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

Prepared by:

Chesapeake Tunnel Joint Venture
2377 Ferry Road
Virginia Beach, Virginia 23455

Submitted to:
National Marine Fisheries Service
Office of Protected Resources
1315 East-West Highway
Silver Spring, Maryland 20910-3226

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ACRONYMS AND ABBREVIATIONS

CBBT	Chesapeake Bay Bridge-Tunnel
CTJV	Chesapeake Tunnel Joint Venture
cy	cubic yards
dB	decibel
dB re 1μPa^{2}sec	decibels reference level 1 micropascal squared per second
District	Chesapeake Bay Bridge and Tunnel District
DTH	Down-the-hole
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
NAVFAC	Naval Facilities Engineering Command
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_{CUM}	Cumulative sound pressure level
SPL_{PEAK}	Peak sound pressure level
SOE	Support of excavation
sq ft	Square foot (feet)
TBM	Tunnel boring machine
TSS	Total suspended sediment
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VDEQ	Virginia Department of Environmental Quality
VMRC	Virginia Marine Resources Commission
VPDES	Virginia Pollution Discharge Elimination System
WSDOT	Washington State Department of Transportation
ZOI	Zone of Impact

1. DESCRIPTION OF SPECIFIED ACTIVITY

1.1 INTRODUCTION

The Chesapeake Tunnel Joint Venture (CTJV) 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 (Temporary dock on Portal Island 1, Roadway Trestle on Portal Island 2 and Omega Trestles on both Island to support Berm construction) and Support of excavation (SOE) walls on both islands are 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 or a down-the-hole (DTH) 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 CTJV, 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 driving, and on-land pile (hollow steel, sheet pile and double king 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, minimal number of harbor porpoise Level A and B takes are requested for these species. Pile driving operations will cease if the North Atlantic right whale individuals are observed within the Level A or Level B zones of impact (ZOIs, Figures 5-25).

A previous IHA application was submitted by the CTJV in April 2018, and an IHA was issued by NOAA with an effective date of 01 August 2018. A new IHA application was submitted in May 2019. This new IHA application was prepared to include changes in the project construction methods and use of a new technology for pile driving (down-the-hole (DTH) hammer). Given the uncertainty of the sounds created by this new technology, the CTJV contracted JASCO to conduct hydroacoustic monitoring prior to the expiration of the previous IHA (31 July 2019, Denes et al. 2019). Results of the monitoring are included in this updated application; importantly, the most profound finding was that the DTH creates an impulsive sound whereas it was previously believed to be continuous. This new IHA application includes construction activities that are expected to be completed during the 12-month period from 01 November 2019 through 31 October 2020. A request for an IHA renewal will be submitted to NOAA for activities that will be executed after 31 October 2020.

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 structure.

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, Appendix A).

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 6,350 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 with limited effect on the existing tunnel and traffic operations.

The tunnel boring machine (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. 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.

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

- Construction of a new parallel two-lane tunnel 6,350 feet (ft) in overall total length using a TBM, with 5,356 linear ft located below Mean High Water (MHW).

- Upland activities on the portal islands, 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/king piles and excavating sand from the interior.

    - Construction of Temporary Dock Trestle at Portal Island No.1 working as a roadway trestle during the portal excavation first and acting as a temporary

platform for storage, equipment (Gantry Crane and Conveyor Belt) and temporary dock for Hopper barges for Muck disposal.

- Construction of Roadway Trestle on Portal Island No.2 to accommodate traffic during the portal excavation.
- Construction of Temporary Omega Trestles used as working platforms and access to both Berms.
- Slurry wall construction and excavation of on-island material for TBM entry/exit portals, and on-island tunnel approaches on Portal Island Nos. 1 and 2.
- Jet grouting 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.
- 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.
- Replacement of the existing fishing pier superstructure at Portal Island No. 1, and potential substructure repair in-place (of deteriorated pilings), if any.

- In-water activities, including:
  - Temporary dock construction: Construction of a 32,832 sq ft working platform on the west side of Portal Island No. 1. This construction includes installation of 64 in-water and 47 upland piles for a total of 111 (6 in-water piles were installed as a part of CTJV's prior IHA), 36-inch diameter hollow steel pipe piles. A 42-inch steel casing will initially be driving with a down the hole hammer and the 36-inch piles will be installed with an impact hammer. A bubble curtain will be used during the impact driving of each 36" pile. Of the total piles, 12 are expected to be installed using the impact hammer without mitigation due to complexity of the

substrate and/or less than 10ft of water. The design for the mooring structures has been completed, and it is now necessary to use timber piles for construction of the temporary mooring dolphins. The timber piles will be installed using a vibratory hammer. However, should refusal be encountered prior to design tip elevation when driving with the vibratory hammer an impact hammer will be used to drive the remainder of the pile length. No bubble curtains will be utilized for the installation of the timber piles.

- Construction of two temporary Omega trestles, including:
  - Island 1: 8 upland and 26 in-water 36" diameter steel pipe piles
  - Island 2: 8 upland and 28 in-water 36" diameter steel pipe piles
  - These trestles will be offset to the west side of each engineered berm; extending approximately 659 ft channelward from Portal Island Nos. 1 and 2, respectively.
- Construction of two engineered berms, approximately 1,395 ft. in length for Portal Island No. 1 (435 ft. above MHW and 960 ft below MHW), and approximately 1,354 ft. in length for Portal Island No. 2 (446 ft. above MHW and 908 ft. below MHW). Both berms will extend channelward from each portal island. Construction methods will include: dredging; stone placement (core, bedding, filter, armor 1&2 stone); impact and vibratory pile driving; casing advancement (Down the Hole (DTH) hammer); installation of horizontal and vertical inclinometers, piezometers and survey points; excavation between SOE walls; and placement of engineered and flowable fill. Interlocked pipe piles will be installed through the use of DTH drilling equipment. This equipment uses reverse circulation drilling techniques in order to advance hollow steel pipes through the existing rock found within the project site. Once the pipes are advanced through the rock layer using the DTH technology, they are driven to final grade via traditional impact driving methods.
- Installation of interlocked pipe piles on both sides of the new tunnel alignment for settlement mitigation, SOE, and to facilitate flowable fill placement.
- Some of construction activities will be occurring simultaneously, it is estimated that those simultaneous activities will follow the estimated driving days below (driving at Portal Is. 1 and Portal Is. 2 would be one hammer at each island):

	Island 1	Island 2	Driving at Portal Is. 1 and Portal Is. 2
Simultaneous Scenarios	No. of Days		
Impact with DTH	13	14	13
DTH + DTH	22	11	17

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 existing portal islands are man-made and completely impermeably paved. During construction, areas on the portal islands will be exposed and erosion and sediment control practices will be implemented. 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.

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.

To comply with Section 401 of the Clean Water Act, Virginia Protection Permit, Virginia Water Protection Permit, Virginia Pollutant Discharge Elimination System permits, Stormwater Construction General Permit and the conditions of the Virginia Marine Resources Commission, daily water quality monitoring will be performed during all in-water construction activities, including pile driving. This will ensure that aquatic resources in the vicinity of the project site will not be adversely impacted by in-water activities.

The anticipated pile driving schedule for the period of November 2019 to October 2020 is provided in Table 1.

Table 1. Anticipated Pile Installation Schedule (November 2019 through October 2020)

Pile Location	Pile Function	Pile Type	Installation/Removal Method	Bubble Curtain	Number of Piles below MHW	Days per Activity (Total)	Days per activity (by Hammer Type)
1	Mooring dolphins	12-inch Timber piles	Vibratory (Install)	No	120	21 Days	12 Days (10 Piles/Day)
			Impact (if needed)	No			3 Days (12 Piles/Day)
			Vibratory (Removal)	No			6 Days (20 Piles/Day)
1	Temporary Dock	42-inch Diameter Steel Pipe Casing	DTH (install)	No	58	48 Days	29 Days (2 Piles/day)
			Vibratory (removal)	No			19 Days (3 Piles/day)
		36-inch Diameter Steel Pipe Pile	Impact	Yes	58*	29 Days	29 Days (2 Piles/day)
1	Omega Trestle	36-inch Diameter Steel Pipe Piles	DTH (Install)	No	36**	78 Days	13 Days (2 Piles/Day)
			Impact	Yes			65 Days (0.4 Piles/Day)
1	Berm Support of Excavation Wall - West Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (install)	No	135	58 Days	45 Days (3 Piles/Day
			Impact	Yes			13 Days (10 Piles/Day)
1	Berm Support of Excavation Wall - East Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	121	121 Days	80 Days (1.5 Piles/Day)
			Impact	Yes			41 Days (3 Piles/Day)
1	Mooring Piles and Templates	36-inch Diameter Steel Pipe Piles	Vibratory (Install & Removal)	No	12	2 Days	2 Days (12 Piles/Day)
2	Mooring Dolphins	12-inch Timber Piles	Vibratory (Install)	No	60	12 Days	6 Days (10 Piles/Day)
			Impact (if needed)	No			2 Days (15 Piles/Day)***
			Vibratory (Removal)	No			4 Days (20 Piles/Day)
2	Omega Trestle	36-inch Diameter Steel Pipe Piles	DTH (Install)	No	28	28 Days	16 Days (2 Piles/Day)
			Impact	Yes			12 Days (2.33 Piles/Day)
2	Berm Support of Excavation Wall - West Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	129	55 Days	42 Days (3 Piles/Day)
			Impact	Yes			13 Days (9.5 Piles/Day)
2	Berm Support of Excavation Wall - East Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	115	106 Days	71 Days (1.5 Piles/Day)
			Impact	Yes			35 Days (3 Piles/Day)
2	Mooring Piles and Templates	36-inch Diameter Steel Pipe Piles	Vibratory (Install & Removal)	No	16	4 Days	4 Days (4 Piles/Day)
Total					878		

*11 piles will be installed in <10 ft water so bubble curtain will not be used.
**10 piles will be installed in <10 ft water so bubble curtain will not be used.

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 Table 1 for the anticipated pile installation schedule.

- Phase I (on-island/upland pre-tunnel excavation activities): June 2017 – June 2020
    - 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): September 2018 – January 2021
    - Construction of a temporary dock (Portal Island No. 1) and pile installation for temporary moorings (Portal Island Nos. 1 and 2).
    - Construction of temporary Omega 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 islands.
    - Construction of engineered berms (limited mechanical dredging of unsuitable foundation materials at Berm No. 1, 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)

- Phase III (tunnel excavation and disposal of excavated material): July 2020 – June 2021
  - 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): October 2020 – 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 U.S. Army Corps of Engineers (USACE). These resources, and remaining State Waters are regulated by Virginia Department

of Environmental Quality (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	*Balaenoptera physalus*	FE/SE
Humpback whale	*Megaptera novaeangliae*	
North Atlantic right whale	*Eubalaena glacialis*	FE/SE
Bottlenose Dolphin	*Tursiops spp.*	
Harbor Porpoise	*Phocoena phocoena*	
Harbor Seal	*Phoca vitulina*	
Gray Seal	*Halichoerus grypus*	

*Federally endangered species (FE); State endangered species (SE)

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) has been completed.

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). A survey conducted in October 2017 – March 2018 off the coast of Virginia Beach, VA found 10 individuals over the course of 15 survey events, with one sighted in December and nine sighted in January (Aschettino et al. 2018).

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. Three years of survey data collected by HDR and funded by the Naval Facilities Engineering Command (NAVFAC) are available for the Humpback Whale off the coast of Virginia Beach, VA (Aschettino et al. 2015; 2017; 2018). In 2015, 2016/2017 and 2017/2018, there were a total of 61, 248, and 32 Humpback whales sighted, respectively (Table 3). The distribution of whale sightings occur most frequently in the month of January; however, no survey data are available for the summer months as whales are not expected to be present at that time.

Table 3. Results of Humpback Whale Surveys off the coast of Virginia Beach, VA

Month	2015	2016–2017	2017–2018
January	56	106	1
February	5	84	0
March	0	7	0
April	0	-	-
May	0	-	-
June	-	-	-
July	-	-	-
August	-	-	-
September	-	-	-
October	-	-	2
November	-	21	8
December	-	30	21

- indicates no surveys occurred in that month

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. A 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; Aschiettino et al. 2015, 2017, 2018). 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). For 2017 – 2019, NOAA has established a North Atlantic Right Whale Unusual Mortality Event which can be defined as unexpected strandings, significant die-offs, and populations needing immediate attention under the Marine Mammal Protection Act.

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. One right whale mortality off the coast of Virginia Beach reported in January 2018 resulted in the awareness of four live right whales in the same general area and Dynamic Management Area was established to reduce the disturbance of the live whales (NOAA Fisheries 2018a). 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. A second North Atlantic Right whale mortality was reported in January 2018 off the coast of Virginia Beach, VA, the whale was a juvenile female (~10 years old). Following necropsy, the death was determined to be attributed to entanglement (NOAA Fisheries 2018a).

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 dolphin are rarely found north of North Carolina in the winter (NOAA Fisheries 2016a).

Aerial surveys conducted in the summers of 2016 estimated the northern and southern migratory stock at 10,390 (NOAA Fisheries 2018bc). 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 April through November with approximately 65 strandings occurring each year (Barco and Swingle 2014, Engelhaupt 2016). 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 and 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 2019a). 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 pinnepeds 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 424,000 animals (NOAA Fisheries 2019b).

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, down-the-hole pile driving and on-island sheet pile driving activities associated with the PTST Project. CTJV requests an IHA for incidental take of five species of marine mammals: harbor porpoise, bottlenose dolphin, humpback whale, harbor seal, and gray seal (Table 4). The noise created by impact and down-the-hole pile driving during the installation of piles has the potential to cause takes of marine mammals at Level B. ZOIs for Level B harassment have been calculated according to the 2016 NOAA guidance (NOAA Fisheries 2016h) and are described in Chapter 6.

If North Atlantic right whale or fin whale appear to be crossing into the Level B ZOI, in-water pile driving activities will cease immediately until the animal(s) depart the ZOI on its (their) own (Table 4).

Incidental taking by Level A harassment is being requested for species including the harbor porpoise, harbor seal, and gray seal. 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 without an authorized take appears to be crossing into the Level A ZOIs, 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 (November 2019 through October 2020).

Table 4. Summary of Marine Mammals and Action During Project Activity

Common Name	Scientific Name	Status*	Take Requested	Action during Project Activity
Fin whale	*Balanoptera physalus*	FE/SE	No	Shutdown if observed approaching or within ZOIs A or B
Humpback whale	*Megaptera novaeangliae*		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI
North Atlantic right whale	*Eubalaena glacialis*	FE/SE	No	Shutdown if observed approaching or within ZOIs A or B
Bottlenose dolphin	*Tursiops spp.*		Yes	Record take for Level B; Shutdown if observed approaching or within Level A ZOI
Harbor porpoise	*Phocoena phocoena*		Yes	Record take for Levels A and B; Shutdown if observed approaching 200 meters
Harbor seal	*Phoca vitulina*		Yes	Record take for Levels A and B; Shutdown if observed approaching 15 meters
Gray seal	*Halichoerus grypus*		Yes	Record take for Levels A and B; Shutdown if observed approaching 15 meters

*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, down-the-hole and vibratory hammers) and sheet piles (using a vibratory and impact 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 in-water pile driving installation. Hollow steel round pile installation is expected to occur from November 2019 through October 2020.

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 5). 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 5. Level A Harassment Thresholds for Marine Mammals that May Occur in the Project Area

	Level A Harassment[1]		
	PTS Onset Acoustic Thresholds (SEL_{CUM}) (dB re 1µPa²sec)		**Peak Sound Threshold (SPL_{PEAK}) (dB re 1µPa)**
Functional Hearing Group	**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

[1]NOAA 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 1µPa²sec—decibels reference level 1 micropascal squared per second

The NOAA Fisheries (2016h) guidance addresses only new thresholds for Level A harassment by underwater sound. Level B harassment was not addressed. Therefore, guidance received from NOAA Fisheries' Protected Resource's Office in Silver Spring, Maryland, was used to evaluate Level B sources of sound (Table 6).

Table 6. Level B Harassment Thresholds

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

RMS SPL – Root Mean Squared Sound Pressure Level – 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 1µPa^{2}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 calculated for impact (Impulsive; Sheet E.1), DTH, and vibratory pile driving (non-impulsive, stationary, continuous; Sheet A). See Appendix B for screenshots of the completed spreadsheets. For round pile installation, a DTH hammer will be used to begin pile driving through rock, the remainder of the pile installation will be completed with an impact hammer. A vibratory hammer will be used for the installation of sheet and king piles above MHW water on islands. Table 7 provides output for all proposed methods of driving hollow steel 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 CTJV contracted JASCO to conduct hydroacoustic monitoring of the Down-the-hole hammer and found that the sound produced is impulsive and generates sound levels presented in Table 7 (Denes et al 2019). The PTST Project will drive and vibrate round, 36-inch-diameter, hollow steel piles and 28-inch wide sheet piles and king piles (above MHW). Data reported in the Compendium of Pile Driving Sound Data (Caltrans 2015) for similar piles size and types are shown in Table 7. Use of an encased bubble curtain is expected to reduce sound levels by 7 decibels for an impact hammer (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 exposure level (sSEL) for each pile driving scenario of the PTST Project (Table 7).

Table 7. The Sound Levels (dB Peak, dB RMS, and dB sSEL) Expected to be Generated in Water by each Hammer Type/Mitigation Measure at the PTST Project

Type of Pile	Hammer Type	Estimated Peak Noise Level (dB Peak)	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	193	183	Plumb	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Impact with Bubble Curtain[b]	203	186	176	Plumb	Berm Wall West, Berm Wall East, and Temporary Dock
	DTH – Impulsive[d]	190	180	164	Plumb	Omega Trestle, Berm Wall West, and Berm Wall East
	Vibratory[e]	NA	170	170	Pipe Piles	Mooring Piles and Templates
Simultaneous Driving of 36-inch Steel Round Pile	DTH – Impulsive[d] (2)	190	180	164	Plumb	Temporary Dock, Berm Wall West, and Berm Wall East
Simultaneous Driving of 36-inch Steel Round Pile	DTH - Impulsive[e] and Impact with Bubble Curtain	190	180	164	Plumb	Omega Trestle, Berm Wall West, and Berm Wall East
12-inch Timber Pile	Vibratory[c]	NA	152	152	Plumb	Mooring Dolphins
	Impact[a]	177	165	157	Plumb	Mooring Dolphins
42-inch Steel Casing	DTH – Impulsive[d]	190	180	164	Steel Casing	Temporary Dock
	Vibratory[e]	NA	170	170	Pipe Piles	Temporary Dock

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

[a] Caltrans 2015

[b] A 7 dB reduction was assumed 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.

[c] Chehalis River Bridge – Scour Repair in Washington State (IHA July 2019 – Feb 2020).

[d] Denes et al 2019. Sound Source Characterization of Down-the-hole Hammering

[e] Caltrans. 2015. *Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish*. Using vibratory driving of 36" steel pile as surrogate data.

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 7 for impact hammer and impact hammer with encased bubble curtain. Model inputs are provided in Table 8 and outputs are provided in Table 9 and in Figures 5-9.

DTH Hammer Pile Driving – Pile driving using a DTH hammer produces an impulsive sound source similar to an impact hammer pile driving. Hydroacoustic monitoring data at the project location shows 7 pulses per second during DTH operation. Distances for deleterious sound production to respective hearing frequencies (Level A) were determined by NOAA's Optional User Spreadsheet (impulsive, stationary) (Sheet E.1). The RMS SPL's for simultaneous pile driving were determined using the rules for decibel addition (WSDOT 2017). Model inputs are provided in Table 8 and outputs are provided in Table 9.

Vibratory Hammer Pile Driving – Sound collected from vibratory installation of 36-inch-diameter piles resulted in mean170dB RMS (Caltrans 2015). Model inputs are provided in Table 8 and outputs are provided in Table 9 and in Figures 11 and 12.

Table 8. Model Inputs for Calculating Isopleths

Model Parameter	12-in timber		36-in steel			42-in steel casing		
	Vibratory	Impact	Vibratory	Impact	Impact - with bubble	Vibratory	DTH	DTH - Simult.
Weighting Factor (kHz)	2.5	2	2.5	2.0	2.0	2.5	2.0	2.0
RMS (dB)	152.0	165	170.0	193.0	186.0	170.0	180.0	180.0
Peak/SEL (dB)	na	177/157	na	210/183	203/176	na	190/164	190/164
Number of piles/day	5	5	5	4	5	5	2	3
Duration to drive a pile (minutes)	30.0	na	12.0	na	na	12.0	na	na
Propagation	15.0	15	15.0	15.0	15.0	15.0	15.0	15.0
Distance from source (meters)	10.0	10	10.0	10	10	10.0	10	10
Strikes per pile	na	1000	na	1000	1000	na	25200	50400

dB = decibel
na = not applicable
RMS = root mean square pressure level
SEL = sound exposure level

Table 9. 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		Pile Location in the PTST Project
SEL_{cum} Threshold (dB)	**Impact/Impulsive**		183		185		155		185		
	Continuous		199		198		173		201		
	--	**Pile Type**	**Island 1**	**Island 2**	**Island 1**	**Island 2**	**Island 1**	**Island 2**	**Island 1**	**Island 2**	
PTS Isopleth to threshold (meters)	**Impact**	12-in. Timber	54	54	1.9	1.9	65	65	2	2	Mooring Dolphins
		36-in. Steel†	2,516	2,516	90	90	2,997	2,997	1,347	1,347	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Impact with Bubble Curtain	36-in. Steel**	997	997	36	36	1,188	1,188	534	534	Berm Wall West, Berm Wall East, and Temporary Dock
	DTH – Impulsive	36 and 42-in. Steel	737	737	26	26	878	878	395	395	Casing for Temporary Dock
	DTH Simultaneous		1,534	1,534	55	55	1,827	1,827	821	821	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	DTH & Impact Hammer Simultaneous	36-and 42-in. Steel	1,734	1,734	62	62	2,066	2,066	929	929	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Continuous (Vibratory)	12-in. Timber	3	3	0.3	0.3	5	5	2	2	Mooring Dolphins
		36-in. Steel	27	27	2	2	40	40	17	17	Mooring Piles and Templates
		42-in. Steel	27	--	2	--	40	--	17	--	Casing for Temporary Dock

*Model inputs above in Table 8

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 10 and Figures 26 – 39.

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

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 10. Radial distance (meters) from Pile Driven to Level B Sound Thresholds for Cetaceans and Pinnipeds

Hearing Group	Hammer Type		Cetaceans / Pinnipeds		Pile Location in the PTST Project
Sound Threshold (dB)			160 (impact) 120 (vibratory)		
	--	Pile Type	Island 1	Island 2	
PTS Isopleth to threshold (meters)	Impact	12-in. Timber	22	22	Mooring Dolphins
		36-in. Steel	1,584	1,584	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Impact with Bubble Curtain	36-in. Steel	541	541	Berm Wall West, Berm Wall East, and Temporary Dock
	DTH - Impulsive	42-in. Steel	215	--	Casing for Temporary Dock
		36-in. Steel	215	215	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Continuous (Vibratory)	12-in. mooring	1,354	1,354	Mooring Dolphins
		36-in. Steel	21,544	21,544	Mooring Piles and Templates
		42-in. Steel	21,544	--	Casing for Temporary Dock

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 11.

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

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 impact 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 11). AZ 24-inch sheet pile was used as a proxy for the sheet pile to be driven during the PTST Project (Table 11). Airborne sound produced from Down-the-hole pile driving for 36-inch diameter hollow steel piles was estimated based on the measurements taken from an 18-inch hammer using a 28-inch casing. An additional 4dB was added to the measured noise as estimates show an increase in 10-inches of the casing the sound increased by 3-4dB. Using the spherical spreading loss model with these estimates, Level B ZOI's were estimated (Table 11).

Table 11. 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
Vibratory Hammer 28-30-inch Sheet Pile	88 dB_{L5SEQ} at 6.2m[b]	N/A	4.92
Vibratory 48-inch King Pile	87 dB_{LAeq} at 15m[c]	N/A	10.6
Down-the-hole hammer 42-inch casing	88 dB_{L5SEQ} at 10m[d]	N/A	7.94

[a]Laughlin 2010a,b as cited in City of Unalaska 2016 IHA for Unalaska Marine Center
[b] Paulus, Sokolowski and Sartor Engineering, PC. 2008.
[c]NAVFAC 2017 (Sound from king pile installation at Mayport)
[d] Mincon Group PLC. 2019.

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 and along the coast of Virgina Beach. Like the majority of wildlife, bottlenose dolphins do not use habitat uniformly. The heterogeneity in available habitat, dietary items and protection likely results in some individuals preferring ocean and others estuary (Ballance, 1992; Gannon and Waples 2004). Although, clearly dolphins have the ability to move between these habitat types Gannon and Waples (2004) suggest individuals prefer one habitat over the other based on gut contents of dietary items. Therefore, a subset of survey data from Engelhaupt et al. 2016 was used to determine seasonal dolphin densities within the project area. A spatially refined approach was used by plotting dolphin sightings within 12km of the project location. Densities were determined following methodology outlined Engelhaupt et al. 2016 and Miller et al. 2019 using the package DISTANCE in R statistical software (R. Core Team 2018). Calculated densities by season are provided in Table 12.

Table 12. Densities (individual/km^2) of Bottlenose Dolphin from Inshore Areas of Virginia

Season	Density within 12km distance around the project area
Spring	0.6
Summer	0.62
Fall	1.17
Winter	0.26

Total number of takes for bottlenose dolphin were calculated using the seasonal density (above) of animals (individuals/km^2). Construction project specific dolphin densities were calculated within the respective Level B ZOIs and seasons. Six Level B ZOIs were used to calculate dolphin takes; these correspond to the specific construction project and hammer type (Table 13).

Table 13. In-Water Area (km2) Used for Calculating Dolphin takes per Construction Components per Hammer Type

Construction Component	Impact Hammer	Impact with Bubble Curtain	Vibratory Hammer	Impact + DTH Hammers	DTH + DTH Hammers
Mooring Cluster	0.003	0.003	4.16	--	--
Temporary Dock	5.55	0.63	830	--	0.25
Omega Trestle and West O-pile wall	8.55	8.55	830	1.72	0.49
East O-Pile Walls	--	--	--	1.43	--

Densities were then used to calculate the monthly takes based on the number of pile driving days. The number of dolphin takes per construction component per pile driving method was then summed for each month (Table 14). The total number of requested Level B takes is 10,109 dolphins (Table 14).

Table 14. Information to Calculate Bottlenose Dolphin Takes

Dolphin Density (n/km2)	November	December	January	February	March	April	May	June	July	August	September	October	Total
	1.17	0.26	0.26	0.26	0.6	0.6	0.6	0.62	0.62	0.62	1.17	1.17	
Days/Month based on Pile Driving Activity	**Mooring Cluster**												
Vibratory - Timber Piles	7	2	0	0	0	0	0	0	0	0	0	0	9
Impact - Timber Piles	3	1	0	0	0	0	0	0	0	0	0	0	4
Dolphin Takes	34	2	0	0	0	0	0	0	0	0	0	0	36
Temporary Dock													
Impact - Steel Pile	0	1	1	1	1	1	1	0	0	0	0	0	6
Impact with Bubble Curtain - Steel Pile	0	2	2	2	2	2	2	0	0	0	0	0	12
Vibratory - Steel Pile	0	4	4	4	4	4	4	0	0	0	0	0	24
Two DTH - Steel Pile	0	3	3	3	3	3	3	0	0	0	0	0	18
Dolphin Takes	0	865	649	649	1499	1499	1499	0	0	0	0	0	6,660
Omega Trestle/ West O-pile Walls/ Mooring Piles & Templates													
Impact - Steel Pile	2	2	2	2	4	3	2	0	0	0	0	0	17
Vibratory - Steel Pile	1	1	0	0	0	0	1	1	1	1	0	0	6
Two DTH - Steel Pile	2	2	2	2	6	4	4	0	0	0	0	0	22
DTH+ Impact - Steel Pile	3	3	3	3	8	6	4	0	0	0	0	0	30
Dolphin Takes	998	222	6	6	31	23	514	515	515	515	0	0	3,343
Omega Trestle / East O-Pile Walls													
Impact - Steel Pile	0	2	2	2	2	4	2	2	2	2	0	0	20
DTH+ Impact - Steel Pile	0	1	1	1	1	2	1	1	1	1	0	0	10
Two DTH - Steel Pile	0	1	1	1	1	2	1	1	1	1	0	0	10
Dolphin Takes	0	4	4	4	8	16	8	9	9	9	0	0	70
Total No. of Pile Driving Days per Month	**18**	**25**	**21**	**21**	**32**	**31**	**25**	**5**	**5**	**5**	**0**	**0**	**188**
												Total Level B Takes	**10,109**

6.3.5 Harbor Porpoise

This analysis assumes that there is a porpoise sighting once during every two months of operations which would equate to five sightings over ten months. Assuming an average group size of two results in a total estimated take of 10 porpoises. Harbor porpoises are members of the high-frequency hearing group which would have Level A isopleths as large as 5,521 meters during impact installation of seven battered piles per day. Given the relatively large Level A zones during impact driving, NMFS previously assumed 40 percent of porpoises are taken by Level A harassment and authorized the take of 4 porpoises by Level A take and 6 porpoises by Level B take. This is the same number of takes being requested for this application.

