APPENDIX – E

PROJECT DESCRIPTION, REV 1

I-64 Hampton Roads Bridge-Tunnel Expansion Project

Hampton Roads Connector Partners
240 Corporate Blvd. 4th floor
Norfolk, VA 23502

Hampton-Norfolk, Virginia
December 19, 2019

Design Joint Venture

DOCUMENT HISTORY

Issue Date	Description	By	Revision
December 19, 2019	Revised to incorporate design refinement and USACE agency comment	DG/AS	1

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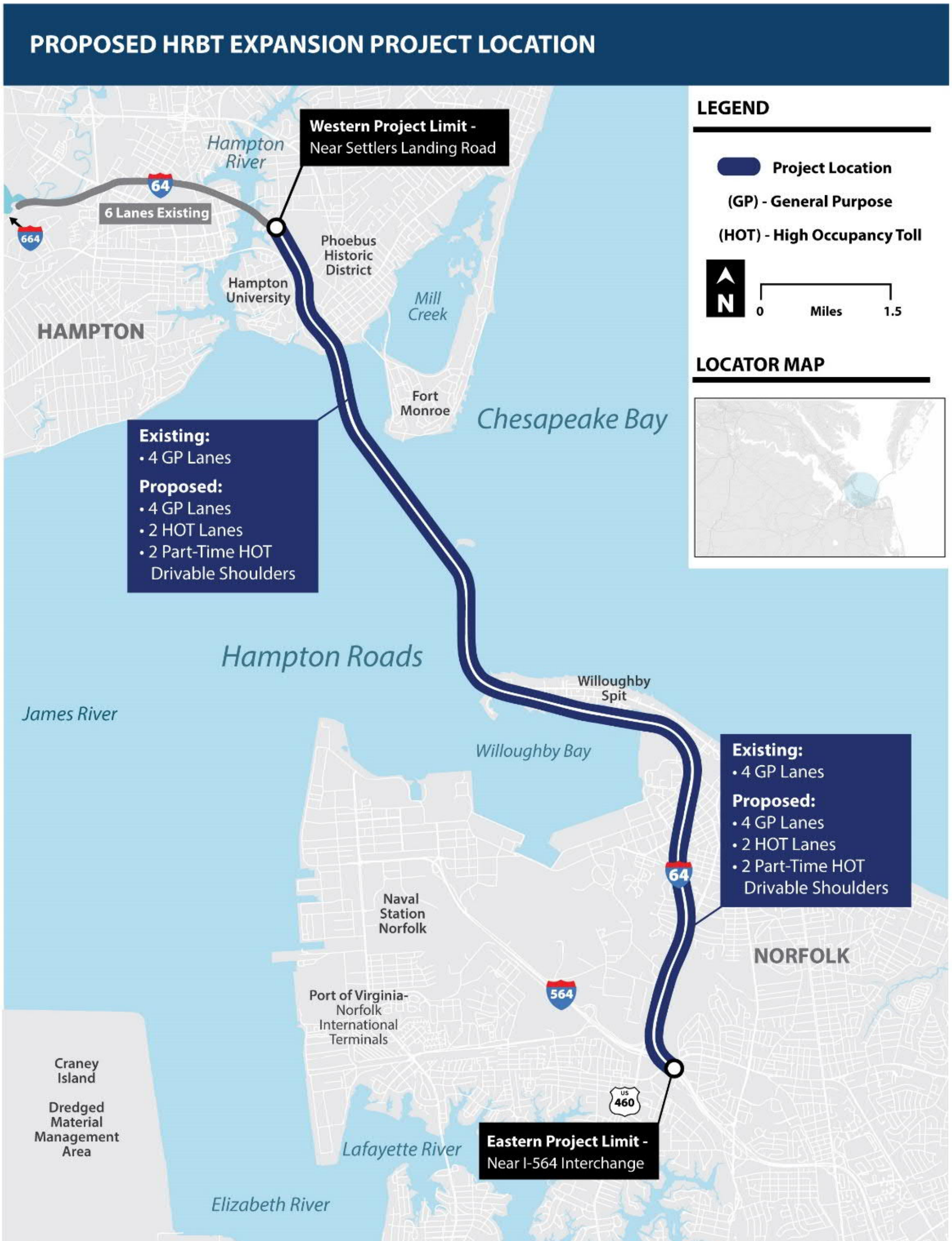
E.1 PROJECT OVERVIEW

The Virginia Department of Transportation (VDOT) awarded the design and construction of the Hampton Roads Bridge-Tunnel (HRBT) Expansion Project (Project) in April 2019 to Hampton Roads Connector Partners (HRCP), a design-build joint venture and the permit applicant. The Federal Highway Administration (FHWA) is the lead federal agency for the Project.

The Project will address severe traffic congestion at the existing HRBT crossing by increasing capacity and upgrading approximately 9.9 miles of Interstate 64 (I-64) between the Settlers Landing Road Interchange (Exit 267, MM 267.26) in Hampton and the I-564 Interchange (Exit 276, MM 277.19) in Norfolk, Virginia. Over 90,000 vehicles use the HRBT daily, seasonally exceeding 100,000 vehicles per day, which represents about half of all traffic crossing the James River, Hampton Roads water body between South Hampton Roads (“Southside”), and the lower “Peninsula” formed by the James and York Rivers. HRBT is part of the Hampton Roads Beltway, an approximate 55-mile loop of I-64 and I-664, encircling the metropolitan area. Likewise, the HRBT is an important regional transportation link for residential, commercial, industrial, and military mobility. Figure E-1 provides a map of the Project location.

Figure E-1: HRBT Expansion Project Location



The HRBT Expansion will widen I-64 for approximately 9.9 miles to create an eight-lane facility with six consistent lanes. The expanded facility will include four general purpose (GP) lanes, two new High Occupancy Toll (HOT) lanes, and two new drivable (hard-running) shoulders to be used as HOT lanes during certain times of the day. I-64 is currently six-lanes from the I-64/I-664 Interchange to the Settlers Landing Road Interchange in Hampton, which represents the western Project limit. The eastern Project limit is near Little Creek Road at the I-564/I-64 interchange in Norfolk. The typical roadway section includes the two existing 12-foot GP lanes and the addition of one 12-foot permanent HOT lane, and one 12-foot part-time drivable shoulder HOT lane in each direction. The Project will include the construction of two new two-lane tunnels, expansion of the existing portal islands, and full replacement of the existing North and South Trestle-Bridges at the HRBT. The Mallory Street Bridge will be fully replaced and the Willoughby Bay Trestle-Bridges will be expanded. Upland portions of I-64 will be widened to accommodate the additional lanes and overpass bridges will be improved.

The two new parallel tunnels will be constructed using a Tunnel Boring Machine (TBM). When complete, four (two existing tunnels and two new tunnels) subaqueous tunnels will connect to the two expanded portal islands.

For the purposes of this application, the term “trestle-bridge” will refer to structures over water that carry traffic. The permanent trestle-bridges associated with this Project are:

- The North Trestle-Bridges: From the Hampton shoreline to the North Island
- South Trestle-Bridge: From the South Island to Willoughby Spit
- Willoughby Bay Trestle-Bridges: Over Willoughby Bay
- Bay Avenue Bridges: Over the northern branch of Oastes and Mason Creeks
- Oastes Creek Bridges: Over the southern branch of Oastes and Mason Creeks

Additionally, there will be Maintenance of Traffic (MOT) trestle-bridges that, while temporary, will be used to phase construction and carry traffic prior to completion of the new structures. “Temporary trestles” are work trestles that will be used to aid in construction and will be removed before Project completion. Temporary trestles or work trestles will not carry traffic. Landside bridges, such as the Mallory Street Interchange, will be referred to as “bridges.”

HRCP is responsible for obtaining the Section 10, Section 404, Section 401, and Submerged Lands Permits from the U.S. Army Corps of Engineers (USACE), Virginia Department of Environmental Quality (VDEQ), and the Virginia Marine Resources Commission (VMRC), and is submitting this Joint Permit Application (JPA) as the permit applicant in accordance with federal and state statutory requirements. Contact information for the VDOT Project Director and the HRCP Project Executive are included in the JPA Form.

E.2 PURPOSE AND NEED

The purpose of the Project is to relieve congestion at the I-64 HRBT in a manner that improves accessibility, transit, emergency evacuation, and military and goods movement along the primary transportation corridors in the Hampton Roads region, including the I-64, I-664, I-564, and VA 164 corridors.

The Project addresses the following needs identified in the 2017 HRCS Supplemental Environmental Impact Statement (EIS):

- Accommodate travel demand – capacity is inadequate on the Study Area Corridors, contributing to congestion at the HRBT.
- Improve transit access – lack of transit access across the Hampton Roads waterway;
- Increase regional accessibility – limited number of water crossings, inadequate highway capacity, and severe congestion decrease accessibility.
- Address geometric deficiencies – insufficient vertical and horizontal clearance at the HRBT contribute to congestion.
- Enhance emergency evacuation capability – increase capacity for emergency evacuation, particularly at the HRBT.
- Improve strategic military connectivity – congestion impedes military movement missions.

Increase access to port facilities – inadequate access to interstate highway travel in the Study Area Corridors impacts regional commerce.

E.3 PROJECT SCHEDULE

HRCP began Early Works in April 2019 with approval from VDOT. It is estimated that the Project will reach substantial completion in July 2025 and full completion in October 2025. The Project construction schedule is provided in Appendix N: Project Schedule.

E.4 PROJECT LOCATION

The Project is located in Southeastern Virginia, in the Coastal Plain physiographic region. The Project lies within Hampton Roads subbasin (HUC 02080208) and Hampton Roads watershed (HUC 0208020803), which represents the confluence of the James River and Chesapeake Bay. More specifically, the Hampton side falls within Hampton Roads-Hampton River subwatershed (HUC 020802080303), the center channel is in Hampton Roads Channel subwatershed (HUC 020802080304), and the Norfolk side lies in Willoughby Bay subwatershed (HUC 020802080302) (USGS Stream Stats). The James River is the longest river in Virginia, and the associated drainage area is a significant component (about 16%) of the approximately 64,000 square mile Chesapeake Bay Watershed. The Project is located within the core of the Hampton Roads metropolitan area, which is characterized as a heavily urbanized landscape with dense residential, commercial, and industrial facilities, as well as major military installations, all in close proximity to, and served by, the Project.

E.5 DESIGN OVERVIEW

E.5.1 DESIGN SEGMENTS

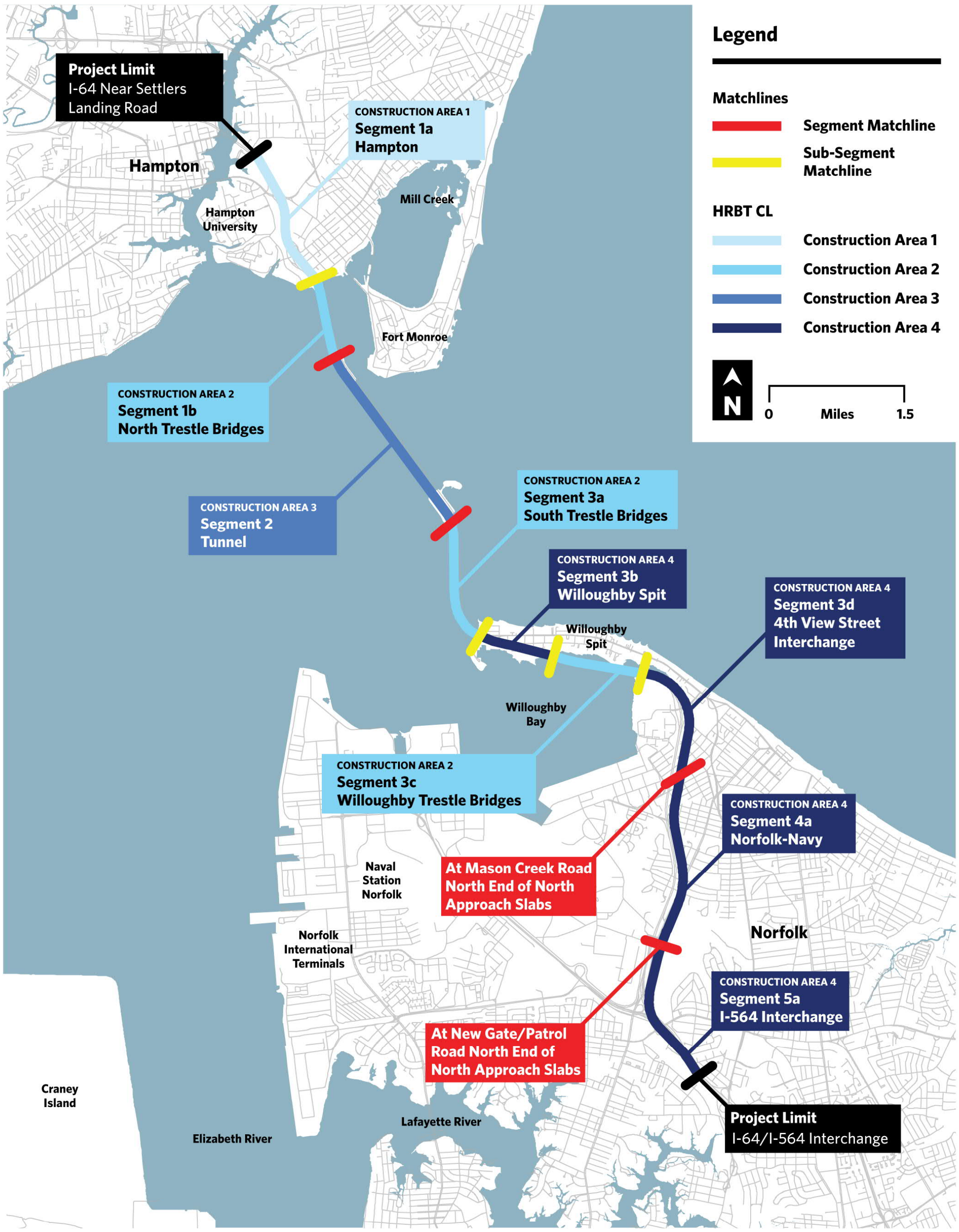
The design is divided into five segments as seen in Figure E-2 below. Approximate lengths for each segment are indicated. The total length is approximately 9.9 miles. Construction areas (see Section E.7 in this appendix) are also indicated in the figure.

