
Request for an Incidental Harassment Authorization Parallel Thimble Shoal Tunnel Project Virginia Beach, Virginia

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CONTENTS

1. Description of Specified Activity	1
1.1 Introduction	1
1.2 Purpose and Need	5
1.3 Project Description	5
2. Dates and Duration, Specified Geographic Region	12
2.1 Dates and Duration	12
2.2 Specified Geographic Region	14
3. Species and Numbers of Marine Mammals in the Project Area	15
4. Affected Species Status and Distribution	16
4.1 Fin Whale (<i>Balaenoptera physalus</i>)	16
4.1.1 Distribution and Status	16
4.1.2 Presence in the Project Area	16
4.1.3 Life History	16
4.1.4 Acoustics	17
4.2 Humpback Whale (<i>Megaptera novaeangliae</i>)	17
4.2.1 Distribution and Status	17
4.2.2 Presence in the Project Area	17
4.2.3 Life History	18
4.2.4 Acoustics	19
4.3 North Atlantic Right Whale (<i>Eubalaena glacialis</i>)	19
4.3.1 Distribution and Status	19
4.3.2 Presence in the Project Area	20
4.3.3 Life History	20
4.3.4 Acoustics	21
4.4 Bottlenose Dolphin (<i>Tursiops</i> spp.)	21
4.4.1 Distribution and Status	21
4.4.2 Presence in the Project Area	22
4.4.3 Life History	22
4.4.4 Acoustics	22
4.5 Harbor Porpoise (<i>Phocoena phocoena</i>)	22
4.5.1 Distribution and Status	22
4.5.2 Presence in the Project Area	23
4.5.3 Life History	23
4.5.4 Acoustics	23
4.6 Harbor Seal (<i>Phoca vitulina</i>)	23
4.6.1 Distribution and Status	23
4.6.2 Presence in the Project Area	24

4.6.3	Life History	24
4.6.4	Acoustics	24
4.7	Gray Seal (<i>Halichoerus grypus</i>).....	24
4.7.1	Distribution and Status.....	24
4.7.2	Presence in the Project Area	25
4.7.3	Life History	25
4.7.4	Acoustics.....	25
5.	Type of Incidental Taking Authorization Requested	26
6.	Take Estimates for Marine Mammals	27
6.1	NOAA Fisheries Service Acoustic Criteria	27
6.2	Estimated Extent of Activity	28
6.2.1	Calculation of Disturbance ZOIs for In-water Noise.....	30
6.2.1.1	Level A	30
6.2.1.2	Level B (In-Water)	32
6.2.2	Calculation of Disturbance ZOIs for Airborne Noise.....	34
6.3	Estimated Incidental Takes	34
6.3.1	Fin Whale.....	34
6.3.2	Humpback Whale.....	34
6.3.3	North Atlantic Right Whale	35
6.3.4	Bottlenose Dolphin	35
6.3.5	Harbor Porpoise	36
6.3.6	Harbor Seal	36
6.3.7	Gray Seal.....	36
6.4	All Marine Mammal Takes	37
7.	Anticipated Impact of the Activity	37
7.1	Potential Effects of Pile Driving on Marine Mammals.....	38
7.2	Potential Effects of Vessel Interactions on Marine Mammals.....	39
7.3	Habitat Modification	40
7.4	Turbidity and Water Quality Impacts.....	41
7.5	Impacts to Prey.....	43
7.6	Conclusions Regarding Impacts to Species or Stocks	43
8.	Anticipated Impacts on Subsistence Uses.....	45
9.	Mitigation Measures	46
9.1	General Construction Mitigation.....	46
9.2	Monitoring and Shutdown of Disturbance Zones	49
9.3	Marine Mammal Observation and Protection	49
10.	Arctic Subsistence Plan of Cooperation	50
11.	Monitoring and Reporting	51
11.1	Monitoring Plan.....	51

11.2	Reporting	51
12.	Suggested Means of Coordination.....	52
13.	References.....	53

Appendix A – Model Screenshots

Appendix B – Marine Mammal Monitoring Plan

LIST OF FIGURES

- Figure 1 Project Location Map Chesapeake Bay Bridge and Tunnel District Thimble Shoal Parallel Tunnel
- Figure 2 Portal Island No. 1 Permit Level Design Impact Area Plan
- Figure 3 Portal Island No. 2 Permit Level Design Impact Area Plan
- Figure 4 Little Creek Location Map
- Figure 5 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 1 – 1, 2, or 3 Piles per Day
- Figure 6 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 1 – 6 or 8 Piles per Day
- Figure 7 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 2 – 1, 2, or 3 Piles per Day
- Figure 8 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 2 – 6 or 8 Piles per Day
- Figure 9 Distance (meters) to Shutdown Zone using an Impact Hammer for Simultaneous Pile Driving of Piles at Portal Island Nos. 1 and 2 – 1, 2, or 3 Piles per Day
- Figure 10 Distance (meters) to Shutdown Zone using an Impact Hammer for Simultaneous Pile Driving of Piles at Portal Island Nos. 1 and 2 – 6 or 8 Piles per Day
- Figure 11 Distance (meters) to Level B Threshold using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 1
- Figure 12 Distance (meters) to Level B Threshold using an Impact Hammer for Non-Simultaneous Pile Driving at Portal Island No. 2
- Figure 13 Distance (meters) to Level B Threshold using an Impact Hammer for Simultaneous Pile Driving of Plumb Piles at Portal Island Nos. 1 and 2
- Figure 14 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving of Plumb Piles for Berm Construction at Portal Island No. 1 – 1, 2, or 3 Piles per Day
- Figure 15 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving of Plumb Piles for Berm Construction at Portal Island No. 1 – 6 or 8 Piles per Day

- Figure 16 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving of Plumb Piles for Berm Construction at Portal Island No. 2 – 1, 2, or 3 Piles per Day
- Figure 17 Distance (meters) to Shutdown Zone using an Impact Hammer for Non-Simultaneous Pile Driving of Plumb Piles for Berm Construction at Portal Island No. 2 – 6 or 8 Piles per Day
- Figure 18 Distance (meters) to Shutdown Zone Using a Vibratory Hammer for Non-Simultaneous Pile Driving for the Berm Construction Trestle at Portal Island No. 1
- Figure 19 Distance (meters) to Shutdown Zone Using a Vibratory Hammer for Non-Simultaneous Pile Driving for Berm Construction Trestle at Portal Island No. 2
- Figure 20 Distance (meters) to Shutdown Zone Using Simultaneous Impact Plumb Pile Driving on the Berm Construction Trestle of Portal Island Nos. 1 and 2 – 1, 2, or 3 Piles Per Day
- Figure 21 Distance (meters) to Shutdown Zone Using Simultaneous Impact Plumb Pile Driving on the Berm Construction Trestle of Portal Island Nos. 1 and 2 – 6 or 8 Piles Per Day
- Figure 22 Distance (meters) to Shutdown Zone for Simultaneous Pile Driving for Berm Construction using an Impact Hammer at Portal Island No. 1 and a Vibratory Pile Driving at Portal Island No. 2 – 1, 2, or 3 Piles Per Day
- Figure 23 Distance (meters) to Shutdown Zone for Simultaneous Pile Driving for Berm Construction using an Impact Hammer at Portal Island No. 1 and a Vibratory Pile Driving at Portal Island No. 2 – 6 or 8 Piles Per Day
- Figure 24 Distance (meters) to Shutdown Zone for Simultaneous Pile Driving for Berm Construction using an Impact Hammer at Portal Island No. 2 and Vibratory Pile Driving at Portal Island No. 1 – 1, 2, or 3 Piles Per Day
- Figure 25 Distance (meters) to Shutdown Zone Threshold for Simultaneous Pile Driving for Berm Construction using an Impact Hammer at Portal Island No. 2 and Vibratory Pile Driving at Portal Island No. 1 – 6 or 8 Piles Per Day
- Figure 26 Distance (meters) to Level B Threshold Using an Impact Hammer for Non-Simultaneous Plumb Pile Driving for the Berm Construction Trestle at Portal Island No. 1
- Figure 27 Distance (meters) to Level B Threshold Using an Impact Hammer for Non-Simultaneous Plumb Pile Driving for the Berm Construction Trestle at Portal Island No. 2
- Figure 28 Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous Sheet Pile Driving for the Berm Construction Trestle at Portal Island No. 1

- Figure 29 Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous Pile Driving on Berm Construction at Portal Island No. 2
- Figure 30 Distance (meters) to Level B Threshold Using Simultaneous Impact Plumb Pile Driving on the Berm Construction Trestle of Portal Island Nos. 1 and 2
- Figure 31 Distance (meters) to Level B Threshold for Simultaneous Pile Driving for Berm Construction using an Impact Hammer at Portal Island No. 1 and a Vibratory Pile Driving at Portal Island No. 2
- Figure 32 Distance (meters) to Level B Threshold for Simultaneous Pile Driving for Berm Construction using an Impact Plumb Pile Driving at Portal Island No. 2 and Vibratory Sheet Pile Driving at Portal Island No. 1
- Figure 33 Radial Distances to Level B Threshold (Airborne) from Plumb Piles Driven with Impact Hammer for the Temporary Trestle on Portal Island No. 1
- Figure 34 Radial Distances to Level B Threshold (Airborne) from Plumb Piles Driven with Impact Hammer for the Temporary Trestle on Portal Island No. 2
- Figure 35 Radial Distances to Level B Threshold (Airborne) for Vibratory Sheet Pile for the installation of the Muck Bin at Portal Island No.1

LIST OF TABLES

Table 1	Anticipated Pile Installation Schedule
Table 2	Marine Mammal Species Potentially within the Project Area
Table 3	Summary of Marine Mammals and Action During Project Activity
Table 4	Level A Harassment Thresholds for Marine Mammals that May Occur in the Project Area
Table 5	Level B Harassment Thresholds
Table 6	The sound levels (dB Peak, dB RMS, and dB sSEL) expected to be generated by each hammer type/mitigation measure at the PTST Project
Table 7	Radial Distance (meters) from Pile Driven to <u>Level A</u> Sound Thresholds for Cetaceans and Pinnipeds
Table 8	Radial distance (meters) from pile driven to <u>Level B</u> sound thresholds for Cetaceans and Pinnipeds
Table 9	Radial distance (meters) from pile driven above MHW to PTS sound thresholds for Harbor Seals and Gray Seals
Table 10	Densities of Bottlenose Dolphin from Inshore Areas of Virginia
Table 11	Summary of Information to Calculate Bottlenose Dolphin Takes
Table 12	Calculation for the number of harbor seal takes
Table 13	Calculation for the number of gray seal takes
Table 14	Number of Level B takes requested per species

ACRONYMS AND ABBREVIATIONS

ACBM	Articulated concrete block mattress
CBBT	Chesapeake Bay Bridge-Tunnel
CTJV	Chesapeake Tunnel Joint Venture
cy	cubic yards
dB	decibel
dB re 1 μ Pa ² sec	decibels reference level 1 micropascal squared per second
District	Chesapeake Bay Bridge and Tunnel District
DQM	National Dredging Quality Management System
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FE	Federally Endangered
FR	Federal Register
ft	foot/feet
GARFO	Greater Atlantic Regional Fisheries Office
hr	Hour(s)
HRSD	Hampton Roads Sanitation District
Hz	Hertz
IHA	Incidental Harassment Authorization
IWC	International Whaling Commission
JGR	Jet grout residuals
kHz	Kilohertz
km ²	square kilometer
MHW	Mean High Water
mg/L	Milligram(s) per liter
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MMMP	Marine Mammal Monitoring Plan
MMPA	Marine Mammal Protection Act
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	NOAA National Marine Fisheries Service
NODS	Norfolk Ocean Disposal Site
PTS	Permanent Threshold Shift

PTST	Parallel Thimble Shoal Tunnel
RMS SPL	Root mean squared sound pressure level
SE	State Endangered
SEL _{CUM}	Cumulative sound exposure level
SPL _{PEAK}	Peak sound pressure level
sq ft	Square foot (feet)
TBM	Tunnel boring machine
TSS	Total suspended sediment
USACE	U.S. Army Corps of Engineers
VDEQ	Virginia Department of Environmental Quality
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollution Discharge Elimination System
ZOI	Zone of Impact

1. DESCRIPTION OF SPECIFIED ACTIVITY

1.1 INTRODUCTION

The Chesapeake Tunnel Joint Venture (CT JV) is submitting this Incidental Harassment Authorization (IHA) application for the proposed Parallel Thimble Shoal Tunnel Project (the PTST Project). The Chesapeake Bay Bridge and Tunnel District, (the District), is the PTST Project owner, and the Federal Highway Administration is the lead federal sponsor for the PTST Project. The PTST Project will be part of the Lucius J. Kellam, Jr. Bridge Tunnel; a 23-mile-long facility that connects the Hampton Roads area of Virginia to the Eastern Shore of Virginia. The PTST Project is proposed for construction between Portal Island No. 1 and No. 2 and will be bored underneath the Thimble Shoal Channel in the lower Chesapeake Bay.

The District plans to construct a two-lane parallel tunnel to the west of the existing Thimble Shoal Tunnel, connecting Portal Island Nos. 1 and 2. In-water pile driving to create vessel moorings, temporary work trestles and a temporary dock is expected to be part of the construction process. Pile driving activities for the PTST Project have the potential to cause sound levels that exceed Level A and Level B acoustic harassment thresholds for marine mammals as defined by the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries) Office of Protected Resources (NOAA Fisheries 2016h).

The proposed project will occur in areas of the lower Chesapeake Bay that overlap with the range of several marine mammal species. Marine mammals are protected under the Marine Mammal Protection Act (MMPA) of 1972. The MMPA prohibits the incidental take (i.e., to “harass, hunt, capture or kill, or attempt to harass, hunt, capture or kill”) of marine mammals. An IHA may be granted under 101(a)(5)(D) of the MMPA, which can allow for a set number of takes per species of marine mammal during project activities provided there is negligible impact to the marine mammal species.

This IHA application follows the new guidance provided by NOAA in August 2016. The new guidance acknowledges that variation exists among mammal groups in their sensitivity to sound and incorporates the hearing range of marine mammal groups in the development of group-specific acoustic thresholds. The updated guidance provides updated sound thresholds for Level A harassment, and a methodology for calculating the distance from the activity that these sound thresholds are expected to be exceeded. Separate acoustic thresholds are given for impulsive activities (e.g., pile driving with an impact hammer) and non-impulsive sounds (e.g., pile driving with a vibratory hammer). For impulsive sound, thresholds are presented as the dual metrics of cumulative sound exposure level (SEL_{CUM}) and peak sound pressure level (SPL_{PEAK}); for non-impulsive sound; thresholds are presented at SEL_{CUM} . The NOAA Fisheries 2016 guidance does not address Level B harassment thresholds. The previous guidance (NOAA Fisheries 2015a) was used for Level B harassment.

This IHA application, submitted by the CT JV, requests takes for four species of marine mammals by Level B harassment: harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), humpback whale (*Megaptera novaeangliae*), and bottlenose dolphin (*Tursiops spp.*). The takes requested are associated with in-water round pile and sheet pile driving, and on-land pile (hollow

steel and sheet pile) driving. Fin whales (*Balaenoptera physalus*), North Atlantic right whales (*Eubalaena glacialis*), and harbor porpoises (*Phocoena phocoena*) are expected to be rare at the PTST Project Area; therefore, no Level A or Level B takes are requested for these species. Pile and sheet pile driving operations will cease if individuals of these species are observed within the Level A or Level B zones of impact (ZOIs).

The PTST Project includes the following components (Figures 2 and 3):

- Construction of a new parallel two-lane tunnel 6,525 feet (ft) in overall total length using a tunnel boring machine (TBM), with 5,356 linear ft located below Mean High Water (MHW).
- Upland activities on the portal islands prior to tunnel boring, including:
 - Utility and power installation beginning at an existing sub-station near Lookout Road to Portal Island No. 1 (for temporary construction TBM requirements and permanent build-out conditions).
 - Demolition and removal of the existing island restaurant and other ancillary/non-essential facilities on Portal Island No. 1.
 - Selected splash wall panel removal, replacement, and/or repair on Portal Island Nos. 1 and 2.
 - Construction of TBM muck bin on Portal Island No. 1 by driving steel sheet pile and excavating sand from the interior.
 - Construction of temporary roadway trestles at both portal islands to accommodate safe construction vehicle movements around the portals.
 - Slurry wall construction and excavation of 90,150 cubic yards (cy) *in situ* (108,175 bulked cy) of on-island material for TBM entry/exit portals, and on-island tunnel approaches on Portal Island Nos. 1 and 2.
 - Jet grouting of 67,204 cy *in situ* (107,526 cy bulked) of on-island material to facilitate excavation of the entry/exit portals and tunnel approaches on Portal Island Nos. 1 and 2.
 - Set-up of temporary laydown areas, stormwater/erosion control management, process water management, excavation material management system (decanting bins), and cooling and TBM water management features.
 - Onsite assembly of the TBM within the launch/entry portal on Portal Island No. 1.
 - Construction of a temporary conveyor system on Portal Island No. 1 to facilitate removal of the excavated tunnel material.

- Upland activities at Little Creek and the South Toll Plaza, including:
 - Installation of a new substation at the South Toll Plaza, and power cable installation from the substation to Portal Island No. 1.
 - Flow meter installation at the South Toll Plaza for metering water usage and discharges to Hampton Roads Sanitation District (HRSD).
 - Upgrades to the rail yard and adjacent area at Little Creek for receiving and stockpiling armor, bedding, and filter stone for the engineered berms.
- In-water activities prior to tunnel boring, including:
 - Construction of a 32,115 square-foot (sq ft) temporary dock and construction roadway trestle on the west side of Portal Island No. 1 (located within a designated docking area), including 58 in-water, 36-inch diameter hollow steel piles. Within this total area, the conveyor dock will occupy an area of 3,650 sq ft, and the temporary dock for receiving TBM components will occupy the remaining area (28,465 sq ft).
 - Installation of 6 breasting dolphins, consisting of 5 round piles each, and up to 24 anchor blocks or delta anchors adjacent to the west and east sides of Portal Island Nos. 1 and 2 for moorings to accommodate construction-related vessels.
 - Installation of 6 piezometers off-set from the tunnel alignment. To allow for instrument placement, a perforated steel pipe (<12 inches in diameter) will be installed to a depth up to 100 ft below the sediment surface. A cable with a signal transmitter will be placed on the sediment surface to record measurements. These instruments will be abandoned in-place following completion of the tunnel construction activities.
 - Removal and temporary stockpiling of approximately 10,000 cy (16,000 tons) of armor stones adjacent to each portal island within either the designated adjacent subaqueous armor stone temporary storage areas or upland storage at Little Creek.
 - Removal and temporary stockpiling of approximately 17,000 cy (30,000 tons) of Quarry Rock ($W_{50}=1000$ pounds) of up to 1 ton each below the armor stone layer, adjacent to each portal island within either the designated adjacent subaqueous armor stone temporary storage areas or at Little Creek.
 - Construction of two temporary work trestles each installed on 36-inch diameter round piles offset to the west side of each engineered berm; extending approximately 841 ft and 809 ft channelward from Portal Island Nos. 1 and 2, respectively.
 - Construction of two engineered berms located predominantly under water, approximately 1,300 ft in length for Portal Island No. 1 and approximately 1,400 ft in length for Portal Island No. 2. Both berms will extend channelward

from each portal island. Construction methods will include: temporary work trestle as described above; sheet pile installation; installation of horizontal and vertical inclinometers and multi-point borehole extensometers, placement of engineered and/or flowable fill; and placement of exterior bedding stone, filter stone, and armor stone.

- Mechanical dredging of 48,352 cy *in situ* (or 77,363 cy bulked) of unsuitable materials from an area of 151,456 sq ft (3.48 acres) prior to placement of stone for the engineered berm at Portal Island No. 1. Of this total volume, 29,246 cy (46,794 cy bulked) are suitable for barge transport and placement of the dredged material at the Norfolk Ocean Disposal Site (NODS), and 19,106 cy (30,570 cy bulked) will be disposed at an approved upland location. Of the total dredging volume, 42,197 cy *in situ* (or 67,515 cy bulked) is located within the berm footprint, and 6,155 cy *in situ* (or 9,848 cy bulked) is located outside the berm footprint.
- Jet grouting operations beneath the engineered berm at Portal Island No. 2 to stabilize unsuitable subsurface foundation material. Jet grout residuals (JGR) will be dewatered in a contained system with disposal of 26,660 cy *in situ* or 42,656 cy (bulked) of JGR at an approved offsite location.
- Installation of steel sheet pile on both sides of the new tunnel alignment for settlement mitigation and to facilitate flowable fill placement extending approximately 350 ft and 355 ft channelward from the MHW line on Portal Island Nos. 1 and 2, respectively.
- Onsite management and transport for disposal of approximately 524,000 cy (bulk volume) of excavated tunnel material at an approved off-site location(s).
- Treatment of decanted water and process water from tunnel boring operations.
- Installation of a TBM cooling water system with 260,000-gallon capacity.
- Discharge of treated decant water and process water to either HRSD or via a permitted Virginia Pollutant Discharge Elimination System (VPDES) discharge location off the east side of Portal Island No. 1. As part of the construction VPDES permit, non-contact TBM cooling water may be periodically discharged via a diffuser on the east side of Portal Island No. 1.
- Trestle deck replacement and potential repairs or modifications to the first three bridge trestle spans and abutments at Portal Island Nos. 1 and No. 2. Bridge trestle pilings along the three trestle spans will also be repaired (e.g., piling jackets), as necessary.
- Completion of the new tunnel roadway structures/connections/resurfacing between Portal Island Nos. 1 and No. 2.

- Construction of new buildings/structures/paved facilities associated with permanent stormwater and facilities management on the portal islands.
- Installation of new security fencing, parking areas, and adjacent bollards.
- Replacement of the existing fishing pier superstructures at Portal Island No. 1, and potential substructure repair in-place (of deteriorated pilings), if any.

1.2 PURPOSE AND NEED

The purpose and need of the PTST Project is to:

- Address existing constraints to regional mobility based on current traffic volume along the Chesapeake Bay Bridge-Tunnel (CBBT) facility.
- Improve safety by minimizing one lane, two-way traffic in the tunnel.
- Improve the ability to conduct necessary maintenance with minimal impact to traffic flow.
- Ensure a reliable southwest hurricane evacuation route for residents of the eastern shore and/or a northern evacuation route for residents of the eastern shore, Norfolk, and Virginia Beach.
- Design and construct the Project to improve mobility with sufficient capacity to accommodate anticipated increases in traffic volumes, minimize lane closures due to oversized loads and ordinary maintenances, support economic vitality between the Eastern Shore and the rest of the Commonwealth, and enhance corridor safety over the 100-year projected life expectancy of the proposed structures.

1.3 PROJECT DESCRIPTION

The PTST Project consists of the construction of a two-lane parallel tunnel to the west of the existing Thimble Shoal Tunnel, connecting Portal Island Nos. 1 and 2 (Figure 1). Upon completion, the new tunnel will carry two lanes of southbound traffic and the existing tunnel will remain in operation and carry two lanes of northbound traffic. The new parallel tunnel will be bored under the Thimble Shoal Channel. The 6,525 linear ft of new tunnel will be constructed with a top of tunnel depth/elevation of 100 ft below Mean Low Water (MLW) within the width of the 1,000-ft-wide navigation channel.

Construction of the tunnel structure will begin on Portal Island No. 1 and move from south to north to Portal Island No. 2. It is anticipated that this project will be constructed without any or minimal effect on the existing tunnel and traffic operations. The only short-term possibility for traffic impact could occur when connecting the existing roadway to the new roadway.

The TBM components will be barged and trucked to Portal Island No. 1. The TBM will be assembled within an entry/launch portal that will be constructed on Portal Island No. 1. The

machine will then both excavate material and construct the tunnel as it progresses from Portal Island No. 1 to Portal Island No. 2. Material excavated from within the tunnel will be transported via a conveyor belt system back to Portal Island No 1. Approximately 350,000 cy (*in situ* volume) of material will be excavated by the TBM and 524,000 cy (bulk volume) will be conveyed to Portal Island No. 1. This material will be transported offsite using a combination of trucks and barges and will be disposed at an approved off-site, upland facility in accordance with the Dredged Material Management Plan.

Precast concrete tunnel segments will be transported to the TBM for installation. The TBM will assemble the tunnel segments in-place as the tunnel is bored. After the TBM reaches Portal Island No. 2, it will be disassembled and the components will be removed via an exit/receiving portal on Portal Island No. 2. After the tunnel structure is completed, final upland work for the PTST Project will include installation of the final roadway, lighting, finishes, mechanical systems, and other required internal systems for tunnel use and function. In addition, the existing fishing pier will be repaired and refurbished.

In-Water Construction Activities. In-water activities for the tunnel construction will be limited to eight primary actions:

- 1) Construction and use of temporary dock, an integrated temporary conveyor dock, and mooring facilities.
- 2) Construction of temporary roadway trestles requiring a limited number of in-water piles and partially extending over water to facilitate safe construction vehicle movements on each portal island. For Portal Island No. 1, the temporary docking will integrate the roadway trestle in the same structure.
- 3) Construction of temporary work trestles approximately 850 ft long and 35 ft wide each, and offset west of the tunnel alignment to facilitate construction of the berms.
- 4) Temporary subaqueous stockpiling of existing armor stones for re-use.
- 5) Construction of two permanent engineered berms (one extending channelward from each of the two portal islands) including installation of steel sheet pile to provide settlement mitigation between the existing tunnel and the new tunnel, handling of existing stone, adding new stone, and limited mechanical dredging at Portal Island No. 1.
- 6) Underground (below the sediment-water interface) tunnel boring.
- 7) Repair/rehabilitation to the existing fishing pier substructure and trestle substructure (only if deemed necessary based on inspection).
- 8) Construction and use of outfalls on the east side of Portal Island No. 1 to allow for permitted process water discharges from a project-specific wastewater treatment facility, and periodic, intermittent warm water discharges of non-contact cooling water from an on-site cooling system.

All other construction activities will be conducted either on the portal islands, at Little Creek or the South Toll Plaza, within the installed tunnel structure, within the existing roadway and trestle spans, or at approved offsite disposal locations. Approximately 7 acres of upland area on the existing portal islands will be disturbed during construction. The portal islands are man-made and completely impermeably paved. Erosion and sediment control will be in place during construction. A wastewater treatment plant will be used for process water, and a cooling system will be installed for providing non-contact cooling water to the TBM cutting head.

Of the approximately 35 acres of upland area at Little Creek, approximately 10 acres will be used for construction staging, rail access, and stone stockpiling at Little Creek. Additionally, the piers and waterfront railhead will be utilized without alteration. These uses are compatible with the existing uses by the District and its tenants at this site.

The total temporary in-water impact footprint, exclusive of the permanent impact, is 2.16 acres. At Portal Island No. 1, a temporary dock / unloading facility 28,465 sq ft (including the temporary construction roadway trestle) will be constructed on the west side of the island and will be used by barges and vessels delivering construction equipment and bulk materials. A temporary conveyor dock 75 ft by 48 ft (3,650 sq ft) will be integrated into the southern portion of the temporary dock to facilitate loading and offsite transport of excavated tunnel material by barge.

It is estimated that vessels and barges ranging in size from 20 to 500 ft will deliver the necessary equipment and construction materials to the PTST Project site over the 60-month construction period. The majority of the barging/vessel traffic is expected to occur during the first 27 months of construction. During the busiest construction period, there may be up to six construction-related vessels moored along each engineered berm at any particular time. Equipment and materials required for the PTST Project will also be transported onto the portal islands via trucks throughout the construction period.

Up to 132 hollow steel piles measuring 36 inches in diameter will be installed to support the integrated temporary dock/barge unloading/conveyor facility and temporary conveyor dock at Portal Island No. 1. Of these, 82 will be placed in-water and 50 will be placed upland (above the MHW line). Up to 30 hollow steel piles (36-inch diameter) will be installed to provide mooring facilities along each portal island (6 dolphin moorings comprised of 5 piles each).

Up to 160 hollow steel piles (36-inch in diameter, below MHW) will be installed to support temporary work platforms (trestles) offset to the west of each of the two engineered berms. These trestles will extend 841 ft and 809 ft channelward from Portal Island Nos. 1 and 2, respectively.

Up to 12 round piles will be installed on the island above MHW to support a temporary roadway trestle at Portal Island No. 2. Installation for the temporary docks and mooring dolphins will occur over approximately 2 months; commencing in April 2018 as shown in Table 1. Installation of the temporary offset construction trestles will occur over approximately 5 months. In-water pile driving activities will also include installation of sheet pile for settlement mitigation and as an in-water containment system to facilitate construction of the engineered berms adjacent to Portal Island Nos. 1 and 2. A total of 1,540 linear ft of sheet pile (or 830 individual sheets

each 27.56 inches in length) will be installed over approximately 8 months. There will also be driving of landside sheet pile on Portal Island No. 1 to construct the holding bins (muck bin) for excavated tunnel material.

All pile driving activity will be completed within 1 year of initiation of driving activities.

Table 1. Anticipated Pile Installation Schedule

Pile Location	Pile Function	Pile Type	Number of Piles (Upland / In-water)	Anticipated Installation Date
Portal Island Nos. 1 and 2	Mooring dolphins	36-inch diameter hollow steel	30	1 June to 30 June 2018
West of Portal Island No. 1	Berm construction trestle (in-water)	36-inch diameter hollow steel	80	1 July 2018 through 1 January 2019
West of Portal Island No. 2	Berm construction trestle (in-water)	36-inch diameter hollow steel	80	1 July 2018 through 1 January 2019
Portal Island No. 1	Temporary docks (upland)	36-inch diameter hollow steel	50	1 May 2018 through 30 June 2018
Portal Island No. 1	Temporary docks (in-water)	36-inch diameter hollow steel	82	1 July 2018 to 30 August 2018
Portal Island No. 2 (above MHW)	Temporary roadway trestle (upland)	36-inch diameter hollow steel	12	1 May to 31 May 2018
Portal Island No. 1 (above MHW)	Excavated TBM material containment holding (muck) bin (upland)	28 and 18-inch steel sheet	1,110	1 May 2018 to 30 September 2018
Portal Island Nos. 1 and 2 (above and below MHW)	Settlement mitigation and flowable fill containment	28-inch steel sheet	2,554	1 August 2018 to 30 March 2019
Portal Island Nos. 1 and 2 (above MHW)	Portal excavation	Steel sheet	1,401	1 June 2018 to 30 September 2018, 1 January to 30 March 2019
Portal Island Nos. 1 and 2 (above MHW)	Excavation Support	Steel sheet	240	1 April 2018 to 30 August 2019 to 1 January 2019 to 30 March 2019
Total (above and below water)			5,305 Sheet Piles 334 Round Piles	

Prior to initiation of the boring of the tunnel, construction of two engineered in-water berms will be required to provide structural support to the launch/receiving sections of the tunnel that are in

closest proximity to the portal islands. Each engineered berm (at its maximum design configuration) will extend from the portal island channelward and will be approximately 1,400 ft long by 260 ft wide (at its widest point). The total impact area of both berms is 12.03 acres (6.14 acres at Portal Island No. 1 and 5.84 acres at Portal Island No. 2), of this 11.65 acres is below the MHW line. Final water depths over the berms will extend from 0 ft to -60 ft MLW. The berms will be constructed using a 2:1 slope except for the scour protection toe. The maximum footprint of the new berms will permanently impact 11.65 acres of subaqueous bottom (6.03 acres of engineered berm adjacent to Portal Island No. 1 and 5.62 acres of engineered berm adjacent to Portal Island No. 2). There will also be an additional 0.03 acres of permanent impact of subaqueous bottom associated with the repairs to the bridge trestles and fishing pier supports. Of the 11.68 acres of permanent bottom impact, a total of 1.50 acres will be habitat loss (conversion of subaqueous bottom to elevation greater than MHW or fill with bridge trestle fishing pier supports), and 10.18 acres will be conversion of habitat below MLW by change in water depth and/or bottom substrate composition. The habitat conversion includes 8.27 acres of sandy habitat converted to rock/reef habitat, and 1.91 acres of rock/reef habitat remaining as rock/reef.

Construction of the engineered berms will require:

- Installation of temporary trestles offset to the west of each berm alignment to serve as work platforms. The trestles will be supported by 36-inch diameter round steel piles driven by impact hammer (with encased bubble curtain).
- Mechanical dredging of 77,363 cy (bulked) to remove unsuitable berm foundation material (Portal Island No. 1 only) and disposal of dredged material at either NODS via bottom-dump, or upland placement at an approved site.
- Removal/replacement of up to 10,000 cy of existing berm stone and 17,000 cy of quarry rock adjacent to each portal island to enable installation of sheet pile sections.
- Use of Articulated Concrete Block Mattresses (ACBMs) to provide temporary slope protection of the existing tunnel berm during rock removal operations. The ACBMs will be removed prior to addition of new stone.
- Installation of parallel rows of sheet pile (using vibratory hammer) approximately 530 linear ft in length by 60 ft in width channelward from MHW along the berm alignment at both Portal Islands.
- Placement of sand, rock, and other engineered fill.
- Placement of flowable fill material (cementitious mix) via tremie pipes within enclosed containment cells (formwork) or large, low permeability geotextile bags.
- Final placement of external bedding, filter stone, and armor stone over the top and side slopes to protect the berm structures.

At Portal Island No. 2, jet grout activities will be required to stabilize *in situ* organic sediment materials at depth (below the Bay bottom) as a foundation. Wet jet grout material (known as

JGR or soil cement) will be collected at the island, from where the activities will be completed. The jet grouting operations will be conducted using an inclined directional drill to reach the area to be treated/stabilized from the portal island. The JGR will be a cementitious slurry including unsuitable subsurface material (primarily organic sandy material). JGR will be contained in lined cells on each portal island, decanted, and transported offsite via either truck or barge to an approved offsite upland disposal facility. For both engineered berms, material removed via mechanical dredging and jet grouting (JGR) will be managed, processed, and disposed at an approved location as per the Dredged Material Management Plan.

The existing fishing pier will be temporarily closed during construction activities. Following completion of the tunnel construction, the decking of the fishing pier will be replaced, pilings will be repaired in place (if needed based on substructure inspection), and new lighting will be installed.

Prior to tunnel excavation, installation of up to six vibrating wire piezometers (less than 12 inches in diameter) off-set from the tunnel alignment will be required to measure static pressure.

Upland Construction on Portal Islands and Other Construction Support Activities. Neither portal island will be expanded in size as a result of the PTST Project. To maximize usable staging area on Portal Island No. 1, the existing restaurant and gift shop owned by the District has been permanently removed. Certain sections of the existing splash wall will be refurbished around the perimeters of Portal Island Nos. 1 and 2 to support construction activities and staging. The splash wall repair/replacement activities will occur above MLW on the existing portal islands. Approximately 7 acres of upland area will be disturbed during construction. The portal islands are man-made and completely impermeably paved.