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 14). 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. There are seal survey data available from 2017-2018 (Jones et al. 2018); however, survey methodology changed from the previous studies due to construction at the Portal Islands one and two and surveys were limited or not conducted for March and April due to inclement weather. Therefore, we propose use of abundance data collected in 2014 – 2016 (Rees et al. 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 0.8 seals per hour, within an 8-hour workday there may be 0.8 seals * 18 workdays in November, resulting in 14 seals being impacted. The anticipated number of seals impacted were summed (6,723). The largest Level A isopleth for phocid species is approximately 1,364 meters which would occur during impact isolation of ten battered piles. The smallest Level A zone during impact driving is 3 meters which would occur when ten timber piles are installed via vibratory hammer. NMFS authorized a shutdown zone for harbor seals of 15 meters since seals are common in the project area and are known to approach the shoreline. A larger shutdown zone would likely result in multiple shutdowns and impede the project schedule. From the previously issued IHA, NMFS assumed that 40 percent of the exposed seals will occur within the Level A zone specified for a given scenario and the remaining impacted seals would result in Level B takes. Therefore, the total number of requested Level A takes is 2,257 and total Level B takes is 3,385 harbor seals (Table 15).

Table 15. Calculation of the Number of Harbor Seal Takes

Month	Estimated Seals per Work Day	In Water Pile Driving Days per Month	Total Number of Level A Takes Requested	Total Number of Level B Takes Requested
Nov 2019	0.8	18	6	9
Dec 2019	20.8	25	208	312
Jan 2020	49	21	412	617
Feb 2020	96	21	806	1210
Mar 2020	88	32	1126	1690
Apr 2020	8	31	99	149
May 2020	3.2	25	32	48
Jun-Oct 2020	Seals not expected to be present.			

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 16). The anticipated numbers of monthly takes were calculated following the same approach for harbor seals, the monthly takes were then summed. The Level A isopleths for gray seals are identical to those for harbor seals. With a shutdown zone of 15 meters, previously, NMFS recommended the Level A take of 40 percent of exposed gray seals will occur within the Level A zone specificd for a given scenario. Therefore, the total number of requested gray seal Level A takes is 14 and Level B takes is 20 (Table 16).

Table 16. Calculation for the Number of Gray Seal Takes

Month	Estimated Seals per Work Day	In Water Pile Driving Days per Month	Total Number of Level A Takes Requested	Total Number of Level B Takes Requested
Nov-19	0	18	0	0
Dec-19	0	25	0	0
Jan-20	0	21	0	0
Feb-20	1.6	21	14	20
Mar-20	0	32	0	0
Apr-20	0	31	0	0
May-20	0	25	0	0
Jun -Oct 2020	Seals not expected to be present.			

6.4 ALL MARINE MAMMAL TAKES

The Level A and Level B takes being requested for each species are summarized in Table 17.

Table 17. Number of Takes Requested per Species

Animal	Level A Takes	Level B Takes
Harbor seal	2,689	4,034
Gray seal	14	20
Bottlenose dolphin	-	10,109
Harbor porpoise	4	6
Humpback whale	-	10

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 near the construction areas is unlikely. Although, whales have been observed in the deeper waters in the vicinity 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; 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 within the 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

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 µPa 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 µPa rms for impulsive sounds (e.g., impact pile driving) and greater than 120 dB re 1 µPa rms for non-impulsive noise (e.g., vibratory pile driving or extraction).

Tables 8 through 10 provide the estimated distances from the activity where injury and behavioral impacts are expected for marine mammals. Mitigative measures will be employed to minimize the pressure waves and underwater noise associated with pile driving activities. Use of a soft start will occur prior to pile driving ramp up to provide aquatic animals and marine mammals with a warning of pile driving activity. Secondly, a cushion block and an encased bubble curtain (plumb piles only) will be used with an impact hammer to aid in sound reductions within the water.

The impact driving of each hollow steel pile (plumb) 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 impact driven per day per portal island. Simultaneous impact piling driving may occur at both islands. The zone of passage for marine mammals in the Lower Chesapeake Bay is substantially greater than the zones of impact where injury (Level A) 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 marine mammal without an authorized Level A take enters the Level A ZOI (shutdown zone), pile driving activity will cease, in accordance with the Marine Mammal Monitoring Plan (MMMP) (Appendix C). Marine mammals that happen to be within the zone of behavioral impact (Level B) 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 will travel at less than 10 knots to be protective of right whales and other marine mammals. Vessels used for construction will consist of tugboats (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 to approved upland disposal locations 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 negligible for dolphins and seals and not viable for whales.

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 following construction. 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.

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 [USEPA 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). Monitoring turbidity during pile driving activities is part of the water quality monitoring program for the project. No impacts to marine mammals as a result of localized, temporary changes to water quality are expected.

Removal and Placement of Armor Stone —There are no known studies that estimate the amount of suspended sediment created by the removal and placement 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 bay (west) side of the Project Area via a Virginia Pollution Discharge Elimination System (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 containment area 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, 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 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 avoid disturbance from construction activity in the Project Area. Reduced vessel speeds in the Project Area will protect marine mammals from potential ship strikes.

Omega trestle, containment structure, 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 Marine Mammal Observers or 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 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 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.

    - Use of DTH hammer technology to directly drill through existing rock/armor stone will eliminate the need to remove and relocate stone to a subaqueous stockpile area, thus eliminating bottom impact and disturbance to adjacent subaqueous bottom.

    - 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.

- Dredged material will be disposed of at an approved offsite upland location via sealed trucks with mud locks or barges.

- 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.

- 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 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 pipe piles using a combination of DTH hammer through existing stone, followed by impact hammer to the target tip elevation.

  - Measurements of underwater acoustics for DTH driving to provide underwater sound data specific to the equipment being used and to facilitate modification to the ZOIs for marine mammals, as appropriate.

  - 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 steel pipe 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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Appendix A: Figures

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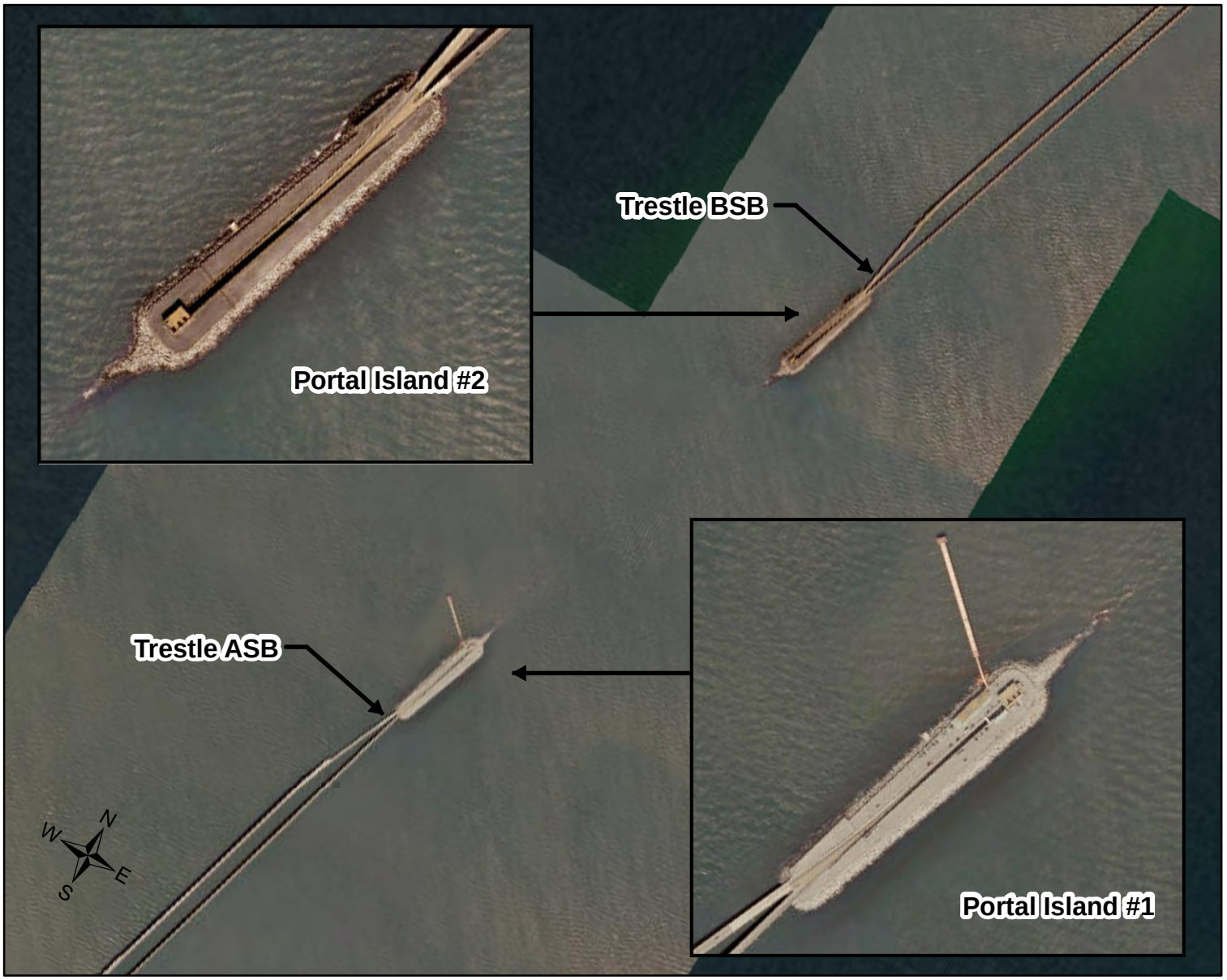

Figure 1. Project Location Map
Chesapeake Bay Bridge and Tunnel District
Thimble Shoal Parallel Tunnel

CHESAPEAKE TUNNEL JV

CHESAPEAKE BAY BRIDGE-TUNNEL

MOTT MACDONALD

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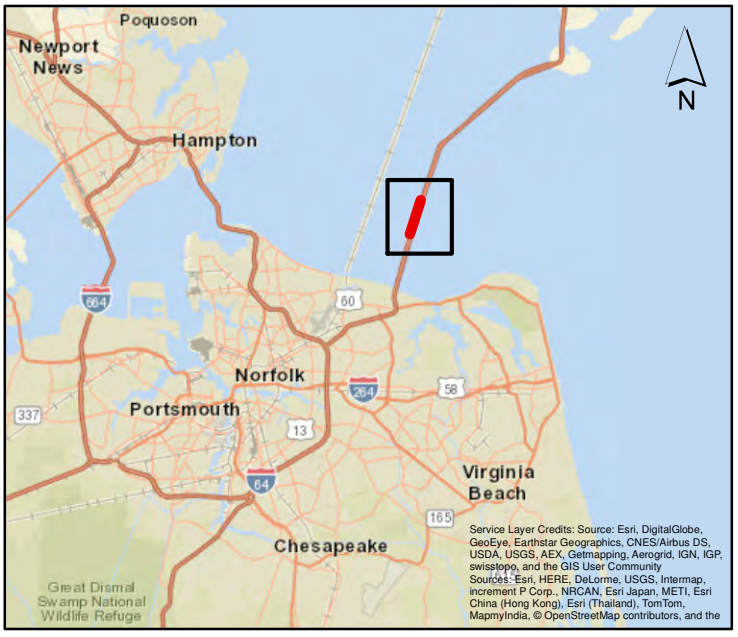

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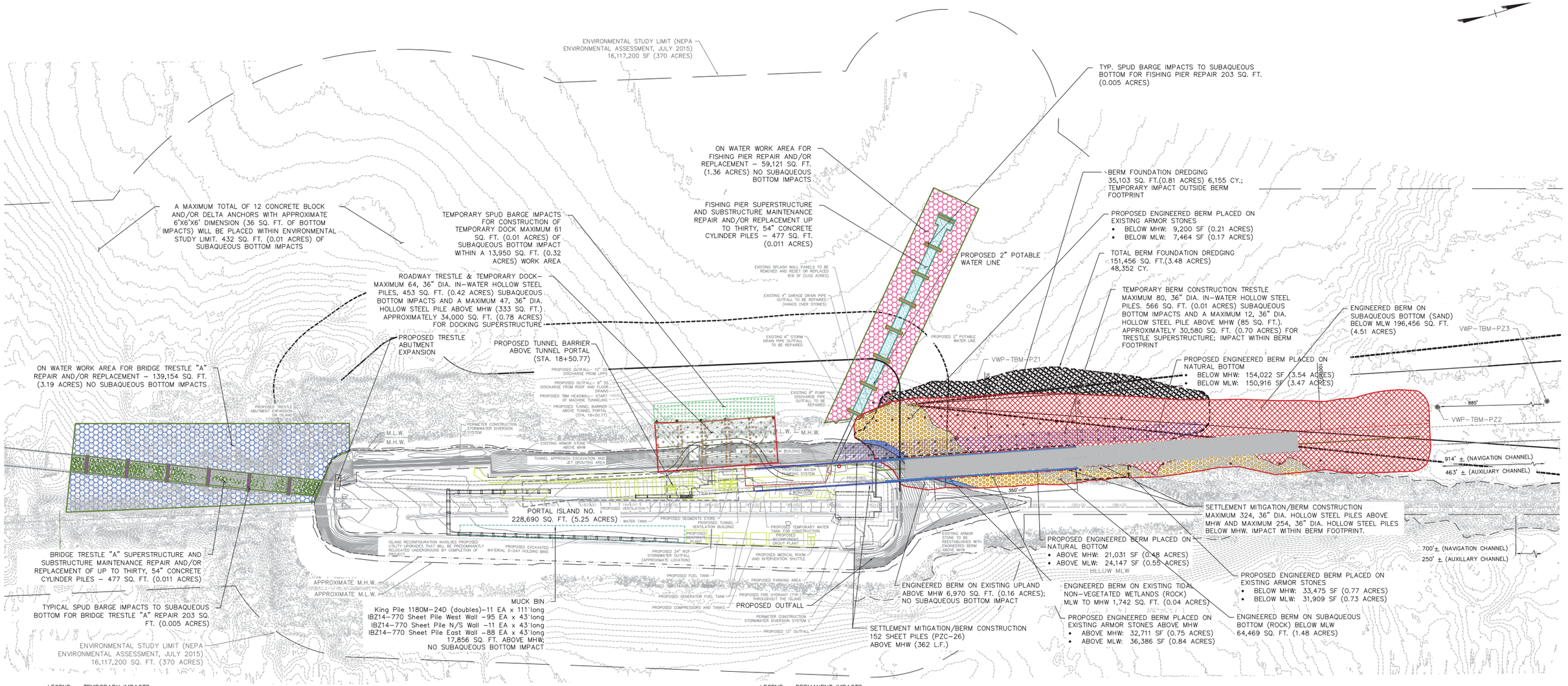

LEGEND – TEMPORARY IMPACTS

- SUBAQUEOUS ROCK STOCKPILE AREA 133,158 SQ. FT. (3.06 ACRES), AREA OUTSIDE BERM FOOTPRINT 24,068 SQ. FT. (0.55 ACRES)
- ROADWAY TRESTLE & TEMPORARY DOCK– MAXIMUM 64, 36" DIA. IN–WATER HOLLOW STEEL PILES, 453 SQ. FT. (0.42 ACRES) SUBAQUEOUS BOTTOM IMPACTS AND A MAXIMUM 47, 36" DIA. HOLLOW STEEL PILE ABOVE MHW (333 SQ. FT.) APPROXIMATELY 34,000 SQ. FT. (0.78 ACRES) FOR DOCKING SUPERSTRUCTURE
- LOCATION TO BE DETERMINED — 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 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)
- SETTLEMENT MITIGATION/BERM CONSTRUCTION MAXIMUM 324, 36" DIA. HOLLOW STEEL PILES ABOVE MHW AND MAXIMUM 254, 36" DIA. HOLLOW STEEL PILES BELOW MHW. IMPACT WITHIN BERM FOOTPRINT.
- SETTLEMENT MITIGATION/BERM CONSTRUCTION 152 SHEET PILES (PZC–26) ABOVE MHW (362 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 King Pile 1180M–24D (doubles)–11 EA x 111'long IBZ14–770 Sheet Pile West Wall –95 EA x 43'long IBZ14–770 Sheet Pile N/S Wall –11 EA x 43'long IBZ14–770 Sheet Pile East Wall –88 EA x 43'long 17,856 SQ. FT. ABOVE MHW; NO SUBAQUEOUS BOTTOM IMPACT
- 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 30,580 SQ. FT. (0.70 ACRES) FOR TRESTLE SUPERSTRUCTURE; IMPACT WITHIN BERM FOOTPRINT
- BERM FOUNDATION DREDGING 35,103 SQ. FT.(0.81 ACRES) 6,155 CY.; TEMPORARY IMPACT OUTSIDE BERM FOOTPRINT
- TEMPORARY SPUD BARGE IMPACTS FOR CONSTRUCTION OF TEMPORARY DOCK MAXIMUM 61 SQ. FT. (0.001 ACRES) OF SUBAQUEOUS BOTTOM IMPACT WITHIN A 13,950 SQ. FT. (0.32 ACRES) WORK AREA

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)

NOTES:

- 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.

120 60 0 120 240
SCALE IN FEET

Figure 2. Permit Level Design Impact Area Plan - Portal Island No. 1

SUBMISSION TYPE:

NO.	DATE	BY	APP.	REVISION

FILE NAME
JOB NO.

CHESAPEAKE TUNNEL JV
2377 FERRY ROAD
VIRGINIA BEACH, VA 23455

COMMONWEALTH OF VIRGINIA
CHESAPEAKE BAY BRIDGE AND TUNNEL DISTRICT

PARALLEL THIMBLE SHOAL TUNNEL
TO
LUCIUS J. KELLAM, JR. BRIDGE-TUNNEL

CTJV PERMIT UPDATE
PORTAL ISLAND #1

DRAWN BY: MH	DATE: 3/06/19	DWG. NO.
CHECKED BY:	SCALE: AS NOTED	SHEET 1 OF 2

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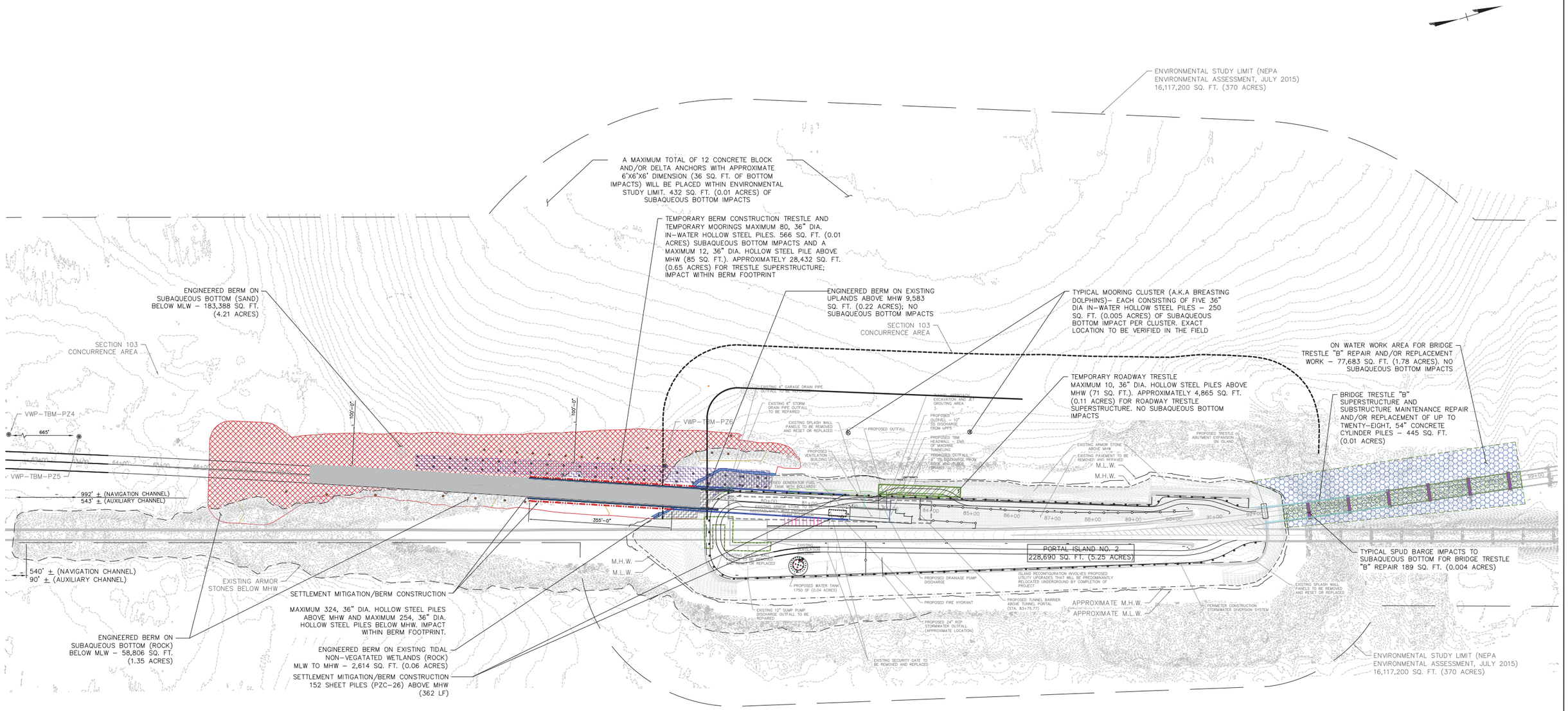

LEGEND – TEMPORARY IMPACTS

LOCATION TO BE DETERMINED — 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 AND TEMPORARY MOORINGS 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

SETTLEMENT MITIGATION/BERM CONSTRUCTION MAXIMUM 324, 36" DIA. HOLLOW STEEL PILES ABOVE MHW AND MAXIMUM 254, 36" DIA. HOLLOW STEEL PILES BELOW MHW. IMPACT WITHIN BERM FOOTPRINT.

SETTLEMENT MITIGATION/BERM CONSTRUCTION 152 SHEET PILES (PZC-26) ABOVE MHW (362 LF)

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) SUBAQUEOUS BOTTOM IMPACTS). EXACT LOCATION TO BE VERIFIED IN THE FIELD

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

Figure 3. Permit Level Design Impact Area Plan - Portal Island No. 2

120 60 0 120 240
SCALE IN FEET

SUBMISSION TYPE:

NO.	DATE	BY	APP.	REVISION

CHESAPEAKE TUNNEL JV
2377 FERRY ROAD
VIRGINIA BEACH, VA 23455

COMMONWEALTH OF VIRGINIA
CHESAPEAKE BAY BRIDGE AND TUNNEL DISTRICT

PARALLEL THIMBLE SHOAL TUNNEL
TO
LUCIUS J. KELLAM, JR. BRIDGE-TUNNEL

CTJV PERMIT UPDATE PORTAL ISLAND #2

DRAWN BY: MH	DATE: 03/06/19	DWG. NO.
CHECKED BY:	SCALE:	SHEET 2 OF 2

FILE NAME
JOB NO.

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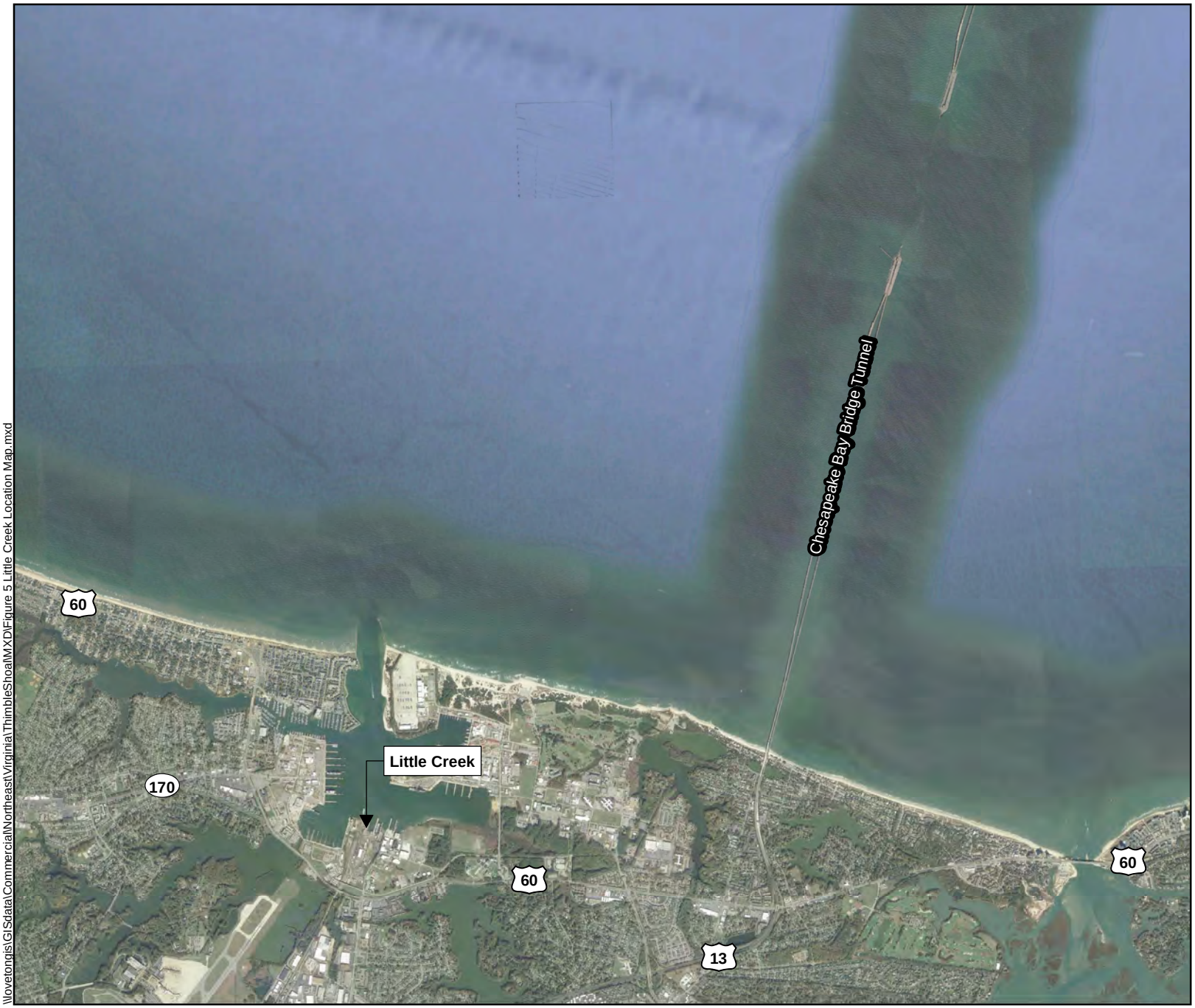

VICINITY MAP

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

N

0 2,000 4,000

Feet

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

EA

Figure 4

Little Creek Location Map

~~Parallel Thimble Shoal Tunnel~~

\\lovetongis\GIStata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\Figure 5 Little Creek Location Map.mxd