- Segment 1a (Hampton) begins at the northern terminus of the Project in Hampton and ends at the north end of the north approach slabs for the north tunnel approach trestles. This segment has two interchanges and also includes improvements along Mallory Street to accommodate the bridge replacement over I-64. This segment covers approximately 1.2 miles along I-64.
- Segment 1b (North Trestle-Bridges) includes the new and replacement north tunnel approach trestles, including any approach slabs. This segment covers approximately 0.6 mile along I-64.
- Segment 2a (Tunnel) includes the new bored tunnels, the tunnel approach structures, buildings, the North Island improvements for tunnel facilities, and South Island improvements. This segment covers approximately 1.8 miles along I-64.
- Segment 3a (South Trestle-Bridge) includes the proposed South Trestle-Bridge and any bridge elements that interface with the South Island to the south end of the south abutments at Willoughby Spit. This segment covers approximately 1.2 miles along I-64.
- Segment 3b (Willoughby Spit) continues from the south end of the south approach slabs for the south trestle and ends at the north end of the north approach slabs for the Willoughby Bay trestles. This segment includes a modified interchange connection to Bayville Street, and has a

truck inspection station for the westbound tunnels. This segment covers approximately 0.6 mile along I-64.

- Segment 3c (Willoughby Bay Trestle-Bridges) includes the entire structures over Willoughby Bay, from the north end of the north approach slabs on Willoughby Spit to the south end of south approach slabs near the 4th View Street interchange. This segment covers approximately 1.0 mile along I-64.
- Segment 3d (4th View Street Interchange) continues from the Willoughby Trestle-Bridges south, leading to the north end of the north approach slabs of I-64 bridges over Mason Creek Road along mainline I-64. This segment covers approximately 1.0 mile along I-64.
- Segment 4a (Norfolk-Navy) goes from the I-64 north end of the north approach slabs at Mason Creek Road to the north end of the north approach slabs at New Gate/Patrol Road. There are three interchange ramps in this segment: westbound I-64 exit ramp to Bay Avenue, eastbound I-64 entrance ramp from Ocean Avenue, and westbound I-64 entrance ramp from Granby Street. The ramps in this segment are all on structure. This segment covers approximately 1.5 miles along I-64.
- Segment 5a (I-564 Interchange) starts from the north end of the north approach slab of the New Gate/Patrol Road Bridge to the southern Project Limit. This segment runs along the Navy property and includes an entrance ramp from Patrol Road, access ramps to and from the existing I-64 Express Lanes, ramps to and from I-564, and an eastbound I-64 entrance ramp from Little Creek Road. This segment covers approximately 1.2 miles along I-64.

Figure E-2: HRBT Design Segments and Key Map



E.5.2 PROJECT COMPONENTS

Improvements along I-64 in the Project area will include highway expansion and bridge improvements. Highway construction will have impacts to surface waters, wetlands or Jurisdictional Waters of the US (WOUS). All impacts are accounted for and depicted in Appendix G. Table E-1 provides a summary of the Project structures with impacts to surface waters (including WOUS). Additional details are provided in the following sections.

Table E-1: Structures with Impacts to Surface Waters

STRUCTURE	TYPE OF STRUCTURE (DURATION IN MONTHS)	AREA OF STRUCTURE (SQUARE FEET)[1]	TYPE OF PILE (DIAMETER[2])	TYPE OF PILE (MATERIAL)[3]	NUMBER OF PILES[4]
MALLORY STREET (Appendix G - Attachment 1, Sheet 3)					
Mallory Street Work Trestle	Temp > 6		36-inch Pipe Piles	Steel	66
NORTH TRESTLE (Appendix G - Attachment 1, Sheets 4, 5 and 6)					
North Shore Work Trestle (EB)	Temp > 6	82,600	36-inch Pipe Piles	Steel	194
Moorings	Temp > 6		42-inch Pipe Piles	Steel	36
Moorings	Temp > 6		24-inch Pipe Piles	Steel	30
Test Pile Program (Load Test)	Temp < 2		54-inch Cylinder	Concrete	1
Test Pile Program (Production Piles)	Permanent		54-inch Cylinder	Concrete	10
North Island Work Trestles (WB)	Temp >6	54,161	36-inch Pipe Piles	Steel	182
Moorings (Safe Heaven - Hampton Flats)	-		Buoy	-	40
Jump Trestles	Temp < 3	228,202	36-inch Pipe Piles	Steel	270
Demolition Trestles	Temp >6		36-inch Pipe Piles	Steel	344
North Trestle Permanent Bridge Replacement	Permanent		54-inch Cylinder	Concrete	426
NORTH ISLAND (Appendix G - Attachment 1, Sheets 6, 7, 8,and 9)					
Moorings	Temp > 6		42-inch Pipe Piles	Steel	80
Channel Marker	Existing	N/A	36-inch Pipe Piles	Steel	1
SOUTH ISLAND (Appendix G - Attachment 1, Sheets 12, 13, 14 and 15)					
TBM Quay (Platform)	Temp > 6	30,697	36-inch Pipe Piles	Steel	216
Jet Grout Trestles	Temp > 6	130,489	36-inch Pipe Piles	Steel	204
Conveyor Trestle	Temp > 6	14,299	36-inch Pipe Piles	Steel	84
Moorings	Temp > 6		42-inch Pipe Piles	Steel	25
Settlement Reduction Piles	Permanent		24-inch Pipe Piles	Steel	712

STRUCTURE	TYPE OF STRUCTURE (DURATION IN MONTHS)	AREA OF STRUCTURE (SQUARE FEET)[1]	TYPE OF PILE (DIAMETER[2])	TYPE OF PILE (MATERIAL)[3]	NUMBER OF PILES[4]
Deep Foundation Piles	Permanent		30-inch Pipe Piles	Steel + Concrete Fill	250
SOUTH TRESTLE (Appendix G - Attachment 1, Sheets 15, 16, 17, and 18)					
Moorings	Temp > 6		42-inch Pipe Piles	Steel	41
Moorings	Temp > 6		24-inch Pipe Piles	Steel	18
Test Pile Program (Load Test)	Temp < 2		54-inch Cylinder	Concrete	2
Test Pile Program (Production Piles)	Permanent		54-inch Cylinder	Concrete	20
Work Trestles	Temp > 6	112,722	36-inch Pipe Piles	Steel	256
Jump Trestles	Temp < 3	185,089	36-inch Pipe Piles	Steel	420
Demolition Trestles	Temp > 6		36-inch Pipe Piles	Steel	72
Temporary MOT Trestle	Temp > 6	104,947	30-inch Square	Concrete	186
South Trestle Permanent Bridge Replacement	Permanent		54-inch Cylinder	Concrete	600
WILLOUGHBY SPIT LAYDOWN AREA (Appendix G - Attachment 1, Sheets 18, 19, and 20)					
Dock on Spuds	Temp > 6	8,154	36-inch Pipe Piles	Steel	8
Dock on Piles	Temp > 6	19,590	36-inch Pipe Piles	Steel	44
Pontoon on Timber Piles	Temp > 6	6,000	16'-inch CCA Piles	Timber	36
WILLOUGHBY BAY BRIDGE (Appendix G - Attachment 1, Sheets 22, 23, 24, and 24)					
Moorings	Temp > 6		42-inch Pipe Piles	Steel	50
Moorings	Temp > 6		24-inch Pipe Piles	Steel	18
Moorings (Safe Heaven - Willoughby Spit)	Temp > 6		42-inch Pipe Piles	Steel	50
Test Pile Program (Load Test)	Temp < 2		54-inch Cylinder	Concrete	1
Test Pile Program (Production Piles)	Permanent		54-inch Cylinder	Concrete	15
Work Trestles	Temp > 6	45,046	36-inch Pipe Piles	Steel	212
Moorings (Safe Heaven - Willoughby Spit)	Temp > 6		42-inch Pipe Piles	Steel	40
Jump Trestles	Temp < 3	214,880	36-inch Pipe Piles	Steel	544
Willoughby Bay Permanent Bridge Expansion	Permanent		24-inch	Concrete	498
BAY AVENUE / OASTES CREEK (Appendix G - Attachment 1, Sheet 30)					
Work Trestles	Temp > 3	83,267	36-inch Pipe Piles	Steel	264
Jump Trestles	Temp < 3	50,451	36-inch Pipe Piles	Steel	304

STRUCTURE	TYPE OF STRUCTURE (DURATION IN MONTHS)	AREA OF STRUCTURE (SQUARE FEET)[1]	TYPE OF PILE (DIAMETER[2])	TYPE OF PILE (MATERIAL)[3]	NUMBER OF PILES[4]
Bay Avenue Permanent Bridge Expansion	Permanent		30-inch Square	Concrete	144
MASON CREEK (Appendix G - Attachment 1, Sheet 33)					
Work Trestles	Temp > 6	45,468	36-inch Pipe Piles	Steel	138
Jump Trestles	Temp < 3	24,059	36-inch Pipe Piles	Steel	96
Mason Creek Permanent Bridge Expansion	Permanent		30-inch Square	Concrete	58
SHEET PILES					
Mallory	Temp < 6		AZ 700-19	Steel	330
North Shore Abutment	Temp < 6		AZ 700-19	Steel	860
North Island Abutment	Temp < 6		AZ 700-19	Steel	590
North Island Expansion	Temp < 6		AZ 700-26	Steel	250
South Island Expansion	Temp < 6		AZ 700-26	Steel	700
South Island Abutment	Temp < 6		AZ 700-19	Steel	320
South Shore Abutment	-		-	-	-
Willoughby N Abutment	-		-	-	-
Willoughby S Abutment	-		-	-	-
Bay Avenue N Abutment	Temp < 6		AZ 700-19	Steel	260
Bay Avenue S Abutment	Temp < 6		AZ 700-19	Steel	480
Oastes Creek N Abutment	Temp < 6		AZ 700-19	Steel	260
Oastes Creek S Abutment	Temp < 6		AZ 700-19	Steel	260

[1]Area of the structure includes portions of the trestles/docks/bridges over jurisdictional areas as well as those portions that extend upland.

[2]Sheet pile types – AZ-700-19 and AZ-700-26

3Bubble curtains will be used when driving steel pipe piles in water deeper than 20 feet. Refer to additional details in the Biological Assessment included in Appendix I – Attachment 1.

[4]Pile counts include the all piles required for the structures (excluding abutments). For permanent pile impact calculations refer to Appendix G – Attachment 2. Permanent pile impacts include piles driven in jurisdictional areas outside of permanent shading or fill areas. Permanent pile impacts that fall within permanent shading or fill are calculated respectively as permanent shading or fill impacts.

Notes: CCA = Chromated copper arsenate; EB = eastbound; MOT = Maintenance of Traffic; N = North; S = South; Temp = temporary; WB = westbound.

E.5.2.1 MALLORY STREET INTERCHANGE/BRIDGE REPLACEMENT (SEGMENT 1A)

The Mallory Street Bridge will be replaced. Along I-64 in Hampton, the outside shoulders will be widened and improvements will be made to the associated drainage systems. Utilities (VDOT and other) will be relocated as required.

The widening of I-64 at the Mallory Street Interchange will require replacement of the Mallory Street Bridge. A temporary work trestle will be constructed to minimize impacts to the Mallory Street cloverleaf (a VDOT wetland mitigation site) during reconstruction of the Mallory Street Bridge. Table E-1 provides the details of the Mallory Street structures.

Once the Mallory Street Interchange is complete, the temporary work trestle pile foundations will be removed. Work trestles may be reused for similar purposes at a different locations on the Project. Appendix G – Attachment 1, Sheet 3 shows the Mallory Street structures as well as the proposed fill.

E.5.2.2 NORTH TRESTLE (SEGMENT 1B)

The existing two-lane North Trestle-Bridges will be demolished and reconstructed. The North Trestle-Bridges will be replaced by two four-lane structures that will have spans of 65 to 120 feet. Final design for the foundation is dependent on supplemental borings which will confirm geotechnical conditions and is being completed. The foundation design currently being considered includes 54-inch concrete cylindrical piles. Piles will be driven to support approximately 75 spans.

Temporary templates will be used to guide installation of the permanent concrete piles. The templates will be supported by four temporary 36-inch steel piles, generally one at each corner of the template. A two-tier template may be used to accommodate for the possible batter of the permanent piles. Each template will allow installation of three permanent concrete piles.

Permanent 54-inch concrete cylinder piles will be installed using an impact hammer. Requisite pile load tests will be performed during construction to confirm permanent concrete pile design of the permanent trestle-bridges.