Stormwater during construction will be managed in accordance with a construction general permit, which requires a 20 percent reduction of total phosphorous below the predevelopment load. Off-site mitigation credits have been purchased from a nutrient bank to allow for a reduction of 5.11 pounds of total phosphorus. The Project has received a General VPDES Permit for Discharges of Stormwater from Construction Activities, which allows the discharge of stormwater to surface waters from Portal Island Nos. 1 and 2.

Initial construction activities on the portal islands will include slurry wall installation to support excavation of a 100-ft deep entry/launch portal (Portal Island No. 1) and an exit/receiving portal (Portal Island No. 2) for the TBM, and for construction of the on-island tunnel roadway approach structures. On each portal island, slurry walls with dimensions of 500 linear ft in length by 5 linear ft in width by 100 ft in depth will be trenched and poured. The pits for each launch and receiving portal will be approximately 82 ft long, 55 ft wide, and 100 ft deep. The material to be excavated from the pits and approaches (approximately 121,000 cy bulked) has been tested for contaminants and geotechnical parameters. Jet grouting of 36,285 cy (*in situ*) of material under Portal Island No. 1, and 30,919 cy (*in situ*) of material under Portal Island No. 2 will be conducted to support the launch/receiving portals and tunnel approach structures. JGR will be treated for high pH, dewatered onsite, and disposed of at an approved offsite upland location. The jet grouting of approximately 26,600 cy (*in situ*) of organic material will be required to stabilize subsurface sediments adjacent to Portal Island No. 2.

The following non-stormwater discharges may occur during construction: fire hydrant flushings; vehicle, equipment and concrete wash water; control dust water; potable water; building wash; pavement wash; condensate; ground water; foundation flows; and/or excavation dewatering. Surface discharges will consist of the dewatering of trenches and excavations that have been filtered, settled, or similarly treated prior to discharge.

In the first phase of construction, process waters will be collected and then pumped to HRSD for further treatment and discharge consistent with their existing operations. Prior to tunnel boring activities, a package wastewater treatment plant will be constructed on Portal Island No. 1 to treat all process waters (decant water from tunnel boring operation, equipment cleaning, etc.); that treated process water will be discharged to either HRSD, or directly under a Project-specific individual VPDES permit issued by the Virginia Department of Environmental Quality (VDEQ). Discharge of “process waters” to the HRSD will be via the existing 4-inch line from Portal Island No. 1. These wastewaters will be pre-treated on the portal islands, and will then be further treated by HRSD before discharge in conformance with HRSD’s existing operational procedures.

Other construction-related activities on the portal islands are expected to include development or installation of: 1) a package wastewater treatment plant on Portal Island No. 1 (including discharge points) to treat process water, 2) water tanks to support TBM operations, 3) a closed-loop (and on-site cooling tower) to circulate cooling water for the TBM, 4) temporary equipment/material laydown areas, and 5) erosion and sediment control and stormwater management facilities on both portal islands. Upland activities on the portal islands will be conducted in accordance with an approved project-specific Environmental Management Plan, Erosion and Sediment Control Plan, Construction Stormwater Discharge General Permit, a Virginia Pollution Discharge Elimination System permit, a Stormwater Pollution Prevention Plan, and other applicable permits.

In addition to material laydown areas on Portal Island Nos. 1 and 2, construction-related materials may also be stored temporarily on Portal Island No. 3. It is anticipated that storage on Portal Island No. 1 will include daily materials. Storage on Portal Island No. 2 will include weekly materials, and storage on Portal Island No. 3 will include monthly materials, such as rebar cages. No changes or improvements to Portal Island No. 3 are planned to accommodate the temporary material storage, and all transport of materials to and from Portal Island No. 3 will occur via roadway (no marine access is planned). To supplement portal island laydown and storage areas, an existing commercial staging area at Little Creek will also be used (Figure 4). This facility is owned and operated by the District and provides an existing marine berth to facilitate vessel docking, loading, and offloading of construction materials, if and as needed. No waterside improvements are required or anticipated for this facility. Rail access and stockpiling of armor, filter, and bedding stone is anticipated at this location, and is consistent with current uses at this site. Minor landside modifications are anticipated to facilitate offloading of stone from rail cars at the site. A supplemental Erosion and Sediment Control Plan, and Stormwater Pollution Prevention Plan associated with these activities are being prepared for submittal to VDEQ along with a modified VDEQ Registration Statement reflecting the expanded Project Area and acreage of land disturbance.

Installation of power to Portal Island No. 1 will be required prior to initiation of tunnel boring operations. The utility corridor for the upgraded power will be installed from and onto the

existing Trestle A, South Bound (ASB trestle) to/from Portal Island No. 1 and will not require in-water activities. Construction of a new electrical substation adjacent to the existing substation at the South Toll Plaza is also proposed for additional future permanent power requirements. The existing substation will be demolished and right-of-way acquisition is not anticipated. A supplemental Erosion and Sediment Control Plan associated with these activities has been submitted to VDEQ along with a modified VDEQ Registration Statement reflecting the expanded project area and acreage of land disturbance.

2. DATES AND DURATION, SPECIFIED GEOGRAPHIC REGION

2.1 DATES AND DURATION

The PTST Project construction activities are divided into four primary phases. It should be noted that some activities will occur simultaneously. See also Table 1 for the anticipated pile driving schedule.

- Phase I (on-island/upland pre-tunnel excavation activities): June 2017 – March 2019
 - Utility and power installation (Portal Island No. 1).
 - Set-up of temporary laydown areas, stormwater/erosion control management, process water management, and excavation material management system (decanting bins).
 - Demolition and removal of the existing island restaurant and other ancillary/non-essential facilities (Portal Island No. 1).
 - Selected splash wall replacement or repair (Portal Island Nos. 1 and 2).
 - Slurry wall construction and excavation for entry/launch and exit/receiving pits and on-island tunnel approaches (Portal Island Nos. 1 and 2).
 - Jet grouting to support construction for entry/launch and exit/receiving pits and tunnel approach construction (Portal Island Nos. 1 and 2).
 - Assembly of the TBM within the launch portal.
 - Construction of water treatment facility (for waters from tunnel excavated TBM material and process waters).
 - Installation of water tanks and cooling system to support TBM operations.
- Phase II (in-water activities to support to tunnel excavation): March 2018 – June 2019
 - Construction of a temporary dock (Portal Island No. 1), an integrated temporary conveyor dock (Portal Island No. 1), and pile installation for temporary moorings (Portal Island Nos. 1 and 2).

- Construction of temporary offset trestles (with driving of in-water piles at both portal islands) to facilitate construction of the engineered berms.
 - Installation of piezometers.
 - Removal of selected existing armor stone from the existing tunnel berm, with stockpiling at Little Creek or at the designated subaqueous stockpile areas. As stated earlier, ACBMs may be used to protect side slopes of the existing tunnel berm.
 - Construction of engineered berms (limited mechanical dredging of unsuitable foundation materials at Portal Island No. 1, sheet pile installation, placement of engineered and flowable fill, and placement of exterior filter stone, bedding stone, and armor stone.
 - Jet grouting to improve subsurface organic layer (Portal Island No. 2)
 - Settlement mitigation (subsurface stabilization using sheet piles) coincident with other sheet pile installation noted earlier.
- Phase III (tunnel excavation and disposal of excavated material): February 2019 – February 2020
 - Tunnel boring activities and placement of pre-cast tunnel sections within the design alignment.
 - Onsite management, transport, and offsite disposal of excavated TBM material at an approved location(s).
- Phase IV (fishing pier rehabilitation/deck repair, roadway trestle and abutment modification/repair, and final upland construction activities on portal islands, roadways, and within tunnel): March 2019 – May 2022
 - Structural modifications to several bridge trestles and bridge abutments (superstructures only), with limited substructure repair (if inspections deem it needed).
 - Completion of the PTST and roadway structures/connection between Portal Island Nos. 1 and 2.
 - Road resurfacing on Portal Island Nos. 1 and 2.
 - Construction of new buildings/structures associated with stormwater and facilities management of the portal islands and final tunnel structures.
 - Installation of new security fencing, installation of parking areas and adjacent bollards.

- Replacement of decking at the fishing pier and limited substructure repair (if inspections deem it needed) at Portal Island No. 1.
- Removal of temporary dock, piles, and moorings.

In-water activities are limited to the duration of Phase II, and the beginning of Phase IV (if substructure repair work is required at the fishing pier and/or bridge trestles and abutments). Management of dredged material, excavated material, and JGR from in-water activities will occur throughout Phase II and Phase III.

2.2 SPECIFIED GEOGRAPHIC REGION

The PTST Project is proposed for construction between Portal Island Nos.1 and 2, and will be bored underneath the Thimble Shoal Channel in the Chesapeake Bay (Figure 1). In Virginia, Waters of the United States, including wetlands, are regulated by USACE. These resources, and remaining State Waters are regulated by VDEQ, and Subaqueous Bottomlands and Tidal Wetlands are regulated by the Virginia Marine Resources Commission (VMRC). Construction activity within the Chesapeake Bay in Virginia is regulated by USACE, VDEQ, and the VMRC. These agencies have jurisdiction under the following regulations:

- Sections 401, 402 and 404 of the Clean Water Act
- Section 10 of the Rivers and Harbors Act of 1899
- The Virginia Water Protection Permit Program Regulation (9 VAC 25-210)
- The Virginia Wetlands Act (Chapter 13, Title 28.2 of the Code of Virginia).

No stream systems are located on the Portal Islands or within the Project's Limit of Disturbance (Figures 2 and 3). There are approximately 370 acres of subaqueous bottomlands (E1UBL) located within the Project's Environmental Study Area; subaqueous bottomlands are also classified as navigable waters and are under USACE jurisdiction. Water depths within the PTST construction area range from -0 to 60 ft below MLW. The Thimble Shoal Channel is 1,000 ft wide, is authorized to a depth of 55 ft below Mean Lower Low Water (MLLW), and is maintained at a depth of 50 ft MLLW.

3. SPECIES AND NUMBERS OF MARINE MAMMALS IN THE PROJECT AREA

Based on correspondence between NOAA Fisheries and Federal Highway Administration and use of the U.S. Fish and Wildlife Service's Information for Planning and Conservation Online System, a list of marine mammals that may be present in the Project Area was developed (Table 2).

Table 2. Marine Mammal Species Potentially within the Project Area

Common Name	Scientific Name	Status*
Fin whale	<i>Balaenoptera physalus</i>	FE/SE
Humpback whale	<i>Megaptera novaeangliae</i>	
North Atlantic right whale	<i>Eubalaena glacialis</i>	FE/SE
Bottlenose Dolphin	<i>Tursiops spp.</i>	
Harbor Porpoise	<i>Phocoena phocoena</i>	
Harbor Seal	<i>Phoca vitulina</i>	
Gray Seal	<i>Halichoerus grypus</i>	

*Federally endangered species (FE); State endangered species (SE), Federally Threatened (FT), State Threatened (ST)

An overview of the distribution and status, presence in the Project Area, and life history for each species is provided in Chapter 4.

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

4.1 FIN WHALE (*BALAENOPTERA PHYSALUS*)

4.1.1 Distribution and Status

Fin whales inhabit a wide range of latitudes between 20 and 75° N and 20 and 75° S (Perry *et al.* 1999). The fin whale is ubiquitous in the North Atlantic and occurs from the Gulf of Mexico and the Mediterranean Sea, northward to the edges of the arctic ice pack (NOAA Fisheries 1998). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. The final 2010 stock assessment for fin whales reported that the minimum population estimates for the fin whale stock in western North Atlantic U.S. waters was 1,618 individuals (NOAA Fisheries 2015d). Fin whales are federally listed as endangered; separate coordination in compliance with the Endangered Species Act (ESA) is ongoing.

4.1.2 Presence in the Project Area

Based on strandings data, fin whales could potentially be present in the Project Area during the winter. There have been 12 fin whale strandings in Virginia since 1988; at least 5 of which had injuries consistent with vessel strikes. Six of the strandings were within the Chesapeake Bay and most of them occurred in the winter (Barco and Swingle 2014). In the past 5 years of reported data (2011-2015), there have been two fin whale strandings in Virginia (Swingle *et al.* 2012, Swingle *et al.* 2013, Swingle *et al.* 2014, Swingle *et al.* 2015, Swingle *et al.* 2016).

4.1.3 Life History

NOAA Fisheries has designated one population of fin whale in U.S. waters of the North Atlantic (Waring *et al.* 1998) which is divided into two subpopulations: *B. physalus physalus* (Northern Atlantic) and *B. physalus quoyi* (Southern Atlantic) (NOAA Fisheries 2017f). Fin whales are commonly found from Cape Hatteras northward. A number of researchers have suggested the existence of fin whale subpopulations in the North Atlantic based on local depletions resulting from commercial overharvesting (Mizroch and York 1984) or genetics data (Bérubé *et al.* 1998). Photo-identification studies in western North Atlantic feeding areas, particularly in Massachusetts Bay, have shown a high rate of annual return by fin whales, both within years and between years (Seipt *et al.* 1990) suggesting some level of site fidelity.

The single most important area for the Western North Atlantic stock appears to be from the Great South Channel, along the 50-meter isobath past Cape Cod, over Stellwagen Bank, and past Cape Ann to Jeffrey's Ledge (Hain *et al.* 1992).

Fin whales are believed to use North Atlantic waters—particularly in the vicinity of New England—primarily for feeding, and more southern waters for calving. However, evidence regarding where the majority of fin whales winter, calve, and mate is still scarce. Clark (1995) reported a general pattern of fin whale movements in the fall from the Labrador/Newfoundland region, south past Bermuda and into the West Indies, but neonate strandings along the U.S. Mid-Atlantic coast from October through January suggest the possibility of an offshore calving

area (Hain et al. 1992). Fin whales are a deep diving (up to 230.1 meters) and fast swimming species (Blaylock 1985). Food resources for fin whales include krill along with squid and forage fish such as herring and capelin (Blaylock 1985).

Human-caused mortality and serious injury records reported by NOAA for the 2009-2013 time period indicate one fin whale mortality off of Norfolk, Virginia in 2012. The individual fin whale had head lacerations and a skull fracture (NOAA Fisheries 2016e). Between 1999 and 2003, no human-caused serious injuries to or mortalities of fin whales were reported in the Chesapeake Bay proper (Cole et al. 2005).

4.1.4 Acoustics

Fin whales have the highest sensitivity to sounds around 20 hertz (Hz), with good sensitivity up to 150 Hz (Erbe 2002). Southall et al. (2007) categorized fin whales in the low-frequency cetacean functional hearing group with an estimated auditory bandwidth of 7 Hz – 22 kilohertz (kHz).

4.2 HUMPBACK WHALE (*MEGAPTERA NOVAEANGLIAE*)

4.2.1 Distribution and Status

Humpback whales inhabit all major ocean basins from the equator to subpolar latitudes. They generally follow a predictable migratory pattern in both hemispheres, feeding during the summer in the higher latitudes (40 to 70 degrees latitude) and migrating to lower latitudes (10 to 30 degrees latitude) where calving and breeding take place in the winter (Perry et al. 1999, NOAA Fisheries 2006a). During the spring, summer, and fall, humpback whales in the North Atlantic Ocean feed over a range that includes the eastern coast of the U.S., the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. Prior to commercial whaling, the global population of humpback whales was thought to be over 125,000. Current estimates for humpback whales in the North Atlantic are around 12,000 animals with a positive trend in population growth (NOAA Fisheries 2016f). The humpback whale is not federally listed under the ESA, but is protected under the MMPA.

4.2.2 Presence in the Project Area

Humpback whales are the whale most likely to occur in the Project Area and could be found there at any time of the year. NOAA reported that between 2009-2013, three humpback whales were stranded in Virginia in the lower Bay (one off of Northampton County, one near the York River, and one off of Ft. Story), and two were stranded in Maryland near Ocean City (NOAA Fisheries 2015b). All of the whales stranded in Virginia and Maryland had signs of human-caused injury. NOAA's database of mortality and serious injury indicates no human caused serious injuries for humpback whales in the Chesapeake Bay proper between 1999 and 2003. The only reported mortality of a humpback whale during the 1999-2003 time period was at the mouth of the Chesapeake Bay in Virginia as the result of a ship strike. Three other humpback whale mortalities related to ship strikes or entanglement in fishing gear in Virginia waters were reported during the study period. One serious injury to a humpback whale as a result of entanglement in fishing gear occurred near Ocean City, Maryland (Cole et al. 2005).

There have been 33 humpback whale strandings recorded in Virginia since 1988; 11 had signs of entanglement and 9 had injuries from vessel strikes. Most of these strandings were reported from ocean facing beaches, but 11 were also within the Chesapeake Bay (Barco and Swingle 2014). Strandings occurred in all seasons, but were most common in the spring. In the past 5 years of reported data (2011-2015), there have been five humpback whale strandings in Virginia (Swingle et al. 2012, Swingle et al. 2013, Swingle et al. 2014, Swingle et al. 2015, Swingle et al. 2016). Since the beginning of 2017, five dead humpback whales have been observed in Virginia (Funk 2017). Ship strikes have been attributed as the likely cause of death in these instances.

4.2.3 Life History

In winter, whales from the six feeding areas mate and calve primarily in the West Indies where spatial and genetic mixing among these groups occur (Waring et al. 2000). Various papers (Clapham and Mayo 1990, Clapham et al. 1992, Barlow and Clapham 1997, Clapham et al. 1999) summarized information gathered from a catalogue of photographs of 643 individuals from the western North Atlantic population of humpback whales (also referred to as the Gulf of Maine stock). These photographs identified reproductively mature western North Atlantic humpbacks wintering in tropical breeding grounds in the Antilles, primarily on Silver and Navidad Banks, north of the Dominican Republic. The primary winter range also includes the Virgin Islands and Puerto Rico (NOAA Fisheries 1991). Not all whales migrate to the West Indies every year and some are found in the mid- and high-latitude regions during the winter months. Increased numbers of humpback whales, specifically juveniles, have been spotted in the Chesapeake and Delaware Bays and along the Virginia and North Carolina coasts.

Humpback whales use the Mid-Atlantic as a migratory pathway to and from the calving/mating grounds, but it may also be an important winter feeding area for juveniles. Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking from January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle et al. (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months. Identified whales using the Mid-Atlantic area were found to be residents of the Gulf of Maine and Atlantic Canada (Gulf of St. Lawrence and Newfoundland) feeding groups; suggesting a mixing of different feeding populations in the Mid-Atlantic region. Strandings of humpback whales have increased between New Jersey and Florida since 1985, consistent with the increase in Mid-Atlantic whale sightings. No critical habitat has been designated for the humpback whale (NOAA Fisheries 2006a). Strandings were most frequent during September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley et al. 1995). Humpback whales feed primarily on krill, plankton, and small fish by filtering them from the water through baleen plates in their mouths. An individual may consume up to 1,360 kilograms of food per day (NOAA Fisheries 2017g).

4.2.4 Acoustics

Humpback whale hearing ranges from 20 Hz to 8 kHz, with highest sensitivity around 120 Hz to 4 kHz (Erbe 2002). Southall et al. (2007) categorized humpback whales in the low-frequency cetacean functional hearing group with an estimated auditory bandwidth of 7 Hz – 22 kHz.

4.3 NORTH ATLANTIC RIGHT WHALE (*EUBALAENA GLACIALIS*)

4.3.1 Distribution and Status

There are five key habitat areas for the right whale, including three areas designated as critical habitat by NOAA Fisheries (in accordance with the ESA) within U.S. waters of the Atlantic Ocean. None of these critical or key habitat areas include the Chesapeake Bay or adjacent waters. The closest key habitat area lies to the north, near Cape Cod; the closest key habitat to the south is along the Georgia coastline. Though right whales move through mid-Atlantic waters regularly, areas north of Georgia and south of Cape Cod are not considered to be high use areas for right whales (NOAA Fisheries 2006b). Calving occurs primarily in the waters along the Florida and Georgia coasts, though some mother-calf pairs of whales use coastal waters of North Carolina and South Carolina as wintering and calving areas (NOAA Fisheries 2006b). The areas in Cape Cod Bay and east of Cape Cod were designated as critical habitat for their importance as foraging sites (NOAA Fisheries 2006b). NOAA Fisheries received a petition to increase the critical habitat in 2002 based on new distribution information. The ESA requires that critical habitat be identified based on specific habitat features, not distribution information, and additional analyses of the sightings and their environmental correlations would be necessary to designate these areas as critical habitat (NOAA Fisheries 2006b).

There are relatively few right whales remaining in the western North Atlantic, although the exact number is unknown. As is the case with most wild animals, an exact count cannot be obtained; however, abundance can be reasonably estimated as a result of the extensive study of this subpopulation. International Whaling Commission (IWC) participants from a 1999 workshop agreed that it was reasonable to state that the number of western North Atlantic right whales as of 1998 was probably around 300 (± 10 percent) (Best et al. 2001). A review reported by NOAA of the photo-identification recapture database indicated that the minimum population size of western North Atlantic right whales on 20 October 2012 was 476 individuals (NOAA Fisheries 2015c).

Between 1999 and 2015, a total of 293 right whale calves were estimated; including a record calving season in 2009 with 39 births (NOAA Fisheries 2015c). Calving numbers have been sporadic, with large differences among years. The calving years 1997-2000 provided low recruitment with only 10 calves born, while 39, 19, 22, 7, and 20 births were reported for each year between 2009 and 2013, respectively.

Data collected in the 1990s suggested that right whales were experiencing a slow but steady recovery (Knowlton et al. 1994). However, Caswell et al. (1999) used photo-identification data and modeling to estimate survival and concluded that right whale survival decreased from 1980 to 1994. Modified versions of the Caswell et al. (1999) model as well as several other models were reviewed at the 1999 IWC workshop (Best et al. 2001). Despite differences in approach,

all of the models indicated a decline in right whale survival in the 1990s relative to the 1980s with female survival, in particular, affected (Best et al. 2001, Waring et al. 2002). In 2002, NOAA Fisheries' Northeast Fisheries Science Center hosted a workshop to review right whale population models to examine: 1) potential bias in the models and 2) changes in the subpopulation trend based on new information collected in the late 1990s (Clapham 2002). Three different models were used to explore right whale survivability and to address potential sources of bias. Although biases were identified that could negatively affect the results, all three modeling techniques resulted in the same conclusion; survival, particularly of females, has continued to decline (Clapham 2002). An increase in mortality rate was noted during 2004 and 2005 which created additional concern (Kraus et al. 2005). However, since that period of decline, the population has continued to grow (NOAA Fisheries 2015c). Most recently, a positive increasing trend in population size was indicated by examination of the minimum number alive population index which is based on the individual sightings database from 20 October 2014 (NOAA Fisheries 2015c).

4.3.2 Presence in the Project Area

Based on the sighting and stranding data, it is possible, but unlikely, for right whales to occur in the Project Area. Six right whales were sighted and reported to NOAA in Virginia waters in 2015-2016. Most whales sighted in Virginia waters are found in the vicinity of Norfolk and Virginia Beach, Virginia. Most of the right whale sightings were in waters off the coast of New England and Canada NOAA Fisheries 2016g).

There have been four right whale strandings recorded in Virginia since 1988, two of which had injuries consistent with a vessel strike. None of these were within the Chesapeake Bay. Three of the four strandings occurred in the winter, and no right whale strandings have been reported in Virginia in the past 5 years (Barco and Swingle 2014, Swingle et al. 2012, Swingle et al. 2013, Swingle et al. 2014, Swingle et al. 2015, Swingle et al. 2016).

4.3.3 Life History

Right whales were one of the first large whales to be hunted on a systematic, commercial basis (Clapham et al. 1999). Records indicate that commercial whaling of right whales in the North Atlantic Ocean may have begun as early as 1059 (Aguilar 1986). Commercial whaling for right whales along the U.S. Atlantic coast peaked in the 18th century, but right whales continued to be taken opportunistically along the coast and in other areas of the North Atlantic into the early 20th century (Kenney 2002). Right whales have occurred historically in all the world's oceans from temperate to subarctic latitudes (Perry et al. 1999). In both hemispheres, they are observed at low latitudes and in nearshore waters where calving takes place in the winter months, and in higher latitude foraging grounds in the summer (Clapham et al. 1999, Perry et al. 1999).

In 2000, the IWC reviewed the taxonomic nomenclature of right whales. Based on the results of genetic studies, the IWC formally recognized North Pacific, North Atlantic, and southern hemisphere right whales as three separate species (Best et al. 2001). In April 2003, NOAA Fisheries published a final rule in the Federal Register (FR) (68 FR 17560) that amended the ESA-listing for right whales by recognizing three separate species: North Atlantic right whale (*Eubalaena glacialis*), North Pacific right whale (*Eubalaena japonica*), and southern right whale

(*Eubalaena australis*). However, on 11 January 2005, another final rule was published (70 FR 1830) that removed the April 2003 final rule on the grounds that it was procedurally and substantively flawed. As a result, the ESA-listing for right whales has reverted to that in effect prior to the April 2003 rule; all right whales are listed as endangered either as Northern right whales (*Eubalaena glacialis*) or Southern right whales (*Eubalaena australis*).

Right whales feed on zooplankton, which they filter from the water through large baleen plates that hang from their upper jaw. Feeding typically occurs from spring through fall, and may occur anywhere from the surface to near the ocean bottom (NOAA Fisheries 2017h).

Unknowns about right whale habitat persist. For example, some female right whales have never been observed in the Georgia and Florida calving grounds but have been observed with a calf on the summer foraging grounds (Best et al. 2001). It is unknown whether these females are calving in an unidentified calving area or have just been missed during surveys off of Florida and Georgia (Best et al. 2001). The absence of some known (photo-identified) whales from identified habitats for months or years at a time suggests the presence of an unknown feeding ground (Kenney 2002). Finally, while behavior suggestive of mating is frequently observed on the foraging grounds, conception is not likely to occur at that time given the known length of gestation in other baleen whales. More likely, mating and conception occur in the winter (Kenney 2002). Based on genetic data, it has been suggested that two mating areas may exist with a somewhat different population composition (Best et al. 2001). The location of the mating area(s) is unknown.

Human-caused mortality and serious injury records reported by NOAA for 2009-2013, report one injury in Virginia waters off of the state's ocean coastline near Virginia Beach. No human-caused serious injuries to, or mortalities of, the right whale have been identified in the Chesapeake Bay.

4.3.4 Acoustics

Little has been reported on the hearing abilities of the North Atlantic right whale, but they are likely most sensitive to frequencies between 100-400 Hz (Erbe 2002). NOAA has classified baleen whales, including the Northern right whale, as part of the low-frequency cetacean functional hearing group.

4.4 BOTTLENOSE DOLPHIN (*TURSIOPS* SPP.)

4.4.1 Distribution and Status

Bottlenose dolphins occur in temperate and tropical oceans throughout the world, ranging in latitudes from 45° N to 45° S (Blaylock 1985). In the western Atlantic Ocean there are two distinct morphotypes of bottlenose dolphins, an offshore type that occurs along the edge of the continental shelf and an inshore type. The inshore morphotype can be found along the entire U.S. coast from New York to the Gulf of Mexico, and typically occurs in waters less than 20 meters deep (NOAA Fisheries 2016a). There is evidence that the inshore bottlenose dolphins may be made up of seven different stock which may be either year-round residents or migratory. Bottlenose dolphins found in Virginia are representative of what is likely a northern migratory

stock, which spends the winter along the coast of North Carolina and migrates as far north as Long Island, New York in the summer. Bottlenose dolphins are rarely found north of North Carolina in the winter (NOAA Fisheries 2016a).

Aerial surveys conducted in the summers of 2010 and 2011 estimated the northern migratory stock at 11,548 (NOAA Fisheries 2016a). Bottlenose dolphins are not listed under the ESA, but are protected under the MMPA. The western North Atlantic Coastal type is designated as depleted under the MMPA.

4.4.2 Presence in the Project Area

Bottlenose dolphins are abundant along the Virginia coast and within the Chesapeake Bay. They are seen annually in Virginia from May through October with around 65 strandings occurring each year (Barco and Swingle 2014). Stranded bottlenose dolphins have been recorded as far north as the Potomac River in the Chesapeake Bay (Blaylock 1985).

4.4.3 Life History

The inshore variety of bottlenose dolphins often travel in small groups of 2 to 15 individuals. These groups will travel into bays, estuaries, and rivers to feed, utilizing echolocation to find a variety of prey, including fish, squid, and benthic invertebrates. Bottlenose dolphins will work cooperatively to herd prey, which may be stunned by a strike from the dolphin's fluke prior to capture (NOAA Fisheries 2017b).

Bottlenose dolphins reach sexual maturity between 5-14 years of age. Gestation lasts 12 months, followed by 18-20 months of nursing. Bottlenose dolphins have a lifespan of 40-50 years, and females may give birth every 3-6 years throughout their lives (NOAA Fisheries 2017b).

The primary threat to bottlenose dolphins is injury and death due to entanglement with fishing gear, such as gillnets, seine nets, trawls, and longline fishing operations. Exposure to pollution and biotoxins and viral outbreaks are also a threat (NOAA Fisheries 2017b).

4.4.4 Acoustics

Southall et al. (2007) categorized bottlenose dolphins in the mid-frequency cetacean functional hearing group with an estimated auditory bandwidth of 150 Hz – 160 kHz.

4.5 HARBOR PORPOISE (*PHOCOENA PHOCOENA*)

4.5.1 Distribution and Status

The harbor porpoise is typically found in colder waters in the northern hemisphere. In the western North Atlantic Ocean, harbor porpoises range from Greenland to as far south as North Carolina (Barco and Swingle 2014). They are commonly found in bays, estuaries, and harbors less than 200 meters deep (NOAA Fisheries 2017c).

Harbor porpoises in the U.S. are made up of the Gulf of Main/Bay of Fundy stock. Gulf of Main/Bay of Fundy stock are concentrated in the Gulf of Maine in the summer, but are widely

dispersed from Maine to New Jersey in the winter. South of New Jersey, harbor porpoises occur at lower densities. Migrations to and from the Gulf of Maine do not follow a defined route. (NOAA Fisheries 2016c).

Harbor porpoises are not listed under the ESA, but are protected by the MMPA. The Gulf of Maine/Bay of Fundy stock was estimated at approximately 80,000 animals in 2011 (NOAA Fisheries 2016c).

4.5.2 Presence in the Project Area

Harbor porpoise are the second most common marine mammal in Virginia (Barco and Swingle 2014). They occur seasonally in the winter and spring in small numbers. Strandings occur primarily on ocean facing beaches, but they occasionally travel into the Chesapeake Bay to forage and could occur in the Project Area (Barco and Swingle 2014).

4.5.3 Life History

The only true porpoise in the northern Atlantic Ocean, the harbor porpoise is one of the smallest marine mammals, only reaching around 1.5 meters in length (Blaylock 1985). Harbor porpoises frequent inshore habitats where they feed primarily on small schooling fish species, such as anchovies and shad, as well as squid and octopus (NOAA Fisheries 2017c).

Female harbor porpoises reach sexual maturity at 3 to 4 years of age and may give birth annually for several years in a row. Gestation lasts 10-11 months, with nursing lasting 8-12 months (NOAA Fisheries 2017c). The life span of harbor porpoises is around 24 years. Harbor porpoises are unlikely to be affected by vessel strikes but are susceptible to entanglement in fishing gear, particularly gill nets.

4.5.4 Acoustics

Harbor porpoises are sensitive to frequencies ranging from 16-140 kHz, with a reduction in sensitivity around 64 kHz (Kastelein et al 2005). Southall et al. (2007) categorized harbor porpoises in the high-frequency cetacean functional hearing group with an estimated auditory bandwidth of 150 Hz – 160 kHz.

4.6 HARBOR SEAL (*PHOCA VITULINA*)

4.6.1 Distribution and Status

Harbor seals occur in arctic and temperate coastal waters throughout the northern hemisphere, including on both the east and west coasts of the U.S. On the east coast, harbor seals can be found from the Canadian Arctic down to Georgia (Blaylock 1985). Harbor seals occur year-round in Canada and Maine and seasonally (September-May) from southern New England to New Jersey (NOAA Fisheries 2016d). The range of harbor seals appears to be shifting as they are regularly reported further south than they were historically. In recent years, they have established haul out sites in the Chesapeake Bay including on the portal islands of the CBBT (NOAA Fisheries 2016d, Rees et al 2016).

A 2012 survey estimated the abundance of harbor seals in the western North Atlantic at around 76,000 (NOAA Fisheries 2016d). Population trends of this stock have not been conducted, but are thought to be increasing (Barco and Swingle 2014, NOAA Fisheries 2016d).

4.6.2 Presence in the Project Area

Harbor seals are the most common seal in Virginia (Barco and Swingle 2014). They can be seen resting on the rocks around the portal islands of the CBBT from December through April. Seal observation surveys conducted at the CBBT recorded 112 harbor seals in the 2014/2015 season and 184 harbor seals during the 2015/2016 season (Rees et al 2016).

4.6.3 Life History

The harbor seal is a medium-sized seal, reaching about 2 meters in length. They spend a fair amount of time hauled out on land, often in large groups (Rees et al 2016). Haul out sites—which may be rocks, beaches, or ice—provide the opportunity for rest, thermal regulation, social interaction, parturition, and predator avoidance (NOAA Fisheries 2017e). When feeding, harbor seals may dive shallow or deep to locate prey, which include fish, shellfish, and crustaceans (NOAA Fisheries 2017e).

Harbor seals mate at sea and give birth during the spring and summer. Pups can swim just minutes after being born. The nursing period lasts for an average of 24 days. The lifespan of harbor seals is 25-30 years (NOAA Fisheries 2017e).

Entanglement in fishing gear, vessel strikes, pollution are the primary threats to harbor seals. Harassment by humans when on land may also impact harbor seals (NOAA Fisheries 2017e).

4.6.4 Acoustics

Harbor seals are sensitive to frequencies ranging from 1-180 kHz, with peak sensitivity around 32 kHz (Kastak and Schusterman 1995). Southall et al. (2007) categorized harbor seal in the pinnipeds in water functional hearing group with an estimated auditory bandwidth of 75 Hz – 75 kHz.

4.7 GRAY SEAL (*HALICHOERUS GRYPUS*)

4.7.1 Distribution and Status

Gray seals occur on both coasts of the Northern Atlantic Ocean and are divided into three major populations (NOAA Fisheries 2016b). The western north Atlantic stock occurs in eastern Canada and the northeastern U.S., occasionally as far south as North Carolina. Gray seals inhabit rocky coasts and islands, sandbars, ice shelves and icebergs (NOAA Fisheries 2016b). In the U.S., gray seals congregate in the summer to give birth at four established colonies in Massachusetts and Maine (NOAA Fisheries 2016b). From September through May, they disperse and can be abundant as far south as New Jersey. The range of gray seals appears to be shifting as they are regularly being reported further south than they were historically (Rees et al 2016).