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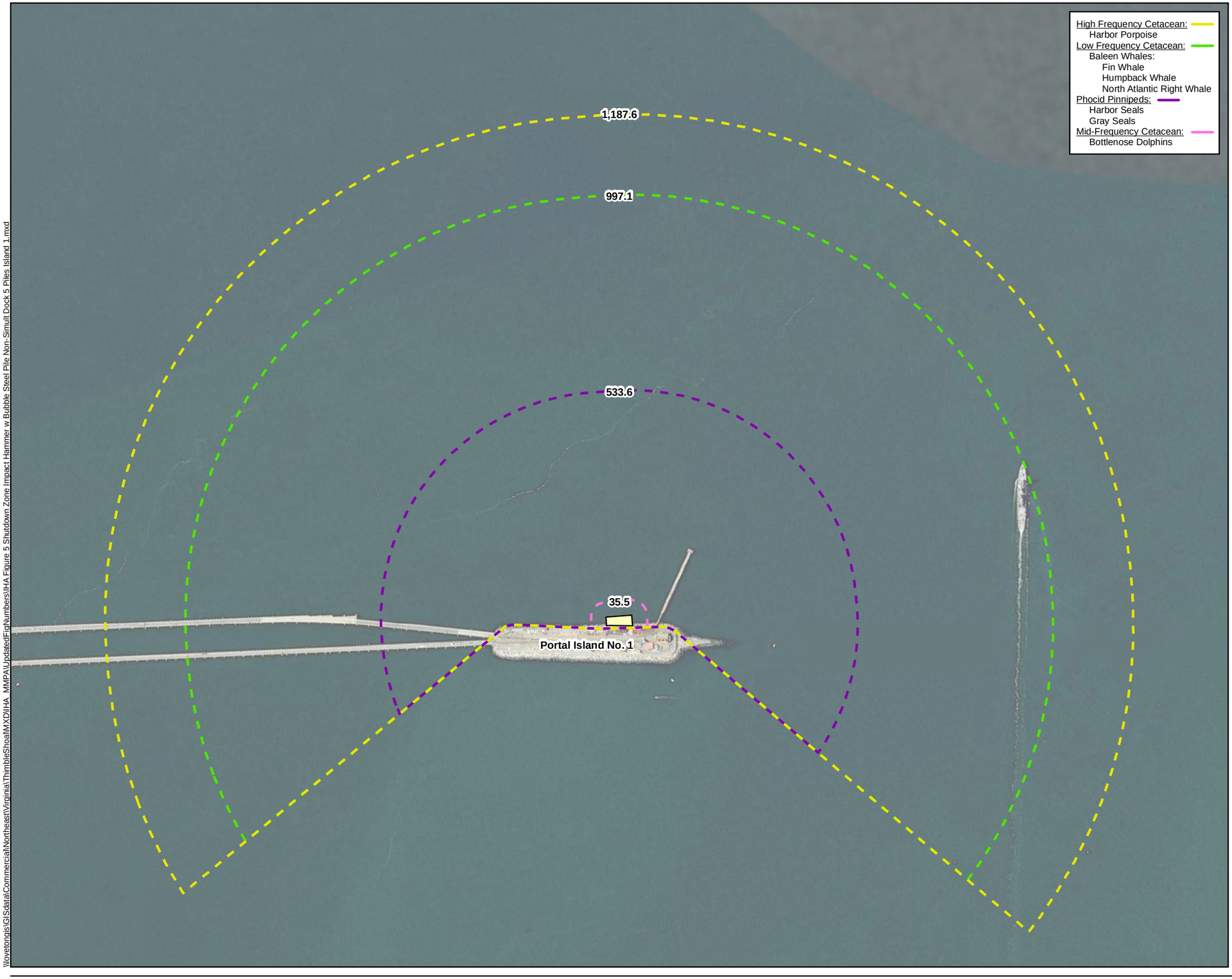
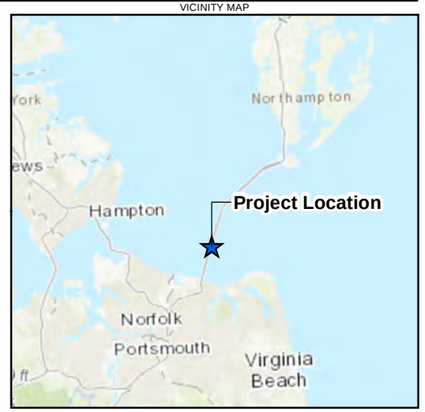


VICINITY MAP



Legend

Temporary Dock

5 Impact Piles per Day - Shutdown Zone

- 1,187.6 m - High-Frequency Cetaceans
- 997.1 m - Low-Frequency Cetaceans
- 533.6 m - Phocid Pinnipeds
- 35.5 m - Mid-Frequency Cetaceans

Map Date: 11/22/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 100 200
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 5
Distance (meters) to Shutdown Zone Using an Impact Hammer with Bubble Curtain for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock – 5 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonnis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 5 Shutdown Zone Impact Hammer w Bubble Steel Pile Non-Simult Dock 5 Piles Island 1.mxd

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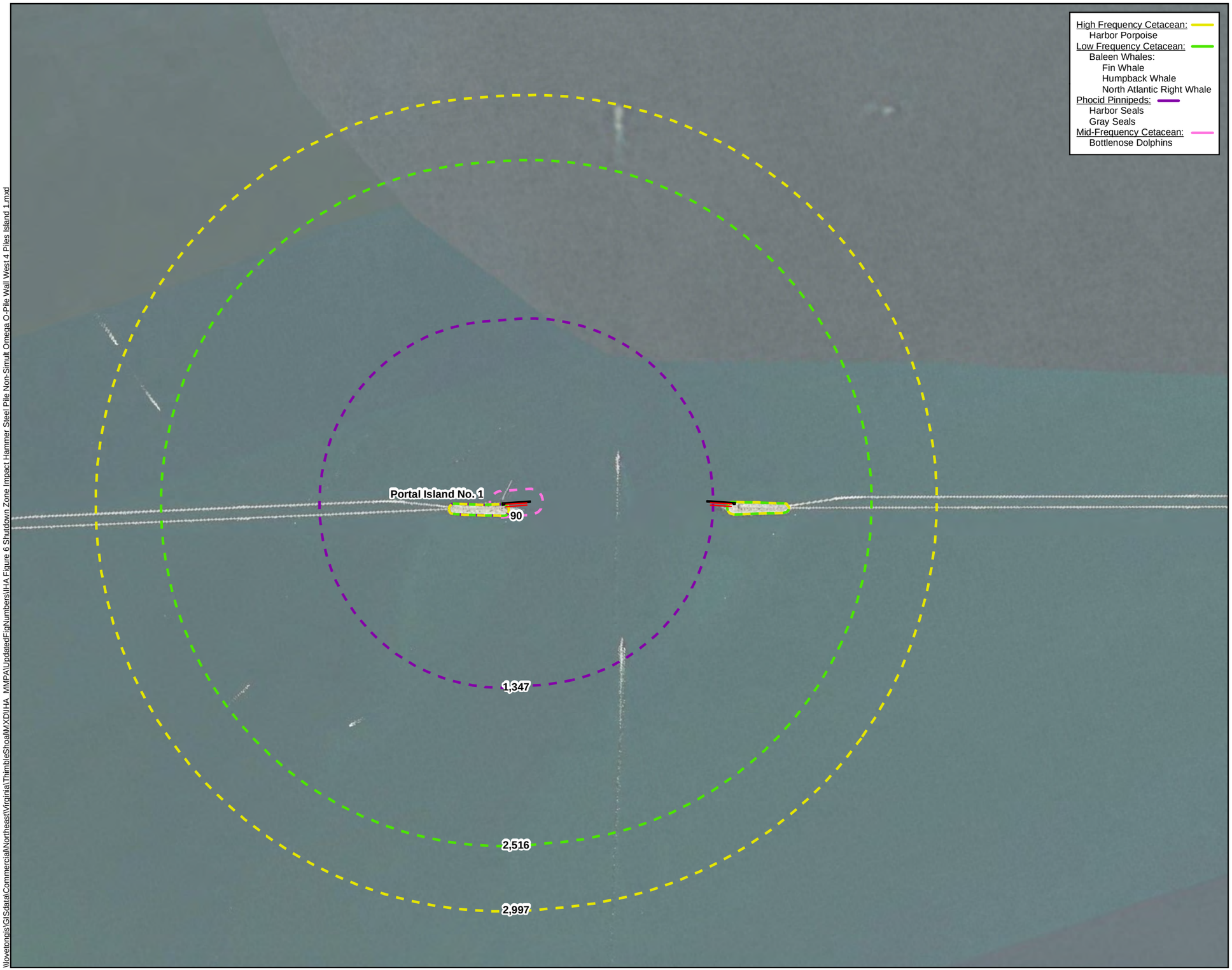
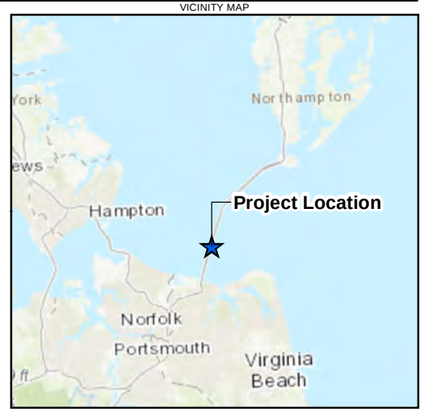


VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

4 Impact Piles per Day - Shutdown Zone

- 2,997 m - High-Frequency Cetaceans
- 2,516 m - Low-Frequency Cetaceans
- 1,347 m - Phocid Pinnipeds
- 90 m - Mid-Frequency Cetaceans

Map Date: 11/22/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

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CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 6
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 4 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonnis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 6 Shutdown Zone Impact Hammer Steel Pile Non-Simult Omega O-Pile Wall West 4 Piles island 1.mxd

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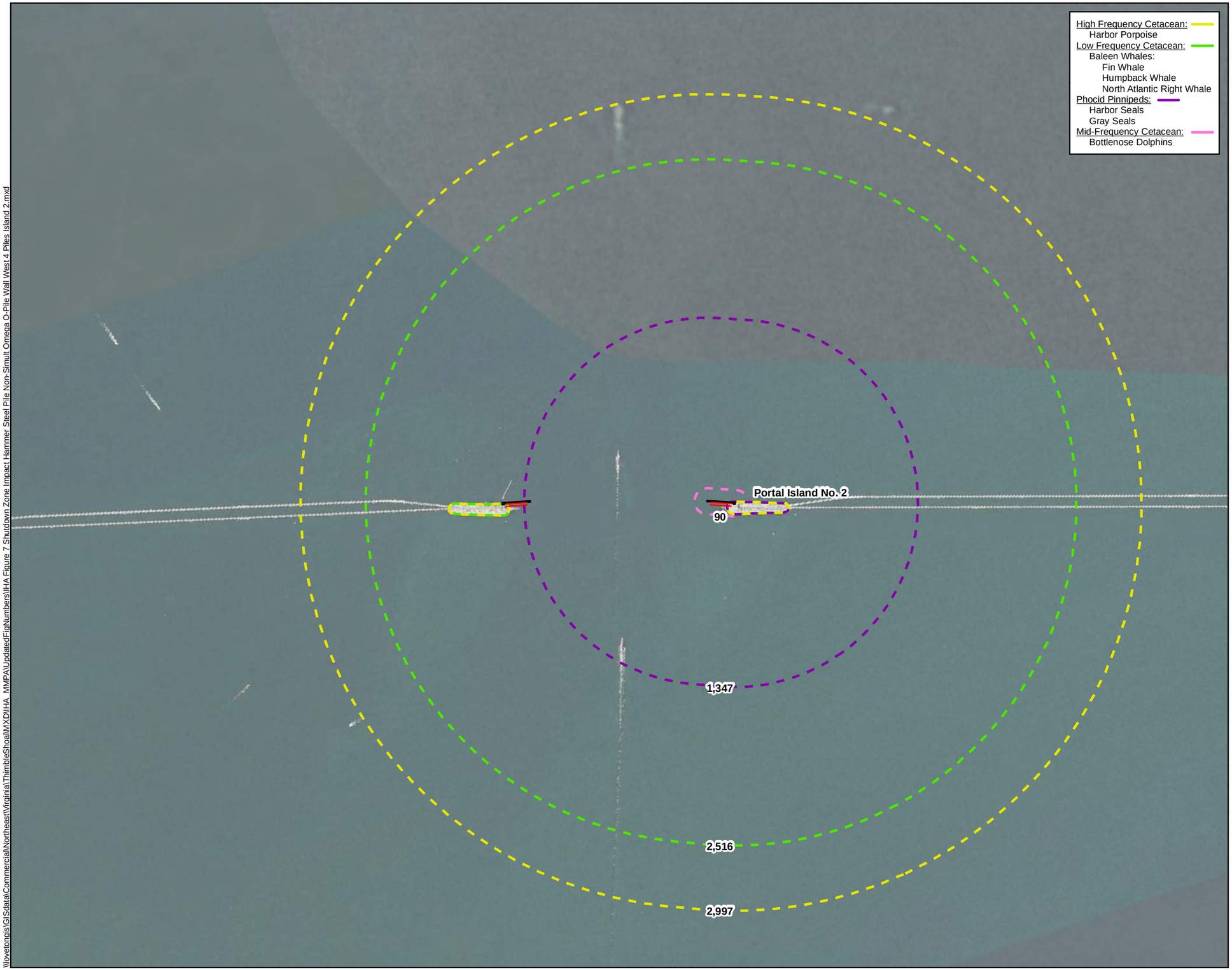
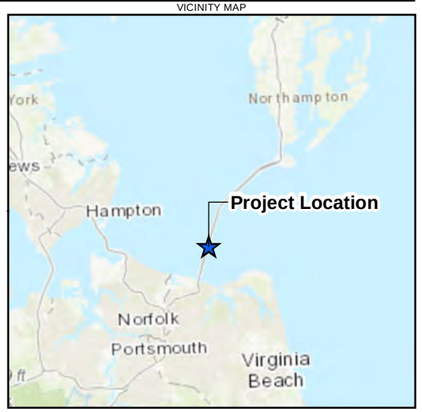


VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

4 Impact Piles per Day - Shutdown Zone

- 2,997 m - High-Frequency Cetaceans
- 2,516 m - Low-Frequency Cetaceans
- 1,347 m - Phocid Pinnipeds
- 90 m - Mid-Frequency Cetaceans

Map Date: 11/22/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 7
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 4 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 7 Shutdown Zone Impact Hammer Steel Pile Non-Simult Omega O-Pile Wall West 4 Piles island 2.mxd

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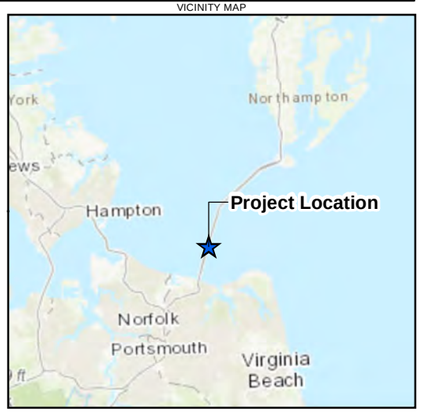
VICINITY MAP



Legend

⊗ Mooring Dolphin

Impact Pile - Level B

21.5 m - Cetaceans and Pinnipeds

Vibratory Pile - Level B

1,359.4 m - Cetaceans and Pinnipeds

Map Date: 11/22/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 8
Distance (meters) to Level B Threshold Using an Impact Hammer or Vibratory Hammer for Non-Simultaneous Timber Pile Driving for the Mooring Dolphins at Portal Island Nos. 1 and 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\HA_MMPA\UpdatedFigNumbers\HA Figure 8 Level B Impact Hammer Vibratory Hammer Timber Pile Non-Simult Mooring Dolphins Island 1 and 2.mxd

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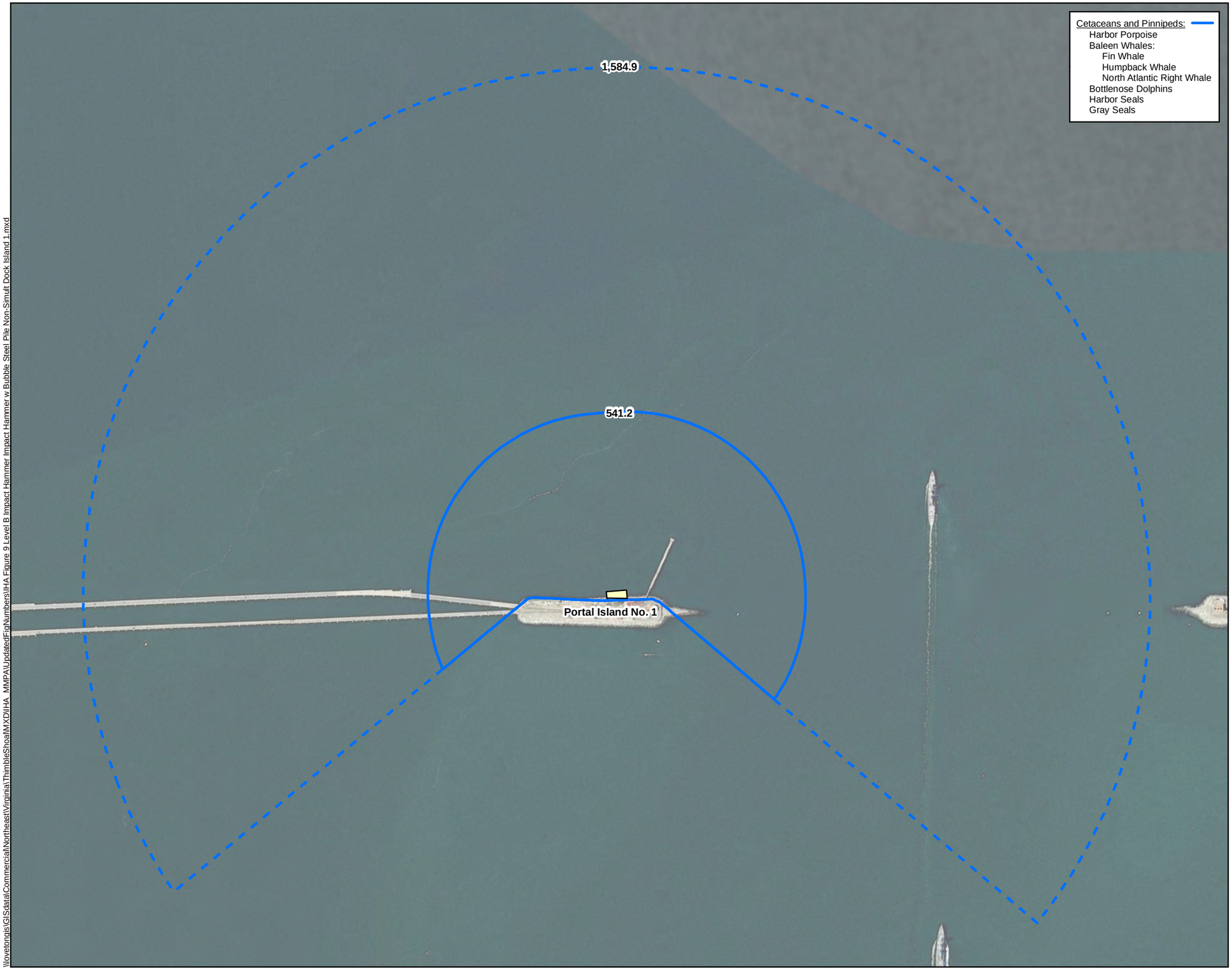
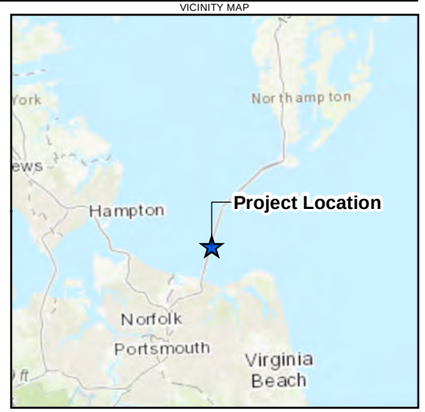


VICINITY MAP



Legend

Temporary Dock

Impact Pile - Level B

1,584.9 m - Cetaceans and Pinnipeds

Impact Pile with Bubble Curtain - Level B

541.2 m - Cetaceans and Pinnipeds

Map Date: 11/22/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 9
Distance (meters) to Level B Threshold
Using an Impact Hammer or
Impact Hammer with Bubble Curtain for
Non-Simultaneous
36- and 42-in Steel Pile Driving for the
Temporary Dock
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 9 Level B Impact Hammer Impact Hammer w Bubble Steel Pile Non-Simult Dock Island 1.mxd

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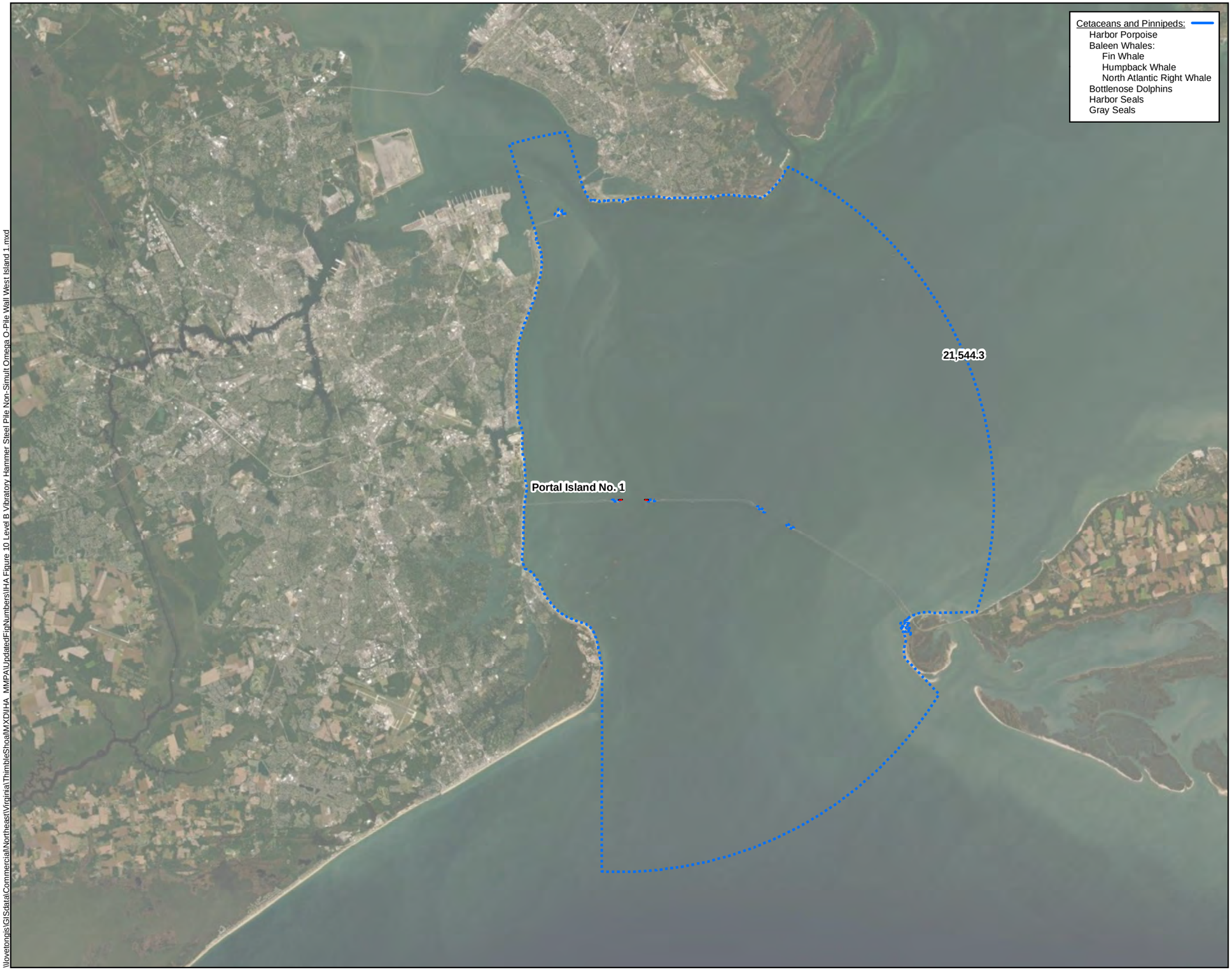
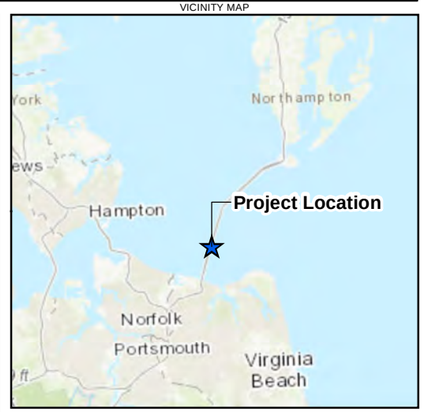


VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

Vibratory Steel Piles - Level B

- 21,544.3 m - Cetaceans and Pinnipeds

Map Date: 11/22/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 4,000 8,000
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 10
Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonnis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 10 Level B Vibratory Hammer Steel Pile Non-Simult Omega O-Pile Wall West Island 1.mxd

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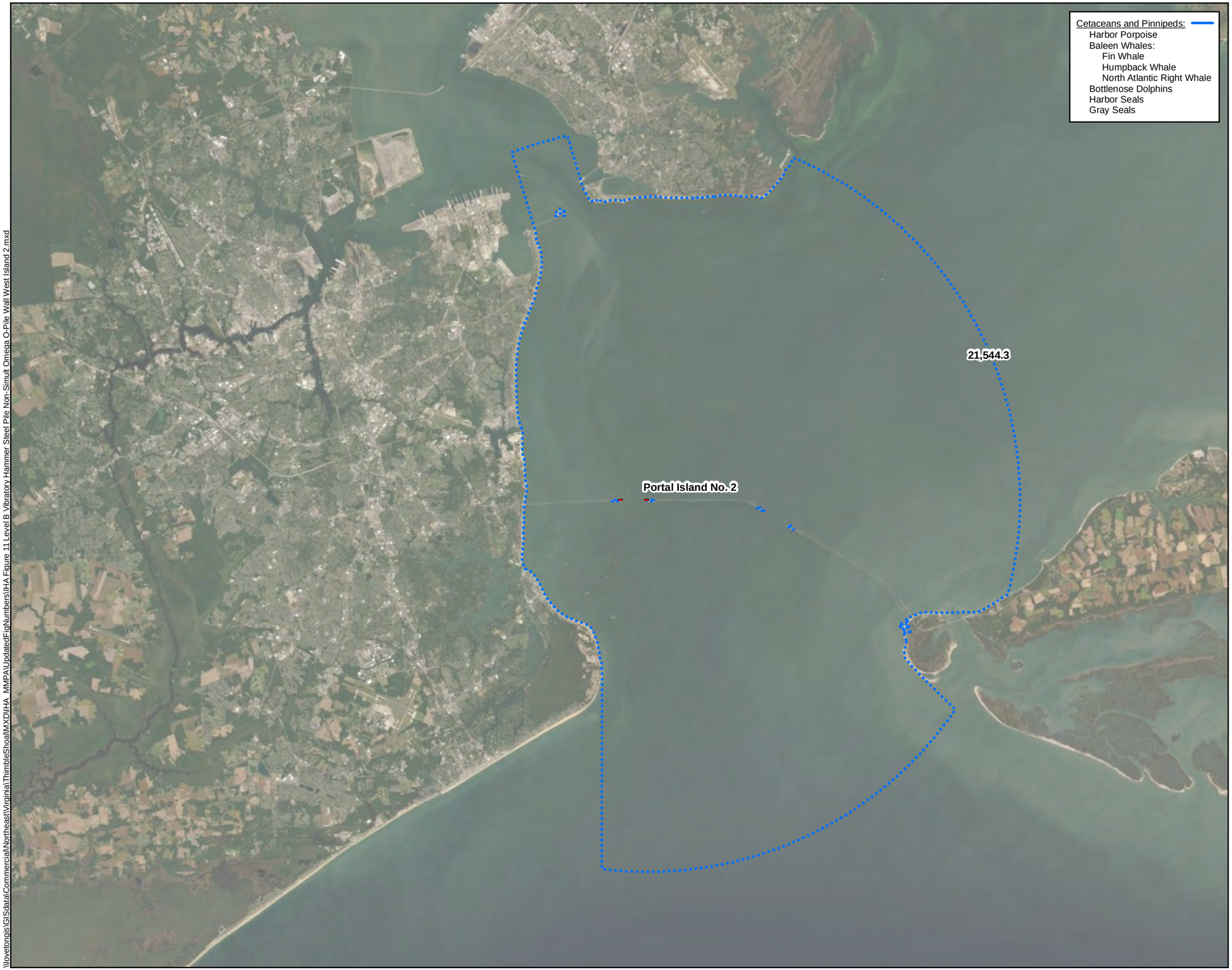
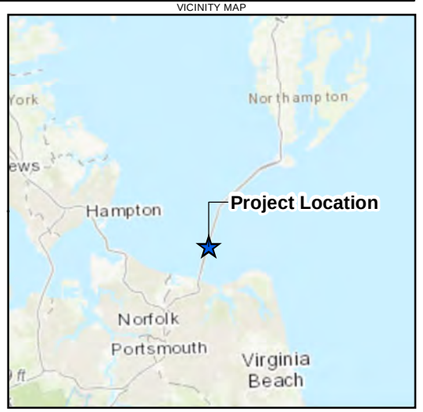


VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

Vibratory Steel Piles - Level B

- 21,544.3 m - Cetaceans and Pinnipeds

Map Date: 11/22/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 4,000 8,000
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 11
Distance (meters) to Level B Threshold
Using a Vibratory Hammer for
Non-Simultaneous
36- and 42-in Steel Pile Driving for the
Omega Trestle/West O-Pile Wall/
Mooring Piles and Templates
at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\IHA_MMPA\UpdatedFigNumbers\IHA Figure 11 Level B Vibratory Hammer Steel Pile Non-Simult Omega O-Pile Wall West Island 2.mxd

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Appendix B: Model Screenshots

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Caltrans 2015

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	170
Number of piles within 24-h period	5
Duration to drive a single pile (minutes)	12
Duration of Sound Production within 24-h period (seconds)	3600
10 Log (duration of sound production)	35.56
Propagation (xLogR)	15
Distance from source level measurement (meters)•	10

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

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring

requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**27.2**	**2.4**	**40.2**	**16.5**	**1.2**

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**

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Caltrans 2015

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	152
Number of piles within 24-h period	5
Duration to drive a single pile (minutes)	30
Duration of Sound Production within 24-h period (seconds)	9000
10 Log (duration of sound production)	39.54
Propagation (xLogR)	15
Distance from source level measurement (meters)•	10

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

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring

requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**3.2**	**0.3**	**4.7**	**1.9**	**0.1**

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)†	**-0.05**	**-16.83**	**-23.50**	**-1.29**	**-0.60**

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Denes 2019

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)¥	2	

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

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

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

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

PK

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

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

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

RESULTANT ISOPLETHS*

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

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

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

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**219.0**

SEL_{cum}

Source Level (Single Strike SEL)	183
Number of strikes per pile	1000
Number of piles per day	4
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

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

PK

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

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**2,516.4**	**89.5**	**2,997.4**	**1,346.7**	**98.0**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**2.5**	**NA**	**34.1**	**2.9**	**NA**

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Denes 2019

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)¥	2	

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

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

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

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

PK

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

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

NOTE: The User Spreadsheet tool provides a means to estimates distances associated with the Technical Guidance's PTS onset thresholds. Mitigation and monitoring

requirements associated with a Marine Mammal Protection Act (MMPA) authorization or an Endangered Species Act (ESA) consultation or permit are independent management decisions made in the context of the proposed activity and comprehensive effects analysis, and are beyond the scope of the Technical Guidance and the User Spreadsheet tool.