Several temporary work trestles will support construction of the permanent eastbound and westbound North Trestle-Bridges. The temporary North Shore Work Trestle will support construction of the permanent eastbound North Trestle-Bridge in the shallow water (less than 4 to 6 feet Mean Low Water (MLW)) closer to the North Shore, avoiding the need to dredge or deepen this area and minimizing potential impacts to the adjacent submerged aquatic vegetation (SAV).

Jump Trestles will also be used at the North Trestle. Jump Trestles are temporary heavy duty platforms used to support cranes and other equipment. They are built with a maximum of three spans which are progressively removed and reinstalled one span at a time, moving forward with the construction of the adjacent structure. Each span is supported by six temporary 36-inch steel pipe piles. The steel pipe piles will be installed, removed, and reinstalled as the spans move forward using a combination of vibratory and impact hammers for installation and vibratory hammers for removal. Table E-1provides the pile installations and removals needed to support the Jump Trestle movement for construction of the permanent North Trestle-Bridge and demolition of the existing trestle. The area where Jump

Trestles will be used are shown in Appendix G – Attachment 1. The area where Jump Trestles will be used are shown in Appendix G – Attachment 1.

Table E-1 provides the structural details of the permanent and temporary North Trestle structures.

Steel sheet piles will also be installed at the North Shore shoreline to support excavation and construction of the North Shore Abutment (see Appendix G – Attachment 1, Sheet 5). Sheet piles will be temporarily installed using a vibratory hammer to form a continuous wall. Most of this work is expected to be done at lower tides so that in-water work is minimized. However, some installation work below the tidal elevations (in-water) can be expected. Sheet piles will be removed using a vibratory hammer. Table E-1 provides the type and quantity of sheet piles to be installed.

E.5.2.3 NORTH ISLAND (SEGMENT 2A)

To provide necessary structural support and protection for the new HRBT, the North Island will be expanded and modified.

The North Island will be expanded by 15.84 (toe of fill) acres to the west to accommodate the new tunnels and the Tunnel Approach Structure (TAS) as shown in Figure E-3. The TAS is a concrete structure which connects the at-grade highway to the bored tunnel. The North Island Expansion will be constructed of well-graded and compacted sand fill, surrounded by a rock perimeter made of gravel, stone, and armor stone designed to provide scour protection to protect the island from wave action current scour and propeller wash.

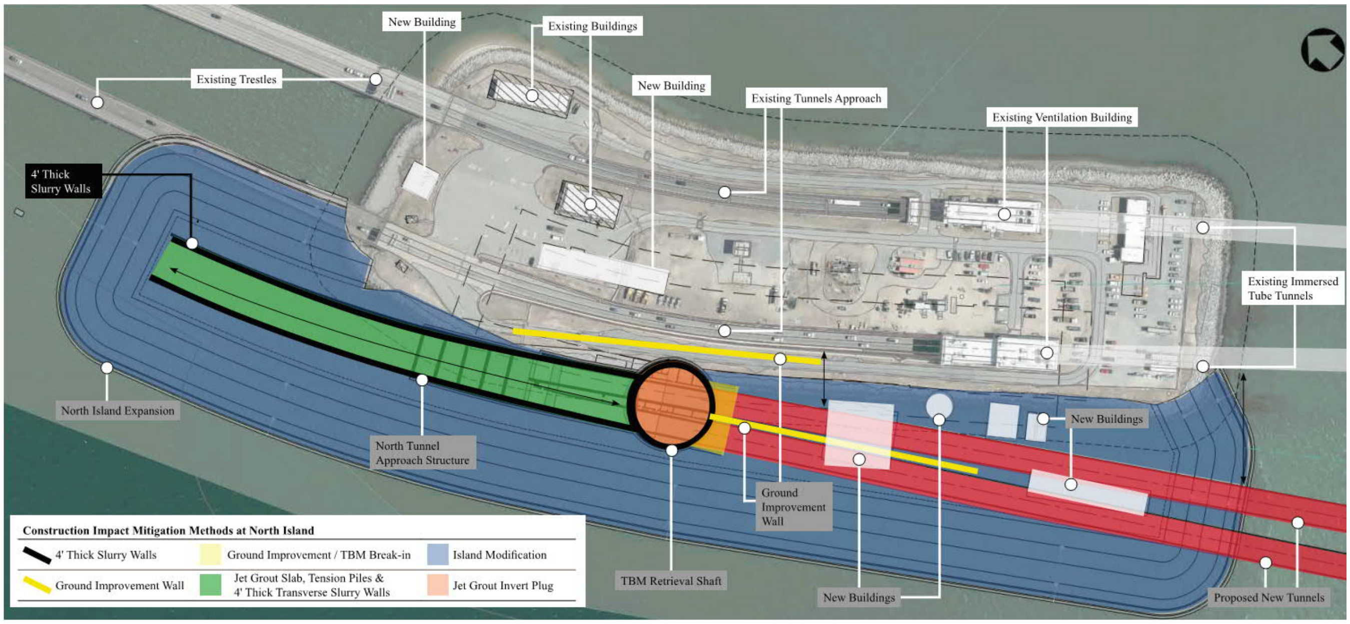
Eighty (80) temporary moorings will be installed along the perimeter of the North Island Expansion. Mooring locations are shown in Appendix G – Attachment 3B. The moorings will be removed using a vibratory hammer or cut to approximately 2 to 3 feet below the seabed at the conclusion of the Project.

Steel sheet piles will be installed as part of the North Island Expansion and at the shoreline of the North Island to support excavation and construction of the North Island Abutments and Expansion. AZ-700-26 (or similar) sheet pile will be installed around the perimeter of the North Island Expansion to support dredge and replacement of native soft soils. Refer to Table E-3 (Section E.8.5) for specific quantities. Steel sheet piles will be driven using a vibratory hammer. Additional sheet pile panels will be installed around the perimeter of the North Island expansion to support construction of the abutment and tunnel approach structure.

AZ-700-19 (or similar) sheet pile will be installed at the North Island shoreline to support excavation and construction of the North Island Abutment. Similar to the South Shore Abutment work, most of this work is expected to be done at lower tides so that in-water work is minimized. However, some sheet pile installation work below the tidal elevations (in-water) can be expected. Any temporary sheet piles outside the expansion perimeter will be removed using a vibratory hammer.

Table E-1 provides a summary of the type and quantity of sheet piles to be installed.

Figure E-3: North Island Layout



E.5.2.4 SOUTH ISLAND (SEGMENT 2A)

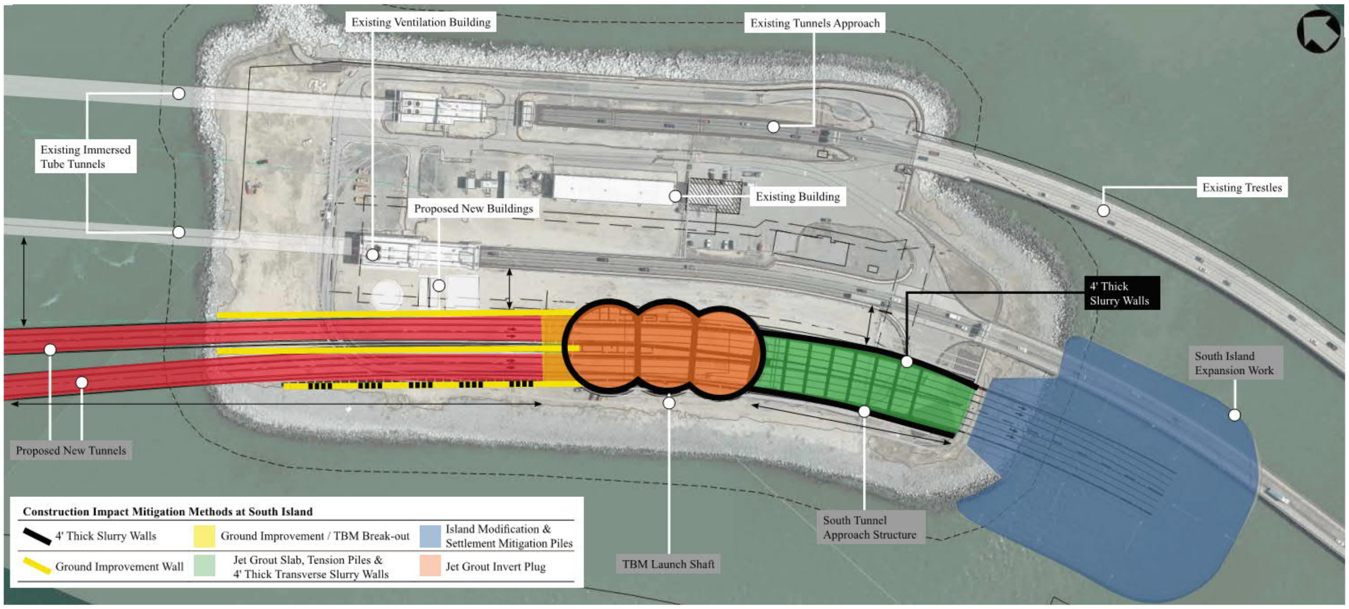
To provide necessary structural support and protection for the new HRBT, the South Island will be expanded and modified. The South Island will be expanded by 4.04 (toe of fill) acres to the south to accommodate the transition between the trestle abutment and the TAS as illustrated in Figure E-4. Expanding the island to the south avoids the need to construct a berm on the channel side of the island. The South Island will be made of well-graded and compacted sand inside a rock perimeter similar to the North Island.

Soil conditions in the South Island Expansion area will require ground improvement to avoid settlement of the expanded island and surrounding structures, including the trestle-bridges. Final design for the ground improvement is dependent on supplemental borings, which will confirm geotechnical conditions, and are being completed. Alternatives being evaluated include installation of settlement reduction piles (pipe piles) equipped with a cap and a gravel bed, dredging unsuitable sediments and backfilling with structurally suitable fill, or a combination of those alternatives. In either case, the footprint of expansion is the same. Pile installations will include 24-inch steel pipe settlement reduction piles and 30-inch concrete-filled steel pipe deep foundation piles to address these geotechnical conditions.

Both the settlement reduction piles and the deep foundation piles will be driven using vibratory and impact hammers. Temporary templates will be supported by four temporary 36-inch steel piles that will be spudded in place and used to align the piles during driving. Steel sheet piles will be installed to partially enclose the deep foundation piles as installation progresses north to south along the island expansion area. Refer to Table E-1 for specific quantities. These piles will not be removed as they are within the permanent footprint of the expansion.

The settlement reduction piles and deep foundation piles are permanent piles that will remain in place at the end of construction.

Figure E-4: South Island Layout



HRCP is constructing the temporary TBM Platform or "quay" at the South Island, as shown on Appendix G – Attachment 1, Sheet 14, to allow for the delivery, unloading, and assembly of the TBM components from barges to the South Island. The TBM Platform is a steel structure founded on 36-inch diameter steel piles as described in Table E-1.Tunnel boring spoils and other related materials will be moved between the South Island and barges via a conveyor belt and other equipment inside the tunnel boring. The Conveyor Belt Quay (Appendix G – Attachment 1, Sheet 14) will also be used for maintenance and mooring of barges and vessels carrying TBM materials and other Project-related materials. The Conveyor Trestle is a steel structure founded on 36-inch diameter steel piles as described in Table E-1.

Unconsolidated soil conditions at the western edge of the South Island – along the centerline and depth of the planned tunnel alignment – require ground improvements to allow tunnel boring to proceed safely and efficiently. Ground improvements will be achieved using deep injection or jet grouting to stabilize and consolidate the sediments along the planned tunnel alignment and tunnel depth. Two temporary work trestles (Jet Grout or Ground Improvement Trestles) will be constructed along either side of the planned tunnel alignment to support jet grouting activity (Appendix G – Attachment 1, Sheet 14).

Temporary moorings will be installed along the perimeter of the South Island Expansion to support the construction of the island expansion. Forty-two inch steel pipe piles will be installed to provide mooring points for barges and vessels. At the conclusion of the Project, temporary piles and moorings at the South Island will be removed using a vibratory hammer or cut to 2 to 3 feet below the seabed. Several associated mooring dolphins consisting of 36-inch steel piles, will also be removed using a vibratory hammer.

Steel sheet piles will be installed as part of the South Island Expansion and at the shoreline of the South Island to support excavation and construction of the South Island Abutment. Panels of AZ-700-26 sheet pile will be installed around the perimeter of the South Island Expansion deep foundation piles as pile installation progresses to support backfilling. Steel sheet piles will be driven using a vibratory hammer. In addition, panels of AZ-700-26 temporary steel sheet pile will be installed around the perimeter of the South Island Expansion to support dredge and replacement of native soft soils. Temporary steel sheet piles will be driven using a vibratory hammer.

Panels of AZ-700-19 (or similar) sheet pile will be installed at the South Island shoreline to support excavation and construction of the abutment and tunnel approach structure at the South Island. Similar to the North Shore Abutment work, most of this work is expected to be done at lower tides so that marine-based water work is minimized. However, some sheet pile installation work below the tidal elevations (in-water) will occur.

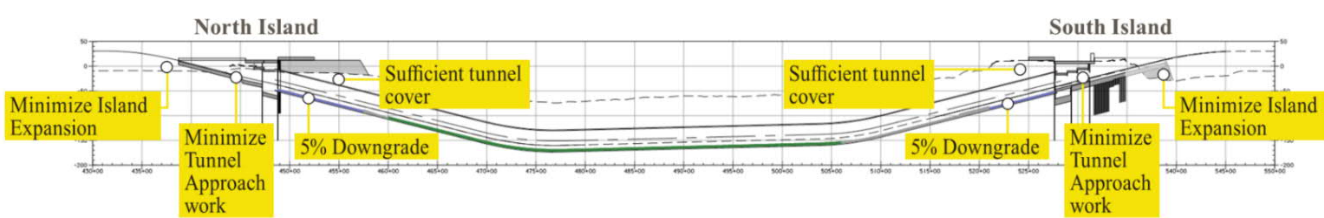
All sheet piles temporarily installed for the abutment will be removed using a vibratory hammer.