Population estimates of the total western north Atlantic stock are not available, but assessments of the Canadian population are greater than 500,000 animals (NOAA Fisheries 2016b).

4.7.2 Presence in the Project Area

Uncommon in Virginia and the Chesapeake Bay. Only 15 gray seal strandings were documented in Virginia from 1988-2013 (Barco and Swingle 2014). They are rarely found resting on the rocks around the portal islands of the CBBT from December through April alongside harbor seals. Seal observation surveys conducted at the CBBT recorded one gray seal in each of the 2014/2015 and 2015/2016 seasons (Rees et al 2016).

4.7.3 Life History

Gray seals are a large seal at around 2-3 meters in length, and can dive to depths of 475 meters to capture prey. Prey include fish, crustaceans, squid, octopus, and occasionally seabirds (NOAA Fisheries 2017d). Like harbor seals, gray seals spend a fair amount of time hauled out on land to rest, thermoregulate, give birth or avoid predators (Rees et al 2016).

Gray seals will gather in large colonies in the summer for mating and birthing. At the breeding colonies, a male may maintain a harem of up to 10 females. After a 3-month delay in the implantation of the fertilized egg, the gestation period lasts around 11.5 months with pupping occurring from September through November. The lifespan of gray seals is 25-35 years.

Gray seals are susceptible to entanglement in fishing gear, vessel strikes, and harassment from humans when hauled out of the water.

4.7.4 Acoustics

Southall et al. (2007) categorized gray seal as part of the in water functional hearing group with an estimated auditory bandwidth of 75 Hz – 75 kHz.

5. TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

The CTJV requests an IHA under Section 101(a)(5)(D) of the MMPA for takes for Level B harassment during in-water and on-island impact pile driving, in-water sheet pile driving, and construction activities associated with the PTST Project. No takes are requested in association with on-island sheet pile driving as a result of airborne noise. CTJV requests an IHA for incidental take of four species of marine mammals: bottlenose dolphin, humpback whale, harbor seal, and gray seal (Table 3). The noise created by impact pile driving during the installation of piles and vibratory pile driving during the installation of sheet piles has the potential to take marine mammals at Level B. Exposure to both underwater and airborne sound disturbance is possible. ZOIs for Level B harassment have been calculated according to the 2016 NOAA guidance (NOAA Fisheries 2016h) and are described in Chapter 6.

If harbor porpoise, North Atlantic right whale or fin whale appear to be crossing into the Level B ZOI, pile and in-water sheet pile driving activities will cease immediately until the animal(s) depart the ZOI on its (their) own (Table 3).

Incidental taking by Level A harassment is not being requested at this time. ZOIs for Level A harassment have been calculated according to the new NOAA guidance (NOAA Fisheries 2016h) and are described in Chapter 6 of this IHA Application. If any marine mammal species appears to be crossing into the Level A ZOIs, pile and sheet pile driving activities will cease immediately until the animal(s) depart on their own.

CTJV requests that the IHA issued be effective for one calendar year beginning with the start of pile driving activities.

Table 3. Summary of Marine Mammals and Action During Project Activity

Common Name	Scientific Name	Status*	Take Requested	Action during Project Activity
Fin whale	<i>Balanoptera physalus</i>	FE/SE	No	Shutdown if observed approaching or within ZOIs A or B
Humpback whale	<i>Megaptera novaeangliae</i>		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI
North Atlantic right whale	<i>Eubalaena glacialis</i>	FE/SE	No	Shutdown if observed approaching or within ZOIs A or B
Bottlenose dolphin	<i>Tursiops spp.</i>		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI
Harbor porpoise	<i>Phocoena phocoena</i>		No	Shutdown if observed approaching or within Level A or Level B ZOI
Harbor seal	<i>Phoca vitulina</i>		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI
Gray seal	<i>Halichoerus grypus</i>		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI

*FE=Federally Endangered, SE=State Endangered; ZOI = Zone of Impact

6. TAKE ESTIMATES FOR MARINE MAMMALS

This section discusses the size of the ZOIs for the installation of hollow steel piles (using an impact hammer) and sheet piles (using a vibratory hammer) above and below MHW and the number of takes being requested for each species. Incidental take estimates on a per species basis are determined by the likelihood of that species presence within the Level B ZOI during the period of round pile and in-water sheet pile installation. Hollow steel round pile installation is expected to occur from June 2018 through March 2019. In water sheet pile installation is expected to occur from August 2018 through March 2019.

6.1 NOAA FISHERIES SERVICE ACOUSTIC CRITERIA

New guidance provided by NOAA Fisheries (2016h) describes updated definitions for the Permanent Threshold Shift (PTS) onset for Level A harassment for each of the four marine mammal functional hearing groups (Table 4). This new guidance provides a refinement of previously used thresholds by incorporating the hearing range specific to each mammal group into the development of the threshold. Separate onset levels are defined for impulsive sound (e.g., impact pile driving) and non-impulsive sound (e.g., vibratory sound). For impulsive sounds, acoustic thresholds are described with two metrics: cumulative sound exposure (SPL_{CUM} and SPL_{PEAK}); non-impulsive thresholds are described only with SEL_{CUM} .

Table 4. Level A Harassment Thresholds for Marine Mammals that May Occur in the Project Area

Functional Hearing Group	Level A Harassment ¹		
	PTS Onset Acoustic Thresholds (SEL_{CUM}) (dB re $1\mu Pa^2sec$)		Peak Sound Threshold (SPL_{PEAK}) (dB re $1\mu Pa$)
	Impulsive (Impact Pile Driving)	Non-Impulsive (Vibratory Pile Driving)	Impulsive (Impact Pile Driving)
Low-Frequency Cetaceans (e.g., fin whale, humpback whale, North Atlantic right whale)	183	199	219
Mid-Frequency Cetaceans (e.g., bottlenose dolphin)	185	198	230
High-Frequency Cetaceans (e.g., harbor porpoise)	155	173	202
Phocid Pinnipeds (e.g., harbor seals and gray seals)	185	201	218

¹NOAA Fisheries 2016h updated guidance

SEL_{CUM} —Cumulative Sound Exposure Level. A measure of the cumulative sound exposure over time. A function of the sum of the SELs for one strike and the number of strikes over a defined amount of time.

SPL_{PEAK} —Peak Sound Pressure Level – The highest sound pressure level made by the action. In a sinusoidal sound pressure wave, this is the absolute value of the maximum variation from the neutral position of the wave.

dB re $1\mu Pa^2sec$ —decibels reference level 1 micropascal squared per second

The NOAA Fisheries (2016h) guidance addresses only new thresholds for Level A harassment by underwater sound. Neither Level B harassment nor airborne noise harassment were addressed. Therefore, guidance received from NOAA Fisheries' Protected Resource's Office in Silver Spring, Maryland, was used to evaluate Level B and airborne sources of sound (Table 5).

Table 5. Level B Harassment Thresholds

Functional Hearing Group	Level B Harassment		
	RMS SPL (dB re 1µPa)	RMS SPL (dB re 1µPa)	RMS SPL Airborne (dB re 20 µPa)
	Impulsive (Impact Pile Driving)	Non-Impulsive (Vibratory Pile Driving)	Airborne - All Source Types
Low-Frequency Cetaceans (e.g., fin whale, humpback whale, North Atlantic right whale)	160	120	N/A
Mid-Frequency Cetaceans (e.g., bottlenose dolphin)	160	120	N/A
High-Frequency Cetaceans (e.g., harbor porpoise)	160	120	N/A
Phocid Pinnipeds (e.g., harbor seals and gray seals)	160	120	90

RMS SPL – Sound Pressure Level Root Mean Squared – The RMS is a type of average that is determined by squaring all the sound wave amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of the mean of the squared values.

dB re 1µPa²/sec—decibels reference level 1 micropascal squared per second

6.2 ESTIMATED EXTENT OF ACTIVITY

The ZOIs for Level A harassment were calculated following the NOAA Fisheries 2016 guidance and the accompanying Optional User Spreadsheet. Separate ZOIs were initially calculated for vibratory pile driving (non-impulsive, stationary, continuous; Sheet A) and for impact pile driving (impulsive; Sheet E.I). See Appendix A for screenshots of the completed spreadsheets. Based on the results of the initial modeling, it was determined that only an impact hammer will be used for driving hollow steel piles. A vibratory hammer will be used for the installation of sheet piles. Table 6 provides output for all initially proposed methods for hollow steel piles, but only the use of an impact hammer was carried forward for Level A and B ZOI calculations. Table 6 provides output for use of a vibratory hammer to install sheet piles.

The Optional User Spreadsheet requires estimates of the sound produced by the source (RMS SPL) and the distance at which the sound was measured. Because sound data from the PTST Project site were not available, literature values published for projects similar to the PTST project were used to estimate the amount of sound (RMS SPL) that could potentially be produced. The PTST Project will use round, 36-inch-diameter, hollow steel piles and 28-inch wide sheet piles. Data reported in the Compendium of Pile Driving Sound Data (Caltrans 2015) for similar piles size and types are shown in Table 6. The use of an encased bubble curtain is expected to reduce sound levels by 10 decibels (dB) (NAVFAC 2014, ICF Jones and Stokes 2009). Using data from previous projects (Caltrans 2015) and the amount of sound reduction expected from each of the sound mitigation methods, we estimated the peak noise level (SPL_{peak}), the root mean squared sound pressure level (RMS SPL), and the single strike sound exposure level (sSEL) for each pile driving scenario of the PTST Project (Table 6).

Table 6. The sound levels (dB Peak, dB RMS, and dB sSEL) expected to be generated by each hammer type/mitigation measure at the PTST Project

Type of Pile	Hammer Type	Estimated Peak Noise Level (dB Peak)	Estimated Cumulative Sound Exposure Level (dBcSEL)	Estimated Pressure Level (dB RMS)	Estimated Single Strike Sound Exposure Level (dB sSEL)	Relevant Piles at the PTST Project	Pile Function
36-inch Steel Pipe	Impact ^a	210	NA	193	183	Battered	Mooring dolphins
36-inch Steel Pipe	Impact with Bubble Curtain ^b	200	NA	183	183	Plumb	Mooring dolphins and Temporary Pier
24-inch AZ Sheet Pile	Vibratory ^c	182	NA	154	165	Sheet	Containment Structure
36-inch Steel Pipe and 24-inch AZ Sheet Pile	Impact w/Bubble Curtain at PI 1 and PI 2 ^d	200	NA	186	183	Plumb	Mooring Dolphins, Temporary Pier
36-inch Steel Pipe and 24-inch AZ Sheet Pile	Impact w/ Bubble Curtain at PI 1 and Vibratory at PI 2	200	NA	183	183	Plumb and Sheet	Mooring Dolphins, Containment Structure
36-inch Steel Pipe and 24-inch AZ Sheet Pile	Vibratory at PI 1 and Impact w/Bubble Curtain at PI 2	200	NA	183	183	Plumb and Sheet	Mooring Dolphins and Containment Structure

^aExamples from Caltrans 2015. These examples were the loudest provided in the Caltrans 2015 compendium for 36-inch-diameter hollow steel piles and in the Proxy Source Sound Levels and Potential Bubble Curtain Attenuation for Acoustic Modeling of nearshore marine Pile Driving at Navy Installations in Puget Sound (NAVFAC 2014).

^bEstimates of sound produced from impact that use sound mitigation measures were developed by subtracting 10 dB for an encased bubble curtain (ICF Jones and Stokes 2009, NAVFAC 2014) using the Greater Atlantic Regional Fisheries Office (GARFO) spreadsheet tool from the highest levels reported in the proxy project that reported unattenuated sound levels. A 10-dB reduction in sound for this sound mitigation method is the minimum that may be expected and, therefore, represents a conservative estimate in sound reduction.

^cExample from NAVFAC 2017. Average 1-second and 10-second Broadband RMS SPL (dB re 1 μ Pa) for Vibratory Pile-Driving normalized to 10 meters at JEB Little Creek.

NOTE: sSEL = Single Strike Exposure Level; dB = decibel; N/A = not applicable

^d The RMS in instances of simultaneous pile driving were determined by applying the rules of decibel addition outlined in the Biological Assessment Advanced Training Manual Version 4-2017.

6.2.1 Calculation of Disturbance ZOIs for In-water Noise

6.2.1.1 Level A

Impact Hammer Pile Driving – The Impact Pile Driving (Stationary Source: Impulsive, Intermittent) (Sheet E.1) provided by NOAA Fisheries requires inputs for the sound pressure level of the source (dB RMS SPL), the expected activity duration in hours per 24-hour period, pulse duration (seconds), number of strikes in a 1-hour period or number of strikes per pile, the propagation of the sound (unitless constant), and the distance from the source at which the sound pressure level was measured. Our calculations assumed the RMS SPL's were as given in Table 6 for impact hammer and impact hammer with encased bubble curtain. RMS SPL's for simultaneous pile driving were determined using the rules for decibel addition (WSDOT 2017). The expected activity duration in hours during a 24-hour period would be 8, that the sound propagation was 15 (unitless constant), the pulse duration was 0.1 seconds, that the distance from the source where the literature based RMS SPL was 10 meters, and that the number of strikes per pile was 1,000. Model outputs are provided in Table 7 and shown on Figures 5 through 30.

Vibratory Hammer Pile Driving – Sound generated by driving of sheet pile will be the result of vibratory pile driving. The Optional User Spreadsheet for vibratory pile driving (non-impulsive, stationary, continuous) (Sheet A) provided by NOAA Fisheries requires inputs for the sound pressure level of the source (dB RMS SPL), the expected activity duration in hours during per 24-hour period, the propagation of the sound (unitless constant), and the distance from the source at which the sound pressure level was measured. Our calculations assumed that the RMS SPL's as given in Table 7 for vibratory hammer. RMS SPL's for simultaneous pile driving were determined using the rules for decibel addition (WSDOT 2017). Calculations also assumed that the expected activity level duration would be 8 hours per portal island per 24-hour period, that the sound propagation was 15 (unitless constant), that the distance from the from the source where the literature based RMS SPL was measured was 10 m. These inputs produced isopleths delineating the ZOI for underwater sound disturbance shown in Table 7 and shown on Figures 5 through 30.

Table 7. Radial Distance (meters) from Pile Driven to Level A Sound Thresholds for Cetaceans and Pinnipeds*

	Hammer Type	Low-Frequency Cetaceans		Mid-Frequency Cetaceans		High-Frequency Cetaceans		Phocid Pinnipeds		Applicable Piles in the PTST Project
SEL _{cum} Threshold (dB)	Impact	183		185		155		185		--
SEL _{cum} Threshold (dB)	Vibratory	199		198		173		201		--
--	--	Island 1	Island 2	Island 1	Island 2	Island 1	Island 2	Island 1	Island 2	--
PTS Isopleth to threshold (meters)	Impact	2,077.2	2,077.2	73.9	73.9	2,474.3	2,474.3	1,111.6	1,111.6	Battered Piles for Mooring Dolphins
PTS Isopleth to threshold (meters)	Impact with Bubble Curtain	860.6	860.6	30.6	30.6	1,025.1	1,025.1	460.5	460.5	Plumb Piles for Temporary Pier and Mooring Dolphins
PTS Isopleth to threshold (meters)	Vibratory	9.3	9.3	0.8	0.8	13.8	13.8	5.7	5.7	Sheet Piles for Containment
PTS Isopleth to threshold (meters)	Impact w/Bubble Curtain at PI 1 and PI 2	1,363.9	1,363.9	48.5	48.5	1624.7	1624.7	729.9	729.9	Plumb Piles for temporary pier
PTS Isopleth to threshold (meters)	Impact w/ Bubble Curtain at PI 1 and Vibratory at PI 2	860.6	9.3	30.6	0.8	1,025.1	13.8	460.5	5.7	Plumb Piles for Temporary Pier and Mooring Dolphins; Sheet Pile for Containment
PTS Isopleth to threshold (meters)	Vibratory at PI 1 and Impact w/Bubble Curtain at PI 2	9.3	860.6	0.8	30.6	13.8	1,025.1	5.7	460.5	Plumb Piles for temporary pier and Mooring Dolphins; Sheet Pile for Containment

*Distances based on up to 3 battered round steel piles per day, 8 plumb round steel piles per day, and up to 8 sheets per day – per portal island.

6.2.1.2 Level B (In-Water)

The underwater practical spreading loss equation (Equation 1) was used to determine the Level B harassment ZOI for marine mammals. Level B ZOI are shown on Table 8

$$TL = GL \times \log_{10} \frac{R_2}{R_1} \quad (\text{Equation 1})$$

Where

TL= Transmission (propagation) loss constant; the transmission in loss constant is assumed to be 15 underwater

R1= The distance of a known or measured sound level

R2 = The estimated distance required for sound to attenuate to a prescribed acoustic threshold

GL = Geometric Loss Coefficient.

Table 8. Radial distance (meters) from pile driven to Level B sound thresholds for Cetaceans and Pinnipeds

Hearing Group	Hammer Type	Cetaceans		Pinnipeds		Applicable Piles in the PTST Project
Sound Threshold (dB)		160 (impact) / 120 (vibratory)		160 (impact) / 120 (vibratory)		
		Island 1	Island 2	Island 1	Island 2	
PTS Isopleth to threshold (meters)	Impact	1,584.9	1,584.9	1,584.9	1,584.9	Battered Piles for Mooring Dolphins
PTS Isopleth to threshold (meters)	Impact with Bubble Curtain	341.5	341.5	341.5	341.5	Plumb Piles for Temporary Pier and Mooring Dolphins
PTS Isopleth to threshold (meters)	Vibratory	1,847.8	1,847.8	1,847.8	1,847.8	Sheet Piles for Containment
PTS Isopleth to threshold (meters)	Impact w/Bubble Curtain at PI 1 and PI 2	541.2	541.2	541.2	541.2	Plumb Piles for temporary pier
PTS Isopleth to threshold (meters)	Impact w/ Bubble Curtain at PI 1 and Vibratory at PI 2	341.5	1,847.8	341.5	1,847.8	Plumb Piles for Temporary Pier and Mooring Dolphins; Sheet Pile for Containment
PTS Isopleth to threshold (meters)	Vibratory at PI 1 and Impact w/Bubble Curtain at PI 2	1,847.8	341.5	1,847.8	341.5	Plumb Piles for temporary pier and Mooring Dolphins; Sheet Pile for Containment

6.2.2 Calculation of Disturbance ZOIs for Airborne Noise

The spherical spreading loss equation (Equation 2) was used to determine the Level B harassment ZOIs for marine mammals. The ZOIs are shown in Table 9 and on Figures 31 through 33.

$$TL = GL \times \log_{10} \frac{R_2}{R_1} \quad (\text{Equation 2})$$

Where

TL= Transmission (Propagation) loss constant; the transmission loss constant is assumed to be 20 in air

R1= The distance of a known or measured sound level

R2 = The estimated distance required for sound to attenuate to a prescribed acoustic threshold

GL = Geometric Loss Coefficient.

Literature estimates were used to estimate the amount of in-air sound produced from driving a pile above the MHW line (Laughlin 2010a,b). Hollow steel piles that were 30 inches in diameter were used as a close proxy to the 36-inch-diameter hollow steel piles that will be driven at the PTST Project (Table 9). AZ 24-inch sheet pile was used as a proxy for the sheet pile to be driven during the PTST Project (Table 9). Using the spherical spreading loss model with these estimates, Level B ZOI's were estimated (Table 9).

Table 9. Radial distance (meters) from pile driven above MHW to PTS sound thresholds for Harbor Seals and Gray Seals

Source	Sound Level	Level A Harassment Zone (m)	Level B Harassment Zone (m)	
			Harbor Seals	Gray Seals
Impact Hammer 36-inch Pile	110 dB _{L5SEQ} at 15m ^a	N/A	150	150
Vibratory Hammer 28-30-inch Sheet Pile	88 dB _{L5SEQ} at 6.2m ^b	N/A	4.92	4.92

^aLaughlin 2010a,b as cited in City of Unalaska 2016 IHA for Unalaska Marine Center

^b Paulus, Sokolowski and Sartor Engineering, PC. 2008.

6.3 ESTIMATED INCIDENTAL TAKES

6.3.1 Fin Whale

No takes are being requested for fin whale.

6.3.2 Humpback Whale

Humpback whales are relatively rare in the Chesapeake Bay and density data for this species within the Project vicinity were not able to be found nor calculated. Populations in the mid-Atlantic have been estimated for humpback whales off the coast of New Jersey with a density of 0.000130 per square kilometer (Whitt et al. 2015). A similar density may be expected off the coast of Virginia. Because occurrence is low, the CTJV is requesting one Level B take every two months for the duration of in-water pile driving activities. Pile driving activities are

expected to occur over a 10-month period, therefore, a total of 5 Level B takes of humpback whales is requested. No Level A takes are requested.

6.3.3 North Atlantic Right Whale

No takes are being requested for North Atlantic right whale.

6.3.4 Bottlenose Dolphin

There are no Level A takes being requested; therefore, only Level B takes are presented here. The expected number of bottlenose dolphin in the Project Area was estimated using a 2016 report on the occurrence, distribution, and density of marine mammals near Naval Station Norfolk and Virginia Beach, Virginia (Engelhaupt et al. 2016). This report provides seasonal densities of bottlenose dolphins for inshore areas in the vicinity of the Project (Table 10).

Table 10. Densities of Bottlenose Dolphin from Inshore Areas of Virginia (Engelhaupt et al. 2016)

Season	Density (individuals per km ²)
Spring	1.00
Summer	3.55
Winter	3.88
Fall	0.63

Total number of takes for bottlenose dolphin were calculated using the seasonal density (above) of animals (individuals/km²) within the inshore study area at the mouth of the Chesapeake Bay (Engelhaupt et al. 2016). Project specific dolphin densities were calculated within the respective Level B ZOIs and season. Densities were then used to calculate the monthly takes based on the number and type of pile driving days. For example, the density of dolphins in summer months is assumed to be 3.55 dolphins/km² * 2.08 km² (ZOI for Simultaneous Plumb Pile driving) = 7.38 dolphins/km² in this ZOI in summer. This density was then multiplied by number of simultaneous plumb pile driving days to provide takes for that month and activity (e.g. 7.38 dolphins/km² * 12 days = 88 dolphins). The anticipated numbers of monthly takes were summed. The total number of requested level B takes is 3,723 dolphins (Table 11).

Table 11. Summary of Information to Calculate Bottlenose Dolphin Takes

Season	Estimated Number of Pile Driving Days	Total Number of Requested Takes
Summer 2018	45	1,092
Fall 2018	77	2,242
Winter 2018-2019	46	279
Spring 2019	10	110

6.3.5 Harbor Porpoise

No takes are being requested for harbor porpoise.

6.3.6 Harbor Seal

The number of harbor seals expected to be present at the PTST Project Area was estimated using survey data for in-water and hauled out seals collected by the U.S. Navy at the portal islands from 2014 through 2016 (Rees et al. 2016) (Table 12). The survey data were used to estimate the number of seals observed per hour for the months of January-May and October-December between 2014 and 2016. Seal density data are in the format of seal per unit time; therefore, seal take requests were calculated as total number of potential seals per pile driving day (8 hours) multiplied by the number of pile driving days per month. For example, in November seal density data are reported at 0.1 seals per hour, within an 8-hour work day there may be 0.8 seals * 27 work days in November, resulting in a 21.6 (or 22) seal takes. The anticipated numbers of monthly takes were summed. The total number of requested level B takes is 7,585 harbor seals (Table 12).

Table 12. Calculation of the Number of Harbor Seal Takes

Month	Estimated Seals per Work Day	Total Pile Driving Days per Month (includes upland driving)	Total Number of Requested Takes
May 2018	3.2	15	48
June 2018	Seals not expected to be present.		
July 2018	Seals not expected to be present		
August 2018	Seals not expected to be present		
September 2018	Seals not expected to be present		
October 2018	Seals not expected to be present		
November 2018	0.8	27	22
December 2018	20.8	24	499
January 2019	48	42	2,016
February 2019	96	42	4,032
March 2019	88	11	968

6.3.7 Gray Seal

The number of gray seals expected to be present at the PTST Project Area was estimated using survey data collected by the U.S. Navy at the portal islands from 2014 through 2016 (Rees et al. 2016) (Table 13). The anticipated numbers of monthly takes were calculated following the same approach for harbor seals, the monthly takes were then summed. The total number of requested level B takes is 67 gray seals (Table 13).

Table 13. Calculation for the number of gray seal takes

Month	Estimated Seals per Work Day	Total Pile Driving Days per Month (includes upland driving)	Harbor Seal Takes (Pv)
May 2018	0	15	0
June 2018	Seals not expected to be present.		
July 2018	Seals not expected to be present		
August 2018	Seals not expected to be present		
September 2018	Seals not expected to be present		
October 2018	Seals not expected to be present		
November 2018	0	27	0
December 2018	0	24	0
January 2019	0	42	0
February 2019	1.6	42	67
March 2019	0	11	0

6.4 ALL MARINE MAMMAL TAKES

No Level A takes are being requested for any species. The Level B takes being requested for each species are summarized in Table 14.

Table 14. Number of Level B takes requested per species

Animal	Number of Takes
Harbor seal	7,585
Gray seal	67
Bottlenose dolphin	3,723
Humpback whale	5

7. ANTICIPATED IMPACT OF THE ACTIVITY

Of the marine mammal species that may occur in the Project Area, harbor seals, gray seals, bottlenose dolphin, and humpback whales are the most likely to be present. Whales, seals, and porpoises are mobile species and are expected to easily avoid the disturbance and activity associated with construction.

Given the preference of whales for water deeper than is found in the Project Area, their presence in the construction areas is unlikely. Whales have been observed in the deeper waters in the general area of the PTST Project. Construction activity within open water will be located adjacent to Portal Island Nos. 1 and 2, and the use of the bored method for construction will prevent open water impacts in the areas more likely to be used by whale species. Given the

feeding habits of whales, they are unlikely to be attracted to the portal islands and are not expected to venture into shallower construction areas.

Seals, bottlenose dolphins, and harbor porpoises may be found in shallower areas than whales; however, it is unlikely that bottlenose dolphins and harbor porpoises are using the shallowest areas of the Project Area. Both species may be temporarily displaced from the Project Area and Level A and B ZOIs. Seals are known to use the shallow portion of the Project Area to reach shoreline haul out areas on the portal islands. Seals would be displaced from these upland areas during construction areas and would likely continue to use Portal Island Nos. 3 and 4. Portal Island No. 3 would be used for storage of monthly materials, which would be consistent with existing routine operations associated with CBBT maintenance. Portal Island No. 4 is not located within the Project footprint.

7.1 POTENTIAL EFFECTS OF PILE DRIVING ON MARINE MAMMALS

To support Project construction activities, up to 272 hollow steel piles measuring 36 inches in diameter, and 1,936 sheet piles will be installed below the MLW line. An additional 62 hollow steel piles measuring 36 inches in diameter, and 3,369 sheet piles will be installed above the MHW line. To reduce the ZOIs to marine mammals, hollow steel piles will be driven using an impact hammer rather than a vibratory hammer. Sheet piles will be installed using a vibratory hammer.

A pressure wave/underwater noise created in the water column as a result of pile driving could cause injury and/or behavioral impacts to marine mammals. Since 1997, NOAA Fisheries has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (70 FR 1871). Exposure of marine mammals to impulsive sounds greater than 180 dB re 1 μ Pa rms are considered to have been taken by Level A (i.e., injurious) harassment (NOAA Fisheries 2016h). Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to underwater sounds below the injury threshold, but greater than 160 dB re 1 μ Pa rms for impulsive sounds (e.g., impact pile driving) and greater than 120 dB re 1 μ Pa rms for non-impulsive noise (e.g., vibratory pile driving or extraction).

Tables 7 through 9 show the estimated distances from the activity where injury and behavioral impacts are expected for marine mammals. The zones of acoustic impact are relatively small for most pile driving scenarios compared to the width of the Chesapeake Bay where the Action Area is located (approximately 17 miles). Mitigative measures will be employed to minimize the pressure waves and underwater noise associated with pile driving activities. Use of a soft start to deter marine mammals from the Action Area, as well as a cushion block and an encased bubble curtain (plumb piles only) when an impact hammer will be used should keep underwater sound below harassment thresholds.

The driving of each hollow steel pile (plumb or battered) is expected to take approximately 1 hour (including the time it takes to position the pile, set-up the hammer and bubble curtain, and disassembly), and a maximum of eight hollow steel piles will be driven per day per portal island. Simultaneous piling driving may occur at both islands. Sheet pile driving will also occur and driving of each sheet is expected to take approximately 1 hour, and approximately eight sheet

piles will be driven per day per portal island. Only sheet or round piles will be driven on a given day at each portal island. The zone of passage for marine mammals in the Lower Chesapeake Bay is substantially greater than the zones of impact where injury may occur. Species are expected to move away from these zones during the soft start/ramp up procedures. For impact hammer pile driving, the hammer will be initially raised not more than a couple feet and dropped repeatedly several times at 30 second intervals. For diesel impact hammers, the construction crew will turn on the sound attenuation device for 15 seconds prior to the ramp-up (50 CFR part 217). A series of short strokes will be completed prior to initiating start full strikes. For vibratory hammers, contractors will initiate sound at reduced energy followed by a 1-minute waiting period. This will be repeated 2 times before full energy is achieved (from 50 CFR part 217).

If a marine mammal enters the Level A ZOI (shutdown zone), pile driving activity will cease, in accordance with the MMMP (Appendix B). No injury to marine mammals is expected. Marine mammals that happen to be within the zone of behavioral impact are expected to move away from the location of pile driving during the soft start procedure and to areas with reduced or no behavioral impact.

The Action Area is within an area actively used for navigation and by the Navy. There are existing periodic high ambient noise levels and the overall background noise levels are relatively high.

7.2 POTENTIAL EFFECTS OF VESSEL INTERACTIONS ON MARINE MAMMALS

The presence of increased ship traffic throughout the duration of the Project could increase the chances of ship strikes with marine mammals. The North Atlantic right whale, in particular, is vulnerable to ship strikes, though its presence in the Project Area is rare. Harbor seals and gray seals that haul out on the portal islands of the CBBT from November through May, as well as bottlenose dolphins and harbor porpoises may be susceptible to ship strikes.

To minimize the potential for ship strikes associated with vessel traffic in the Action Area, vessels within the Project Area and travelling to and from NODS will travel at less than 10 knots to be protective of right whales and other marine mammals. Based on the quantity of dredged material and the size of the scows, it is anticipated that there will be up to 20 vessel trips to NODS. Vessels used for construction will consist of tug boats (50-100 ft long with a draft of 5-15 ft), barge/transport vessels (up to 500 ft long with a draft of up to 30 ft), and workboats (up to 60 ft long with a draft of approximately 5 ft). Vessels traveling to the Action Area will come from existing commercial facilities and will travel via established navigation channels. Approximately 1,400 vessel trips are expected during construction activities. This includes vessel trips transporting dredged material and excavated TBM material up the James River to an upland disposal facility, vessel trips to NODS, and vessel trips to and from the Little Creek Staging Area. The majority of the barging/vessel traffic is expected to occur during the first 27 months of construction. During the busiest construction period, there may be up to six construction-related vessels moored along each engineered berm at any time. The equipment and materials required for the PTST Project will also be transported onto the portal islands via trucks throughout the construction period.

Outside the Action Area and within the established channels, vessels will operate within U.S. Coast Guard requirements and any vessel speed requirements. Given the high amount of vessel traffic already occurring in the area because of existing Navy operations and the nearby federal navigation channel, and because of the reduced vessel speeds that will be implemented, the increase in potential for vessel strikes will not measurably increase the risk of interaction with vessels for marine mammals. The mouth of the Bay and Atlantic Ocean are approximately 7 miles due east of the Action Area. The area between the Action Area and the Ocean consists of open water. Water depths in the Action Area extend to approximately 55 ft. Maximum water depths in the vicinity of the Action Area are approximately 80 ft. The width and depth of the waterway provide ample clearance in all directions for marine mammals to avoid project activities and disturbance. Therefore, any effects from the increase in the number and mooring of vessels are insignificant.

7.3 HABITAT MODIFICATION

Loss of Open Water Habitat—Habitat modification will occur through the loss of open water habitat. The PTST Project would permanently convert 1.50 acres of aquatic habitat/subaqueous bottom (1.02 acres of rock habitat and 0.48 acres of sand habitat) into upland. This habitat would be permanently eliminated from use as open water habitat by marine mammals, but would serve as additional hauling out area for seals. The 1.50 acres of aquatic habitat to be eliminated is shallower than is preferred by whales, and some areas within the Action Area are too shallow to support whales. Therefore, the effects of habitat modification for whales are discountable.

Habitat Conversion—There are 10.18 acres of open habitat (including rock and sand substrate) that would be converted to a shallower depth, and 8.27 acres of the 10.18 acres will have substrate converted from sand to rock. While this area would be converted to a shallower depth, it would still remain available foraging habitat for bottlenose dolphins, harbor porpoises, seals and their prey. Some of the habitat that will be converted is already at depths too shallow to support dolphins, porpoises, and whales. Of the habitat that will be converted, 7.49 acres are currently deeper than 30 ft; of which 3.15 acres are deeper than 45 ft. After construction, there will still be 4.81 acres deeper than 30 ft, of which 0.71 acres will still have depths greater than 45 ft. These areas may, but are unlikely to, serve as foraging habitat for whales. Whales are typically found at deeper depths closer to and within the federal navigation channel, which would not be directly affected by construction activity. The shallow depths present in the Project Area make it unlikely that whales would be present in the first place; therefore, effects on whales are discountable.

Disturbance to the Bottom—Removal and replacement of existing armor stone could also disturb the substrate and the water column. As construction proceeds, existing armor stone will be stockpiled at a nearby subaqueous location that overlaps with the footprint of the engineered berm. The subaqueous stockpile area will temporarily impact an additional 1.27 acres adjacent to the engineered berms. Stones will be removed and replaced one stone at a time, with directed placement into the subaqueous stockpile and then later back on the engineered berm. The temporary subaqueous stockpile of existing armor stone may cause an additional disturbance to the bottom. The shallow depths present in the Project Area make it unlikely that whales would be present; therefore, effects on whales are discountable.

7.4 TURBIDITY AND WATER QUALITY IMPACTS

Dredging—Suspended sediment levels from conventional mechanical clamshell bucket dredging operations have been shown to range from 105 milligrams per liter (mg/L) in the middle of the water column to 445 mg/L near the bottom (210 mg/L, depth-averaged) (USACE 2001) in systems with less dynamic water currents. Furthermore, a study by Burton (1993) measured turbidity levels at 500, 1,000, 2,000, and 3,300 ft from dredge sites in the Delaware River and was able to detect turbidity levels between 15 and 191 mg/L up to 2,000 ft from the dredge site. Based on these analyses, elevated suspended sediment levels of up to 445 mg/L may be present in the immediate vicinity of the clamshell bucket, and suspended sediment levels of up to 191 mg/L could be present within a 2,000-ft radius from the location of the clamshell dredge. The area of elevated turbidity is expected to be substantially smaller at the PTST Project because sediments are primarily comprised of sand, and current velocities range from 2.5 to 3.2 knots (CBBT 2015). Materials excavated at the PTST Project will be disposed of at an existing upland disposal facility or the existing NODS in accordance with the Project's Dredged Material Management Plan. Material will be transported to NODS via split hull scow and to the upland disposal site via barge or sealed, lined trucks. Material excavated by the TBM will be transported to Portal Island No. 1 via a conveyor system located in the tunnel for offsite disposal via barge and truck and will not have contact with aquatic habitat. No impacts to marine mammals are expected as a result of dredging.