RESULTANT ISOPLETHS*

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

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

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

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

SEL_{cum}

Source Level (Single Strike SEL)	164
Number of strikes per pile	25200
Number of piles per day	2
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

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

PK

Source Level (PK SPL)	190
Distance of source level measurement (meters)*	10
Source level at 1 meter	205.0

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**737.4**	**26.2**	**878.3**	**394.6**	**28.7**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**1.6**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Denes 2019

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)¥	2	

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

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

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

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

PK

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

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

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

RESULTANT ISOPLETHS*

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

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

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

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**215.8**

SEL_{cum}

Source Level (Single Strike SEL)	164
Number of strikes per pile	50400
Number of piles per day	3
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

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

PK

Source Level (PK SPL)	190
Distance of source level measurement (meters)*	10
Source level at 1 meter	205.0

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**1,533.8**	**54.6**	**1,827.0**	**820.8**	**59.8**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**1.6**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Denes 2019

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)¥	2	

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

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

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

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

PK

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

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

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

RESULTANT ISOPLETHS*

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

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

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

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**194.0**

SEL_{cum}

Source Level (Single Strike SEL)	157
Number of strikes per pile	1000
Number of piles per day	5
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

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

PK

Source Level (PK SPL)	177
Distance of source level measurement (meters)*	10
Source level at 1 meter	192.0

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**54.0**	**1.9**	**64.3**	**28.9**	**2.1**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**NA**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

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

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

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

VERSION 2.0: 2018

KEY

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

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Parallel Thimble Shoals - CTJV
PROJECT/SOURCE INFORMATION	Denes 2019

Please include any assumptions

PROJECT CONTACT	Jamie Suski 410.527.2459

STEP 2: WEIGHTING FACTOR ADJUSTMENT

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

Weighting Factor Adjustment (kHz)¥	2	

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

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

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

STEP 3: SOURCE-SPECIFIC INFORMATION

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

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

SEL_{cum}

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

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

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

PK

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

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

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

RESULTANT ISOPLETHS*

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

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

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

Unweighted $SEL_{cum\ (at\ measured\ distance)}$ = SEL_{ss} + 10 Log (# strikes)	**213.0**

SEL_{cum}

Source Level (Single Strike SEL)	176
Number of strikes per pile	1000
Number of piles per day	5
Propagation (xLogR)	15
Distance of single strike SEL measurement (meters)*	10

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

PK

Source Level (PK SPL)	203
Distance of source level measurement (meters)*	10
Source level at 1 meter	218.0

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

RESULTANT ISOPLETHS*

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

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	**997.1**	**35.5**	**1,187.6**	**533.6**	**38.8**
PK Threshold	219	230	202	218	232
PTS PK Isopleth to threshold (meters)	**NA**	**NA**	**11.7**	**NA**	**NA**

WEIGHTING FUNCTION CALCULATIONS

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

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

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Appendix C: Marine Mammal Monitoring Plan

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Marine Mammal Monitoring Plan
for the
Parallel Thimble Shoal Tunnel Project

Prepared by:

Chesapeake Tunnel Joint Venture
2377 Ferry Road
Virginia Beach, Virginia 23455

Submitted to:

National Marine Fisheries Service
Office of Protected Resources
1315 East-West Highway
Silver Spring, Maryland 20910-3226

November 22, 2019

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ACRONYMS AND ABBREVIATIONS

CT JV	Chesapeake Tunnel Joint Venture
DTH	Down the Hole
ft	feet
GPS	Global Positioning System
IHA	Incidental Harassment Authorization
MHW	Mean High Water
MLW	Mean Low Water
MMMP	Marine Mammal Monitoring Plan
MMO	Marine Mammal Observer
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
Nos.	Numbers
PTS	Permanent Threshold Shift
PTST	Parallel Thimble Shoal Tunnel
SOE	Support of Excavation
TBM	Tunnel boring machine
ZOI	Zone of impact

1. INTRODUCTION

The Parallel Thimble Shoal Tunnel (PTST) Project consists of the construction of a two-lane parallel tunnel to the west of the existing Thimble Shoal Tunnel, connecting Portal Island Numbers (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 6,350 linear feet (ft) of new tunnel will be constructed using a tunnel boring machine (TBM), with 5,356 linear ft located below Mean High Water (MHW).

Pile driving during construction of the PTST Project has 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 2016).

During a 12-month construction period extending from November 2019 through October 2020 (Table 1), the following in water work will take place:

- Temporary dock construction: Construction of a 32,832 sq ft working platform on the west side of Portal Island No. 1. This construction includes installation of 64 in-water and 47 upland piles for a total of 111 (6 in-water piles were installed as a part of CTJV's prior IHA), 36-inch diameter hollow steel pipe piles. A 42-inch steel casing will initially be driving with a down the hole hammer and the 36-inch piles will be installed with an impact hammer. A bubble curtain will be used during the impact driving of each 36" pile. Of the total piles, 12 are expected to be installed using the impact hammer without mitigation due to complexity of the substrate and/or less than 10ft of water. The design for the mooring structures has been completed, and it is now necessary to use timber piles for construction of the temporary mooring dolphins. The timber piles will be installed using a vibratory hammer. However, should refusal be encountered prior to design tip elevation when driving with the vibratory hammer an impact hammer will be used to drive the remainder of the pile length. No bubble curtains will be utilized for the installation of the timber piles.

- Construction of two temporary Omega trestles, including:

  - Island 1: 8 upland and 26 in-water 36" diameter steel pipe piles
  - Island 2: 8 upland and 28 in-water 36" diameter steel pipe piles

These trestles will be offset to the west side of each engineered berm; extending approximately 659 ft channelward from Portal Island Nos. 1 and 2, respectively.

  - Construction of two engineered berms, approximately 1,395 ft. in length for Portal Island No. 1 (435 ft. above MHW and 960 ft below MHW), and approximately 1,354 ft. in length for Portal Island No. 2 (446 ft. above MHW and 908 ft. below MHW). Both berms will extend channelward from each portal island. Construction methods will include: dredging; stone placement (core, bedding, filter, armor 1&2 stone); impact and vibratory pile driving; casing advancement (Down the Hole (DTH) hammer); installation of

horizontal and vertical inclinometers, piezometers and survey points; excavation between SOE walls; and placement of engineered and flowable fill. Interlocked pipe piles will be installed through the use of DTH drilling equipment. This equipment uses reverse circulation drilling techniques in order to advance hollow steel pipes through the existing rock found within the project site. Once the pipes are advanced through the rock layer using the DTH technology, they are driven to final grade via traditional impact driving methods.

- Installation of interlocked pipe piles on both sides of the new tunnel alignment for settlement mitigation, SOE, and to facilitate flowable fill placement.

Table 1. Anticipated Pile Installation Schedule (November 2019 through October 2020)

Pile Location	Pile Function	Pile Type	Installation/Removal Method	Bubble Curtain	Number of Piles below MHW	Days per Activity (Total)	Days per activity (by Hammer Type)
1	Mooring dolphins	12-inch Timber piles	Vibratory (Install)	No	120	21 Days	12 Days (10 Piles/Day)
			Impact (if needed)	No			3 Days (12 Piles/Day)
			Vibratory (Removal)	No			6 Days (20 Piles/Day)
1	Temporary Dock	42-inch Diameter Steel Pipe Casing	DTH (install)	No	58	48 Days	29 Days (2 Piles/day)
			Vibratory (removal)	No			19 Days (3 Piles/day)
		36-inch Diameter Steel Pipe Pile	Impact	Yes	58*	29 Days	29 Days (2 Piles/day)
1	Omega Trestle	36-inch Diameter Steel Pipe Piles	DTH (Install)	No	36**	78 Days	13 Days (2 Piles/Day)
			Impact	Yes			65 Days (0.4 Piles/Day)
1	Berm Support of Excavation Wall - West Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (install)	No	135	58 Days	45 Days (3 Piles/Day
			Impact	Yes			13 Days (10 Piles/Day)
1	Berm Support of Excavation Wall - East Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	121	121 Days	80 Days (1.5 Piles/Day)
			Impact	Yes			41 Days (3 Piles/Day)
1	Mooring Piles and Templates	36-inch Diameter Steel Pipe Piles	Vibratory (Install & Removal)	No	12	2 Days	2 Days (12 Piles/Day)
2	Mooring Dolphins	12-inch Timber Piles	Vibratory (Install)	No	60	12 Days	6 Days (10 Piles/Day)
			Impact (if needed)	No			2 Days (15 Piles/Day)***
			Vibratory (Removal)	No			4 Days (20 Piles/Day)
2	Omega Trestle	36-inch Diameter Steel Pipe Piles	DTH (Install)	No	28	28 Days	16 Days (2 Piles/Day)
			Impact	Yes			12 Days (2.33 Piles/Day)
2	Berm Support of Excavation Wall - West Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	129	55 Days	42 Days (3 Piles/Day)
			Impact	Yes			13 Days (9.5 Piles/Day)
2	Berm Support of Excavation Wall - East Side	36-inch Diameter Steel Interlocked Pipe Piles	DTH (Install)	No	115	106 Days	71 Days (1.5 Piles/Day)
			Impact	Yes			35 Days (3 Piles/Day)
2	Mooring Piles and Templates	36-inch Diameter Steel Pipe Piles	Vibratory (Install & Removal)	No	16	4 Days	4 Days (4 Piles/Day)
Total					878		

*11 piles will be installed in <10 ft water so bubble curtain will not be used.

**10 piles will be installed in <10 ft water so bubble curtain will not be used.

The Chesapeake Tunnel Joint Venture (CTJV) has submitted an Incidental Harassment Authorization (IHA) application to request takes for five species: harbor seals (*Phoca vitulina*), gray seals (*Halichoerus grypus*), bottlenose dolphin (*Tursiops* spp.), harbor porpoise (*Phocoena phocoena*) and humpback whales (*Megaptera novaeangliae*) by Level B harassment. Fin whales (*Balaenoptera physalus*) and North Atlantic right whales (*Eubalaena glacialis*) are expected to be rare in the PTST Project Area, and no takes have been requested for these species. Pile and sheet pile driving operations will cease if any marine mammal species without an authorized take enters the Level A Shutdown Zones (Section 3) or if fin whales, humpback whales, North Atlantic right whales, and harbor porpoise are observed in the level B monitoring zones (Section 3). No takes are requested for airborne noise associated with on-land pile driving. Prior to the issuance of the IHA, pile driving on Portal Islands will cease if gray or harbor seals are observed entering the Level B airborne noise monitoring zone associated with these activities. Takes requested are summarized in Table 2.

Table 2. Number of Level B Takes Requested per Species

Animal	Level A Takes	Level B Takes
Harbor seal	3,114	4,671
Gray seal	8	13
Bottlenose dolphin	-	10,109
Harbor porpoise	4	6
Humpback whale	-	10

Level A Shutdown Zones and B Zones of Impact (ZOI) are calculated based on the type of activity occurring and the hearing frequency of the marine mammal. Animals that may inhabit or pass through the area of construction are classified within the following hearing frequencies:

<u>High Frequency Cetacean:</u>

- Harbor Porpoise (*Phocoena phocoena*)

<u>Mid-Frequency Cetacean:</u>

- Bottlenose Dolphins (*Tursiops spp.*)

<u>Low Frequency Cetacean:</u>

- Baleen Whales:
    - Fin Whale (*Balaenoptera physalus*)
    - Humpback Whale (*Megaptera novaeangliae*)
    - North Atlantic Right Whale (*Eubalaena glacialis*)

Phocid Pinnipeds:

- Harbor Seals (*Phoca vitulina*)
- Gray Seals (*Halichoerus grypus*)

This PTST Marine Mammal Monitoring Plan (MMMP) proposes a protocol for monitoring marine mammals during round pile and sheet pile driving activities in the Project Area. The goal of this MMMP is to prevent unauthorized Level A or Level B takes and to minimize Level B harassment using clearly defined methods for monitoring and shutdown procedures during construction. Incidents of harassment and construction shutdown events will be recorded and reported.

2. METHODS

2.1 MONITORING PROCEDURES

The CTJV, the design-build contractor for the PTST Project, proposes the following MMMP procedures:

- Use of marine mammal observers during pile and sheet pile driving activities. Observers will meet the criteria defined in Section 2.2.
- Monitoring distances, in accordance with the Level A Shutdown Zone and Level B ZOI identified in Section 3, will be determined by using a range finder, scope, hand-held global positioning system (GPS) device or landmarks with known distances from the monitoring positions. Monitoring locations will be based on land at either Portal Island No. 1 or Portal Island No. 2.
- If the entire Level B monitoring zone is not visible, pile driving activities may continue, and the number of individual listed animals within the Level B zone will be estimated and recorded. Estimated numbers of individuals will be extrapolated by dividing the number of observed individuals by the percentage of the monitoring zone that was visible.
- Zones will be monitored for the presence of marine mammals 30 minutes before, during, and 30 minutes after any pile driving activity. Observers will scan the waters within the area of potential sound effects using binoculars (10X42 or similar) or spotting scopes (20-60 zoom or equivalent), and make visual observations.
- Monitoring will be continuous unless the contractor takes a break longer than 2 hours from active pile and sheet pile driving, in which case, monitoring will be required 30 minutes prior to restarting pile installation.
- If marine mammals are observed, their location within the zones, and their reaction (if any) to pile activities will be documented.

- If a marine mammal crosses into the designated ZOIs for that species, additional monitoring or a temporary stop to pile driving activity will occur, in accordance with the procedures outlined in Section 5 of this Monitoring Plan.

- If weather or sea conditions restrict the observer's ability to observe, or become unsafe, pile installation will be suspended until conditions allow for monitoring to resume.

- For in-water pile driving, under conditions of fog or poor visibility that might obscure the presence of a marine mammal within the shutdown zone, the pile in progress will be completed and then pile driving suspended until visibility conditions improve. Visibility will be confirmed and approved by the Marine Mammal Observer (MMO) at the beginning of the shift. Likewise, the certified MMO will suggest the number of observers needed to cover the ZOI based on the visibility conditions anticipated for the following shift and their best professional judgement call.

Monitoring will occur year-round, during pile driving operations, because some marine mammal species have the potential to be present at any time of the year.

2.2 OBSERVER QUALIFICATIONS

The CTJV will employ NOAA Fisheries-approved marine mammal observers to monitor Level A Shutdown Zones and Level B ZOI. These individuals will be independent (i.e., not construction personnel) trained biologists with:

- Visual acuity in both eyes sufficient to see moving objects on the water's surface; ability to estimate object size and distance.

- The ability to make visual field observations and collect data as described in the protocol.

- Experience or training with identifying marine mammals in the field.

- Sufficient training, orientation or experience with the construction operation to provide for personal safety during observations.

- Ability to communicate orally, by radio or in person, with project personnel to provide real-time information on marine mammals observed in the area as necessary.

- Experience and ability to conduct field observations and collect data according to assigned protocols (this may include academic experience).

- The ability to prepare a status report of monitoring activities that describes the species and number of individuals observed, dates and times of construction activities; dates of when construction activities were ceased or shutdown to avoid Level A harassment to any species or Level B harassment for any species for that the PTST Project is not authorized to take.

If only one marine mammal observer is needed, this individual will have prior experience with observing marine mammals in the field. If teams of two or more observers are needed, one

observer will be designated as the lead observer. The lead observer will have prior experience working as a marine mammal observer, and additional observers may substitute education or training for experience.

2.3 DATA COLLECTION

Marine mammal observers at the PTST Project Area will use Observation Record Forms approved by NOAA. An observation record will be completed by each observer for each location and day of survey.

The following data will be included in the observation records:

- Date and time that in-water or upland round pile or sheet pile driving/installation begins and/or ends;
- Sea state using the Beaufort Wind Force Scale and weather including percent cloud cover, percent glare, visibility;
- Species, numbers of individuals, and when possible the sex and age class of observed marine mammals;
- Pile driving or sheet pile activities occurring during each sighting;
- Behaviors exhibited by observed marine mammals, including bearing and direction of travel, and behavioral responses to soft-start and shutdown procedures;
- Location of marine mammal, distance from observer to marine mammal, and distance from the pile driving activities to the marine mammal.
- Whether the observation required implementation of shutdown procedures and the duration of each shutdown;
- Other human activity in the area such as fishing or transit of navy or cargo ships in the navigation channel. Hull numbers of fishing, cargo, or navy vessels will be recorded if possible.

2.4 EQUIPMENT

Marine mammal observers will have the following equipment available during monitoring:

- Binoculars
- Range finder
- Logbook
- Cell phone or other wireless communication
- GPS Unit (for all vessel based observations, if implemented).

3. LEVEL A AND LEVEL B MONITORING ZONES

Impact hammer and Down-the-hole (DTH) drill will be used to install hollow steel piles, a vibratory hammer will be used for steel casing extraction. Above Mean High Water, sheet and King piles will be installed using a vibratory and impact hammer. No airborne sound data were available for impact driving of King Piles and Sheet Piles to determine in-air Level B monitoring zones and therefore, the Level B ZOI for impact driving of the hollow steel pile (150 m) should be followed during such activity. The Level B ZOI will remain constant in size through the daily pile driving activities. The Level A Shutdown Zones will depend on the duration of pile driving activity and the presence of marine mammals per 24-hour period.

The Level A Shutdown Zone and Level B ZOIs for underwater noise associated with driving hollow steel piles and sheet piles are shown in Tables 3 & 4. The monitoring zone sizes for Level A (shutdown) depend on the number of piles to be driven each day and whether simultaneous pile driving will occur. For this Project, simultaneous pile driving refers to one hammer operating on each Portal Island or two hammers operating on the same island. The Level B ZOIs for airborne noise are shown in Table 6. Maps of the Level A Shutdown Zone and Level B ZOIs are provided as Figures 2 through 33.

Table 3. Radial Distance (Meters*) from Pile Driven to Level A Sound Thresholds (Shutdown Zones) for Cetaceans and Phocid Pinnipeds for Scenarios Involving a Down-the-Hole Hammer

Hammer Type*	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds
DTH Hammer	966	34	1,151	517
2 DTH Hammers Simultaneous	1,534	55	1,827	821
DTH & Impact Hammer Simultaneous	1,734	62	2,066	929

*Distances based on 3 round steel piles per day per DTH hammer.

Table 4. Level B Underwater Zones of Impact (meters*)

Hearing Group	Hammer Type		Cetaceans / Pinnipeds		Pile Location in the PTST Project
Sound Threshold (dB)			160 (impact) 120 (vibratory)		
	--	**Pile Type**	**Island 1**	**Island 2**	
PTS Isopleth to threshold (meters)	**Impact**	12-in. Timber	22	22	Mooring Dolphins
		36-in. Steel	1,589	1,589	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Impact with Bubble Curtain	36-in. Steel	541	541	Berm Wall West, Berm Wall East, and Temporary Dock
	DTH - Impulsive	42-in. Steel	215	--	Casing for Temporary Dock
		36-in. Steel	215	215	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	DTH & Impact Hammer Simultaneous	36-and 42-in. Steel	541	541	Omega Trestle, Temporary Dock, Berm Wall West, and Berm Wall East
	Continuous (Vibratory)	12-in. mooring	1,354	1,354	Mooring Dolphins
		36-in. Steel	21,544	21,544	Mooring Piles and Templates
		42-in. Steel	21,544	--	Casing for Temporary Dock

*Distances based on impact hammer/vibratory hammer of 10 plumb round steel piles per day and DTH of 3 round steel piles per day.

Table 5. Level B Airborne Zones of Impact (meters)

Common Name	Scientific Name	Level B ZOI – Impact Hammer	Level B ZOI – DTH Hammer	Level B ZOI – Vibratory Hammer - sheet	Level B ZOI – Vibratory Hammer King Pile
Harbor Seal	*Phoca vitulina*	150	7.94	4.92	10.6
Gray Seal	*Halichoerus grypus*	150	7.94	4.92	10.6

4. OBSERVER LOCATIONS

Marine mammal observers will be located on Portal Island Nos. 1 and 2.

5. RESPONSE TO OBSERVED MARINE MAMMALS

5.1 OBSERVATIONS OF HEALTHY MARINE MAMMALS

If a whale or harbor porpoise is observed entering the Level A or Level B monitoring zones, the observer will directly contact the construction supervisor to indicate that pile driving needs to be stopped immediately. The observer will track the individual until it has left the Level A Shutdown Zone. After the whale or porpoise has been out of the Level A Shutdown Zone and B monitoring zones for 30 minutes, the observer will notify the construction supervisor that pile driving activities may resume. The observer will record a Level B take of the species observed.

If a seal or bottlenose dolphin enters the Level A Shutdown Zones, the observer will directly contact the construction supervisor to indicate that pile driving needs to be stopped immediately. The observer(s) tracks the individual until it has left the Level A Shutdown Zone. After the seal or dolphin has been out of the Level A Shutdown Zone for 15 minutes, the observer will notify the construction supervisor that pile driving activities may resume. The observer will record a Level B take of the species observed.

If a bottlenose dolphin enters the Level B monitoring zone for in-water activities, the observer will record a Level B take of the species observed. Each individual marine mammal will count once as a take in a 24-hour period.

All observations and takes of marine mammals will be documented on observation forms and compiled records will be reported to NOAA in accordance with the reporting procedures described in Section 6.

5.2 OBSERVATIONS OF INJURED OR DEAD MARINE MAMMALS

If dead or dying marine mammals are observed in the monitoring zones, regardless of known cause, the observer(s) will:

- Record the species type (if known), date, time, and location of the observation,
- Take a photograph of the specimen, and

- Immediately notify NOAA Fisheries.

5.3 UNAUTHORIZED EXPOSURES

If an unauthorized exposure occurs (e.g., a marine mammal occurring in a Level A Shutdown Zone or Level B ZOI without an authorized take), the observer(s) will:

- Record the species type (if known), date, time, and location of the observation,
- Record any behavioral changes that occur during observation,
- Contact the construction manager to cease pile driving activity immediately, and
- Immediately notify NOAA Fisheries.

6. REPORTING

An annual report will be prepared and distributed to NOAA Fisheries once per calendar year that pile or sheet pile driving occurs. The report will be provided to NOAA Fisheries by December 31 of each year where a report is needed. This annual report will include an executive summary, monitoring methodology, tabulation of marine mammal observations (including number, type, and location of observations), dates and times when monitoring occurred, and pile driving was completed, and dates and times when in-water construction was suspended because of marine mammals.

7. REFERENCES

NOAA. 2016. Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. Technical Memorandum NMFS-OPR-55.