E.5.2.5 TUNNELS (SEGMENT 2A)

Two tunnels with an internal diameter of 41.5 feet will be bored using a single multi-mode capable, Variable Density (VD) TBM. The length of each tunnel is approximately 7,900 feet between launch and reception portals located respectively on the South and North Islands, adjacent to the existing HRBT tunnel portals. The TBM will be delivered by barge to a temporary dock (quay) installed at South Island. The TBM will be fully assembled in the 'Tri-cell' launching shaft preassembled at ground level and lowered into the shaft using high-capacity crawler cranes.

In the main channel, the new tunnels will be under 55 feet of water, and an additional 60 feet of overburden material. The tunnels will vary in depth from approximately 40 to 150 feet below the water surface (as measured from the tunnel axis) as shown in Figure E-5.

Figure E-5: Key Design and Construction Considerations for the Final Tunnel Grade



At these depths, the geology varies between loose to stiff cohesive material, traversing different combinations of mixed-face conditions. The TBM will also have to bore through areas where there are different types of ground improved areas. Bored material removed from the face of the tunnel will be amended with bentonite and pumped hydraulically to a Separation and Treatment Plant (S&TP) located on the South Island near the portal (for a detailed list of TBM materials and additives, refer to the JPA Appendix L: Material Management Plan (MMP)). The S&TP will remove solids, and the treated slurry will be pumped back to the tunnel face to support the excavation. This TBM technology does not use foaming agents. The removed solids in slurry form will be dewatered in a filter press. The filtrate will be directed to the Water Treatment Plant (WTP) for final polishing prior to be discharged via a VPDES-permitted discharge pipe. The filter cake will be transported via conveyor to a barge for disposal at an approved disposal facility.

Once the TBM reaches North Island, a U-turn will be performed within the reception shaft for excavation of the second tunnel. The TBM supply lines and slurry circuit will be through the first tunnel, and therefore the supplies and spoil removal will remain on the South Island.

E.5.2.6 SOUTH TRESTLE (SEGMENT 3A)

The two existing two-lane South Trestle- Bridges will also be demolished. They will be replaced by an eight-lane structure with spans up to 130 feet long. Final design for the foundation is dependent on supplement borings which will confirm geotechnical conditions, and conditions, and is being completed. Alternatives currently being considered includes approximately 680 precast 54-inch concrete cylindrical piles as described in Table E-1or 30-inch precast concrete square piles. Piles will be driven to support approximately 91 spans. Additionally, two MOT Bridges will be constructed to temporarily carry traffic during construction of the new structure. The MOT Bridges will be founded on 30-inch square concrete piles.

Several temporary work trestles will support construction of the permanent trestle-bridges and temporary bridges used for maintaining traffic (MOT Bridges) during construction (Appendix G – Attachment 1, Sheet 15). The South Trestle Work Trestles will consist of two separate structures at the South Island shoreline (Appendix G – Attachment 1, Sheet 15) and two structures at the South Shore or Norfolk shoreline (Appendix G – Attachment 1, Sheet 18). Temporary work trestles will be founded on 36-inch diameter steel piles with 30 to 40 feet spans sized to accommodate a 300-ton crane.

Temporary steel pile foundations for each of the work trestles will be installed using a vibratory and impact hammer. Some areas near the shores and islands will require the use of a down-the-hole-hammer to install the temporary piles. The South Trestle Work Trestle pile foundations will be removed using a vibratory hammer.

Once the permanent roadway is complete, the temporary MOT Bridge will be removed as well as the work trestle temporary pile foundations and mooring piles. Piles will be cut 2 to 3 feet below the seabed. Work trestles may be reused for similar purposes at a different location on the Project.

Temporary heavy duty moving platforms (Jump Trestles) will be used for constructing trestle-bridges (both permanent and temporary MOT bridges) at the South Trestle (Appendix G – Attachment 1, Sheet 15 and 16). A combination of working from jump trestles and/or the existing trestles will be used to build the new trestle-bridges. Jump trestles are built with a maximum of three spans which are progressively uninstalled and reinstalled one span at a time, moving forward with the construction of the adjacent structure.

The 36-inch steel pipe piles will be installed, removed, and reinstalled as the spans move forward using a combination of vibratory and impact hammers for installation and vibratory hammers for removal.

E.5.2.7 WILLOUGHBY SPIT LAYDOWN AREA (SEGMENT 3B)

HRCP has been granted use of property on Willoughby Spit next to the South Trestle-Bridge (Appendix G – Attachment 1, Sheets 19 and 20) for laydown areas and as a base for marine operations. Two temporary piers will be constructed to allow barge access: one will be a fixed pier on 36-inch steel pipe piles, and the other will be a floating dock on 36-inch steel pipe (spuds) piles. This is illustrated in Figure E-6. Piles will be installed using vibratory and impact hammers, as well as a pile template. The pile template will be supported by four temporary 36-inch steel piles. The temporary piers, including the steel pile foundations, will be removed upon completion of the Project. The temporary steel piles will be removed using a vibratory hammer.

Figure E-6: Willoughby Spit Laydown Area

The existing bulkheads on the inside of Willoughby Spit will be repaired and three new piers will be constructed to provide access for crew boats and similar-sized vessels. (Appendix G – Attachment 1, Sheets 19 and 20).

E.5.2.8 WILLOUGHBY BAY (SEGMENT 3C), BAY AVENUE, AND OASTES CREEK TRESTLE- BRIDGES

The existing Willoughby Bay Trestle-Bridge structure will be modified by widening the two existing structures to the outside in both directions to accommodate new travel lanes, shoulders, and new sound walls. This will require installation of two to three additional piles at each pier location on the outside of both structures. Three 24-inch piles concrete piles will be driven at each pier to support the expansion (see Table E-1).

A combination of working from jump trestles and/or the existing trestles will be used to construct the widening of the existing Willoughby Bay westbound roadway (Appendix G – Attachment 1, Sheets 22, 23 and 24). Two temporary work trestles will be installed along the outside edge of the existing eastbound structure to provide access in the shallow water area near both shorelines. Thirty-six (36)-inch steel pipe piles will be driven using a combination of vibratory and impact hammers to support the temporary work trestles. The temporary steel piles will be removed using a vibratory hammer.

Similar to other locations, jump trestles will be supported by temporary 36-inch steel pipe pile foundations that will be installed, removed, and reinstalled as the spans move forward using a combination of vibratory and impact hammers for installation and vibratory hammers for removal.

Requisite pile load tests will be performed during construction to confirm permanent concrete pile design of the permanent trestle-bridges. Where geotechnical conditions require, jetting may be used to assist in pile installation. During Jetting pressurized fluid will be used to temporary loosen soils thus reducing the resistance of the pile to sinking into the ground. Jetting will not be conducted at the surface of the seabed but rather at depth once sufficient resistance to pile driving has been met. Jetting will not be used to remove or displace surface sediments.

E.5.2.9 BAY AVENUE/OASTES CREEK/MASON CREEK (SEGMENT 4A)

The existing I-64 Bridges in Segment Four will be modified by widening the two existing structures to the outside in both directions to accommodate new travel lanes, shoulders, and new sound walls (if required). This will require installation of two additional piles at each pier location on the outside of both structures. Two 30-inch square concrete piles will be driven at each pier to support the expansion (see Table E-1).

A combination of jump trestles and work trestles will be used to construct the widening of the existing roadway (Appendix G – Attachment 1, Sheets 30 and 33). Temporary work trestles will be installed along the outside edge of the existing structures to provide access in wetland areas. Thirty-six (36)-inch steel pipe piles will be driven using a combination of vibratory and impact hammers to support the temporary work trestles. The temporary steel piles will be removed using a vibratory hammer.

E.5.2.10 ROADWAY EXPANSION (ALL SEGMENTS)

In Hampton and Norfolk, I-64 will be widened to the outside. Existing overpass bridges will be widened, and sound walls will be constructed as required. A hurricane evacuation crossover will also be constructed west of the 4th View Street interchange. Traffic crossovers for emergency use will be provided at both the Hampton and Norfolk approaches. Appendix G – Attachment 1 shows the I-64 alignment and associated fills.

E.6 CONSTRUCTION EQUIPMENT OVERVIEW

Tunneling will be performed using a Variable Density TBM. On-island and upland construction will require equipment including, but not limited to, support equipment, a Separation and Treatment Plant (S&TP) for the bored material, a Water Treatment Plant (WTP), a Slurry Treatment Plant (STP) for jet grout and slurry wall residuals, jet grout drills, pile drivers (including impact hammers, vibratory hammers, and drilling with a down-the-hole hammer), excavators, cranes, bulldozers, and skid steers. In-water construction will require mobilization of multiple pieces of marine equipment, including, but not limited to, mechanical bucket dredges, tugboats, dredge tending tugboats, equipment barges, anchor barges, material supply vessels, and survey support vessels. Vessels and barges will be required to deliver the necessary equipment and construction materials to the Project area and to transport material offsite for stockpiling or disposal at an approved facility.

E.7 CONSTRUCTION AREAS

HRCP has organized the Project into four Construction Areas as shown in Figure E-7. The Construction Areas correspond to the design segment and sub-segments described earlier, and as indicated in Table E-2.

Figure E-7: HRBT Expansion Project Construction Areas

Table E-2: Relationship between Design Segments and Construction Areas

Design Segment No.	Design Segment Name	Construction Area No.
Segment 1a	Hampton	Area 1
Segment 1b	North Trestle-Bridge	Area 2
Segment 2a	Tunnel	Area 3
Segment 3a	South Trestle-Bridge	Area 2
Segment 3b	Willoughby Spit	Area 4
Segment 3c	Willoughby Bay Trestle-Bridge	Area 2
Segment 3d	4th View Street Exchange	Area 4
Segment 4a	Norfolk-Navy	Area 4
Segment 5a	I-564 Interchange	Area 4

E.8 CONSTRUCTION ELEMENTS AND PHASING

The Project construction is divided into three main phases: 1) Design, 2) Permitting, and 3) Procurement and Construction. Phases 1 and 2 (Design and Permitting) have already started and will continue through 2020, including the following activities:

- Start of baseline site instrumentation;
- Start of the supplemental geotechnical borings;
- Design and submission of permit applications; and,
- Start of TBM design and contract procurement

Early works at the South Island – including paving and utility relocations – began at the end of 2019. The remainder of the onshore (upland) construction activities, and the start of off-shore (in-water) construction is planned to begin in the second quarter of 2020. Construction will continue into 2025.

A linear schedule which shows the expected duration of construction activities for the Project, is provided in Appendix N: Project Schedule.

A description of the major construction elements that are part of the Project is provided below. This includes island expansions, tunnel boring, trestle-bridge construction, and Roadway Expansion. Other Project elements described in this Appendix include: Materials Management, Marine Operations and Construction Logistics, Removal of Temporary Structures, and Demolition and Removal of Existing Structures.

E.8.1 ISLAND EXPANSION

In-water island expansion activities will occur in Construction Area 3 at both the North and South Islands. Creation of the South Island launch pit, portal, and TAS will result in the excavation of approximately 260,000 cubic yards of sandy material. Dependent on the results of chemical and physical analyses, up to 150,000 cubic yards of clean, sandy material from the South Island portal excavation may be reused. If the material is determined to be unsuitable, it will be disposed and certified clean fill material will be imported to facilitate construction of the North Island Expansion.

E.8.1.1 NORTH ISLAND

Placement of material in surface waters is regulated under Section 404 of the Clean Water Act (CWA) regulated by the Virginia Administrative Code, USACE, VDEQ and VMRC. Clean fill used for this purpose is discussed in Appendix L: Material Management Plan.

Phasing of North Island expansion is as follows:

Phase 1 – On-shore Cutoff Wall

Approximately 170 steel pipe piles will be driven along the existing upland west shore to create a cutoff wall. Refer to Table E-2 for specific quantities. The purpose of the cutoff wall is to protect the existing TAS from settlement that might be induced by the North Island expansion.

Phase 2 - Dredging

The dredging footprint of the future North Island expansion will be mechanically dredged to remove mud and provide improved foundation conditions. Dredging volumes and areas are represented in Table E-3 (Section E.8.5). Obstructions located within the footprint of the island expansion are will also be removed during dredging (i.e., armor rock displaced from shore) with a mechanical style grapple bucket. Sediments will be placed in barges for transport directly to an approved disposal facility. Dredging at the North Island expansion area is described in detail in Appendix L: Material Management Plan.

Phase 3 – Mooring Piles

Mooring piles (a total of 80, 42-inch steel pipe piles) will be driven from a barge with a vibratory hammer every 40 feet within and along the footprint of the island expansion. Moorings will keep work vessels stable during construction, and will reduce construction activity from encroaching on the adjacent Hampton Creek Approach Channel. Piles will be vibrated out or cut 2 to 3 feet below the seabed once the North Island Expansion is complete in accordance with United States Coast Guard (USCG) and USACE guidance.