Dredged Material Placement—A subset of the material dredged as part of the PTST Project will be disposed of at the existing NODS, which involves the placement of dredged material in the open ocean. This is an existing, approved placement site that was separately evaluated and designated by the U.S. Environmental Protection Agency (EPA). Compliance with the Limiting Permissible Concentration for water quality criteria, water column toxicity, benthic impacts, and bioaccumulation has been demonstrated for the material to be placed per the requirements of the Marine Protection, Research, and Sanctuaries Act. EPA Region 3 has provided concurrence for the placement of the material at the NODS. No impacts to marine mammals are expected.

Pile Driving—The installation of piles will disturb bottom sediments and may cause a temporary increase in suspended sediment in the Action Area. Previous studies from systems with less dynamic water currents have shown that pile driving activities can produce total suspended sediment (TSS) concentrations of approximately 5.0-10.0 mg/L within approximately 300 ft of the pile being driven (FHWA 2012). The small resulting sediment plume is expected to settle out of the water column within a short period of time. Studies of the effects of turbid water on fish suggest that concentrations of suspended sediment can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). The TSS levels expected for pile driving (5.0-10.0 mg/L) are below those shown to have adverse effects on fish (580.0 mg/L for the most sensitive species, with 1,000.0 mg/L more typical; see summary of scientific literature in Burton 1993) and benthic communities (390.0 mg/L [EPA 1986]). The area of elevated turbidity is expected to be substantially smaller at the PTST Project because sediments are primarily comprised of sand, and current velocities range from 2.5 to 3.2 knots (CBBT 2015). No impacts to marine mammals as a result of localized, temporary changes to water quality are expected.

Removal and Replacement of Armor Stone to/from the Stockpile—There are no known studies that estimate the amount of suspended sediment created by the removal and replacement of armor stone. However, this activity is not expected to create any more suspended sediment than pile driving or dredging, as described above. The area of elevated turbidity is expected to be substantially smaller at the PTST Project compared to the examples provided because sediments are primarily comprised of sand, and current velocities range from 2.5 to 3.2 knots (CBBT 2015). No impacts to marine mammals are expected.

Wastewater Treatment Plant Discharges—Discharges from the wastewater treatment plant will be discharged to HRSD and directly to the ocean side of the Project Area via a VPDES permit, managed in accordance with a discharge permit from VDEQ, and would comply with state and federal water quality criteria. Treated wastewater would be managed within required permit limits and is not expected to affect water quality or generate turbidity. No impacts to marine mammals are expected.

Containment Using Geotextile Bags—Containment of flowable fill during engineered berm construction will be completed using geotextile bags in the deepest areas of the berm footprint. Engineered (flowable) fill material will be placed within the sheet pile cell up to the required elevation. The engineered fill will be capped in sections with a flowable fill (cementitious mix) plug. The flowable fill will be placed in an enclosed steel frame or geotextile bag system using a tremie pipe. Prior to filling, the bags will be filled with pumped water from the Chesapeake Bay to ensure they have opened properly. After the geotextile bags are open, flowable fill for berm construction will be pumped directly into the geotextile bags and water will empty out of the bags through valves at the top of the bag. Discharge of this water is expected to occur at a rate of approximately 60 gallons per minute and no change to water quality or additional turbidity is expected to occur as a result of this discharge because of the tidal flushing and strong currents. No impacts to marine mammals are expected.

Thermal Discharges—Water used to cool the TBM may be intermittently discharged into the Chesapeake Bay during periods of very hot weather. This discharge of non-contact cooling water will pass through a cooling tower located at the site before being discharged into the Bay at a temperature of 95 degrees Fahrenheit or less. The total volume of water discharged is expected to be approximately 260,000 gallons per event and will be discharged over several hours. These thermal discharges are expected to occur approximately three times during the course of TBM operations, and would only occur during the summer months. These discharges would be completed in accordance with a VPDES permit and would comply with state and federal water quality criteria.

Thermal discharges would be from a single point source via a multi-point diffuser, and may cause elevated temperatures in a localized area around the discharges. However, given the strong currents and tidal activity in the area, this discharge is expected to mix with the Chesapeake Bay and only cause a minor, localized increase in water temperatures. A negligible amount of sediment resuspension may occur, but given the currents and tidal flushing in the area, TSS levels will return to background levels within a short distance of the discharge point. However, given the limited number of releases expected and the tidal flushing and currents in the area, impacts to marine mammals are not expected.

7.5 IMPACTS TO PREY

Primary impacts to forage species would result from disturbance to the water column from construction activities (e.g., dredging, rock placement, pile driving) and from permanent and temporary fill of open water. Construction activities would result in the displacement of forage fish and the loss of benthos that they feed upon. Some areas of disturbance and fill will be temporary and would only have a temporary adverse effect on planktonic crustaceans, forage fish and their prey species. There would be 18.5 acres of permanently affected aquatic habitat. Of this, 1.3 acres would be permanently converted to upland habitat. This area of aquatic habitat loss is relatively minor when considered relative to the overall aquatic habitat in the lower Chesapeake Bay.

There are no hydrodynamic changes expected as a result of this Project. Since there are no changes to prevailing water currents, no changes to plankton presence or distribution in the Project area or region are expected. Water quality impacts are expected to be negligible because the Project area occurs in a high energy, dynamic area with strong tidal currents.

The pressure wave caused by pile driving could temporarily impact forage fish species, particularly those with a swim bladder. These species will likely avoid the Project Area during the time period when pile driving is occurring. The Project will also employ a soft start and ramp up of impact pile driving activities to allow mobile species to leave the area before impact pile driving occurs at full intensity.

7.6 CONCLUSIONS REGARDING IMPACTS TO SPECIES OR STOCKS

Sound resulting from pile driving during the construction process has the potential to impact marine mammals. Mitigative measures such as the use of an impact hammer with cushion block, and impact hammer with both cushion block and encased bubble curtain, to the extent practical, will be used to reduce the impact of construction noise in the Project Area. Note that only encased bubble curtains were included as a sound reduction in the underwater sound modeling. No noise reduction credit was included in the model for cushion blocks.

Marine mammals that are present in the lower Chesapeake Bay during construction activities are expected to easily avoid the disturbance and activity associated with construction. Given the preference of fin whales, humpback whales, and the North Atlantic right whales for water deeper than is found in the Project Area and their rare presence in the Chesapeake Bay, their presence in the construction area is unlikely. Whales have been observed in the deeper waters in the area. Bottlenose dolphins, harbor porpoises, and seals may use shallower areas within the Action Area; however, they are highly mobile and able to avoid the construction activity. Construction activity within open water will be located adjacent to Portal Island Nos. 1 and 2, and the use of the bored method for construction will prevent open water impacts in the areas more likely to be used by whale species. Given the feeding habits of whales, they are unlikely to be attracted to the portal islands and are not expected to venture into shallower construction areas. Bottlenose dolphins and harbor porpoises are also expected to easily avoid disturbance from construction activity in the Project Area. Reduced vessel speeds in the Project Area will protect marine mammals from potential ship strikes.

Berm and other in-water construction adjacent to the portal islands has the potential to impact the use of the portal islands by harbor seals and gray seals as haul out areas. The impact is expected to be temporary and is not expected to result in the permanent abandonment of the area.

8. ANTICIPATED IMPACTS ON SUBSISTENCE USES

No impacts to subsistence uses are expected. There are no known subsistence uses of marine mammals in the vicinity of the PTST Project Area.

9. MITIGATION MEASURES

9.1 GENERAL CONSTRUCTION MITIGATION

This Project serves to address/enhance vehicle transportation safety, and facilitate traffic crossing the Chesapeake Bay at the location of the existing Thimble Shoal Tunnel. Impacts, both temporary (during construction) and permanent have been minimized by choosing the bored tunnel versus the immersed tube tunnel construction method. However, some impacts to the Chesapeake Bay cannot be avoided while meeting the Project purpose. Through the selection of a bored tunnel approach, which modified the construction methods from an immersed tube tunnel for the Project, the total in-water impact for the Project was reduced from 59 acres to approximately 18.5 acres to 13.8 acres. The total temporary in-water impacts for the Project will also be reduced as there will be substantially less dredging. The reduced bored tunnel footprint stays within the environmental study area and after the Project is completed and temporarily impacted areas would be returned to their original conditions to the maximum extent possible. Direct disruption to the federal navigation channel would be substantially reduced or eliminated.

In addition to reducing the in-water impact area for the Project, the District has sought to minimize other impacts associated with the Project through the implementation of construction best management practices and specific measures designed to reduce aquatic impacts. These measures include:

- Implementation of a 10-meter shutdown zone for marine mammals during in-water construction activities to avoid physical injury to marine mammals. This zone will be monitored by onsite construction personnel who have undergone Project-specific training on environmental, health, and safety protocols. Observations of marine mammals within 10 meters of in-water construction activities will be reported to the onsite construction supervisor.
- Containment of upland impacts:
 - Erosion and sediment controls implemented under the Virginia Erosion and Sediment Control Program.
 - Purchase of 5.11 pounds of phosphorus credits to reduce loading from Portal Island Nos. 1 and 2 by 20 percent.
 - Use of a package wastewater treatment plant on Portal Island No. 1 prior to discharge of wastewater in accordance with a VDPES permit.
 - Discharge of process waters to the HRSD sanitary sewer system following HRSD requirements.
 - Implementation of a Stormwater Pollution Prevention Plan and Spill Prevention Control and Countermeasure plan.
 - Construction and post-construction compliance with the Virginia Stormwater Management Program.

- Angling of construction lighting toward the island along with use of acorn-shaped lenses and 360 degree top shields around LED lightbulbs to minimize impacts to sea turtles and other aquatic life.
- During Berm Construction:
 - Dredging will be performed by mechanical means using clamshell or excavator instead of hydraulic dredging which could entrain marine life.
 - Placement of engineered/flowable fill within a steel form containment structure or large geotextile bags, and use of tremie pipes to directly place flowable fill within containment structure.
 - For the deepest portion of the flowable fill operation outside the sheet piling area and where forms are not feasible, flowable fill will be placed by means of low permeability (~0.66 gallons/square foot/minute) bags made of geotextiles that will minimize turbidity while filling with the flowable fill.
 - Temporary subaqueous stockpiling of armor stone removed from the existing berms for re-use in new berm construction. The in-water/subaqueous bottom footprint of these areas is primarily located within the footprint of the engineered berm to avoid additional areas of subaqueous bottom impacts.
 - Use of a barge to stage new rocks for armor stone material rather than placement in the subaqueous stockpile. Armor stone will be placed one stone at a time, avoiding dumping them over an area and reworking them.
 - Implementation of a Water Quality Monitoring Plan during in-water berm construction activities.
- During Dredging and Placement Activities:
 - Use of mechanical dredging instead of hydraulic, which reduces localized turbidity and potential entrainment of aquatic organisms.
 - Prevention of overfilling of bucket to minimize additional loss of material during ascent through the water column.
 - Verification that the bucket is completely closed prior to raising it to the surface.
 - If the bucket is not closed completely because of debris or obstructions, the operator will not drop the load at the water surface to dislodge the debris, but will complete the dredge pass and place the debris on the barge or scow.
 - Pausing of the bucket after ascent through the water column to allow free water to drain prior to swinging the bucket to the barge.
 - Reduction of the bucket ascent rate, which reduces loss of residuals from the

clamshell bucket.

- Implementation of an approved Water Quality Monitoring Plan during dredging activities.
 - A portion of dredged material will be disposed of at an approved offsite upland location via lined trucks or barges, and a portion of dredged material may be transported to NODS via barges and placed using bottom-dump scows.
 - Because the dredging is expected to be conducted mechanically (bucket dredge), it is not anticipated that monitoring and precautions necessary to protect sea turtles will be required. It is not anticipated that placement operations will impact sea turtles or other marine mammals. Transportation and placement activities (vessel traffic to and from the NODS) will be conducted in compliance with the National Oceanic and Atmospheric Administration Fisheries Right Whale Ship Strike Reduction Rule (50 CFR 224.105), which limits vessels greater than 65 ft to speeds less than 10 knots.
 - If used, split hull dump scows will be used to transport the material to NODS and will be equipped with Automated Scow Monitoring Systems in compliance with the USACE National DQM System requirements. These systems collect, store, and transmit barge draft, location in transit, and verification data for offshore material placement. This information will be available daily and will be transmitted to USACE (per DQM requirements), and/or the dredging contractor's management team, and these data will serve as quality assurance and quality control for the offshore placement activities.
- During Tunnel Excavation Activities:
 - Non-contact cooling water for the TBM will be recycled via a closed loop system throughout the tunneling process. Two to three times during the summer season, warm cooling water may need to be discharged to surface waters in accordance with VPDES permit conditions.
 - Excavated material will be removed from the tunnel at a thick consistency (paste-like) via a conveyor system and placed directly into either a containment system or directly to barges. Decant water from the containment cell will be routed into the on-island water treatment system.
 - The conveyor system will be completely enclosed which will eliminate material exposure to rain events during conveyance and will contain any spills. When directed to the conveyor dock, the conveyor will transport the material directly to a barge that will be positioned at the temporary dock.
 - Construction materials (excavated tunnel material and jet grout residuals) will be disposed of at approved offsite upland locations and transported via lined trucks or barges.

- Tunneling will be temporarily ceased if for any reason excavated material management and process water management and disposal cannot keep pace with tunneling progress.
- During Pile Installation:
 - Installation of hollow steel piles with an impact hammer rather than a vibratory hammer to reduce the duration of pile driving and ZOI for marine mammals.
 - Minimization of underwater pressure waves from pile driving:
 - Use of cushion blocks during use of an impact hammer.
 - Implementing a ramp up/soft start protocol during use of an impact hammer to allow mobile marine organisms more time to avoid the marine mammal zones of impact.
 - Use of encased bubble curtains for plumb round piles at water depths >10 feet. Note that bubble curtains will not function properly in shallow water depths. (<10 ft).
 - Implementation of an MMMP during pile driving activities.

9.2 MONITORING AND SHUTDOWN OF DISTURBANCE ZONES

The proposed Level A (Shutdown Zone) and Level B ZOI will be monitored during all phases of construction.

9.3 MARINE MAMMAL OBSERVATION AND PROTECTION

Qualified observers will be onsite during pile driving activities. Observers will have the authority to shut down pile driving activities if marine mammals are observed entering the designated shutdown zones. A detailed MMMP is provided in Appendix B.

10. ARCTIC SUBSISTENCE PLAN OF COOPERATION

The Project is not located in the Arctic; therefore, this is not applicable.

11. MONITORING AND REPORTING

11.1 MONITORING PLAN

A MMMP developed for this project is provided in Appendix B. This plan will be implemented during in-water and on-land round pile and sheet pile driving activities.

11.2 REPORTING

A detailed report discussing the results of the MMMP and the implementation of mitigation measures will be submitted to NOAA Fisheries following Project completion. The report will include:

- Summary of the activity (dates, times, and specific locations)
- Summary of mitigation implementation
- Detailed monitoring results and a comprehensive summary addressing goals of monitoring plan, including:
 - Number, species, and any other relevant information regarding marine mammals observed and estimated exposed/taken during activities
 - Description of the observed behaviors (in both presence and absence of activities)
 - Environmental conditions when observations were made
- Assessment of the implementation and effectiveness of prescribed mitigation and monitoring measures.

12. SUGGESTED MEANS OF COORDINATION

The data recorded during the MMMP for the proposed project will be provided to NOAA Fisheries with the completion of the monitoring report. This report will provide detailed information on the use of the site by fin whales, humpback whales, North Atlantic right whales, bottlenose dolphins, harbor porpoises, harbor seals, and gray seals. Information on any other species of marine mammal encountered at the Project site will also be included. This report will also provide NOAA Fisheries—as well as future applicants—information about the reaction of these species to these types of activities.

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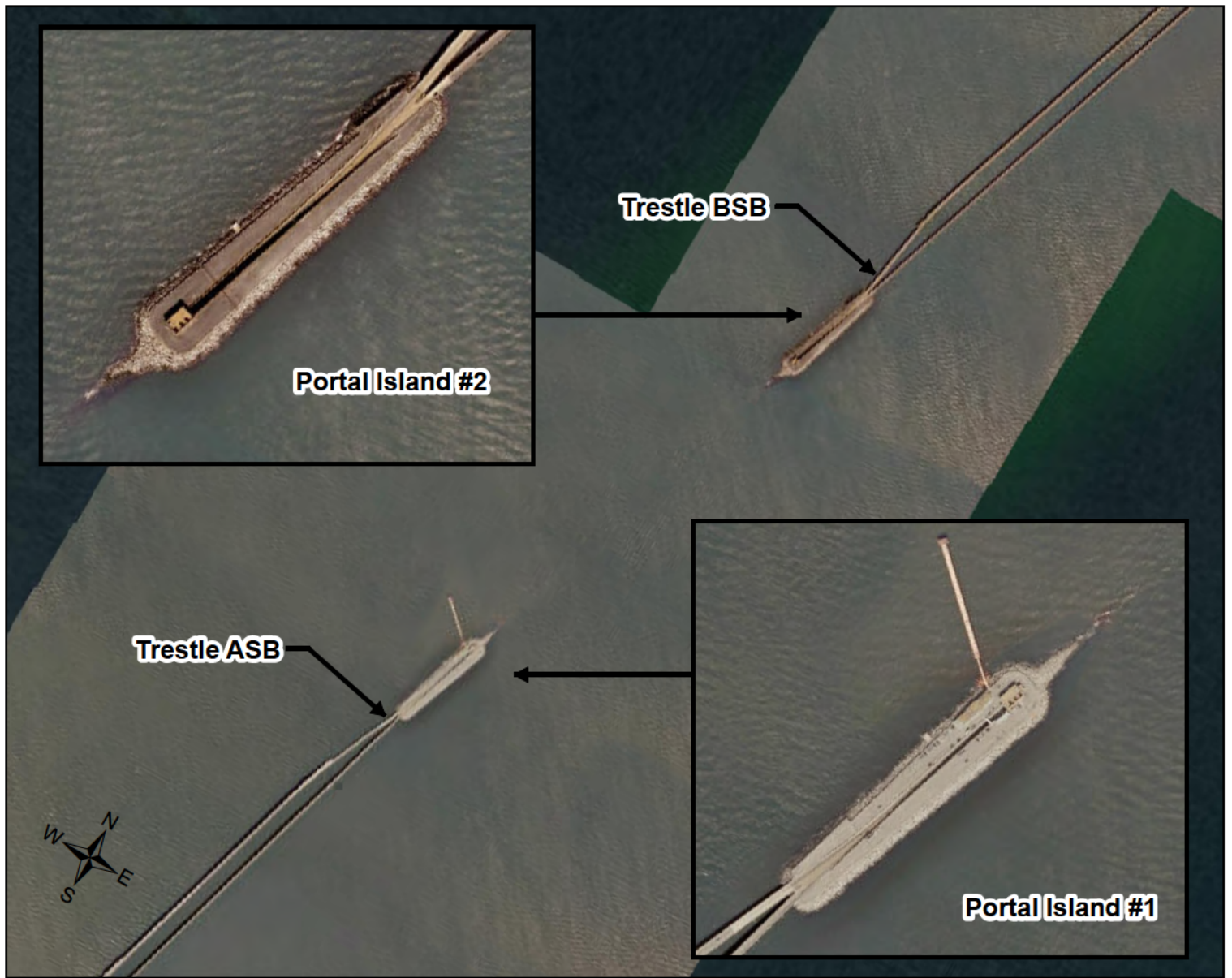
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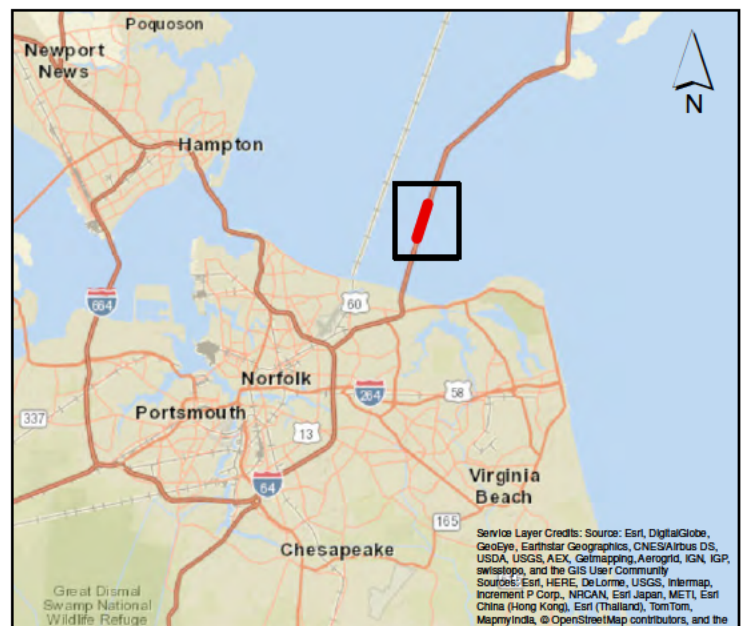
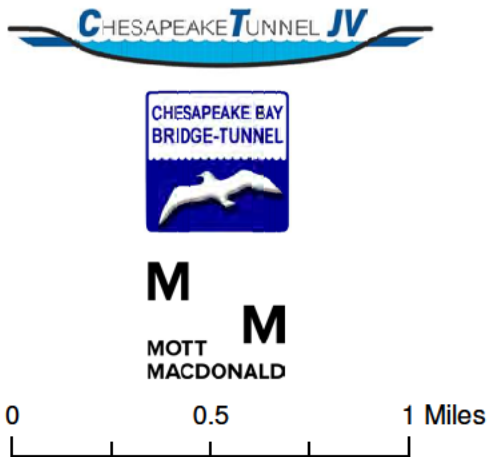
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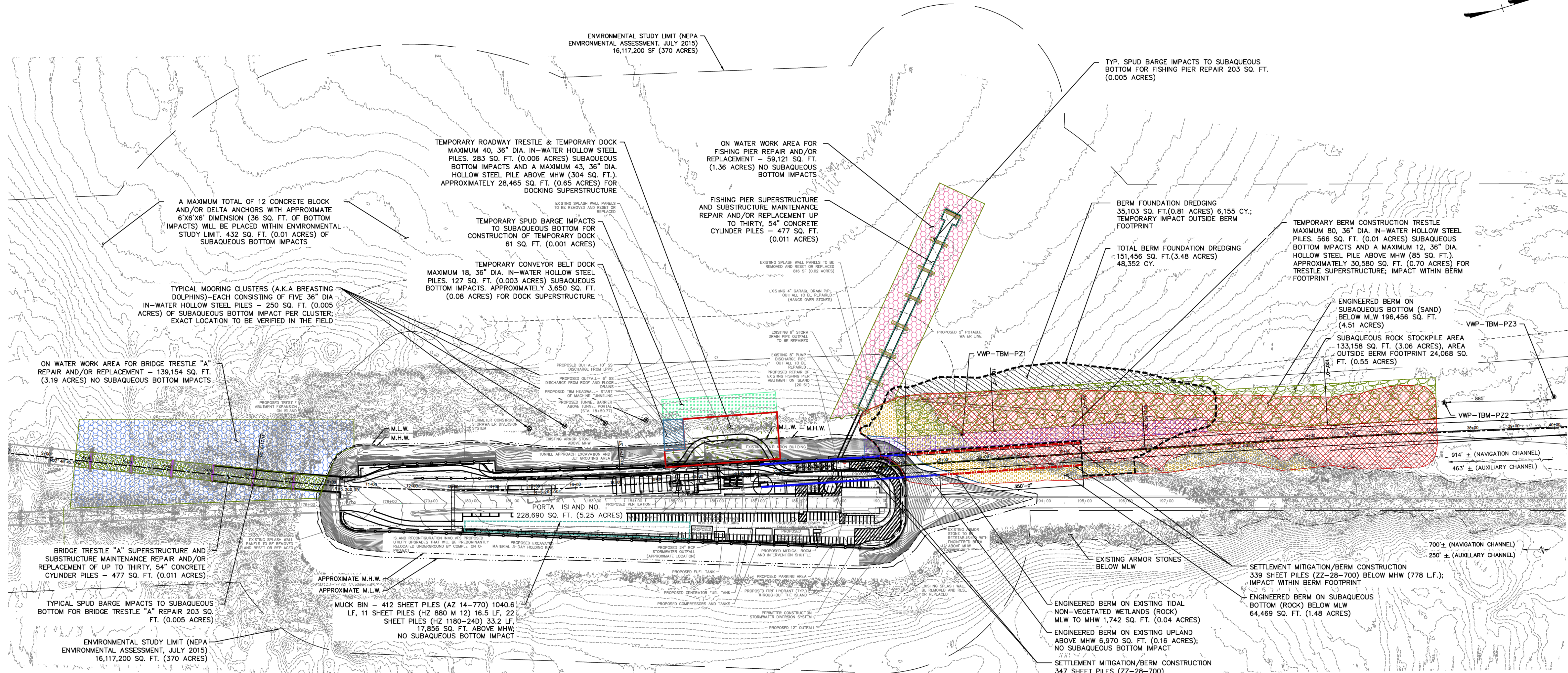
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**Figure 1. Project Location Map
Chesapeake Bay Bridge and Tunnel District
Thimble Shoal Parallel Tunnel**



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LEGEND - TEMPORARY IMPACTS

- SUBAQUEOUS ROCK STOCKPILE AREA 133,158 SQ. FT. (3.06 ACRES), AREA OUTSIDE BERM FOOTPRINT 24,068 SQ. FT. (0.55 ACRES)
- TEMPORARY ROADWAY TRESTLE & TEMPORARY DOCK MAXIMUM 40, 36" DIA. IN-WATER HOLLOW STEEL PILES. 283 SQ. FT. (0.006 ACRES) SUBAQUEOUS BOTTOM IMPACTS AND A MAXIMUM 43, 36" DIA. HOLLOW STEEL PILE ABOVE MHW (304 SQ. FT.). APPROXIMATELY 28,465 SQ. FT. (0.65 ACRES) FOR DOCKING SUPERSTRUCTURE
- A MAXIMUM TOTAL OF 12 CONCRETE BLOCK AND/OR DELTA ANCHORS WITH APPROXIMATE 6'X6'X6' DIMENSION (36 SQ. FT. OF BOTTOM IMPACTS) WILL BE PLACED WITHIN ENVIRONMENTAL STUDY LIMIT. 432 SQ. FT. (0.01 ACRES) OF SUBAQUEOUS BOTTOM IMPACTS
- LOCATION TO BE DETERMINED
- TYPICAL SPUD BARGE IMPACTS TO SUBAQUEOUS BOTTOM FOR FISHING PIER REPAIR 203 SQ. FT. (0.005 ACRES)
- TYPICAL SPUD BARGE IMPACTS TO SUBAQUEOUS BOTTOM FOR BRIDGE TRESTLE "A" REPAIR 203 SQ. FT. (0.005 ACRES)
- TEMPORARY CONVEYOR BELT DOCK MAXIMUM 18, 36" DIA. IN-WATER HOLLOW STEEL PILES. 127 SQ. FT. (0.003 ACRES) SUBAQUEOUS BOTTOM IMPACTS. APPROXIMATELY 3,650 SQ. FT. (0.08 ACRES) FOR DOCK SUPERSTRUCTURE
- SETTLEMENT MITIGATION/BERM CONSTRUCTION 339 SHEET PILES (ZZ-28-700) BELOW MHW (778 L.F.); IMPACT WITHIN BERM FOOTPRINT
- SETTLEMENT MITIGATION/BERM CONSTRUCTION 347 SHEET PILES (ZZ-28-700) ABOVE MHW (796 L.F.)
- PIEZOMETER (VWP-TBM-PZ#) 3 PIEZOMETER TOTAL OF 3 SQ. FT. BOTTOM IMPACTS
- TYPICAL MOORING CLUSTERS (A.K.A BREASTING DOLPHINS)-EACH CONSISTING OF FIVE 36" DIA HOLLOW STEEL PILES - 250 SQ. FT. OF SUBAQUEOUS BOTTOM IMPACT PER CLUSTER (4 CLUSTERS = TOTAL 1,000 SQ. FT. (0.02 ACRES) SUBAQUEOUS BOTTOM IMPACTS)
- MUCK BIN - 412 SHEET PILES (AZ 14-770) 1040.6 LF, 11 SHEET PILES (HZ 880 M 12) 16.5 LF, 22 SHEET PILES (HZ 1180-24D) 33.2 LF, 17,856 SQ. FT. ABOVE MHW; NO SUBAQUEOUS BOTTOM IMPACT

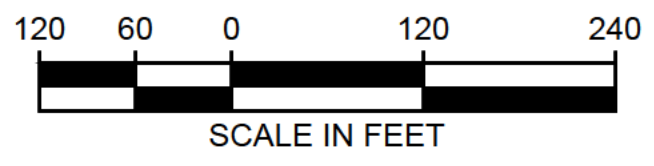
LEGEND - PERMANENT IMPACTS

- ENGINEERED BERM ON SUBAQUEOUS BOTTOM (SAND) BELOW MLW 196,456 SQ. FT. (4.51 ACRES)
- ENGINEERED BERM ON SUBAQUEOUS BOTTOM (ROCK) BELOW MLW 64,469 SQ. FT. (1.48 ACRES)
- ENGINEERED BERM ON EXISTING TIDAL NON-VEGETATED WETLANDS (ROCK) MLW TO MHW 1,742 SQ. FT. (0.04 ACRES)
- BRIDGE TRESTLE "A" SUPERSTRUCTURE AND SUBSTRUCTURE MAINTENANCE REPAIR AND/OR REPLACEMENT OF UP TO THIRTY, 54" CONCRETE CYLINDER PILES - 477 SQ. FT. (0.011 ACRES)
- FISHING PIER SUPERSTRUCTURE AND SUBSTRUCTURE MAINTENANCE REPAIR AND/OR REPLACEMENT OF UP TO THIRTY, 54" CONCRETE CYLINDER PILES - 477 SQ. FT. (0.011 ACRES)


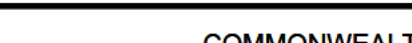
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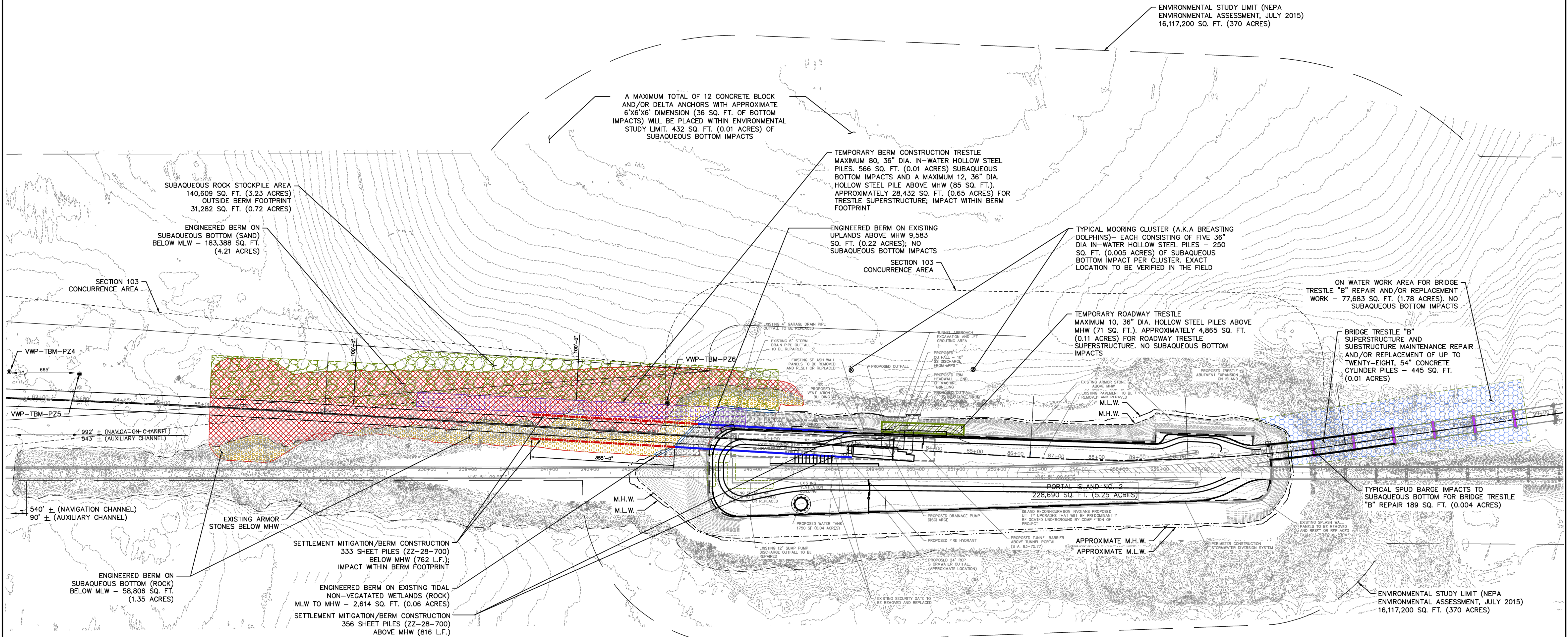
- ON WATER WORK AREA FOR BRIDGE TRESTLE "A" REPAIR AND/OR REPLACEMENT - 139,154 SQ. FT. (3.19 ACRES) NO SUBAQUEOUS BOTTOM IMPACTS
- ON WATER WORK AREA FOR FISHING PIER REPAIR AND/OR REPLACEMENT - 59,121 SQ. FT. (1.36 ACRES) NO SUBAQUEOUS BOTTOM IMPACTS
- TOTAL BERM FOUNDATION DREDGING 151,456 SQ. FT.(3.48 ACRES) 48,352 CY.
- ENGINEERED BERM ON EXISTING UPLAND ABOVE MHW 6,970 SQ. FT. (0.16 ACRES); NO SUBAQUEOUS BOTTOM IMPACT

MHW = 2.92' CBBT DATUM
MLW = 0.37' CBBT DATUM
NOTES: MHW/MLW SHOWN AS APPROXIMATE LOCATIONS, ADDITIONAL SURVEY DATA REQUIRED.



