US Army Corps of Engineers
Baltimore District

MARYLAND DEPARTMENT OF TRANSPORTATION
MARYLAND PORT ADMINISTRATION

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC) MODIFICATION OF SEAGIRT LOOP CHANNEL FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B:

ENGINEERING

FEBRUARY 2023

This page intentionally left blank.

List of Appendices

Contents

List of Figures

List of Tables

1. Introduction

The U.S. Army Corps of Engineers (USACE) Baltimore District (CENAB), in partnership with the Maryland Department of Transportation Maryland Port Administration (MDOT MPA), evaluated the advisability of modifications to the Baltimore Harbor Anchorages and Channels (BHAC), particularly pertaining to the Seagirt Loop, which includes the West Dundalk Branch Channel, the Dundalk-Seagirt Connecting Channel, and the West Seagirt Branch Channel. This Engineering Appendix details the methodology, assumptions, and analyses completed to determine sufficient details to prepare costs of alternatives for plan formulation leading to the selection of the Recommended Plan.

The lead federal agency for this study is USACE. The non-Federal sponsor for this study is the MDOT MPA.

2. Existing Federal Channels

2.1. General

The Port of Baltimore's (Port) harbor is located on a 32-square-mile area of the Patapsco River and its tributaries, approximately 12 miles northwest of the Chesapeake Bay. Container ship traffic enters the Port through federally authorized Baltimore Harbor Channels that run from the Atlantic Ocean by two distinct shipping routes: from the south through the Virginia Capes and the Chesapeake Bay, or from the east through the Delaware Bay, Chesapeake and Delaware (C&D) Canal, and the Chesapeake Bay. The Port includes three federal dredging projects; the BHAC Project (which is dredged to various depths), the 42-Foot Project, and a portion of the 50-Foot Project.

Baltimore Harbor encompasses many channels that provide access to the public and private terminals serving the Port and several anchorages serving those ports (Figure 1). The Baltimore Harbor Channels are defined as those channels west of the North Point-Rock Point line in the Patapsco River. The federally authorized channels located within the Baltimore Harbor are Curtis Bay Channel, Curtis Creek Channel, Middle Branch Channel, Ferry Bar East, Northwest Branch (East and West Channels), East and West Dundalk Branch Channels, Dundalk/Seagirt Connecting Channel, West Seagirt Branch Channel, South Locust Point Branch Channel, Brewerton Channel, Brewerton Angle, and Fort McHenry Channel.

The Port is the farthest inland port on the East Coast. The Baltimore District presently maintains approximately 18 nautical miles (nm)of navigation channels within the harbor, which are used intensively for both commercial and recreational vessels. Other channels within the harbor are maintained by MDOT MPA, private terminal owners, and various commercial interests. Historically most channels have been maintained as two-way channels; however, increasing vessel sizes often limit certain channels to one-way traffic due to limitations imposed by channel width or channel depth. The West Seagirt Branch Channel, for example, is maintained to -45 feet mean lower low water (MLLW) for vessels outbound to the Fort McHenry Channel but can only accommodate vessels that draft up to 42 feet. Larger vessels requiring a deeper draft must back out from the Seagirt Marine Terminal (SMT), turn around in a turning basin, and transit outbound through the West Dundalk Branch Channel. Figure 1 shows the study area and the existing navigation channels within the Port. The channels of interest to this study are described in detail below.

The goal of this project is to reasonably maximize the contribution that the Seagirt Loop channels provide, consistent with protecting the Nation's environment, by addressing the physical constraints and inefficiencies in the existing navigation system's ability to safely and efficiently serve the current and forecasted vessel fleet and process the forecasted cargo volumes.

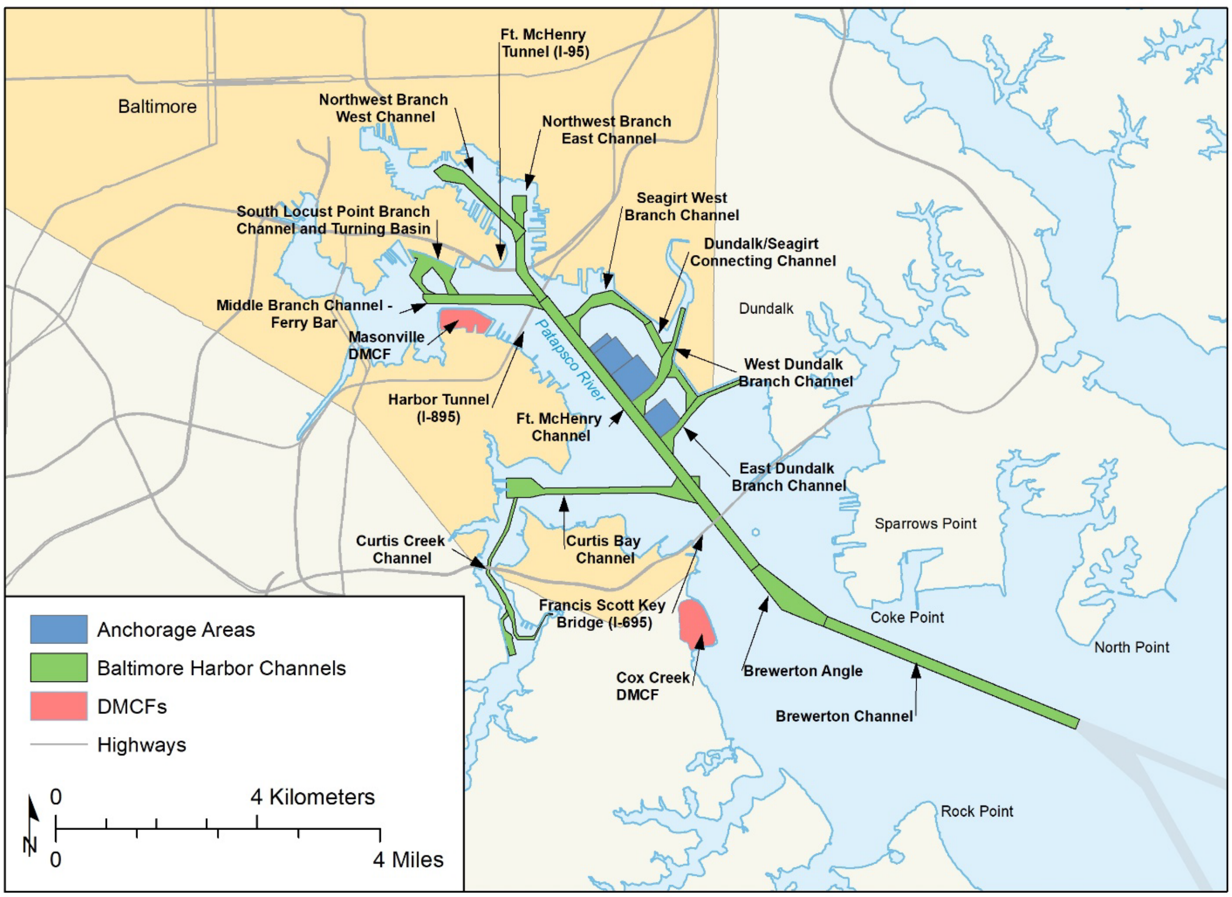


Figure 1. Baltimore Harbor Federal Channels, Anchorages, and dredged material containment facilities (DMCFs) (USACE 2017).

2.1.1. West Dundalk Branch Channel

The West Dundalk Branch Channel serves the Seagirt and Dundalk Marine Terminals. The Dundalk Marine Terminal, a 570-acre cargo terminal, is the largest general cargo facility at the Port. This terminal handles containers, automobiles, farm, construction and other Roll-on/Roll-off (Ro/Ro) equipment, wood pulp, steel, breakbulk, and project cargo. The West Dundalk Branch Channel is authorized to 500 feet wide by 0.67 nm long and is federally maintained to a depth of 42 feet and state maintained to a depth of -50 feet MLLW.

2.1.2. Seagirt/Dundalk Connecting Channel

The Seagirt/Dundalk Connecting Channel provides access to both the Dundalk and SMT. The SMT is a state-of-the-art, 284-acre container terminal, currently capable of handling 450,000 containers a year. The terminal has four ship berths, including two 50-foot berths, with a total of 15 cranes, eight of which are super post-Panamax size with an outreach of 23 containers wide, thus providing the capability of unloading and loading new-Panamax ships. The Seagirt/Dundalk Connecting Channel is authorized at 500 feet wide by 0.42 nm long. The channel is federally maintained to a depth of -42 feet MLLW and state maintained to a depth of -50 feet MLLW.

2.1.3. West Seagirt Branch Channel

The West Seagirt Branch Channel allows for outbound transit of vessels from the SMT. This channel is authorized to 500 feet wide with an actual average width of 655 feet wide by 0.86 nm long and is federally maintained to a depth of -42 feet MLLW and state maintained to a depth of -45 feet MLLW.

2.2. Physical Conditions of Baltimore Harbor

2.2.1. Climate

The project area has a continental climate with four distinct seasons, although extreme winter and some temperatures are moderated somewhat by the Chesapeake Bay. The average annual temperature is 62 degrees Fahrenheit (F), with the highest temperatures occurring in late July (the average maximum is 89 degrees F) and the lowest temperatures occurring in January and February (the average minimum is 21 degrees F).

Annual precipitation ranges from 40 to 44 inches, distributed evenly throughout the year. The lowest average monthly precipitation (2.57 inches) occurs in January and the highest (4.26 inches) in August. Winter low pressure systems moving up the Atlantic coast cause most of the precipitation during the cold months, while summer showers and thunderstorms provide warm weather precipitation. Average snowfall in the project area is 20 to 25 inches, mainly occurring in December, January, and February.

The prevailing winds are southerly from May through September and west-northwesterly to northwesterly during the rest of the year. Hurricanes, blizzards, tornadoes, and other destructive storms are uncommon.

2.2.2. Tides, Currents, and Wind

The tide range is approximately 1 foot in the project area. In the larger Chesapeake Bay area, the mean range of tide is 2.8 feet at the Cape Henry Channel, 2.3 feet at the York Spit Channel, 1.4 feet at the Rappahannock Shoal Channel, 0.8 feet at the Craighill Entrance, 0.9 feet in the Craighill Upper Range, 1.1 feet at Fort McHenry, and 1.2 feet at Pooles Island in the upper Chesapeake Bay. Prolonged high winds from the north tend to blow water out of the bay, resulting in unusually low tides, and prolonged high winds from the south tend force water into the bay, resulting in unusually high tides.

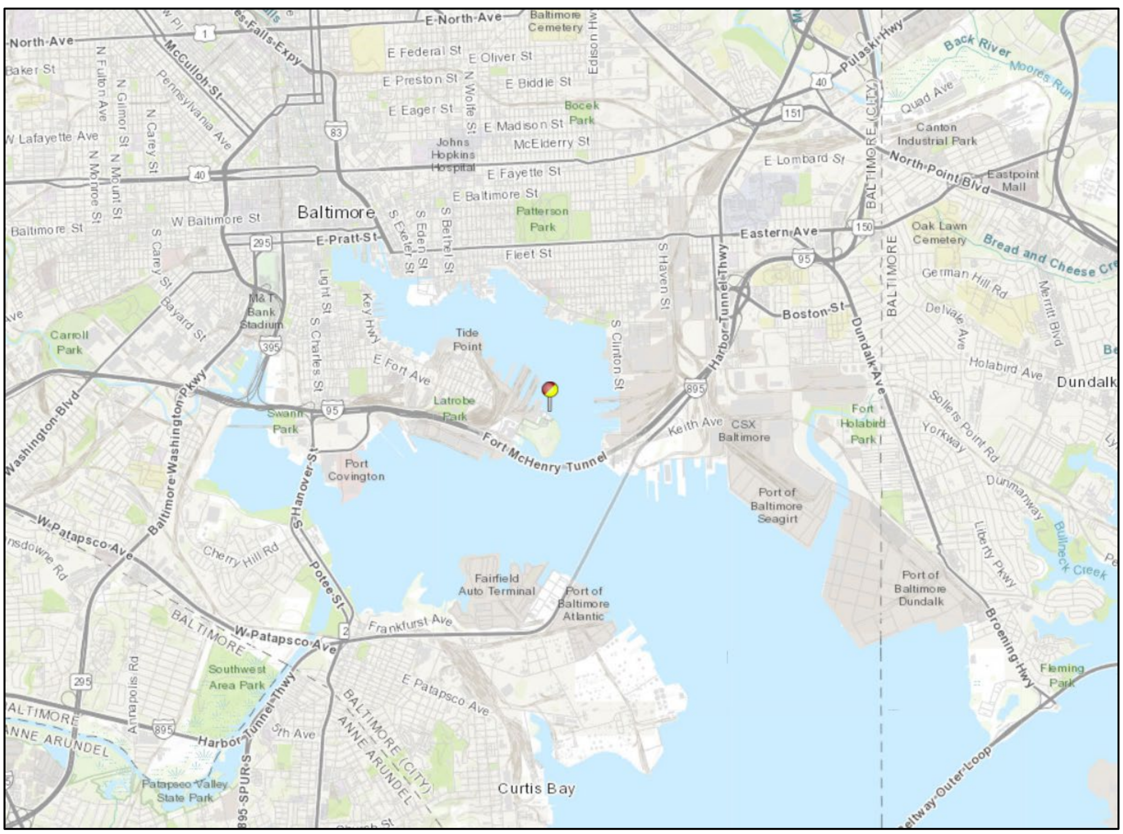


Figure 2. Location of National Atmospheric and Oceanic Administration (NOAA) Water Level/Meteorological Station at Fort McHenry (Station ID: 8574680).

Water levels in the Chesapeake Bay are dominated by a semidiurnal lunar tide, which is a tide multiple times a day driven by the gravitational pull of the moon. Tides enter the

Bay via the Chesapeake Bay entrance and the C&D Canal. The combination of tides and freshwater inflow creates a spring tide (a high tide caused by a new or full moon) approximately 30 to 40 percent larger than mean tide and a neap tide (the lowest tides that occur during quarter and last quarter phases of the moon) approximately 30 to 40 percent smaller than the mean tide (Schubel and Pritchard 1987). While a single NOAA monitoring station is located in the vicinity of the project area (Figure 2), hydrodynamic studies of the Baltimore Harbor (Boicourt and Olson 1982) included field measurements of current velocity, temperature and salinity at several locations in the Patapsco River. Results from the study's tidal current measurements indicated the existence of a three-layer, density-driven circulation that can dominate flow such that typical semi-diurnal tidal current direction reversals (shifting between high and low tide) do not necessarily occur. The study also determined that wind events often dominate circulation patterns, especially within the Middle Branch and the tributaries; however, high flow events from the Patapsco River often produce a typical two-layer estuarine circulation. Two-layer circulation consists of fresh river water flowing out on the surface and higher salinity bay water flowing in at the bottom. The study determined that the short-term variability of circulation and density is as significant as seasonal variability.

2.2.3. Sediment Quality in Baltimore Harbor

Bottom sediments in the Chesapeake Bay and approach channels to Baltimore Harbor are predominantly clayey silt, with some locations containing a fraction of sandy material (CENAB 1997 and EA EST 2019). The upper Chesapeake Bay and Baltimore Harbor are zones of sediment deposition. The principal source of sediment is the Susquehanna River. The bottom sediments in the study area are generally characterized as soft, highly plastic, organic silty clay. The upper layer of sediment in the project area, varying from 0.5 to 3 feet thick, exists primarily in a semi-liquid state.

Sediment characteristics have been obtained from previous reports (CENAB 1997, MDOT MPA 2019, and EA EST 2019). In general, the site is characterized by very fine silt and clay sediments with a very low percentage of sand sediments. Surveys of bottom sediments by the Chesapeake Biological Laboratory in 1997 found that the sediments in the Patapsco River near the Masonville Dredged Material Containment Facility (DMCF), located about two miles to the northwest of the project area, consisted of 90 to 95 percent silts and clays, while sediments closer to the mouth of the Patapsco were comprised mainly of sand sediments (CENAB 1997). Analyses conducted in 2019 confirm that sediments remain consistent with the 1997 survey findings (EA EST 2019).

Sediments in Baltimore Harbor and the Patapsco River contain contaminants from industrial and municipal sources as well as from non-point sources as would be expected in an urbanized/industrialized region. Studies indicate that sediments in some areas of

Baltimore Harbor presently exhibit toxic characteristics, and sediment toxicity in tributary creeks and bays is patchy (USACE 2017). Due to these characteristics, all dredged material in the Harbor is by Maryland Law stipulated to be unsuitable for open water disposal in an unconfined manner into the Chesapeake Bay or of the tidewater portions of any of the Chesapeake Bay's tributaries outside of Baltimore Harbor. However, the dredged material may be disposed in contained areas approved by the Maryland Department of the Environment (Maryland Environmental Code Section 5-1102(a)). An evaluation of the dredged material is required prior to dredging and placement to document the existing physical and chemical attributes of the sediments and ensure that the materials are appropriate for available placement options.

2.2.3.1 West Seagirt Branch Channel and Seagirt/Dundalk Connecting Channel

Under contract with the MDOT MPA and Gahagan & Bryant and Associates (GBA), Soil and Land Use Technology, Inc. (SaLUT) performed an extensive sampling program in 2019 in support of a study to deepen the Seagirt Loop Channel. Fifty-six borings were drilled to an elevation of approximately -60 feet MLLW. Borings were located afront Berth 1, Berth 2, Berth 3, in the Seagirt-Dundalk Connecting Channel, and in the West Seagirt Branch Channel (Appendix B1).

In nearly all boreholes, dark gray to grayish-brown and black silt and clay was encountered to the full depth of the borings. Blow counts ranged from Weight of Rod (WOR) to 15 blows per foot. Lab testing on representative samples indicates that the average moisture content of the material is 121.2 percent, fines content is 81 percent, plasticity index is 64 percent, and liquid limit is 108 percent. Given the in-situ moisture content of the sediments exceeds the liquid limit, the sediments exist in a liquid state. Blow counts indicate that the material is exceptionally weak and exhibits nearly no shear strength.

Analysis of a multi-beam survey performed by CENAB in January 2021 shows the range of natural side-slopes that are achieved after dredging the channels. While some side slopes are as steep as 2H:1V (2:1) and 3:1, side slopes are generally between 4:1 and 5:1. If not for the low unit weight (approximately 86 lb/cubic foot given the average properties above), the side slopes would be much shallower because of the low shear strengths. Refer to Figure 8. Hydrographic survey of Seagirt Loop and Anchorage 3 in February 2021 with side slopes.

2.2.3.2 West Dundalk Branch Channel

Under contract with MDOT MPA and GBA, Findling Inc. performed a geotechnical investigation of the West Dundalk Branch channel in 2012 in support of the proposed widening and deepening of the channel. The widening and deepening have since been completed. A total of 15 borings were drilled in the area in which the channel was widened.

All borings contained surficial layers of dark gray to green silt with trace fine sand. Beneath the surficial layer of silt, brown silty fine to coarse sand with varying amounts of gravel was found. The sand layer was encountered anywhere from approximately El. -43 feet MLLW to El. -53 feet MLLW. In some borings, only the silt layer was observed (Appendix B1).

Blow counts within the silt layer were either WOR or Weight of Hammer (WOH). Blow counts within the sand layer ranged from one to 48. Only two Atterberg Limits tests were performed on the silt, resulting in plasticity indices of 39 and 44, with liquid limits of 84 and 90. Natural water contents within the silt layer generally exceeded 100 percent, indicating they exist in a liquid state. Based on grain size analysis, the sand classified as well-graded sand, poorly graded sand to silty sand, and silty sand with interspersed layers of gravel, classifying as well-graded gravel and well-graded to silty gravel.

2.2.3.3 South Locust Point Branch Channel and Turning Basin Sediments

A dredged material evaluation of Baltimore Harbor Channels was completed in 2019. This evaluation was the latest in a series of routine evaluations to assess the physical and chemical attributes of the sediments within the federal channels and anchorages. Three samples were collected in the South Locust Point Channel and analyzed. A composite sample that was composed of all three samples was tested.

Grain size analysis indicated that the material within the South Locust Point Channel was sandy elastic silt. The material was highly plastic. The in-situ water content was 76 percent. Unlike the material within the Seagirt Loop and Dundalk Loop Channels, the material within South Locust Point exists in a plastic state.

Strength data was not collected as a part of the material evaluation. However, given the lower in-situ water content, it is presumed that while still weak, the material likely had more strength than the materials found within the Seagirt Loop and Dundalk Loop Channels. A multi-beam survey performed by USACE in January 2021 indicates most existing channel side slopes are between 3H:1V and 4H:1V. This also suggests the material is slightly stronger than the material found within the Seagirt Loop Channel (EA EST 2019).

2.3. Geology

The Chesapeake Bay is located within the Atlantic Coastal Plain physiographic province and is underlain by sequences of clay, silt, sand, and gravel. The general geologic setting of Baltimore Harbor consists of a series of wedge-shaped sediment layers dipping and thickening bayward. The older, and generally harder, Cretaceous sediments are encountered to the north and west within Baltimore Harbor, while younger and less compact Tertiary and Quaternary sediments are typically encountered eastward.

A review of the Geologic Map of the Baltimore East Quadrangle, Maryland (Reinhardt and Cowley, 1979) indicates extensive areas of artificial fill used to construct the terminals. Underwater, the primary surficial geologic unit is the Arundel Formation, a lower cretaceous formation consisting of kaolinitic and illitic clays with locally interbedded quartz silt or sand lenses. Limited Holocene formations are evident and consist mostly of the Talbot formation adjacent to the SMT. The Talbot formation consists of poorly-sorted quartz silts with kaolinite and montmorillonite clays. The geologic map predates placement of artificial fill used to construct the Seagirt terminal.

While the geologic map gives insight into the surficial geology of the land in and adjacent to the project sites, it does not provide great insight into the sediment composition underwater in areas of proposed dredging. Surficial sediments within the Chesapeake Bay and approach channels are predominantly more recent Holocene alluvial deposits which are not shown on the surficial geologic map. Extensive sediment samples and past borings within the project site have been collected over the past several decades. Sediment composition in the proposed areas of dredging is fairly inform and predominantly highly-plastic silts and clays.

3. Recommended Plan

The proposed authorized depth for the Seagirt Loop Channel is -50-feet MLLW which is the National Economic Development (NED) plan. Following the Tentatively Selected Plan (TSP) milestone, which identified the NED plan as the 47-foot channel, multiple plan optimization activities were completed in order to address concerns related to the plan evaluation and selection. Plan optimization activities performed after the TSP milestone included examining assumptions for the future without project (FWOP) conditions, re-running HarborSym modeling, and ship simulation modeling at the USACE Engineer Research and Development Center (ERDC) Coastal Hydraulics Lab (CHL) Ship/Tow Simulator to optimize channel design and compare safety and other considerations related to the 47 and 50-foot channel depths.

A major change in the FWOP condition was implemented in the HarborSym modeling to account for berth deepening and improvements in parallel with deepening of the federally authorized channel. This change allowed vessels to call at SMT and use the loop channel for both inbound and outbound traffic allowing improved access to three Berths as is anticipated to occur in normal Port operations. Additionally, the dredged quantities were updated to include additional channel wideners proposed during ship simulation (see wideners A, B, and C in Appendix B4). Following optimization, the NED plan was updated to the 50-foot plan. Dredging would include two feet of allowable overdepth (to -52 feet MLLW) to allow for inaccuracies in the dredging process, as permitted in ER-1130-2-520 (Navigation and Dredging Operations and Maintenance Policies).

4. Design Vessel

The design vessel is based upon economic projections of the vessels most likely to call on the Port in the near future with consideration of limiting air draft conditions approaching the Port. The design vessel chosen for this study is *CMA CGM Marco Polo*, which is in the Ultra Large Container Vessel (ULCV) class of ship (Appendix B2). The dimensions of the design ship for this study are shown in Table 1.

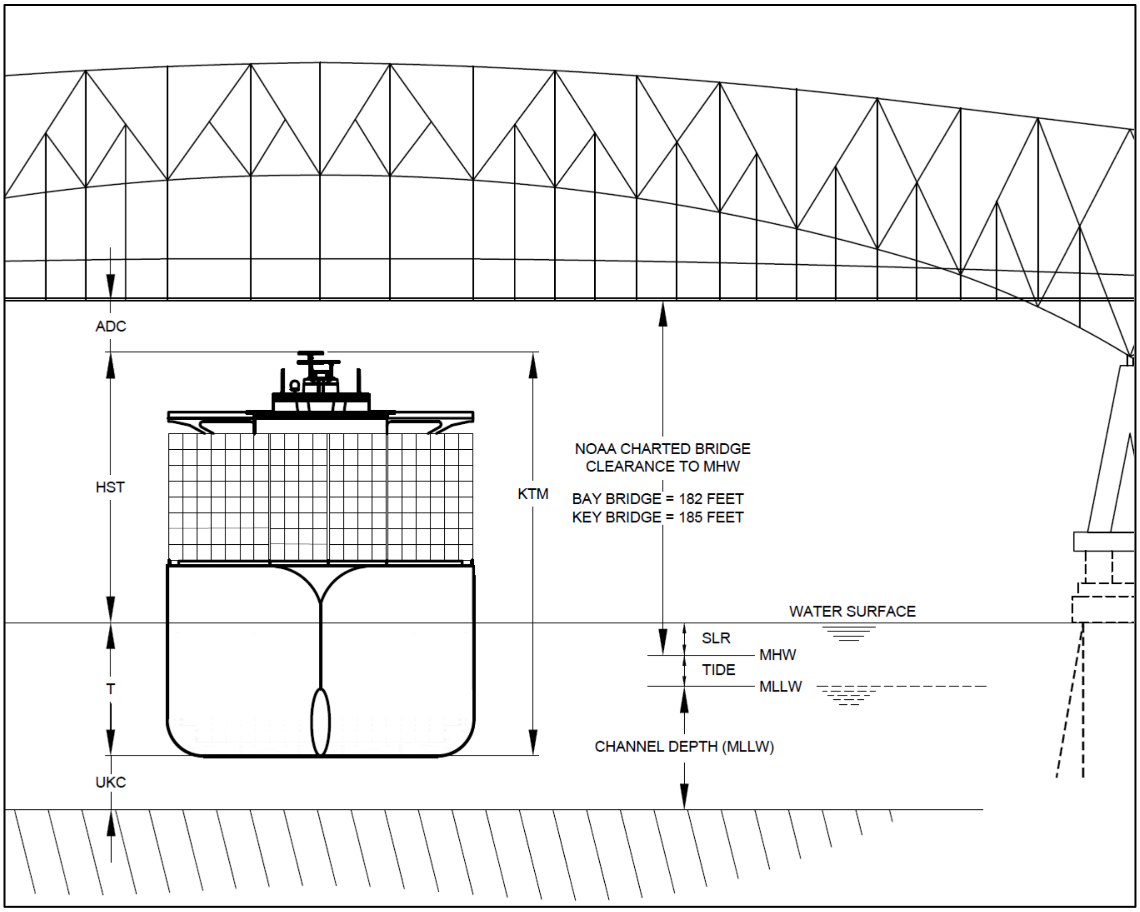
Table 1. CMA CGM Marco Polo E Design Ship Dimensions (dimensions from Clarkson Register 2021).

Vessel	*CMA CGM Marco Polo*
Capacity (TEU)*	16,000
Length Over All (LOA)	1,299 feet
Beam	175.9 feet
Design Draft	46 feet
Scantling Draft	52.5 feet
Keel to Masthead	227.9 feet

*TEU (Twenty-foot equivalent unit)

4.1. Air Draft

Vessel access to Baltimore Harbor will be constrained by the channel width and depth and the two bridges under which vessels must pass to reach Baltimore: the Chesapeake Bay Bridge (“Bay Bridge”) and the Francis Scott Key Bridge (“Key Bridge”). The air draft of the vessel is defined as the distance from the water surface to the highest point on a vessel (Figure 3).



*Not to Scale
KTM: Keel to Masthead. Distance from the bottom of the hull of the vessel to the highest point on the mast atop the wheelhouse.
HST: Air Draft. Distance from the water surface to the top of the vessel mast.
T: Vessel draft under water surface.
ADC: Air Draft Clearance. Distance from the top of the ship mast to the lowest point of the overhanging bridge.
UKC: Underkeel Clearance. Distance from lowest point on the ship hull to the mudline of the channel.
SLR: Sea Level Rise. Varies depending on scenario.

*Figure 3. Air draft parameter definitions.**

To pass under the bridge safely, a minimum air draft clearance (ADC) is required. The clearance is determined by the elevation of the water surface at a given time, the vessel's draft, which varies based on loading, and the speed of transit. The charted clearance of the two bridges is given by NOAA on the nautical chart relative to the mean high water (MHW) elevation:

- Chesapeake Bay Bridge 182 feet MHW
- Francis Scott Key Bridge 185 feet MHW

5. Relative Sea Level Change and Air Draft Clearance

5.1. General Conditions

Changes in sea level and its potential to impact the Seagirt Loop Channel project are detailed in Appendix E. The USACE Sea Level Change Curve Calculator (described in Appendix E) was used to evaluate the effects of projected sea level rise (SLR) on the ADC at the Chesapeake Bay Bridge and Francis Scott Key Bridge and potential long-term impacts on navigation by Post-Panamax Generation 3 (PPX III) Max (up to 16,000 twenty-foot equivalent units (TEU)) vessels. Since the Bay Bridge, built to 182 feet, and the Key Bridge, built to 185 feet, are fixed bridges (they do not fold up or retract). Air draft sensors on both bridges allow vessels' pilots to manage ADC in real time: for both bridges the available ADC exceeds the charted value 99% of the time under present-day conditions.

Relative SLR (RSLR) projections were obtained from the USACE Sea-Level Change Curve Calculator (Version 2021.12) for the years 2022 to 2130 using measured data relative to the current tidal epoch (1983 - 2001) from the NOAA tide gauge in Baltimore and Annapolis. The Sea-Level Change Curve Calculator provides three possible RSLR scenarios: low, intermediate, and high.

The SLR projections from the Baltimore tide gauge were used to assess future vessel ADC at the Key Bridge while the SLR projections from the Annapolis tide gauge were used at the Bay Bridge due to the location of the gauges relative to the bridges of interest. For reference, the Key Bridge is about 4.25 miles southwest of the Baltimore tide gauge and the Bay Bridge is about 5.50 miles east-northeast of the Annapolis tide gauge.

The future ADC of the PPX III MAX vessel is shown graphically in Figure 4 as the future masthead elevation (relative to MHW) due to SLR for the three RSLR projection scenarios. The controlling elevation of the Bay Bridge (relative to MHW) is also shown in. The intersection between the Bay Bridge elevation (black) and the future vessel masthead elevation (blue, orange, and gray) indicates the time where air draft is project to exceed the charted clearance of the bridge.

It is important to emphasize that the ADC with future SLR incorporated assumes that vessels are transiting at the channel design draft of 47.5 feet. For lighter loaded vessels, the vessel water draft will decrease with a concomitant decrease in ADC. For the PPX III Max, the vessel must be ballasted or loaded to the maximum allowable channel draft of 47.5 feet to provide sufficient ADC.

The Bay Bridge with lower clearance controls the allowable air draft into Baltimore. For the PPX III Max vessel transiting at high tide (e.g., MHW), there is approximately 1.3 feet of ADC to the charted bridge height under present day conditions. For the immediate

SLR scenario, the ADC decreases to 0.90 feet in 2045 and 0.45 feet in 2065. For the high SLR scenario, the ADC reduces to 0.83 feet and 0.36 feet in 2035 and 2045, respectively.

Maryland Transportation Authority has commissioned studies for replacement of the span and the Tier 1 Draft Environmental Impact Study (DEIS) was released for public comment in February 2021. Replacement of the span could alleviate the ADC restrictions and allow unimpeded access by PPX III Max class vessels (and larger). The DEIS focused on alternatives for accommodating traffic volumes in 2040. Under the High RSLR scenario, ADC may limit the PPX Class III Max vessels starting in 2045, therefore bridge replacement by 2040 would alleviate this restriction.

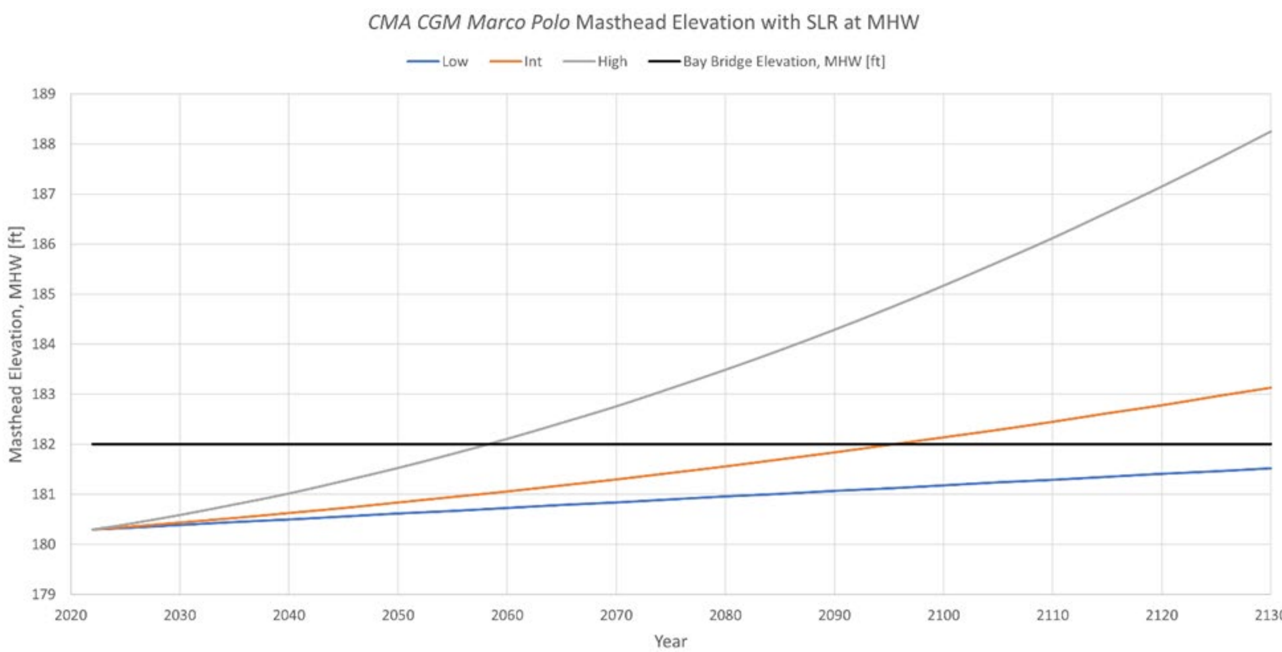


Figure 4. Masthead elevation of the CMA CGM Marco Polo transiting at MHW, draft 47.5 feet, with the three SLR scenarios applied. The controlling Bay Bridge elevation is shown (black) to reflect the change in ADC due to SLR.

6. Ship Simulation Modeling

6.1. Maritime Institute of Technology and Graduate Studies Study (2018)

After the completion of the 50-foot deepening of SMT Berth 4, MDOT MPA commissioned a ship simulation study to design the deepening of SMT Berth 3 and help develop best practices for ULCVs to efficiently transit to SMT. This study was conducted on behalf of MDOT MPA at the Maritime Institute of Technology and Graduate Studies Study (MITAGS) facility in Linthicum Heights, Maryland from April 30 to May 4, 2018. Participants in the study included pilots from the Association of Maryland Pilots (AMP) and docking and tug pilots from Moran Towing Corporation and McAllister Towing and Transportation Company.

Ships modeled for this study included the 14,000 TEU MSC *Kalina* and the 18,000 TEU *Ben Franklin*. Throughout the study, 34 runs were completed with the *Kalina* and *Ben Franklin* container vessels transiting to SMT Berth 3 via the East and West Loop.

During the study wideners 1-7 were proposed (Figure 5). Widener 1 expanded the channel width in front of Berth 3. Widener 2A/2B increased the size of the turning basin between Berth 4 and the Dundalk Marine Terminal, expanding the turning basin for ULCVs to back up, turn, and exit via the Seagirt-Dundalk Connecting Channel. These wideners were constructed as part of the project to deepen Berth 3.

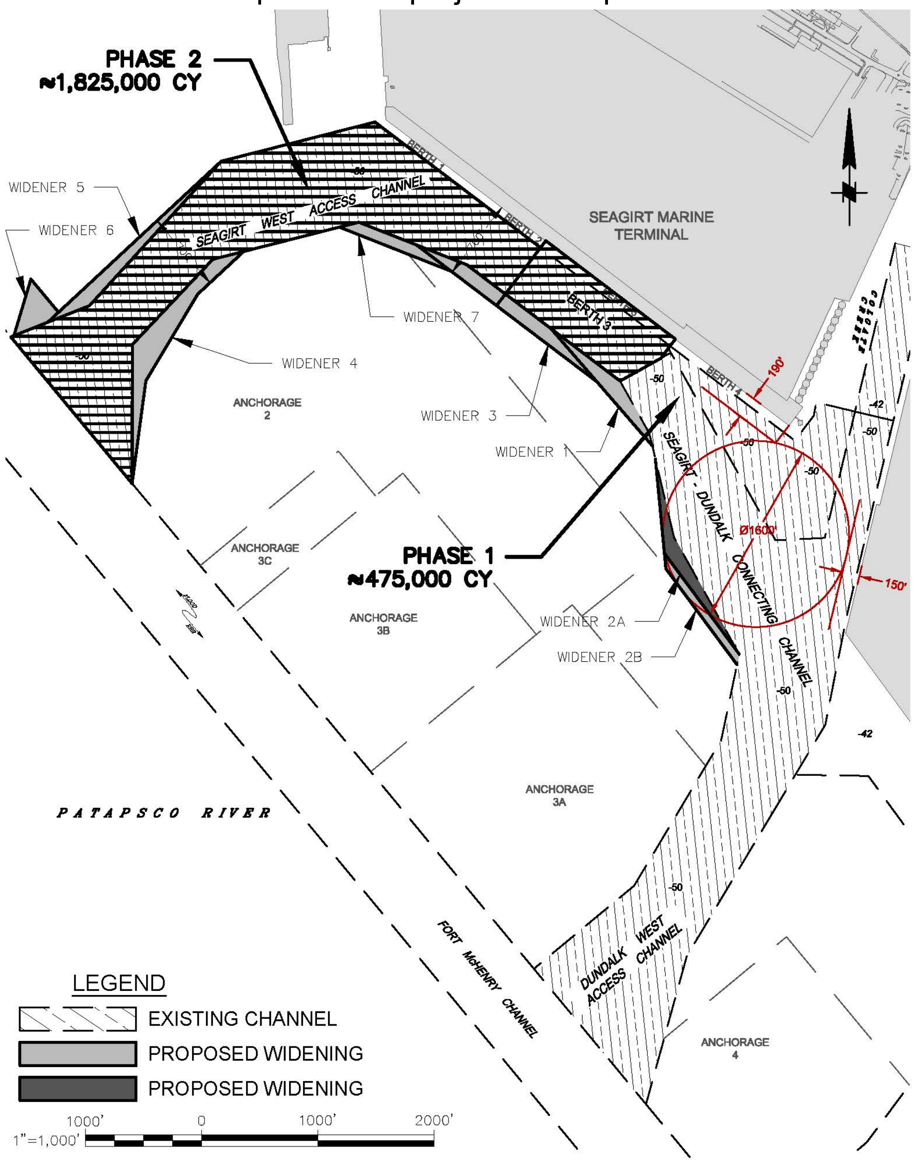


Figure 5. Wideners proposed during the MITAGS 2018 study.

The remaining wideners (4-7) were not constructed but were used in development of the channel design for the Seagirt Loop Study up through the TSP. Following the TSP, a Seagirt Study Ship/Tow Simulation at ERDC CHL was conducted. The updated modeling was conducted to optimize the recommended channel design and better estimate quantities and safety needs. The CHL ship simulation is described in section 6.2.

6.2. Engineer Research Development Center's Coastal Hydraulics Lab Ship/Tow Simulator

The MDOT MPA and CENAB requested ERDC CHL conduct a ship simulation study to evaluate the safety and efficiency of the proposed navigation improvements in the Seagirt Loop Channel using the Ship/Tow Simulator facility in Vicksburg, Mississippi. The ship simulation testing was performed over the course of two weeks on April 18-22, 2022 (Week 1) and April 25-29, 2022 (Week 2). Four licensed pilots from the AMP participated in the study; two pilots were present for each week of testing. A total of 124 ship simulation exercises were performed over the two testing weeks. The variables in the scenarios performed included channel design, transit path, vessel draft, wind direction and magnitude, visibility, and tug availability. Each scenario was tested using the proposed alternatives; 47-foot-deep channel and 50-foot-deep channel. The underkeel clearance (UKC) was assumed to be 2.5 feet at static draft for both channel designs.

The design vessel for the study was the *CMA CGM Marco Polo* container ship (PPX III Max). Two model versions of the *CMA CGM Marco Polo* container ship were used in this study (Table 2). The Generation III Max (44.5-foot draft vessel model (CNTNR52) was used to evaluate both the 47-foot and 50-foot designs. The 47.5-foot draft vessel model (CNTNR51) was used to evaluate the maximum sailing draft of the 50-foot channel design. Vessel model CNTNR51 cannot transit in the West Seagirt Branch Channel under the 47-foot alternative because the vessel draft exceeds the channel depth; instead, the vessel must back out to exit the Seagirt Loop.

Table 2. CMA CGM Marco Polo design vessel dimensions and characteristics.

Vessel	*CMA CGM Marco Polo*	*CMA CGM Marco Polo*
Vessel Model	CNTNR51	CNTNR52
Class	PPX III Max	PPX III Max
Maximum Capacity	16,022 TEU*	16,022 TEU*
Length Overall (LOA)	1,299 feet	1,299 feet
Beam	175.9 feet	175.9 feet
Static Draft	47.5 feet	44.5 feet
Trim	Even Keel	Even Keel
Deadweight	187,625 tons	187,625 tons
Engine	102,346 hp	102,346 hp
Propeller	Fixed pitch	Fixed pitch
Bow Thruster	2 (9,789 hp)	(9,789 hp)

All simulations included four tugboats of 65-ton push/pull to assist the transiting vessel. Pilots provided tug commands including tonnage and direction to the ERDC simulator operators during the exercises. Wind speeds ranging from 20 to 35 knots from several directions including NW (315°), WNW (300°), SSE (170°), SE (135°), and NE (45°) were tested in the study. The majority of the runs simulated wind from either the WNW or SSE direction. During the database validation, Pilots confirmed these wind conditions were representative of real-world conditions.

Visibility conditions, such as lightning and weather, were also evaluated during testing. Since the Pilots mostly operate at night, the darkness level in the simulator was increased to replicate nighttime conditions. A few simulations were also tested with snow in addition to nighttime lightning. Only one scenario simulated day light, which occurred during the start of testing.

During week one of testing, upon completing several simulation exercises with both of the channel designs, the Pilots identified the need for additional widening along the West Seagirt Branch Channel to improve safety in navigating the *CMA CGM Marco Polo* vessel. Modified 47-foot and 50-foot channels with increased wideners to a minimum of 620 feet following the Pilots' recommendations during the first test week. Pilots tested both the original channel layouts and the modified layouts during week two (Figure 6).

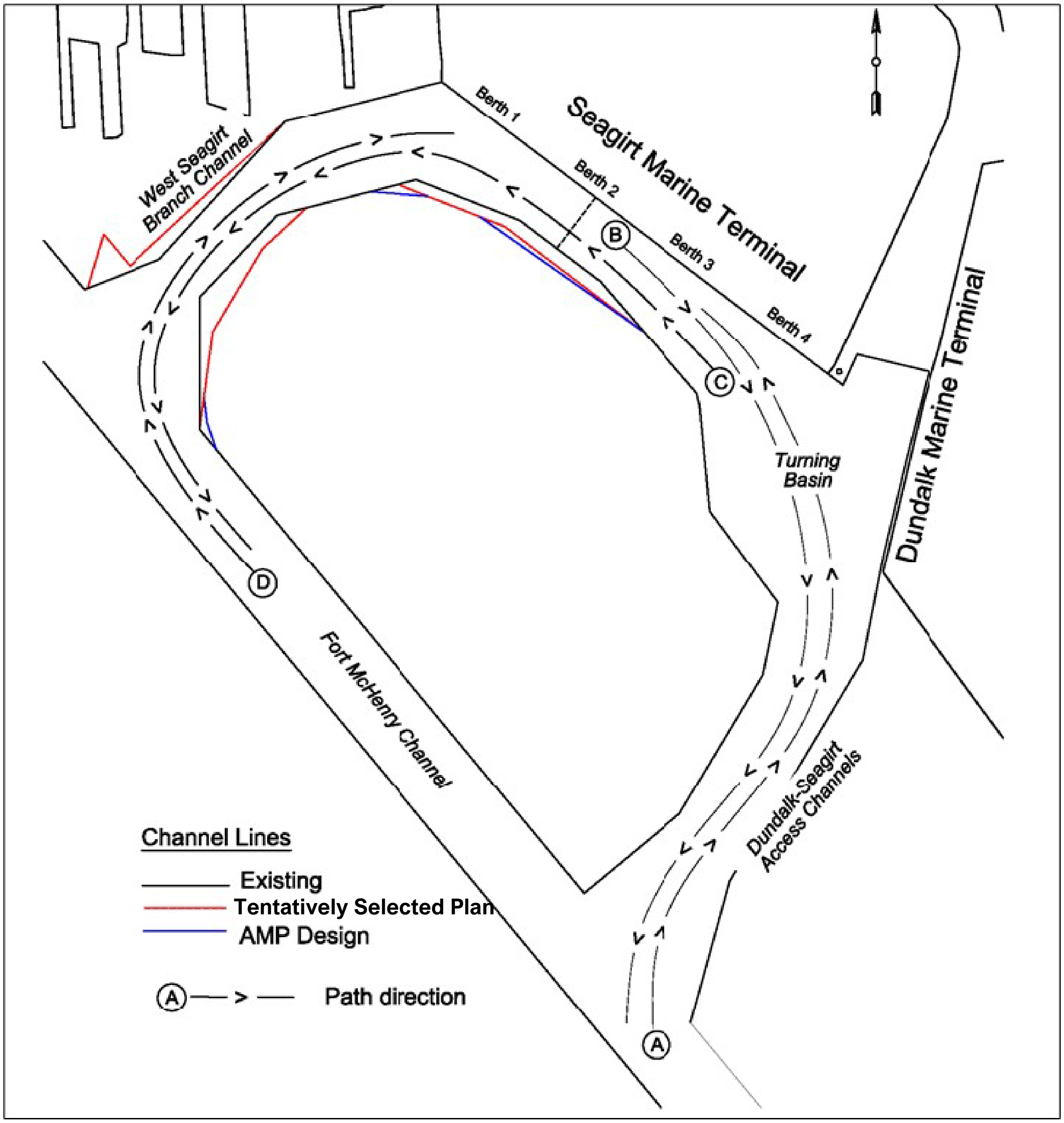


Figure 6. Proposed channel designs and vessel paths in the Seagirt Loop Channel.

Comments provided by the Pilots on the simulation were compiled with the ERDC simulation report found in Appendix B4. Of particular interest for this study was maneuverability of the fully loaded *CMA CGM Marco Polo* vessel when using Path B in the 47-foot channel plan which required backing from Berth 3 into the turning basin. Docked vessels were placed at SMT Berths 1 and 4 and Dundalk Marine Terminal Berth 5. One track showed the vessel nearly exceeding the upper corner of the turning basin when passing SMT Berth 4. The remaining runs showed the vessel had adequate space to maneuver in the turning basin. The Pilots commented that all four tugs were required to complete this maneuver successfully. One vessel track showed the stern not clearing when turning towards the Fort McHenry Channel. Pilots commented that this scenario is manageable with all four tugs, but that it would be safer to depart directly through the West Seagirt Branch Channel. Another vessel track is shown to nearly exceed the southeastern boundary of the turning basin. This scenario was particularly difficult under a NE wind when first entering the turning basin and trying to work stern into the wind. Two pilots stated they would have not been able to recover the vessel in the event of a tug casualty. The Pilots expressed that the vessel is highly exposed in the turning basin and there is less safety margins navigating the *CMA CGM Marco Polo* in the turning basin, compared to exiting via the West Seagirt Branch Channel.

Additional turning basin maneuvers completed with the lighter loaded vessel model showed most turning maneuvers were manageable. One trackplot showed the stern nearly exceeded the upper corner of the turning basin when backing up. Another track showed a vessel not clearing the west corner when entering the Fort McHenry Channel. In two of the tracks, the bow reaches the turning basin limits. To keep the vessel clear of the docked vessels, the pilot needed to work the vessel towards the wind while also staying within the basin limits. The pilots expressed this was a difficult maneuver and that all four tugs are required.

The turning basin maneuver in Path B required significant use of the tugboats. Several scenarios required all four tugboats to exert maximum force for an extended period of time, presenting concerns for overworking the tugboats and potential mechanical failure. Any potential tug casualties could cause a serious, damaging accident, such as striking surrounding terminal infrastructure, an allision with a docked vessel at Dundalk Marine Terminal Berth 6, or exceeding the channel limits and running aground. The Pilots expressed that the vessel is highly exposed in the turning basin and there is less safety margins navigating the *CMA CGM Polo* in the turning basin, compared to exiting via the WSBC.

When the proposed wideners were added to the 50-foot channel configuration, the ERDC study reports that all runs show the Pilots using the proposed wideners while achieving adequate clearance for safe navigation. The Pilots noted that the channel configuration accommodates the *CMA CGM Marco Polo* vessel well and the maneuvers can be completed safely with overall less tug assistance, including in the event of tug casualties which were demonstrated during various runs.

7. Channel Design

In addition to modeling, numerous coordination meetings were held with the AMP, the US Coast Guard, and local interest groups to ensure that the proposed channel improvements would provide adequate navigability for the design ship while meeting the needs of the Port facilities and the maritime community. The recommended channel improvements are shown in Appendix B5.

7.1. Channel Width

The proposed channel improvements were designed in accordance with USACE guidance Engineering Manual (EM) 1110-2-1613. This guidance is based on a number of factors including traffic pattern (one way or two way), design vessel dimensions, channel cross section shape, current speed and direction, quality of aids to navigation and variability of channel and currents. For one-way channels, widths can vary from 2.5 times the vessel beam for a well-defined channel with minimal currents to 5.5 times the vessel beam for a variable channel with stronger currents. Two-way channels can vary from 4 to 8 times the vessel beam.

The improved West Seagirt Branch Channel under the Recommended Plan has an authorized dimension of 760 feet on average with additional widening at bends necessary for the safe handling of vessels. See Figure 7 for details on channel widths.

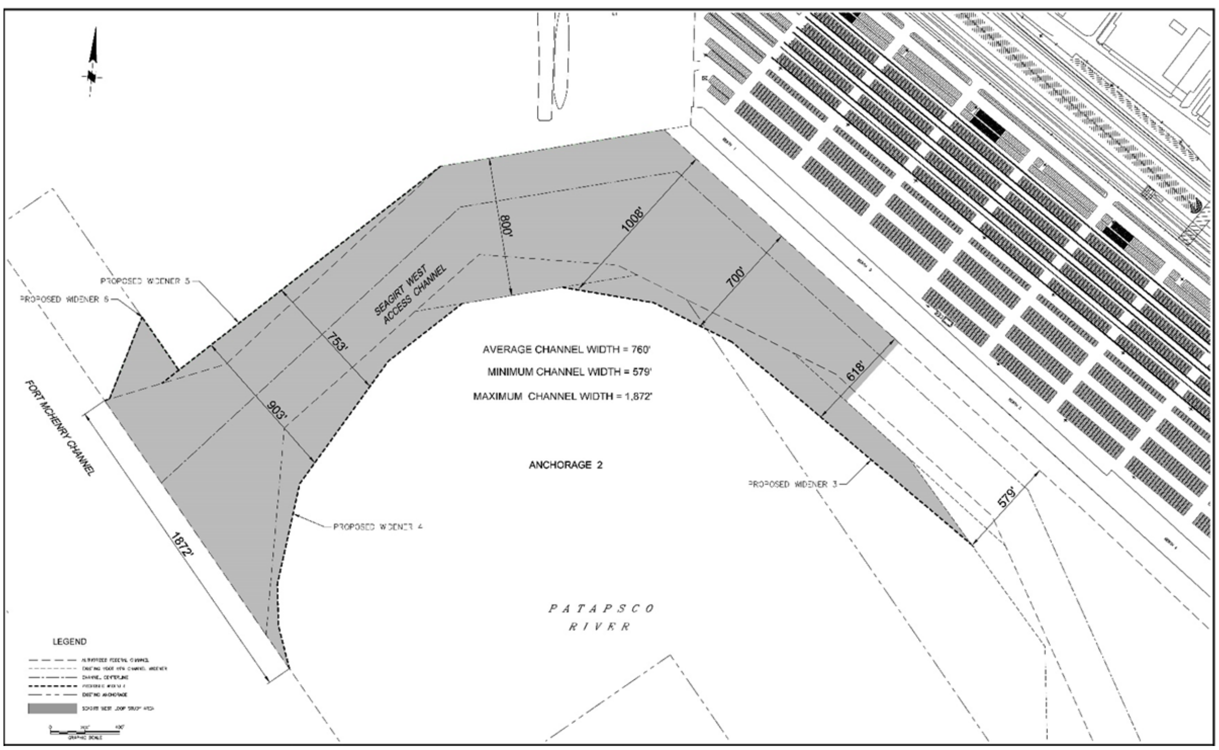


Figure 7. Proposed Channel Dimensions.

7.2. Channel Depth and Underkeel Clearance

The maximum channel depth is designed to permit the safe and efficient transit of a fully loaded design vessel at any phase of the tide. The determination of the navigation channel depth is based upon the loaded static summer saltwater draft of the design vessel, plus allowances for various UKC such as ship squat, water density, ship response to waves, and safety clearance. The selection of the actual project design depth is determined by economic analysis of the expected project benefits compared with the project cost at various alternative depths. Refer to Appendix C, Economic Analysis, for details of the optimization analyses.

7.2.1. Squat

Squat is the tendency of a vessel underway to sink and trim in the waterway, thereby reducing the UKC. The sinkage is due to the reduction in pressure on the ship's hull resulting from the increased water velocity passing the ship. In a shallow or confined channel, squat tends to increase because the blockage caused by the ship creates a higher water velocity around the hull, lowering the actual water surface. Another component of squat is dynamic trim, or the change in pitch of a vessel due to the forward motion. Generally, it has been found that most full-bodied ships such as tankers and bulk carriers trim down at the bow, and sleeker containerships trim down at the stern. The magnitude of the squat depends on several factors including ship speed, dimensions, ship blockage coefficient, and channel depth. EM 1110-2-1613 provides a simplified expression to estimate squat which is proportional to the square of velocity:

$$Z_{max} = \frac{C_b B T V^2}{4.573 L h}$$

Zmax = Squat in feet
Cb = Vessel block coefficient (~0.68 for large containerships)
L = Vessel length (feet)
h = water depth (feet)
V = vessel speed through water (knots)

Assuming a typical maximum transit speed in the Seagirt Loop Channel of 5 knots, the resultant squat for the *CMA CGM Marco Polo* transiting at 47.5-foot draft is approximately 0.5 feet.

7.2.2. Safety Clearance

A safety clearance is provided between the hull of the ship in transit and the design channel bottom to minimize the risk of damage to the vessel due to bottom irregularities and debris. The safety clearance also accounts for uncertainties such as tide stage, survey tolerances, etc. A safety clearance of 2 feet is provided for channels with a soft bottom. In time, as the channel begins to shoal, a safety clearance of 2 feet will be maintained since the recently deposited material tends to be soft.

7.2.3. Total Underkeel Clearance

The total UKC is the sum of the squat and the safety clearance. The total UKC for the *CMA CGM Marco Polo* is estimated at 2.5 feet. The UKC is added to the sailing draft of the vessel. The safety of this depth was confirmed during the ship simulation using the ERDC CHL Ship/Tow Simulator.

7.3. Structural Considerations

7.3.1. Channel Stability Analysis

Seagirt Loop has been extensively sampled over the past three decades in support of numerous dredging contracts. The most recent investigation was performed SaLUT from December 2018 to January 2019. A total of 56 standard penetration borings were performed within and adjacent to the Seagirt Loop Channel. Borings extended approximately to an elevation of -60 feet MLLW.

Blow counts are a poor indication of strength in weak/soft cohesive materials (undrained shear strength less than approximately 1,000 pounds per square foot. A single blow count can cover a wide range of undrained shear strengths, and nearly every blow count within Seagirt Loop down to the proposed channel depth of -50 feet MLLW was WOR. A blow count of WOR indicates that the soil is unable to support the load of the drill rods even before adding the weight of the hammer to begin counting blows. Given that the plasticity index of the material is above 50 percent, and the in-situ water content of the material is above the liquid limit, the material exhibits almost no strength. By definition, a soil with a water content exceeding the liquid limit behaves like a liquid instead of a solid. Liquids generally have extremely small shear strengths. Water has no shear strength. The stability of side slopes can be calculated if reliable estimates of undrained shear strengths can be deduced. Within the Seagirt Loop, this would require either field vane shear testing, cone penetration testing, or dilatometer testing. Because past investigations were used primarily to characterize the dredged material for upland disposal, tests to specifically determine undrained shear strengths were not performed. The best indication of the strength of the material is observation of in-situ channel side slopes.

CENAB performed a multi-beam hydrographic survey of Seagirt Loop and Anchorage 3 in February 2021. Using the multi-beam survey, channel side slopes were computed on a 20-foot grid and plotted on top of the NOAA nautical chart (Figure 8). Side slopes were color-coded so that variations in the side slopes could be easily identified. All prior dredging by both USACE and MDOT MPA within Seagirt Loop and Anchorage 3 was done according to a template with 3 Horizontal to 1 Vertical slopes (3H:1V). If 3H:1V side slopes were dredged in the past, and if they are stable, 3H:1V excavated slopes would be expected on the survey.

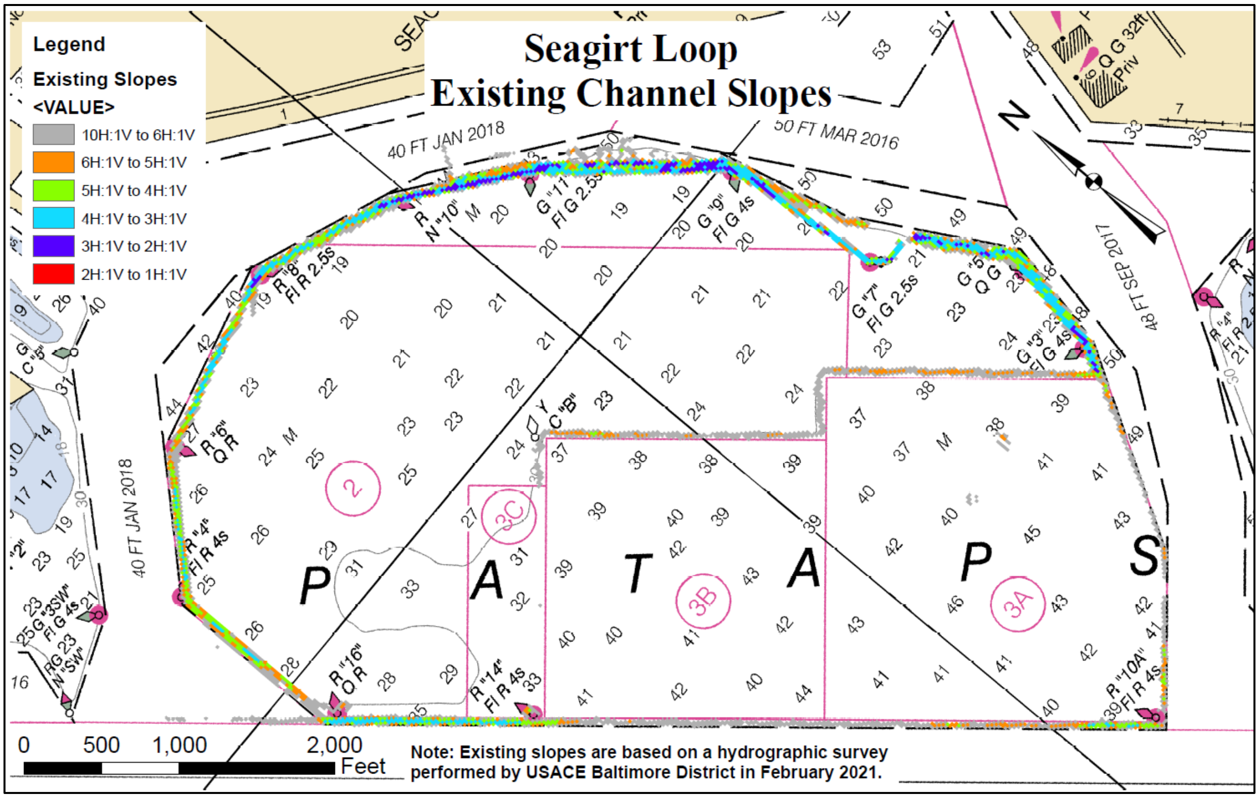


Figure 8. Hydrographic survey of Seagirt Loop and Anchorage 3 in February 2021 with side slopes.

The plot of the side slopes indicates that only limited reaches of the channel in front of Berth 2 and Berth 3 exhibit side slopes of 3H:1V or steeper. The majority of the side slopes for the Seagirt Loop channel are between 3H:1V and 5H:1V. Existing side slopes indicate the slope steepness that is marginally stable. The consequence of slope failure is sloughing of material into the channel, requiring more maintenance dredging. To prevent sloughing of the channel side slopes, a 5H:1V slope is recommended for the proposed project. The 5H:1V slope better matches the existing slopes than the traditionally recommended 3H:1V slopes and is a better risk-informed assumption in the study.

7.3.2. Berth Stability Analysis

A berth stability analysis was completed for existing structures within close proximity of the proposed channel deepening. The relationship of existing structures to the proposed improvements is shown in Figure 9.

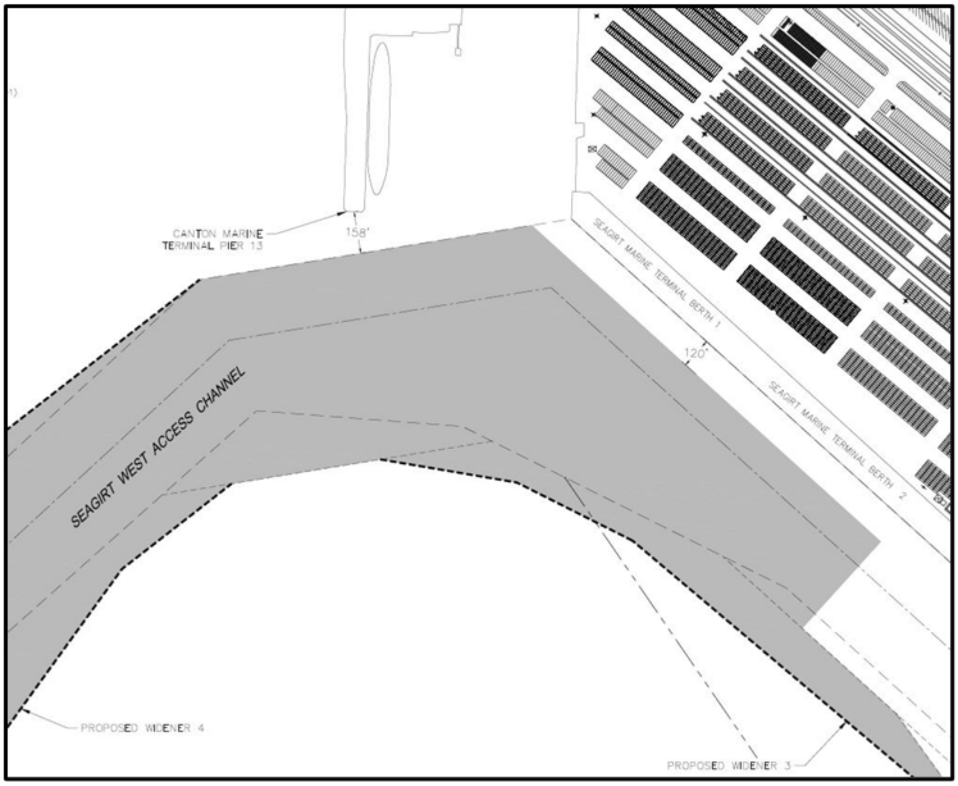


Figure 9. Existing berth features adjacent to the study area.

The proposed federal channel dredging for the West Seagirt Branch Channel (labeled as Seagirt West Access Channel in Figure 9) would not have any detrimental impact on the existing structures adjacent to the channel. The 50-foot dredge depth for the Federal channel footprint is within 158 feet of the southeast corner of the Canton Marine Terminal Pier 13. If a 5:1 side slope is used, it intersects existing river bottom approximately 113 feet from the edge of the 50-foot channel, or 45 feet from the pier. The proposed dredging within the federal channel limits is far enough away from the berth structures that the pile support would be unchanged from its present condition.

The proposed 50-foot dredge depth is within 120 feet of SMT Berths 1 and 2. If a 5:1 side slope is used, the slope intersects existing river bottom approximately 92 feet outboard of the berthing face of Berth 1 and 103 feet outboard of Berth 2. The berth face is supported by concrete piles backed by a cellular cofferdam. The proposed dredging is far enough away from the berth and pier structures that the pile support would be unchanged from its present condition. Local and global stability analyses were performed to assess the impact of deepening the Federally authorized portion of the channel on the structural stability of the piles and existing cofferdam. Calculated factors of safety for the cofferdam stability models exceeded requirements by more than two times when the proposed dredging is considered. The analysis and associated memo dated 13 January 2022 conducted by Moffatt & Nichol can be found in Appendix B6.

8. Developing Quantity Estimates

8.1. Existing Conditions Surface

To estimate excavation quantities, a complete surface of the excavation areas was developed. Areas to be excavated are included mostly within the existing channels and in adjacent areas of channel widening based on bathymetric data collected in December of 2021 and January 2022. Preliminary quantities used in the screening of alternatives for the study are provided in Appendix B7.

Survey data were imported into AutoCAD to create a Triangulated Irregular Network (TIN) of the study area. Extraneous triangles were eliminated from the TIN to create a more representative surface.

8.2. Proposed Condition Surface

The proposed conditions surfaces correspond to the channel “templates” at the proposed depth(s) of excavation. The templates represent the cross-section of the proposed channels, including the side slopes (Appendix B7). The proposed channels maintain the same footprints as the existing channels except where widenings are proposed. The side slope has been set at 5H:1V, which is meant to prevent excessive sedimentation back into the channel (Figure 10).

During plan optimization, the costs of proceeding with 5H:1V side slopes was compared to costs for a 3H:1V side slope channel and the potential increased operations and maintenance dredging. Analysis supported channel slopes dredged to 5H:1V to ensure the long-term stability of the channel and reduce shoaling and therefore operation and maintenance dredging.

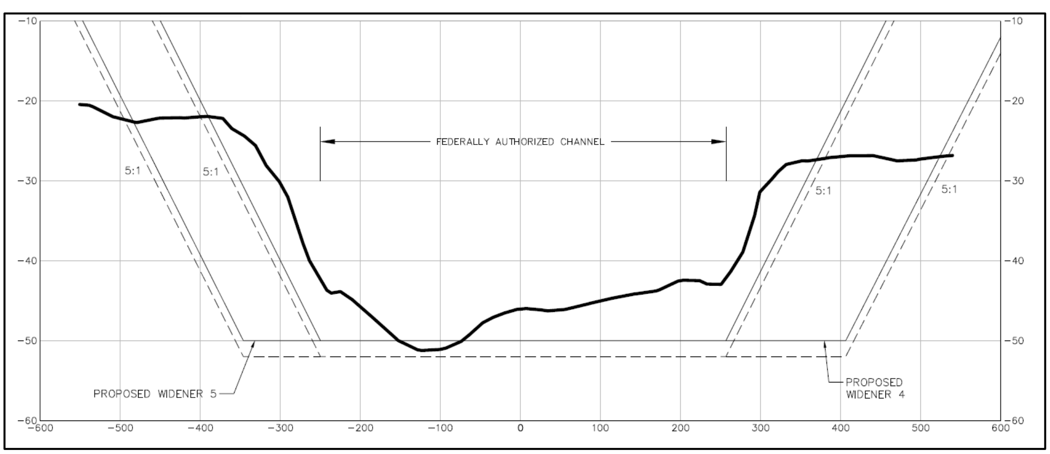


Figure 10. Sample proposed channel template showing 5H:1V side slope.

8.3. Dredge Quantities

The gross excavation quantity for each channel segment was determined simply by subtracting the proposed conditions surface from the existing conditions surface at incremental one-foot depths. Table 3 shows the quantities to be excavated by depth.

Table 3. Cumulative volume dredged for West Seagirt Branch Channel and Wideners at increasing depths.

To Elevation (Feet/MLLW)	Segment	Cumulative Dredging Vol cubic yards(cy)
-45	Channel	173,792
	Wideners	617,770
-46	Channel	248,270
	Wideners	653,197
-47	Channel	338,204
	Wideners	687,924
-48	Channel	453,478
	Wideners	722,124
-49	Channel	596,711
	Wideners	756,198
-50	Channel	753,839
	Wideners	790,450
-51	Channel	916,384
	Wideners	824,961
-52	Channel	1,082,386
	Wideners	859,795

8.4. Excavated Depth Summary

Figure 11 provides an illustration of the different dredge zones referenced in developing quantities. These horizons are defined as:

1) Existing Condition: Based on the most recent hydrographic data at the start of the study.

2) Maintained Depth: The maintenance quantity is the volume required to be dredged from the existing condition to the currently maintained channel dimensions.

3) Authorized Depth: The authorized depth is the nominal depth used for the Plan Formulation increments and includes consideration for UKC.

4) Advanced Maintenance: Dredging contracts typically include a depth of advanced maintenance beyond the authorized depth. This depth is often greater in areas of rock than areas of sand.

5) Paid Overdepth: In consideration of the difficulty to dredge or blast to an exact depth, material within an agreed upon vertical distance below the authorized depth will be paid for.

6) Unpaid Overdepth: Material that is below the agreed upon paid overdepth quantity. Note that some material in this range may be paid for if it falls within the side slope area and is needed for slope stability.

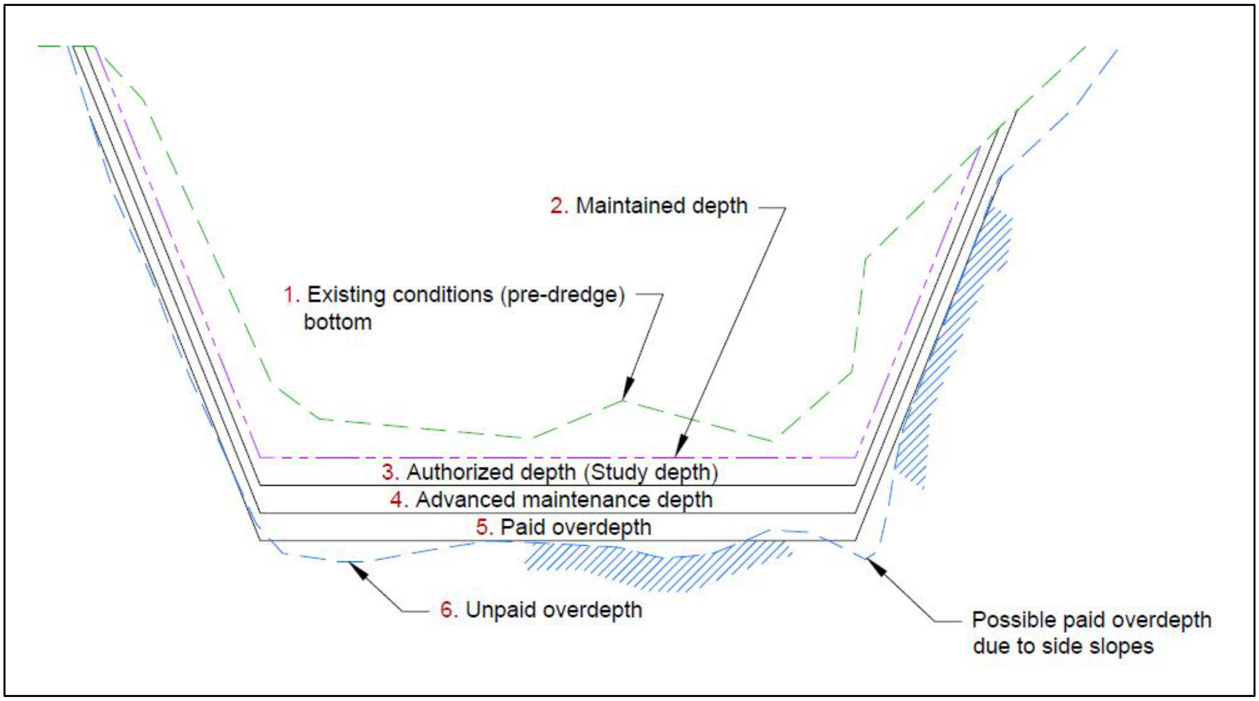


Figure 11. Typical dredge zones.

8.5. Placement Location and Capacity

The 2017 USACE Dredged Material Management Plan details the current dredged material disposal sites for material dredged from the Harbor approach channels. The

MDOT MPA maintains the Baltimore Harbor placement sites to accommodate at least the 20-year dredging placement need, which is calculated based on historical maintenance volumes and identified new work projects. The primary placement site being considered for this project is Cox Creek DMCF. The Cox Creek DMCF is located in Anne Arundel County, Maryland, just south of the Baltimore City line, along the western shoreline of the Patapsco River. In February 2010, Cox Creek was approved by USACE North Atlantic Division as the federal standard for Baltimore Harbor placement. Material dredged from the Harbor that is within the Patapsco River is legally considered to be unsuitable for open water placement by State law, 90 percent of Harbor material has also been found to be unsuitable for open water placement in accordance with local EPA regulations, and thus must be placed in upland contained facilities. Cox Creek is owned and operated by MDOT MPA. The existing Cox Creek site includes a DMCF as well as wetland and upland areas. The current dikes are constructed to +36 feet MLLW. MDOT MPA is actively expanding the Cox Creek DMCF. The Cox Creek Expanded project consists of raising the existing dikes to +60 feet MLLW and expanding the facility onto the upland portion of the property by summer of 2024. Appendix B7 analyzes the considerations utilized in determining available placement capacity.

9. Further Analysis and Design Development Needs

No new data were collected for project's feasibility study, commensurate with risk informed decision-making. However, data from the prior harbor deepening study were used for this study. Suggested data collection and analysis to be conducted during the PED phase are discussed below. The design development concerns discussed are limited to those efforts related to channel design; therefore, this discussion of data and analysis needs should not be considered comprehensive.

9.1. Hydrodynamic Data Collection

The collection of water surface elevation, current velocity data, and wind velocity data may be warranted to both provide insight at critical project locations and to support the validation of an updated hydrodynamic and sediment model. The necessity and distribution of this data collection effort should be considered and developed in collaboration with harbor and docking pilots, and the developers of both the recommended hydrodynamic and sediment model (discussed below).

9.2. Hydrodynamic and Sediment Modeling and Analysis

A comprehensive hydrodynamic model exists for the study area from previous ERDC CHL ship simulation work completed in Baltimore Harbor. Additional hydrodynamic modeling is not needed at this time determined by the subject matter experts at ERDC CHL.

10. References

Boicourt, W.C. and P.L. Olson. 1982. *A Hydrodynamic Study of the Baltimore Harbor System.* Chesapeake Bay Institute and Johns Hopkins University.

CENAB. 1997. Baltimore Harbor Anchorages and Channels, Maryland Integrated Feasibility Report and Environmental Impact Statement Draft Report.

EA EST. 2019. FY19 Sediment Sampling and Chemical Analysis for Baltimore Harbor and Chesapeake Bay, Maryland. Prepared for USACE Baltimore District.

MDOT MPA. 2019. Geotechnical Investigation Report. Seagirt Berth 3 Dredging and Masonville Unloading Area Basin Dredging.

MITAGS. 2016*. Preliminary 18,000 TEU Full Mission Ship Simulation Study Report for the Port of New York/New Jersey Shipping Association.* Linthicum Heights, MD. The Maritime Institute of Technology and Graduate Studies.

Reinhardt, Juergen. and Crowley, W.P. 1979. Geologic Map of the Baltimore East Quadrangle, Maryland.

Schubel, J.R. and D.W. Pritchard, 1987. *A brief physical description of the Chesapeake Bay, in Contaminant problems and management of living Chesapeake Bay resources*. Edited by S. K. Majumdar, L.W. Hall, Jr., and H. M. Austin, 1-32, Pa Acad. Sci., Philadelphia, PA.

USACE. 1996. Engineer Regulation 1130-2-520. “Navigation and Dredging Operations and Maintenance Policies.”

USACE. 2006. Engineer Manual 1110-2-1613. “Hydraulic Design of Deep-Draft Navigation Project.”

USACE. 2017. Baltimore Harbor and Channels Dredged Material Management Plan Update.

USACE. Version 2021.12. *Sea-Level Change Curve Calculator*. Retrieved from https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html

Baltimore Harbor Anchorages and Channels (BHAC)

Modification of Seagirt Loop Channel

Feasibility Study

Final Integrated Feasibility Report & Environmental Assessment

APPENDIX B1:

Geotech Data and Boring Logs

This page intentionally left blank.

Geotechnical Investigation Report

Seagirt Berth 3 Dredging and Masonville Unloading Basin Dredging

Baltimore, Maryland
MES Contract No. 14-07-58 Task 17

Prepared for:

Maryland Port Administration
401 E. Pratt Street,
Suite 1900
Baltimore, MD 21202

MDOT
MARYLAND DEPARTMENT OF TRANSPORTATION™
MARYLAND PORT ADMINISTRATION

And

Maryland Environmental Service
259 Najoles Road
Millersville, MD 21638

MARYLAND ENVIRONMENTAL SERVICE

Prepared by:

Gahagan & Bryant Associates, Inc.
9008 Yellow Brick Road, Suite O
Baltimore, MD 21237

May 2019

GEOTECHNICAL INVESTIGATION DATA REPORT

SEAGIRT LOOP CHANNEL DEEPENING
BALTIMORE, MARYLAND

Prepared for:

Gahagan & Bryant Associates, Inc.
9008 Yellow Brick Road, Suite O
Baltimore, Maryland 21237

Prepared by:

SaLUT-TLB
530 McCormick Drive, Suite S
Glen Burnie, Maryland 21061

MAY 2, 2019

Soil and Land Use Technology, Inc. (SaLUT-TLB)
530 McCormick Drive, Suite S • Glen Burnie, MD 21061 (443) 577-1600
www.SaLUTinc.com

May 2, 2019

Gahagan & Bryant Associates, Inc.
9008 Yellow Brick Road, Suite O
Baltimore, Maryland 21237

Attn: Mr. William Murchison

Re: Geotechnical Investigation Data Report
Seagirt Loop Channel Deepening Project
Dundalk Marine Terminal
SaLUT-TLB Reference No. 18-0043

Dear Mr. Murchison,

Pursuant to your request, we have performed a geotechnical investigation in support of your planning efforts on the referenced project. The following revised report summarizes the results of our subsurface explorations and laboratory testing for the Seagirt Loop Channel Deepening project in Baltimore, Maryland.

We thank you for providing us this opportunity to perform these services for Gahagan & Bryant Associates, Inc., and look forward to working with you as the project progresses. Please do not hesitate to contact us if you have any comments or questions regarding this report, or when we can be of further assistance on this and other projects.

Sincerely,

SaLUT-TLB

Edward Dalton, P.E.
Executive Vice-President

Olivia Erony, P.E.
Project Engineer

TABLE OF CONTENTS

ATTACHMENTS

Z:\01 Projects\2016 PROJECTS\Gahagan & Bryant Associates\Task 17 - Seagirt Loop Channel Deepening - MES 14-07-58\Report\Geotech Data Report- Seagirt R2 5.2.19.Doc

1.0 INTRODUCTION

Gahagan & Bryant Associates, Inc. (GBA) of Baltimore, MD has been engaged to perform engineering services for dredging at the Seagirt Marine Terminal in Baltimore, Maryland. To assist with obtaining subsurface information and laboratory testing GBA retained SaLUT-TLB. The subsurface investigation and testing were conducted in general accordance with the scope of services outlined in SaLUT-TLB's proposal dated November 15, 2018. The results of our investigation and testing are included in this data report.

2.0 PROJECT DESCRIPTION

The project consists of dredging in front of the Seagirt Marine Terminal Berth 3 and adjacent channels. More specifically the area included in this investigation included Berth 3, Seagirt – Dundalk Connecting Channel and the Seagirt West Access Channel. These areas will be deepened and widened. The project location is shown on the attached Drawing No. 1 – Project Location Plan. The areas will be dredged to about El -50 plus 2 foot over depth MLLW. To evaluate the subsurface conditions and obtain samples for testing in the area to be dredged 56 test borings were drilled at locations identified by GBA. Laboratory test were conducted on soil samples to identify the soil physical and environmental characteristics. This data report provides the geotechnical data and laboratory testing results for the project.

3.0 SCOPE OF SERVICES

The general scope of services consisted of:

- Mark boring locations from the barge using a handheld GPS unit.
- Obtain a Miss Utility ticket to identify underground utilities.
- Drill 56 soil borings to a depth of about El -60 ft MLLW
- Perform SPT sampling at 2.5-foot intervals
- Decontaminate down the hole drill tools between designated drill areas
- Perform laboratory testing on select samples to identify physical and environmental characteristics
- Perform strength test – Pocket Penetrometer and Torvane test to identify soil strength characteristics
- Prepare a Geotechnical Data Report

4.0 SUBSURFACE EXPLORATION

To evaluate the subsurface conditions, 56 test borings (PR-1 to PR-56) were drilled in 8 designated zones between Dec 06, 2018 to Jan 15, 2019. The borings were drilled with a Mobile 57 drill rig mounted on a barge equipped with two spuds to hold the barge in position during drilling. The test boring locations were selected by GBA and marked in the field by SaLUT-TLB using a Trimble Geo-7X handheld GPS and Terra-sync software. The planned test boring locations and the eight (8) designated environmental composite sample areas (Area 1 through Area 8) are shown on the attached Drawing No. 2– Test Boring Location Plan. The as-drilled coordinates for the test borings are included on the boring logs. The time each boring was drilled was recorded and based on the date and time of drilling the water surface elevation was estimated from National Oceanic and Atmospheric Administration tide recordings from Ft. McHenry Station. All tide data is referenced from MLLW.

The test borings extended to an approximate El -60 ft. The depth of the water was estimated using a lead line over the side on the barge prior to start of drilling, the lead line is approximately 4-inches in diameter and weighs about 5 lbs. The depth of water varied from about 20 feet to 52 feet and mudline elevation varied from about El -19.6 to El -50.3 ft. Depth and elevation data are included on the boring logs. Soil samples were obtained from the test borings at 2.5-foot intervals using a split-barrel sampler (spoon) in accordance with the Standard Penetration Test (SPT) procedure ASTM D1586. A representative portion of each split spoon sample was placed in a glass jar and transported to our laboratory for evaluation and testing. Two jar samples were retained from each split spoon sample, one for environmental testing and one for physical and strength testing. The environmental jar samples from each of the 8 designated areas were combined to make up one composite sample from each of the 8 areas for environmental testing. Environmental jar samples were stored in SaLUT lab refrigerator until the composite sample was delivered to the environmental lab for testing. To prevent cross contamination between the 8 designated environmental areas the down the hole drill tools were decontaminated when moving between areas. The initial drilling plan was to complete all borings in each one of the 8 environmental areas before moving to the next area but due to ship traffic restrictions and access restrictions in the Berth 3 area this was not possible, therefore multiple decontamination events were required during the day and at the end of each day.

5.0 SUBSURFACE CONDITIONS

Logs describing the subsurface soil conditions, are presented as "Records of Soil / Rock Exploration" in Appendix A. The descriptive terminology used to classify the soils encountered during this study is summarized on the first page of Appendix A. The subsurface conditions are summarized below.

5.1 Subsurface Stratigraphy

Dark Gray to Grayish-Brown, Brown and Black Silt and Clay was encountered from the mudline to the full depth of the borings except in PR-16, PR-36, PR-39, PR-46 and PR-51 to PR-56. The Standard Penetration Test (SPT) N-values for Clay and Silt ranged from Weight of Rods (WOR) over 18-inches to 15 blows per foot (bpf), indicating very soft to stiff relative consistencies. Gray, Brown to Dark Grayish-brown, and Dark Green interbedded Sand layers were encountered within Clay and Silt in borings PR-23, PR-35, PR-47 and PR-53 with Standard Penetration Test (SPT) N –values ranging from 1 to 7, indicating very loose to lose relative consistencies. Tan, Brown, and Gray to Grayish-Brown Sand was encountered in borings PR-16, PR-36, PR-39, PR-46 and PR-51 to PR-56 about EL. 29.7 to EL.54.3 and continued through boring termination depth. The Standard Penetration Test (SPT) N –values for Sand ranged from 2 to 27, indicating very loose to medium dense relative consistencies. Very loose Clay and Silt layers were encountered within Sand strata at Boring B-39 below elevation EL.-29.7 feet.

5.2 Laboratory Test Results

SaLUT-TLB selected soil samples from each boring for laboratory physical testing. The tests included natural moisture content (ASTM D2216), gradation analysis (with hydrometer) (ASTM D7928), Atterberg limits (ASTM D4318) and Specific Gravity (ASTM D854). The test results are presented in Appendix B and are summarized in the table on the next page. Each split spoon sample was tested for shear strength evaluation using a Pocket Penetrometer and Torvane. The Pocket Penetrometer is a spring-operated device that provides direct measure of the unconfined compressive strength of the soil. A 0.25-inch diameter piston is pushed into the soil sample a depth of 0.25 inches and the unconfined compressive strength is indicated by the direct-reading scale on the piston barrel. The shear strength of the soil is one-half the unconfined compressive strength. The Torvane device uses a torsion spring to provide direct measurement of soil shear strength. Several samples were too soft to obtain any strength data as the range for the Pocket Penetrometer is about 500psf to about 4,500psf and the Torvane range is about 200psf to 5,000psf. The results are summarized in Appendix B. The environmental jar samples from each boring in each of the designated environmental areas were combined to make up one composite sample for environmental testing. The results of environmental test are included in Appendix B.

Test	Results	
	Range	**Average**
Moisture Content (%)	11.2 - 216.5	121.2
% Passing No. 200 Sieve	2.8 - 100	80.8
Liquid Limit (%)	27 - 178	107.7
Plastic Index (%)	3 - 126	64.1
Specific Gravity	2.52 - 2.67	2.59

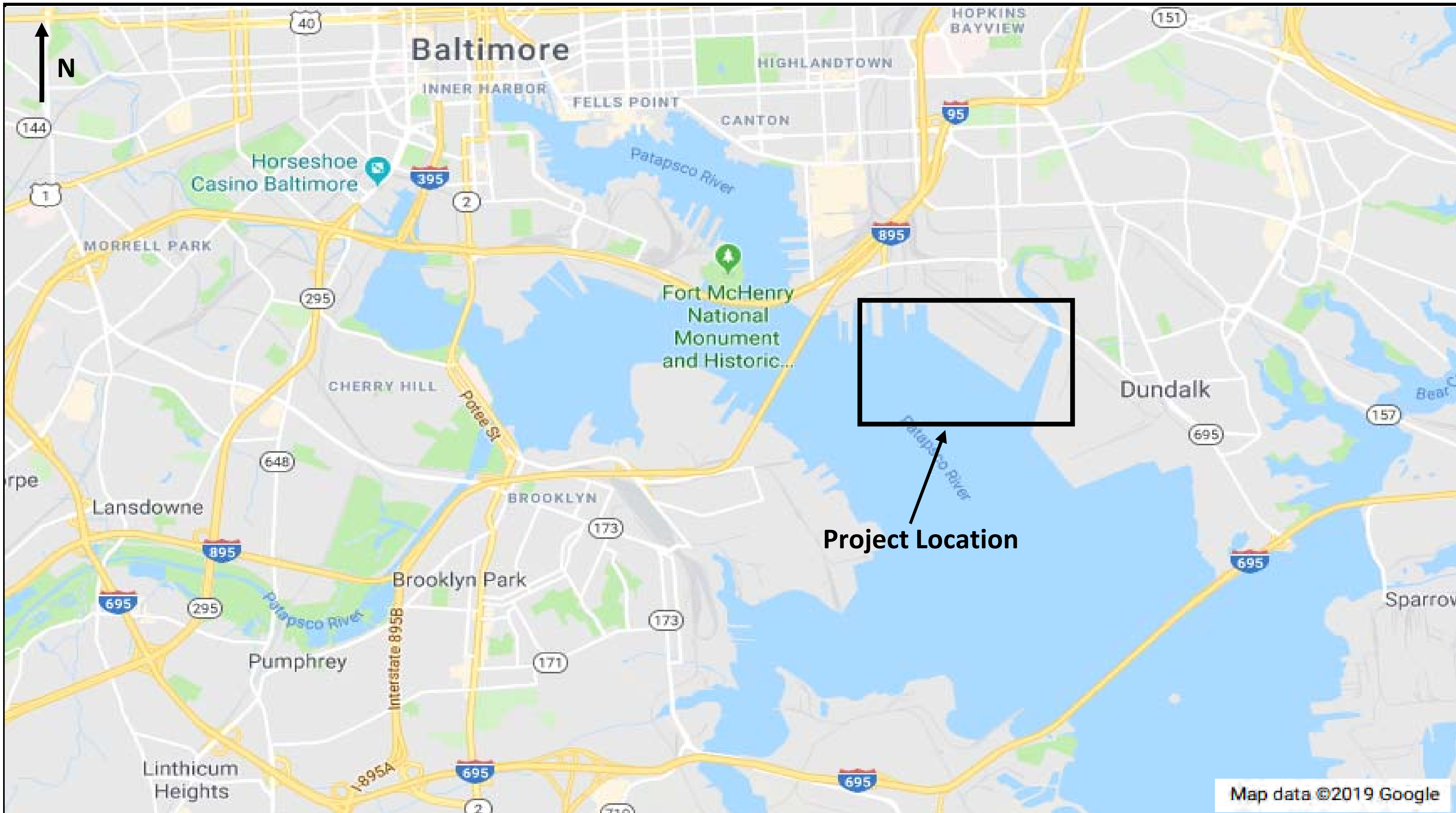
The remaining soil samples are being temporarily stored in our Glen Burnie, Maryland laboratory and are available for review. The samples will be discarded forty-five (45) days following the submittal of this report unless other arrangements are made.

6.0 LIMITATIONS

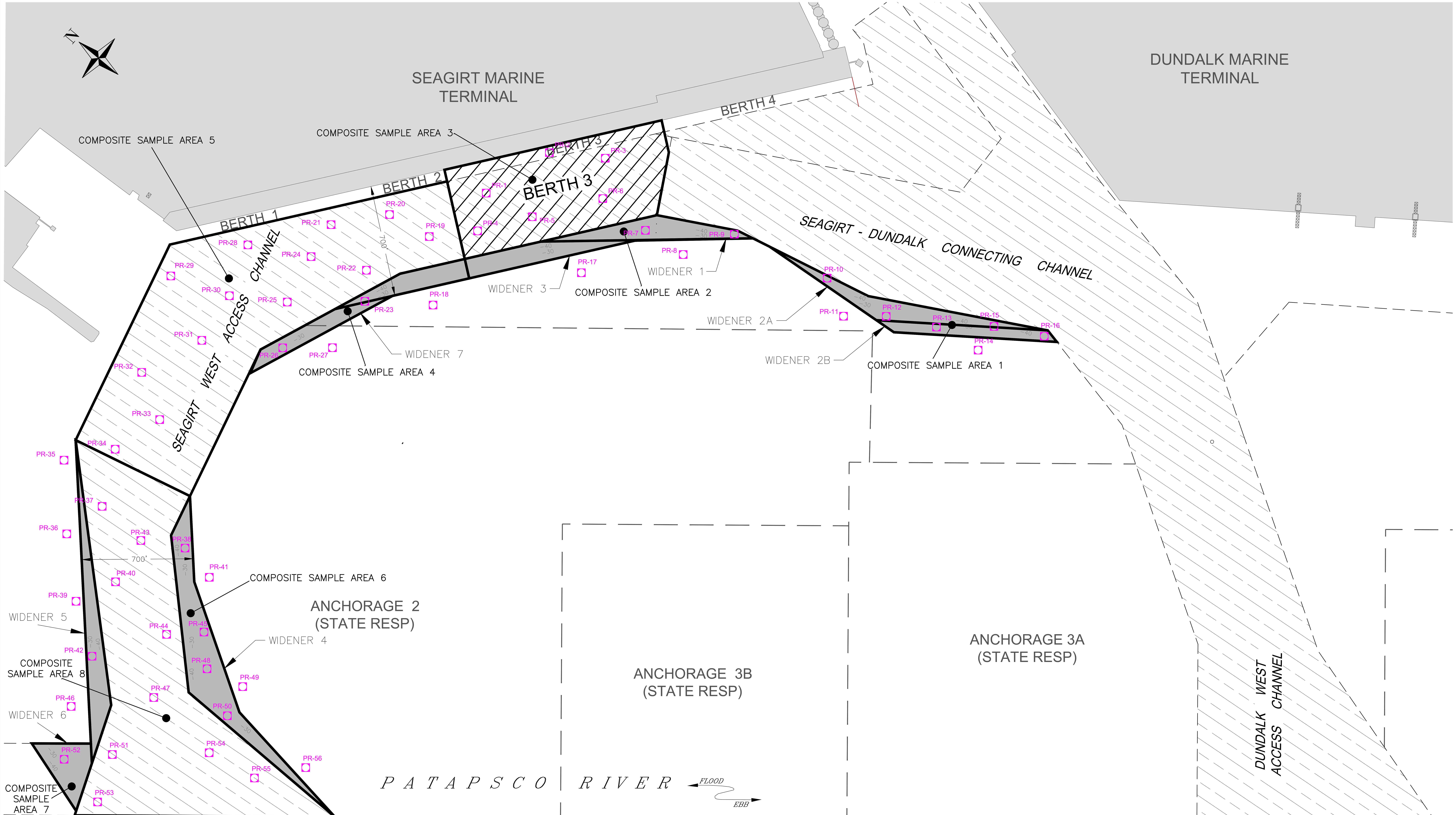
This report has been prepared to aid in the evaluation of this site and to assist GBA in the design aspects of aforementioned project. All subsurface explorations require the extrapolation of limited amounts of data based on general geologic knowledge. The water level observations, geologic descriptions, presented on the accompanying logs have been made with reasonable care and accuracy, but must be considered only an approximate representation of subsurface conditions to be encountered beyond a particular exploratory location.

Variations in the soil conditions noted in this report may be encountered during construction. SaLUT-TLB should be retained to observe subsurface conditions encountered during construction and to verify that conditions are compatible with the findings of this study. SaLUT-TLB should be contacted immediately if significant variations are encountered or if the proposed locations or designs are altered.

We have completed these services in accordance with general engineering practices used by members of the profession in the same region and under similar conditions of this project. We make no warranty or guarantee, either expressed or implied, for these services.



SaLUT-TLB Soil and Land Use Technology, Inc. Glen Burnie, Maryland	Seagirt Loop Channel Deepening Baltimore, Maryland	**PROJECT LOCATION PLAN**		
		DRAWN BY: OE	**CHECKED BY:** ED	**DRAWING NO.:** 1
		JOB NO.:18-0043	**DATE:** MAR 2019	**SCALE:** NTS



COMPOSITE SAMPLE AREA 1 (PHASE 1)		
PR. BORING	EASTING	NORTHING
PR-10	1441386.0803	576416.2574
PR-11	1441268.6613	576183.1192
PR-12	1441440.2735	575976.898
PR-13	1441591.8165	575691.9358
PR-14	1441649.1389	575398.3053
PR-15	1441827.5281	575417.5132
PR-16	1441983.1282	575135.5544

COMPOSITE SAMPLE AREA 2 (PHASE 1)		
PR. BORING	EASTING	NORTHING
PR-7	1440881.6958	577484.172
PR-8	1440917.6434	577204.1649
PR-9	1441222.5504	577040.2574
PR-17	1440418.7174	577621.1743

COMPOSITE SAMPLE AREA 3 (PHASE 1)		
PR. BORING	EASTING	NORTHING
PR-1	1440417.67	578401.036
PR-2	1440867.845	578260.2853
PR-3	1441066.7303	577968.2668
PR-4	1440200.7509	578289.8773
PR-5	1440489.9875	578083.8059
PR-6	1440861.9873	577817.2736

COMPOSITE SAMPLE AREA 4 (PHASE 2)		
PR. BORING	EASTING	NORTHING
PR-18	1439663.8782	578204.704
PR-23	1439406.6793	578548.228
PR-26	1438850.5128	578755.8638
PR-27	1439052.0762	578516.862

COMPOSITE SAMPLE AREA 5 (PHASE 2)		
PR. BORING	EASTING	NORTHING
PR-19	1439978.3964	578499.6903
PR-20	1439923.422	578779.8429
PR-21	1439638.8122	579020.4536
PR-22	1439562.2206	578666.313
PR-24	1439404.423	578987.5915
PR-25	1439089.3611	578918.9919
PR-28	1439205.382	579339.5189
PR-29	1438744.3601	579584.7894
PR-30	1438885.7923	579222.9721
PR-31	1438559.7439	579175.4598
PR-32	1438162.7446	579335.731
PR-33	1438007.9953	579058.5037
PR-34	1437685.3715	579153.0294

COMPOSITE SAMPLE AREA 6 (PHASE 2)		
PR. BORING	EASTING	NORTHING
PR-38	1437491.9489	578417.2049
PR-41	1437449.1108	578182.4102
PR-45	1437164.0436	577986.8197
PR-48	1436999.6013	577823.7906
PR-49	1437057.9605	577579.8153
PR-50	1436855.5389	577536.0004
PR-56	1436922.7654	576949.4077

COMPOSITE SAMPLE AREA 7 (PHASE 2)		
PR. BORING	EASTING	NORTHING
PR-35	1437426.1048	579355.1833
PR-36	1437082.3542	579044.0955
PR-39	1436795.3538	578727.3493
PR-42	1436595.5865	578428.1664
PR-46	1436269.5955	578326.0217
PR-52	1435986.7205	578146.3857

COMPOSITE SAMPLE AREA 8 (PHASE 2)		
PR. BORING	EASTING	NORTHING
PR-37	1437357.7321	578984.9141
PR-40	1437048.4475	578615.467
PR-43	1437349.6848	578660.5862
PR-44	1437001.9553	578157.6202
PR-47	1436646.1089	577964.469
PR-51	1436204.2654	577933.3239
PR-53	1435916.3407	577812.9134
PR-54	1436603.95	577474.4278
PR-55	1436665.4302	577154.2811

BATHYMETRY NOTE:

1. CONTOURS SHOWN ARE IN MEAN LOWER LOW WATER (MLLW), AND ARE FROM MARCH 2016 THROUGH JANUARY 2018 USACE BATHYMETRIC SURVEYS.

LEGEND

BORINGS – PROPOSED JUNE 2018

EXISTING CHANNEL

PROPOSED WIDENING

GRAPHIC SCALE 0 300' 600'

MARYLAND PORT ADMINISTRATION
HARBOR DEVELOPMENT

GBA ENGINEERS ★ SURVEYORS
9008 Yellow Brick Rd. Unit O Baltimore, MD 21237 Phone (410) 682-5595

SEAGIRT MARINE TERMINAL 50 FT STUDY
BALTIMORE, MARYLAND

SEAGIRT LOOP CHANNEL DEEPENING AND WIDENING

Designed by: DLB | Dwn by: DCM | Ckd by: BMN | Reviewed by: OAK | Submitted by: WAM
Date: OCT. 2018 | Drawing Name: Seagirt_Geotech | Scale: AS SHOWN | Plot scale: 1 = 1

SEAL

Drawing No. 2: Boring Location Plan

APPENDIX A

RECORDS OF SOIL EXPLORATION

GENERAL CLASSIFICATION SUMMARY FOR SOIL AND ROCK EXPLORATION

SOIL

Particle Size Identification

Boulders		- 12 inch diameter or more
Cobbles		- 3 to 12 inch diameter
Gravel	- Coarse	- 3/4 to 3 inches
	- Fine	- 4.75mm to 3/4 inch
Sand	- Coarse	- 2.00mm to 4.75 mm [Sieve #10 to #4]
	- Medium	- 0.4mm to 2.00mm [Sieve #40 to #10]
	- Fine	- 0.075mm to 0.4mm [Sieve #200 to #40]
Silt/Clay		- less than 0.075mm (Cannot see particles)
Silt		- Atterberg limits plot below "A" line
Clay		- Atterberg limits plot above "A" line

Relative Proportions

In accordance with ASTM D 2487 and ASTM D 2488

COHESIONLESS SOILS

Density	*N-Value*
Very loose	0-4 blows/ft.
Loose	5-10 blows/ft.
Medium Dense	11-30 blows/ft.
Dense	31-50 blows/ft.
Very Dense	> 50 blows/ft.

COHESIVE SOILS

Consistency	*N-Value*
Very Soft	0-1 blows/ft
Soft	2-4 blows/ft.
Medium Stiff	5- 8 blows/ft.
Stiff	9-15 blows/ft.
Very Stiff	16-30 blows/ft.
Hard	> 30 blows/ft.

Classifications on logs are made by visual inspection.

Standard Penetration Test - Driving a 2.0" O.D., 1 3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free failing a distance of 30.0 inches. It is customary for us to drive the spoon 6.0 inches of penetration to seat into undisturbed soil, and then perform the test. The number of hammer blows for seating the spoon and making the tests are recorded for each 6.0 inches of penetration on the drill log (Example: 6-8-9). The standard penetration test resistance or "N"-value can be obtained by adding the last two figures (i.e., 8 + 9 = 17 blows/ft.).

Strata Changes - In the column "Soil Descriptions" on the drill log, the horizontal lines represent estimated strata changes.

Groundwater observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

ROCK

Rock Quality Designation (RQD) - The sum of the lengths of pieces of recovered core which are greater than four inches in length, expressed as a percentage of the total length of the core run. If the core has been broken by the drilling process, it is considered to be intact provided the broken fragments are cumulatively greater than 4 inches in length. For this investigation, vertical separations which split the core have not been considered discontinuities when determining RQD.

Recovery (REC) - The total length of core recovered expressed as a percentage of the total length of that coring run.

ROCK CLASSIFICATION

Residual Soil – reduced to soil. Rock fabric not discernible. Can be easily broken by hand.
Completely weathered (Saprolite) – Rock fabric discernible in a few scattered locations. Effectively reduced to soil and can be broken by hand.
Highly weathered – Almost all of the rock shows severe discoloration and weathering. Rock fabric evident in majority of the rock.
Moderately weathered – Significant portions show discoloration and weakening (softening, lighter color). Shows loss of weight. Rock fabric evident.
Slightly weathered – Slightly discolored. Lower in strength than fresh rock. Dull under hammer.
Fresh - No visible signs of discoloration or decomposition.

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 1
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/7/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 3 2. 578387.55 N 1440418.45 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 1
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/7/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-49.4		49.0								
	Gray, wet, very soft, elastic **SILT**, **(MH)**			50		WOR/18"	1	DS	12	
						WOR/18"	2	DS	18	
				55		WOR/18"	3	DS	15	
-58.4		58.0				WOR/18"	4	DS	18	
	Bottom of Boring at 58.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR- 2
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/12/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 3 2. 578240.32 N 1440788.45 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. ______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 2
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/12/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-46.3		47.0								
	Brown, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	8	
				50		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	15	
				60		WOR/18"	6	DS	18	
-60.3		61.0								
	Bottom of Boring at 61.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 3
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/6/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/6/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5 10 15 20 25 30 35 40						1. Area 3 2. 577978.12 N 1441071.79 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 3
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.4 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/6/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/6/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-49.6		50.0		50						
	Gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	18	
						WOR/18"	2	DS	14	
				55		WOR/18"	3	DS	18	
-58.6		59.0				WOR/18"	4	DS	18	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 4
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/7/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5 10 15 20 25 30 35 40						1. Area 3 2. 578283.25 N 1440214.8 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 4
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/7/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-47.9		49.0								
	Gray, wet, very soft, elastic **SILT**, **(MH)**			50		WOR/18"	1	DS	18	
						WOR/18"	2	DS	8	
				55		WOR/18"	3	DS	18	
-56.9		58.0				WOR/18"	4	DS	18	
	Bottom of Boring at 58.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 5
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/7/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			0–40 (5, 10, 15, 20, 25, 30, 35, 40)						1. Area 3 2. 578091.83 N 1440507.82 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR- 5
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/7/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/7/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-49.8		50.0		50						
	Gray, wet, very soft, elastic **SILT**					WOR/18"	1	DS	18	
						WOR/18"	2	DS	18	
				55		WOR/18"	3	DS	18	
-58.8		59.0				WOR/18"	4	DS	18	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 6
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.8 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/6/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/6/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 3 2. 577852.7 N 1440848.53 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 6
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.8 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/6/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/6/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-50.2		51.0		50						
	Gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	14	
				55		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
-59.2		60.0		60		WOR/18"	4	DS	18	
	Bottom of Boring at 60.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR- 7
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.0 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/10/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 2 2. 577490.31 N 1440874.29 E
-24.0		25.0		25						
	Black, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	10	
						WOR/18"	2	DS	12	
				30		WOR/18"	3	DS	14	
-33.0		34.0				WOR/18"	4	DS	15	
	Dark gray, wet, very soft, elastic **SILT**			35		WOR/18"	5	DS	15	
-35.5		36.5								
	Gray, wet, very soft, elastic **SILT**					WOR/18"	6	DS	15	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR- 7
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.0 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/10/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, elastic **SILT** *(continued)*					WOR/18"	7	DS	18	
						WOR/18"	8	DS	14	
				45		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				50		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
				55		WOR/18"	13	DS	18	
-58.0		59.0				WOR/18"	14	DS	15	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR- 8
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.0 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/10/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 2 2. 577206.57 N 1440904.41 E
-21.0	Gray, wet, very soft, elastic **SILT**	22.0				WOR/18"	1	DS	14	
-22.5	Gray, black, wet, very soft, elastic **SILT**, **(MH)**	23.5		25		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
				30		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
-32.5	Gray, wet, very soft, elastic **SILT**, **(MH)**	33.5		35		WOR/18"	6	DS	18	
						WOR/18"	7	DS	18	
				40						

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 8
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.0 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/10/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	8	DS	18	
						WOR/18"	9	DS	18	
				45		WOR/18"	10	DS	18	
						WOR/18"	11	DS	18	
				50		WOR/18"	12	DS	18	
						WOR/18"	13	DS	18	
				55		WOR/18"	14	DS	18	
						WOR/18"	15	DS	18	
-60.0		61.0		60		WOR/18"	16	DS	18	
	Bottom of Boring at 61.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 9
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.0 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/14/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/14/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 2 2. 577067.3 N 1441281.03 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR- 9
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.0 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/14/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/14/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
				50						
-51.0		52.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	6	
-52.5		53.5								
	Gray, wet, very soft, elastic **SILT**, **(MH)**			55		WOR/18"	2	DS	10	
						WOR/18"	3	DS	12	
				60		WOR/18"	4	DS	18	
-60.0		61.0								
	Bottom of Boring at 61.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-10
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/14/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/14/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 576427.13 N 1441383.55 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-10
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/14/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/14/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*		45						
-47.3		49.0							
	Black, wet, very soft, elastic **SILT**		50		WOR/18"	1	DS	6	
					WOR/18"	2	DS	8	
-51.3		53.0							
	Gray, wet, very soft, elastic **SILT**		55		WOR/18"	3	DS	14	
					WOR/18"	4	DS	14	
			60		WOR/18"	5	DS	14	
-58.8		60.5							
	Bottom of Boring at 60.5 ft		65						
			70						
			75						
			80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-11
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.4 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/11/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/11/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 576187.01 E 1441274.66 N
				5						
				10						
				15						
				20						
-21.6		23.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	6	
				25		WOR/18"	2	DS	8	
						WOR/18"	3	DS	15	
				30		WOR/18"	4	DS	18	
						WOR/18"	5	DS	3	
				35		WOR/18"	6	DS	15	
-35.6		37.0								
	Gray, wet, very soft, fat **CLAY**					WOR/18"	7	DS	18	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-11
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.4 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/11/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/11/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, fat **CLAY** *(continued)*					WOR/18"	8	DS	18	
				45		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				50		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
				55		WOR/18"	13	DS	18	
						WOR/18"	14	DS	18	
-58.1		59.5		60		WOR/18"	15	DS	18	
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-12
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/12/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 575994.1 N 1441432.01 E
-21.8		23.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	7	
				25		WOR/18"	2	DS	10	
						WOR/18"	3	DS	10	
				30						
-30.8		32.0				WOR/18"	4	DS	10	
	Brown, dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	5	DS	10	
				35		WOR/18"	6	DS	12	
				40		WOR/18"	7	DS	12	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-12
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/12/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Brown, dark gray, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	8	DS	18	
				45		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				50		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
				55		WOR/18"	13	DS	18	
						WOR/18"	14	DS	18	
-58.3		59.5		60		WOR/18"	15	DS	18	
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-13
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/12/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 575717.76 N 1441578.68 E
				5						
				10						
				15						
				20						
-22.8		24.0								
	Black, wet, very soft, elastic **SILT**			25		WOR/18"	1	DS	8	
						WOR/18"	2	DS	10	
				30		WOR/18"	3	DS	12	
						WOR/18"	4	DS	10	
-34.3		35.5		35		WOR/18"	5	DS	12	
	Gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	6	DS	14	
				40		WOR/18"	7	DS	18	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-13
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/12/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/12/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	8	DS	18	
				45		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				50		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
				55		WOR/18"	13	DS	18	
						WOR/18"	14	DS	18	
-59.3		60.5		60		WOR/18"	15	DS	18	
	Bottom of Boring at 60.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-14
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/11/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/11/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 575400.7 N 1441670.31 E
-21.8		23.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	18	
				25		WOR/18"	2	DS	18	
						WOR/18"	3	DS	12	
				30		WOR/18"	4	DS	12	
-30.8		32.0								
	Gray, wet, very soft, elastic **SILT**					WOR/18"	5	DS	18	
				35		WOR/18"	6	DS	18	
				40		WOR/18"	7	DS	18	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-14
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/11/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/11/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, elastic **SILT** *(continued)*					WOR/18"	8	DS	18	
				45		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				50		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
				55		WOR/18"	13	DS	18	
						WOR/18"	14	DS	18	
-58.3		59.5		60		WOR/18"	15	DS	18	
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-15
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/13/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/13/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 575376.43 N 1441841.45 E
				5						
				10						
				15						
				20						
				25						
				30						
-33.4		35.0		35						
	Black, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	3	
						WOR/18"	2	DS	3	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-15
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/13/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/13/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Black, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	3	DS	14	
						WOR/18"	4	DS	15	
				45		WOR/18"	5	DS	18	
						WOR/18"	6	DS	15	
-48.4	Gray, wet, very soft, fat **CLAY**	50.0		50		WOR/18"	7	DS	18	
						WOR/18"	8	DS	18	
				55		WOR/18"	9	DS	18	
-57.4	Bottom of Boring at 59.0 ft	59.0				WOR/18"	10	DS	18	
				60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-16
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/20/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/20/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 1 2. 575143.1 N 1442012.05 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With	Gahagan & Bryant Associates	Boring #	PR-16
Project Name	Task 17 - Seagirt Loop Channel Deepening	Job #	18-0043
Location	Baltimore, MD		

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/20/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/20/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*							
-50.3		51.0						
	Black, wet, very soft to soft, **SILT**			WOR/18"	1	DS	4	
				WOH/12"-2	2	DS	6	
-54.3		55.0						
	Gray, wet, very soft, **CLAY**			WOH/18"	3	DS	12	
				WOH/12"-6	4	DS	10	
-60.8		61.5						
	Brown, wet, medium dense, clayey **SAND**, and fine Gravel			7-7-6	5	DS	10	
-63.3		64.0						
	Gray, wet, loose to medium dense, fine to coarse, **SAND**, and fine Gravel			7-6-4	6	DS	10	
				6-4-4	7	DS	10	
-66.8		67.5						
	Bottom of Boring at 67.5 ft							

Depth scale: 45, 50, 55, 60, 65, 70, 75, 80

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-17
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/10/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 2 2. 577624.52 N 1440418.84 E
-21.8		22.5								
	Black, wet, very soft, fat **CLAY**					WOR/18"	1	DS	8	
				25		WOR/18"	2	DS	10	
						WOR/18"	3	DS	14	
				30		WOR/18"	4	DS	15	
-33.3		34.0				WOR/18"	5	DS	18	
	Dark gray, black, wet, very soft, fat **CLAY**, **(CH)**			35		WOR/18"	6	DS	18	
				40		WOR/18"	7	DS	18	

SAMPLER TYPE	SAMPLE CONDITIONS	GROUNDWATER DEPTH	BORING METHOD
DS - DRIVEN SPLIT SPOON	D - DISINTEGRATED	AT COMPLETION ______ ft	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	I - INTACT	AFTER ______ HRS. ______ ft	CFA - CONTINUOUS FLIGHT AUGERS
CA - CONTINUOUS FLIGHT AUGER	U - UNDISTURBED	AFTER 24 HRS. ______ ft	DC - DRIVING CASING
RC - ROCK CORE	L - LOST	CAVED AT ______ ft	MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-17
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/10/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/10/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Dark gray, black, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	8	DS	15	
-43.3		44.0				WOR/18"	9	DS	18	
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**			45		WOR/18"	10	DS	18	
						WOR/18"	11	DS	18	
				50		WOR/18"	12	DS	18	
						WOR/18"	13	DS	18	
				55		WOR/18"	14	DS	18	
-58.3		59.0				WOR/18"	15	DS	18	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-18
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	2.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/21/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/21/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 4 2. 578230.52 N 1439625.1 E
-19.6		22.0								
	Black, dark gray, wet, very soft, elastic **SILT**, with sand, **(MH)**					WOR/18"	1	DS	14	
				25		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
				30		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
				35		WOR/18"	6	DS	18	
-36.1		38.5				WOR/18"	7	DS	15	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-18
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.4 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/21/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/21/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, brown, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	8	DS	18	
						WOR/18"	9	DS	18	
				45		WOR/18"	10	DS	18	
						WOR/18"	11	DS	18	
				50		WOR/18"	12	DS	18	
						WOR/18"	13	DS	18	
				55		WOR/18"	14	DS	18	
						WOR/18"	15	DS	18	
-58.6		61.0		60		WOR/18"	16	DS	18	
	Bottom of Boring at 61.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-19
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.0 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 578539.11 N 1440002.23 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-19
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	2.0 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/17/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-47.0		49.0								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			50		WOR/18"	1	DS	15	
						WOR/18"	2	DS	18	
				55		WOR/18"	3	DS	18	
						WOR/18"	4	DS	18	
-56.0		58.0								
	Bottom of Boring at 58.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-20
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.4 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 578798.45 N 1439933.66 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-20
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/17/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-46.6		48.0								
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	18	
				50		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
-58.1		59.5		60						
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-21
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579027.67 N 1439621.84 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-21
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-46.7		48.0								
	Gray, dark greenish brown, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	1	DS	9	
				50		WOR/18"	2	DS	18	
				55		WOR/18"	3	DS	18	
						WOR/18"	4	DS	18	
-55.7		57.0								
	Bottom of Boring at 57.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-22
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 578650.62 N 1439547.35 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-22
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/17/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/17/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-43.7	Black, wet, very soft, elastic **SILT**	46.0				WOR/18"	1	DS	6	
-45.2	Dark gray, wet, very soft, elastic **SILT**, **(MH)**	47.5		50		WOR/18"	2	DS	15	
-49.7	Dark gray, wet, very soft, fat **CLAY**, **(CH)**	52.0				WOR/18"	3	DS	18	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
-57.7		60.0		60		WOR/18"	6	DS	18	
	Bottom of Boring at 60.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-23
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.3 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/26/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/26/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 4 2. 578528.9 N 1439393.75 E
-26.7		28.0								
	Black, wet, very soft, **SILT**					WOR/18"	1	DS	6	
				30		WOR/18"	2	DS	8	
						WOR/18"	3	DS	10	
-34.7		36.0		35						
-35.2	Brown, wet, loose, Silty **SAND**	36.5				WOR/6"-2-3	4	DS	12	
	Brown, dark gray, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	5	DS	12	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-23
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/26/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/26/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Brown, dark gray, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOH/18"	6	DS	5	
				45		WOR/18"	7	DS	9	
						WOR/18"	8	DS	18	
-47.2	Dark gray, wet, very soft, elastic **SILT**, **(MH)**	48.5				WOR/18"	9	DS	5	
				50		WOR/18"	10	DS	18	
						WOR/18"	11	DS	18	
				55		WOR/18"	12	DS	18	
-58.2	Bottom of Boring at 59.5 ft	59.5		60		WOR/18"	13	DS	18	
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-24
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/18/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 578981.14 N 1439396.94 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-24
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/18/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-46.8		47.0								
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	18	
				50		WOR/18"	2	DS	18	
-51.8		52.0								
	Dark gray, wet, very soft, fat **CLAY**					WOR/18"	3	DS	15	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	16	
-58.3		58.5								
	Bottom of Boring at 58.5 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-25
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/18/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579033.53 N 1439109.98 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-25
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/18/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-49.4		50.0		50						
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	1	DS	15	
						WOR/18"	2	DS	15	
				55		WOR/18"	3	DS	18	
-58.4		59.0				WOR/18"	4	DS	18	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-26
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/27/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/27/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 4 2. 578724.72 N 1438875.95 E
-21.8		23.0								
	Black, wet, very soft, fat **CLAY**					WOR/18"	1	DS	9	
				25		WOR/18"	2	DS	15	
						WOR/18"	3	DS	12	
				30		WOR/18"	4	DS	15	
						WOR/18"	5	DS	12	
				35		WOR/18"	6	DS	18	
				40		WOR/18"	7	DS	15	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-26
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.2 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/27/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/27/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Black, wet, very soft, fat **CLAY** *(continued)*					WOR/18"	8	DS	18	
						WOR/18"	9	DS	18	
-43.8		45.0		45						
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	10	DS	18	
						WOR/18"	11	DS	15	
-48.8		50.0		50						
	Black, wet, very soft, fat **CLAY**					WOR/18"	12	DS	18	
						WOR/18"	13	DS	14	
				55						
						WOR/18"	14	DS	18	
						WOR/18"	15	DS	18	
-58.3		59.5		60						
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-27
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/27/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/27/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER							1. Area 4 2. 578555.9 N 1439086.09 E
-19.9	Black, wet, very soft, **CLAY**	21.0		WOR/18"	1	DS	9	
				WOR/18"	2	DS	12	
-23.9	Dark gray, black, wet, very soft, fat **CLAY**	25.0		WOR/18"	3	DS	14	
				WOR/18"	4	DS	15	
				WOR/18"	5	DS	14	
				WOR/18"	6	DS	15	
				WOR/18"	7	DS	15	
-36.4	Dark gray, wet, very soft, elastic **SILT**, **(MH)**	37.5		WOR/18"	8	DS	15	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-27
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/27/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/27/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Dark gray, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	9	DS	18	
				45		WOR/18"	10	DS	15	
						WOR/18"	11	DS	18	
				50		WOR/18"	12	DS	18	
						WOR/18"	13	DS	18	
				55		WOR/18"	14	DS	18	
						WOR/18"	15	DS	18	
-58.9		60.0		60		WOR/18"	16	DS	18	
	Bottom of Boring at 60.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-28
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/18/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			0–40						1. Area 5 2. 579334.71 N 1439198.76 E

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-28
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/18/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/18/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-47.4	Dark gray, wet, very soft, elastic **SILT**, **(MH)**	48.0		50		WOR/18"	1	DS	7	
						WOR/18"	2	DS	18	
						WOR/18"	3	DS	14	
-54.4	Dark gray, wet, very soft, fat **CLAY**	55.0		55		WOR/18"	4	DS	16	
						WOR/18"	5	DS	18	
-58.9	Bottom of Boring at 59.5 ft	59.5		60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-29
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/19/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/19/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579628.66 N 1438708.3 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With	Gahagan & Bryant Associates	Boring #	PR-29
Project Name	Task 17 - Seagirt Loop Channel Deepening	Job #	18-0043
Location	Baltimore, MD		

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/19/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/19/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-45.6	Black, wet, very soft, **SILT**	46.0				WOR/18"	1	DS	6	
				50		WOR/18"	2	DS	4	
						WOR/18"	3	DS	5	
-52.1	Dark gray, wet, very soft, fat **CLAY**, **(CH)**	52.5		55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	15	
-59.6		60.0		60		WOR/18"	6	DS	18	
	Bottom of Boring at 60.0 ft			65, 70, 75, 80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-30
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.3 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/19/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/19/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579207.97 N 1438917.54 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
- DS - DRIVEN SPLIT SPOON
- PT - PRESSED SHELBY TUBE
- CA - CONTINUOUS FLIGHT AUGER
- RC - ROCK CORE

SAMPLE CONDITIONS
- D - DISINTEGRATED
- I - INTACT
- U - UNDISTURBED
- L - LOST

GROUNDWATER DEPTH
- AT COMPLETION ______ ft
- AFTER ______ HRS. ______ ft
- AFTER 24 HRS. ______ ft
- CAVED AT ______ ft

BORING METHOD
- HSA - HOLLOW STEM AUGERS
- CFA - CONTINUOUS FLIGHT AUGERS
- DC - DRIVING CASING
- MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-30
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/19/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/19/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-48.7		49.0								
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**			50		WOR/18"	1	DS	7	
						WOR/18"	2	DS	18	
-53.2		53.5								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			55		WOR/18"	3	DS	18	
						WOR/18"	4	DS	18	
-60.2		60.5		60		WOR/18"	5	DS	18	
	Bottom of Boring at 60.5 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-31
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.0 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/19/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/19/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5, 10, 15, 20, 25, 30, 35, 40						1. Area 5 2. 579132.27 N 1438527.52 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-31
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.0 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/19/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/19/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-50.0		51.0		50						
-51.5	Black, wet, very soft, fat **CLAY**	52.5				WOR/18"	1	DS	18	
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			55		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
-59.0		60.0		60		WOR/18"	4	DS	18	
	Bottom of Boring at 60.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-32
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 12/20/18	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 12/20/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579392.21 N 1438139.6 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-32
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/20/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/20/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*							
-44.4		45.0						
	Black, wet, very soft, elastic **SILT**			WOR/18"	1	DS	4	
-45.9		46.5						
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			WOR/18"	2	DS	9	
				WOR/18"	3	DS	15	
				WOR/18"	4	DS	18	
				WOR/18"	5	DS	18	
				WOR/18"	6	DS	18	
-58.4		59.0						
	Bottom of Boring at 59.0 ft							

Depth scale: 45, 50, 55, 60, 65, 70, 75, 80

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-33
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.5 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/28/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/28/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5 10 15 20 25 30 35 40						1. Area 5 2. 579027.25 N 1437981.34 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-33
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.5 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/28/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/28/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-47.5		49.0								
	Black, wet, very soft, elastic **SILT**			50		WOR/18"	1	DS	7	
-49.0		50.5								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	2	DS	16	
				55		WOR/18"	3	DS	18	
						WOR/18"	4	DS	18	
				60		WOR/18"	5	DS	15	
-59.0		60.5								
	Bottom of Boring at 60.5 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-34
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	2.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/28/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/28/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 5 2. 579157.52 N 1437661.81 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-34
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	2.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	12/28/18	Spoon Size	2 in	Boring Method	HSA	Date Completed	12/28/18

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-43.6		46.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	4	
-45.1		47.5								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			50		WOR/18"	2	DS	16	
						WOR/18"	3	DS	18	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
-57.6		60.0		60		WOR/18"	6	DS	18	
	Bottom of Boring at 60.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-35
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.3 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/2/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/2/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 7 2. 579367.57 N 1437422.29 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-35
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/2/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/2/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
-41.7	**WATER** *(continued)*	42.0								
-45.7	Black, moist to wet, medium stiff to very stiff, elastic **SILT**	46.0				2-2-3	1	DS	18	
				45		5-5-11	2	DS	12	
-48.2	Dark green, moist to wet, very loose, fine to coarse, silty **SAND**, with gravel	48.5				2-1-1	3	DS	10	
-55.7	Gray, brown, moist to wet, very soft to soft, **SILT**, with sand, **(ML)**	56.0		50		WOH/6"-1-2	4	DS	18	
						WOH/18"	5	DS	18	
				55		WOR/18"	6	DS	18	
-60.7	Gray, moist to wet, soft to medium stiff, elastic **SILT**, trace sand, trace mica	61.0				WOH/6"-2-3	7	DS	18	
				60		WOH/12"-4	8	DS	16	
	Bottom of Boring at 61.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-36
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/2/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/2/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 7 2. 579039.74 N 1437071.29 E
-19.8		20.0		20						
	Black, brown, grey, wet, very soft, **CLAY**					WOR/18"	1	DS	7	
-23.8		24.0				WOR/18"	2	DS	10	
	Black, brown, dark gray, wet, very soft, fat **CLAY**, **(CH)**			25		WOR/18"	3	DS	15	
						WOR/18"	4	DS	12	
				30		WOR/18"	5	DS	18	
						WOR/18"	6	DS	16	
				35		WOR/18"	7	DS	14	
						WOR/18"	8	DS	18	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-36
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.2 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/2/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/2/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Black, brown, dark gray, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	9	DS	13	
						WOR/18"	10	DS	5	
				45		WOR/18"	11	DS	7	
-46.3	Dark greenish-brown, wet, loose to medium dense, fine to coarse, **SAND**, some silt and gravel	46.5				6-9-10	12	DS	2	
				50		5-10-12	13	DS	10	
						4-6-7	14	DS	6	
				55		3-3-7	15	DS	5	
						1-3-5	16	DS	12	
-58.8	Bottom of Boring at 59.0 ft	59.0		60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-37
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/9/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 579010.45 N 1437367.65 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-37
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/9/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-45.3		47.0								
	Black, wet, very soft, elastic **SILT**					WOR/18"	1	DS	8	
-46.8		48.5								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**			50		WOR/18"	2	DS	18	
						WOR/18"	3	DS	15	
				55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
				60		WOR/18"	6	DS	18	
-59.3		61.0								
	Bottom of Boring at 61.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-38
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.8 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/14/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/14/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 578408.06 N 1437491.71 E
-27.2		28.0								
	Black, wet, very soft, fat **CLAY**					WOR/18"	1	DS	5	
				30		WOR/18"	2	DS	7	
-33.7		34.5				WOR/18"	3	DS	10	
	Dark green, wet, very soft, fat **CLAY**, **(CH)**			35		WOR/18"	4	DS	18	
				40		WOR/18"	5	DS	18	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-38
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.8 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/14/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/14/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Dark green, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	6	DS	18	
						WOR/18"	7	DS	18	
-44.2		45.0		45						
	Dark green, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	8	DS	18	
						WOR/18"	9	DS	16	
-49.2		50.0		50						
	Dark gray, wet, very soft, fat **CLAY**					WOR/18"	10	DS	18	
						WOR/18"	11	DS	18	
				55						
						WOR/18"	12	DS	18	
						WOR/18"	13	DS	18	
-58.7		59.5		60						
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-39
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.9 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/3/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/3/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER							1. Area 7 2. 578726.69 N 1436798.21 E
-21.1	Black, gray, wet, very soft, elastic **SILT**, **(MH)**	22.0		WOR/18"	1	DS	12	
				WOR/18"	2	DS	18	
				WOR/18"	3	DS	18	
				WOR/18"	4	DS	18	
-30.1	Dark gray, wet, very loose to loose, fine to coarse, **SAND**, some gravel, trace silt, trace shells	31.0		2-2-3	5	DS	9	
				6-2-1	6	DS	7	
-35.1	Brown, wet, medium stiff, sandy **SILT**, trace mica	36.0		2-2-3	7	DS	11	
-38.1		39.0						

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-39
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.9 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/3/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/3/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Greenish-brown, wet, very loose, fine, silty **SAND**, **(SM)** *(continued)*					WOH/6"-1-1	8	DS	18	
						WOH/12"-1	9	DS	18	
-42.6		43.5								
	Orange- brown, brown, wet, medium dense, fine, silty **SAND**, some gravel, **(SM)**			45		28-7-6	10	DS	18	
						8-12-17	11	DS	15	
-47.6		48.5								
	Brown, wet, soft, **CLAY**			50		5-2-2	12	DS	10	
-49.6		50.5								
	Dark gray, wet, soft, **SILT**, with sand, **(ML)**					6-2-2	13	DS	7	
-52.6		53.5								
	Orange-brown, wet, medium dense, fine, **SAND**, trace silt			55		2-7-8	14	DS	15	
						2-8-9	15	DS	9	
				60		4-8-12	16	DS	10	
-60.1		61.0								
	Bottom of Boring at 61.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-40
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/9/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 578642.07 N 1437025.38 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-40
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/9/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-45.9		47.0								
	Dark gray, wet, very soft, fat **CLAY**, trace sand, **(CH)**					WOR/18"	1	DS	18	
				50		WOR/18"	2	DS	18	
						WOR/18"	3	DS	18	
-51.9		53.0								
	Dark gray, wet, very soft, elastic **CLAY**, **(MH)**			55		WOR/18"	4	DS	18	
						WOR/18"	5	DS	18	
				60		WOR/18"	6	DS	18	
-59.9		61.0								
	Bottom of Boring at 61.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-41
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.5 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/8/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/8/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 578181.16 N 1437432.76 E
-26.5		28.0								
	Black, wet, very soft, fat **CLAY**					WOR/18"	1	DS	4	
				30		WOR/18"	2	DS	10	
-33.0		34.5				WOR/18"	3	DS	12	
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**			35		WOR/18"	4	DS	15	
				40		WOR/18"	5	DS	18	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-41
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.5 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/8/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/8/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Dark gray, wet, very soft, elastic **SILT**, **(MH)** *(continued)*					WOR/18"	6	DS	18	
				45		WOR/18"	7	DS	18	
						WOR/18"	8	DS	18	
				50		WOR/18"	9	DS	16	
						WOR/18"	10	DS	18	
				55		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
-58.0		59.5		60		WOR/18"	13	DS	16	
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-42
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/9/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 7 2. 578425.93 N 1436587.91 E
-33.3		34.0								
	Black, wet, very soft, elastic **SILT**, trace fine sand			35		WOR/18"	1	DS	4	
						WOR/18"	2	DS	8	
				40		WOR/18"	3	DS	12	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-42
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/9/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Black, wet, very soft, elastic **SILT**, trace fine sand *(continued)*					WOR/18"	4	DS	15	
				45		WOR/18"	5	DS	15	
-45.3	Dark gray, wet, very soft, fat **CLAY**, trace fine sand	46.0				WOR/18"	6	DS	15	
				50		WOR/18"	7	DS	15	
						WOR/18"	8	DS	15	
				55		WOR/18"	9	DS	15	
						WOR/18"	10	DS	12	
-59.8		60.5		60		WOR/18"	11	DS	7	
	Bottom of Boring at 60.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL EXPLORATION SEAGIRT LOGS.GPJ TLB2010.GDT 5/1/19

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-43
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/9/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 578666.37 N 1437370.13 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-43
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/9/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/9/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-47.4		49.0								
	Dark gray, wet, very soft, fat **CLAY**			50		WOR/18"	1	DS	18	
-49.4		51.0								
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	2	DS	18	
				55		WOR/18"	3	DS	15	
						WOR/18"	4	DS	15	
-56.4		58.0								
	Bottom of Boring at 58.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With	Gahagan & Bryant Associates	Boring #	PR-44
Project Name	Task 17 - Seagirt Loop Channel Deepening	Job #	18-0043
Location	Baltimore, MD		

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/10/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 578134.06 N 1437023.39 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-44
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-1.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/10/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*									
-46.1		45.0		45						
	Black, wet, very soft, **CLAY**					WOR/18"	1	DS	8	
-47.6	Dark gray, wet, very soft, fat **CLAY**, trace sand, **(CH)**	46.5				WOR/18"	2	DS	12	
				50		WOR/18"	3	DS	18	
						WOR/18"	4	DS	18	
				55		WOR/18"	5	DS	18	
-60.1		59.0				WOR/18"	6	DS	18	
	Bottom of Boring at 59.0 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-45
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-1.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/10/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 577991.32 N 1437151.02 E
-29.6		28.0								
	Black, wet, very soft, fat **CLAY**					WOR/18"	1	DS	7	
						WOR/18"	2	DS	5	
						WOR/18"	3	DS	12	
-36.6		35.0								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	4	DS	10	
						WOR/18"	5	DS	10	

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION _____ ft
AFTER _____ HRS. _____ ft
AFTER 24 HRS. _____ ft
CAVED AT _____ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-45
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: -1.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/10/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Dark gray, wet, very soft, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	6	DS	18	
				45		WOR/18"	7	DS	15	
						WOR/18"	8	DS	18	
				50		WOR/18"	9	DS	18	
						WOR/18"	10	DS	18	
				55		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
-61.1		59.5		60		WOR/18"	13	DS	18	
	Bottom of Boring at 59.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-46
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/4/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/4/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 7 2. 578332.37 N 1436280.4 E
-22.9		24.0								
	Black, gray, wet, very soft to stiff, fat **CLAY**			25		WOR/18"	1	DS	9	
						WOR/18"	2	DS	10	
				30		WOR/18"	3	DS	8	
-31.9	Trace gravel at 32'	33.0				3-7-8	4	DS	7	
	Brown, wet, very loose to medium dense, fine to coarse, **SAND**, and gravel, trace silt			35		6-11-14	5	DS	10	
						4-6-5	6	DS	9	
				40		2-4-6	7	DS	8	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-46
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 1.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/4/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/4/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Brown, wet, very loose to medium dense, fine to coarse, **SAND**, and gravel, trace silt *(continued)*					3-2-2	8	DS	9	
-41.9		43.0								
	Gray, tan, brown, wet, very loose to loose, fine, **SAND**, trace silt			45		6-3-3	9	DS	7	
						2-3-3	10	DS	14	
				50		2-1-1	11	DS	7	
						1-1-2	12	DS	10	
-52.9		54.0								
	Tan, brown, wet, very loose, fine to medium, **SAND**, **(SP)**			55		2-2-2	13	DS	12	
						2-1-2	14	DS	8	
-59.4		60.5		60		4-4-4	15	DS	6	
	Bottom of Boring at 60.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-47
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.9 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/10/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5, 10, 15, 20, 25, 30, 35, 40						1. Area 8 2. 577963.18 N 1436641.95 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-47
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: -0.9 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/10/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/10/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-48.9		48.0								
-50.4	Light gray, wet, soft, **CLAY**, trace sand, trace mica	49.5				6-1-3	1	DS	12	
-52.9	Reddish brown, wet, very loose, fine, silty **SAND**	52.0		50		WOH/12"-2	2	DS	7	
-55.4	Light gray, wet, very soft, **CLAY**	54.5				WOR/18"	3	DS	5	
	Tan, brown, wet, very loose to medium dense, fine, silty **SAND**			55		WOH/12"-2	4	DS	15	
-60.4		59.5				6-9-5	5	DS	10	
	Bottom of Boring at 59.5 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-48
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.5 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/14/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/14/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 577809.49 N 1436996.37 E
-26.5		27.0								
	Brown, black, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	10	
				30		WOR/18"	2	DS	18	
-31.5		32.0								
	Dark gray, wet, very soft, fat **CLAY**, **(CH)**					WOR/18"	3	DS	17	
				35		WOR/18"	4	DS	18	
						WOR/18"	5	DS	14	
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-48
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.5 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/14/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/14/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
-40.5		41.0				WOR/18"	6	DS	18	
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	7	DS	14	
				45		WOR/18"	8	DS	18	
						WOR/18"	9	DS	16	
				50		WOR/18"	10	DS	18	
						WOR/18"	11	DS	17	
				55		WOR/18"	12	DS	18	
-58.0		58.5				WOR/18"	13	DS	12	
	Bottom of Boring at 58.5 ft			60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-49
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	2.1 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/8/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/8/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 577567.31 N 1437052.45 E
-26.9		29.0								
	Black, gray, wet, very soft, fat **CLAY**			30		WOR/18"	1	DS	6	
						WOR/18"	2	DS	11	
				35		WOR/18"	3	DS	9	
						WOR/18"	4	DS	2	
				40		WOR/18"	5	DS	15	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-49
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/8/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/8/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
-38.9	Black, gray, wet, very soft, fat **CLAY** *(continued)*	41.0								
	Dark gray, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	6	DS	18	
				45		WOR/18"	7	DS	16	
						WOR/18"	8	DS	18	
				50		WOR/18"	9	DS	17	
						WOR/18"	10	DS	18	
				55		WOR/18"	11	DS	18	
						WOR/18"	12	DS	18	
-58.4		60.5		60		WOR/18"	13	DS	18	
	Bottom of Boring at 60.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-50
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/15/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/15/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 577536 N 1436855.53 E
-29.6		31.0		30						
	Gray, black, wet, very soft, elastic **SILT**, **(MH)**					WOR/18"	1	DS	10	
				35		WOR/18"	2	DS	18	
						WOR/18"	3	DS	17	
-38.6		40.0		40		WOR/18"	4	DS	18	

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-50
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	1.4 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/15/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/15/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Gray, wet, very soft, fat **CLAY**					WOR/18"	5	DS	18	
				45		WOR/18"	6	DS	18	
						WOR/18"	7	DS	17	
				50		WOR/18"	8	DS	18	
						WOR/18"	9	DS	18	
				55		WOR/18"	10	DS	18	
						WOR/18"	11	DS	14	
-58.6		60.0		60		WOR/18"	12	DS	18	
	Bottom of Boring at 60.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-51
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: -0.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/11/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			5 10 15 20 25 30 35 40						1. Area 8 2. 577973.42 N 1436379.64 E

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-51
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: -0.6 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/11/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-48.6		48.0								
-50.1	Black, wet, very soft, **CLAY**	49.5				WOR/18"	1	DS	8	
	Gray, wet, very loose, fine to medium, clayey **SAND**			50		3-3-4	2	DS	15	
-55.6		55.0				1-2-3	3	DS	16	
	Gray-brown, wet, very loose to loose, fine to coarse, **SAND**, little gravel, **(SP)**			55		2-3-6	4	DS	18	
						3-3-4	5	DS	13	
-62.6		62.0		60		2-2-1	6	DS	12	
	Bottom of Boring at 62.0 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-52
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/7/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/7/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 7 2. 577936.74 N 1436029.5 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE	SAMPLE CONDITIONS	GROUNDWATER DEPTH	BORING METHOD
DS - DRIVEN SPLIT SPOON	D - DISINTEGRATED	AT COMPLETION ______ ft	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	I - INTACT	AFTER ______ HRS. ______ ft	CFA - CONTINUOUS FLIGHT AUGERS
CA - CONTINUOUS FLIGHT AUGER	U - UNDISTURBED	AFTER 24 HRS. ______ ft	DC - DRIVING CASING
RC - ROCK CORE	L - LOST	CAVED AT ______ ft	MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-52
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 0.3 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/7/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/7/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-45.7		46.0								
	Black, wet, very soft, **CLAY**					WOR/18"	1	DS	6	
						WOR/18"	2	DS	6	
-49.7		50.0		50						
	Gray, brown, wet, very loose, fine, **SAND**, trace silt, **(SP-SM)**					1-1-2	3	DS	18	
-52.7		53.0								
	Gray, brown, wet, very loose, fine, **SAND**, **(SP)**			55		1-1-1	4	DS	16	
						1-2-1	5	DS	14	
						1-1-3	6	DS	17	
-59.7		60.0		60						
	Bottom of Boring at 60.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-53
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.9 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/7/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/7/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 577796.88 N 1435910.87 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-53
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	0.9 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/7/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/7/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
-40.1	**WATER** *(continued)*	41.0								
	Black, wet, very soft, **CLAY** to **SILT**					WOR/18"	1	DS	4	
				45		WOR/18"	2	DS	4	
-46.6		47.5				WOR/18"	3	DS	6	
-49.1	Gray-brown, wet, very loose, fine to medium, **SAND**, trace clay, **(SP)**	50.0		50		3-3-4	4	DS	14	
-51.1	Black, wet, medium stiff, **CLAY**	52.0				6-2-3	5	DS	9	
	Gray-brown, wet, very loose to loose, fine to medium, **SAND**, trace silt, trace gravel			55		6-1-2	6	DS	15	
						2-4-5	7	DS	18	
-59.1		60.0		60		3-3-4	8	DS	18	
	Bottom of Boring at 60.0 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-54
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/11/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER			0–40						1. Area 8 2. 577479.82 N 1436578.7 E

SAMPLER TYPE

DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS

D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH

AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD

HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates — Boring #: PR-54
Project Name: Task 17 - Seagirt Loop Channel Deepening — Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.6 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/11/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*			45						
-48.6		48.0								
-50.1	Dark gray, wet, very soft, sandy fat **CLAY**, **(CH)**	49.5		50		WOR/18"	1	DS	12	
	Tan, wet, very loose to loose, medium to coarse, **SAND**, trace gravel					3-1-2	2	DS	5	
				55		7-4-5	3	DS	3	
						20-6-3	4	DS	4	
-60.1		59.5		60		3-3-3	5	DS	3	
	Bottom of Boring at 59.5 ft			65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-55
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: -0.7 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/11/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 8 2. 577137.49 N 1436714.92 E
				5						
				10						
				15						
				20						
				25						
				30						
				35						
				40						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER _______ HRS. _______ ft
AFTER 24 HRS. _______ ft
CAVED AT _______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-55
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum	MLLW	Hammer Wt.	140 lb	Hole Diameter	8 in	Foreman	M. Fletcher
Surf. Elev.	-0.7 ± ft	Hammer Drop	30 in	Rock Core Dia.	N/A	Inspector	D. Patterson
Date Started	1/11/19	Spoon Size	2 in	Boring Method	HSA	Date Completed	1/11/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER *(continued)*									
-42.7		42.0								
	Dark gray, wet, medium stiff, elastic **SILT**, trace fine sand, **(MH)**					WOR/18"	1	DS	9	
				45		WOR/18"	2	DS	8	
						WOR/18"	3	DS	18	
-50.2		49.5								
	Gray-brown, wet, medium dense, clayey **SAND**, and gravel, **(SC)**			50		4-9-17	4	DS	11	
-52.7		52.0								
	Grayish-brown, wet, very loose to medium dense, clayey **SAND**, little gravel					9-13-14	5	DS	7	
				55		2-2-4	6	DS	10	
						WOH/12"-1	7	DS	6	
-59.2		58.5								
	Bottom of Boring at 58.5 ft									
				60						
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION ______ ft
AFTER ______ HRS. ______ ft
AFTER 24 HRS. ______ ft
CAVED AT ______ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates
Boring #: PR-56
Project Name: Task 17 - Seagirt Loop Channel Deepening
Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/15/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/15/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	WATER									1. Area 6 2. 576972.07 N 1436910.2 E
-31.9		34.0								
	Black, gray, wet, very soft to medium stiff, fat **CLAY**, **(CH)**			35		WOR/18"	1	DS	6	
						WOR/18"	2	DS	16	
				40		WOR/18"	3	DS	18	

SAMPLER TYPE	SAMPLE CONDITIONS	GROUNDWATER DEPTH	BORING METHOD
DS - DRIVEN SPLIT SPOON	D - DISINTEGRATED	AT COMPLETION ______ ft	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	I - INTACT	AFTER ______ HRS. ______ ft	CFA - CONTINUOUS FLIGHT AUGERS
CA - CONTINUOUS FLIGHT AUGER	U - UNDISTURBED	AFTER 24 HRS. ______ ft	DC - DRIVING CASING
RC - ROCK CORE	L - LOST	CAVED AT ______ ft	MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

RECORD OF SOIL / ROCK EXPLORATION

Contracted With: Gahagan & Bryant Associates | Boring #: PR-56
Project Name: Task 17 - Seagirt Loop Channel Deepening | Job #: 18-0043
Location: Baltimore, MD

SAMPLER

Datum: MLLW	Hammer Wt.: 140 lb	Hole Diameter: 8 in	Foreman: M. Fletcher
Surf. Elev.: 2.1 ± ft	Hammer Drop: 30 in	Rock Core Dia.: N/A	Inspector: D. Patterson
Date Started: 1/15/19	Spoon Size: 2 in	Boring Method: HSA	Date Completed: 1/15/19

ELEV. (ft)	SOIL DESCRIPTION Color, Moisture, Density, Plasticity, Size Proportions	STRA DEPTH (ft)	SOIL SYMBOL	DEPTH SCALE	SAMPLE Cond	Blows/6"	No.	Type	Rec (in)	BORING & SAMPLE NOTES
	Black, gray, wet, very soft to medium stiff, fat **CLAY**, **(CH)** *(continued)*					WOR/18"	4	DS	18	
				45		WOR/18"	5	DS	18	
						WOR/18"	6	DS	18	
				50		WOR/18"	7	DS	17	
-50.9		53.0				WOH/6"-2-3	8	DS	18	
	Gray, wet, loose, **ROCK FRAGMENTS**			55		3-4-4	9	DS	4	
-53.4		55.5								
	Grayish-brown, wet, medium dense, medium to coarse, **SAND**, little gravel, trace silt					4-5-8	10	DS	10	
-58.4		60.5		60		6-6-7	11	DS	7	
	Bottom of Boring at 60.5 ft									
				65						
				70						
				75						
				80						

SAMPLER TYPE
DS - DRIVEN SPLIT SPOON
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

GROUNDWATER DEPTH
AT COMPLETION _____ ft
AFTER _____ HRS. _____ ft
AFTER 24 HRS. _____ ft
CAVED AT _____ ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST DRIVING 2" OD SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS

FINDLING, INC.
3401 Carlins Park Drive, Baltimore, Maryland 21215
TEL: 410-367-1400
FAX: 410-466-6867
info@findlinginc.com

July 10, 2012

Gahagan & Bryant Associates, Inc.
9008 Yellow Brick Road, Unit O-P
Baltimore, Maryland 21237-5606

Attention: Mr. Martin R. Snow
Associate

Re: Results of Borings in
Seagirt Marine Terminal Channel
Baltimore, Maryland
Findling Project No. 07-1122-10

Dear Mr. Snow:

Findling, Inc. is pleased to submit this report containing the results of the test borings that were drilled for Seagirt Marine Terminal. This work was performed in order to obtain information related to subsurface condition for a widening project at Seagirt Marine Terminal in the Dundalk West Access Channel and Seagirt-Dundalk Connecting Channel and Turning Basin. This work was performed in accordance with our proposal dated June 2, 2012 and was authorized by you.