Phase 4 – Sheet Pile Wall

A sheet pile wall will be installed west of the future tunnel shaft and TAS, within the expansion area. Sheet pile will be driven from a barge with a vibratory hammer. The sheet pile will separate the interior sand (fill) from the perimeter gravel. Separation will prevent the gravel from entering the slurry wall construction area. Slurry walls are required for construction of the future tunnel shaft and TAS.

Phase 5 – Rock Perimeter (enclosure)

The rock perimeter will be constructed first to enclose the North Island Expansion area. Removal of existing perimeter stone and placement of new stone material will start at one extremity of the island and finish at the other. The new bund, rock perimeter, and scour toe will be comprised of four stone classes.

- Bund: 2- to 4-inch diameter crushed rock or gravel
- Underlayer rock – Type 3: VDOT Class I riprap, W_{50} = 100 lbs
- Underlayer rock – Type 2: W_{50} = 0.65 tons
- Armor rock – Type 1: W_{50} = 6.5 tons

Schedule constraints might require starting at both extremities at the same time and to complete the rock enclosure in the middle of the island. In either case, the phasing described below is the same.

- Dredging
    - The footprint of the future North Island Expansion including toe scour area will be dredged
- Existing rock removal:
    - In order to place the material at each extremity of the North Island, the first layer of existing armor stones located at each corner will be removed.
    - Armor stones will be removed both from shore-based equipment and from a barge with a crane and clamshell or grapple.
    - Armor stones will be stockpiled on North Island until all stones have been placed. In case of a weather event, armor stones can be replaced quickly.
- Retaining Rock Bund placement:
    - A retaining rock bund will be constructed in-water, forming the perimeter of the expansion area.
    - Gravel material will be placed from barges using a crane or a long reach excavator with a mechanical bucket.
    - The maximum size of the supply barge will be 360 feet x 60 feet.
    - In addition to the mooring piles, barges may need to use anchors (4 per barge) and/or spuds (4 per barge).
- Underlayer stone (Types 2 and 3) placement for the scour protection toe:

- While placement of the bund is progressing, the underlayer material for the scour protection toe will be placed on the seaward side of the bund with the same type of equipment.
- There are two types of underlayer: small stone with a W_{50} = 100lb and rock with a W_{50} = 0.65 tons.

- Armor stone (Type 1) placement:
  - Armor stone placement will follow the underlayer placement per the cross-section drawings in Appendix G.
  - The median weight of armor stone (Type 1) is 6.5 tons.

Phase 6 – Fill

To construct the island interior, the remaining existing armor rock located along the west slope of the existing island will be removed and transported to an approved disposal location. Approximately 206,000 cubic yards of clean fill will be installed using conveyor systems placed on the rock perimeter enclosure and barges for sand supply and/or equipped with either a crane or long reach excavator. Dozers will be used to place and compact the fill material within the exterior protection. Fill will be vibro-compacted to a depth of 20 feet below the seabed.

E.8.1.2 SOUTH ISLAND

The South Island expansion is in the same location as the existing and new eastbound trestle-bridges. The piles of the new structure will be located within the armor protection of the South Island Expansion. Construction will be phased to start the South Island Expansion once the existing eastbound trestle-bridge has been demolished. This will allow driving the new structure concrete piles at the same time as the settlement reduction piles (SRPs) and deep foundation piles (DFPs). SRPs and DFPs are needed for settlement reduction for the South Island expansion.

The sequence to build the South Island Expansion is as follows:

Phase 1 - Dredging

Dredging is required within the footprint of the expansion area (3.14 acres) to clear the mud, reduce settlement, and remove obstructions (i.e., armor stones displaced from shore). Mechanical dredging will be conducted to improve foundation conditions. Depth of dredging will be determined by the results of the geotechnical borings (currently underway). The dredged sediments will be placed in a barge for transport to an upland, approved disposal facility. Depth of the dredge cut will range from 3 feet around the perimeter to 18 feet in the interior (plus 2 feet over dredge) depending on results of the supplemental geotechnical boring program.

Phase 2 – Settlement Reduction Piles (SRPs) and Deep Foundation Piles (DFPs)

Due to weak foundation soils, 24-inch steel pipe SRPs will likely be driven to a depth of 95 feet below grade, except in the area of the future roadway location, where 30-inch steel concrete-filled pipe DFPs will be driven to the same depth.

After dredging, a gravel bed of 4 to 7 feet will be installed on the seabed. This bedding layer forms the foundation of the new structure and provides separation between the seabed and larger stone above. The offshore SRPs and the DFPs will be driven from a barge using vibratory and impact hammers. A pile template will be used to align the piles during driving. The template is placed in the proper location and held in place through the use of spuds (piles). The SRPs and DFPs will be supplied from a barge. Barges will be secured using spuds and anchors. Onshore SRPs and DFPs will be install using land-based vibratory and impact hammers.

The SRPs and DFPs are permanent piles and will remain at the end of construction, within the confines of the expansion area.

Phase 3 – Sheet Pile Installation

Following or concurrently with Phase 2, sheet pile walls will be installed from barges with vibratory hammers. Sheet piles will enclose the TAS to facilitate construction of the "U" Wall (see Appendix G).

Sheet piling will remain after construction is complete since they are within the confines of the South

Island Expansion.

Phase 4 – Material Placement

Clean fill materials will be placed from shore and from barges.

Placement of material in surface waters are regulated under Section 404 of the CWA and Virginia Water Protection (VWP) Regulations regulated by the USACE, VDEQ and VMRC. Clean fill used for this purpose is discussed in Appendix L: Material Management Plan.

Similar to the North Island, the different layers and materials of the South Island will be placed in phases.

- Dredging
    - The footprint of the future South Island Expansion including toe scour area will be dredged.
- Existing rock removal:
    - In order to place the material at the interface between the existing edge of the island and the expansion, the first layer of existing armor stones will need to be removed.
    - Armor stones removal will be performed from the shore and from a barge.

- Armor stones may be stockpiled on South Island until all stones have been placed for the scour protection structure. In case of a weather event, armor stones can be replaced quickly.

- Retaining Rock Bund placement:
  - A retaining rock bund will be constructed in-water, waterward of the steel sheet pile enclosure.
  - Gravel material will be placed from barges using a crane or a long reach excavator with a mechanical bucket.
  - The typical size of the supply barge will be 360 feet x 60 feet.
  - In addition to the mooring piles, barges may need to use anchors (4 per barge) and/or spuds (4 per barge).
- Underlayer stone (Types 2 and 3) placement for the scour protection toe:
  - While placement of the bund is progressing, the underlayer material for the scour protection toe will be placed on the seaward side of the bund with the same type of equipment.
  - There are two types of underlayer: small stone with a W_{50} = 100lb and rock with a W_{50} = 0.65 tons.
- Armor stone (Type 1) placement:
  - Armor stone placement will follow the underlayer placement per the cross-section drawings in Appendix G.
  - Median weight of armor stone (Type 1) is 6.5 tons.
- Fill:
  - Finally, the sheet pile enclosure will be filled with clean fill from barges using a crane. The crane will be equipped with a mechanical bucket or a long reach excavator. Work will progress from barges or from the shore.

Phase 5 – Onshore (upland) Works

Concurrently with in-water work, the island expansion will require DFPs to be driven onshore using impact and drilling with a down-the-hole hammer. Armor stones above Mean High Water (MHW) will need to be removed to place the new material for the island expansion and facilitate construction of the Tunnel Approach Structure (TAS).

E.8.2 TUNNELS

The two new tunnels will be bored using a single Variable Density TBM. The TBM will bore a tunnel in one pass that will accommodate two new lanes of traffic. The tunnel construction activities will occur in Construction Area 3 (Design Sub-Segment 2a). These activities will occur predominantly beneath the subaqueous bottom, with the exception of upland (on-island) construction for the TAS, including the South Portal (launching shaft) and the North Portal (receiving shaft), and in-water subsurface jet grouting at the north end of the South Island.

Tunnel activities include:

- Tunnel boring using the TBM.
- Construction of a temporary TBM Platform (quay) to receive the TBM components for assembly in the launch portal.
- Temporary Conveyor Trestle for offloading TBM excavated material.
- GI to support the TBM boring.
    - Temporary offshore trestles (extending north from the South Island) for GI.
    - On-Island GI using jet grout.
- Construction of the TAS (including shafts).
    - Slurry walls and guide wall construction.
    - Excavation of material from the shafts and TAS.
    - Break-in / break-out walls (head walls) at the beginning and end of the bore.
    - Jet grout plug for water tightness and jet grout struts.

Phasing of the tunnel boring activities is as follows:

Phase 1 – Installation of the TBM

The TBM will be delivered by barge to South Island to a temporary Platform (quay) designed for loading and unloading ships. The TBM will be fully assembled and prepared for launch in the 'Tri-cell' launch shaft using high capacity cranes to lower components of the TBM into position. The TBM assembly is expected to take 6 months to complete.

Phase 2 – First Bore

Construction of the tunnel structures will begin on the South Island and move from south to north to the North Island receiving shaft. The TBM will both excavate material and construct the new tunnel as it progresses from South Island to North Island.

Tunnel lining works will occur behind the TBM as it drives forward. The tunnel lining will be a reinforced, precast concrete lining with a hybrid reinforcement of both steel fibers and conventional reinforcement. A precast invert ballast piece will provide buoyancy control in the temporary condition, a level working platform for construction logistics, and will be incorporated into the final ballast for the finished tunnel structure. Precast segments are supplied from South Island to the TBM by a Multi-Service Vehicle (MSV).

Once launched, the first boring operation, or "Drive 1," is expected to take 12 months to complete, moving south to north. Production is expected to occur in 2 shifts per day, 12 hours per shift. Work will occur 6 days per week with maintenance occurring on weekends. Ballast installation will be done once the first bore is completed.

Phase 3 – U-Turn

Upon reaching the North Island, the TBM will be turned around using high capacity cranes. This operation is expected to take 4 months.

Phase 4 – Second Bore

A parallel tunnel will be bored back to the South Island for the second set of lanes. Drive 2 is expected to take 11 months to complete, moving north to south. Drive 2 considers downtime for ballast installation behind the boring, as this will be a concurrent activity.

Phase 5 – Disassembly of the TBM

Upon reaching the South Island and completing the second tunnel, the TBM will be disassembled and the components will be removed via the portal on the South Island.

Once the tunnel structure is completed, final upland work for the Project will include installation of the final roadway, lighting, finishes, mechanical systems, and other required internal systems for tunnel use, traffic safety and facility function.

E.8.2.1 TUNNEL APPROACH STRUCTURES (TAS) AND PORTALS

The South Island TAS is 1,130 feet long, comprised of a concrete structure that connects the at-grade highway to the bored tunnels and consists of two primary sections: 1) the U-wall and 2) the tri-cell cut-and-cover section from where the TBM will be launched. This launching shaft (also referred as the South Portal) will be the first activity to start, as South Island does not need to be expanded prior to building the shaft. Having a tri-cell launching shaft allows the full assembly of the TBM and its support, and is required to launch the TBM.

The North Island TAS is 980 feet long, comprised of a concrete structure that connects the at-grade highway to the bored tunnels. It consists of three primary sections: 1) the U-wall, 2) a rectilinear section, and 3) a circular receiving shaft (also referred to as the North Portal). The receiving shaft is located on the expansion of North Island and therefore, can only be constructed once the expansion is complete.

Both TAS will be built with deep slurry walls and sealed with a watertight jet grout plug or by taking advantage of a low permeability geological stratum.

A slurry wall is a technique used to build reinforced concrete walls in areas of soft earth close to open water. Guide walls are constructed on the ground surface to outline the desired trench and guide excavation equipment, then a trench is excavated to create a form for a wall while simultaneously being filled with bentonite slurry. The dense slurry prevents the trench from collapsing by providing outward pressure. Once a length of trench is excavated, a reinforcing cage is lowered into the slurry-filled trench and the trench is filled with concrete from the bottom up. The heavier concrete displaces the bentonite slurry, which is pumped out, filtered, and stored in tanks for use in the next wall segment, or properly disposed of. All spoils will be decanted to segregate the material from the slurry and pH neutralized before transport to a dedicated disposal area off site. Additional information on slurry wall waste can be found in Appendix L: Material Management Plan.

Jet grouting is a technique used to directly inject a concrete-like material into subsurface environments to stabilize an area. A single fluid system consisting only of air, water and grout will be used for the jet. The process uses grout that has been engineered and tested for soil type, design strength, and permeability. It is anticipated that the grout for ground improvement will consist of a mix of Portland cement and water with a cement-to-water ratio weight varying between 1.25 and 1.42, with the possible addition of a small quantity of bentonite (up to bentonite-to-water weight ratio of 4%). Additional information on Jet Grout Residuals can be found in Appendix L: Material Management Plan.

Phasing of works for both shafts is as follow:

- Installation of the guide walls.
- Construction of the slurry walls.
- Once the slurry walls are complete, the bottom of the shaft will be sealed with a watertight jet grout plug.
- The shaft will then be dewatered and excavated (cross walls in the tri-cell shaft allow to avoid having struts in the launching shaft).
- Installation of a waterproofing membrane and construction of the base concrete slab.
- Construction of the head wall.

The shaft is then ready to receive the TBM.

The rest of the TAS (U-walls and cut and cover) will be built as follows:

- Guide walls installation.
- Construction of slurry walls.
- Construction of jet grout plug (for water-tightness) and jet grout struts below the (future) concrete slab.
- Start of dewatering and excavation. Concrete struts are installed during excavation.
- Construction of the concrete base slab and walls.