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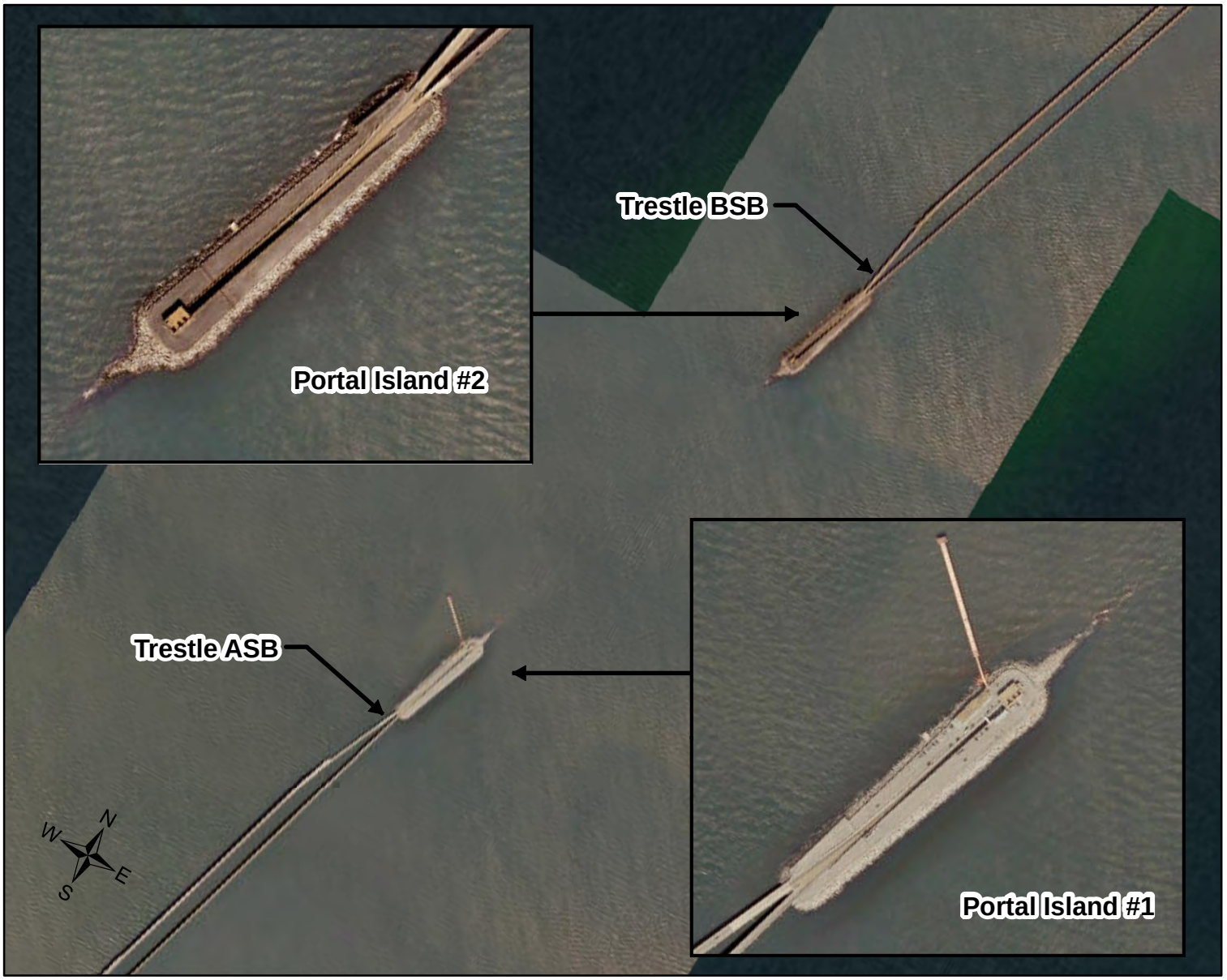


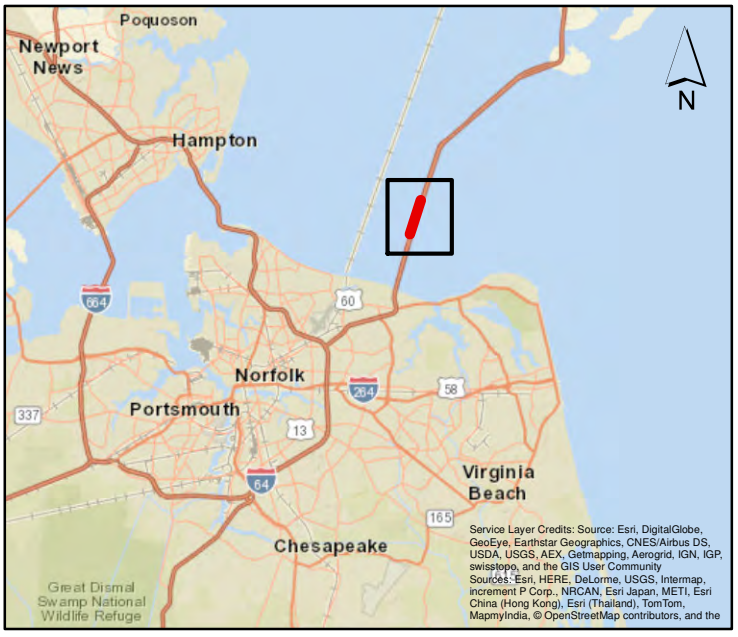
Figure 1. Project Location Map
Chesapeake Bay Bridge and Tunnel District
Thimble Shoal Parallel Tunnel

CHESAPEAKE TUNNEL JV

CHESAPEAKE BAY BRIDGE-TUNNEL

MOTT MACDONALD

0 0.5 1 Miles



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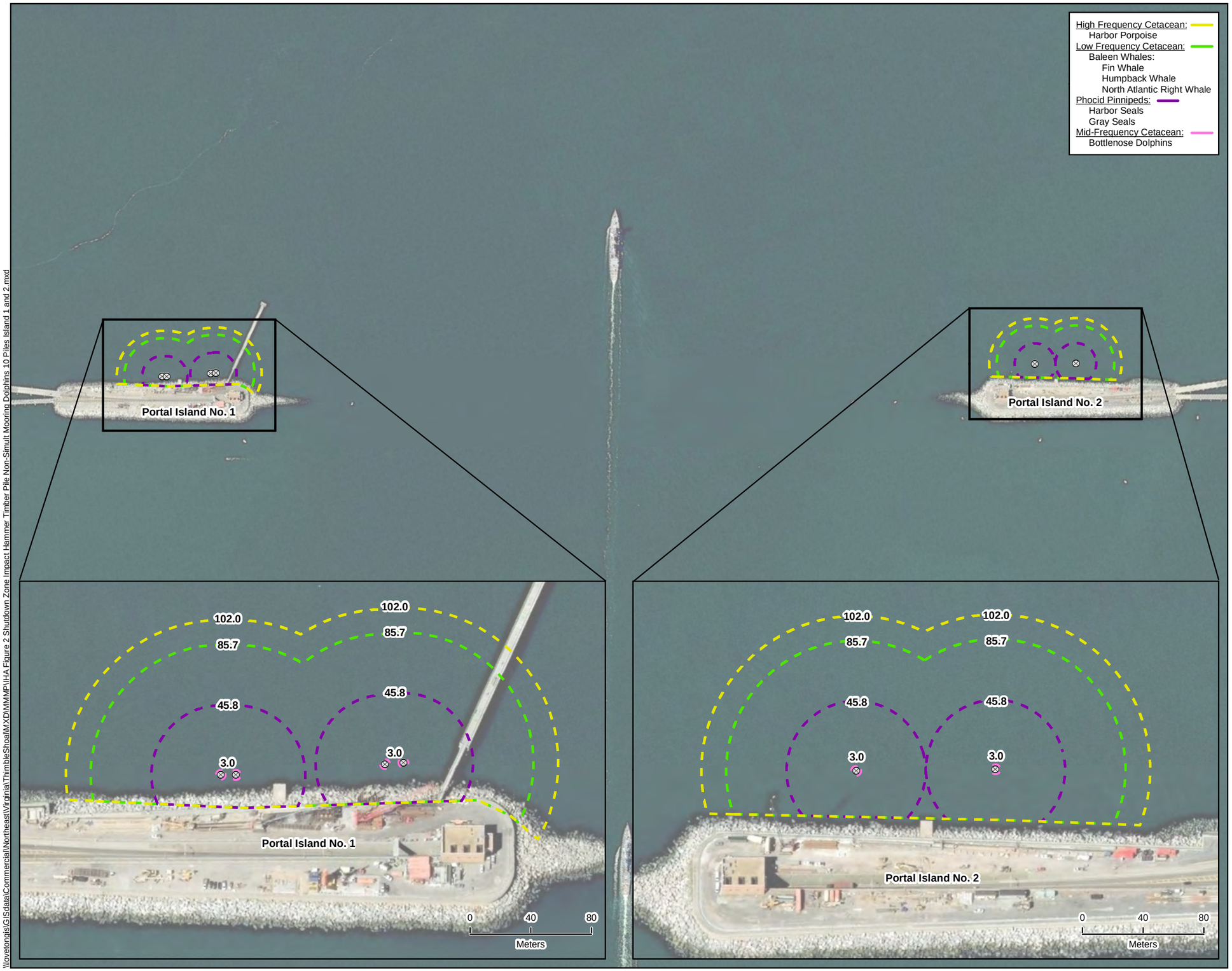

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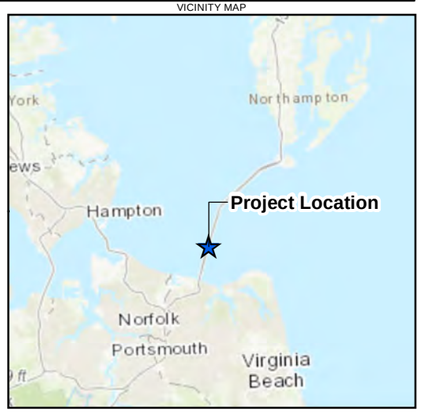

Legend

- Mooring Dolphin

10 Impact Piles per Day - Shutdown Zone

- 102.0 m - High-Frequency Cetaceans
- 85.7 m - Low-Frequency Cetaceans
- 45.8 m - Phocid Pinnipeds
- 3.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 100 200
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 2
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous Timber Pile Driving for the Mooring Dolphins – 10 Piles per Day at Portal Island Nos. 1 and 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonnis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 2 Shutdown Zone Impact Hammer Timber Pile Non-Simult Mooring Dolphins 10 Piles Island 1 and 2.mxd

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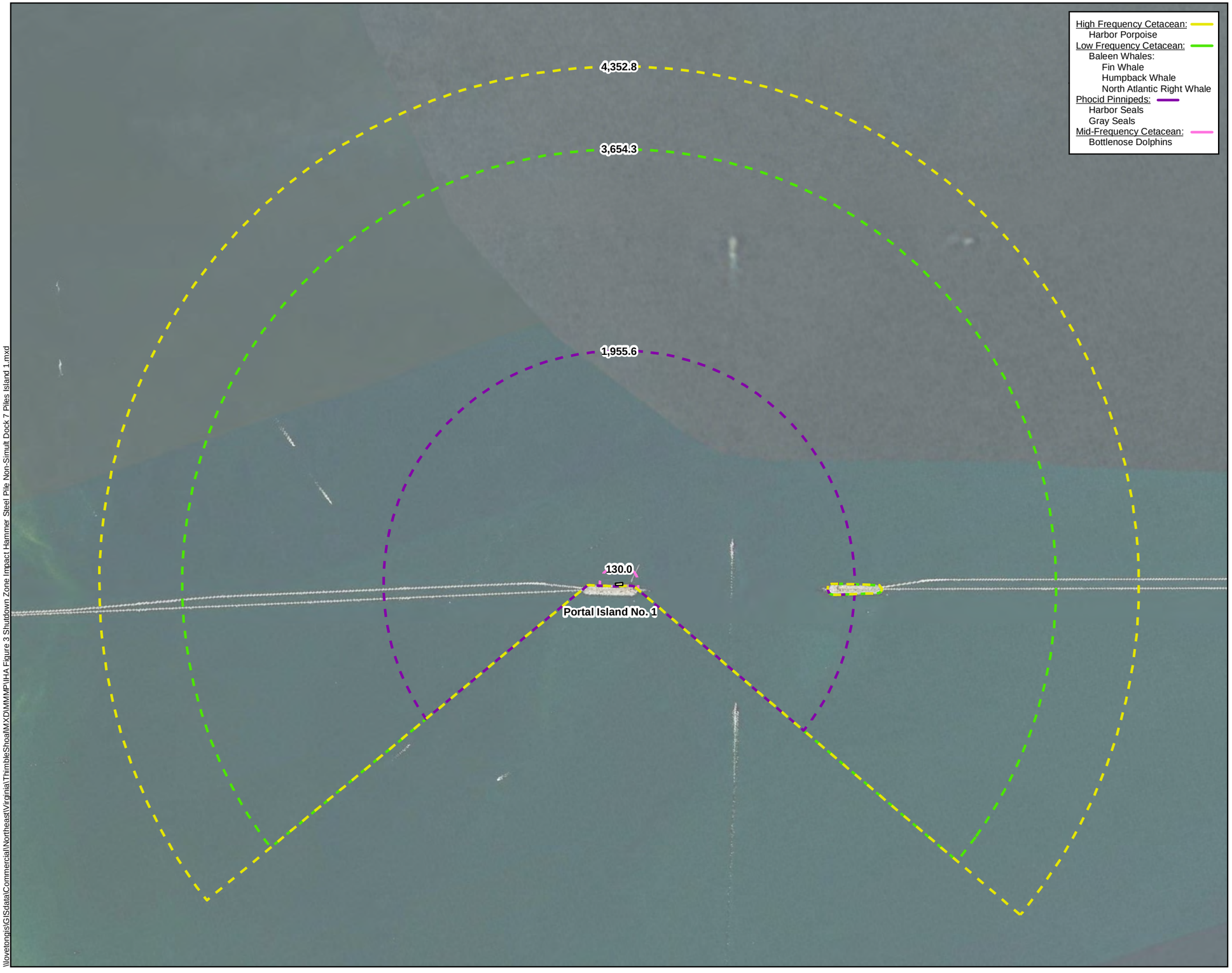

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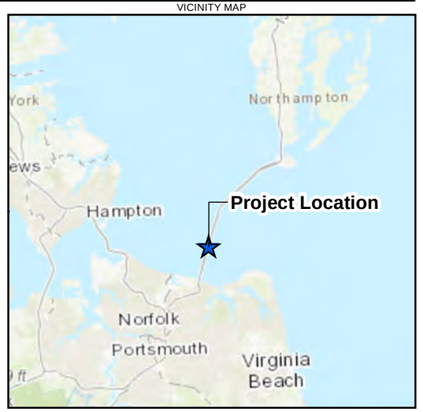

Legend

Temporary Dock

7 Impact Piles per Day - Shutdown Zone

4,352.8 m - High-Frequency Cetaceans

3,654.3 m - Low-Frequency Cetaceans

1,955.6 m - Phocid Pinnipeds

130.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 400 800
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 3
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock – 7 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 3 Shutdown Zone Impact Hammer Steel Pile Non-Simultaneous 7 Piles Island 1.mxd

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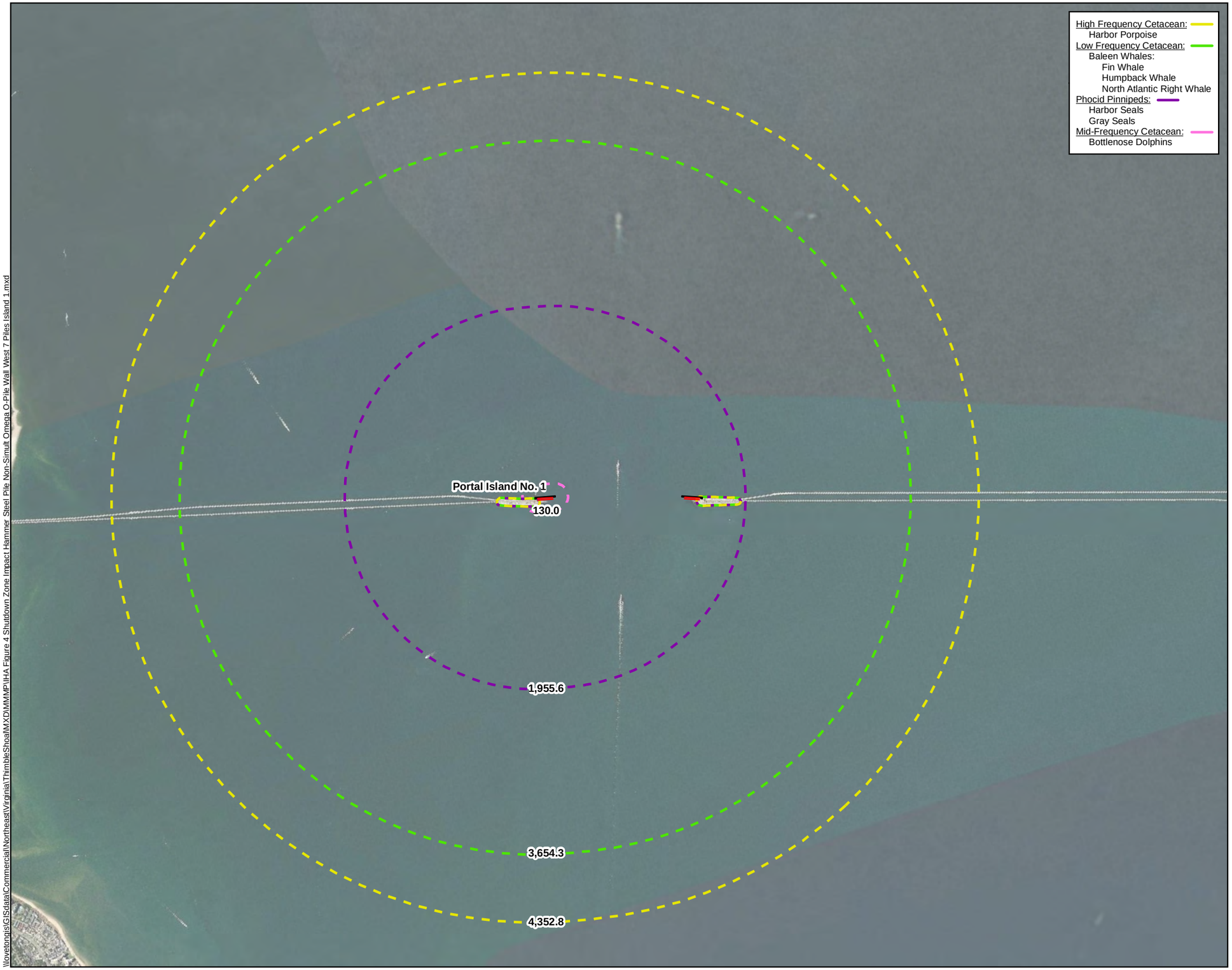

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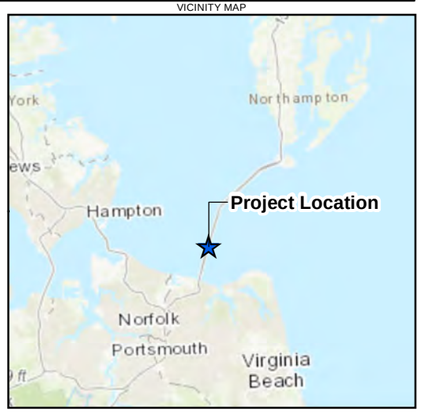

Legend

- O-Pile Wall
- Omega Trestle

7 Impact Piles per Day - Shutdown Zone

- 4,352.8 m - High-Frequency Cetaceans
- 3,654.3 m - Low-Frequency Cetaceans
- 1,955.6 m - Phocid Pinnipeds
- 130.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

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CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 4
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 7 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 4 Shutdown Zone Impact Hammer Steel Pile Non-Simult Omega O-Pile Wall West 7 Piles island 1.mxd

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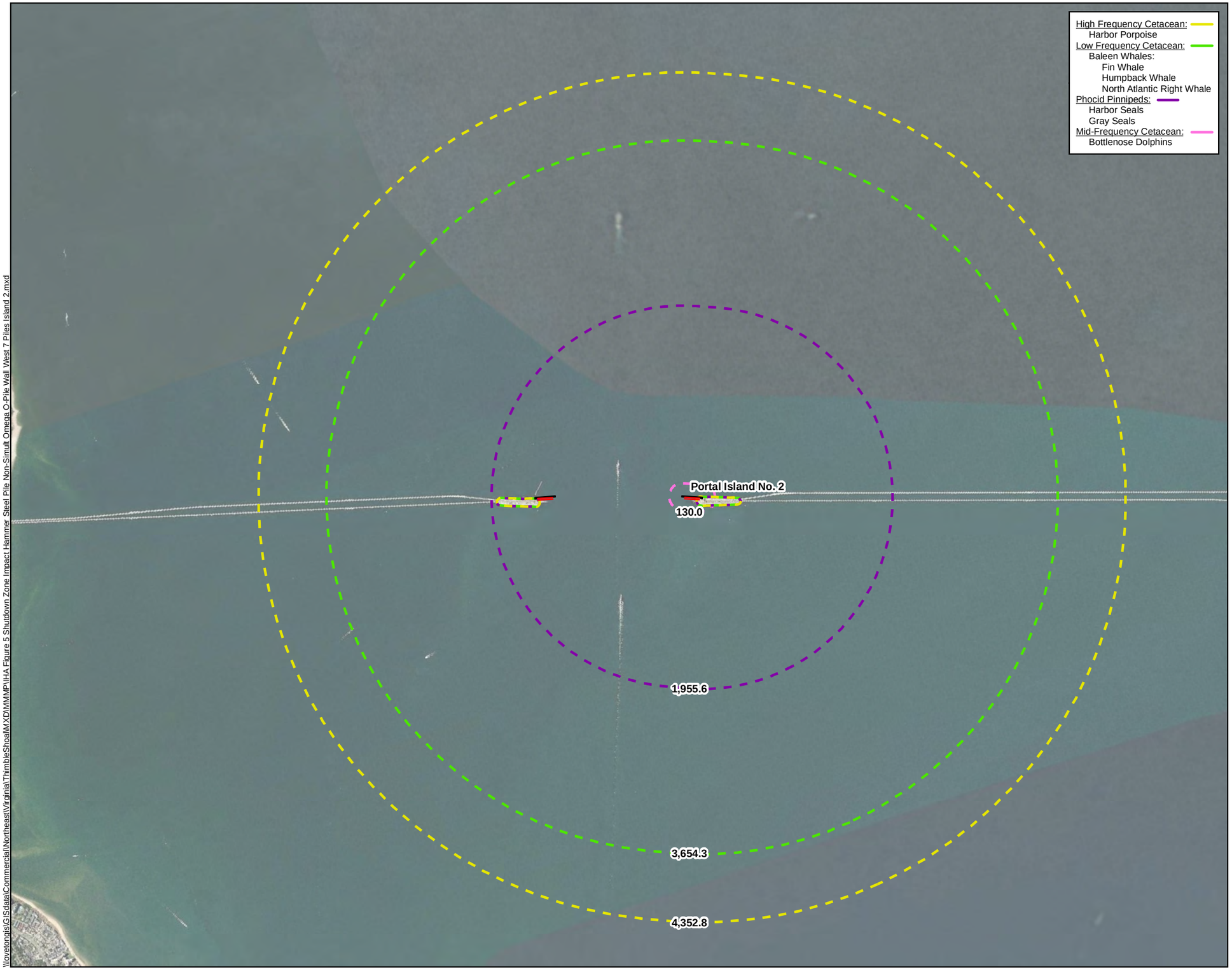

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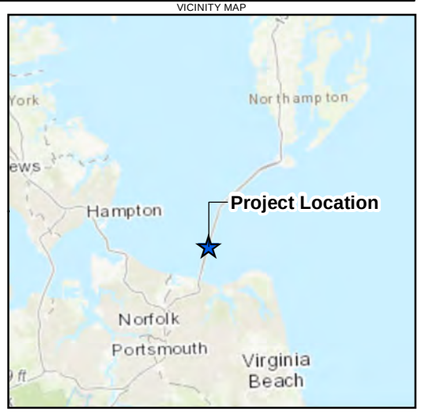

Legend

- O-Pile Wall
- Omega Trestle

7 Impact Piles per Day - Shutdown Zone

- 4,352.8 m - High-Frequency Cetaceans
- 3,654.3 m - Low-Frequency Cetaceans
- 1,955.6 m - Phocid Pinnipeds
- 130.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 5
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 7 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 5 Shutdown Zone Impact Hammer Steel Pile Non-Simult Omega O-Pile Wall West 7 Piles island 2.mxd

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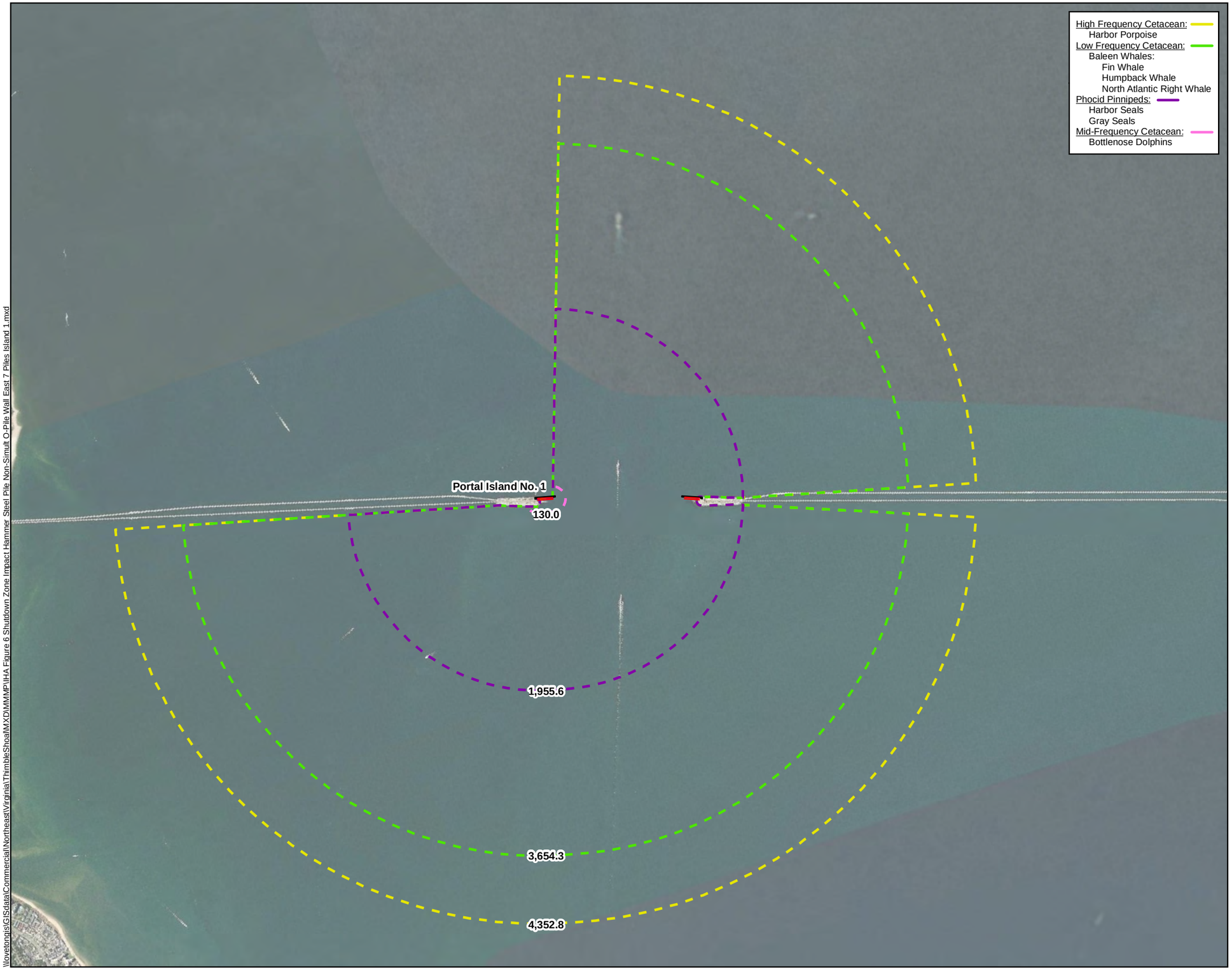

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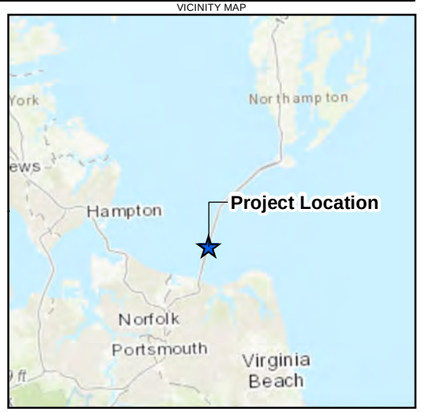

Legend

- O-Pile Wall
- Omega Trestle

7 Impact Piles per Day - Shutdown Zone

- 4,352.8 m - High-Frequency Cetaceans
- 3,654.3 m - Low-Frequency Cetaceans
- 1,955.6 m - Phocid Pinnipeds
- 130.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 6
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 7 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 6 Shutdown Zone Impact Hammer Steel Pile Non-Simult O-Pile Wall East 7 Piles Island 1.mxd

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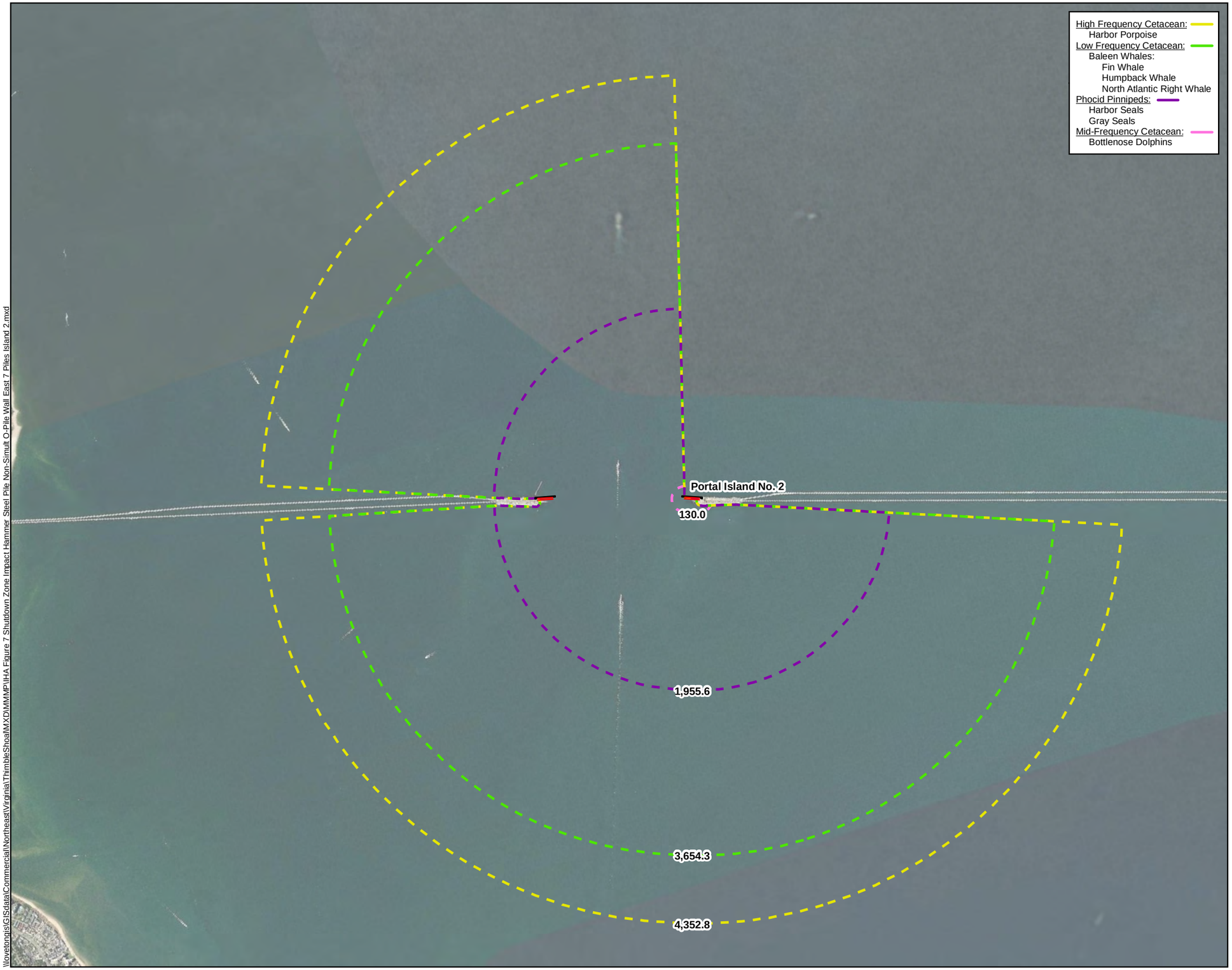