1.0 Subsurface Exploration

1.1 Soil Test Borings

A total of fifteen (15) test borings (P-1 to P-15) were drilled in the vicinity of proposed channel widening area. The locations of these borings are shown graphically on Figure 1: Boring Location Plan, in the Appendix.

The test borings were drilled using a truck mounted drill rig positioned above the deck of a barge. The borings were advanced using hollow-stem augers. The borings were advanced to depths ranging from 62.4 feet to 64.2 feet below Mean Lower Low Water (MLLW) level.

1.2 Standard Penetration Test (SPT) Samples

Soil samples were recovered from each boring at 2-foot intervals by driving a 1 3/8 inch ID (2-inch OD) split-spoon sampler in accordance with ASTM D-1586 specifications.

The sampler was first seated about 6-inches to penetrate through the loose cuttings and then driven an additional 1 foot with blows of a 140-pound hammer falling 30 inches. The summation of the number of hammer blows required to drive the sampler two additional successive 6-inches is typically designated as the Standard Penetration Resistance (N) value (i.e., the summation of the 2^{nd} 6-inch and the 3rd 6-inch penetration resistance). The sampler was driven an additional 6-inch to complete the 2-foot continuous sampling procedure (the penetration resistance for the 4^{th} 6-inch penetration is not used in computing the SPT N-value).

Soils obtained from the sampling device were sealed in glass sample jars and transported to our soils testing laboratory. The recovered soil samples were inspected and classified by a Geotechnical Engineer using ASTM D2487 - Unified Soil Classification System (USCS,). A description of the soils conditions encountered at each test boring location is presented on the individual Boring Logs and is included in the Appendix.

2.0 Laboratory Soil Tests

The following laboratory tests were performed on selected soil samples that were obtained from the soil test borings.

Moisture Content Tests (ASTM D2216)
Atterberg Limits (ASTM D4318)
Sieve Analysis (ASTM D421, D422)

All tests were performed in accordance with applicable ASTM procedure.

We appreciate the opportunity to be of service to you on this project. If you have any questions, please call us.

Very truly yours,

FINDLING, INC.

M. Surendra

M. Suri Surendra, Ph.D., P.E.
Chief Engineer

Amsalu Duressa

Amsalu Duressa, P.E.
Chief Executive Officer

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	**P-1**
LOCATION: See Boring Location Plan	BEGUN: 06/11/12	COMPLETED: 06/11/12		HOLE SIZE: 7"	GROUND ELEVATION: 0.0 MLLW
COORDINATES: E: 1,440,964.31, N: 576,156.54	DEPTH WATER ENC.: N/A	AT END DRILL: N/A		AT 24 HRS: N/A	CAVED DEPTH: N/A
DRILLER: D. Fincham	WEIGHT OF HAMMER: 140 LB	HEIGHT OF FALL: 30"		TYPE OF CORE: N/A	BORING DEPTH (FT): 63.6
TYPE OF DRILL RIG & METHOD: CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK: N/A	LOGGED BY: S. Faris			PAGE NO. 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 22.7 ft at 9:22 a.m. Tide = 1.39' Corrected water depth at start: = 21.3 ft (MLLW)						
5									
10									
15									
20	-21.3								
			Dark gray wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	6"	
25				S-2	24"	WOR/24"	DS	16"	
				S-3	24"	WOR/24"	DS	18"	
				S-4	24"	WOR/24"	DS	24"	
30				S-5	24"	WOR/24"	DS	20"	
				S-6	24"	WOR/24"	DS	18"	

Findling,Inc.	BORING LOG	BORING NO. P-1	
PROJECT Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35	-36.1		Dark gray wet SILT, trace fine Sand	S-7	24"	WOR/24"	DS	24"	
			Green wet SILT, trace fine Sand	S-8	24"	WOR/24"	DS	24"	
				S-9	24"	WOR/24"	DS	24"	
40				S-10	24"	WOR/24"	DS	24"	
				S-11	24"	WOR/24"	DS	24"	
45				S-12	24"	WOR/24"	DS	24"	
				S-13	24"	WOR/24"	DS	18"	
				S-14	24"	WOR/24"	DS	24"	
50				S-15	24"	WOR/24"	DS	24"	
				S-16	24"	WOR/24"	DS	24"	
55				S-17	24"	WOR/24"	DS	24"	
				S-18	24"	WOR/24"	DS	20"	
				S-19	24"	WOR/24"	DS	24"	
60				S-20	24"	WOR/24"	DS	24"	
				S-21	24"	WOR/24"	DS	24"	
			Bottom of Boring at 63.6 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	P-2
LOCATION	BEGUN	COMPLETED	HOLE SIZE		GROUND ELEVATION
See Boring Location Plan	06/11/12	06/11/12	7"		0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
E: 1,442,016.17, N: 575,360.48	N/A	N/A	N/A		N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE		BORING DEPTH (FT)
D. Fincham	140 LB	30"			63
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:			PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris			1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 27.0 ft at 12:38 p.m. Tide = 2.03' Corrected water depth at start: = 25.0 ft (MLLW)						
5									
10									
15									
20									
25	-25		Dark gray to gray with brown wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	18"	
				S-2	24"	WOR/24"	DS	12"	
30	-31			S-3	24"	WOR/24"	DS	14"	
			Green wet SILT, trace fine Sand	S-4	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-2	
PROJECT: Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	24"	
				S-7	24"	WOR/24"	DS	24"	
40				S-8	24"	WOR/24"	DS	24"	
	-42			S-9	24"	WOR/18"-WOH	DS	24"	
			Green wet SILT, trace fine Sand, trace Clay						
45				S-10	24"	WOH/24"	DS	24"	
	-46.5			S-11	24"	1-2-0-1	DS	24"	
			Brown wet Silty fine to coarse SAND, little to some Gravel	S-12	24"	1-0-1-0	DS	10"	
50				S-13	24"	2-2-2-2	DS	18"	
	-53			S-14	24"	2-1-3-3	DS	8"	
			Brown wet fine to coarse SAND and GRAVEL, trace Silt	S-15	24"	2-3-3-2	DS	12"	
55				S-16	24"	3-3-4-4	DS	12"	
				S-17	24"	4-7-12-14	DS	16"	
60				S-18	24"	4-7-10-13	DS	20"	
				S-19	24"	13-22-26-24	DS	22"	
			Bottom of Boring at 63.0 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel			07-1122-10	P-3
LOCATION	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
See Boring Location Plan	06/14/12	06/14/12	7"	0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
E: 1,441,850.08, N: 574,594.76	N/A	N/A	N/A	N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE	BORING DEPTH (FT)
D. Fincham	140 LB	30"	N/A	64.2
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:		PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris		1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 25.2 ft at 7:18 a.m. Tide = 0.80' Corrected water depth at start: = 24.4 ft (MLLW)						
5									
10									
15									
20									
	-24.4								
25			Dark gray wet SILT, trace fine Sand	S-1	24"	WOR/18"-WOH/4"	DS	20"	
				S-2	24"	WOR/24"	DS	14"	
30	-30.2			S-3	24"	WOR/24"	DS	24"	
			Green wet SILT, trace fine Sand	S-4	24"	WOR/24"	DS	18"	
				S-5	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-3	
PROJECT: Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-6	24"	WOR/24"	DS	24"	
				S-7	24"	WOR/24"	DS	24"	
				S-8	24"	WOR/24"	DS	24"	
40				S-9	24"	WOR/24"	DS	24"	
				S-10	24"	WOR/24"	DS	24"	
45	-46.2			S-11	24"	WOR/12"-WOH/1'	DS	24"	
	-48.2		Green wet SILT, trace to little Clay, trace fine Sand	S-12	24"	WOH/18"-1	DS	24"	
50	-51.2		Brown wet fine to coarse SAND and GRAVEL, little Silt	S-13	24"	1-4-4-9	DS	8"	
				S-14	24"	6-4-6-7	DS	15"	
	-54.2		Light brown, gray wet fine to coarse SAND, little Silt, trace to little Gravel	S-15	24"	1-1-1-3	DS	14"	
55			Light grey wet SILT, trace fine Sand	S-16	24"	WOH/24"	DS	22"	
	-57.7			S-17	24"	WOH/18"-13	DS	5"	
			Brown wet fine to coarse SAND and GRAVEL, trace to little Silt	S-18	24"	4-4-4-5	DS	5"	
60				S-19	24"	4-5-5-6	DS	10"	
				S-20	24"	5-6-7-6	DS	16"	
65			Bottom of Boring at 64.2 ft						
70									
75									

Findling,Inc.				BORING LOG	
PROJECT: Seagirt Marine Terminal Channel				PROJECT NO.: 07-1122-10	BORING NO.: P-4
LOCATION: See Boring Location Plan	BEGUN: 06/14/12	COMPLETED: 06/14/12	HOLE SIZE: 7"		GROUND ELEVATION: 0.0 MLLW
COORDINATES: E: 1,441,767.30, N: 574,157.27	DEPTH WATER ENC.: N/A	AT END DRILL: N/A	AT 24 HRS: N/A		CAVED DEPTH: N/A
DRILLER: D. Fincham	WEIGHT OF HAMMER: 140 LB	HEIGHT OF FALL: 30"	TYPE OF CORE: N/A		BORING DEPTH (FT): 64.1
TYPE OF DRILL RIG & METHOD: CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK: N/A	LOGGED BY: S. Faris			PAGE NO.: 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 42.3 ft at 10:54 a.m. Tide = 0.87' Corrected water depth at start: = 41.4 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc. — BORING LOG

PROJECT	BORING NO.	PROJECT NO.	PAGE
Seagirt Marine Terminal Channel	P-4	07-1122-10	2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Water						
40	-41.4								
	-44.6		Dark gray wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	6"	
45			Green to brown wet SILT, trace fine Sand, trace Clay	S-2	24"	WOR/24"	DS	14"	
	-49.1			S-3	24"	WOR/24"	DS	20"	
50			Gray brown wet SILT, some fine sand, with layers silty fine sand	S-4	24"	WOH/24"	DS	24"	
	-52.1			S-5	24"	WOH/18"-3	DS	20"	
	-53.6		Brown with grey moist SILT, little Clay, trace fine to medium Sand, trace wood fragments	S-6	24"	WOH/18"-6	DS	20"	
55	-54.1		Green wet Silty fine to medium SAND	S-7	24"	WOH/24"	DS	9"	
	-57.1		Brown wet fine to coarse SAND, trace Silt	S-8	24"	WOH/12"-3-4	DS	20"	
			Brown and green wet Silty fine to medium SAND	S-9	24"	1-1-2-4	DS	10"	
60	-61.1		Brown with green, grey wet fine to coarse SAND, trace to little silt	S-10	24"	2-2-3-3	DS	16"	
			Brown moist SILT, little to some fine Sand, little Clay, with layers of silty fine Sand	S-11	24"	2-2-3-3	DS	18"	
65			Bottom of Boring at 64.1 ft						
70									
75									

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	**P-5**
LOCATION	BEGUN	COMPLETED	HOLE SIZE		GROUND ELEVATION
See Boring Location Plan	06/14/12	06/14/12	7"		0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
E: 1,441,626.96, N: 573,901.61	N/A	N/A	N/A		N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE		BORING DEPTH (FT)
D. Fincham	140 LB	30"	N/A		63.6
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:			PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris			1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
				SAMPLE DATA					
0			Water depth at start: = 44.8 ft at 1:03 p.m. Tide = 1.40' Corrected water depth at start: = 43.4 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc.	BORING LOG	BORING NO. P-5
PROJECT Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Water						
40									
	-43.4		Green to brown wet SILT, trace to little fine Sand						
45				S-1	24"	WOR/24"	DS	18"	
				S-2	24"	WOR/24"	DS	20"	
	-48.6		Green with brown, grey moist SILT, some fine Sand, trace Clay with layers of fine Sand	S-3	24"	WOR/12"-1-2	DS	24"	
50				S-4	24"	2-1-4-3	DS	15"	
	-51.6		Brown and green wet SILT, little fine to medium Sand, trace Clay	S-5	24"	WOH/24"	DS	24"	
	-54.6		Brown moist Silty CLAY, little fine Sand	S-6	24"	WOH/18"-2	DS	24"	
55	-55.6		Brown ans green wet Silty fine SAND						
	-56.1		Brown, green, grey to brown wet fine to coarse SAND, trace to little Silt	S-7	24"	2-1-1-2	DS	12"	
				S-8	24"	WOH/6"-1-0-0	DS	6"	
60				S-9	24"	WOR/12"-WOH/1'	DS	7"	
				S-10	24"	1-1-1-2	DS	18"	
			Bottom of Boring at 63.6 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT Seagirt Marine Terminal Channel				PROJECT NO. 07-1122-10	BORING NO. P-6
LOCATION See Boring Location Plan	BEGUN 06/15/12	COMPLETED 06/15/12	HOLE SIZE 7"		GROUND ELEVATION 0.0 MLLW
COORDINATES E: 1,441,570.87, N: 573,792.06	DEPTH WATER ENC. N/A	AT END DRILL N/A	AT 24 HRS N/A		CAVED DEPTH N/A
DRILLER D. Fincham	WEIGHT OF HAMMER 140 LB	HEIGHT OF FALL 30"	TYPE OF CORE N/A		BORING DEPTH (FT) 62.7
TYPE OF DRILL RIG & METHOD CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK N/A	LOGGED BY: S. Faris			PAGE NO. 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 45.5 ft at 08:00 a.m. Tide = 2.33' Corrected water depth at start: = 43.2 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc.	BORING LOG	BORING NO. P-6	
PROJECT Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35		Water						
40								
	-43.2	Dark grey to green wet SILT, trace fine Sand, trace Clay	S-1	18"	WOR/18"	DS	10"	
45			S-2	24"	WOR/24"	DS	24"	
	-47.7	Brown wet fine to coarse SAND and GRAVEL, little Silt	S-3	24"	WOR/6"-2-5-7	DS	18"	
50			S-4	24"	4-6-8-8	DS	14"	
			S-5	24"	6-5-5-6	DS	20"	
			S-6	24"	12-12-8-9	DS	16"	
55	-55.2	Brown wet fine to coarse SAND and Cemented Sand Fragments, little Silt	S-7	9"	7-100/3"	DS	9"	Cemented Sand layer noted at 55.2'
	-56	Brown wet fine to coarse SAND, trace to little Silt	S-8	24"	1-1-5-5	DS	7"	
60			S-9	24"	2-3-4-5	DS	12"	
			S-10	24"	4-5-3-4	DS	6"	
		Bottom of Boring at 62.7'						
65								
70								
75								

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	P-7
LOCATION	BEGUN	COMPLETED	HOLE SIZE		GROUND ELEVATION
See Boring Location Plan	06/18/12	06/18/12	7"		0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
E: 1,441,373.88, N: 573,536.11	N/A	N/A	N/A		N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE		BORING DEPTH (FT)
D. Fincham	140 LB	30"	N/A		63.2
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:			PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris			1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 49.8 ft at 7:44 a.m. Tide = 1.82' Corrected water depth at start: = 48.0 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc. | **BORING LOG**

BORING NO. P-7

PROJECT: Seagirt Marine Terminal Channel

PROJECT NO. 07-1122-10

PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35									
40									
45	-48								
			Green wet SILT, little Clay, trace fine Sand						
50	-51.2			S-1	24"	WOR/24"	DS	24"	
			Brown, gray to brown wet Silty fine to coarse SAND and GRAVEL	S-2	24"	3-3-5-5	DS	10"	
				S-3	24"	6-4-4-6	DS	10"	
55	-56.7			S-4	24"	6-7-7-2	DS	8"	
			Brown with grey wet fine to coarse SAND. little to trace to little Silt, trace Gravel	S-5	24"	1-0-1-3	DS	5"	
60				S-6	24"	1-3-3-4	DS	18"	
				S-7	24"	4-5-5-5	DS	20"	
			Bottom of Boring at 63.2 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT: Seagirt Marine Terminal Channel			PROJECT NO.: 07-1122-10	BORING NO.: **P-8**
LOCATION: See Boring Location Plan	BEGUN: 06/18/12	COMPLETED: 06/18/12	HOLE SIZE: 7"	GROUND ELEVATION: 0.0 MLLW
COORDINATES: E: 1,442,110.83, N: 573,430.53	DEPTH WATER ENC.: N/A	AT END DRILL: N/A	AT 24 HRS: N/A	CAVED DEPTH: N/A
DRILLER: D. Fincham	WEIGHT OF HAMMER: 140 LB	HEIGHT OF FALL: 30"	TYPE OF CORE: N/A	BORING DEPTH (FT): 62.4
TYPE OF DRILL RIG & METHOD: CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK: N/A	LOGGED BY: S. Faris		PAGE NO.: 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 32.0 ft at 9:30 a.m. Tide = 2.59' Corrected water depth at start: = 29.4 ft (MLLW)						
5									
10									
15									
20									
25									
	-29.4								
30			Dark grey wet SILT, trace fine Sand						
	-31.4		Green wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	24"	
				S-2	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-8
PROJECT: Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35				S-3	24"	WOR/24"	DS	24"	
	-37.9			S-4	24"	WOR/18"-1	DS	20"	
40			Grey, brown wet fine to coarse SAND with trace to little silt, some gravel	S-5	24"	1-2-2-2	DS	11"	
				S-6	24"	2-2-4-4	DS	13"	
				S-7	24"	4-3-1-1	DS	14"	
45	-46.4			S-8	24"	WOH/24"	DS	3"	
			Grey brown wet Silty CLAY with little fine to medium Sand	S-9	24"	WOH/18"-1	DS	14"	
50	-50.4			S-10	24"	WOR/6"-1-3-10	DS	20"	
	-52.4		Grey brown wet SAND, little Silt, trace Gravel	S-11	24"	1-2-5-7	DS	20"	
			Brown wet fine to coarse SAND and GRAVEL, little Silt	S-12	24"	5-2-5-8	DS	14"	
55				S-13	24"	7-13-12-9	DS	16"	
				S-14	24"	8-4-5-4	DS	14"	
	-59.9			S-15	24"	3-3-2-2	DS	15"	
60			Red wet fine to medium SAND, little Silt	S-16	24"	1-2-3-3	DS	10"	
			Bottom of Boring at 62.4 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT: Seagirt Marine Terminal Channel			PROJECT NO.: 07-1122-10	BORING NO.: P-9
LOCATION: See Boring Location Plan	BEGUN: 06/18/12	COMPLETED: 06/18/12	HOLE SIZE: 7"	GROUND ELEVATION: 0.0 MLLW
COORDINATES: E: 1,441,942.53, N: 573,101.88	DEPTH WATER ENC.: N/A	AT END DRILL: N/A	AT 24 HRS: N/A	CAVED DEPTH: N/A
DRILLER: D. Fincham	WEIGHT OF HAMMER: 140 LB	HEIGHT OF FALL: 30"	TYPE OF CORE: N/A	BORING DEPTH (FT): 63.2
TYPE OF DRILL RIG & METHOD: CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK: N/A	LOGGED BY: S. Faris		PAGE NO. 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 27.0 ft at 12:50 p.m. Tide = 1.77' Corrected water depth at start: = 25.2 ft (MLLW)						
5									
10									
15									
20									
25	-25.2		Dark grey wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	15"	
	-27.7		Green wet SILT, trace fine Sand	S-2	24"	WOR/24"	DS	24"	
30				S-3	24"	WOR/24"	DS	20"	
				S-4	24"	WOR/24"	DS	18"	

Findling,Inc.	BORING LOG	BORING NO. P-9	
PROJECT: Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	10"	
	-38.2		Green wet SILT, trace clay, trace fine sand	S-7	24"	WOR/24"	DS	24"	
40				S-8	24"	WOR/12"-WOH/12	DS	24"	
	-42.7			S-9	24"	WOR/12"-1-1	DS	22"	
	-43.2		Gray wet fine to coarse SAND, some Gravel, little Silt						
45	-45.2		Brown wet Silty fine to medium SAND, trace Shells	S-10	24"	WOH/24"	DS	24"	
			Brown with grey wet fine to coarse SAND, some Gravel, little Silt	S-11	24"	1-1-1-3	DS	9"	
				S-12	24"	3-4-5-6	DS	14"	
50				S-13	24"	3-2-3-4	DS	6"	
	-52.2		Brown wet Silty fine to coarse SAND and GRAVEL	S-14	24"	3-3-3-4	DS	13"	
55				S-15	24"	3-3-2-4	DS	7"	
				S-16	24"	4-3-3-4	DS	10"	
				S-17	24"	4-5-2-2	DS	6"	
60				S-18	24"	2-3-2-1	DS	8"	
				S-19		2-3-3-3	DS	9"	
			Bottom of Boring at 63.2 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	**P-10**
LOCATION	BEGUN	COMPLETED	HOLE SIZE		GROUND ELEVATION
See Boring Location Plan	6/21/12	6/21/12	7"		0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
E: 1,442,031.38, N: 573,270.27	Dry	N/A	N/A		N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE		BORING DEPTH (FT)
D. Fincham	140 lbs	30"	N/A		63
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:			PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris			1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 27.6 ft at 7:19 a.m. Tide = 2.00' Corrected water depth at start: = 25.6 ft (MLLW)						
5									
10									
15									
20									
25	-25.6		Dark grey wet SILT, trace fine Sand	S-1	16.8"	WOR/12"-WOR/5"	DS	16"	
				S-2	24"	WOR/24"	DS	24"	
30	-30		Green wet SILT, trace fine Sand	S-3	24"	WOR/24"	DS	24"	
				S-4	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-10
PROJECT: Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	24"	
	-38		Green wet SILT, trace to little Clay, trace fine Sand	S-7	24"	WOR/24"	DS	24"	
40				S-8	24"	WOH/12"-2-2	DS	24"	
	-42.5		Brown and grey wet fine coarse SAND, trace Gravel, little SILT	S-9	24"	1-1-1-2	DS	24"	
45				S-10	24"	5-2-1-1	DS	5"	
	-46		Brown, grey, black wet fine coarse SAND, trace Silt	S-11	24"	1-2-2-2	DS	8"	
	-48		Brown with grey to brown wet fine coarse SAND and GRAVEL, trace Silt	S-12	24"	1-1-3-4	DS	14"	
50				S-13	24"	4-5-8-7	DS	12"	
				S-14	24"	5-5-5-6	DS	8"	
				S-15	24"	2-3-3-2	DS	8"	
55				S-16	24"	3-4-5-4	DS	7"	
				S-17	24"	4-5-7-7	DS	12"	
60				S-18	24"	4-5-4-3	DS	10"	
				S-19	24"	3-4-5-4	DS	12"	
			Bottom of Boring at 63.0 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT		PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel		07-1122-10	P-11

LOCATION	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
See Boring Location Plan	06/21/12	06/21/12	7"	0.0 MLLW
COORDINATES	**DEPTH WATER ENC.**	**AT END DRILL**	**AT 24 HRS**	**CAVED DEPTH**
E: 1,441,781.84, N: 572,823.85	N/A	N/A	N/A	N/A
DRILLER	**WEIGHT OF HAMMER**	**HEIGHT OF FALL**	**TYPE OF CORE**	**BORING DEPTH (FT)**
D. Fincham	140 lb	30"	N/A	63.3
TYPE OF DRILL RIG & METHOD	**DEPTH TO ROCK**	**LOGGED BY:**		**PAGE NO.**
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris		1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 28.1 ft at 11:00 a.m. Tide = 1.70' Corrected water depth at start: = 26.4 ft (MLLW)						
5									
10									
15									
20									
25	-26.4								
			Dark grey wet SILT, trace fine Sand, trace Shells	S-1	24"	WOR/24"	DS	24"	
30	-30.3			S-2	24"	WOR/24"	DS	24"	
			Green wet SILT, trace fine Sand	S-3	24"	WOR/24"	DS	24"	

Findling,Inc. — BORING LOG

BORING NO. P-11

PROJECT: Seagirt Marine Terminal Channel

PROJECT NO. 07-1122-10

PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-4	24"	WOR/24"	DS	24"	
				S-5	24	WOR/24"	DS	24"	
				S-6	24	WOR/24"	DS	24"	
40				S-7	24	WOR/24"	DS	24"	
				S-8	24	WOR/24"	DS	16"	
45				S-9	24	WOR/12"- WOH/1'	DS	24"	
	-47.3			S-10	24	WOR/24"	DS	24"	
	-48.8		Green wet SILT, trace Clay, fine Sand	S-11	24	WOH/18"-3	DS	20"	
50	-50.3		Grey with brown wet Silty fine to coarse SAND, trace Cemented Sand Fragments	S-12	24	7-8-5-4	DS	5"	Cemented Sand fragments noted in Sample No. 12
			Brown with grey to brown wet Silty fine to coarse SAND and GRAVEL	S-13	24	5-6-7-9	DS	7"	
55				S-14	24	4-5-6-6	DS	12"	
				S-15	24	8-8-7-6	DS	15"	
				S-16	24	5-5-4-4	DS	15"	
60				S-17	24	3-2-2-3	DS	8"	
				S-18	24	4-9-4-3	DS	10"	
			Bottom of Boring at 63.3 ft						
65									
70									
75									

Findling,Inc.				BORING LOG	
PROJECT Seagirt Marine Terminal Channel				PROJECT NO. 07-1122-10	BORING NO. P-12
LOCATION See Boring Location Plan	BEGUN 6/22/12	COMPLETED 6/22/12	HOLE SIZE 7"		GROUND ELEVATION 0.0 MLLW
COORDINATES E: 1,441,375.75, N: 572,214.77	DEPTH WATER ENC. N/A	AT END DRILL N/A	AT 24 HRS N/A		CAVED DEPTH N/A
DRILLER D. Fincham	WEIGHT OF HAMMER 140 lb	HEIGHT OF FALL 30"	TYPE OF CORE N/A		BORING DEPTH (FT) 63
TYPE OF DRILL RIG & METHOD CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK N/A	LOGGED BY: S. Faris			PAGE NO. 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 39.0 ft at 7:55 a.m. Tide = 2.00' Corrected water depth at start: = 37.0 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc.	BORING LOG	BORING NO. P-12
PROJECT Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35	-37		Water						
			Green wet SILT, trace fine Sand, trace Gravel	S-1	24"	WOR/24"	DS	8"	
40				S-2	24"	WOR/24"	DS	24"	
				S-3	24"	WOR/24"	DS	20"	
				S-4	24"	WOR/24"	DS	24"	
45				S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	20"	
50				S-7	24"	WOR/24"	DS	24"	
				S-8	24"	WOR/24"	DS	20"	
				S-9	24"	WOR/24"	DS	24"	
55	-57			S-10	24"	WOR/24"	DS	24"	
			Green with brown wet SILT, trace to little Clay, fine Sand	S-11	24"	WOR/24"	DS	24"	
60				S-12	24"	WOR/24"	DS	24"	
				S-13	24"	WOH/24"	DS	24"	
			Bottom of Boring at 63.0 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel				07-1122-10	P-13
LOCATION	BEGUN	COMPLETED		HOLE SIZE	GROUND ELEVATION
See Boring Location Plan	6/22/12	6/22/12		7"	0.0 MLLW
COORDINATES	DEPTH WATER ENC.	AT END DRILL		AT 24 HRS	CAVED DEPTH
E: 1,441,300.25, N: 571,576.99	N/A	N/A		N/A	N/A
DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL		TYPE OF CORE	BORING DEPTH (FT)
D. Fincham	140 lb	30"		N/A	62.9
TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:			PAGE NO.
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris			1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 42.4 ft at 10:36 a.m. Tide = 2.10' Corrected water depth at start: = 40.3 ft (MLLW)						
5									
10									
15									
20									
25									
30									

Findling,Inc.	BORING LOG	BORING NO. P-13
PROJECT Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Water						
40	-40.3		Grey with greet wet SILT, trace Sand	S-1	24"	WOR/24"	DS	24"	
				S-2	24"	WOR/24"	DS	24"	
45	-45.9		Green wet SILT, trace fine Sand	S-3	24"	WOR/24"	DS	24"	
				S-4	24"	WOR/24"	DS	18"	
50				S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	24"	
				S-7	24"	WOR/24"	DS	24"	
55				S-8	24"	WOR/24"	DS	24"	
	-58.9			S-9	24"	WOR/24"	DS	24"	
60			Green brown wet SILT, trace Clay, fine Sand	S-10	24"	WOR/24"	DS	24"	
				S-11	24"	WOR/24"	DS	24"	
			Bottom of Boring at 62.9 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Seagirt Marine Terminal Channel			07-1122-10	**P-14**

LOCATION	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
See Boring Location Plan	6/25/12	6/25/12	7"	0.0 MLLW
COORDINATES	**DEPTH WATER ENC.**	**AT END DRILL**	**AT 24 HRS**	**CAVED DEPTH**
E: 1,441,821.55, N: 574,321.45	N/A	N/A	N/A	N/A
DRILLER	**WEIGHT OF HAMMER**	**HEIGHT OF FALL**	**TYPE OF CORE**	**BORING DEPTH (FT)**
D. Fincham	140 lb	30"	N/A	63.2
TYPE OF DRILL RIG & METHOD	**DEPTH TO ROCK**	**LOGGED BY:**		**PAGE NO.**
CME-75 (from a Barge) & HSA, ASTM 1586	N/A	S. Faris		1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 27.7 ft at 7:14 a.m. Tide = 1.80' Corrected water depth at start: = 25.9 ft (MLLW)						
5									
10									
15									
20									
25	-25.9		Dark grey wet SILT, trace fine Sand	S-1	24"	WOR/24"	DS	15"	
30	-31.2			S-2	24"	WOR/24"	DS	24"	
			Green wet SILT, trace fine Sand	S-3	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-14
PROJECT: Seagirt Marine Terminal Channel	PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Green wet SILT, trace fine Sand	S-4	24"	WOR/24"	DS	24"	
				S-5	24"	WOR/24"	DS	24"	
				S-6	24"	WOR/24"	DS	24"	
40				S-7	24"	WOR/24"	DS	24"	
	-43.2			S-8	24"	WOR/24"	DS	24"	
			Green with brown wet SILT, trace to little Clay, trace fine Sand	S-9	24"	WOR/24"	DS	24"	
45				S-10	24"	WOH/24"	DS	24"	
	-48.2			S-11	24"	1-0-1-0	DS	24"	
50	-51.2		Brown with grey wet Clayey SILT, little fine Sand	S-12	24"	WOH/24"	DS	15"	
			Brown with grey wet Silty fine to coarse SAND, trace Gravel, trace Cemented Sand Fragments	S-13	24"	1-2-3-3	DS	6"	Cemented Sand fragments noted in Sample No. 13,14,15 and 16
55				S-14	24"	2-1-2-1	DS	10"	
				S-15	24"	1-2-1-2	DS	18"	
				S-16	24"	1-1-2-2	DS	9"	
60	-60.2			S-17	24"	1-1-2-4	DS	18"	
	-61.2		Reddish brown wet SILT, fine medium Sand, trace Clay						
			Brown wet Silty fine coarse SAND, trace Gravel	S-18	24"	3-6-7-7	DS	18"	
			Bottom of Boring at 63.2 ft						
65									
70									
75									

Findling,Inc.

BORING LOG

PROJECT: Seagirt Marine Terminal Channel			PROJECT NO.: 07-1122-10	BORING NO.: P-15
LOCATION: See Boring Location Plan	BEGUN: 6/22/12	COMPLETED: 6/22/12	HOLE SIZE: 7"	GROUND ELEVATION: 0.0 MLLW
COORDINATES: E: 1,441,433.87, N: 576,332.90	DEPTH WATER ENC.: N/A	AT END DRILL: N/A	AT 24 HRS: N/A	CAVED DEPTH: N/A
DRILLER: D. Fincham	WEIGHT OF HAMMER: 140 lb	HEIGHT OF FALL: 30"	TYPE OF CORE: N/A	BORING DEPTH (FT): 63.5
TYPE OF DRILL RIG & METHOD: CME-75 (from a Barge) & HSA, ASTM 1586	DEPTH TO ROCK: N/A	LOGGED BY: S. Faris		PAGE NO.: 1

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
0			Water depth at start: = 24.3 ft at 12:38 p.m. Tide = 1.50' Corrected water depth at start: = 22.8 ft (MLLW)						
5									
10									
15									
20									
	-22.8		Dark grey with red wet SILT, trace fine Sand						
25				S-1	24"	WOR/24"	DS	20"	
				S-2	24"	WOR/24"	DS	24"	
				S-3	24"	WOR/24"	DS	24"	
30				S-4	24"	WOR/24"	DS	24"	
				S-5	24"	WOR/24"	DS	24"	

Findling,Inc.	BORING LOG	BORING NO. P-15	
PROJECT: Seagirt Marine Terminal Channel		PROJECT NO. 07-1122-10	PAGE 2

DEPTH (ft)	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH (in)	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY (in)	REMARKS:
35			Dark grey with red wet SILT, trace fine Sand	S-6	24"	WOR/24"	DS	24"	
	-36.5		Green wet SILT, trace fine Sand	S-7	24"	WOR/24"	DS	24"	
				S-8	24"	WOR/24"	DS	20"	
40				S-9	24"	WOR/24"	DS	24"	
				S-10	24"	WOR/24"	DS	24"	
45				S-11	24"	WOR/24"	DS	24"	
				S-12	24"	WOR/24"	DS	24"	
				S-13	24"	WOR/24"	DS	24"	
50				S-14	24"	WOR/24"	DS	24"	
				S-15	24"	WOR/24"	DS	24"	
55				S-16	24"	WOR/24"	DS	24"	
				S-17	24"	WOR/24"	DS	24"	
				S-18	24"	WOR/24"	DS	24"	
60				S-19	24"	WOR/24"	DS	24"	
				S-20	24"	WOR/24"	DS	24"	
			Bottom of Boring at 63.5 ft						
65									
70									
75									

FIELD CLASSIFICATION SYSTEM

NON COHESIVE SOILS
(Silt, Sand, Gravel and Combinations)

Density	
Very Loose	- 5 blows/ft. or less
Loose	- 6 to 10 blows/ft.
Medium Dense	-11 to 30 blows/ft.
Dense	-31 to 50 blows/ft.
Very Dense	-51 blows/ft. or more

Relative Proportions Descriptive Term	Percent
Trace	1 -10
Little	11-20
Some	21-35
And	36-50

Particle Size Identification		
Boulders	-8 inch diameter or more	
Cobbles	-3 to 8 inch diameter	
Gravel	-Coarse	-1 to 3 inch
	Medium	-½ to 1 inch
	Fine	-¼ to ½ inch
Sand	-Coarse	-0.6mm to ¼ inch (dia. of pencil lead)
	Medium	-0.2mm to 0.6mm (dia. of broom straw)
	Fine	-0.05mm to 0.2mm (Dia. of human hair)
Silt		-0.6mm to 0.002mm (Cannot see particles)

COHESIVE SOILS
(Clay, Silt and Combinations)

Consistency	
Very Soft	- 3 blows/ft. or less
Soft	- 4 to 5 blows/ft.
Medium Stiff	- 6 to 10 blows/ft.
Stiff	-11 to 15 blows/ft.
Very Stiff	-16 top 30 blows/ft.
Hard	-31 blows/ft. or more

Plasticity Degree of Plasticity	Plasticity Index
None to slight	0- 4
Slight	5- 7
Medium	8-22
High to Very High	over 22

Classification on logs are made by visual inspection of samples.

Standard Penetration Test – The Standard Penetration Test (SPT) (ASTM D1586) consists of driving a 2.0" O.D., 1-3/8" I.D., sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches.

It is customary to spoon 6-inches to penetrate through the loose cuttings and then perform the test. The number of hammer blows for each successive 6-inches of penetration is recorded on the boring logs (Example: 5/6/7/9). The summation of the number of hammer blows required to drive the sampler two additional successive 6-inches is typically designated as the Standard Penetration Resistance (N) value (i.e., the summation of the 2nd 6-inch and the 3rd 6-inch penetration resistance) (i.e., 6+7=13 blows/foot).

The sampler was driven an additional 6-inch to complete the 2-foot continuous sampling procedure (the penetration resistance for the 4th 6-inch penetration is not used in computing the SPT N-value).

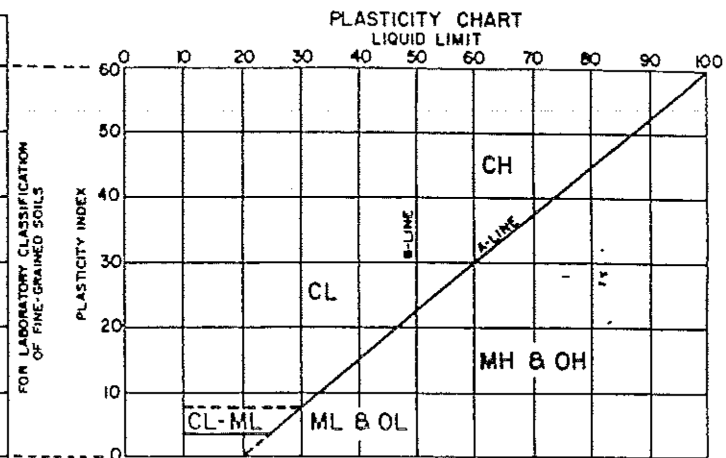
Strata Changes — In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes.

Ground Water observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL CLASSIFICATION CHART

MAJOR GROUPS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
FINE-GRAINED SOILS 50% OR MORE PASSES No. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50%		ML	INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY
			PT	PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS
COARSE-GRAINED SOILS MORE THAN 50% RETAINED ON No. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON No. 4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING No. 4 SIEVE	CLEAN SANDS LITTLE OR NO FINES	SW	WELL-GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
			SP	POORLY GRADED SANDS AND GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES

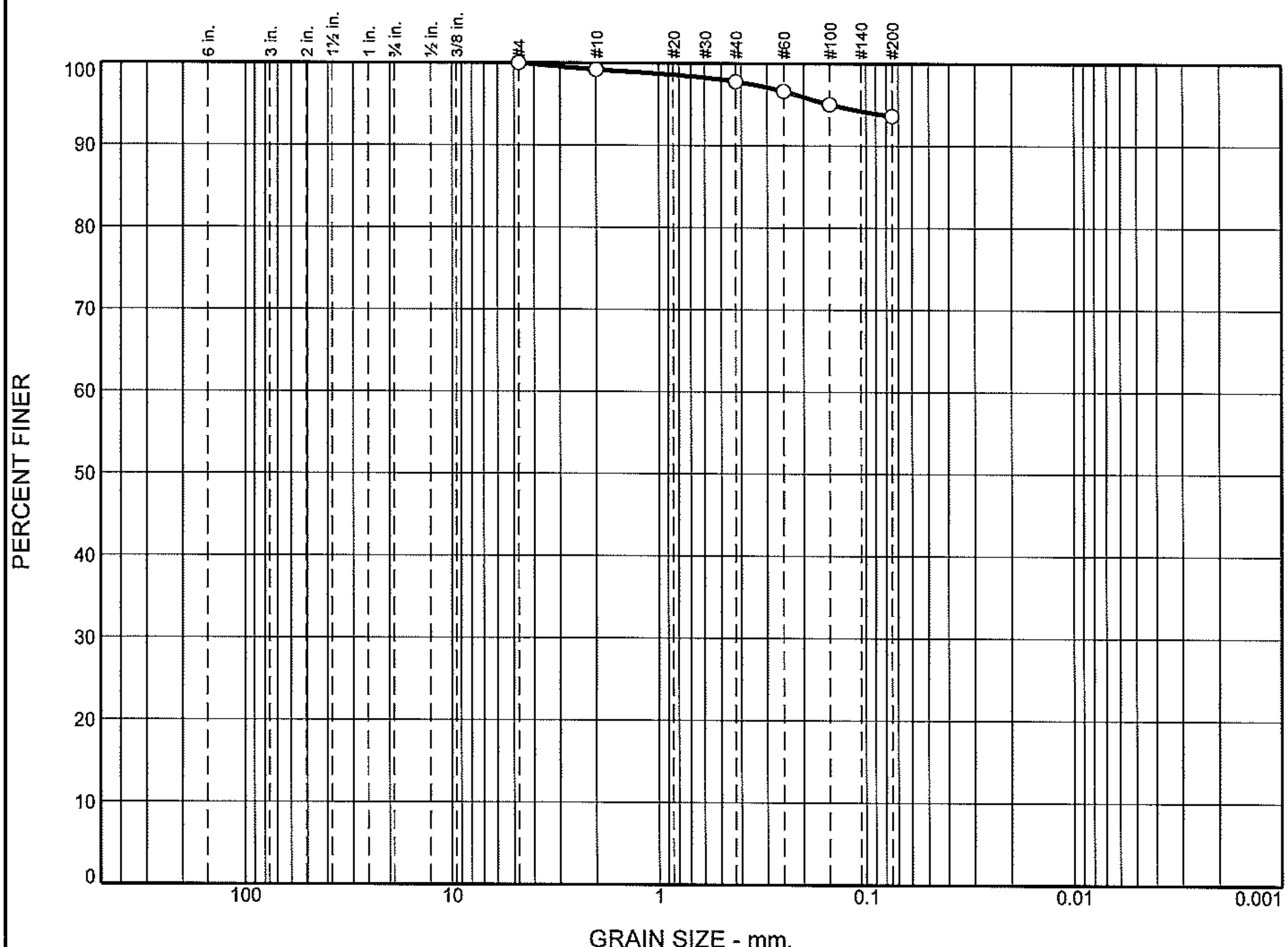


GRADATION CHART

MATERIAL SIZE		PARTICLE SIZE			
		LOWER LIMIT		UPPER LIMIT	
		MILLIMETERS	SIEVE SIZE	MILLIMETERS	SIEVE SIZE
SAND	FINE	.074	200	0.42	40
	MEDIUM	0.42	40	2.00	10
	COARSE	2.00	10	4.76	4
GRAVEL	FINE	4.76	4	19	3/4"
	COARSE	19	3/4"	76	3"
COBBLES		76	3"	305	12"
BOULDERS		305	12"	914	36"

Grain Size Analysis: Findling, Inc., 2012 (P – Series)

Particle Size Distribution Report



	% +3"	% Gravel Coarse	% Gravel Fine	% Sand Coarse	% Sand Medium	% Sand Fine	% Fines Silt	% Fines Clay
○	0.0	0.0	0.0	0.8	1.4	4.2	93.6	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		81	55								

Material Description	USCS	AASHTO
○ Dark brown SILT	MH	A-7-5(37)

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-2 **Depth:** 43.0'-45.0' **Sample Number:** S-10

Date: ○ 06/12/12

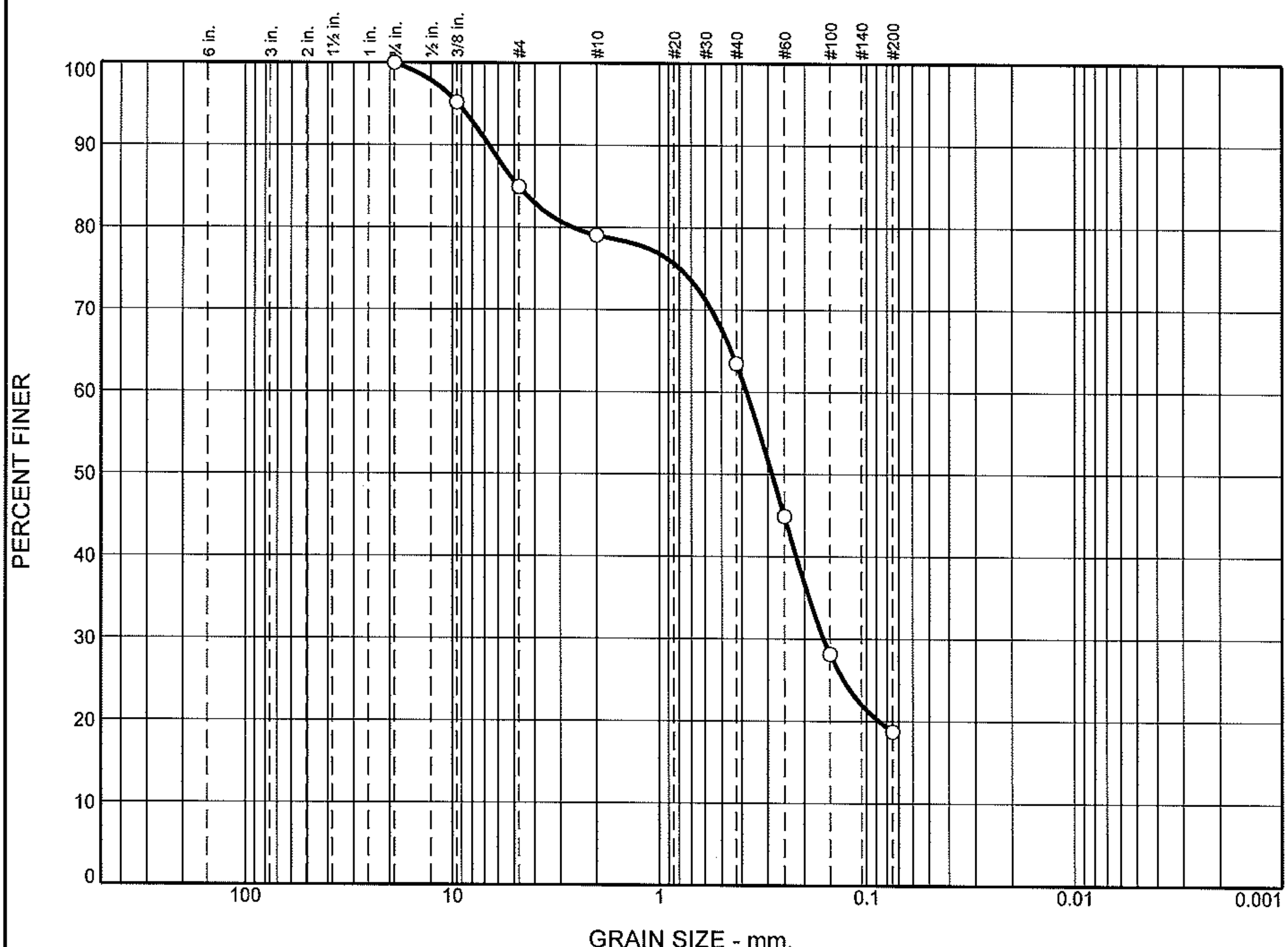
Remarks:
○ Moisture Content=92.9%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	15.1	5.9	15.5	44.8	18.7	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		NV	NP	4.7815	0.3794	0.2862	0.1611				

Material Description	USCS	AASHTO
○ Dark brown Silty SAND	SM	A-2-4(0)

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-2 **Depth:** 49.0'-51.0' **Sample Number:** S-13

Date: ○ 06/12/12

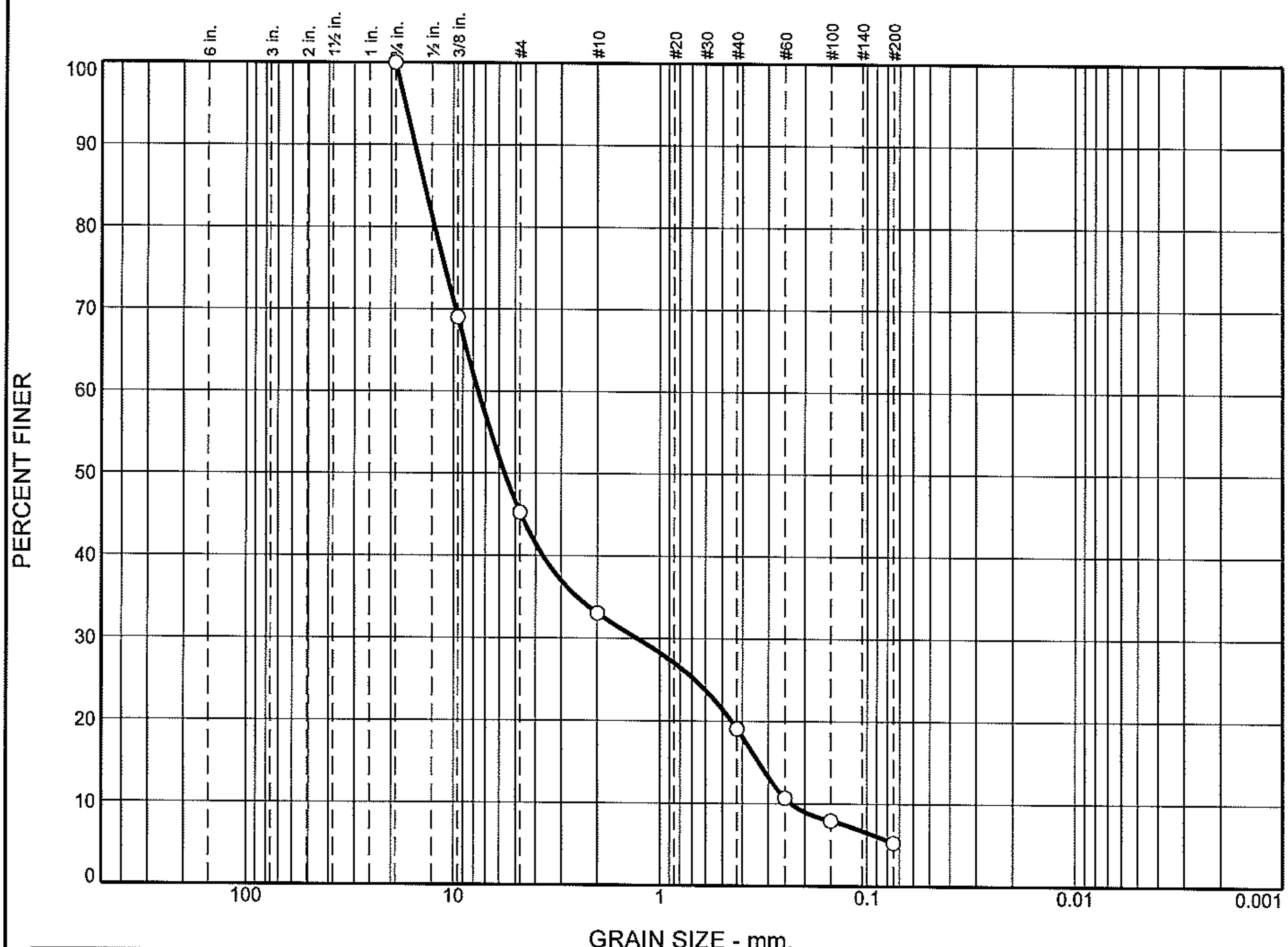
Findling, Inc.

Baltimore, Maryland

Remarks:
○Moisture Content=21.9%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	54.7	12.2	14.0	13.8	5.3	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		NV	NP	13.7470	7.5802	5.6452	1.2848	0.3343	0.2326	0.94	32.59

Material Description	USCS	AASHTO
○ Dark brown Silty GRAVEL	GP-GM	A-1-a

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-2 **Depth:** 53.0'-55.0' **Sample Number:** S-15

Date: ○ 06/12/12

Findling, Inc.

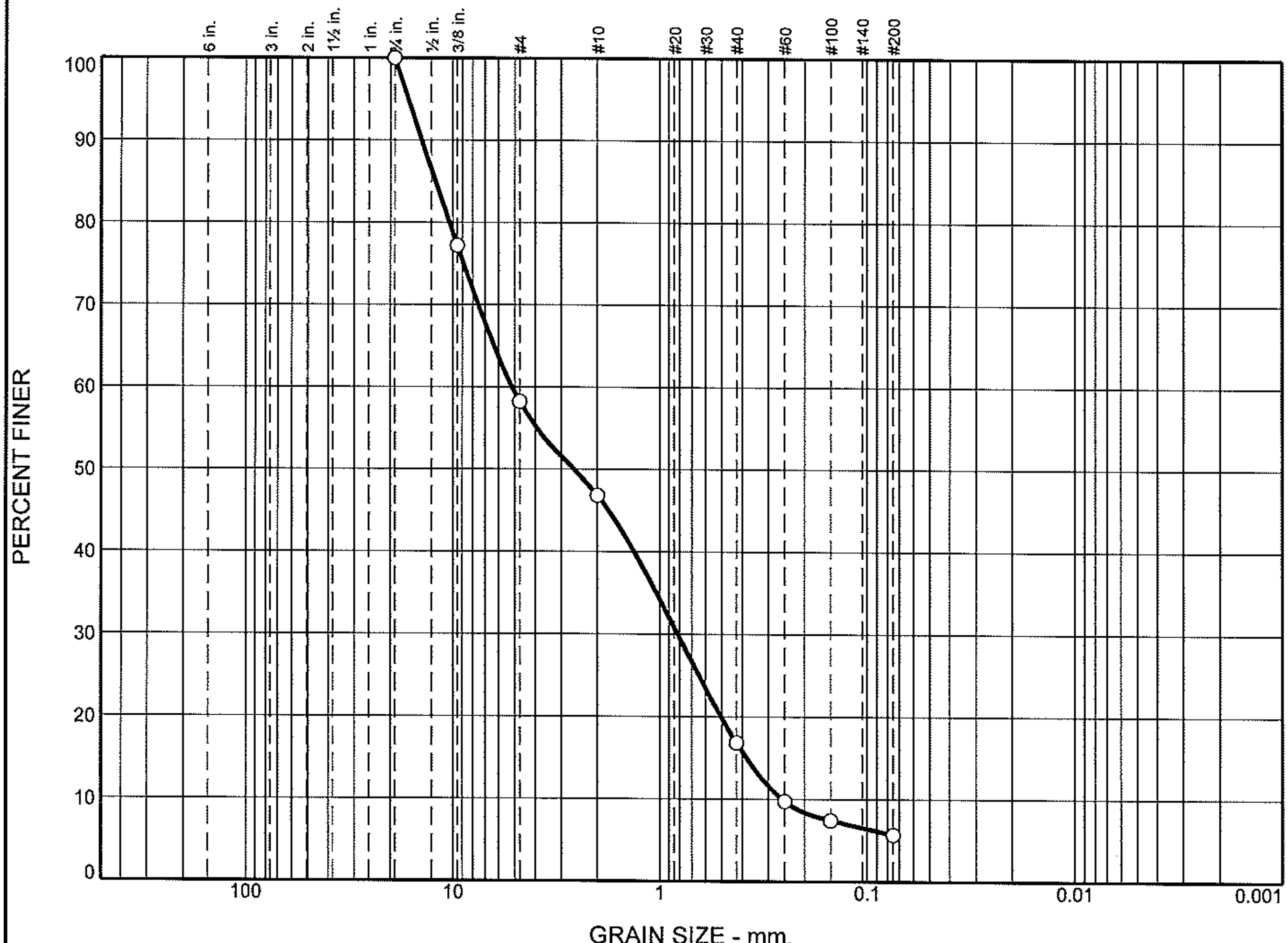
Baltimore, Maryland

Remarks:

○Moisture Content=9.8%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	41.8	11.4	29.9	11.2	5.7	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		NV	NP	12.1203	5.1724	2.6046	0.8172	0.3804	0.2567	0.50	20.15

Material Description	USCS	AASHTO
○ Dark grey Silty SAND	SP-SM	A-1-a

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-2 **Depth:** 59.0'-61.0' **Sample Number:** S-18

Date: ○ 06/12/12

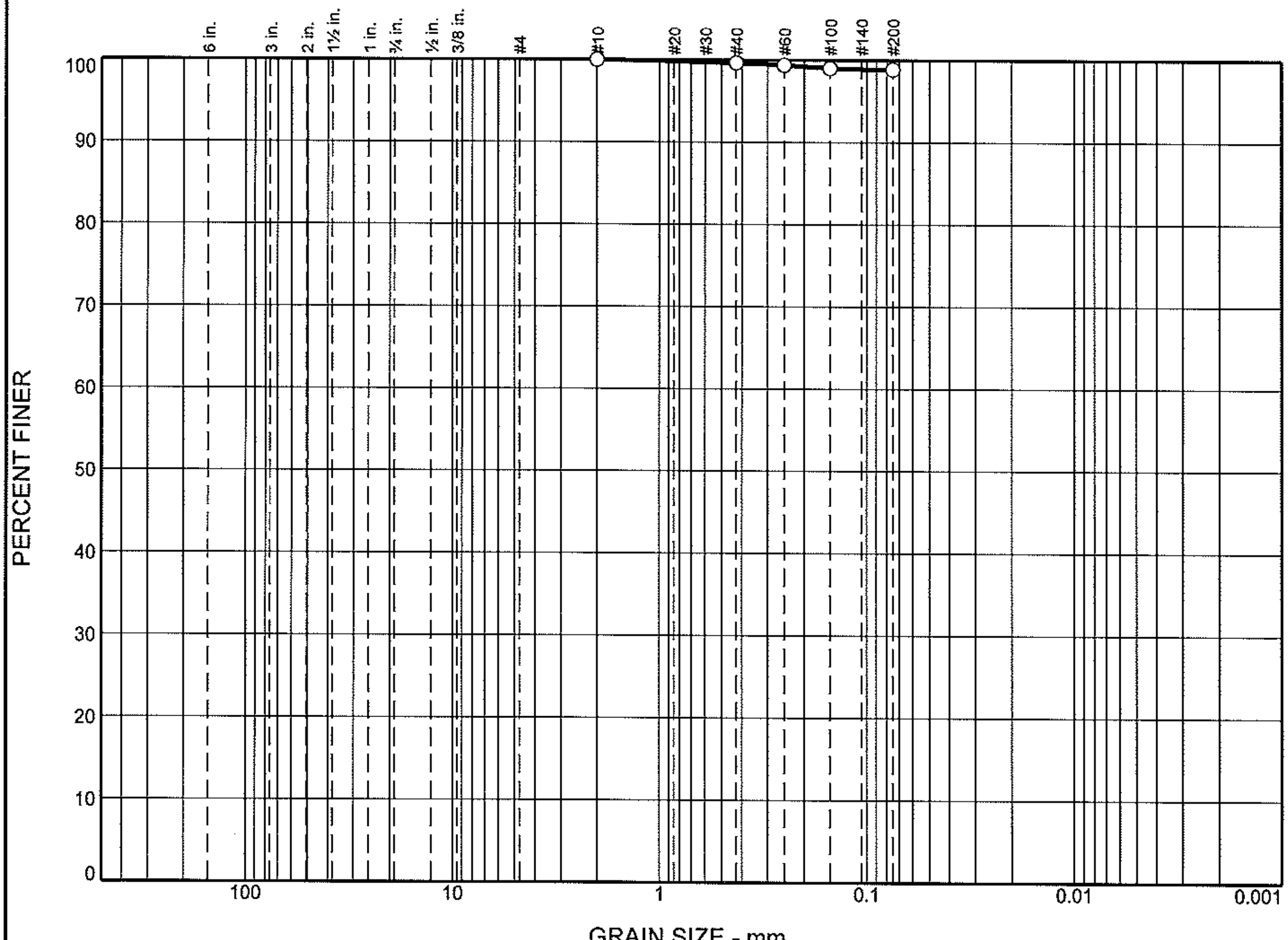
Remarks:
○Moisture Content=10.7%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.4	0.7	98.9	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		90	46								

Material Description	USCS	AASHTO
○ Light grey SILT	MH	A-7-5(57)

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-3 **Depth:** 42.2'-44.2' **Sample Number:** S-10

Date: ○ 06/18/12

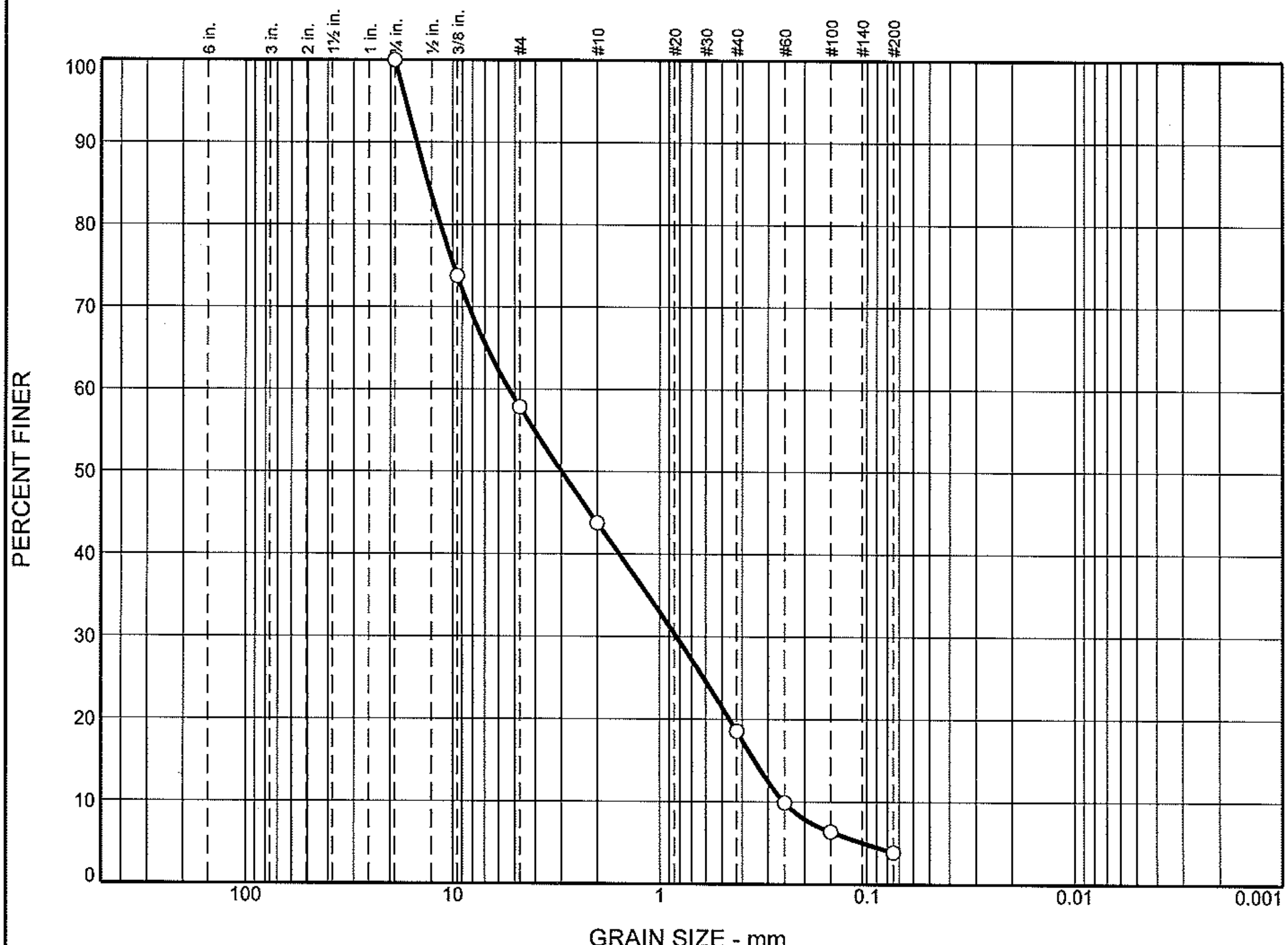
Remarks:
○Moisture Content=128.7%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	42.2	14.0	25.2	14.7	3.9	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				13.1391	5.3431	2.9802	0.8298	0.3490	0.2520	0.51	21.21

Material Description	USCS	AASHTO
o Dark brown SAND	SP	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

o **Source of Sample:** P-3 **Depth:** 50.2'-52.2' **Sample Number:** S-14

Date: o 06/18/12

Findling, Inc.

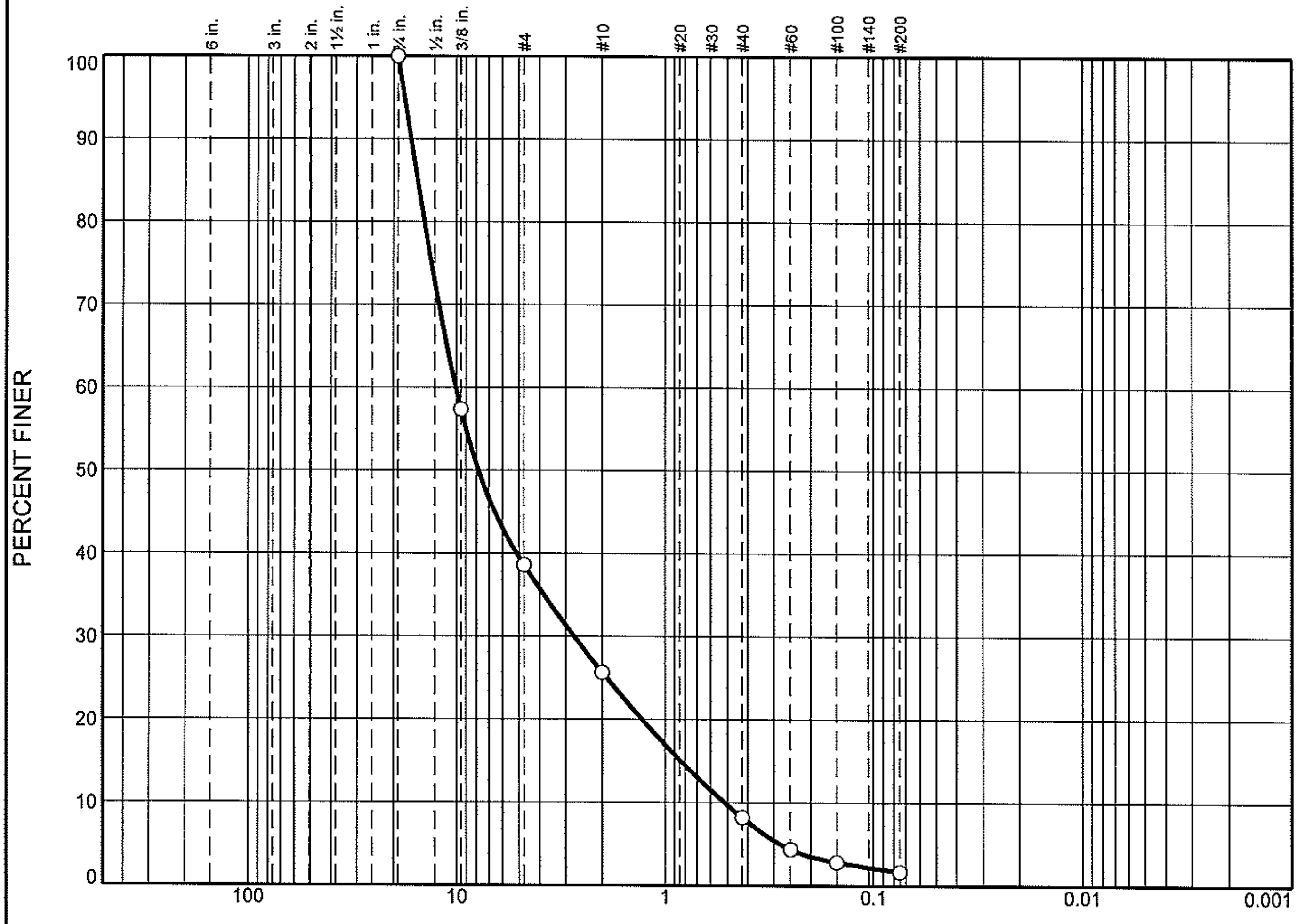
Baltimore, Maryland

Remarks:

o Moisture Content=8.5%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	61.4	12.9	17.5	6.5	1.7	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				15.3335	10.0778	7.8523	2.7360	0.8386	0.5157	1.44	19.54

Material Description	USCS	AASHTO
○ Light brown GRAVEL with SAND	GW	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-3 **Depth:** 60.2'-62.2' **Sample Number:** S-19

Date: ○ 06/18/12

Remarks:

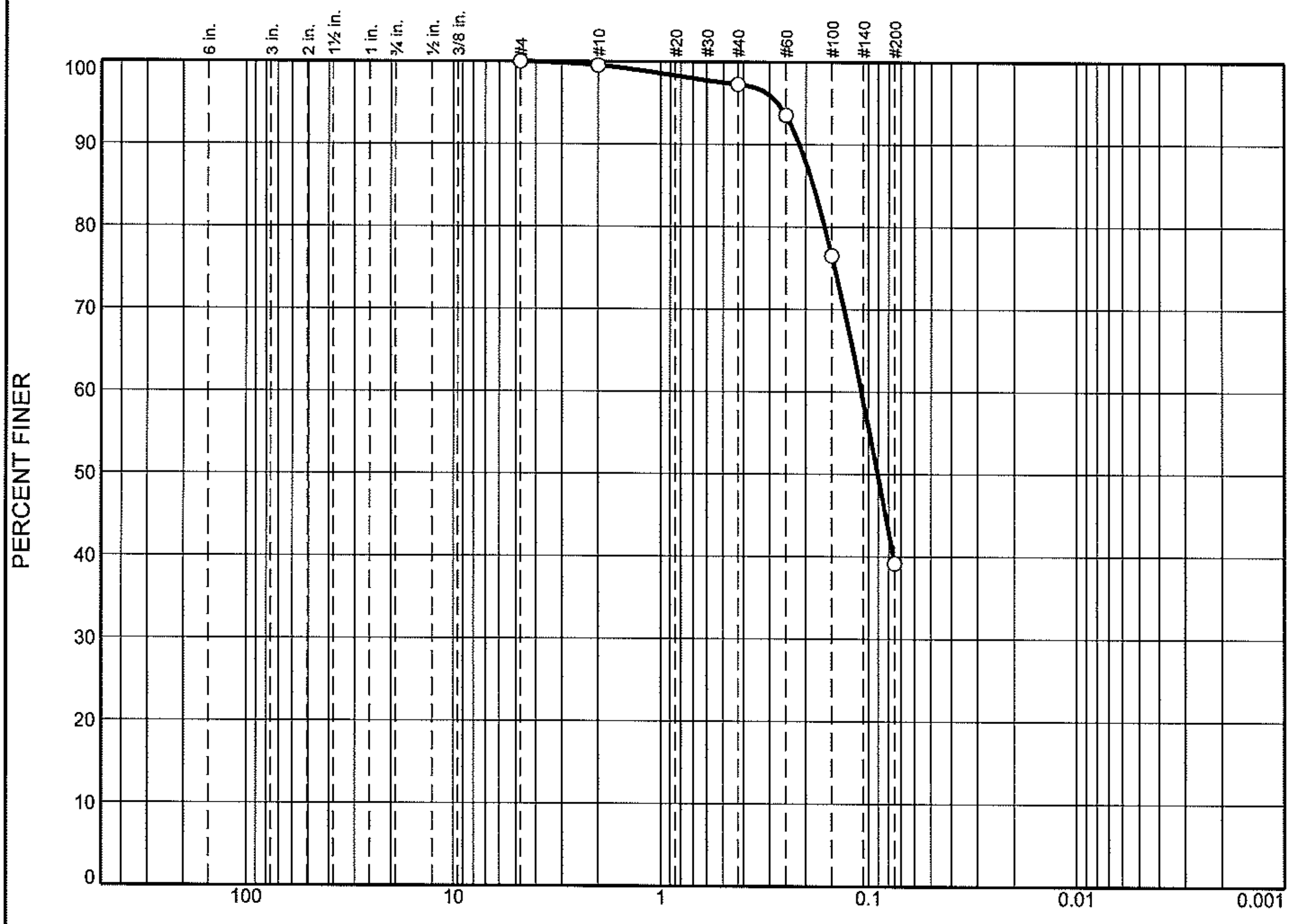
○ Moisture Content=8.8%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.5	2.2	58.1	39.2	

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		NV	NP	0.1844	0.1081	0.0904					

Material Description	USCS	AASHTO
○ Light grey Silty SAND	SM	A-4(0)

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-4 **Depth:** 48.1'-50.1' **Sample Number:** S-4

Date: ○ 06/18/12

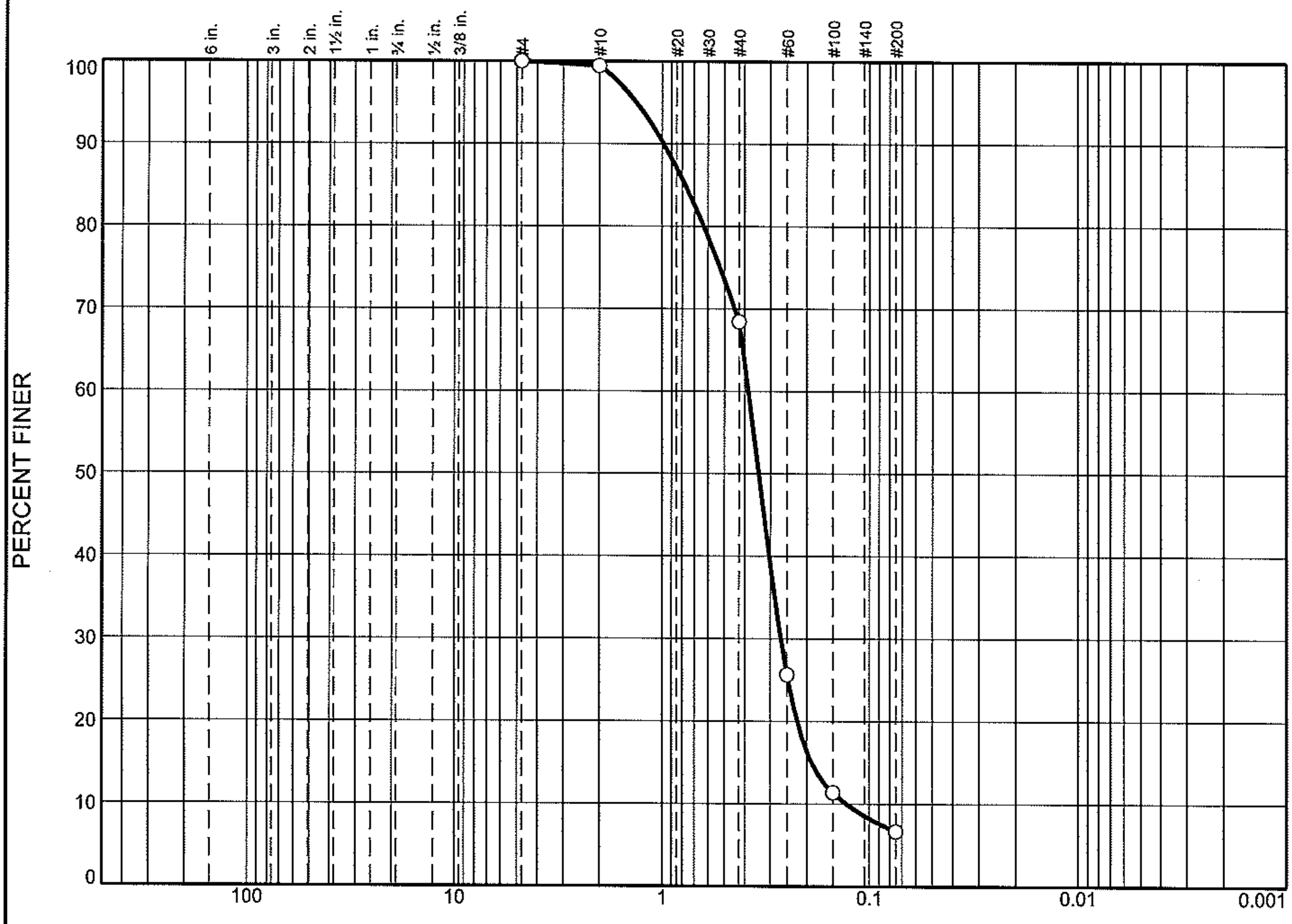
Remarks:
○Moisture Content=61.3%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	0.0	0.6	31.0	61.7	6.7	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				0.7739	0.3830	0.3414	0.2672	0.1905	0.1293	1.44	2.96

Material Description	USCS	AASHTO
o Light grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

o **Source of Sample:** P-4 **Depth:** 60.1'-62.1' **Sample Number:** S-10

Date: o 06/18/12

Remarks:

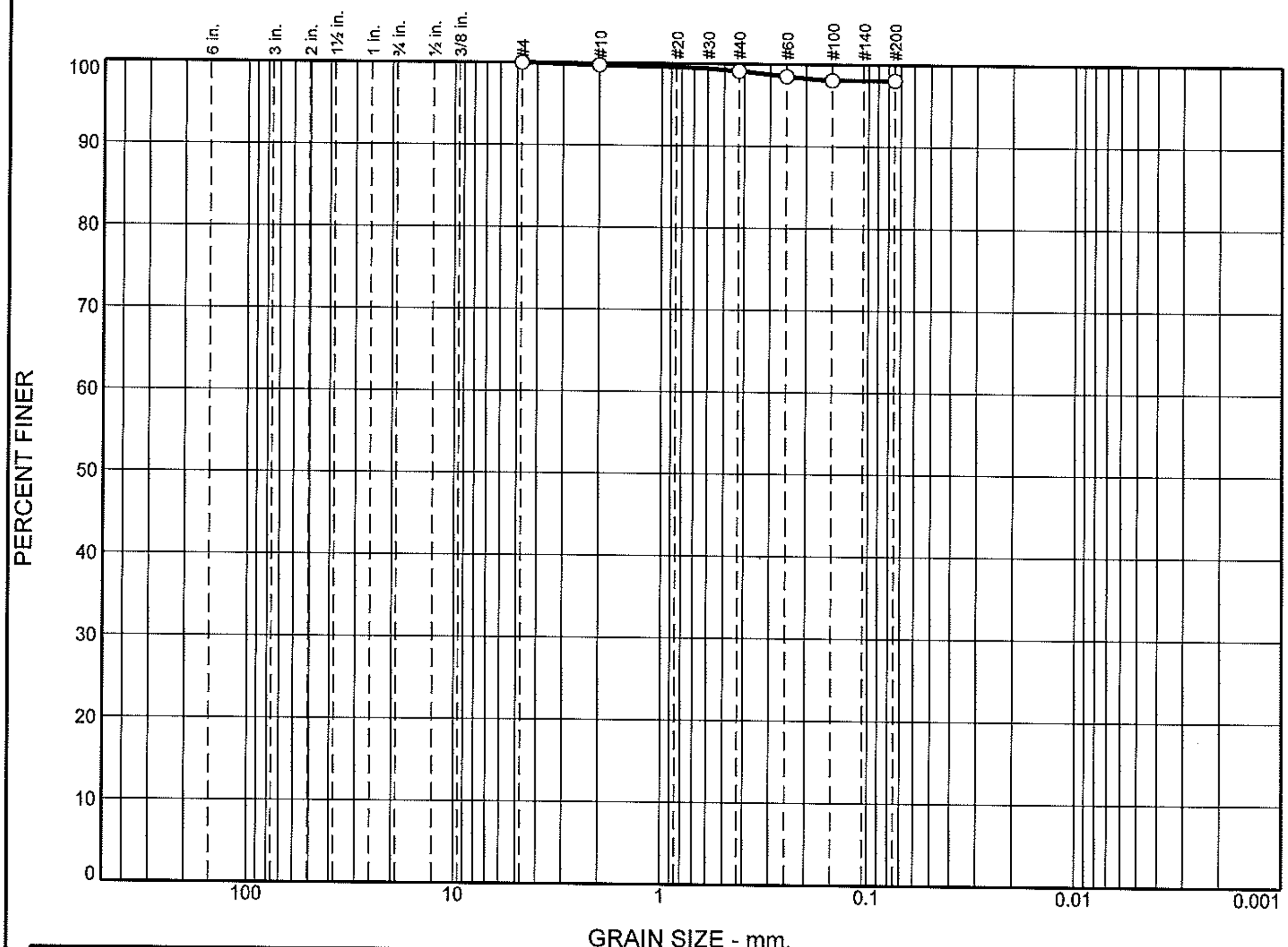
o Moisture Content=18.6%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.3	0.6	1.0	98.1	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		84	45								

Material Description	USCS	AASHTO
○ Light grey SILT	MH	A-7-5(51)

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-5 **Depth:** 45.6'-47.6' **Sample Number:** S-2

Date: ○ 06/18/12

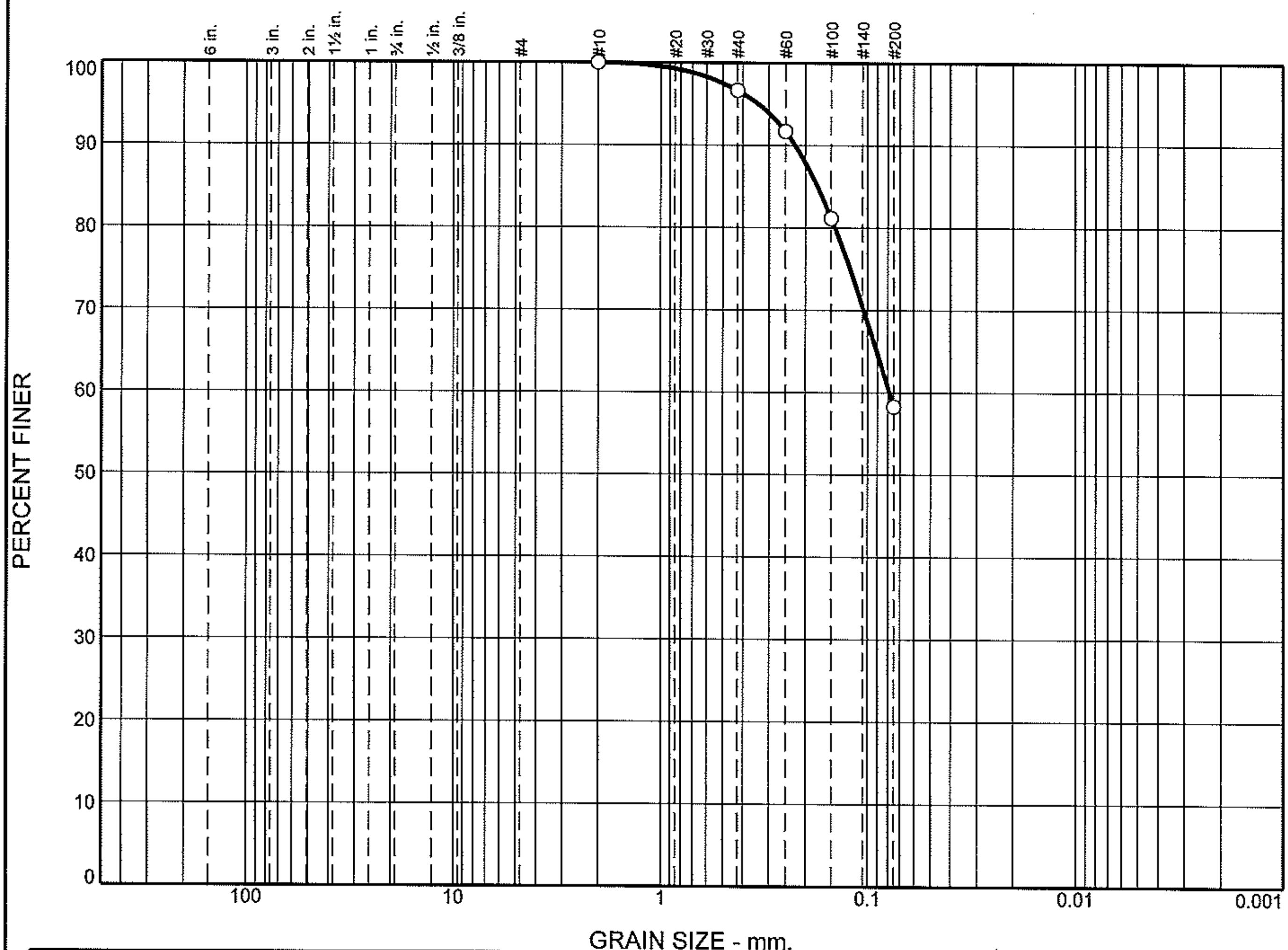
Remarks:
○Moisture Content=96.1%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	3.4	38.3	58.3	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.1748	0.0787						

Material Description	USCS	AASHTO
○ Light grey SILT	ML	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-5 **Depth:** 49.6'-51.6' **Sample Number:** S-4

Date: ○ 06/18/12

Remarks:

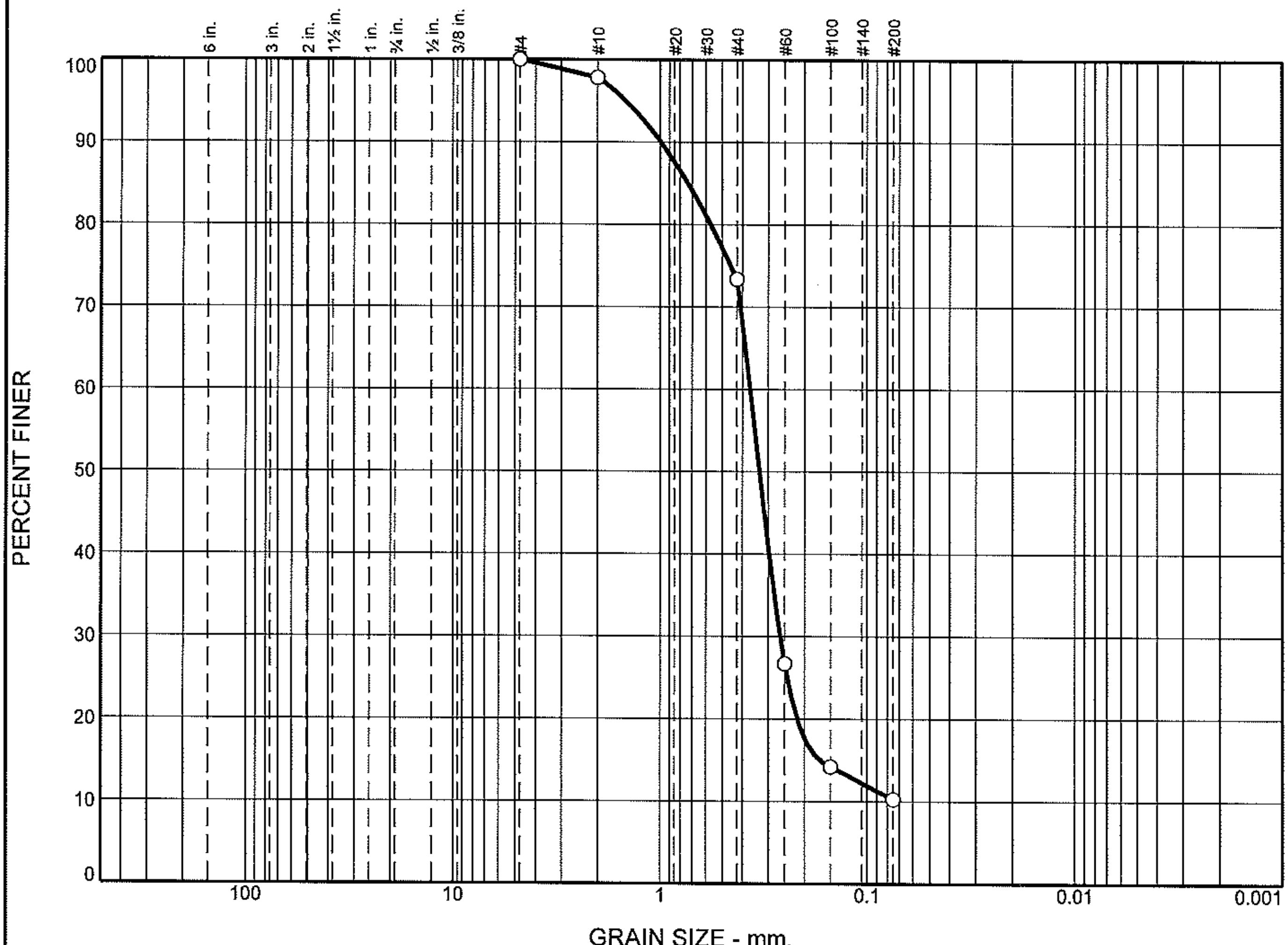
○ Moisture Content=37.5%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	2.2	24.4	63.1	10.3	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.7340	0.3664	0.3304	0.2626	0.1684			

Material Description	USCS	AASHTO
○ Grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-5 **Depth:** 61.6'-63.6' **Sample Number:** S-10

Date: ○ 06/18/12

Remarks:

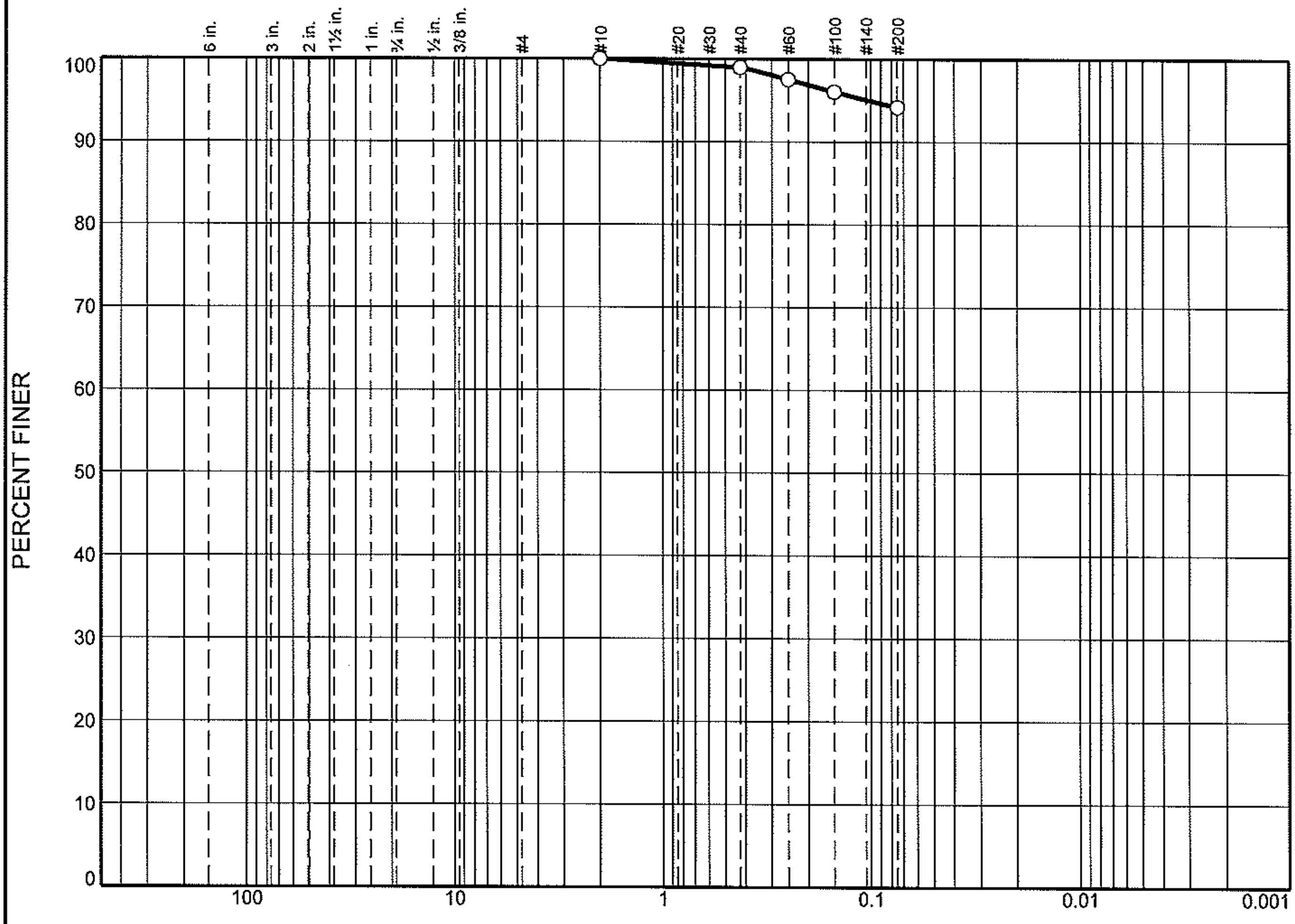
○Moisture Content=22.8%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	1.0	4.8	94.2	

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○		78	43								

Material Description	USCS	AASHTO
○ Dark grey SILT	MH	A-7-5(43)

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-6 **Depth:** 46.7'-48.7' **Sample Number:** S-3

Date: ○ 06/18/12

Findling, Inc.

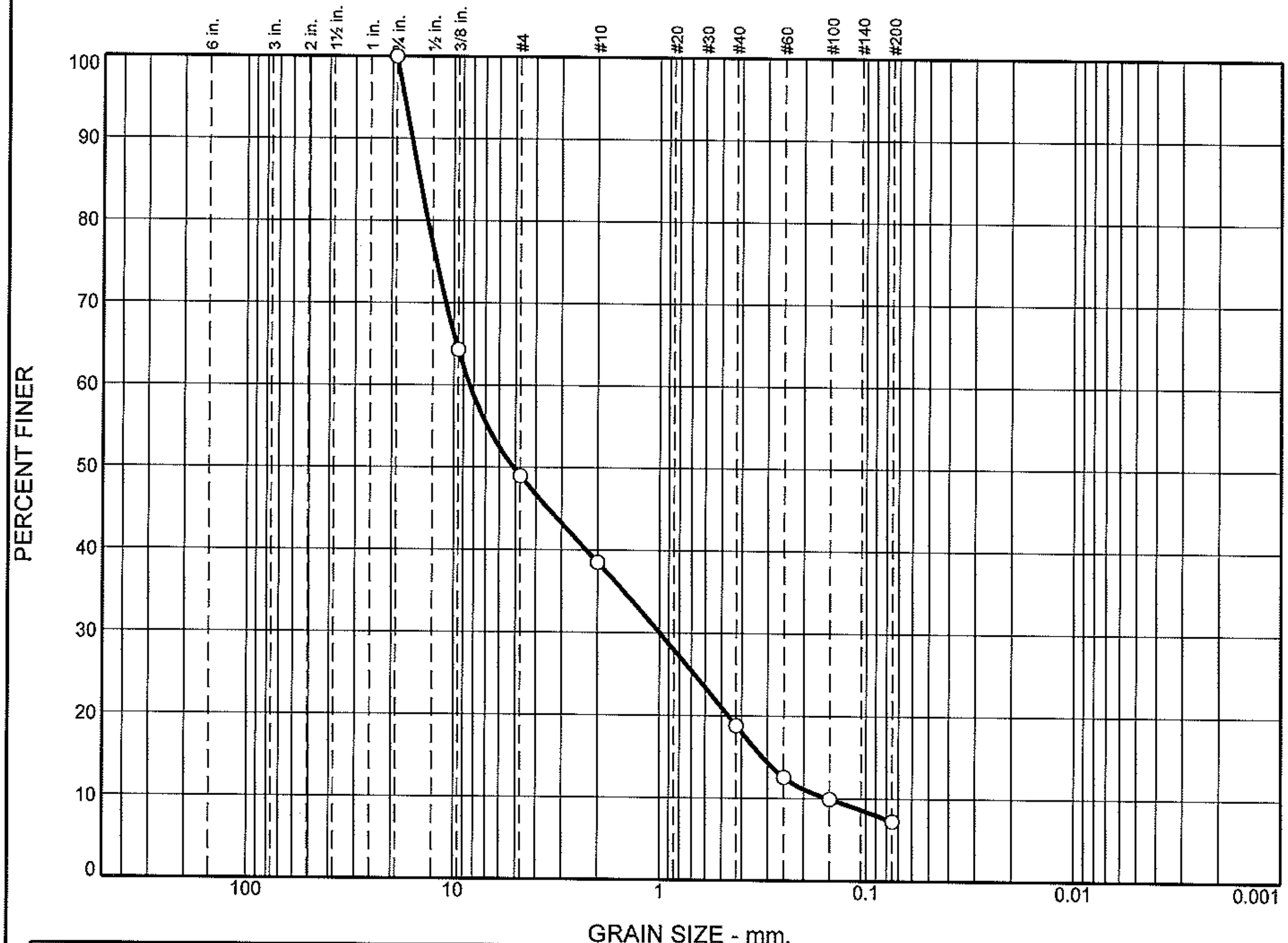
Baltimore, Maryland

Remarks:

○Moisture Content=86.4%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	51.0	10.5	19.7	11.5	7.3	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				14.6890	8.3742	5.1173	0.9960	0.3163	0.1521	0.78	55.05

Material Description	USCS	AASHTO
○ Grey Silty GRAVEL	GP-GM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-6 **Depth:** 52.7'-54.7' **Sample Number:** S-6

Date: ○ 06/18/12

Remarks:

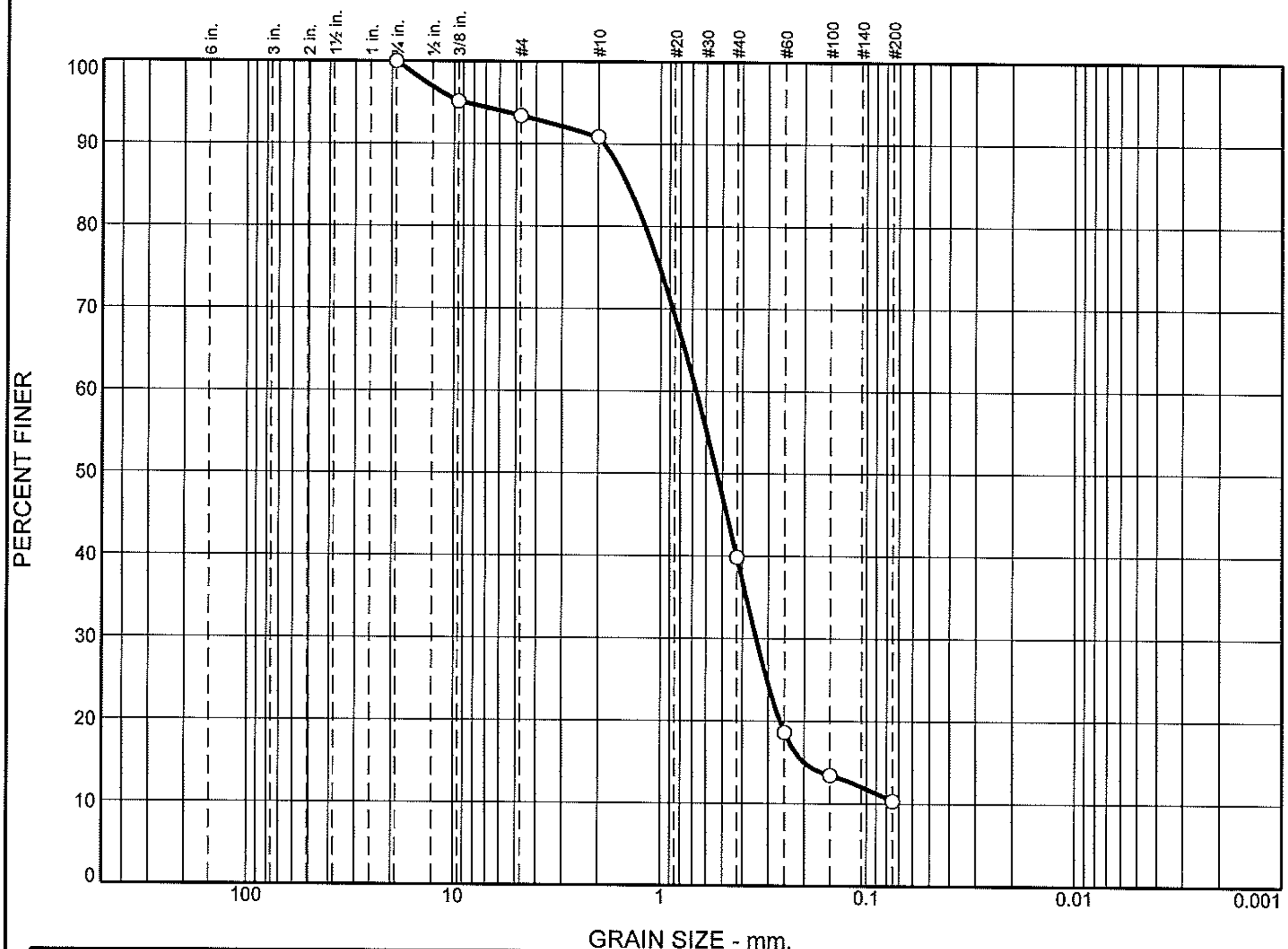
○Moisture Content=7.8%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	6.6	2.5	51.0	29.5	10.4	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				1.4400	0.6720	0.5313	0.3428	0.2008			

Material Description	USCS	AASHTO
○ Light grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-6 **Depth:** 60.7'-62.7' **Sample Number:** S-10

Date: ○ 06/18/12

Remarks:

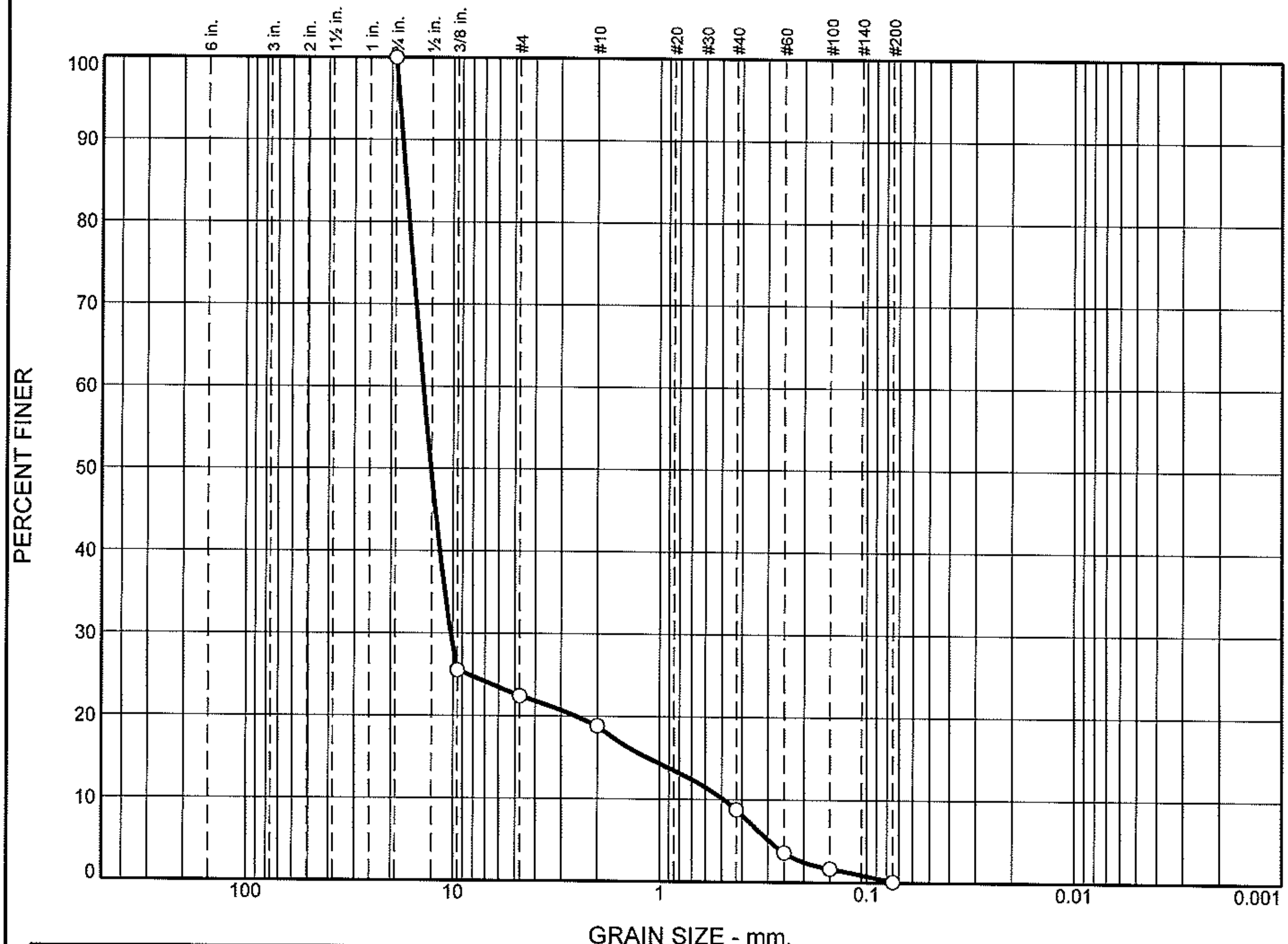
○Moisture Content=14.4%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	77.6	3.6	10.0	8.7	0.1	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				17.0316	13.9779	12.7964	10.2411	1.1396	0.4890	15.34	28.58

Material Description	USCS	AASHTO
o Dark brown GRAVEL with Sand	GP	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
o **Source of Sample:** P-7 **Depth:** 51.2'-53.2' **Sample Number:** S-2

Date: o 06/21/12

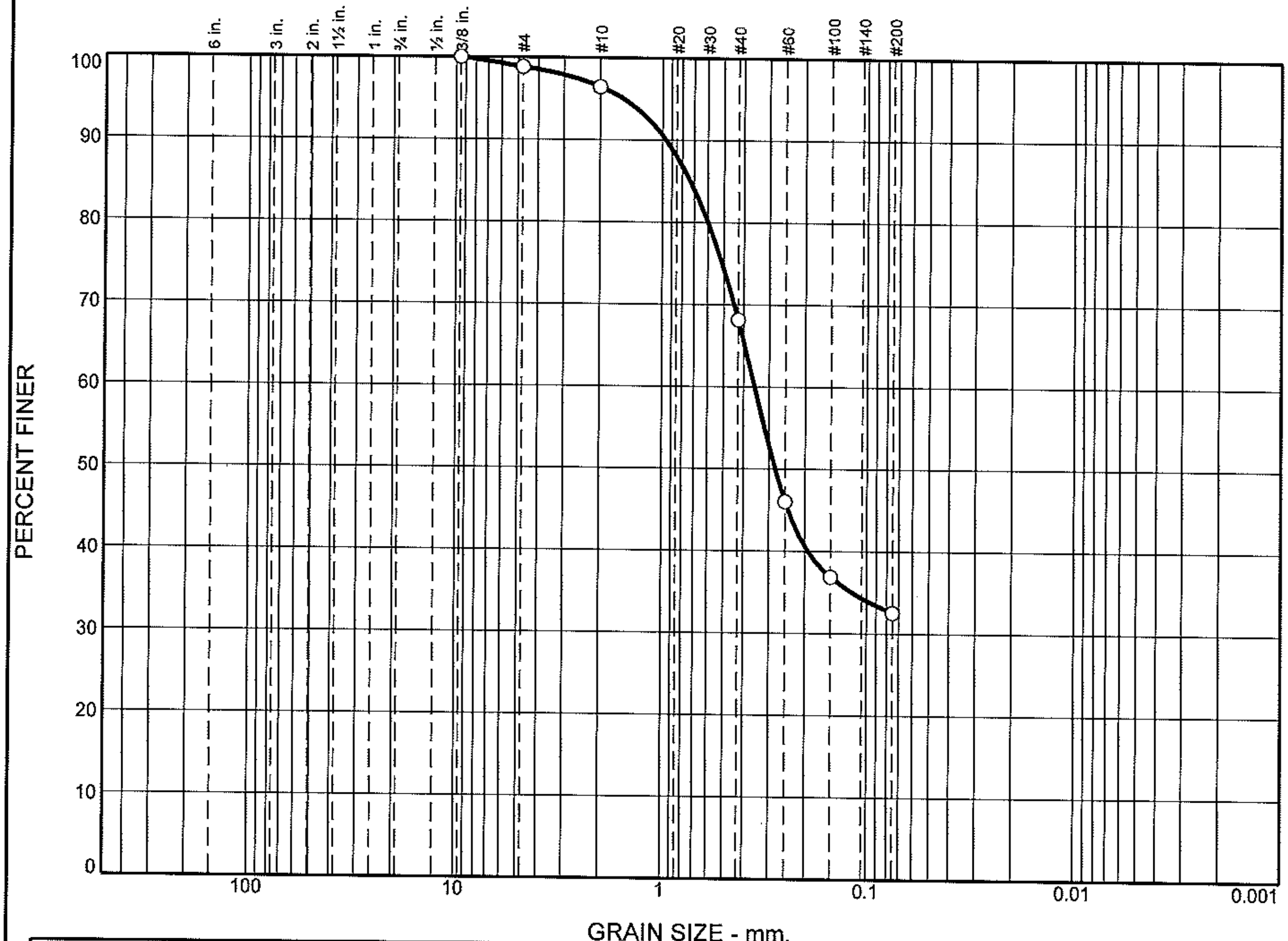
Findling, Inc.

Baltimore, Maryland

Remarks:
o Moisture Content=15.9%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	1.2	2.4	28.3	35.5	32.6	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.7326	0.3528	0.2794					

Material Description	USCS	AASHTO
○ Grey Silty SAND	SM	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-7 **Depth:** 57.2'-59.2' **Sample Number:** S-5

Date: ○ 06/21/12

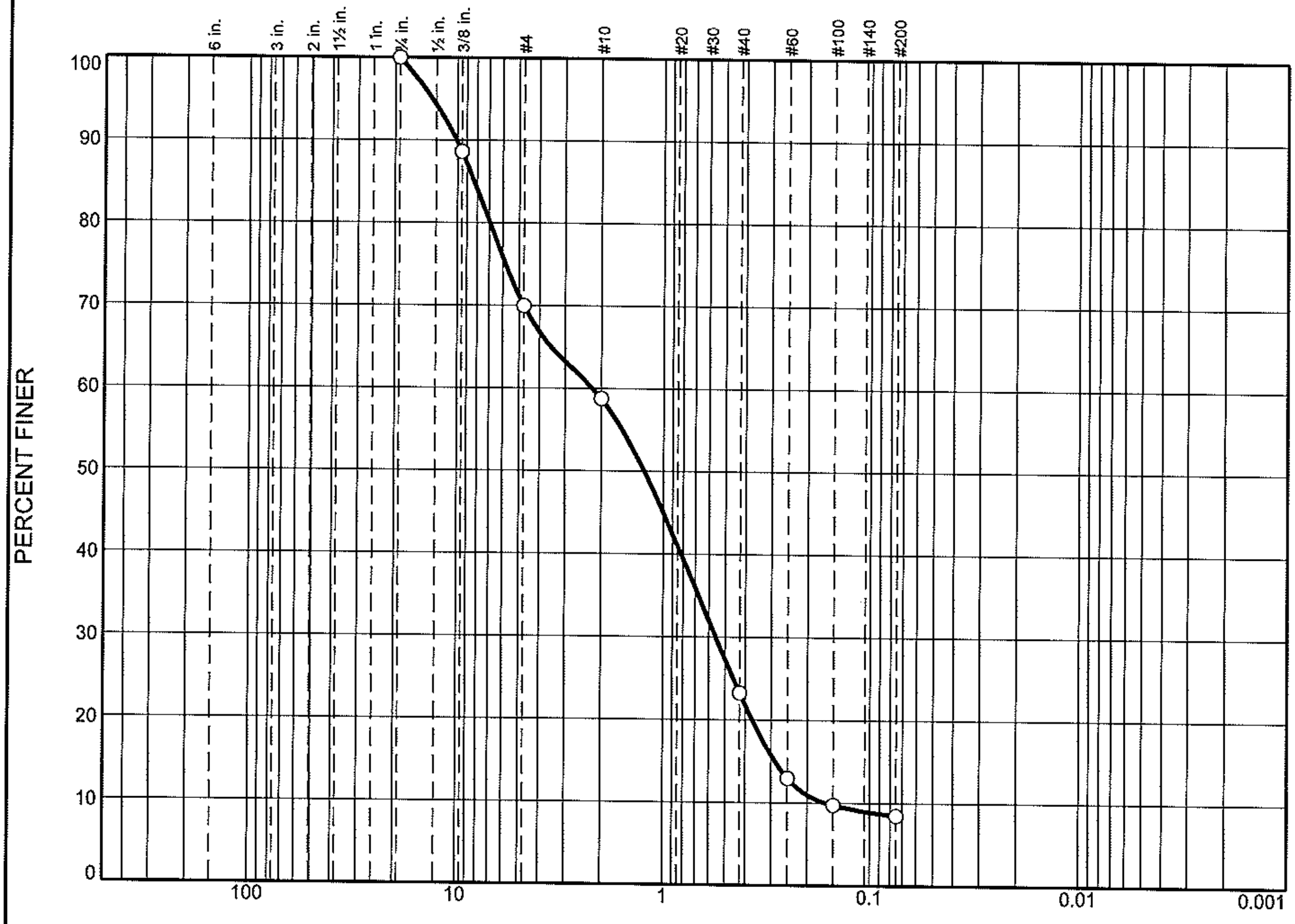
Findling, Inc.

Baltimore, Maryland

Remarks:
○ Moisture Content=21.1%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	30.1	11.2	35.4	14.8	8.5	

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				8.2869	2.2108	1.2386	0.5562	0.2868	0.1631	0.86	13.56

Material Description	USCS	AASHTO
o Dark grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

o **Source of Sample:** P-8 **Depth:** 38.4'-40.4' **Sample Number:** S-5

Date: o 06/21/12

Findling, Inc.

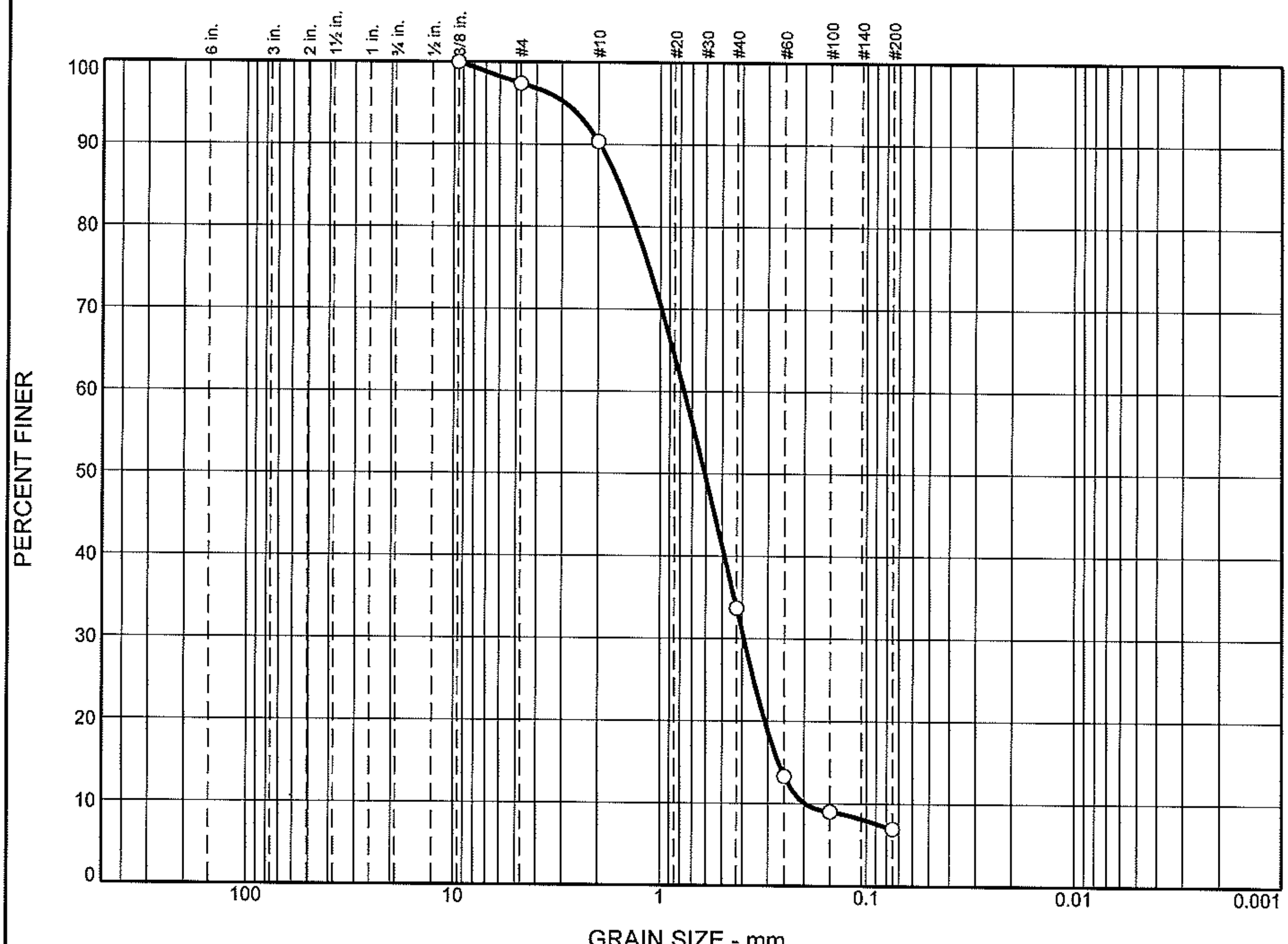
Baltimore, Maryland

Remarks:

o Moisture Content=21.4%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	2.6	7.0	56.7	26.7	7.0	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o		NV	NP	1.5707	0.7669	0.6083	0.3921	0.2669	0.1986	1.01	3.86

Material Description	USCS	AASHTO
o Dark grey Silty SAND	SP-SM	A-1-b

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

o **Source of Sample:** P-8 **Depth:** 44.4'-46.4' **Sample Number:** S-8

Date: o 06/21/12

Findling, Inc.