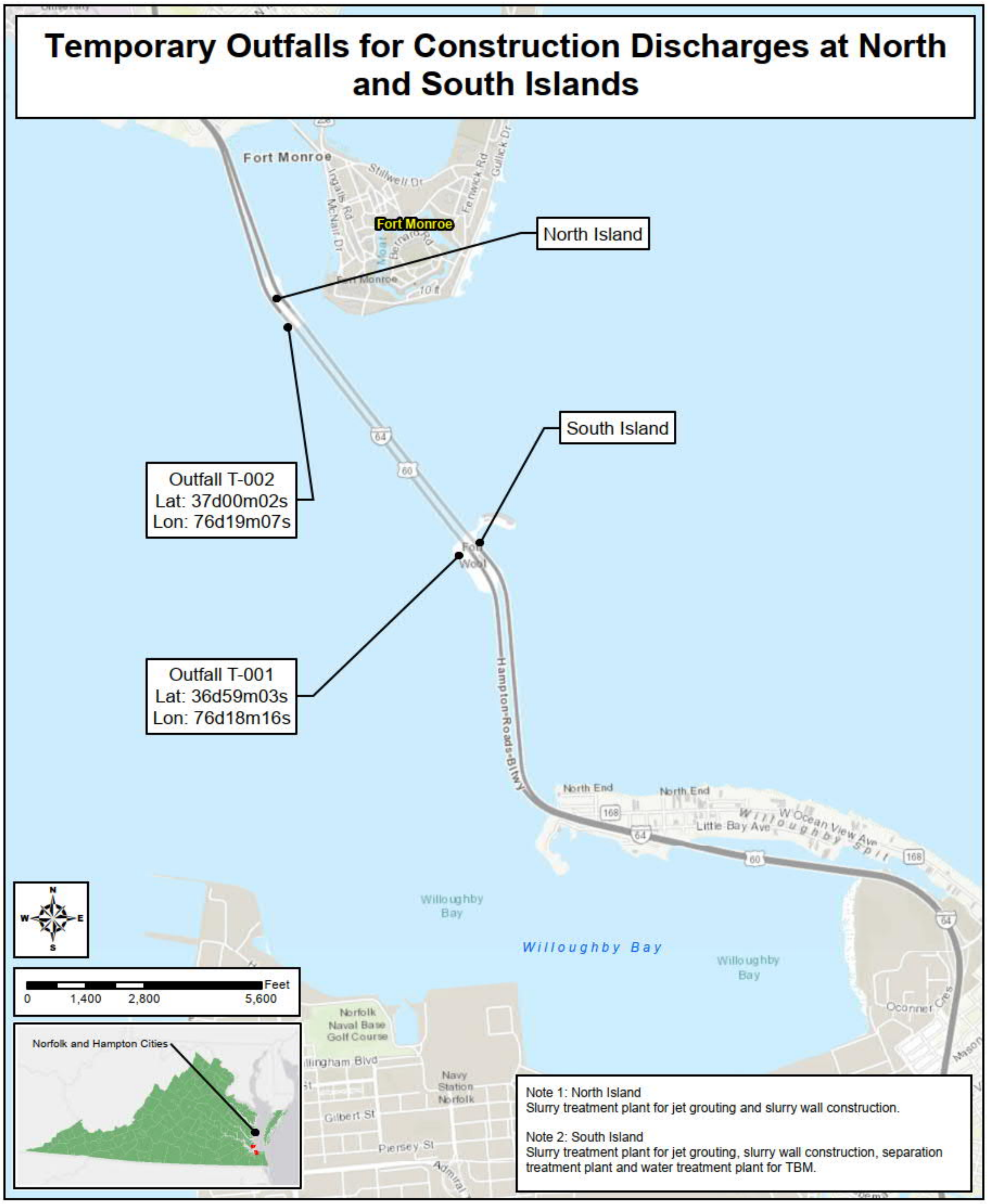
E.8.2.2 MANAGEMENT OF EXCAVATED MATERIAL

Bored material removed from the face of the tunnel will be amended with bentonite and other soil amendments as detailed in Appendix L: Material Management Plan. Material excavated from within the tunnel will be transported via a closed slurry piping system back to the South Island where the excavated materials will be filtered out of the slurry at the S&TP. Approximately 1,416,000 cubic yards (bulked volume) of material is anticipated to be excavated by the TBM and transported via the slurry plumbing system to South Island. After separation at the S&TP, the solid materials will be characterized for beneficial use or will be disposed off-site at a permitted facility. After separation, the residual water (filtrate) will be processed through the water treatment plant and subsequently discharged under a VPDES discharge permit.

Potable water is used for grout, slurry, and TBM slurry for maintaining cutter head pressure. The TBM slurry acts as the carrying media to remove sediment/formation cuttings as the tunnel is bored and to maintain a positive pressure head at the face of the boring machine.

The process water generated from the jet grout and slurry wall activities will be captured, decanted, physically separated, and will undergo necessary filtration/treatment prior to discharge under a VPDES process water discharge permit. Figure E-8 shows the planned outfall location for the treated VPDES process water discharges (outfalls T-001 and T-002). As part of the VPDES discharge mitigation credits for nitrogen and phosphorus will be obtained to offset N and P discharges and meet offset requirements under General Permit for Total Nitrogen and Total Phosphorus Discharges and Nutrient Trading in the Chesapeake Watershed in Virginia. The offset is needed as the Total Nitrogen and Total Phosphorous concentrations expected in the discharge will cumulatively exceed the annual allowance as defined in 9VAC25-820-70. Under the code, discharges are authorized to surface water when credits are obtained.

Figure E-8: Temporary Outfalls for Construction Discharges at the North and South Islands



E.8.2.3 ONSHORE AND OFFSHORE GROUND IMPROVEMENT

A geologic stratum with weak geotechnical properties exists along a portion of the tunnel alignment just beneath and to the north of South Island. GI will be used to strengthen this soil and support the TBM progress through the soft ground layers.

Two, 1,000 feet long, temporary trestles will be built at the north of South Island to perform the offshore GI. The trestles will be supported by 36-inch steel pipe piles that will be installed using vibratory and impact hammers. To minimize hydroacoustic impacts caused by the impact hammer a bubble curtain will be used when installing piles for the temporary trestles in water depths greater than 20 feet.

The jet grout plant will be positioned on the trestle. A steel casing will be utilized between the grout plant at trestle level, through the water column, and extending approximately 20 feet below the river bottom. This casing will be set to control the return of jet grout residual (JGR) and prevent spillage into the river. JGR is returned to the island for treatment via a slurry pipe. More detail of this GI activity and pollution controls is provided in Appendix L Material Management Plan.

E.8.2.4 OFFSHORE (IN-WATER) STRUCTURES FOR TUNNEL CONSTRUCTION SUPPORT

TBM Platform (Quay)

A quay will be constructed on the South Island adjacent to the tri-cell area to facilitate delivery and removal of the TBM.

The TBM quay is a steel structure supported on 36-inch steel pipe piles. Piles will be installed from land and from barges with vibratory and impact hammers, and with the help of a pile template.

In some cases, drilling with a down-the-hole hammer will also be used to drive piles through large armor stone. Approximately 2/3 of the piles of the TBM quay are located offshore (around 216 piles). Armor rock onshore and close to shore will be removed in phases during installation and replaced after pile installation.

Dolphins (sets of three 36-inch steel pipe piles) will also be driven from barges with vibratory and impact hammers.

Installation will last 6 months and the TBM quay is scheduled to be used until the completion of the tunnel activities. Once the TBM has been dismantled, the quay will be removed. The piles will be vibrated out or cut 2 to 3 feet below the seabed.

Conveyor Trestle

The bored TBM material separated from the slurry at the S&TP will be transferred to barges for disposal via a conveyor system.

The conveyor support is a steel structure. The covered conveyor belt structure will be supported with 84 36-inch steel piles installed from land and/or from a barge using vibratory and impact hammers, and with the help of a pile template. Drilling with a down-the-hole hammer may be required to drive piles near shore (through armor stones). Dolphins (sets of three 36-inch steel mooring piles) will also be driven from barges with vibratory and impact hammers.

The conveyor support area will also be used for maintenance and mooring of delivery vessels for TBM delivery and other construction materials.

Installation will last approximately 4 months. Upon completion of the tunnel installation, the Conveyor Trestle will be removed. The piles will be vibrated out or cut 2 to 3 feet below the seabed.

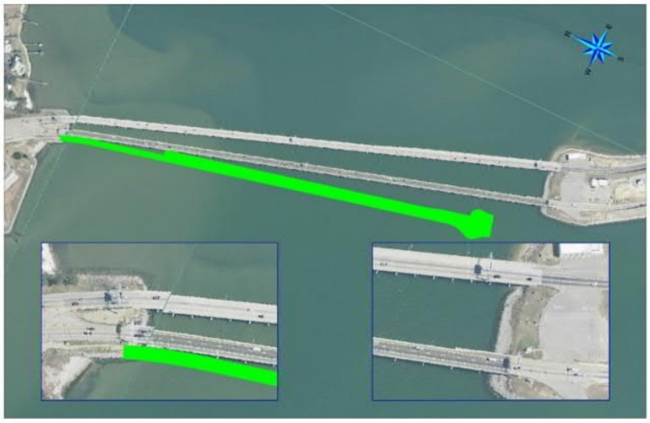
TRESTLE-BRIDGES

The trestle-bridge reconstruction and widening activities will occur in Construction Area 2. These activities will occur entirely in or over the water.

E.8.3.1 NORTH TRESTLE-BRIDGE

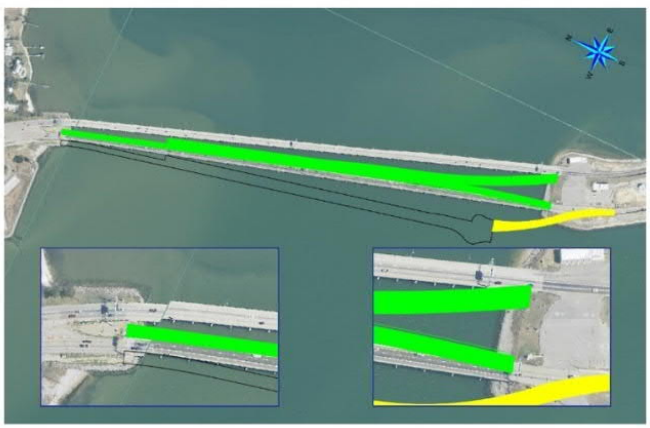
- The four phases of construction for the North Trestle-Bridge are shown in E-10 and described below.
- **Phase 1:** The new eastbound 4-lane trestle-bridge will be built first with the support of a temporary work trestle-bridge in the shallower areas closer to the North Shore at Hampton. This is to avoid and minimize impacts to SAV. The rest of the eastbound trestle will be built using marine barges and equipment.
- **Phase 2:** Once the new eastbound trestle-bridge is completed, eastbound traffic will be shifted to the new structure which will transport vehicles back into the existing eastbound tunnel until the new tunnels are ready to receive traffic.
- **Phase 3:** Shifting eastbound traffic will free the existing two-lane eastbound bridge-trestle, which will be used to provide support for the construction of the new westbound four-lane trestle-bridge. Jump trestles will also be used to build the new structure. A combination of working from the jump trestles and/or the existing trestles will be used to build the westbound bridge. Jump trestles are built with a maximum of three spans which are progressively uninstalled and reinstalled one span at a time, moving forward with the construction of the adjacent structure.
- **Phase 4:** Once the new westbound structure has been built, westbound traffic will be shifted to the new four-lane structure. This will allow the demolition of the existing two-lane bridge-trestles. Since the new structures are overlapping with the existing ones at the North Shore, this will also allow completion of the new trestles.

Figure E-9: North Trestle-Bridge Construction Sequence

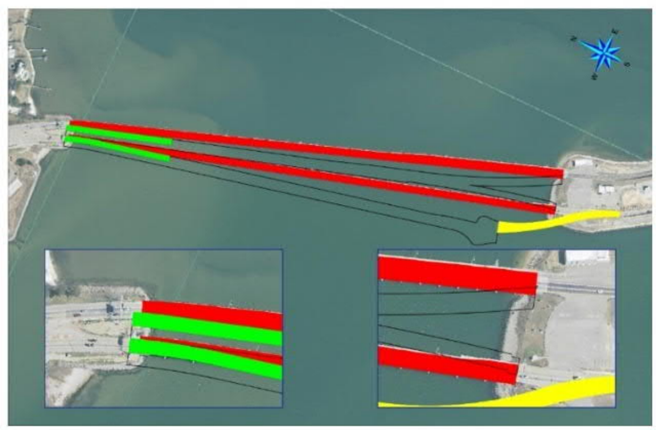


Phase 1 – Build EB Trestle with a temporary work trestle or marine methods

Phase 2 – Build Temporary Connection to EB Tunnel



Phase 3 – Build WB Trestle from the existing structure



Phase 4 – Demolish the existing structure and complete the north approaches

The main stages of trestle-bridge construction are: driving of the piles using spudded pile templates, installation of the pile cap, setting of the girder, and completion of the structure with the deck. Pile caps will be installed after piles are cut off to the proper elevations, followed by setting of bearings and girders, installation of the utility system, installation of deck panels, reinforcing steel, and placement of concrete for the bridge deck.

E.8.3.2 SOUTH TRESTLE-BRIDGE

A bathymetric survey in 2019 indicates that work barges will have insufficient draft (less than 7 feet North American Vertical Datum (NAVD) '88) in several areas around the new and existing South Bridge-Trestles. To allow for barge access, these areas will be dredged. The total volume of material to be removed for construction is approximately 19,550 cubic yards (35,185 cubic yards – bulked). Prior to demolition of the existing South Trestle approximately 33,957 cubic yards (61,123 cubic yards – bulked) will be dredged to allow vessel access. The Dredging Plan is provided in Appendix L: Material Management Plan.