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

7 Impact Piles per Day - Shutdown Zone

- 4,352.8 m - High-Frequency Cetaceans
- 3,654.3 m - Low-Frequency Cetaceans
- 1,955.6 m - Phocid Pinnipeds
- 130.0 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 7
Distance (meters) to Shutdown Zone Using an Impact Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 7 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 7 Shutdown Zone Impact Hammer Steel Pile Non-Simult O-Pile Wall East 7 Piles Island 2.mxd

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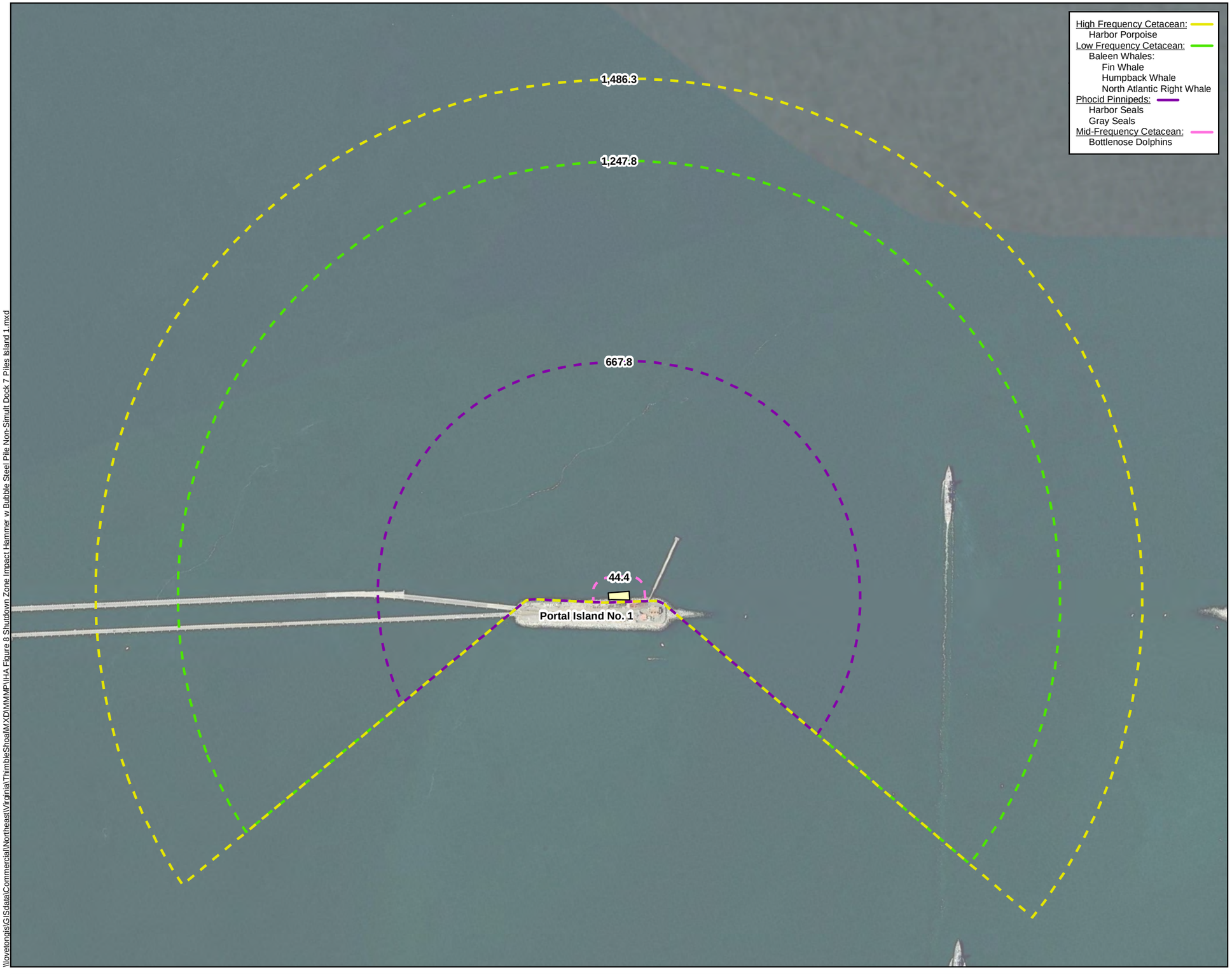

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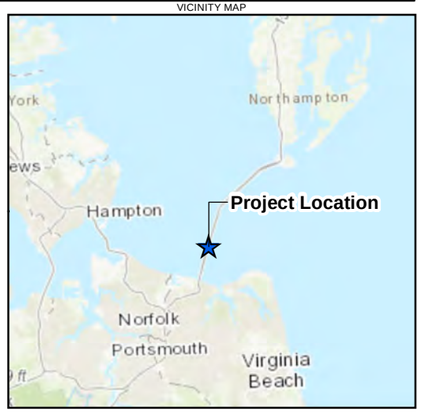

Legend

Temporary Dock

7 Impact Piles per Day - Shutdown Zone

- 1,486.3 m - High-Frequency Cetaceans
- 1,247.8 m - Low-Frequency Cetaceans
- 667.8 m - Phocid Pinnipeds
- 44.4 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 8
Distance (meters) to Shutdown Zone Using an Impact Hammer with Bubble Curtain for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock – 7 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 8 Shutdown Zone Impact Hammer w Bubble Steel Pile Non-Simult Dock 7 Piles Island 1.mxd

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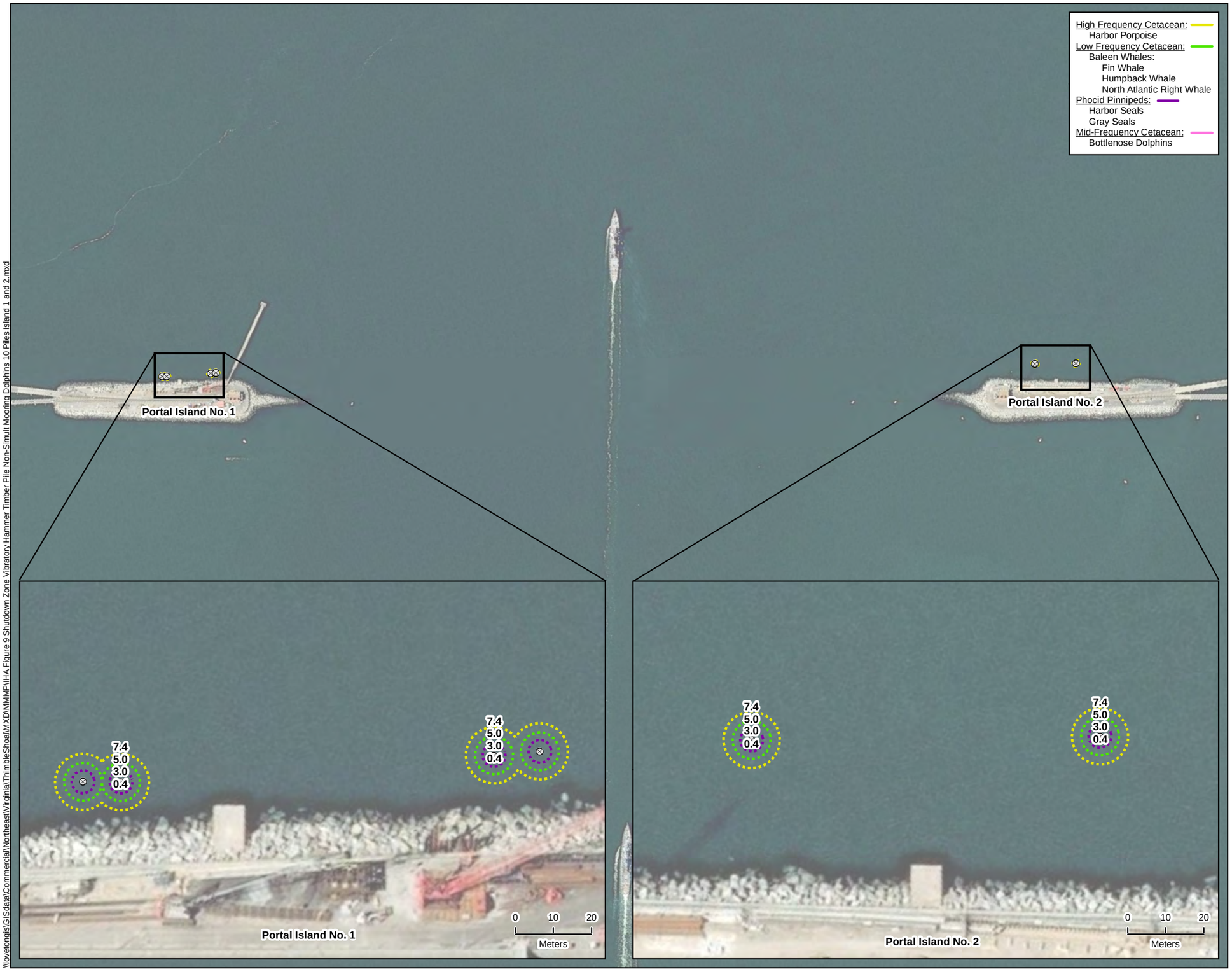

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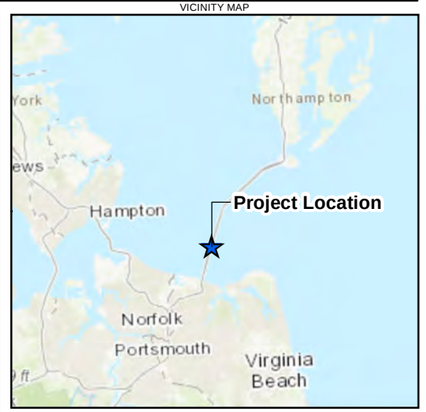

Legend

⊗ Mooring Dolphin

10 Vibratory Piles per Day - Shutdown Zone

- 7.4 m - High-Frequency Cetaceans
- 5.0 m - Low-Frequency Cetaceans
- 3.0 m - Phocid Pinnipeds
- 0.4 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 100 200
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 9
Distance (meters) to Shutdown Zone Using a Vibratory Hammer for Non-Simultaneous Timber Pile Driving for the Mooring Dolphins – 10 Piles per Day at Portal Island Nos. 1 and 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonnis\GISdata\Commercial\Northeast\VirginiaThimbleShoal\MXD\MMPI\HA Figure 9 Shutdown Zone Vibratory Hammer Timber Pile Non-Simult Mooring Dolphins 10 Piles Island 1 and 2.mxd

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VICINITY MAP

Legend

Temporary Dock

10 Vibratory Piles per Day - Shutdown Zone

63.8 m - High-Frequency Cetaceans

43.2 m - Low-Frequency Cetaceans

26.2 m - Phocid Pinnipeds

3.8 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 20 40
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 10
Distance (meters) to Shutdown Zone Using a Vibratory Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock – 10 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 10 Shutdown Zone Vibratory Hammer Steel Pile Non-Simult Dock 10 Piles Island 1 and 2.mxd

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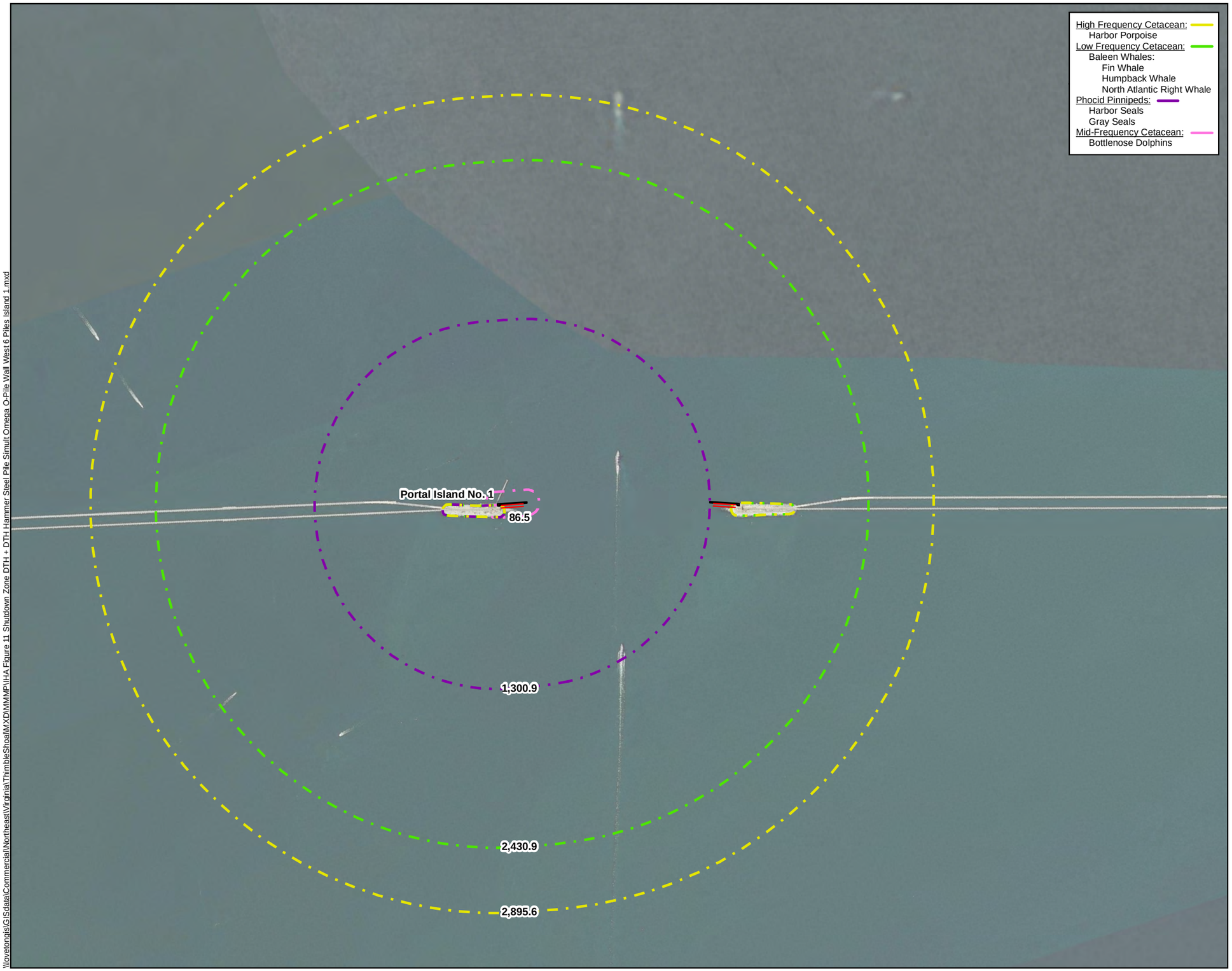

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

6 Down-the-Hole Piles per Day - Shutdown Zone

- 2,895.6 m - High-Frequency Cetaceans
- 2,430.9 m - Low-Frequency Cetaceans
- 1,300.9 m - Phocid Pinnipeds
- 86.5 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 11
Distance (meters) to Shutdown Zone Using Two Down-the-Hole Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 6 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMMP\IHA Figure 11 Shutdown Zone DTH + DTH Hammer Steel Pile Simult Omega O-Pile Wall West 6 Piles Island 1.mxd

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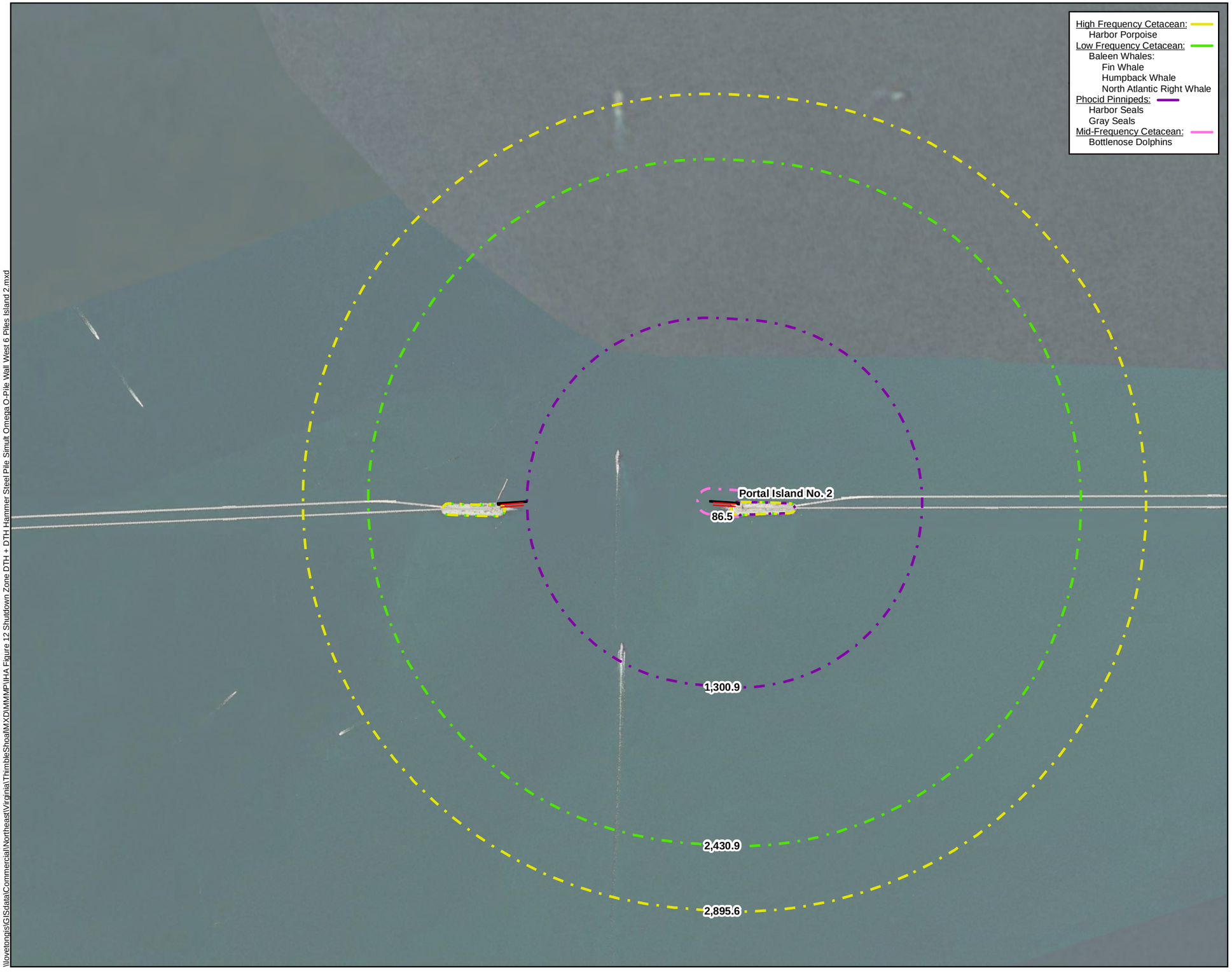
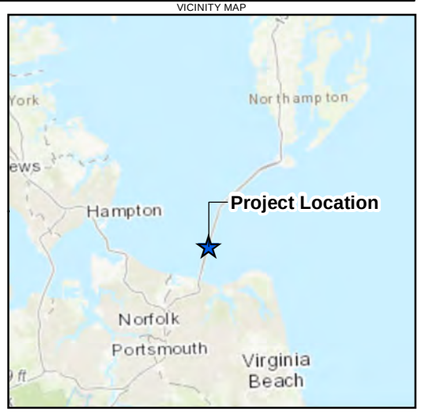


VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

6 Down-the-Hole Piles per Day - Shutdown Zone

- 2,895.6 m - High-Frequency Cetaceans
- 2,430.9 m - Low-Frequency Cetaceans
- 1,300.9 m - Phocid Pinnipeds
- 86.5 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 12
Distance (meters) to Shutdown Zone Using Two Down-the-Hole Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 6 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 12 Shutdown Zone DTH + DTH Hammer Steel Pile Simult Omega O-Pile Wall West 6 Piles Island 2.mxd

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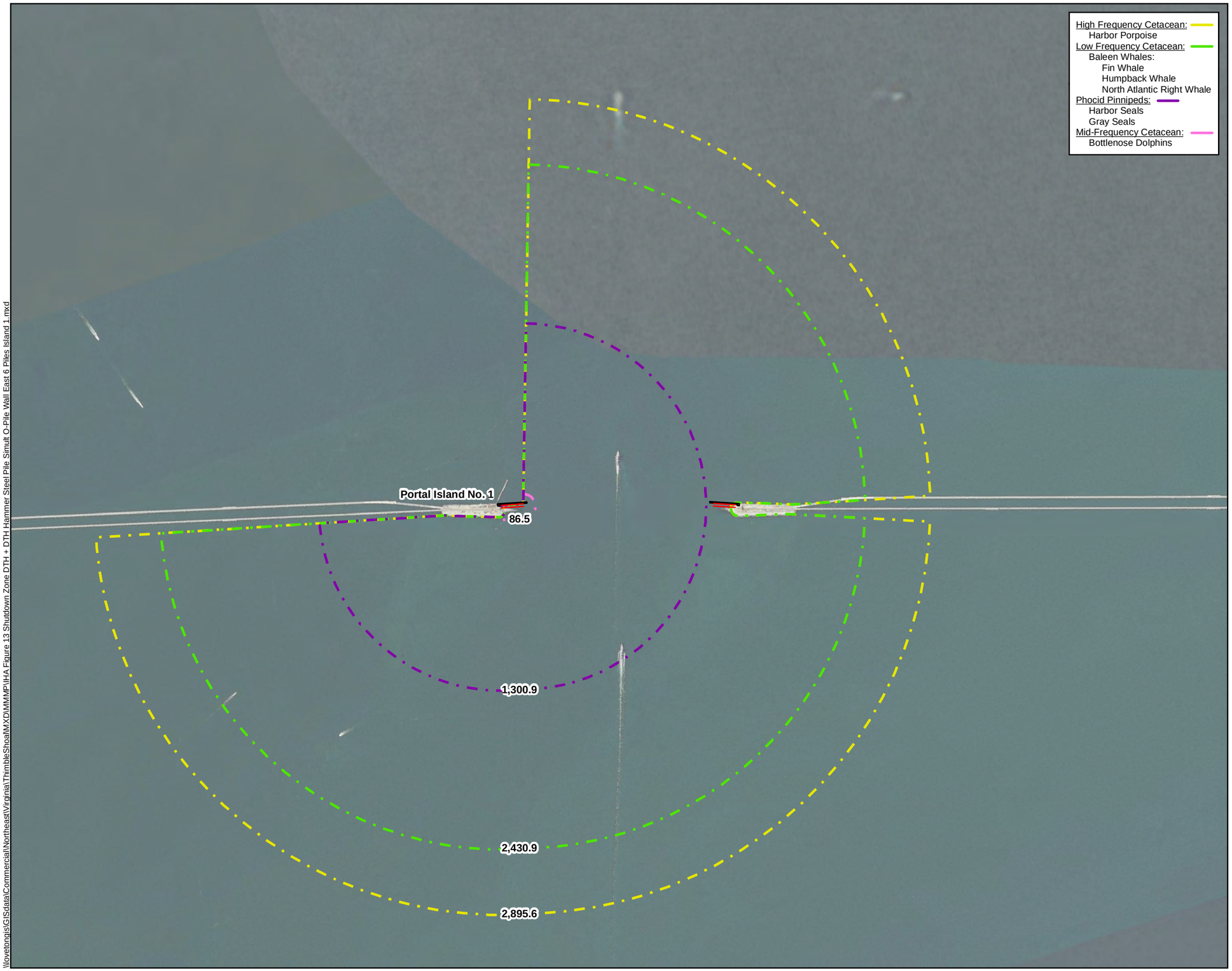

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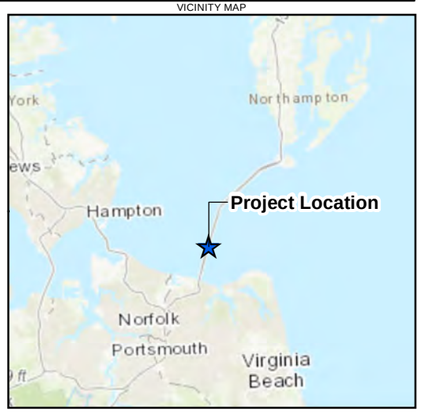

Legend

- O-Pile Wall
- Omega Trestle

6 Down-the-Hole Piles per Day - Shutdown Zone

- 2,895.6 m - High-Frequency Cetaceans
- 2,430.9 m - Low-Frequency Cetaceans
- 1,300.9 m - Phocid Pinnipeds
- 86.5 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 13
Distance (meters) to Shutdown Zone Using Two Down-the-Hole Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 6 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetonqis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 13 Shutdown Zone DTH + DTH Hammer Steel Pile Simult O-Pile Wall East 6 Piles Island 1.mxd

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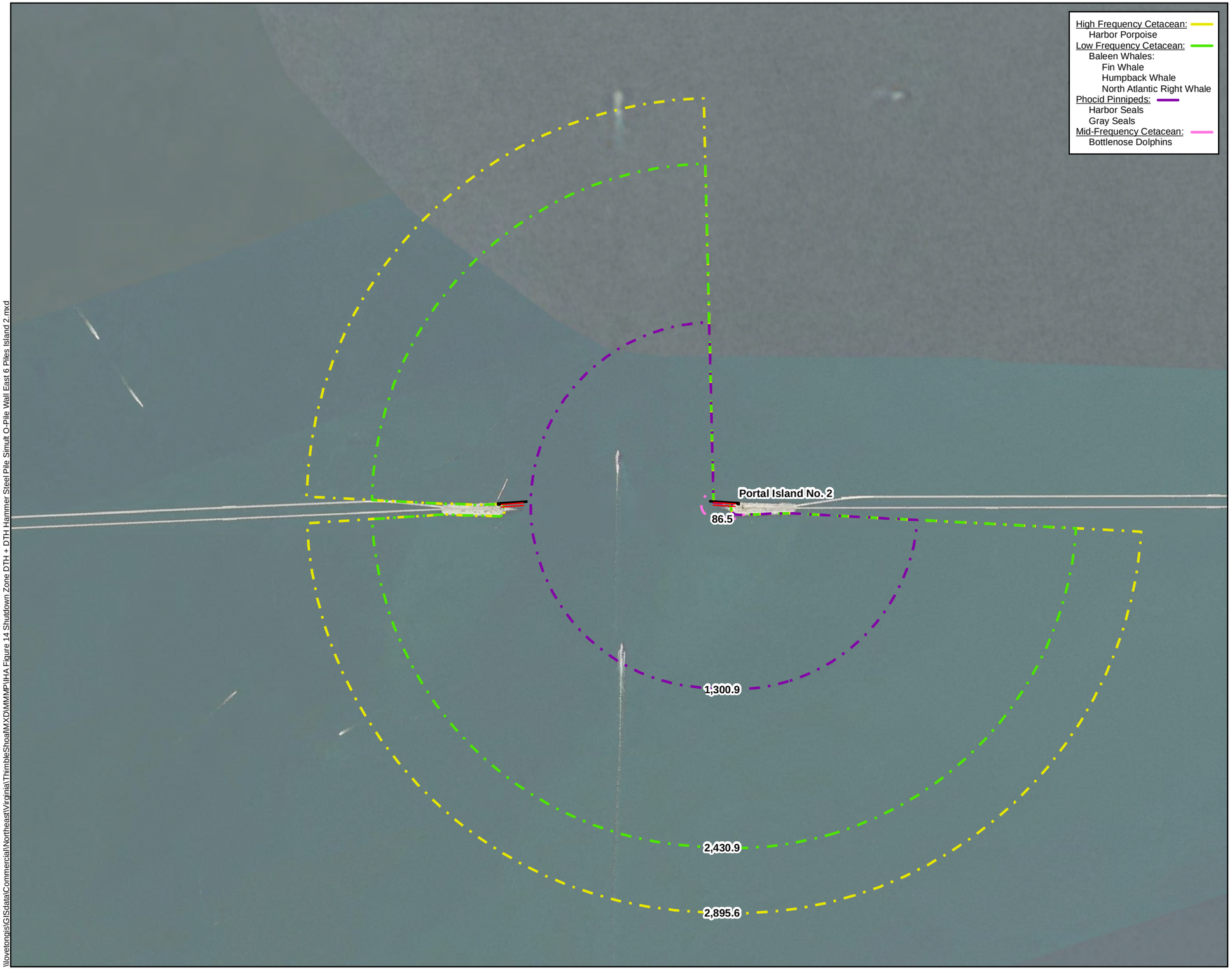