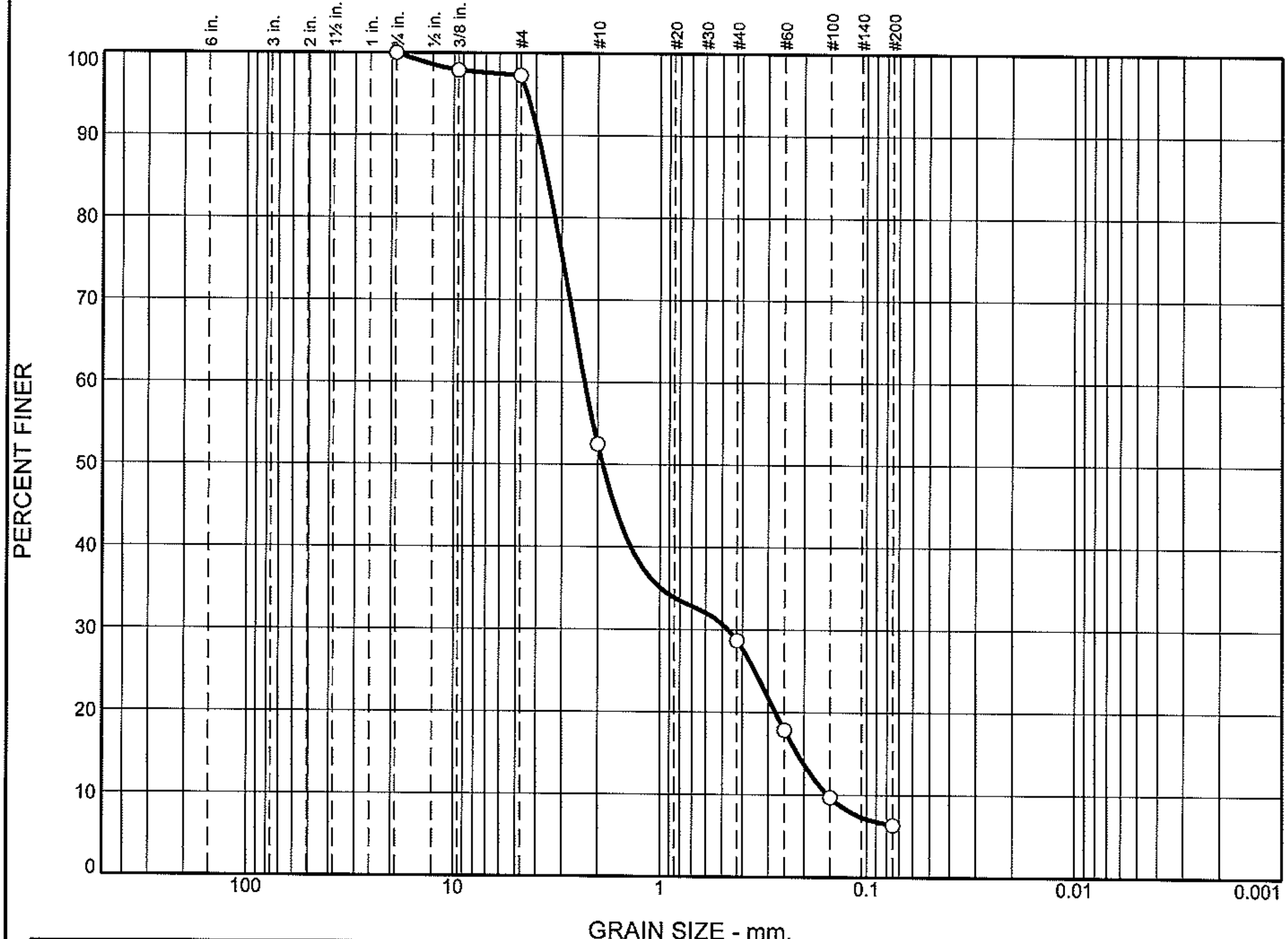
Baltimore, Maryland

Remarks:

o Moisture Content=27.9%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	2.7	44.8	23.8	22.3	6.4	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				3.5418	2.3113	1.8918	0.4682	0.2161	0.1538	0.62	15.03

Material Description	USCS	AASHTO
o Light grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

o **Source of Sample:** P-8 **Depth:** 50.4'-52.4' **Sample Number:** S-11

Date: o 06/21/12

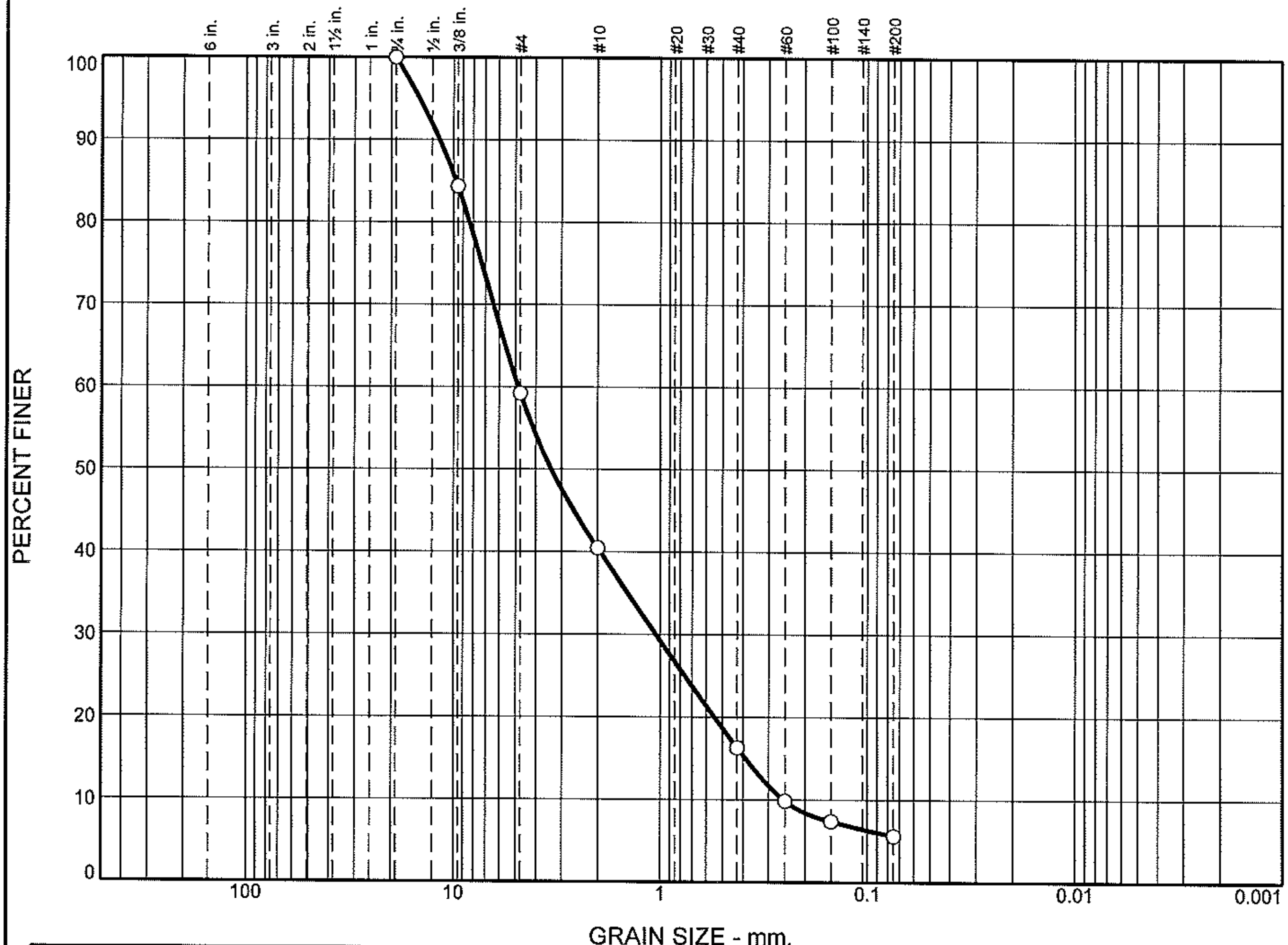
Remarks:
o Moisture Content=22.0%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	0.0	40.8	18.7	24.2	10.7	5.6	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				9.7367	4.8636	3.3629	1.0460	0.3872	0.2542	0.88	19.13

Material Description	USCS	AASHTO
o Grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
o **Source of Sample:** P-8 **Depth:** 58.4'-60.4' **Sample Number:** S-15

Date: o 06/21/12

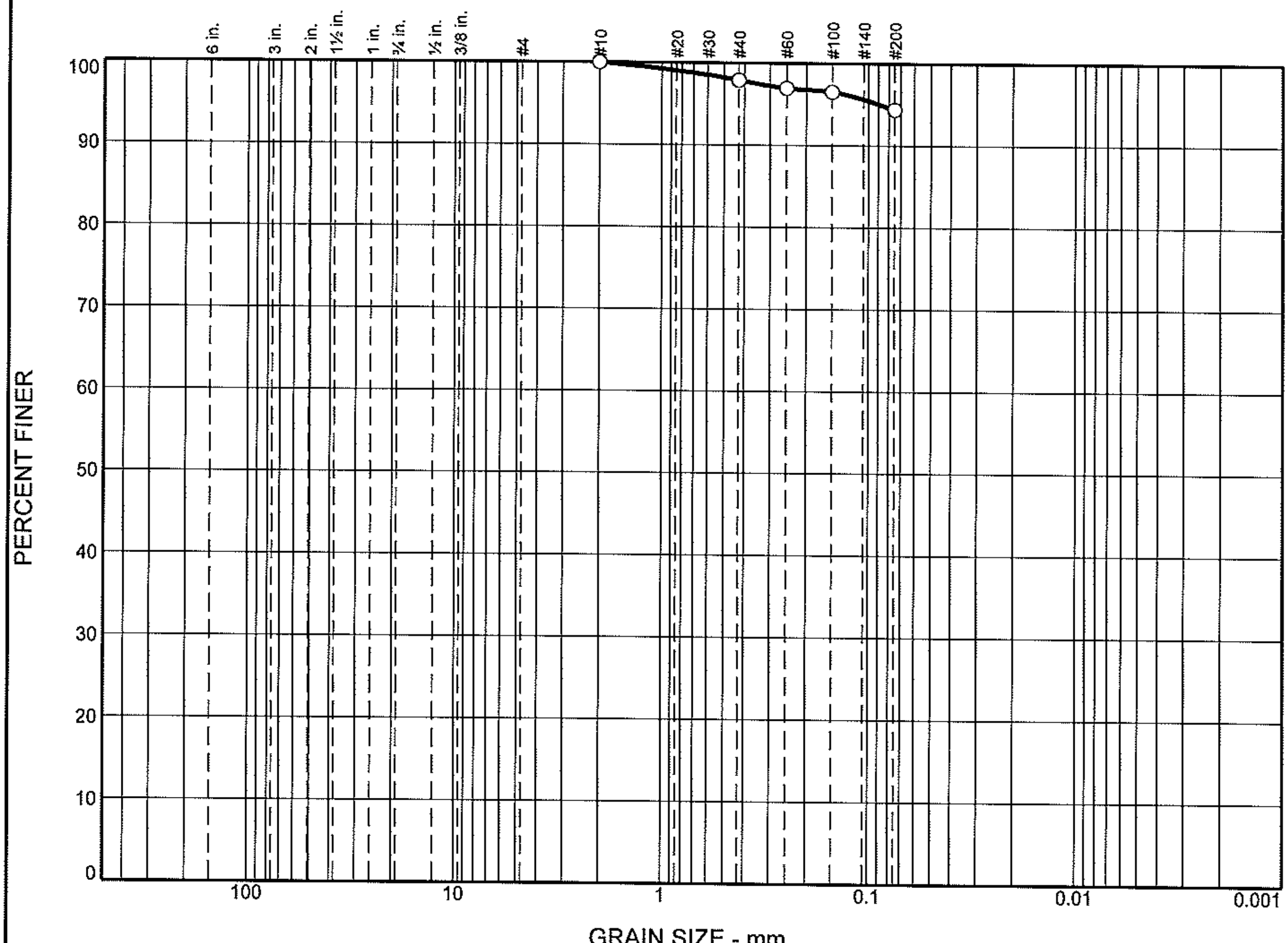
Findling, Inc.

Baltimore, Maryland

Remarks:
o Moisture Content=11.5%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
O	0.0	0.0	0.0	0.0	2.1	3.5	94.4	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
O											

Material Description	USCS	AASHTO
O Grey CLAY	ML	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
O **Source of Sample:** P-9 **Depth:** 41.2'-43.2' **Sample Number:** S-9

Date: O 06/21/12

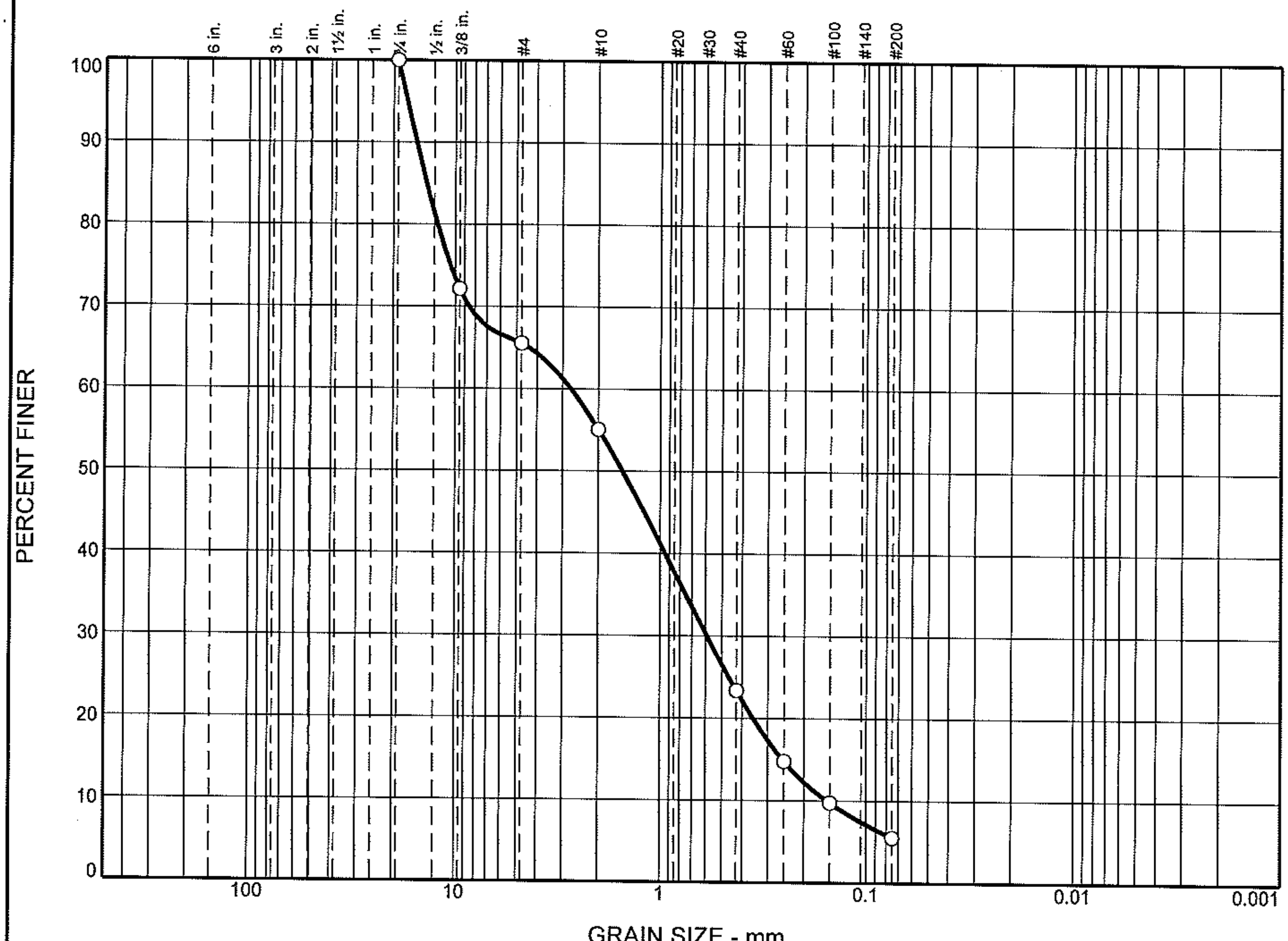
Findling, Inc.

Baltimore, Maryland

Remarks:
O Moisture Content=85.4%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	34.5	10.4	31.7	17.9	5.5	

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				13.8072	2.7324	1.5238	0.5919	0.2543	0.1551	0.83	17.61

Material Description	USCS	AASHTO
○ Grey Silty SAND	SP-SM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Marine Terminal Channel

○ **Source of Sample:** P-9 **Depth:** 49.2'-51.2' **Sample Number:** S-13

Date: ○ 06/21/12

Remarks:

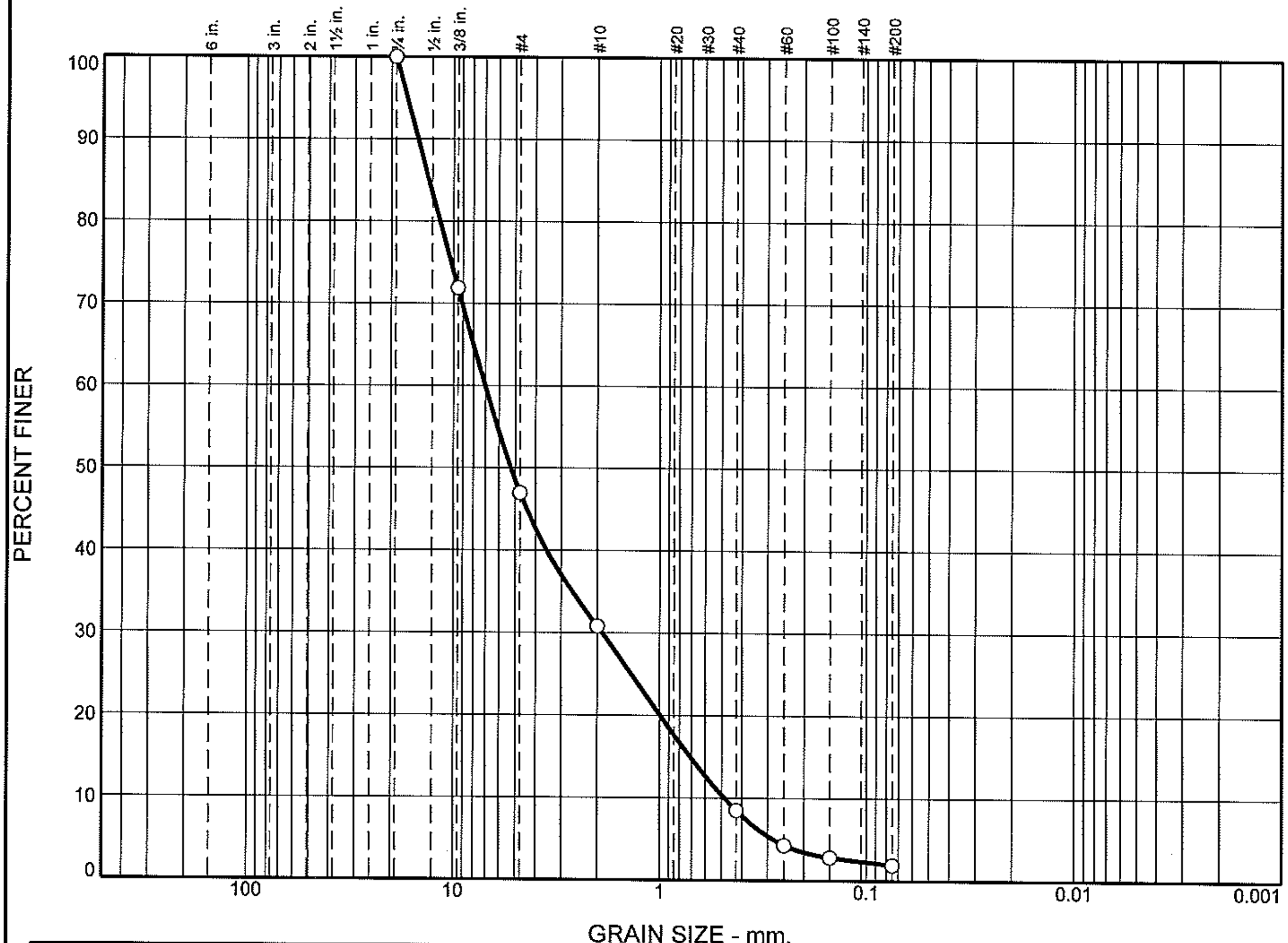
○Moisture Content=12.0%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	53.0	16.2	22.3	6.6	1.9	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				13.1838	7.0315	5.2628	1.8941	0.7101	0.4845	1.05	14.51

Material Description	USCS	AASHTO
○ Grey GRAVEL with Sand	GW	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Marine Terminal Channel
○ **Source of Sample:** P-9 **Depth:** 59.2'-61.2' **Sample Number:** S-18

Date: ○ 06/21/12

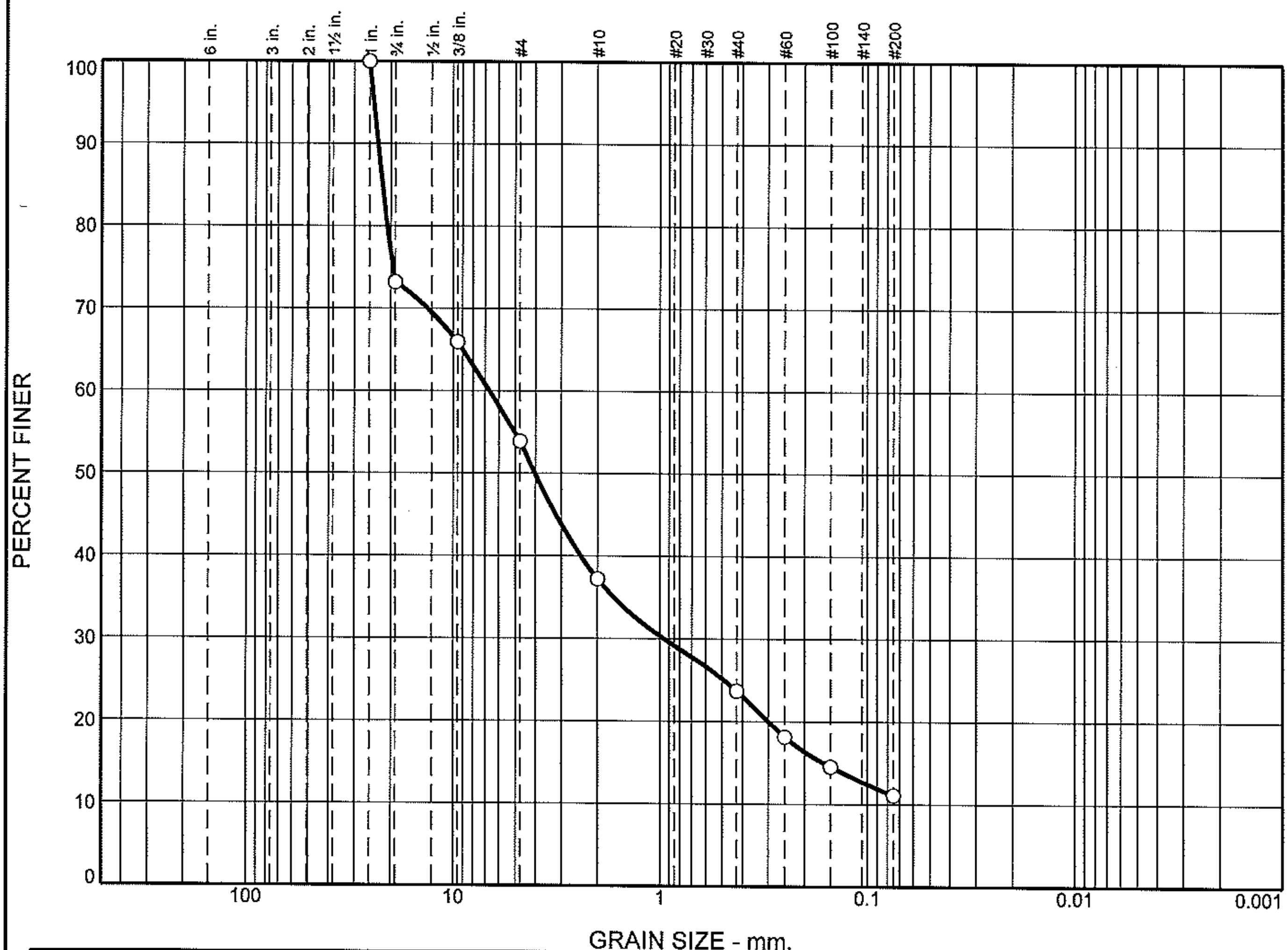
Remarks:
○Moisture Content=13.1%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	26.8	19.3	16.7	13.5	12.6	11.1	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				21.9717	6.6963	4.0292	0.9534	0.1623			

Material Description	USCS	AASHTO
○ Grey Silty GRAVEL	GP-GM	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Dundalk Channels
○ **Source of Sample:** P-10 **Depth:** 43.0'-45.0' **Sample Number:** S-10

Date: ○ 06/22/12

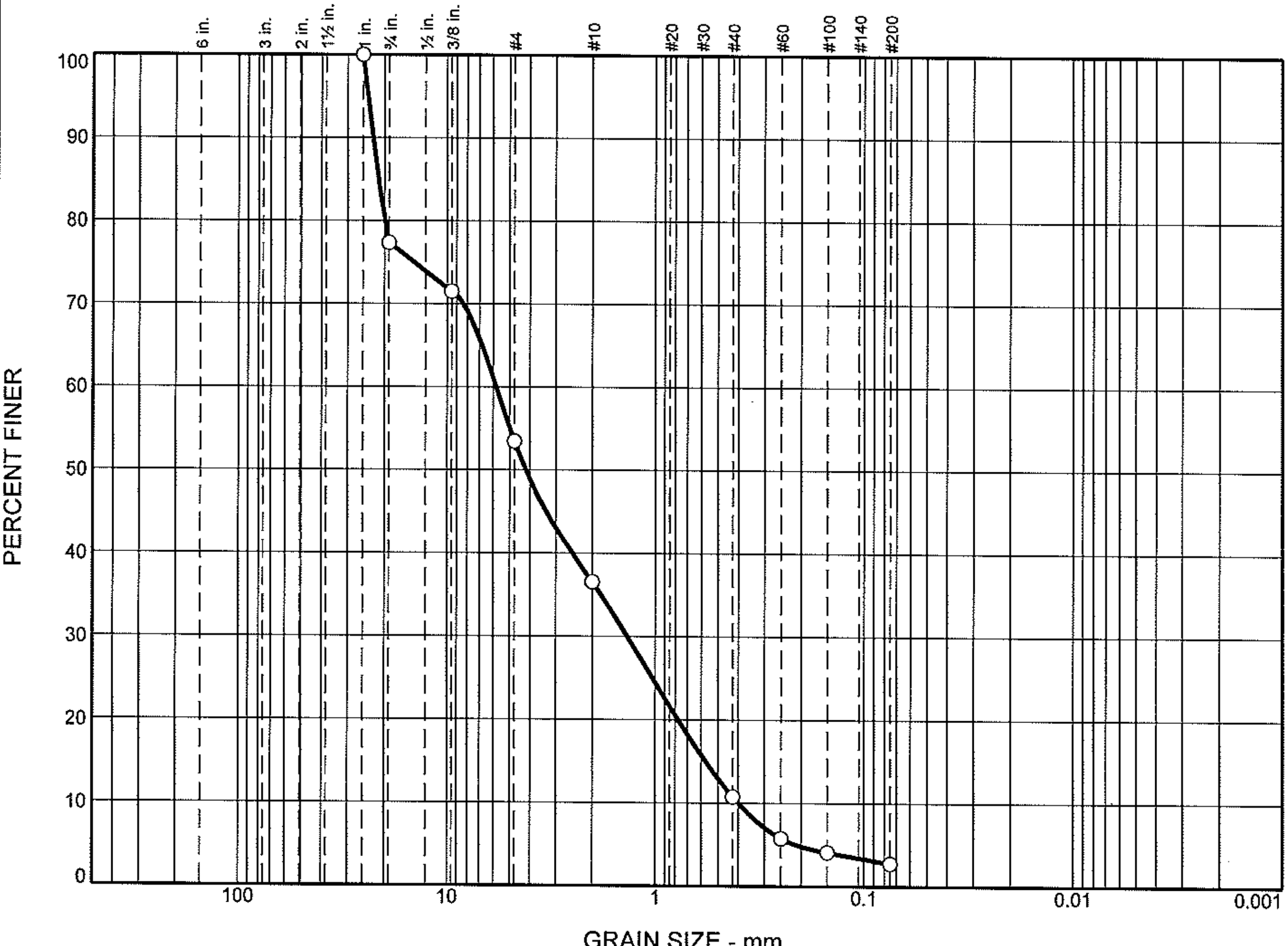
Findling, Inc.

Baltimore, Maryland

Remarks:
○Moisture Content=14.6%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
o	0.0	22.7	23.8	16.9	25.8	8.0	2.8	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
o				21.3557	5.8202	4.1861	1.3597	0.5724	0.3990	0.80	14.59

Material Description	USCS	AASHTO
o Light grey SAND with gravel	SP	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Dundalk Channels

o **Source of Sample:** P-10 **Depth:** 51.0'-53.0' **Sample Number:** S-14

Date: o 06/22/12

Remarks:

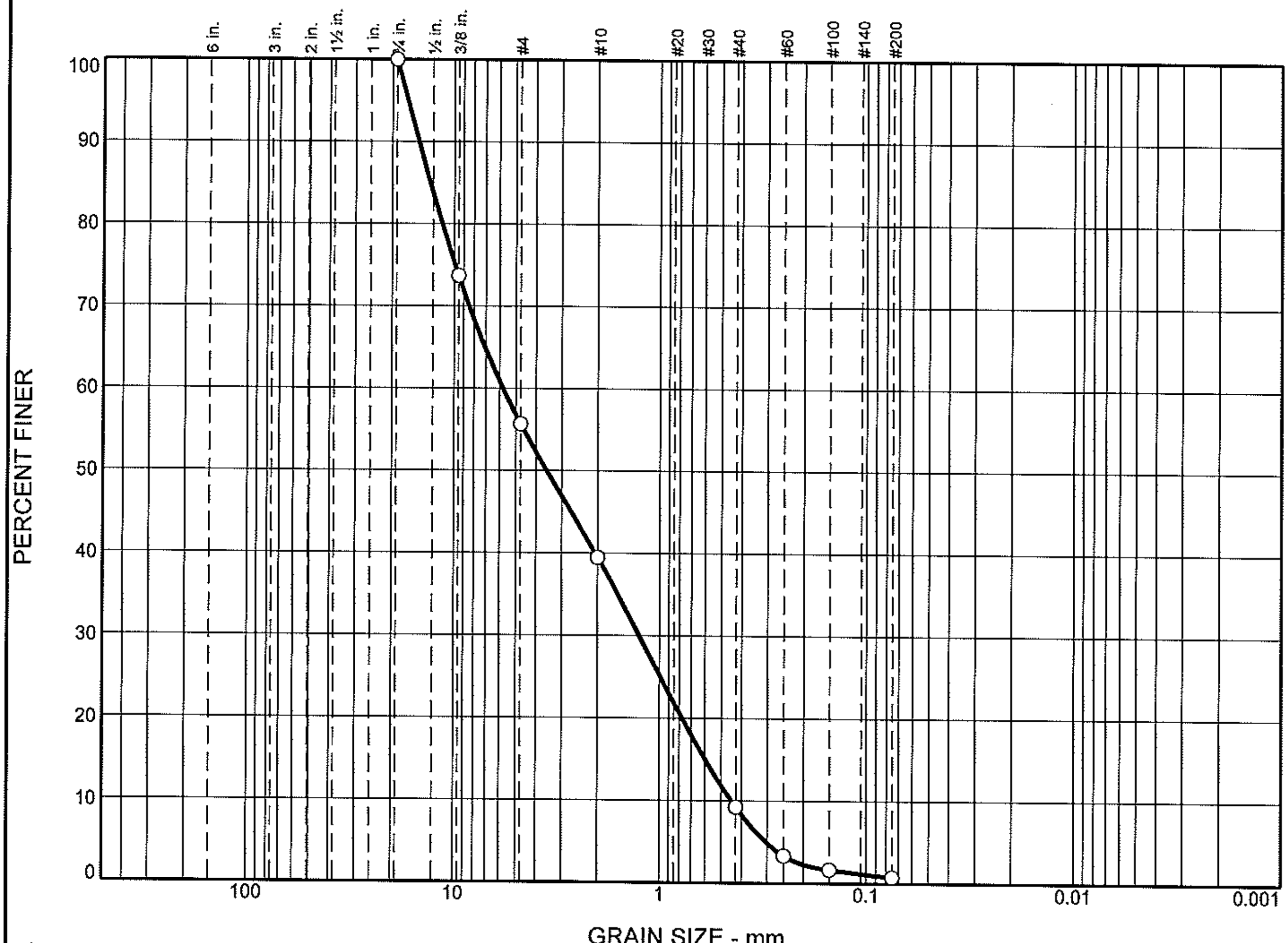
o Moisture Content=5.5%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	44.3	16.2	30.2	8.5	0.8	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				13.0803	5.7867	3.5503	1.2541	0.5983	0.4464	0.61	12.96

Material Description	USCS	AASHTO
○ Light grey SAND with gravel	SP	

Project No. 07-1122-10 **Client:** GBA
Project: Seagirt Dundalk Channels
○ **Source of Sample:** P-10 **Depth:** 61.0'-63.0' **Sample Number:** S-19

Date: ○ 06/22/12

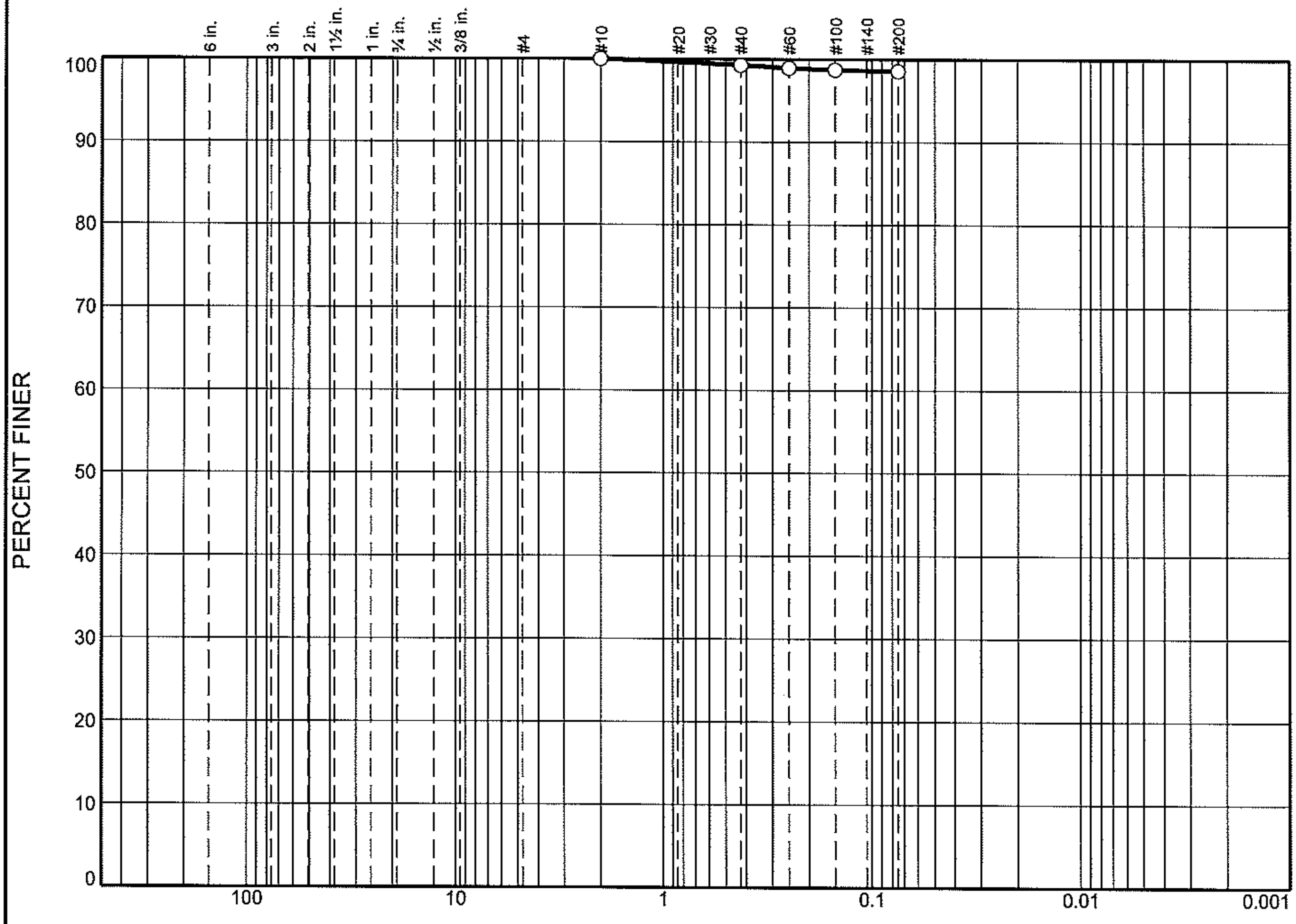
Remarks:
○Moisture Content=12.0%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.0	0.0	0.7	0.7	98.6	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○											

Material Description	USCS	AASHTO
○ Grey SILT	ML	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Dundalk Channels

○ **Source of Sample:** P-11 **Depth:** 41.3'-43.3' **Sample Number:** S-8

Date: ○ 06/22/12

Findling, Inc.

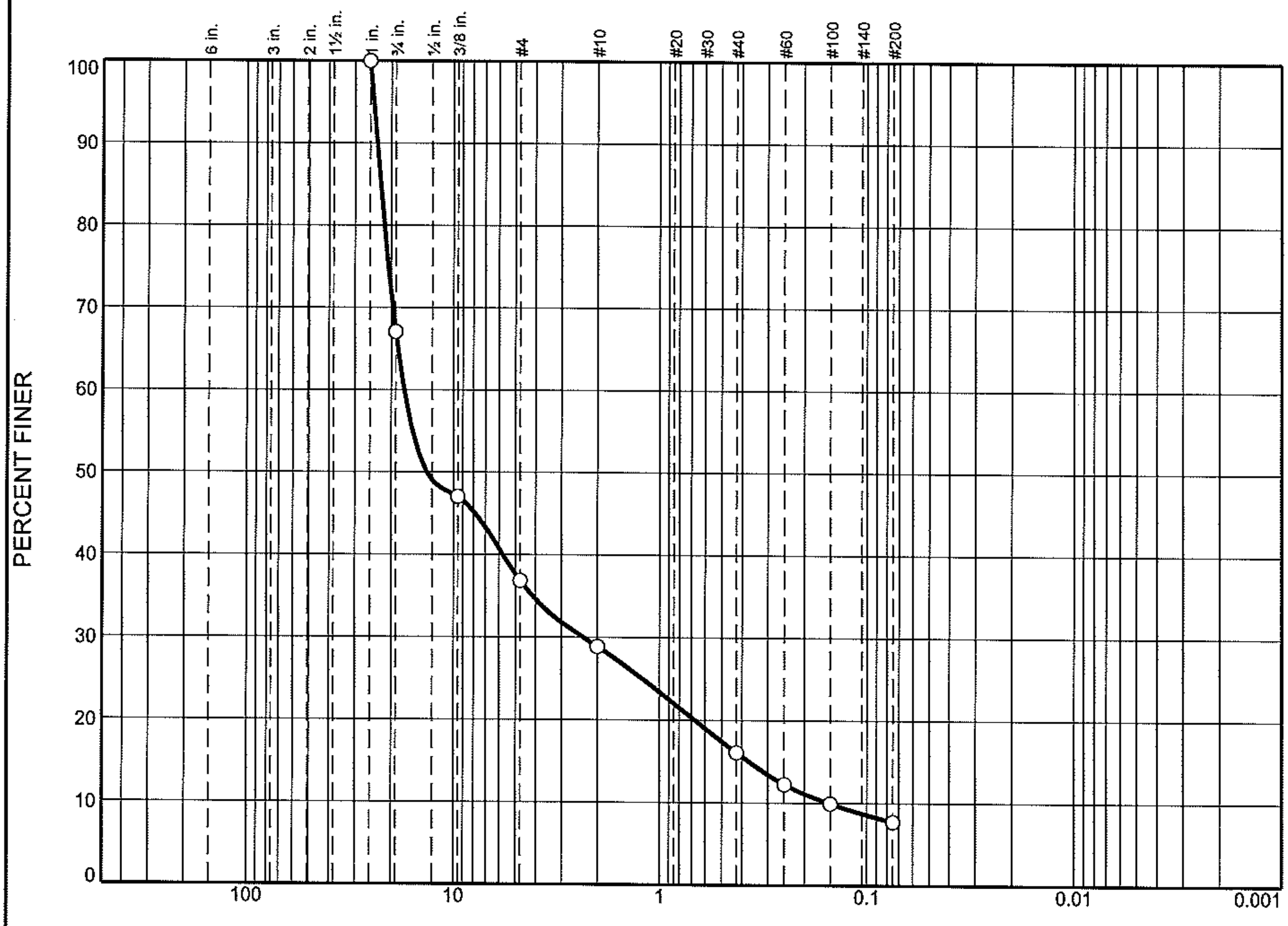
Baltimore, Maryland

Remarks:

○Moisture Content=130.9%

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	33.0	30.1	8.0	12.8	8.4	7.7	

☒	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				22.5402	17.3562	13.4463	2.3461	0.3698	0.1530	2.07	113.47

Material Description	USCS	AASHTO
○ Grey Silty GRAVEL	GW-GM	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Dundalk Channels

○ **Source of Sample:** P-11 **Depth:** 49.3'-51.3' **Sample Number:** S-12

Date: ○ 06/22/12

Remarks:

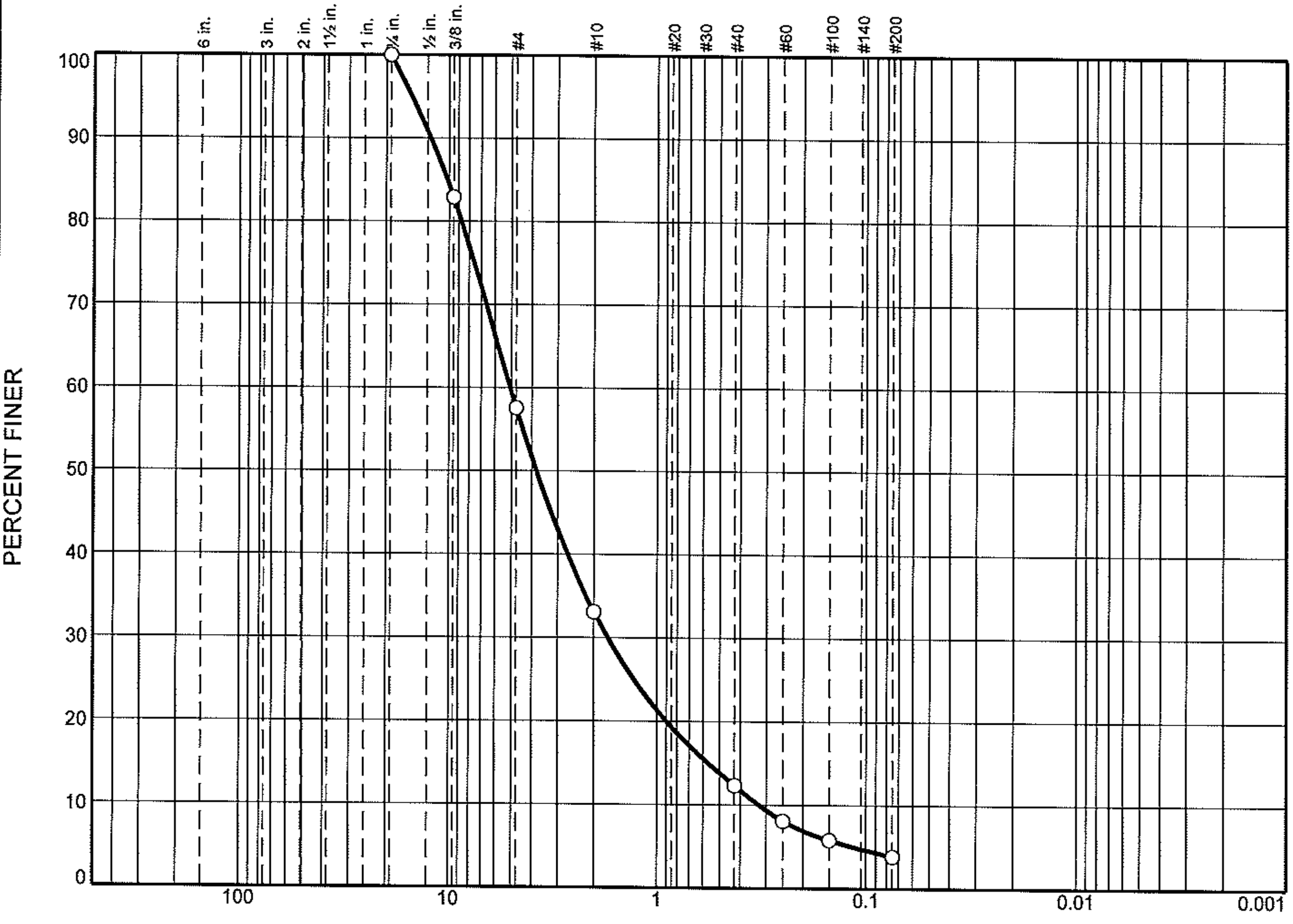
○Moisture Content=11.4%

Findling, Inc.

Baltimore, Maryland

Figure

Particle Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	42.5	24.4	20.8	8.4	3.9	

X	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				10.2027	5.0828	3.7957	1.7160	0.5669	0.3246	1.79	15.66

Material Description	USCS	AASHTO
○ Light grey SAND with Gravel	SW	

Project No. 07-1122-10 **Client:** GBA

Project: Seagirt Dundalk Channels

○ **Source of Sample:** P-11 **Depth:** 59.3'-61.3' **Sample Number:** S-17

Date: ○ 06/22/12

Findling, Inc.

Baltimore, Maryland

Remarks:

○Moisture Content=9.4%

Figure

Laboratory Data:
Findling, Inc., 2012
(P – Series)

TABLE 1: Summary of Laboratory Test Results

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

FINDLING, INC.

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-1	6/11/12	21.3	S-1	21.6 - 23.6	154.5							
			S-2	23.6 - 25.6	209.4							
			S-3	25.6 - 27.6	156.2							
			S-4	27.6 - 29.6	203.2							
			S-5	29.6 - 31.6	238.1							
			S-6	31.6 - 33.6	172.2							
			S-7	33.6 - 35.6	163.2							
			S-8	35.6 - 37.6	165.0							
			S-9	37.6 - 39.6	170.0							
			S-10	39.6 - 41.6	168.0							
			S-11	41.6 - 43.6	160.0						100	
			S-12	43.6 - 45.6	153.7							
			S-13	45.6 - 47.6	151.8							
			S-14	47.6 - 49.6	148.9						100	
			S-15	49.6 - 51.6	144.4							
			S-16	51.6 - 53.6	145.2							
			S-17	53.6 - 55.6	140.1						100	
			S-18	55.6 - 57.6	135.0							
			S-19	57.6 - 59.6	140.1							
			S-20	59.6 - 61.6	127.9						100	
			S-21	61.6 - 63.6	121.7							

NV = Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

FINDLING, INC.

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-2	6/11/12	25	S-1	25.0 - 27.0	145.3							
			S-2	27.0 - 29.0	150.7							
			S-3	29.0 - 31.0	162.3							
			S-4	31.0 - 33.0	171.1							
			S-5	33.0 - 35.0	164.9							
			S-6	35.0 - 37.0	152.4							
			S-7	37.0 - 39.0	147.5							
			S-8	39.0 - 41.0	125.0							
			S-9	41.0 - 43.0	109.6							
			S-10	43.0 - 45.0	92.9				0	6	94	ML
			S-11	45.0 - 47.0	22.0							
			S-12	47.0 - 49.0	19.6							
			S-13	49.0 - 51.0	21.9	NV	NP	NP	15	66	19	SM
			S-14	51.0 - 53.0	14.1							
			S-15	53.0 - 55.0	9.8	NV	NP	NP	55	40	5	GP-GM
			S-16	55.0 - 57.0	9.2							
			S-17	57.0 - 59.0	8.3							
			S-18	59.0 - 61.0	10.7	NV	NP	NP	42	51	6	SP-SM
			S-19	61.0 - 63.0	5.9							

NV = Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

FINDLING, INC.

Seagirt Marine Terminal Channel
Baltimore, MD
Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Grain Size Analysis Gravel %	Grain Size Analysis Sand %	Grain Size Analysis Fines (Silt+Clay) %	USCS Classification
P-3	6/14/12	24.4	S-1	24.4 - 26.2	185.6							
			S-2	26.2 - 28.2	106.6							
			S-3	28.2 - 30.2	122.9							
			S-4	30.2 - 32.2	162.6							
			S-5	32.2 - 34.2	155.2							
			S-6	34.2 - 36.2	151.5							
			S-7	36.2 - 38.2	141.3							
			S-8	38.2 - 40.2	140.6							
			S-9	40.2 - 42.2	129.4							
			S-10	42.2 - 44.2	128.7	90	46	44	0	1	99	MH
			S-11	44.2 - 46.2	100.4							
			S-12	46.2 - 48.2	77.7							
			S-13	48.2 - 50.2	8.4							
			S-14	50.2 - 52.2	8.5				42	54	4	SP
			S-15	52.2 - 54.2	29.8							
			S-16	54.2 - 56.2	34.7							
			S-17	56.2 - 58.2	22.7							
			S-18	58.2 - 60.2	6.7							
			S-19	60.2 - 62.2	8.8				61	37	2	GW
			S-20	62.2 - 64.2	9.5							
P-4	6/14/12	41.4	S-1	42.1 - 44.1	274.1							
			S-2	44.1 - 46.1	128.3							
			S-3	46.1 - 48.1	83.1							
			S-4	48.1 - 50.1	61.3	NV	NP	NP	0	61	39	SM
			S-5	50.1 - 52.1	30.2							
			S-6	52.1 - 54.1	45.7							
			S-7	54.1 - 56.1	26.3							
			S-8	56.1 - 58.1	31.1							
			S-9	58.1 - 60.1	21.1							
			S-10	60.1 - 62.1	18.6				0	93	7	SP-SM
			S-11	62.1 - 64.1	49.2							

NV= Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

Seagirt Marine Terminal Channel
Baltimore, MD
Findling Project No. 07-1122-10

FINDLING, INC.

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-5	6/14/12	43.4	S-1	43.6 - 45.6	214.3							
			S-2	45.6 - 47.6	96.1	84	45	39	0	2	98	MH
			S-3	47.6 - 49.6	91.3							
			S-4	49.6 - 51.6	37.5				0	42	58	ML
			S-5	51.6 - 53.6	81.6							
			S-6	53.6 - 55.6	37.4							
			S-7	55.6 - 57.6	28.5							
			S-8	57.6 - 59.6	33.7							
			S-9	59.6 - 61.6	35.2							
			S-10	61.6 - 63.6	22.8				0	90	10	SP-SM
P-6	6/15/12	43.2	S-1	43.4 - 44.7	232.6							
			S-2	44.7 - 46.7	102.9							
			S-3	46.7 - 48.7	86.4				0	6	94	MH
			S-4	48.7 - 50.7	7.4							
			S-5	50.7 - 52.7	8.7							
			S-6	52.7 - 54.7	7.8				51	42	7	GP-GM
			S-7	54.7 - 56.7	15.2							
			S-8	56.7 - 58.7	19.0							
			S-9	58.7 - 60.7	19.3							
			S-10	60.7 - 62.7	14.4				7	83	10	SP-SM

NV= Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

FINDLING, INC.

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-7	6/18/12	48.0	S-1	49.2 - 51.2	95.5							
			S-2	51.2 - 53.2	15.9				78	22	0	GP
			S-3	53.2 - 55.2	7.4							
			S-4	55.2 - 57.2	7.1							
			S-5	57.2 - 59.2	21.1				1	66	33	SM
			S-6	59.2 - 61.2	22.5							
			S-7	61.2 - 63.2	16.2							
P-8	6/18/12	29.4	S-1	30.4 - 32.4	184.5							
			S-2	32.4 - 34.4	143.9							
			S-3	34.4 - 36.4	132.6							
			S-4	36.4 - 38.4	54.7							
			S-5	38.4 - 40.4	21.4				30	61	9	SP-SM
			S-6	40.4 - 42.4	16.3							
			S-7	42.4 - 44.4	15.6							
			S-8	44.4 - 46.4	27.9	NV	NP	NP	3	90	7	SP-SM
			S-9	46.4 - 48.4	143.8							
			S-10	48.4 - 50.4	105.2							
			S-11	50.4 - 52.4	22.0				3	91	6	SP-SM
			S-12	52.4 - 54.4	11.2							
			S-13	54.4 - 56.4	8.7							
			S-14	56.4 - 58.4	10.4							
			S-15	58.4 - 60.4	11.5				41	53	6	SP-SM
			S-16	60.4 - 62.4	26.2							

NV=Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

FINDLING, INC.

Seagirt Marine Terminal Channel
Baltimore, MD
Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-9	6/18/12	25.2	S-1	25.2 - 27.2	135.5							
			S-2	27.2 - 29.2	172.8							
			S-3	29.2 - 31.2	168.0							
			S-4	31.2 - 33.2	166.3							
			S-5	33.2 - 35.2	147.6							
			S-6	35.2 - 37.2	164.3							
			S-7	37.2 - 39.2	138.7							
			S-8	39.2 - 41.2	119.5							
			S-9	41.2 - 43.2	85.4				0	6	94	ML
			S-10	43.2 - 45.2	36.3							
			S-11	45.2 - 47.2	21.4							
			S-12	47.2 - 49.2	11.3							
			S-13	49.2 - 51.2	12.0				34	60	6	SP-SM
			S-14	51.2 - 53.2	12.7							
			S-15	53.2 - 55.2	8.0							
			S-16	55.2 - 57.2	7.3							
			S-17	57.2 - 59.2	9.4							
			S-18	59.2 - 61.2	13.1				53	45	2	GW
			S-19	61.2 - 63.2	9.7							

NV=Non Viscous, NP=Non Plastic

FINDLING, INC.

TABLE 1: Summary of Laboratory Test Results

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-10	6/21/12	25.6	S-1	25.6 - 27.0	109.4							
			S-2	27.0 - 29.0	134.9							
			S-3	29.0 - 31.0	155.9							
			S-4	31.0 - 33.0	156.1							
			S-5	33.0 - 35.0	145.4							
			S-6	35.0 - 37.0	138.5							
			S-7	37.0 - 39.0	122.5							
			S-8	39.0 - 41.0	98.4							
			S-9	41.0 - 43.0	129.6							
			S-10	43.0 - 45.0	14.6				46	43	11	GP-GM
			S-11	45.0 - 47.0	29.3							
			S-12	47.0 - 49.0	100.9							
			S-13	49.0 - 51.0	10.7							
			S-14	51.0 - 53.0	5.5				47	50	3	SP
			S-15	53.0 - 55.0	9.8							
			S-16	55.0 - 57.0	14.3							
			S-17	57.0 - 59.0	11.3							
			S-18	59.0 - 61.0	7.6							
			S-19	61.0 - 63.0	12.0				44	55	1	SP

NV=Non Viscous, NP=Non Plastic

FINDLING, INC.

TABLE 1: Summary of Laboratory Test Results

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-11	6/21/12	26.4	S-1	27.3 - 29.3	196.3							
			S-2	29.3 - 31.3	162.3							
			S-3	31.3 - 33.3	166.3							
			S-4	33.3 - 35.3	163.9							
			S-5	35.3 - 37.3	151.7							
			S-6	37.3 - 39.3	140.9							
			S-7	39.3 - 41.3	139.5							
			S-8	41.3 - 43.3	130.9				0	1	99	ML
			S-9	43.3 - 45.3	127.5							
			S-10	45.3 - 47.3	107.9							
			S-11	47.3 - 49.3	84.2							
			S-12	49.3 - 51.3	11.4				63	29	8	GW-GM
			S-13	51.3 - 53.3	11.5							
			S-14	53.3 - 55.3	10.0							
			S-15	55.3 - 57.3	6.2							
			S-16	57.3 - 59.3	9.3							
			S-17	59.3 - 61.3	9.4				42	54	4	SW
			S-18	61.3 - 63.3	12.3							

NV=Non Viscous, NP=Non Plastic

FINDLING, INC.

TABLE 1: Summary of Laboratory Test Results

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
P-12	6/22/12	37	S-1	37.0 - 39.0	186.0							
			S-2	39.0 - 41.0	152.3							
			S-3	41.0 - 43.0	159.2							
			S-4	43.0 - 45.0	150.1							
			S-5	45.0 - 47.0	146.0							
			S-6	47.0 - 49.0	135.9							
			S-7	49.0 - 51.0	137.3							
			S-8	51.0 - 53.0	128.7							
			S-9	53.0 - 55.0	122.4							
			S-10	55.0 - 57.0	116.7							
			S-11	57.0 - 59.0	105.1							
			S-12	59.0 - 61.0	103.2							
			S-13	61.0 - 63.0	94.7							
P-13	6/22/12	40.3	S-1	40.9 - 42.9	138.9							
			S-2	42.9 - 44.9	134.3							
			S-3	44.9 - 46.9	143.3							
			S-4	46.9 - 48.9	146.0							
			S-5	48.9 - 50.9	142.0							
			S-6	50.9 - 52.9	135.3							
			S-7	52.9 - 54.9	129.0							
			S-8	54.9 - 56.9	122.3							
			S-9	56.9 - 58.9	121.5							
			S-10	58.9 - 60.9	109.4							
			S-11	60.9 - 62.9	107.6							
P-14	6/25/12	25.9	S-1	27.2 - 29.2	147.8							
			S-2	29.2 - 31.2	162.3							
			S-3	31.2 - 33.2	172.2							
			S-4	33.2 - 35.2	162.6							
			S-5	35.2 - 37.2	153.9							
			S-6	37.2 - 39.2	146.4							
			S-7	39.2 - 41.2	142.8							

NV=Non Viscous, NP=Non Plastic

TABLE 1: Summary of Laboratory Test Results

FINDLING, INC.

Seagirt Marine Terminal Channel

Baltimore, MD

Findling Project No. 07-1122-10

Boring No.	Date Drilled	Depth of Water, feet (below MLLW)	Sample Number	Sample Elevation, feet (Depth below MLLW)	Natural Moisture Content, %	Atterberg Limits			Grain Size Analysis			USCS Classification
						LL	PL	PI	Gravel %	Sand %	Fines (Silt+Clay) %	
			S-8	41.2 - 43.2	126.5							
			S-9	43.2 - 45.2	107.8							
			S-10	45.2 - 47.2	92.8							
			S-11	47.2 - 49.2	46.3							
			S-12	49.2 - 51.2	41.8							
			S-13	51.2 - 53.2	21.9				12	80	8	SP-SM
			S-14	53.2 - 55.2	21.0							
			S-15	55.2 - 57.2	18.6							
			S-16	57.2 - 59.2	27.8							
			S-17	59.2 - 61.2	23.8							
			S-18	61.2 - 63.2	21.7				3	90	7	SP-SM
P-15	6/22/12	22.8	S-1	23.2 - 25.2	106.9							
			S-2	25.2 - 27.2	182.1							
			S-3	27.2 - 29.2	263.7							
			S-4	29.2 - 31.2	216.5							
			S-5	31.2 - 33.2	140.3							
			S-6	33.2 - 35.2	142.4							
			S-7	35.2 - 37.2	168.8							
			S-8	37.2 - 39.2	167.1							
			S-9	39.2 - 41.2	164.2							
			S-10	41.2 - 43.2	168.8							
			S-11	43.2 - 45.2	154.0							
			S-12	45.2 - 47.2	152.3							
			S-13	47.2 - 49.2	146.2							
			S-14	49.2 - 51.2	142.4							
			S-15	51.2 - 53.2	140.7							
			S-16	53.2 - 55.2	137.4							
			S-17	55.2 - 57.2	135.2							
			S-18	57.2 - 59.2	129.6							
			S-19	59.2 - 61.2	122.3							
			S-20	61.2 - 63.2	124.0							

NV=Non Viscous, NP=Non Plastic

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B2:

Design Vessel and Air Draft Analysis

moffatt & nichol

2780 Lighthouse Point East, Suite D
Baltimore, MD 21224

(410)563-7300
www.moffattnichol.com

MEMORANDUM

To:	MPA and MES PDT
From:	Moffatt & Nichol
Date:	July 5, 2022
Subject:	*Design Vessel and Air Draft Clearance [REV 2]*
M&N Job No.:	10848-07 BHAC Seagirt Loop Deepening Feasibility

The purpose of this memorandum is to evaluate the selection of design vessels for the BHAC Seagirt Loop Channel Deepening Feasibility in regard to compatibility with Seagirt Marine Terminal, the existing vessel services on the East Coast, and air draft clearance under the bridges, accounting for future sea level rise.

Design Vessel

Two vessel classes have been identified for use in the Seagirt Loop Deepening Feasibility Study: Post Panamax (PPX) Generation III and Generation III Max containerships with capacity of 13,800 – 16,000 TEU Capacity. PPX III vessels represent the existing vessels calling at Seagirt Marine Terminal (SMT) Berth 4 and will be accommodated at Berth 3 following ongoing upgrades to the berth.

SMT cargo cranes will be able to handle vessels loaded with container stacks up to 22 containers wide with a working boom height of 164 feet. PPX III vessels (up to 14,000 TEU) are typically loaded 20 containers wide. PPX III Max vessels (up to 16,000 TEU) up to 22 containers wide can take full advantage of the capacity of the upgrade to SMT.

Two representative vessels were selected as prototypes for evaluating the relative dimensions of the design vessels as shown in Table 1. Two draft design values are provided in Table 1:

Design Draft	The draft of the vessel upon which the naval architecture stability and performance of the vessel hull are based.
Scantling Draft	The maximum structural draft for which the ship hull and supporting structures are designed. Typically, greater than the design draft and represents the maximum limit to which a ship can be loaded.

PPX III Vessels currently call at SMT Berth 4 on a regular basis. According to AIS records from Jan 2019 to Jun 2020, 46 vessels greater than 1,180 feet called at SMT 4, or an average of 30 per year. In 2018, only 8 vessels in this class called at SMT, therefore the trend shows increasing calls of vessels of this size and it is anticipated to continue with SMT Berth 3 upgrades.

PPX III MAX vessels began to work routes on the US East Coast beginning in 2021. The *CMA CGM Marco Polo* made its first calls to US East Coast in May 2021 stopping at Halifax, New York, Norfolk, Charleston and Savannah. The *CMA CGM Marco Polo* and her sister ships have established a rotating service between South Asian Ports and US West and East Coasts as shown in Figure 1. During 2021, three *Marco Polo*-class vessels called at East Coast Ports.. While these vessels were the largest containerships in the world when constructed in 2012, newer vessels greater than 20,000 TEU have supplanted them on the high volume Asia-Europe/Asia-West Coast services and the PPX III MAX vessels are therefore providing more service on East Coast routes. Berth 4 at SMT currently has sufficient water depth and crane capacity to service PPX III MAX vessels. Starting in 2022, Berth 3 will have the same capability, providing 2 berths in Baltimore equipped for PPX III MAX vessels.

Table 1. Design Vessel Characteristics

Parameter	PPX III	PPX III Max
Prototype	*MSC Beatrice*	*CMA CGM Marco Polo*
Number of Vessels in Peer Group*	54	18
Nominal TEU Capacity	13,800	16,000
Length Overall (LOA)	1200 ft	1299 ft
Beam (B)	168.0 ft	175.9 ft
Design Draft (T)	47.6 ft	46 ft
Scantling Draft	51.2 ft	52.5 ft
Keel to Masthead	220 ft	227.9 ft
Air Draft**	168.8 - 172.4 ft	175.4 – 181.9 ft

* Represents number of vessels in world fleet with similar dimensions and cargo capacity, as reported by Clarkson Register 2021

** Range of values reflect possible air draft between scantling and design draft

Figure 1. Planned Service Routes for CMA CGM PPX III MAX Containerships

Air Draft

Efficient access to Baltimore Harbor for the design vessels will be constrained both by the channel dimensions (width and depth) and the two bridges which vessels must pass under to reach Baltimore: The William Preston Lane Jr. Memorial Bridge ("Bay Bridge") and the Francis Scott Key Bridge ("Key Bridge"). The Air Draft of the vessel is defined as the distance from the water surface to the highest point on a vessel. Figure 2 presents definitions important to defining clearance distance under the controlling bridges. It should be noted that Figure 2 is not to scale and should only be used for relevant term definitions or as a general schematic.

KTM Keel to Masthead. Distance from the bottom of the hull of the vessel to the highest point on the mast atop the wheelhouse.

HST Air draft. Distance from water surface to the top of the vessel mast.

T	Vessel draft under water surface.
ADC	Air Draft Clearance. Distance from the top of the ship mast to the lowest point on the overhanging bridge.
UKC	Distance from lowest point on ship hull to the mudline of the channel.

To pass under the bridge safely, a minimum air draft clearance is required. The clearance is determined by the elevation of the water surface at a given time, the draft to which the vessel is loaded, and the speed of transit. The charted clearance of the two bridges is given by NOAA on the nautical chart relative to the mean high water (MHW) elevation (see Figure 3 and Figure 4):

Chesapeake Bay Bridge	182 feet MHW
Francis Scott Key Bridge	185 feet MHW

The charted channel depths are given relative to mean lower low water (MLLW). Therefore, to calculate the vertical clearance available at a given time, the water surface elevation must be computed accounting for stage of the tide and any additional allowance, such as sea level rise (SLR). Figure 2 illustrates the variability in the water surface elevation with tide and future SLR. The tidal datum elevations from the NOAA tide gauge at Baltimore (8574680) and Annapolis (8575512) for the current tidal epoch (1983 – 2001) relative to NAVD88 are shown in Table 2.

Table 2. Tidal datum conversions at Baltimore and Annapolis relative to NAVD88 (Tidal Epoch 1983-2001).

Tidal Datum	Elevation, NAVD88 [ft]	
	Baltimore	Annapolis
Mean Higher High Water (MHHW)	0.82	0.66
Mean High Water (MHW)	0.53	0.42
NAVD88	0.00	0.00
Mean Sea Level (MSL)	-0.03	-0.05
Mean Low Water (MLW)	-0.62	-0.55
Mean Lower Low Water (MLLW)	-0.84	-0.77

The general trend of air draft of a vessel (based on the vessel design draft) with increasing TEU capacity is presented in Figure 5. The data is based on general arrangement drawings of vessels from the annual publication *Significant Ships* (RINA, 2004-2019). For reference the bridge clearances of the Bay Bridge and Key Bridge are included as horizontal lines. Above 16,000 TEU, the best fit trend line and data exceed the height of the bridges (at MHW). Therefore, the selection of design vessels appears to represent the feasible maximum under present day bridge constraints. The accessibility of the design vessels is examined in more detail below.

Air Draft of Design Vessels

The dimensions of the prototype Post Panamax Generation III vessel (*MSC Beatrice*) air draft at design draft is 172.4 feet and therefore can clear both bridges at any tide stage and has margin to transit when loaded lighter than design draft. Air draft for PPX III vessels is evaluated on a case-by-case basis, as shown in Figure 5 there are vessels in this class with air draft greater than *MSC Beatrice*.

The Post Panamax Generation III Max vessel (Marco Polo) keel to masthead height is such that at the maximum operating draft of 47.5 feet (corresponding to the existing 50-foot channel), the vessel air draft is 180.3 feet, therefore this class of vessel must manage ballast and cargo to take advantage of the 50 -foot channel both on approach and departing Baltimore to clear the bridge.

Sea Level Rise Effect on Air Draft

The Bay Bridge and Key Bridge are fixed bridges (i.e., do not fold up or retract) and therefore SLR will act to decrease the ADC unless properly managed by supplying additional ballast to vessels transiting below the Bay and Key Bridges. The impact of SLR to navigation of the design vessels (e.g., *MSC Beatrice and CMA CGM Marco Polo*) in the future to Baltimore Harbor is assessed below.

Relative SLR (RSLR) projections were obtained from the USACE Sea-Level Change Curve Calculator (Version 2021.12) for the years 2022 to 2130 using measured data relative to the current tidal epoch (1983 - 2001) from the NOAA tide gauge in Baltimore and Annapolis. The Sea-Level Change Curve Calculator provides three possible RSLR scenarios: low, intermediate, and high. The RSLR projections are shown in Figure 6 and tabulated in Table 3.

The SLR projections from the Baltimore tide gauge were used to assess future vessel ADC at the Key Bridge while the SLR projections from the Annapolis tide gauge were used at the Bay Bridge due to the location of the gauges relative to the bridges of interest. For reference, the Key Bridge is about 4.25 miles southwest of the Baltimore tide gauge and the Bay Bridge is about 5.50 miles east-northeast of the Annapolis tide gauge.

The future ADC of the PPX III and PPX III MAX Vessels are reported below in Table 4 and Table 5, respectively, for the three RSLR scenarios relative to MHW. Note that the tables use the charted bridge clearance and not the air gap sensor. Based on the measured tide gauge records at Baltimore and Annapolis, there has been 0.32 ft and 0.37 ft of SLR, respectively, from the middle of the current tidal epoch (i.e., 1992) to 2022. Therefore, the observed SLR values from 1992 – 2022 were added to the MHW tidal datum, relative to NAVD88, to account for SLR at Baltimore and Annapolis since the current tidal datums were established.

The future ADC of the PPX III MAX vessel is shown graphically in Figure 7 as the future masthead elevation (relative to MHW) due to SLR for the three RSLR projection scenarios. The controlling elevation of the Bay Bridge (relative to MHW) is also shown in Figure 7. The intersection between the Bay Bridge elevation (black) and the future vessel masthead elevation (blue, orange, and gray) indicates the time where air draft is project to exceed the charted clearance of the bridge.

It is important to emphasize that the ADC with future SLR incorporated assumes that both vessels are transiting at the channel design draft of 47.5 ft draft. For lighter loaded vessels, the vessel water draft will decrease with a concomitant decrease in ADC. For the PPX III Max, the vessel must be ballasted or loaded to the maximum allowable channel draft of 47.5 feet to provide sufficient ADC.

The Bay Bridge with lower clearance controls the allowable air draft into Baltimore. For the PPX III Max vessel transiting at high tide (e.g., MHW), there is approximately 1.3 feet of ADC to the charted bridge height under present day conditions. For the intermediate SLR scenario, the ADC decreases to 0.90 feet in 2045 and 0.45 feet in 2065. For the high SLR scenario, the ADC reduces to 0.83 feet and 0.36 feet in 2035 and 2045, respectively.

Air Gap Sensors and ADC Management

Both bridges into Baltimore have suspension spans over the navigation channel, therefore the bridge deck elevation changes with factors such as temperature and auto traffic volume. The charted bridge clearance is based on the design conditions with bridge deck at its lowest elevation (i.e. high temperature and traffic). Under most conditions the clearance to the lower structural steel of the bridge is more than 3 feet higher than the charted value. Two air gap sensors have been installed at each bridge and are reported through the NOAA PORTS reporting system. The Association of Maryland Pilots (Pilots) use this data to evaluate the bridge clearances and manage ship ballast during approach or upon departure. Each sensor is placed below the lowest structural steel elements of the bridge: the Bay Bridge the sensor is 1.4 feet below structural steel and the Francis Scott Key sensor is 5.47 feet below structural steel.

Figure 8 plots the percent of time that the gap between the water and structural steel exceeds given elevations. For both bridges, the available clearance exceeds the charted value 99% of the time. The Pilots utilize the sensors to evaluate required air draft for each vessel and will transit at air drafts higher than the charted values if the sensors show adequate clearance. However, if the sensors are non-functional or non-reporting then the pilots will revert to the charted values.

Additional Considerations

Squat

The ADC will vary by individual vessel, loading conditions, speed of transit, and environmental conditions at the time of transiting under the bridge. The ADC presented in Table 4 and Table 5 does not account for squat of the vessel underway, which will increase ADC. Vessel squat is a sinkage of the hull lower in the water due to the effects of water running past the hull. EM 1110-2-1613 provides a simplified expression to estimate squat (see below) which is proportional to the square of velocity. Assuming a typical transit speed in the upper Chesapeake of 10 knots, the resultant squat for the *CMA CGM Marco Polo* is approximately 1.9 feet, which would provide additional ADC to a vessel passing under the bridge.

$$Z_{max} = \frac{C_b B T V^2}{4.573 L h}$$

Z_{max} = Squat in feet

C_b = Vessel block coefficient (~0.68 for large containerships)

L = Vessel length (feet)

h = water depth (feet)

V = vessel speed through water (knots)

Sea Level Rise and Dredged Channels

The existing channels are maintained to a grade of -50 feet MLLW based on the current tidal epoch (1983 - 2001). As sea level rises, channels maintained to the same mudline will become concomitantly deeper. For example, a 0.5 ft increase in sea level, would increase channel depth to 50.5 feet relative to MLLW measured against the 1983 - 2001 tidal epoch. Therefore, vessels could take advantage of the deeper water to transit at a deeper draft and offset the reduction in ADC due to sea level rise. However, when the tidal epoch is updated (next update in 2025 for the 2002-2000 epoch) the MLLW elevation will change with sea level rise. This offset is dependent on how the maintained depth of the channel is defined as water levels change and is a USACE policy issue outside the purview of this memorandum. For the purposes of the analysis, any increase in operational channel depth is neglected.

Conclusion

Recent trends in container service to the US East Coast indicates the PPX II Max Class will become more common at East Coast ports. Based on both the air draft trend in the world fleet and the 100-year projected SLR, the PPX III Max class (16,000 TEU) represents the practical maximum feasible design vessel for the Seagirt Loop Channel that can call at the Seagirt Marine Terminal with the present-day air gap clearance of the Bay Bridge.

The effects of SLR on the ADC of the PPX III Max class vessels showed to be dependent on both the assumed projection scenario (low, intermediate, high) and the tide stage when the vessel would pass beneath the Chesapeake Bay Bridge. The low, intermediate, and high SLR projection showed that ADC at MHW will be approximately 0.5 feet by 2095, 2060, and 2045, respectively. However, actual operational air draft regularly exceeds the charted value by several feet and by utilizing air gap sensors, use of the channel by the design vessel will be extended in all three RSLR scenarios. Note that for the design vessels, ballast and cargo will have to be managed to maintain a draft of 47.5 feet to provide reliable air draft clearance. Therefore, the design vessel requires the full, 50-foot dredged channel depth.

The main restriction for vessel access is the height of the Chesapeake Bay Bridge. Maryland Transportation Authority has commissioned studies for replacement of the span and the Tier 1 Draft Environmental Impact Study (DEIS) was released for public comment in February 2021. Replacement of the span could alleviate the ADC restrictions and allow unimpeded access by PPX III Max class vessels (and larger). The DEIS focused on alternatives for accommodating traffic volumes in 2040. Under the High RSLR scenario, ADC may limit the PPX Class III Max vessels starting in 2045, therefore bridge replacement by 2040 would alleviate this restriction.

Given present-day bridge clearance, utilization of air gap sensors, and anticipated future improvements to the bridge spans, the selection of the PPX Class III Max vessels as the maximum design vessel for the Seagirt Loop Deepening is appropriate..

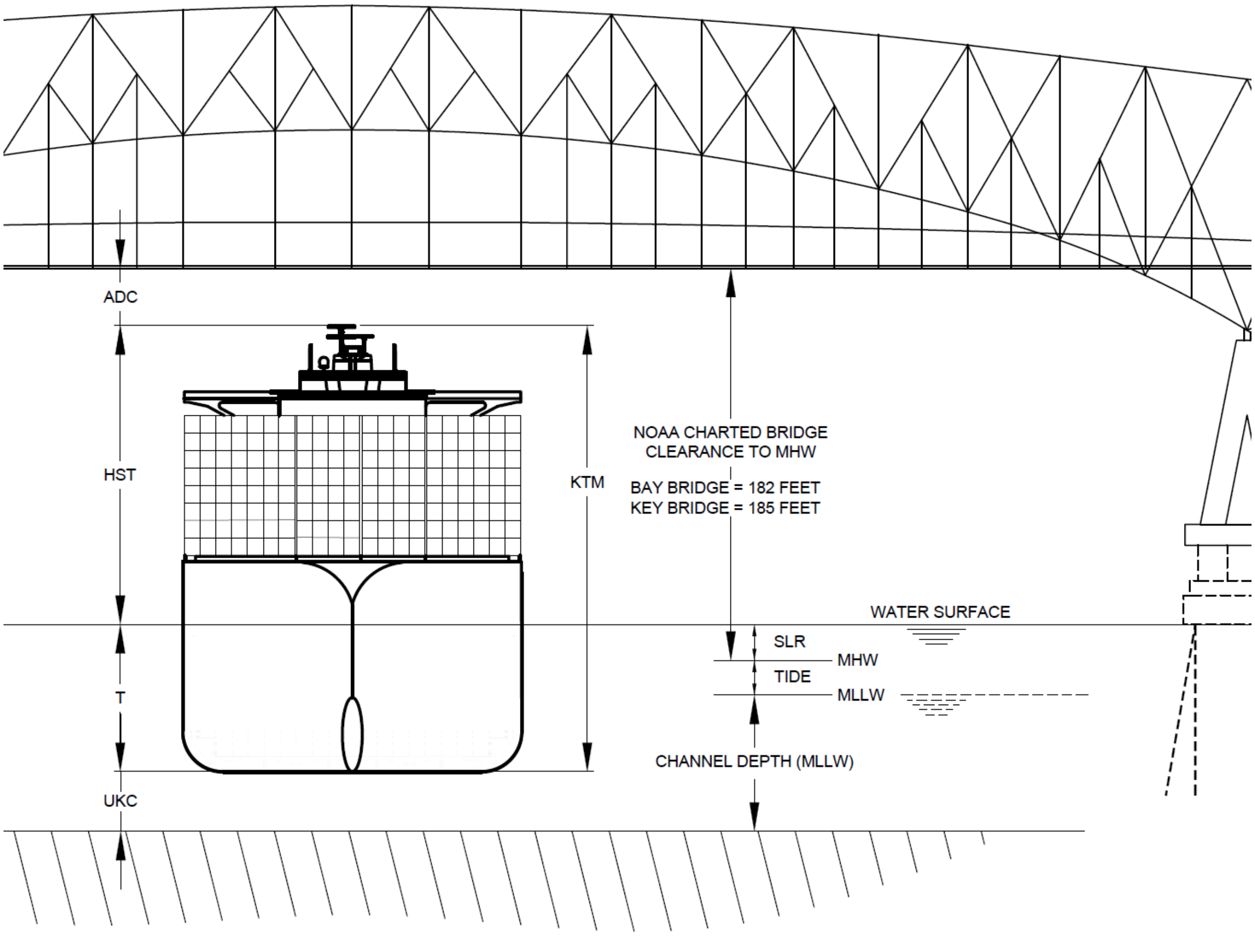


Figure 2. Air Draft Parameter Definitions (Not to scale)

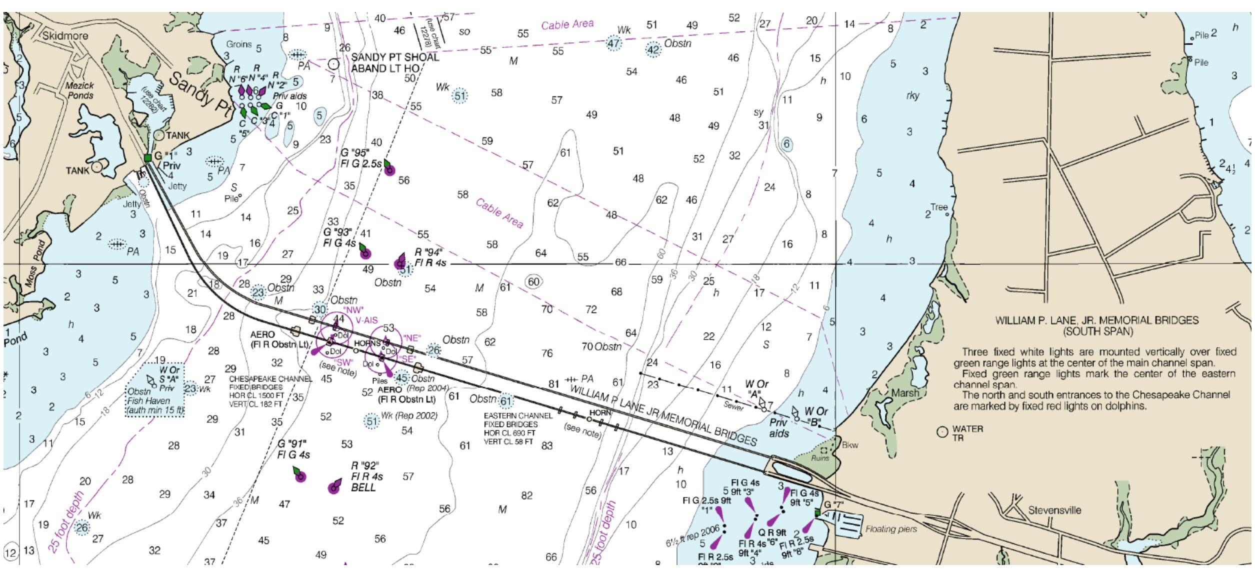


Figure 3. William P. Lane Jr. Memorial Bridge, NOAA Chart 12270

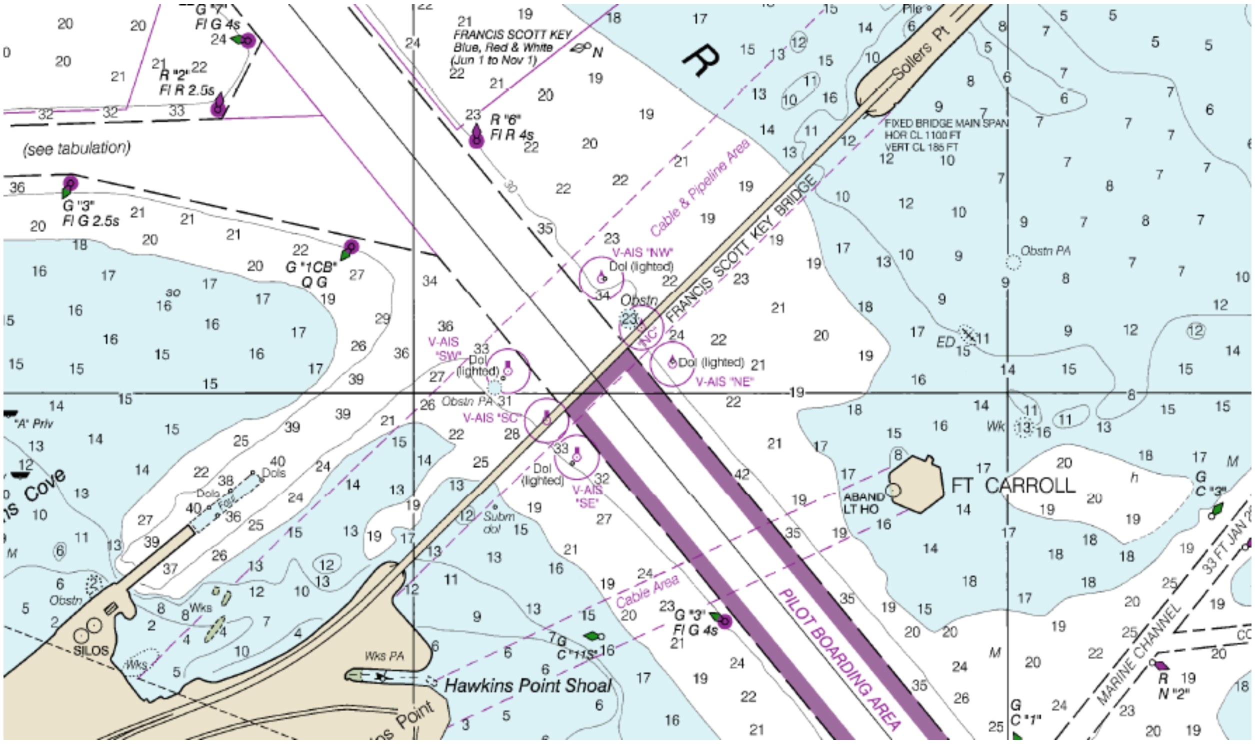


Figure 4. Francis Scott Key Bridge, NOAA Chart 12281

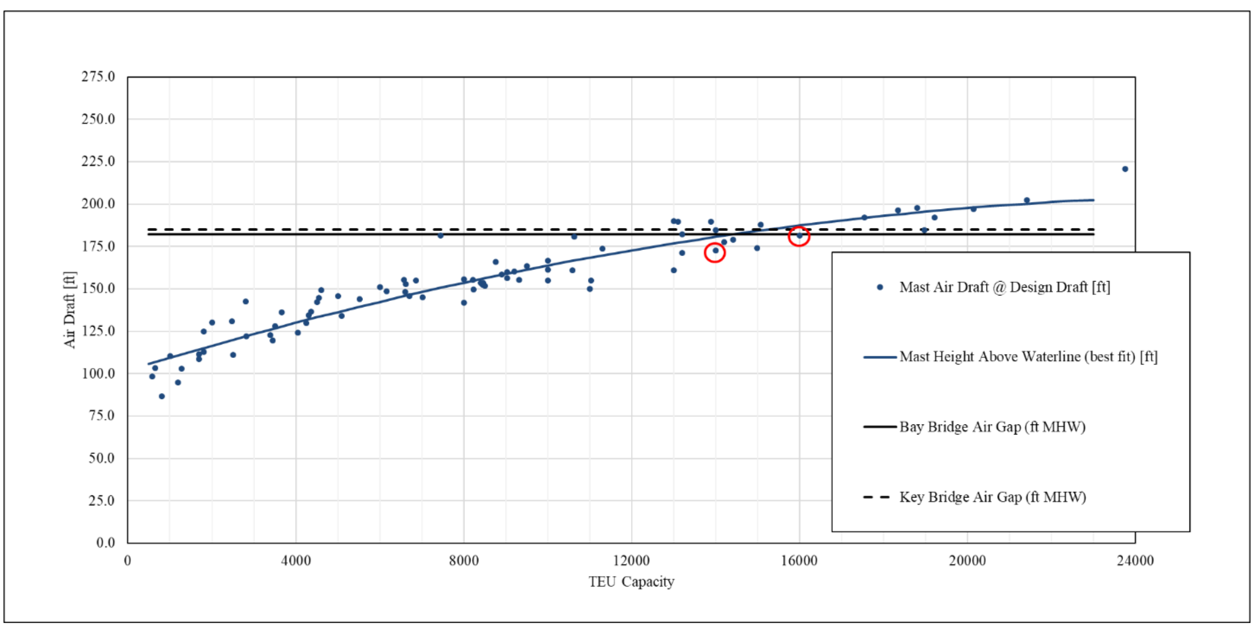


Figure 5. Air Draft Trend for Containerships (RINA), design prototype vessels circled in red

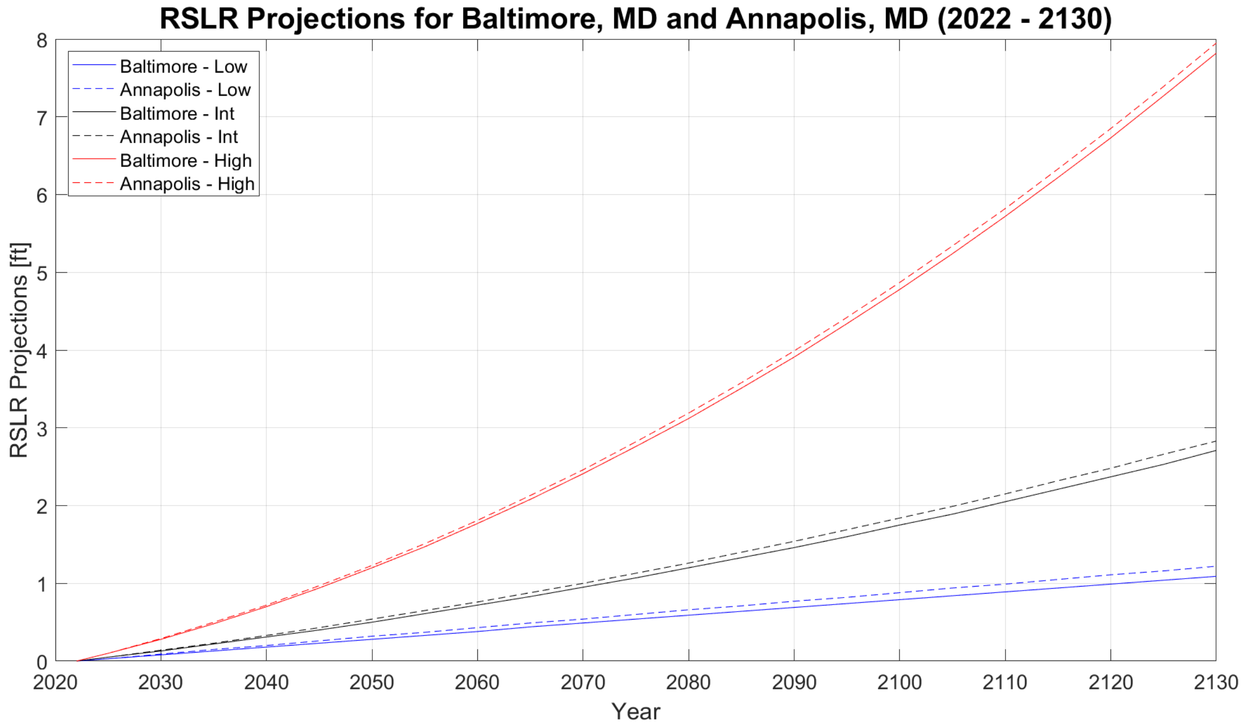


Figure 6. RSLR projections (low, intermediate, and high) from USACE Sea-Level Change Calculator (Version 2021.12) at Baltimore (8574680) and Annapolis (8575512)

Table 3. Tabulated RSLR projections (low, intermediate, and high) from USACE Sea-Level Change Calculator (Version 2021.12) at Baltimore (8574680) and Annapolis (8575512)

Year	Relative Sea Level Rise (RSLR) [ft]					
	Baltimore (8574680)			Annapolis (8575512)		
	Low	Intermediate	High	Low	Intermediate	High
2022	0.00	0.00	0.00	0.00	0.00	0.00
2025	0.03	0.05	0.10	0.03	0.05	0.10
2030	0.08	0.13	0.28	0.09	0.14	0.29
2035	0.13	0.22	0.48	0.15	0.23	0.50
2040	0.18	0.31	0.70	0.20	0.33	0.72
2045	0.23	0.40	0.94	0.26	0.43	0.97
2050	0.28	0.50	1.20	0.32	0.54	1.23
2055	0.33	0.61	1.47	0.37	0.65	1.51
2060	0.38	0.72	1.77	0.43	0.76	1.81
2065	0.44	0.83	2.08	0.49	0.88	2.13
2070	0.49	0.95	2.41	0.54	1.00	2.46
2075	0.54	1.07	2.76	0.60	1.13	2.82
2080	0.59	1.20	3.12	0.66	1.26	3.19
2085	0.64	1.33	3.51	0.71	1.40	3.58
2090	0.69	1.46	3.91	0.77	1.54	3.99
2095	0.74	1.60	4.34	0.82	1.69	4.42
2100	0.79	1.75	4.78	0.88	1.84	4.87
2105	0.84	1.89	5.24	0.94	1.99	5.34
2110	0.89	2.05	5.72	0.99	2.15	5.82
2115	0.94	2.21	6.22	1.05	2.32	6.33
2120	0.99	2.37	6.73	1.11	2.48	6.85
2125	1.04	2.53	7.27	1.16	2.66	7.39
2130	1.09	2.71	7.82	1.22	2.83	7.95

Table 4. Air Draft Clearance (ADC) of MSC Beatrice with Sea Level Rise Projection*

Year	Air Draft Clearance** (ADC) [ft] at MHW					
	Bay Bridge			Key Bridge		
	Low	Inter	High	Low	Inter	High
2022	9.13	9.13	9.13	12.18	12.18	12.18
2025	9.10	9.08	9.03	12.15	12.13	12.08
2030	9.04	8.99	8.84	12.10	12.05	11.90
2035	8.98	8.90	8.63	12.05	11.96	11.70
2040	8.93	8.80	8.41	12.00	11.87	11.48
2045	8.87	8.70	8.16	11.95	11.78	11.24
2050	8.81	8.59	7.90	11.90	11.68	10.98
2055	8.76	8.48	7.62	11.85	11.57	10.71
2060	8.70	8.37	7.32	11.80	11.46	10.41
2065	8.64	8.25	7.00	11.74	11.35	10.10
2070	8.59	8.13	6.67	11.69	11.23	9.77
2075	8.53	8.00	6.31	11.64	11.11	9.42
2080	8.47	7.87	5.94	11.59	10.98	9.06
2085	8.42	7.73	5.55	11.54	10.85	8.67
2090	8.36	7.59	5.14	11.49	10.72	8.27
2095	8.31	7.44	4.71	11.44	10.58	7.84
2100	8.25	7.29	4.26	11.39	10.43	7.40
2105	8.19	7.14	3.79	11.34	10.29	6.94
2110	8.14	6.98	3.31	11.29	10.13	6.46
2115	8.08	6.81	2.80	11.24	9.97	5.96
2120	8.02	6.65	2.28	11.19	9.81	5.45
2125	7.97	6.47	1.74	11.14	9.65	4.91
2130	7.91	6.30	1.18	11.09	9.47	4.36

* Vessel analyzed at channel design draft of 47.5 ft.

** ADC computed based on charted bridge clearance, additional clearance may be available from air gap sensors

Table 5. Air Draft Clearance (ADC) of CMA CGM Marco Polo with Sea Level Rise Projection*

Year	Air Draft Clearance** [ft] at MHW					
	Bay Bridge			Key Bridge		
	Low	Inter	High	Low	Inter	High
2022	1.33	1.33	1.33	4.38	4.38	4.38
2025	1.30	1.28	1.23	4.35	4.33	4.28
2030	1.24	1.19	1.04	4.30	4.25	4.10
2035	1.18	1.10	0.83	4.25	4.16	3.90
2040	1.13	1.00	0.61	4.20	4.07	3.68
2045	1.07	0.90	0.36	4.15	3.98	3.44
2050	1.01	0.79	0.10	4.10	3.88	3.18
2055	0.96	0.68	-0.18	4.05	3.77	2.91
2060	0.90	0.57	-0.48	4.00	3.66	2.61
2065	0.84	0.45	-0.80	3.94	3.55	2.30
2070	0.79	0.33	-1.13	3.89	3.43	1.97
2075	0.73	0.20	-1.49	3.84	3.31	1.62
2080	0.67	0.07	-1.86	3.79	3.18	1.26
2085	0.62	-0.07	-2.25	3.74	3.05	0.87
2090	0.56	-0.21	-2.66	3.69	2.92	0.47
2095	0.51	-0.36	-3.09	3.64	2.78	0.04
2100	0.45	-0.51	-3.54	3.59	2.63	-0.40
2105	0.39	-0.66	-4.01	3.54	2.49	-0.86
2110	0.34	-0.82	-4.49	3.49	2.33	-1.34
2115	0.28	-0.99	-5.00	3.44	2.17	-1.84
2120	0.22	-1.15	-5.52	3.39	2.01	-2.35
2125	0.17	-1.33	-6.06	3.34	1.85	-2.89
2130	0.11	-1.50	-6.62	3.29	1.67	-3.44

* Vessel analyzed at channel design draft of 47.5 ft.

** ADC computed based on charted bridge clearance, additional clearance may be available from air gap sensors

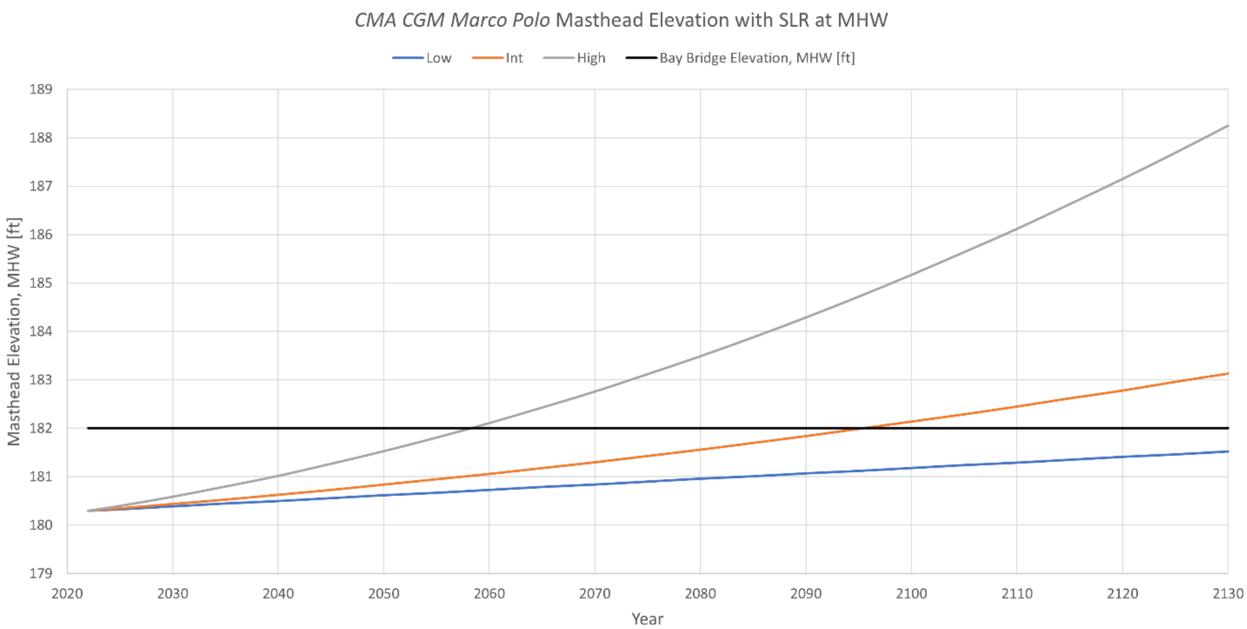


Figure 7. Figure Masthead elevation of the CMA CGM Marco Polo transiting at MHW, draft 47.5 feet, with the three SLR scenarios (blue, orange, and grey) applied. The controlling Bay Bridge elevation is shown (black) to reflect the change in ADC due to SLR.

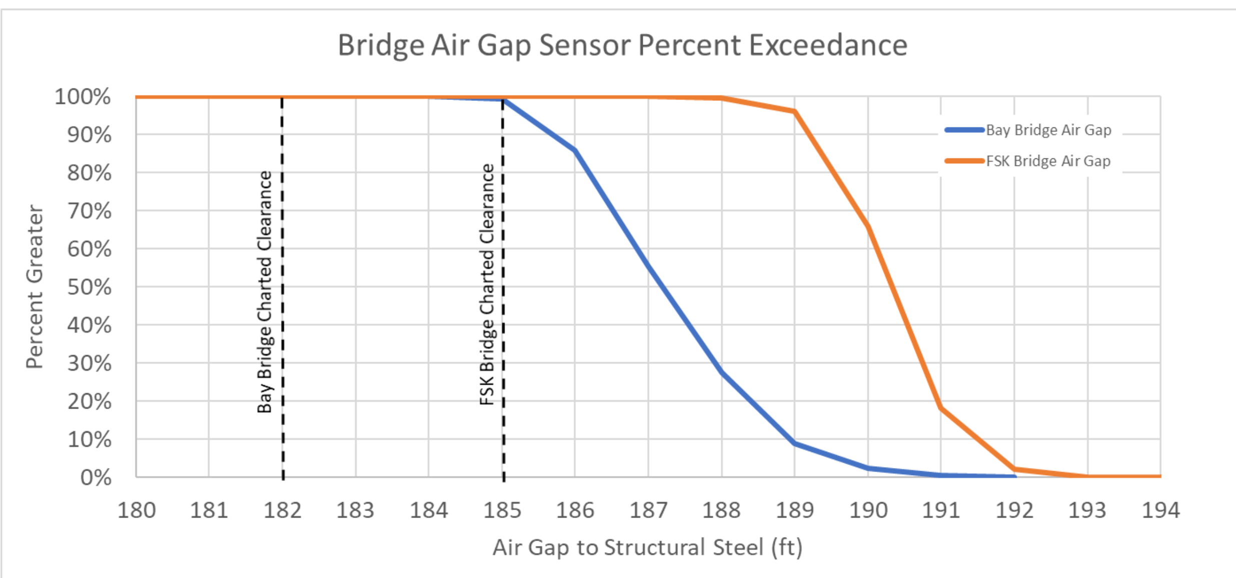


Figure 8. Percent Air Gap to Structural Steel Exceedance from NOAA Air Gap Sensors

References

Clarkson Research. (2021). *The Containership Register.* Clarkson Research.

Royal Institute of Naval Architects. (2009-2012). *Significant Ships.*

US Army Corps of Engineers. (2006). *EM 1110-2-1613 Hydraulic Design of Deep Draft Navigation Projects.*

US Army Corps of Engineers. (2019). *(ER) 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs.*

US Army Corps of Engineers. (2019). *Engineer Pamphlet (EP) 1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation.*

US Army Corps of Engineers. (2020). *Engineering and Construction Bulletin (ECB) 2018-14, Guidance for Incorporating Climate Change Impacts to inland Hydrology in Civil Works Studies, Designs, and Projects.*

US Department of Transportation, Federal Highway Adminstratoin, and Maryland Transportation Authority. (2021). *Cheapeake Bay Crossing Stdy: Tier 1 NEPA Draft Environmental Impact Statement.* MDTA.

http://www.cma-cgm.com/products-services/line-services/flyer/CJX

https://tidesandcurrents.noaa.gov/ports/ports.html?id=8575432&mode=show_all

https://tidesandcurrents.noaa.gov/ports/ports.html?id=8574730&mode=show_all

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B3: Maritime Institute of Technology and Graduate Studies (MITAGS) Study

Full Mission Ship Simulation for Seagirt Simulation Study

Provided by
The Maritime Institute of Technology and Graduate Studies (MITAGS)

April 30 – May 4, 2018

The Maritime Institute of Technology & Graduate Studies-Pacific Maritime Institute (MITAGS-PMI) was pleased to provide this desktop and Full Mission Bridge Navigation Simulation Study.

RFP Name	Seagirt West Loop Improvement Simulation Study
Project Location	Seagirt Marine Terminal, Baltimore, MD
Purpose	Validate channel improvements
Customer	Maryland Port Administration
Customer Representative	Mr. Daniel Behnke, Gahagan & Bryant Associates, Inc.
Bidder Legal Name and Location	The MMP MATES Program, DBA the Maritime Institute of Technology & Graduate Studies, and the Pacific Maritime Institute (MITAGS-PMI). MITAGS-PMI 692 Maritime Boulevard Linthicum Heights, MD 21090-1952 Web: http://www.mitags-pmi.org
Bidder Description	The MM&P Mates Program is a 501(c)9 VEBA Non-profit Trusteeship. The "MATES Program" was founded by the International Organizations of Masters, Mates and Pilots and the leading U.S. Flag ship operators in 1968. Its mission is to enhance professionalism through the development and presentation of internationally recognized programs in leadership, education, training and safety for the maritime industry. MITAGS and PMI are the primary training and simulation centers for the MMP professional deck officers and pilots. Tax ID Number: 13-2577386. MD Tax Exemption Number: 31000665 Dun and Bradstreet Number: 010094977
Report Release Date	December 4, 2018
MITAGS Project Leader	Ms. Colleen Schaffer
Project Review	Mr. Glen Paine, Executive Director, MMP MATES Program
Authorized Signature	

MITAGS-PMI accepts no liability for the use of the findings, conclusions and recommendations provided by the conning pilots in this simulation study. Additionally, MITAGS-PMI cannot be held responsible for errors in the data provided by the client and other third parties used for the programming of the simulator hydrodynamic ship / tug models, and databases.

The recommendations provided within this report are for guidance. The final decision on whether it is safe to transit rests with the master of the vessel and the local pilot.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. BACKGROUND AND PURPOSE

The Maryland Port Administration (MPA) is evaluating channel improvements for the Seagirt Terminal's East and West Loop in order to facilitate ULCV transits. The improvements include:

1. The creation of a turning basin between Berth 4 and the Dundalk Marine Terminal.
2. Expansion of channel width off Berth 3 in order to accommodate ULCVs.
3. Expansion of Seagirt East and West Access Channel for facilitating ULCV movements.

MPA has selected Gahagan & Bryant Associates (GBA), a leading marine engineering consultancy, to complete engineering and design plans for these improvements. As part of the design validation and optimization processes, GBA desires to conduct a full-mission ship navigation simulation study.

The study was conducted at the Maritime Institute of Technology and Graduate Studies (MITAGS) conducted the study on April 30 to May 4, 2018.

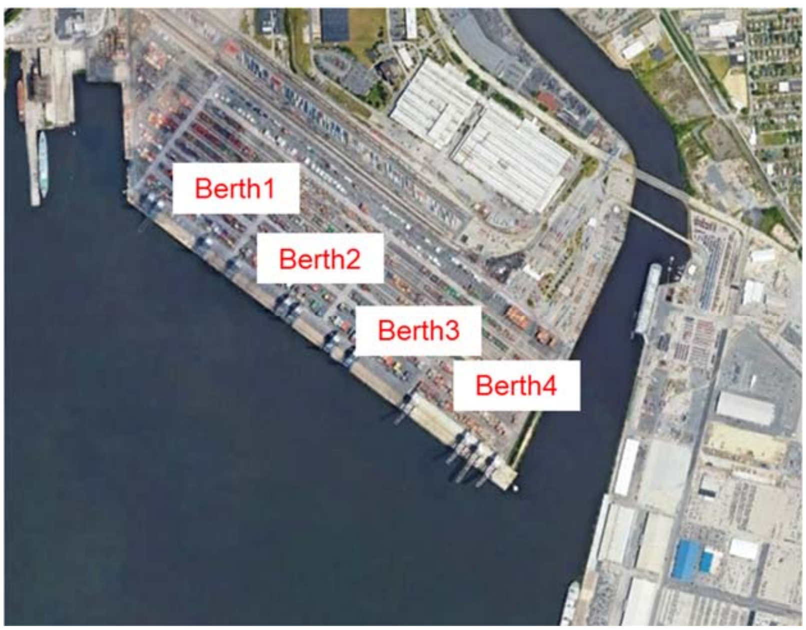


Figure 1-1: Site location (provided by Google Earth)

1.1 OBJECTIVES

The following objectives were evaluated throughout the study:

- Determine if with channel improvements, the 14,000 TEU container vessel (*Kalina)* can transit to/from Berth 3 with ULCV at Berth 4 via East Loop

- Determine if with channel improvements, the 14,000 TEU container vessel (*Kalina)* can transit from Berth 3 and Berth 4 via West Loop

- Determine if with channel improvements, the 18,000 TEU container vessel (*Ben Franklin)* can transit to/from Berth 3 with ULCV at Berth 4 via East Loop

- Determine if with channel improvements, the 18,000 TEU container vessel (*Ben Franklin)* can transit from Berth 3 and Berth 4 via West Loop

1.2 ASSUMPTIONS AND LIMITATIONS OF SIMULATION

MITAGS used the following assumptions for this study:

- The MITAGS ship models selected by the client are reflective of what is expected to call on the container terminals
- The client provided environmental data that is sufficiently accurate for the purposes of this preliminary study
- The primary focus of the study was ship maneuvering behavior

The fidelity of the hydrodynamic model is dependent on the accuracy of the source data, mathematical formulas, and recommended adjustments provided by subject matter experts (captains). The model behaviors are based on the pilot card, windage, general arrangement plans, squat table, and any other data provided by the client or other sources. The model behaviors, as calculated by the simulator, are adjusted based on the consensus opinion of MITAGS and the pilots. Since the adjustments are subjective, the recommended model adjustments may vary depending on the collective experience of the testing captains and pilots at each session.

The MITAGS simulator provides a close approximation of vessel squat in shallow water. However, an adequate safety margin needs to be used in order to account for changes in squat due to vessel speeds, displacements, channel shoaling, and tidal actions.

Model behavior is highly dependent on the accuracy of the bathymetry, the current, and wind flows. In real world situations, such forces could vary significantly over the operating area. In addition, the models used in these tests were representative of vessel classes similar in size and displacement. Vessels of the same class may have significant differences in handling characteristics in real-word conditions. During berthing exercises, the simulator does not account for the forces on the fendering system due to a ship rolling in a swell.

The auto-tug feature of the simulator provided a more realistic simulation of the assist tug than vector forces, but is not as accurate as having a tug bridge integrated with the full-mission simulator. Auto-tugs and a tug bridge were used.

1.3 MITAGS SIMULATION FACILITIES AND PROJECT TEAM

MITAGS used a full-mission ship simulator (FMSS) for the study (April 30 to May 4, 2018) as well as two integrated tug bridges.

Past studies that specifically focused on the safe navigation transits of ultra large container vessels (ULCVs) included Philadelphia (Packer Avenue), Port of NY/NJ, PortMiami, Port of Baltimore and Chesapeake Bay, Puget Sound (Port of Tacoma), Houston (Bayport and Barbour's Cut), and Savannah. International container ports studies included the Port of Itapoá (Brazil), Superport Acu (Brazil), Port of Antofagasta (Chile), Port of Colombo (Sri Lanka), and the Port of San Antonio (Chile).

Additionally, we have worked on cruise, LNG, oil, and bulk carrier projects for ports / pilot groups in Bermuda, Mauritania, Peru, Columbia, and Canada. Future ULCV simulation projects include the Port of New York / New Jersey, and potentially, Freeport Bahamas.

The MITAGS simulators are capable of providing the most realistic 360° presentation, from the perspective of a pilot / master / tug operator, in the world. The theater projection area is over twenty-four meters wide and twelve meters in height. This provides unsurpassed depth perception and visual accuracy.

Additionally, the large simulator control room had ample space for client representatives to remotely observe the entire simulation including visuals, environmental conditions, pilot orders and their effects on the vessel behavior. The full-mission shiphandling simulator met or exceeded the Det Norske Veritas (DNV) Class A standards. MITAGS-PMI is DNV certified as a Maritime Training and Simulation Center. Please refer to the MITAGS-PMI Simulation Capability & Facilities Guide for further details on team member qualifications and simulation capabilities.

Figure 1-2: Bridge 1 FMSS, simulation control room, and tug bridge

The simulator was supported by a highly experienced in-house simulation modeling team and ship handling experts (listed below in Table 1-1). In addition to the Maryland Pilots, MITAGS provided an experienced maritime pilot (Captain Bergin). MITAGS also provided an experienced simulator operator (Commander Birch). The simulation engineering team provided on-site simulation, hydrodynamic modeling, and engineering support during the Study.

Table 1-1: MITAGS support team

Attendees	Position and Duties
Mr. Glen Paine Executive Director	Responsible for overall coordination with client representatives and ensure the necessary resources are allocated to this project.
Mr. Hao Cheong Direct of Simulation Engineering	Responsible for the overall simulation technical support of project. Assisted in collection of data necessary to model the terminal, vessel under the expected environmental conditions. Served as liaison with MITAGS Simulation Engineering Staff.
Mr. Robert Weiner Naval Architect Hydrodynamic Ship Modeler	Responsible for the programming of the ship models. Also provided support for simulator projection system and maintenance during tests. Assisted in review of report.
Ms. Colleen Schaffer Coastal Engineer	Responsible for overseeing simulation project and preparing report on findings, conclusions, and recommendations with supporting data.
Commander Allen Birch Simulator Operator	Responsible for operating the simulator during the tests.
Captain Larry Bergin Shiphandling Consultant	Responsible for validating the ship models and databases. Responsible for conning the simulated vessels and providing expertise in the handling of the ships. Provided support as needed.
Captain Steve Thalheimer	Responsible for assisting in running the simulated tug bridges and providing expertise in the handling of the tugs.
Captain Jonathan Steinberg	Responsible for assisting in running the simulated tug bridges and providing expertise in the handling of the tugs.

Table 1-2: Participants

Attendees	Company
Captain Mike Flanagan	Association of Maryland Pilots
Captain John Traut	Association of Maryland Pilots
Captain Bruce Morse-Ellington	Association of Maryland Pilots
Captain Kevin Hanna	Association of Maryland Pilots
Captain Tad Whitin	Association of Maryland Pilots
Captain Carroll Cudworth	Association of Maryland Pilots
Captain Jim Hickey	Association of Maryland Pilots
Captain Mike Reagoso	McAllister
Captain Bob Dempsey	McAllister
Captain John Shellenberger	McAllister
Captain Paul Swensen	Moran

Captain Eddie Lucas	Moran
Captain Matt Barranco	Moran
Captain Wes Southward	Moran
Dan Behnke	GBA
Dennis Urso	GBA
Captain Greg Brooks	Towing Solution
Dave Bibo	Maryland Port Administration
Shawn Kiernan	Maryland Port Administration
Ryan Barry	Maryland Port Administration
Joe Greco	Ports of America

MITAGS is uniquely qualified to conduct this type of study. MITAGS has the ship / tug hydrodynamic ship models that provide the level of fidelity needed to conduct this type of study. MITAGS-PMI has a large library of vetted ship and assist tug models.

Our organization has over 30 years of experience in ship simulators, modeling, and is among the leading maritime training and simulation centers. The center is supported by experienced shiphandling consultants, and full-time simulation engineering staff. MITAGS has the ship / tug hydrodynamic ship models that provide the level of fidelity needed to conduct this type of study. MITAGS-PMI has a large library of vetted container ships and assist tug models. For more information on the MITAGS, please visit http://www.mitags-pmi.org/ and YouTube® for videos of simulation projects at http://www.youtube.com/user/MaritimeInstitute.

2. VESSEL MODELING

The *Kalina* (14,000 TEU) and *Ben Franklin* (18,000 TEU) were the two container vessels used in this study. The specific ship parameters are listed in Table 2-1; the Pilot Cards are available in Appendix A. In the majority of the runs, only three tugs were used with a fourth on standby. Two tugs were simulated as live tugs using the integrated tug bridges. The remaining two tugs were controlled by the simulator operator using AutoTug mode – one was a 60 t ASD tug and the other a 40 t ASD tug. The two live tugs were simulated using the Z-Tech 7500 had a bollard pull of 75 t; however, the tug operators attempted to limit the bollard pull to 60 t.

Each hydrodynamic model was pre-validated by the MITAGS-PMI shiphandling experts comparing the model to sea trial data, tank tests (if available), pilot / captain reports, and vessels of similar class and size. (Please see the *MITAGS-PMI Simulation Guide* for more details on model validation processes).

Table 2-1: Ship models

Parameters	Kalina	Ben Franklin
Model Name	Container Kalina_Seagirt	Container Ben Franklin_Seagirt
Displacement Loaded (tons)	192,245	213,040
Length (m)	366	399.2
Beam (m)	51.2	54
Trim	Even	Even
Load Draft (m)	14.3	14.3
Engine (kW)	2 x 73,340	2 x 63,910
Propeller	Fixed pitch	Fixed pitch
Bow Thrusters	2 (1700 kW)	2 (2043 kW)

Table 2-2: Tug models

arameters	Z-Tech 6500	Z-Tech 7500
Length (m)	30	30
Beam (m)	12	12
Trim	Even	Even
Load Draft (m)	5	5
Bollard Pull	65 t Limited to 60 t for Tug 2 Limited to 40 t for Tug 3	85 t Limited to 60 t

3. DATABASE DEVELOPMENT

3.1 BATHYMETRY

MITAGS programmed and validated a hydro-dynamically accurate geographic area database that included detailed visual scenes, RADAR, and ECDIS images. The local chart and bathymetric data were assembled to form the base layer of the database from the Army Corps of Engineers and NOAA. The MITAGS Simulation Engineering Department used proprietary Transas® database modeling software to import the electronic chart display information system (ECDIS) data. This software automatically transferred the information from ECDIS into the simulator database and linked the visual and radar databases. The ECDIS data transferred included:

- Hydrographic: depth points, depth lines, depth contours, drying areas, three dimensional (3D) channel bottom.
- Landmass: 3D terrain, DEM data, coastlines, islands, pier structures, etc.
- Navigation Aids: buoys, ranges, and lighthouses.
- Navigation Signals: color, light timing, light sector, etc.

Bathymetric surveys from the Army Corps of Engineers from 2018 were used to populate the channel and surrounding areas. Figure 3-1 shows the two widener designs that were visible to the Pilots and Tug Masters on their ECDIS displays. In addition to the loop channel at Seagirt, the areas in the Wideners were dredged to 51 ft.

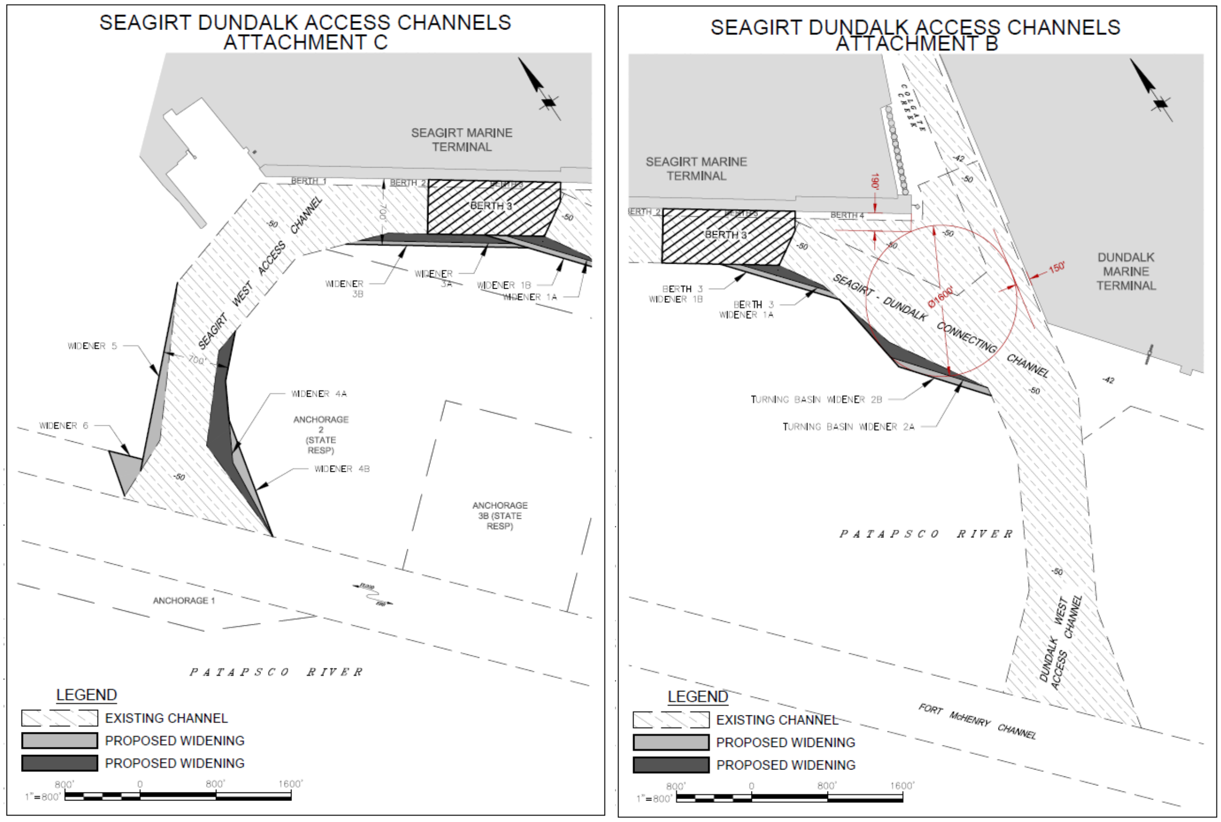
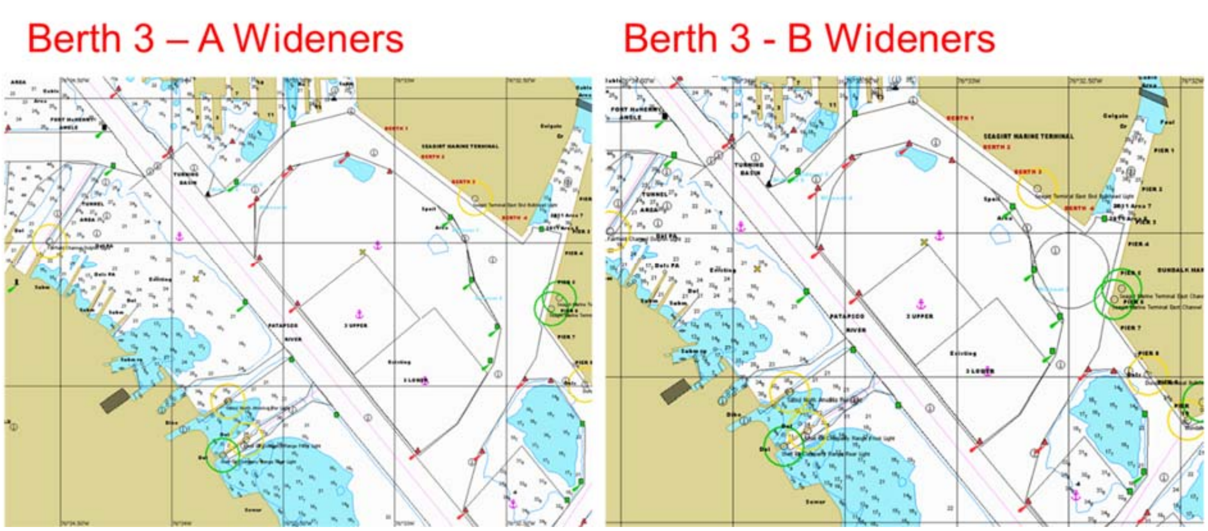


Figure 3-1: Display of Widener A and Widener B designs (GBA)

Two databases were created to execute the design and are shown below in Figure 3-2.



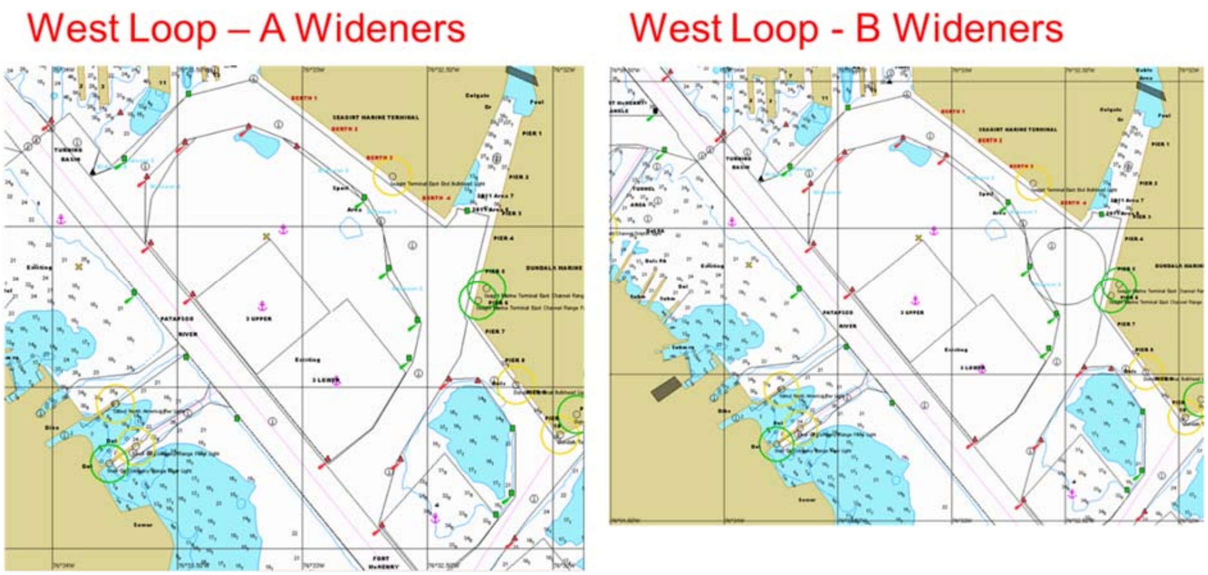


Figure 3-2: Databases showing Widener A and Widener B designs

3.2 ENVIRONMENTAL PARAMETERS

3.2.1 WIND PARAMETERS

Wind speeds ranging from 15 kts to 30 kts were simulated from several directions including the S, SW,SE, W, WNW, WSW, NW, and NE. However, the majority of the runs simulated wind from either the WNW or NW. The wind was simulated as a static wind.

3.2.2 CURRENTS/TIDE

No current was used in the simulations simulating slack water. No tide was used in the simulations as all simulations were conducted at Mean Lower Low Water.

3.2.3 WAVES

No waves were used in the simulation except negligible wind waves originating from the same direction as the wind in all of the runs.

3.2.4 VISIBILITY AND TIME OF DAY

Tests were conducted in clear visibility. However, the simulator operator is able to simulate rain, squalls, fog, and low-altitude clouds if needed in future simulations.

4. RESULTS

This section includes an analysis of the swept path, reserve power analysis, and a summary of the Pilot and Tug Master evaluations. Table 4-1 shows the test matrix summarizing each simulation and the conditions tested. Each run was recorded and can be reviewed by the client or MITAGS.

Table 4-1: Test matrix

Run	Ship	Run Scenario	Route	Wind		Notes
				Dir (FROM)	Speed (knot)	
1	Kalina	In	Familiarization; Berth 3 Via East Loop	S	15	
2	Kalina	In	Berth 3 Via East Loop	WNW	20	
3	Kalina	Out	Berth 3 Via East Loop	WNW	20	Grounded in Widener 3
4	Kalina	Out	Berth 3 Via East Loop	WNW	25	
5	Kalina	Out	Berth 3 Via East Loop	WNW	30	
6	Kalina	In	Berth 3 Via East Loop	WNW	25	
7	Kalina	In	Berth 3 Via East Loop	WNW	30	
8	Kalina	Out	Berth 3 Via East Loop	SW	25	Re-started exercise halfway through
9	Kalina	Out	Berth 3 Via West Loop	NW	15	
10	Kalina	Out	Berth 3 Via West Loop	NW	20	Grounded in Widener 3

Run	Ship	Run Scenario	Route	Wind		Notes
				Dir (FROM)	Speed (knot)	
11	Kalina	Out	Berth 3 Via West Loop	NW	20	
12	Kalina	Out	Berth 3 Via West Loop	NW	30	
13	Kalina	Out	Berth 3 Via West Loop	SE	30	
14	Kalina	Out	Berth 3 Via West Loop	SW	25	Tug 4 hit ship
15	Kalina	Out	Berth 3 Via East Loop	NW	20	
16	Kalina	Out	Berth 3 Via East Loop	WSW	25; gusts	
17	Ben Franklin	In	Berth 3 Via East Loop	NW	20	
18	Ben Franklin	Out	Berth 3 Via East Loop	W	25	
19	Ben Franklin	Out	Berth 3 Via East Loop	NW	25	
20	Ben Franklin	Out	Berth 3 Via West Loop	NW	25	No tug commands received due to radio issues
21	Ben Franklin	Out	Berth 3 Via West Loop	NW	25	Tug 2 hit Buoy 10
22	Ben Franklin	Out	Berth 3 Via West Loop	SW	25	
23	Kalina	In	Berth 3 Via West Loop	W	20	
24	Kalina	In	Berth 3 Via East Loop	SE	20	

Run	Ship	Run Scenario	Route	Wind		Notes
				Dir (FROM)	Speed (knot)	
25	Kalina	Out	Berth 3 Via East Loop	WNW 292	20	
26	Kalina	Out	Berth 3 Via East Loop	W	25	
27	Kalina	Out	Berth 3 Via East Loop	315/330	25;	
28	Kalina	Out	Berth 3 Via East Loop	215	25	
29	Ben Franklin	In	Berth 3 Via East Loop	NW	25	
30	Ben Franklin	Out	Berth 3 Via East Loop	S	15	
31	Ben Franklin	Out	Berth 3 Via East Loop	NW	25	
32	Ben Franklin	Out	Berth 3 Via West Loop	NW	20	
33	Ben Franklin	In	Berth 3 Via West Loop	NW	20	
34	Ben Franklin	Out	Berth 3 Via East Loop;	NW	20	Dead engine in Tug 2 (stern tug)

4.1 SWEPT PATH ANALYSIS

In this section, each run's swept path is plotted. Each run is shaded according to its time throughout the run where dark red represents the beginning of the run (time = 0 sec) and dark blue represents the end of the run. Tug 1, Tug 2, Tug 3, and Tug 4 are represented by the blue, red, green, and turquoise tugs respectively as shown in the legend. The light blue lines show the existing channel boundaries while the yellow lines represent the Widener A design and the red lines represent that Widener B design (Figure 4-1). Each ship and tug are also plotted in 45 second intervals. Figure 4-2 shows all of the runs and the overall area the swept paths used with Both Widener A and Widener B designs laid over it. As the figure shows, the additional space provided from these wideners was used.