The general phasing of the works of this South Trestle-Bridge are shown in Figure E-10 and described below.

- **Phase 1:** Most of the new eight-lane bridge-trestle will be built starting from South Shore, using a temporary trestle to access shallow areas near South Shore and barges. Necessary dredging will also be performed during this phase, in accordance with the dredge plan contained in Appendix L: Material Management Plan.

- **Phase 2:** A temporary MOT trestle will be built from South Island next to the existing eastbound trestle. The eastbound traffic will be shifted on the new MOT trestle to allow for a partial demolition of the existing eastbound bridge-trestle.

- **Phase 3:** Once the partial demolition is completed, the new eastbound connection to the 8-lane trestle will be built with the support of a jump trestle and eastbound traffic will be shifted on it.

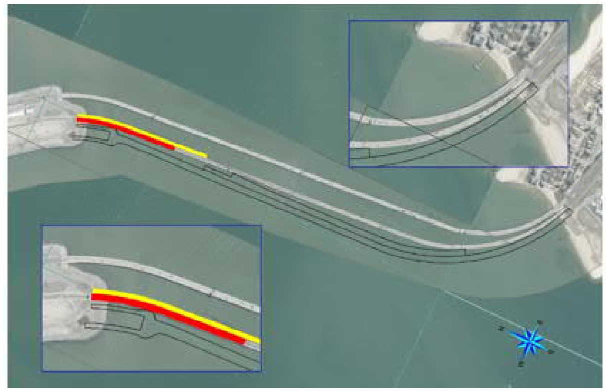
- **Phase 4:** A temporary MOT trestle will be built from South Island next to the existing westbound trestle. The westbound traffic will be shifted on the new MOT trestle to allow for a partial demolition of the existing westbound bridge-trestle. A portion of the existing eastbound bridge-trestle will also be demolished to allow to build the new connection between the eight-lane bridge-trestle and the new westbound bridge-trestle.

- **Phase 5:** Once the partial demolition is completed, the new westbound connection to the eight-lane bridge-trestle will be built with the support of a jump trestle and westbound traffic will be shifted on it.

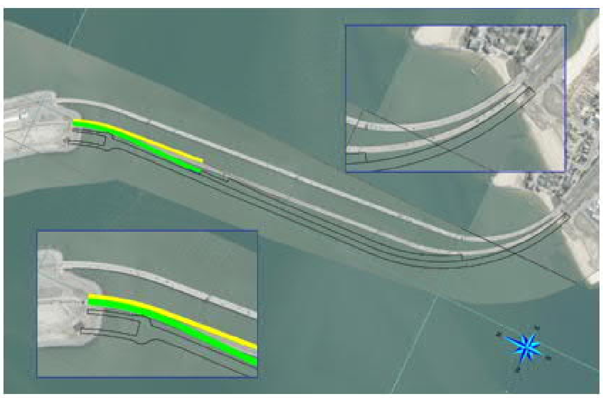
- **Phase 6:** The existing two-lane bridge-trestles will be fully demolished to allow the last connection to South Shore of the eight-lane structure to be built.

Figure E-10: South Trestle-Bridge Construction Sequence

Phase 1 – Build most of the 8-lane structure using marine methods.

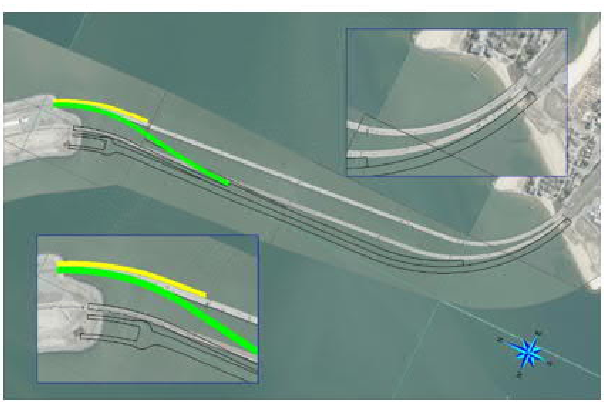


Phase 2 – Widen and shift EB traffic to the widening to demolish part of the EB trestle

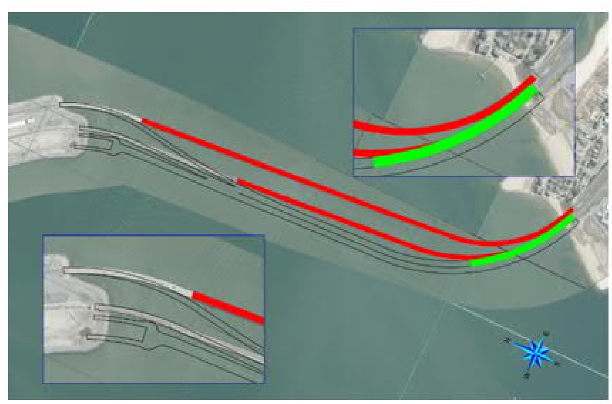


Phase 3 – Build the new EB tie-in while traffic is on the widened section. Shift EB traffic on top.

Phase 4 – Widen and shift WB traffic to the widening and demolish part of EB & WB trestles



Phase 5 – Build the new WB tie-in while traffic is on the widened section. Shift WB traffic on top.



Phase 6 – Demolish the existing structure and complete the south approach

Similar to the North Trestle-Bridge, pile caps will be set after piles are cut off to the proper elevations, followed by installation of girder bearings, setting of the girders, installation of the utility system, installation of deck panels, reinforcing steel, and placement of concrete for the bridge deck.

E.8.3.3 WILLOUGHBY BAY TRESTLE-BRIDGE

The existing Willoughby Bay Trestle-Bridge structure will be modified by widening the two existing structures to the outside in both directions to accommodate new travel lanes, shoulders, and new sound walls. This will require installation of two to three additional piles at each pier location on the outside of both structures.

The phasing is described below:

Phase 1 – Eastbound widening: Work sequence at this location requires widening of the eastbound trestle-bridge first. Installation of piling, pouring the pile cap, erection of the precast girders and construction of the deck for the widening of this eastbound trestle-bridge will be performed mainly from barges utilizing barge-mounted cranes and from temporary trestles on the shallow edges.

Phase 2 – Westbound widening: Once the eastbound trestle-bridge is complete, traffic (westbound included) will be shifted onto the widened eastbound trestle-bridge. The existing westbound structure will then be available to support the westbound widening works. In this case, the supply of the precast elements, concrete, and rebar will be done from the existing bridge. Cranes required to perform heavy work, like driving piles, will be mounted on temporary structures (jump trestles) that will be moved forward to follow the advancement of the works.

E.8.3.4 MASON CREEK AND OASTES CREEK TRESTLE-BRIDGES

I-64 crosses Mason Creek and Oastes Creek via bridges in the Northside neighborhood of the City of Norfolk. The Mason Creek and Oastes Creek bridges will be widened.

Phasing of works is similar to the Willoughby Bay Bridge-Trestle widening.

Phase 1 – Eastbound widening: Work sequence requires widening of the eastbound trestle-bridge first. Installation of piling, pouring the pile cap, erection of the precast girders and construction of the deck for the widening of this eastbound trestle-bridge will be performed from temporary trestles.

Phase 2 – Westbound widening: Once the eastbound trestle-bridge is complete, traffic (westbound included) will be shifted onto the widened eastbound trestle-bridge. The existing westbound structure will then be available to support the westbound widening works. In this case, the supply of the precast elements, concrete, and rebar will be done from the existing bridge. Cranes required to perform heavy work, like driving piles, will be mounted on temporary structures (jump trestles) that will be moved forward to follow the advancement of the works.

E.8.4 ROADWAY EXPANSION

For the Hampton approach, a new bridge will tie-in between the existing I-64 West and I-64 East, requiring roadway realignment. Initial work will start with widening the new I-64 westbound lanes and outside shoulders, associated drainage systems, and relocation of private and VDOT utilities. Construction of the new bridge abutments will start during this phase. I-64 eastbound will be widened to accommodate new lanes and construction of the new area for the inspection station. Once widening to the outside is complete, traffic and barrier service will be shifted to make way for pavement construction, median barrier removal, and construction of the new median pier for the new Mallory Street bridge.

For the Mallory Street Bridge replacement, demolition of the existing bridge will be completed in stages, starting with realignments of the existing travel lanes and pedestrian access on the bridge, utility relocations, and adjustment of the traffic signals. Crews will install traffic barriers across the bridge to isolate sections of the bridge to be demolished. Demolition of the structure will be performed during the night shift, with nightly lane closures on I-64 westbound and eastbound. Once partial demolition of the structure is complete, the new bridge will be constructed along the existing trestle-bridge.

For the Norfolk approach, each existing bridge will be widened, and sound walls will be constructed. A hurricane evacuation crossover will also be constructed west of the 4th View Street interchange. Crossovers for emergency use will be provided at both the Hampton and Norfolk approaches.

Barricade fencing will be placed around all non-impacted wetlands and streams. Temporarily impacted areas will be restored after construction. Erosion and Sediment Control Best Management Practices (BMPs) will be employed at all construction sites in accordance with the VPDES Construction General Permit. Stormwater Management features are discussed in detail in Appendix T: Stormwater Facilities.

E.8.5 MATERIALS MANAGEMENT

Both on-island (upland) and in-water construction activities will generate materials requiring management, removal, and disposal. There are eight primary types/sources of material requiring management for the Project:

- Dredged material mechanically removed within the limits of the North and South Island Expansions to improve foundation conditions and to remove obstructions, and around the South Trestle-Bridges to increase water depth for safe marine construction operations.
- Materials displaced during stabilization of unsuitable subsurface material (on-island and in-water), and residuals created during construction of the break in/breakout plug.
- Excavated materials from slurry wall construction.
- Excavated material from the construction of the entry/launch and exit/receiving portals and the tunnel approaches (both portal islands).
- Excavated/bored material from the TBM (in-water and subsurface).
- Concrete generated from the trestle demolition.
- Excavated upland soils from roadway construction.

- Upland cut and fill at select roadway areas.

The in-water construction activities that will generate material requiring management, removal, and disposal include: 1) dredging of surficial sediments within the footprint of the island expansions; 2) dredging at select locations along the trestle alignment where water depth is shallow and barge access is necessary; 3) jet grouting operations north of the South Island to improve sediment characteristics for TBM operations; 4) trestle demolition; 5) amended, bored material from the tunnels; and, 6) removal of the existing armor rock associated with the island expansions. The volume of material estimated to be generated for each category is provided in further detail in Appendix L: Material Management Plan. Material placement options include onsite re-use (suitable material only) and offsite disposal at approved locations.

E.8.5.1 DREDGING AREAS AND QUANTITIES

Dredging of soft sediments within the footprint of the island expansions is required to improve stability. Dredging of surficial sediments will occur at select locations along the South trestle alignment where water depth is shallow and barge access is required. This dredging will be conducted in 2 phases 1) during construction of the new south trestle-bridge and 2) demolition of the existing South trestle-bridges. Removal of vessel hulls that were sunk near Willoughby Spit will need to be removed to facilitate the new trestle-bridge. Dredging areas, depths and *in situ* volumes (not bulked for disposal calculations) are tabulated in Table E-3 below. Dredging of soft sediments within the footprint of the island expansions is required to improve stability. Dredging of surficial sediments at select locations along the South trestle alignment where water depth is shallow and barge access is required. This dredging will be conducted in 2 phases 1) during construction of the new south trestle-bridge and 2) demolition of the existing South trestle-bridges. Removal of vessel hulls that were sunk near Willoughby Spit will need to be removed to facilitate the new trestle-bridge. Dredging areas, depths and *in situ* volumes (not bulked for disposal calculations) are tabulated in Table E-4 below.

Table E-3 Dredging Areas and In Situ Volumes

Location	Area	Elevation of Dredge Cut (NAVD 88)	Volume (in situ) Cubic Yards
North Island Expansion	577,017 SF 13.25 acres	-34 ft	112,225
North Island Shape Array	90,454 SF 2.08 acres	-23 ft	20,101
South Island Expansion	136,851 SF 3.14 acres	-42 ft	52,900
South Trestle (Construction Phase)	439,808 SF 10.1 acres	-7.5 ft	19,550
South Trestle (Demolition phase ~2024)	382,021 SF 8.77 acres	-7.5 ft	33,957
Shipwreck Debris Removal	38,880 SF 0.89 acre	-7.5 ft	13,000
Total	1,665,031 SF 38.22 acres	----	251,733

E.8.6 MARINE OPERATIONS & LOGISTICS

All in-water construction activities will take place outside of the Federal navigation channels, and vessels and barges associated with the Project will be required to avoid obstruction and interference to navigation within the channels and Anchorage F.

Formal coordination under Section 408 with the USCG, U.S. Navy and the maritime community is ongoing and will continue to take place prior to initiation of construction activities, and a formal communication plan will be executed to relay in-water Project information and to facilitate transfer of information among the maritime users.

E.8.6.1 MARINE OPERATIONS PLAN

The Marine Operations Plan for Construction (currently under refinement as part of the Section 408 process) and Tunnel Construction Plan (TCP) provide details on vessels and equipment likely to be used, temporary mooring and anchoring areas to be constructed, procedures for daily operations and communications within and outside of the Norfolk Harbor Entrance Reach Channel and Anchorage F, vessel mobility limitations, and contingency plans for weather related incidents. It is the intent of HRCP to implement operational practices that will either avoid or minimize impacts to navigation within the channel and will allow for safe passage of vessels and safe conditions for work-related vessels.