JOB NO. 375986
FILENAME CV-1110-103-104 (1) IMPACT

PERMITTING PACKAGE										COMMONWEALTH OF VIRGINIA CHESAPEAKE BAY BRIDGE AND TUNNEL DISTRICT CAPE CHARLES, VIRGINIA 23310		Figure 2 - PORTAL ISLAND NO. 1 PERMIT LEVEL DESIGN IMPACT AREA PLAN				
SUBMISSION TYPE										PARALLEL THIMBLE SHOAL TUNNEL TO LUCIUS J. KELLAM, JR. BRIDGE-TUNNEL						
JPA IMPACT DRAWINGS 11-27-2017		G	12-06-17	JJS	RSL	VMRC/DEQ IMPACT DRAWINGS						DRAWN BY:	JJS	SCALE:	1" = 120'	DWG. NO.
		F	08-31-17	JJS	RSL	JPA IMPACT DRAWINGS						CHECKED BY:	RSL	DATE:		SHEET 1 OF 2
		E	7-27-17	JJS	RSL	VMRC/DEQ IMPACT DRAWING REVISIONS										
		D	04-27-17	JJS	RSL	VMRC/DEQ SUPPLEMENTAL IMPACT DRAWINGS										
		NO.	DATE	BY	APP.	DESCRIPTION										



LEGEND - TEMPORARY IMPACTS

- SUBAQUEOUS ROCK STOCKPILE AREA 140,609 SQ. FT. (3.23 ACRES) OUTSIDE BERM FOOTPRINT 31,282 SQ. FT. (0.72 ACRES)
- A MAXIMUM TOTAL OF 12 CONCRETE BLOCK AND/OR DELTA ANCHORS WITH APPROXIMATE 6'X6'X6" DIMENSION (36 SQ. FT. OF BOTTOM IMPACTS) WILL BE PLACED WITHIN ENVIRONMENTAL STUDY LIMIT. 432 SQ. FT. (0.01 ACRES) OF SUBAQUEOUS BOTTOM IMPACTS.
- TYPICAL SPUD BARGE IMPACTS TO SUBAQUEOUS BOTTOM FOR BRIDGE TRESTLE "B" REPAIR 189 SQ. FT. (0.004 ACRES)
- TEMPORARY BERM CONSTRUCTION TRESTLE MAXIMUM 80, 36" DIA. IN-WATER HOLLOW STEEL PILES. 566 SQ. FT. (0.01 ACRES) SUBAQUEOUS BOTTOM IMPACTS AND A MAXIMUM 12, 36" DIA. HOLLOW STEEL PILE ABOVE MHW (85 SQ. FT.). APPROXIMATELY 28,432 SQ. FT. (0.65 ACRES) FOR TRESTLE SUPERSTRUCTURE; IMPACT WITHIN BERM FOOTPRINT

LEGEND - PERMANENT IMPACTS

- SETTLEMENT MITIGATION/BERM CONSTRUCTION 333 SHEET PILES (ZZ-28-700) BELOW MHW (762 L.F.); IMPACT WITHIN BERM FOOTPRINT
- SETTLEMENT MITIGATION/BERM CONSTRUCTION 356 SHEET PILES (ZZ-28-700) ABOVE MHW (816 L.F.)
- PIEZOMETER (VWP-TBM-PZ#) 3 PIEZOMETERS TOTAL OF 3 SQ. FT. OF SUBAQUEOUS BOTTOM IMPACTS
- TYPICAL MOORING CLUSTERS (A.K.A BREASTING DOLPHINS)- EACH CONSISTING OF FIVE 36" DIA HOLLOW STEEL PILES 250 SQ. FT. OF SUBAQUEOUS BOTTOM IMPACT PER CLUSTER (2 CLUSTERS = TOTAL 500 SQ. FT. (0.01 ACRES)

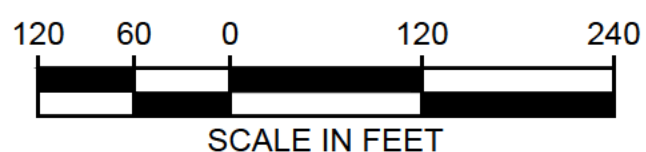
LEGEND - PERMANENT IMPACTS

- ENGINEERED BERM ON SUBAQUEOUS BOTTOM (SAND) BELOW MLW - 183,388 SQ. FT. (4.21 ACRES)
- ENGINEERED BERM ON SUBAQUEOUS BOTTOM (ROCK) BELOW MLW - 58,806 SQ. FT. (1.35 ACRES)
- ENGINEERED BERM ON EXISTING TIDAL NON-VEGATATED WETLANDS (ROCK) MLW TO MHW - 2,614 SQ. FT. (0.06 ACRES)
- BRIDGE TRESTLE "B" SUPERSTRUCTURE AND SUBSTRUCTURE MAINTENANCE REPAIR AND/OR REPLACEMENT OF UP TO TWENTY-EIGHT, 54" CONCRETE CYLINDER PILES - 445 SQ. FT. (0.01 ACRES)

NOTES:

- TEMPORARY ROADWAY TRESTLE MAXIMUM 10, 36" DIA. HOLLOW STEEL PILES ABOVE MHW (71 SQ. FT.); APPROXIMATELY 4,865 SQ. FT. (0.11 ACRES) FOR ROADWAY TRESTLE SUPERSTRUCTURE. NO SUBAQUEOUS BOTTOM IMPACTS
- ON WATER WORK AREA FOR BRIDGE TRESTLE "B" SUPERSTRUCTURE REPAIR AND/OR REPLACEMENT - 77,683 SQ. FT. (1.78 ACRES) NO SUBAQUEOUS BOTTOM IMPACTS
- ENGINEERED BERM ON EXISTING UPLANDS ABOVE MHW 9,583 SQ. FT. (0.22 ACRES); NO SUBAQUEOUS BOTTOM IMPACTS

MHW = 2.92' CBST DATUM
MLW = 0.37' CBST DATUM
NOTE: MINIMUM SHOWN AS APPROXIMATE LOCATIONS.
ADDITIONAL SURVEY DATA REQUIRED.

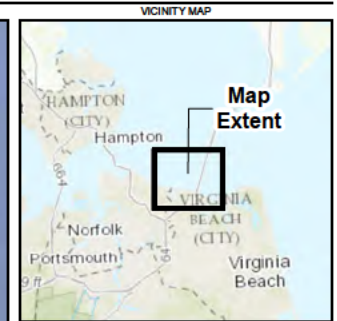
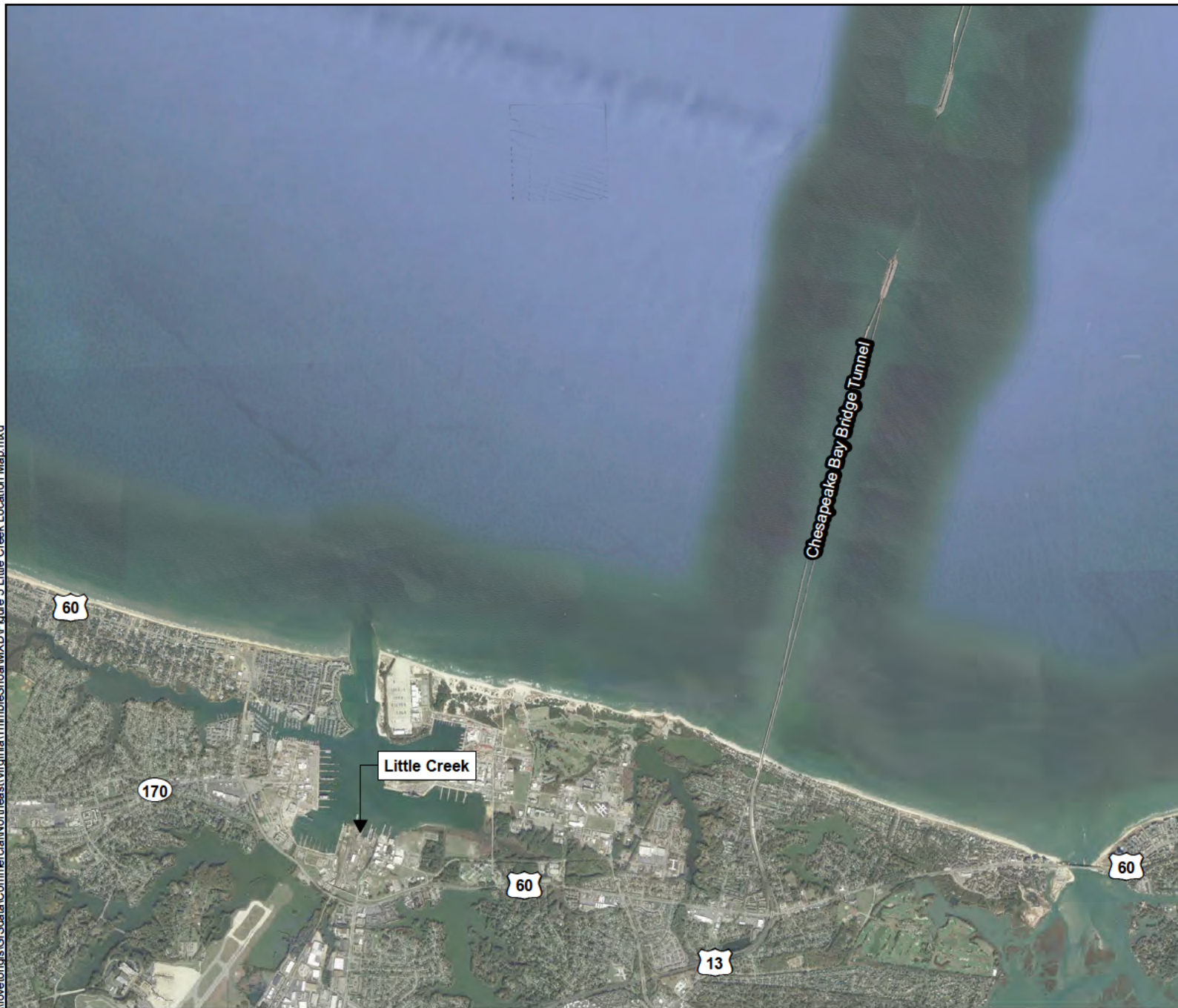


JOB NO. 375966
FILENAME CV-1110-105-106 IMPACT

PERMITTING PACKAGE							COMMONWEALTH OF VIRGINIA CHESAPEAKE BAY BRIDGE AND TUNNEL DISTRICT CAPE CHARLES, VIRGINIA 23310		
SUBMISSION TYPE									
JPA IMPACT DRAWINGS		G	12-06-17	JJS	RSL	VMRC/DEQ IMPACT DRAWINGS			
11-27-2017		F	08-31-17	JJS	RSL	JPA IMPACT DRAWINGS			
		E	07-18-17	JJS	RSL	VMRC/DEQ IMPACT DRAWINGS REVISIONS			
		D	04-27-17	JJS	RSL	VMRC/DEQ SUPPLEMENTAL IMPACT DRAWINGS			
		NO.	DATE	BY	APP.	DESCRIPTION			

FIGURE 3. PORTAL ISLAND NO. 2
PERMIT LEVEL DESIGN IMPACT
AREA PLAN

DRAWN BY:	JJS	SCALE:	1" = 120'	DWG. NO.	CV-1110
CHECKED BY:	RSL	DATE:		SHEET	2 OF 2



Map Date: 12/29/2016
Source: Google Earth 2015
Projection: NAD 1983, State Plane
Virginia South, US Feet

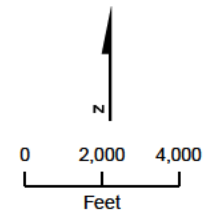
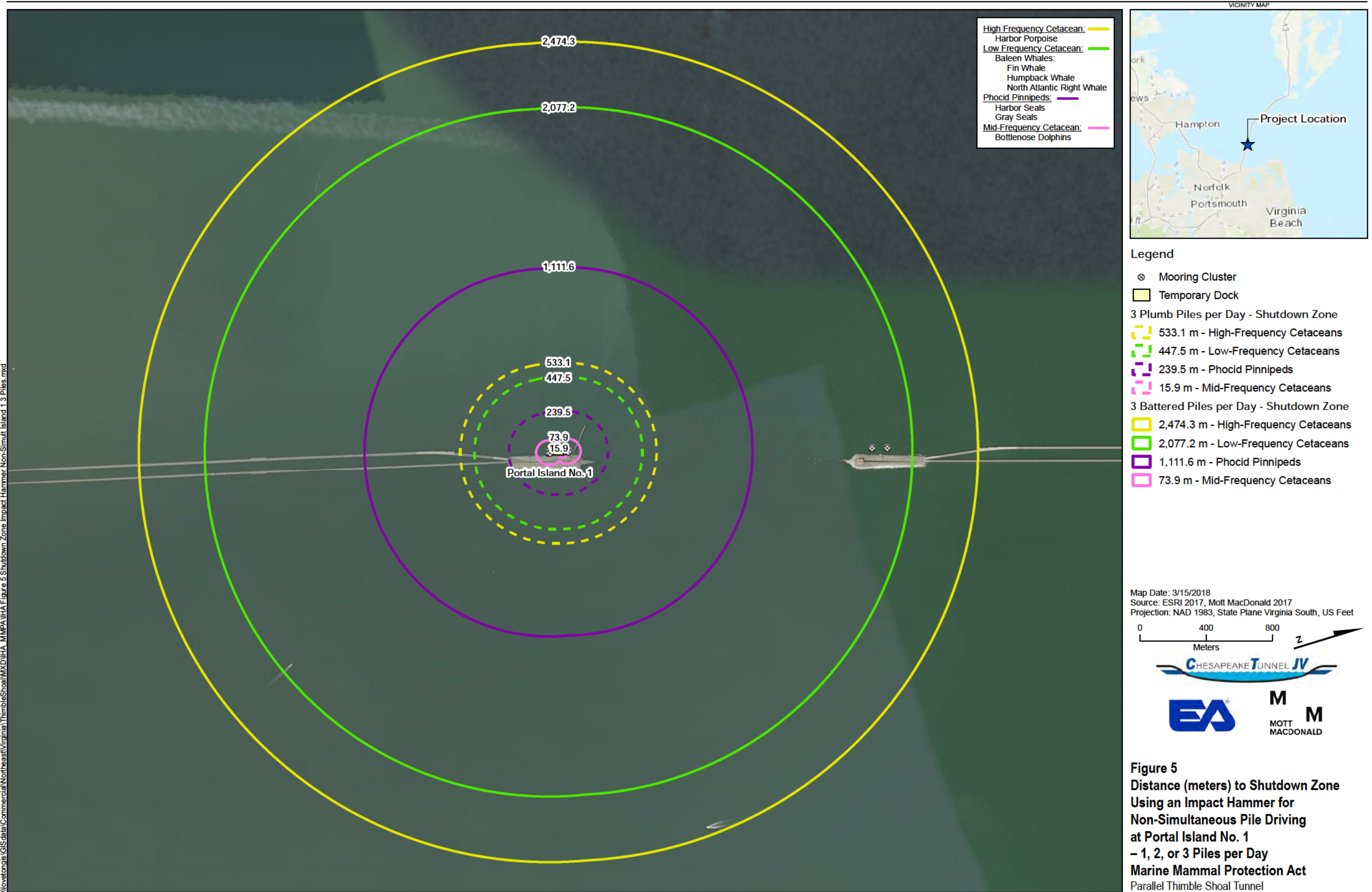


Figure 4

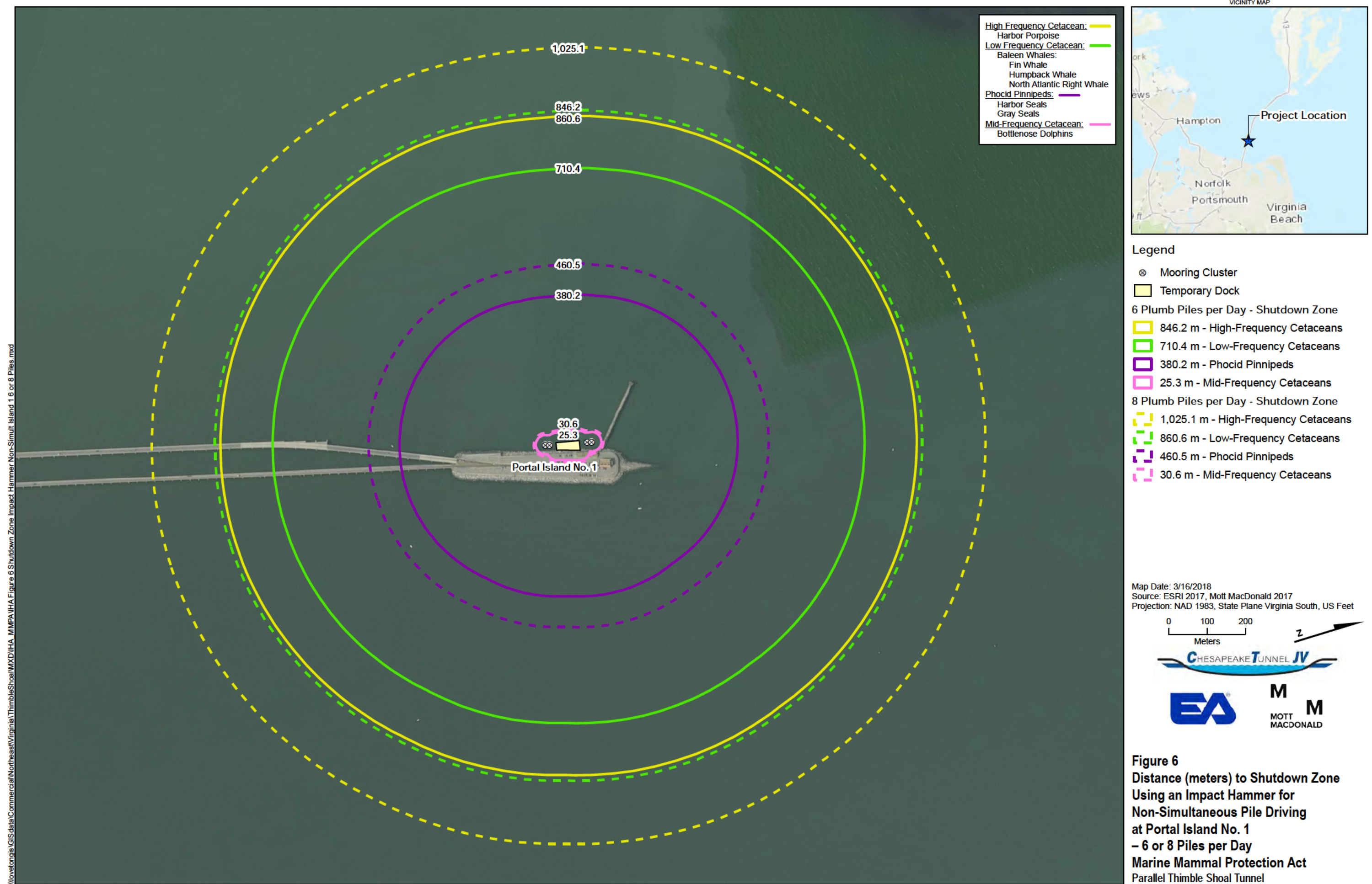
Little Creek
Location Map

Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPEA\IHA Figure 5 Shutdown Zone Impact Hammer Non-Simult Island 1 3 Piles.mxd



\\novetondg\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPIA\IHA Figure 6 Shutdown Zone Impact Hammer Non-Simult Island 1 6 or 8 Piles.mxd



\\ovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA IHA Figure 7 Shutdown Zone Impact Hammer Non-Simult Island 2 3 Piles.mxd

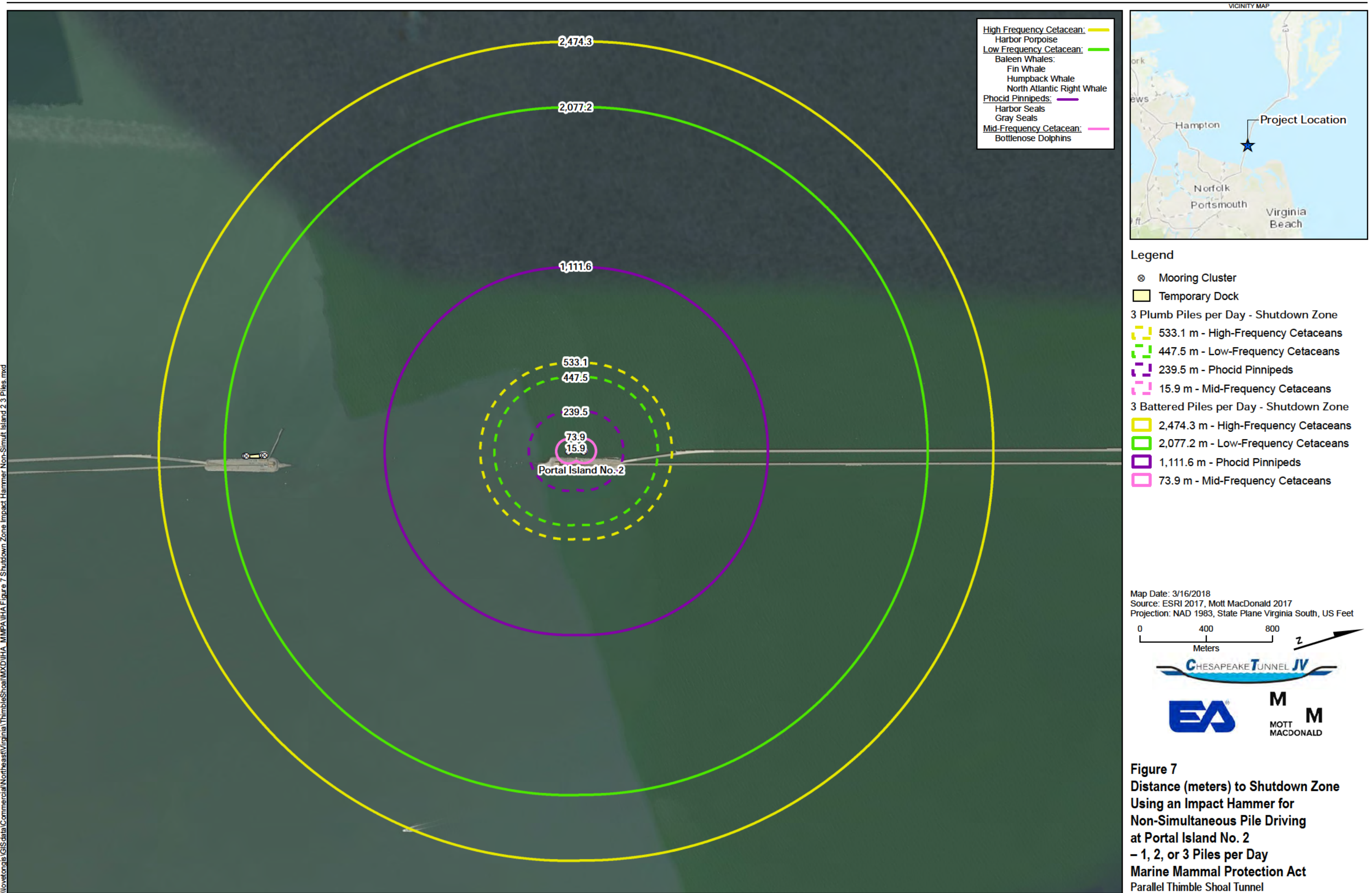
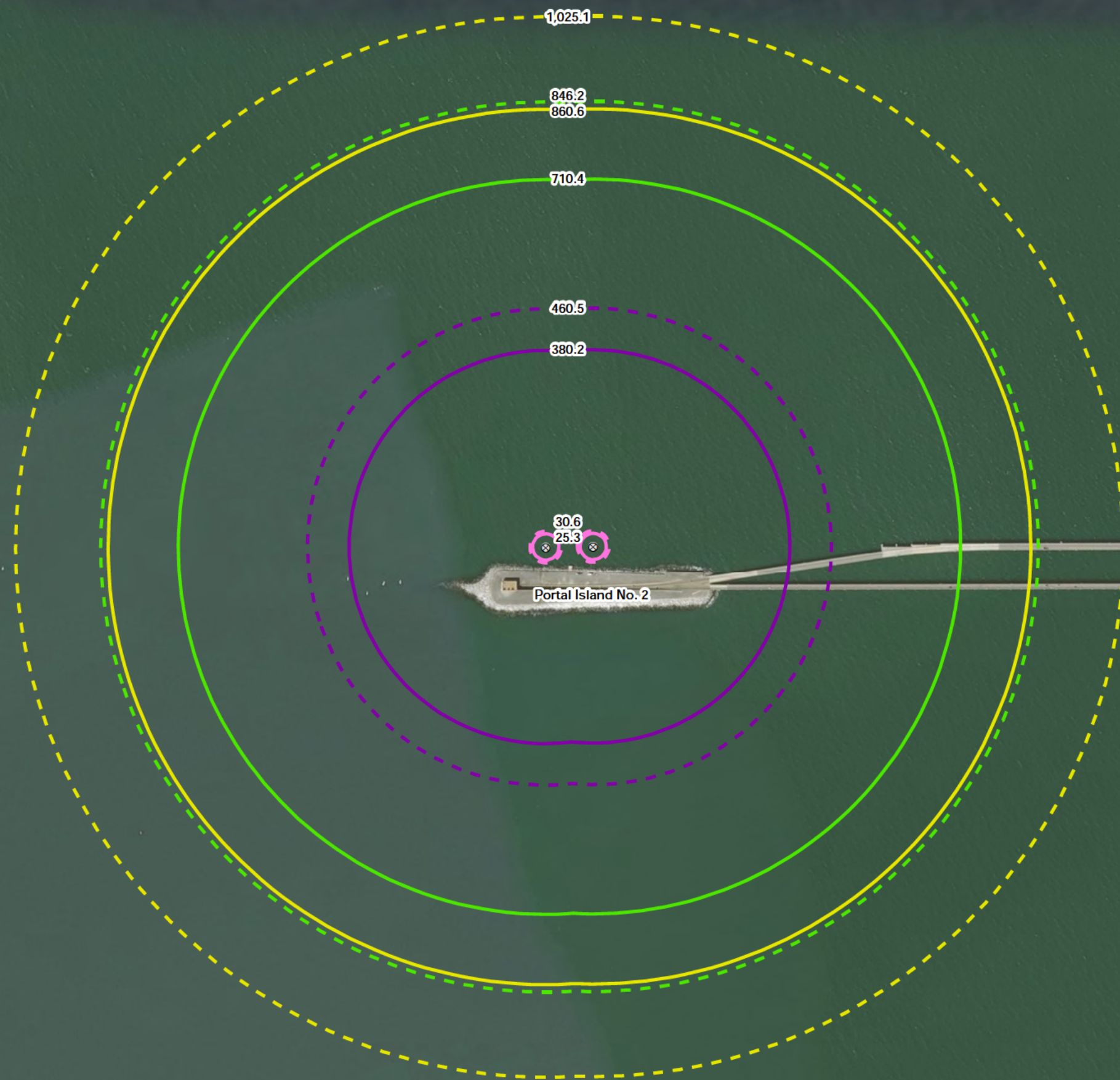
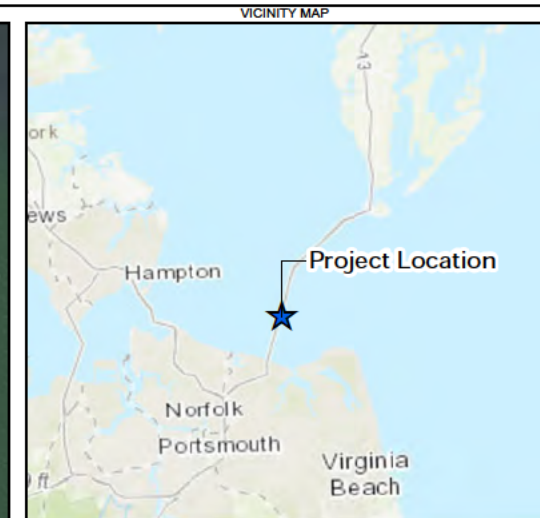


Figure 7
Distance (meters) to Shutdown Zone
Using an Impact Hammer for
Non-Simultaneous Pile Driving
at Portal Island No. 2
– 1, 2, or 3 Piles per Day
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\ovetond\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPIA\IHA Figure 8 Shutdown Zone Impact Hammer Non-Simult Island 2 6 or 8 Piles.mxd



- High Frequency Cetacean:**
Harbor Porpoise
- Low Frequency Cetacean:**
Baleen Whales:
Fin Whale
Humpback Whale
North Atlantic Right Whale
- Phocid Pinnipeds:**
Harbor Seals
Gray Seals
- Mid-Frequency Cetacean:**
Bottlenose Dolphins



- Legend**
- ⊗ Mooring Cluster
 - Temporary Dock
- 6 Plumb Piles per Day - Shutdown Zone**
- 846.2 m - High-Frequency Cetaceans
 - 710.4 m - Low-Frequency Cetaceans
 - 380.2 m - Phocid Pinnipeds
 - 25.3 m - Mid-Frequency Cetaceans
- 8 Plumb Piles per Day - Shutdown Zone**
- 1,025.1 m - High-Frequency Cetaceans
 - 860.6 m - Low-Frequency Cetaceans
 - 460.5 m - Phocid Pinnipeds
 - 30.6 m - Mid-Frequency Cetaceans

Map Date: 3/16/2018
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

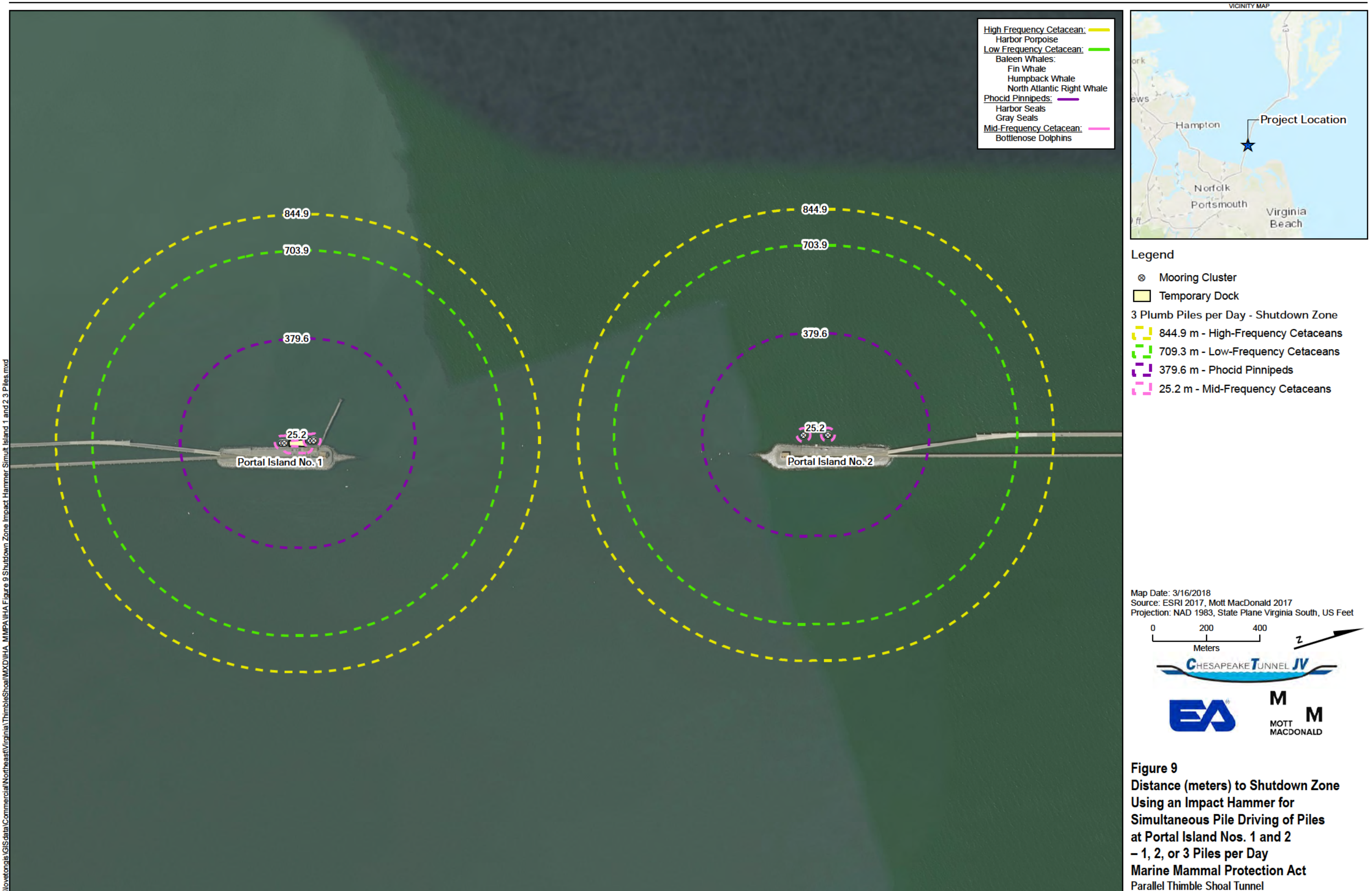
0 100 200
Meters

CHESAPEAKE TUNNEL JV

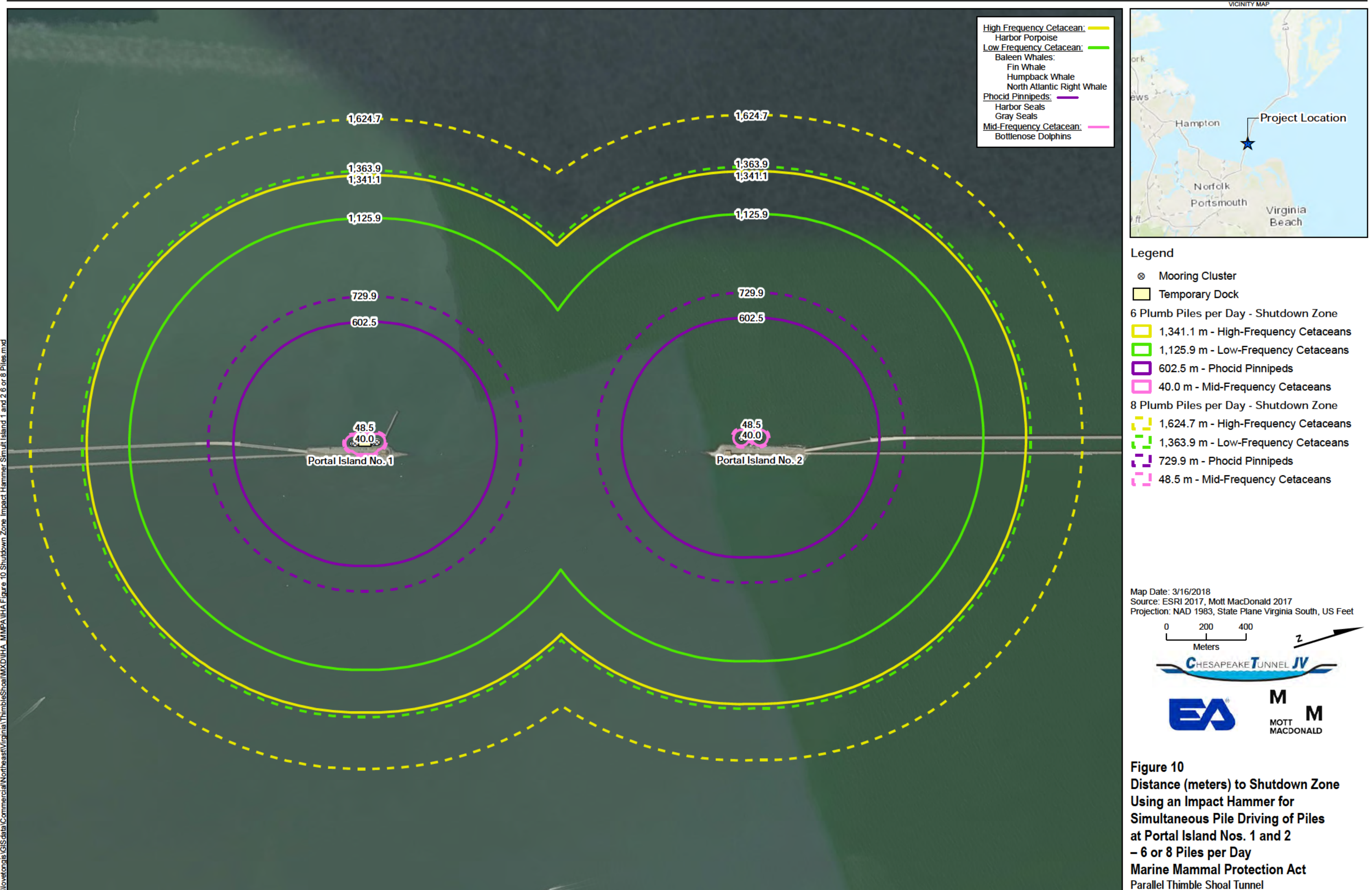
EA **M** **M**
MOTT
MACDONALD

Figure 8
Distance (meters) to Shutdown Zone
Using an Impact Hammer for
Non-Simultaneous Pile Driving
at Portal Island No. 2
– 6 or 8 Piles per Day
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\novetondg\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 9 Shutdown Zone Impact Hammer Simult Island 1 and 2 3 Piles.mxd