Figure 4-1: Channel boundaries and Widener A and B designs

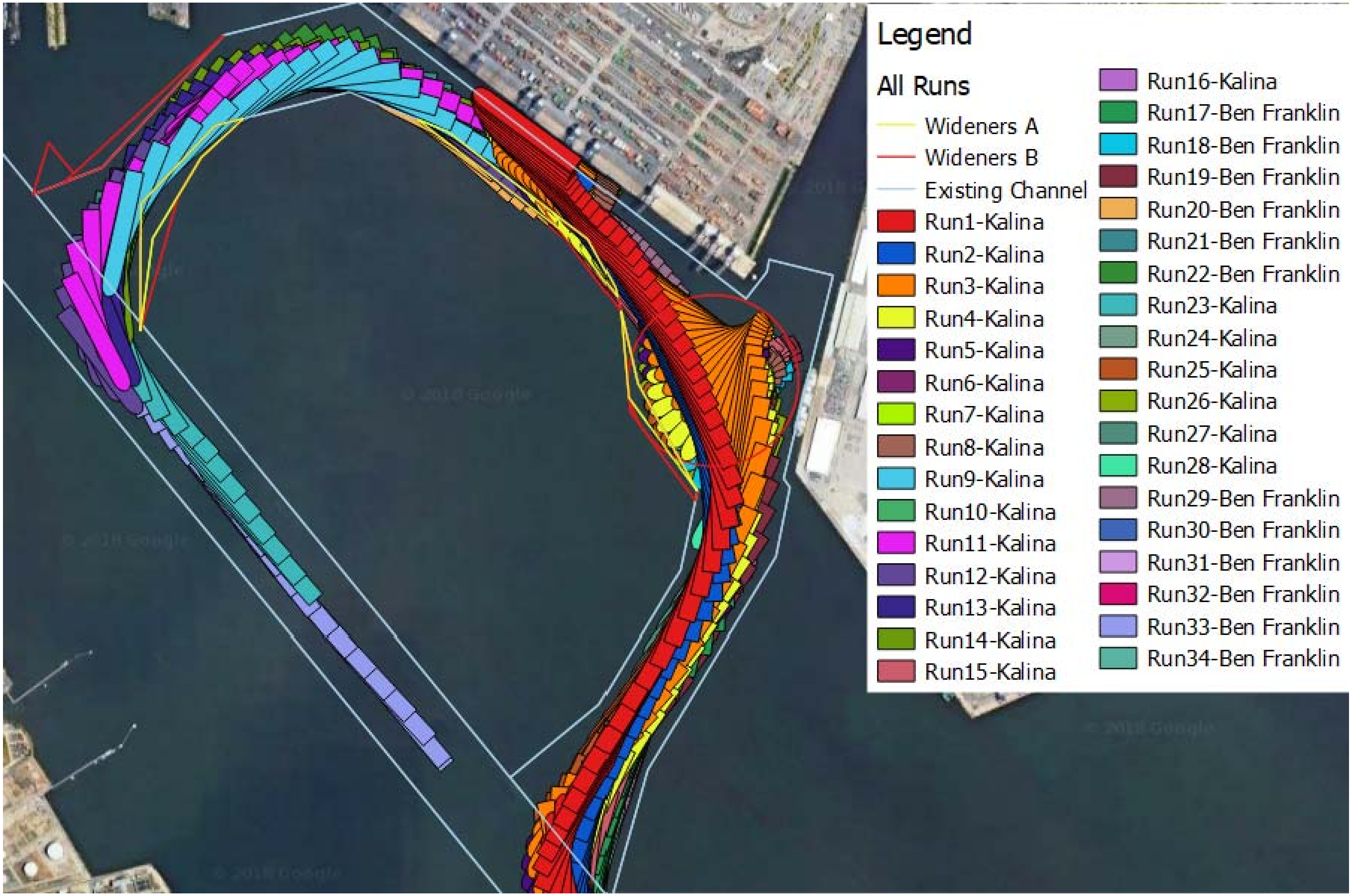


Figure 4-2: All runs summary

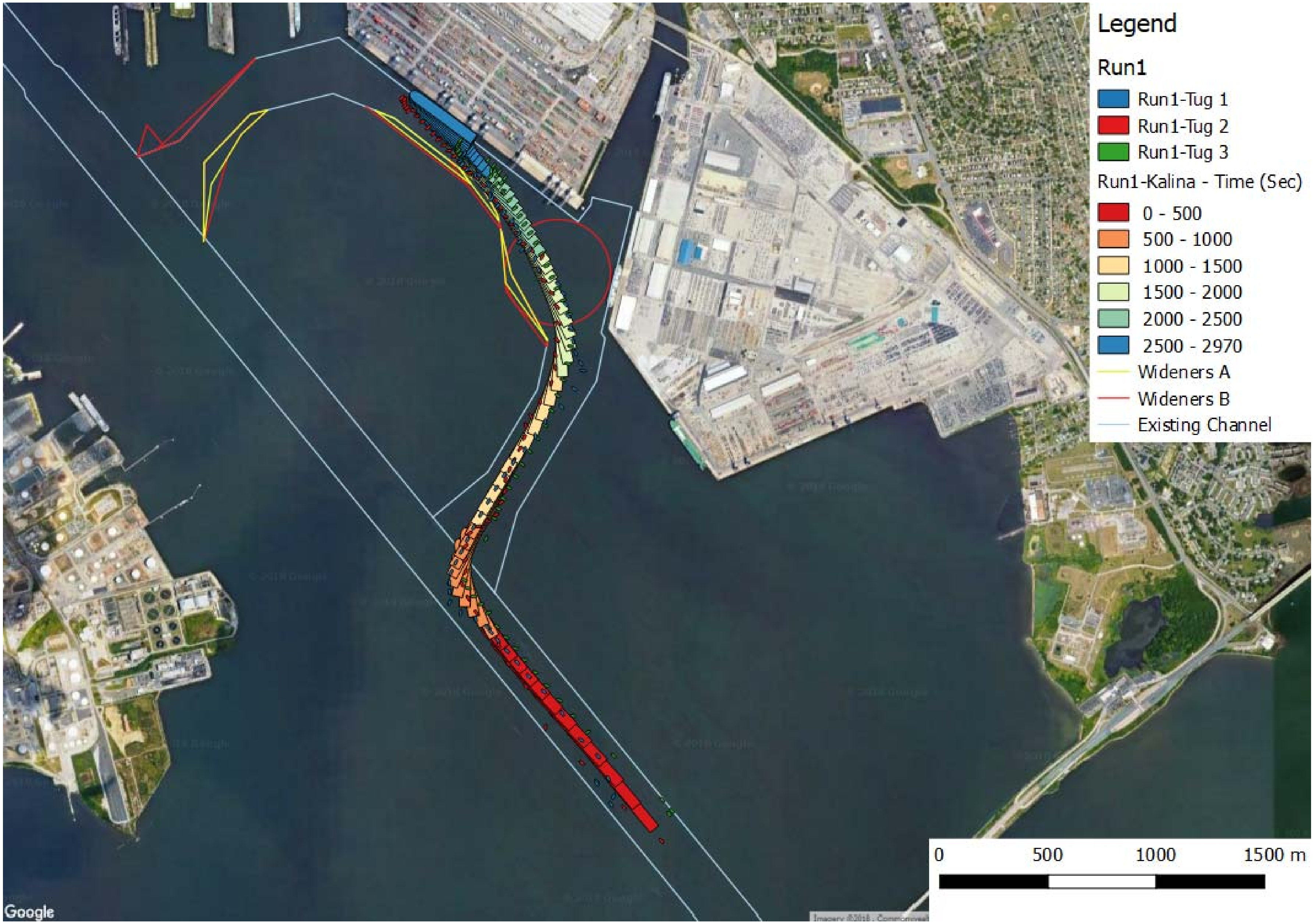


Figure 4-3: Run 1 – Overall view

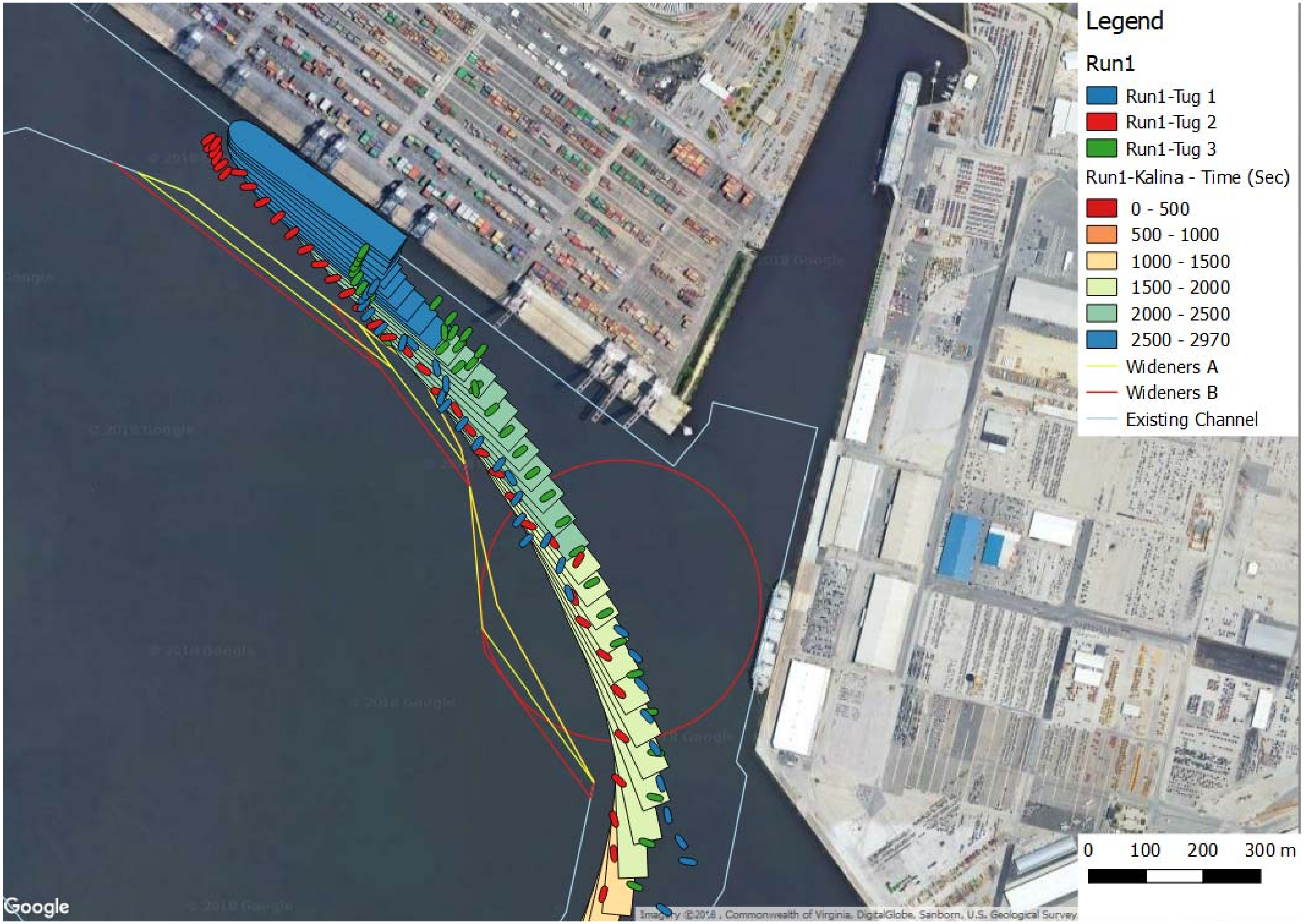


Figure 4-4: Run 1 – Zoomed in view

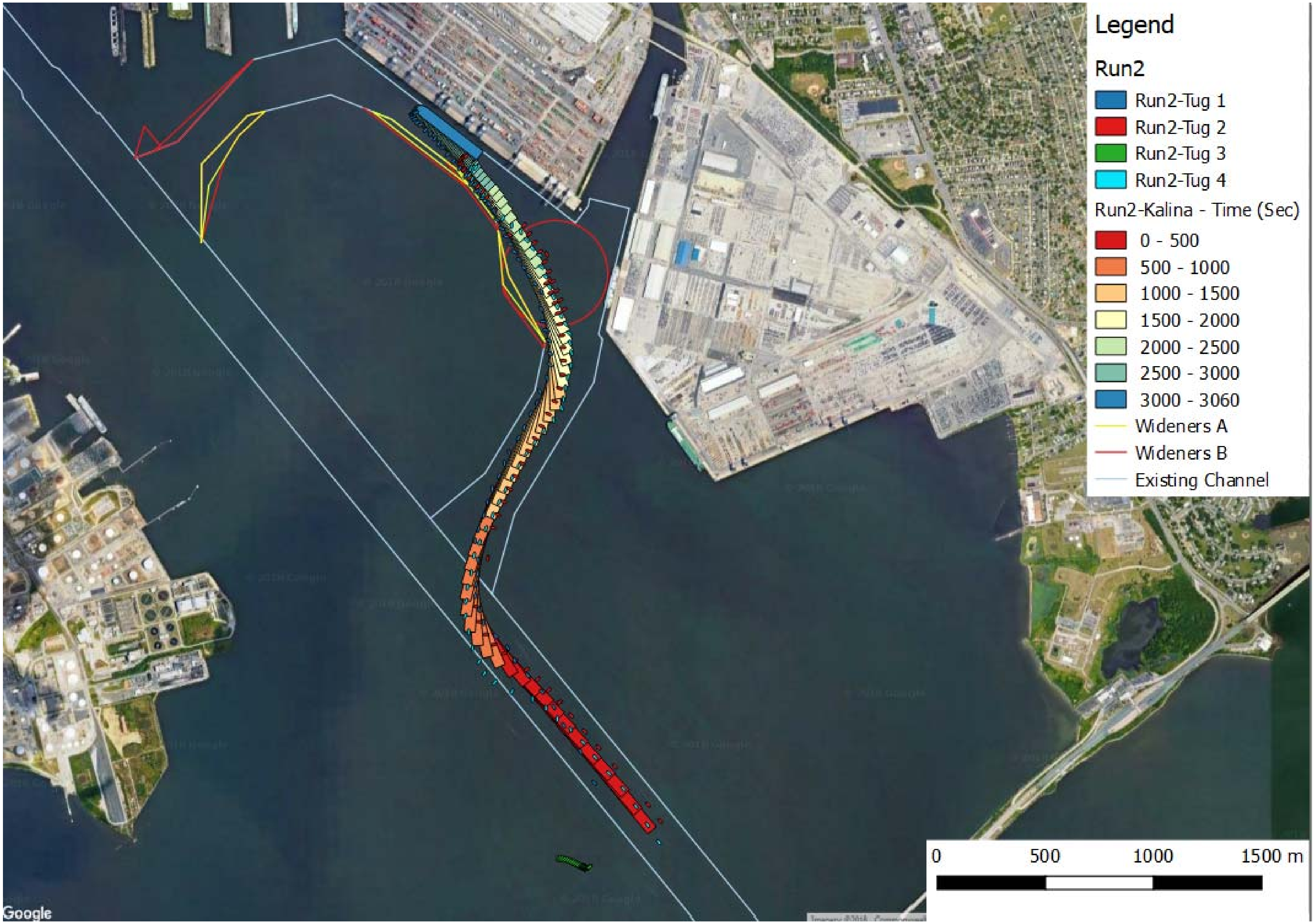


Figure 4-5: Run 2 – Overall view

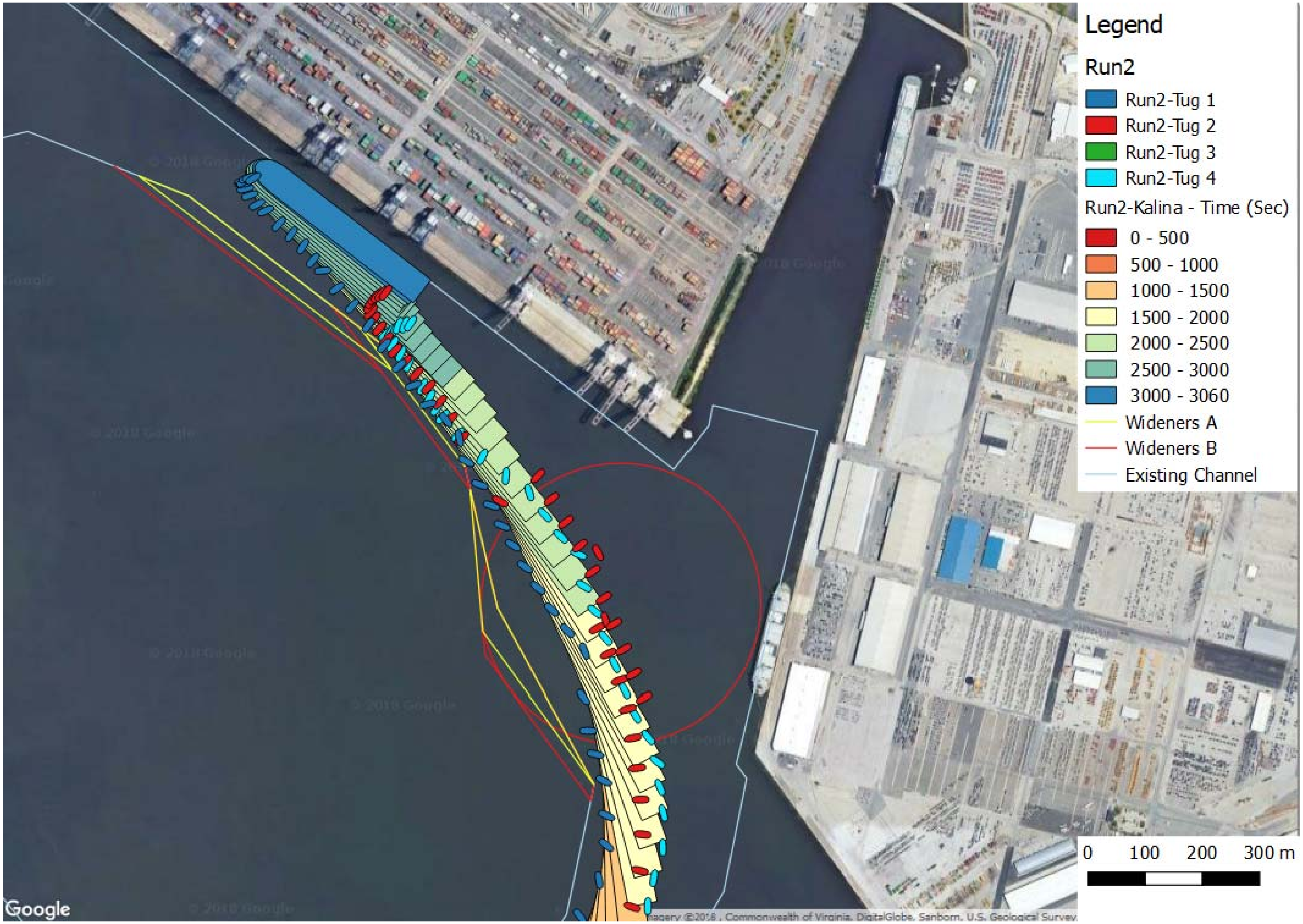


Figure 4-6: Run 2 – Zoomed in view

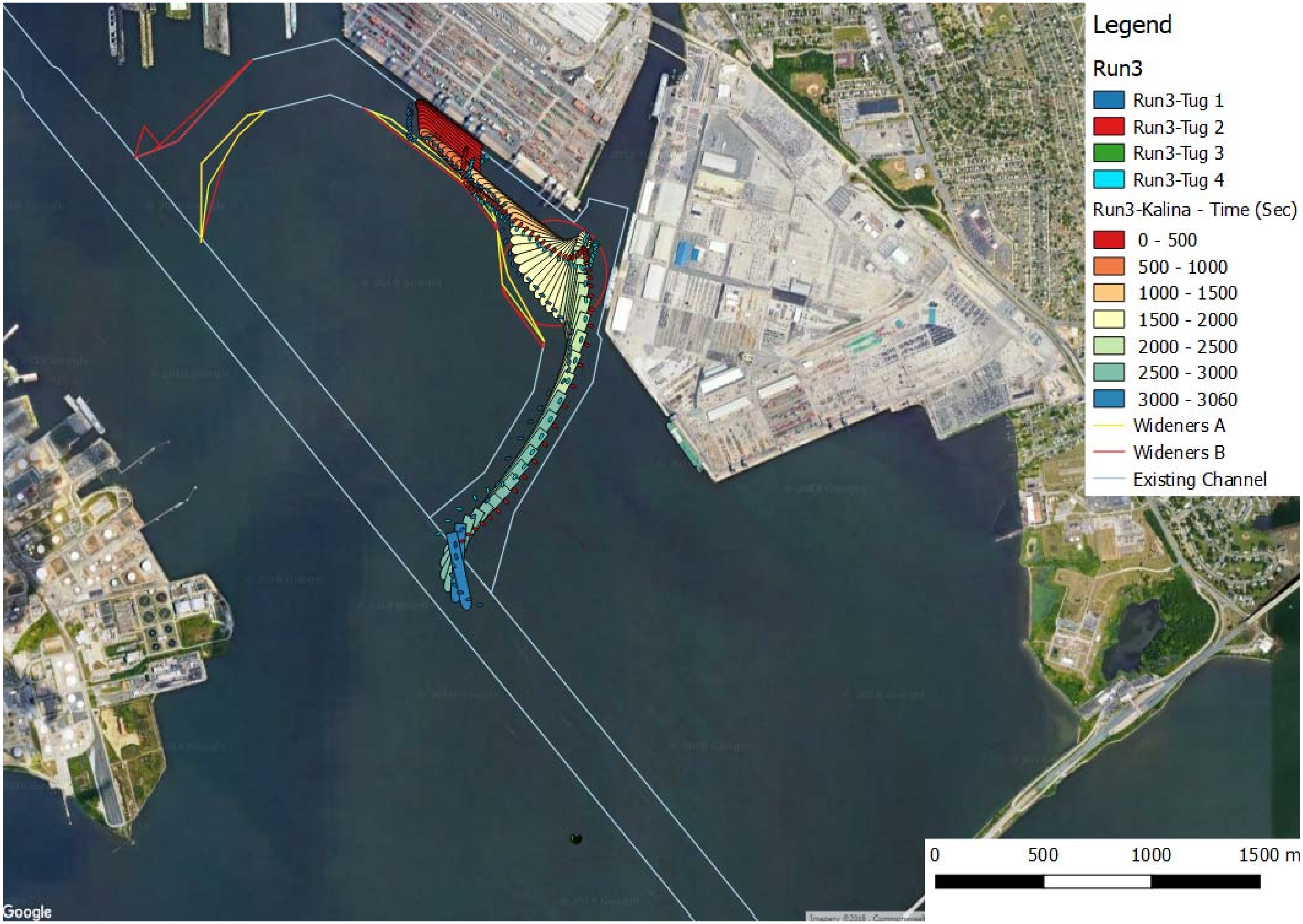


Figure 4-7: Run 3 – Overall view

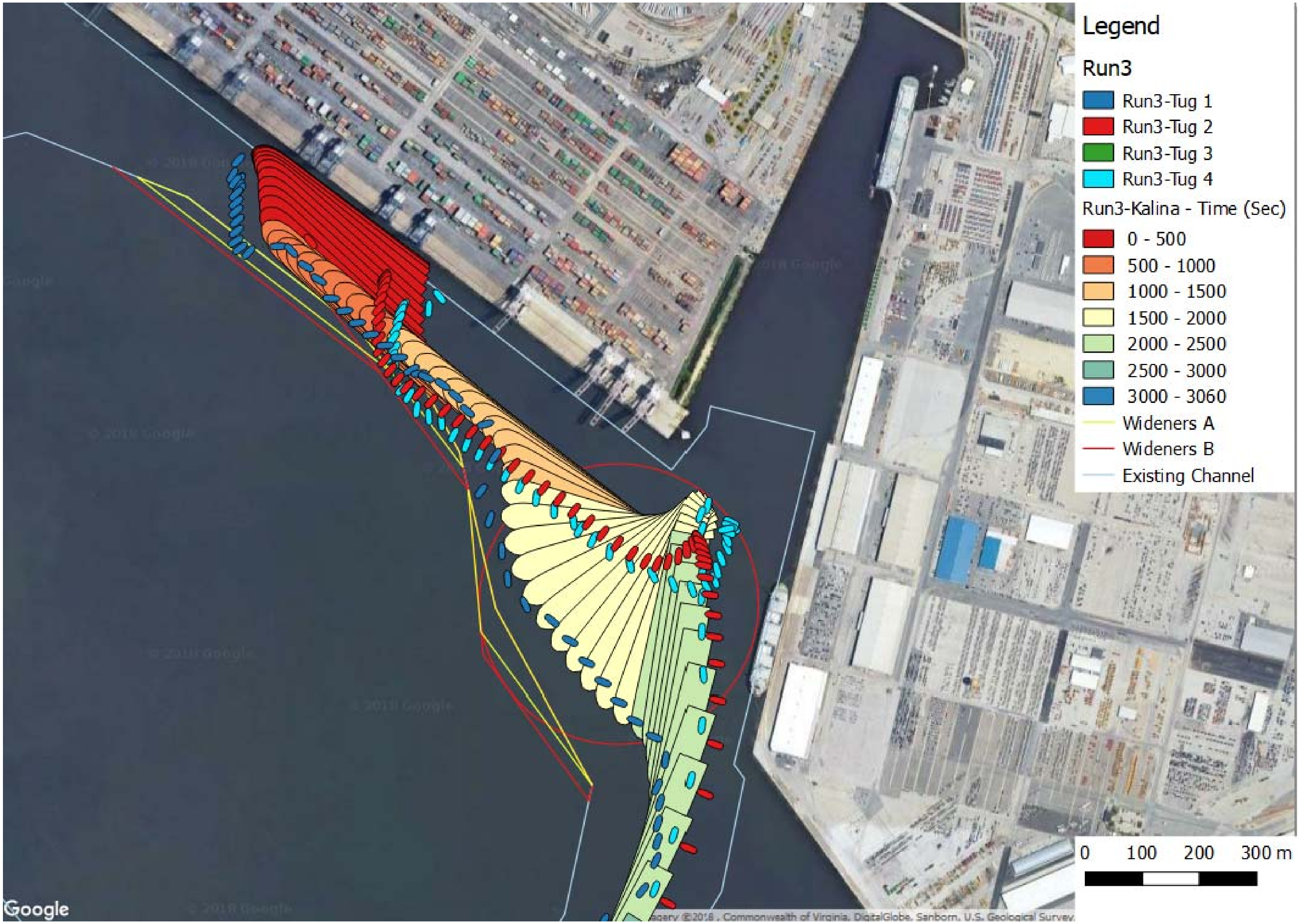


Figure 4-8: Run 3 – Zoomed in view

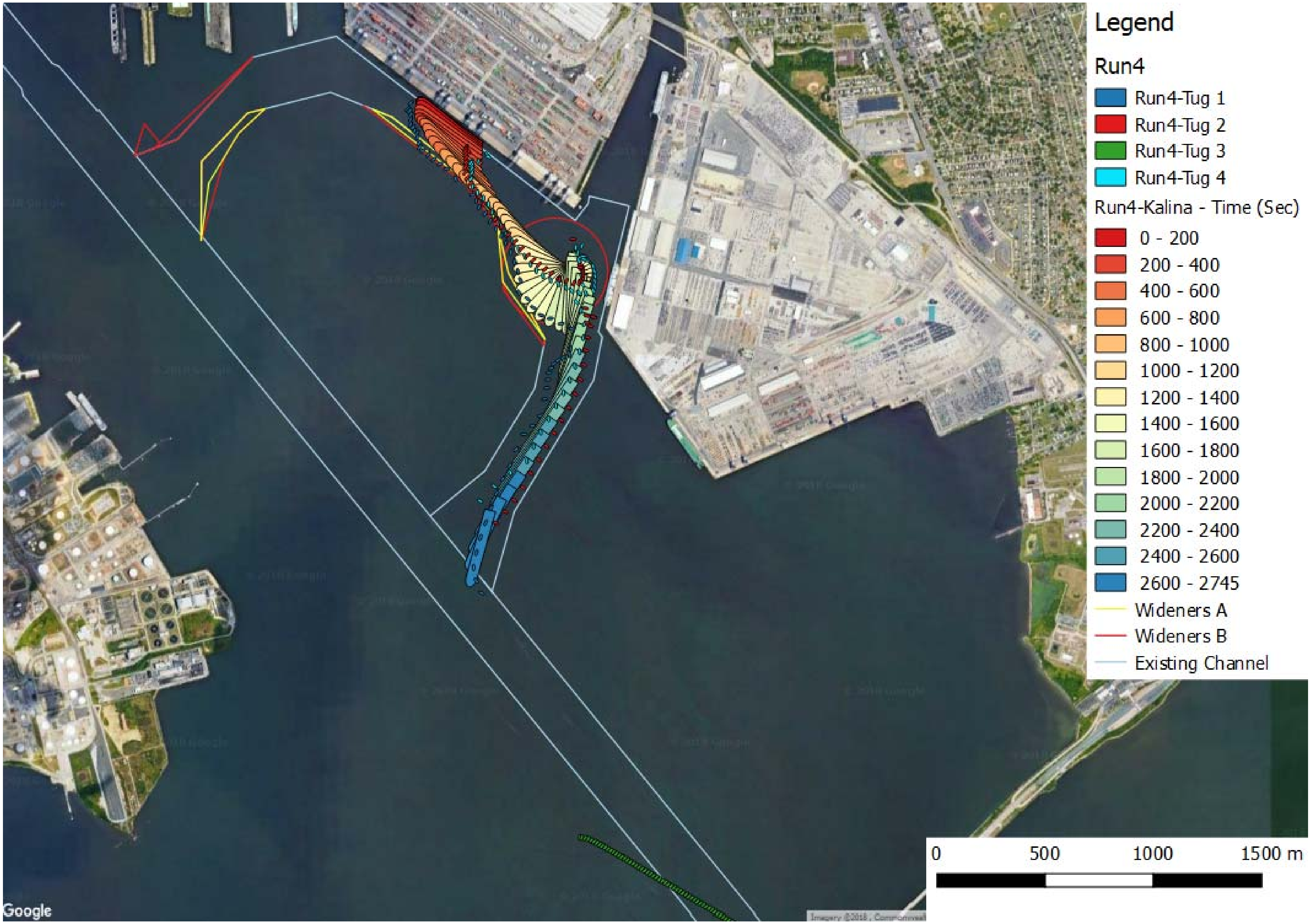


Figure 4-9: Run 4 – Overall view

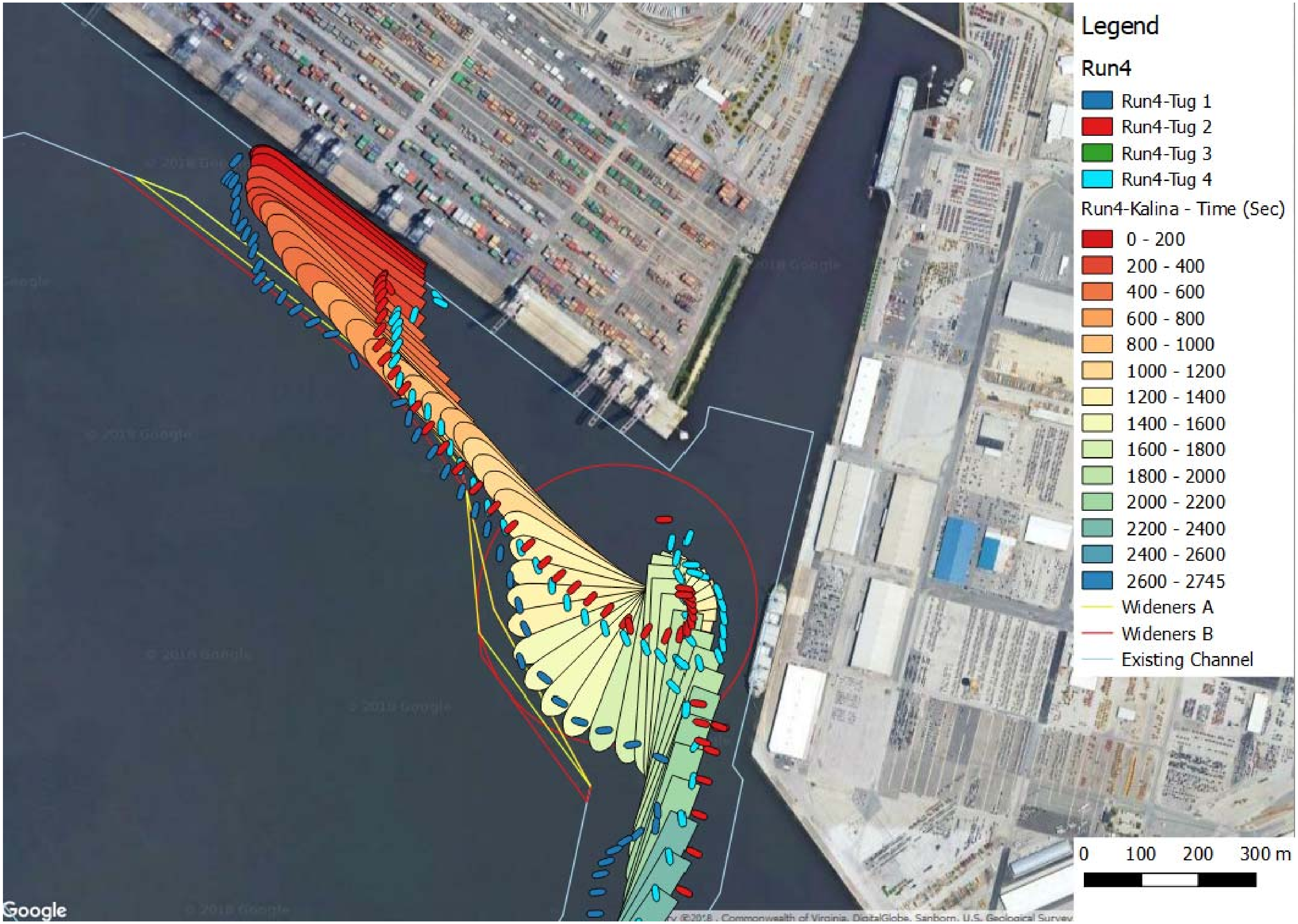


Figure 4-10: Run 4 – Zoomed in view

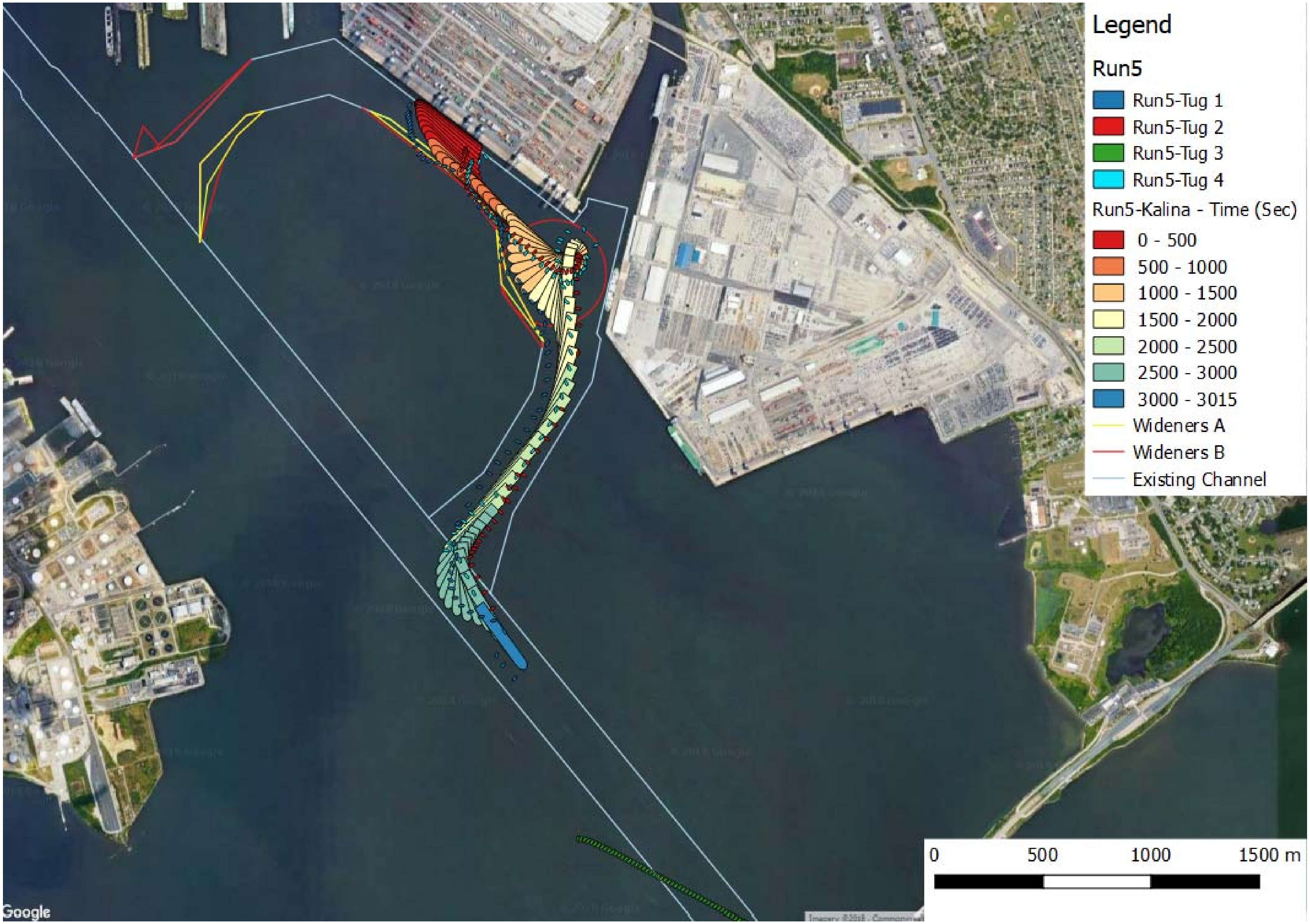


Figure 4-11: Run 5 – Overall view

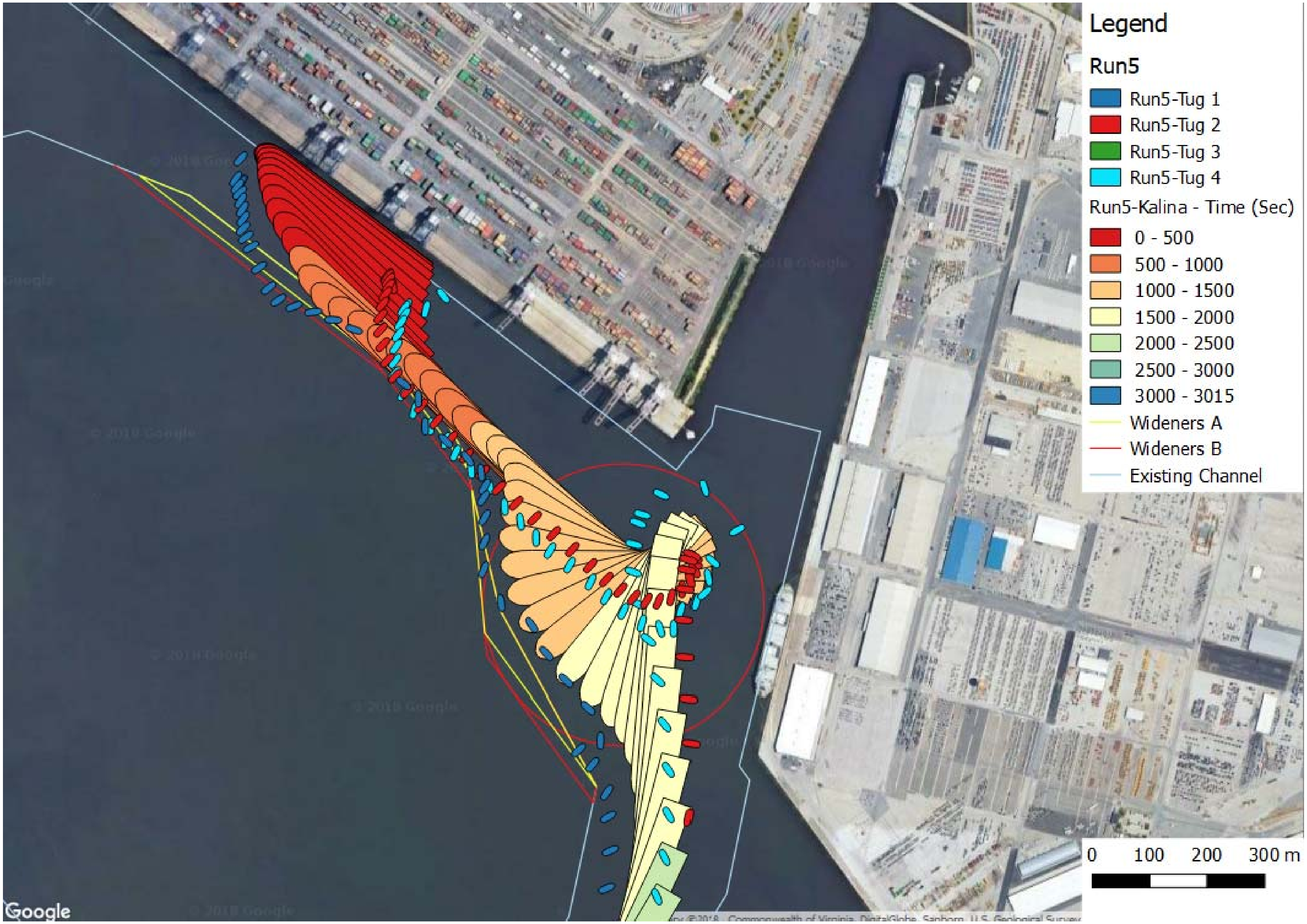


Figure 4-12: Run 5 – Zoomed in view

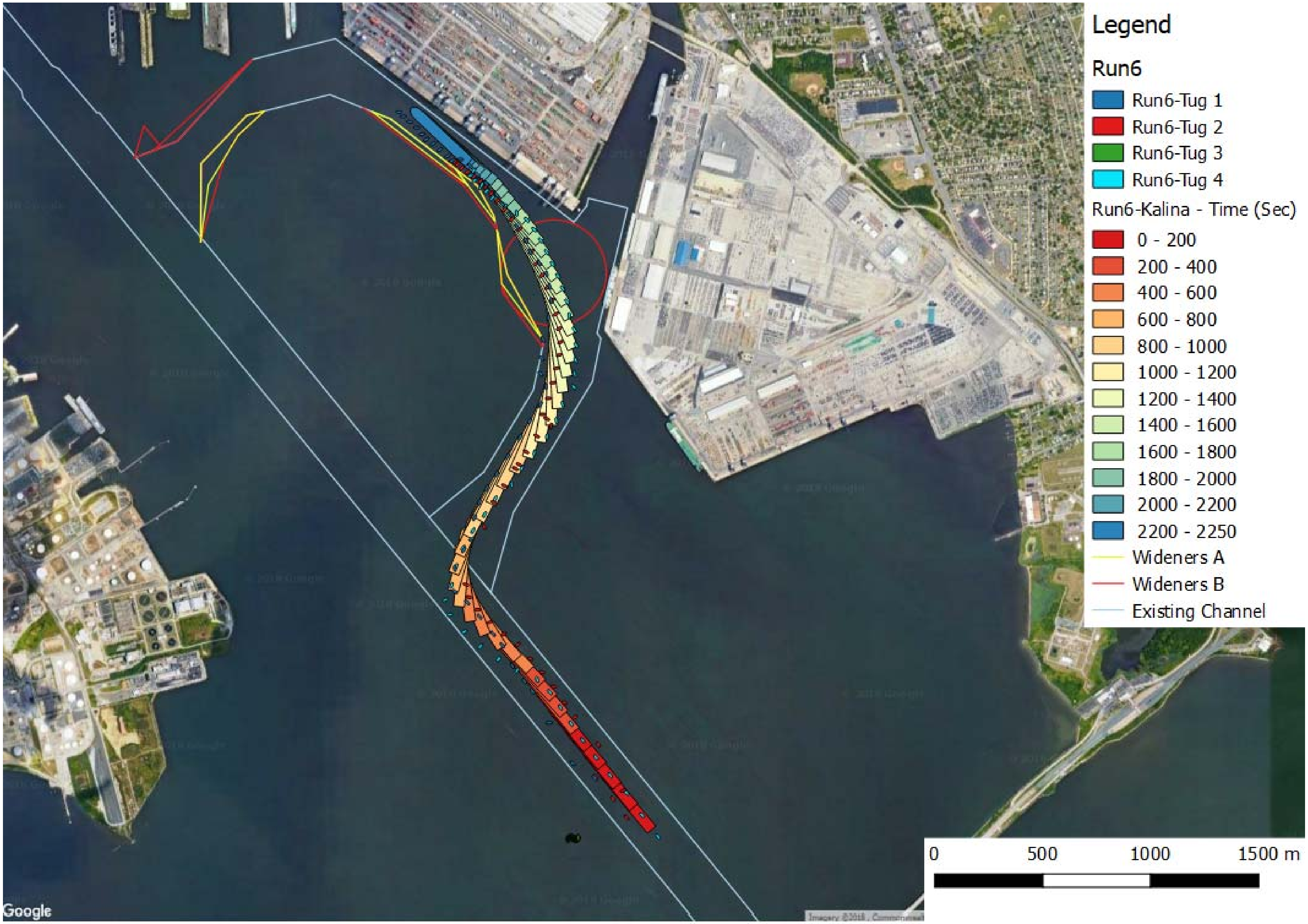


Figure 4-13: Run 6 – Overall view

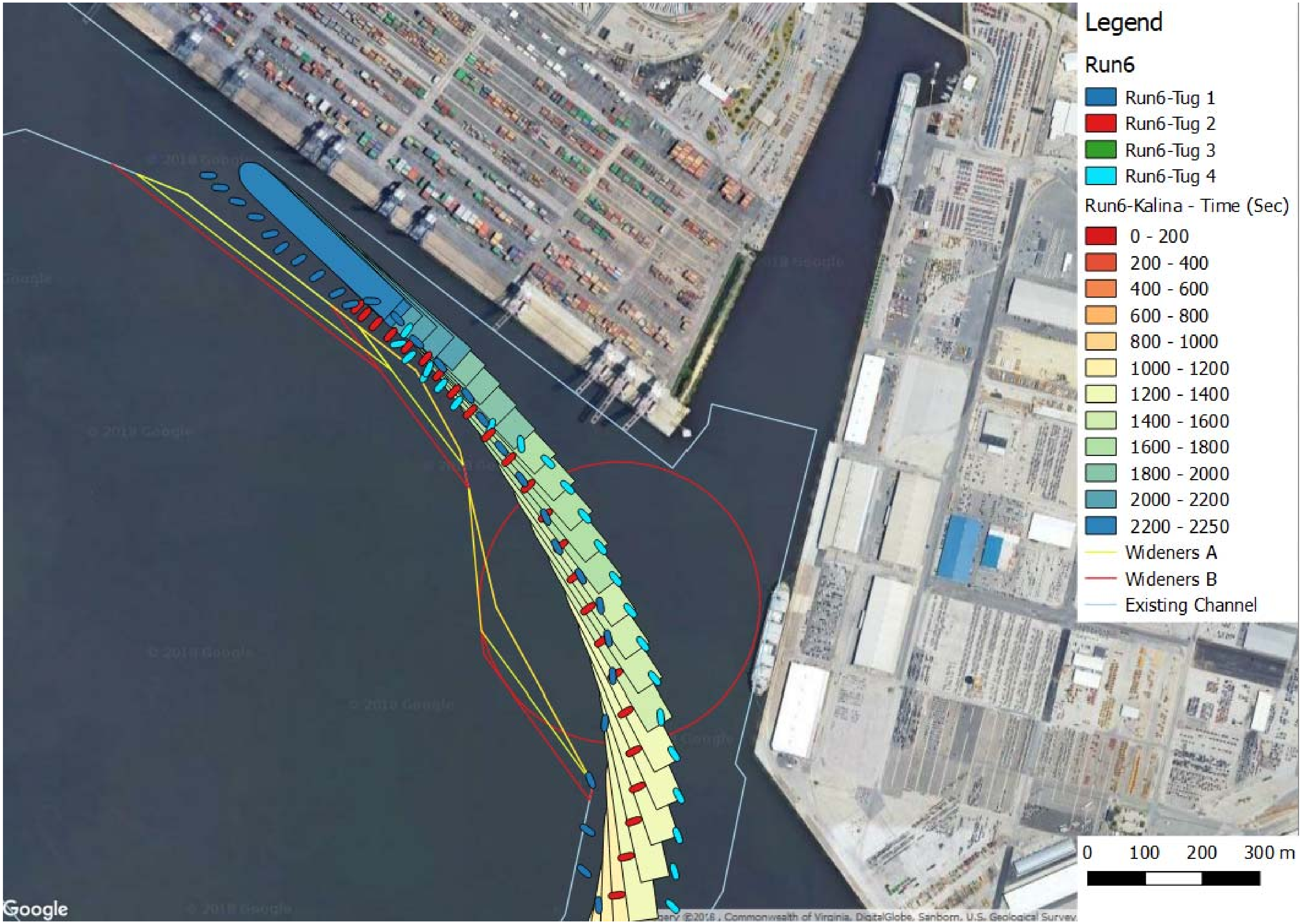


Figure 4-14: Run 6 – Zoomed in view

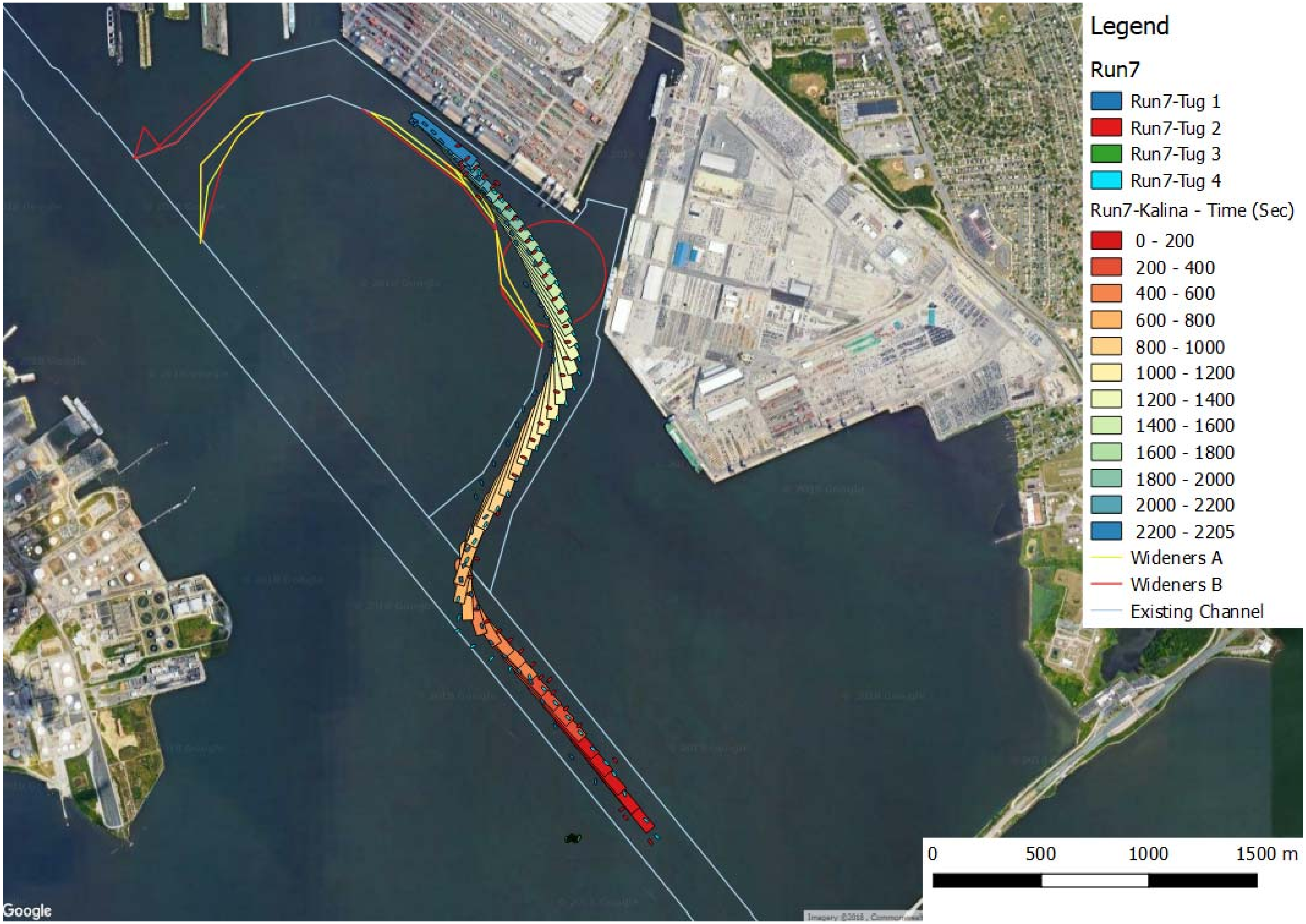


Figure 4-15: Run 7 – Overall view

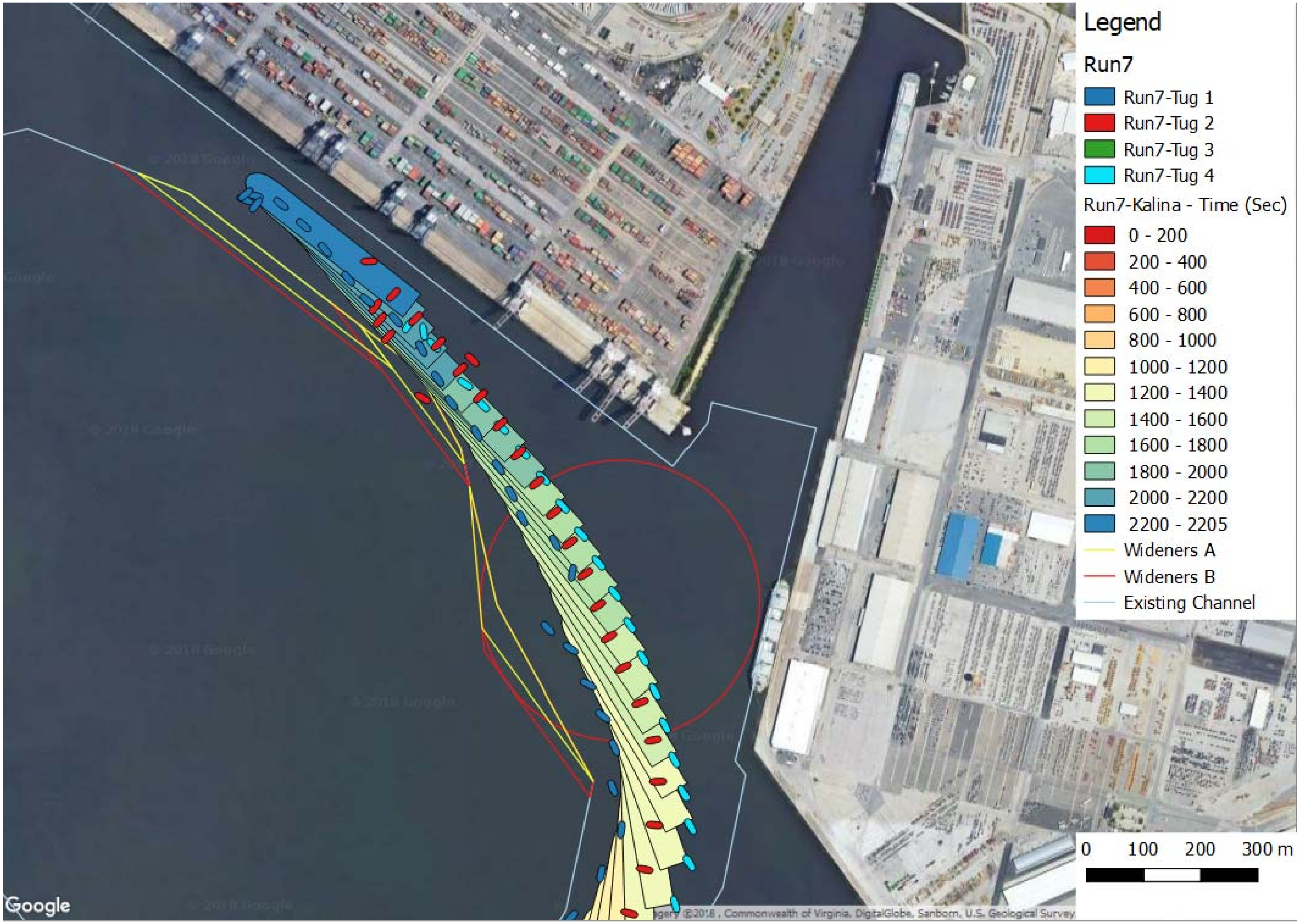


Figure 4-16: Run 7 – Zoomed in view

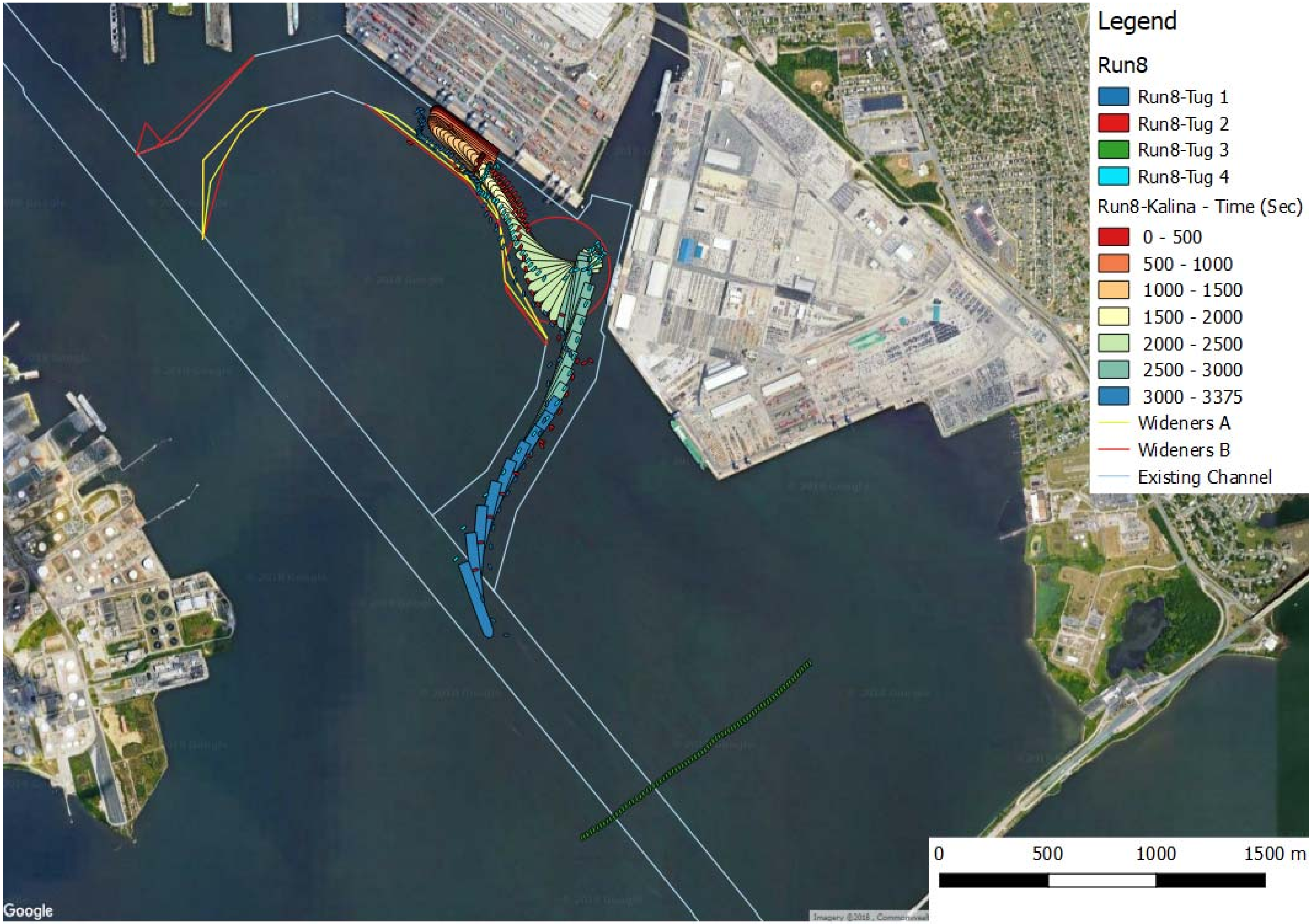


Figure 4-17: Run 8 – Overall view

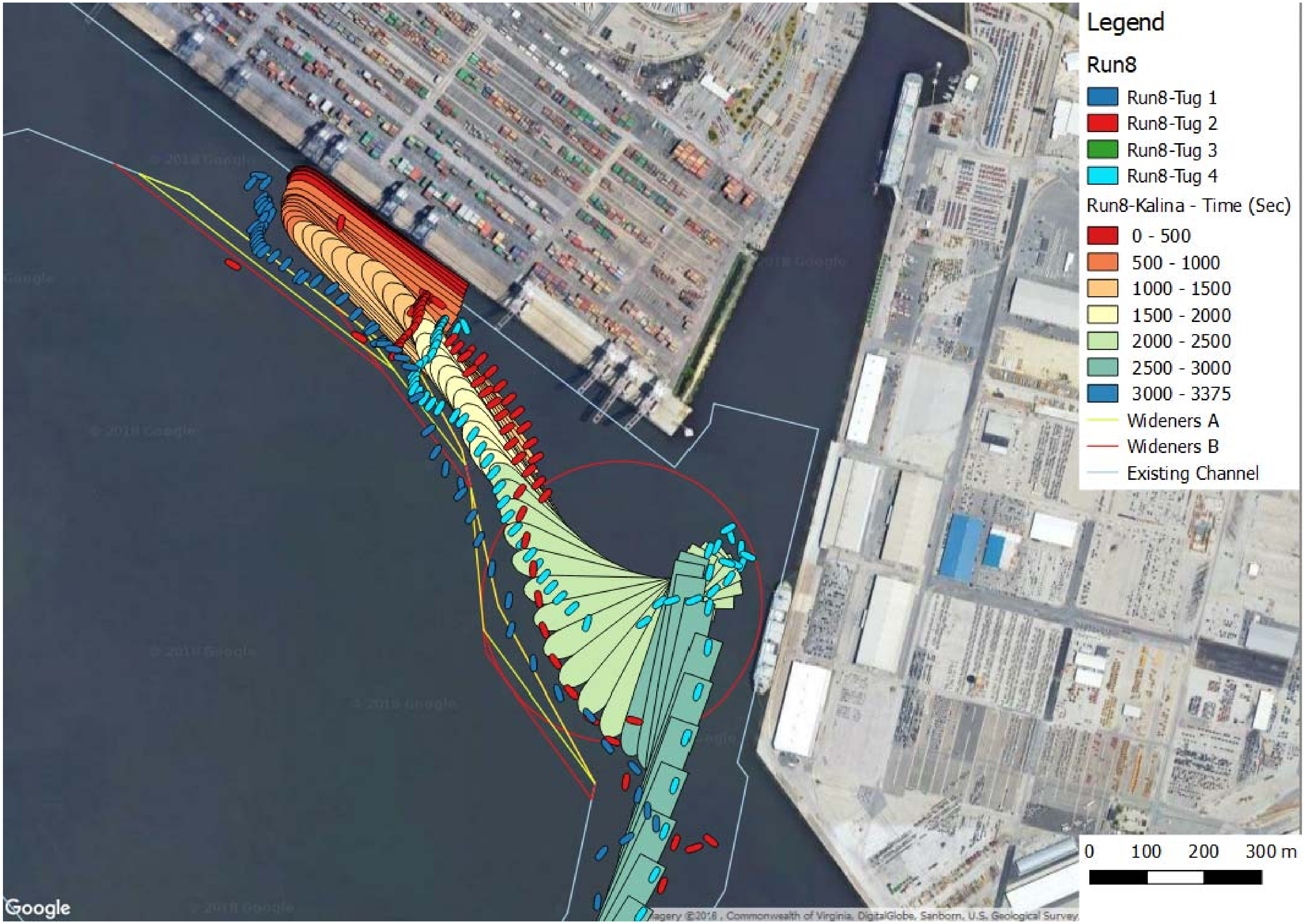


Figure 4-18: Run 8 – Zoomed in view

Figure 4-19: Run 9 – Overall view

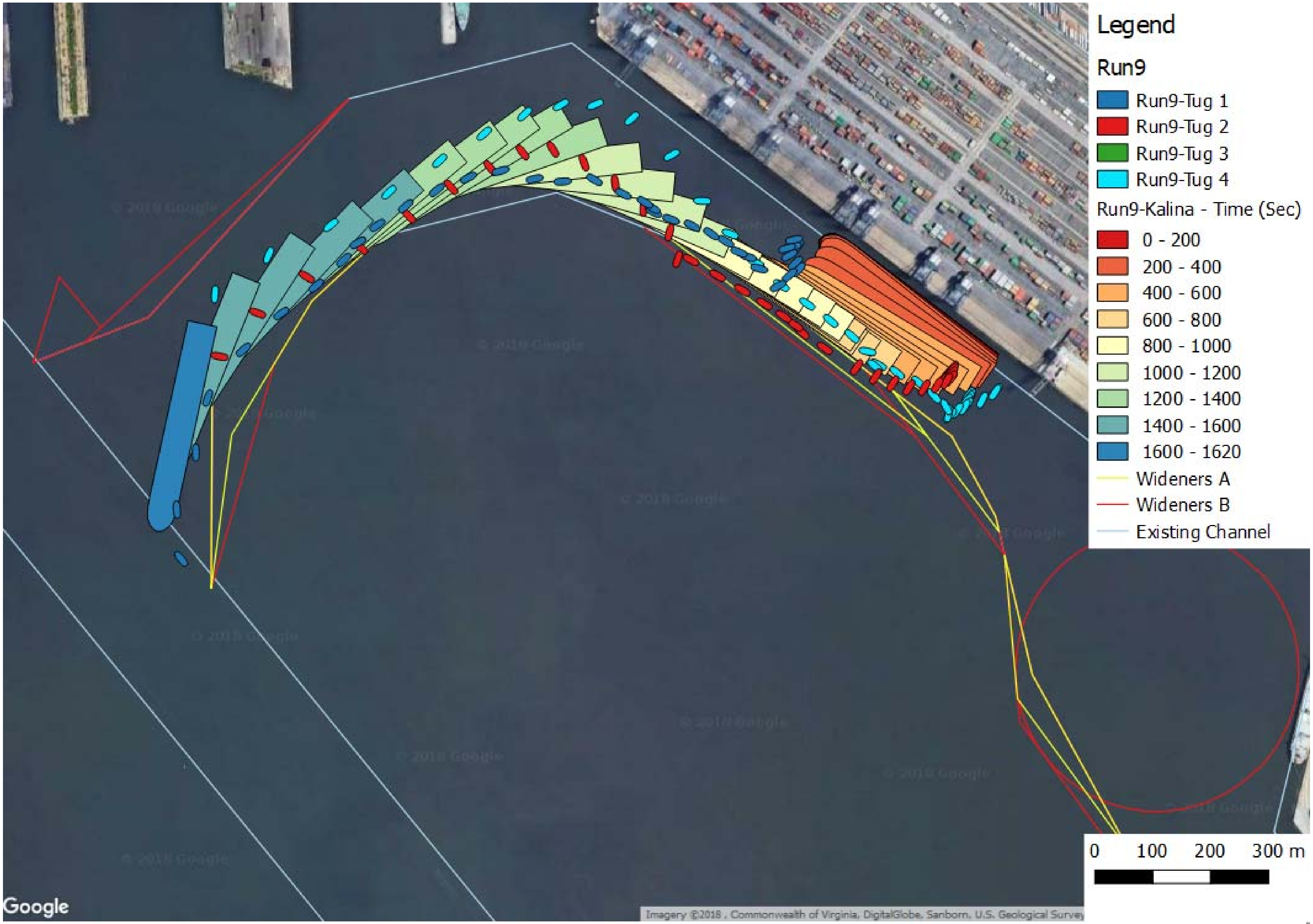


Figure 4-20: Run 9 – Zoomed in view

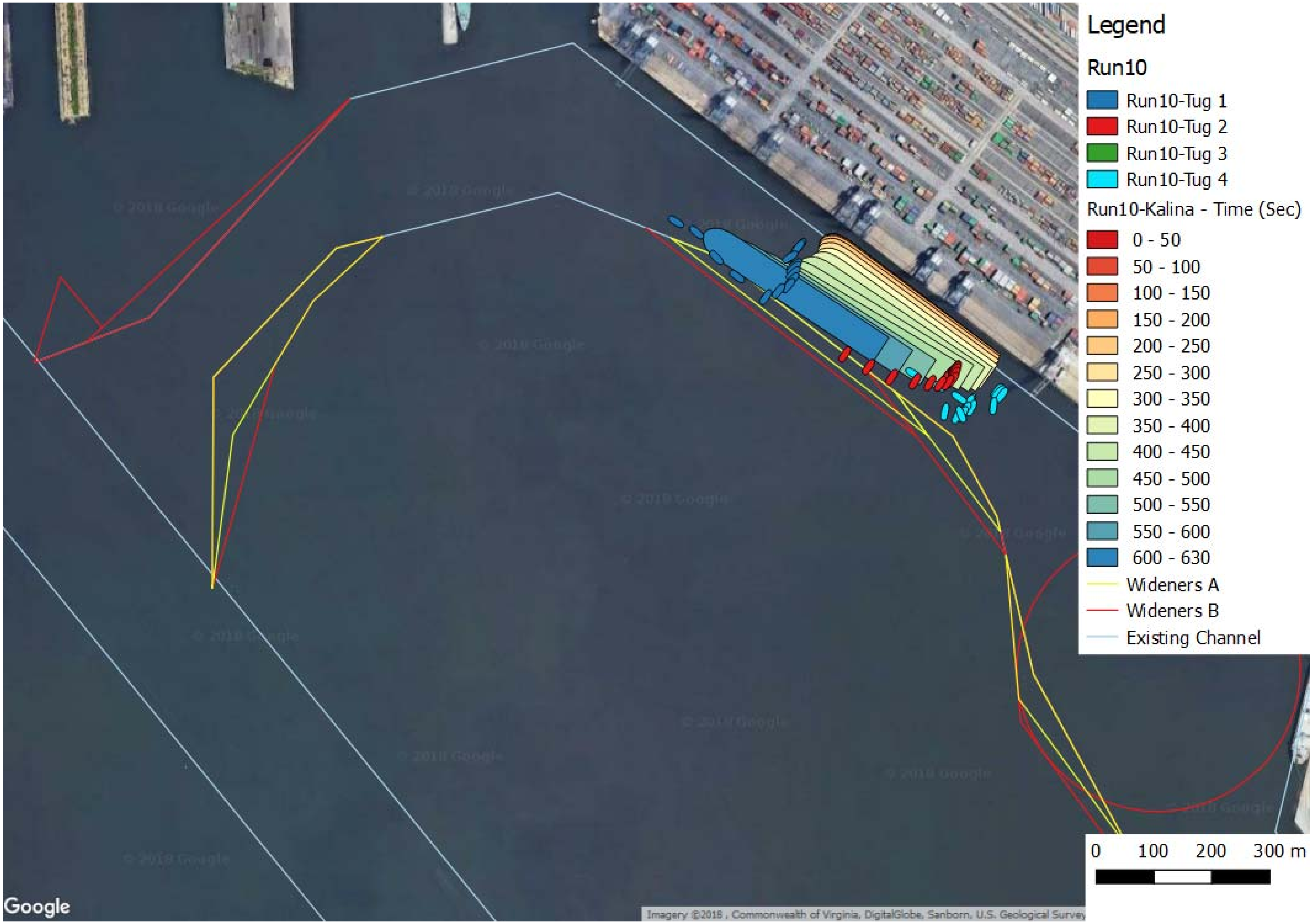


Figure 4-21: Run 10 – Overall view

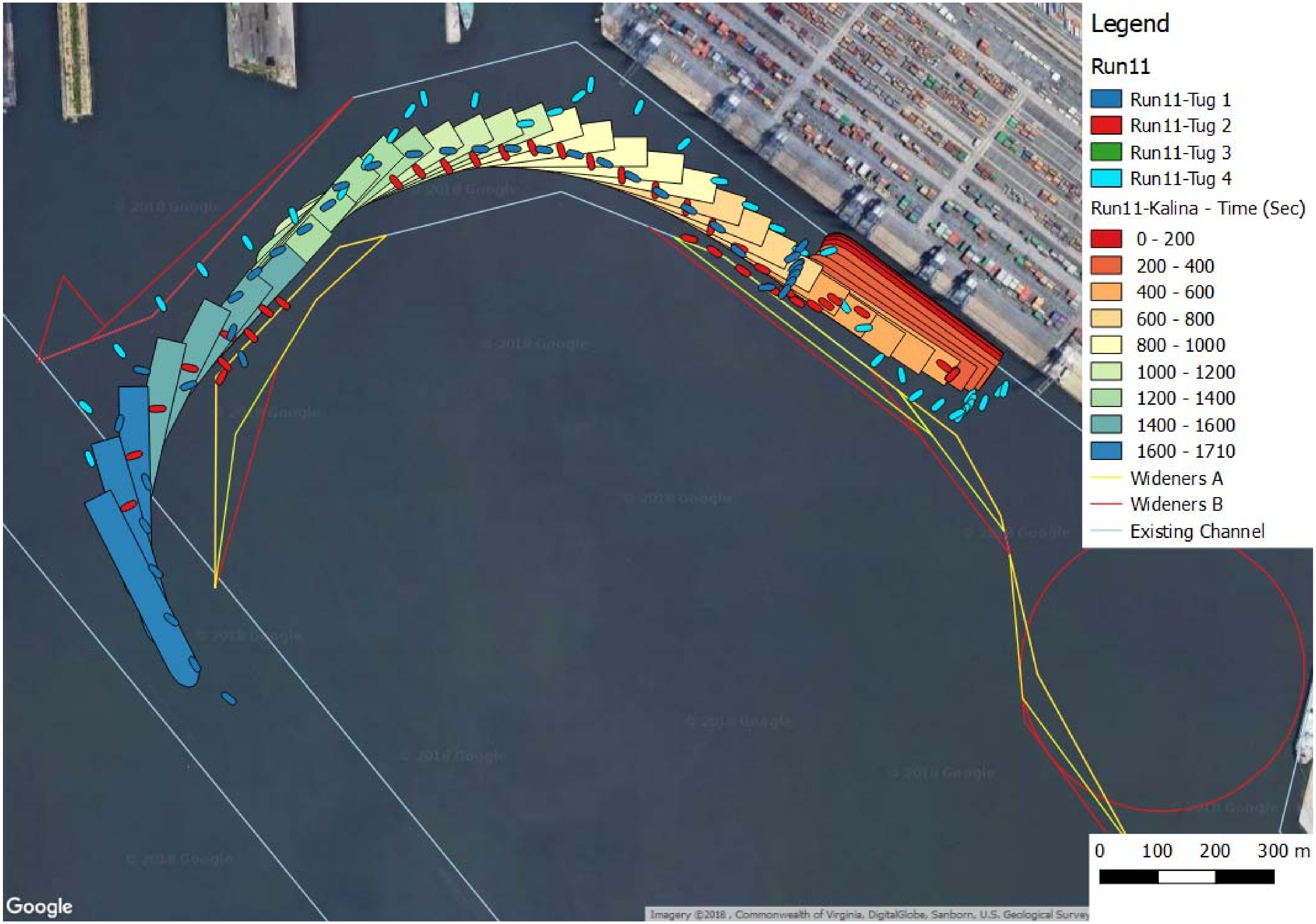


Figure 4-22: Run 11 – Zoomed in view

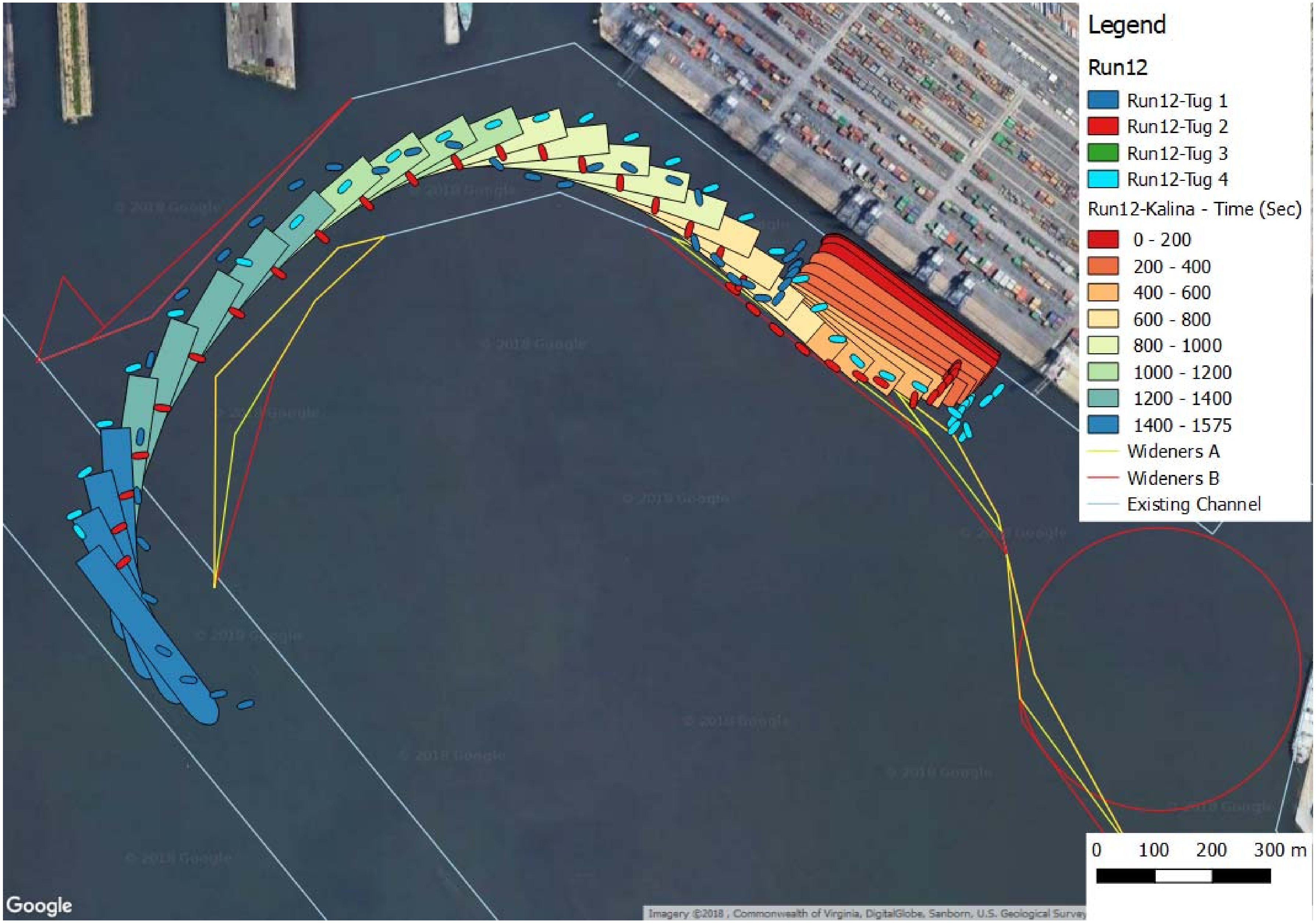


Figure 4-23: Run 12 – Zoomed in view

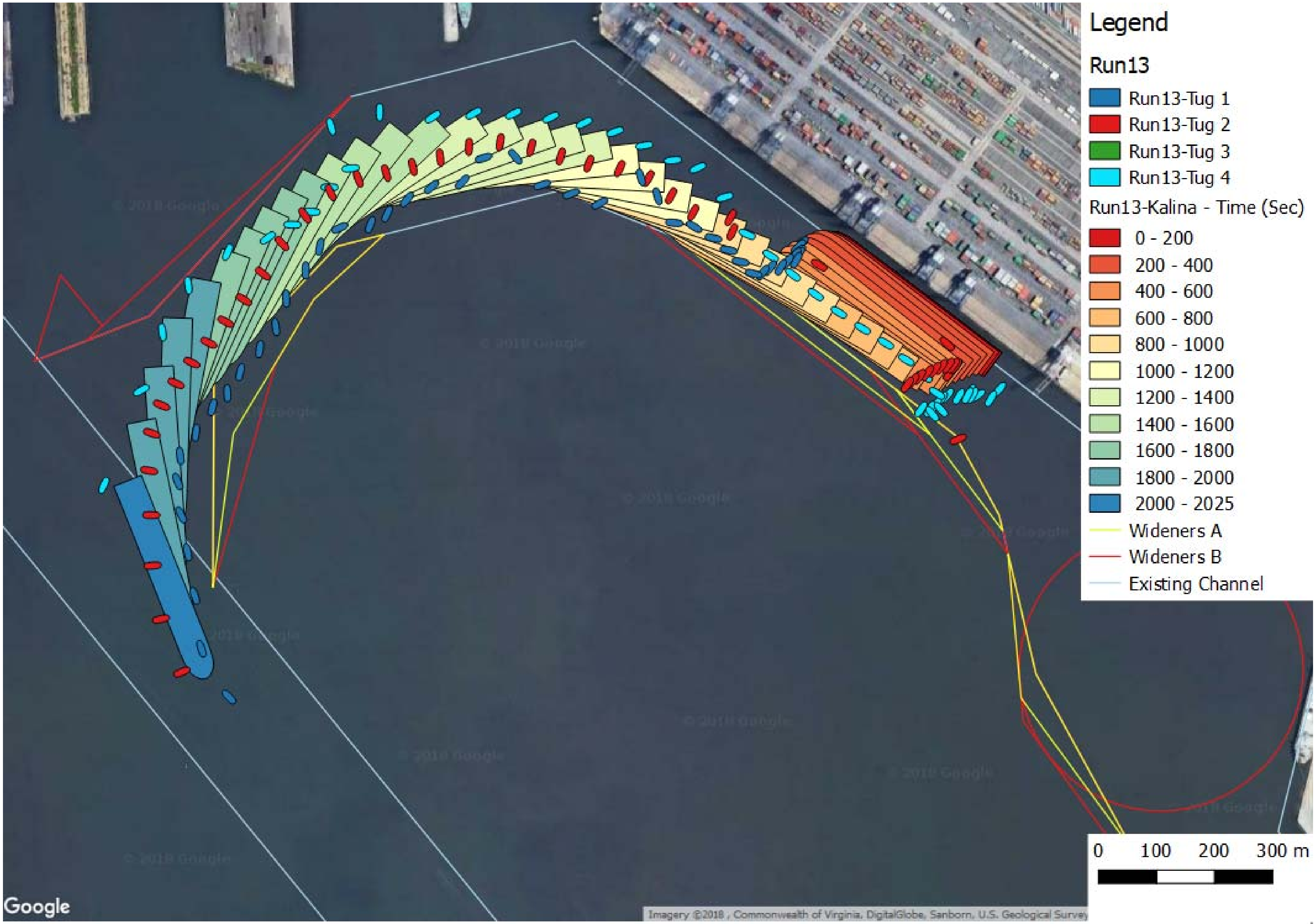


Figure 4-24: Run 13 – Zoomed in view

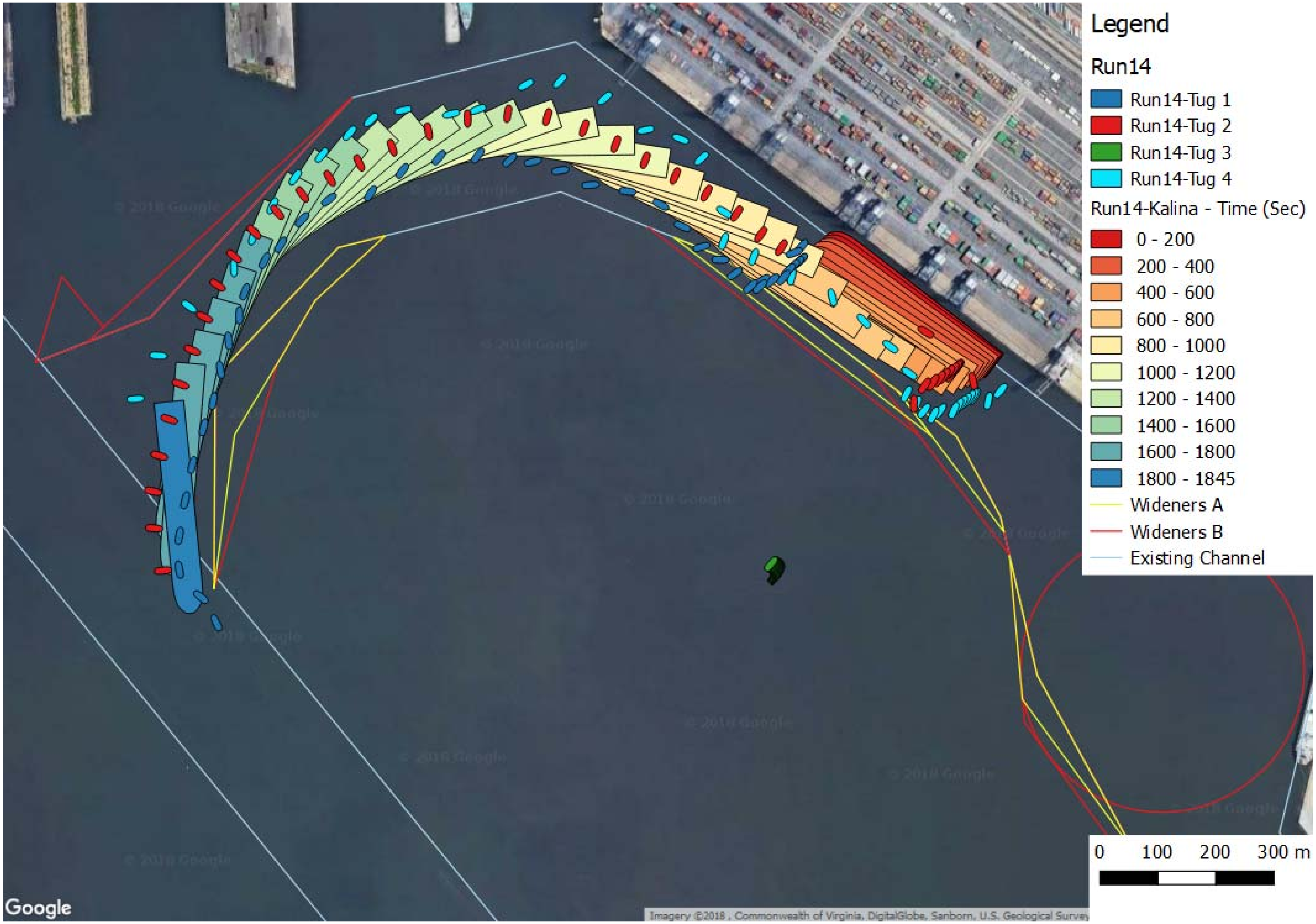


Figure 4-25: Run 14 – Zoomed in view

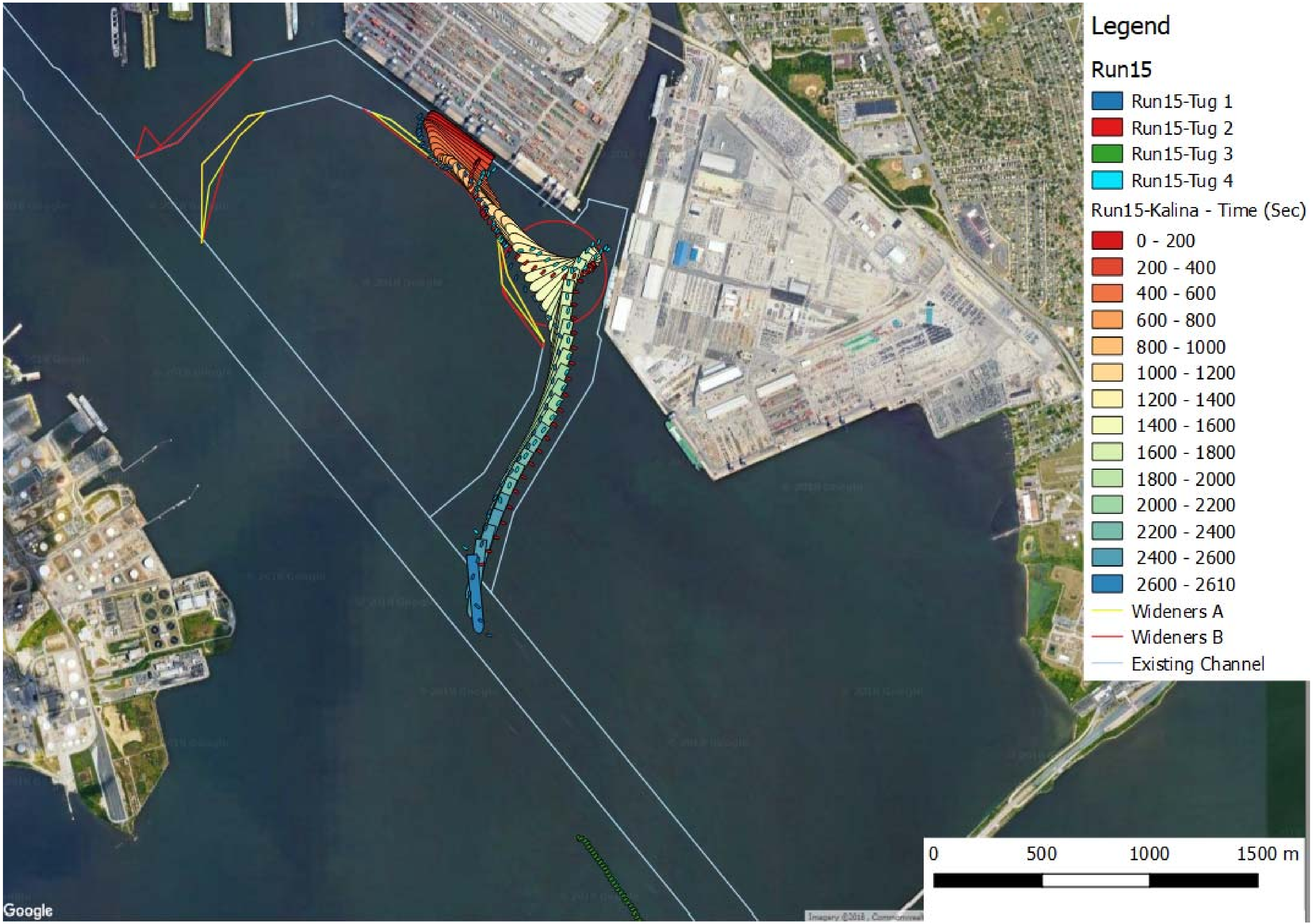


Figure 4-26: Run 15 – Overall view

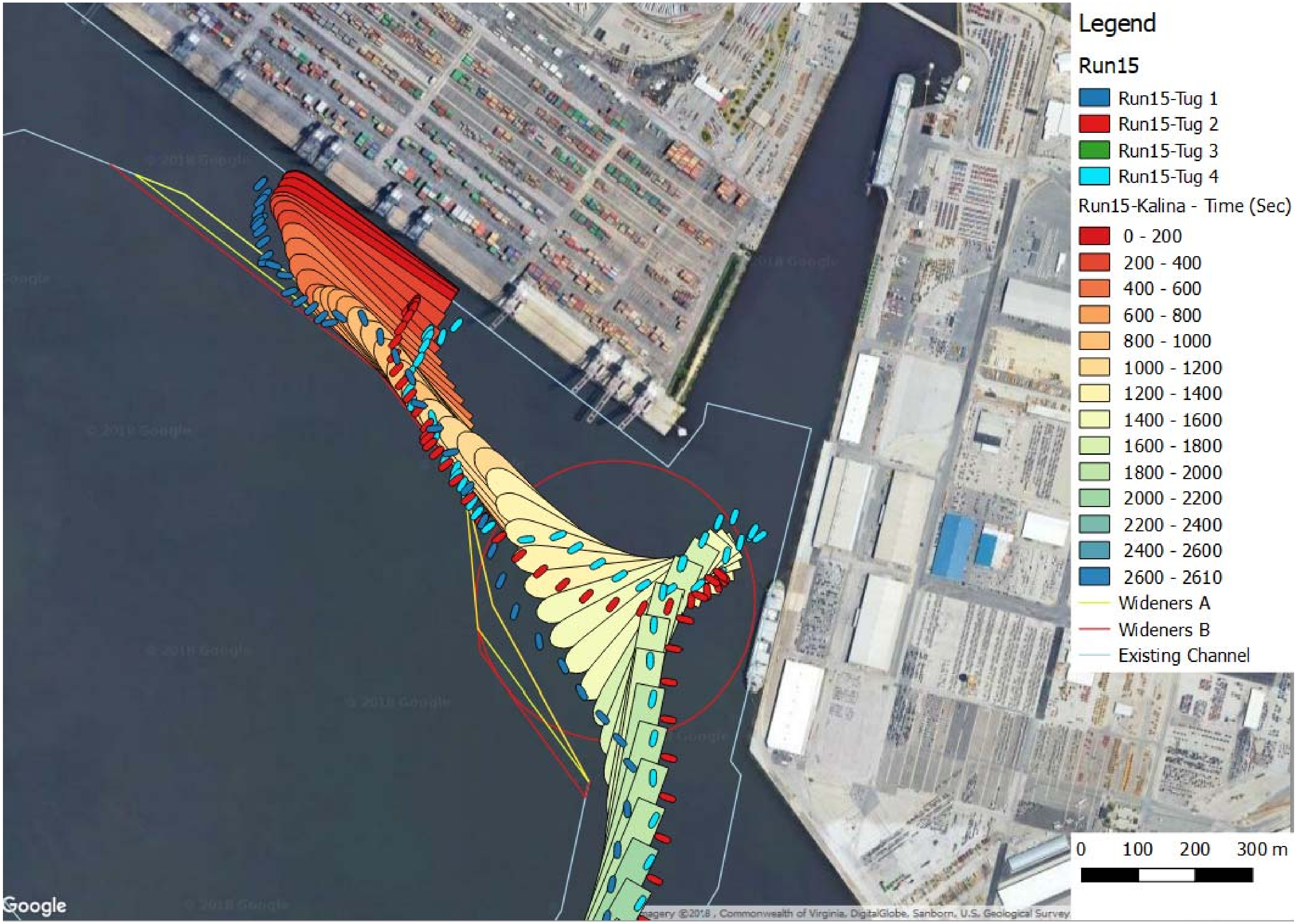


Figure 4-27: Run 15 – Zoomed in view

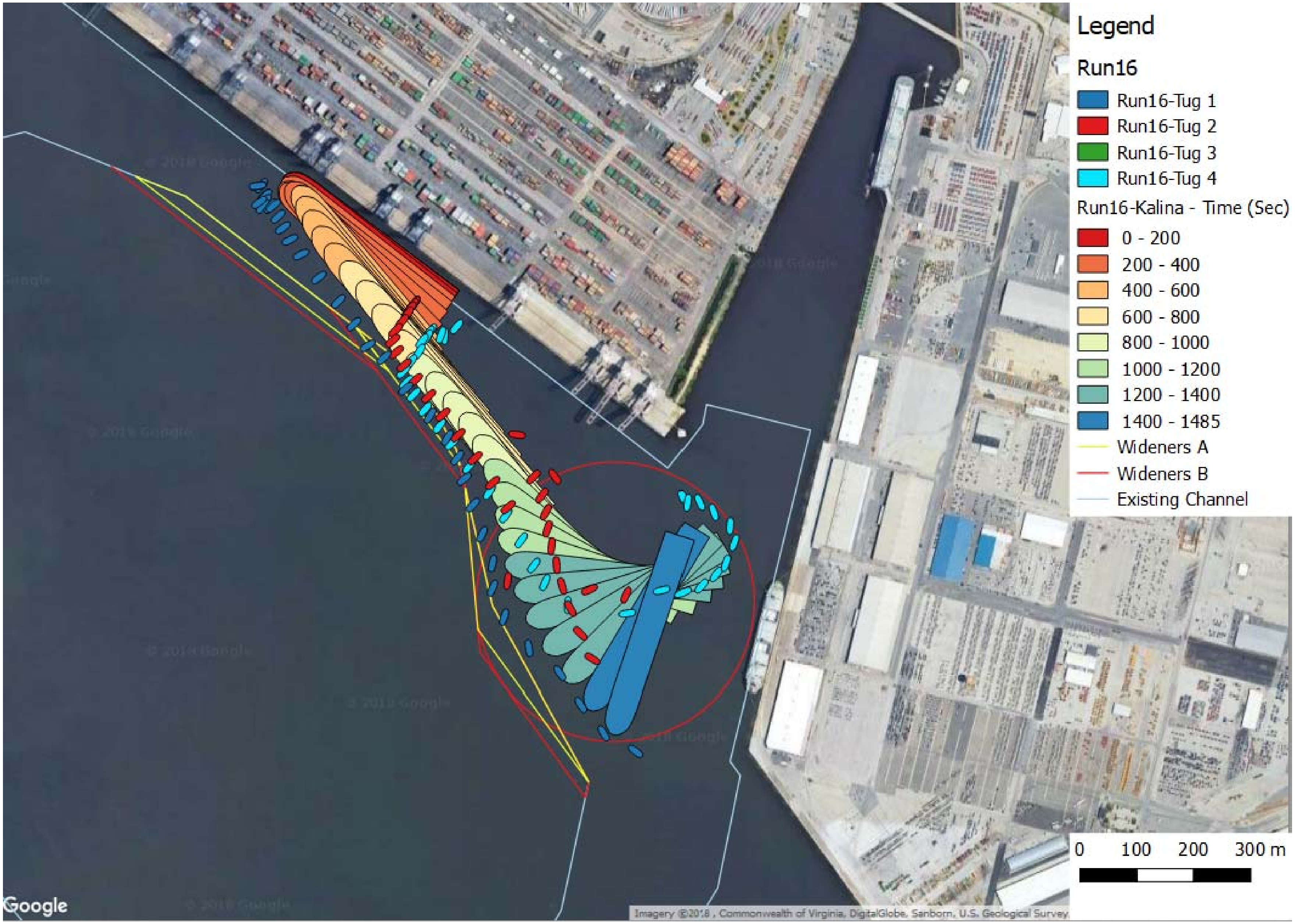


Figure 4-28: Run 16 – Zoomed in view

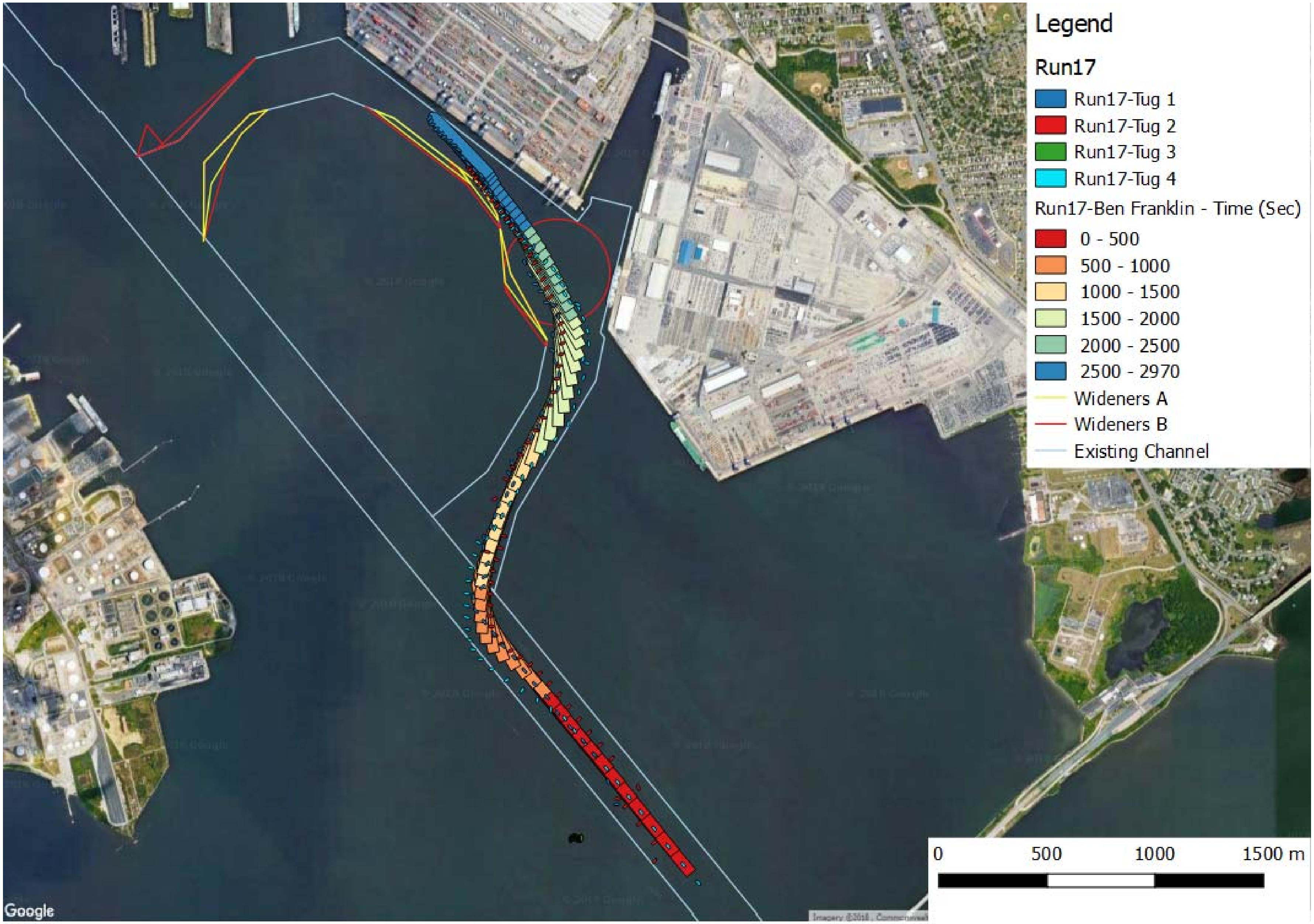


Figure 4-29: Run 17 – Overall view

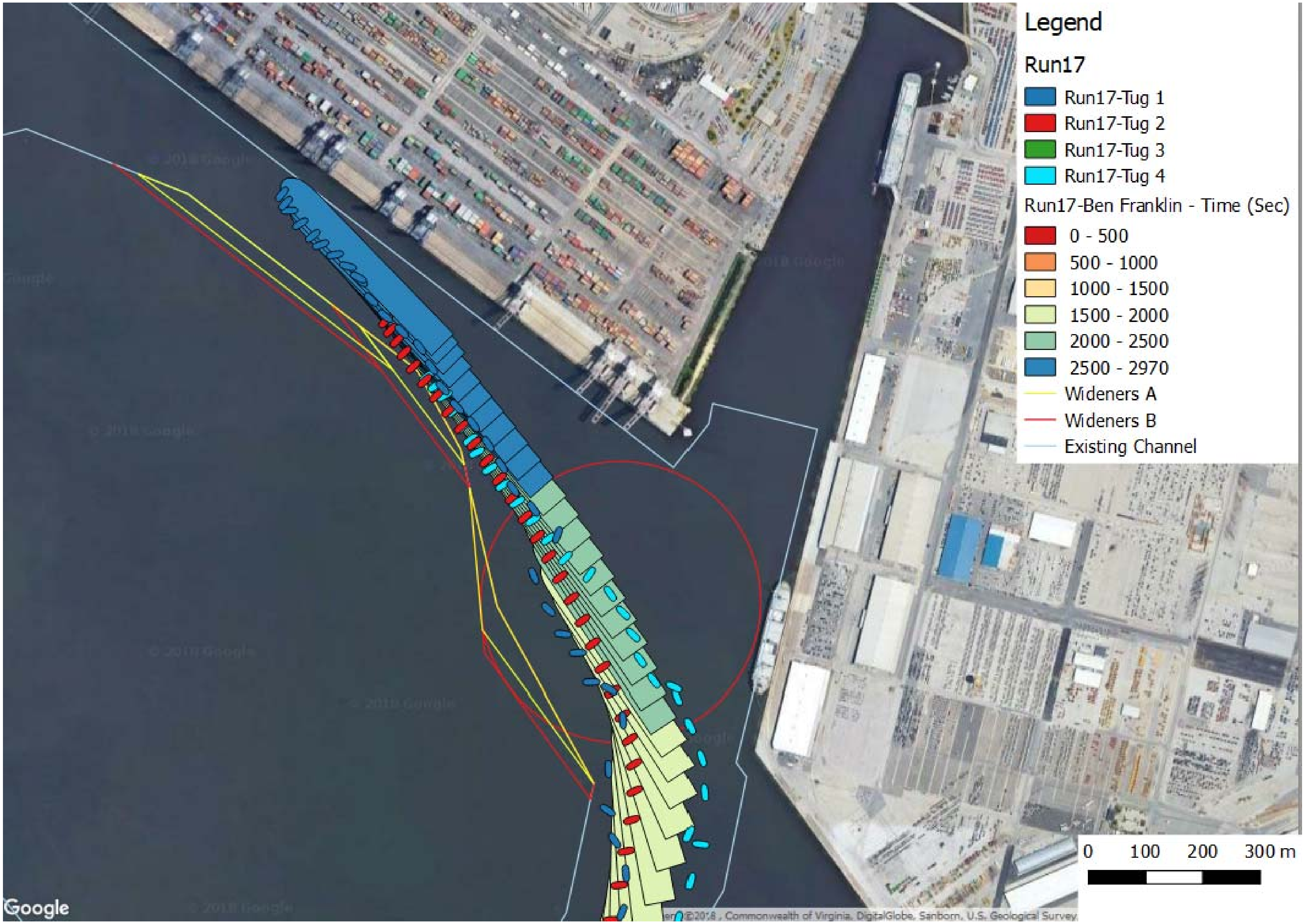


Figure 4-30: Run 17 – Zoomed in view

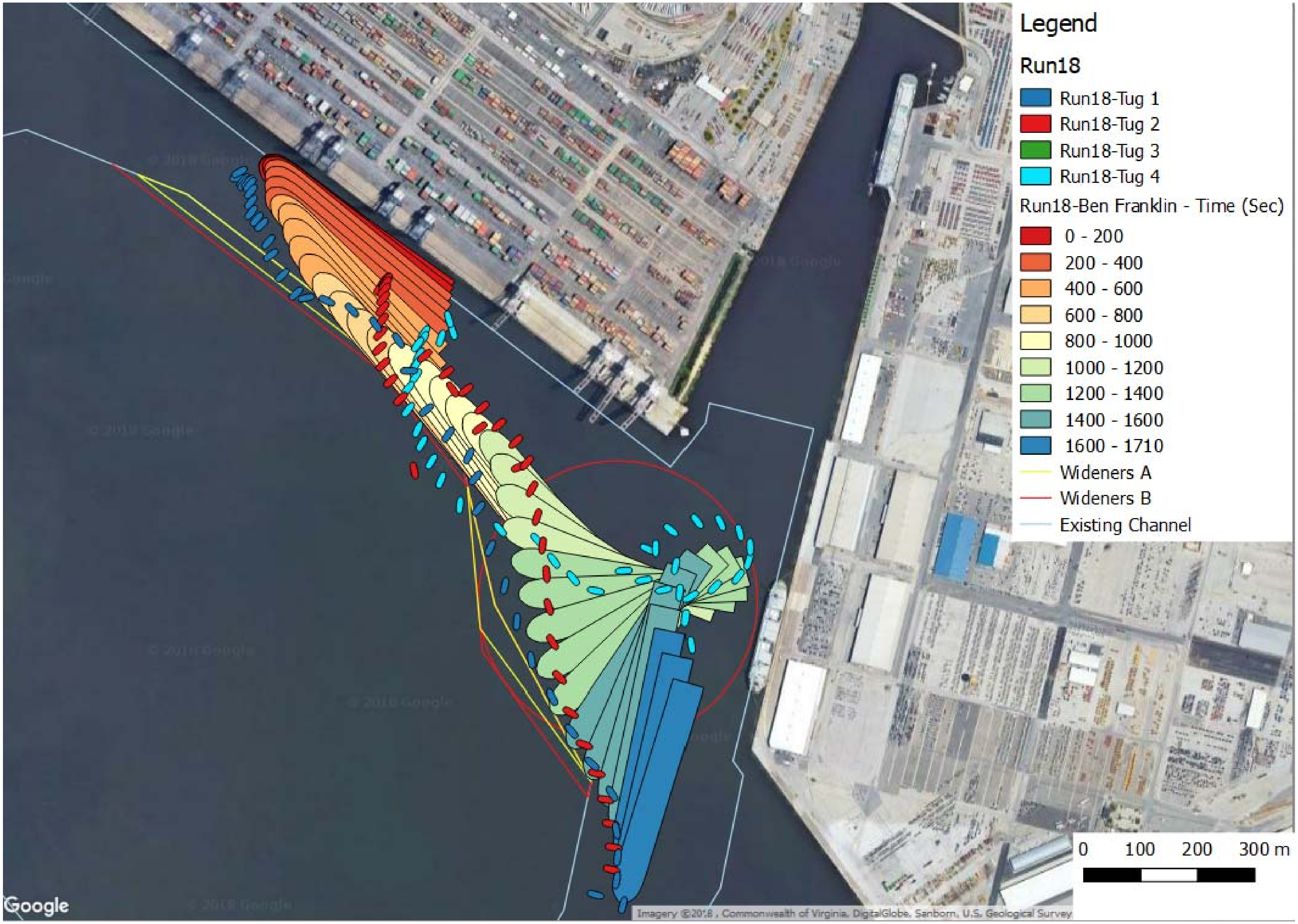


Figure 4-31: Run 18 – Zoomed in view

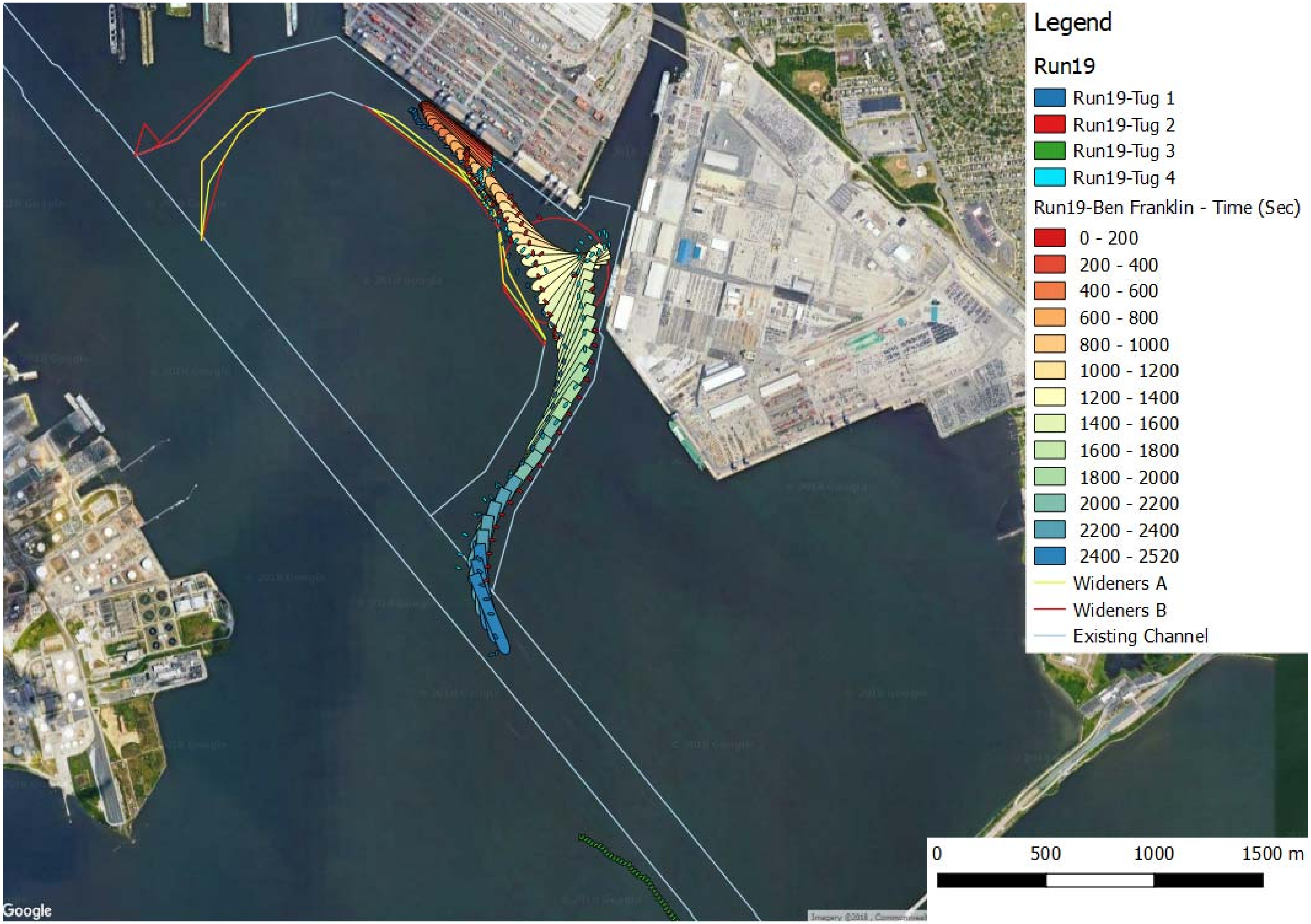


Figure 4-32: Run 19 – Overall view

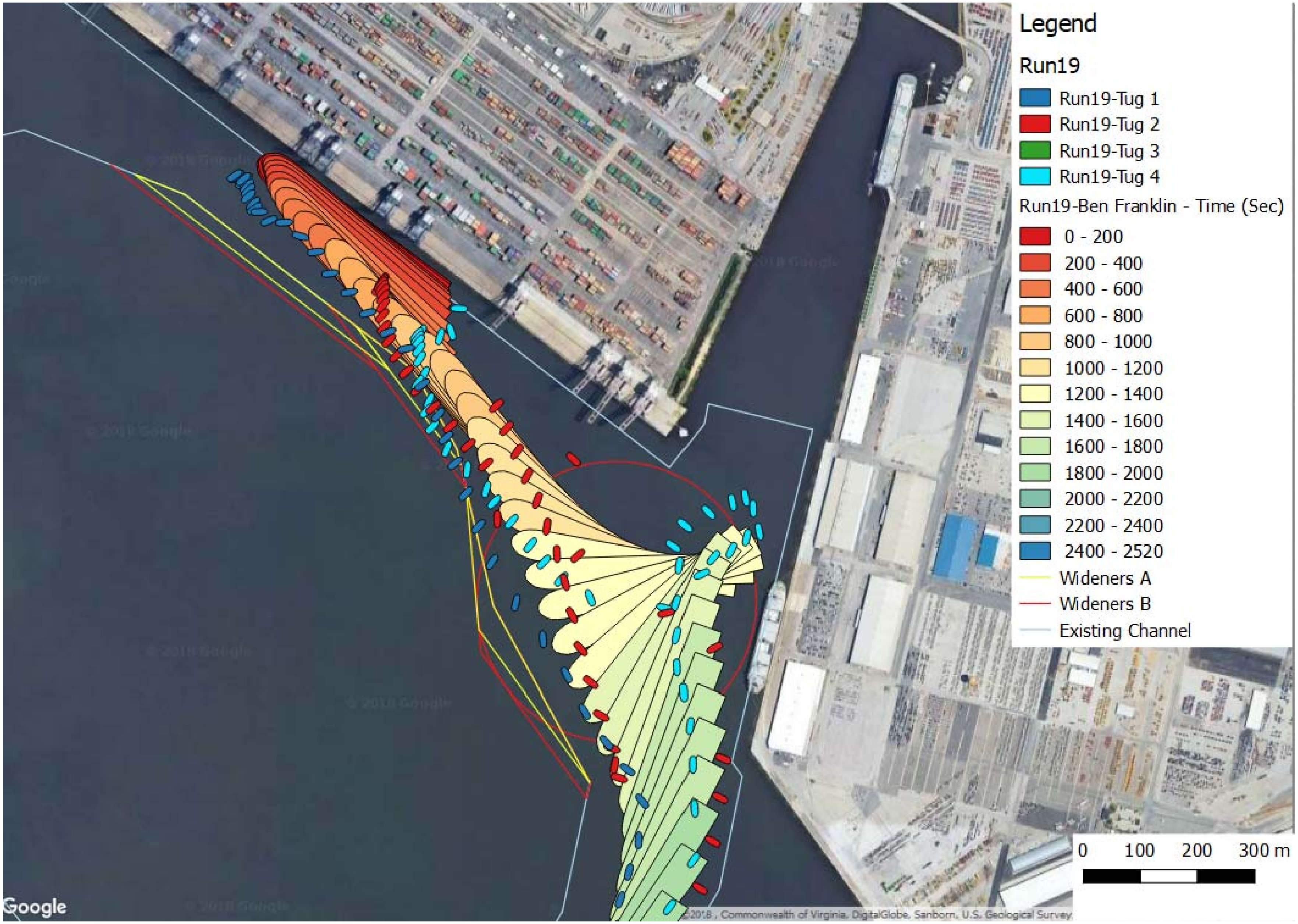


Figure 4-33: Run 19 – Zoomed in view

Figure 4-34: Run 20 – Zoomed in view

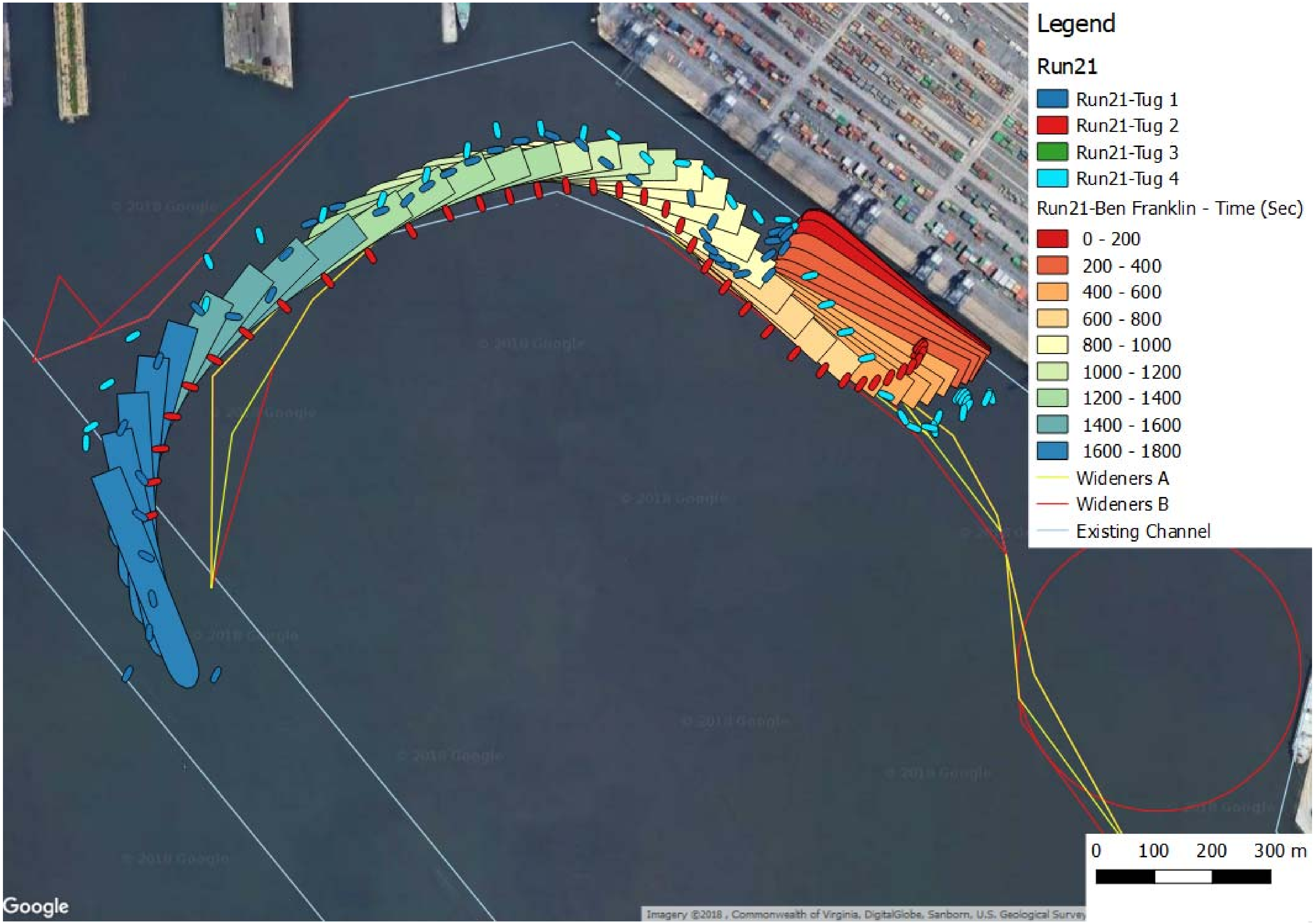


Figure 4-35: Run 21 – Zoomed in view

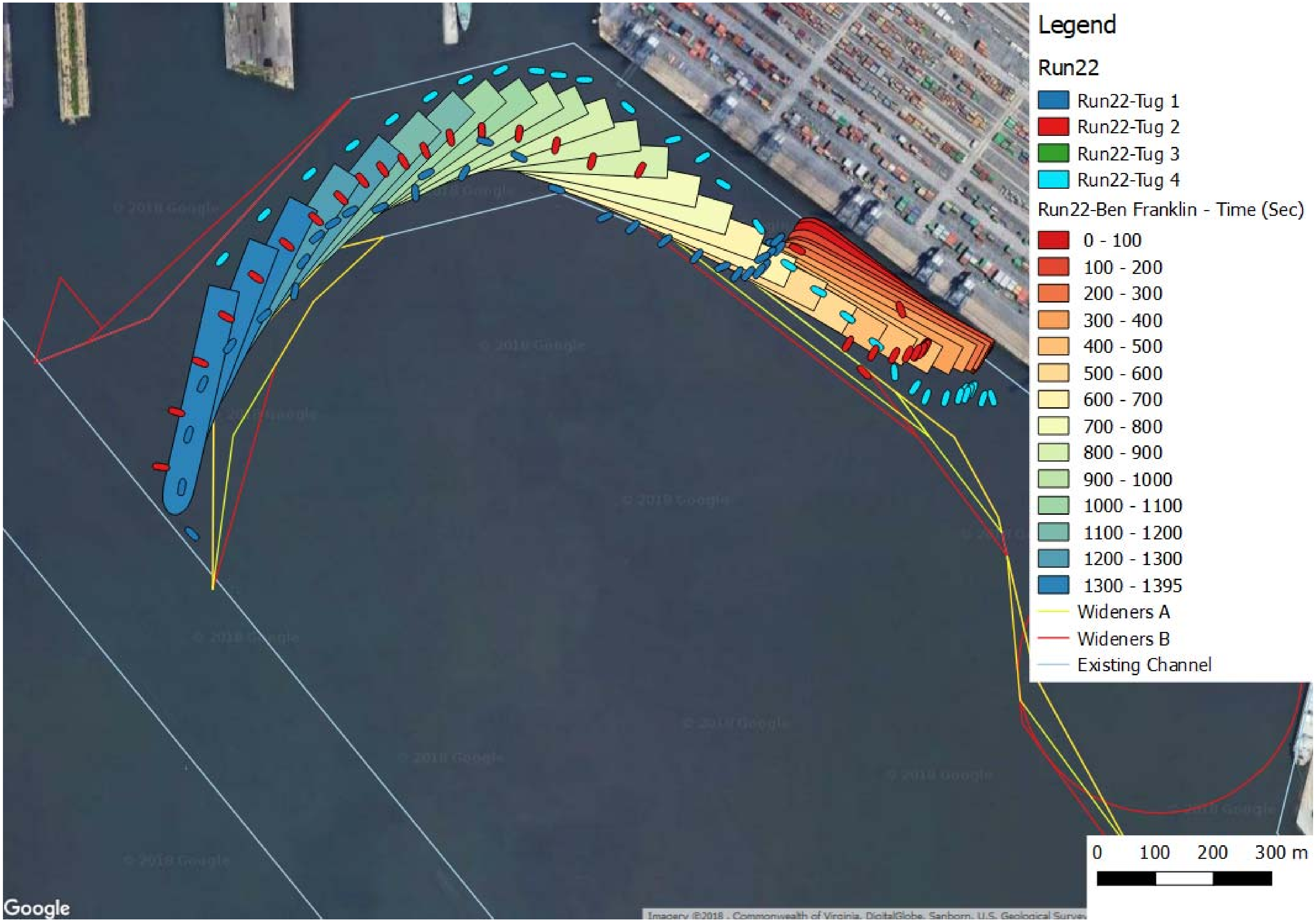


Figure 4-36: Run 22 – Zoomed in view

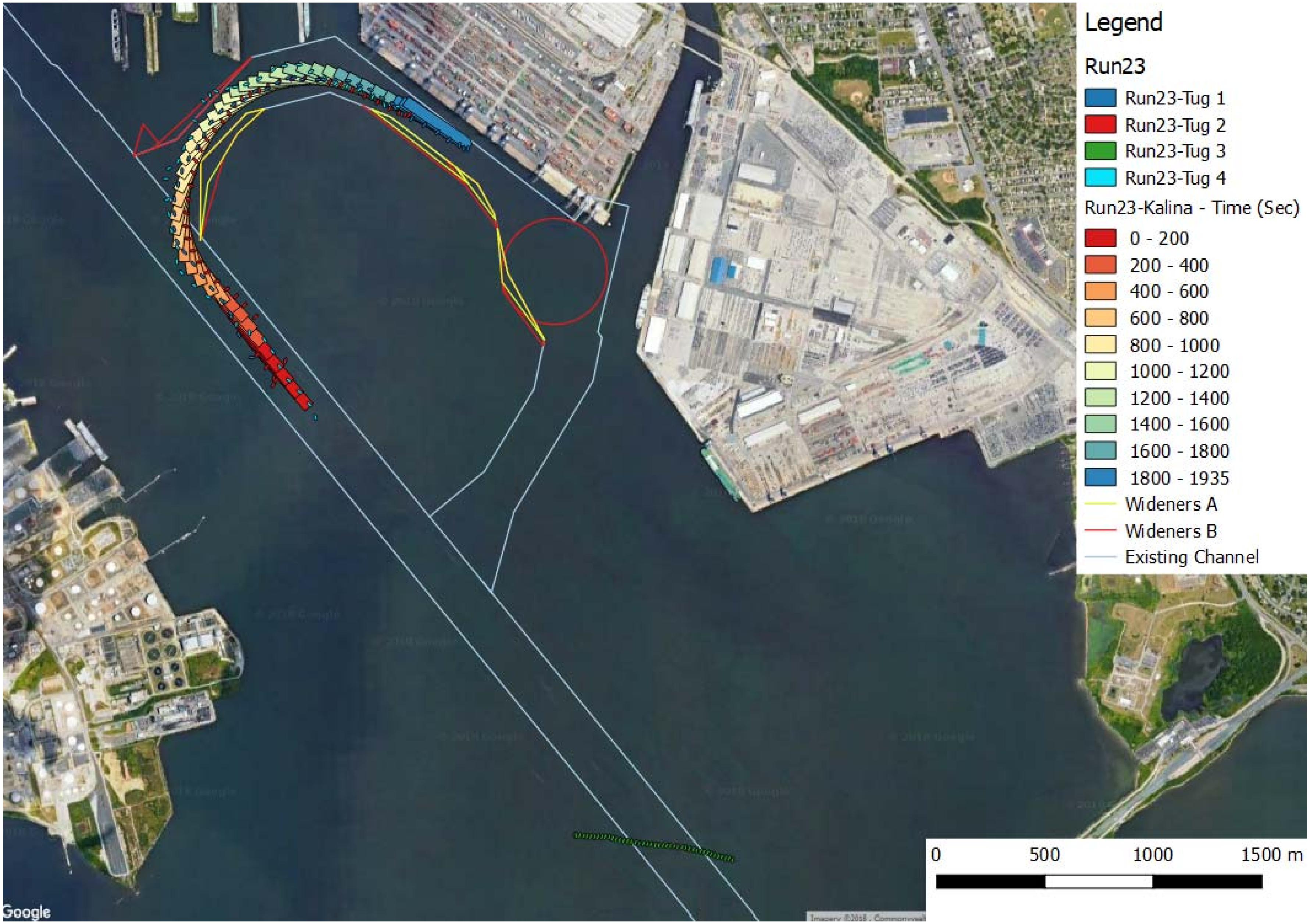


Figure 4-37: Run 23 – Overall view

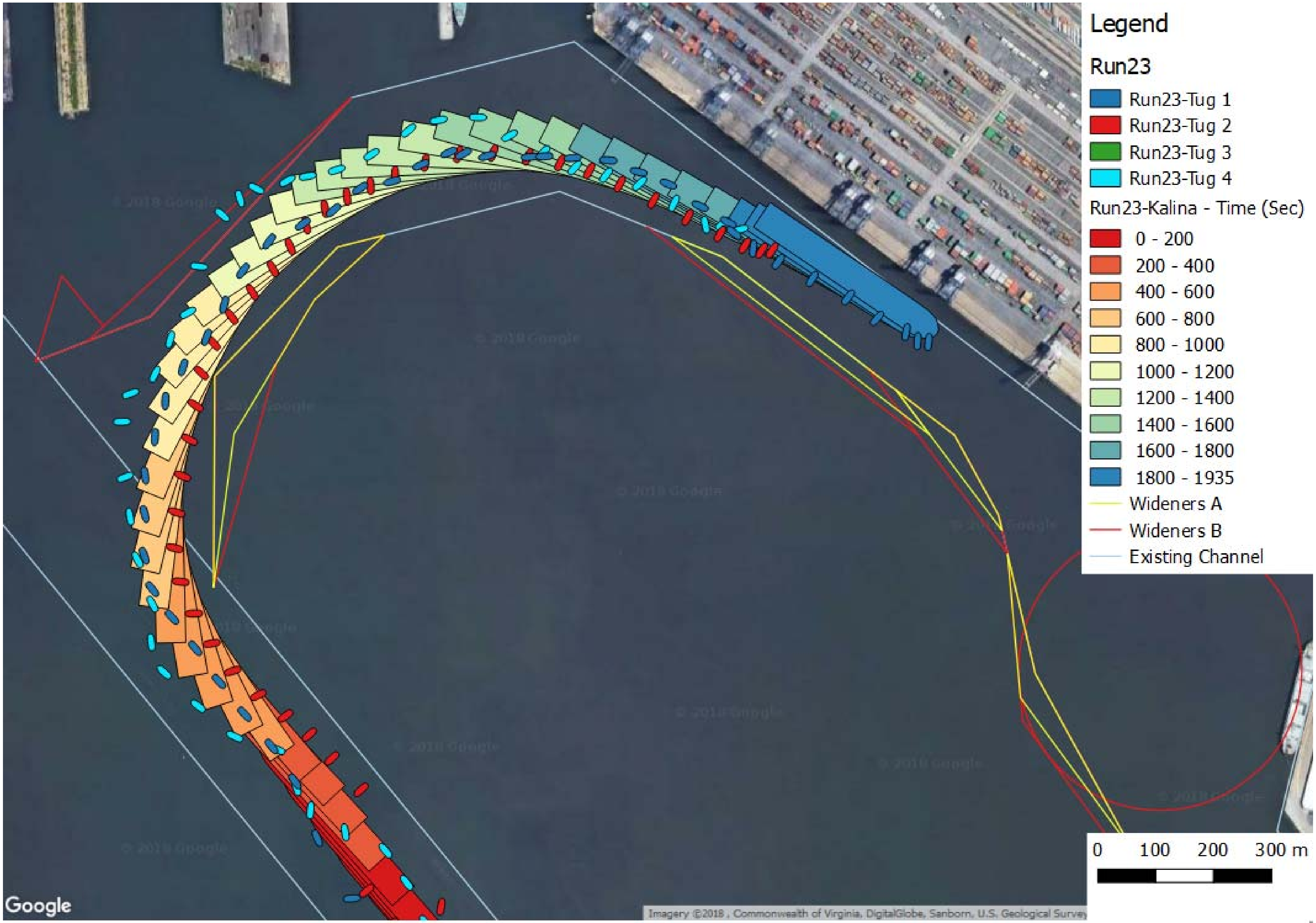


Figure 4-38: Run 23 – Zoomed in view

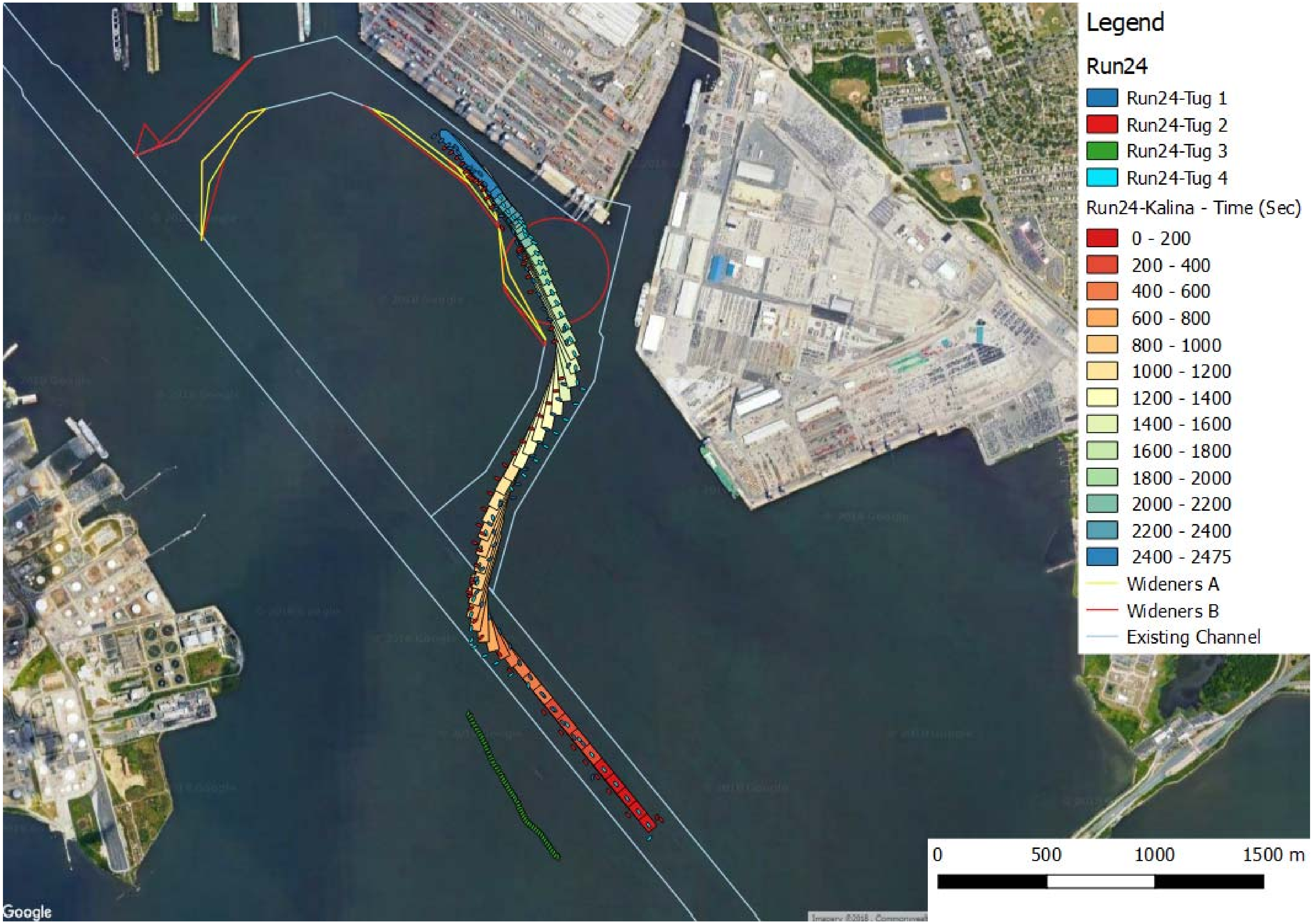


Figure 4-39: Run 24 – Overall view

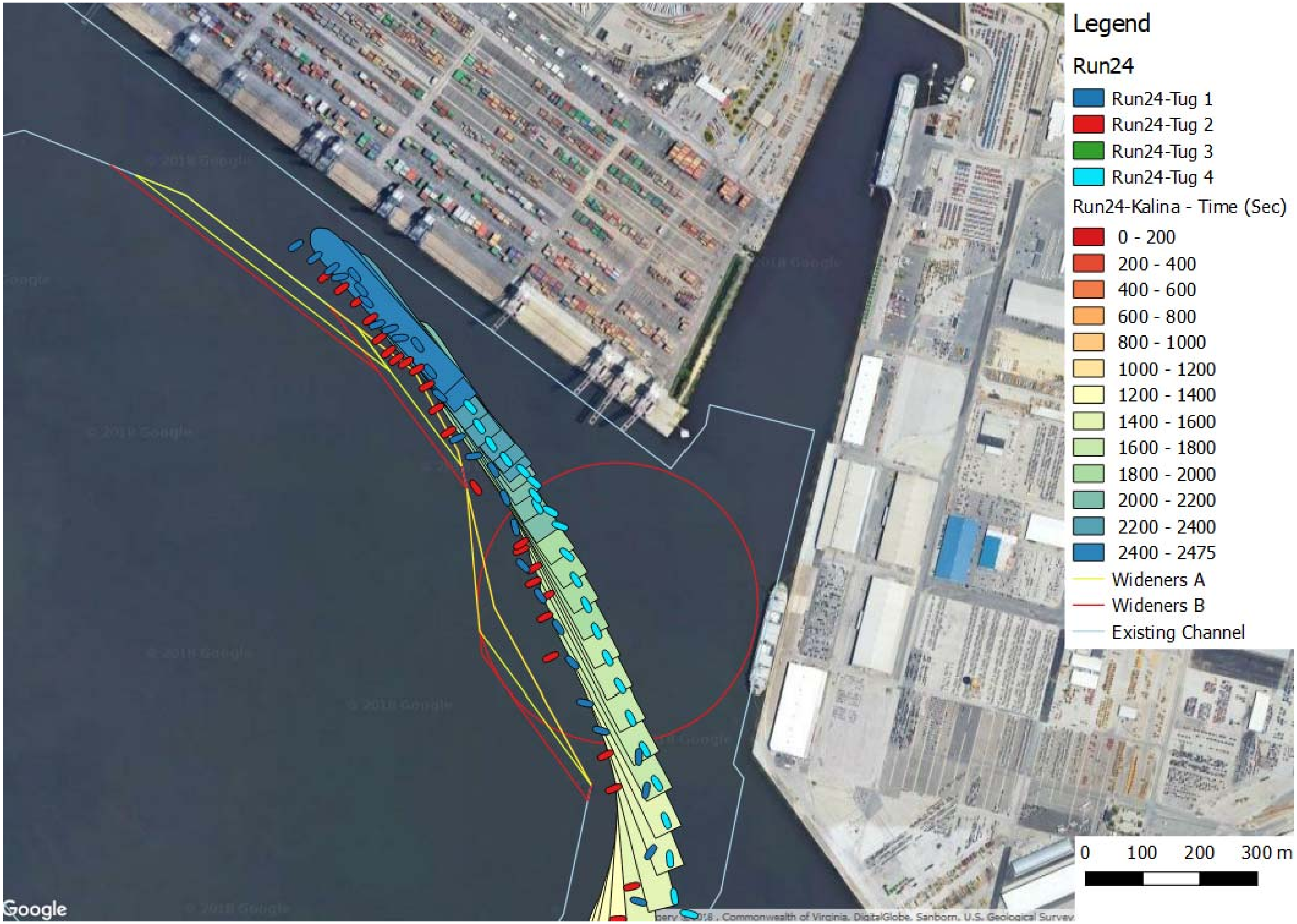


Figure 4-40: Run 24 – Zoomed in view

Figure 4-41: Run 25 – Overall view

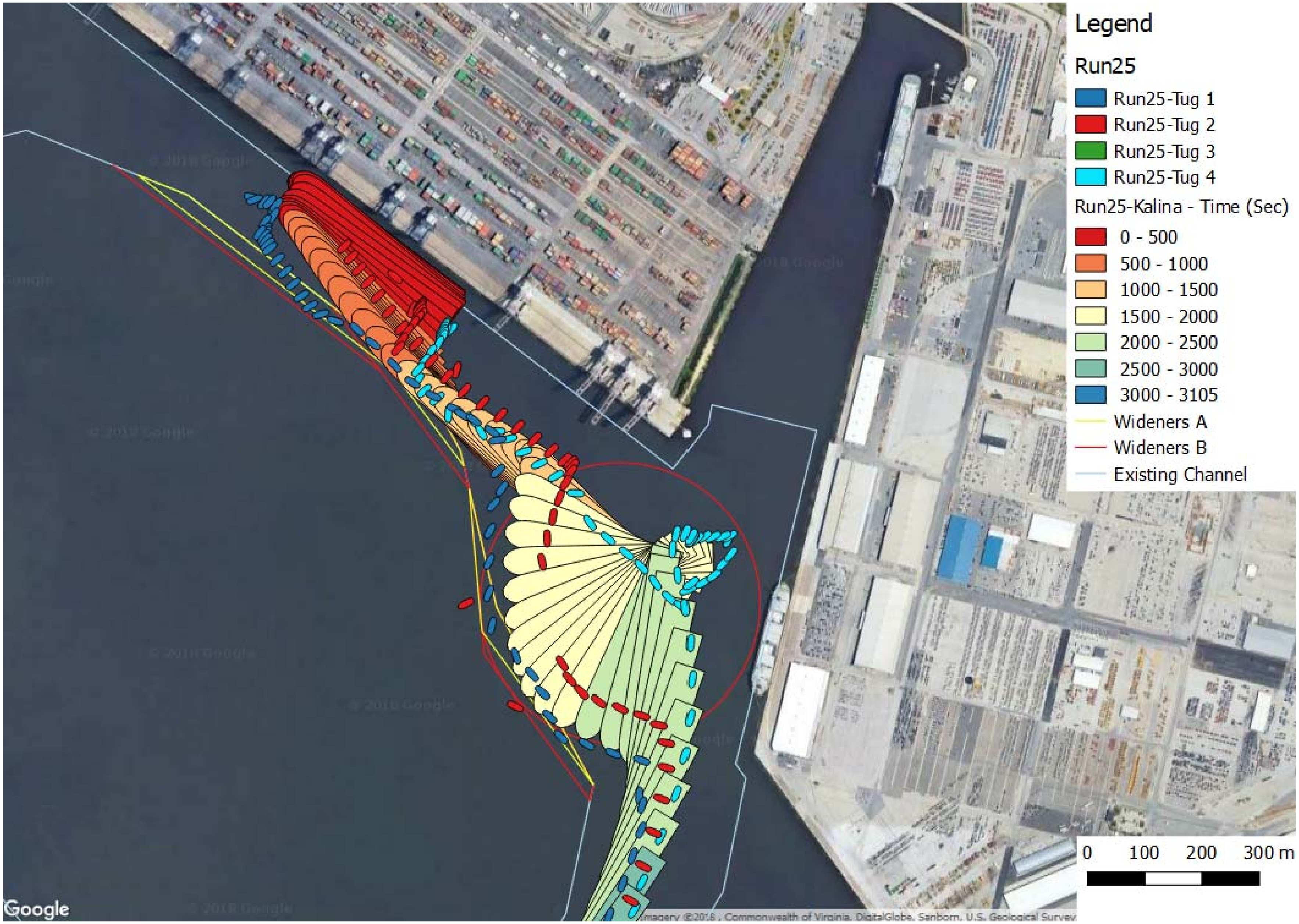


Figure 4-42: Run 25 – Zoomed in view

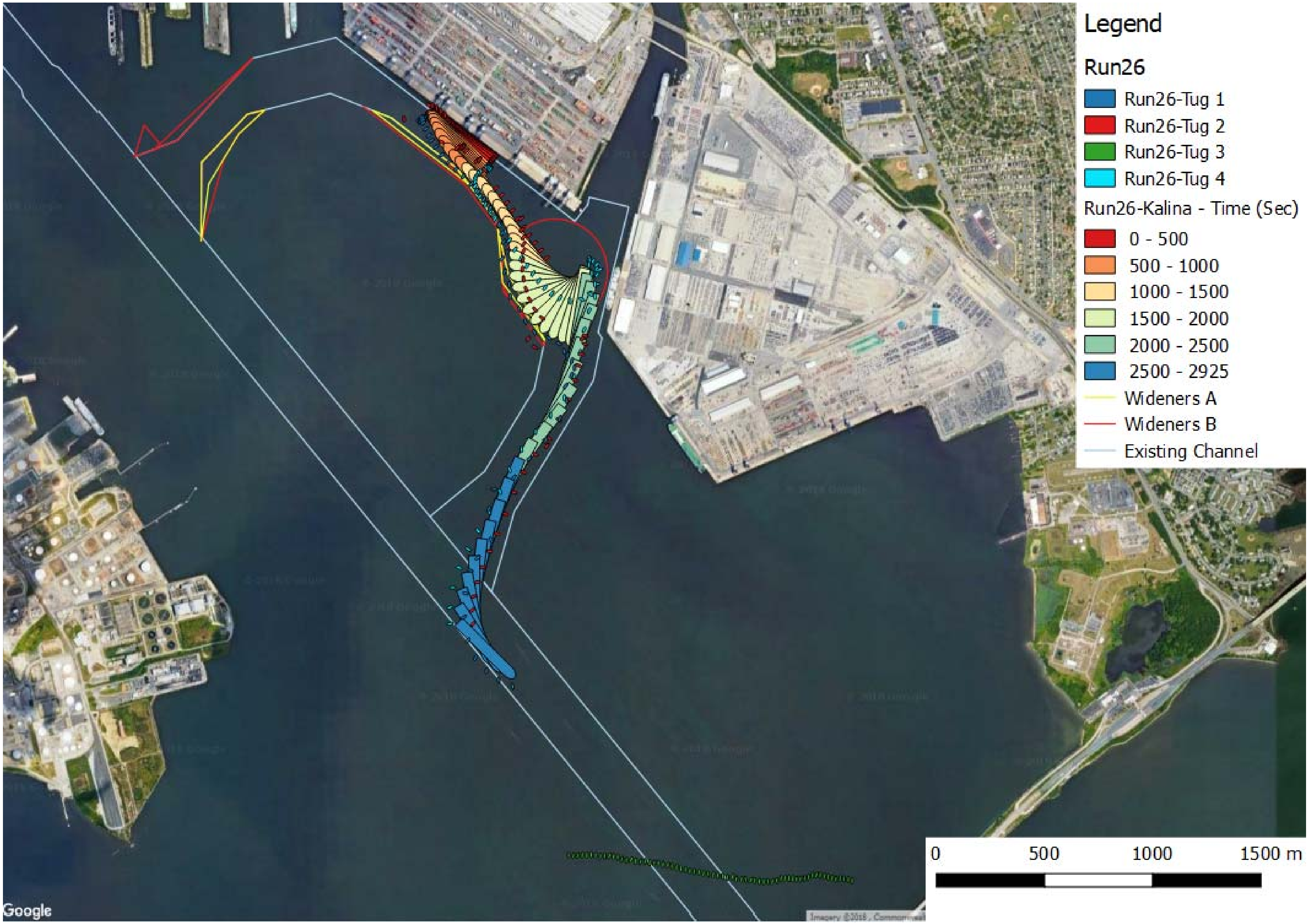


Figure 4-43: Run 26 – Overall view

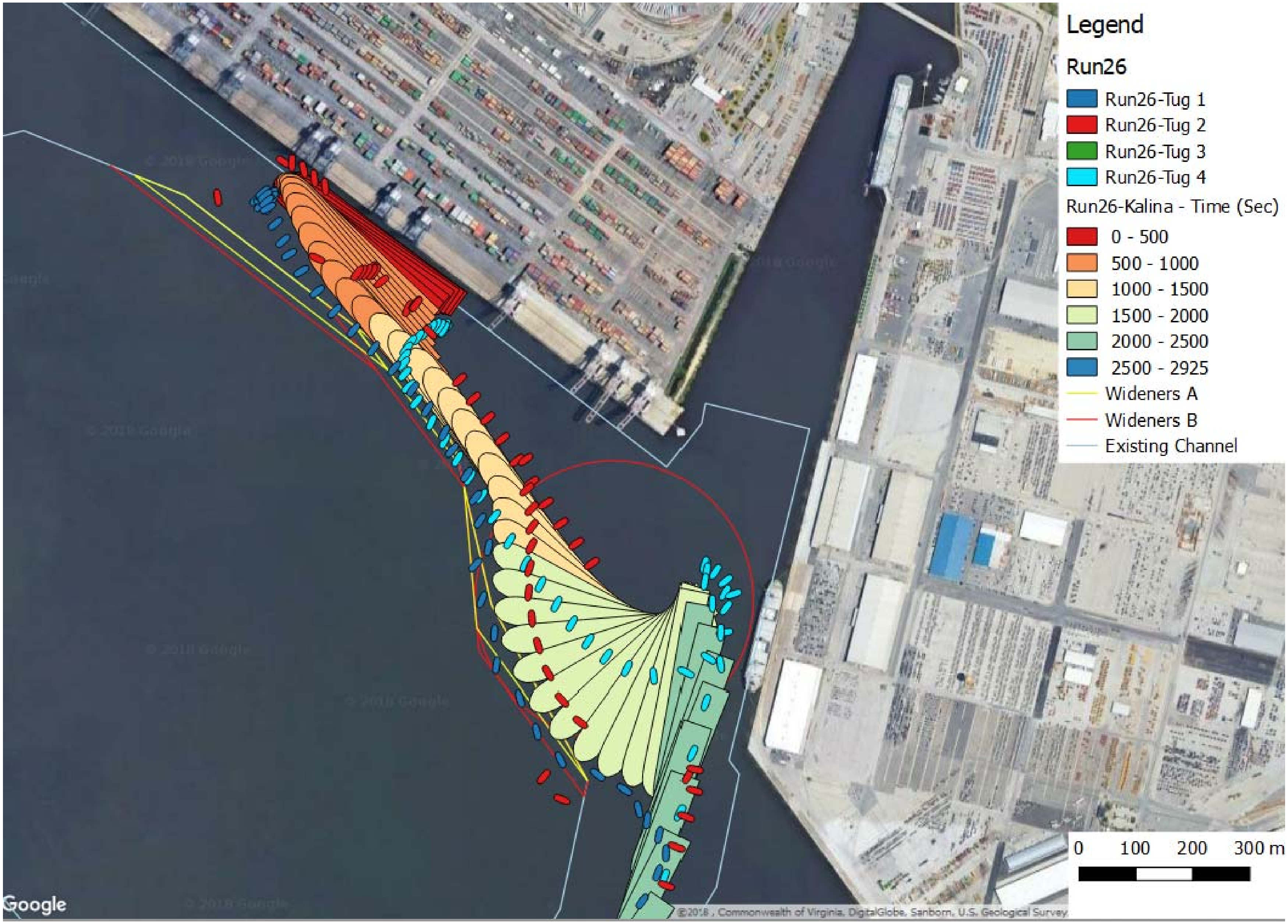


Figure 4-44: Run 26 – Zoomed in view

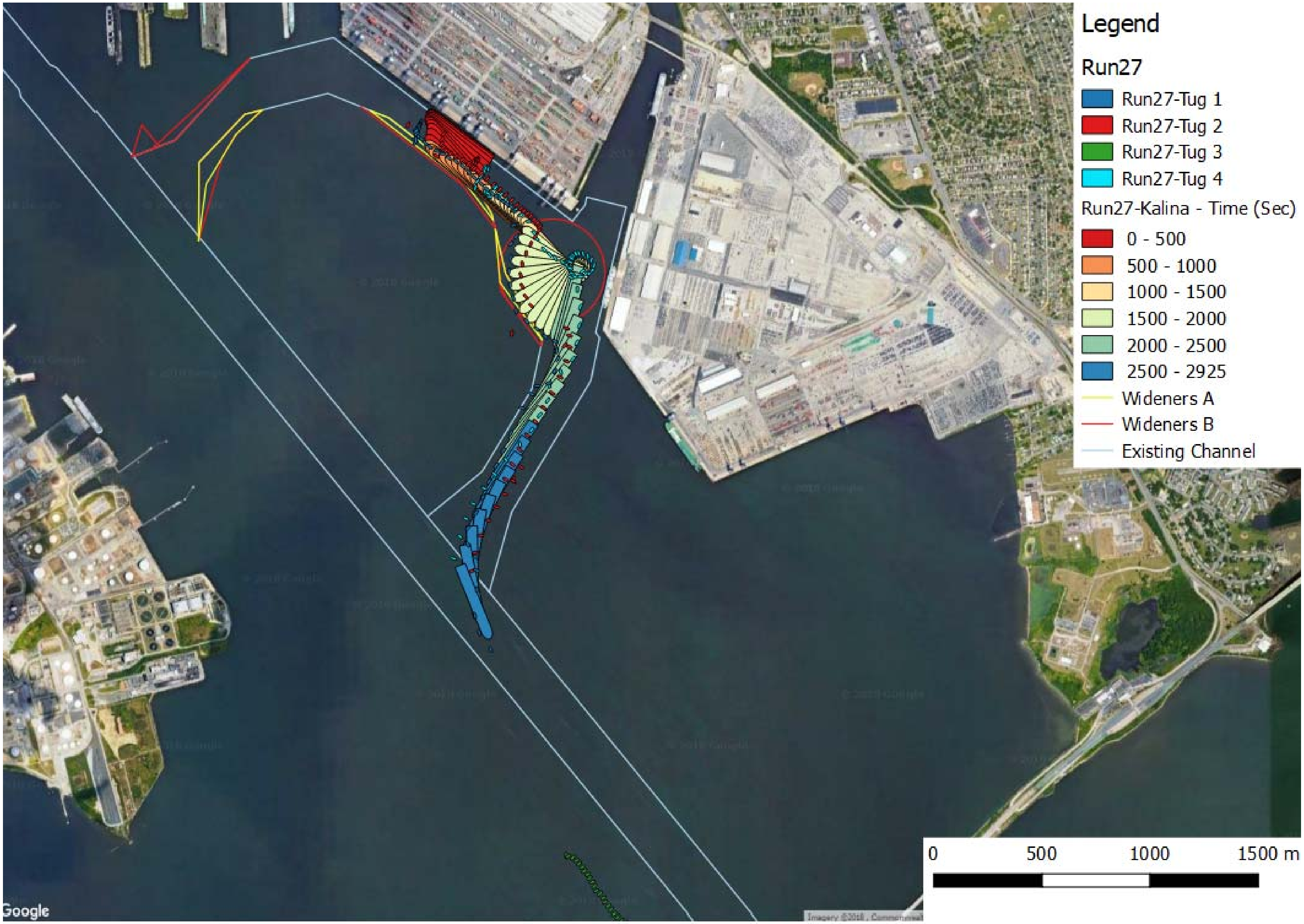


Figure 4-45: Run 27 – Overall view

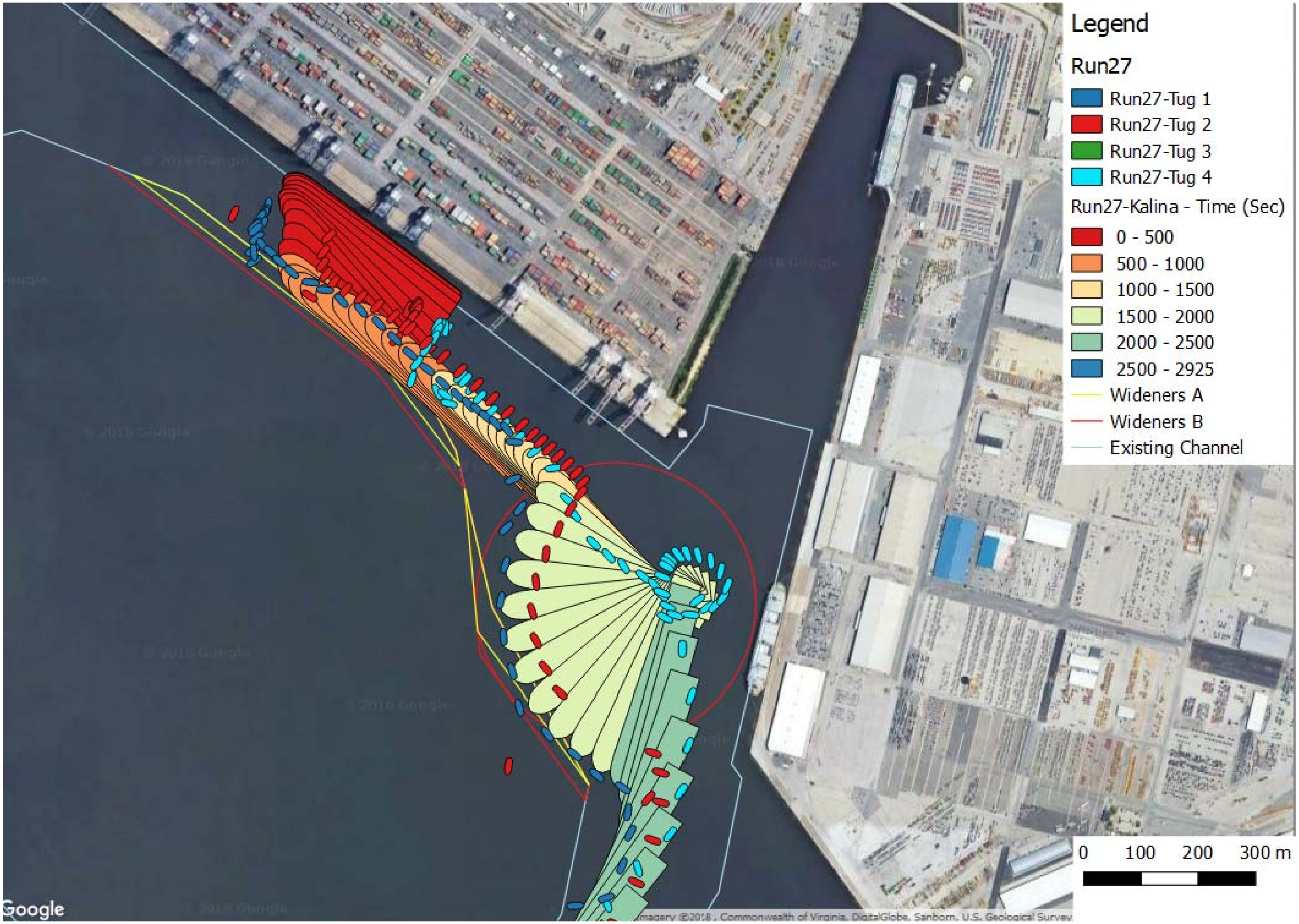


Figure 4-46: Run 27 – Zoomed in view

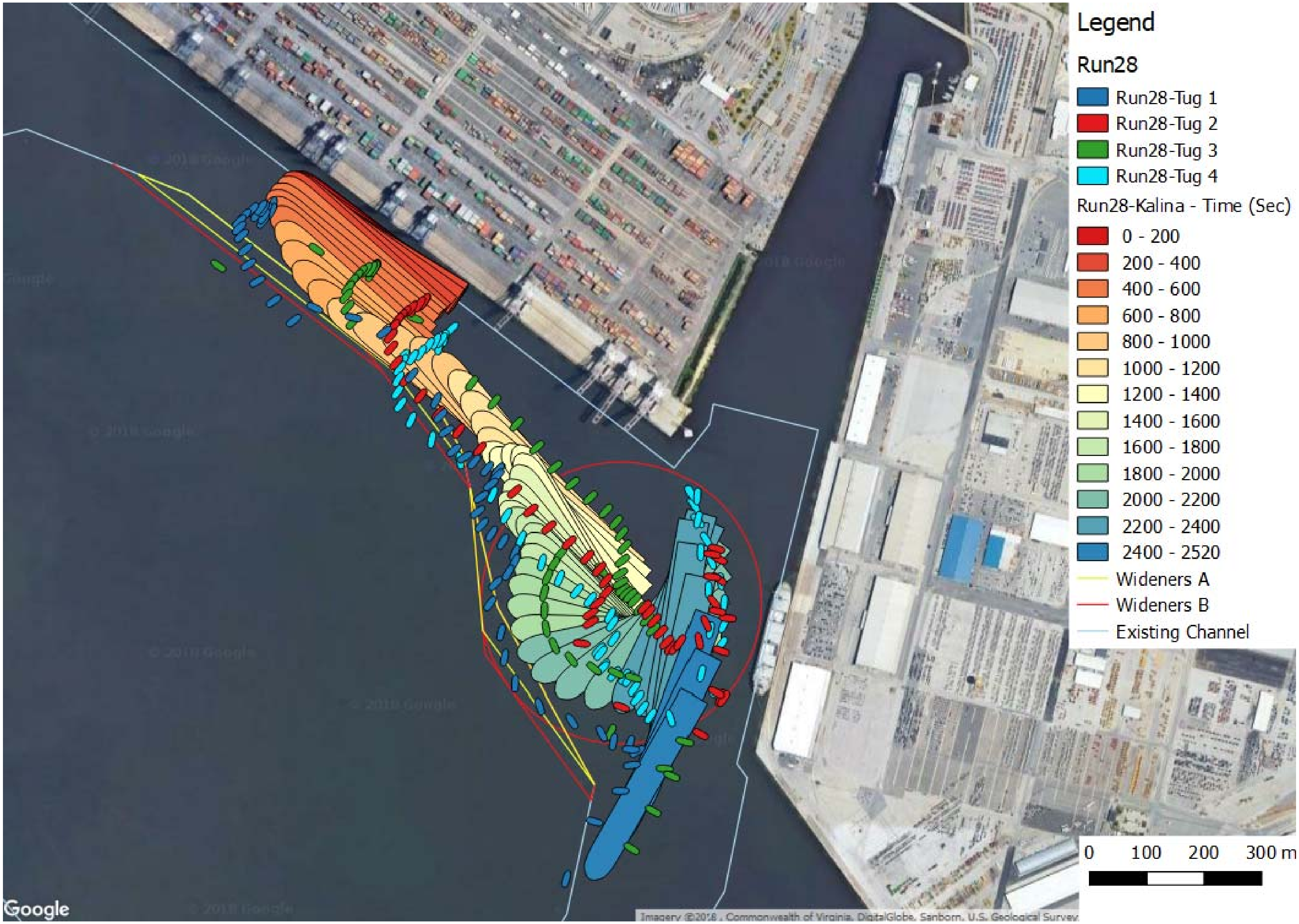


Figure 4-47: Run 28 – Zoomed in view

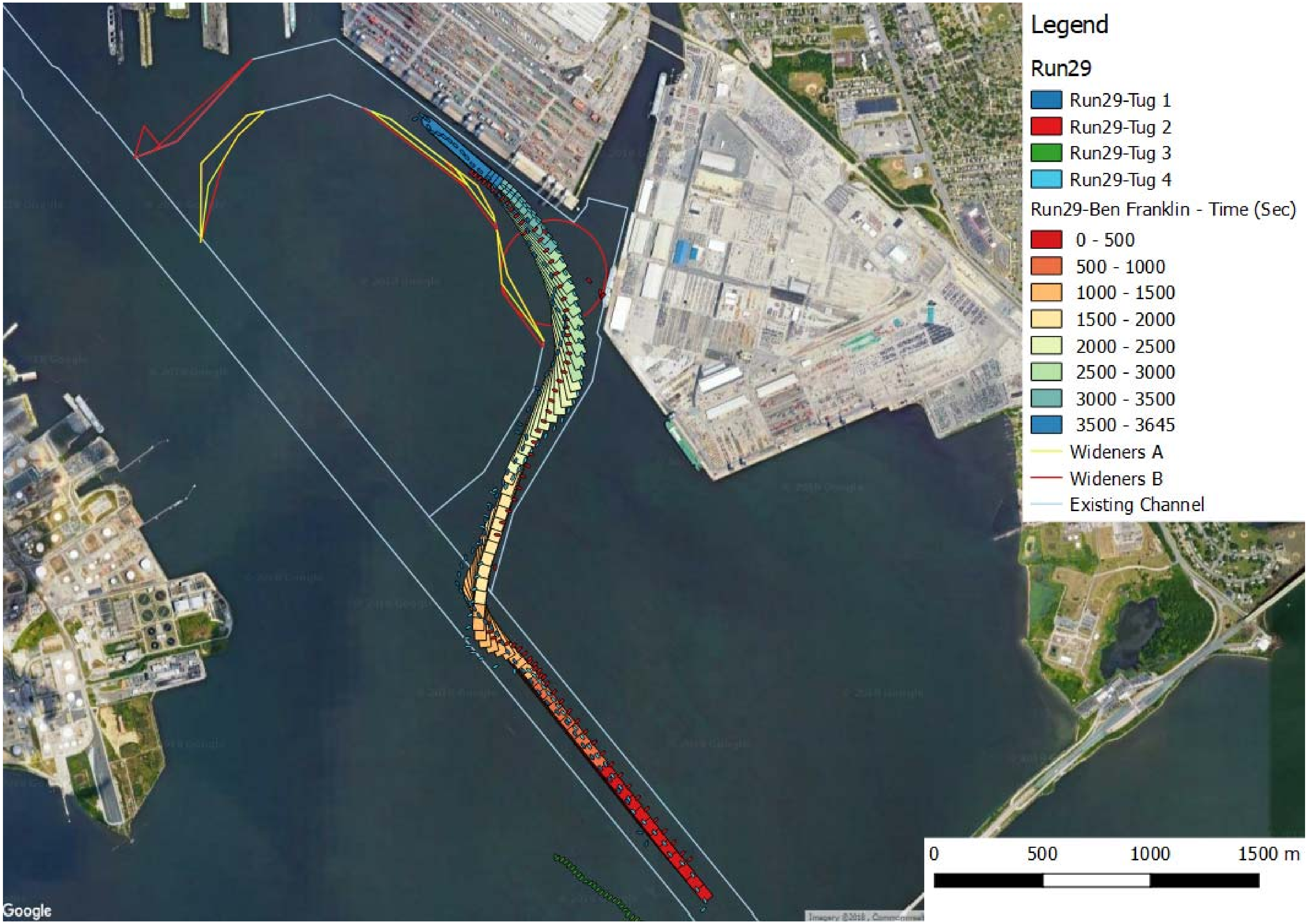


Figure 4-48: Run 29 – Overall view

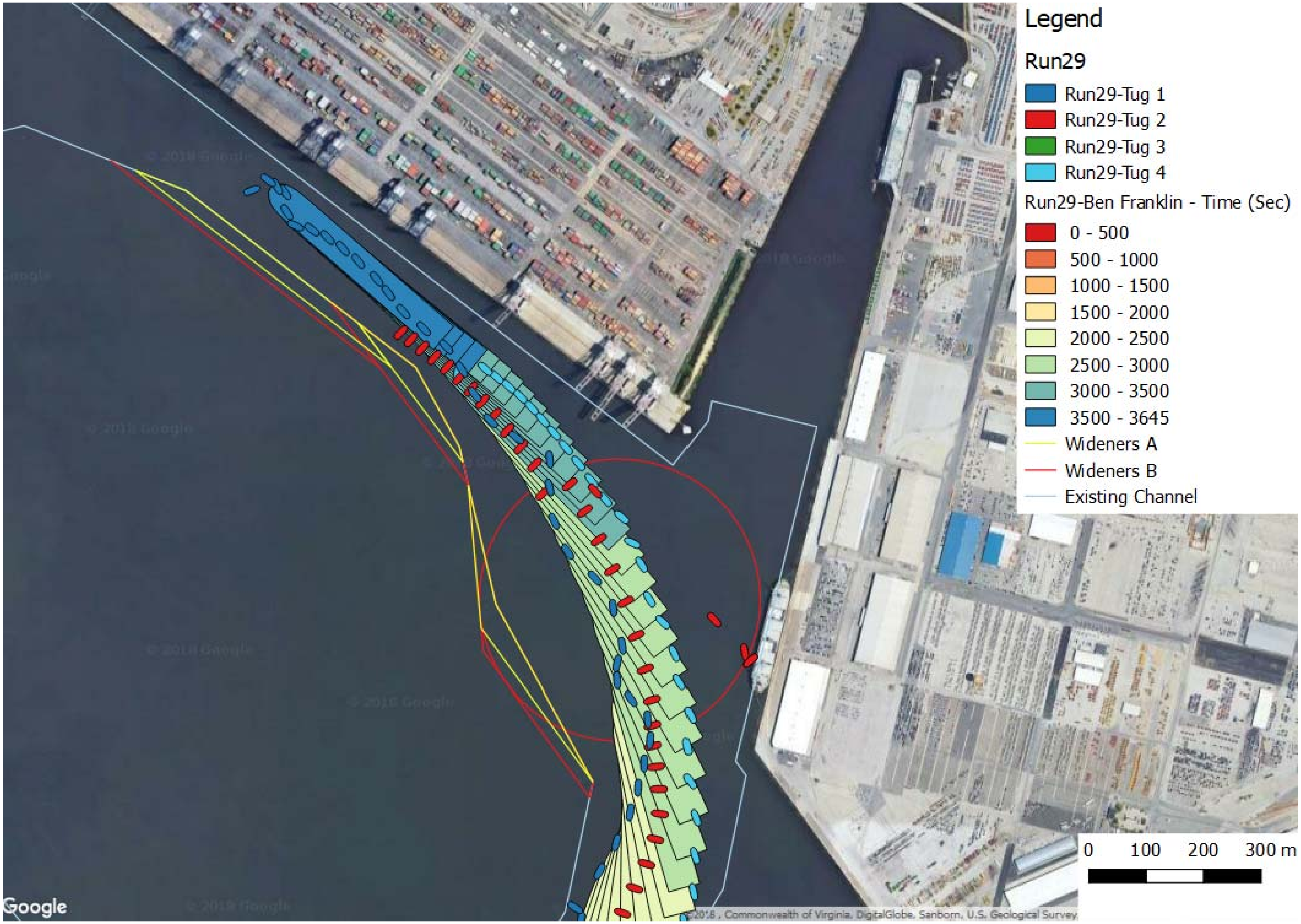


Figure 4-49: Run 29 – Zoomed in view

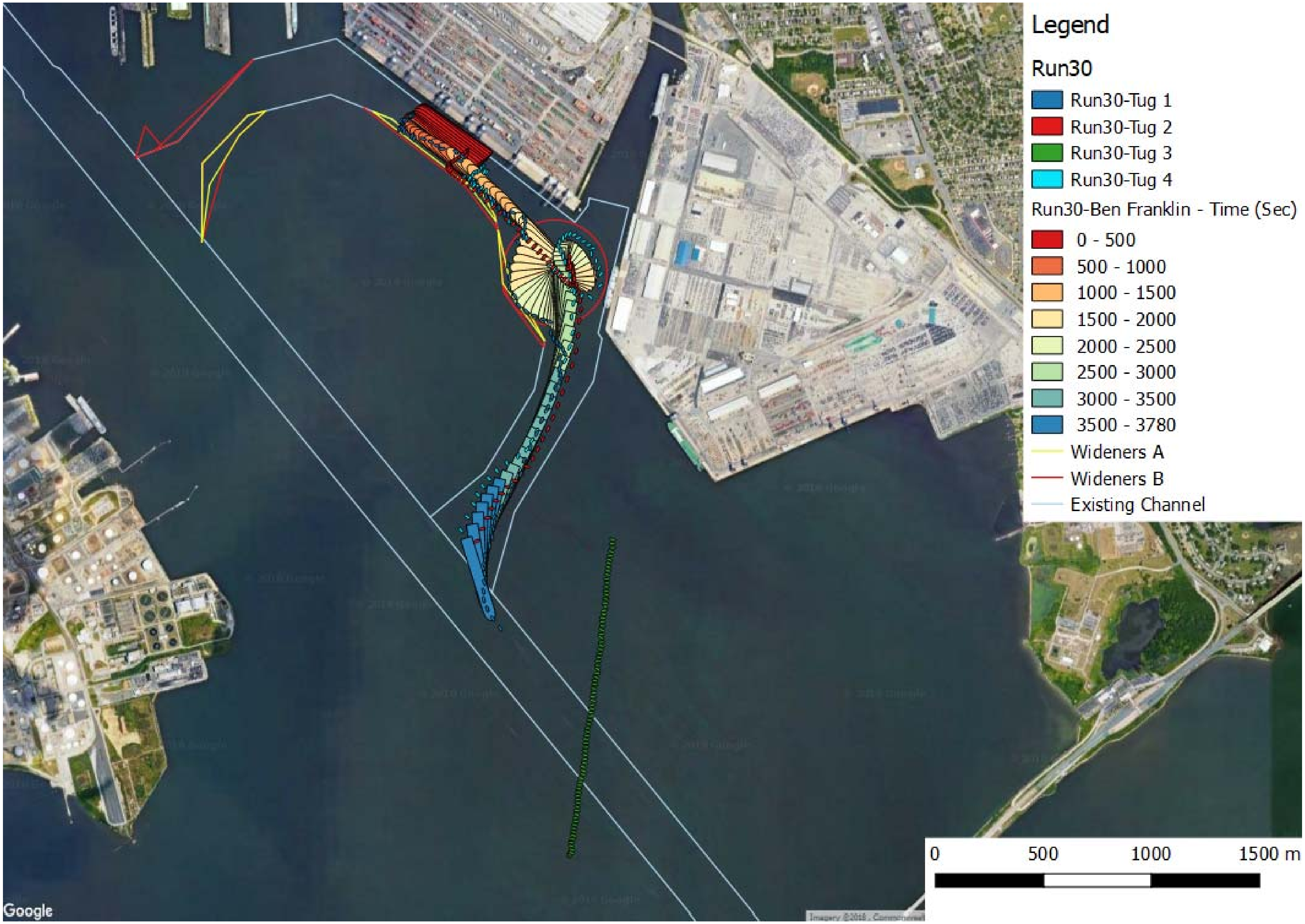


Figure 4-50: Run 30 – Overall view

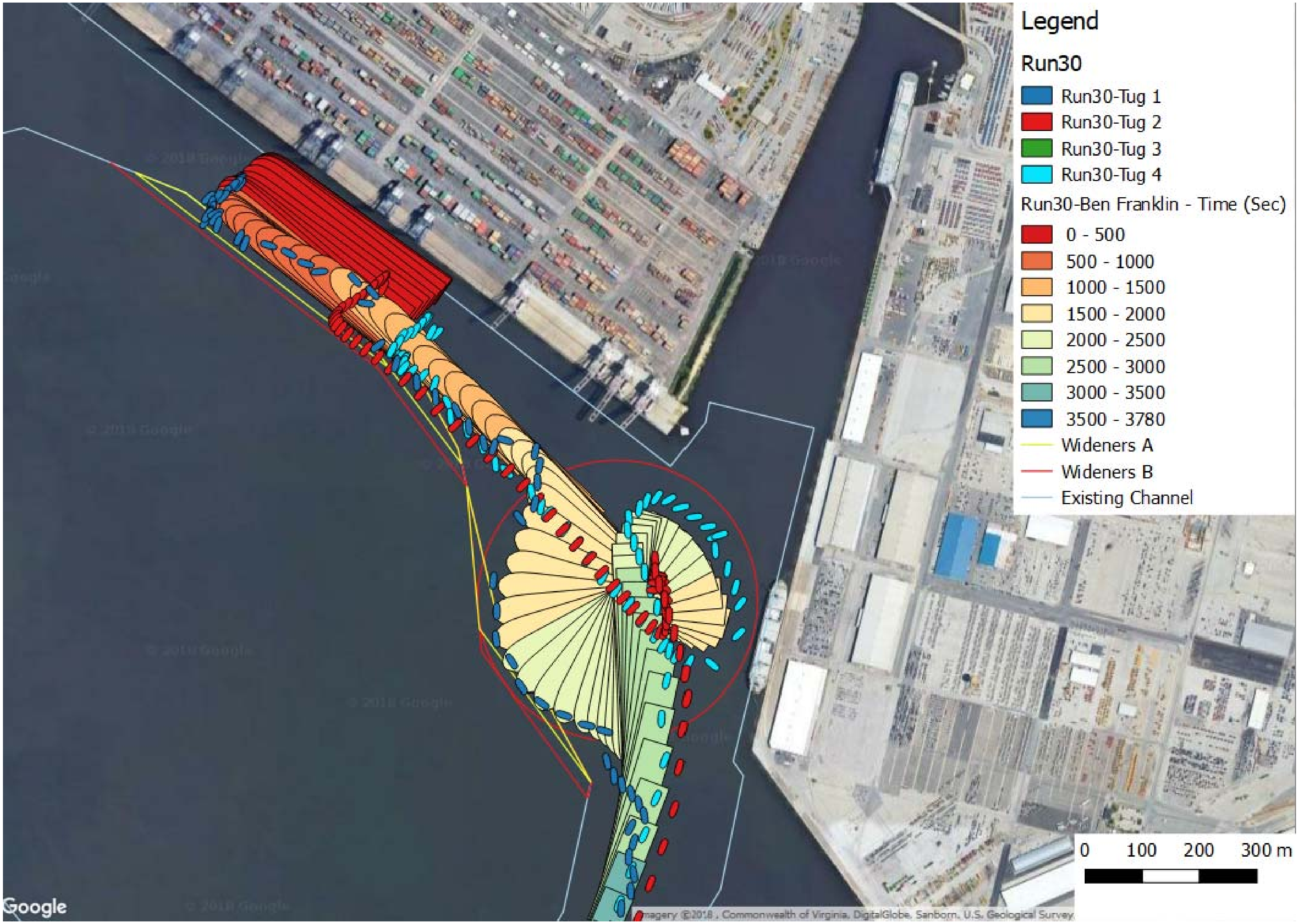


Figure 4-51: Run 30 – Zoomed in view

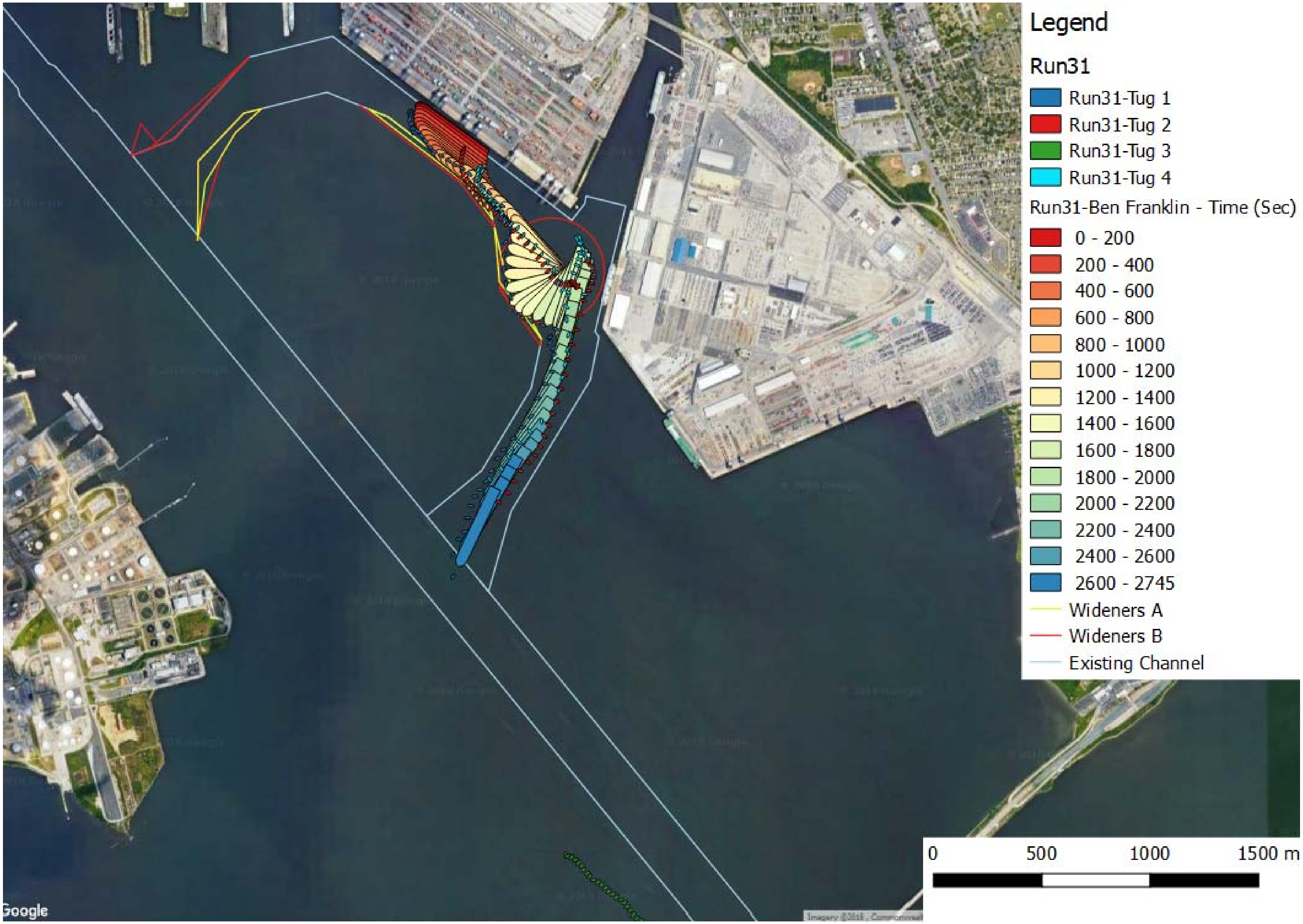


Figure 4-52: Run 31 – Overall view

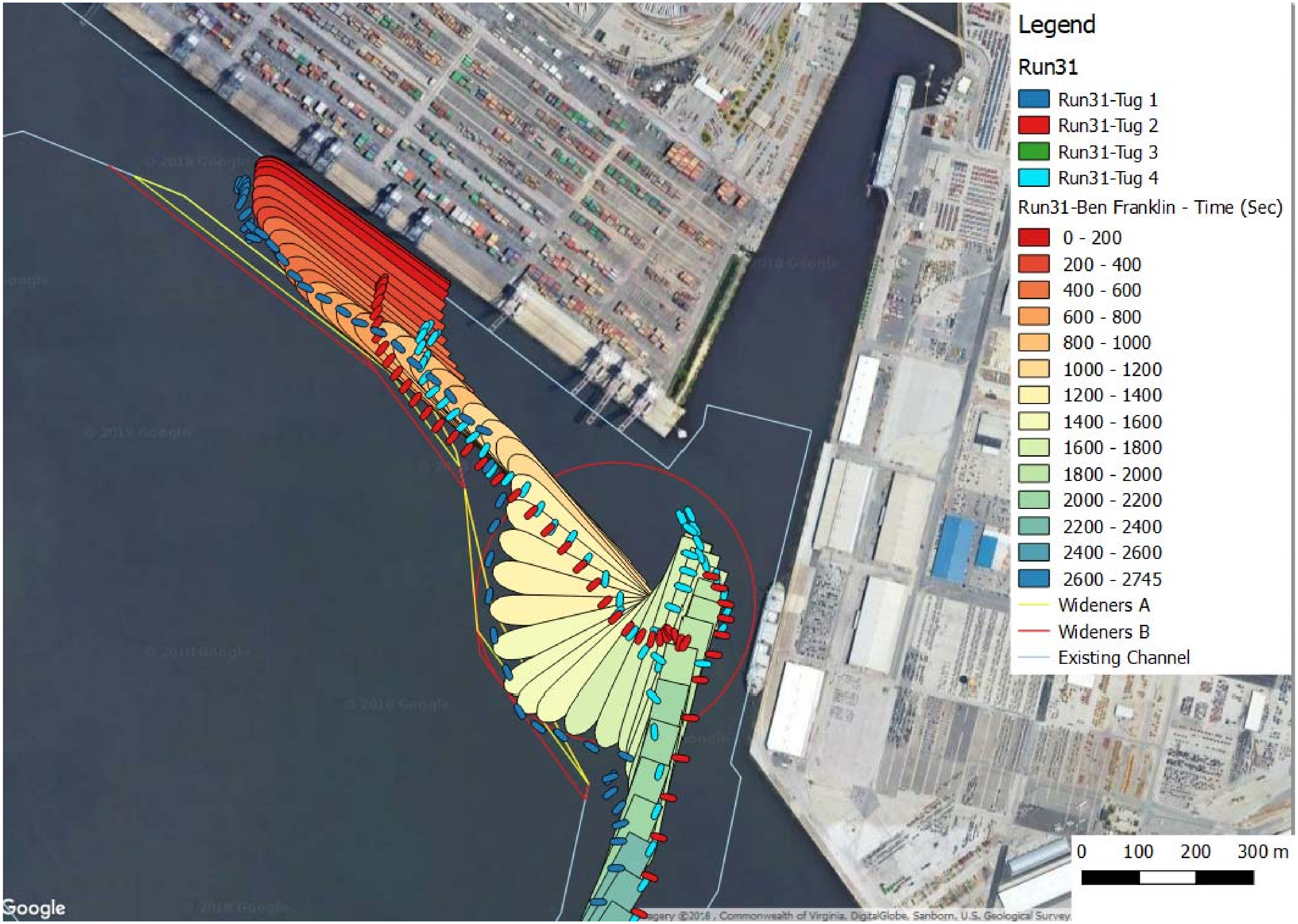


Figure 4-53: Run 31 – Zoomed in view

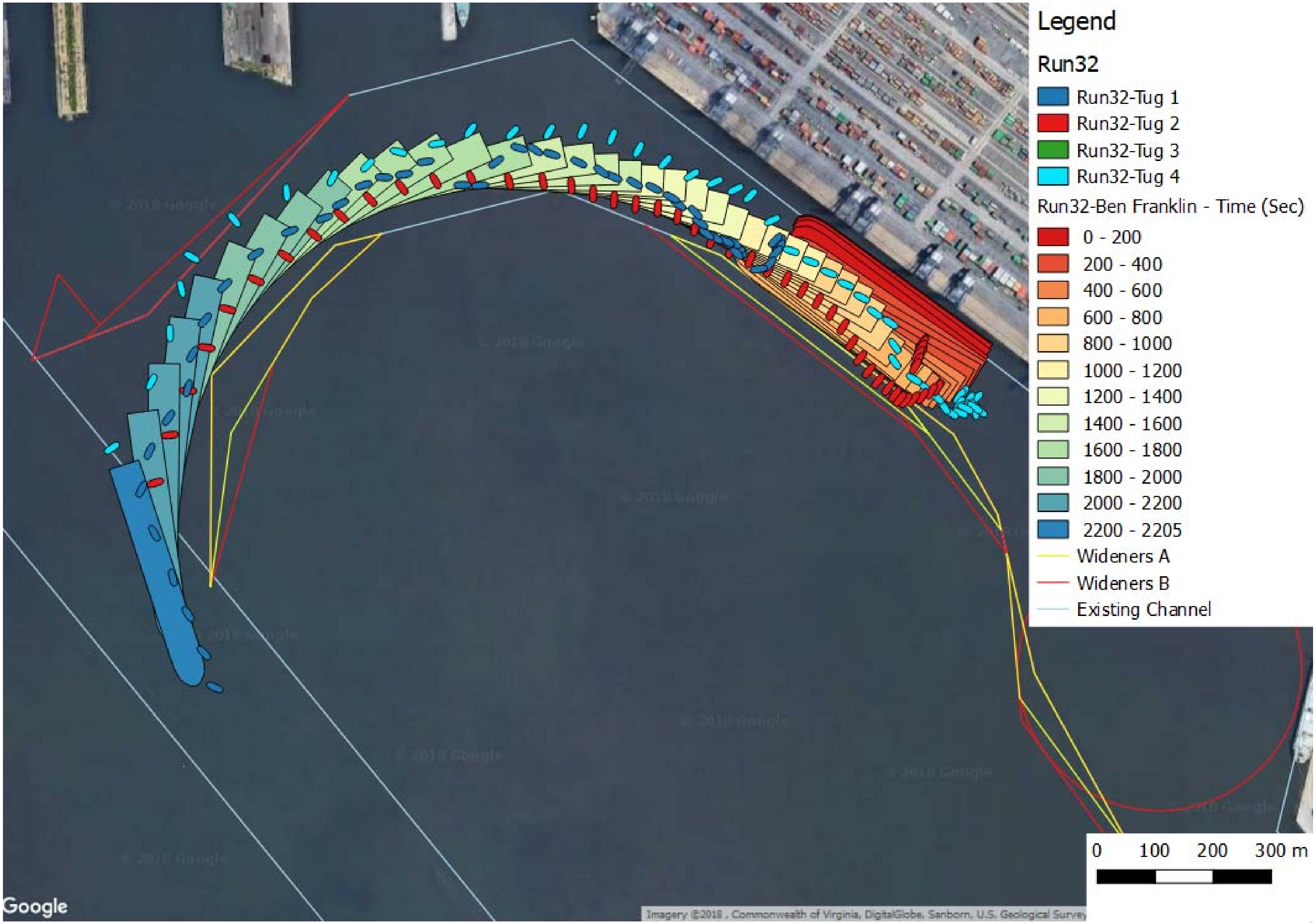


Figure 4-54: Run 32 – Zoomed in view

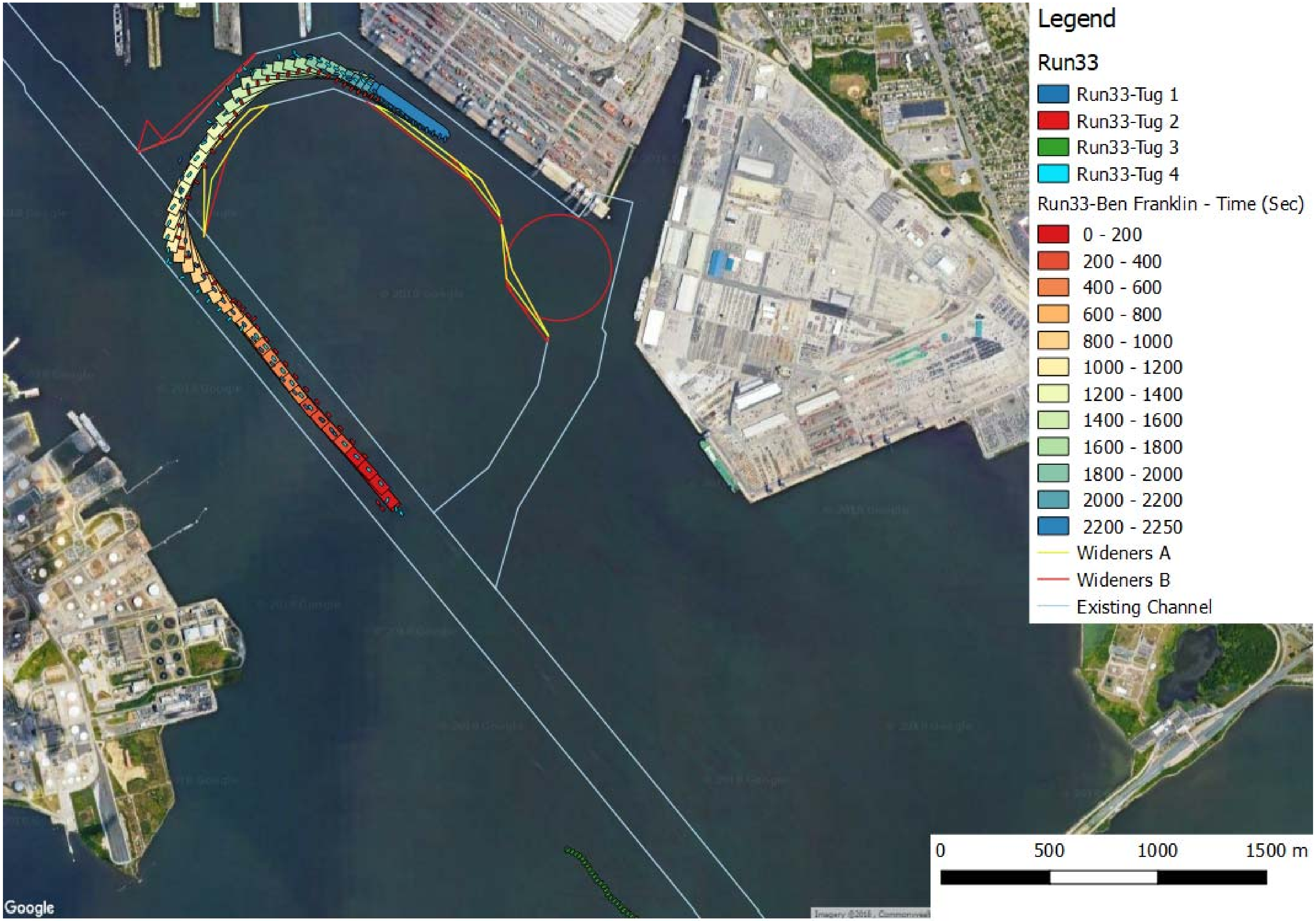


Figure 4-55: Run 33 – Overall view

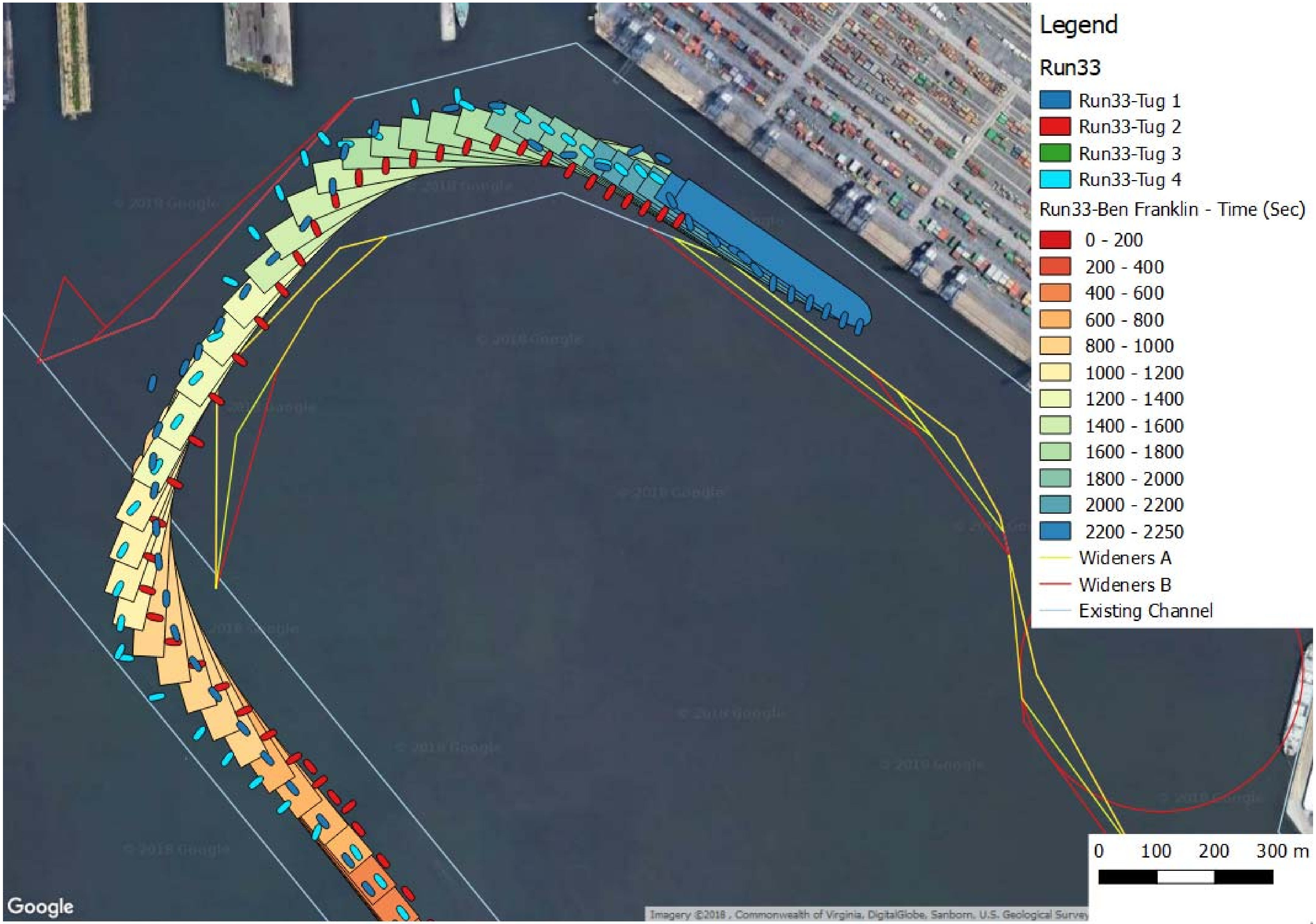


Figure 4-56: Run 33 – Zoomed in view

Figure 4-57: Run 34 – Zoomed in view

4.2 POWER RESOURCES ANALYSIS

Table 4-3 shows the maximum power order used and the duration it was used for each tug, ship's engine order, and bow power order. To fully understand the reserve power capacity, all three variables need to be analyzed together. The column titled "Power Used Simultaneously?" contains four sub-columns. The first sub-column addresses if all three power sources (tugs, ship's engine, and bow thruster) were used simultaneously at maximum power of each. The second and third sub-columns describe if all three tugs and/or four tugs were used at the same time respectively. The adjacent sub-column lists the duration that this occurred if this event occurred. If the duration occurred longer than 2 minutes, the value is highlighted in blue. All power sources (all tugs, ship's engine, and bow thrusters) were never used at 100%. In most runs, there was sufficiently more reserve power than that. All runs only used 3 tugs with the exception of Run 28 where all 4 tugs were used but not at 100% bollard pull at the same time. In several of the runs, three tugs were operated at 100% of their bollard pull or higher at the same time leaving no reserve tug power. When this occurred for longer than 2 minutes, the value is highlighted in blue. This only occurred in Runs 12, 16, and Run 24.

The next columns list each tug individually and shows the maximum amount of bollard pull used in each run and the longest continuous duration that it was used at 100%. If the tug never reached 100%, no duration is provided. Values highlighted in blue indicate values that are 2 minutes or longer. This value was selected by the tug master who stated using a tug's full engine for 2 minutes or less is not problematic. After this 2-minute range, tug masters will ask the pilot to decrease their power usage in order to avoid overheating their engines. Tug 1 and 4 were operated as live tugs by local tug masters. The tugs used as live tugs in the simulations had a bollard pull of 75 t; because this value is higher than the 60 t available in the harbor, the tug masters were asked to limit their bollard pull to 60 t. So any value above 100% in the table for Tugs 1 and 4 represents more than 60 t bollard pull being used. It should also be noted the bollard pull values for Tugs 1 and 4 are a 30 second average. Tugs 2 and 3 were operated as Autotugs and were operated with 60 t and 40 t bollard pulls respectively.

The container ship's maximum engine order is listed. If it reached 100%, its duration is also listed. Positive engine orders indicate the ship is moving ahead while negative engine orders indicate the ship is moving astern. The ship's engine was never used at 100%. 70% was the maximum engine power used in any of the runs.

The last columns describe the ship's bow thruster orders. Positive orders indicate the thruster was used on the starboard side and negative indicate thruster use on the port side. Bow thrusters are designed to be used extensively during berthing. Therefore they can be used for a longer duration at maximum power than the tugs' or ship's engines. Any thruster use lasting longer than 15 minutes is highlighted in blue. This did not occur in any of the runs.

Plots for each run showing each tug's maximum bollard pull as a percentage, the percent of engine used, and the percent of bow thruster used as each varies in time is available in Appendix B.

Table 4-2: Reserve power analysis

Run	Ship	Power Used Simultaneously?				Tug 1 Percent of Bollard Pull Used (60t)		Tug 2 Percent of Bollard Pull Used (60t)		Tug 3 Percent of Bollard Pull Used (40t)		Tug 4 Percent of Bollard Pull Used (60t)		Ship's Engine Power Order		Ship's Bow Thruster Power Order	
		All Sources?	3 Tugs?	4 Tugs?	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)
1	Kalina	No	No	No	--	117	200	89	--	100	400	--	--	40	--	100	89
2	Kalina	No	No	No	--	86	--	100	148	0	--	86	--	40	--	100	164
3	Kalina	No	No	No	--	93	--	100	330	0	--	112	119	40	--	100	629
4	Kalina	No	No	No	--	104	28	100	477	--	--	114	84	40	--	100	484
5	Kalina	No	Yes	No	40	110	128	100	521	--	--	106	135	40	--	100	515
6	Kalina	No	No	No	--	8	--	100	212	0	--	0	--	60	--	100	126
7	Kalina	No	Yes	No	7	115	106	100	238	0	--	116	78	40	--	100	251
8	Kalina	No	No	No	--	125	599	100	589	--	--	132	160	70	--	100	495
9	Kalina	No	Yes	No	48	119	90	100	636	--	--	131	79	40	--	100	155
10	Kalina	No	No	--	--	66	--	5	--	--	--	92	--	40	--	100	104
11	Kalina	No	Yes	No	116	116	36	100	210	0	--	144	253	50	--	100	132
12	Kalina	No	Yes	--	141	134	172	100	278	--	--	108	142	70	--	100	219
13	Kalina	No	No	No	--	133	104	100	139	--	--	130	181	60	--	100	214
14	Kalina	No	Yes	No	118	139	413	100	402	0	--	133	161	60	--	100	232
15	Kalina	No	Yes	--	82	135	82	100	362	--	--	126	143	40	--	100	480
16	Kalina	No	Yes	No	130	155	716	100	269	--	--	115	264	40	--	99	--
17	Ben Franklin	No	No	No	--	107	37	100	81	0	--	86	--	40	--	100	247
18	Ben Franklin	No	Yes	No	40	137	30	100	436	--	--	119	327	40	--	100	463
19	Ben Franklin	No	Yes	No	62	146	240	100	438	--	--	154	331	60	--	100	704
20	Ben Franklin	No	No	No	--	25	--	100	207	--	--	125	32	60	--	100	114

Run	Ship	Power Used Simultaneously?				Tug 1 Percent of Bollard Pull Used (60t)		Tug 2 Percent of Bollard Pull Used (60t)		Tug 3 Percent of Bollard Pull Used (40t)		Tug 4 Percent of Bollard Pull Used (60t)		Ship's Engine Power Order		Ship's Bow Thruster Power Order	
		All Sources?	3 Tugs?	4 Tugs?	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)
21	Ben Franklin	No	Yes	No	20	116	27	100	379	--	--	154	126	60	--	100	324
22	Ben Franklin	No	Yes	No	44	128	41	100	427	--	--	131	324	60	--	99	
23	Kalina	No	No	No	--	57	--	100	178	--	--	162	86	70	--	99	88
24	Kalina	No	Yes	No	176	122	183	100	373	--	--	137	325	40	--	100	194
25	Kalina	No	No	No	--	0	--	100	378	--	--	136	191	70	--	100	558
26	Kalina	No	No	No	--	137	299	100	344	--	--	161	546	70	--	100	468
27	Kalina	No	No	Yes	33	119	275	100	472	--	--	124	158	50	--	100	327
28	Kalina	No	Yes	No	30	123	385	100	237	100	287	2	0	60	--	100	577
29	Ben Franklin	No	No	No	--	73	--	100	329	--	--	123	227	60	--	100	500
30	Ben Franklin	No	No	No	--	100	5	100	390	--	--	108	101	60	--	100	582
31	Ben Franklin	No	Yes	No	109	121	107	100	272	--	--	136	305	70	--	100	587
32	Ben Franklin	No	Yes	No	57	114	127	100	131	--	--	133	221	60	--	100	614
33	Ben Franklin	No	No	No	--	97	--	100	255	--	--	115	74	60	--	100	144
34	Ben Franklin	No	Yes	No	93	122	108	100	127	0	--	130	272	40	--	100	385

4.3 PILOT AND TUG MASTER EVALUTATIONS

4.3.1 PILOT EVALUATIONS

After each run, the pilots filled out an individual run questionnaire. A summary of the evaluation is presented in Table 4-3 while the full comments are shown in Table 4-4. One column ranks tug configuration and reserve capacity on a scale of 1 to 10 with 10 being equivalent to most adequate. The overall difficulty was also assessed on a scale of 1 to 10 with 10 being the most difficult. The last column of the table shows the overall safety ranking. This value is also on a 1 to 10 scale with 10 being the safest scenario possible. Both the river and docking pilots completed the surveys.

The average tug configuration and reserve capacity was 5.7 (10 = most adequate). The average overall difficulty was 7.0 (10 = most difficult), and the average safety ranking was 5.4 (10 = most safe).

Table 4-3: Pilot ratings

Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety
1	8	5	5	**11**	--	8	10	**21**	5	8	3	**31**	5	7	6
2	9	7.5	7	**12**	6	7.5	5.5	**22**	8	8	7	**32**	4.5	4.5	5.5
3	5	5	--	**13**	10	10	10	**23**	7	7	7	**33**	5.5	6	5
4	4.5	9	3.5	**14**	7	5	5.5	**24**	5	--	5	**34**	5.5	5.5	5
5	4	8	5	**15**	7	7	5	**25**	5	7	4				
6	--	--	--	**16**	3	7	6	**26**	--	--	--				
7	5	5	5	**17**	5	7	5	**27**	5	8	4				
8	10	--	10	**18**	4	8	5	**28**	--	--	--				
9	5	5	5	**19**	4	8	3	**29**	4	8	4				
10	--	--	--	**20**	3	9	5	**30**	7	6	6				

MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

Table 4-4: Pilot evaluation comments

Run	Captain	1.Successfully made transit	2. Average drift angle and minimum speed to offset environments	3. Successfully complete berthing/unberthing evolutions? If not, what were limiting factors?	4. Ship model react as expected with environment	5. Maintain acceptable distance from shoals and terminal	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
1	John Trout	Yes	NA	Yes	Yes	Yes		8		5	5	Experienced pilots only; minimum of 3 tugs (min 60 t)
2	Mike Flanagan	Yes	3-4 deg	Yes	Yes	I was on extreme edge of channel w/ safe distance off the vessel at berth 4	No	9	For 20 kts condition, 3 (60 t) tugs	7.5	7	Channel width off of berth 3 & 4
3	John Trout	Yes		Yes	Yes	Yes	Yes, after turning in the basin, push the stern further to NW to position vessel more to windward in the channel	5	6	5		
4	Mike Flanagan	Yes		Yes	Yes	Yes, but close to vessel at #4 and Dundalk 5 & 6 Berth		4.5	For 25 kts 3 (60 t) boots we working at max most of the tume	9	3.5	3 (60 t) boats & widened channels necessary
5	John Trout	Yes		Yes	Yes	Yes	somewhat - additional tug/power	4		8	5	experienced pilots
6		Yes	3 kts	Yes	Yes	Yes	Steer higher up on the green buoys off #4 berth due o the winds					
7	Mike Flanagan	Yes	3 deg	Yes	Yes	Yes with wideners in place	No	5		5	5	
8	Bruce Morse-Ellington	Yes	More than 1.5 and I was having trouble when backing by Berth 4	Yes	Yes	Yes	No	10			10	
9	Mike Flanagan	Yes	NA	Yes	Yes	Used all widener on red side of channel	Hold vessel more centerline of channel (west access)	5		5	5	
10	Bruce Morse-Ellington	Sim failure										

Run	Captain	1.Successfully made transit	2. Average drift angle and minimum speed to offset environments	3. Successfully complete berthing/unberthing evolutions? If not, what were limiting factors?	4. Ship model react as expected with environment	5. Maintain acceptable distance from shoals and terminal	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
11	Bruce Morse-Ellington	Yes	Yes	Yes	Yes	Yes	No			8	10	
12	Mike Flanagan	Yes	NA	Yes	Yes	was maximum distance off Seagirt	execute turn sooner into Fort McHenry	6		7.5	5.5	
13	Bruce Morse-Ellington	Yes	Yes	Yes	Yes	Yes	No	10		10	10	
14	Mike Flanag	Yes	3-4 deg	Yes	Yes	Yes	No	7		5	5.5	
15	Kevin Hanna	Yes and no just pushed too far to the channel	3 kts	Yes	Yes	Mostly	Yes slightly more speed	7		7	5	
16	Tad Whitin	Yes	NA	Yes wind above 25 kts is a limiting factor	Yes	Close to DMT 5 vessels	No	3	if wind increased above 25 kts more bollard pull would be needed	7	6	Increased turning basin not withstanding, it's a tight place to turn a heavy ship
17	Kavin Hanna	Yes	3 kts	Yes	Yes	Yes	Slightly more speed	5	with 25 kts maybe 4 boats	7	5	
18	Tad Whitin	Yes		Yes (grounding off 4 berth but I don't think it was a factor (simulator familiarity)	Yes	No	Remain closer to sea berth 4	4	the 3 tugs are limited for vessel and wind	8	5	daylight
19	Kevin Hanna	On the edge	3.5 minimum	Yes	Yes	Yes/no (close to berthed ships)	would have turned colgate creek sooner	4	with 25 kts, 3 60 t boats was on edge	8	3	given wind conditions and tug power no margin for error
20	Tad Whitin	No after a couple tug miscues vessel grounded port side	Not calculated		Yes	No	See voyage/ Run 21 essentially maintain more distance to shoaling on port side	3	4 tugs is preferable	9	5	

Run	Captain	1.Successfully made transit	2. Average drift angle and minimum speed to offset environments	3. Successfully complete berthing/unberthing evolutions? If not, what were limiting factors?	4. Ship model react as expected with environment	5. Maintain acceptable distance from shoals and terminal	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
21	Tad Whitin	Yes	Not calculated	Yes	Yes	Yes	No	5		8	3	tight space for the maneuver
22	Kevin Hanna	Yes	Minimium 2.5 kt max 3.5 - 4 kts	Yes	Yes	Yes	No	8		8	7	
23	Tad Whitin	Yes	Not calculated	Yes	No	Yes	No	7		7	7	
24	Carroll Cudworth	Yes	1.5 kts	Yes	Yes	Yes	No	5			5	Using tug forward center lead not real so far for myself