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

6 Down-the-Hole Piles per Day - Shutdown Zone

- 2,895.6 m - High-Frequency Cetaceans
- 2,430.9 m - Low-Frequency Cetaceans
- 1,300.9 m - Phocid Pinnipeds
- 86.5 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 14
Distance (meters) to Shutdown Zone Using Two Down-the-Hole Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 6 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 14 Shutdown Zone DTH + DTH Hammer Steel Pile Simult O-Pile Wall East 6 Piles Island 2.mxd

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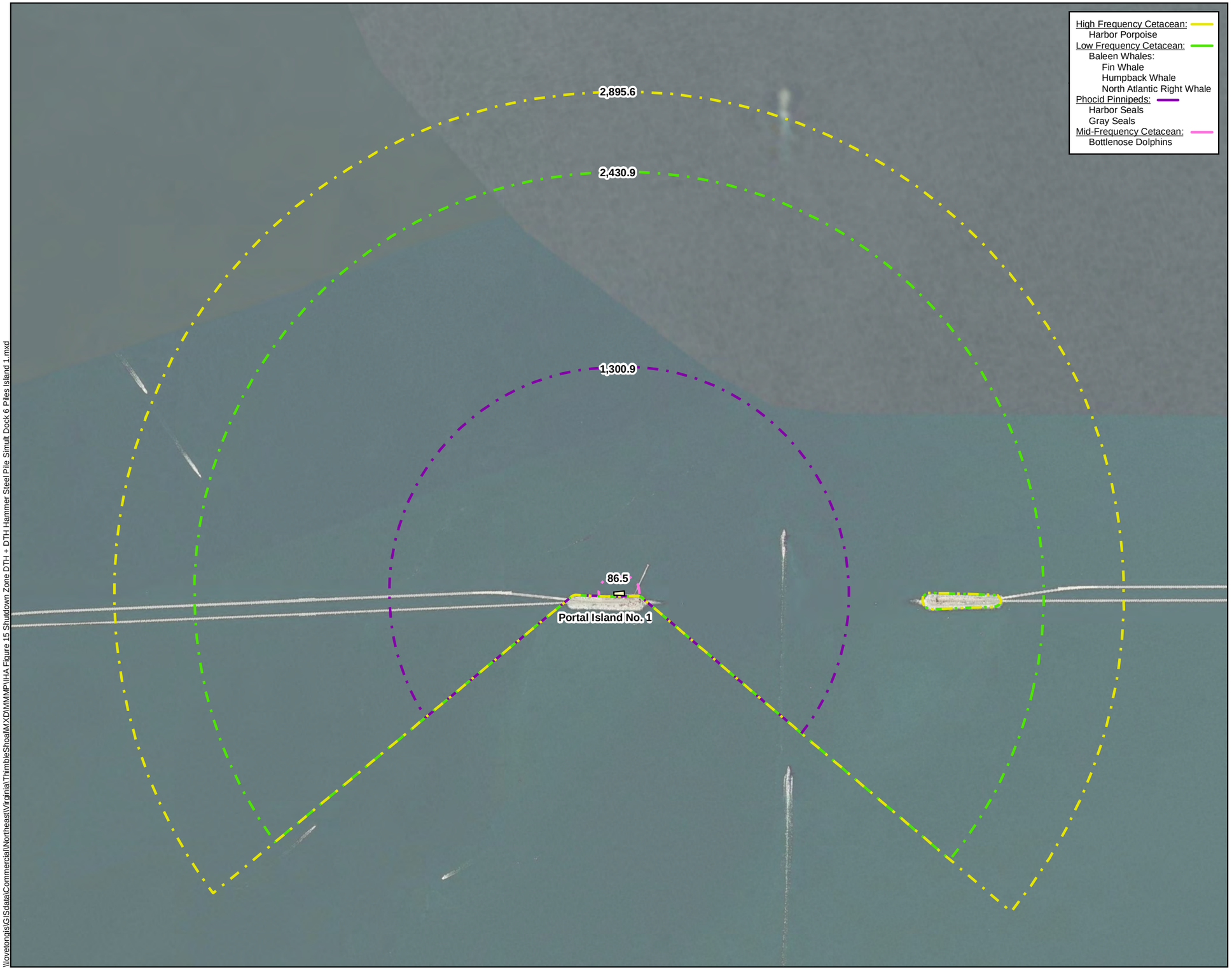

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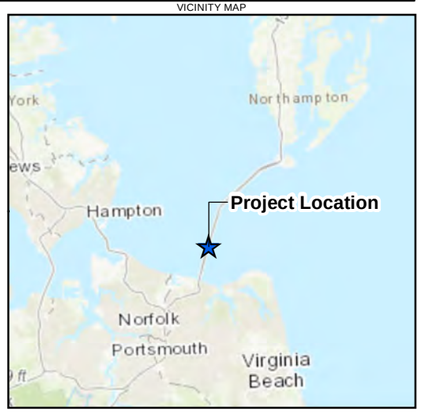

Legend

Temporary Dock

6 Down-the-Hole Piles per Day - Shutdown Zone

- 2,895.6 m - High-Frequency Cetaceans
- 2,430.9 m - Low-Frequency Cetaceans
- 1,300.9 m - Phocid Pinnipeds
- 86.5 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 400 800
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 15
Distance (meters) to Shutdown Zone Using Two Down-the-Hole Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock – 6 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 15 Shutdown Zone DTH + DTH Hammer Steel Pile Simult Dock 6 Piles Island 1.mxd

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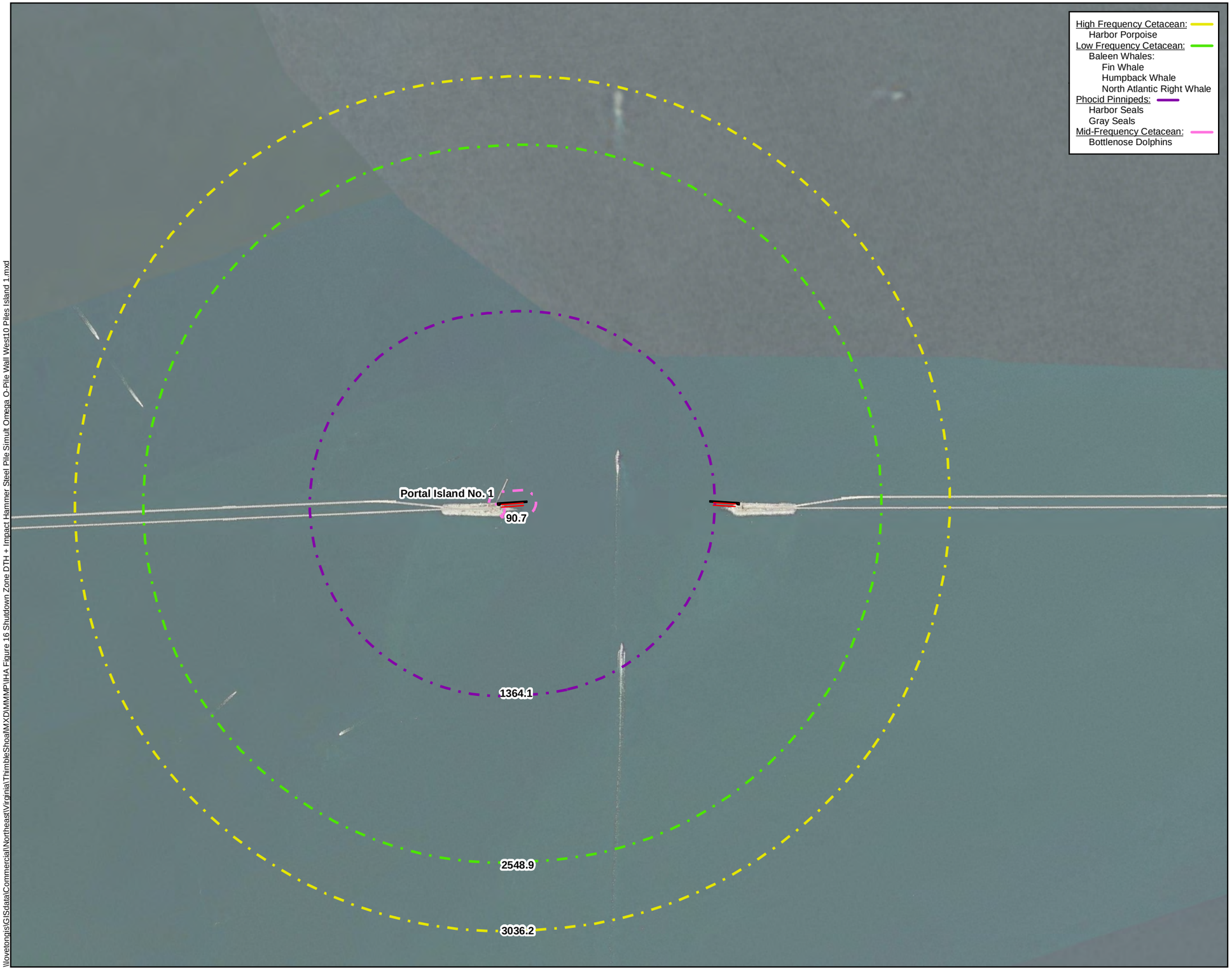

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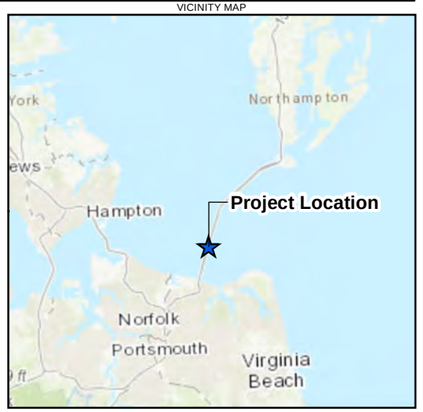

Legend

- O-Pile Wall
- Omega Trestle

3 Down-the-Hole and 10 Impact Piles per Day - Shutdown Zone

- 3036.2 m - High-Frequency Cetaceans
- 2548.9 m - Low-Frequency Cetaceans
- 1364.1 m - Phocid Pinnipeds
- 90.7 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 16
Distance (meters) to Shutdown Zone Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 3 DTH and 10 Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 16 Shutdown Zone DTH + Impact Hammer Steel Pile Simult Omega O-Pile Wall West10 Piles Island 1.mxd

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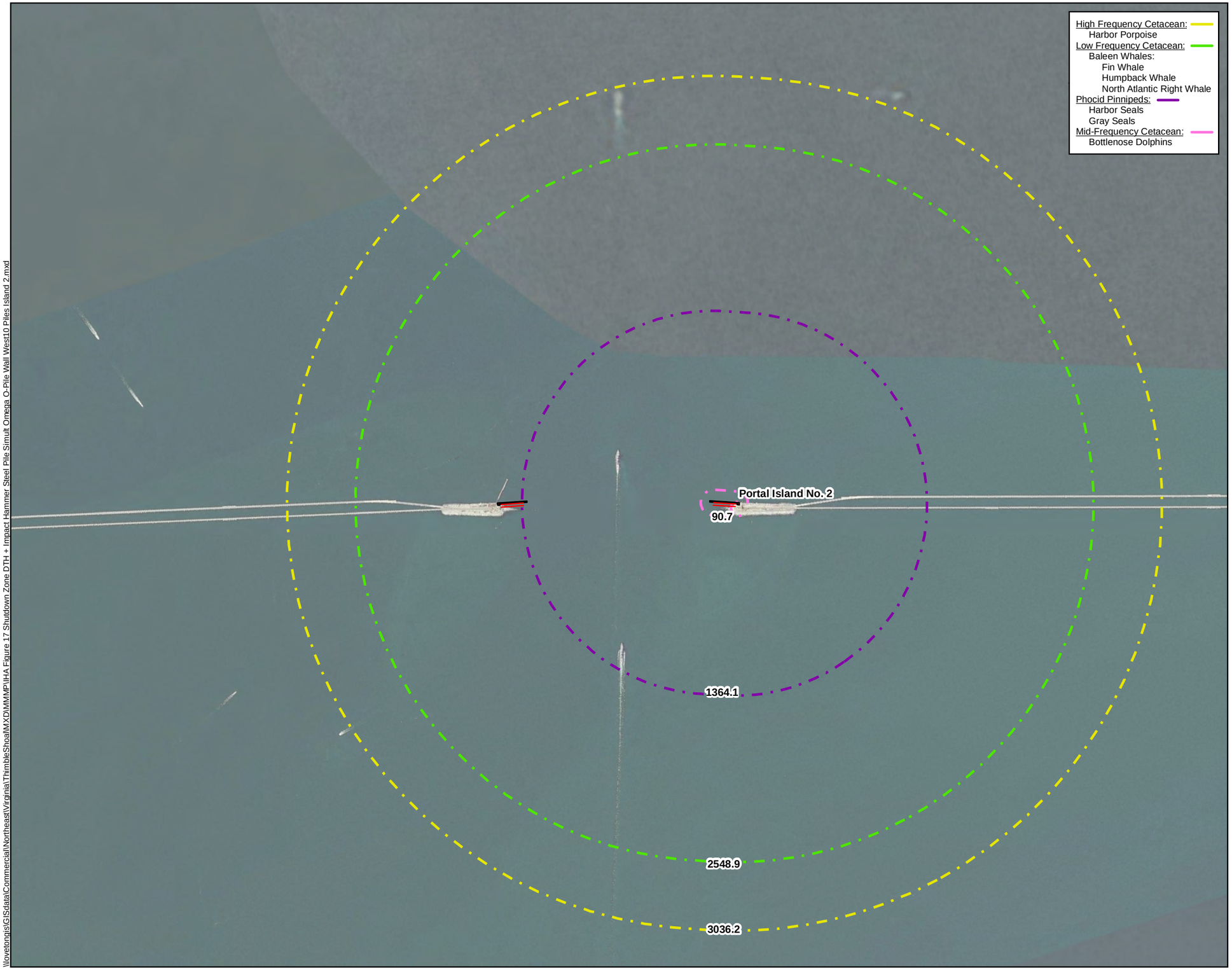

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

3 Down-the-Hole and 10 Impact Piles per Day - Shutdown Zone

- 3036.2 m - High-Frequency Cetaceans
- 2548.9 m - Low-Frequency Cetaceans
- 1364.1 m - Phocid Pinnipeds
- 90.7 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 17
Distance (meters) to Shutdown Zone Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates – 3 DTH and 10 Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 17 Shutdown Zone DTH + Impact Hammer Steel Pile Simult Omega O-Pile Wall West10 Piles Island 2.mxd

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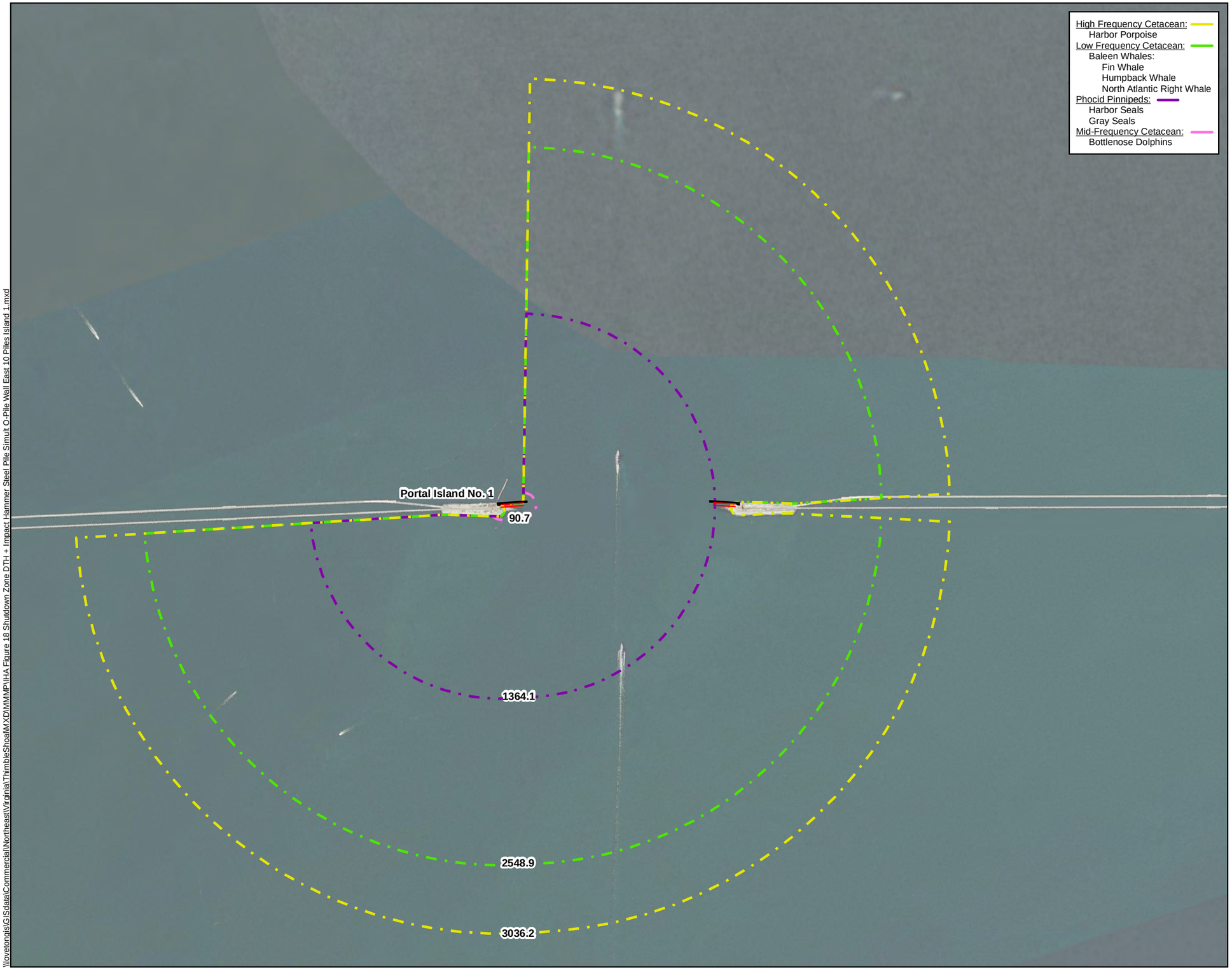

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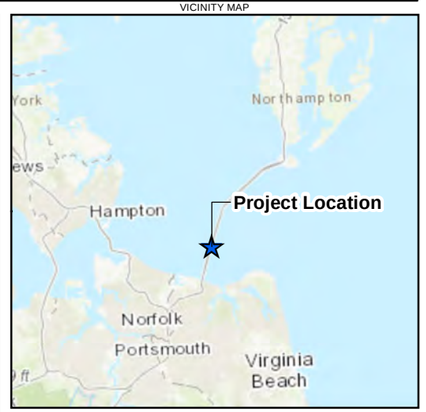

Legend

- O-Pile Wall
- Omega Trestle

3 Down-the-Hole and 10 Impact Piles per Day - Shutdown Zone

- 3036.2 m - High-Frequency Cetaceans
- 2548.9 m - Low-Frequency Cetaceans
- 1,364.1 m - Phocid Pinnipeds
- 90.7 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 18
Distance (meters) to Shutdown Zone Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 3 DTH and 10 Impact Piles per Day at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 18 Shutdown Zone DTH + Impact Hammer Steel Pile Simult O-Pile Wall East 10 Piles Island 1.mxd

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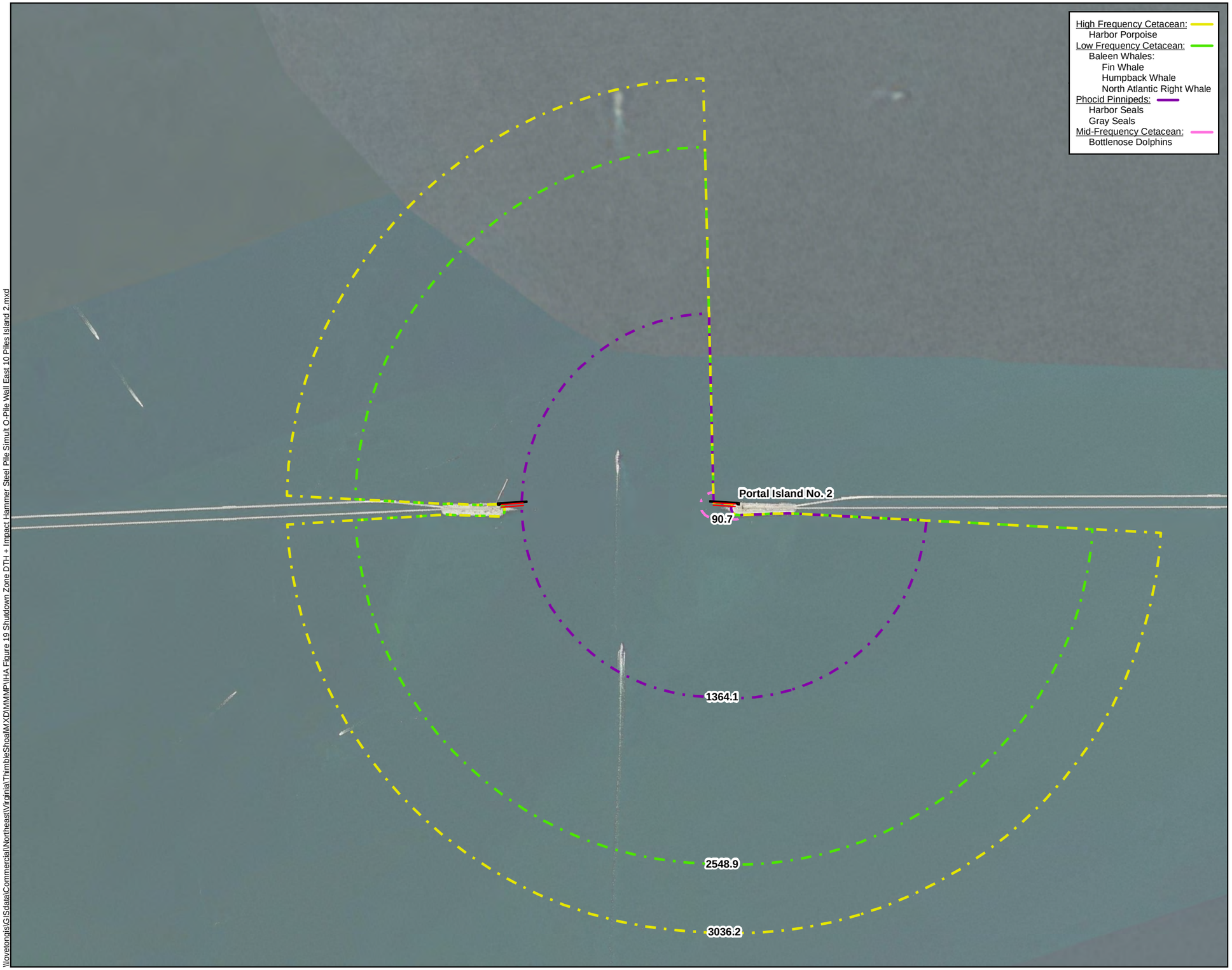

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

3 Down-the-Hole and 10 Impact Piles per Day - Shutdown Zone

- 3036.2 m - High-Frequency Cetaceans
- 2548.9 m - Low-Frequency Cetaceans
- 1364.1 m - Phocid Pinnipeds
- 90.7 m - Mid-Frequency Cetaceans

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 500 1,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 19
Distance (meters) to Shutdown Zone Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall – 3 DTH and 10 Impact Piles per Day at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 19 Shutdown Zone DTH + Impact Hammer Steel Pile Simult O-Pile Wall East 10 Piles Island 2.mxd

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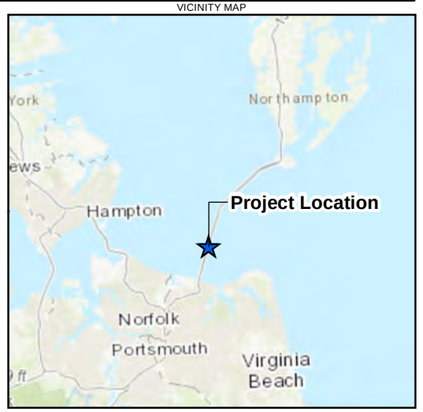

Legend

O-Pile Wall

Omega Trestle

Down-the-Hole and Impact Hammers - Level B

756.6 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 20
Distance (meters) to Level B Threshold Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/Mooring Piles and Templates at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 20 Level B DTH and Impact Hammer Steel Pile Simult Omega O-Pile Wall West Island 1.mxd

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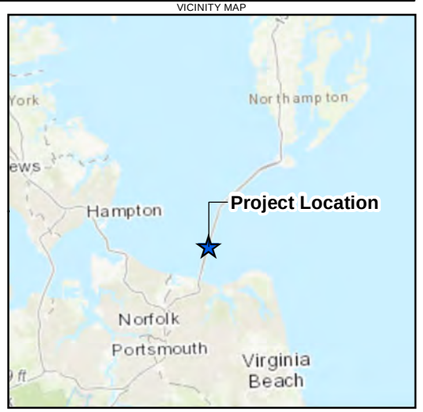
VICINITY MAP



Legend

O-Pile Wall

Omega Trestle

Down-the-Hole and Impact Hammers - Level B

756.6 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 21
Distance (meters) to Level B Threshold Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/Mooring Piles and Templates at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 21 Level B DTH and Impact Hammer Steel Pile Simult Omega O-Pile Wall West Island 2.mxd

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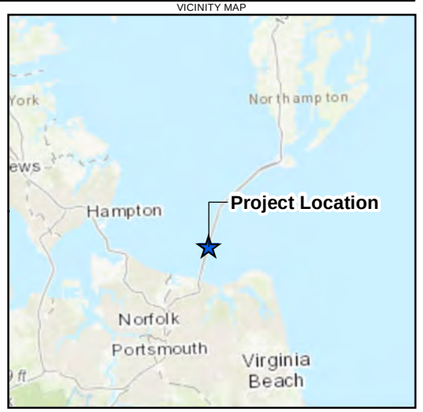

Legend

O-Pile Wall

Omega Trestle

Down-the-Hole and Impact Hammers - Level B

756.6 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 22
Distance (meters) to Level B Threshold
Using a Down-the-Hole and Impact
Hammers for Simultaneous
36- and 42-in Steel Pile Driving for the
East O-Pile Wall
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 22 Level B DTH and Impact Hammer Steel Pile Simult O-Pile Wall East Island 1.mxd

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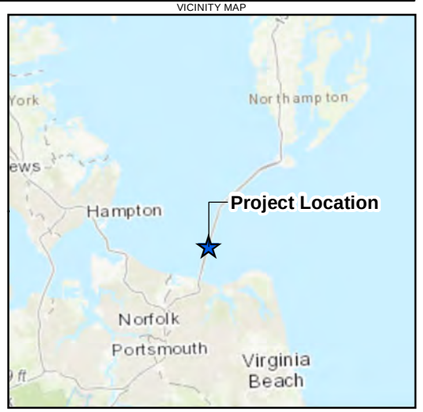
VICINITY MAP