\\novetondg\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 10 Shutdown Zone Impact Hammer Simult Island 1 and 2 6 or 8 Piles.mxd



\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPIA\IHA Figure 11 Level B Impact Hammer Non-Simult Island 1.mxd

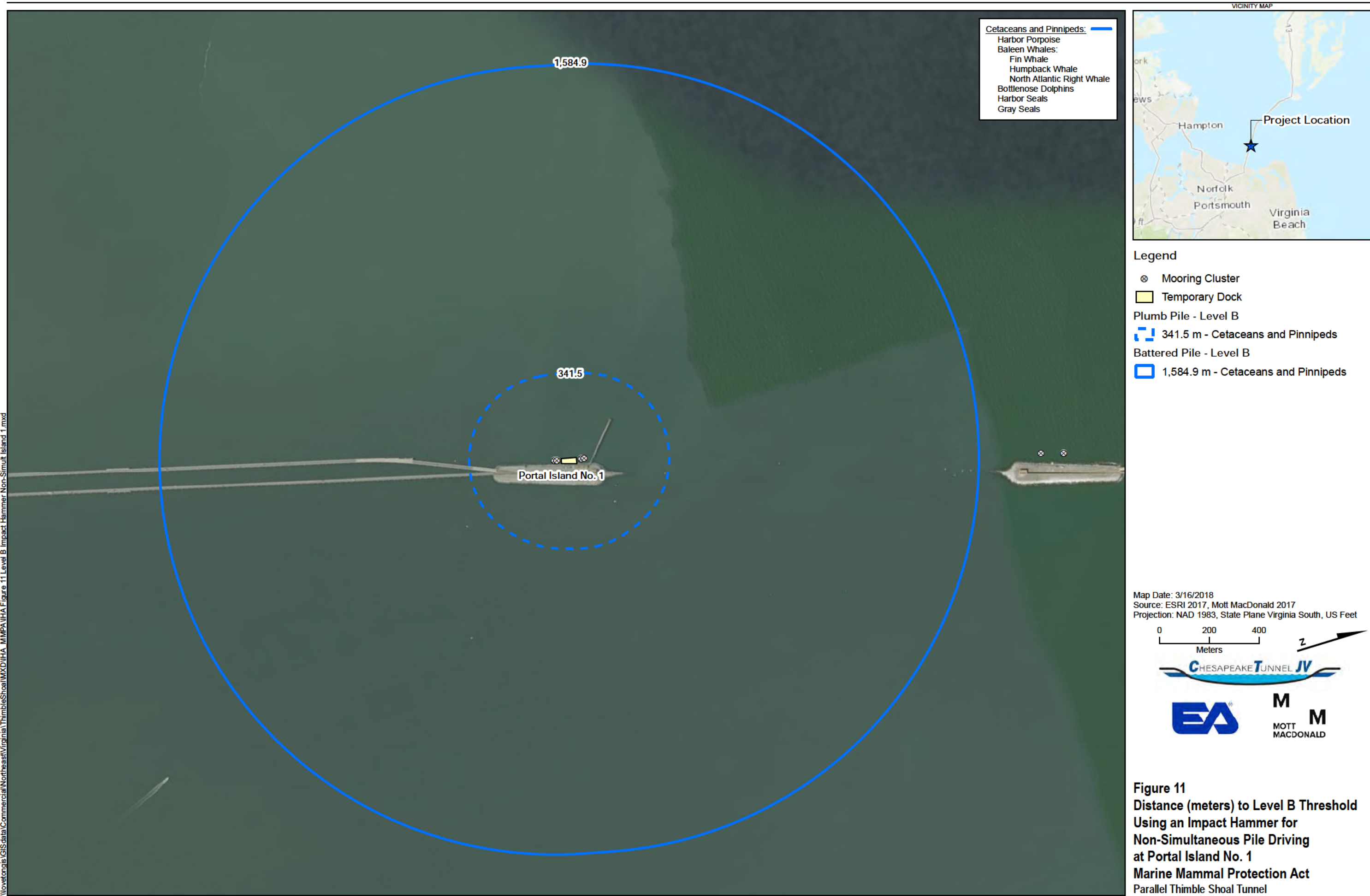
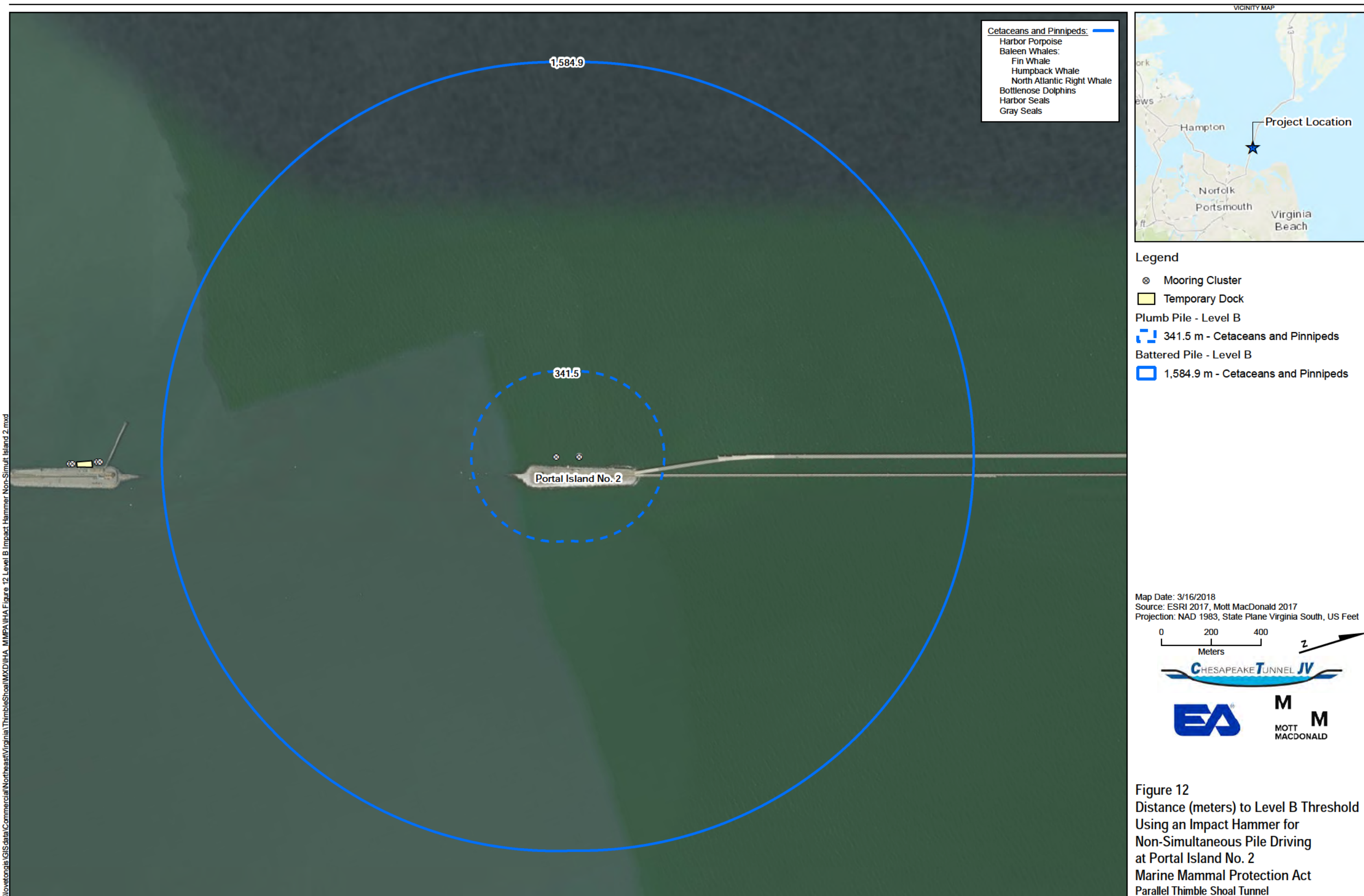
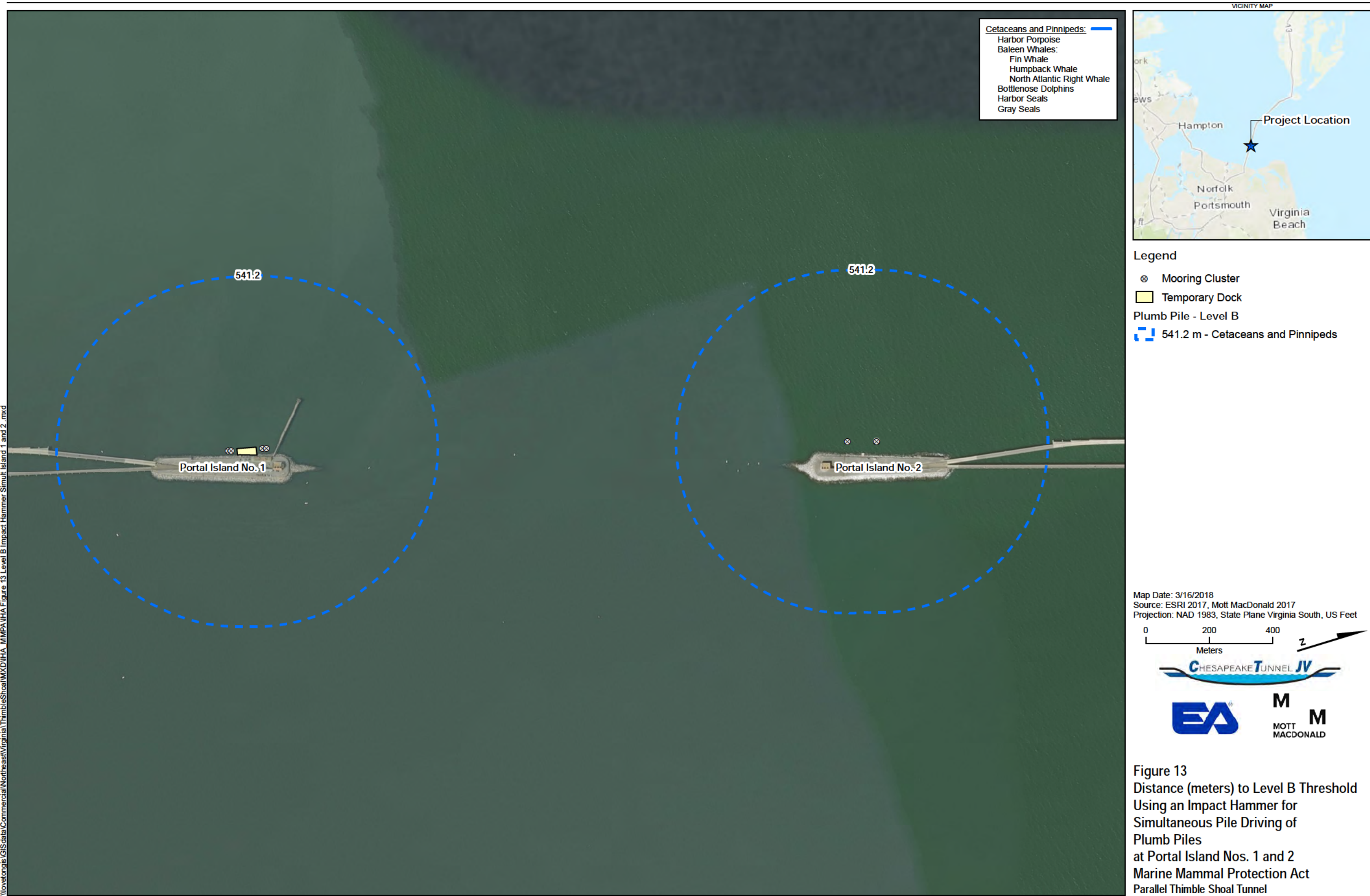


Figure 11
Distance (meters) to Level B Threshold
Using an Impact Hammer for
Non-Simultaneous Pile Driving
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

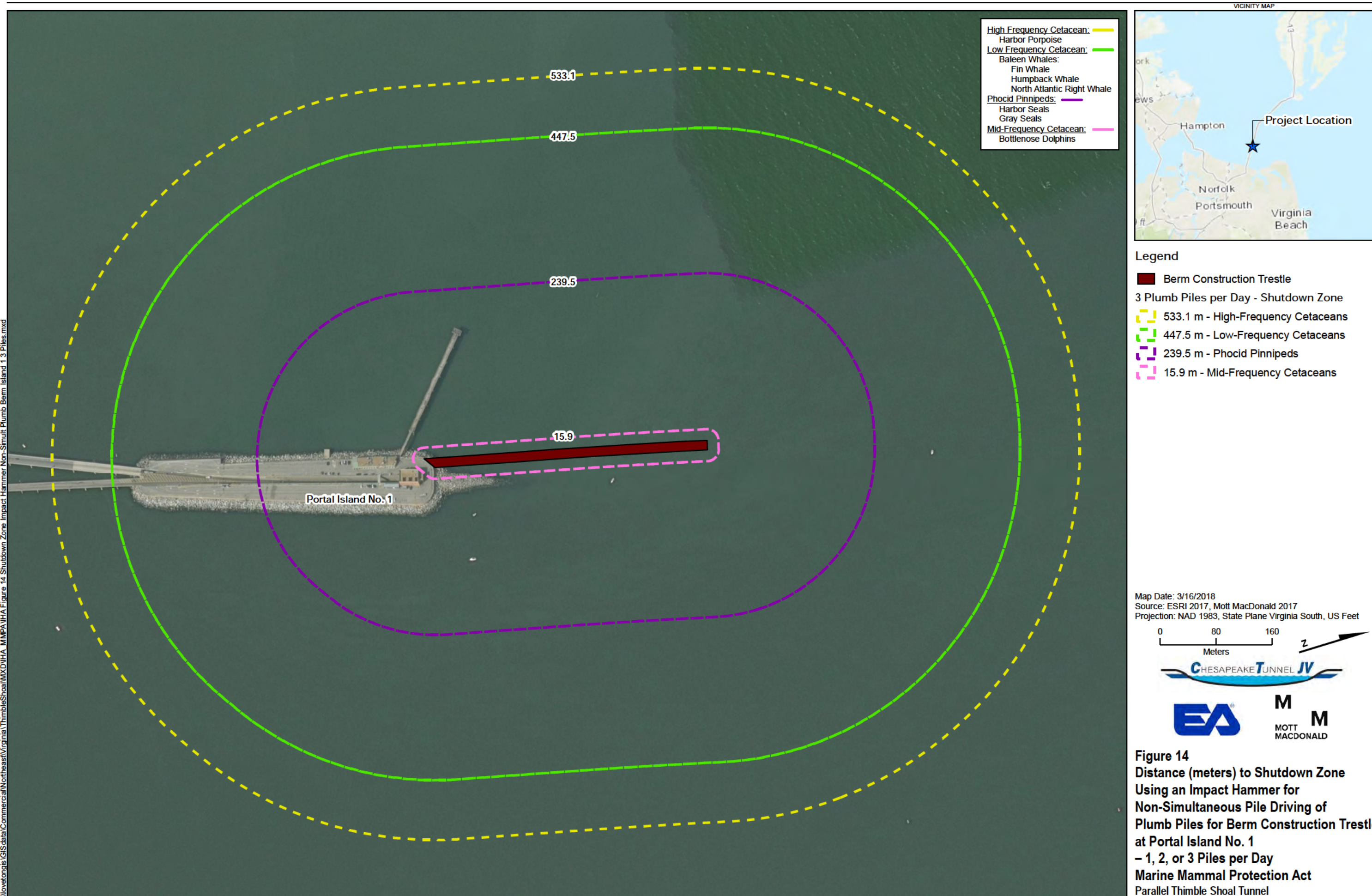
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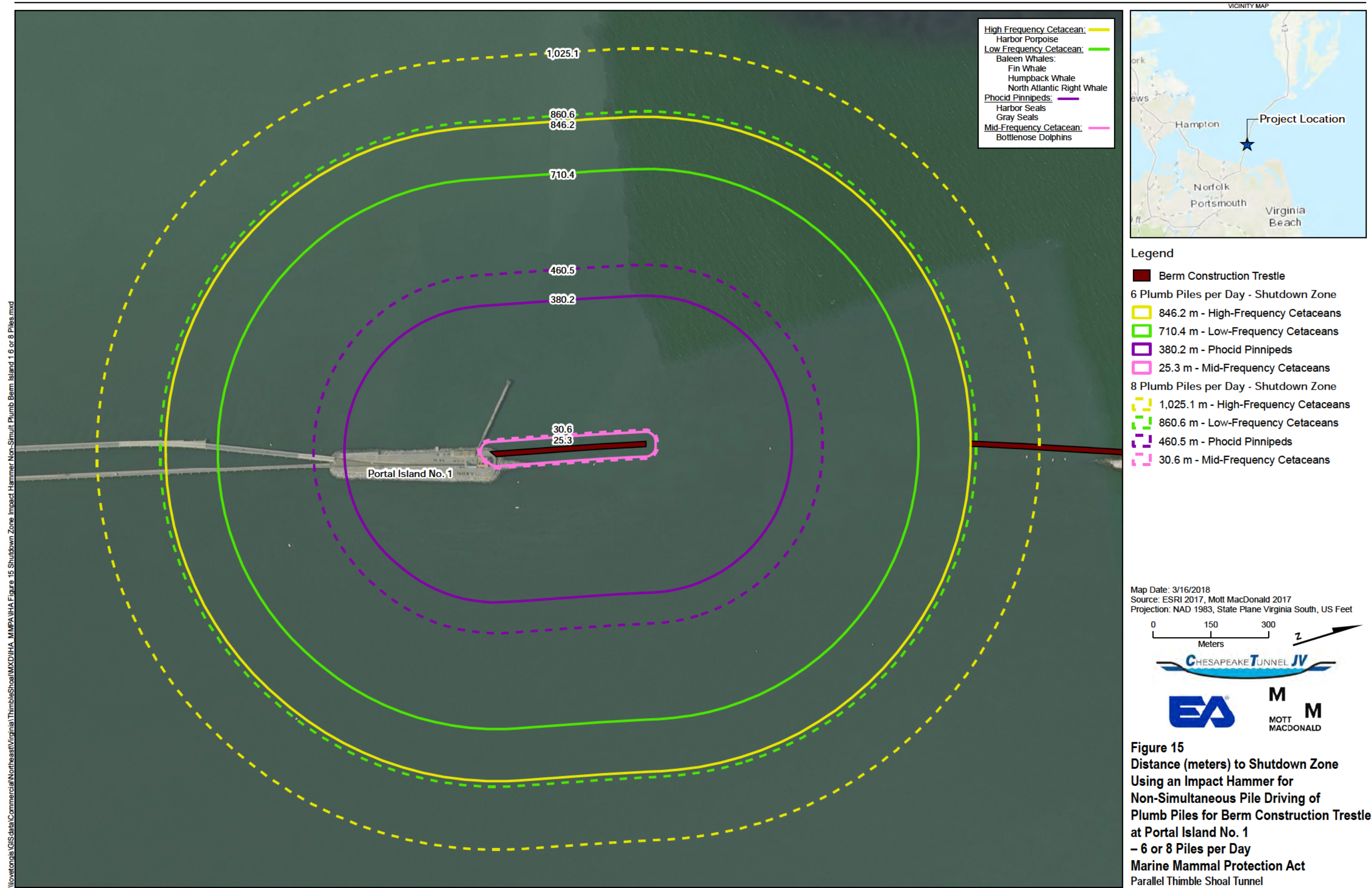
\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPIA\IHA Figure 13 Level B Impact Hammer Simult Island 1 and 2 .mxd



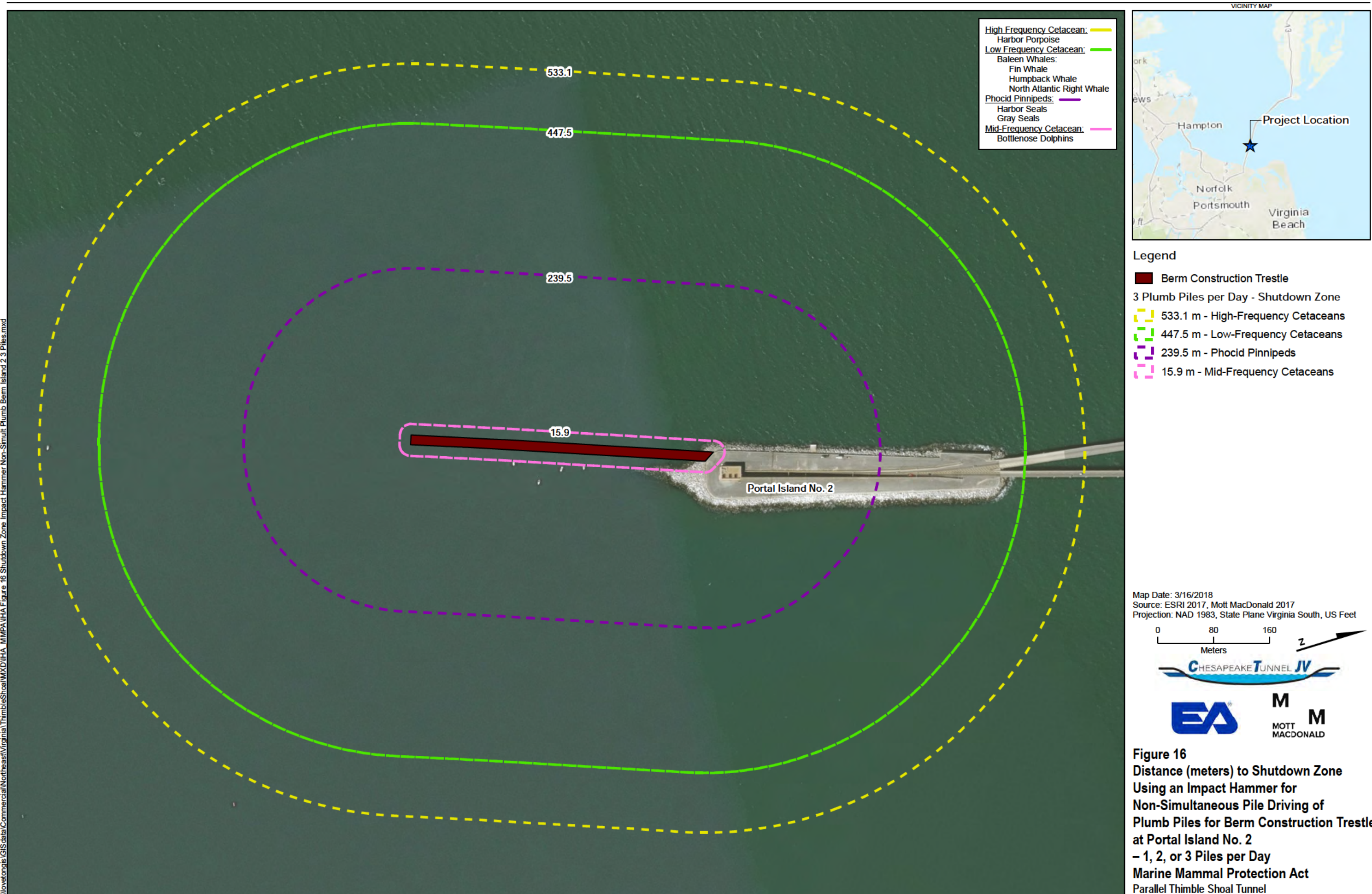
\\ovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 14 Shutdown Zone Impact Hammer Non-Simult Plumb Berm Island 1 3 Piles.mxd



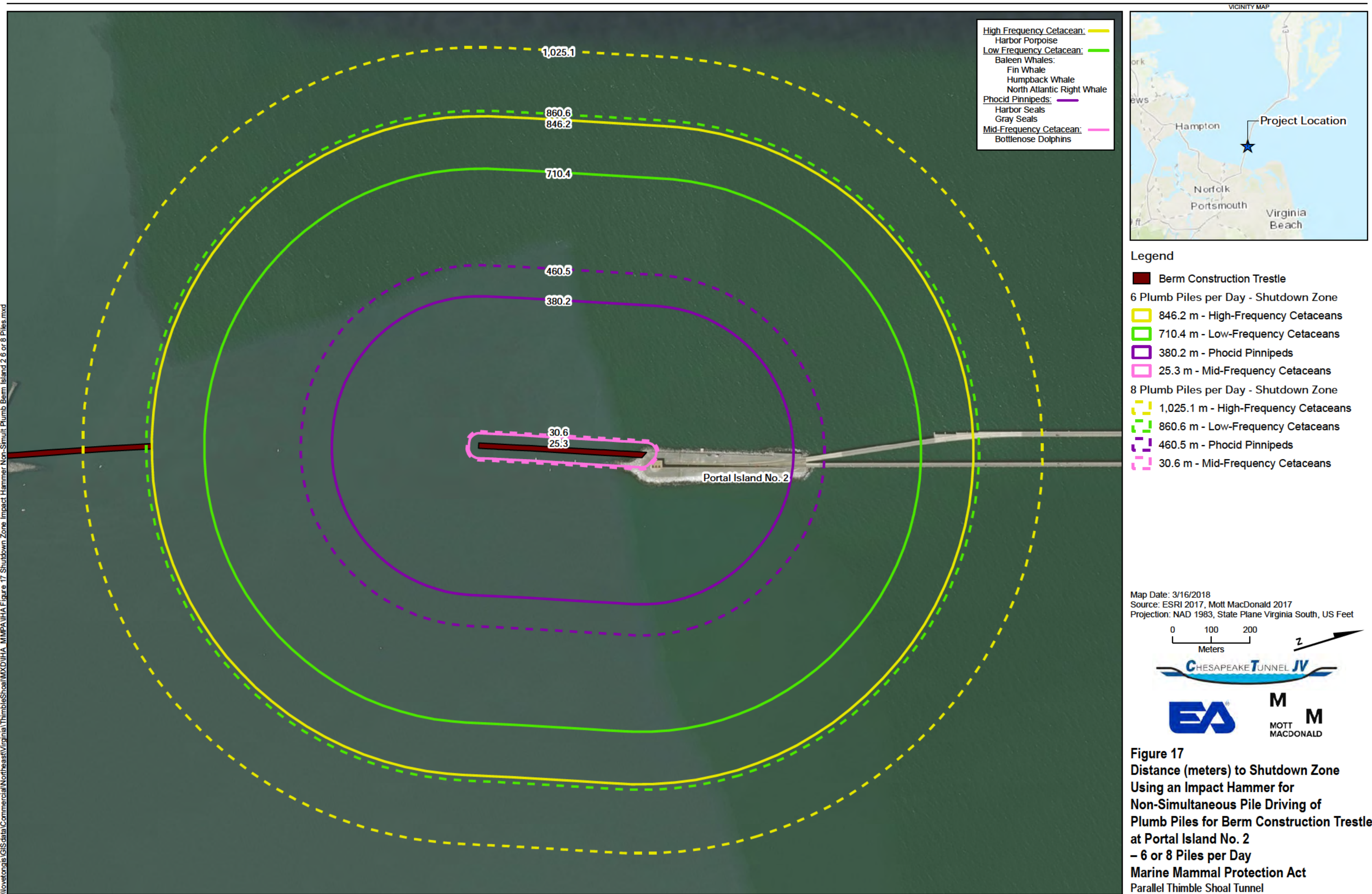
\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPA\IHA Figure 15 Shutdown Zone Impact Hammer Non-Simult Plumb Berm Island 1 6 or 8 Piles.mxd



\\novetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\IHA Figure 16 Shutdown Zone Impact Hammer Non-Simult Plumb Berm Island 2 3 Piles.mxd



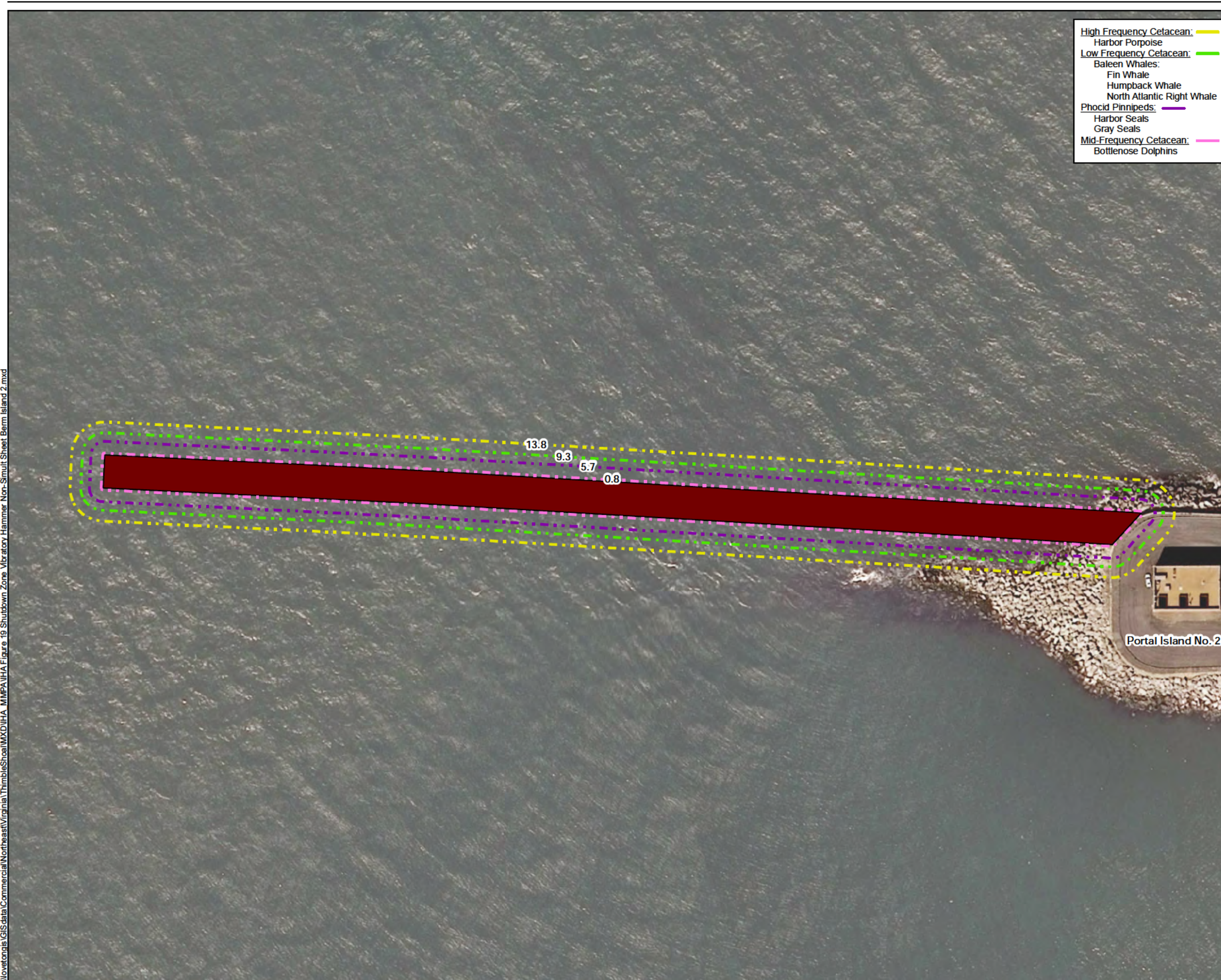
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\\lovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\IHA_Figure 18 Shutdown Zone Vibratory Hammer Non-Simult Sheet Berm Island 1.mxd



\\ovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPIA\IHA Figure 19 Shutdown Zone Vibratory Hammer Non-Simult Sheet Berm Island 2.mxd



- High Frequency Cetacean:
Harbor Porpoise
- Low Frequency Cetacean:
Baleen Whales:
Fin Whale
Humpback Whale
North Atlantic Right Whale
- Phocid Pinnipeds:
Harbor Seals
Gray Seals
- Mid-Frequency Cetacean:
Bottlenose Dolphins



Legend

- Berm Construction Trestle
- 8 Sheet Piles per Day - Shutdown Zone
- 13.8 m - High-Frequency Cetaceans
- 9.3 m - Low-Frequency Cetaceans
- 5.7 m - Phocid Pinnipeds
- 0.8 m - Mid-Frequency Cetaceans