25	Jim Hickey	Yes, but at several points I was close	1.5 - 3 kts	Yes, wind certainly a factor	I thought draft due to wind effect was less than actual	Not by my standards	Yes, limit speed if allowed (by wind, etc.) and distances to shoal areas	5	For this class of vessels, I feel this in the minimum total horsepower/bollard pull that is acceptable	7	4	Wind restrictions, traffic restrictions, visibility restrictions, minimum bollard pull, vessel proximity, PPU or ECDIS required
26	Carroll Cudworth	Winds set us to vessels at DMT 5/6	3 kts outbound DMT West	No, again the bow tug forward not used correctly	Yes		Yes would use tug alongside					
27	Jim Hickey	Yes	1.5 - 4 kts	Yes, wind a definite factor	Very very similar	Acceptable but not to my standards	I did	5	I believe 3, 60 t tugs should be the minimum	8	4	in this exercise, the wind was the decisive factor
28	Carroll Cudw	Same as Run 24 and 25										
29	Jim Hickey	Yes but not planned with drift angle	1.5 - 2.3 kts	Yes, wind a certain factor, as was ship characteristics	not sure, but it was difficult increasing speeds on this simulaiton	Yes	Yes, maneuevring speeds were not as applicable to this run so would adjust if again	4	this class of vessel requires a significant amount of horsepower	8	4	this class of vessel should have a wind restriction and a minimum horsepower restriction
30	Mike Flanagan	Yes	NA	Yes	Yes	Used all available space	No	7		6	6	
31	Mike Flanagan	Yes	3 - 4 deg	Yes	Yes	Used all available space	No	5	Could have used another tug	7	6	4 tugs with conditions
32	Mike Flanagan	Yes	NA	Yes	Yes	Yes, new channel	No	4.5		4.5	5.5	
33	Mike Flanagan	Yes	Yes	Yes	Yes	Yes with widener	No	5.5		6	5	
34	Mike Flanagan	Yes	Yes	Yes	Yes	Yes with widener	No	5.5		5.5	5	

4.3.2 TUG MASTER EVALUATIONS

After each run, each tug master filled out an individual run questionnaire. A summary of the evaluations are presented in Table 4-5 while the full comments are shown in Table 4-6. Note, there are 2 evaluations for each run as there were 2 Tug Masters working their tugs for each run. One column ranks tug configuration and reserve capacity on a scale of 1 to 10 with 10 being equivalent to most adequate. The overall difficulty was also assessed on a scale of 1 to 10 with 10 being the most difficult. The last column of the table shows the overall safety ranking. This value is also on a 1 to 10 scale with 10 being the safest scenario possible. Both the river and docking pilots completed the surveys.

The average tug configuration and reserve capacity was 8 (10 = most adequate). The average overall difficulty was 4 (10 = most difficult), and the average safety ranking was 8.3 (10 = most safe).

Table 4-5: Tug master ratings

Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety	Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety
1	5	1	10	**11**	7	5	7	**21**	10	8	10	**31**	2	9	2
1	8	1	9	**11**	9	2	9	**21**	5	5	5	**31**	5	8	5
2	8	5	8	**12**	6	7	7	**22**	2	9	2	**32**	1	10	1
2	5	1	10	**12**	9	2	9	**22**	10	8	10	**32**	7	8	7
3	8	1	10	**13**	8	6	7	**23**	5	8	5	**33**	2	9	2
3	9	5	6	**13**	9	2	9	**23**	4	9	4	**33**	2	9	2
4	9	5	8	**14**	5	8	7	**24**	5	8	5	**34**	8	7	8
4	7	1	10	**14**	8	5	8	**24**	2	9	2	**34**	1	10	1
5		7	8	**15**	10	7	7	**25**	2	9	2				
5	8	1	10	**15**	9	2.5	9	**25**	5	7	5				
6	10	2	10	**16**	9	7	7	**26**	2	9	2				
6	3	5	6	**16**	9	2	9	**26**	5	4	5				
7	10	2	10	**17**	7	8	6	**27**	2	9	2				
7	8	7	7	**17**	9	2	9	**27**	5	8	5				
8	9	2	9	**18**	8	7	7	**28**	6	7	6				
8	8	7	8	**18**	10	1	10	**28**	2	9	2				
9	8	2	8	**19**	8	8	8	**29**	2	9	2				
9	9	2	9	**19**	4	5	7	**29**	1	9	1				
10	--	--	--	**20**	--	--	--	**30**	2	9	2				
10	--	--	--	**20**	--	--	--	**30**	10	8	10				

Table 4-6: Tug master evaluation comments

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
1	Steve Thalheimer	Yes, centerline frwd, 159' of line	Yes, no problems	Yes, not a problem	Yes	Little slugish, power was low, 49-53 tons bollard pull on full power	No	5	indequate; power is only 49 ton	1	10	Very safe no problems
1	Bob Dempsey	Yes, took time	Yes once started	No	Yes	stern 50% power more helm the real world to remain centered w/ ship turning	more issues setting use to winch control	8		1	9	All good
2	Bob Dempsey	Yes	Yes	No	Yes	At 2.8 kts when swinging out to port or starboard at low speed tonnage reached higher than real-world maneuver	No	8		5	8	
2	Steve Thalheimer	Yes hip should make fast close to Key Bridge; centerline frwd, 160' of line	Yes, no issues	No	Yes	Yes, a little low in power	No	5	Little low on power, bollard pull was 49-53 tug on full power	1	10	Very safe no problems
3	Steve Thalheimer	Yes centerline frwd, 159' of line	Yes, 53 tons at 100% power	Yes, no problems	Yes	Yes	No	8		1	10	Very safe no issues
3	Bob Dempsey	Yes	Yes	No	Yes	Yes	No modification	9		5	6	
4	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	9		5	8	fine
4	Steve Thalheimer	Yes, centerline frwd, 178' of line	Yes	No	Yes	Yes	No	7		1	10	Very safe, no issues
5	Bob Dempsey	Yes	Could not push on port quarter; tug slid	No	Yes	Yes actually while trying to push would have been too far aft would have been metal to metal	No			7	8	Wind retarded turnout into Fort McHenry Stream
5	Steve Thalheimer	Yes centerline frwd, 184' of line	Yes	Yes	Yes	Yes	No	8		1	10	Very safe, no issues or problems

MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
6	John Shellenberge	Yes	Yes	No	Yes	Yes	No	10		2	10	Smooth approach with no close calls
6	Bob Dempsey	Yes	Yes, full only produced 48-50 tons	No	Yes	Yes	No	3	Bollard pull issue	5	6	
7	John Shellenberge	Yes	Yes	No	Yes	Yes	No	10		2	10	smooth approach w/ no close calls
7	Bob Dempsey	Yes	Yes	No	Yes	Yes, shorten line rubber coefficient held to bow	No	8		7	7	All good
8	John Shellenberge	Yes	Yes	No	Yes	No- bollard pull was lower than expected in powered indirect	No	9		2	9	
8	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	8		7	8	
9	Bob Dempsey	Yes	Yes	Yes	Yes	Yes	No	8		2	8	
9	John Shellenberge	Yes	Was not able to flank out to stbd on a 90 deg in final turn into Fort McHenry	No	Yes	No, at idle stbd engine would randomly drop from 10 to 5 rpm causing tug to skew and part		9		2	9	
10												
10												
11	Bob Dempsey	Yes	Yes	No	Yes	Yes	Yes	7		5	7	
11	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
12	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	6	Needed more bollard pull	7	7	
12	John Shellenberge	Yes	Yes	No	Yes	I only put out 100' of line this time; felt that in the real world. I would be getting blown out by the prop wash in power indirect mode	No	9		2	9	
13	Jon Steinberg	Yes	Yes	No	Yes	Yes	No	8		6	7	
13	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
14	Bob Dempsey	Yes	Yes	Yes, wind on pier	Yes	Yes	No	5	Needed reserve power to work off pier	8	7	
14	Jon Steinberg	Yes	No, I had too much line out around SMT #1 and ran into docked ship	No	No too much line out and ship was too close to berth SMT #1	Yes	Yes, less line	8		5	8	
15	Ed Lucas	Yes	Yes	Yes, I did but no I was not concerned	Yes	Yes	No	10		7	7	
15	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2.5	9	

MITAGS-PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
16	Ed Lucas	Yes	Yes	Yes, not concerned	Yes	Yes	No	9		7	7	
16	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
17	Ed Lucas	Yes	Yes	No	Yes	Yes	No	7		8	6	
17	John Shellenberge	Yes	Yes	No	Yes, at one point it looked like I would run over a buoy on ECDIS but didn't see it in the simulator	No, it takes a long time for the azipods to turn; almost 30 seconds - very long for full rotation	No	9		2	9	
18	Ed Lucas	Yes	Yes	Yes, no	Yes	Yes	No	8		7	7	
18	Kevin Hanna	Yes	Yes	No	Yes	Yes	None	10		1	10	
19	Ed Lucas	Yes	Yes	Yes, no	Yes	Yes	No	8		8	8	
19	Bob Dempsey	Yes	Yes	No	Shoal areas and ship at DMT 5 dependent on command and length of line	Ship port turn at 5 kts and flank tug to starboard left hand is on 90 to hold vessel up and shake violently	No	4	When limit tug to 90%, 60 t marginal	5	7	
20	Steve Thalheimer	Ended early										
20	Bob Dempsey	Ended early										
21	Steve Thalheimer	Yes	Yes	Yes, no	Yes	Yes	No	8		10	8	
21	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	6		5	5	

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
22	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
22	Ed Lucas	Yes	Yes	Yes, no	Yes, no	Yes	No	8		10	8	
23	Bob Dempsey	Yes	Yes	No	Yes	Yes	No			5	8	
23	Kevin Hanna	Yes	Yes	No, NA	Yes	Yes	No	9		4	9	
24	Bob Dempsey	Yes	Yes	No	Yes	Yes	No			5	8	No limits on run; tug kept full @ 90% to mimic 60 t BP
24	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
25	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
25	Bob Dempsey	Yes	Yes	Yes	Yes	Yes	No	8		5	7	c.c. first run inbound
26	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
26	Bob Dempsey	Yes	Last turn out @ 10 idle speed tug head to starboard side ship too fast to keep up	Needed full power to stay safe final turn out	Yes	Yes	Different final turnout	6		5	4	
27	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
27	Bob Dempsey	Yes	Yes	No	Yes	Yes - 58 m on a 90	No nice turn in basin	5		5	8	

MITAGS PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

Run	Captain	1. Able to make fast at location requested by pilot?	2. Able to successfully respond to pilot orders?	3. Used full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Did tug model respond as expected in real-world?	6. Would you modify transit plan?	7. Tug configuration and reserve capacity	8. Qualifiers to rating	9. Difficulty rating	10. Overall safety	11. Safety qualifier
28	Bob Dempsey	Yes, parted line trying to wind in for shortened pull	Pulling off dock winch slow, defaulted to 296' tried	No	Closer to edge due to line length	Yes	Yes, no wind till we are at correct workable length	6		6	7	
28	John Shellenberge	Yes	Yes	No	No ship was all the way over to the far side of the channel	Yes	No	9		2	9	
29	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
30	Matt Barranco	Yes	Yes	No	Yes	Yes	No	9		1	9	No problems
30	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
31	Matt Barranco	Yes	Yes	Yes and no issues	Yes	Yes	No	9		2	9	
31	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	8		5	8	smooth run
32	Matt Barranco	Yes centerline forward 125' of line	Yes	No	Yes	Yes	No	9	Very realistic	1	10	very safe - no issues or problems
32	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	6		7	8	Good run
33	John Shellenberge	Yes	Yes	No	Yes	Yes	No	9		2	9	
33	Matt Barranco	Yes	Yes	No	Yes	Yes	No	10		2	9	
34	Bob Dempsey	Yes	Yes	No	Yes	Yes	No	7		8	7	Used thrust to push disabled tug out of harms way to complete this job
34	Matt Barranco	Yes	Yes	No	Yes	Yes	No	9		1	10	

5. CONCLUSION SUMMARY

Throughout the study, 34 runs were completed with the *Kalina* and *Ben Franklin* container vessels transiting to/from Berth 3 via the East and West Loop. The additional space provided from Wideners A and B were used in a majority of the runs. Figure 5-1 shows all of the runs and the overall area the swept paths occupied. Halfway through the runs GBA modified Widener 1 on the East side and added a new Widener on the West side. Both modifications are shown in Figure 5-2.

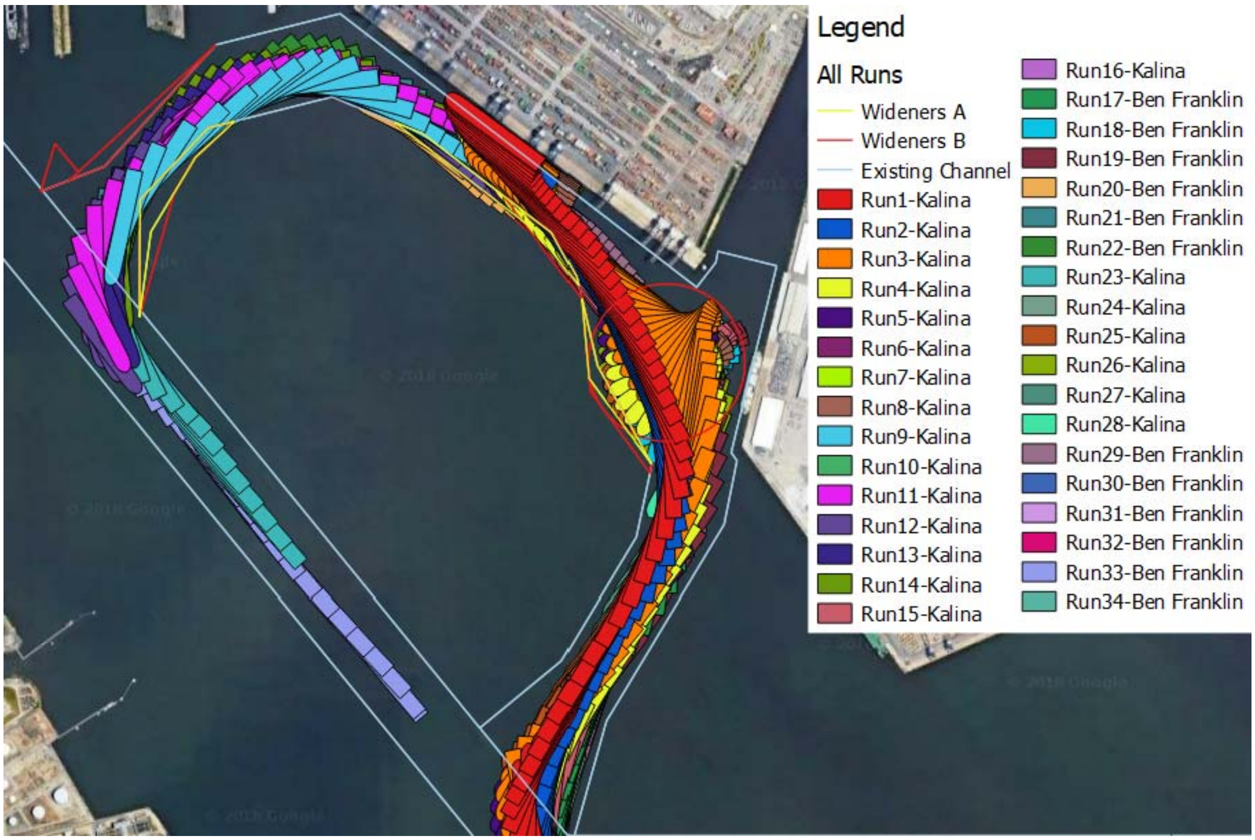


Figure 5-1: Summary of all runs

Figure 5-2: Channel modifications (dotted green lines) in addition to the Widener A and B designs

For safe transits to/from Berth 3, the Maryland Pilot Association and Tug Masters made the following recommendations determined from this study:

- Transit speed:
  - 3 kts or less
- Environmental conditions:
  - For winds greater than 25 kts, consideration of the results of this study, wind direction and magnitude, available tug support, and Maryland Pilots professional judgement should be used in determining safe transit conditions
- *Kalina* tug requirements:
  - Wind less than 20 kts: 3 ASD tugs each with a minimum bollard pull of 60 t
  - Wind 20 kts or greater: 4 ASD tugs each with a minimum bollard pull of 60 t
- *Ben Franklin* tug requirements:
  - 4 ASD tugs each with a minimum bollard pull of 60 t
- Additional tug requirements:
  - Tugs must operate on shorter lines in the limited space and have no room for error in this position
  - Upgrade to more stable tugs: current tugs are not stable enough and get caught in wash
- Conduct additional Pilot and Tug Master training with the *Kalina* and *Ben Franklin*

MITAGS·PMI
MARITIME INSTITUTE OF TECHNOLOGY & GRADUATE STUDIES
PACIFIC MARITIME INSTITUTE

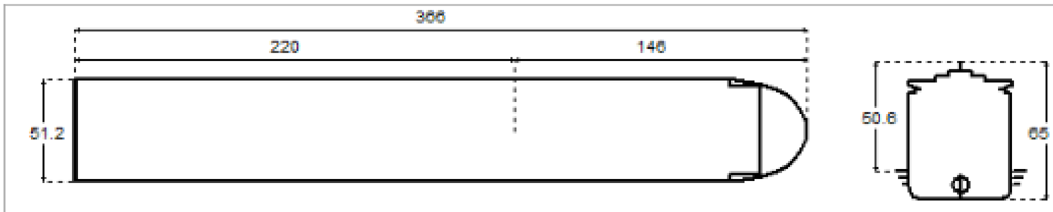
6. APPENDIX A – PILOT CARDS

PILOT CARD

Ship name	Container Kalina_Seagirt			Date	24.04.2018
IMO Number	N/A	Call Sign	N/A	Year built	1995
Load Condition	Loaded				
Displacement	192245 tons		Draft forward	14.33 m / 47 ft 1 in	
Deadweight	135460 tons		Draft forward extreme	14.33 m / 47 ft 1 in	
Capacity			Draft after	14.33 m / 47 ft 1 in	
Air draft	50.67 m / 166 ft 8 in		Draft after extreme	14.33 m / 47 ft 1 in	

Ship's Particulars

Length overall	366 m	Type of bow	Bulbous
Breadth	51.2 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	14 / 14	(1 shackle =27.5 m / 15 fathoms)	
Max. rate of heaving, m/min	15 / 15		



Steering characteristics

Steering device(s) (type/No.)	Semisuspended / 1	Number of bow thrusters	2
Maximum angle	35	Power	1700 kW / 1700 kW
Rudder angle for neutral effect	0.21 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	22 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	446.6 s	9.5 cbls	Advance	5.57 cbls
HAH to HAS	512.6 s	8.68 cbls	Transfer	2.06 cbls
SAH to SAS	640.6 s	8.71 cbls	Tactical diameter	5.05 cbls

Main Engine(s)

Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 73340 kW	Propeller type	FPP
Astern power	85 % ahead	Min. RPM	14
Time limit astern	N/A	Emergency FAH to FAS	26.2 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"10"	24.1	71140	100	1.03
"8"	16.9	24479	70	1.03
"6"	13.3	11912	55	1.03
"4"	10.8	6557	45	1.03
"2"	6.8	1610	28	1.03
"-2"	-3	1925	-28	1.03
"-4"	-4.8	7861	-45	1.03
"-6"	-5.8	14297	-55	1.03
"-8"	-6.9	23550	-65	1.03
"-10"	-9.5	62339	-90	1.03

PILOT CARD

Ship name	Container Ben Franklin_Seagirt			Date	24.04.2018
IMO Number	9454436	Call Sign	2FYD5	Year built	2012
Load Condition	Loaded				
Displacement	213040 tons		Draft forward	14.33 m / 47 ft 1 in	
Deadweight	185199 tons		Draft forward extreme	14.33 m / 47 ft 1 in	
Capacity			Draft after	14.33 m / 47 ft 1 in	
Air draft	47.97 m / 157 ft 9 in		Draft after extreme	14.33 m / 47 ft 1 in	

Ship's Particulars

Length overall	399.2 m	Type of bow	Bulbous
Breadth	54 m	Type of stern	Transom
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	17 / 17		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	13.2 / 13.2		

Steering characteristics

Steering device(s) (type/No.)	Normal balance rudder / 1	Number of bow thrusters	2
Maximum angle	35	Power	2043 kW / 2043 kW
Rudder angle for neutral effect	0.16 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	13 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	753.6 s	24.87 cbls	Advance	5.66 cbls
HAH to HAS	630.6 s	16.99 cbls	Transfer	2.53 cbls
SAH to SAS	626.6 s	6.62 cbls	Tactical diameter	5.98 cbls

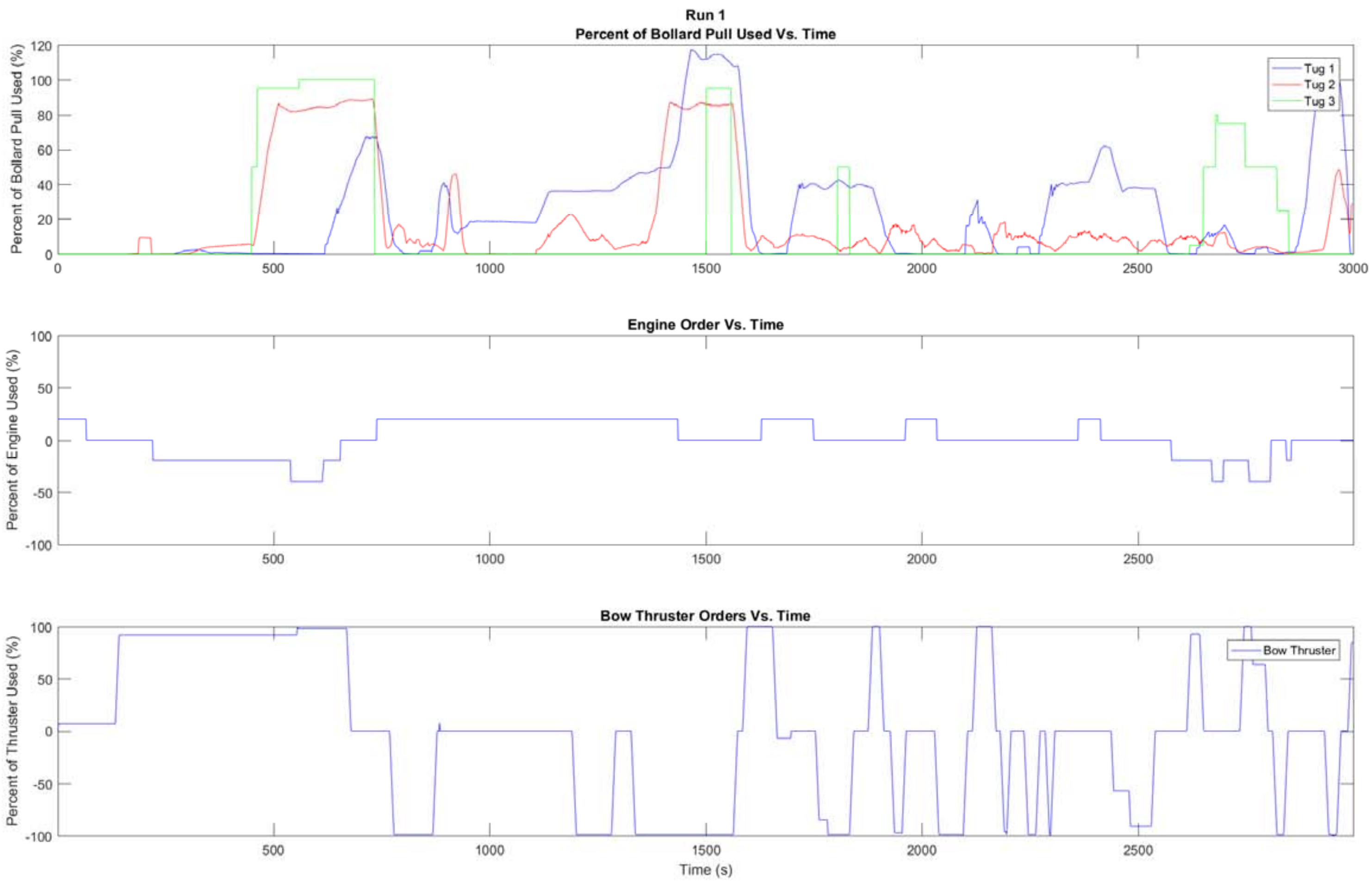
Main Engine(s)

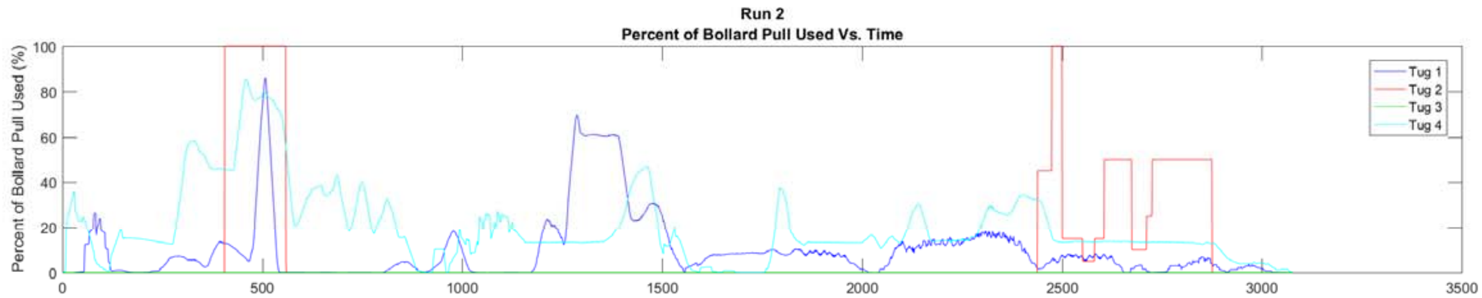
Type of Main Engine	Low speed diesel	Number of propellers	1
Number of Main Engine(s)	1	Propeller rotation	Right
Maximum power per shaft	1 x 63910 kW	Propeller type	FPP
Astern power	85 % ahead	Min. RPM	14
Time limit astern	N/A	Emergency FAH to FAS	325.6 seconds

Engine Telegraph Table

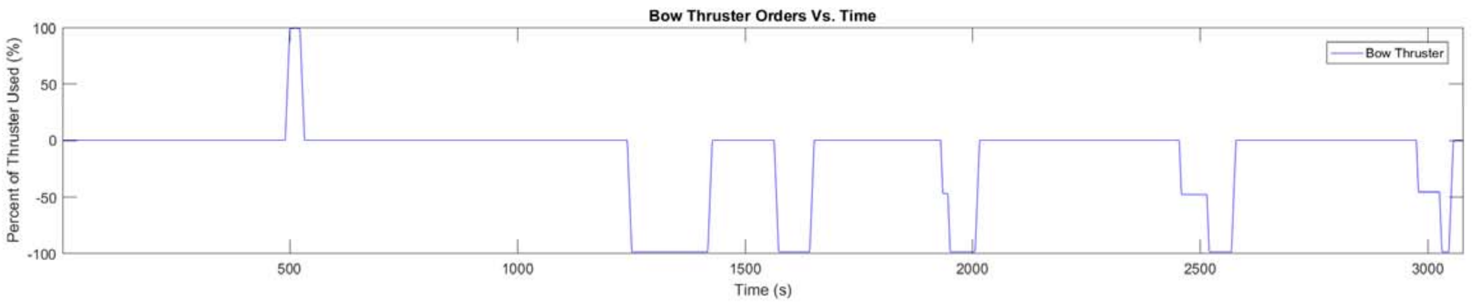
Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	26.4	59111	85	0.92
"FAH"	21	33321	67.6	0.92
"HAH"	17.7	20053	56.9	0.92
"SAH"	9.7	5275	31.1	0.92
"DSAH"	6.2	1936	20.1	0.92
"DSAS"	-4.1	2461	-20.3	0.92
"SAS"	-6.3	7275	-31.8	0.92
"HAS"	-10.4	31312	-56.8	0.92
"FAS"	-12.5	50141	-68	0.92

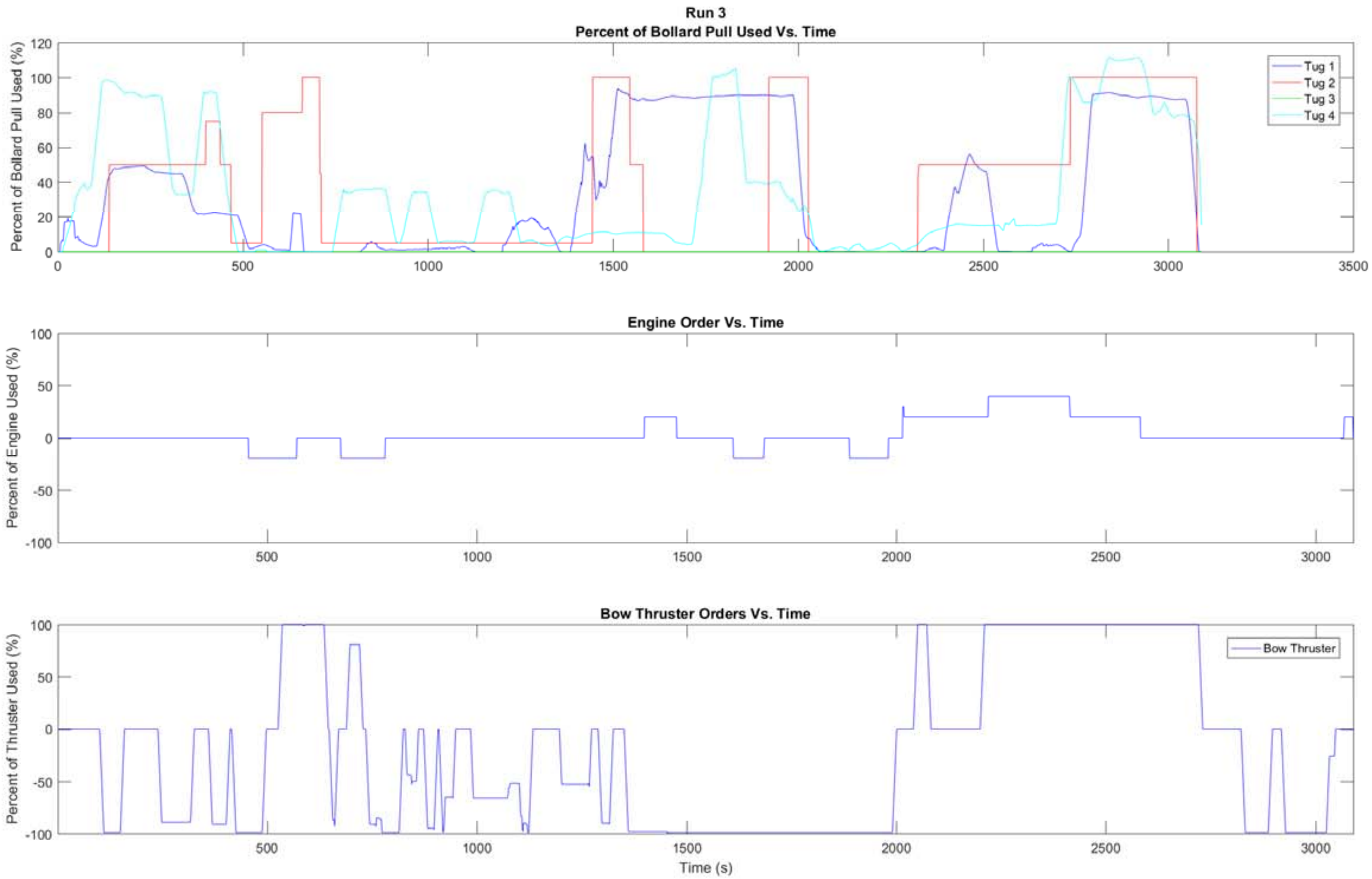
7. APPENDIX B - RESERVE POWER ANALYSIS PLOTS

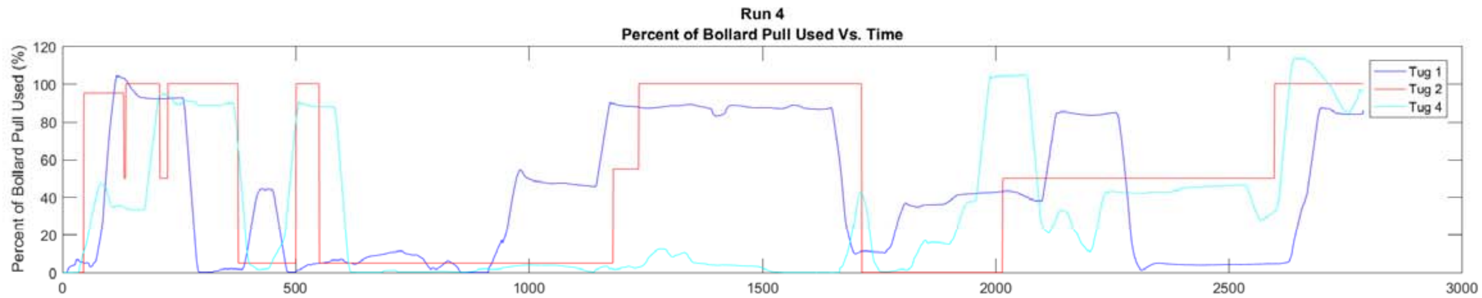


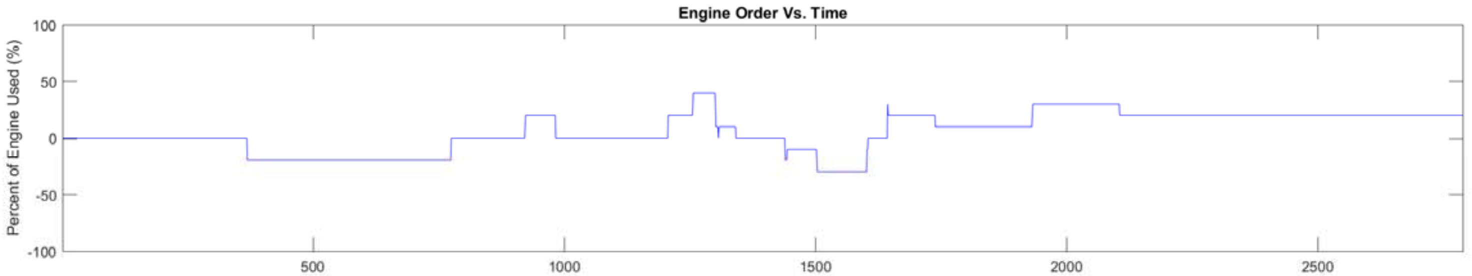

Run 2
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4

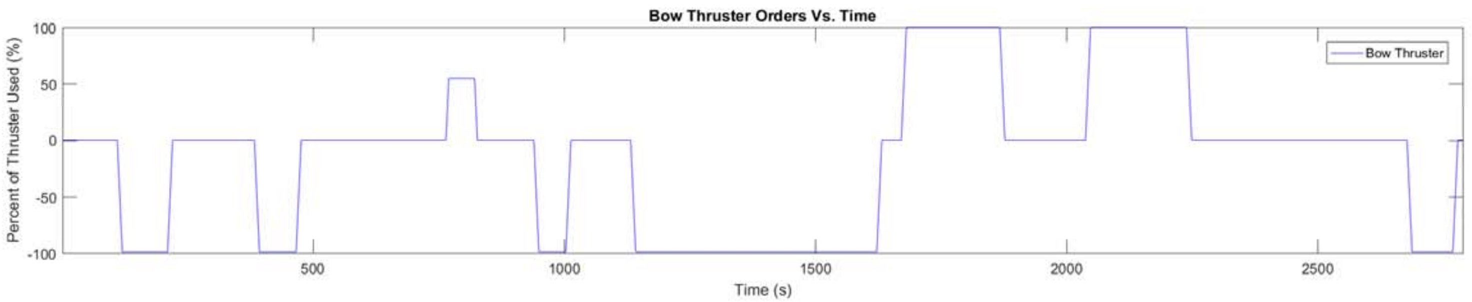

Engine Order Vs. Time
Percent of Engine Used (%)

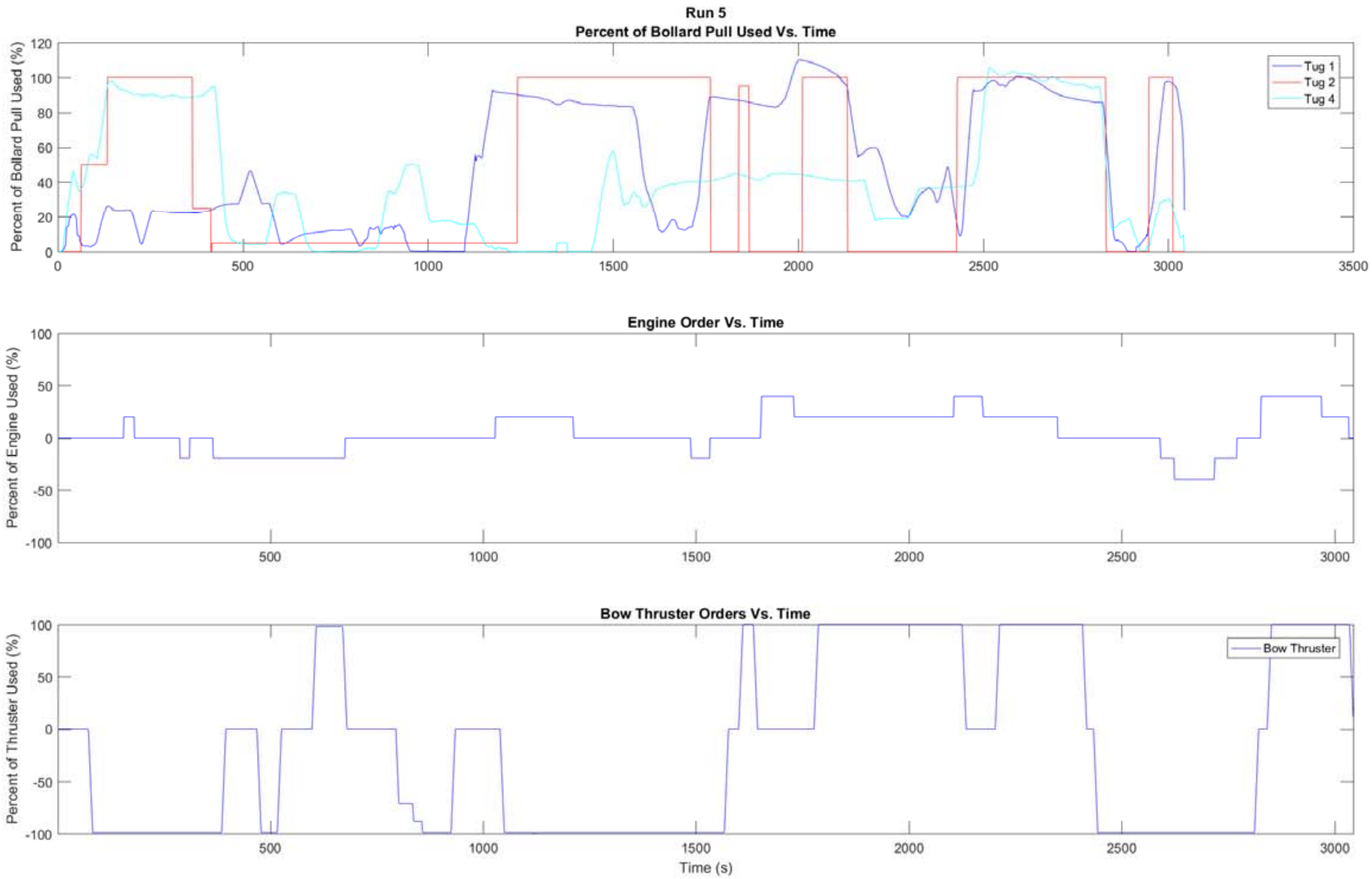

Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

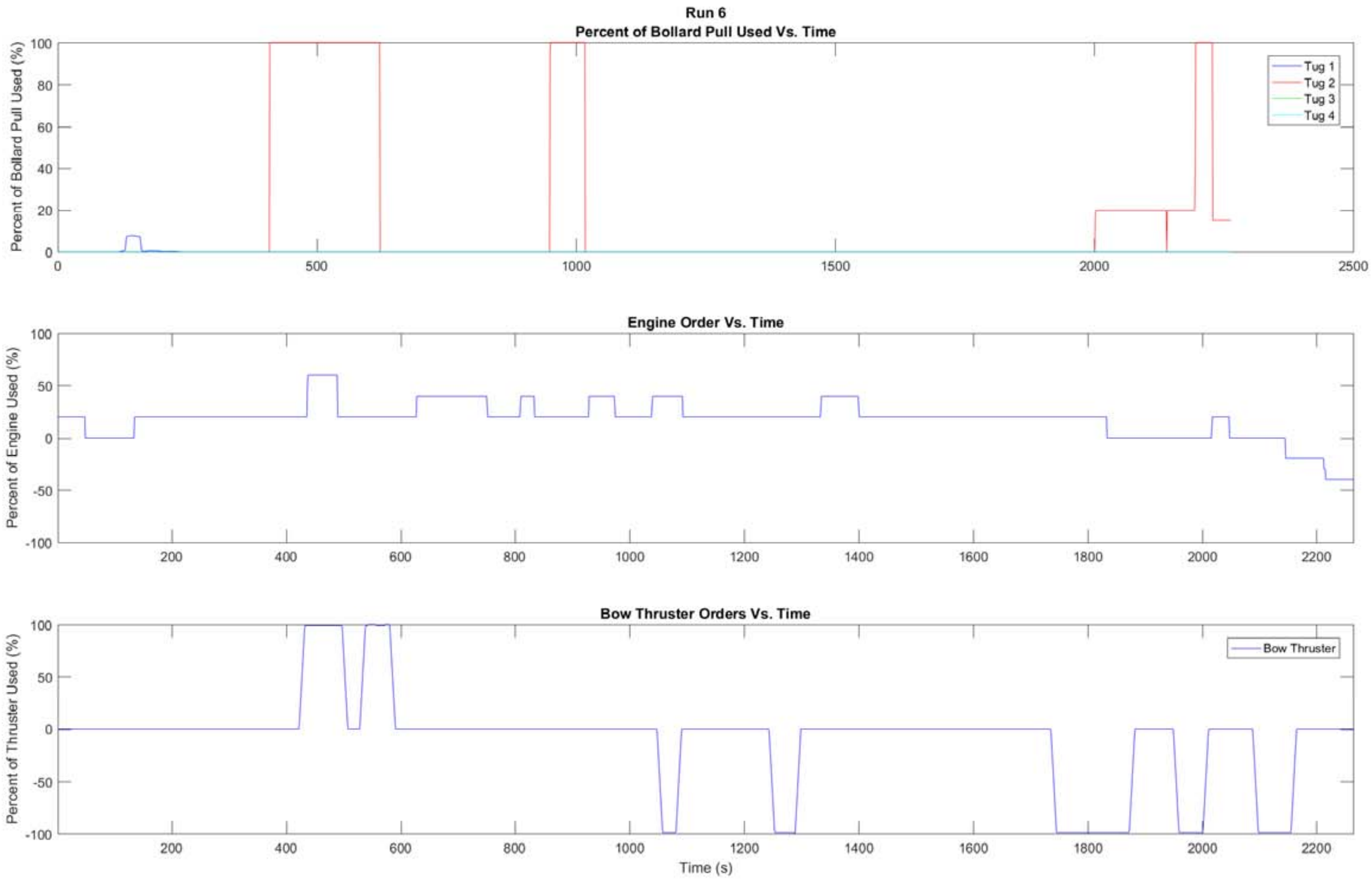

Run 3
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

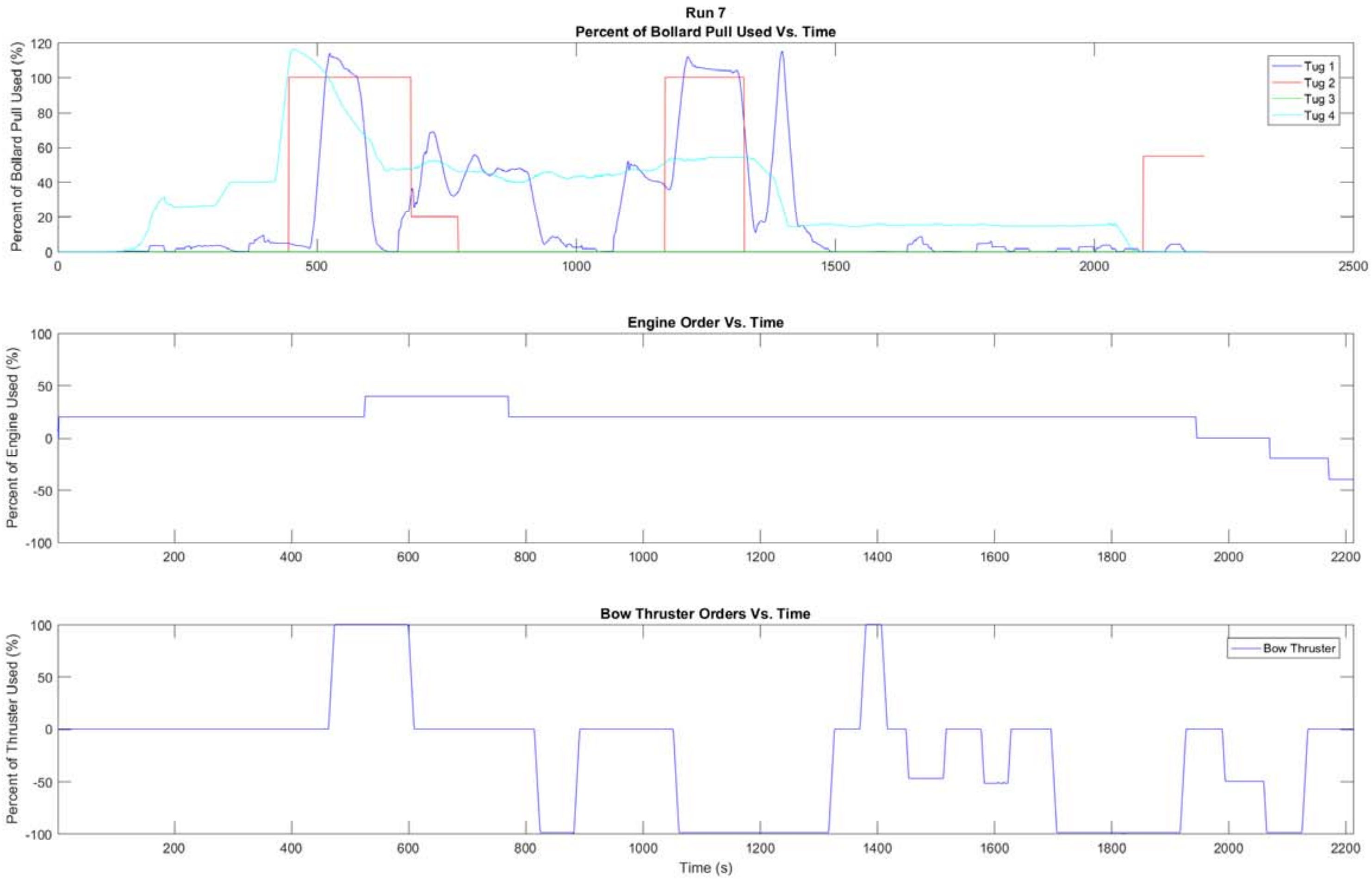

Run 4
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4

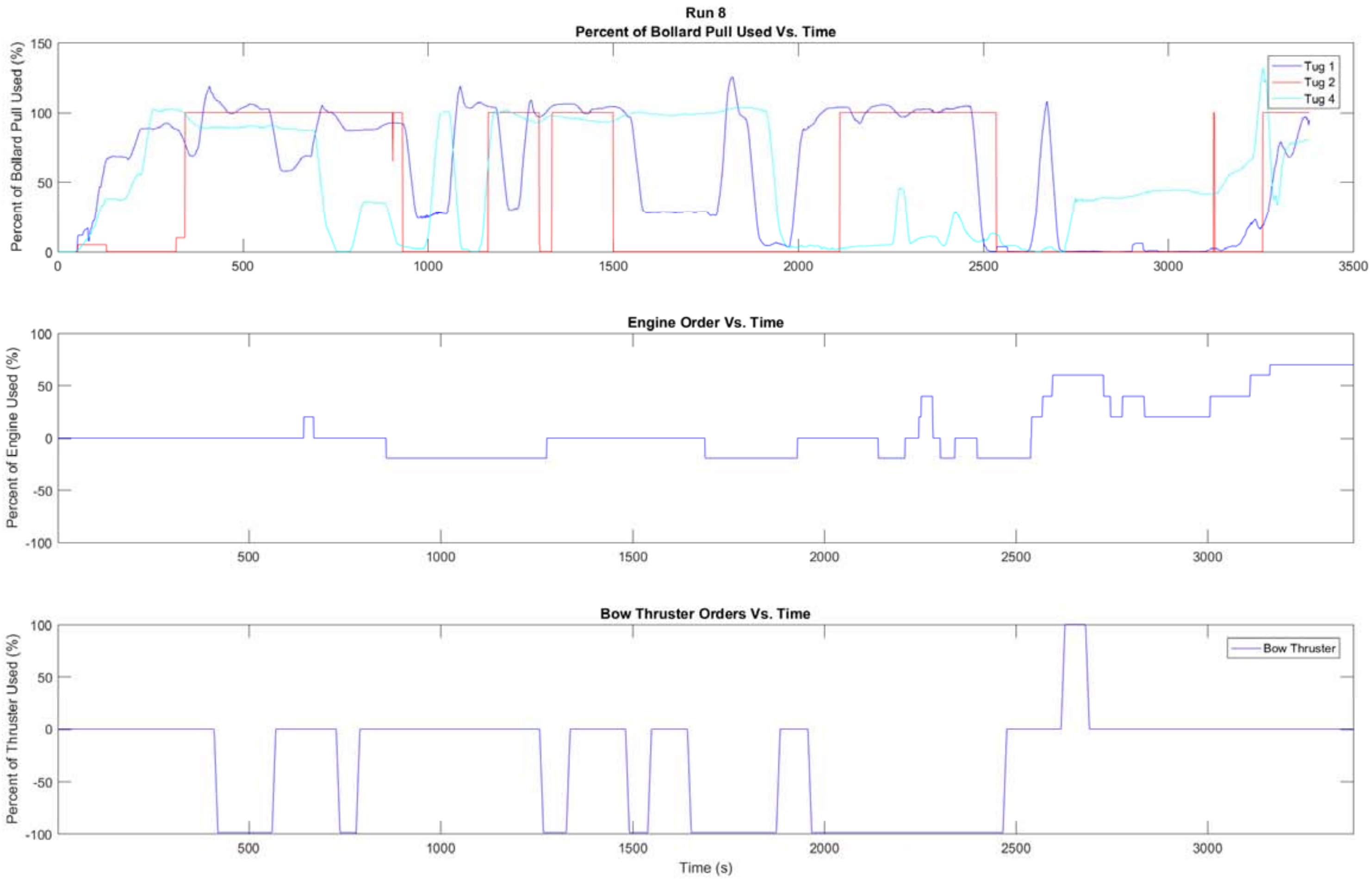

Engine Order Vs. Time
Percent of Engine Used (%)