E.8.6.2 VESSEL FLEET

Vessels for construction include:

- Crane barges
- Supply/material barges
- Tug boats
- Crew boats

Barge operation areas – including possible anchors – around the North Trestle-Bridge, the North Island, the South Island, the South Trestle-Bridge, the Willoughby Bay Trestle-Bridge and Willoughby Spit are indicated in Figure E-11, E-12, E-13.

Figure E-11: Barge Operation Areas - North Trestle-Bridge

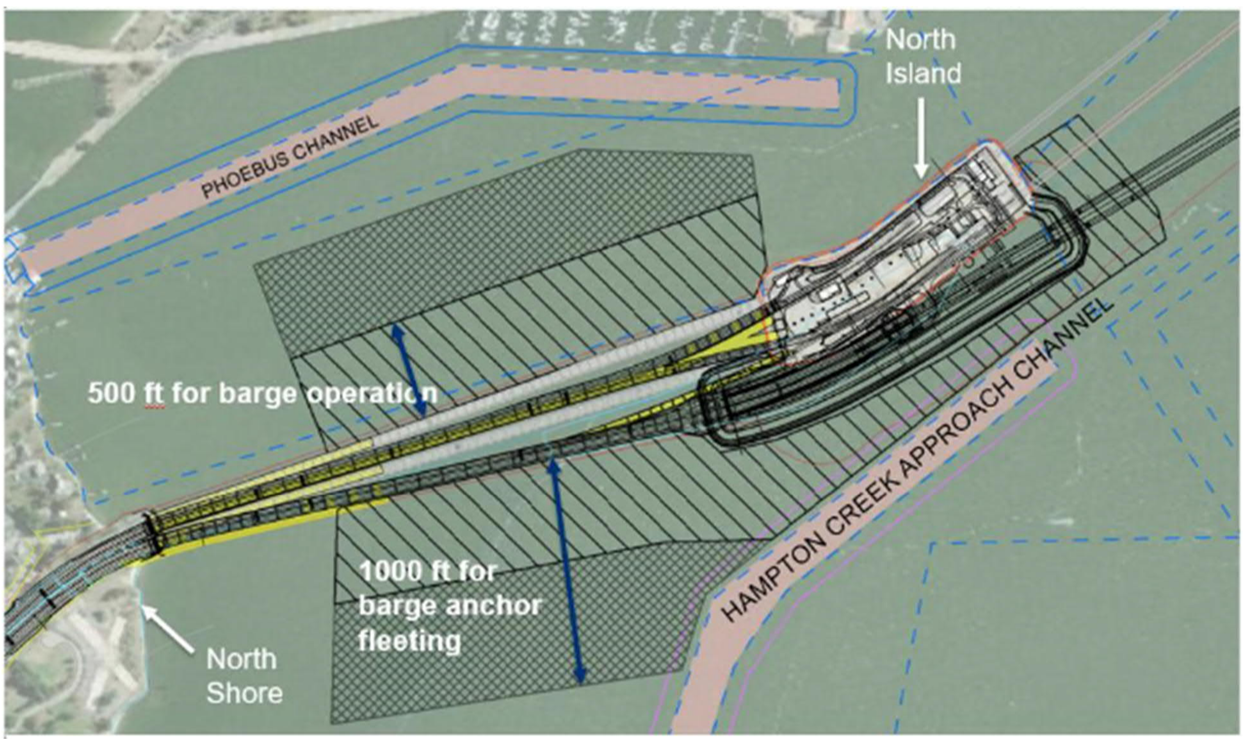


Figure E-12: Barge Operation Areas - South Trestle-Bridge

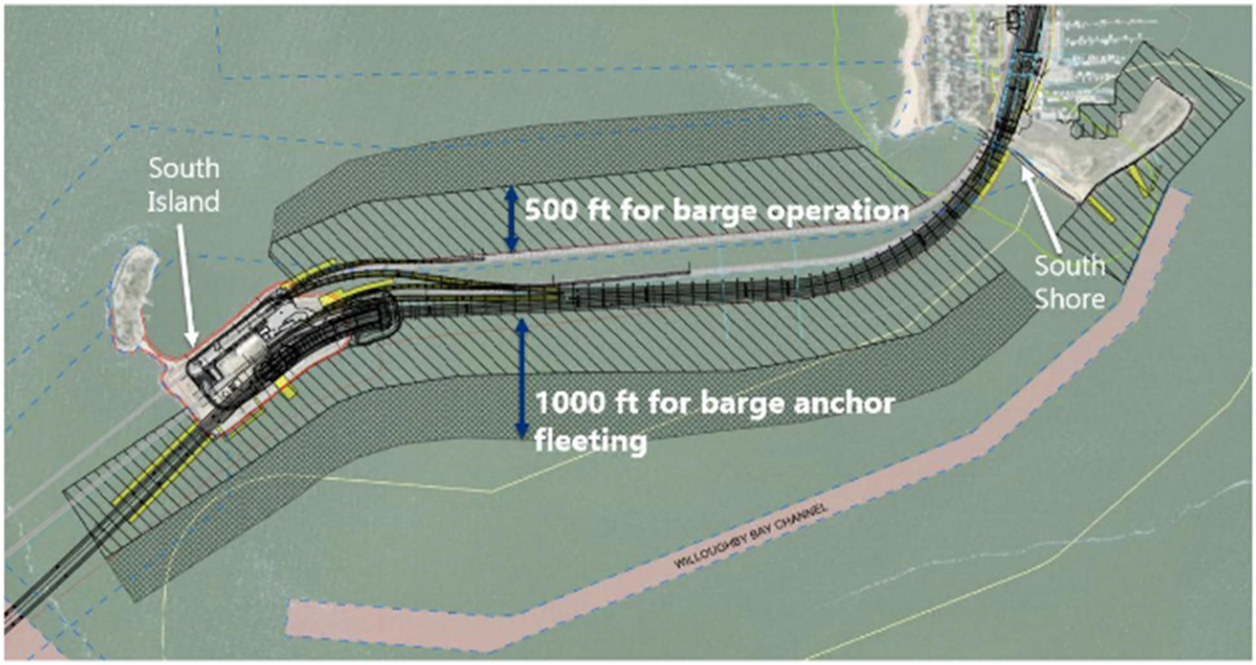


Figure E-13: Barge Operation Areas - Willoughby Bay

E.8.6.3 HARBOR OF SAFE REFUGE AND MOORING AREAS

In the case of a significant weather event, two safe harbor (safe haven) locations have been identified in the vicinity of the Project.

- Willoughby Bay: Mooring piles (steel pipe piles, 36-inch diameter) will be installed with a vibratory hammer.
- Phoebus Safe Harbor area: Anchors and mooring buoys will be used. This location will be used only in the event of severe weather.

Many vessels will have the option of returning to their homeport.

An area within Hampton Flats has been designated a mooring area for daily use by barges. Anchors and mooring buoys will be used. The location of mooring areas is shown in Figure E-15. The schedule for installation of the mooring areas is provided in Appendix N: Project Schedule.

Figure E-14: Project Safe Refuge and Mooring Areas

E.8.7 REMOVAL OF TEMPORARY STRUCTURES

All temporary structures will be removed once works have been completed, including:

- Temporary work trestles for the construction of the North and South Trestle-Bridges, Bay Avenue Bridge at Mason Creek, Oastes Creek near Bayview Blvd., and the Willoughby Bay Trestle-Bridge
- TBM quay and Conveyor Trestle
- Temporary trestles for off-shore ground improvement north of the South Island
- MOT trestle-bridges
- Jump trestles
- Willoughby Spit temporary piers
- Anchors and mooring piles

As discussed earlier, jump trestles are built with a maximum of three spans which are progressively uninstalled and reinstalled one span at a time, moving forward with the construction of the adjacent structure. All other piles will be vibrated out or cut 2 to 3 feet below the mudline.

E.8.8 DEMOLITION AND REMOVAL OF EXISTING STRUCTURES

Approximately 80,508 cubic yards of concrete debris will be collected during demolition of the permanent trestles. Provided the demolition material is deemed environmentally safe and has the appropriate physical characteristics for beneficial reuse, it is anticipated that the concrete from the North and South Trestles demolition will be deposited as materials of opportunity within the Virginia artificial reef program.

Several environmental conditions would preclude the demolition material from being used in the artificial reef program. These conditions include:

- Petroleum product coatings;
- Lead paint;
- Friable asbestos (any exposed asbestos needs to be sealed prior to material deployment to the reef); and
- Asphalt.

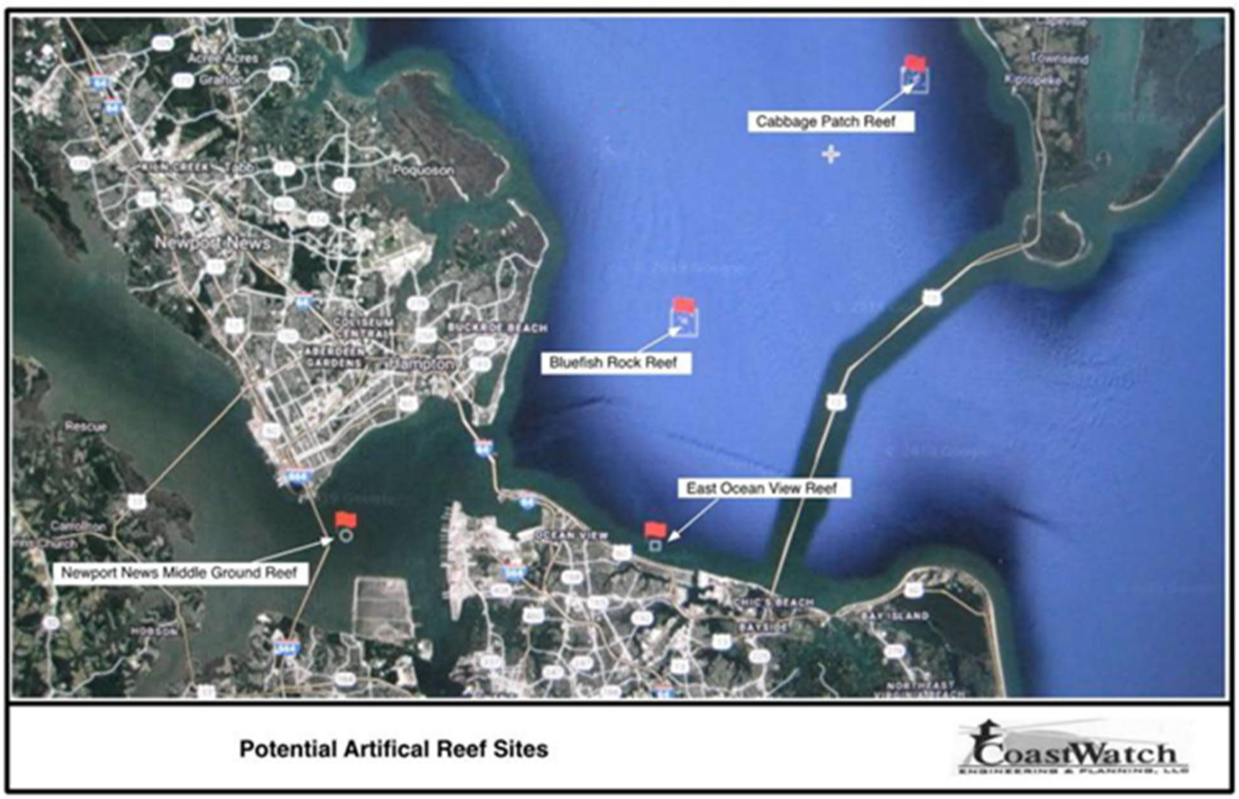
A reef plan will be created documenting the types of materials that are expected, quantities of materials to be expected (in tons and cubic yards), a date range that the material is expected to be placed, environmental concerns, and the preferred reef locations to be used. The demolition material will be tested using protocols defined by VMRC for the environmental conditions listed above. Besides environmental conditions, several physical conditions also must be met. Any protruding rebar needs to be trimmed to 1-inch prior to deployment and the size of pieces must be acceptable to VMRC. VMRC cannot accept loose rubble that has the potential to move during storm events. All material that is placed in the artificial reef must stay inside the permitted footprint. VMRCs terms must also be agreed upon prior to placement. These include, but are not limited to, not deploying petroleum products, maintaining all Coast Guard standards and clearances, operating during daylight hours, and adhering to VMRC's weather window.

There are three reef locations being considered for this Project, Newport News Middle Ground Reef, East Ocean View Reef, and Bluefish Rock Reef, and Cabbage Patch Reef. Mapping of the Middle Ground Reef is incomplete. VMRC is in the process of re-scanning this reef to determine if it can take more material or not, so this reef may be off limits for disposal. Ocean View Reef is located in shallower water than the other reefs being considered. There are also crane height restrictions at this site. Bluefish Rock Reef has no known restrictions for use and is favored by VRMC.

Figure E-15: Potential Artificial Reef Sites below depicts the approximate locations of the four inshore Virginia artificial reefs being considered.

Offsite disposal is a secondary option if the concrete is not suitable for placement at the reef sites. All other demolition debris for either the permanent or temporary trestles will be disposed at an approved disposal facility.

Figure E-15: Potential Artificial Reef Sites



Source: NOAA CoastWatch

E.9 REFERENCES

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