Map Date: 3/21/2018
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

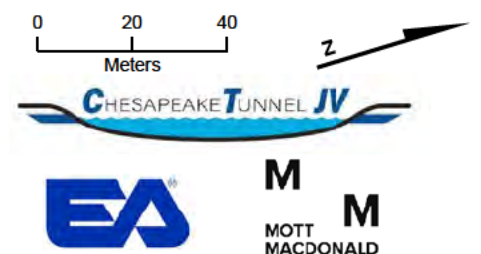
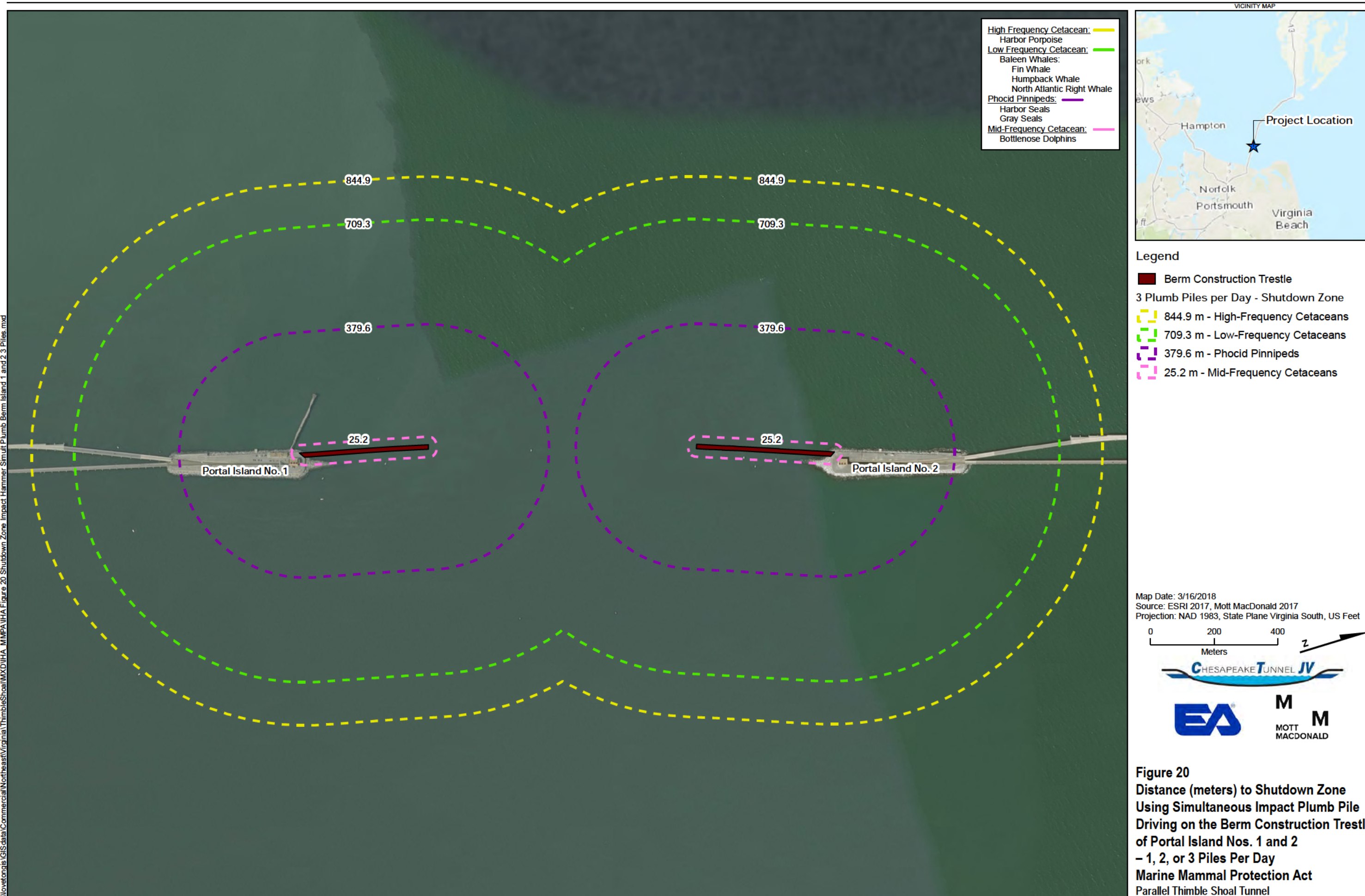
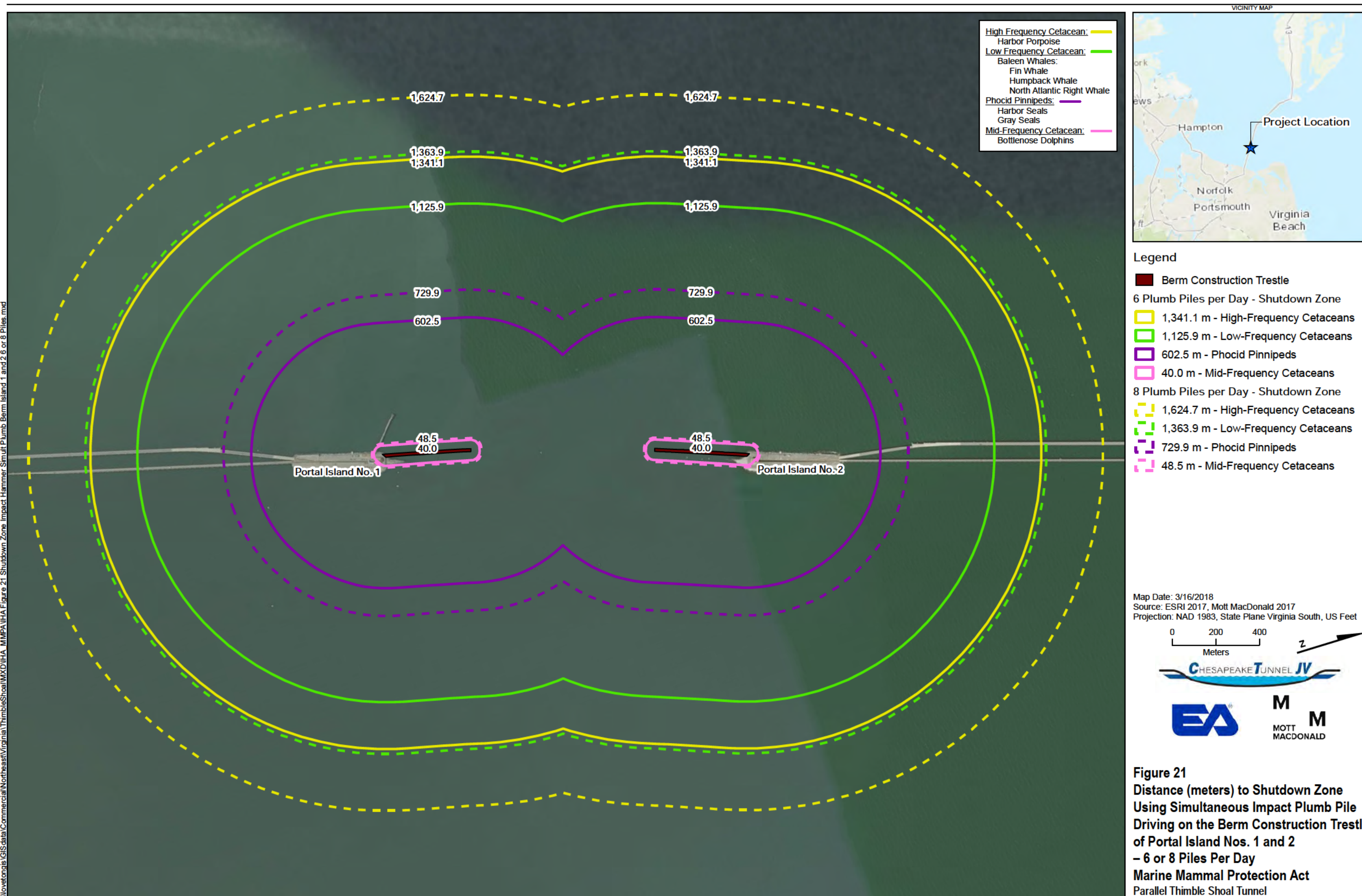


Figure 19
Distance (meters) to Shutdown Zone
Using a Vibratory Hammer for
Non-Simultaneous Sheet Pile Driving for
the Berm Construction Trestle
at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

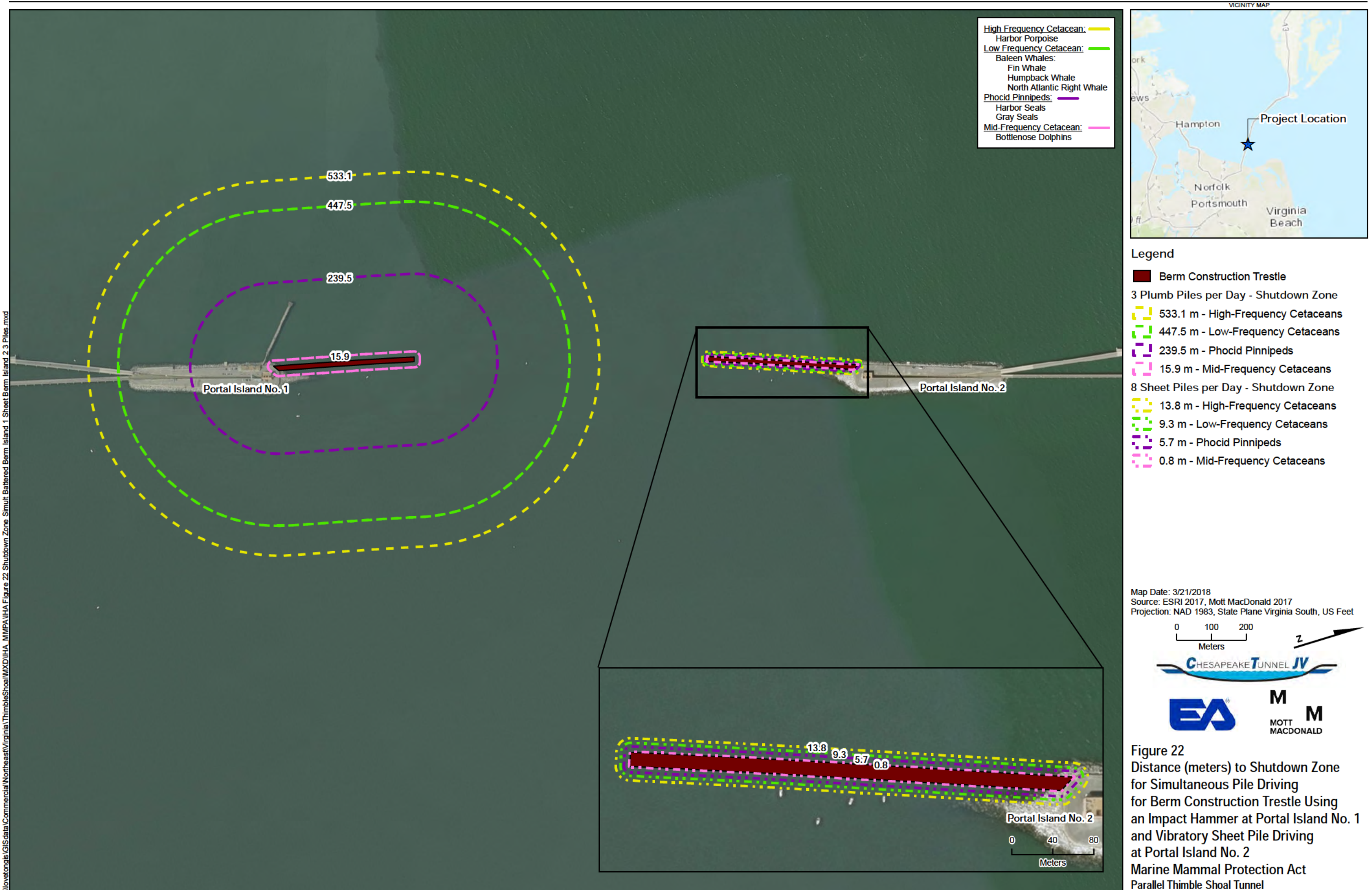
\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 20 Shutdown Zone Impact Hammer Simult Plumb Berm Island 1 and 2 3 Piles.mxd



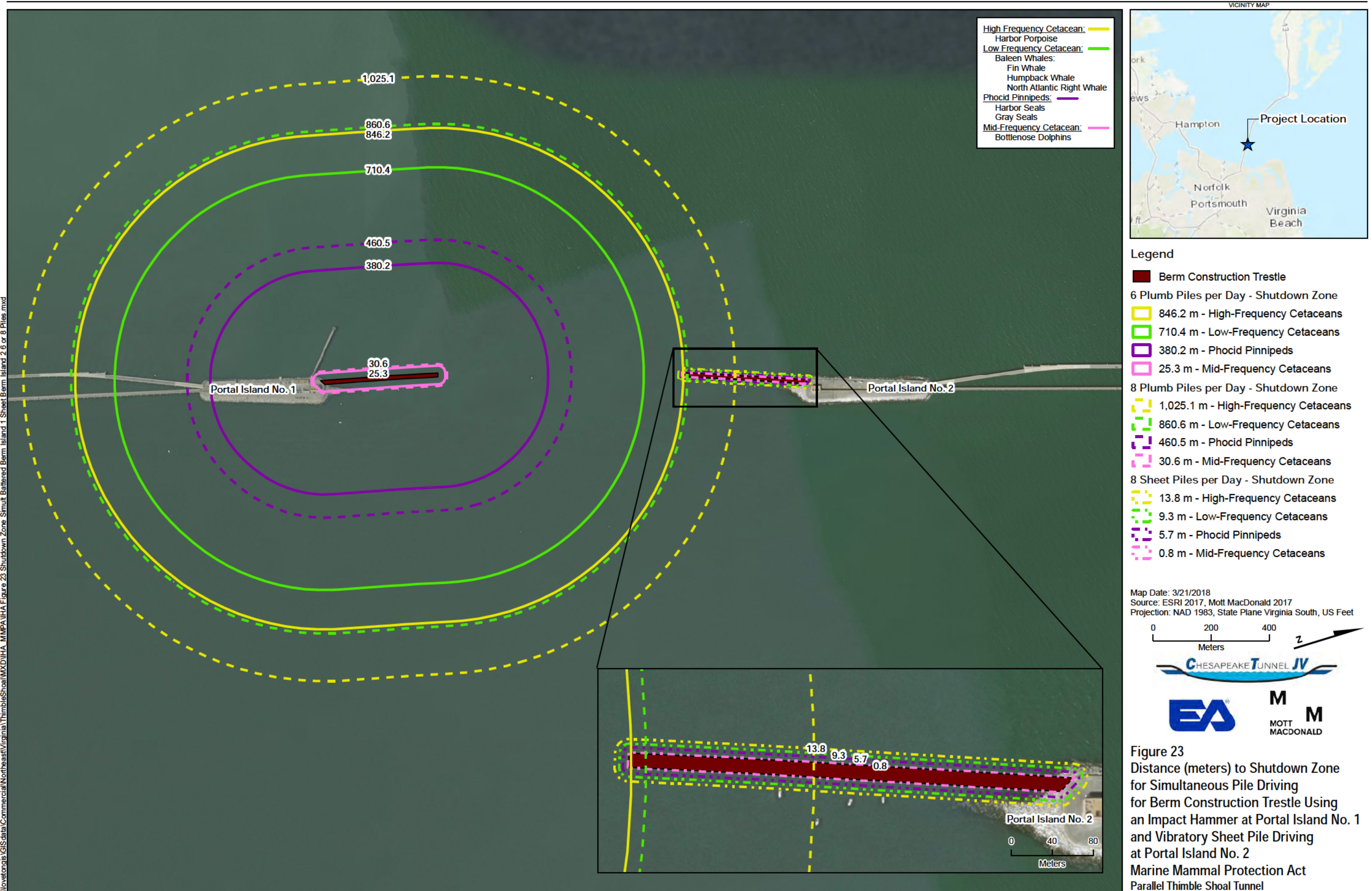
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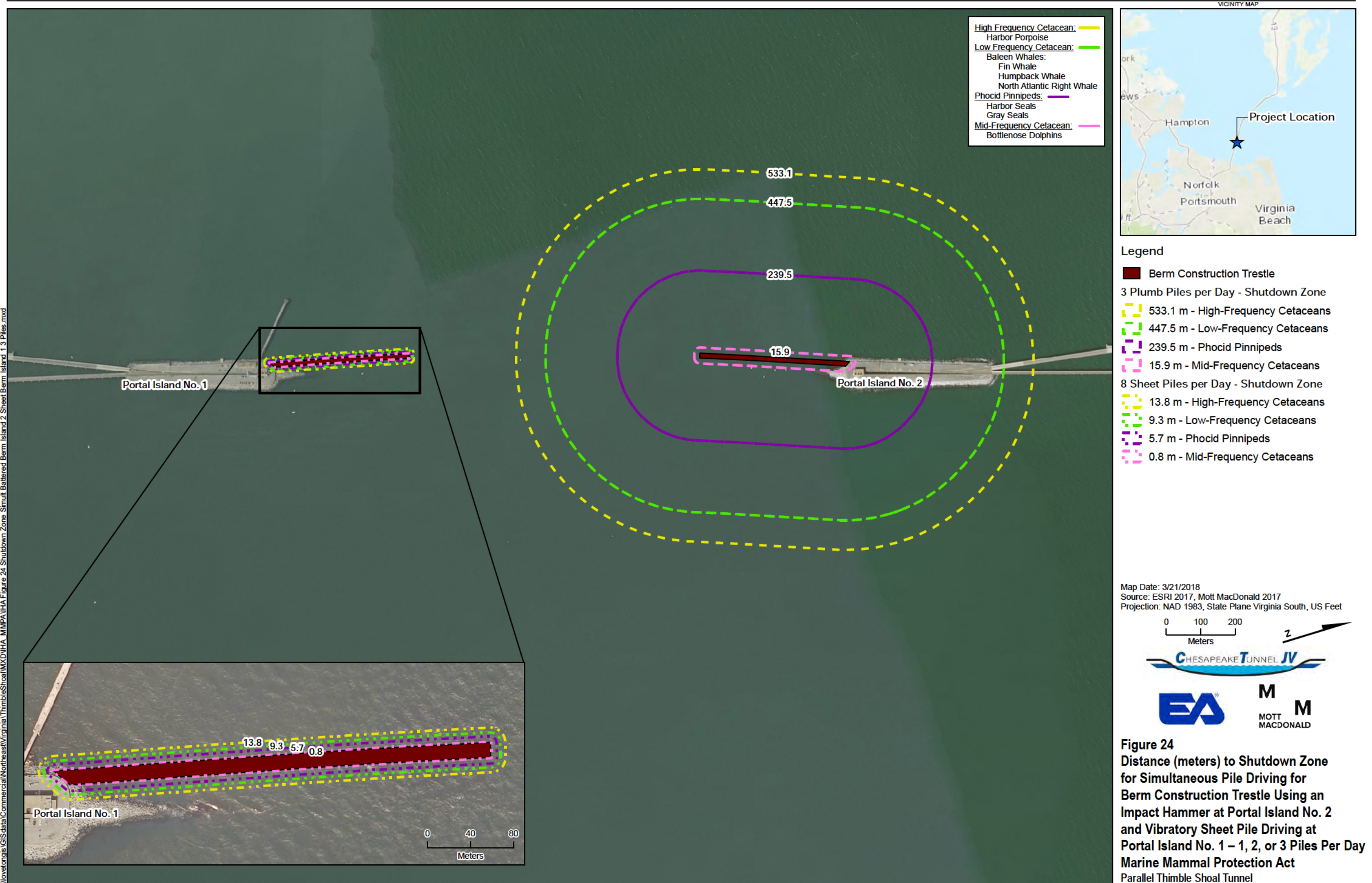
\\novetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 22 Shutdown Zone Simult Battered Berm Island 1 Sheet Battered Berm Island 2 3 Piles.mxd



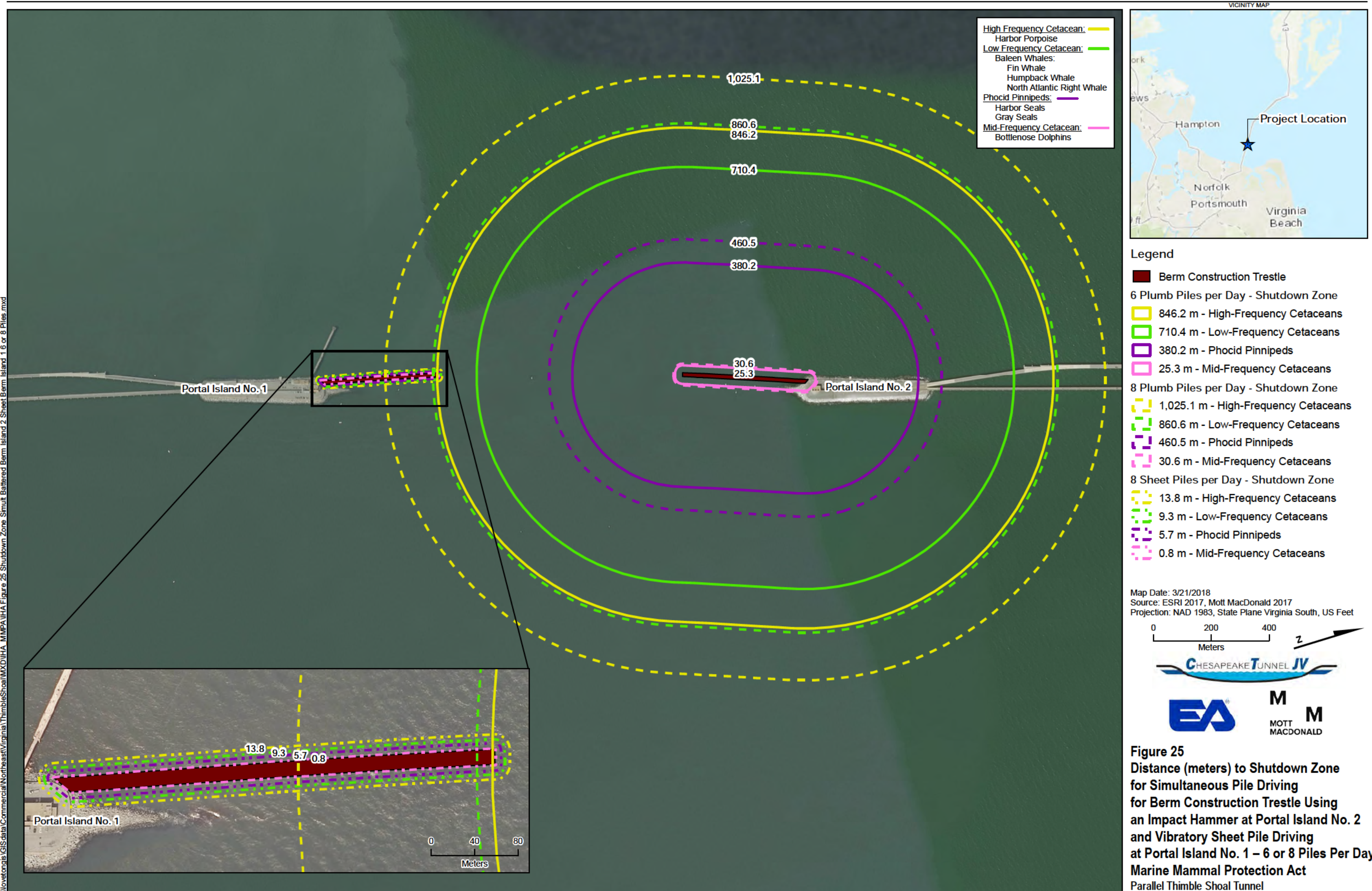
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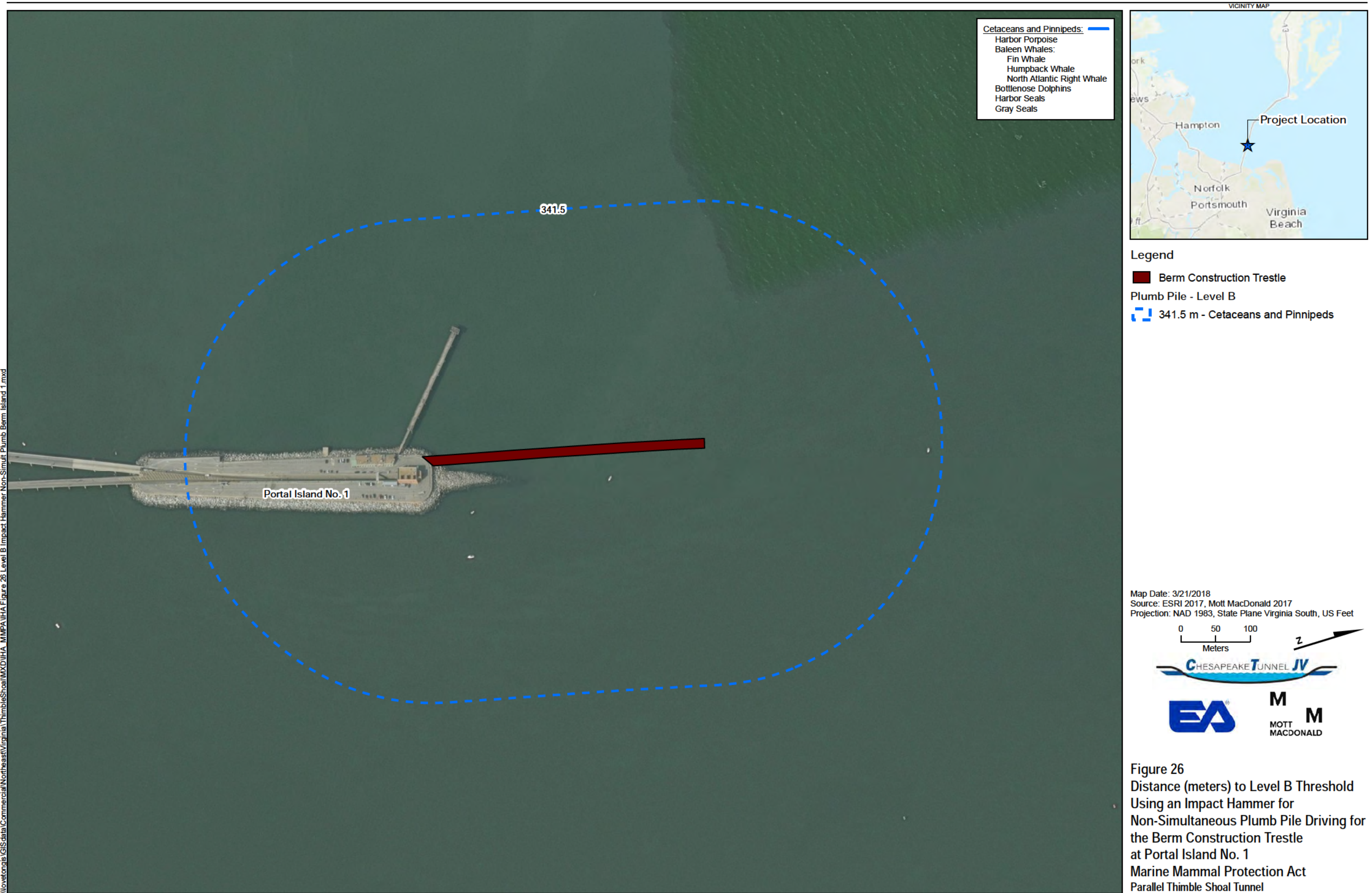
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\\novet\eng\GIS\data\Commercial\Northeast\Virginia\Thimble Shoal\MXD\IHA MPA\IHA Figure 25 Shutdown Zone Simultaneous Pile Driving Berm Island 1 6 or 8 Piles.mxd



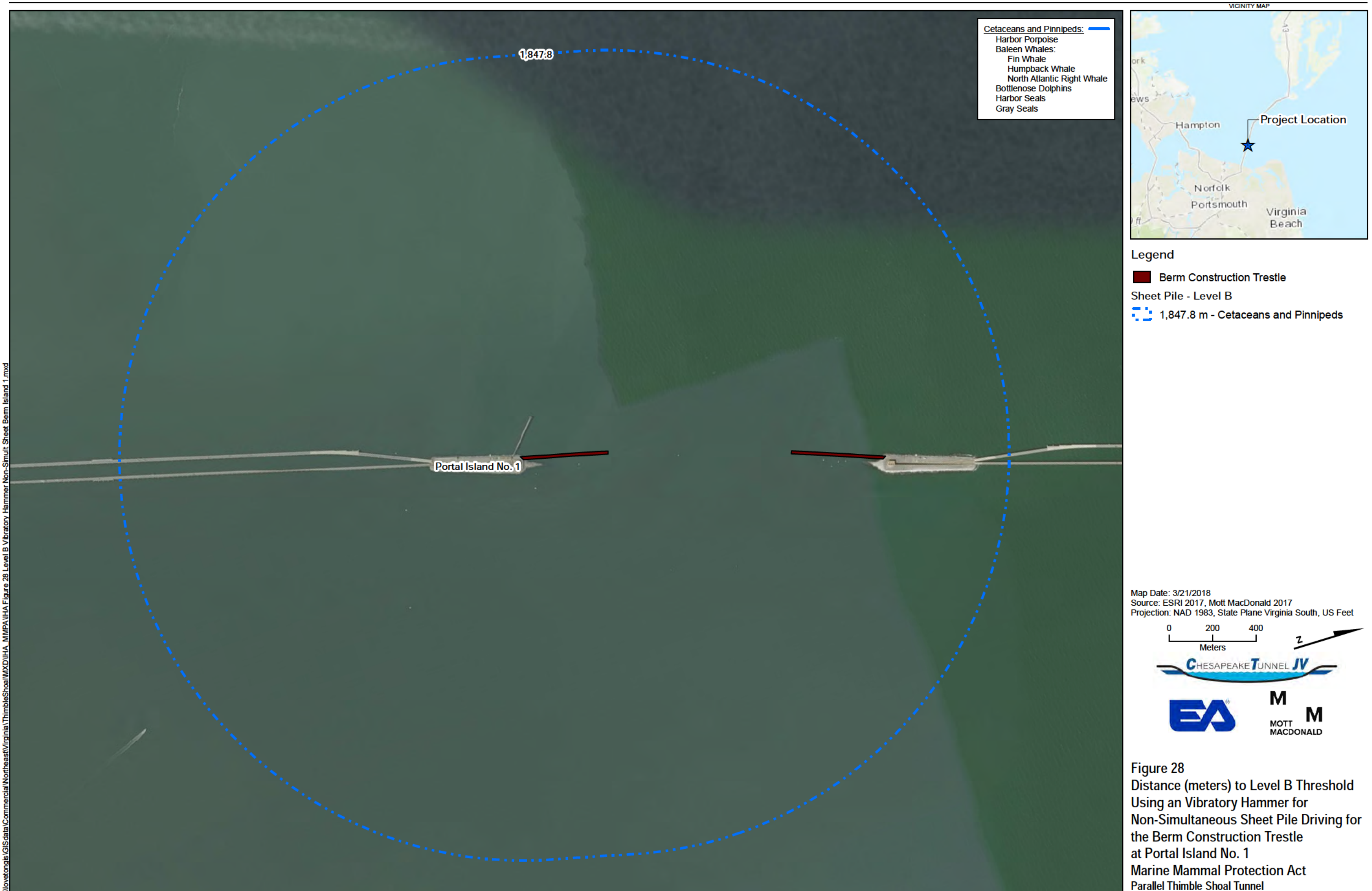
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\\ovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMFA\IHA Figure 27 Level B Impact Hammer Non-Simult Plumb Berm Island 2.mxd



\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\IHA_Figure 28 Level B Vibratory Hammer Non-Simult Sheet Berm Island 1.mxd



\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\IHA Figure 29 Level B Vibratory Hammer Non-Simult Sheet Berm Island 2.mxd

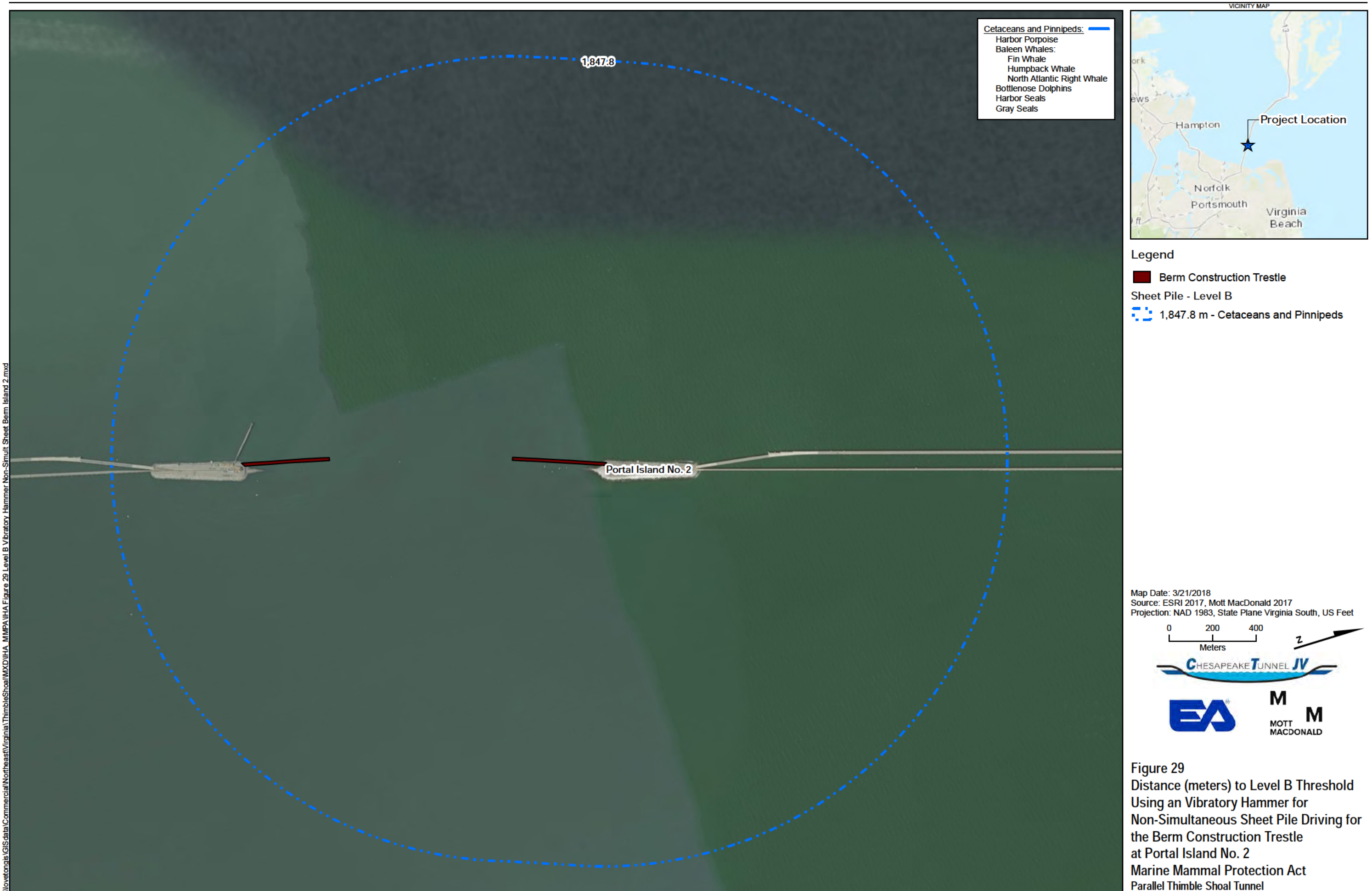


Figure 29
Distance (meters) to Level B Threshold
Using an Vibratory Hammer for
Non-Simultaneous Sheet Pile Driving for
the Berm Construction Trestle
at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\novetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 30 Level B Impact Hammer Simult Plumb Berm Island 1 and 2.mxd