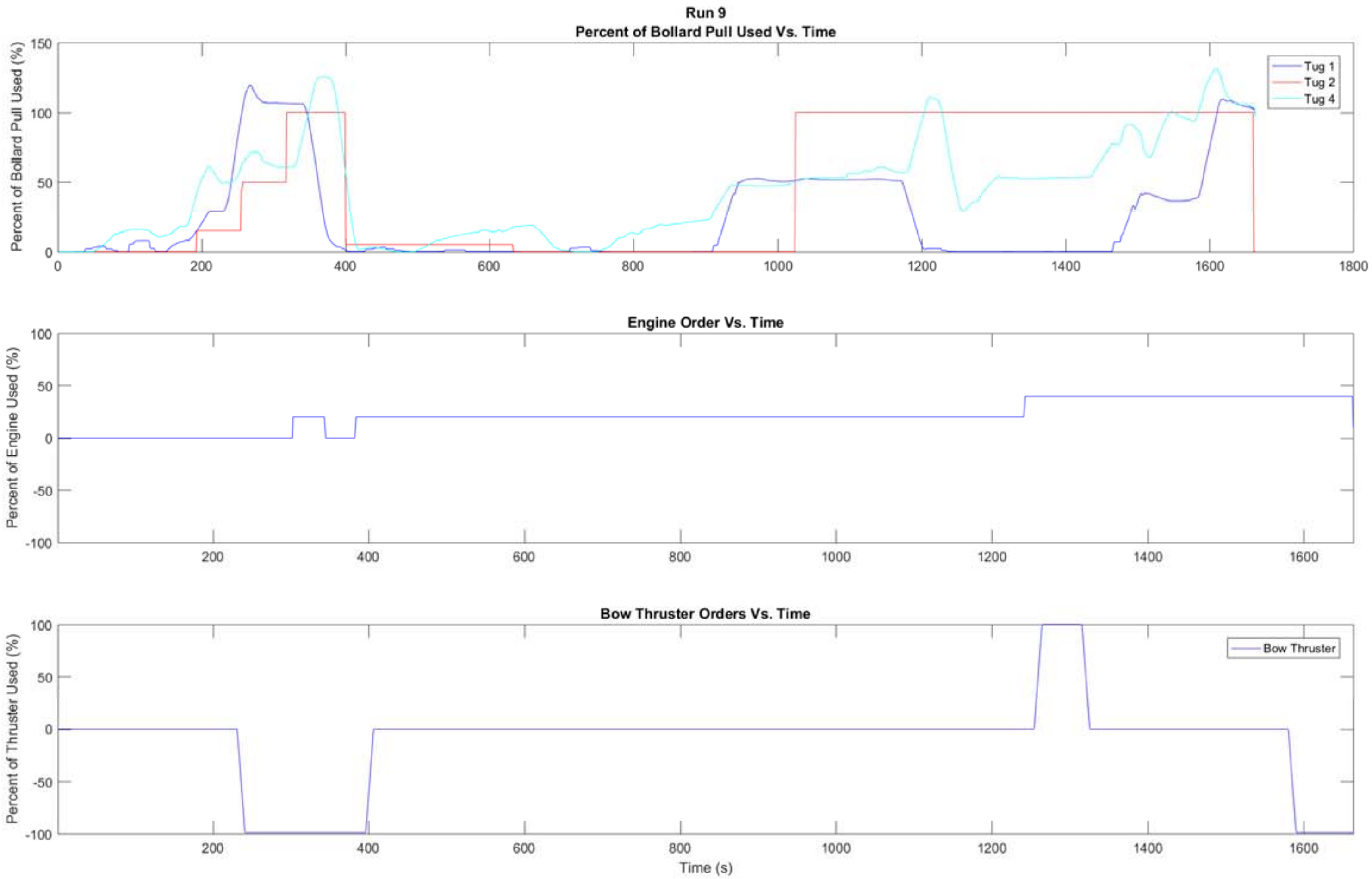

Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

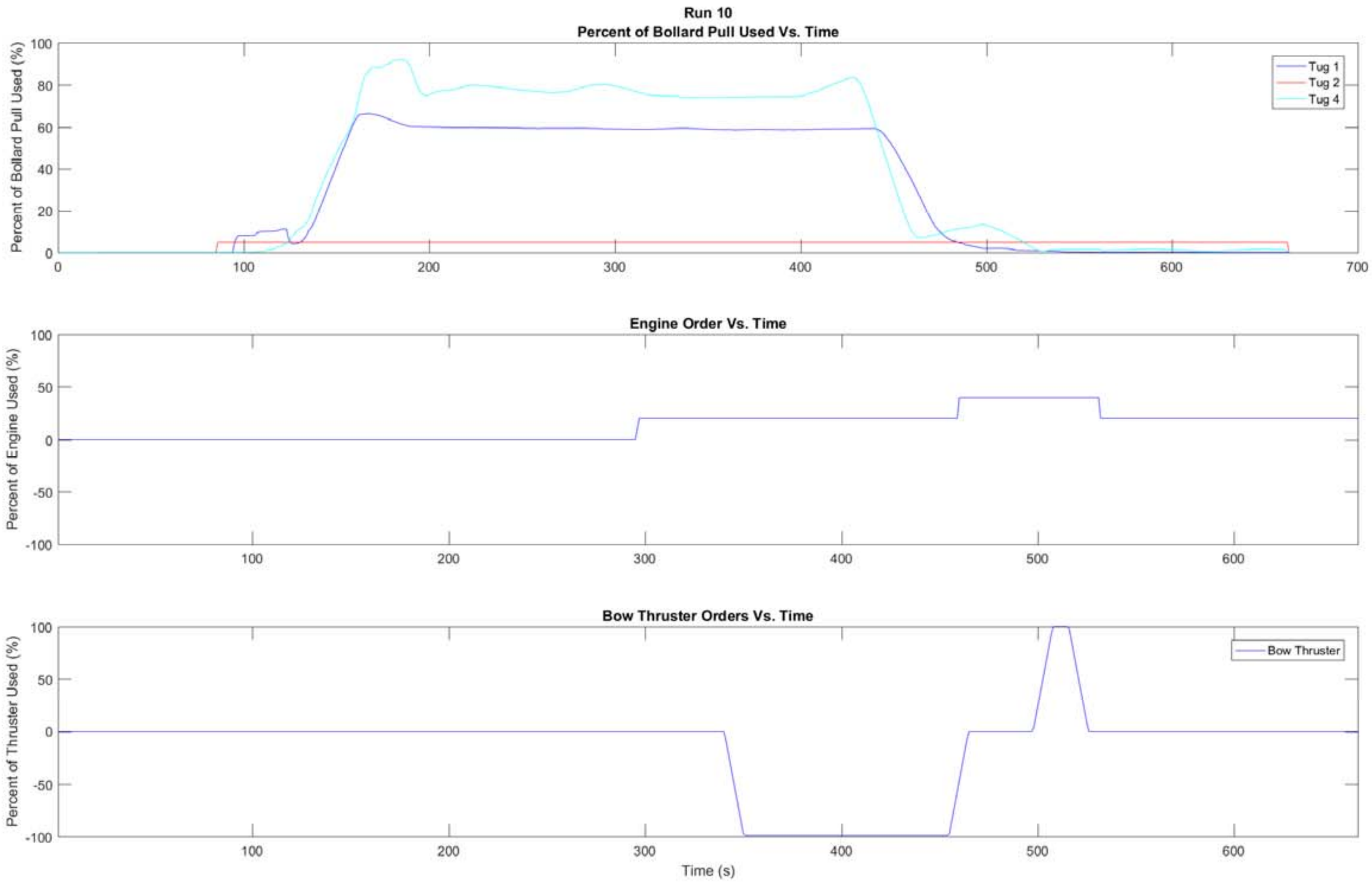

Run 5
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

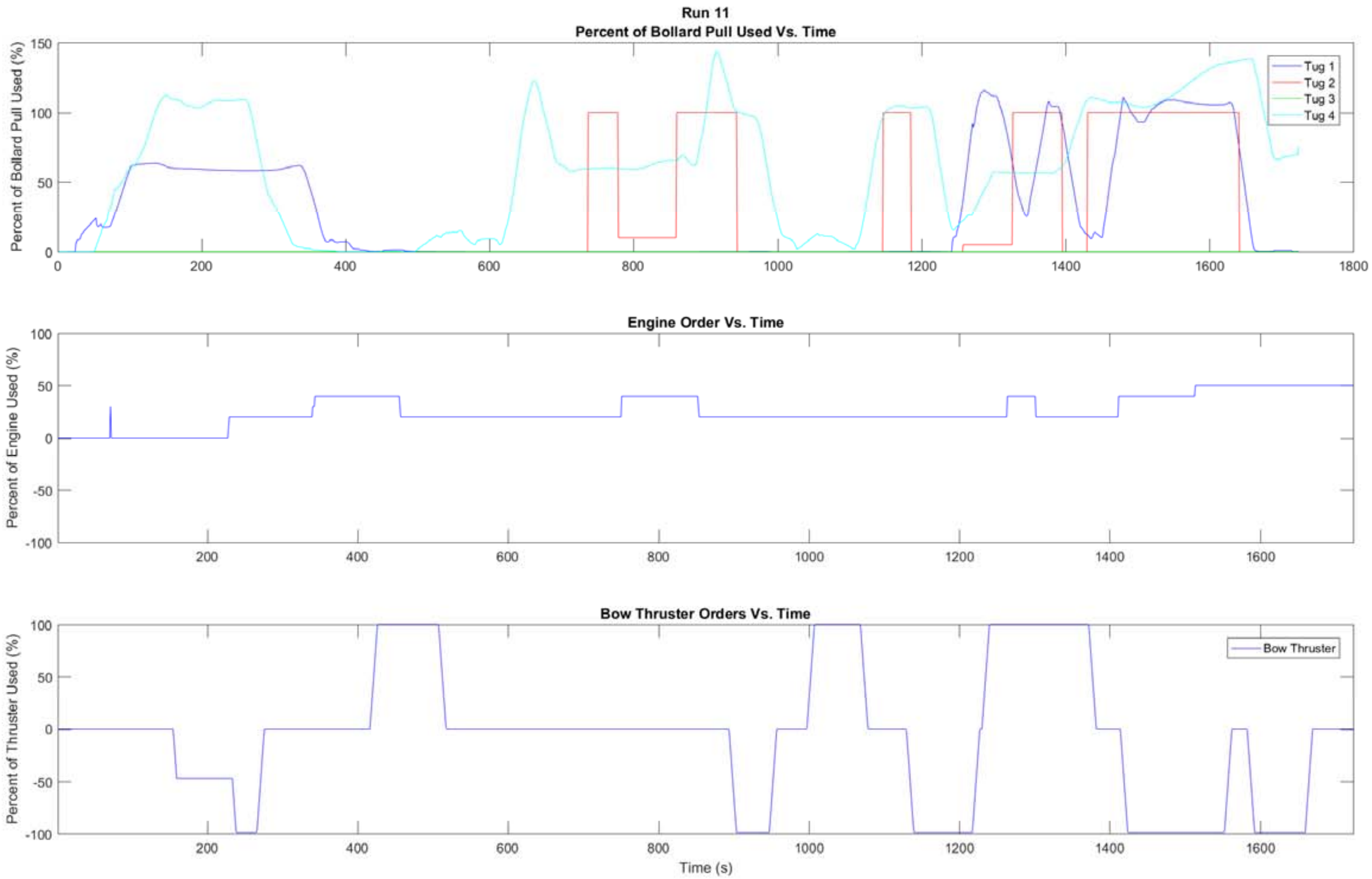

Run 6
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

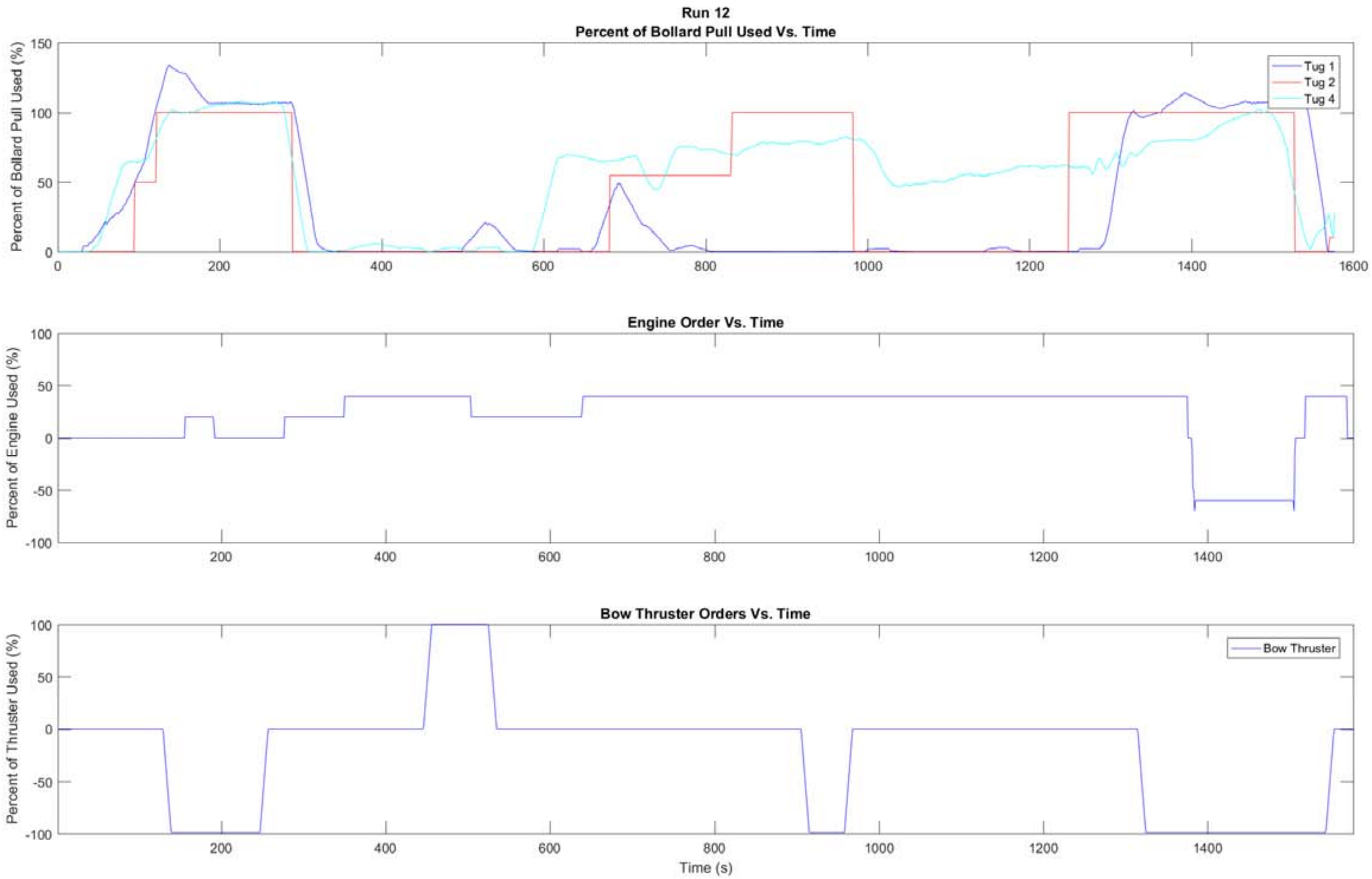

Run 7
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

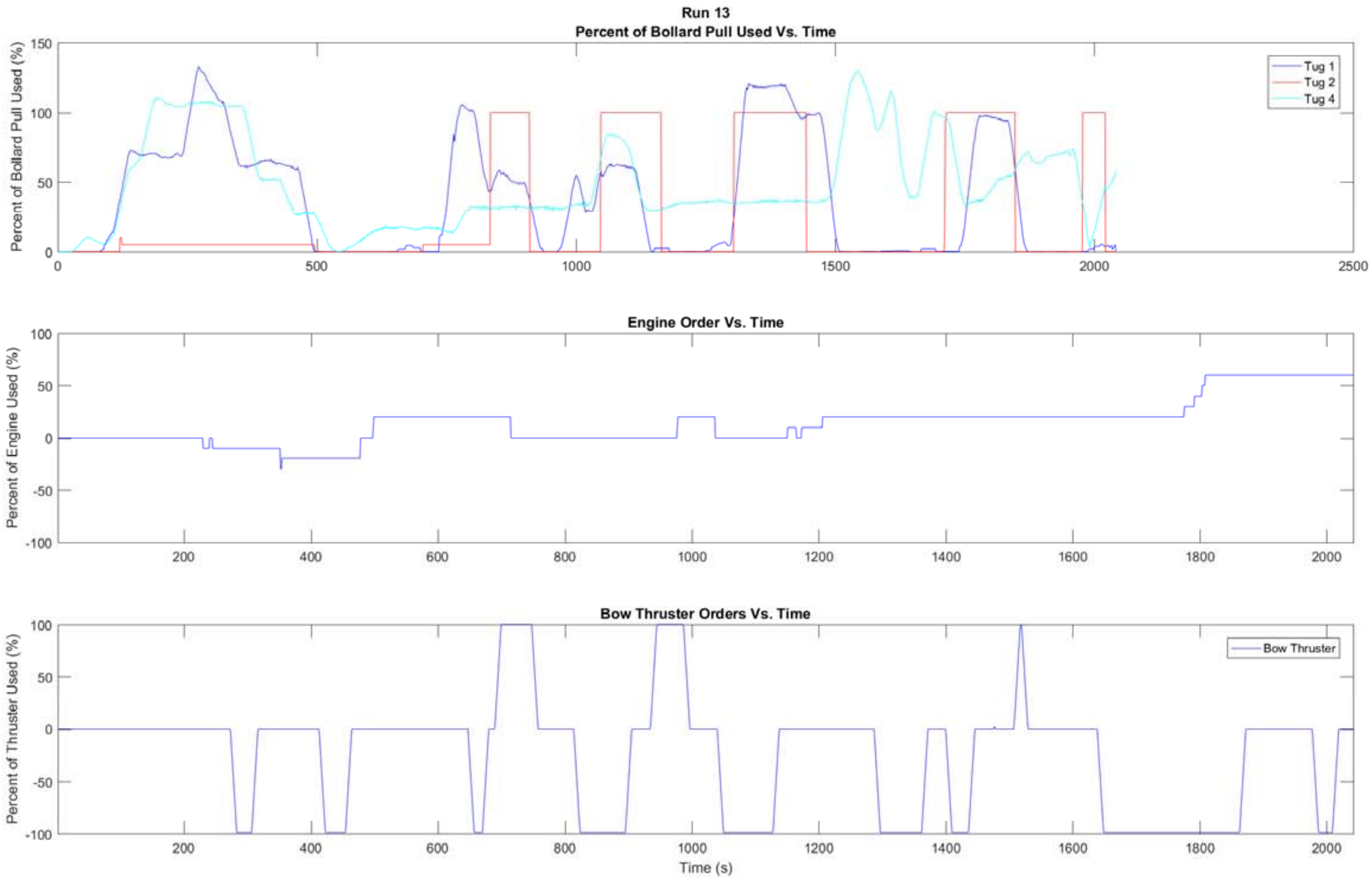

Run 8
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

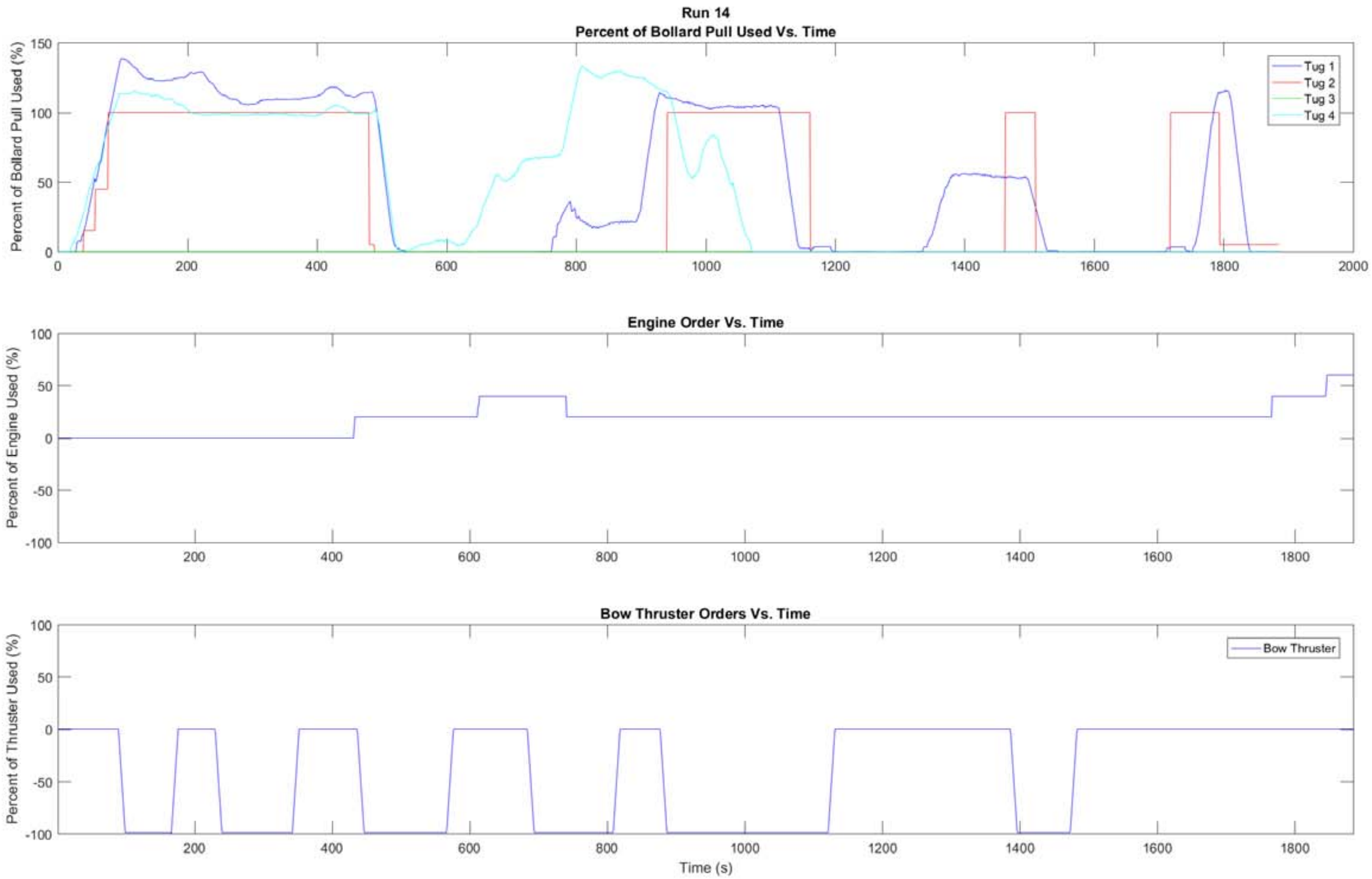

Run 9
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

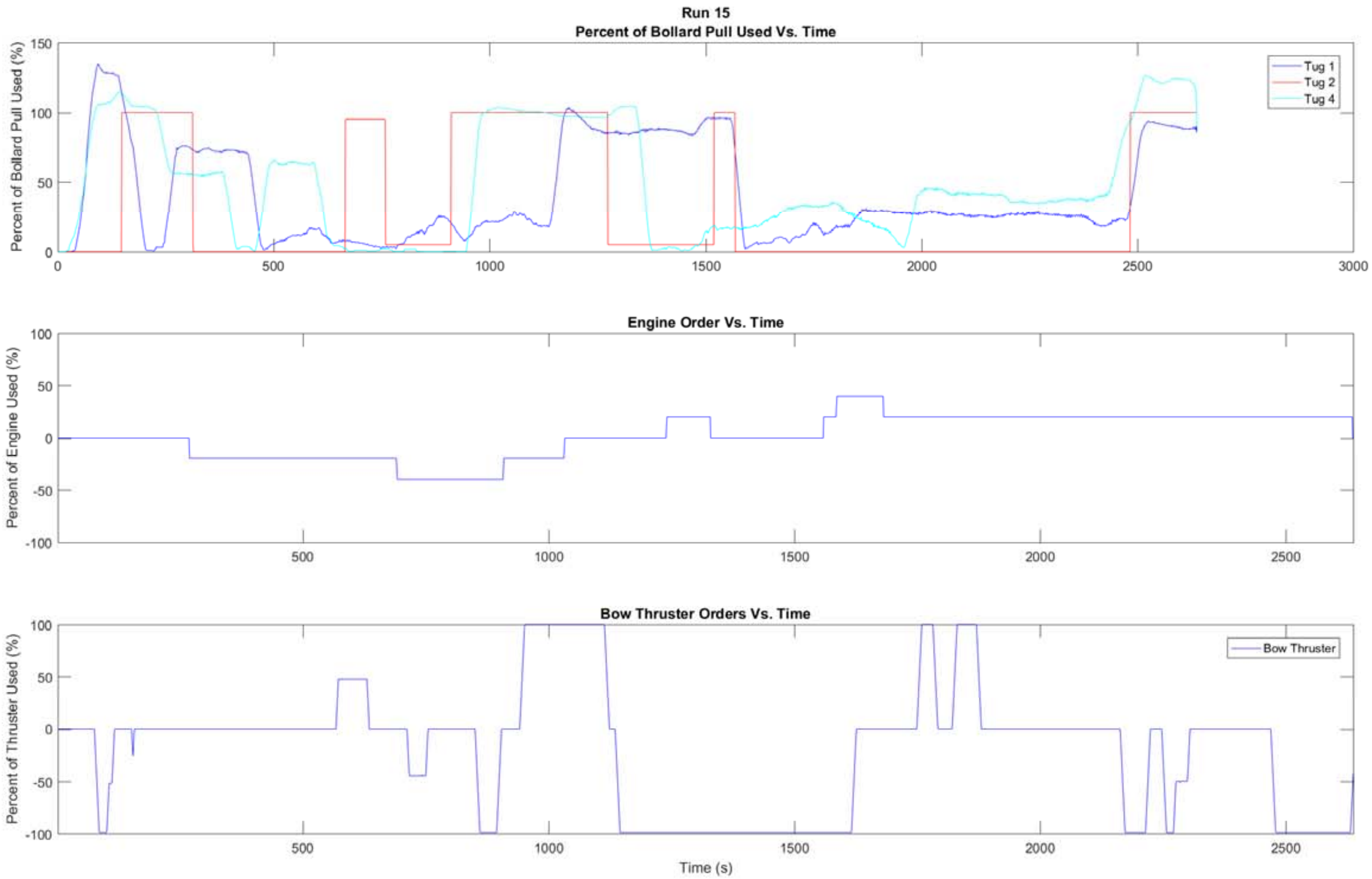

Run 10
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

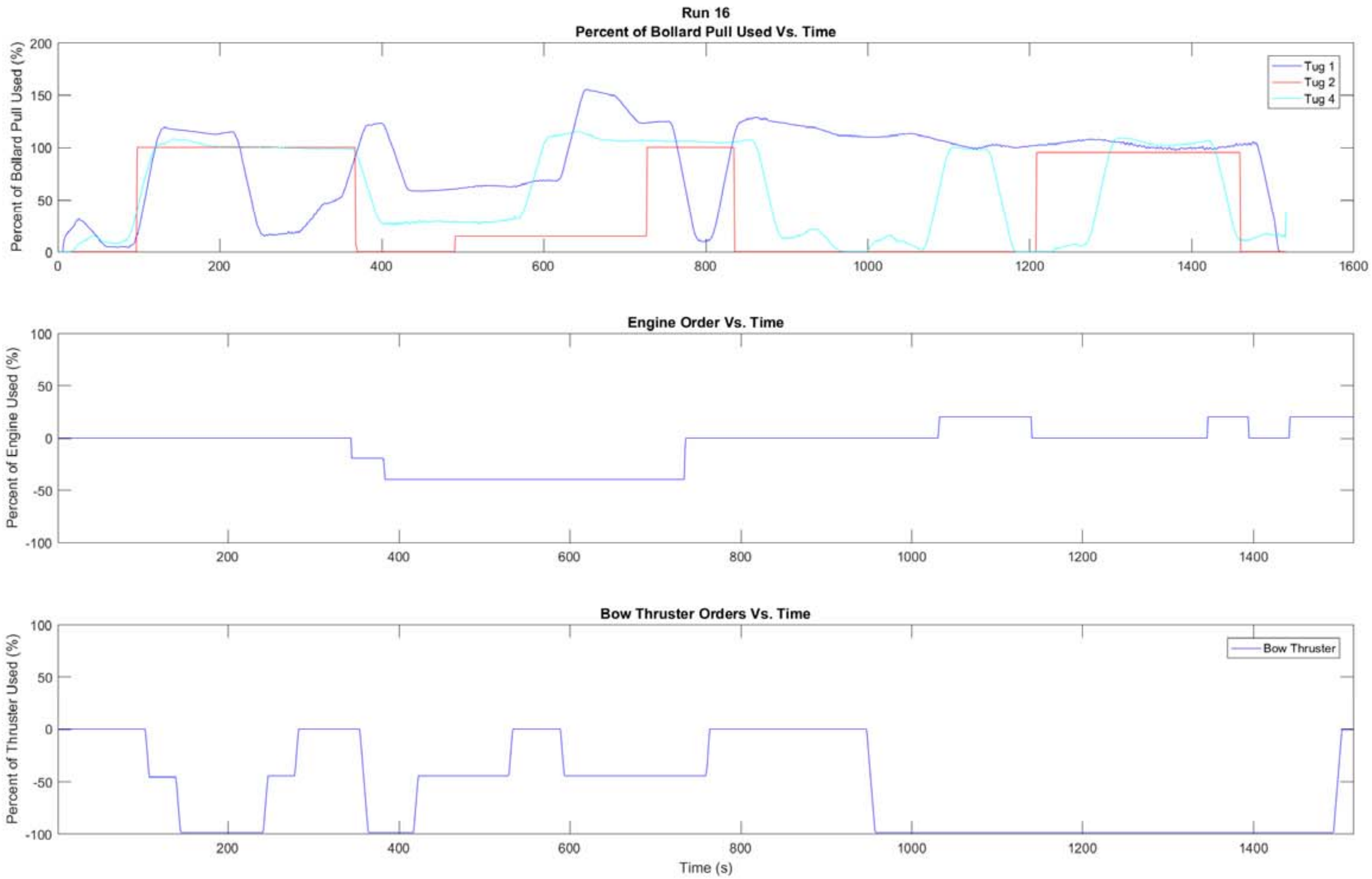

Run 11
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

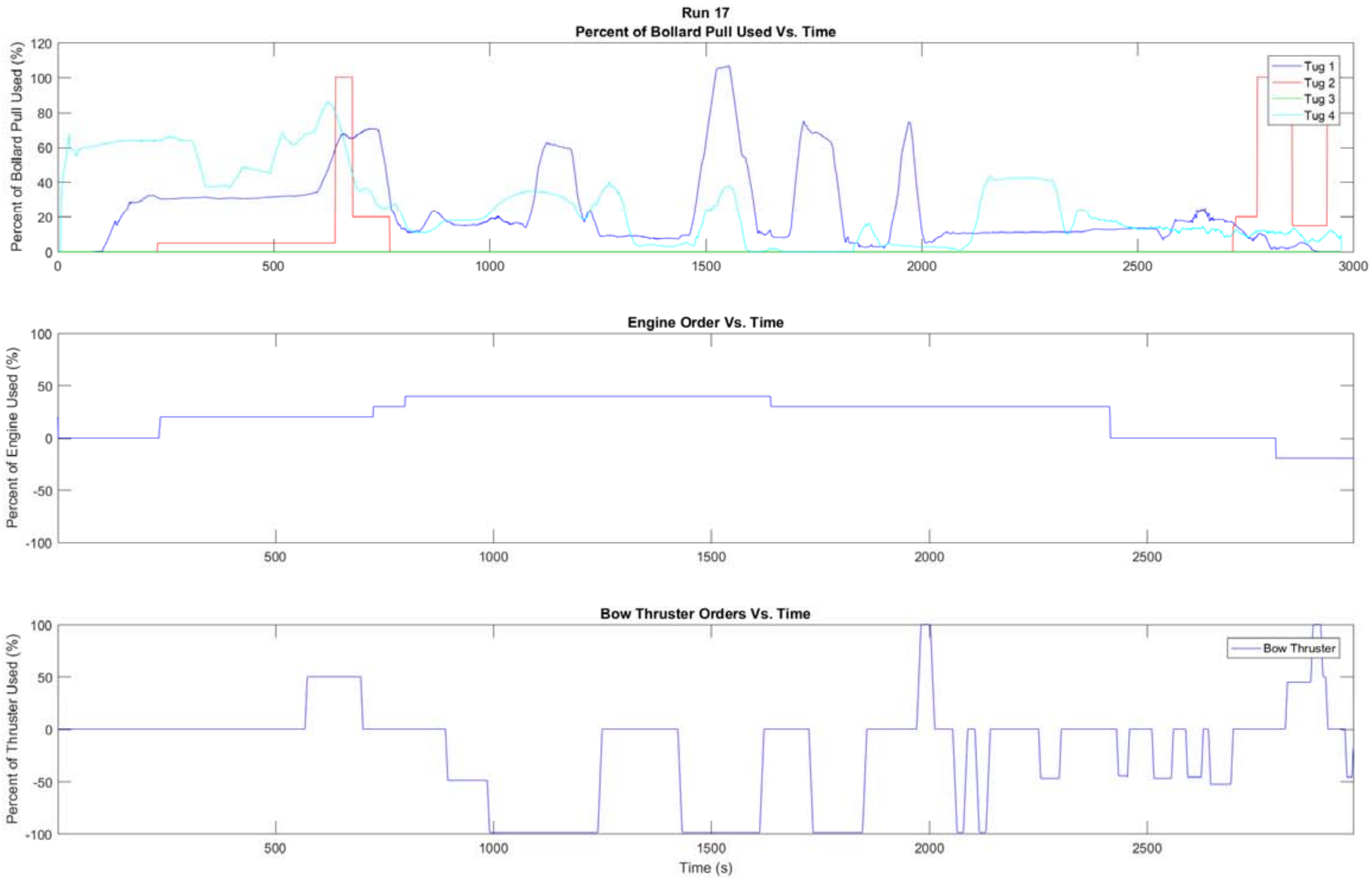

Run 12
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

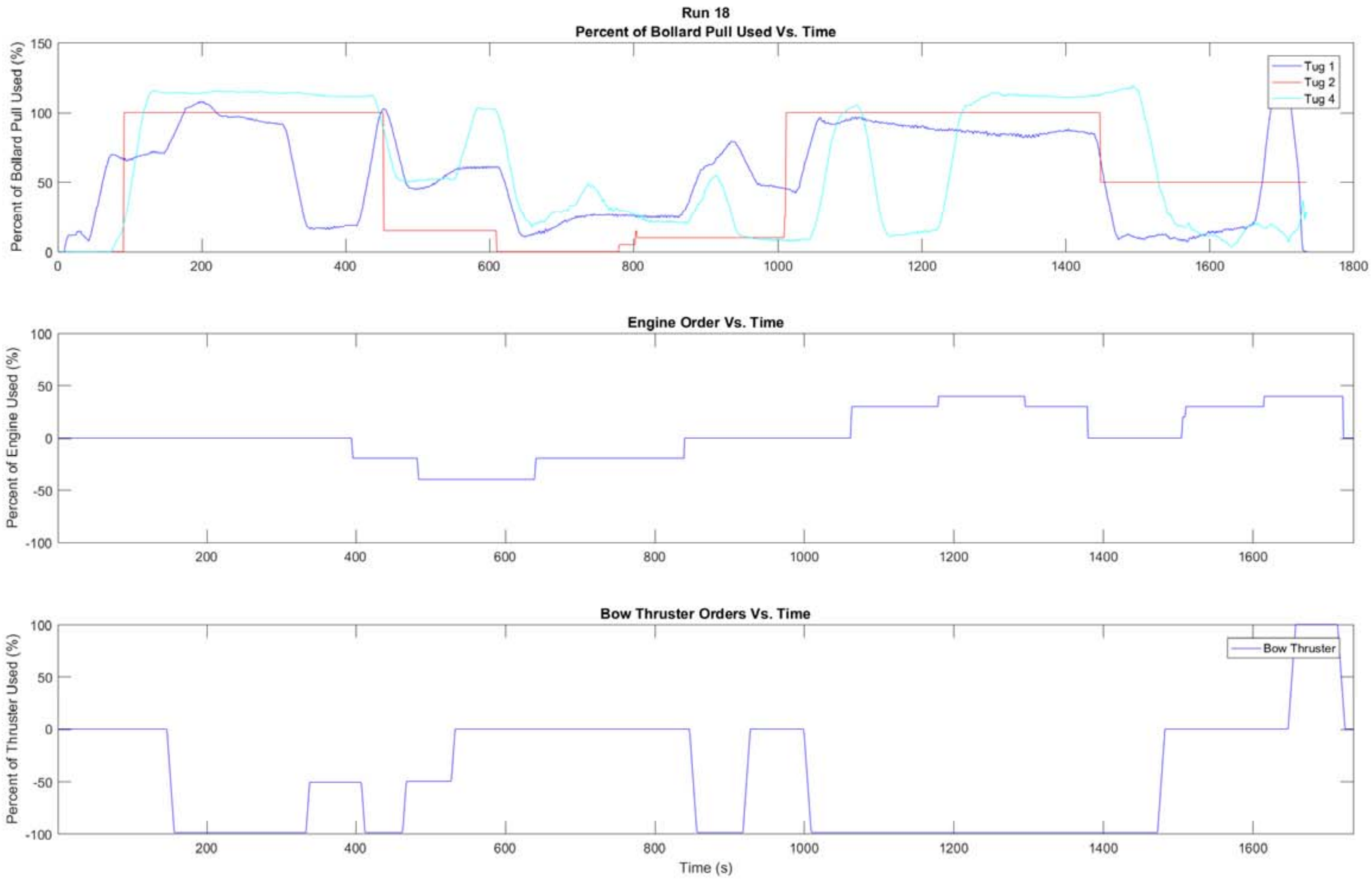

Run 13
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

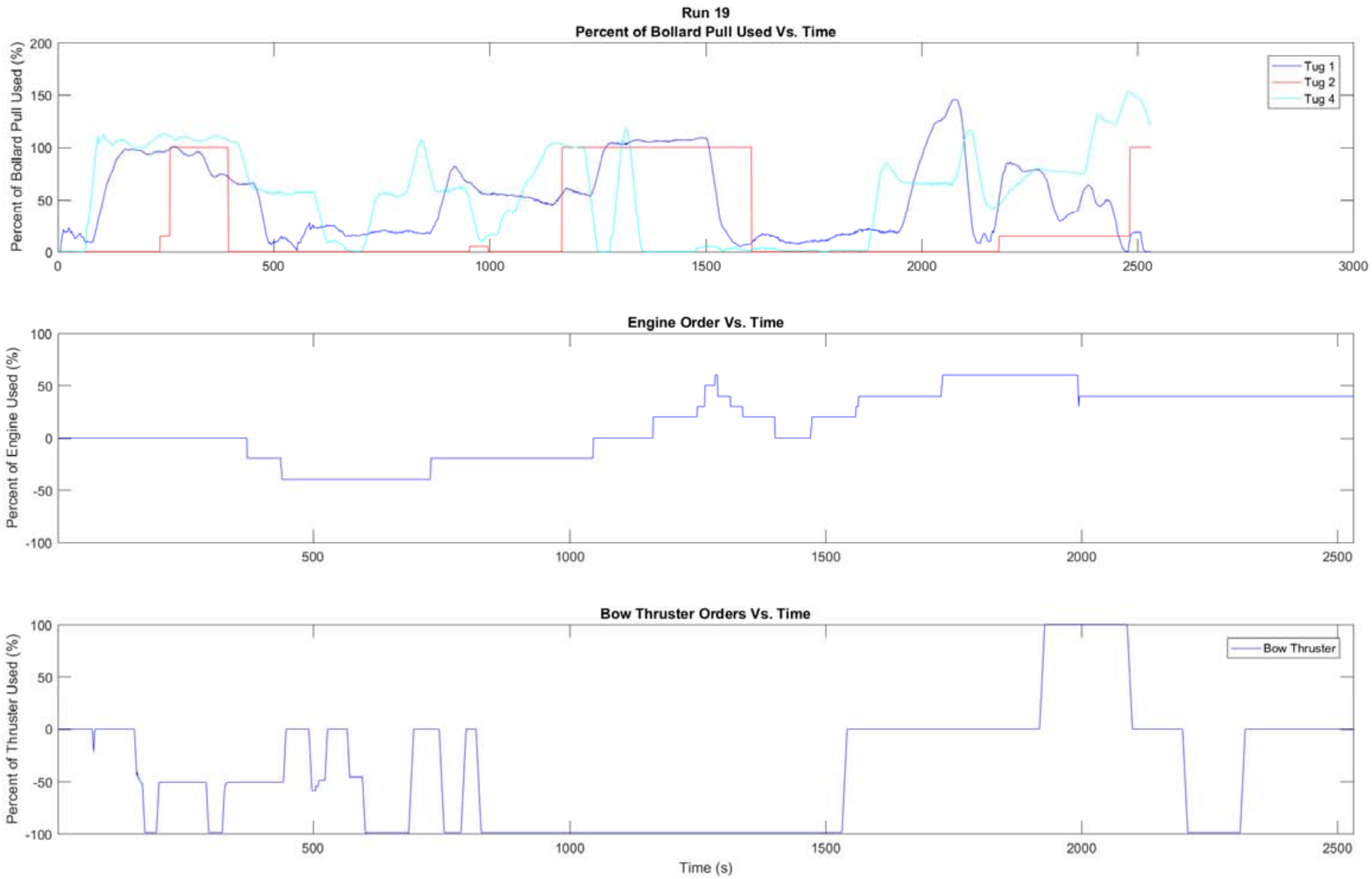

Run 14
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

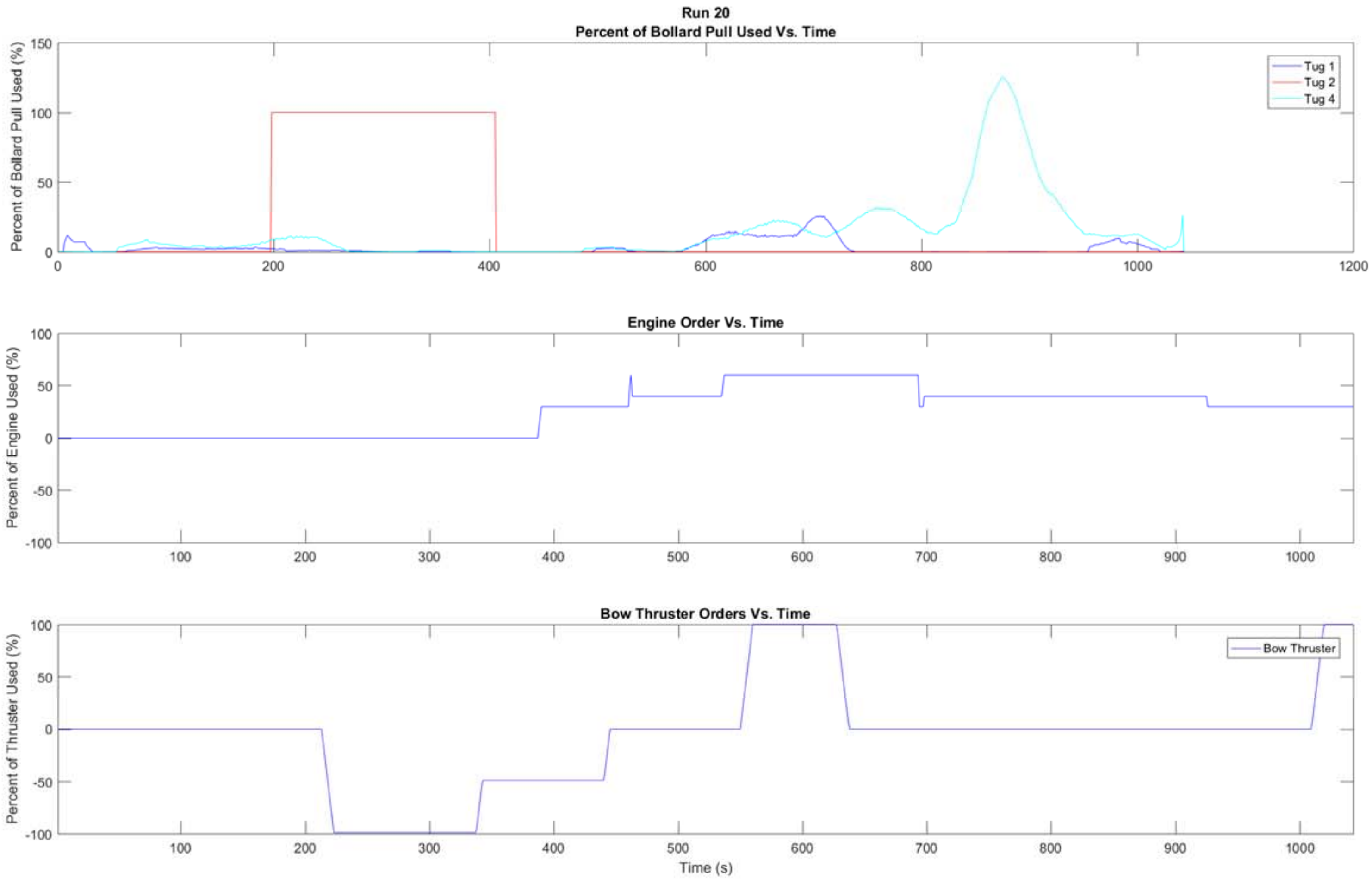

Run 15
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

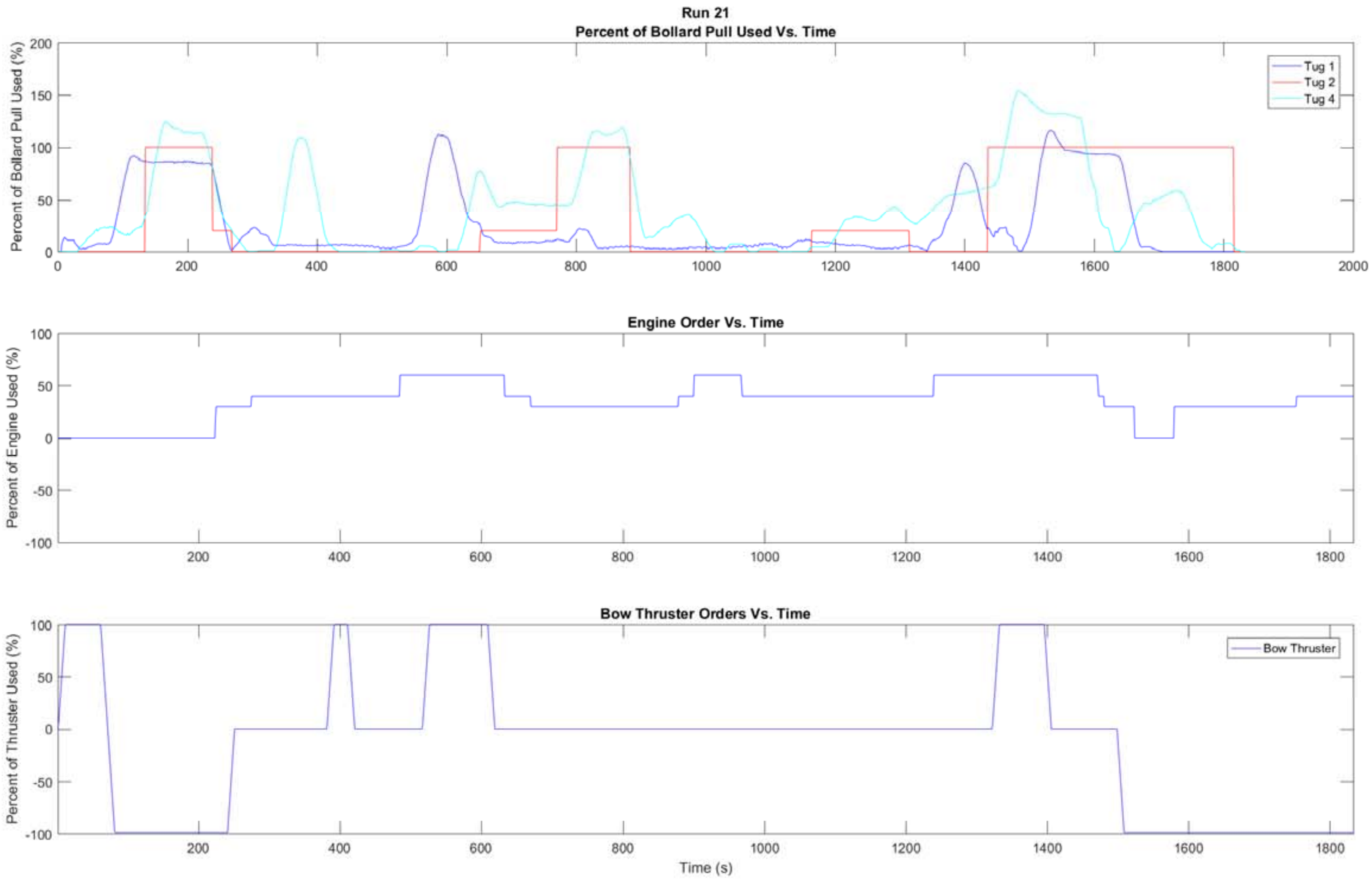

Run 16
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

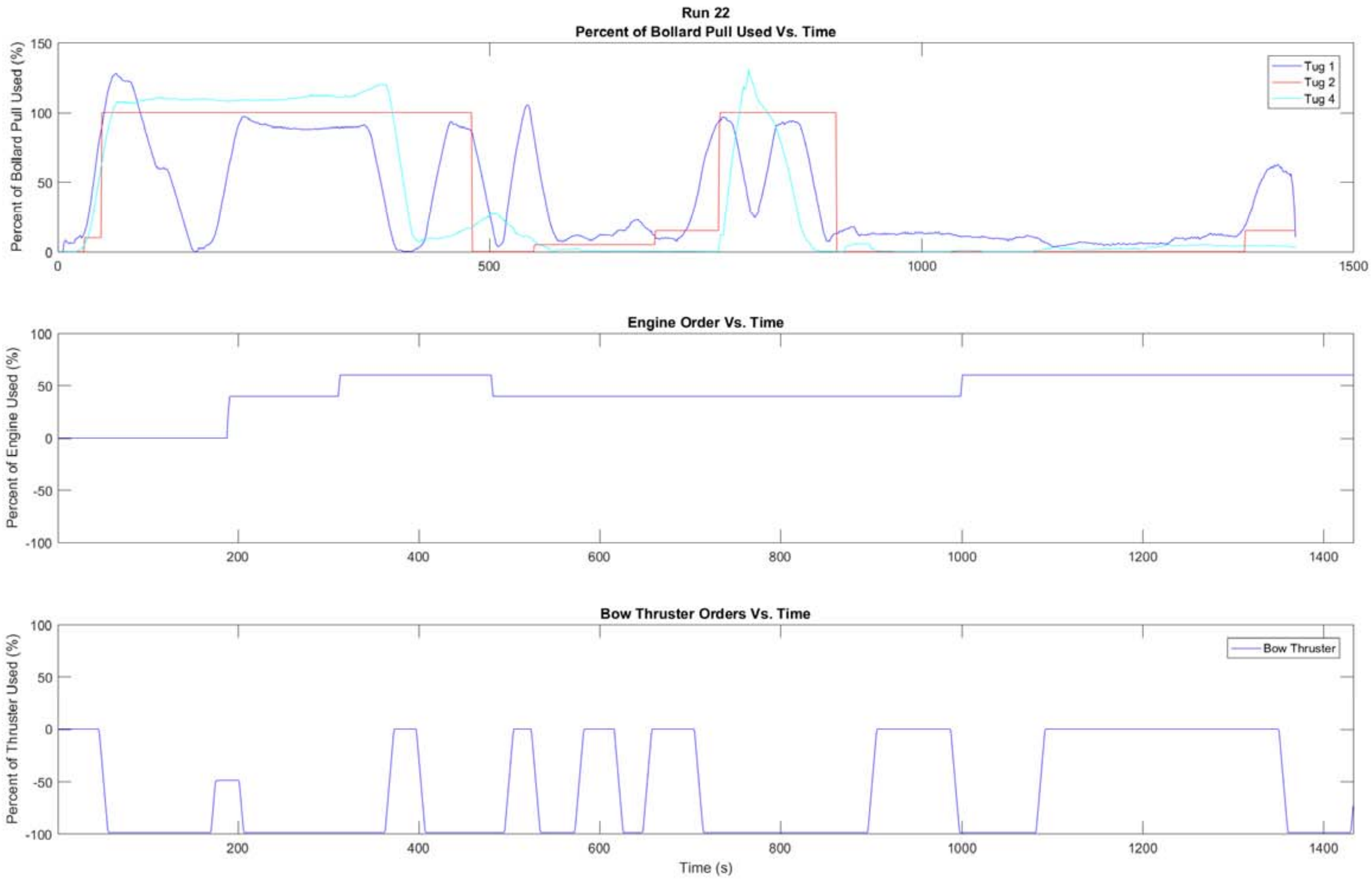

Run 17
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 18
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

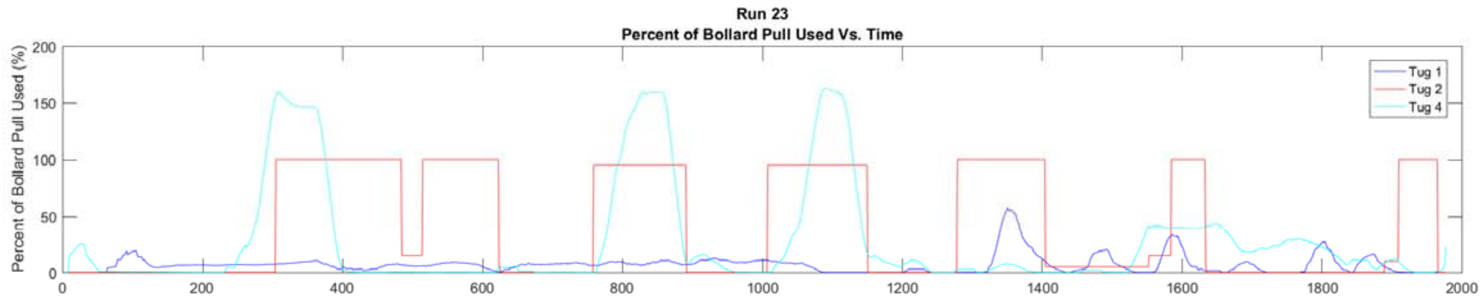

Run 19
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 20
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

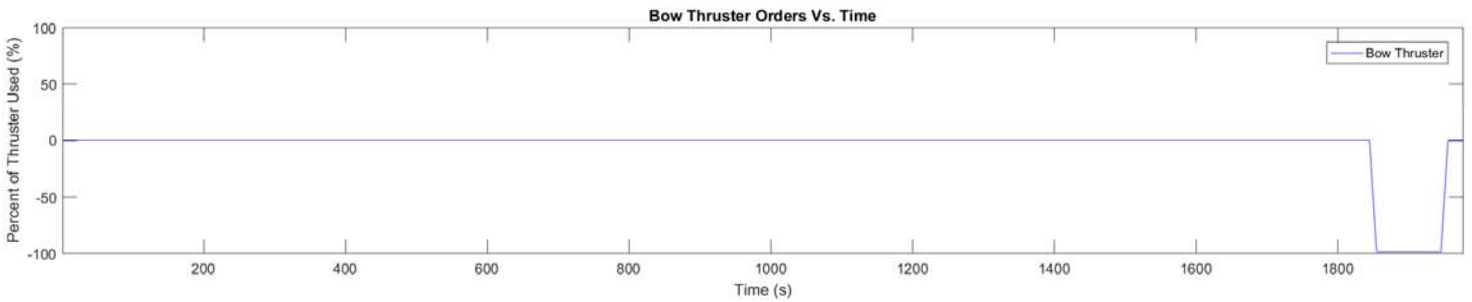

Run 21
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

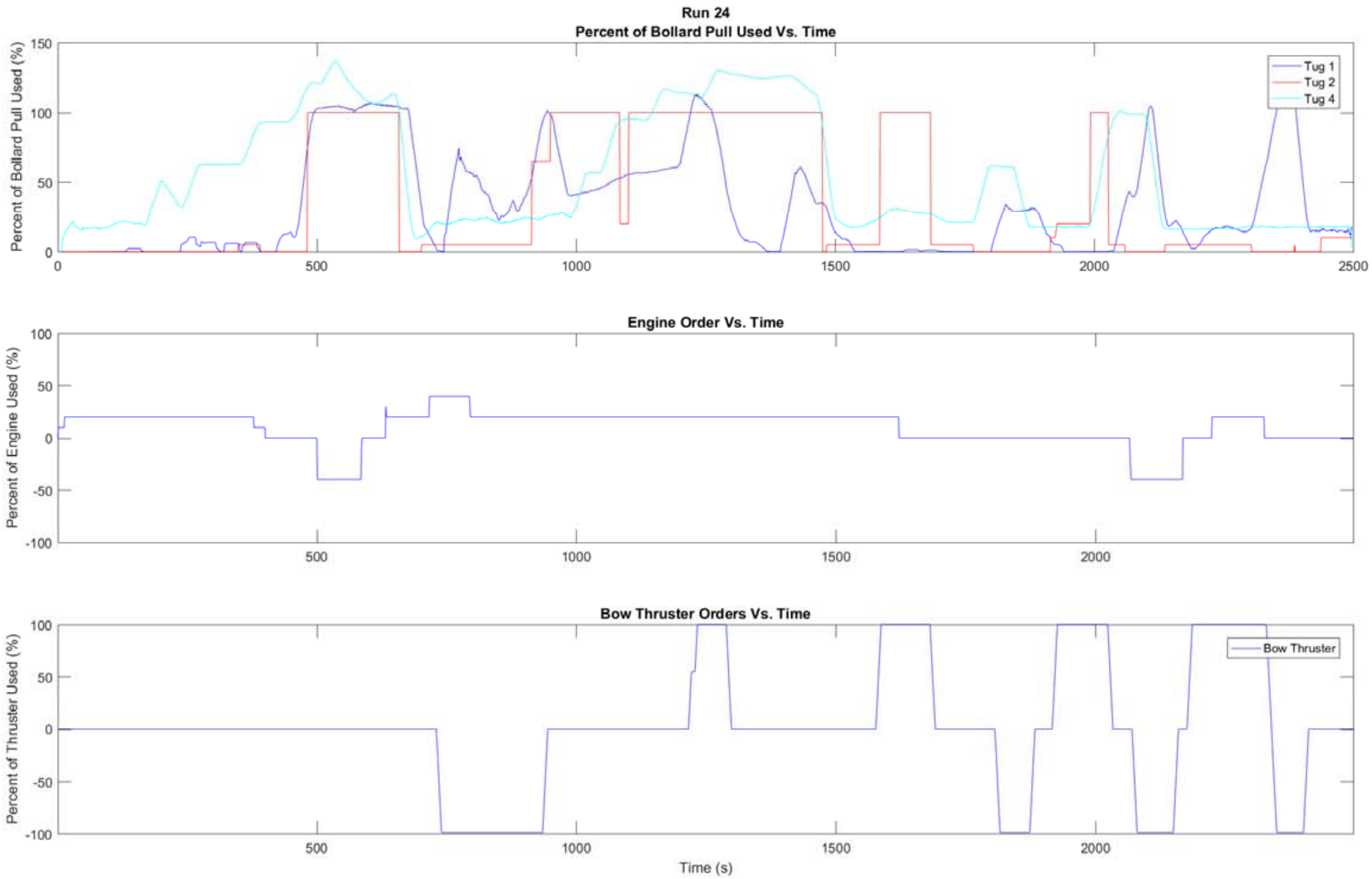


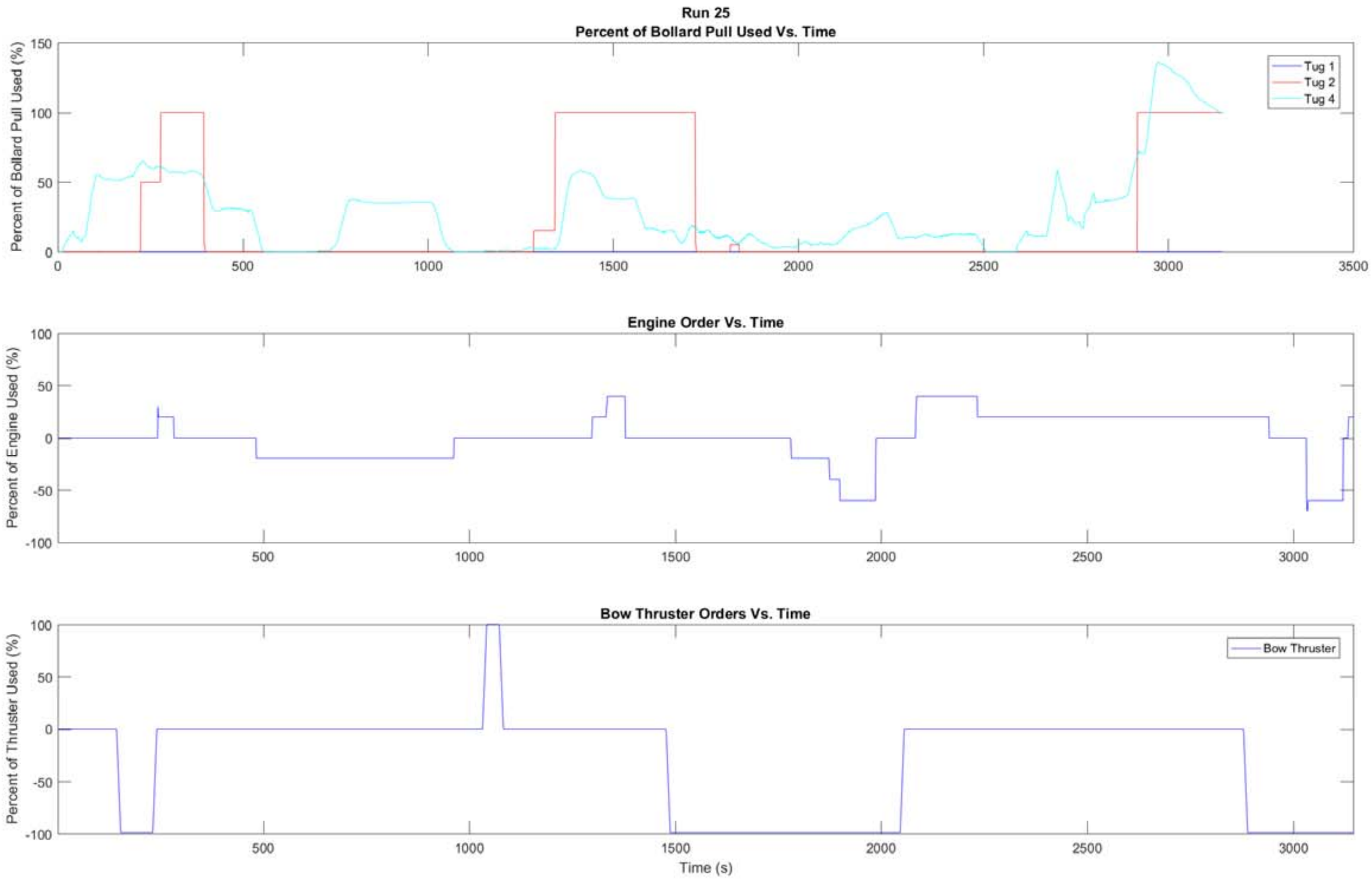
Run 22
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

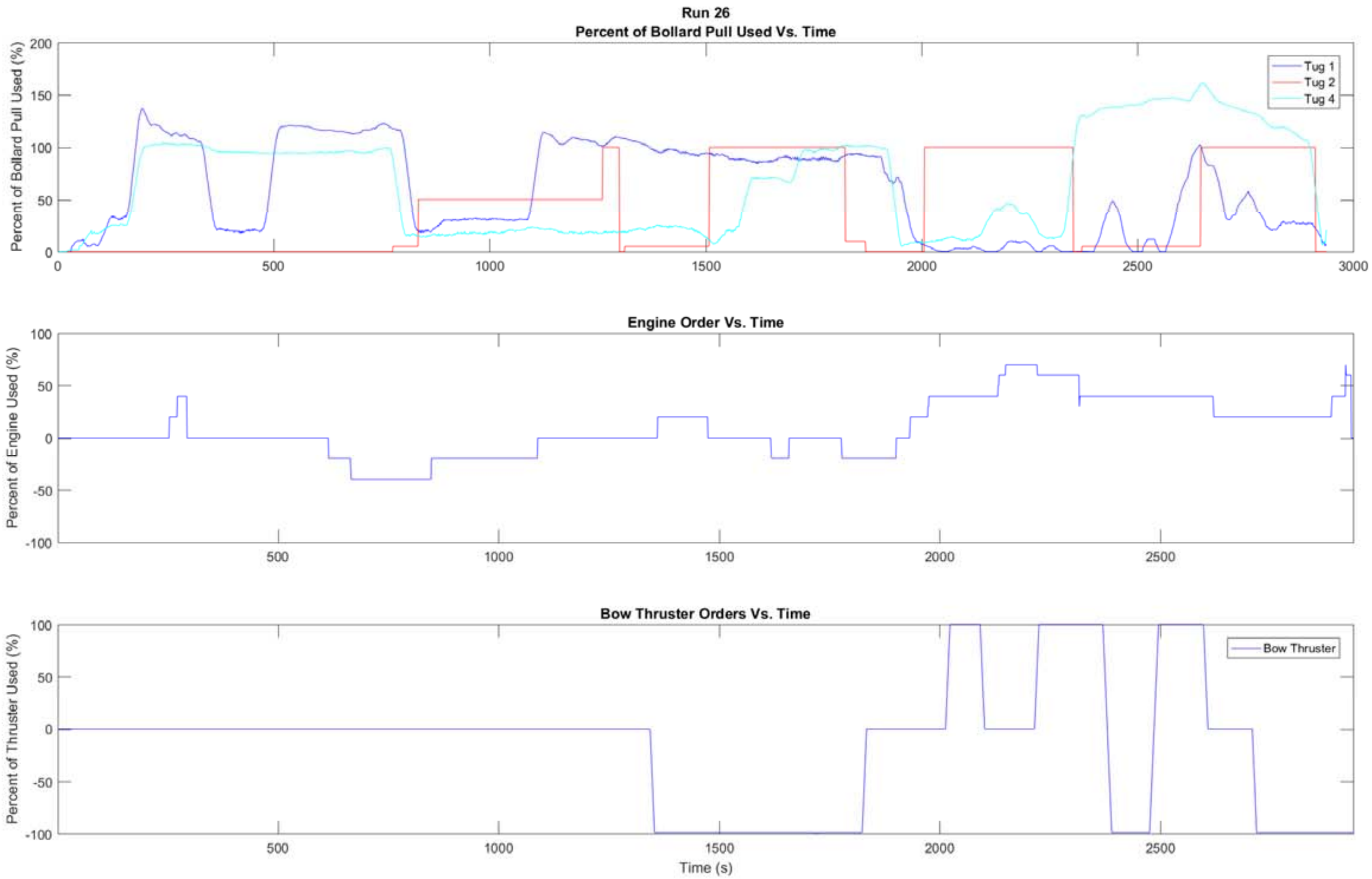

Run 23
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4

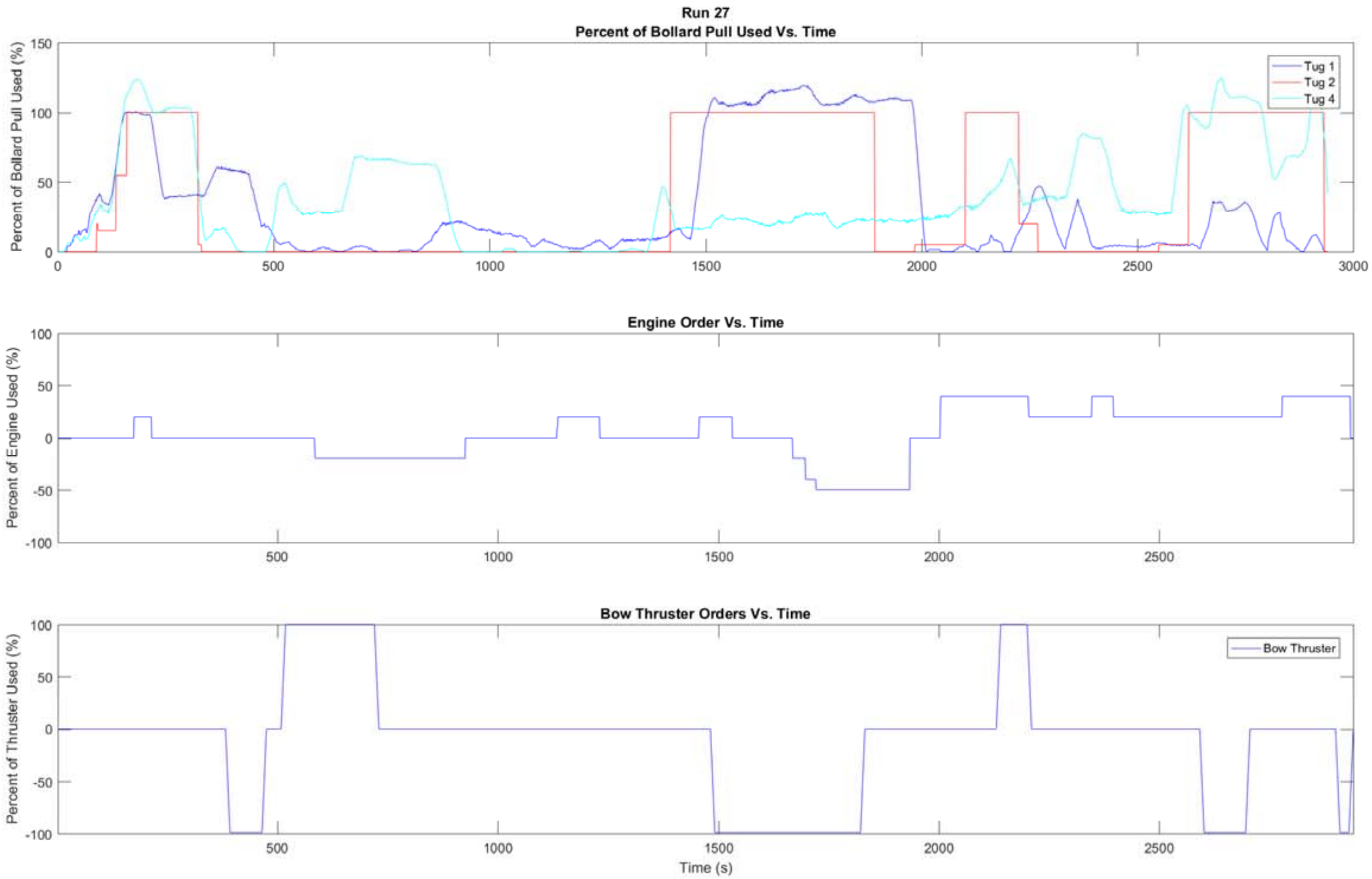

Engine Order Vs. Time
Percent of Engine Used (%)

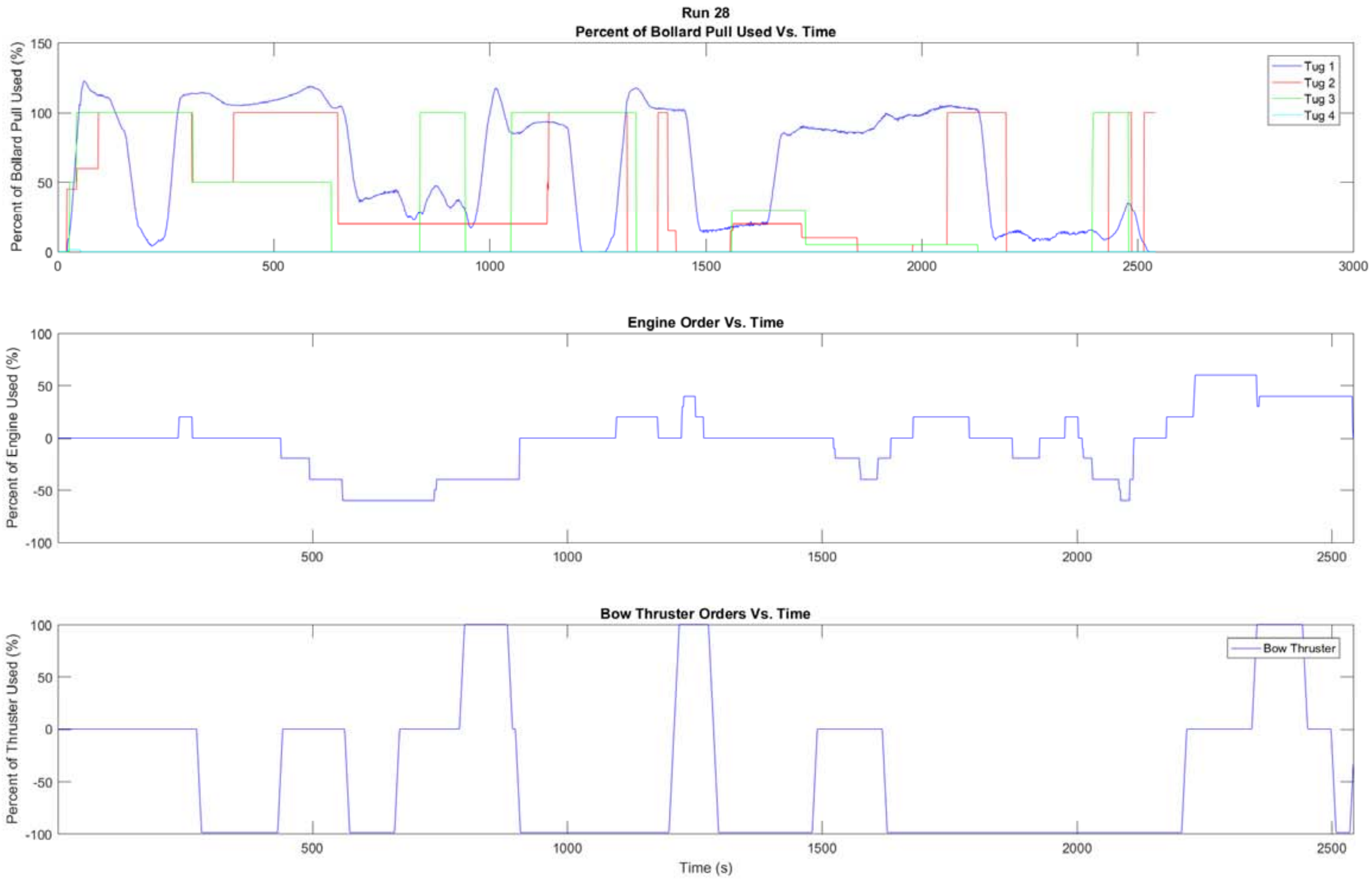

Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

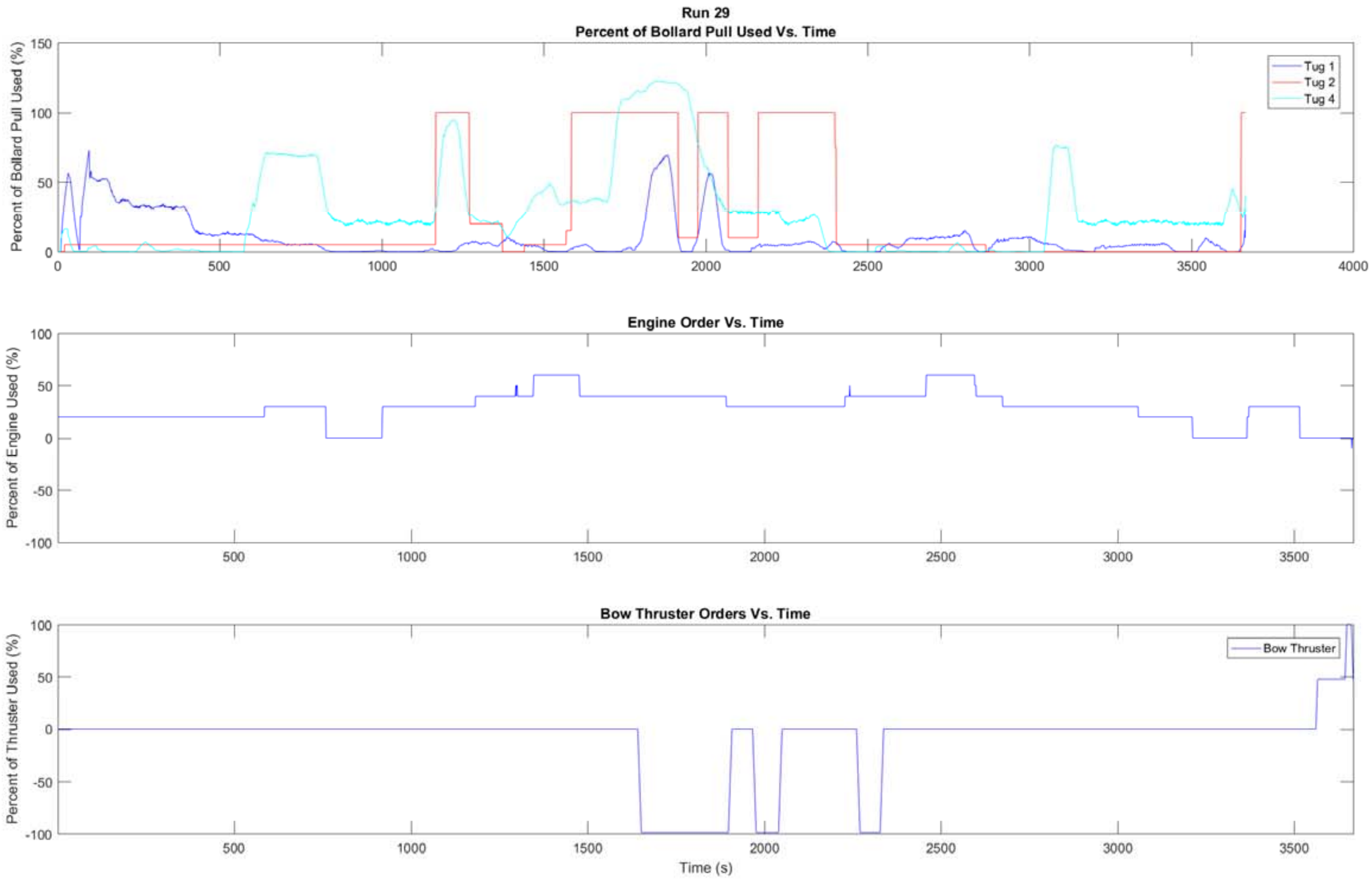

Run 24
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

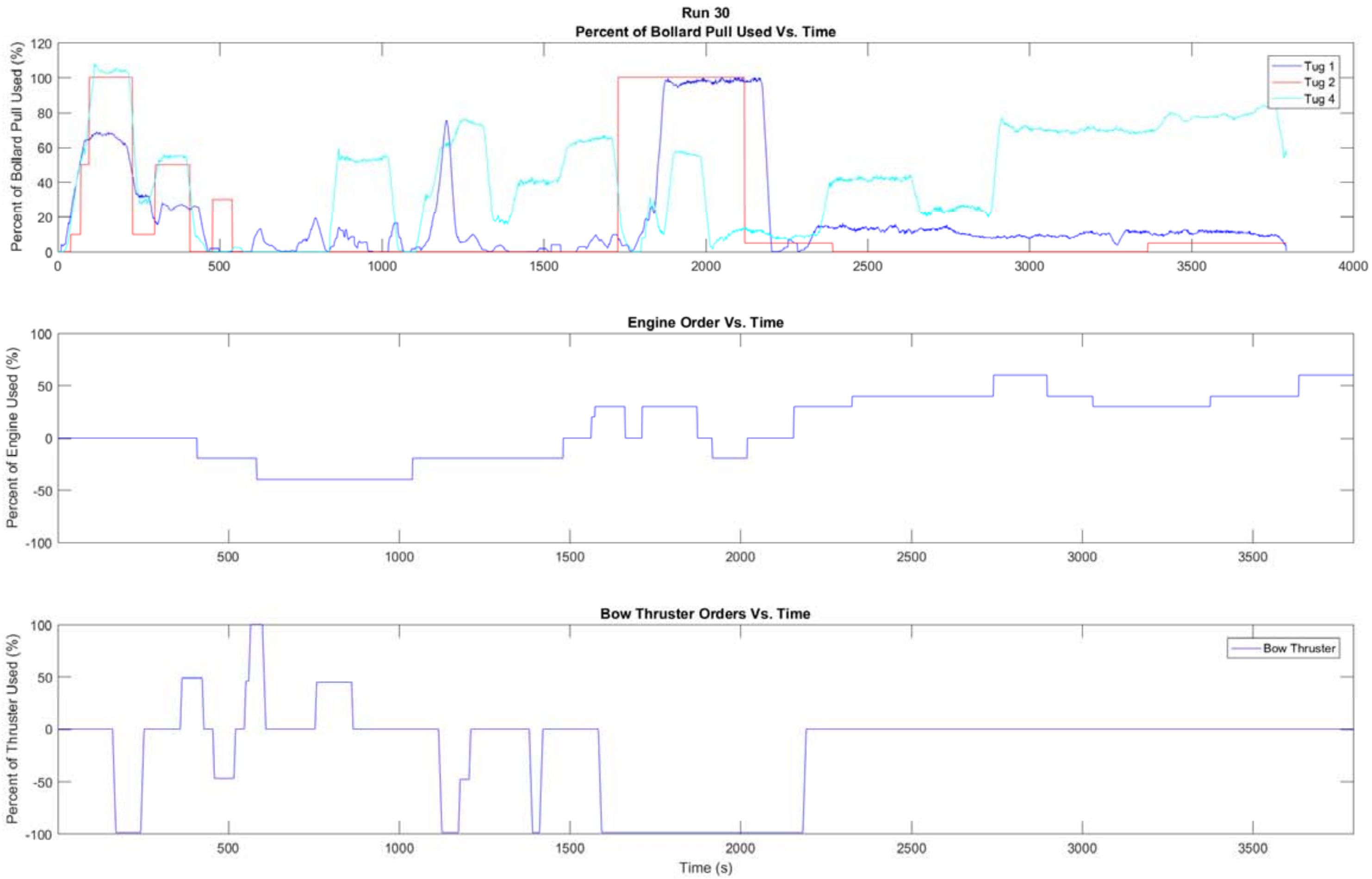

Run 25
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

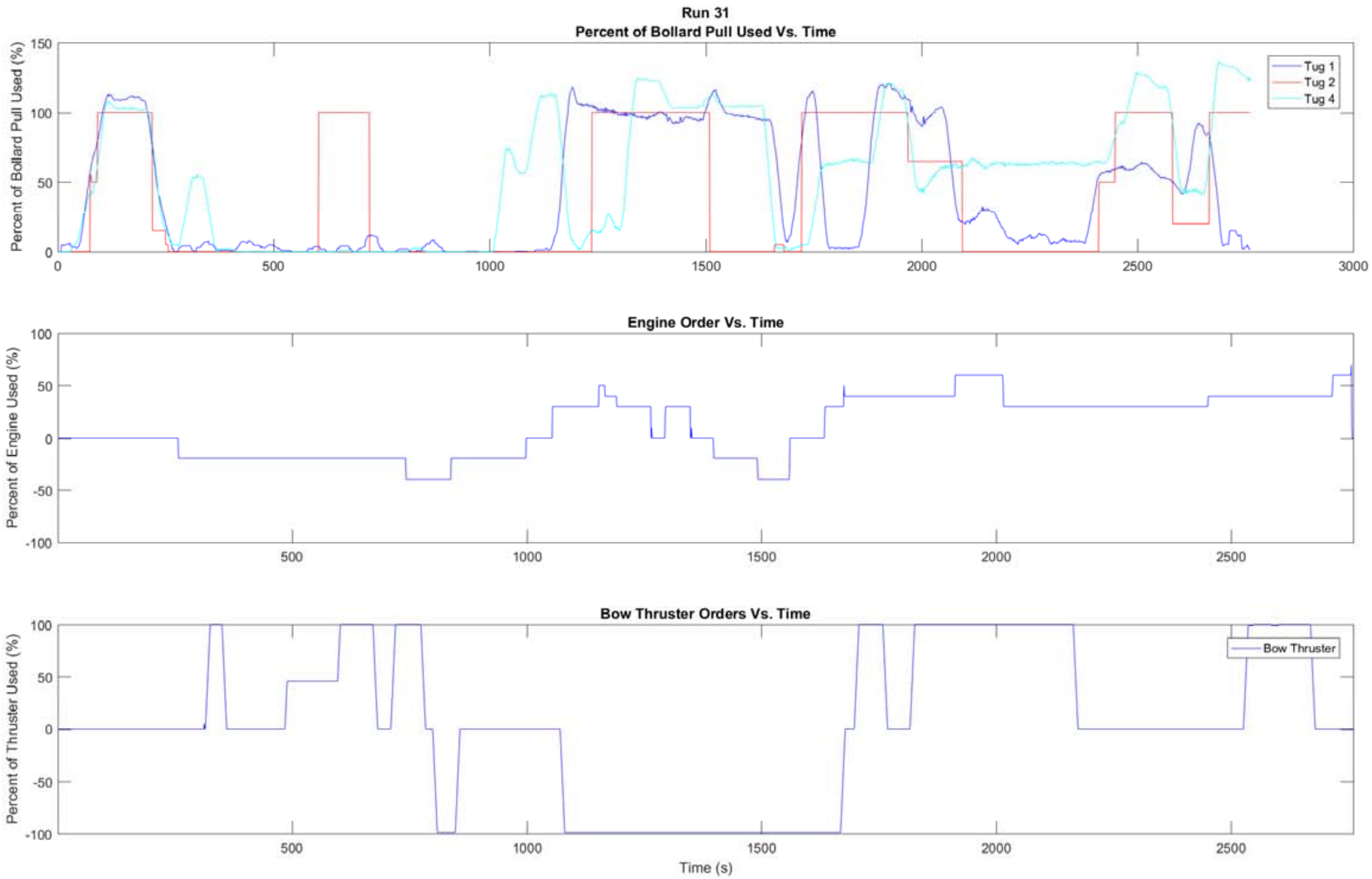

Run 26
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

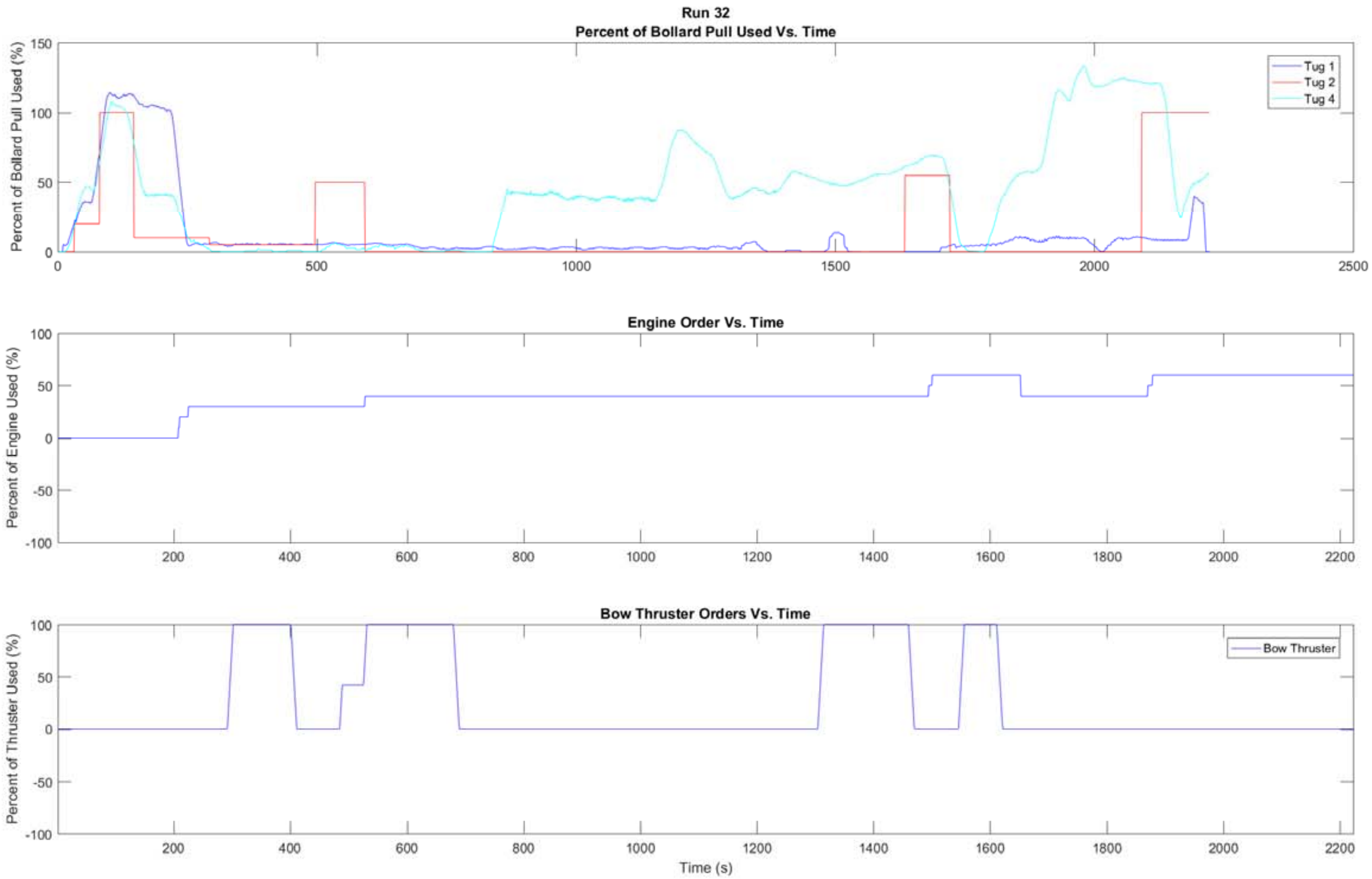

Run 27
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

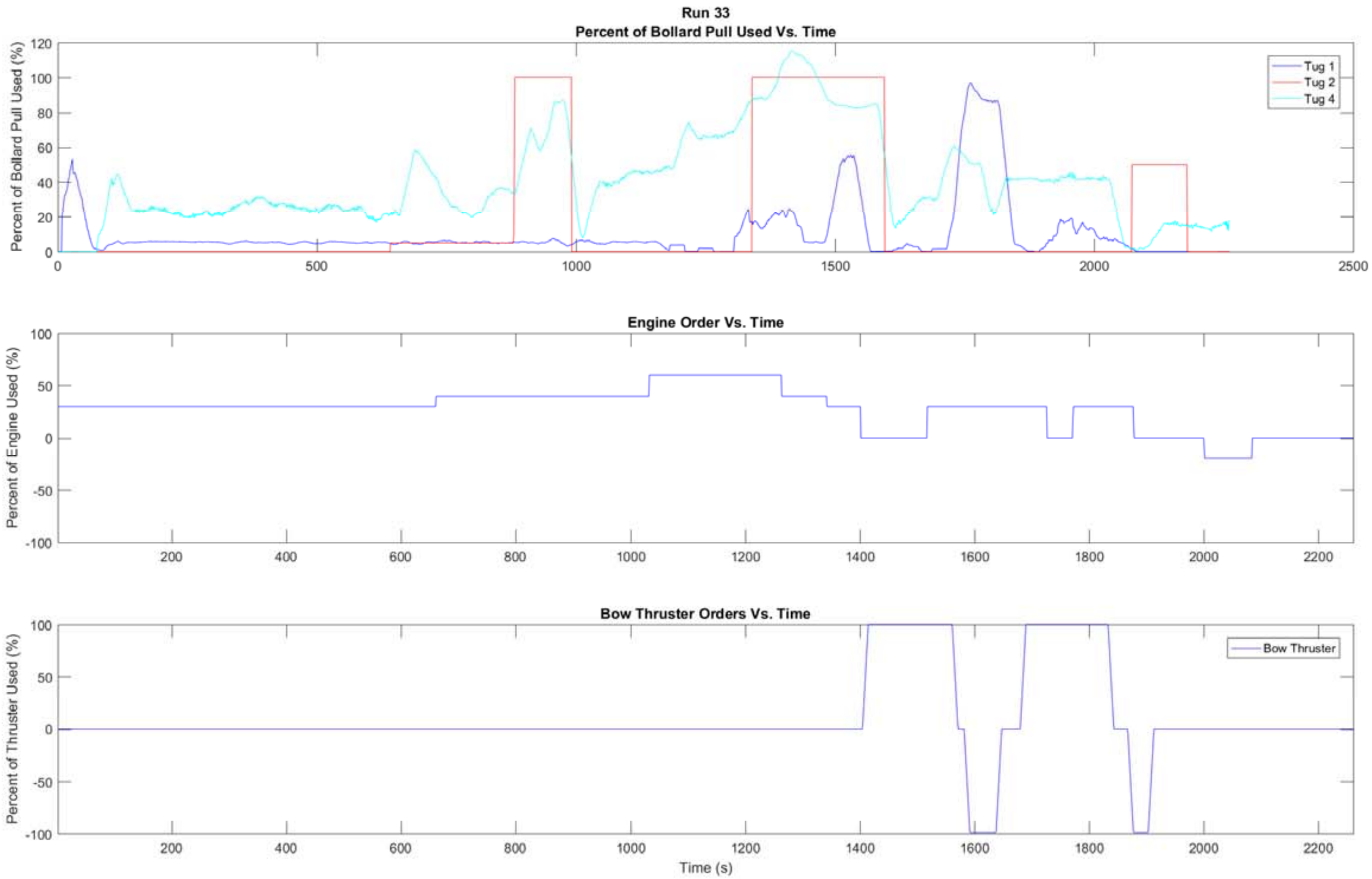

Run 28
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

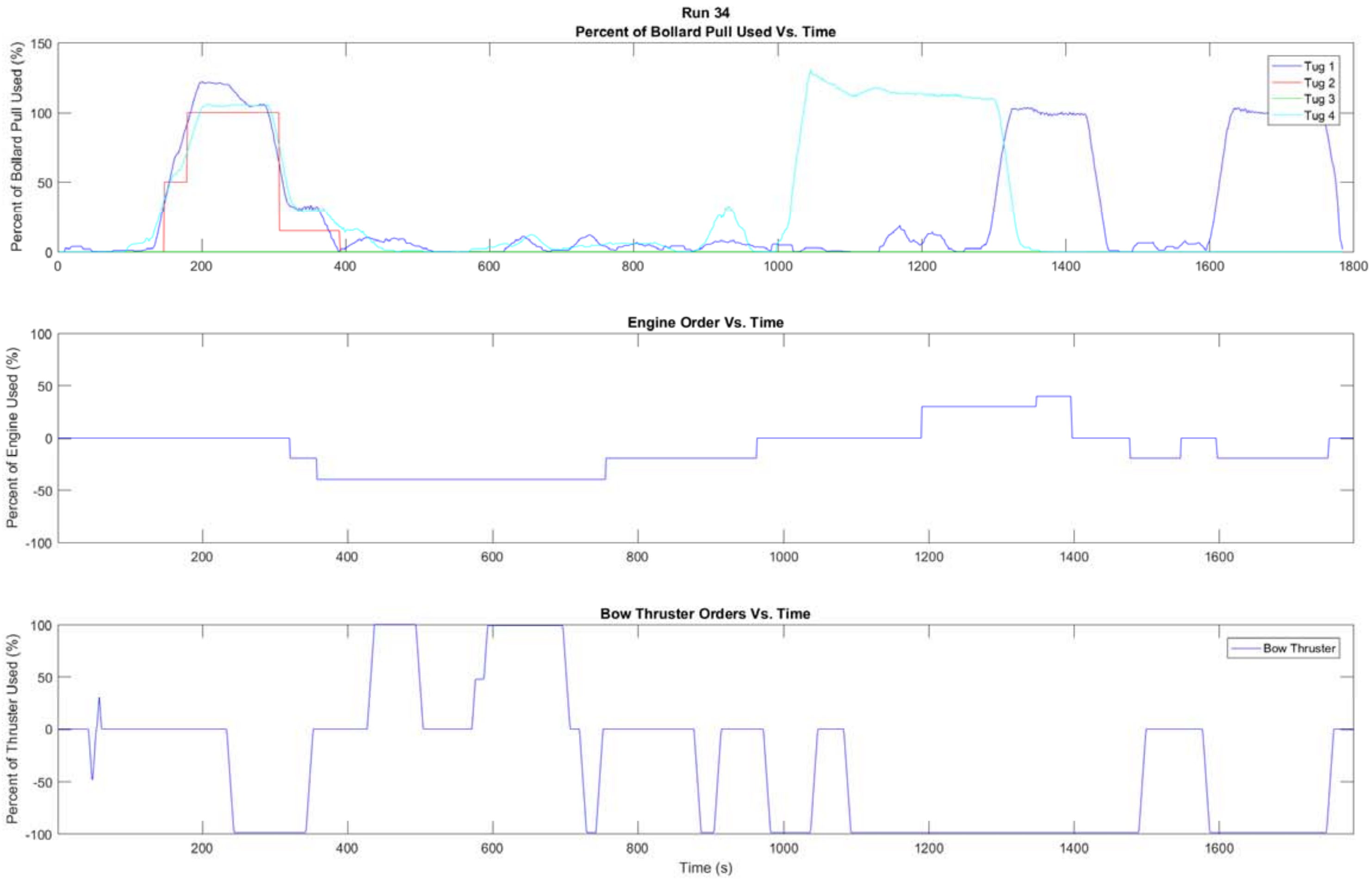

Run 29
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 30
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 31
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 32
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 33
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)


Run 34
Percent of Bollard Pull Used Vs. Time
Percent of Bollard Pull Used (%)
Tug 1
Tug 2
Tug 3
Tug 4
Engine Order Vs. Time
Percent of Engine Used (%)
Bow Thruster Orders Vs. Time
Percent of Thruster Used (%)
Bow Thruster
Time (s)

8. APPENDIX C – MITAGS/PMI INFORMATION

The Maritime Institute of Technology and Graduate Studies (MITAGS) and the Pacific Maritime Institutes (PMI) are non-profit, continuing education centers for professional mariners. The Institutes provide training for both civilian and military mariners at every level of their career.

MITAGS LOCATION AND GENERAL FACILITY DESCRIPTION

MITAGS is located less than five (5) miles from the Baltimore-Washington International Thurgood Marshall Airport (BWI). Complimentary shuttle links the campus with the airport, BWI Amtrak Rail, Baltimore Light Rail, and regional bus services. It is also near major tourist destinations; including Baltimore, Annapolis, and Washington, DC.

The MITAGS campus encompasses over forty (40) acres. The 300,000 square-feet facilities include:

- On campus hotel with 232 hotel rooms (3-STAR equivalent). Hotel and conference facilities approved by the International Association of Conference Centers (IACC).
- 500-seat dining facility, 250-seat auditorium, pub, and store.
- Indoor swimming pool, Jogging / walking trails, Nautilis® Fitness Room.
- Maritime Museum.
- ECDIS, Stability, LNG Cargo and Engine Room Training Software.
- Emergency Medical Lab.
- 16-station networked computer Lab.
- Two, 360° Transas Full-Mission Shiphandling Simulator integrated with a 120° Bridge Tug and a 300° Bridge Tug Simulators.
- 8-Ship Radar, Automatic Radar Plotting Aids (ARPA), and Electronic Chart Display and Information Systems (ECDIS) Simulators.
- Global Maritime Distress and Safety Systems (GMDSS) Communications Lab.
- Vessel Traffic System (VTS) Watchstander Training Lab.

PMI LOCATION AND GENERAL FACILITY DESCRIPTION

The Pacific Maritime Institute (PMI) is a subsidiary of MITAGS in Seattle, Washington. PMI is located approximately twenty (20) minutes from Seattle Tacoma (SEA-TAC) International Airport. Their waterfront facility is positioned directly within the Maritime Technology and Career Center. PMI offers the following onsite technology and training support facilities:

- 240° DNV Class A Full-Mission Bridge Simulator.
- Two 300° Full-Mission Tugboat Simulator.
- 6-Radar/Automatic Radar Plotting Aids (ARPA) Simulators.
- Two Electronic Chart Display and Information Systems (ECDIS)/Electronic Navigation Labs.
- Global Maritime Distress and Safety Systems (GMDSS) Communications Lab.
- 2-Simulation Debriefing Rooms and 12 conference / classrooms.

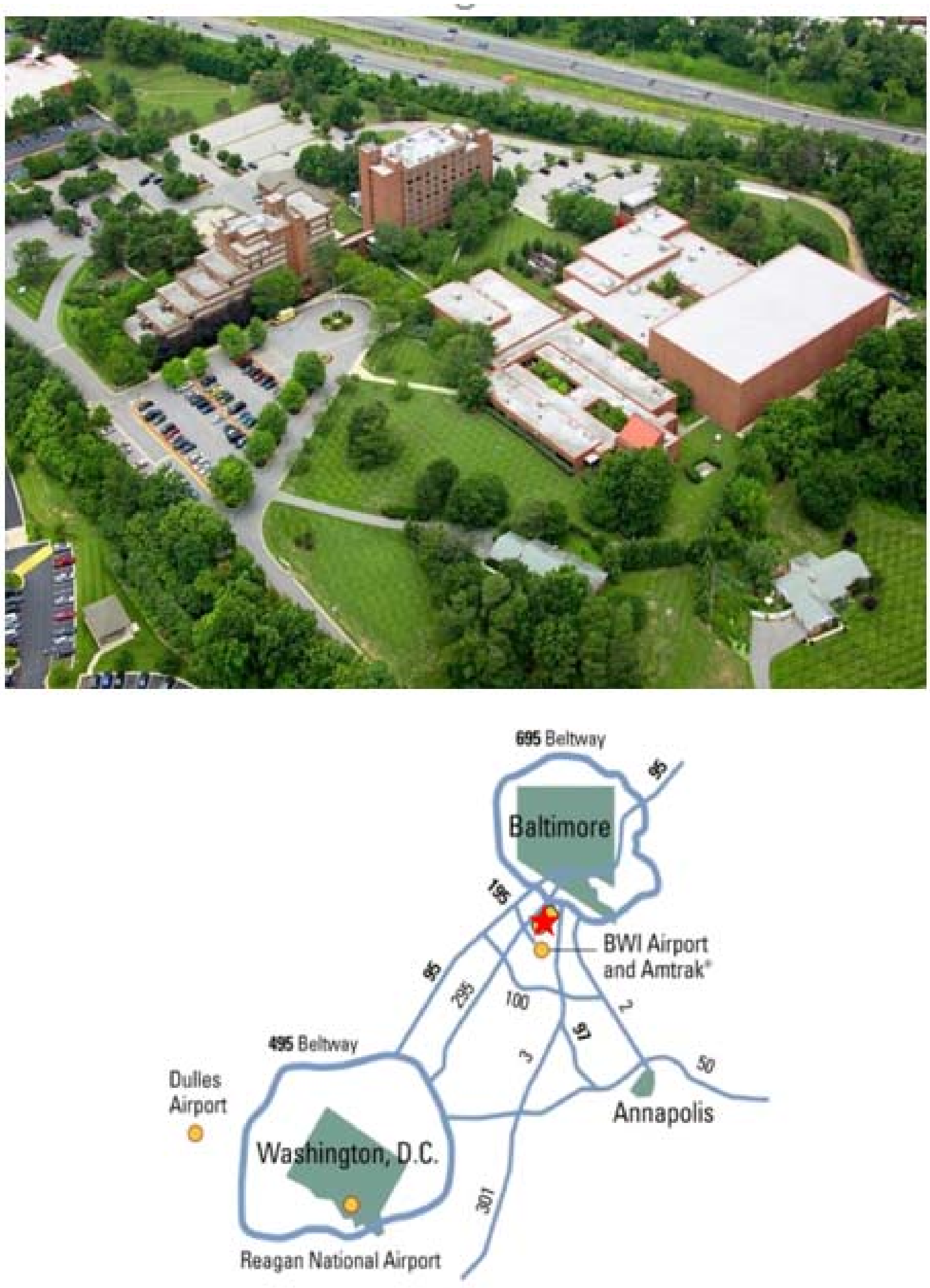


Figure 8-1: Aerial photograph of MITAGS campus and location

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B4:

Seagirt Loop Channel

Navigation Impact Assessment

ERDC/CHL TR-XX-DRAFT

Coastal and Hydraulics Laboratory

US Army Corps of Engineers®
Engineer Research and Development Center

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

Seagirt Loop Channel Navigation Impact Assessment

Ship Simulation Report

Shannon N. Stever, Kiara I. Pazan, and Mary C. Allison

November 2022

Approved for public release; distribution is unlimited.

The US Army Engineer Research and Development Center (ERDC) solves the nation's toughest engineering and environmental challenges. ERDC develops innovative solutions in civil and military engineering, geospatial sciences, water resources, and environmental sciences for the Army, the Department of Defense, civilian agencies, and our nation's public good. Find out more at www.erdc.usace.army.mil.

To search for other technical reports published by ERDC, visit the ERDC online library at http://acwc.sdp.sirsi.net/client/default.

Seagirt Loop Channel Navigation Impact Assessment

Ship Simulation Report

Shannon N. Stever, Kiara I. Pazan, and Mary C. Allison

Coastal and Hydraulics Laboratory
U.S. Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Final report

Prepared for U.S. Army Corps of Engineers, Baltimore District
2 Hopkins Plaza
Baltimore, MD 21201

Abstract

The U.S. Army Engineer Research and Development Center (ERDC) Coastal and Hydraulics Laboratory (CHL) assisted the U.S. Army Corps of Engineers (USACE), Baltimore District (CENAB) and the Maryland Department of Transportation (MDOT) Maryland Port Administration (MPA) in evaluating navigation channel deepening and widening designs in the West Seagirt Branch Channel (WSBC) within the Seagirt Loop Channel in the Baltimore Harbor. The primary objective of the study was to determine if the design vessel, the *CMA CGM Marco Polo* container ship, can safely navigate in the Seagirt Loop Channel. The two proposed authorized channel depth designs evaluated in the WSBC were -47 ft feet (ft) Mean Lower Low Water (MLLW) and -50 ft MLLW. Along with the channel depths, a proposed widening design in the WSBC was evaluated. Upon completing several ship simulation exercises, the participating pilots identified additional widening in the three areas of the WSBC. The modified widening design and both proposed channel depth designs were tested during the second week of testing.

A real-time ship simulation study was conducted using ERDC's Ship/Tow Simulator facility to assess the maneuverability of the design vessel and identify potential navigation issues in the proposed channel designs. Ship simulation testing was conducted over the course of ten days on 18-22 April 2022 and 25-29 April 2022 with four licensed pilots from the Association of Maryland Pilots (AMP). Based on the data collected from this study, including pilot elicitation, vessel track plots, and final pilot surveys, final recommendations on the channel design were provided to support the Baltimore Harbor Anchorages and Channels (BHAC) Modification of Seagirt Loop Channel, Maryland Feasibility Study.

Contents

Figures and Tables

Figures

Tables

Preface

This study was conducted for the U.S. Army Corps of Engineers (USACE), Baltimore District (CENAB). The technical lead at CENAB was Mr. Luis Santiago.

The ship simulation study was completed by the U.S. Army Engineer Research and Development Center (ERDC), Coastal and Hydraulics Laboratory (CHL), Navigation Branch of the Navigation Division. At the time of this study, Mr. Ryan Hoben was Acting Chief of the Navigation Branch, and Ms. Ashley Frey was Chief of the Navigation Division.

At the time of publication of this report, the Deputy Director of CHL was Mr. Keith Flowers, and the Director of CHL was Dr. Ty V. Wamsley.

The Commander of ERDC was COL Theresa A. Schlosser, and the Director of ERDC was Dr. David W. Pittman.

1 Introduction

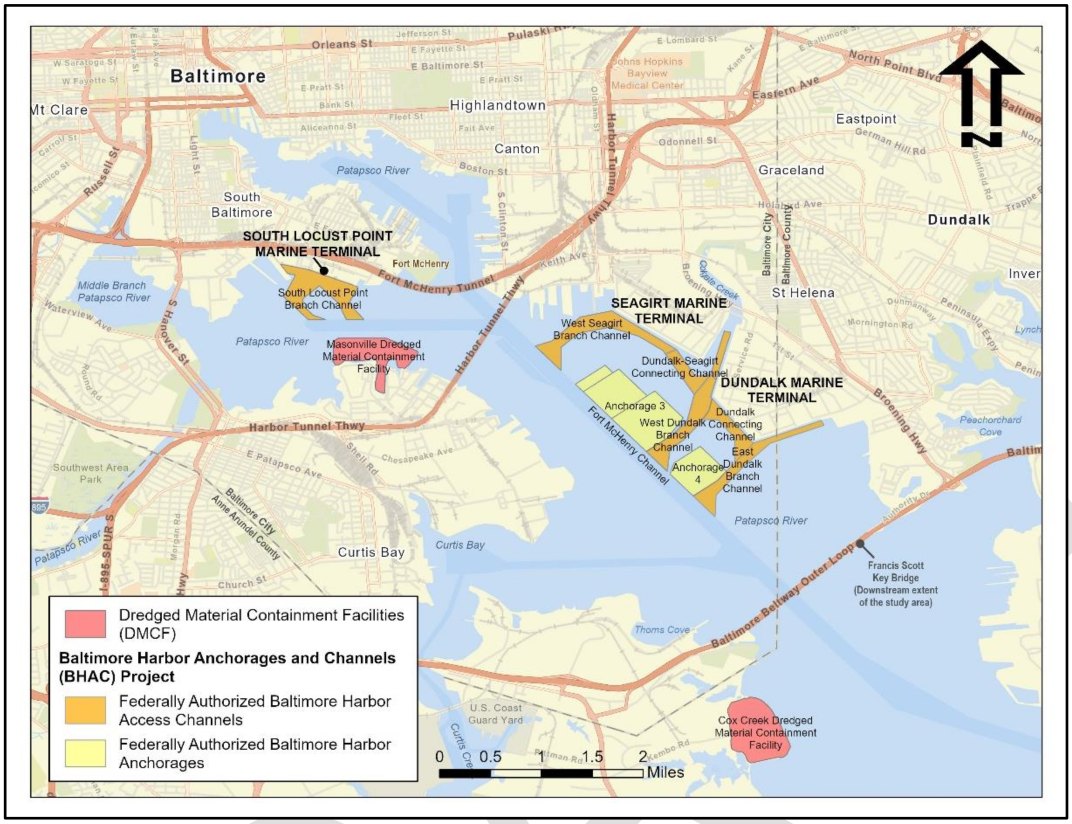
1.1 Background

The Port of Baltimore is located along the Patapsco River approximately 12 miles northwest of the Chesapeake Bay in Baltimore, Maryland. The Port is operated and maintained by the Maryland Port Administration (MPA), a division of the Maryland Department of Transportation (MDOT). The Port of Baltimore is one of the largest ports in the United States (U.S.) and it can accommodate some of the largest container ships in the world. The Port has five public terminals and twelve private terminals that support a variety of cargo and passenger cruises.

The Port has three federal dredging projects: the Baltimore Harbor Anchorages and Channels Project (BHAC project), the 42-Ft Project, and the 50-Ft Project. The BHAC feasibility study was completed in 1998 and construction for the project was completed in 2003, following federal authorization in the Water Resources Development Act of 1999. The BHAC project resulted in federal authorization of Anchorages 3 and 4 as well as deepening and assumption of maintenance in the access channels serving the Seagirt, Dundalk, and South Locus Point Marine Terminals. The BHAC project study area is shown in Figure 1. The navigation channel improvements authorized in the BHAC project study were designed to accommodate the types of vessels calling on the Port of Baltimore at the time. The design vessel used in the study was a Panamax container vessel that measured 965 ft long with a 106 ft beam, with design considerations for vessels with a larger beam of 135 ft to 145 ft.

Since the completion of the study in 1998, the Port of Baltimore has experienced an increase in calls from longer, wider, and deeper draft vessels that can carry over twice the cargo capacity than the vessels used to design the existing channels. To meet current and projected needs for container vessel traffic at the Port of Baltimore, the MDOT MPA and CENAB are conducting the BHAC Modification of Seagirt Loop Channel, Maryland Feasibility Study to evaluate the advisability of modifications to the BHAC project, particularly the Seagirt Loop Channel. The objectives of the study are to identify solutions that will improve navigation, increase safety, and decrease transportation delays for vessels calling to the Seagirt Marine Terminal (SMT) and Dundalk Marine Terminal (DMT).

Figure 1. Study area for the Baltimore Harbor Anchorages and Channels project.



The DMT is the largest general cargo facility at the Port of Baltimore. The terminal handles containers, automobiles, breakbulk, wood pulp, steel, project cargo, and Roll-on/Roll-off cargo (such as farm and construction equipment). Adjacent to the DMT across Colgate Creek is the SMT. The SMT is the destination for a majority of container traffic in the Port of Baltimore. The facility consists of four ship berths (Berths 1-4) with seven post-Panamax cranes and eight super post-Panamax cranes. Berths 1 and 2 at the SMT are -45 ft MLLW deep, and Berths 3 and 4 are -50 ft MLLW deep.

The Seagirt Loop Channel consists of the West Seagirt Branch Channel (WSBC), the Dundalk-Seagirt Connecting Channel, and the West Dundalk Branch Channel (Figure 1). The Dundalk-Seagirt Connecting Channel and the West Dundalk Branch Channel together are referred to as the Dundalk-Seagirt Access Channels. Currently, these navigation channels are maintained at various dredging depths. The WSBC is maintained to a depth of -45 ft MLLW, and the Dundalk-Seagirt Access Channels are maintained to a depth of -50 ft MLLW.

The existing channel configuration of the WSBC is inadequate to accommodate the growing fleet of Post-Panamax vessels. Vessels with a static draft of 42 ft or greater do not use the WSBC due to insufficient underkeel clearance (UKC). Vessels with a draft greater than 42 ft departing from SMT Berths 3 and 4 are required to back out of the loop with the assistance of several tug boats, turn around in the turning basin at the mouth of the Colgate Creek adjacent to the DMT, and transit outbound toward the Fort McHenry Channel (FMC). Backing out of the Seagirt Loop Channel and maneuvering in the turning basin requires additional transit time and significant use of the tug boats and presents safety concerns with the proximity to docked vessels and surrounding terminal infrastructure. Larger vessels have a greater risk of grounding, collision, allision, and tug casualties during this maneuver. Exiting through the Dundalk-Seagirt Access Channels instead of the WSBC also results in transportation delays for other vessels waiting to access the SMT or DMT berths, ultimately causing maneuverability concerns, transportation inefficiencies, and limiting operations within the Baltimore Harbor.

The MDOT MPA and CENAB proposed two channel designs in the 2022 *Draft Integrated Feasibility Report and Environmental Assessment* for the BHAC Modification of Seagirt Loop Channel Feasibility Study. The proposed channel designs consist of deepening and widening the WSBC to accommodate Post-Panamax vessels and provide an alternate path to exit the terminal instead of backing out through the Dundalk-Seagirt Connecting Channels. The design vessel used to test both plans was the *CMA CGM Marco Polo* container ship, a vessel that is anticipated to call to the Port of Baltimore in the future.

1.2 Objective

The objective of this study was to evaluate the proposed navigation channel deepening and widening designs in the WSBC and assess vessel maneuverability and tug requirements in the Seagirt Loop Channel. A real-time ship simulation study was performed to identify potential navigation problems in the Seagirt Loop Channel and optimize the channel design for safe vessel transit. The recommendations provided in this report will support the BHAC Modification of Seagirt Loop Channel, Maryland Feasibility Study.

1.3 Approach

The MDOT MPA and CENAB requested ERDC CHL to conduct a ship simulation study to evaluate the safety and efficiency of the proposed navigation improvements in the Seagirt Loop Channel using the Ship/Tow Simulator (STS) facility. Ship simulation testing was performed over the course of ten days on 18-22 April 2022 (Week 1) and 25-29 April 2022 (Week 2). Testing was livestreamed via WebEx to allow attendees to observe testing remotely. Table 1 lists all non-ERDC attendees who were present in-person at the ERDC STS facility during testing.

Table 1. List of ship simulation testing attendees.

Name	Affiliation	Role	Pilot Letter	Date(s) Present
Captain John Kinlein	AMP	Pilot	A	18-22 April
Captain Shimon Horowitz	AMP	Pilot	B	18-22 April
Captain Michael (Mike) Flanagan	AMP	Pilot	C	25-29 April
Captain James (Jim) Luke	AMP	Pilot	D	25-29 April
Eric Smith	Moffatt & Nichol	Observer	N/A	18-22 April
David (Dave) Bibo	MDOT MPA	Observer	N/A	26 April

Four licensed pilots from the Association of Maryland Pilots (AMP) participated in the study. Two pilots were present for each week of testing. Each pilot was assigned a letter (A-D) to identify the navigator for each exercise in the data. Each pilot performed a series of ship simulation exercises within the existing and proposed navigation channels to determine whether the channel configurations are sufficient for safe vessel navigation in a range of weather, wind, traffic, and tug casualty scenarios. Prior to beginning ship simulation testing, pilots A-D were provided the Pilot Cards (Appendix A) to learn about the nature of the vessel and plan navigation accordingly.

The testing scenarios were determined in coordination with the AMP pilots, the MDOT MPA, and the CENAB. The data presented in results section of this report includes description of test scenarios, pilot feedback, vessel track plots, and final pilot surveys.

1.4 Ship Simulator Description

The ERDC Ship/Tow Simulator (STS), located at the ERDC Coastal and Hydraulics Laboratory in Vicksburg, Mississippi, has served as a vital model and engineering design tool for navigation channel projects for the USACE since the 1980s.

The ERDC STS facility has three full mission bridges that replicate real vessel bridges. Each bridge contains hardware that pilots use to control the vessel including rudders, thruster, engine power, and tug commands. The simulator bridges can operate independently or can be linked together in the same virtual environment to perform meeting scenarios where two ships pass each other in a channel. The ERDC STS can simulate multiple types of crafts such as container ships, cruise ships, tow boats and barges, military crafts, and more in various types of maritime environments. Vessel maneuvers in the simulator occur in real time, which means transits take the same amount of time in the simulator as they would in real life. Figure 2 shows a captain piloting a container ship in the Seagirt Loop Channel in the Baltimore Harbor.

Figure 2. Captain Shimon Horowitz piloting the ERDC STS during testing

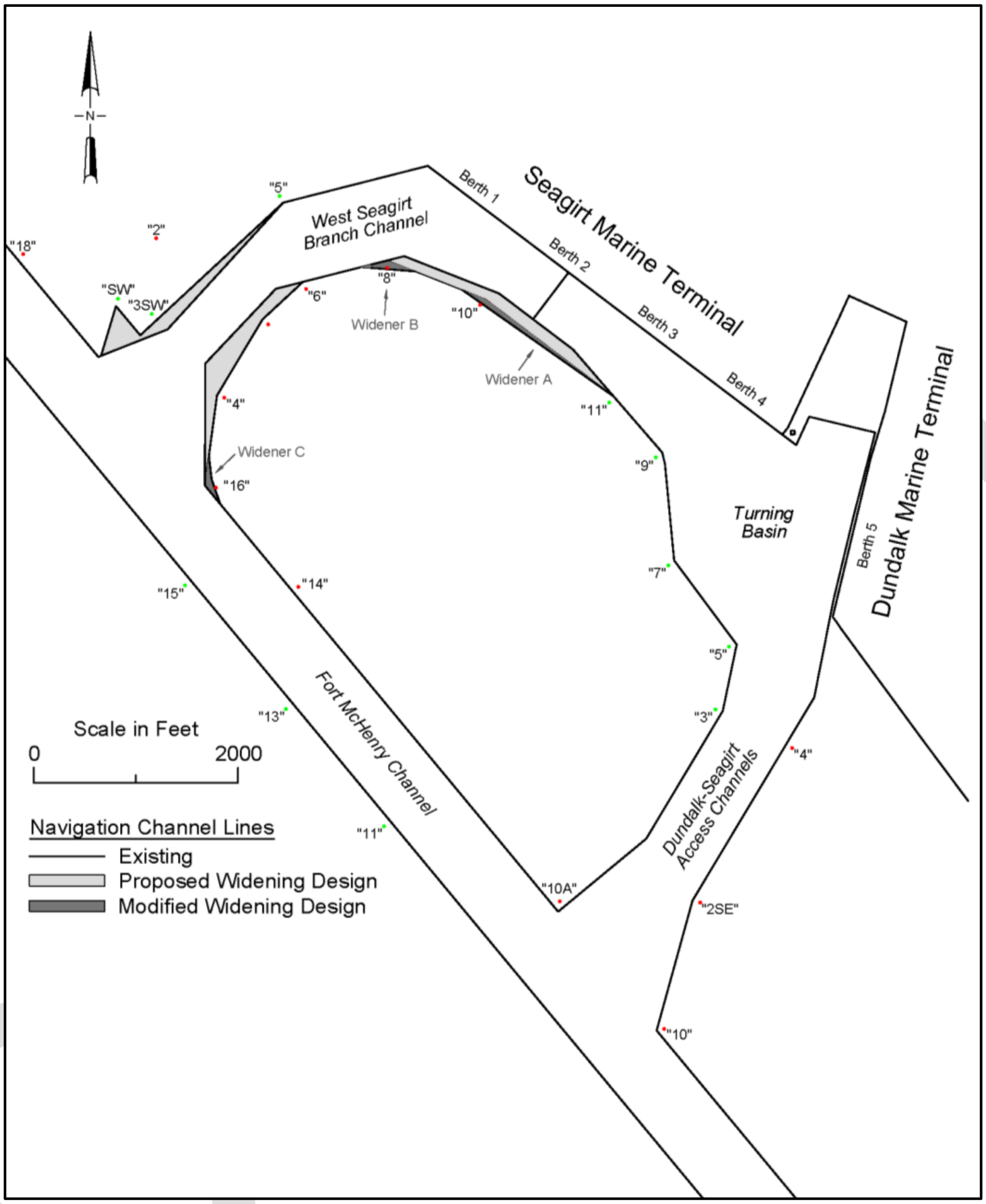
2 Proposed Channel Designs

The MDOT MPA and CENAB presented one navigation channel widening design and two channel depth designs for the WSBC, -47 ft MLLW and -50 ft MLLW. The -47 ft MLLW design proposes an authorized depth of -47 ft MLLW in the WSBC, and the -50 ft MLLW design proposes an authorized depth of -50 ft MLLW in the WSBC to match the current depth of the Dundalk-Seagirt Access Channels. The WSBC is currently maintained to a depth of -45 ft MLLW, and the channel depth changes abruptly from -45 ft MLLW to -50 ft MLLW at SMT Berths 2/3 (Figure 3). The -50 ft MLLW design ensures consistent channel depth throughout the Seagirt Loop Channel.

The proposed channel deepening and widening designs were optimized for Post-Panamax Generation III Max vessels with consideration of *CMA CGM Marco Polo* as the largest vessel that can call to the Port of Baltimore in the future. The UKC the vertical distance between the lowest point of the vessel and the channel bottom, was assumed to be 2.5 ft at static draft for both channel designs. The proposed widening design of the WSBC was initially simulated during a 2018 ship simulation completed at the Maritime Institute of Technology and Graduate Studies (MITAGS) in Linthicum Heights, Maryland.

During the first week of ship simulation testing, the pilots from AMP identified additional areas to widen to improve navigation conditions in the WSBC. The proposed widening design and AMP's modified widening design are shown in Figure 3. The pilots' recommended widening designs are designated by Wideners A, B, and C.

Figure 3. Proposed navigation channel widening designs in the West Seagirt Branch Channel within the Seagirt Loop Channel



3 Database Development

Virtual databases of the existing and proposed project conditions were developed to input into the ERDC STS. A virtual database includes inputs such as vessel hydrodynamics, environmental forces, and visual scenes. The existing condition databases were first validated by the experienced pilots and then modified to reflect the proposed future conditions.

3.1 Design Vessel

The MDOT MPA and CENAB selected the design vessel for the BHAC Modification of Seagirt Loop Channel, Maryland Feasibility Study based upon economic studies of vessels forecasted to call to the Port of Baltimore. The design vessel for the study is the *CMA CGM Marco Polo* container ship, a Post-Panamax Generation III Max (PPX III Max) class ship. The design vessel characteristics are listed in Table 2. Additional details about the CNTNR51 and CNTNR52 vessel models can be found in the Pilot Cards in Appendix A.

Table 2. *CMA CGM Marco Polo* design vessel dimensions and characteristics.

Vessel Name	*CMA CGM Marco Polo*	*CMA CGM Marco Polo*
Vessel Model	CNTNR51	CNTNR52
Class	PPX III Max	PPX III Max
Maximum Capacity	16,022 TEU*	16,022 TEU*
Length Overall (LOA)	1,299 ft	1,299 ft
Beam	175.9 ft	175.9 ft
Static Draft	47.5 ft	44.5 ft
Trim	Even Keel	Even Keel
Displacement	206,000 tons	189,890 tons
Engine Power	102,346 hp	102,346 hp
Propeller	Fixed pitch	Fixed pitch
Bow Thrusters	2 (9,789 hp)	2 (9,789 hp)

*TEU = Twenty-ft equivalent units

Two model versions of the *CMA CGM Marco Polo* container ship were used in this study. The 44.5 ft draft vessel model (CNTNR52) was used to evaluate both the -47 ft MLLW and the -50 ft MLLW designs. The 47.5 ft draft vessel model (CNTNR51) was used to evaluate only the -50 ft MLLW design. Vessel model CNTNR51 cannot transit in the WSBC under the -47 ft MLLW design because the vessel draft exceeds the channel depth.

All simulations included four tug boats of 65-ton push/pull to assist the transiting vessel. Pilots provided tug commands including tonnage and direction to the ERDC simulator operators during the exercises.

3.2 Visual Database

A visual database was developed using Google Earth imagery and photographs taken of the area during a reconnaissance trip for a separate study conducted in 2018. The visual scene included the Seagirt Loop Channel, significant features of the Seagirt Marine Terminal and the Dundalk Marine Terminal, and other essential surrounding structures and environment visible to the pilots during a real-world transit. The visual scene also contained U.S. Coast Guard maintained Aids to Navigation (ATONS) and other existing navigational markers.

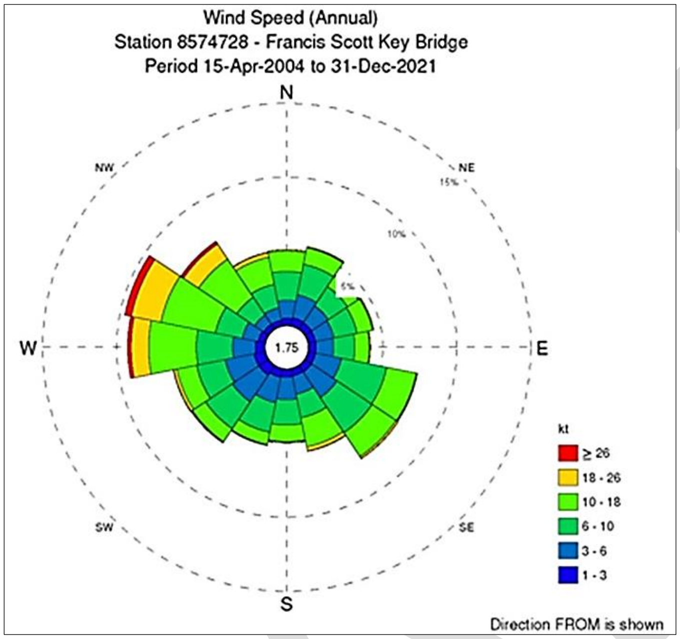
The radar and Electronic Chart Display and Information System (ECDIS) were created for the area from electronic navigation charts (ENCs) developed by the National Oceanic and Atmospheric Administration (NOAA).

3.3 Environmental Database

An environmental database was created for the Seagirt Loop Channel that included wind, bathymetry, and visibility. Wind speeds ranging from 25 knots to 35 knots from several directions including NW (315°), WNW (300°), SSE (170°), SE (135°), and NE (45°) were tested in the study. A NOAA wind rose for Baltimore Harbor was used to identify the most probable adverse wind conditions (Figure 4). The majority of the runs simulated wind from either the WNW or SSE direction. During the database validation, pilots confirmed these wind conditions were representative of real-world conditions.

Visibility conditions, such as lighting and weather, were also evaluated during testing. Since the pilots mostly operate at night, the darkness level in the simulator was increased to replicate nighttime conditions. In addition to nighttime lighting, three simulations were performed with snow to provide a visual indicator of the wind direction. Only one scenario simulated day light, which occurred during the first day of testing on Week 1 and Week 2.

Figure 4. NOAA wind rose for Baltimore Harbor



A bathymetric database was developed for the existing channels and the proposed channel layouts. The side slopes of the channels were set at 5 ft horizontal and 1 ft vertical.

A hydrodynamic model was not developed for this study. The AMP confirmed currents in the Seagirt Loop Channel are negligible. The ERDC CHL deemed it was acceptable to assess vessel navigation in the proposed channel designs with zero water velocity.

3.4 Database Validation

An initial validation effort of the existing condition database was performed with the AMP to ensure ship handling within the study area was realistic and to identify any necessary modifications. The pilots checked the handling of the design vessels and environmental forces acting on the vessel. The pilots indicated the *Marco Polo* responded better to rudder commands than what they expected, i.e. better steerage. In addition, the bow thruster had a higher horsepower than what is typically available. Although the design vessel generally handled well, the pilots indicated this model was adequate for this channel design study.

4 Results

This section discusses the results of the ship simulation testing of the proposed navigation channel designs in the Seagirt Loop Channel. A total of 124 ship simulation exercises were performed over the two testing weeks. Appendix B includes the test matrix of all the unique scenarios that were performed in the study. The variables in the scenarios performed include channel design, transit path, vessel draft, wind direction and magnitude, visibility, and tug availability. Each scenario tested in the proposed widening design and modified widening design with the two proposed channel depths (-47 ft MLLW and -50 ft MLLW) are listed in Tables 4-7, respectively.

Vessel track plots were generated for each simulation to depict the vessel's position over the course of the transit. Vessel track plots completed by the pilots with the same test scenario were combined into a single "plate" in Appendix C. The vessel track plot completed by each pilot are color coded to distinguish which pilot performed the exercise. The pilots are color coded as follows: orange (Pilot A), cyan (Pilot B), green (Pilot C), and purple (Pilot D). Each plate includes the set of test conditions that were simulated, red and green buoys along the Seagirt Loop Channel, the transiting vessel track plots for each pilot, and the appropriate docked vessels at SMT and DMT berths. Although the modified widening areas and corresponding buoys are shown in all plates, this channel widening design was only tested during the second week of testing (Plates 28 – 43).

For each simulation exercise performed, the pilots provided written comments and rated the difficulty and safety of the transit. The difficulty and safety were rated from 1 to 5. For difficulty, 1 is easy and 5 is difficult. For safety, 1 is safe and 5 is dangerous. The median rating (3) represents a neutral response. The pilots' comments and ratings for each scenario are listed in the data sheets in Appendix C. The data sheets also contain the test conditions, the date the simulation exercise was performed, the location of the tug boat when a casualty occurred, and the total elapsed time for each simulation exercise. The vessel track plots and corresponding data sheets are in Appendix C.

In addition, each pilot completed a Final Pilot Survey following the simulation testing weeks. The questions and pilots' responses are provided in Appendix D. Note the pilots referred to the WSBC as the "Elevator

Channel" in the Individual Pilot Feedback (Appendix C) and pilot survey (Appendix D).

Four transit paths in the Seagirt Loop Channel were analyzed. Letters A, B, C, and D were assigned to each path to simplify referencing the heading, start position, and end position in the channels (Table 3).

Table 3. Path descriptions.

Path Letter	Route in the Seagirt Loop Channel	No. of Runs Completed
A	FMC → Dundalk-Seagirt Access Channels → SMT Berth 1	20
B	SMT Berth 3 → Turning Basin → FMC	22
C	SMT Berth 4 → WSBC → FMC	76
D	FMC → WSBC → SMT Berth 1	6

Paths A and B are in the existing Dundalk-Seagirt Access Channels. Although this area of the channel is currently deepened to -50 ft MLLW, no widening was proposed or tested in Path B. The purpose of testing these paths was to assess how both design vessels will maneuver through the existing channel layout. Path A is an inbound transit, starting in the Fort McHenry Channel (FMC), through the Dundalk-Seagirt Access Channels, and ending at Berth 1. In addition to the existing channels, this path also allows the widening south of the SMT berths to be evaluated. Path B is an outbound transit, reversing from Berth 3 and turning around in the turning basin to head seaward through the Dundalk-Seagirt Access Channels to FMC. Tug casualties were not included for this transit.

Paths C and D are in the WSBC which includes the proposed widening. Path C is an outbound transit, starting at Berth 4, through the WSBC, and ending in the FMC. The majority of runs consisted of testing Path C. Path D is a rare inbound transit in which the vessel enters Seagirt Loop Channel from the "opposite" direction through the WSBC to use equipment on the port side of the ship in case there is damage on the starboard side.

In addition to testing maneuverability of the design vessels in the Seagirt Loop Channel, tug requirements were also assessed. Four 65-ton tug boats were available for each pilot to use in all runs. The pilots used four 65-ton tug boats for every simulation run. The pilots ordered tug commands (position, force, and direction) to the ERDC CHL simulator operators during the transit. In some simulations, a tug causality occurred, meaning one tug would suddenly become unavailable during a transit due to unforeseen circumstances. This scenario was recommended to test by the pilots as it is a common occurrence in Baltimore Harbor.

4.1 Proposed Widening Design and -47 ft MLLW Depth

The test conditions and associated plate numbers for ship simulation exercises completed with the proposed widening design and -47 ft MLLW depth are listed in Table 4. All runs used the lighter loaded *Marco Polo* vessel model, CNTNR51, except for Path B transits where CNTNR52 could also be tested.

Table 4. Proposed widening design and -47 ft MLLW depth simulation testing scenarios.

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
1	A	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
2	A	CNTNR52	WNW	35 knots	Night	Yes	A, B
3	A	CNTNR52	SSE	35 knots	Night	No	A, B, C, D
4	A	CNTNR52	SE	35 knots	Night	No	A, B, C, D
5	B	CNTNR51	WNW	35 knots	Night	No	A, B, C, D
6	B	CNTNR51	SSE	35 knots	Night	No	A, B, C, D
7	B	CNTNR51	NE	30 knots	Night	No	A, B, C, D
8	B	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
9	B	CNTNR52	SE	35 knots	Night	No	A, B, C, D
10	B	CNTNR52	NE	30 knots	Night	No	A, B
11	C	CNTNR52	NW	35 knots	Day	No	A, B, C, D
12	C	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
13	C	CNTNR52	WNW	35 knots	Night	Yes	A, B, C, D
14	C	CNTNR52	SSE	35 knots	Night	No	A, B, C, D
15	C	CNTNR52	SE	35 knots	Night	No	A, B, C, D

Plates 1 – 4 contain 14 track plots of transits completed in Path A in the proposed widening design and -47 ft MLLW depth. All simulations were completed with the CNTNR52 (44.5 ft draft) and ended at Berth 1, except for the transits in Plate 2 which ended at Berth 4. Docked vessels were placed at the SMT and DMT berths to represent a realistic adverse scenario. Plate 1 shows the vessel transits completed with WNW wind and nighttime conditions. In one run, the stern of the vessel reached the channel extent after the turn from the FMC. These remaining runs were successful and showed the use of the widener when passing SMT Berth 3. Plate 2 also show the transits completed with WNW wind and nighttime conditions; however, a tug causality occurs, and the transit ends earlier at SMT Berth 4. No issues were encountered during this scenario.

Plates 3 and 4 show transits with SSE and SE wind. These runs were generally rated more difficult and unsafe due to the southerly wind setting the transiting vessel towards the vessels docked at SMT. In Plate 3, one track is shown almost exceed the channel when passing the stern of the vessel docked at Berth 2-3, while another track showed the stern of the transiting vessel almost colliding with the bow of the docked vessel. Pilots need to have sufficient speed to maintain steerage of the vessel while also not transiting too fast that is unsafe for the docked vessels. One track also showed a vessel nearly exceeding the channel at the sharp east corner entering the Dundalk-Seagirt Access Channels. In Plate 4, one track shows the vessel taking too wide of a turn entering the Dundalk-Seagirt Access Channels and exceeding the west channel limit. Another track shows a vessel nearly exceeding the channel just south of Berth 4. All four pilots commented on a strong need for tugs to keep the vessel from setting towards the docked vessels at SMT.

Plates 5 – 10 contain 22 track plots of nighttime transits completed on Path B in the proposed widening design and -47 ft MLLW depth. Docked vessels were placed at SMT Berths 1 and 4 and DMT Berth 5. Plates 5 – 7 show transits completed with the heavier loaded vessel CNTNR51 (47.5 ft draft). Plate 5 contains vessel tracks with WNW wind. One track showed the vessel nearly exceeding the upper corner of the turning basin when passing SMT Berth 4. The remaining runs showed the vessel had adequate space to maneuver in the turning basin. The pilots commented that all four tugs are required to complete this maneuver successfully. Plate 6 contains vessels tracks with SSE wind. Only one vessel track showed the stern not clearing when turning towards the FMC. Pilots commented that this scenario is manageable with all four tugs, but that it would be safer to depart through the WSBC. Plate 7 contains vessel tracks with NE wind. One vessel is shown to nearly exceed the southeastern boundary of the turning basin. This scenario was particularly difficult due to the set from the NE wind when first entering the turning basin and trying to work stern into the wind. Two pilots stated they would have not been able to recover the vessel in the event of a tug casualty.

Plates 8 – 10 show transits completed with CNTNR52, the lighter loaded vessel. Plate 8 contains vessel tracks during WNW wind and showed most turning manuevers were manageable. One trackplot showed the stern nearly exceeded the upper corner of the turning basin when backing up. Another track showed a vessel not clearing the west corner when entering the FMC. Plate 9 contains vessel tracks during SE wind. In two of the tracks, the bow reaches the turning basin limits. To keep the vessel clear of the docked vessels, the pilot needed to work the vessel towards the wind while also staying within the basin limits. The pilots expressed this was a difficult maneuver and that all four tugs are required. Plate 10 contains two vessel track plots completed with NE wind. The maneuver was feasible and required assistance from all four tugs.

The turning basin maneuver in Path B requires significant use of the tug boats. Several scenarios required all four tug boats to exert maximum force for an extended period of time, presenting concerns for overworking the tug boats and potential mechanical failure. Any potential tug casualties could cause a serious, damaging accident, such as striking surrounding terminal infrastructure, an allison with a docked vessel at DMT Berth 6, or exceeding the channel limits and running aground. The pilots expressed that the vessel is highly exposed in the turning basin and there is less safety margins navigating the *Marco Polo* in the turning basin, compared to exiting via the WSBC.

Furthermore, Plates 11 – 15 contain 20 track plots of transits completed on Path C in the -47 ft MLLW design. All simulations were completed with CNTNR52 (44.5 ft draft). Two docked vessels were placed at SMT Berths 1-3. Plate 11 contains four track plots of transits completed with NW wind and the only daylight scenario in the study. One vessel is shown getting set to the south when departing SMT Berth 4. It was able to recover where the channel begins to widen. Another vessel is shown taking a wide turn into WSBC with its stern approximately 50 ft to the docked vessel at SMT Berth 1, not using the widened channel to the south. This was the pilot's initial run who noted using 1 knot more than usual and it was also later determined only three tugs were working instead of four due to a simulator error. One pilot maximized the use of the widenings however noted that the inner corners of the bends were sharp. Track plot shows the vessel had approximately 60 ft of clearance. The remaining runs were successful. Widening to the north and south of WSBC were needed in all runs.

Plates 12 and 13 both contain vessel tracks during WNW wind. Transits in Plate 12 did not undergo a tug casualty. Similar to the track discussed in the previous plate, two vessels were shown to nearly reach the sharp point near buoy "8," with approximately 50-60 ft of clearance, and one vessel with 50 ft of clearance to buoy "16." In one track, a vessel failed to make the turn into FMC. The pilot noted he had too much speed on the vessel and was unable to slow vessel down enough to make the turn. The widening south of the SMT berths provided sufficient clearance to pass the docked vessels. All four tugs were necessary for this maneuver. Track plots in Plate 13 incurred a tug casualty (port quarter tug). This scenario showed vessels generally using more of the widener than the previous plate's track plots without a tug casualty. In one track, a vessel had only 40 ft of clearance near sharp point at buoy "10" and 5 ft at buoy "16." Pilots noted that although the transit was possible without the fourth tug, there was no room for error. The widening on the green buoy side of WSBC was not needed on these runs.

Plate 14 contains vessel tracks completed with SSE wind. All transits were successful, except for one in which the vessel's stern left the channel when turning into WSBC. The vessel was able to recover in the simulator and later slightly exceeded the sharp corner near buoy "16" as well. The SSE wind was a concern when transiting past SMT berth 1 and keeping starboard quarter side off the stern docked vessel when turning. Plate 15 contains vessel tracks completed with SE wind. Two transits were successful, while two transits showed the vessel close the sharp channel points near buoy "16," within 10 ft to 30 ft and buoy "10," within 50 ft. The widening on the green buoy side of WSBC was not used.

4.2 Proposed Widening Design and -50 ft MLLW Depth

The test conditions and associated plate numbers for ship simulation exercises completed with the proposed widening design and -50 ft MLLW depth are listed in Table 5. Both *Marco Polo* vessel models CNTNR51 and CNTNR52 were tested.

Table 5. Proposed widening design and -50 ft MLLW depth simulation testing scenarios.

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
16	C	CNTNR51	WNW	35 knots	Night	No	A, B, C, D
17	C	CNTNR51	WNW	35 knots	Night	Yes	A, B, C, D
18	C	CNTNR51	SSE	25 knots	Night	No	A, B, C, D
19	C	CNTNR51	SSE	25 knots	Night	Yes	A, B
20	C	CNTNR51	SSE	35 knots	Night	No	A, B, C, D
21	C	CNTNR51	NE	30 knots	Night & Snow	No	A, B
22	C	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
23	C	CNTNR52	WNW	35 knots	Night	Yes	A, B
24	C	CNTNR52	SSE	25 knots	Night	No	A, B, C, D
25	C	CNTNR52	NE	30 knots	Night & Snow	No	A, B
26	D	CNTNR51	WNW	25 knots	Night	No	A, B
27	D	CNTNR51	WNW	30 knots	Night & Snow	No	C, D

Plates 16 – 21 consists of simulations completed with CNTNR52 (44.5 ft draft). Plates 16 and 17 contain track plots of transits completed with WNW wind and CNTNR51. Plate 16 contained transits with four tugs available and all were successful. Transits in Plate 17 incurred a tug casualty (port quarter). The runs were successful, however for two of them, there was a clearance of only 40 – 50 ft from sharp points closest to buoy "4" and buoy "16" when turning into FMC.

Four simulations were completed with SSE and CNTNR51 for Plate 18, however only two track plots are shown in the plate. In the track plots shown, the transit was feasible but there was very little clearance available at the sharp points identified in many earlier transits, with less than 10 ft from point near buoy "16" and 40 ft from point near buoy "10." The two track plots not shown are from pilots A and B due to file corruption. Based on solely their comments, they had good safety margins with four tugs and that if one was lost, the maneuver could still be completed. After this run, pilots A and B repeated the same scenario but with a tug casualty shown in

Plate 19. Runs were successful but also reemphasized the need for additional widening at point near buoy “10” (20 ft clearance) and near buoy “8” (40 ft clearance).

A stronger SSE wind of 35 kts was tested for the transits shown on Plate 19. All four tugs were required to assist during this scenario. Due to the direction of the wind, maximum tug power was needed to help maintain a safe clearance from docked vessels at SMT. One pilot was unsuccessful in doing so, observed by the stern coming in contact with the two docked vessels at SMT. Plate 21 contained two track plots with NE wind and snow. The maneuver is successful with all four tug boats. The end of one track showed the vessel running aground when entering FMC. This was due to a simulator operator error that caused the vessel to lose a tug.

Plates 22 – 25 consists of simulations completed with CNTNR52 (44.5 ft draft). Track plots of transits completed with WNW are shown in Plate 22. All runs were successful and are similar to the transits completed with CNTNR51 and WNW wind (Plate 16). The same scenario was completed with a tug casualty shown in Plate 23 and incurred no issues during transit. Plate 24 contains track plots of the transits completed with SSE wind. All runs were successful. The additional widening is also needed in this scenario to maintain a safe distance from the sharp points previously identified. One pilot noted that the additional UKC with this vessel allows for an emergency anchor to be used in the event of a casualty that could not be used on the deeper draft vessel. Plate 25 contains two track plots completed in NE wind and snow conditions. The runs were successful and showed the need for additional widening near buoy “10.”

Plates 26 and 27 both consist of the Path D transits, the rare inbound scenario through WSBC, with 25 knot wind or 30 knot wind and snow. Pilots were comfortable making this maneuver with 3 or 4 tug boats with adequate channel space. Pilot A stated that this maneuver is the only acceptable way to bring in a ship to dock port side as attempting to use the standard route and use the turning basin to back in would be difficult and risky.

4.3 Modified Widening Design and -47 ft MLLW Depth

Upon completing several simulation exercises with the proposed widening design along with the -47 ft MLLW and -50 ft MLLW channel depths during Week 1 of testing, pilots A and B identified the need for additional widening along the WSBC to improve safety in navigating the *Marco Polo* vessel. As discussed in the previous section, several track plots showed the vessel exceeded or nearly exceeded the channel limits in three main areas. The pilots recommended additional widening for the three areas: in front of SMT Berths 1-3 by buoy “10” and buoy “11” (Widener A), the bend easing near buoy “8” past SMT Berth 1 (Widener B), and the bend easing near buoy “16” where the WSBC meets the FMC (Widener C). The pilots’ widening design is shown in red in Figure 3 (Section 2).

The proposed widening design and -47 ft MLLW and -50 ft MLLW design depth databases were modified to include the additional widening recommended by the AMP. Pilots C and D tested the modified channel widening design during Week 2 of testing. All test scenarios completed with the modified widening design are listed by plate in Tables 6 and 7, respectively.

Table 6. Modified widening design and -47 ft MLLW depth simulation testing scenarios.

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
28	A	CNTNR52	WNW	35 knots	Night	No	C, D
29	A	CNTNR52	SSE	35 knots	Night	No	C, D
30	A	CNTNR52	SE	35 knots	Night	No	C, D
31	C	CNTNR52	WNW	35 knots	Night	No	C, D
32	C	CNTNR52	WNW	35 knots	Night	Yes	C, D
33	C	CNTNR52	SSE	35 knots	Night	No	C, D
34	C	CNTNR52	SE	35 knots	Night	No	C, D

Plates 28 – 30 show pilots C and D transiting the CNTNR52 vessel in Path A with 35 knot winds from the WNW, SSE, and SE directions, respectively. In these plates, the pilots used the proposed widening in front of SMT Berths 2/3. In Plate 28, pilot C nearly exceeded the channel near buoy “3” in the Dundalk-Seagirt Access Channels. In the SSE wind condition (Plate 29), the pilots commented that significant tug work was required to maneuver with the wind contacting the ship’s starboard quarter. In Plate 30, both pilots make a tight turn when approaching the SMT from the turning basin and nearly exceeded the channel at buoy “9.” In the described plates, the pilots successfully approached SMT Berth 1 to prepare for docking.

Plates 31-34 show transits in Path C. Plates 31 and 32 involved testing the WNW wind. In both scenarios, the pilots completed the transit using the widening in front of the SMT and on the red side of the WSBC. There were no issues with the tug casualty in Plate 32, and the pilots commented the channel design provides the most safety margins. The SSE and SE wind conditions were tested in Plates 33 and 34. In both scenarios, the port side of the vessel transited close to proposed widened channel limits in front of the SMT and the stern was close to the existing channel lines on the green buoy side of the WSBC. This highlights the need for the additional space provided by Widener A and the widening on the green side of the WSBC. In addition, the vessel was close to the red buoy side of the WSBC throughout the transit in Plate 33 and the vessel was particularly close to Widener C in both Plates 33 and 34.

Table 7. Modified widening design and -50 ft MLLW depth simulation testing scenarios.