Legend

O-Pile Wall

Omega Trestle

Down-the-Hole and Impact Hammers - Level B

756.6 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 23
Distance (meters) to Level B Threshold Using a Down-the-Hole and Impact Hammers for Simultaneous 36- and 42-in Steel Pile Driving for the East O-Pile Wall at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 23 Level B DTH and Impact Hammer Steel Pile Simult O-Pile Wall East Island 2.mxd

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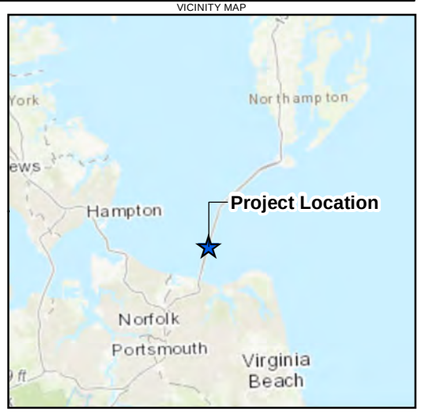
VICINITY MAP



Legend

- O-Pile Wall
- Omega Trestle

Impact Pile - Level B

- 1,584.9 m - Cetaceans and Pinnipeds

Down-the-Hole Pile - Level B

- 341.5 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 24
Distance (meters) to Level B Threshold
Using an Impact Hammer for
Non-Simultaneous or
Two Down-the-Hole Hammers for
Simultaneous
36- and 42-in Steel Pile Driving for the
Omega Trestle/West O-Pile Wall/
Mooring Piles and Templates
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 24 Level B Impact Hammer Steel Pile Non-Simult DTH + DTH Hammer Steel Pile Simult Omega O-Pile Wall West Island 1.mxd

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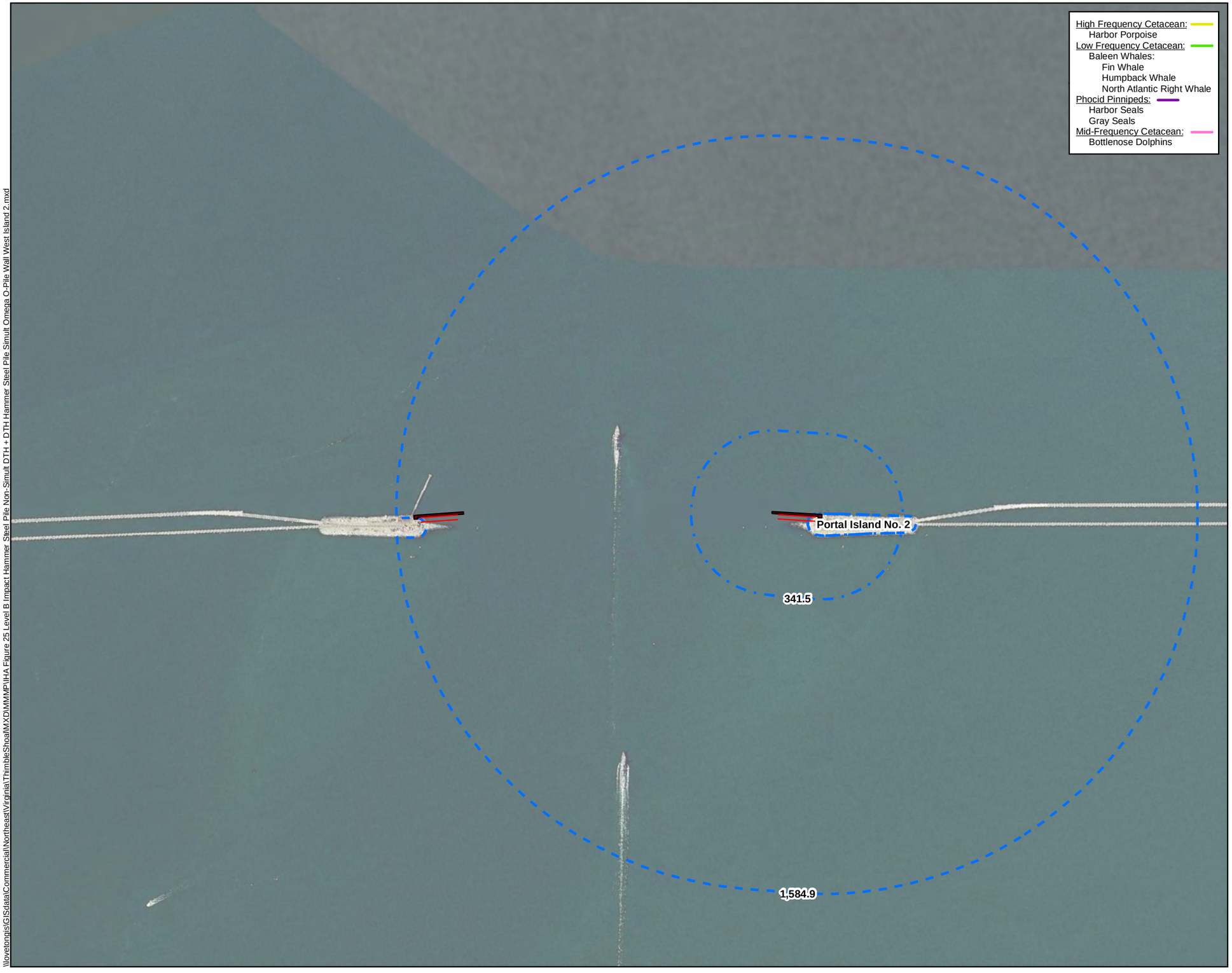
\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 25 Level B Impact Hammer Steel Pile Non-Simult DTH + DTH Hammer Steel Pile Simult Omega O-Pile Wall West Island 2.mxd



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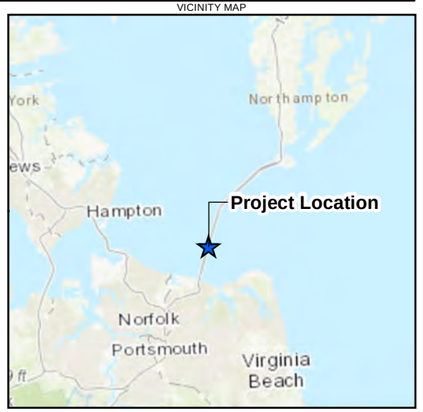

Legend

- O-Pile Wall
- Omega Trestle

Impact Pile - Level B

- 1,584.9 m - Cetaceans and Pinnipeds

Down-the-Hole Pile - Level B

- 341.5 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 25
Distance (meters) to Level B Threshold
Using an Impact Hammer for
Non-Simultaneous or
Two Down-the-Hole Hammers for
Simultaneous
36- and 42-in Steel Pile Driving for the
Omega Trestle/West O-Pile Wall/
Mooring Piles and Templates
at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

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\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 26 Level B Impact Hammer Steel Pile Non-Simult DTH + DTH Hammer Steel Pile Simult O-Pile Wall East Island 1.mxd

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

Impact Pile - Level B

- 1,584.9 m - Cetaceans and Pinnipeds

Down-the-Hole Pile - Level B

- 341.5 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 26
Distance (meters) to Level B Threshold
Using an Impact Hammer for
Non-Simultaneous or
Two Down-the-Hole Hammers for
Simultaneous
36- and 42-in Steel Pile Driving for the
East O-Pile Wall
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

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\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 27 Level B Impact Hammer Steel Pile Non-Simult DTH + DTH Hammer Steel Pile Simult O-Pile Wall East Island 2.mxd

VICINITY MAP

Legend

- O-Pile Wall
- Omega Trestle

Impact Pile - Level B

- 1,584.9 m - Cetaceans and Pinnipeds

Down-the-Hole Pile - Level B

- 341.5 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2017, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 27
Distance (meters) to Level B Threshold
Using an Impact Hammer for
Non-Simultaneous or
Two Down-the-Hole Hammers for
Simultaneous
36- and 42-in Steel Pile Driving for the
East O-Pile Wall
at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

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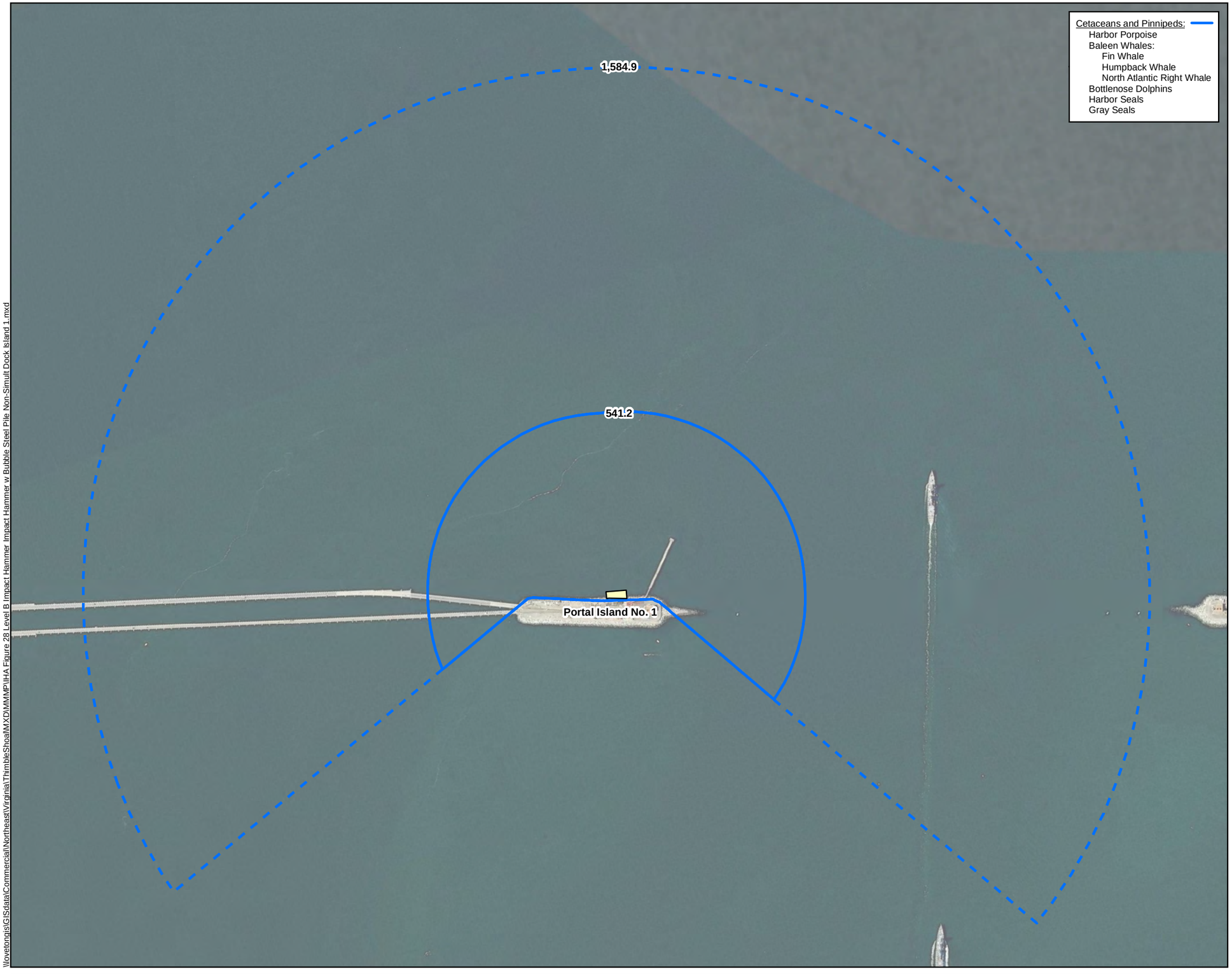

VICINITY MAP

Legend

Temporary Dock

Impact Pile - Level B

1,584.9 m - Cetaceans and Pinnipeds

Impact Pile with Bubble Curtain - Level B

541.2 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 28
Distance (meters) to Level B Threshold
Using an Impact Hammer or
Impact Hammer with Bubble Curtain for
Non-Simultaneous
36- and 42-in Steel Pile Driving for the
Temporary Dock
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongisGISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPIUHA Figure 28 Level B Impact Hammer Impact Hammer w Bubble Steel Pile Non-Simult Dock Island 1.mxd

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VICINITY MAP

Legend

Temporary Dock

Down-the-Hole Pile - Level B

341.5 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 50 100
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 29
Distance (meters) to Level B Threshold Using Two Down-the-Hole Hammers for Simultaneous
36- and 42-in Steel Pile Driving for the Temporary Dock
at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\loveton\gis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 29 Level B DTH + DTH Hammer Steel Pile Simult Dock Island 1.mxd

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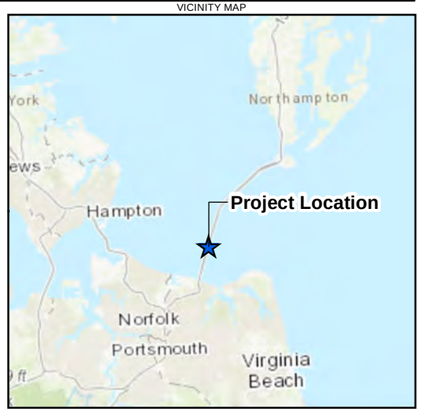
VICINITY MAP



Legend

⊗ Mooring Dolphin

Impact Pile - Level B

21.5 m - Cetaceans and Pinnipeds

Vibratory Pile - Level B

1,359.4 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 200 400
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 30
Distance (meters) to Level B Threshold Using an Impact Hammer or Vibratory Hammer for Non-Simultaneous Timber Pile Driving for the Mooring Dolphins at Portal Island Nos. 1 and 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GIS\data\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 30 Level B Impact Hammer Vibratory Hammer Timber Pile Non-Simult Mooring Dolphins Island 1 and 2.mxd

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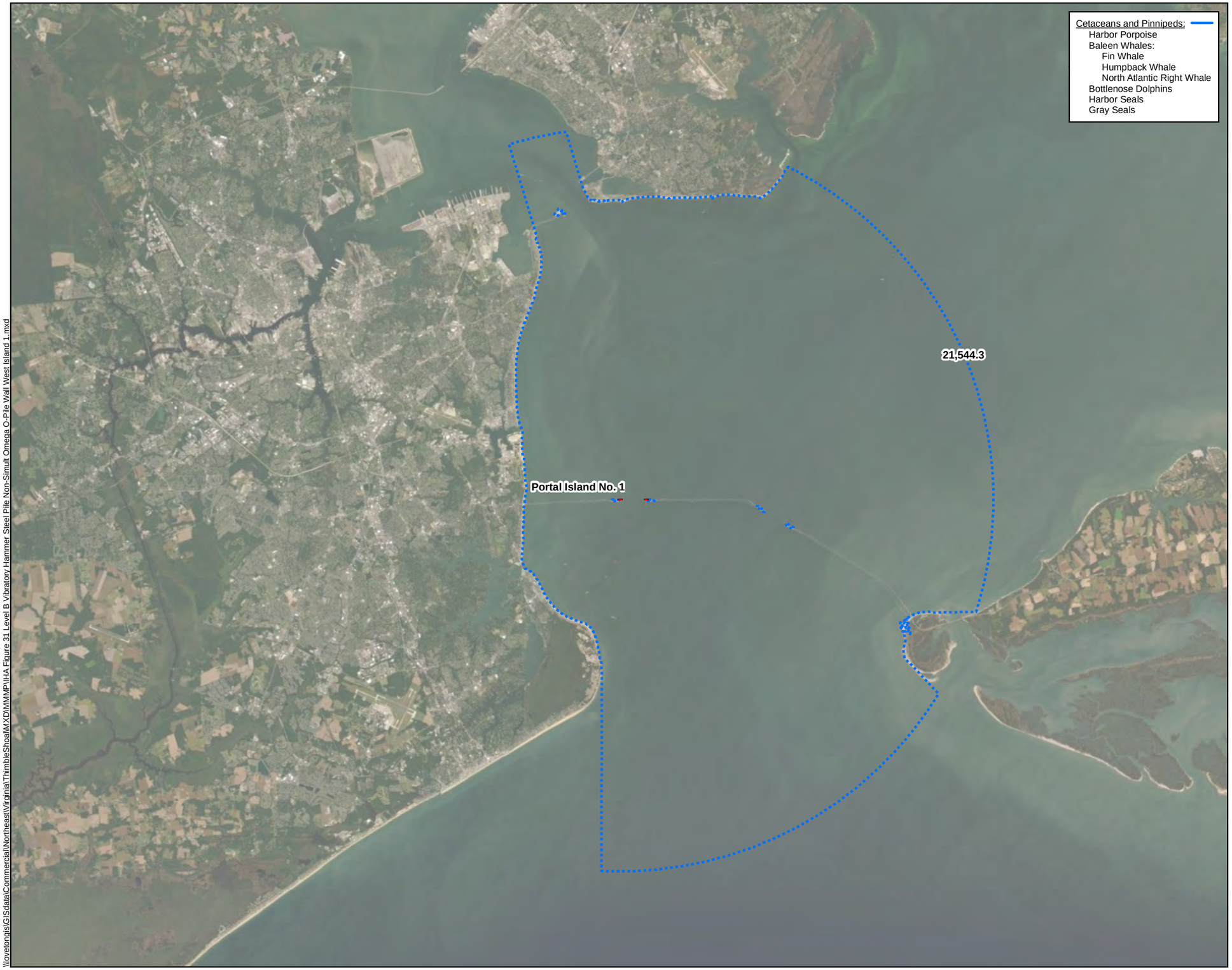
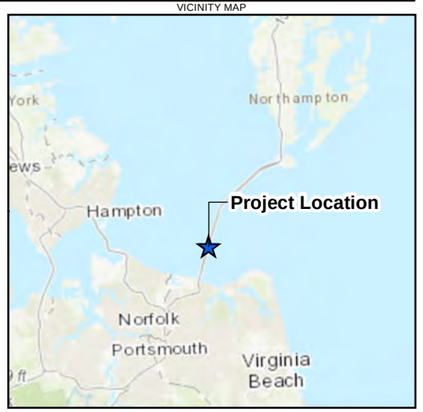


VICINITY MAP



Legend

O-Pile Wall

Omega Trestle

Vibratory Steel Piles - Level B

21,544.3 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 4,000 8,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 31
Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMP\IHA Figure 31 Level B Vibratory Hammer Steel Pile Non-Simult Omega O-Pile Wall West Island 1.mxd

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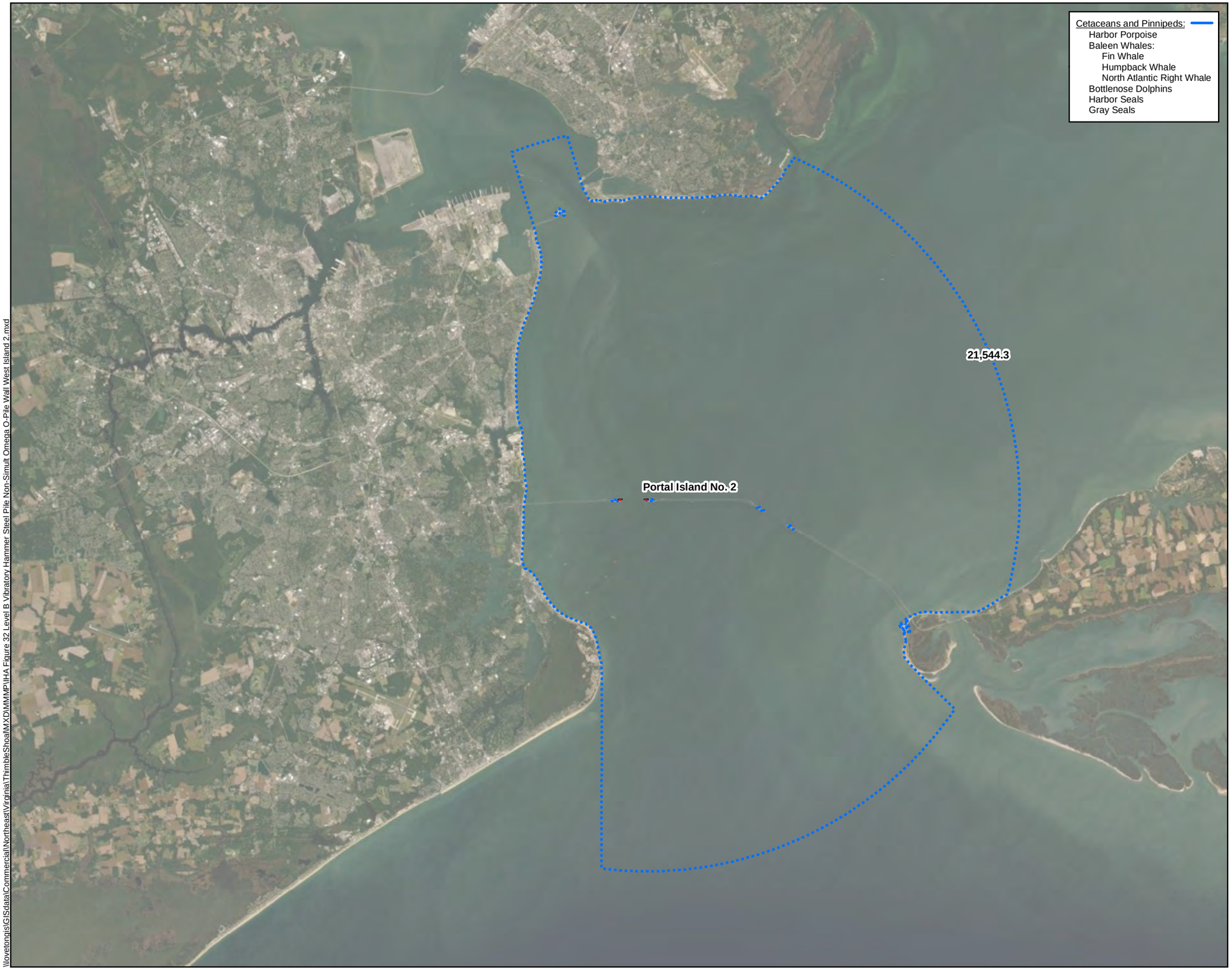
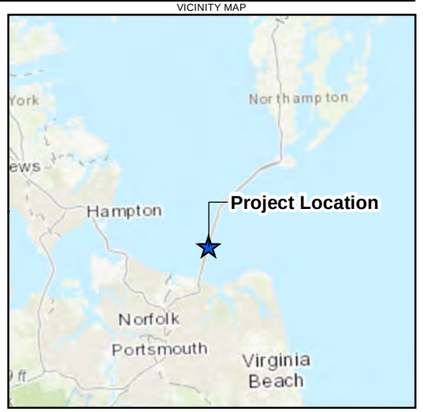


VICINITY MAP



Legend

O-Pile Wall

Omega Trestle

Vibratory Steel Piles - Level B

21,544.3 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 4,000 8,000
Meters

N

CHESAPEAKE TUNNEL JV

MOTT MACDONALD

Figure 32
Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Omega Trestle/West O-Pile Wall/ Mooring Piles and Templates at Portal Island No. 2
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\IHA Figure 32 Level B Vibratory Hammer Steel Pile Non-Simult Omega O-Pile Wall West Island 2.mxd

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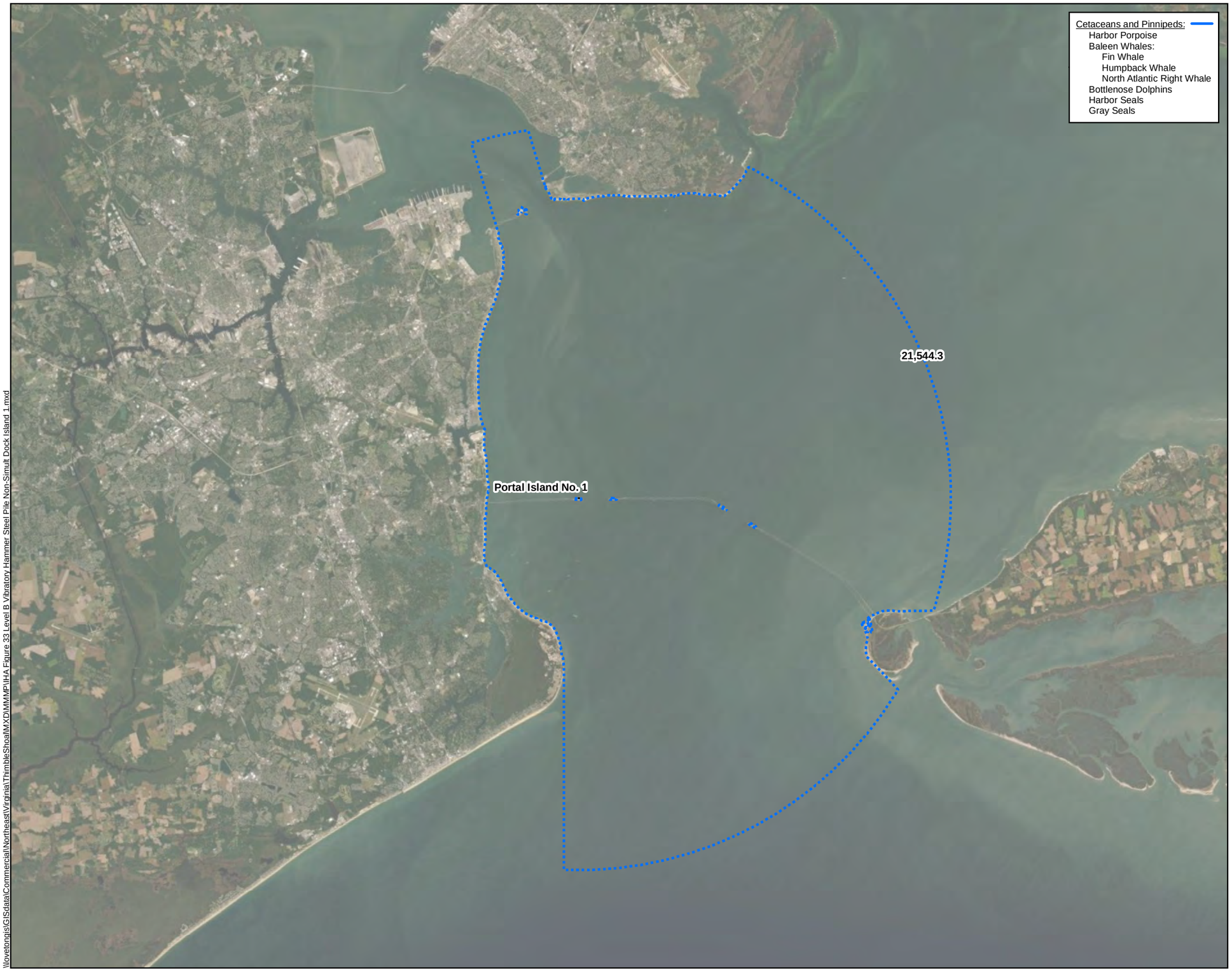

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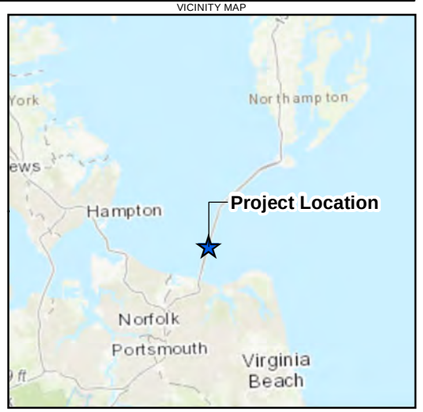

Legend

Temporary Dock

Vibratory Steel Piles - Level B

21,544.3 m - Cetaceans and Pinnipeds

Map Date: 10/3/2019
Source: ESRI 2018, Mott MacDonald 2017
Projection: NAD 1983, State Plane Virginia South, US Feet

0 4,000 8,000
Meters

N

CHESAPEAKE TUNNEL JV

EA

MOTT MACDONALD

Figure 33
Distance (meters) to Level B Threshold Using a Vibratory Hammer for Non-Simultaneous 36- and 42-in Steel Pile Driving for the Temporary Dock at Portal Island No. 1
Marine Mammal Protection Act
Parallel Thimble Shoal Tunnel

\\lovetongis\GISdata\Commercial\Northeast\Virginia\ThimbleShoal\MXD\MMPI\HA Figure 33 Level B Vibratory Hammer Steel Pile Non-Simult Dock Island 1.mxd

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