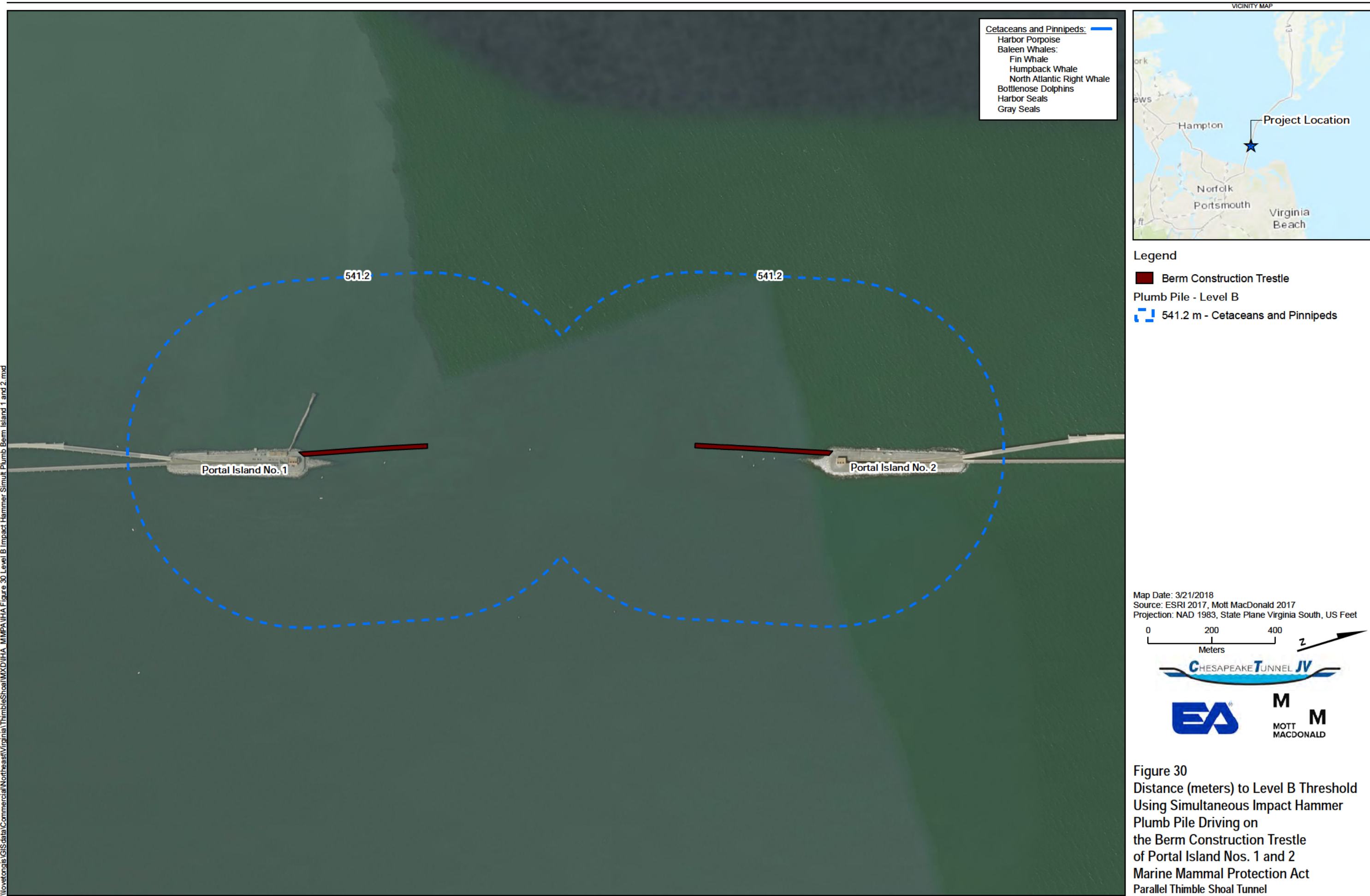
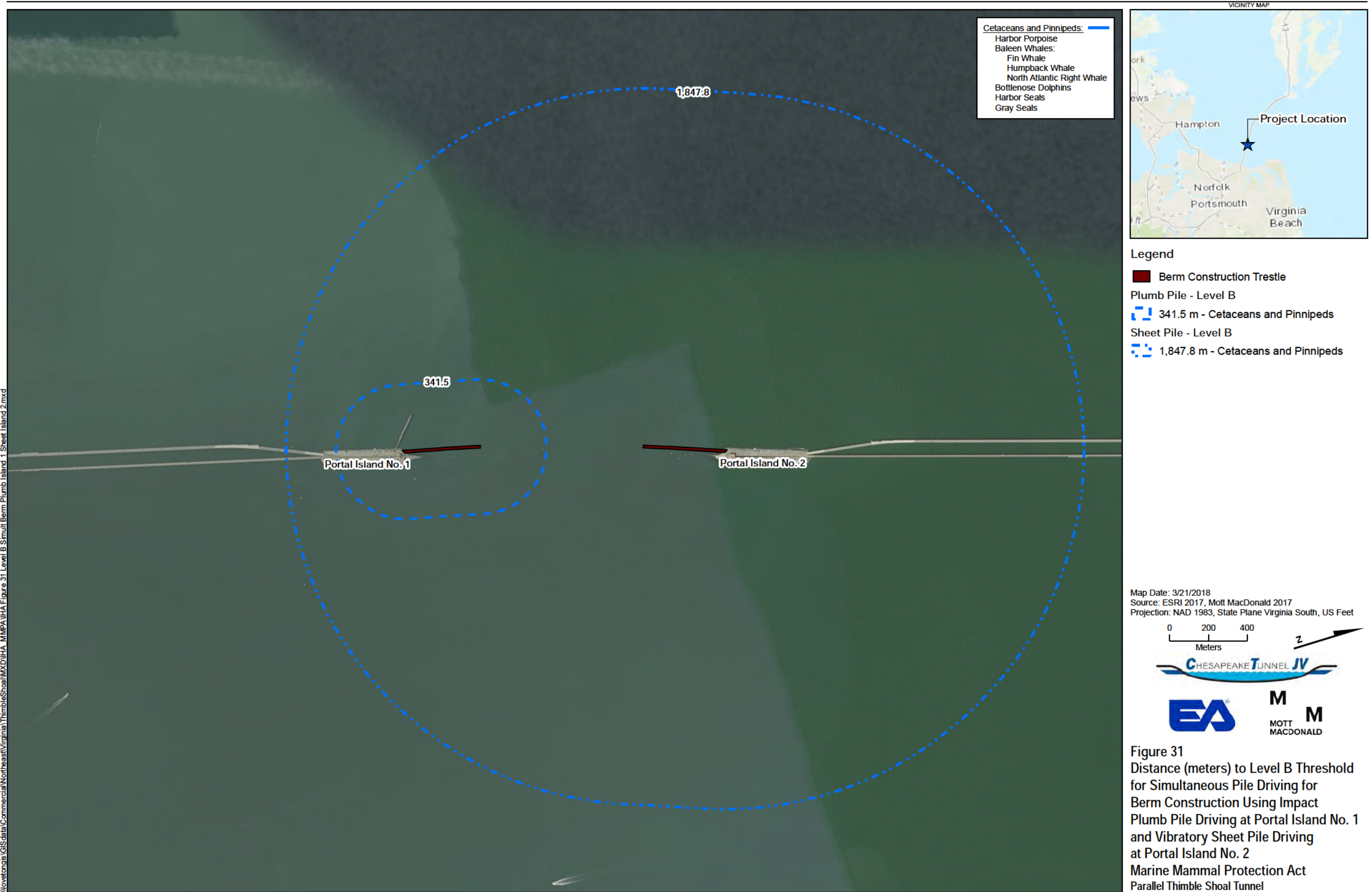
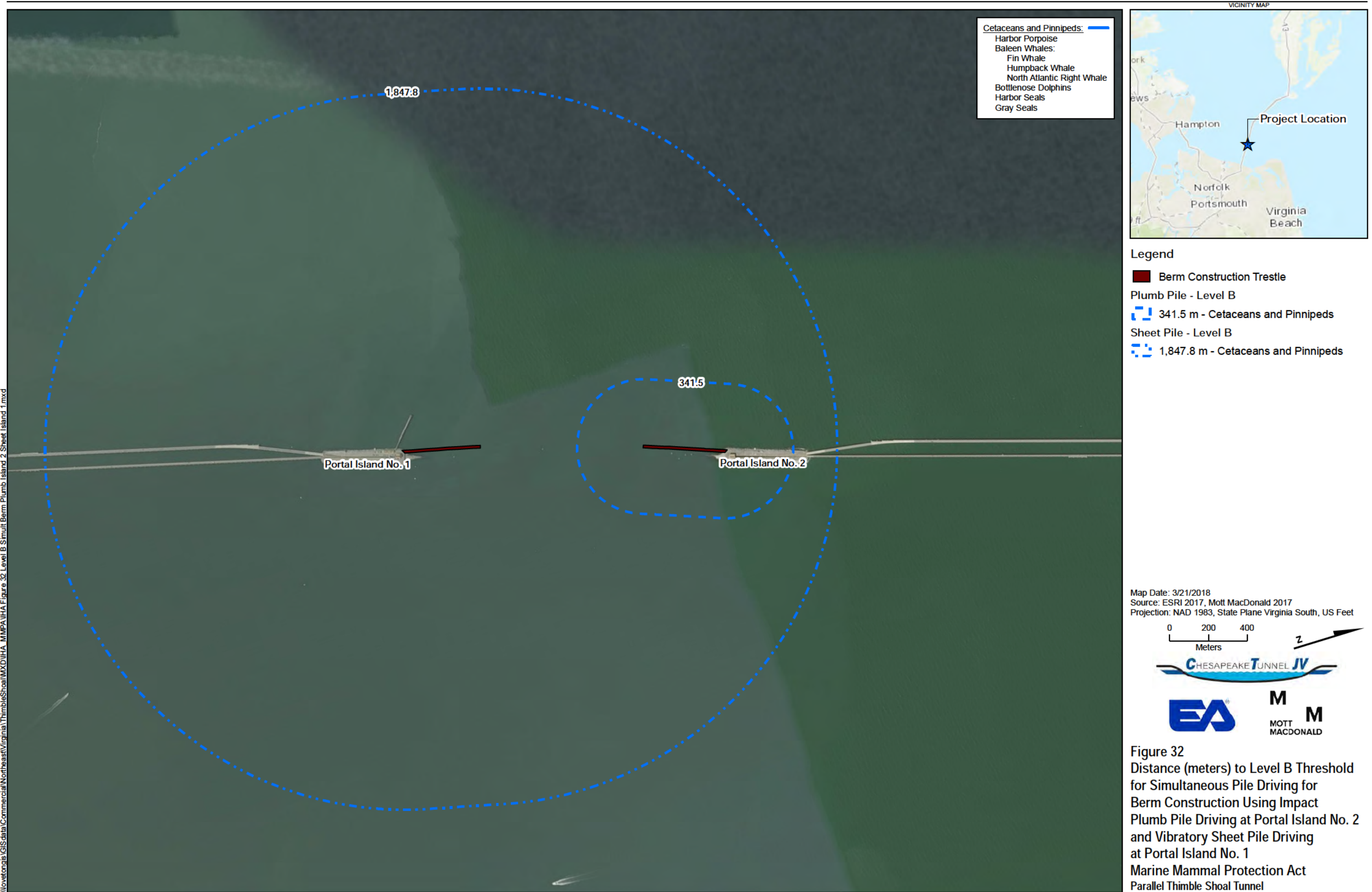


Figure 30
Distance (meters) to Level B Threshold
Using Simultaneous Impact Hammer
Plumb Pile Driving on
the Berm Construction Trestle
of Portal Island Nos. 1 and 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

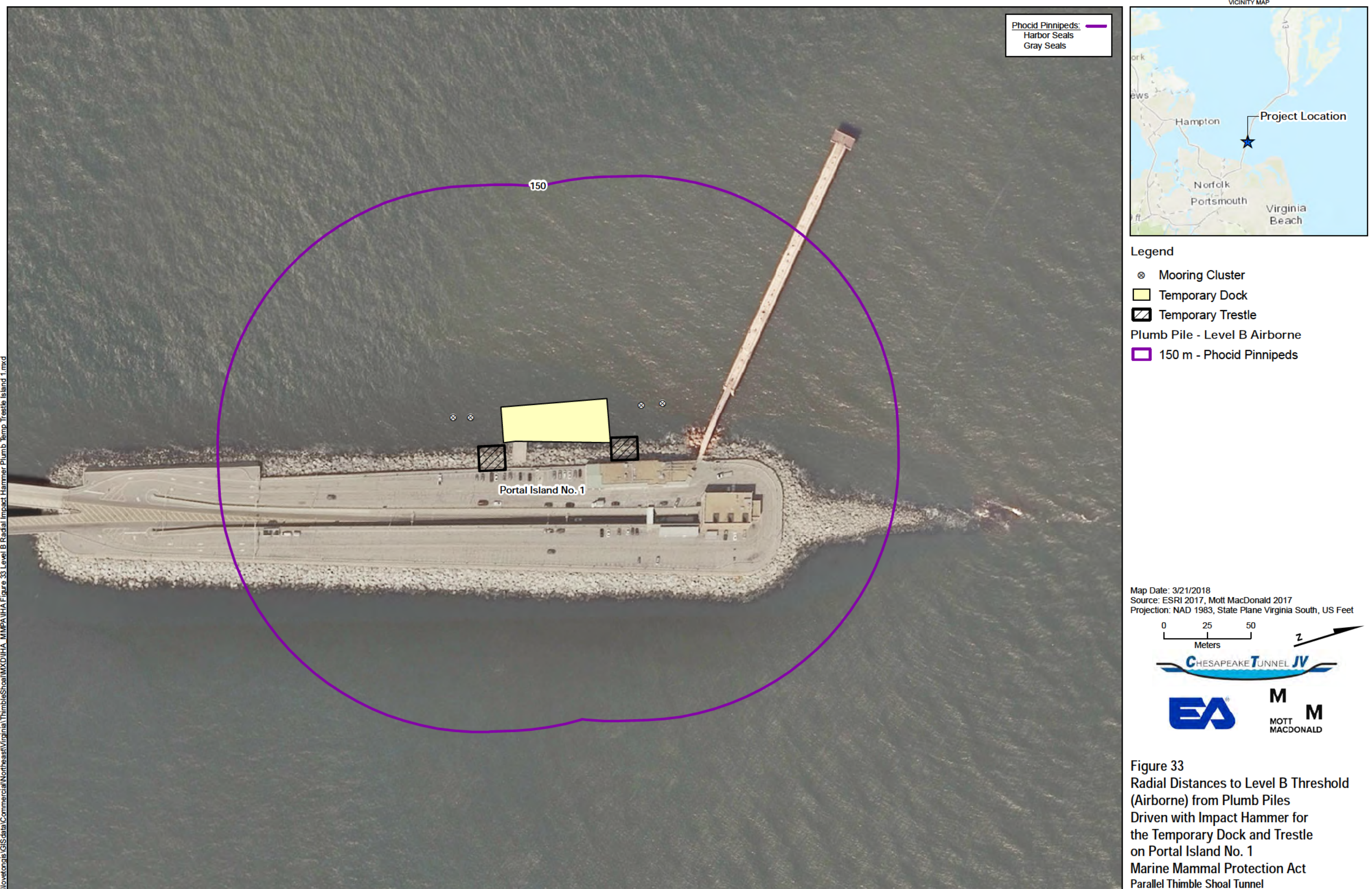
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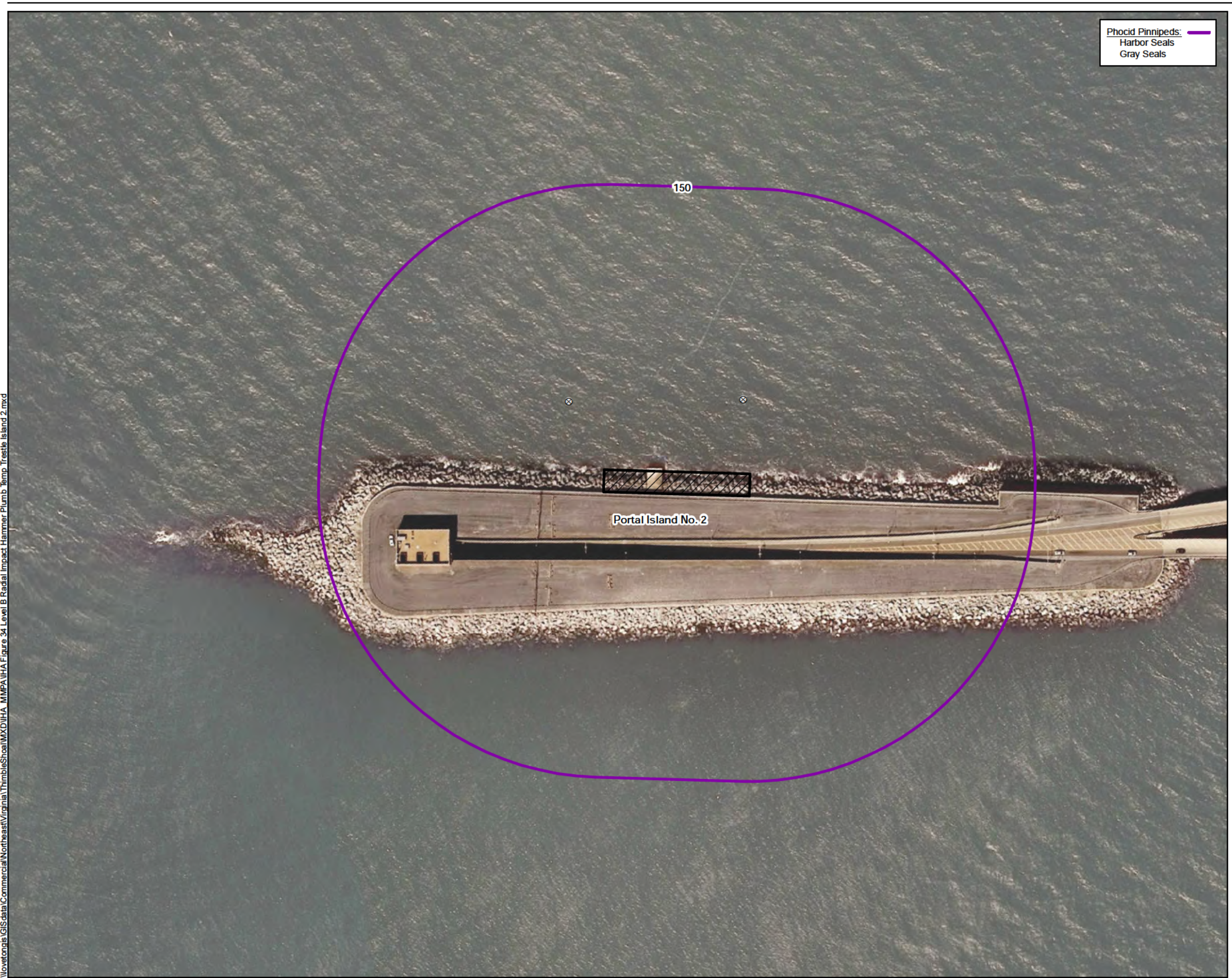
\\ovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MIPA\IHA Figure 32 Level B Smult Berm Plumb Island 2 Sheet Island 1.mxd



\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMFA\IHA Figure 33 Level B Radial Impact Hammer Plumb Temp Trestle Island 1.mxd



\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA MMPA\IHA Figure 34 Level B Radial Impact Hammer Plumb Temp Trestle Island 2.mxd



Phocid Pinnipeds:
Harbor Seals
Gray Seals



- Legend
- ⊗ Mooring Cluster
 - ▨ Temporary Trestle
 - Plumb Pile - Level B Airborne
 - 150 m - Phocid Pinnipeds

Map Date: 3/21/2018
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

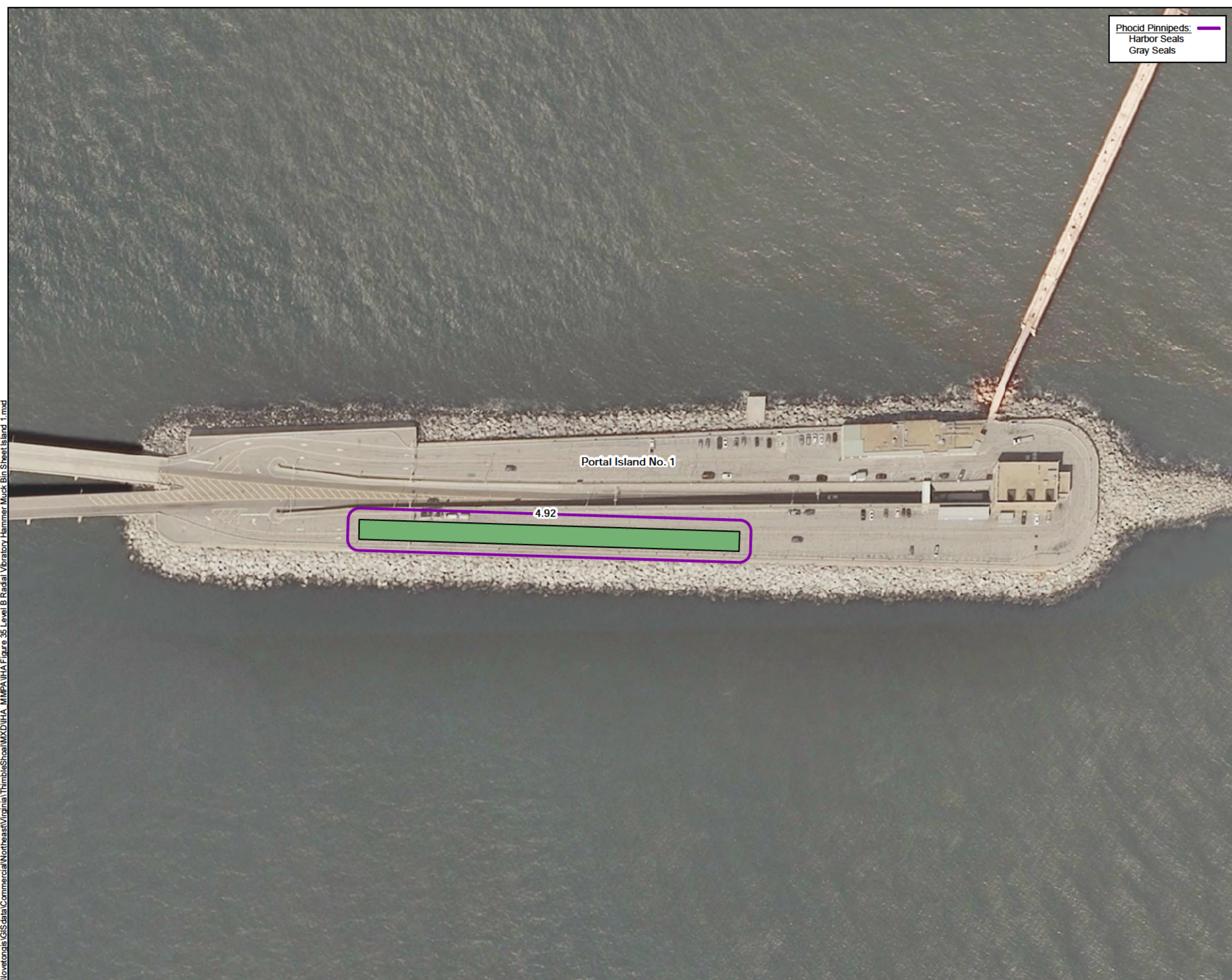
0 25 50
Meters

CHESAPEAKE TUNNEL JV

EA MOTT MACDONALD

Figure 34
Radial Distances to Level B Threshold
(Airborne) from Plumb Piles
Driven with Impact Hammer for
the Temporary Trestle
on Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\ovetong\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\IHA Figure 35 Level B Radial Vibratory Hammer Muck Bin Sheet Island 1.mxd



Legend

- Muck Bin
- Sheet Pile - Level B - Airborne
- 4.92 m - Phocid Pinnipeds

Map Date: 3/21/2018
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

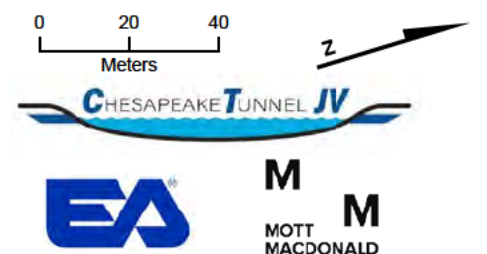


Figure 35
Radial Distances to Level B Threshold
(Airborne) for Vibratory Sheet Pile for
the Installation of the Muck Bin
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

Appendix A: Model Screenshots

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

VERSION: 1.1 (Aug-16)

KEY

Action Proponent Provided Information
 NMFS Provided Information (Acoustic Guidance)
 Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parcel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound Level information from Caltrans 2012; NAVFAC 2014; 2016
Please include any assumptions	
PROJECT CONTACT	Kaitlin McKormick

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz) [‡]	2	
[‡] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab [†] If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	183
a) Activity Duration (h) within 24-h period OR b) Number of piles per day [*]	6
Pulse Duration [‡] (seconds)	0.1
a) Number of strikes in 1 h OR b) Number of strikes per pile [*]	1000
Activity Duration (seconds)	600
10 Log (duration)	27.78
Propagation (xLogR)	15
Distance of source level measurement (meters) [*]	10

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalodhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

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

^{*} For cells B27 & B29 users should supply information for both cells as either a) OR b); Don't mix-n-match.

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

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL _{cum} Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	710.4	25.3	846.2	380.2	27.7

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION: 1.1 (Aug-16)

KEY	
	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parrel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound Level information from Caltrans 2012; NAVFAC 2014; 2016
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

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
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[‡] 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 64), 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 USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	183
a) Activity Duration (h) within 24-h period OR b) Number of piles per day [*]	8
Pulse Duration ^Δ (seconds)	0.1
a) Number of strikes in 1 h OR b) Number of strikes per pile [*]	1000
Activity Duration (seconds)	800
10 Log (duration)	29.03
Propagation (xLogR)	15
Distance of source level measurement (meters) [*]	10

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

^Δ Window that makes up 90% of total cumulative energy (9%-95%) based on Madsen 2005

^{*} For cells B27 & B29 users should supply information for both cells as either a) OR b); Don't mix-n-match.

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

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleth peak sound pressure level (PK) thresholds (dual thresholds).

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)	860.6	30.6	1,025.1	460.5	33.5

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) [†]	-0.01	-19.74	-26.87	-2.08	-1.15

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

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

VERSION: 1.1 (Aug-16)

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parrel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound Level information from Caltrans 2012; NAVFAC 2014; 2016
Please include any assumptions:	
PROJECT CONTACT	Kaitlin McCormick

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
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[‡] 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 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	186
a) Activity Duration (h) within 24-h period OR b) Number of piles per day [*]	6
Pulse Duration ^Δ (seconds)	0.1
a) Number of strikes in 1 h OR b) Number of strikes per pile [*]	1000
Activity Duration (seconds)	600
10 Log (duration)	27.78
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

* For cells B27 & B29 users should supply information for both cells as either a) OR b); Don't mix-n-match.

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

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleth peak sound pressure level (PK) thresholds (dual thresholds).

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)	1,125.9	40.0	1,341.1	602.5	43.9

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION: 1.1 (Aug-16)

KEY

Action Proponent Provided Information

NMFS Provided Information (Acoustic Guidance)

Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parcel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound Level information from Caltrans 2012; NAVFAC 2014; 2016
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz) [†]	2	
[†] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab		
[†] If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	186
a) Activity Duration (h) within 24-h period OR b) Number of piles per day*	8
Pulse Duration [†] (seconds)	0.1
a) Number of strikes in 1 h OR b) Number of strikes per pile*	1000
Activity Duration (seconds)	800
10 Log (duration)	29.03
Propagation (xLogR)	15
Distance of source level measurement (meters)*	10

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

* For cells B27 & B29 users should supply information for both cells as either a) OR b); Don't mix-n-match.

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

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephaloscyllium, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL _{cum} Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	1,363.9	48.5	1,624.7	729.9	53.1

WEIGHTING FUNCTION CALCULATIONS

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

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

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY	
	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2002; NAVFAC 2013, 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz) [‡]	2.5	
[‡] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab		
		[†] If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), 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)	154
Activity Duration (hours) within 24-h period	5
Activity Duration (seconds)	18000
10 Log (duration)	42.55
Propagation (xLogR)	15
Distance of source level measurement (meters) [†]	10

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

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

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)	6.8	0.6	10.1	4.1	0.3

WEIGHTING FUNCTION CALCULATIONS

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

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

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY	
	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2002; NAVFAC 2013, 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz) [‡]	2.5	
[‡] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab		

[†] If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), 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)	157
Activity Duration (hours) within 24-h period	5
Activity Duration (seconds)	18000
10 Log (duration)	42.55
Propagation (xLogR)	15
Distance of source level measurement (meters) [†]	10

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

Marine Mammal Hearing Group	
Low-frequency (LF) cetaceans:	baleen whales
Mid-frequency (MF) cetaceans:	dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans:	true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW):	true seals
Otariid pinnipeds (OW):	sea lions and fur seals

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)	10.8	1.0	16.0	6.6	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: 1.1 (Aug-16)

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thumble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2012; NAVFAC 2013; 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

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

† 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 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	183
Activity Duration (h) within 24-h period OR Number of piles per day	3
Pulse Duration ^A (seconds)	0.1
Number of strikes in 1 h OR Number of strikes per pile	1000
Activity Duration (seconds)	300
10 Log (duration)	24.77
Propagation (xLogR)	15
Distance of source level measurement (meters)*	10

^AWindow 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.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL _{cum} Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	447.5	15.9	533.1	239.5	17.4

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION: 1.1 (Aug-16)

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thumble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2012; NAVFAC 2013; 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

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

† 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 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E.1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	186
Activity Duration (h) within 24-h period OR Number of piles per day	3
Pulse Duration ^a (seconds)	0.1
Number of strikes in 1 h OR Number of strikes per pile	1000
Activity Duration (seconds)	300
10 Log (duration)	24.77
Propagation (xLogR)	15
Distance of source level measurement (meters)*	10

^aWindow 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.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

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)	709.3	25.2	844.9	379.6	27.6

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION: 1.1 (Aug-16)

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thumble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2012; NAVFAC 2013; 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

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

† 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 64), 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 USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	193
Activity Duration (h) within 24-h period OR Number of piles per day	3
Pulse Duration ^a (seconds)	0.1
Number of strikes in 1 h OR Number of strikes per pile	1000
Activity Duration (seconds)	300
10 Log (duration)	24.77
Propagation (xLogR)	15
Distance of source level measurement (meters) [†]	10

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

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

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL _{cum} Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	2,077.2	73.9	2,474.3	1,111.6	80.9

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION: 1.1 (Aug-16)

KEY

	Action Proponent Provided Information
	NMFS Provided Information (Acoustic Guidance)
	Resultant Isoleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thumble Shoal Tunnel
PROJECT/SOURCE INFORMATION	Sound level information from Caltrans 2012; NAVFAC 2013; 2017
Please include any assumptions	
PROJECT CONTACT	Kaitlin McCormick

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

† 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 64), 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 E1-2 method to calculate isopleths (not required to fill in sage boxes for both)

E1-1: METHOD USING RMS SPL SOURCE LEVEL

Source Level (RMS SPL)	196
Activity Duration (h) within 24-h period OR Number of piles per day	3
Pulse Duration ^Δ (seconds)	0.1
Number of strikes in 1 h OR Number of strikes per pile	1000
Activity Duration (seconds)	300
10 Log (duration)	24.77
Propagation (xLogR)	15
Distance of source level measurement (meters) [†]	10

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

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

Marine Mammal Hearing Group	
Low-frequency (LF) cetaceans:	baleen whales
Mid-frequency (MF) cetaceans:	dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans:	true porpoises, <i>Kogia</i> , river dolphins, cephalorhynchid, <i>Lagenorhynchus cruciger</i> & <i>L. australis</i>
Phocid pinnipeds (PW):	true seals
Otariid pinnipeds (OW):	sea lions and fur seals

RESULTANT ISOPLETHS*

*Note: For impulsive sounds, action proponent must also consider isopleths peak sound pressure level (PK) thresholds (dual thresholds).

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL _{cum} Threshold	183	185	155	185	203
PTS Isoleth to threshold (meters)	3,292.2	117.1	3,921.5	1,761.8	128.3

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
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C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-0.01	-19.74	-26.87	-2.08	-1.15

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

$$TL=20\log(R2/R1)$$

TL=Transmission Loss

R1=Distance of a known or measured sound level. Use example from Caltrans. --->

R2=Estimated distance required for sound to attenuate to a prescribed acoustic threshold. This is what we are solving for.

20=Geometric Loss Coefficient

Equation can be rearranged as follows to solve for R2.

$$R2=R1 \times 10^{[(dB_{R1} - dB_{Acoustic\ Threshold})/20]}$$

R1 (meters)	dB _{R1}	dB _{Acoustic Threshold}
15	110	90

R2
150

Modify the green boxes above with inputs from purple boxes below...

...To calculate R2 in the blue box above.

Inputs for In-Air Sound Calculations
above

	Sea Lions	Harbor Seals
Level B Threshold (dB _{Acoustic Threshold})	100 dB	90 dB
Distance of Measured Level (R1)	15m	15m
Vibratory Hammer, 30" Steel Piles ¹ (dB _{R1})	88 dB	88 dB
Impact Hammer, 30" Steel Piles ² (dB _{R1})	110 dB	110 dB

¹Laughlin 2010

²Laughlin 2013 as cited in City of Alaska IHA 2016 for Unalaska Marine Center

Pile	R1 (meters), distance of known sound measurement	dB _{R1} (measured values from literature)	dB _{Acoustic Threshold (Seals)}	R2 (meters), distance of in-air harassment from pile driving
18" Sheet	30.48	72	90	3.84
28 - 30 " Sheet	6.2	88	90	4.92
36" Round	15	110	90	150