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
35	C	CNTNR51	WNW	35 knots	Night	No	C, D
36	C	CNTNR51	WNW	35 knots	Night	Yes	C, D
37	C	CNTNR51	SSE	25 knots	Night	No	C, D
38	C	CNTNR51	SSE	35 knots	Night	No	C, D
39	C	CNTNR52	WNW	35 knots	Night	No	C, D
40	C	CNTNR52	WNW	35 knots	Night	Yes	C, D
41	C	CNTNR52	SSE	25 knots	Night	No	C, D
42	C	CNTNR52	SSE	35 knots	Night	No	C, D
43	D	CNTNR51	WNW	30 knots	Night	No	C, D

Plates 35 – 43 analyze the modified widening design with CNTNR51 and CNTNR52. The track plots in Plates 35 – 37 are spaced farther apart likely due to operator error when preparing the simulation exercise file, however, the general path of the vessel can be assessed. The pilots tested different navigation techniques in the modified widening design. Pilot C navigated in the channel at higher speeds up to 6 knots in Plate 39, and pilot D attempted to navigate the *Marco Polo* CNTNR52 within the bounds of the existing WSBC configuration without using the thruster. Pilot D observed that the proposed channel widening is necessary for safe and efficient transit. All of these runs show the pilots using the proposed widening and Wideners A, B, and C while achieving adequate clearance for safe navigation. The pilots noted that the channel configuration accommodates the *Marco Polo* vessel well and the maneuvers can be completed safely with overall less tug assistance, including in the event of tug casualties in Plates 36 and 40.

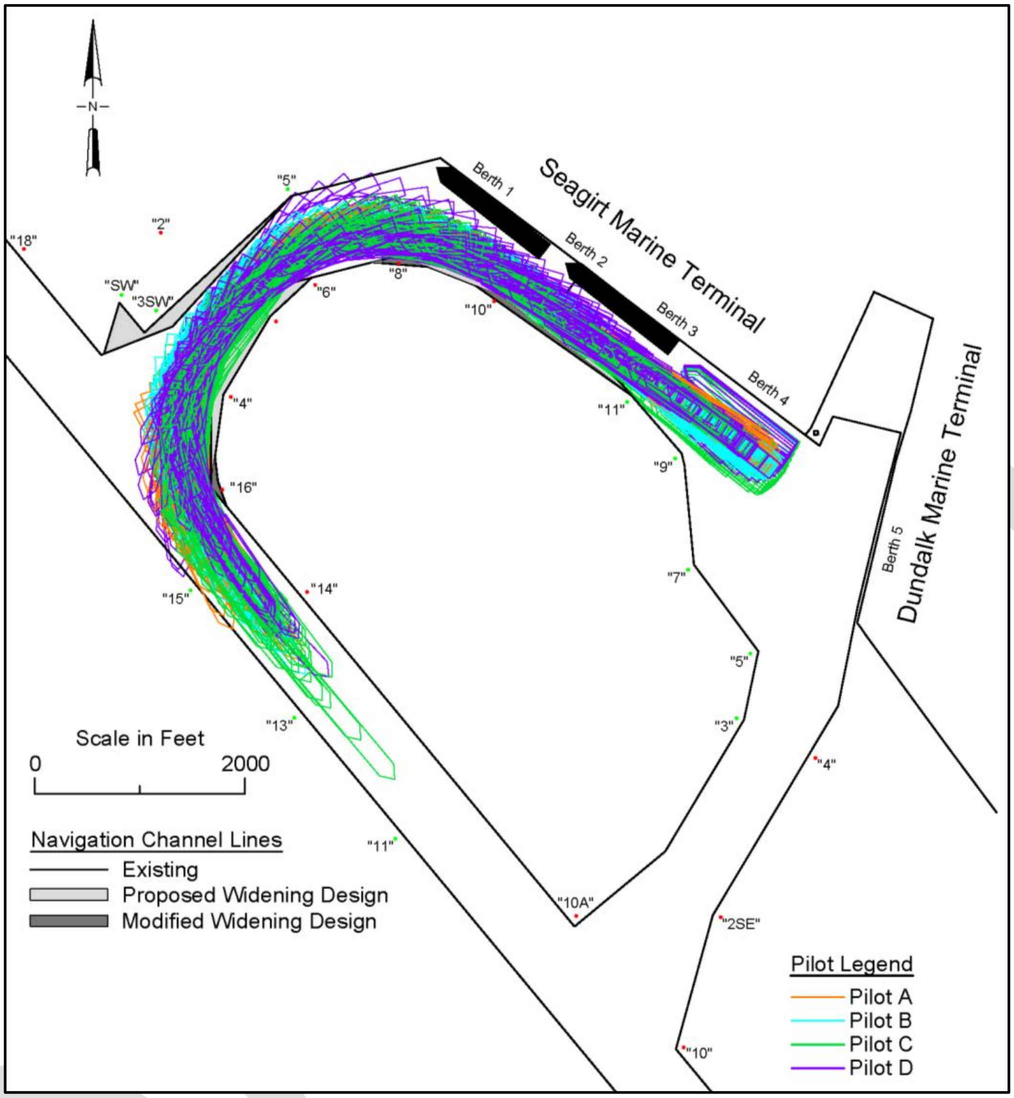
Lastly, Path D was evaluated with CNTNR51 and 30 knot WNW wind in Plate 43. The vessel successfully navigated in the FMC and WSBC and approached SMT Berth 1.

4.4 Further Discussion

The track plots from all transits completed in Path C for each combination of channel widening and depth designs were combined into a single plate (Figure 5). This shows the density of the tracked vessel history to provide a broad understanding of the overall channel widening needs.

The CNTNR52 vessel model (44.5 ft draft) was used to evaluate the proposed -47 ft MLLW channel depth in the WSBC, and both the CNTNR52 and CNTNR51 (47.5 ft draft) vessel models were used to evaluate the -50 ft MLLW channel depth and the Dundalk-Seagirt Access Channels. Both proposed channel depth designs provide adequate underkeel clearance for the appropriate drafting *CMA CGM Marco Polo* design vessels to safely navigate in the WSBC. In the event of an emergency, the CNTNR52 vessel in the -50 ft MLLW deep channels has enough UKC to safely drop the anchor.

Figure 5. Composite plate of all transits completed in the WSBC (Path C).



5 Summary and Recommendations

The recommendations of this study were formulated based on the analysis of vessel track plots, pilot feedback, and final pilot survey responses collected from the participating AMP pilots. In this ship simulation study, 43 unique test conditions and a total of 124 ship simulation exercises were evaluated.

Based on the various ship simulation exercises performed and analyzed, it was determined that the proposed widening design and the supplemental Wideners A, B, and C designed by the AMP pilots are essential to safely maneuver the *CMA CGM Marco Polo* design vessel in the WSBC.

In addition, this study determined that the existing configuration of the Dundalk-Seagirt Access Channels (where no improvements were proposed) provide sufficient channel width and depth to accommodate the *Marco Polo*, including maneuvers in the turning basin. The modified widening design (shown in Figure 3) provides additional channel area to safely maneuver in the Seagirt Loop Channel and transit adjacent to berthed ships at the SMT and DMT.

The -50 ft MLLW depth design in the WSBC provides adequate UKC for safe navigation of the 44.5 ft static draft and 47.5 ft static draft *Marco Polo* vessels. The -47 ft MLLW depth design provides adequate UKC for the 44.5 ft static draft *Marco Polo* vessel. The 44.5 ft draft *Marco Polo* vessel cannot transit in the -47 ft MLLW depth design in the WSBC because the vessel draft exceeds the channel depth.

The -50 ft MLLW depth design accommodates a larger range of deep draft ships and provides additional UKC for improved steerage. Additionally, this channel depth increases navigational safety margins to utilize anchors to stop a ship in the event of an emergency or casualty. The selected channel width design and authorized channel depth in the WSBC will determine the threshold for the size of ships that can call to the Port of Baltimore.

Due to the size of the *CMA CGM Marco Polo* container ship and the imposing wind forces in the area, assistance from four 65-ton tug boats is required for adequate and safe vessel handling.

References

U.S. Army Corps of Engineers, Baltimore District. February 2022. Baltimore Harbor Anchorages and Channels (BHAC) Modification of Seagirt Loop Channel: Feasibility Study Draft Integrated Feasibility Report and Environmental Assessment.

Appendix A: Pilot Cards

PILOT CARD

CNTNR51
Version 2

Ship's name Marco Polo

Call Sign C6EK8 **Deadweight** 187625 tonnes **Year built** 2012

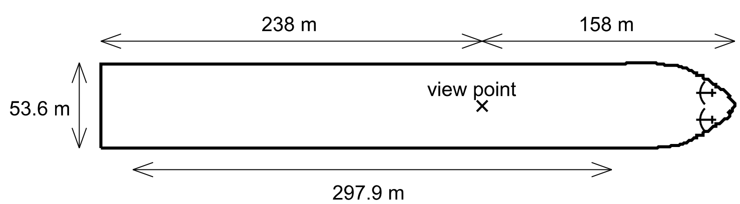
Draught aft 14.5 m / 47 ft 7 in **Forward** 14.5 m / 47 ft 7 in **Displacement** 206000 tonnes

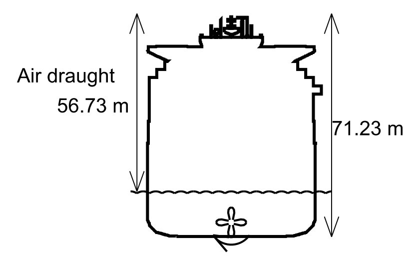
SHIP'S PARTICULARS

Length overall 396 m **Anchor chain:** **Port** 12.0 shackles **Starboard** 12.0 shackles

Breadth 53.6 m

Bulbous bow Yes **(1 shackle = 27.432 m = 15 fathoms)**





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 75275 kW (102346 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots)	
				Loaded	Ballast
Full sea speed	**1**	104.0	N/A	25.1	N/A
Full Ahead	**0.8**	65.0	N/A	16.1	N/A
Half Ahead	**0.5**	50.0	N/A	12.3	N/A
Slow Ahead	**0.25**	35.0	N/A	8.5	N/A
Dead Slow Ahead	**0.125**	25.0	N/A	6.0	N/A
Dead Slow Astern	**-0.125**	-25.0	N/A		
Slow Astern	**-0.25**	-35.0	N/A		
Half Astern	**-0.5**	-50.0	N/A		
Full Astern	**-1**	-65.0	N/A		

STEERING PARTICULARS

Type of rudder: Normal — Maximum angle: 35 °

Hard-over to hard-over: 12.3 s

Rudder angle for neutral effect: 0 °

Thruster: Bow 7200 kW (9789 hp) Stern N/A kW (N/A hp)

CHECKED IF ABOARD AND READY

Anchors ☐

Whistle ☐

Radar ☐ 3 cm ☐ 10 cm

ARPA ☐

Speed log ☐ **Doppler:** Yes / No

- **Water speed** ☐
- **Ground speed** ☐
- **Dual-axis** ☐

Engine telegraphs ☐

Steering gear ☐

- **Number of power units operating** ☐

Indicators: ☐

- **Rudder** ☐
- **Rpm/pitch** ☐
- **Rate of turn** ☐

Compass system ☐

Constant gyro error ± ________ °

VHF ☐

Elec. pos. fix. system ☐

- **Type** ________

OTHER INFORMATION:

PILOT CARD

CNTNR52
Version 2

Ship's name Marco Polo

Call Sign C6EK8 **Deadweight** 187625 tonnes **Year built** 2012

Draught aft 13.6 m / 44 ft 7 in **Forward** 13.6 m / 44 ft 7 in **Displacement** 189890 tonnes

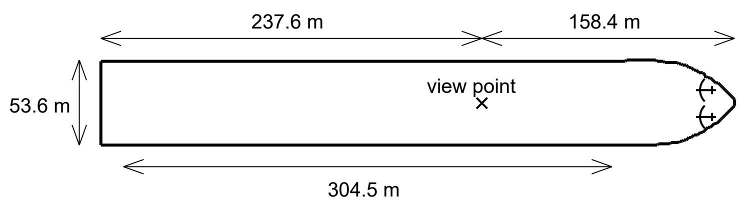
SHIP'S PARTICULARS

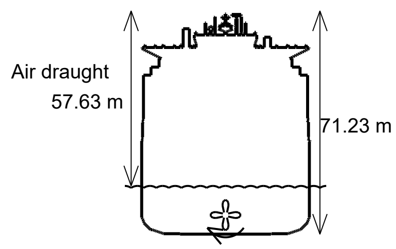
Length overall 396 m **Anchor chain:** **Port** 12.0 shackles **Starboard** 12.0 shackles

Breadth 53.6 m

Bulbous bow Yes

(1 shackle = 27.432 m = 15 fathoms)





PROPULSION PARTICULARS

Type of engine Diesel **Maximum power** 75275 kW (102346 hp)

Manoeuvring engine order		RPM	Pitch	Speed (knots)	
				Loaded	Ballast
Full sea speed	**1**	104.0	N/A	25.1	N/A
Full Ahead	**0.8**	65.0	N/A	16.1	N/A
Half Ahead	**0.5**	50.0	N/A	12.3	N/A
Slow Ahead	**0.25**	35.0	N/A	8.5	N/A
Dead Slow Ahead	**0.125**	25.0	N/A	6.0	N/A
Dead Slow Astern	**-0.125**	-25.0	N/A		
Slow Astern	**-0.25**	-35.0	N/A		
Half Astern	**-0.5**	-50.0	N/A		
Full Astern	**-1**	-65.0	N/A		

STEERING PARTICULARS

Type of rudder Normal **Maximum angle** 35 °

Hard-over to hard-over 12.3 s

Rudder angle for neutral effect 0 °

Thruster: **Bow** 7200 kW (9789 hp) **Stern** N/A kW (N/A hp)

CHECKED IF ABOARD AND READY

Anchors			☐	**Indicators:**	☐
Whistle			☐	**Rudder**	☐
Radar	☐	3 cm	☐	10 cm	**Rpm/pitch** ☐
ARPA			☐	**Rate of turn**	☐
Speed log	☐	**Doppler:**	Yes / No	**Compass system**	☐
Water speed			☐	**Constant gyro error ±** ______ °	
Ground speed			☐	**VHF**	☐
Dual-axis			☐	**Elec. pos. fix. system**	☐
Engine telegraphs			☐	**Type** ______	
Steering gear			☐		
Number of power units operating			☐		

OTHER INFORMATION:

Appendix B: Test Matrix

Seagirt Loop Channel Navigation Impact Assessment Ship Simulation Study Test Matrix

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
1	A	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
2	A	CNTNR52	WNW	35 knots	Night	Yes	A, B
3	A	CNTNR52	SSE	35 knots	Night	No	A, B, C, D
4	A	CNTNR52	SE	35 knots	Night	No	A, B, C, D
5	B	CNTNR51	WNW	35 knots	Night	No	A, B, C, D
6	B	CNTNR51	SSE	35 knots	Night	No	A, B, C, D
7	B	CNTNR51	NE	30 knots	Night	No	A, B, C, D
8	B	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
9	B	CNTNR52	SE	35 knots	Night	No	A, B, C, D
10	B	CNTNR52	NE	30 knots	Night	No	A, B
11	C	CNTNR52	NW	35 knots	Day	No	A, B, C, D
12	C	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
13	C	CNTNR52	WNW	35 knots	Night	Yes	A, B, C, D
14	C	CNTNR52	SSE	35 knots	Night	No	A, B, C, D
15	C	CNTNR52	SE	35 knots	Night	No	A, B, C, D
16	C	CNTNR51	WNW	35 knots	Night	No	A, B, C, D
17	C	CNTNR51	WNW	35 knots	Night	Yes	A, B, C, D
18	C	CNTNR51	SSE	25 knots	Night	No	A, B, C, D
19	C	CNTNR51	SSE	25 knots	Night	Yes	A, B
20	C	CNTNR51	SSE	35 knots	Night	No	A, B, C, D
21	C	CNTNR51	NE	30 knots	Night & Snow	No	A, B
22	C	CNTNR52	WNW	35 knots	Night	No	A, B, C, D
23	C	CNTNR52	WNW	35 knots	Night	Yes	A, B
24	C	CNTNR52	SSE	25 knots	Night	No	A, B, C, D
25	C	CNTNR52	NE	30 knots	Night & Snow	No	A, B
26	D	CNTNR51	WNW	25 knots	Night	No	A, B
27	D	CNTNR51	WNW	30 knots	Night & Snow	No	C, D

Plate No.	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Boat Casualty?	Pilots
28	A	CNTNR52	WNW	35 knots	Night	No	C, D
29	A	CNTNR52	SSE	35 knots	Night	No	C, D
30	A	CNTNR52	SE	35 knots	Night	No	C, D
31	C	CNTNR52	WNW	35 knots	Night	No	C, D
32	C	CNTNR52	WNW	35 knots	Night	Yes	C, D
33	C	CNTNR52	SSE	35 knots	Night	No	C, D
34	C	CNTNR52	SE	35 knots	Night	No	C, D
35	C	CNTNR51	WNW	35 knots	Night	No	C, D
36	C	CNTNR51	WNW	35 knots	Night	Yes	C, D
37	C	CNTNR51	SSE	25 knots	Night	No	C, D
38	C	CNTNR51	SSE	35 knots	Night	No	C, D
39	C	CNTNR52	WNW	35 knots	Night	No	C, D
40	C	CNTNR52	WNW	35 knots	Night	Yes	C, D
41	C	CNTNR52	SSE	25 knots	Night	No	C, D
42	C	CNTNR52	SSE	35 knots	Night	No	C, D
43	D	CNTNR51	WNW	30 knots	Night	No	C, D

Appendix C: Vessel Track Plots and Data Sheets

Plate 1
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots WNW, Night

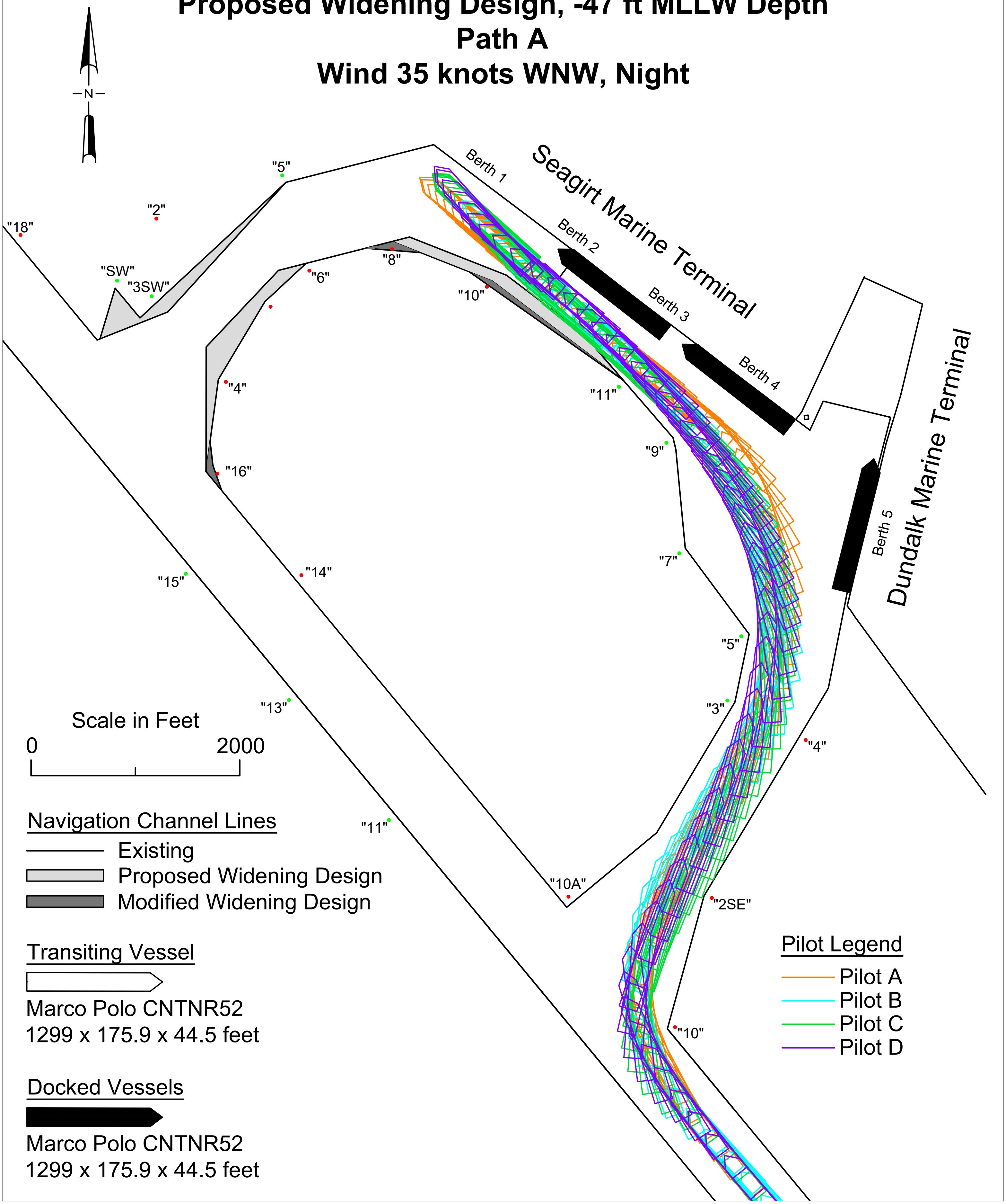


Plate 1

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	A	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	39:09
B	19 April 2022	N/A	38:25
C	25 April 2022	N/A	39:34
C	25 April 2022	N/A	34:58

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Went well with WNW'ly wind. – 4 tugs necessary.	3	3
B	– 4 boats necessary. – Behaved realistically with wind condition.	3	3
C	Went well.	3	3
D	More common scenario. Went well.	4	3.5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 2
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots WNW, Night,Tug Casualty

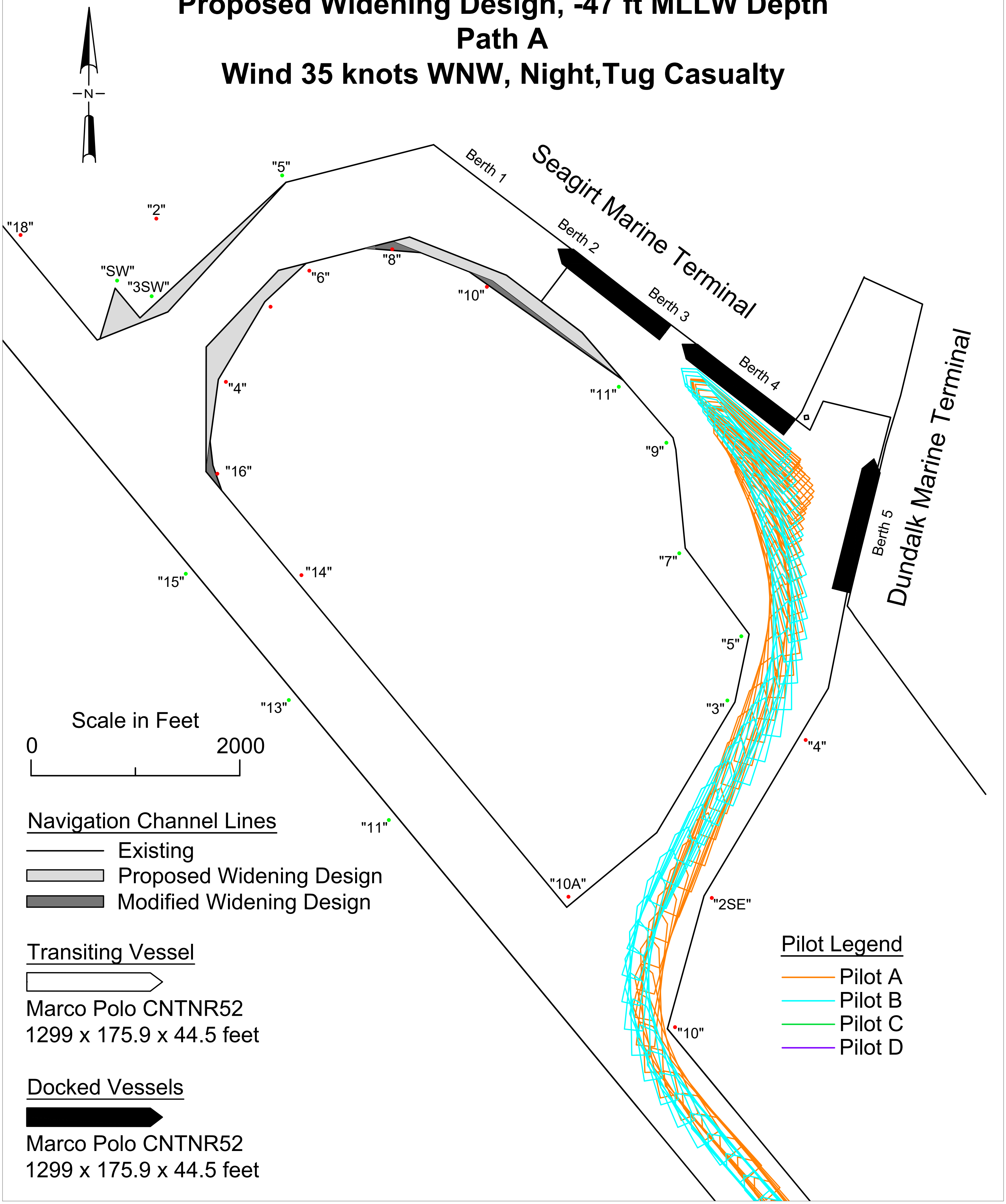


Plate 2

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	A	CNTNR52	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	Starboard shoulder	35:20
B	21 April 2022	Port bow	14:09

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Safe maneuver. 4 tugs allowed for recovery of casualty.	3	2
B	Able to continue maneuver safely with a tug casualty. No other issues noted.	N/A	N/A

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 3
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots SSE, Night

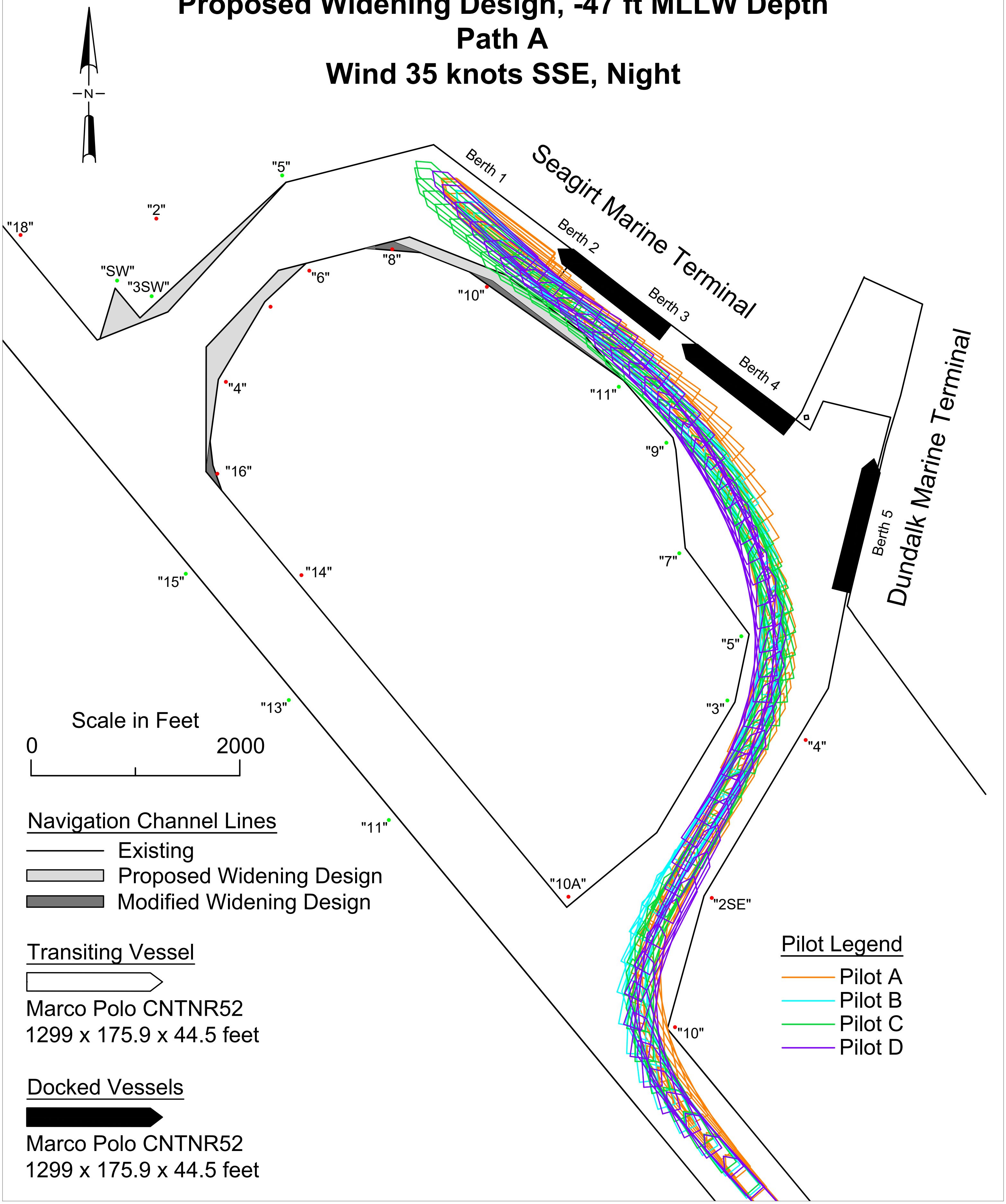


Plate 3

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	A	CNTNR52	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	35:03
B	19 April 2022	N/A	29:24
C	25 April 2022	N/A	32:01
D	25 April 2022	N/A	30:40

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	When speed is bled off to stop while passing ship at 2-3 berth, stern falls. Can safely be done by overshooting berths (destination) and holding on toe, then backing down. Not feasible in reality; speed alongside unsafely high. Had to max aft tugs.	5	5
B	This is not a safe maneuver - all tugs too near limits. The more south in the wind, the larger the issue.	4	5
C	All good.	4	4
D	Vessel needs a fair bit of speed to set by berthed ships.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 4
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots SE, Night

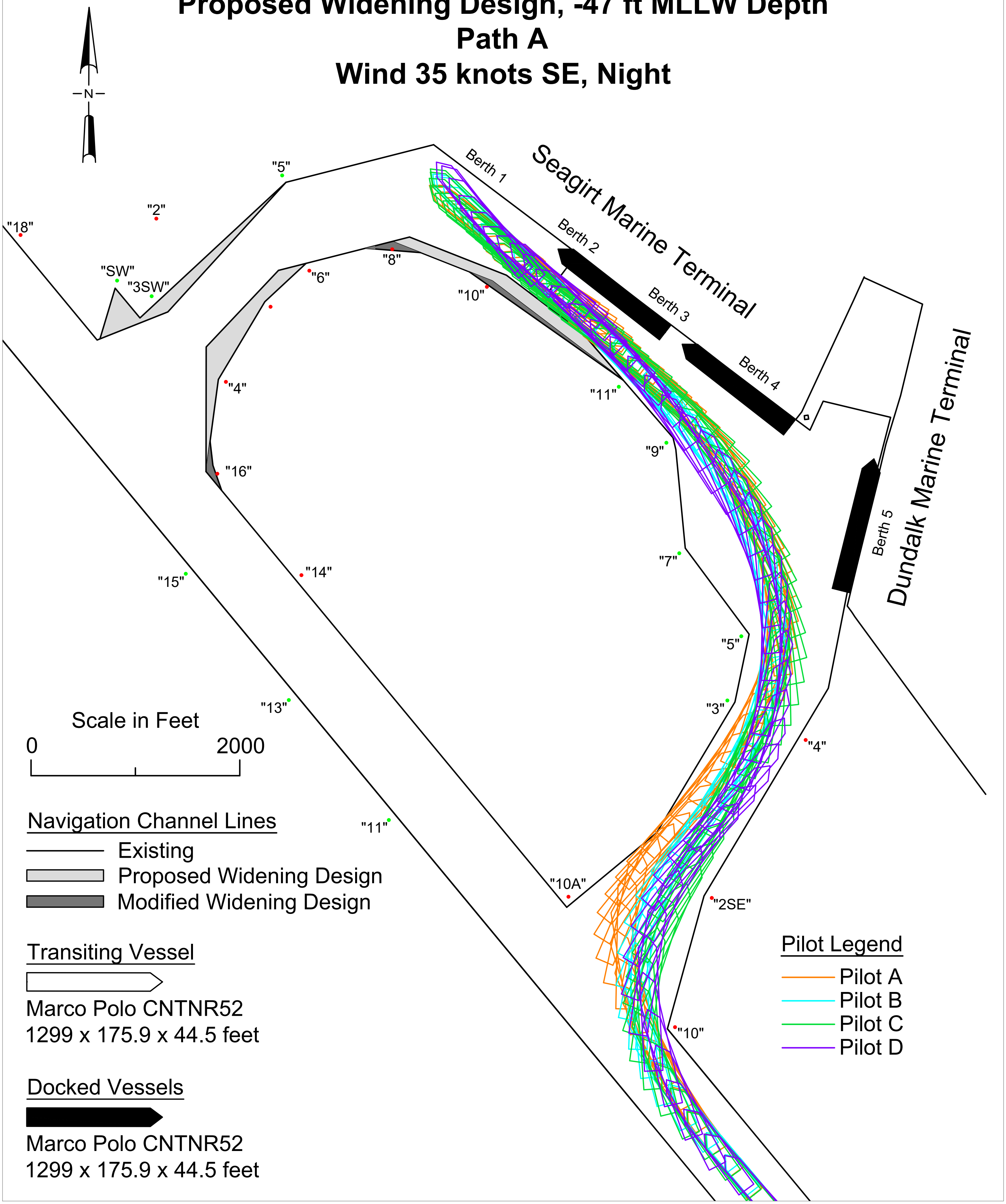


Plate 4

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	A	CNTNR52	SE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	17:21
B	19 April 2022	N/A	30:22
C	28 April 2022	N/A	39:52
D	28 April 2022	N/A	29:47

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	4 tugs used extensively. Necessary all aft tugs maxed to hold off berthed ships.	5	5
B	Wind needs to be more on the port side – more south in the wind to simulate a set towards vessels docked at Seagirt Marine Terminal Berths 3/4. 4 boats necessary.	3	3
C	Went well. Needed the HP of tugs in the West Channel.	3.5	3.5
D	Needed 3/4 tugs working full to hold stern into the wind. Had to be very close on "10" to make ranges in DW channel. Vessel advanced deep in basin due to quarter wind.	5	5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 5
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 35 knots WNW, Night

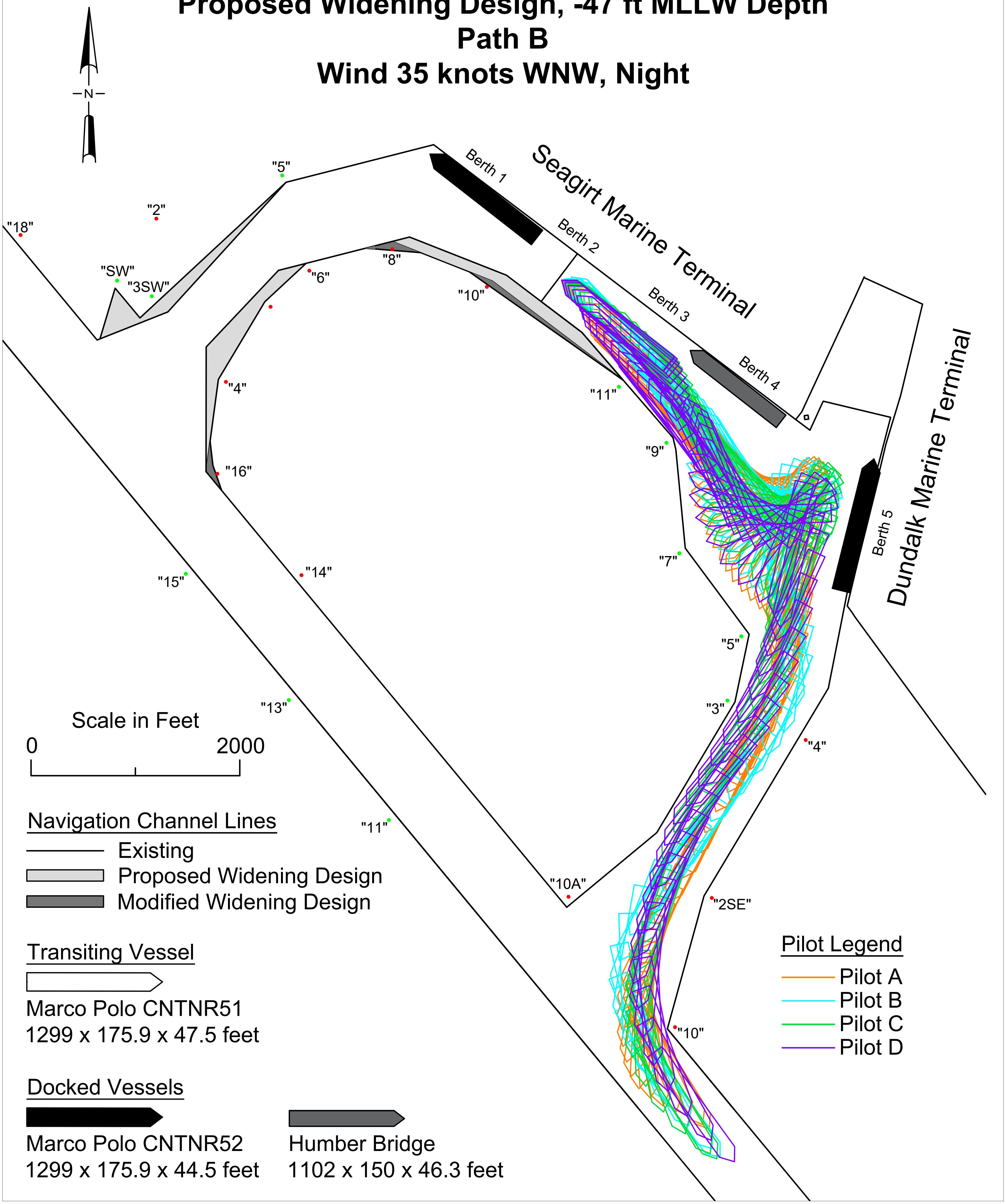


Plate 5

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR51	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	55:03
B	19 April 2022	N/A	40:15
C	25 April 2022	N/A	40:11
D	25 April 2022	N/A	37:17

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	4 tugs made it safe. Turn at "10" buoy awkward but feasible.	4	3
B	Much more difficult and high risk than utilizing the widened west channel of Seagirt. Again, 4 tugs, and additionally, more powerful tugs will likely be necessary.	5	5
C	Needed all 4 boats. Would have gone Elevator Channel.	4	4
D	Standard departure. Vessel is very heavy. Used all tugs.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 6
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 35 knots SSE, Night

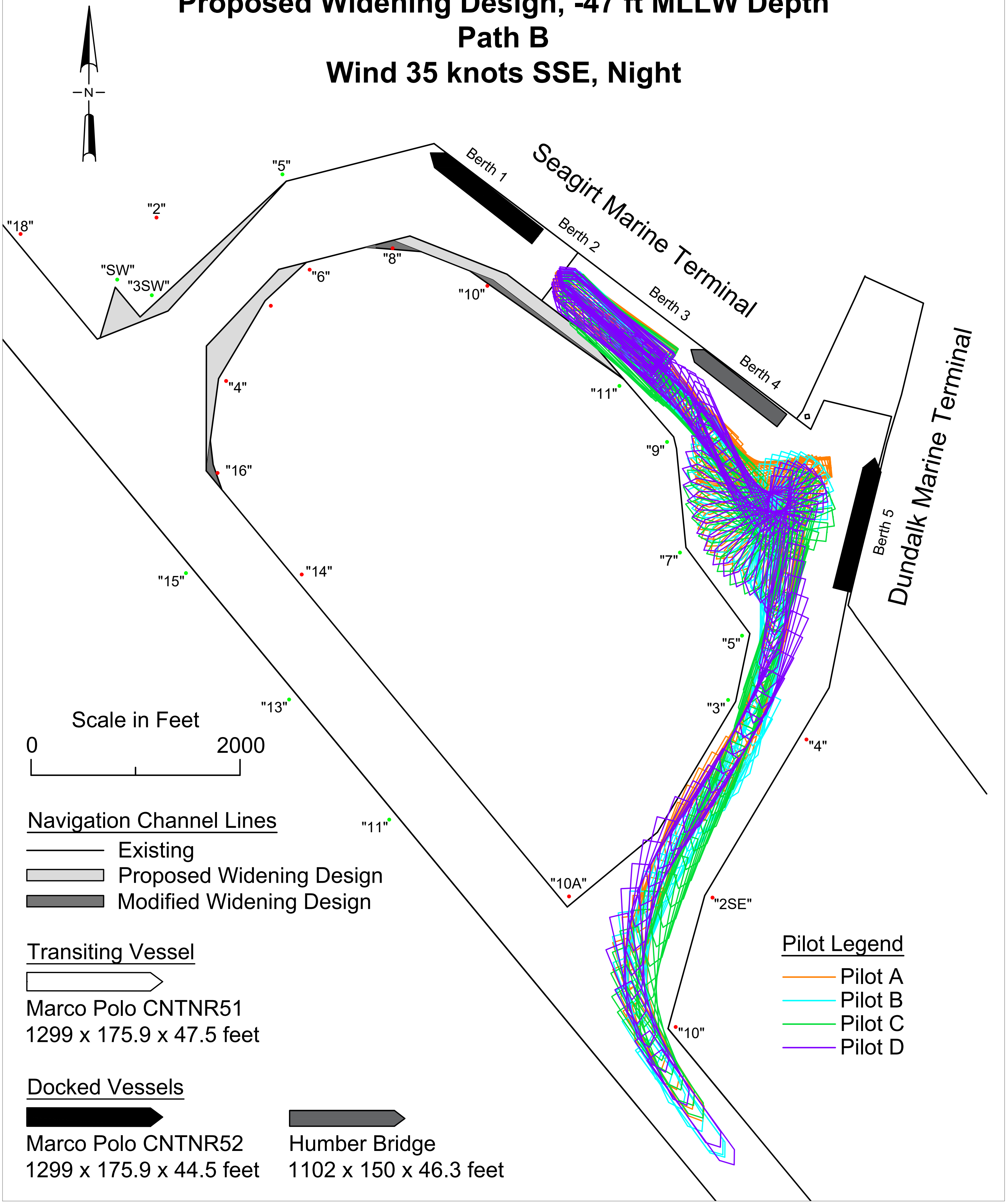


Plate 6

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR51	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	N/A	1:10:26
B	20 April 2022	N/A	1:00:06
C	26 April 2022	N/A	53:50
D	26 April 2022	N/A	51:34

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Had to work all four tugs excessively hard. – Higher exposed risk as opposed to Seagirt West Branch (Elevator) route. Job required all available control mechanisms to work. Any failure point would not be recoverable.	4	4
B	With the heavy ship and slower speeds, this scenario is manageable. 4 tugs are necessary.	4	3
C	The wider Elevator Channel would have been a safer option for departure.	5	5
D	None.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 7
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 30 knots NE, Night

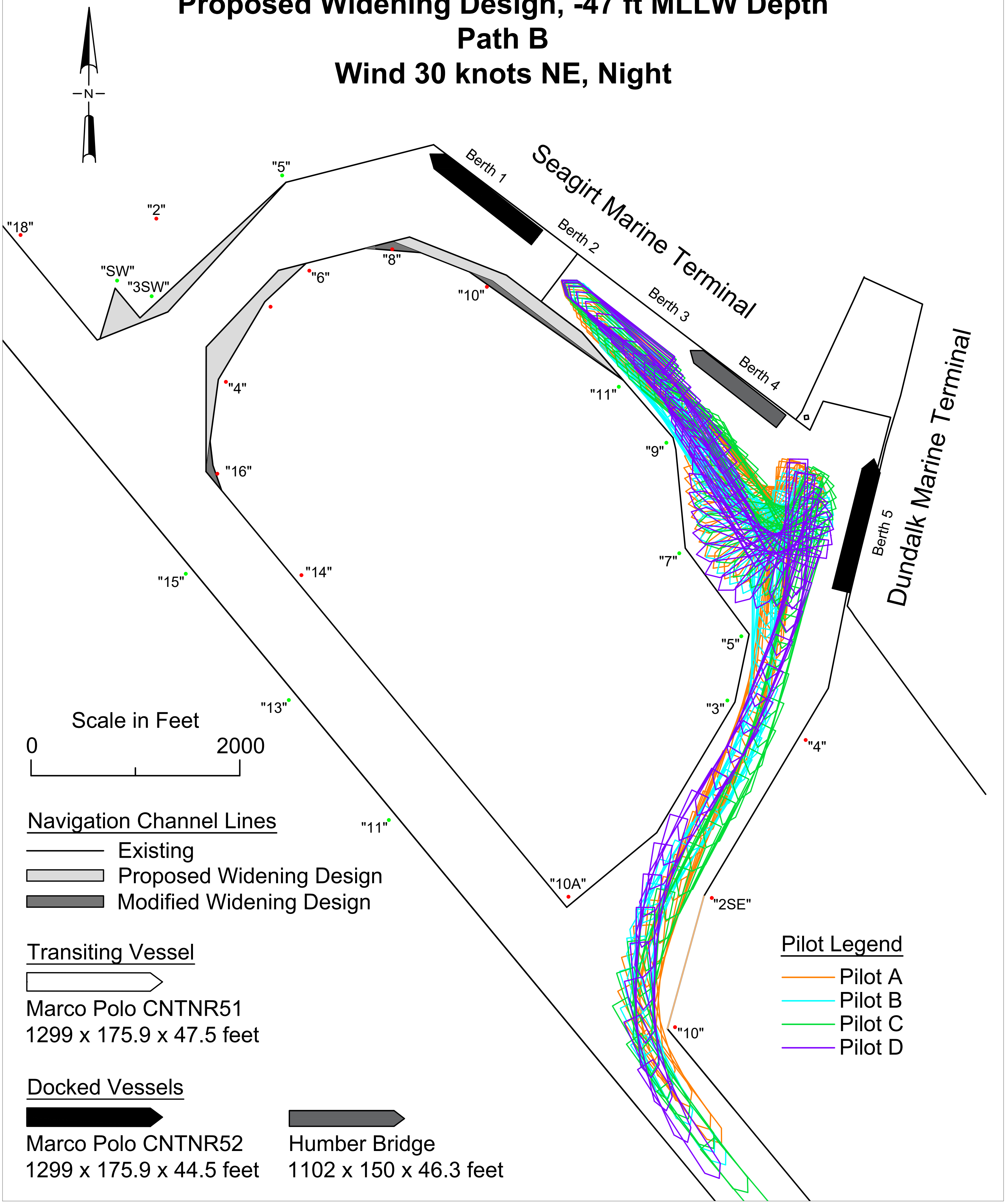


Plate 7

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR51	NE	30 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	22 April 2022	N/A	49:03
B	22 April 2022	N/A	43:49
C	27 April 2022	N/A	39:56
D	27 April 2022	N/A	35:22

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Aft tugs had to work strong in order to stay at safe distance from berthed ships. Any casualty would likely result in allision. Very tug dependent maneuver. Time intensive.	4	4
B	This is much more dangerous than departing via the new widened channel. Tugs were worked near limits for excessive amounts of time. Could not have recovered from a tug casualty. Excessive speed required backing into basin in order to minimize time wind is on the beam.	4	5
C	Tough maneuver at 35 knots.	4.5	4.5
D	Dangerous due to minimal headway and stern way to beam wind. Needed 3 boats to push the stern up wind and correct the ships position in the basin.	5	5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 8
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 35 knots WNW, Night

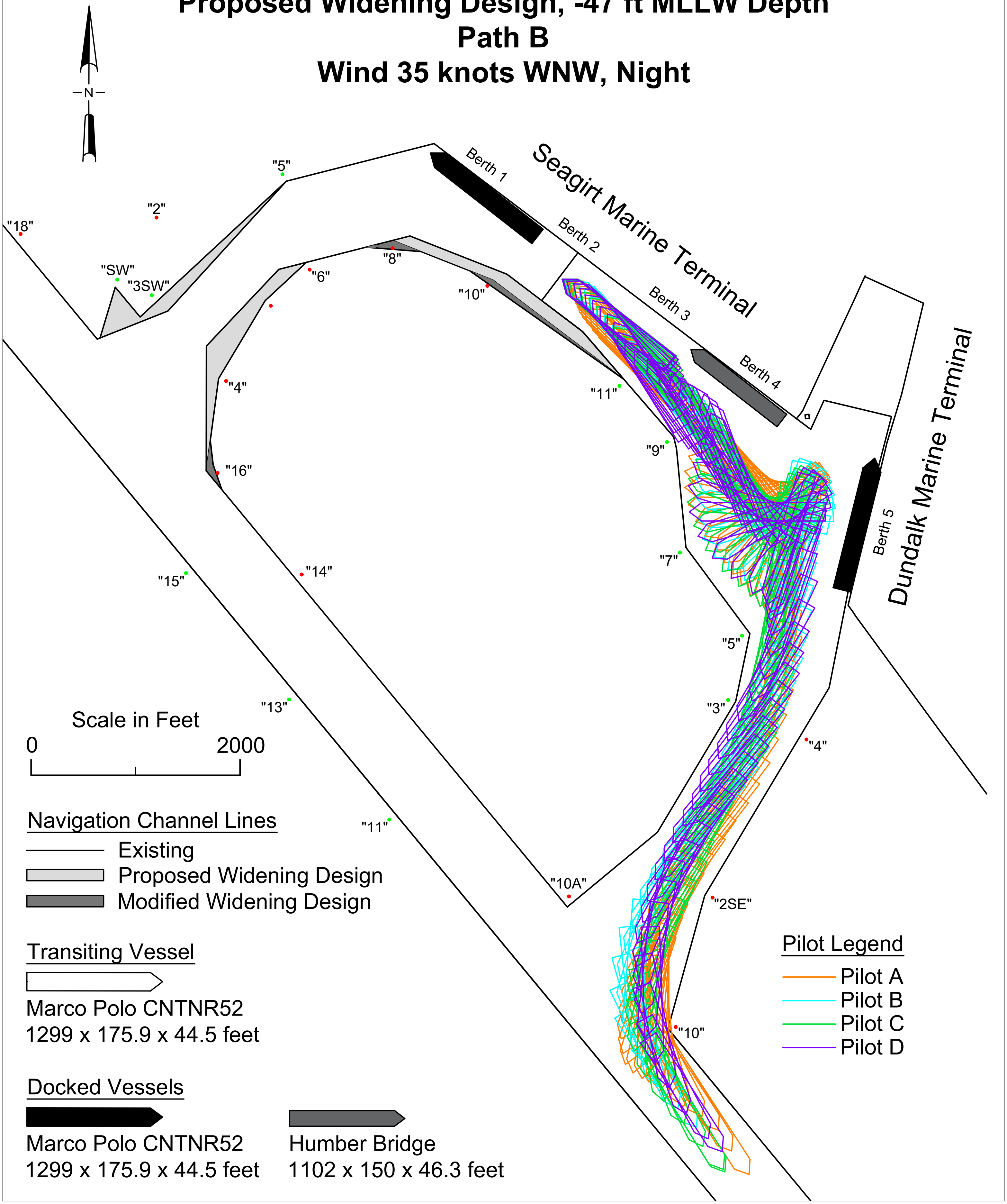


Plate 8

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	54:41
B	21 April 2022	N/A	39:15
C	26 April 2022	N/A	42:25
D	26 April 2022	N/A	38:24

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Very hard to work stern upwind while staying held up off red side. – Extremely exposed in turning basin in event of any casualty.	4	5
B	Speeds required to deal with wind at this draft are unsafe as compared to exiting the Seagirt West Access widened. If ships engine did not start ahead, allision with vessel DMT Berth 5 could easily occur. 4 tugs required.	4	5
C	Normal operation.	4	4
D	None.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 9
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 35 knots SE, Night

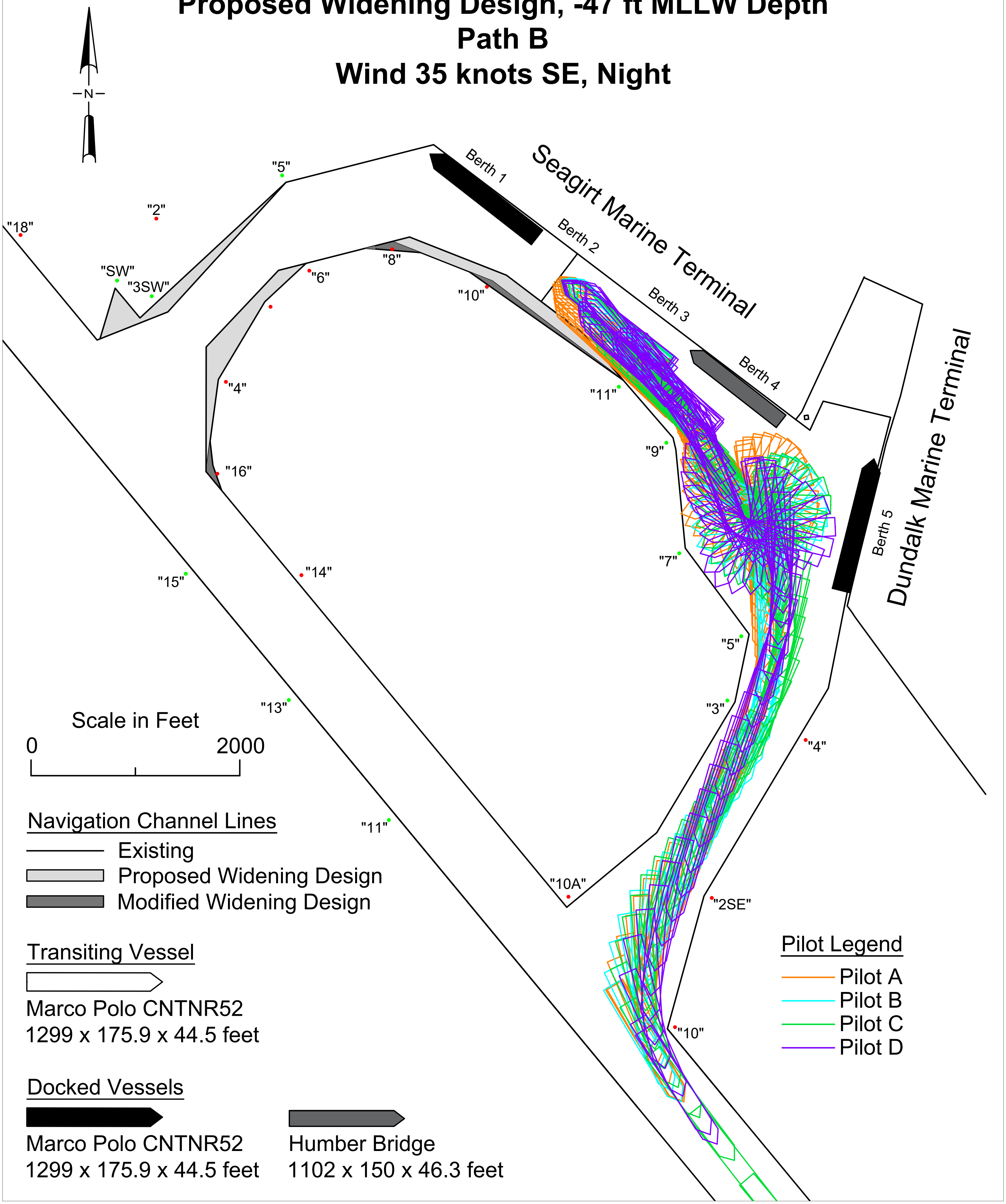


Plate 9

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR52	SE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	N/A	1:03:26
B	20 April 2022	N/A	47:09
C	27 April 2022	N/A	46:31
D	27 April 2022	N/A	48:54

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Ship is very exposed to berthed vessels. Ramifications of casualty (loss of tug, thruster, engine, etc.) are vastly higher than the West Branch ("Elevator") Channel.	3	4
B	4 boats necessary. Due to drift angle, ship needs to ensure exact position in channel outbound - additional tug enables/ensures this.	4	3
C	Tough maneuver at 35 knots with ships at DMT Berth 5 and SMT Berth 4.	4.5	4.5
D	Transition to basin to west. 3.0 knots minimal tug usage ex basin. 4 boat job.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 10
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path B
Wind 30 knots NE, Night

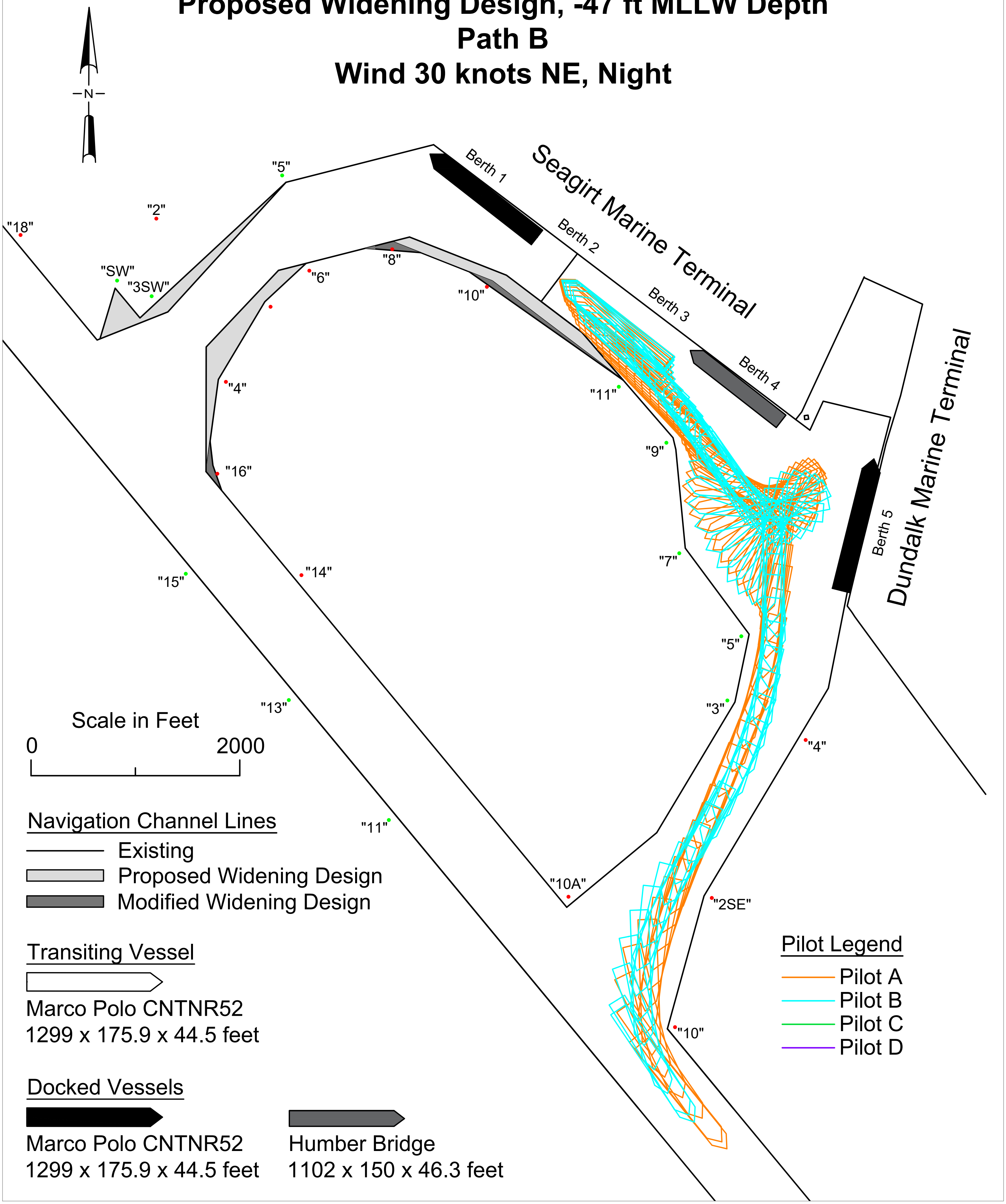


Plate 10

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	B	CNTNR52	NE	30 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	22 April 2022	N/A	45:32
B	22 April 2022	N/A	39:34

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Had to extensively utilize all tugs (strongly). – Elevated exposure to risk of allision (with moored ships). – Prolonged maneuver with prolonged elevated risk period. Time intensive.	4	4
B	Again, tugs used continually at max power to hold ship in this wind condition. 4 tugs required.	3	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 11

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots NW, Day

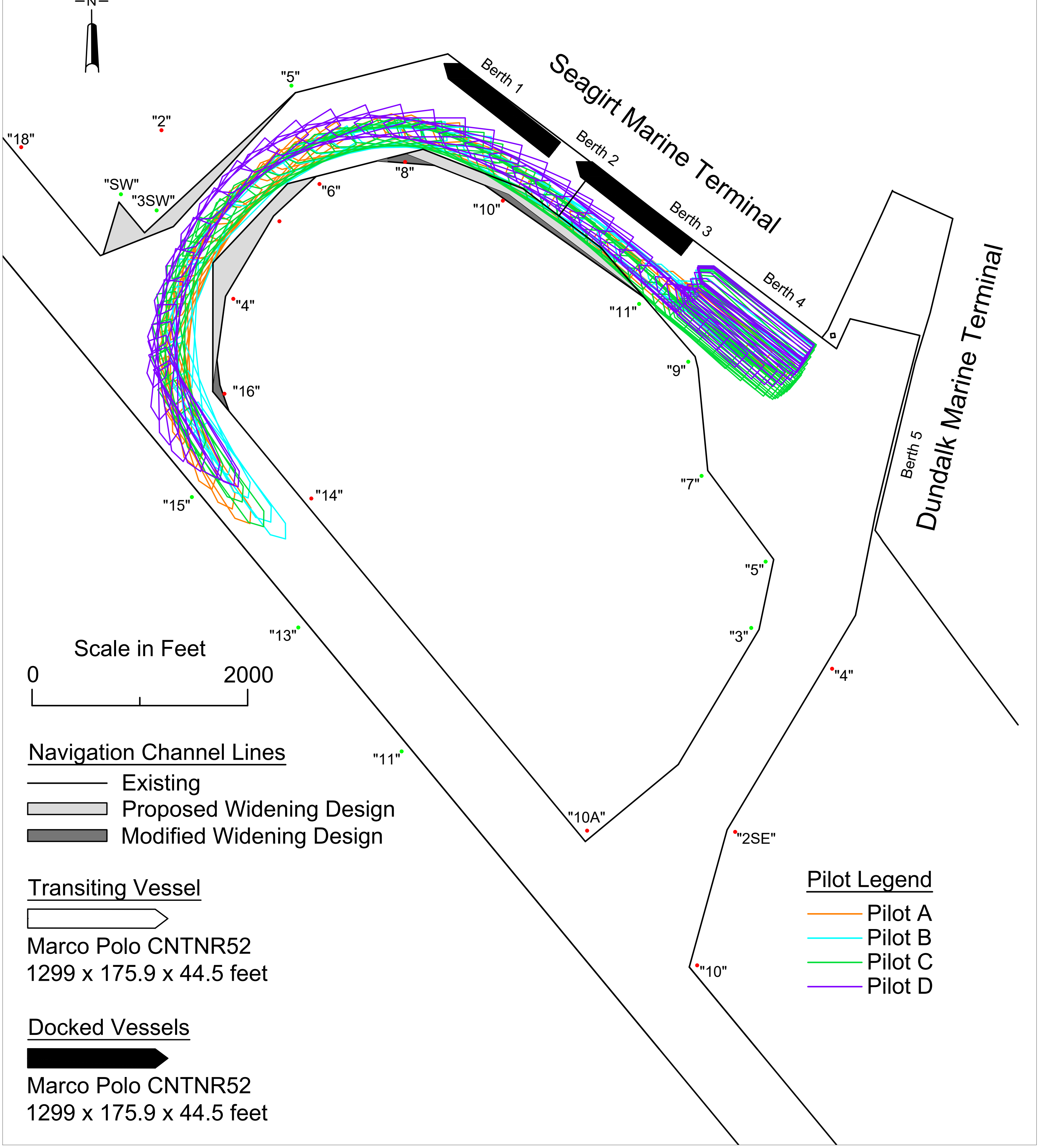


Plate 11

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	C	CNTNR52	NW	35 knots	Day	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	18 April 2022	N/A	35:54
B	18 April 2022	N/A	31:08
C	25 April 2022	N/A	38:41
D	25 April 2022	N/A	28:10

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– 4 tugs absolutely needed for evolution. – Fixed range would be helpful on SW bank or Patapsco for West Seagirt Branch Channel.	3	3
B	Too much North in the wind. Corner at Buoy "16" may be too abrupt.	4	3
C	The needed extra room was great!	3	3
D	Initial run. Used 1 knot more than usual due to wind and size of ship. No forward tug in center lead. 3 boats. Ran up close on the green side of McHenry due to not having center forward tug.	5	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 12
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

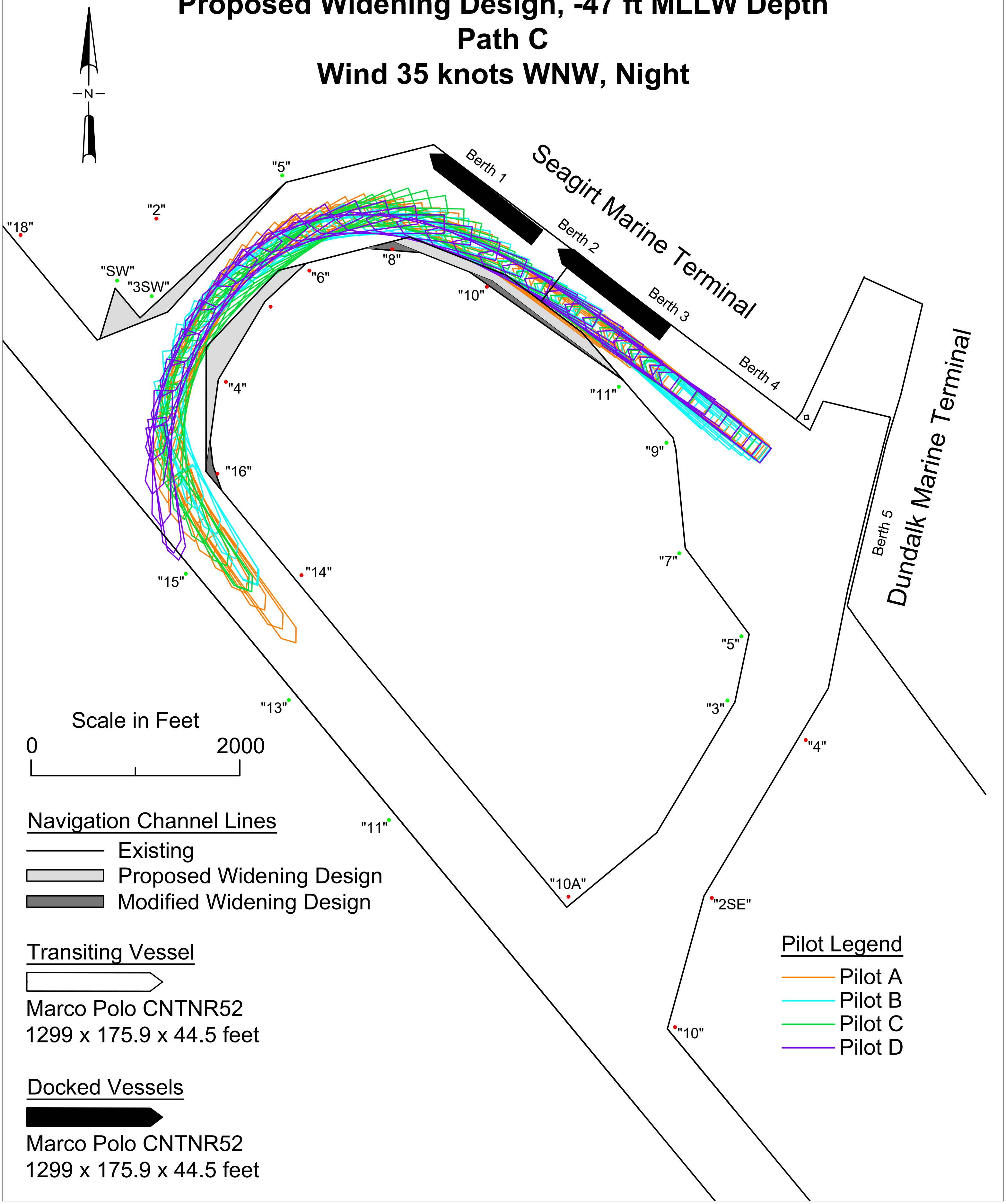


Plate 12

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	C	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	18 April 2022	N/A	35:49
B	18 April 2022	N/A	26:03
C	25 April 2022	N/A	26:05
D	25 April 2022	N/A	20:24

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– 4 tugs necessary. – Fixed range needed on SW bank. – Wideners are working to pass ships in berths.	3	3
B	– Channel corner at red buoy "16" still needs to be eased potentially. – Ship feels as if it handles too well at times. – 4 tugs - all 65 tons - are necessary. – Ship does not seem to set as much as it should with the wind on the beam. – Due to the obstructed view, a range outbound marking channel centerline should be considered in the event of electronics failure.	3	3
C	N/A	3	3
D	Vessel built up too much speed at the end of maneuver with tug working 80% astern in center lead. Went from 4 knots to 4.8 knots.	4	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 13
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

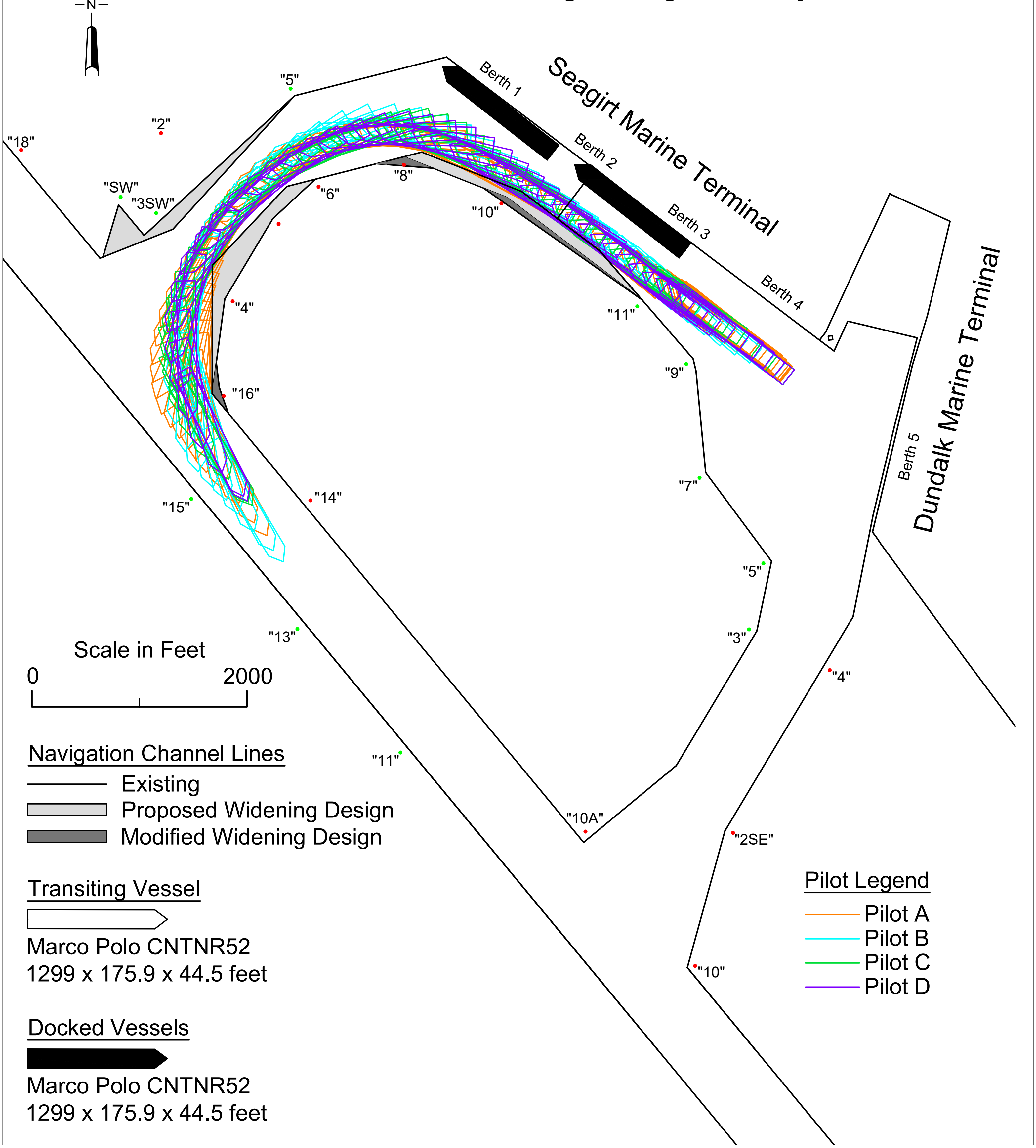


Plate 13

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	C	CNTNR52	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	Port quarter	37:50
B	19 April 2022	Port quarter	27:01
C	26 April 2022	Port quarter	28:08
D	26 April 2022	Port quarter	26:10

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Safety factor of having 4 tugs allowed for maneuver to work. Upon losing quarter tug, center lead aft tug had to be worked strong, but possible.	4	3
B	– Losing tug with this wind condition made it almost impossible to make turn. – Being forced to back ship when attempting a large turn to port makes situation much worse.	4	5
C	Width of Elevator Channel is good for this class of vessel.	3	3
D	3.6-4 knots at maneuver. Still worried about advancing to the green side.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 14
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots SSE, Night

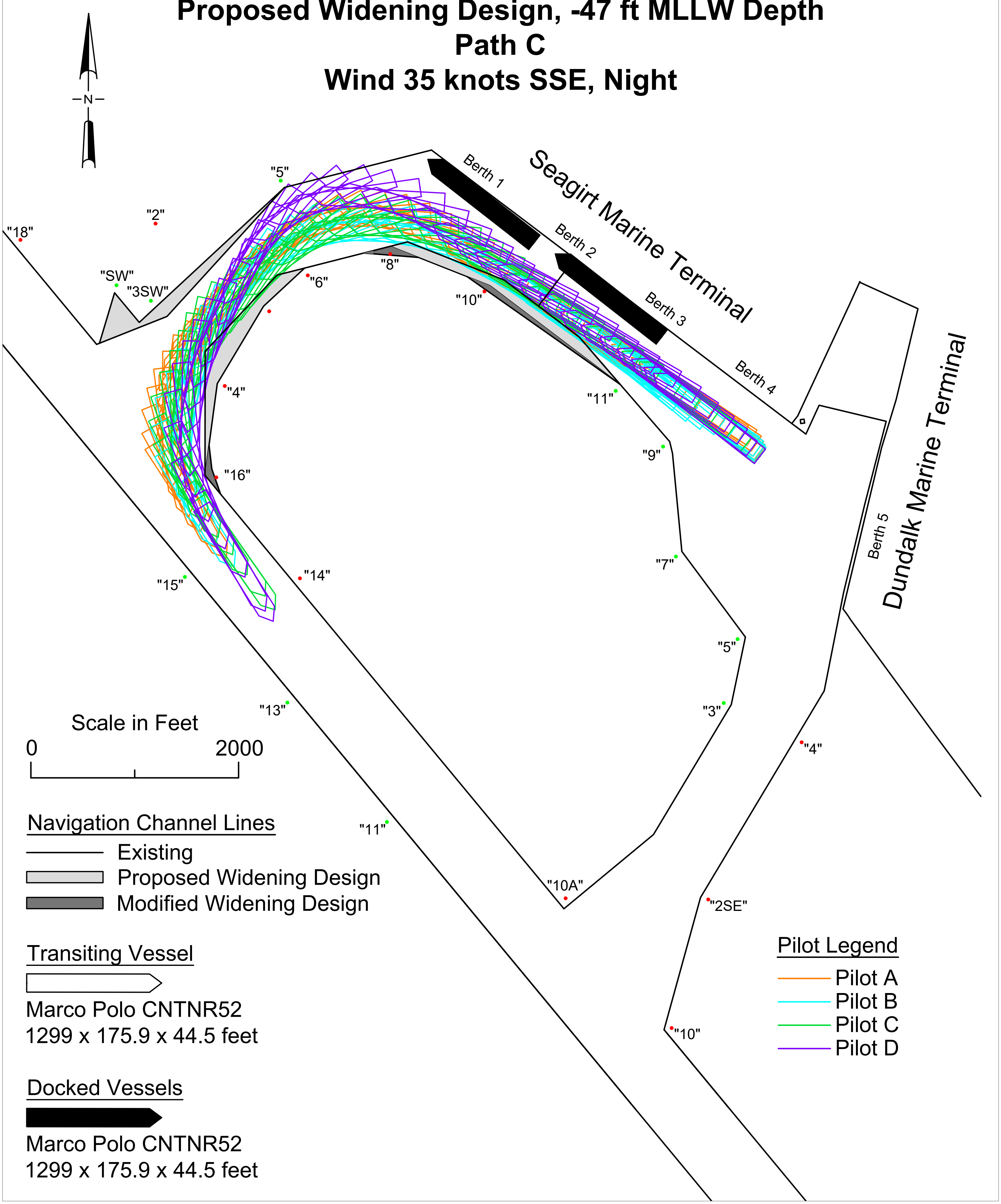


Plate 14

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	C	CNTNR52	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	31:46
B	21 April 2022	N/A	27:21
C	25 April 2022	N/A	58:10
D	25 April 2022	N/A	55:59

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	With SSE'ly wind at this velocity, ship's quarter becomes excessively close to the ship at Seagirt Marine Terminal Berth 1 (~130 ft).	4	4
B	30 ft from shoal water on port side in vicinity of buoy "8" is required to maintain 150 ft from stern to vessel at Seagirt Marine Terminal Berth 1/2. This is unreasonable, and project corner should be widened here. Also, corner at buoy "16" needs to be eased. Otherwise, with wind conditions, 4 tugs required.	N/A	N/A
C	Starboard quarter gets close to Berth 1 with this wind.	3	3
D	Very difficult maneuver.	4	5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 15

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots SE, Night

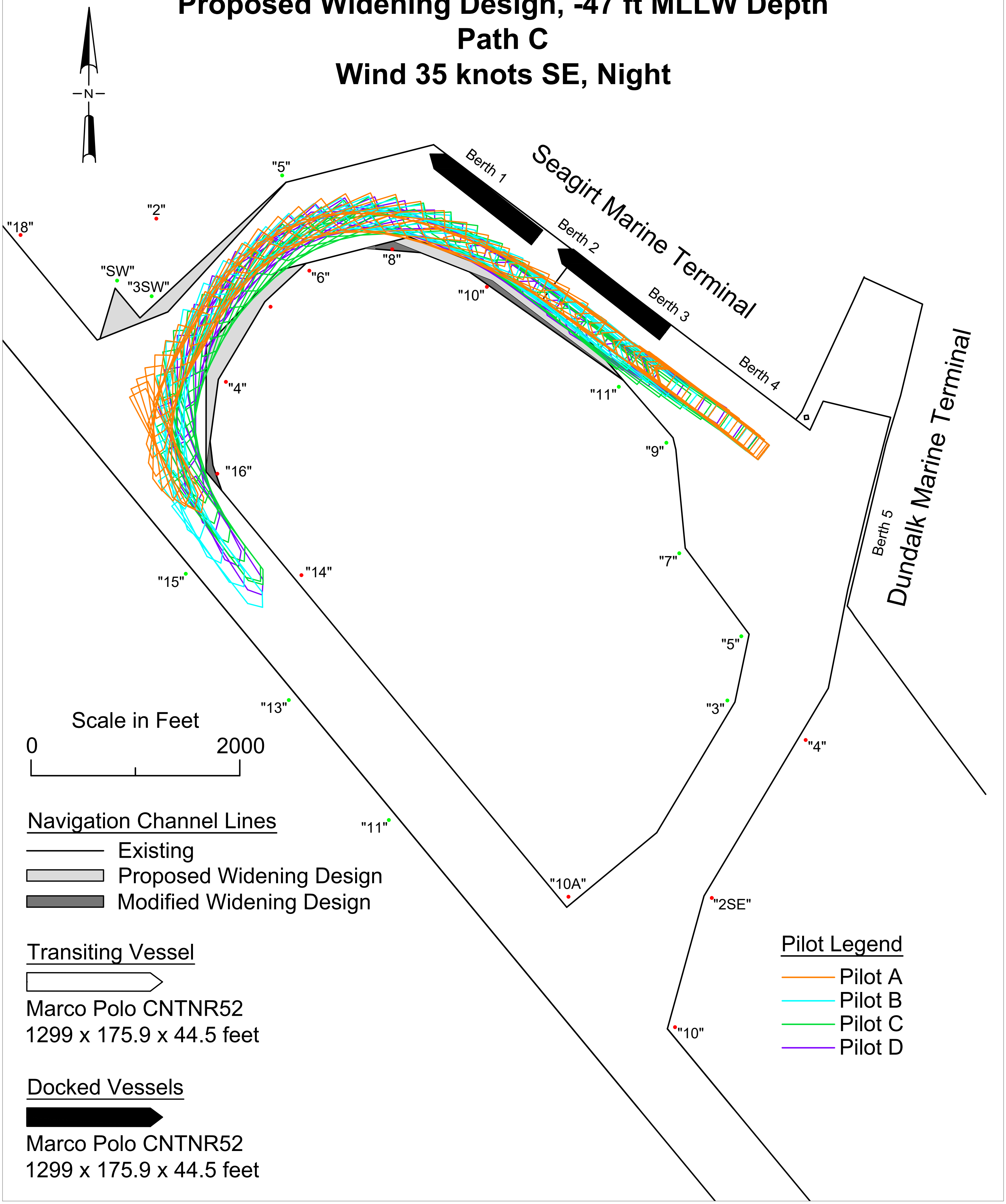


Plate 15

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-47 ft MLLW	C	CNTNR52	SE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	29:22
B	19 April 2022	N/A	22:33
C	28 April 2022	N/A	24:07
D	28 April 2022	N/A	19:59

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Stern uncomfortably close to ship at SMT Berth 1.	4	4
B	– 4 boats necessary. – Range lights marking channel and Fairfield area would make this maneuver safer. – Headway required to keep stern clear of vessels at Berths 1-3 and green side of channel may be excessive, especially at deeper drafts.	4	4
C	Good channel dimensions for swept path of vessel.	3	3
D	4.3-4.4 knots going by 1/2 Berth to overcome set on to Berth. Worked #2/3 tugs full to regain red side.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 16
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

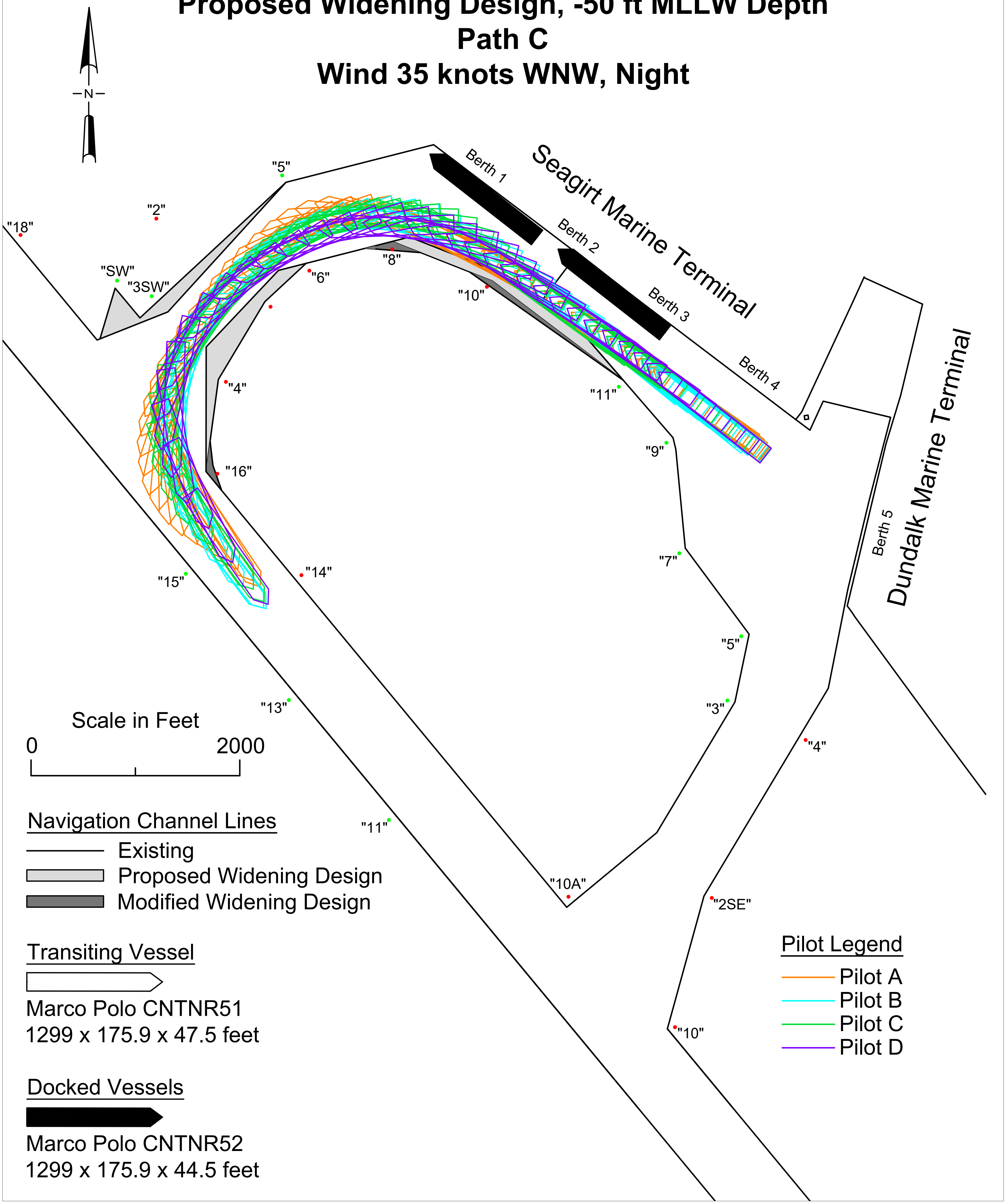


Plate 16

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	19 April 2022	N/A	36:22
B	19 April 2022	N/A	30:44
C	26 April 2022	N/A	26:19
D	26 April 2022	N/A	23:20

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Much safer than with turning basin. – 47.5 ft draft performed well in wind (50' channel). – Did not require heavy tug bells.	3	2
B	This maneuver with a full 50 ft channel loop is a much safer and more efficient maneuver rather than backing out. Less time beam to wind. Directional momentum remains constant as well as rate of turn. Both these are important for control of the vessel.	4	4
C	Much safer departing via new Elevator Channel than backing out to basin.	3	3
D	None.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 17
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

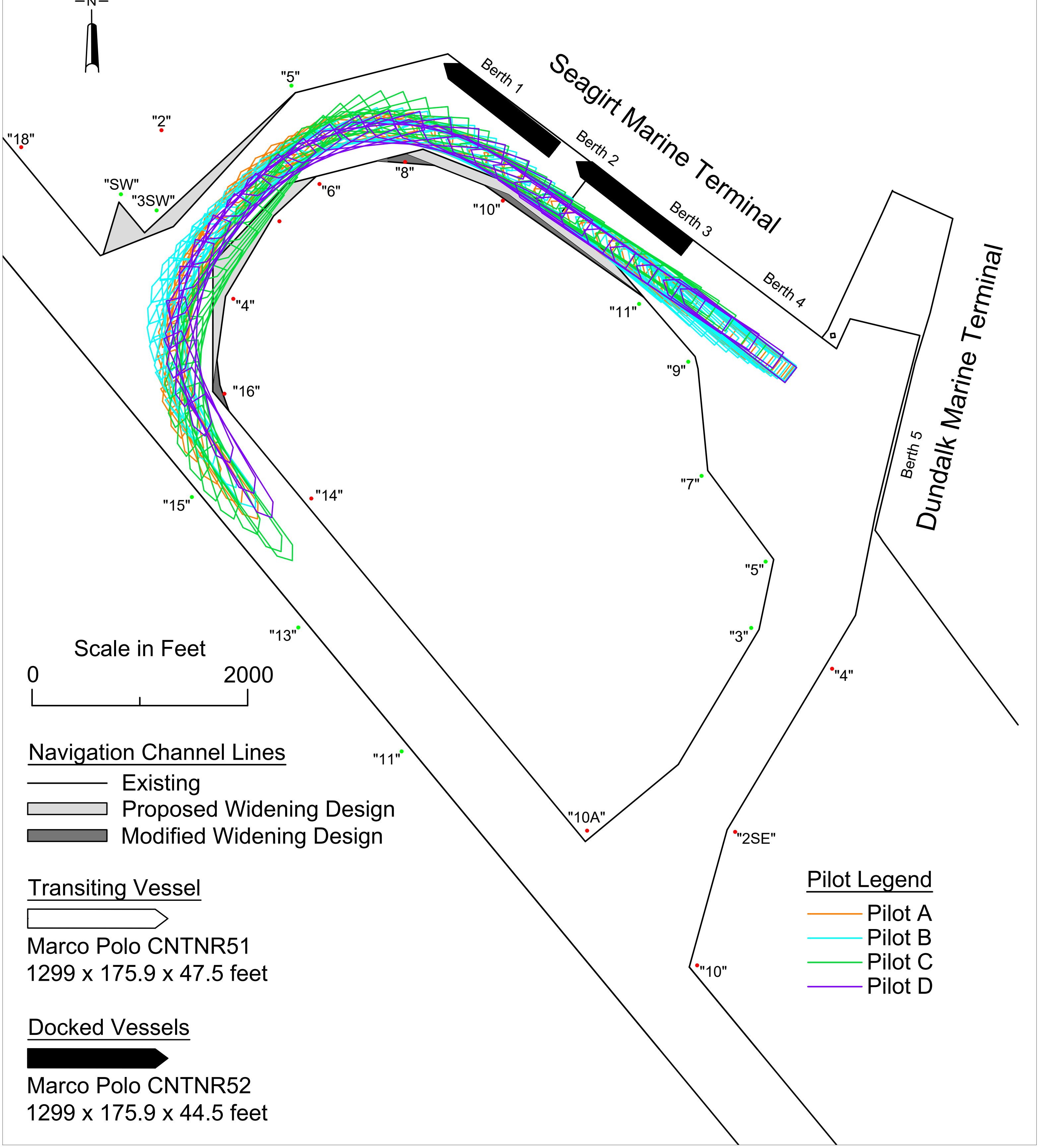


Plate 17

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	Port shoulder	33:50
B	20 April 2022	Port quarter	31:12
C	27 April 2022	Port quarter	27:00
D	27 April 2022	Port quarter	19:49

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Much safer in this channel than in turning basin. Was easily able to compensate for tug casualty. Also, same job (sailing SMT) was completed in half the time. Safer and more efficient.	3	1
B	When tug is lost, remaining equipment is worked full, leaving no margin for safety/error. Maneuver was completed successfully through this channel however.	3	4
C	The loss of port quarter tug made the last turn difficult.	4	4
D	Lost tug #3 - Moved tug #1 to replace. Worked tug #2 45° astern to arrest headway and complete turn. Used tugs #2,3,4 to move stern to starboard.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 18

Seagirt Loop Channel, Baltimore Harbor, MD

Proposed Widening Design, -50 ft MLLW Depth

Path C

Wind 25 knots SSE, Night

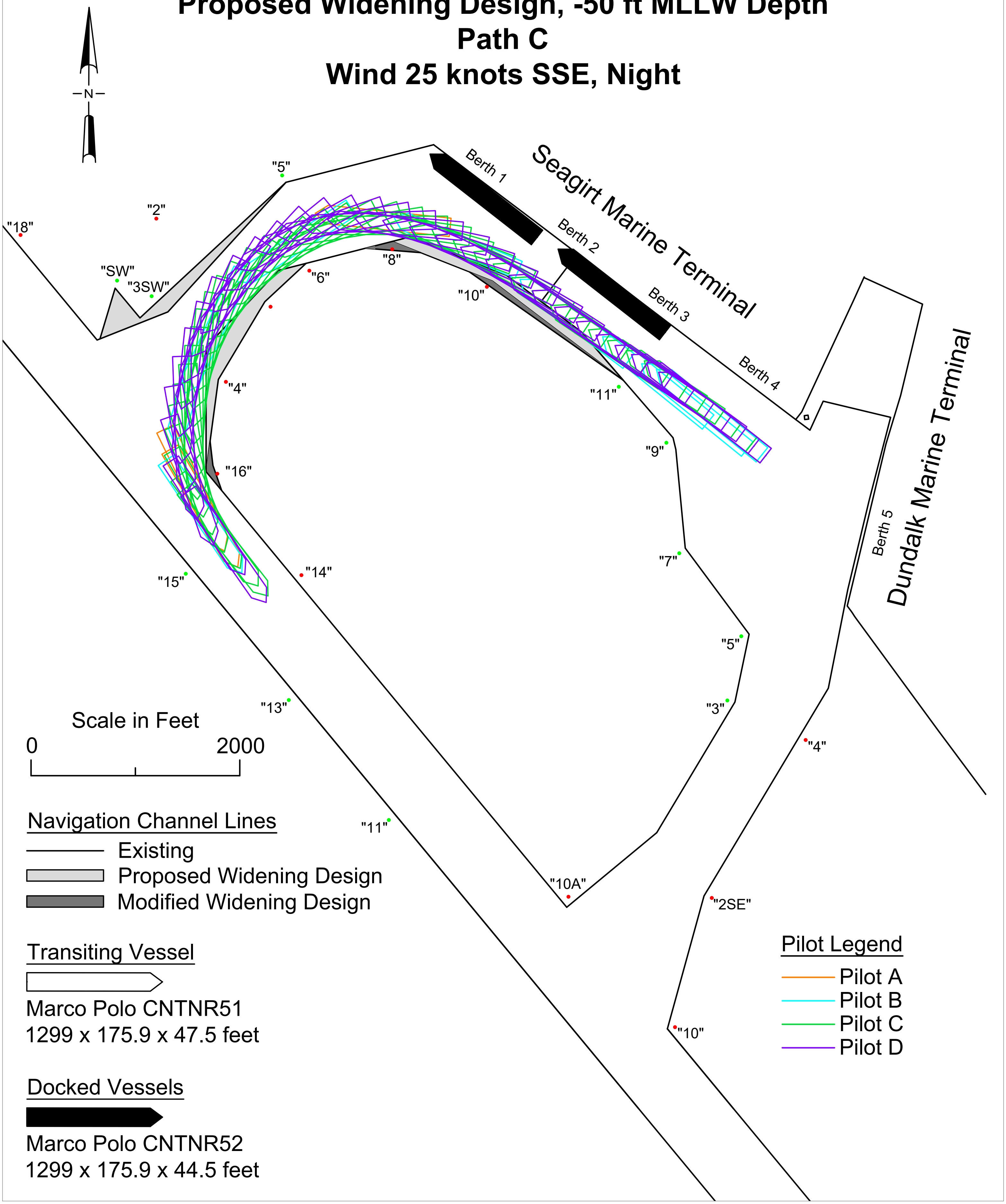


Plate 18

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	SSE	25 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	29:12
B	21 April 2022	N/A	27:57
C	27 April 2022	N/A	25:43
D	27 April 2022	N/A	21:06

Individual Pilot Feedback

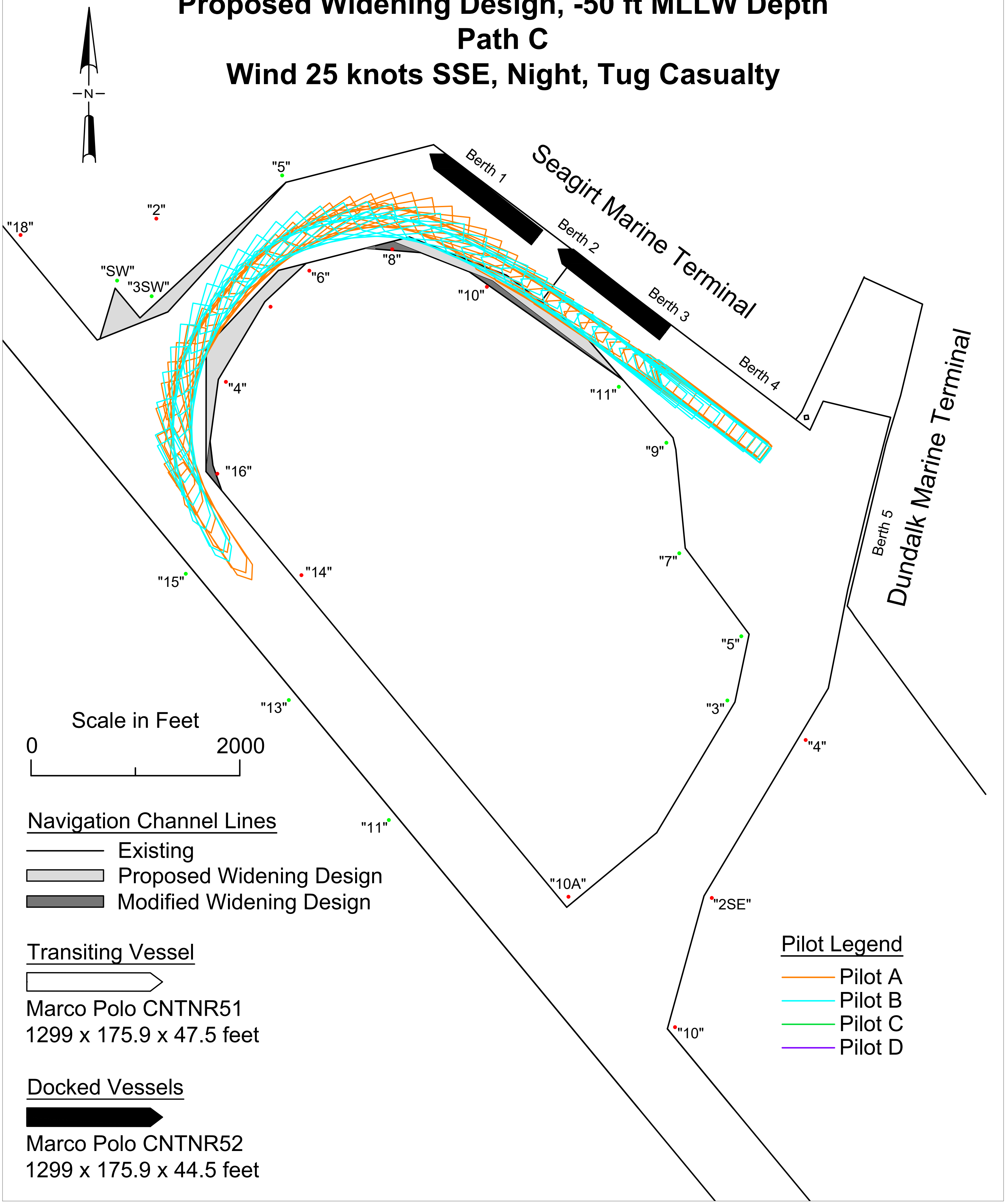
Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Good safety margins. Did not have to overuse tugs beyond safe margins.	3	2
B	4 tugs required. Losing a tug would not have resulted in a failure to complete the maneuver.	3	3
C	Safer maneuver at 25 knots.	3	3
D	Proposed adjustments much better. Bow ran deep. Had to use forward boat to reposition bow closer to windward side of channel.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 19

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 25 knots SSE, Night, Tug Casualty



<u>Plate 19</u>

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	SSE	25 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	Starboard shoulder	30:54
B	20 April 2022	Starboard quarter	26:15

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Worked very well. Was safely able to recover from tug casualty. Approx. half the time as using east basin and channel. Much safer and much more efficient.	3	2
B	This maneuver is acceptable with 4 tugs and can be completed safely if one of these tugs is lost due to casualty.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 20

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots SSE, Night

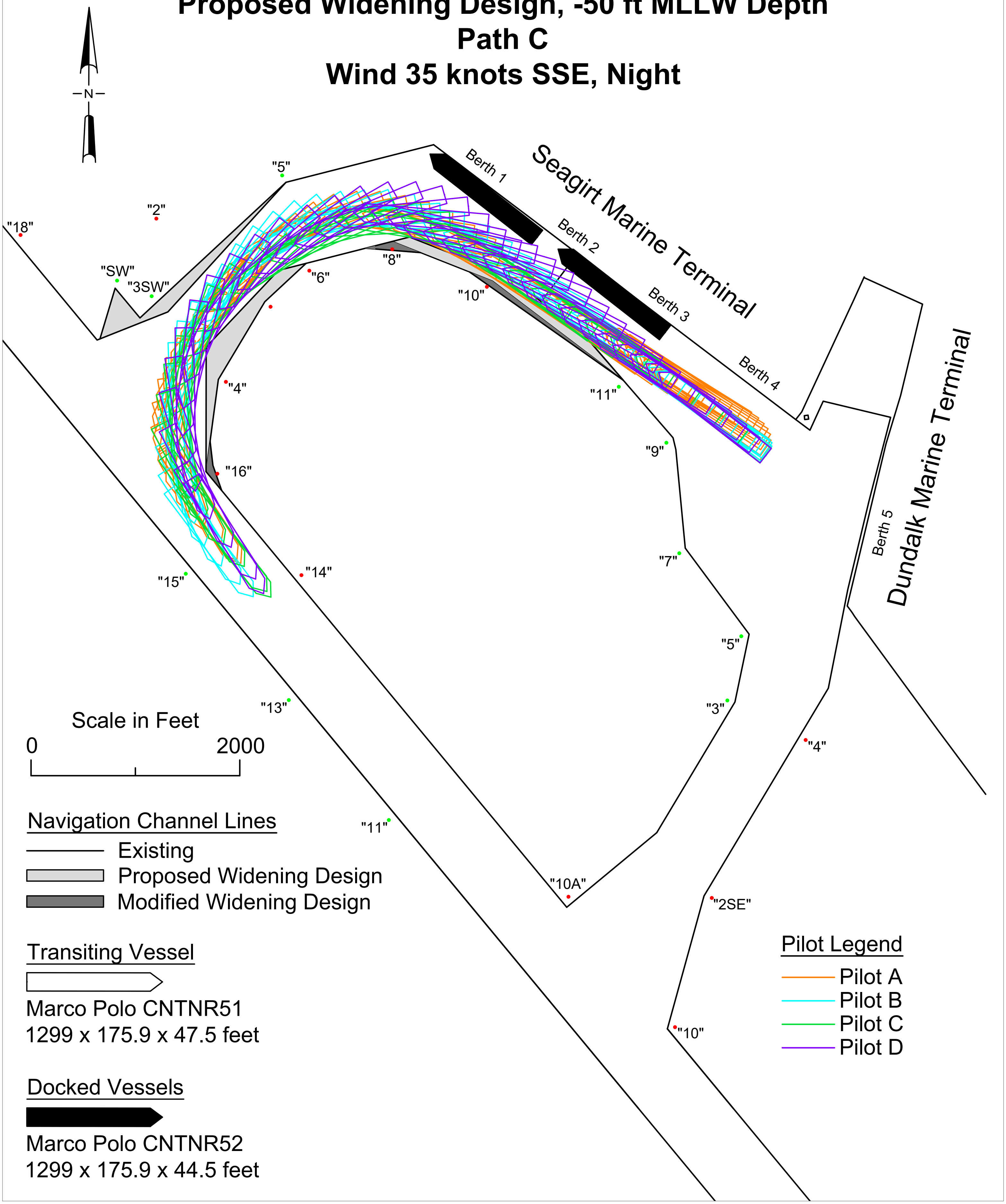


Plate 20

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	N/A	30:50
B	20 April 2022	N/A	29:48
C	26 April 2022	N/A	19:30
D	26 April 2022	N/A	22:55

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Not safe with these winds in this direction. Had to max tug power on all boats at times, eliminating ability to recover from any failure.	4	5
B	– Due to wind direction, tugs worked near maximum for too long of a period. – Widener in vicinity of nun buoy "10" and lit buoy "8" off berths 1 and 2 may need to be increased. Swing distance from stern of vessel to ships at berth has been too close at all wind directions. Requires speeds ahead that are excessive.	4	4
C	Again, much safer departing via the Elevator Channel vs. backing to turning basin.	3	3
D	SE wind very difficult for this configuration of channel.	5	5

*Difficulty Rating: 1 = Easy | 5 = Difficult
**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 21
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 30 knots NE, Night & Snow

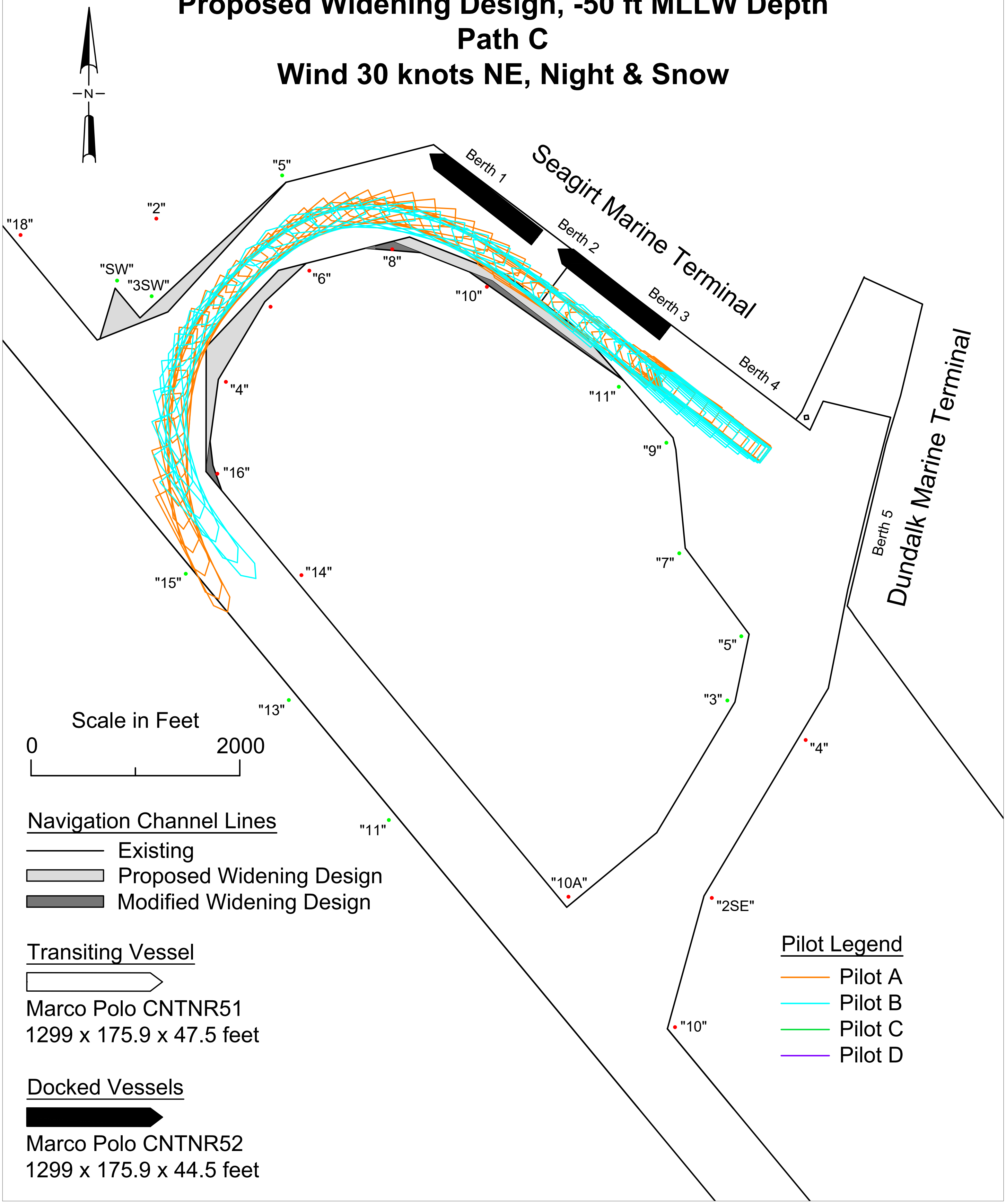


Plate 21

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR51	NE	30 knots	Night & Snow	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	32:28
B	21 April 2022	N/A	25:54

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Evolution was feasible until loss of starboard shoulder tug, which resulted in grounding on green bank of Fort McHenry Channel. Four tugs necessary for safety margin. Grounding would have been recoverable in real loss of tug (operator would have known of loss).	4	2
B	This maneuver requires 4 boats. Considerable power is required to hold ship up into wind. This should be preferable to turning in basin due to length of time exposed to beam winds.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult
**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 22
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

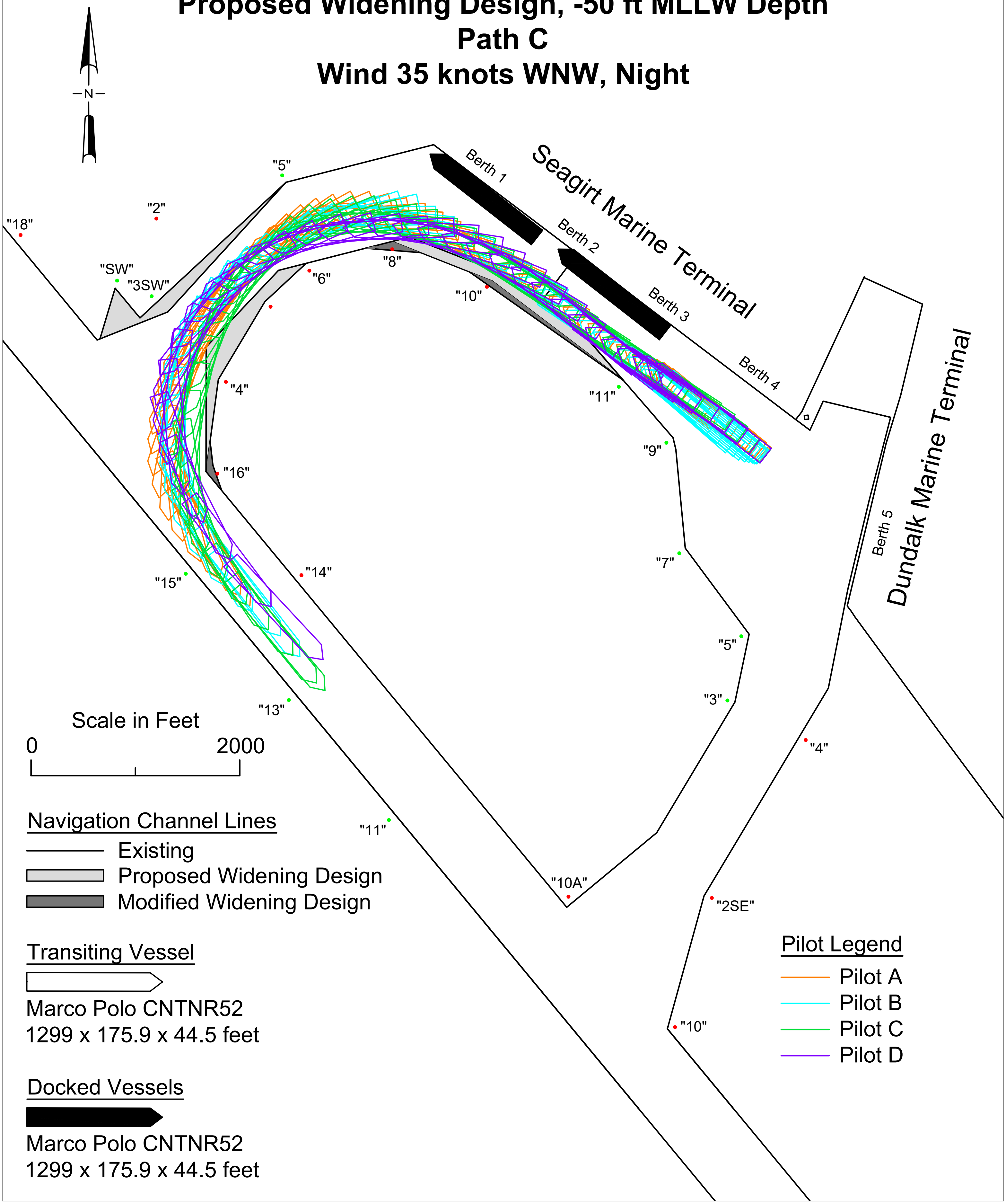


Plate 22

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	N/A	36:23
B	20 April 2022	N/A	1:02:19
C	27 April 2022	N/A	28:14
D	27 April 2022	N/A	22:00

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Increased UKC (50 ft depth) with 44.5 ft draft handled well with comfortable safety margin and contingency.	3	2
B	– Corner at buoy "16" could be/should be eased to assist with final turn in wind. – 4 tugs necessary. – Effective mouth of channel is smaller than previously improved west channel of Dundalk. This should be at least as big.	N/A	N/A
C	All good.	3.5	3.5
D	Channel reduction noticeable. Used tugs 2,3,4 100% at end of maneuver. 3.6-3.9 knots during entire maneuver.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 23

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

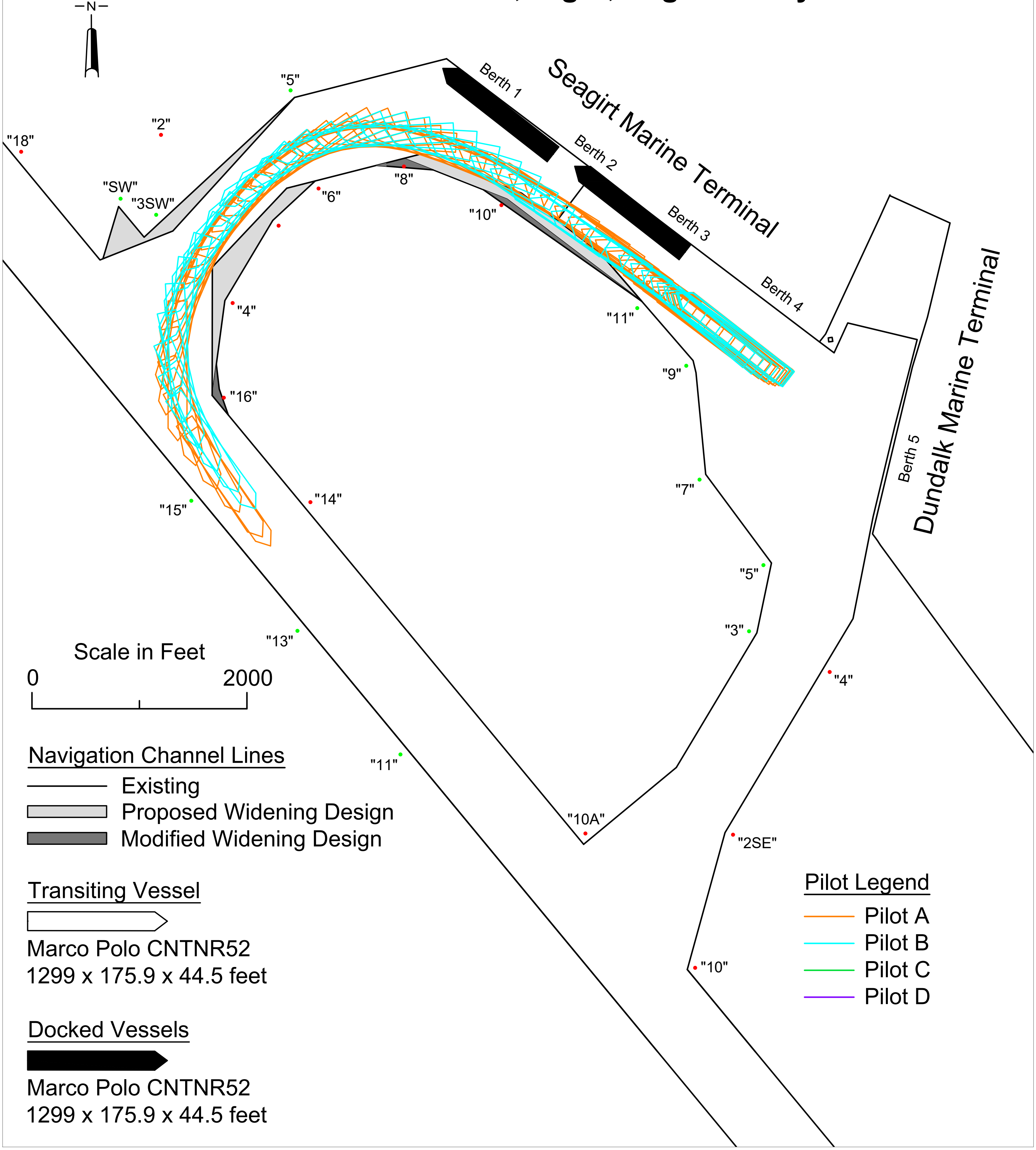


Plate 23

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR52	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	36:15
B	21 April 2022	Port quarter	1:02:19

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Easily able to safely recover from casualty, despite strong winds. Safety margin much higher. Also, less prolonged exposure to risk than in turning basin.	3	2
B	Much safer option than turning in basin. Tug usage much less / very reasonable. Wind forces more distance off buoy "8" – this causes the stern to be closer to the ship at Seagirt Marine Terminal Berth 1/2. This corner is the issue.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 24
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 25 knots SSE, Night

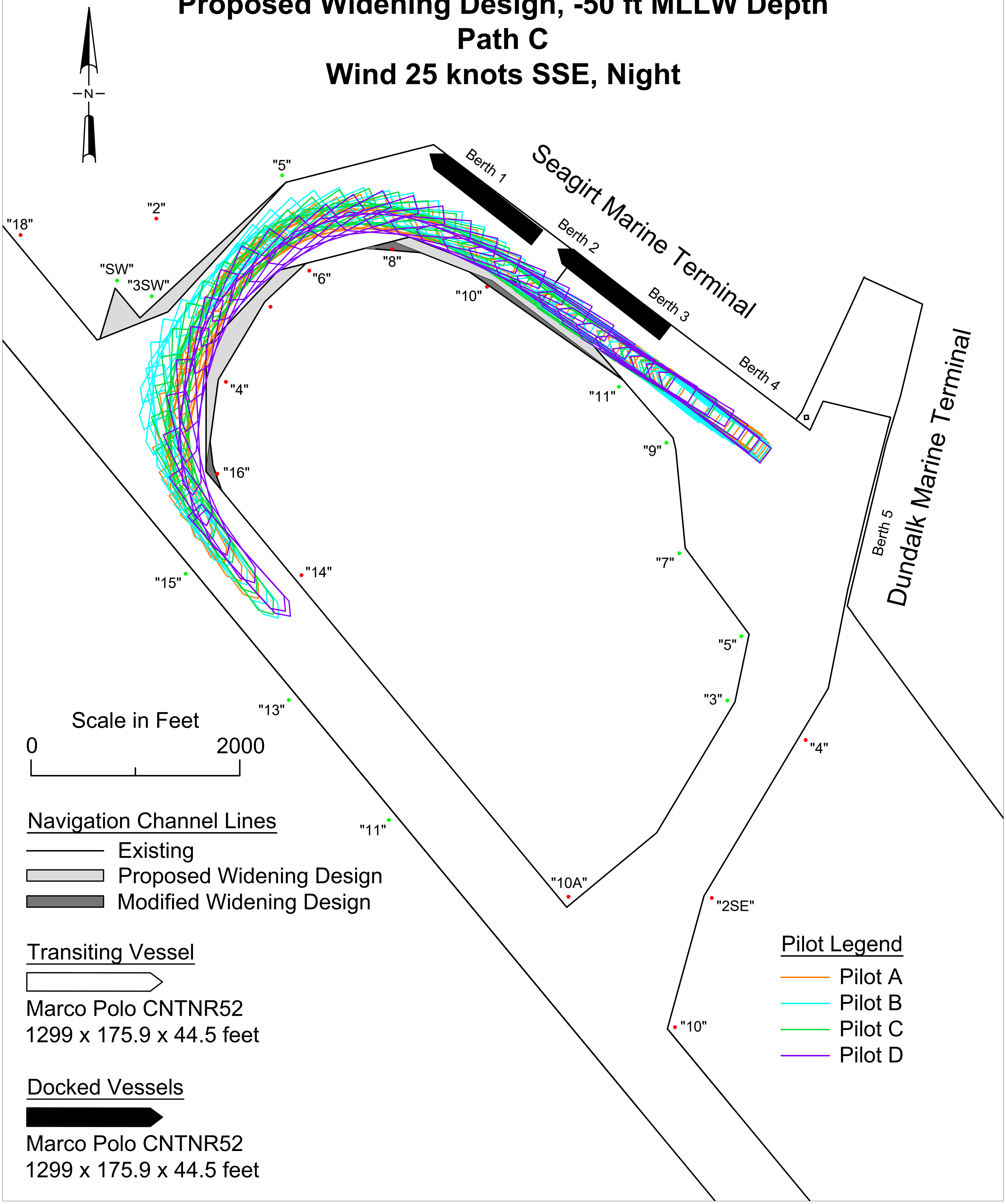


Plate 24

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR52	SSE	25 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	20 April 2022	N/A	31:20
B	20 April 2022	N/A	59:32
C	27 April 2022	N/A	21:02
D	27 April 2022	N/A	20:47

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	– Safe and feasible with adequate safety margin. – Added UKC (50' depth) allows for emergency anchor use in event of casualty at 44.5' draft. This is not possible at 47' depth.	2	2
B	– With a tug failure, this maneuver became very dangerous - 4 boats required. – Swing distance on starboard quarter to berthed ships is still a safety concern - too close if vessel is at all out of position. – More with should be considered in vicinity from nun "10" to lit buoy "8".	3	4
C	The new wideners are needed with a vessel at Seagirt Berth 1.	3	3
D	Needed 4.0 knots to keep off of berthed vessel at Seagirt. Slightly speedy. Needed tug #2 to reposition on red side. Very tight on red buoy in Fort McHenry Channel entrance.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 25

Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path C
Wind 30 knots NE, Night & Snow

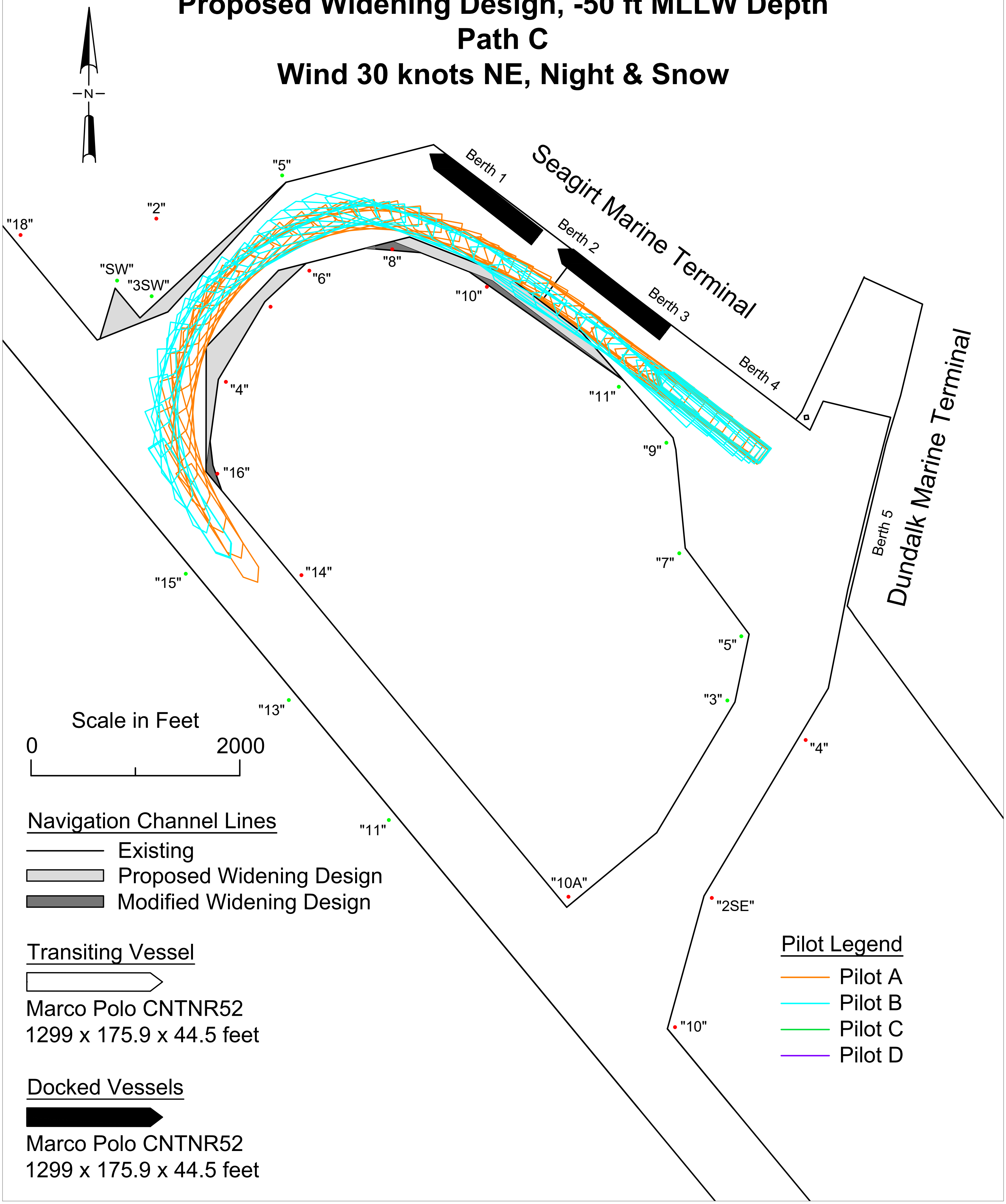


Plate 25

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	C	CNTNR52	NE	30 knots	Night & Snow	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	21 April 2022	N/A	29:56
B	21 April 2022	N/A	26:43

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Worked great. Safe with good margins and available contingencies.	3	2
B	This maneuver in beam wind pushes limitations of tugs.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 26
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path D
Wind 25 knots WNW, Night

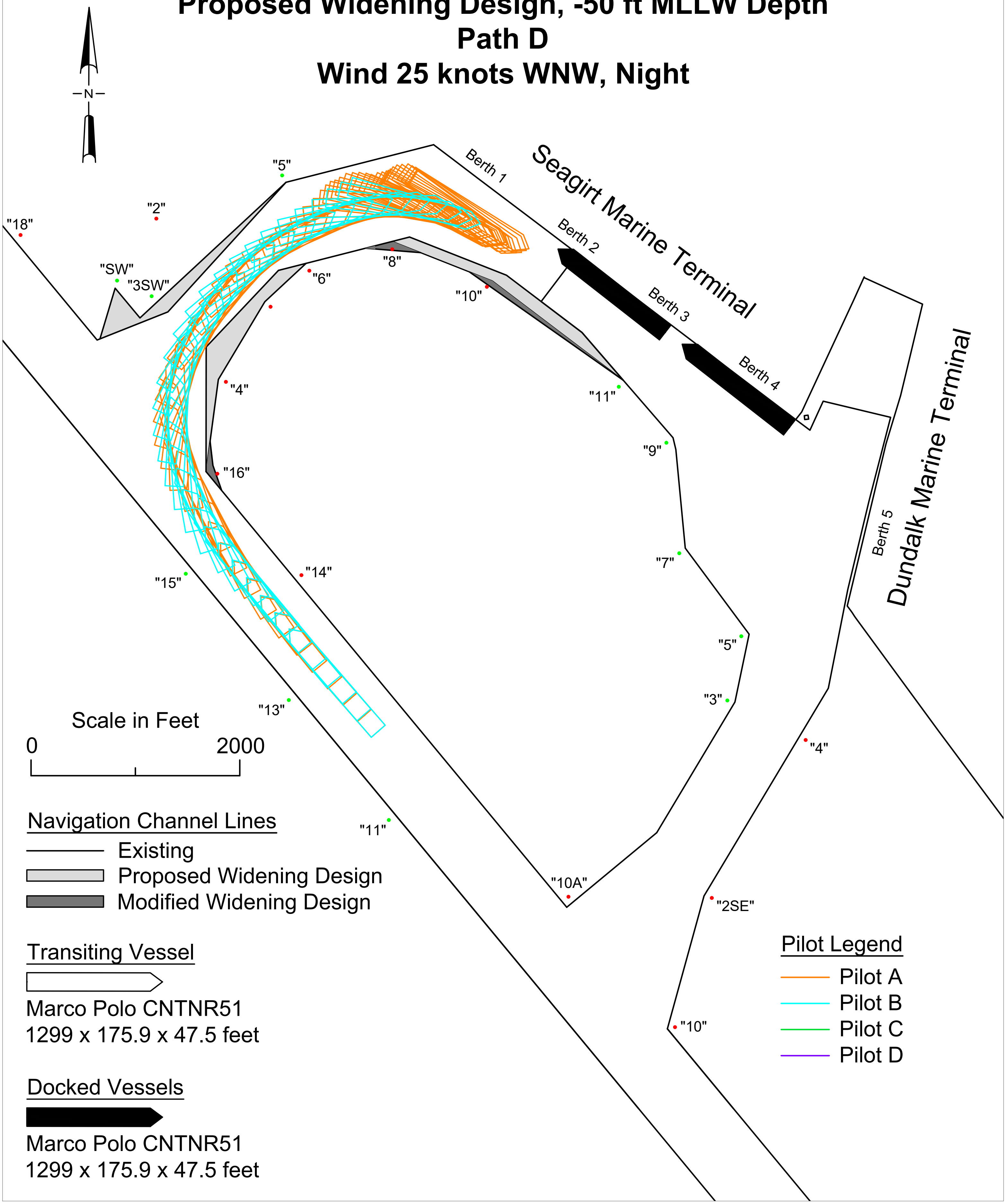


Plate 26

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	D	CNTNR51	WNW	30 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
A	22 April 2022	N/A	35:19
B	22 April 2022	N/A	21:17

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
A	Very safe and feasible. Only acceptable safe way to bring in this ship port side to (which could occur from cause such as gangway damage on starboard side). Would be incredibly difficult and risky if done in Seagirt Marine Terminal Berth 4 turning basin.	3	2
B	This maneuver was safe in these wind conditions with 4 boats.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 27
Seagirt Loop Channel, Baltimore Harbor, MD
Proposed Widening Design, -50 ft MLLW Depth
Path D
Wind 30 knots WNW, Night & Snow

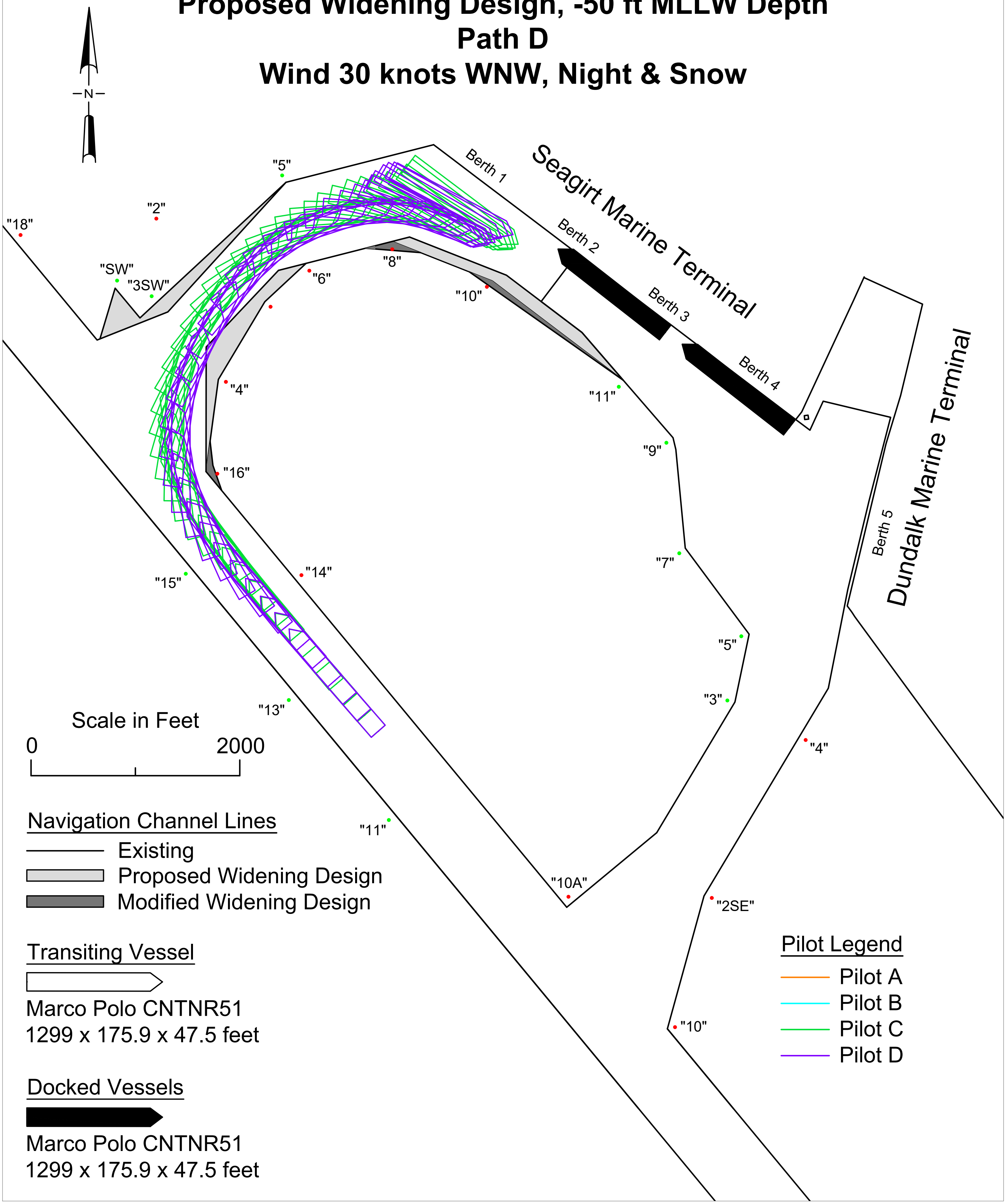


Plate 27

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Proposed	-50 ft MLLW	D	CNTNR51	WNW	30 knots	Night & Snow	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	27:51
D	28 April 2022	N/A	23:09

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Channel dimensions were good for path to SMT Berth 1.	3	3
D	Tight on "16" to drive to green side. Needed tugs #3/4 to turn the ship against wind.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 28
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots WNW, Night

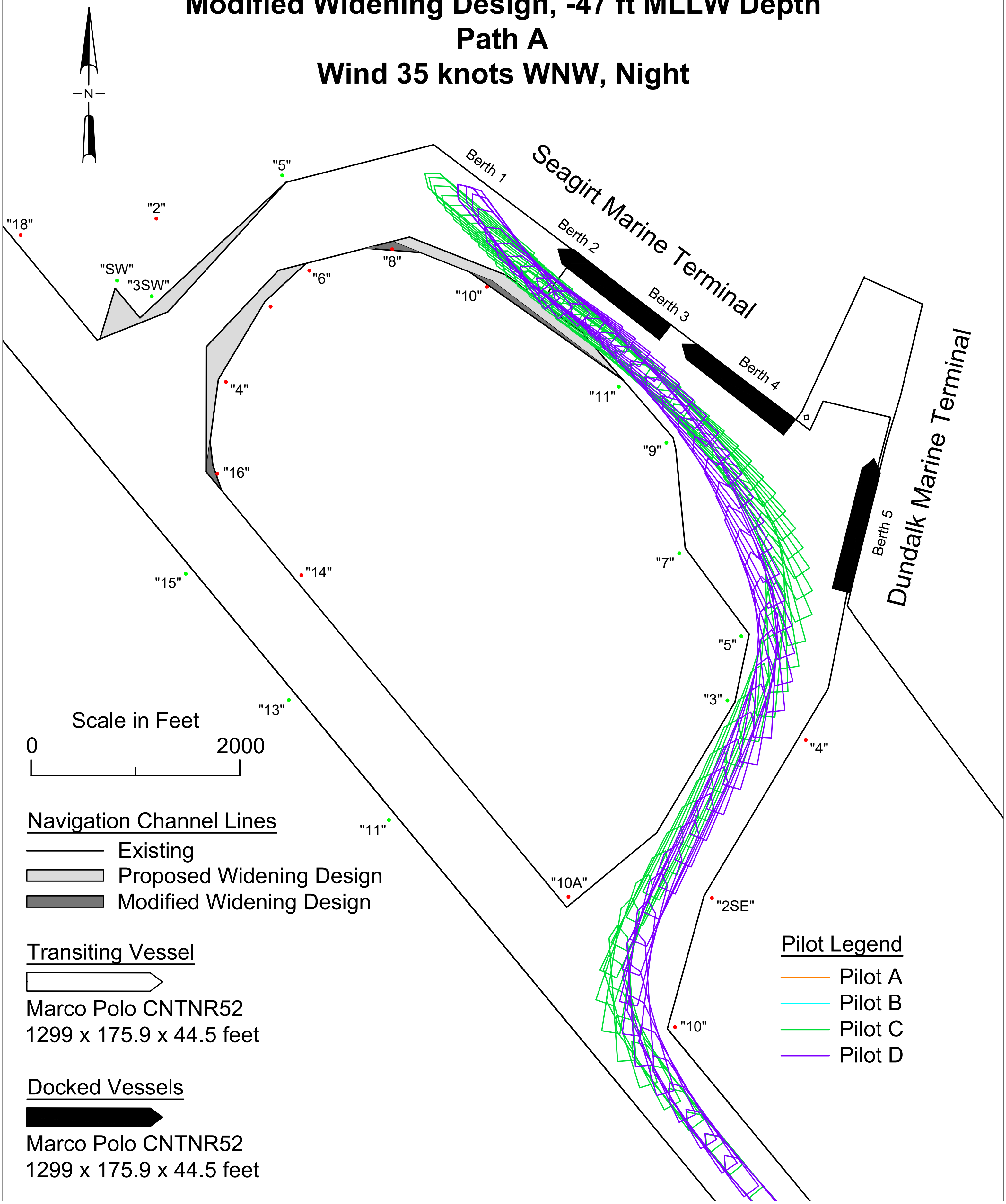


Plate 28

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	A	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	35:56
D	28 April 2022	N/A	30:03

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Standard maneuver.	3	3
D	Extra room essential to line up and clear berthed vessels and still allow room for assist boats.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 29
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots SSE, Night

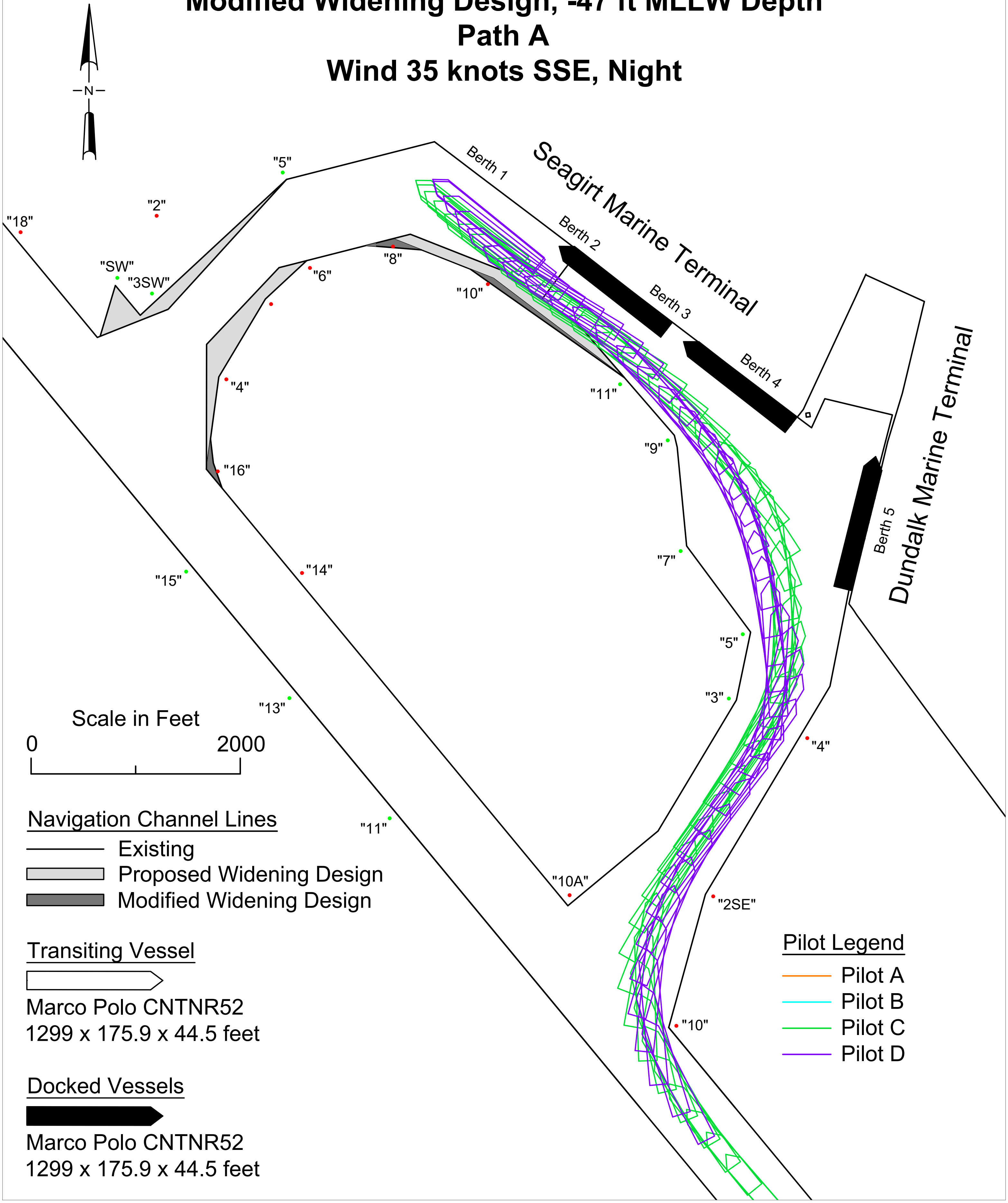


Plate 29

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	A	CNTNR52	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	29:55
D	28 April 2022	N/A	27:26

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Difficult maneuver with 35 knots on starboard quarter.	5	5
D	Wind on starboard quarter hard to overcome at 4.5 knots. Used all four tugs to fair up of Seagirt.	5	5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 30
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path A
Wind 35 knots SE, Night

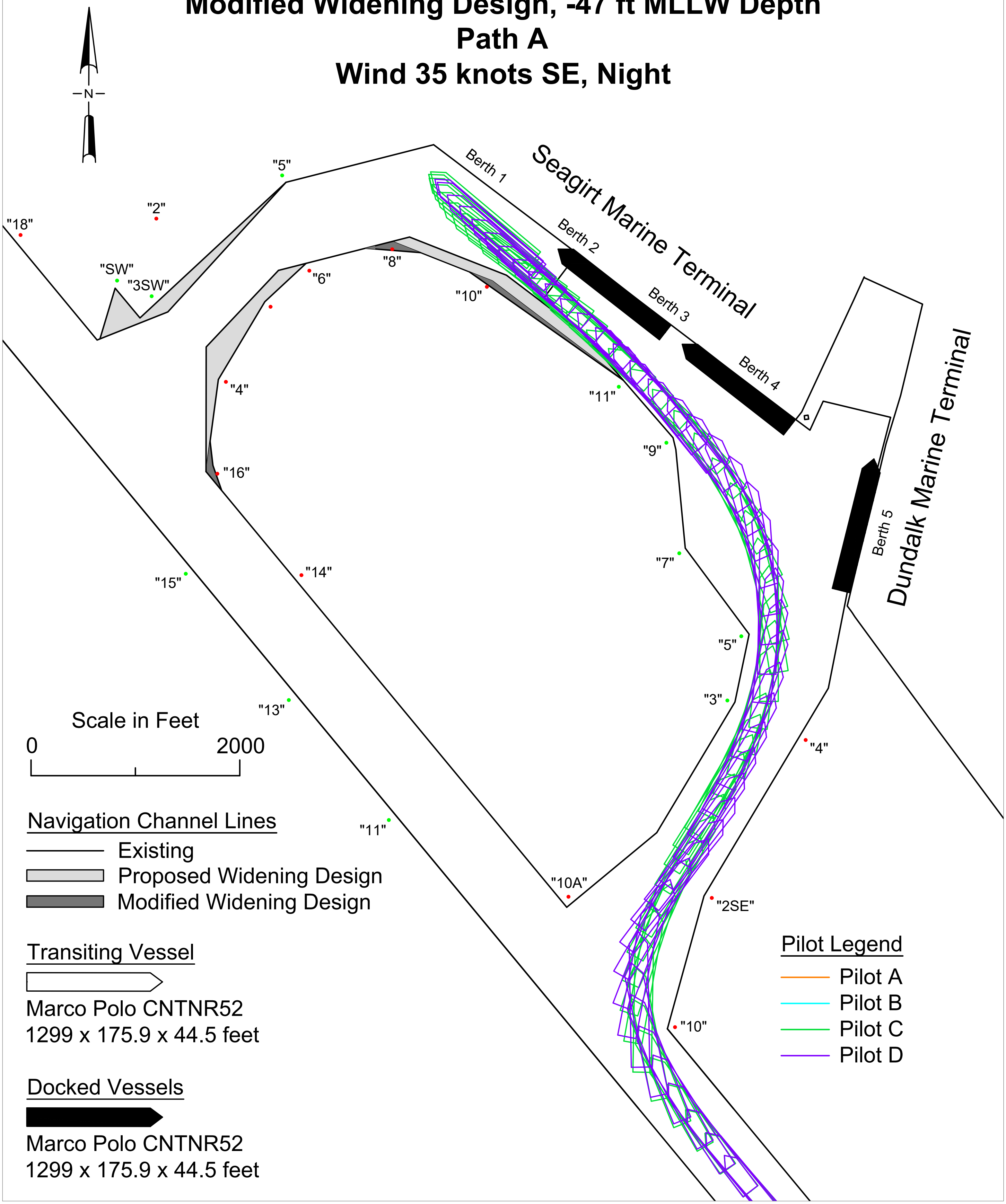


Plate 30

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	A	CNTNR52	SE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	29 April 2022	N/A	31:58
D	29 April 2022	N/A	29:33

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Used a lot of tug force at 35 knots.	4	4
D	Inbound went well. Used tugs #3/4 to get quarter up into wind and tug #2/1 to full bow down.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 31

Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

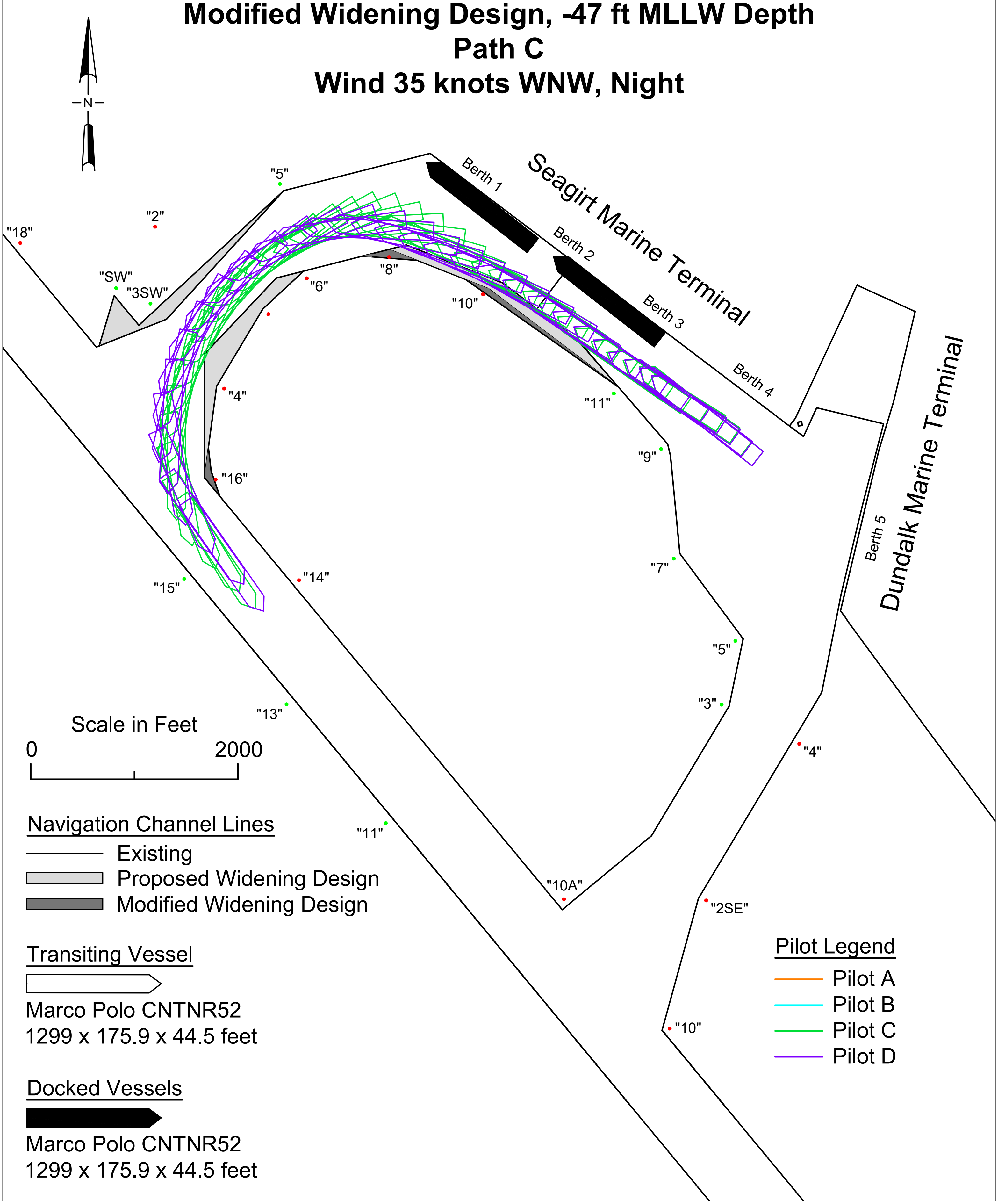


Plate 31

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	C	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	25:10
D	28 April 2022	N/A	19:45

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Needed to work the boats strong to make the final turn.	3.5	3.5
D	This is the preferred configuration with the widest safety margin. Exited at 4.5 knots and it was doable.	N/A	N/A

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 32
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

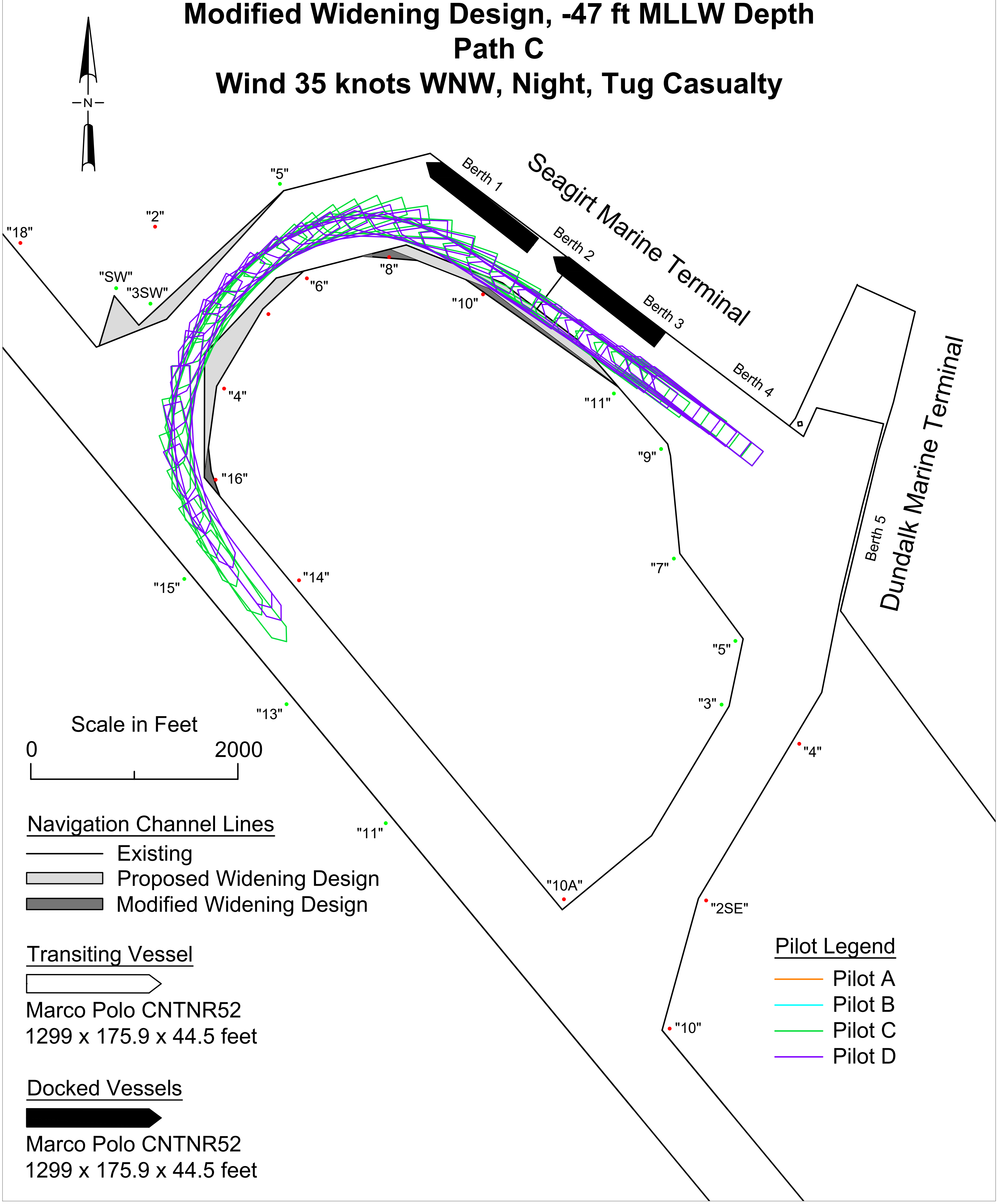


Plate 32

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	C	CNTNR52	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	Port quarter	23:18
D	28 April 2022	Port quarter	19:31

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	None.	3	3
D	Continues to be the preferred channel for vessel maneuvers.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 33
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots SSE, Night

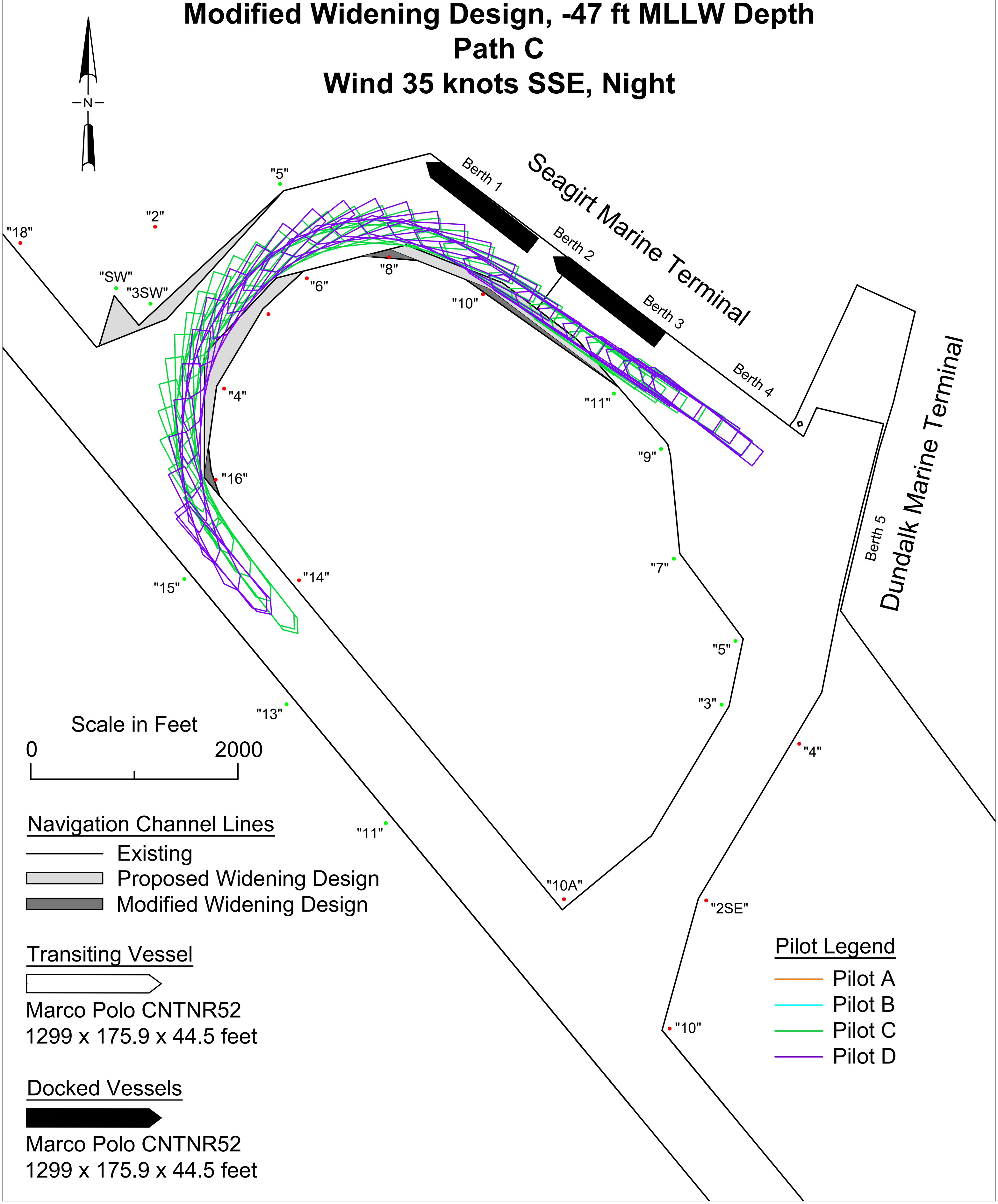


Plate 33

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	C	CNTNR52	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	23:27
D	28 April 2022	N/A	19:28

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Smooth operation. Safer than backing out of Berth 4 with strong winds.	3	3
D	Tried to keep 4.0 knots through maneuver. Used tug #2 to assist turn twice. Very tight on red side throughout.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 34
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -47 ft MLLW Depth
Path C
Wind 35 knots SE, Night

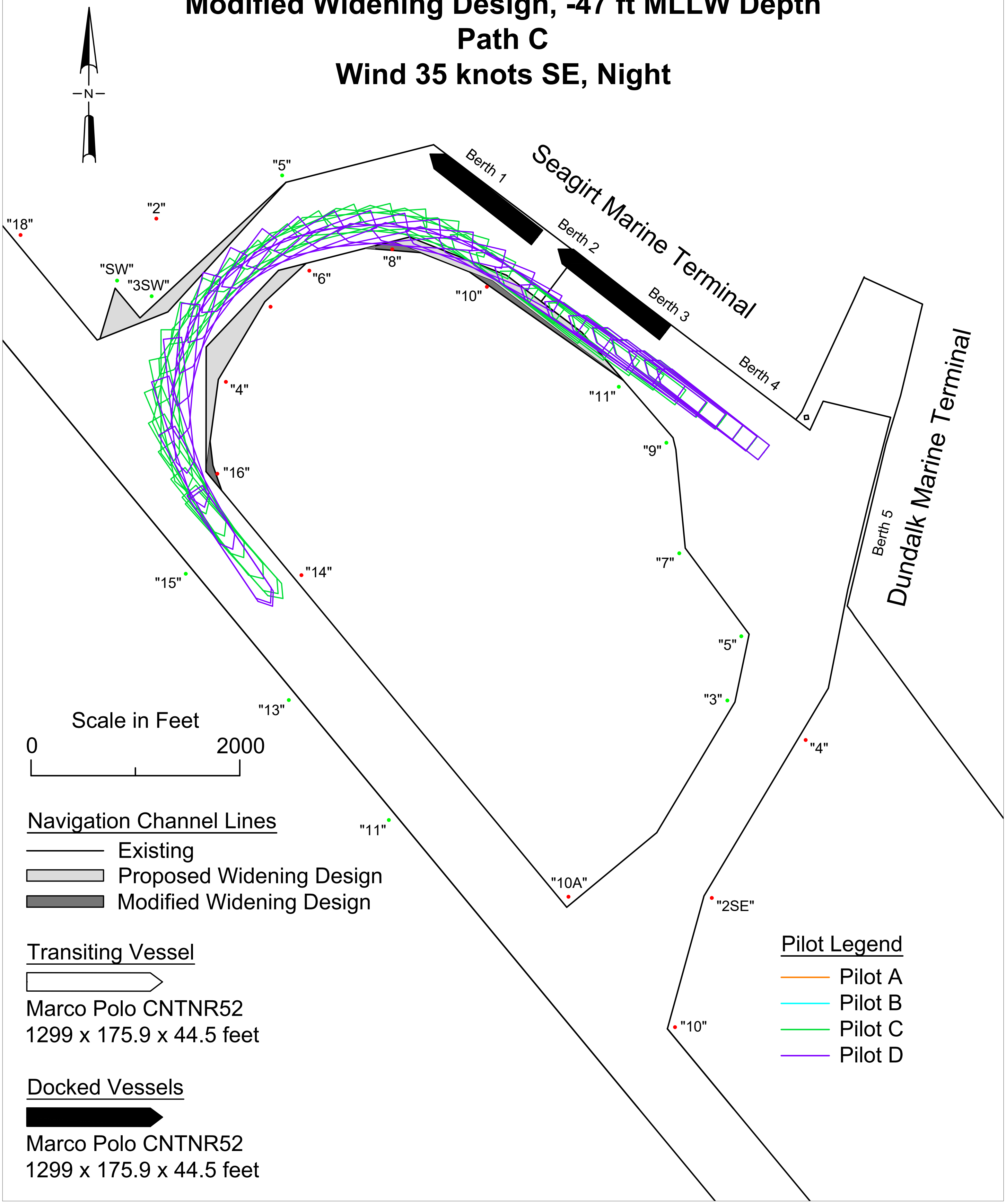


Plate 34

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-47 ft MLLW	C	CNTNR52	SE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	28 April 2022	N/A	20:18
D	28 April 2022	N/A	17:24

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Too much speed needed all boats and extra room on green side of Elevator Channel. Good proof of concept.	3	3
D	Preferred channel configuration - Allows for appropriate speed to overcome elements while still slow enough for external assistance.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 35
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

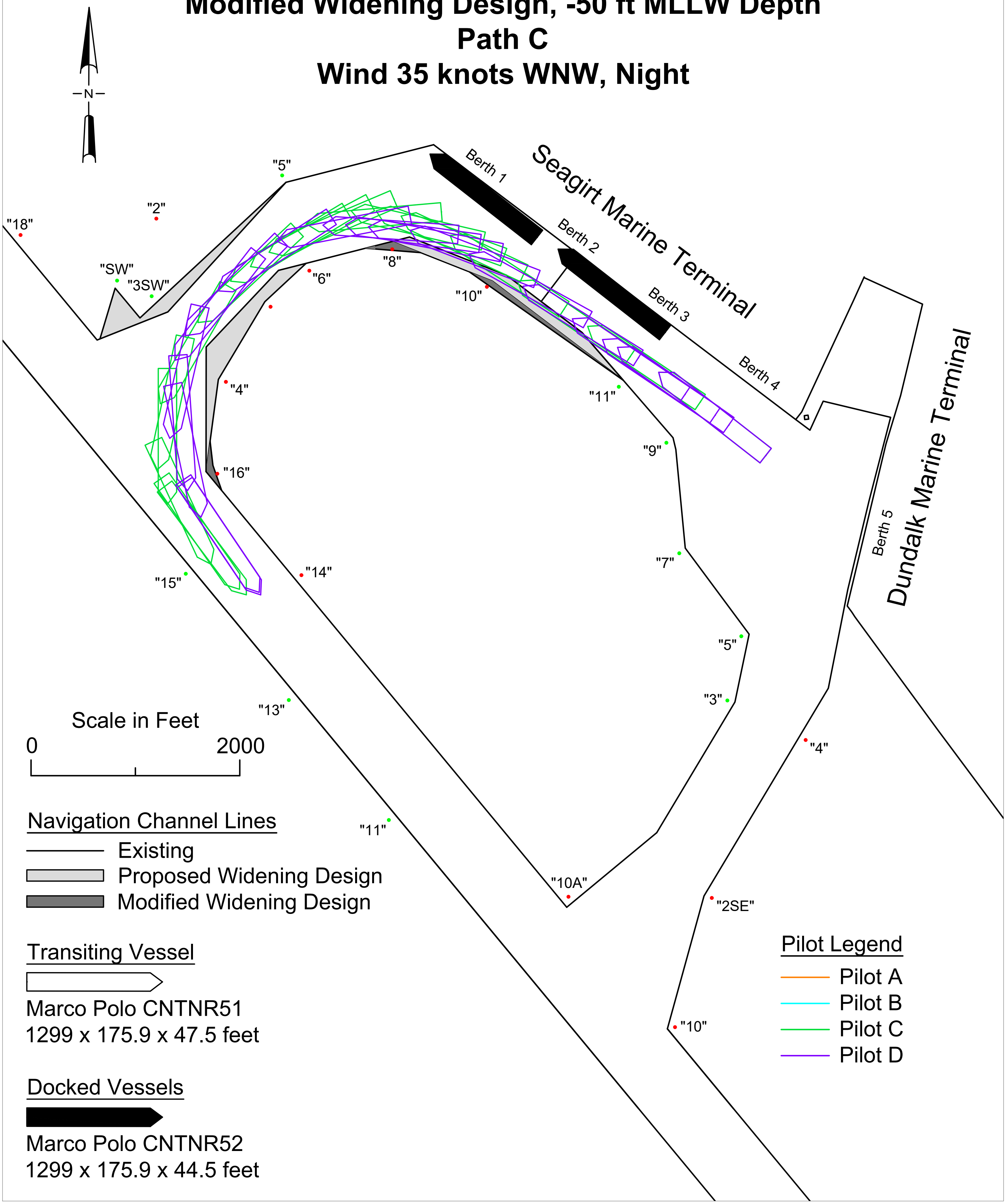


Plate 35

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR51	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	26 April 2022	N/A	20:12
D	26 April 2022	N/A	24:06

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	New modifications look good!	3	3
D	None.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 36
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

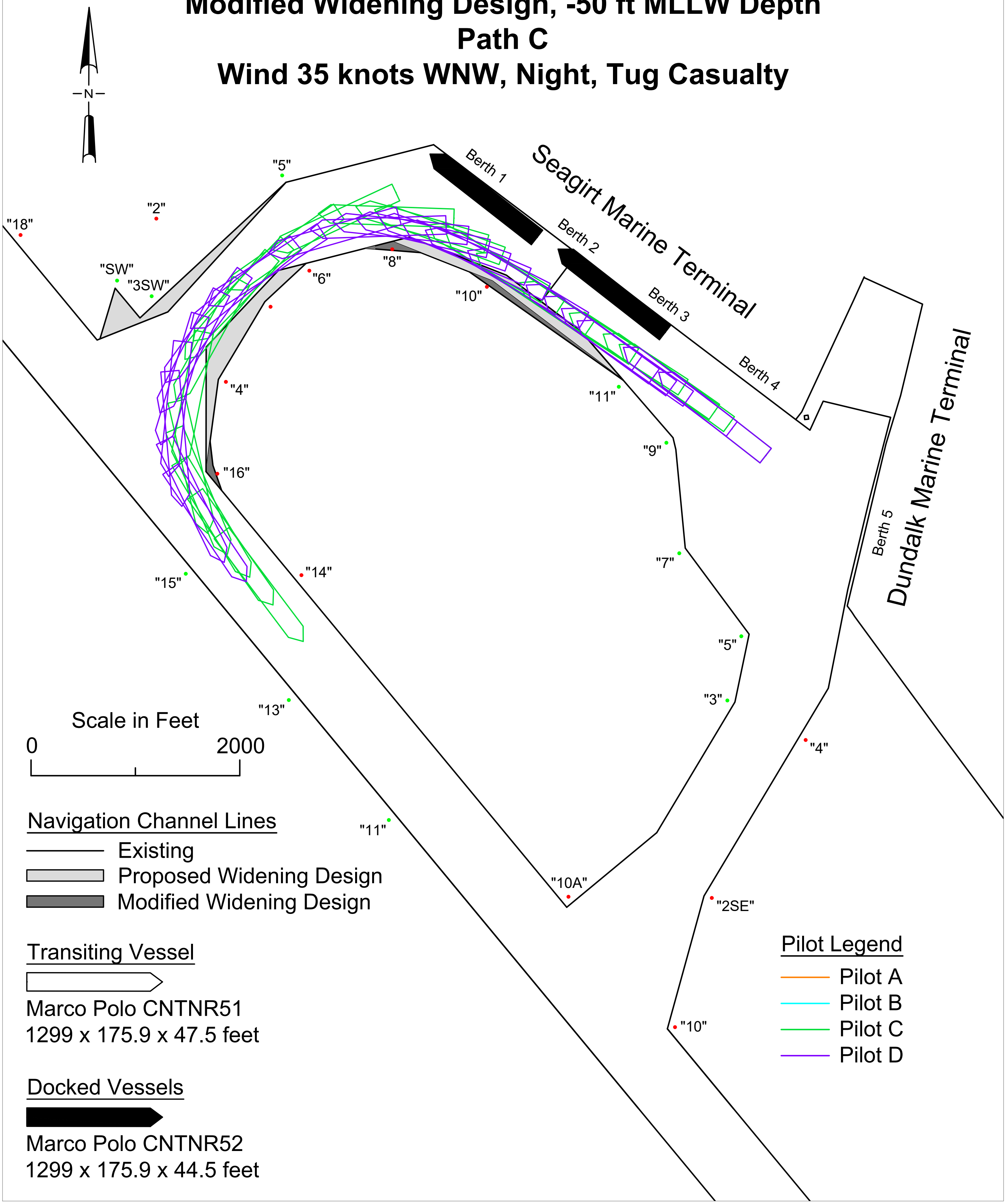


Plate 36

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR51	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	27 April 2022	Port quarter	28:48
D	27 April 2022	Port quarter	22:32

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Good channel dimensions. Smooth operation.	3	3
D	Channel configuration much more accommodating to handling the vessel. A safe evolution should not be overly reliant on tug assistance. Speed was targeted at 4.0 knots by the end of the maneuver.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 37
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 25 knots SSE, Night

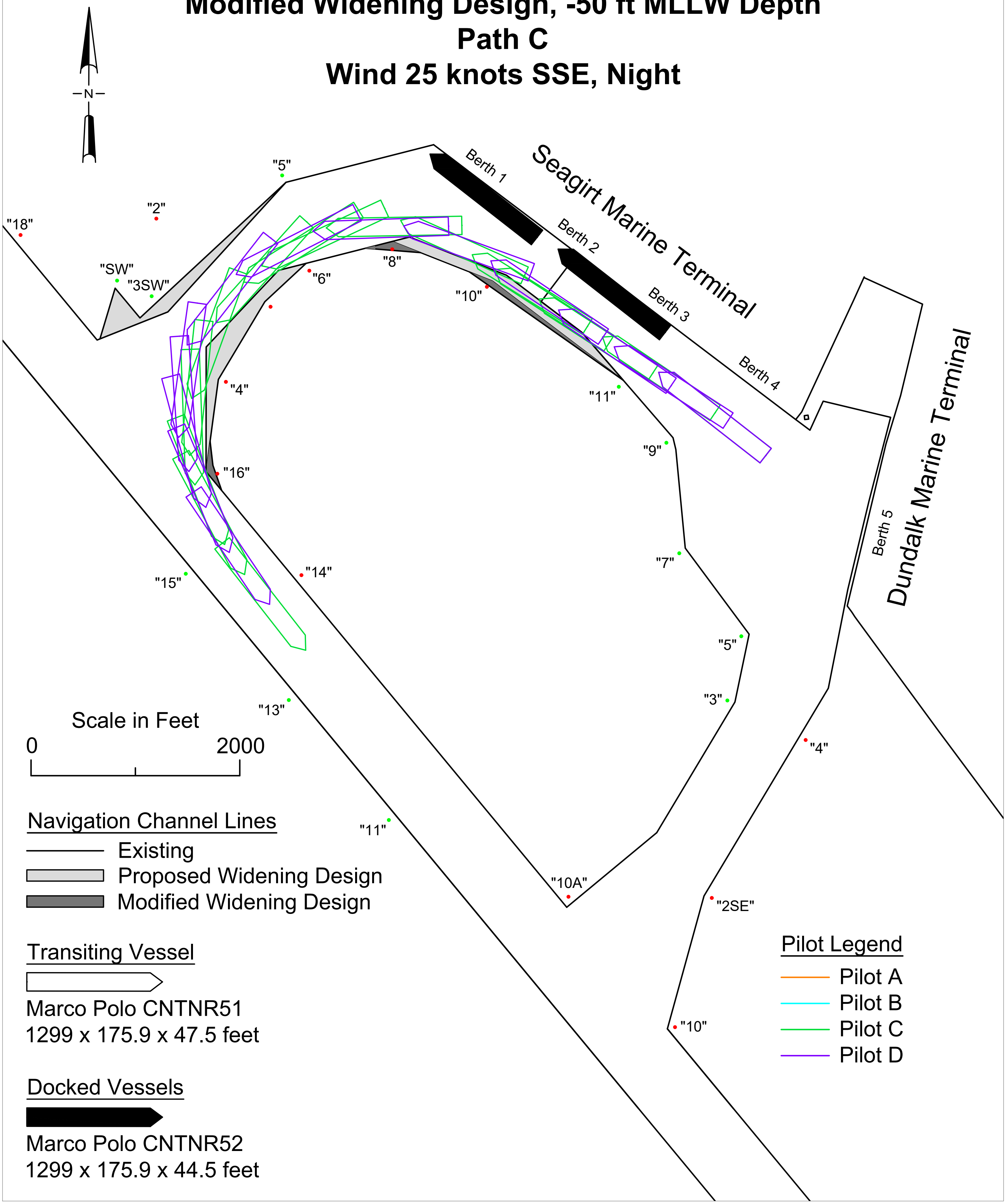


Plate 37

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR51	SSE	25 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	29 April 2022	N/A	21:37
D	29 April 2022	N/A	18:41

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Smooth operations with new channel dimensions.	2	2
D	Best configuration! Minimal tugs required.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 38

Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots SSE, Night

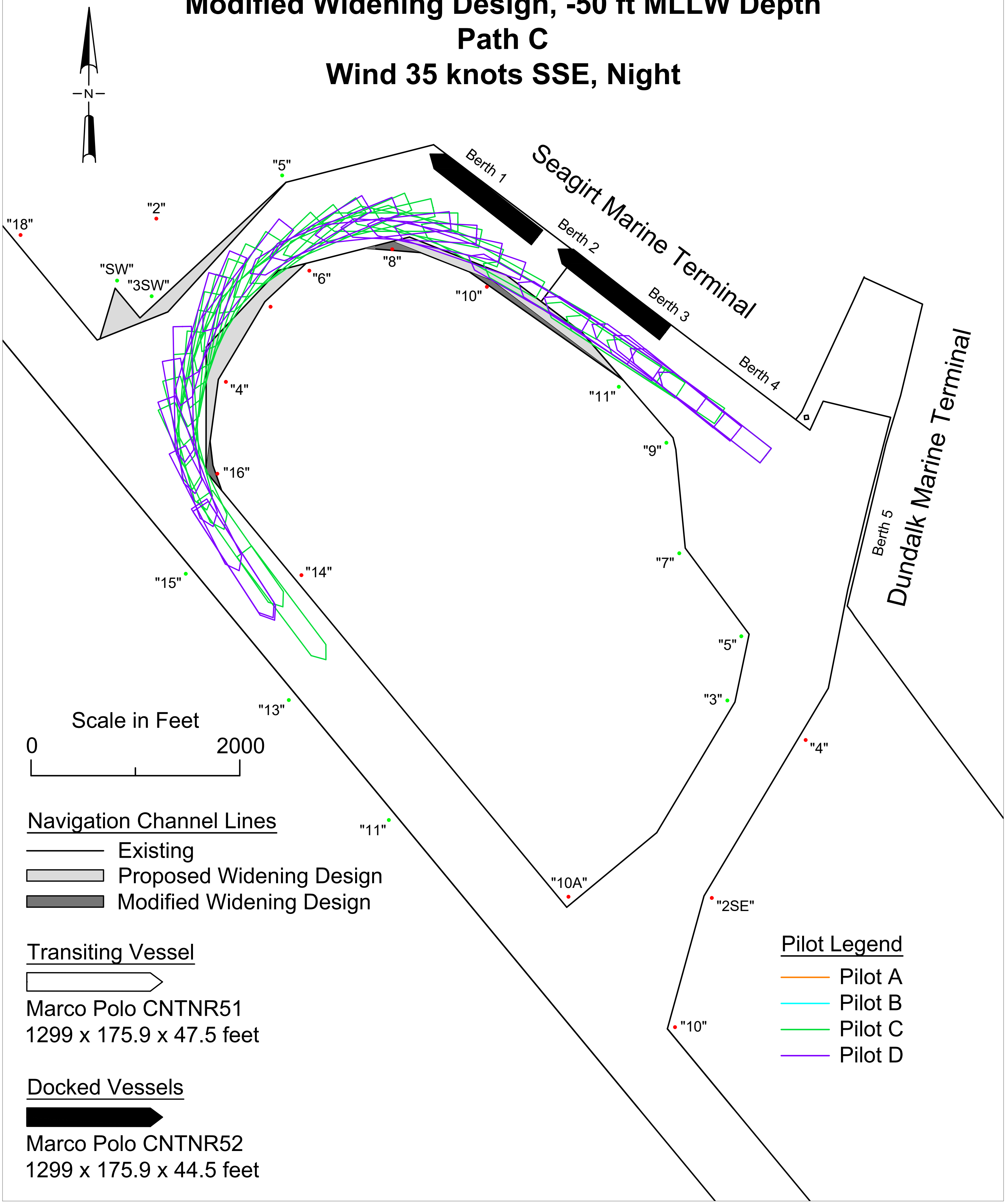


Plate 38

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR51	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	26 April 2022	N/A	25:03
D	26 April 2022	N/A	20:03

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Looks good!!	3	3
D	Channel is much improved.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 39

Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night

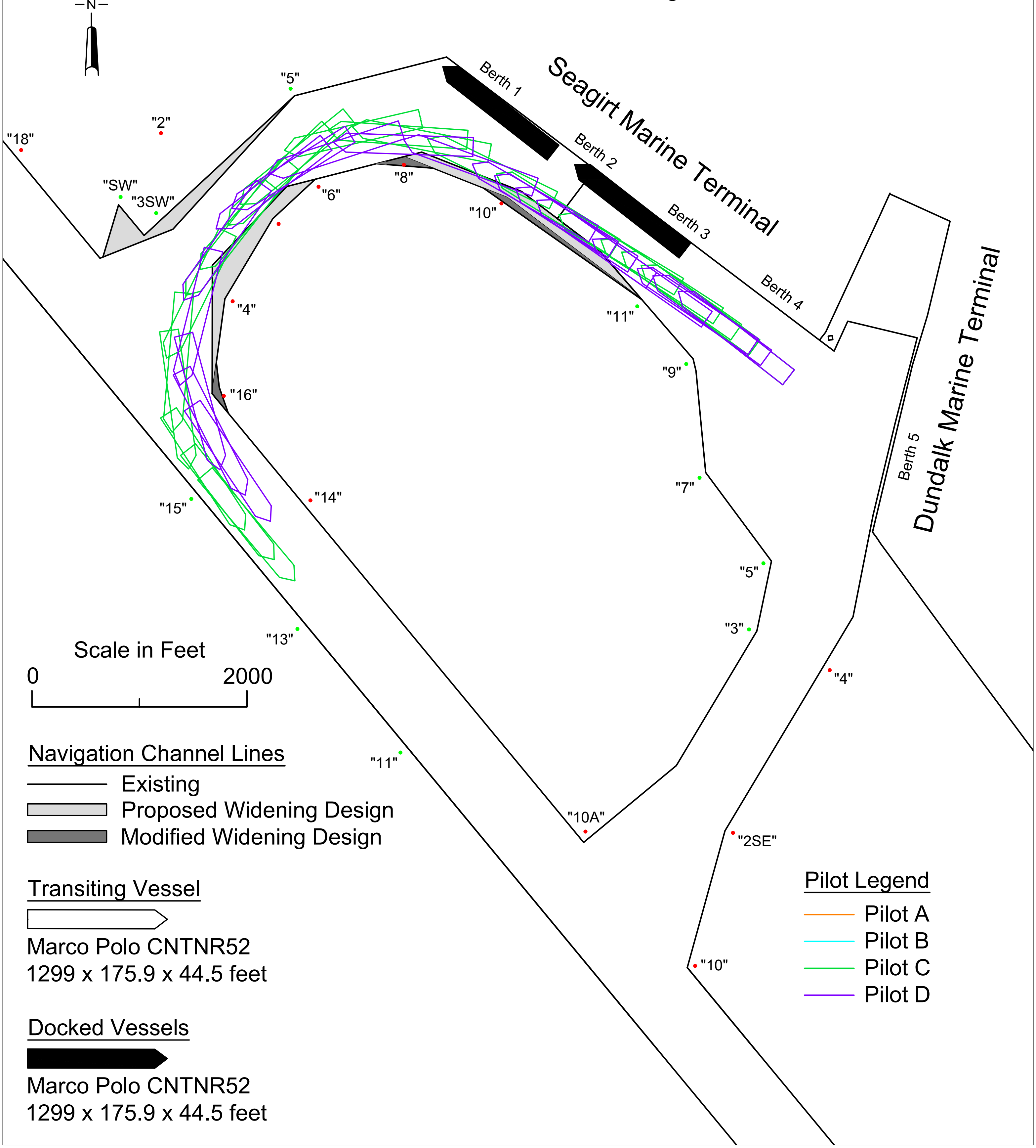


Plate 39

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR52	WNW	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	27 April 2022	N/A	22:30
D	27 April 2022	N/A	23:18

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Experimented with more speed. Bad idea.	3	3
D	Used tugs at final turn. 3/4 boats full. Good room to swing over the stern.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 40

Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots WNW, Night, Tug Casualty

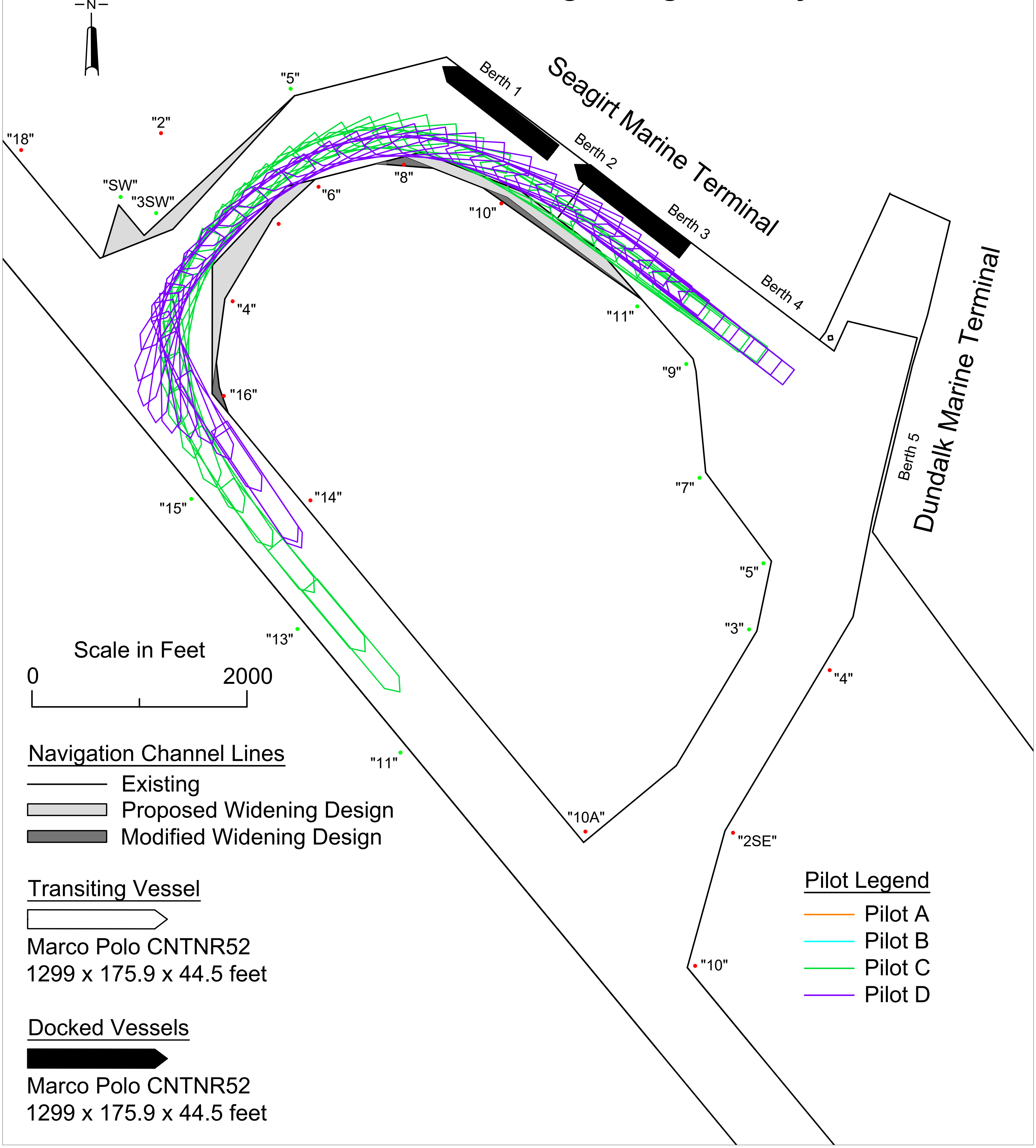


Plate 40

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR52	WNW	35 knots	Night	Yes

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	29 April 2022	Port quarter	23:05
D	29 April 2022	Port quarter	24:05

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	None.	3.5	3.5
D	Kept vessel in old channel configuration (current channel configuration – present day Baltimore) on PPU. Without thruster – channel width necessary for safe, efficient transit.	5	5

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 41

Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 25 knots SSE, Night

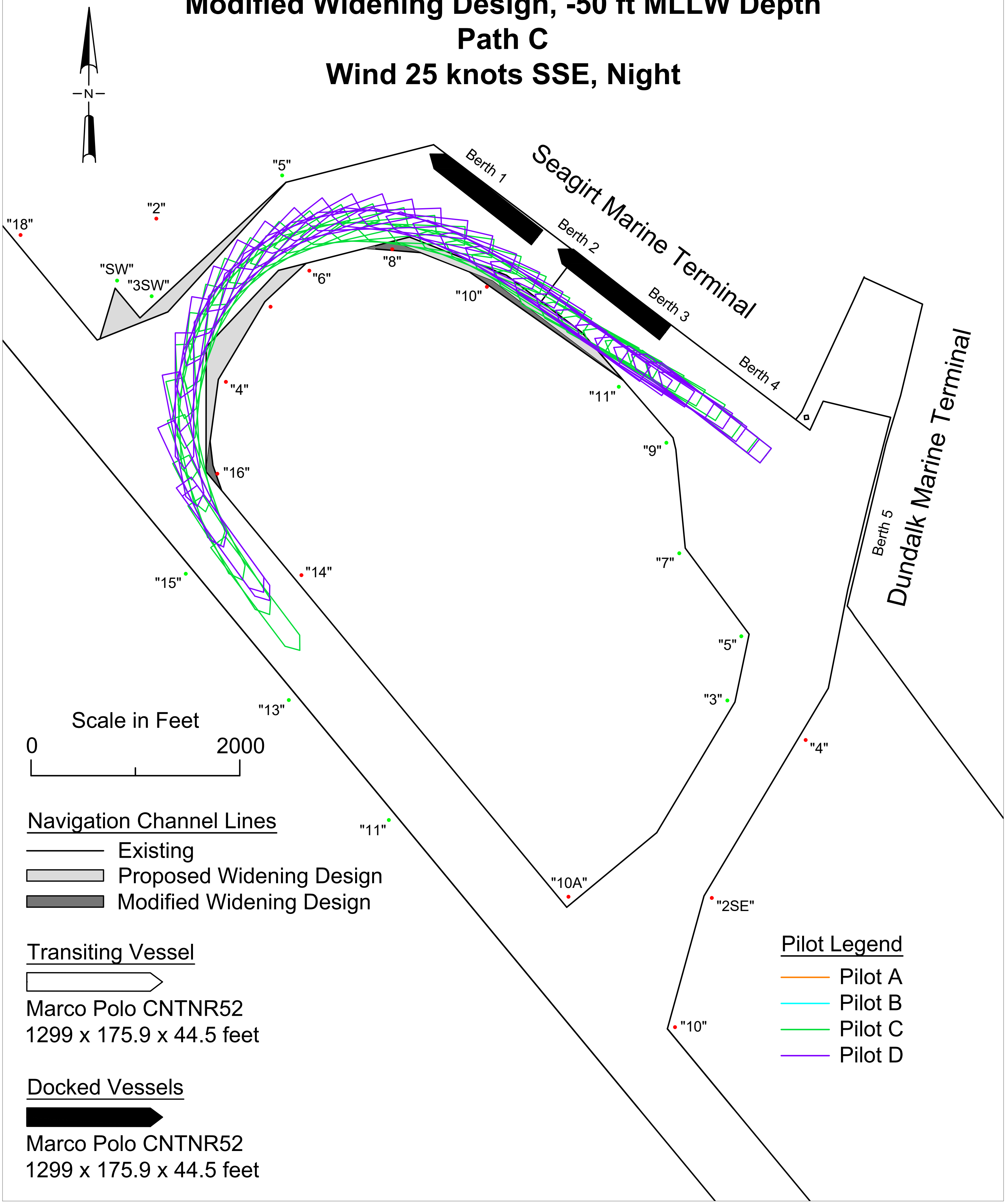


Plate 41

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR52	SSE	25 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	29 April 2022	N/A	20:02
D	29 April 2022	N/A	19:28

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Minimal tug use with 25 knots of wind.	2	2
D	Channel width most safe for departures.	3	3

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 42
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path C
Wind 35 knots SSE, Night

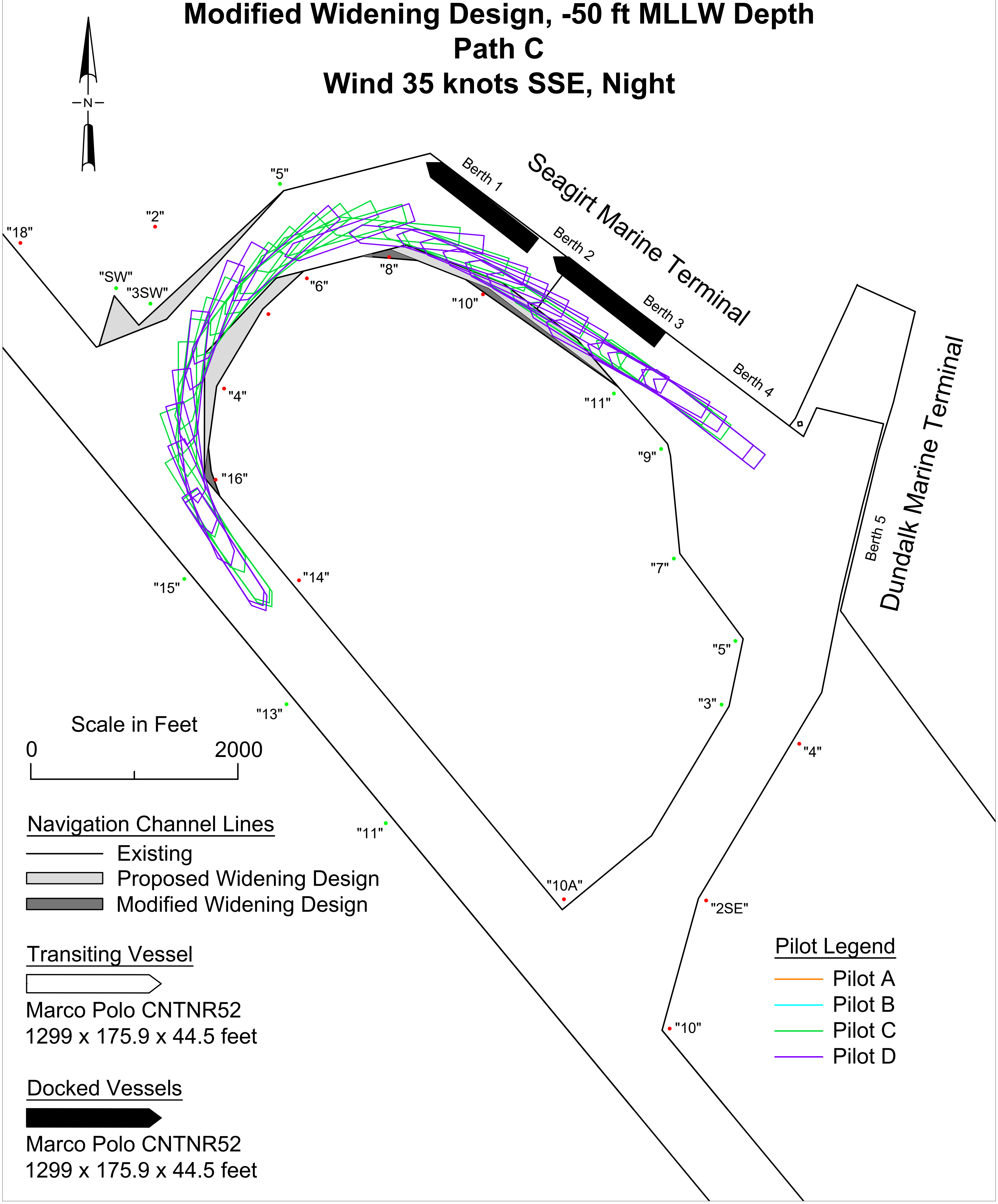


Plate 42

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	C	CNTNR52	SSE	35 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	27 April 2022	N/A	22:04
D	27 April 2022	N/A	21:24

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Good dimension. Smooth run.	3	3
D	New configuration much better for Fort McHenry Ingress. Rounded corner makes a smoother maneuver.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Plate 43
Seagirt Loop Channel, Baltimore Harbor, MD
Modified Widening Design, -50 ft MLLW Depth
Path D
Wind 30 knots WNW, Night

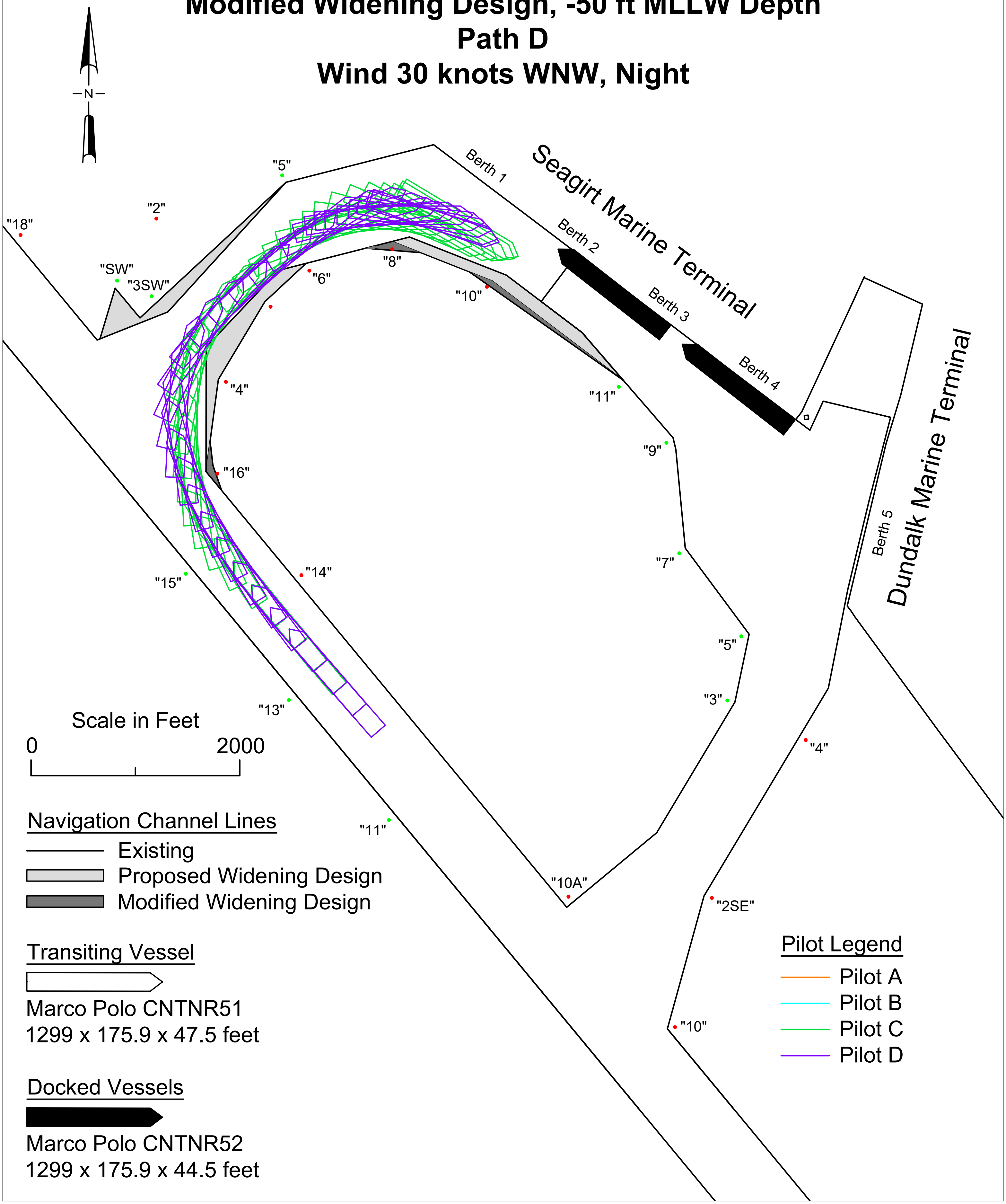


Plate 43

Data Sheet

Test Conditions

Widening Design	Depth Design	Path	Vessel Model	Wind Direction	Wind Speed	Visibility	Tug Casualty?
Modified	-50 ft MLLW	D	CNTNR51	WNW	30 knots	Night	No

Individual Pilot Results

Pilot Letter	Date Performed	Tug Casualty Location	Total Elapsed Time
C	29 April 2022	N/A	21:50
D	29 April 2022	N/A	19:37

Individual Pilot Feedback

Pilot Letter	Comments	Run Ratings	
		Difficulty*	Safety**
C	Great week of simulations!!	2.5	2.5
D	Little hard to hold up on green side. Went well.	4	4

*Difficulty Rating: 1 = Easy | 5 = Difficult

**Safety Rating: 1 = Safe | 5 = Dangerous

Appendix D: Final Pilot Surveys

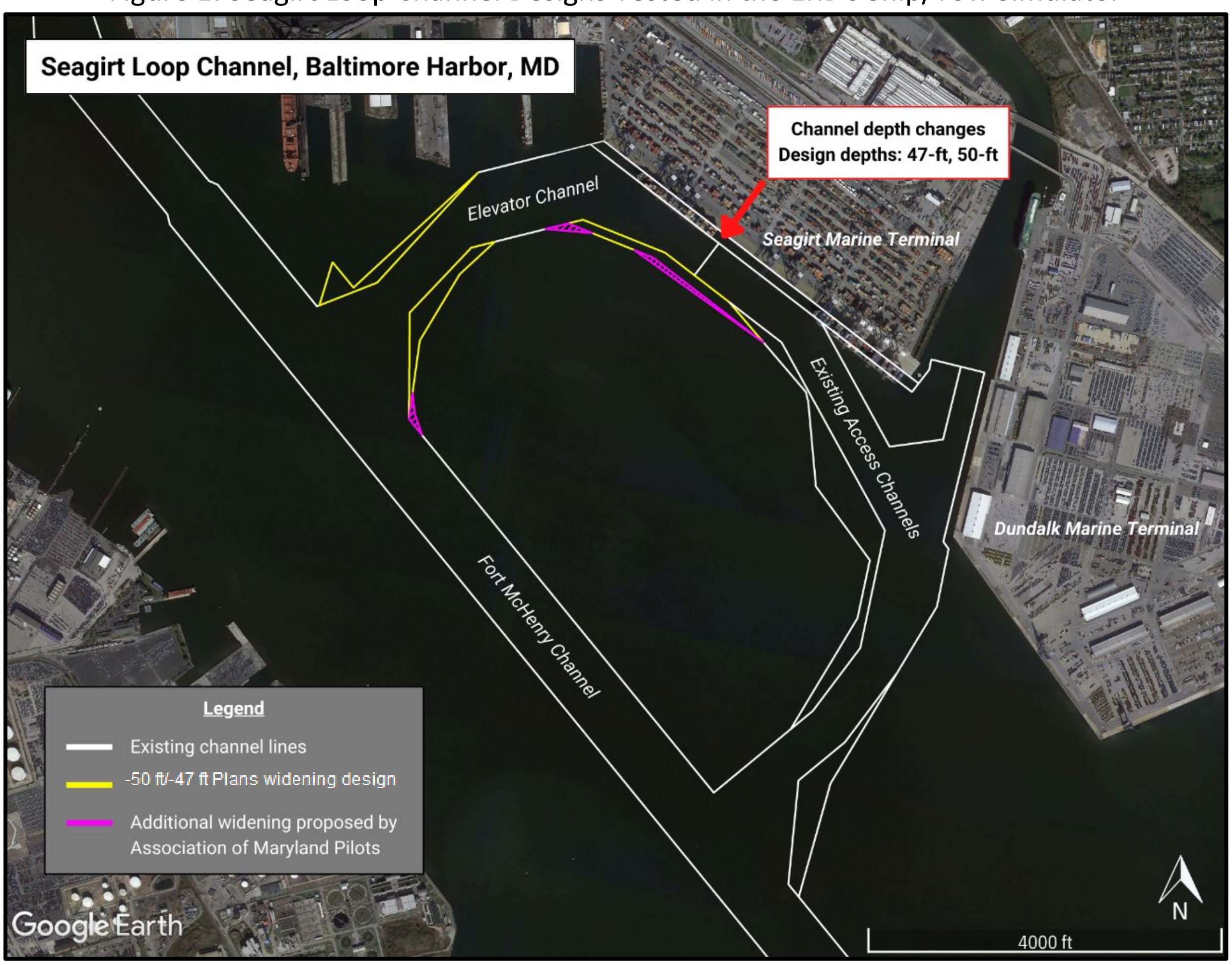
Seagirt Loop Channel Navigation Impact Assessment

Final Pilot Survey

A ship simulation study was performed to evaluate vessel navigation and safety of the proposed navigation channel modifications to the Seagirt Loop Channel in the Baltimore Harbor in Maryland. The purpose of this study is to evaluate channel widening designs and two depth designs (-47 ft and -50 ft MLLW Plans) in the West Seagirt Branch Channel, also known as the "Elevator Channel." Four experienced pilots from the Association of Maryland Pilots participated in the study. A series of ship simulation exercises were conducted on 18-22 April 2022 and 25-29 April 2022 at the ERDC Ship/Tow Simulator facility at the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory (CHL) in Vicksburg, Mississippi.

Figure 1 shows the proposed channel deepening and widening designs for the West Seagirt Branch Channel (Elevator Channel).

Figure 1: Seagirt Loop Channel Designs Tested in the ERDC Ship/Tow Simulator



Please answer the following questions based on your experience.

Name	Affiliation	Role	Pilot Letter
Capt. John Kinlein	AMP	Pilot	A
Capt. Shimon Horowitz	AMP	Pilot	B
Capt. Mike Flanagan	AMP	Pilot	C
Capt. Jim Luke	AMP	Pilot	D

1. **Please provide insight on your experience as a pilot in the industry, specifically navigating vessels in the Baltimore Harbor.**

<u>Pilot A</u> – Capt. John Kinlein
I have been piloting on Baltimore Harbor and the Chesapeake Bay for 10 years, which started as a full time training program for the first two. Since starting here in 2012, I have conducted well over 1000 ship movements on ships as large as Ultra Large Container Vessels. I currently hold a Maryland State License as a Pilot of Unlimited Draft, as well a Federal (USCG issued) license as a Master of Self Propelled Vessels of Any Gross Tons upon Oceans with a First Class Pilot Endorsement. Prior to becoming a pilot, I operated ships in both the Merchant Marine and the military, formerly serving in both the US Coast Guard and US Army.

<u>Pilot B</u> – Capt. Shimon Horowitz
I have been with the Association of Maryland Pilots since 2012, initially training as both a docking pilot and a bay pilot. Since completing training I have continually worked on both the bay pilot and docking pilot rotations. Since starting in the Port of Baltimore, I have seen the size of containerships quickly grow to exceed the capacities of the seagirt loop, specifically utilizing the “elevator” channel.

<u>Pilot C</u> – Capt. Mike Flanagan
I have been a senior pilot with the Association of MD Pilots for 13 years. The five years prior we spent as an apprentice and limited license pilot. While the learning never ends, I have been piloting and handling vessels with tugs in Baltimore Harbor for 18 years. In this time frame, it has been astounding to see how fast vessels have grown in size. The infrastructure to handle these larger vessels has lagged behind.

<u>Pilot D</u> – Capt. Jim Luke
Have held 1st Class Pilots license since 1996. St. Lawrence Seaway Pilot 2004-2010. 2005-2010 US Navy Docking Pilot ports of Ash Shuaiba and Mohamed Al-Ahmed Navy Base, Kuwait. Maryland Pilots 2010 to current. Currently Hybrid pilot responsible for berthing and unberthing in Baltimore Harbor.

2. **Please comment on your overall experience with using the ERDC Ship/Tow Simulator for this project.**

   <u>Pilot A</u> - Capt. John Kinlein
   This was a great experience. The professionalism and meticulousness of the ERDC personnel was second to none. Once properly tuned, the simulator produced realistic feeling results.

   <u>Pilot B</u> - Capt. Shimon Horowitz
   This experience was very productive, and the volume of exercises conducted allowed us to fully evaluate most situations which we could reasonably encounter day to day in expected conditions. The flexibility provided allowed us to change factors and scenarios on the fly, which was very important to ensure the feedback of the pilots was properly integrated into the scenarios conducted.

   <u>Pilot C</u> - Capt. Mike Flanagan
   The experience was great! The ERDC team and pilots worked hard to collect data and show the need for wider/deeper channels to accommodate these larger container vessels calling the Port of Baltimore.

   <u>Pilot D</u> - Capt. Jim Luke
   The simulator was great! It allowed to comfortably simulate adverse conditions in the proposed dredging project.

3. **Did the wind conditions (speed and direction), the visual scene (container ships, tug boats, water, buoys, structures, terminals, weather, visibility, etc.), and tug boats (forces, response time, etc.) provide an accurate representation of the Seagirt Loop Channel and its surroundings?**

   <u>Pilot A</u> - Capt. John Kinlein
   Yes, they absolutely did.

   <u>Pilot B</u> - Capt. Shimon Horowitz
   The factors listed above did provide a very accurate representation as far as simulators are concerned, and certainly were better than I personally have experienced in any other simulation environment. Particularly in difficult wind conditions, the ships did behave in a very unmanageable and realistic way. Some refinement could be provided with visuals as far as lights/navaids and terminals are considered.

   <u>Pilot C</u> - Capt. Mike Flanagan
   Yes.

   <u>Pilot D</u> - Capt. Jim Luke
   Yes.

4. **Two configurations of the post-Panamax CMA CGM Marco Polo container ship were used in the simulation testing. The dimensions of these vessels are as follows:**
   Overall Length: 1,299 ft   Beam: 176 ft
   CNTNR51 – Static Draft 47.5 ft
   CNTNR52 – Static Draft 44.5 ft

   Please comment on the handling and behavior of the vessel models. Were these vessel models adequate as a means of testing various scenarios through the different designs of the proposed modifications to the Seagirt Loop Channel? Did the vessel models handling respond as you expected?

   a. **Heavier loaded vessel (47.5 ft draft)**

      Pilot A - Capt. John Kinlein
      Yes. The model behaved in a realistic manner.

      Pilot B - Capt. Shimon Horowitz
      In general, this vessel did behave and respond as would be expected of a very large and heavy containership. If anything, the ship handled too well, and was a little too responsive based on the displacement and proximity to the bottom.

      Pilot C - Capt. Mike Flanagan
      These models handled as expected

      Pilot D - Capt. Jim Luke
      Much more sluggish and needed more external assistance, consistent with real word scenarios.

   b. **Lighter loaded vessel (44.5 ft draft)**

      Pilot A - Capt. John Kinlein
      Yes. This model behaved in a realistic manner, as well.

      Pilot B - Capt. Shimon Horowitz
      This vessel was realistic to handle, perhaps slightly more so than the loaded vessel. The lighter shipped responded realistically to the wind forces, being set more readily as one would expect.

      Pilot C - Capt. Mike Flanagan
      These models handled as expected.

      Pilot D - Capt. Jim Luke
      Both models handled similar to what I would expect from this class of ship and similar classes.

5. **Were the scenarios completed in the ship simulation exercises representative of realistic environmental conditions and piloting operations?**

Pilot A – Capt. John Kinlein

Yes. This was because the ERDC staff took the time to work with us to make it happen. These scenarios in their entirety did represent realistic conditions, and the scenarios with greater wind were representative of what we regularly experience in the Port of Baltimore for many months of the year. We were unable to manipulate the height of the tide, and this would be an environmental which we would be looking at and considering closely during many of these maneuvers. This is something that should be addressed in the future.

Pilot B – Capt. Shimon Horowitz

As a note for all exercises and scenarios conducted, four (4) tugs would be necessary at all times, but particularly for poor conditions and in the event of a tug casualty during maneuvers.

Pilot C – Capt. Mike Flanagan

Yes, as realistic as possible.

Pilot D – Capt. Jim Luke

Yes, all scenarios represented are experienced frequently in Baltimore Harbor, namely at Seagirt Terminal.

6. **Please comment on your experience navigating the lighter loaded vessel (44.5 draft) in the -47 ft deep Elevator Channel with the -47 feet MLLW Plan channel widening design (yellow channel lines in Figure 1).**

Pilot A - Capt. John Kinlein

While the widening was helpful, the reduced underkeel clearance resulted in poorer handling as well as elimination of the ability to utilize anchors to stop the ship in an emergency. This is due to the lack of space between the hull and the channel floor. This significantly decreases the safety margin of the operation.

Pilot B - Capt. Shimon Horowitz

The lighter vessel in this condition was safe to maneuver until conditions deteriorated or casualties with tugs occurred. Following either of these circumstances, the reduced UKC and lack of additional small wideners made the maneuvers dangerous.

Pilot C - Capt. Mike Flanagan

This widening is required to handle these larger vessels. With such a swept path, you need to have the room to safely clear a vessel docked at Seagirt 1.

Pilot D - Capt. Jim Luke
Vessel was handy given the reduced weight but did not handle as well as in the 50' channel. The ship needed considerable external assistance to make the initial turn off Seagirt 1 and the final turn in the McHenry channel as opposed to the 50' channel.

7. **Please comment on your experience navigating the lighter loaded vessel (44.5 draft) in the 50 ft deep Elevator Channel with the -50 ft channel widening design (yellow channel lines in Figure 1).**

   Pilot A - Capt. John Kinlein
   The ship handled better than in the shallower design, plus the safety margin was increased through the availability of emergency anchor utilization.

   Pilot B - Capt. Shimon Horowitz
   Maneuvers were generally safe in reasonable conditions with the deeper channel, and initially proposed wideners. In poor conditions, the additional small wideners are needed to keep safe distance from other vessels and shoal water.

   Pilot C - Capt. Mike Flanagan
   Same as above. You need to extra room to safely maneuver these longer, wider vessels.

   Pilot D - Capt. Jim Luke
   See number 6.

8. **Please comment on your experience navigating the heavier loaded vessel (47.5 draft) in the 50 ft deep Elevator Channel with the -50 ft channel widening design (yellow channel lines in Figure 1).**

   Pilot A - Capt. John Kinlein
   This is vastly safer than the current method of backing and spinning to utilize the eastern channel. This -50 ft design allows for the ship to be brought out of the west loop ("elevator") channel, which allows the operator to move away from danger using a combination of the ships control mechanisms (engine, rudder, thruster) and the tugs, as opposed to the current method that is fully dependent on the tugs to spin and hold the ship away from leeward (downwind) danger (moored ships, concrete wharf). Also the -50 ft plan allows for the maneuver to be conducted in approximately half the time, also significantly lowering risk exposure. **Pilot B -** Capt. Shimon Horowitz
   The heavier vessel handled as would be expected in the 50 ft channel, with tug and thruster/engine resources used heavily as conditions deteriorated. Due to the sluggish nature of the ship, and the amount of time it took to initiate and complete turns, the small additional wideners were extremely helpful to maintain safety margins.

Pilot C - Capt. Mike Flanagan
Same as above. A vessel will handle better with a greater UKC.

Pilot D - Capt. Jim Luke
Vessel needed more external assistance to complete the maneuver; limited UKC degraded performance

9. **Does the -50 ft/-47 ft Plan channel wideners design in the Elevator Channel provide the additional space necessary for the Marco Polo container ship to safely transit the channel?** **Pilot A** - Capt. John Kinlein

   The additional wideners suggested by us are necessary.

   Pilot B - Capt. Shimon Horowitz

   With vessels at Berth 1 Seagirt, and with poor conditions, both factors which are very likely to occur, the additional wideners recommended by the Maryland Pilots in conjunction with the -50/-47 ft Plan provided the necessary space to complete these maneuvers safely. **Pilot C - Capt. Mike Flanagan**

   The additional widening is required for the Marco Polo class.

   Pilot D - Capt. Jim Luke

   Not without the additional proposed widening.

10. **In the proposed -47 ft Plan channel depth design, the 47.5 ft draft Marco Polo vessel must exit the Seagirt Loop Channel through the turning basin. There are no proposed navigation channel modifications in the turning basin or the existing access channels near Dundalk Marine Terminal. To create a realistic scenario, two Marco Polo vessel models were docked in the simulations at the Seagirt Marine Terminal Berth 3/4 and Dundalk Marine Terminal Berth 5/6. Please comment on your experience completing the maneuver in the turning basin using each vessel model.**

    a. **Lighter loaded vessel (44.5 ft draft)**
       Pilot A - Capt. John Kinlein
       This maneuver imposes unacceptable levels of risk in normal wind conditions. It is completely dependent on the use of all four tugs, with no room for failure of any component. If anything fails, there is substantial risk of allision with a moored vessel or concrete wharf.

Pilot B - Capt. Shimon Horowitz
In general, this is not a safe maneuver, especially with deteriorating environmental conditions or tug/vessel casualty. The risks for serious incident and the lack of space to accommodate and recover from a casualty make this scenario quite risky.

Pilot C - Capt. Mike Flanagan
This is a very tight maneuver, which comes with many risks. the safest way to handle this departure is via a widened/deeper elevator channel

Pilot D - Capt. Jim Luke
Both turning basin scenarios closely replicated real world conditions, with the deeper vessel being harder to maneuver. This evolution is far less preferable than driving the vessel out the proposed elevator channel. In the Basin maneuver as there is less control and the vessel is significantly more exposed to the elements, which have greater effect on the ship due to the static nature of evolution.

b. Heavier loaded vessel (47.5 ft draft)

Pilot A - Capt. John Kinlein
Just as above, this is unacceptably risky for the same reasons.

Pilot B - Capt. Shimon Horowitz
Again, this proved to be a very risky maneuver, particularly with poor conditions or in the case of casualty. The risks and consequences of an accident would be very difficult to justify as opposed to proceeding outbound in a widened and deepened elevator channel.

Pilot C - Capt. Mike Flanagan
Same.

Pilot D - Capt. Jim Luke
See above

11. **Please comment on your experience navigating each vessel model in the approach to the Seagirt Marine Terminal in the existing access channels.**

   a. **Lighter loaded vessel (44.5 ft draft)**

      <u>Pilot A</u> - Capt. John Kinlein
      It was a safe evolution.

      <u>Pilot B</u> - Capt. Shimon Horowitz
      The approach maneuver was safe during the scenarios we conducted with varying environmental conditions.

      <u>Pilot C</u> - Capt. Mike Flanagan
      This access channel is already designed for this class of vessel.

      <u>Pilot D</u> - Capt. Jim Luke
      See below

   b. **Heavier loaded vessel (47.5 ft draft)**

      <u>Pilot A</u> – Capt. John Kinlein
      It was a safe evolution.

      <u>Pilot B</u> – Capt. Shimon Horowitz
      With four tugs, this approach was also safe in the scenarios we conducted.

      <u>Pilot C</u> – Capt. Mike Flanagan
      Same

      <u>Pilot D</u> – Capt. Jim Luke
      Both vessels handled as expected when entering the West Channel from the McHenry Channel, the heavier vessel being more sluggish. There was a tendency for each vessel to seek the windward side of the West Channel due to quartering wind. Thus with the heavier vessel in the sw'ly wind it took quite a bit to keep the vessel fair in the channel and maintain an appropriate approach to the Seagirt Terminal.

12. **On rare occasions, pilots may need to enter the Elevator Channel from the opposite direction, beginning in the Fort McHenry Channel and docking at Berth 1 at the Seagirt Marine Terminal, to access equipment on the port side of the ship. Please comment on your experience navigating the vessels in the channel in this approach.**

<u>**Pilot A**</u> - Capt. John Kinlein
This was acceptably safe.

<u>**Pilot B**</u> **-** Capt. Shimon Horowitz
With the Maryland Pilot proposed modifications and the planned wideners, this maneuver was safely conducted using four tugs. There was enough space to accommodate for stronger winds from most directions and still effect the transit.

<u>**Pilot C**</u> - Capt. Mike Flanagan
This would not be an issue with a widened elevator channel.

<u>**Pilot D**</u> - Capt. Jim Luke
This will be impossible on ships this size without channel modification. In the scenarios, however, there was adequate room to turn into the elevator channel and approach the terminal safely.

13. **Did you encounter any challenges with navigating in the Elevator Channel, and what did you do to adjust? How did the vessel size, navigation channel dimensions, and wind conditions affect the transit?**

<u>**Pilot A**</u> – Capt. John Kinlein
With our proposed additional wideners, this is a much safer and easier operation than currently exists.

<u>**Pilot B**</u> **–** Capt. Shimon Horowitz
The greatest challenge occurred if there was a delay in initiating turns due proximity of the stern to other vessels, infrastructure or shoal water. Also, delays were caused by tug casualty. In this scenario it was very difficult to regain the necessary positioning to complete the maneuvers safely. The deeper loop channel, and the slighter larger proposed wideners allowed a margin for recovery in the event of a delay in initiating critical stages of each maneuver.

<u>**Pilot C**</u> – Capt. Mike Flanagan
Strong winds combined with the size of vessel is always a challenge.

<u>Pilot D</u> – Capt. Jim Luke
The two main challenges in navigating the elevator channel are
1 Maintaining safe distance on moored vessel outbound (starboard quarter) in the initial turn around the #8 buoy. This is done by maintaining sufficient headway and reaching into the turn. The proposed modifications to the dredging plan help maintain an appropriate safety margin.
2 Completing he final turn into the McHenry Channel. External assistance will be needed complete this turn in almost any scenario involving ships of this size. Even under the modified plan the stern will swing close on the green side (#3SW) and the vessel will be close to the red side (corner #16) to facilitate the final turn, however the modified plan contains the best safety margin.

14. A modified channel widening design was tested during the second week based on recommendations provided by the two pilots who performed testing the first week. These modifications included bend easings at Buoy 8 in the Elevator Channel and at Buoy 16 where the Elevator Channel meets the Fort McHenry Channel. The widening design is shown in pink in Figure 1.

Please provide comments on this channel design and how the additional widening helped in the transits in both design depths.

a. 47 ft channel depth

<u>Pilot A</u> – Capt. John Kinlein
I was a first-week pilot.

<u>Pilot B</u> – Capt. Shimon Horowitz
This widening allows for both a safety margin in the maneuver, and also allows the pilot to recover safely in the event of a casualty or very poor environmentals.

<u>Pilot C</u> – Capt. Mike Flanagan
This size of vessel needs the extra room to safely maneuver.

<u>Pilot D</u> – Capt. Jim Luke
See 13

b. 50 ft channel depth

<u>Pilot A</u> – Capt. John Kinlein
See above.

Pilot B – Capt. Shimon Horowitz
The addition of the proposed changes here really made a difference, particularly moving these ships in conditions which were near the upper threshold of environmentals. They provide a margin which in many cases reduced the risk to an acceptable level that would allow the scenario to be conducted in actual practice.

Pilot C – Capt. Mike Flanagan
Same

Pilot D – Capt. Jim Luke
See 13

15. The prevailing wind conditions tested in this study consisted of WNW (300°) and SSE (170°) winds at 25 knots and 35 knots. How did your approach, maneuvers, and tug boat work change with the various wind conditions tested?

Pilot A – Capt. John Kinlein
As would be expected, the tug make up and utilization changes to account for the different wind directions. Also, the ship is generally maneuvered to the windward side of a channel.

Pilot B – Capt. Shimon Horowitz
We found that tug usage increased drastically as wind conditions worsened. Without four tugs, a casualty was not manageable in wind from both directions simulated. Additionally in wind, without four tugs, speeds of the vessel had to be increased to an unsafe level to deal with the set of the ship. Four tugs allowed ship speed and position in the channel to be maintained safely. In the case of all wideners in place, there was enough room to position the ship in the wind correctly so as to complete the different maneuvers with acceptable margins of safety.

Pilot C – Capt. Mike Flanagan
A forth tug was needed with 35 kts. of wind.

Pilot D – Capt. Jim Luke
Approach and tug usage varied due to the wind. These vessels must be held up in the wind to provide adequate leeway for the maneuver.

16. **The proposed channel depth designs in the Elevator Channel assume an underkeel clearance (UKC) of 2.5 feet. Did the Marco Polo container ship provide safe UKC throughout the transits?**

    <u>Pilot A</u> – Capt. John Kinlein
    Yes, it did.

    <u>Pilot B</u> – Capt. Shimon Horowitz
    The UKC in transits was safe in the scenarios conducted. The additional UKC provided by the 50 foot channel provided a very noticeable improvement in safety and vessel handling in every circumstance it was utilized.

    <u>Pilot C</u> – Capt. Mike Flanagan
    My opinion, yes.

    <u>Pilot D</u> – Capt. Jim Luke
    Yes

17. **Please comment on your experience with using 65-ton tug boats in the Seagirt Loop Channel.**

    a. **How did your use of the tug boats (number of tug boats used, positions along the ship, forces, period of time used, and so on) change between transits in the Elevator Channel, the turning basin, and the existing access channels near the Dundalk Marine Terminal?**

       <u>Pilot A</u> – Capt. John Kinlein
       The turning basin requires excessive tug utilization and leaves no room for equipment failure or casualty. In that maneuver, all four tugs are continually used at high power.

       In the tested wind conditions, four boats are necessary for all maneuvers. The make up is centerline fwd and aft, and shoulder and quarter boats. When utilizing the Elevator Channel, the tugs required much less utilization and gentler power settings, also one tug was left as a emergency reserve.

       <u>Pilot B</u> – Capt. Shimon Horowitz
       In general, tugs were made up centerlead forward and aft, and on the port bow and port quarter, all with lines. In the event of unexpected wind conditions, or tug

casualty, tugs were often moved and utilized to push with no line on the leeward side of the ship, or in the place of tug which experienced a casualty.

Tug usage was as expected in the approach scenarios using the existing channels. The equipment was utilized in a safe manner without causing undue stressed due to excessive continual use. Tug casualty could be dealt with.
Tug usage was also acceptable outbound in the deepened and widened elevator channel, as long as four boats were used.

Turning these ships in the existing basin and proceeding outbound in the existing channel in poor conditions is where tug usage became unreasonable and excessive as applied in the real world operational environment. The amount of power and duration of application would be unreasonable to expect, and could likely result in a tug casualty or some other mishap with the equipment.

Pilot C – Capt. Mike Flanagan
The tug horsepower and extra room in the channels is needed to handle these vessels especially with strong winds.

Pilot D – Capt. Jim Luke
Three boats seemed sufficient, however in real life these ships will most likely require 4 boats or more for inclimate weather.

b. How did your use of the tug boats change for transits with the additional widening design (pink channel lines in Figure 1)?

Pilot A – Capt. John Kinlein
N/A

Pilot B – Capt. Shimon Horowitz
Particularly with these proposed additions, the tugs could be more effectively utilized throughout the maneuver as they were not placed dangerously close to buoys and shoal water as the ship made each stage of the turn. Without the additional widening, the tugs were put unreasonably close to the buoys/navaids.

Pilot C – Capt. Mike Flanagan
The widening is a must for this class of vessel.

Pilot D – Capt. Jim Luke
The maneuver became more organic as there was more room for more traditional shiphandling.

c. **How did you adjust the vessel maneuver and use of the tug boats in the simulation exercises where a tug boat unexpectedly stopped working? Did the tug causalities capture realistic scenarios that can occur in real life?**

Pilot A – Capt. John Kinlein
The Elevator Channel allows for safety in the event of tug casualty. The turning basin does not. These casualties are absolutely realistic scenarios.

Pilot B – Capt. Shimon Horowitz
In the event of a casualty, often the remaining tugs were repositioned as necessary to ensure safe completion of the maneuver. The vessel often had to be slowed to ensure the remaining tugs were able to work effectively. The tug failures did simulate realistic scenarios that could occur in day to day operations in real life.

Pilot C – Capt. Mike Flanagan
There was no room for error with a tug causalities-little safety factor.

Pilot D – Capt. Jim Luke
I moved the third tug to the position of the casualty, usually from the center lead aft. The casualty simulations were realistic.

18. **Were there any scenarios performed in the Ship Simulator that you would not perform in real life in the Seagirt Loop Channel?**

Pilot A – Capt. John Kinlein
No.

Pilot B – Capt. Shimon Horowitz
Turning either ship in poor environmental conditions in the existing turning basin and proceeding outbound with ships berthed at Seagirt 4 and Dundalk 5. There is not sufficient space to conduct this maneuver with a reasonable safety margin and recover from a casualty.

Heavy winds on the pier, a large ship at Seagirt 1, and a light ship being maneuvered utilizing the elevator channel.

Heavy wind conditions from either direction, light or loaded ship being maneuvered, and a large ship at Seagirt 1, without the additional widener recommended off of Seagirt 1. This would consider using the elevator channel. The risk of a problem with the stern of the ship and the ship at Seagirt 1 would be too great

Pilot C – Capt. Mike Flanagan
This would be a judgement call based on the wind conditions at the time.

Pilot D – Capt. Jim Luke
NE gale in the turning basin outbound west channel.

19. Were there any scenarios not performed during the simulation testing weeks that you feel should have been considered for the study?

Pilot A – Capt. John Kinlein
No.

Pilot B – Capt. Shimon Horowitz
The breadth of scenarios seemed complete. There are no critical additions that I can think of at this time.

Pilot C – Capt. Mike Flanagan
No.

Pilot D – Capt. Jim Luke
No.

20. Do you have recommendations that could improve safety and efficiency of navigation in the Seagirt Loop Channel, specifically the Elevator Channel?

Pilot A – Capt. John Kinlein
This channel needs to be at 50' and needs to be the primary route for sailing large ships from Seagirt. Also, our suggested wideners are necessary.

Pilot B – Capt. Shimon Horowitz
The Maryland Pilot recommended wideners would drastically improve safety and efficiency of navigation. The 50 foot channel depth is nearly a necessity for not only the deep ship, but also for the light loaded ship to conduct maneuvers as environmental conditions change or worsen.

Pilot C – Capt. Mike Flanagan
The widening and deepening, as simulated, is a must to handle this class of vessel.

Pilot D – Capt. Jim Luke
The channels should be dredged to the modified design.

21. **What is your overall feedback on the proposed widening designs and the proposed 47 ft and 50 ft depths in the Elevator Channel? What is your feedback on navigation of the Marco Polo container ship in the Seagirt Loop Channel? Do you think that the proposed navigation modifications are sufficient to accommodate post-Panamax vessels similar to the Marco Polo container ship?**

Pilot A – Capt. John Kinlein
The 50' design is what is necessary to operate ships of this size. The turning basin is not adequate for safely sailing them.

Pilot B – Capt. Shimon Horowitz
With four tugs utilized, and a 50 foot channel depth, this class of vessel was safely maneuvered in the majority of circumstances we would encounter at the port of Baltimore. All wideners proposed should be integrated into the final dredging plan to ensure these vessels can be moved safely in the majority of conditions that are likely to be encountered.

Pilot C – Capt. Mike Flanagan
Yes, with the extra widening that was simulated.

Pilot D – Capt. Jim Luke
The channels should most definitely be brought to 50'and the modified dredging plan implemented. This plan provided the appropriate safety margin for this class of vessels. As it stands 140' beam ships regardless of draft must use the basin to sail creating a bottleneck for traffic and restricting moments to Seagirt 1-4 (inbound), Dundalk 1-5 and possibly all berths upriver of buoy #10A.

22. **What are the advantages and disadvantages of exiting the Seagirt Loop Channel through the Elevator Channel compared to the turning basin? How would the proposed navigation modifications in the Elevator Channel facilitate navigation safety, enhance port operations, and improve existing transportation delays?**

Pilot A – Capt. John Kinlein
The Seagirt Loop (Elevator Channel) is advantageous over the turning basin in every way. The maneuver has reduced risk exposure duration (50% less time), allows for contingencies in the event of casualty, and moves away from high risk areas with moored ships and wharves to leeward (downwind). It does not require 100% high power tug utilization for the

entire maneuver, as happens in the turning basin. This will allow for more predicable operations because the higher safety margin allows for more sustained operations in normally encountered wind and environmental conditions. Because the safety envelope is wider, less wind-based cancellations would be necessary.

<u>Pilot B</u> – Capt. Shimon Horowitz
The advantages for utilizing the improved elevator channel are significant in every way as opposed to using existing channels. It is much safer, can be performed poorer conditions, is more efficient from a time and traffic perspective and protects the surrounding critical infrastructure in the case of a casualty. The new channel will provide the safety margins necessary and the flexibility/efficiency expected by industry and ship operators which call/may call the Port of Baltimore.

<u>Pilot C</u> – Capt. Mike Flanagan
Without the modifications to the loop channel, Seagirt Marine Terminal will be very limited to the size of vessels that could operate safely in and out of the terminal. This would cause major delays and the Port of Baltimore's infrastructure would really fall behind other east coast ports.

<u>Pilot D</u> – Capt. Jim Luke
This is the only plan that allows for simultaneous harbor movements for Seagirt 1-4 and DMT 1-5 which enhances overall port safety and reduces delays. The safety factor in a widened elevator channel, allowing for a more dynamic mauver is far and away safer than backing the same ULCV at speeds of 1.5 knots into the turning basin. An average departure utilizes a speed of 3.5 knots thus making the elevator channel egress up to three times faster than the less appealing turning basin option.

23. Do you have any additional comments?

<u>Pilot A</u> – Capt. John Kinlein
I have none at this time. Feel free to contact me.
Shannon, Mary Claire and their team were phenomenal to work with.

<u>Pilot B</u> – Capt. Shimon Horowitz
(blank)

<u>Pilot C</u> – Capt. Mike Flanagan
Thank you for all your efforts!!

<u>Pilot D</u> – Capt. Jim Luke
None

Please contact the below personnel for any questions, comments, or concerns about the Seagirt Loop Channel ship simulation study.

Shannon N. Stever, E.I.	**Mary Claire Allison**
Research Civil Engineer	Computer Scientist
Shannon.N.Stever@usace.army.mil	Mary.C.Allison@erdc.dren.mil
(601) 634-3603	(601) 634-3088

Thank you for participating in the study and completing this survey!

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B5:
West Seagirt Branch
Channel Sections

P:\Seagirt_Dundalk\2020_Seagirt_Loop_Feasibility_Study\04_Engineering\2022 CHL Channel Alignment\DWG\Seagirt_CHL_Cross_Sections(5-to-1).dwg

SEAGIRT WEST LOOP
CROSS SECTIONS

BALTIMORE, MD

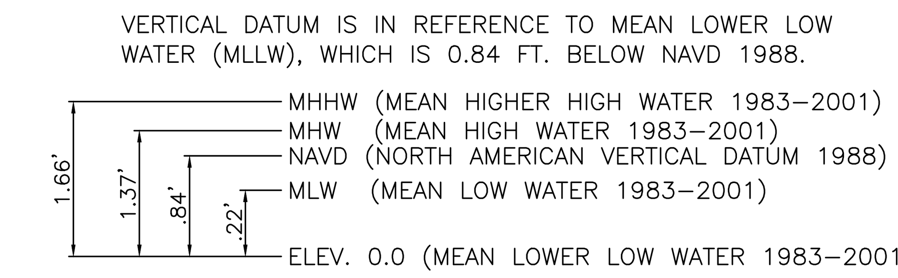
DRAWING DATE:	MAY 2022
DRAWN BY:	C. MANUEL
CHECKED BY:	L. FOLKERT
DRAWING NAME:	Seagirt_CHL_Cross_Sections(5-to-1)
DRAWING SCALE:	1" = 200'
SHEET NUMBER:	1 OF 2

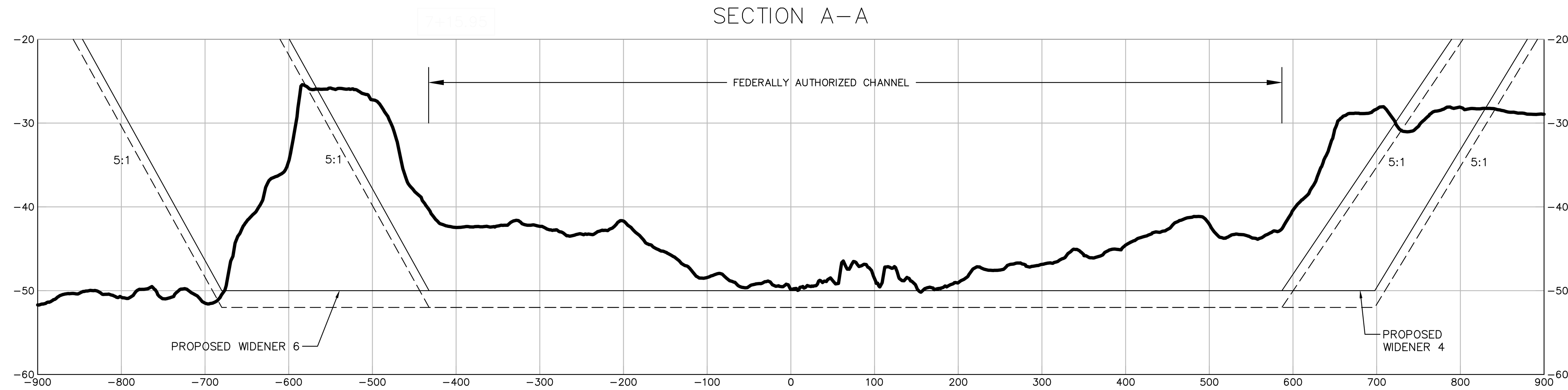
CONDITION SURVEYS	
SURVEY DATE:	DEC. 2021/JAN. 2022(GBA) & FEB. 2021 (CENAB)
HORIZONTAL PROJECTION:	MARYLAND STATE PLANE
ZONE:	1900
VERTICAL REFERENCE:	MEAN LOWER LOW WATER (MLLW)
SURVEY UNITS:	U.S. SURVEY FEET

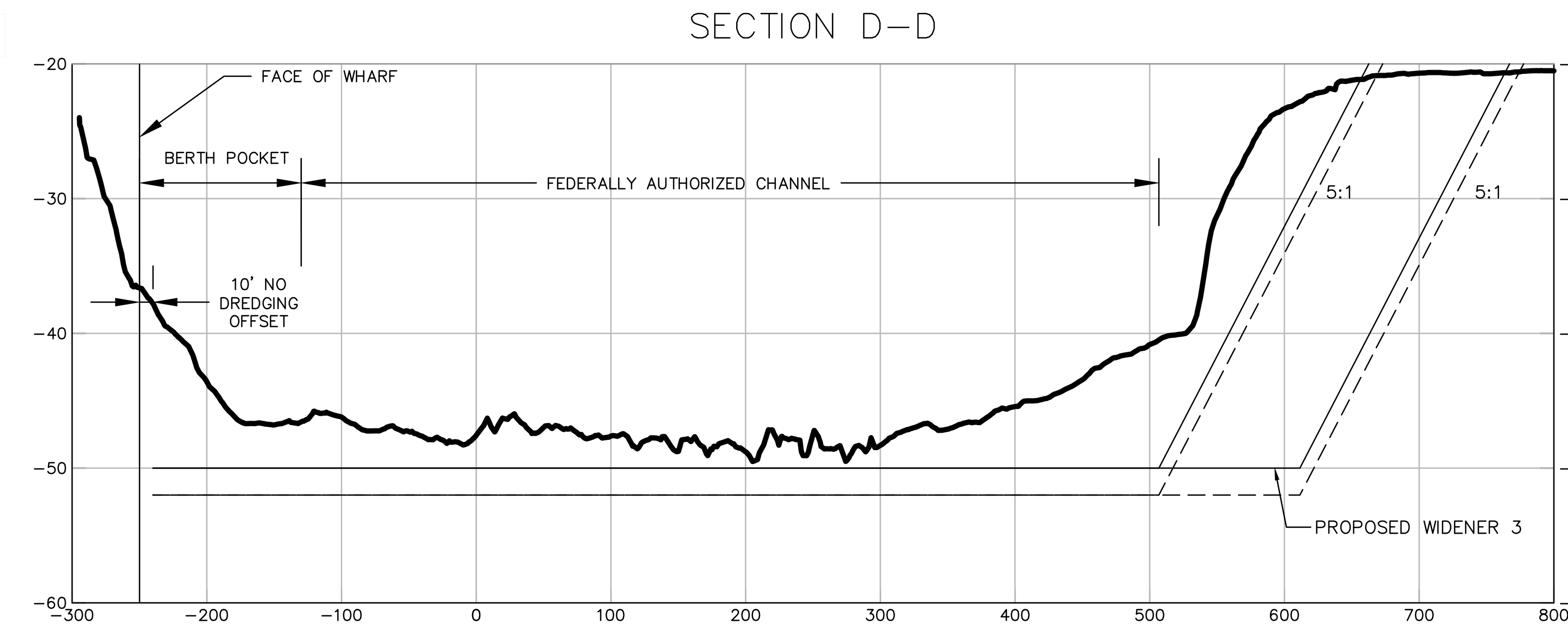
NOTES:
1. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULT OF SURVEYS MADE ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITION EXISTING AT THAT TIME.
2. PLANIMETRICS INDICATE THE APPROXIMATE LOCATION OF FEATURES AS PROVIDED BY THE USACE BALTIMORE DISTRICT.
3. SURVEYED DECEMBER 2021/JANUARY 2022 BY GAHAGAN & BRYANT ASSOCIATES, INC. & FEBRUARY 2021 BY CENAB.
4. TIDES WERE OBTAINED FROM NOAA TIDE STATION 8574680 BALTIMORE, FORT MCHENRY.
5. THE PLANE OF MLLW IS 0.84 FEET BELOW NAVD88.
6. SEAGIRT BERTH 3 CHANNEL DEEPENING AND WIDENING WAS COMPLETED IN JUNE 2021.

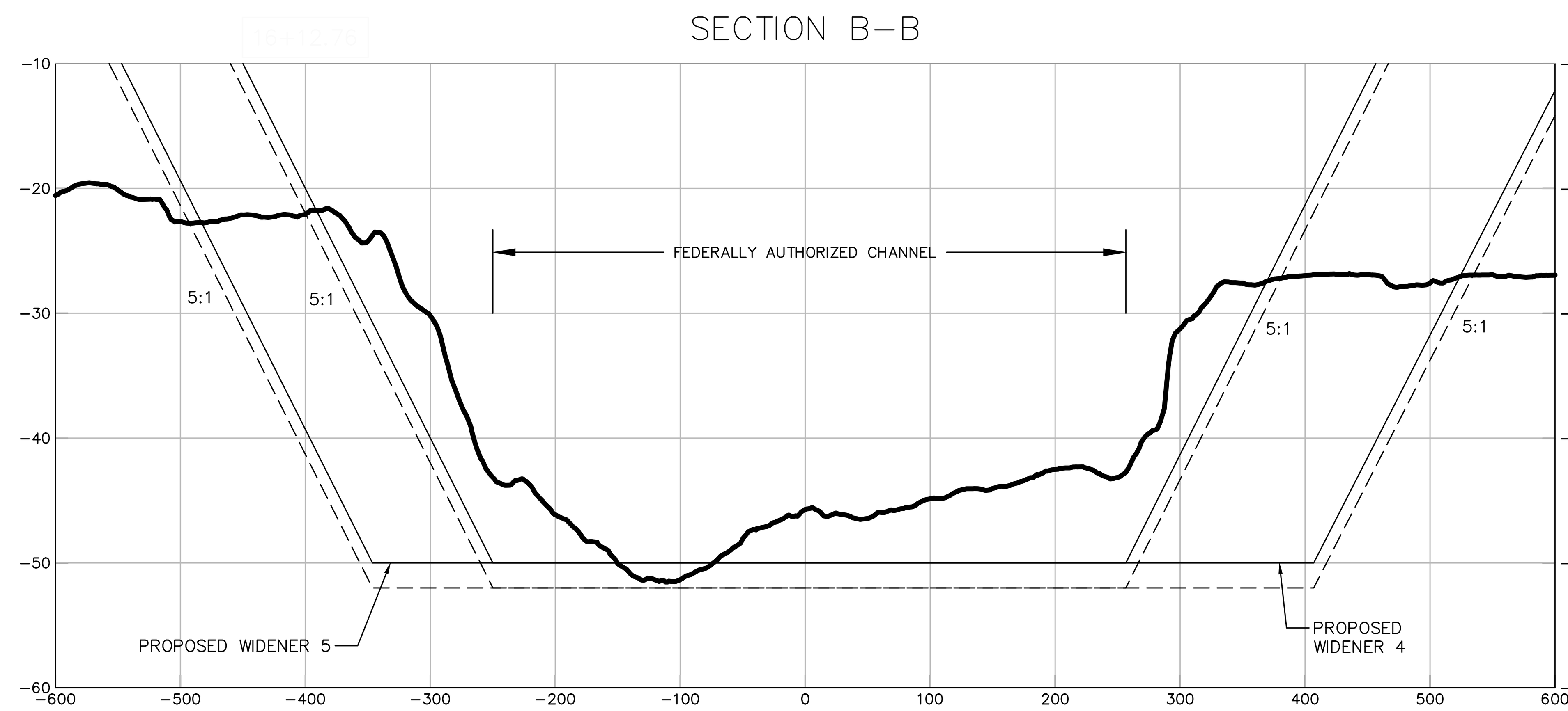
GAHAGAN & BRYANT ASSOCIATES, INC.
BALTIMORE, MARYLAND
(410) 682-5595

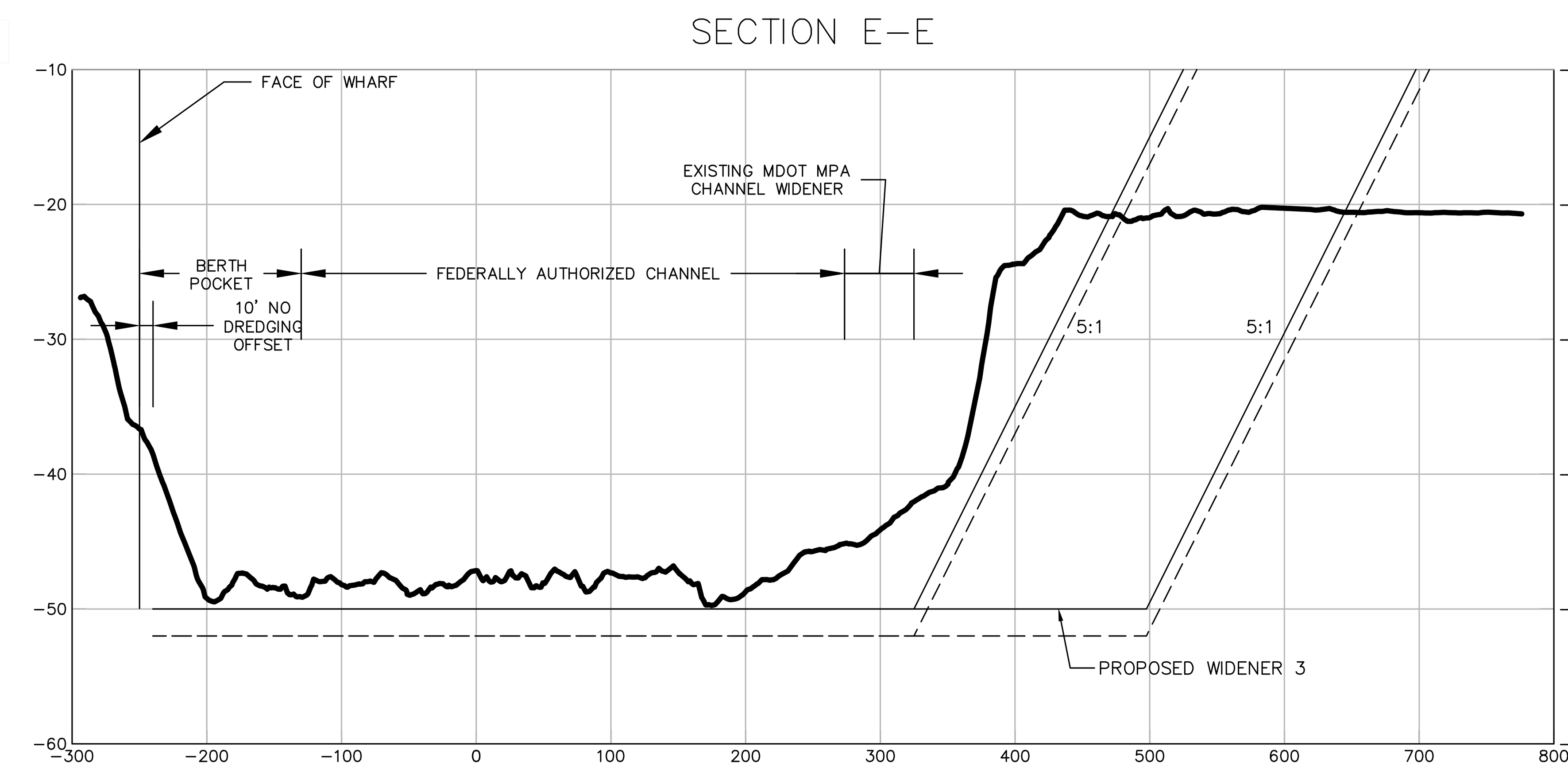
GBA
ENGINEERS ★ SURVEYORS

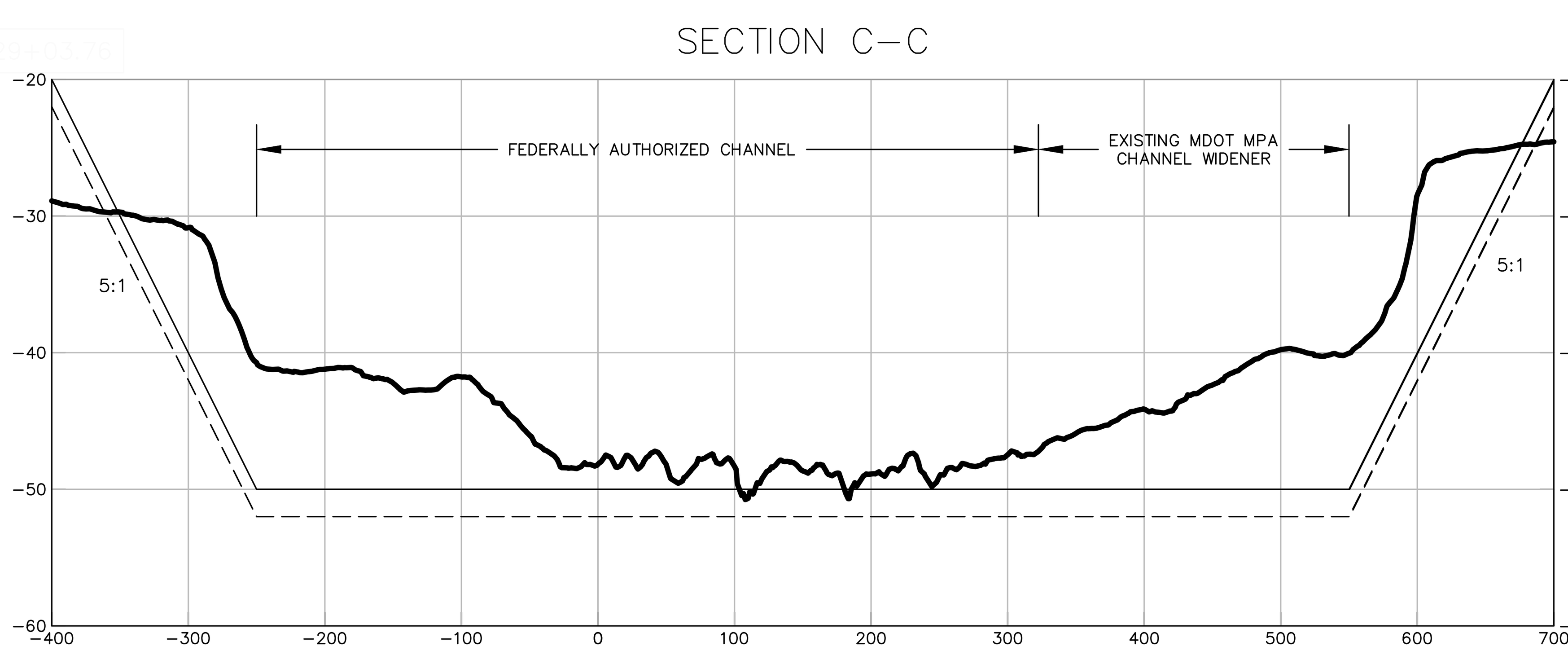


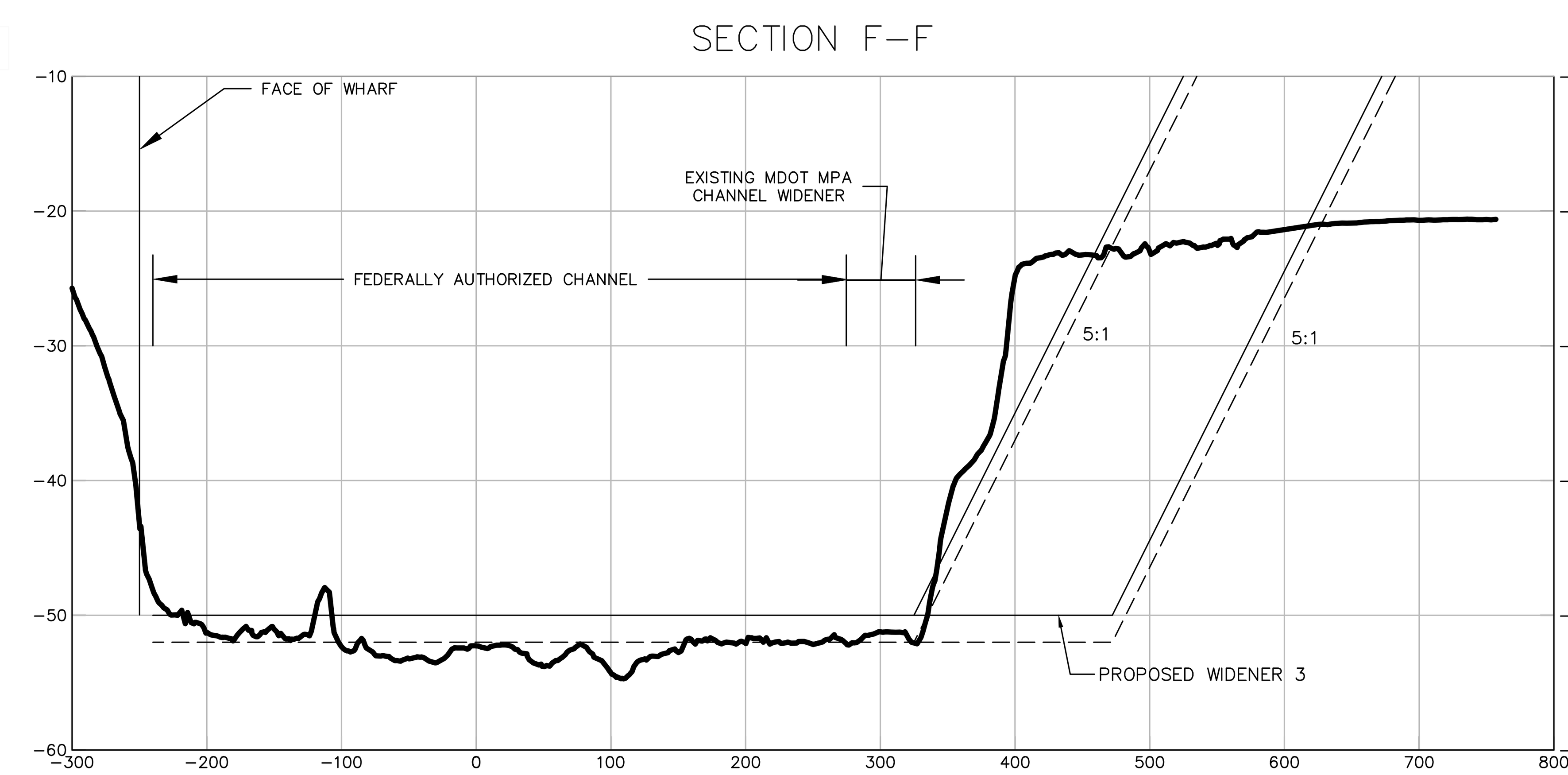






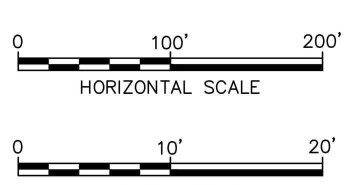






LEGEND

- CENAB/GBA COMBO SURVEY
- PROPOSED REQUIRED GRADE (-50')
- PROPOSED OVERDEPTH (-52')



C:\Users\gbo289\Desktop\FROM SERVER\SEAGIRT\2021_Seagirt_5-to-1\2) Seagirt West Loop\Seagirt_CHL_Cross_Sections(5-to-1).dwg

SEAGIRT WEST LOOP
CROSS SECTIONS – 5H:1V SLOPES

BALTIMORE, MD

DRAWING DATE:	MAY 2022
DRAWN BY:	C. MANUEL
CHECKED BY:	L. FOLKERT
DRAWING NAME:	Seagirt_CHL_Cross_Sections(5-to-1)
DRAWING SCALE:	1" = 200'
SHEET NUMBER:	2 OF 2

CONDITION SURVEYS	
SURVEY DATE:	DEC. 2021/JAN. 2022(GBA) & FEB. 2021 (CENAB)
HORIZONTAL PROJECTION:	MARYLAND STATE PLANE
ZONE:	1900
VERTICAL REFERENCE:	MEAN LOWER LOW WATER (MLLW)
SURVEY UNITS:	U.S. SURVEY FEET

NOTES:
1. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULT OF SURVEYS MADE ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITION EXISTING AT THAT TIME.
2. PLANIMETRICS INDICATE THE APPROXIMATE LOCATION OF FEATURES AS PROVIDED BY THE USACE BALTIMORE DISTRICT.
3. SURVEYED DECEMBER 2021/JANUARY 2022 BY GAHAGAN & BRYANT ASSOCIATES, INC. & FEBRUARY 2021 BY CENAB.
4. TIDES WERE OBTAINED FROM NOAA TIDE STATION 8574680 BALTIMORE, FORT MCHENRY.
5. THE PLANE OF MLLW IS 0.84 FEET BELOW NAVD88.
6. SEAGIRT BERTH 3 CHANNEL DEEPENING AND WIDENING WAS COMPLETED IN JUNE 2021.

GAHAGAN & BRYANT ASSOCIATES, INC.
BALTIMORE, MARYLAND
(410) 682-5595

GBA ENGINEERS ★ SURVEYORS

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B6:

Berth Stability Assessment

moffatt & nichol

2780 Lighthouse Point E, Ste. D,
Baltimore, MD 21224

(410) 563-7300
www.moffattnichol.com

MEMORANDUM

To: MES/MPA PDT

From: Moffatt & Nichol

Date: 1/13/2022

Subject: Berth Stability Assessment with Cofferdam Global Stability

M&N Job No.: 10848-05 BHAC Seagirt Loop Deepening Feasibility

Introduction

The purpose of this memorandum is to summarize the findings regarding potential impact of the proposed Seagirt West Loop deepening on existing berth structures in the vicinity. Moffatt & Nichol has reviewed the Seagirt West Loop dredge plan and cross sections dated June 2021 prepared by Gahagan & Bryant Associates, Inc (GBA), attached. We have also reviewed available structural drawings for Seagirt Marine Terminal Berths 1 and 2 and Canton Marine Terminal Pier 13. Relationship of these structures to the proposed dredge limits is shown in Figure 1, below. The analysis herein evaluates the potential impact, if any, the channel deepening may have on the stability of the existing structures.

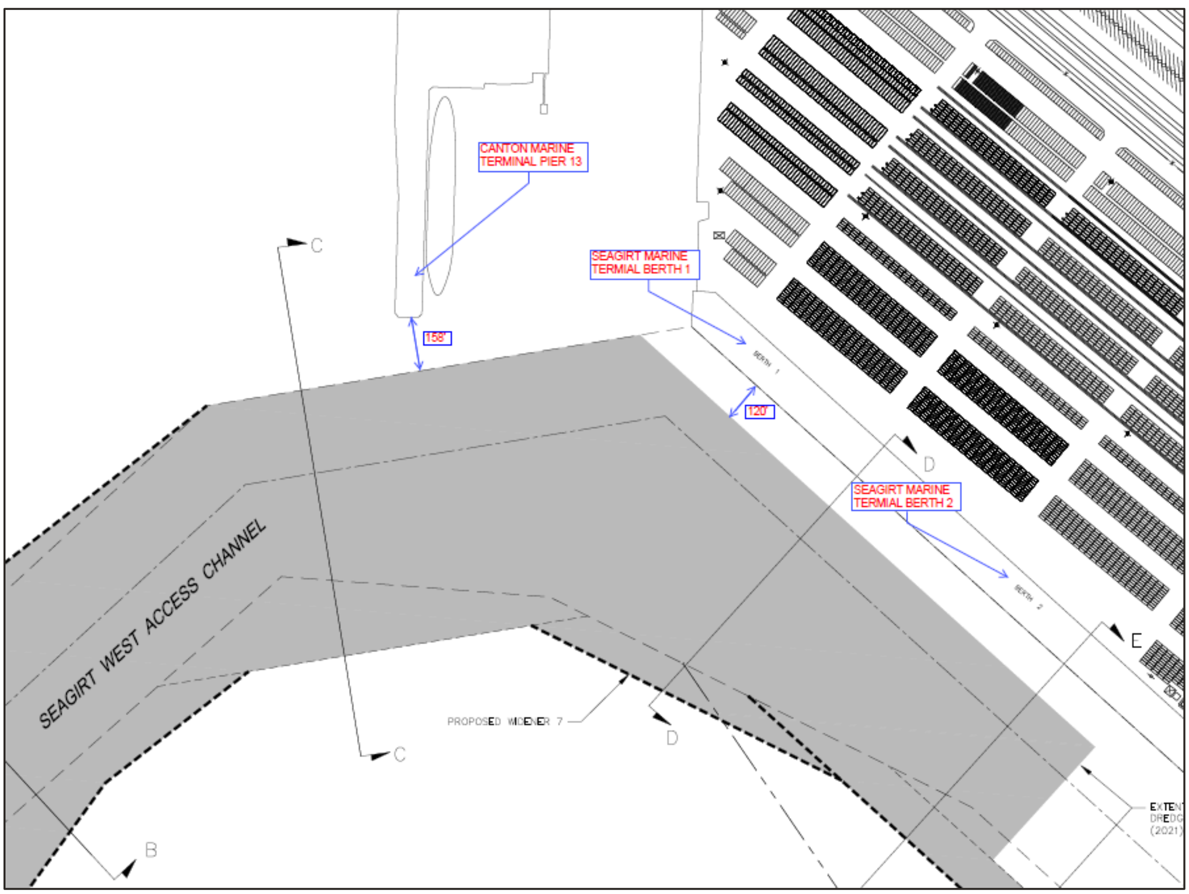


Figure 1 – Structure Location Relative to Proposed Channel Deepening

Analysis Procedure

The primary concern with dredging near existing structures is the effective lengthening of the structure's piles. If the mudline is deepened near a pile, its effective length increases, and it becomes more flexible, with a lower capacity. This deepening can result in lowering the overall capacity of the structure. In the worst case, this deepening can make a structure unstable.

In order to determine whether or not the proposed dredging will compromise the lateral stability or unbraced length of the piles, an estimated depth to fixity was first calculated. The depth to fixity is the depth of pile embedment into the river bottom where the pile is fully laterally braced. This lateral bracing is provided by the surrounding soils and is affected primarily by stiffness of the pile element and stiffness of the soil. A stiff pile in "soft" soil will have a much deeper point of fixity than a relatively flexible pile in very stiff soil.

After depth to fixity was calculated, the width of the passive soil wedge in front of the pile was estimated. The method used to determine the width of the passive wedge for a sheetpile deadman anchor was used as shown in US Army Corps of Engineers EM 1110-2-204 *Design of Sheet Pile Walls.* An excerpt of this manual is included in Attachment B to this memo In sheet pile wall design, the deadman anchor is placed a distance behind the wall sufficient to preclude overlap of the wall's active soil wedge and the anchors passive soil wedge. For evaluation of possible impact of the proposed dredging, if it can be shown the proposed dredging does not overlap the pile's passive soil wedge, then the lateral stability of the pile is not affected by the dredging.

Figure 2, below, illustrates the concepts of depth to fixity and passive soil wedge.

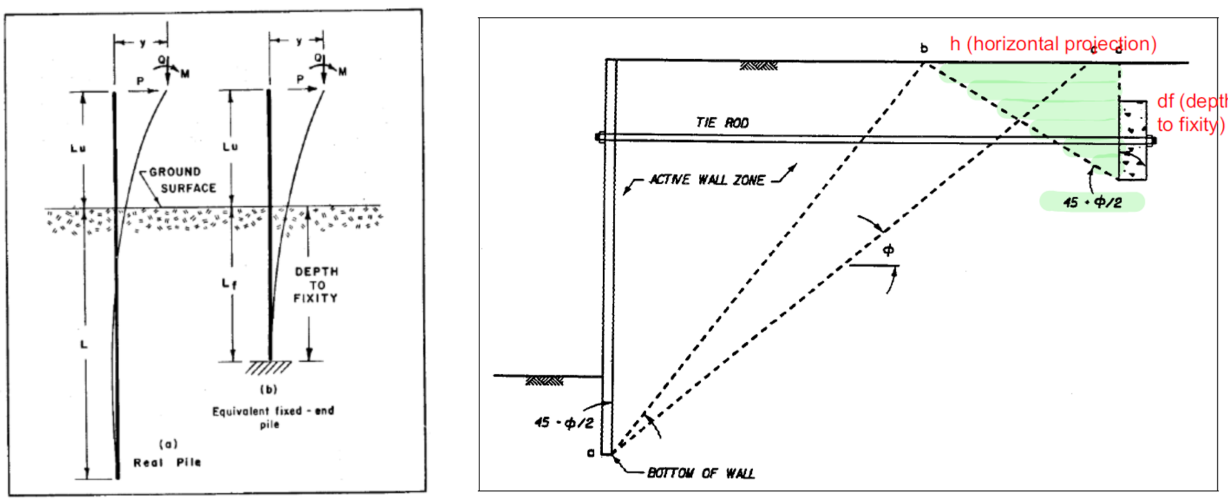


Figure 2 – Depth to Fixity and Passive Soil Wedge

Soil properties were estimated based upon soil boring information included in the Seagirt Berth 1-3 construction drawings. A formula to calculate depth to fixity was used as published in the USDOT FHWA manual *Design and Construction of Driven Pile Foundations – Volume I.* Both the soil boring data and excerpts from the referenced manual are included in Attachment B to this memo.

The pile stiffness is determined primarily by the pile material (concrete, timber, steel) and pile shape (hollow pipe, solid square, H-shape). The pile properties for both Canton Marine Terminal Pier 13 and Seagirt Marine Terminal Berths 1-2 were considered. The resultant depth to fixity and passive soil wedge width for each were compared to the proximity of the proposed dredging. Results of this analysis are summarized below, and calculations are included in Attachment C to this memo.

Canton Marine Terminal Pier 13

Pier 13 at Canton Marine Terminal is a timber pile-supported pier with a low-level concrete deck, several feet of ballast, and an asphalt surface. A typical section of the pier is shown in Figure 3 below. The age of the structure and its original dredge depth are not known. A 2008 inspection report references original drawings dated 1918. Notes from that inspection include some mudline elevations from which we calculate an average depth of 28.6 feet, at the A and V-piles, over the outboard 150 feet of the pier.

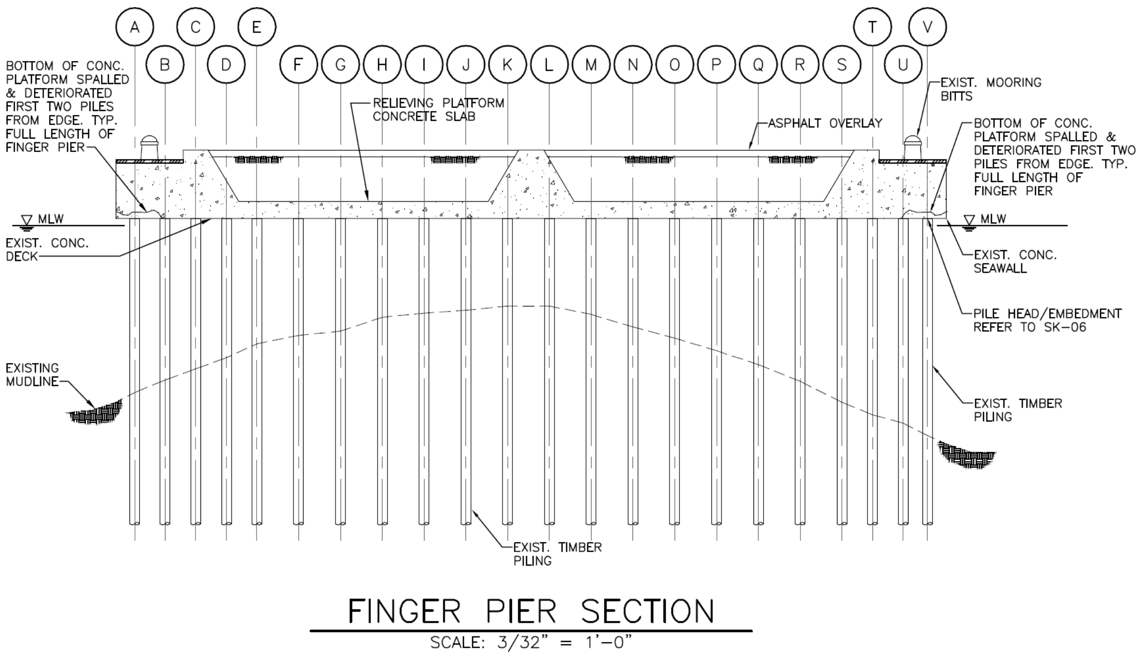


Figure 3 – Typical Section - Canton Marine Terminal Pier 13

The proposed 50-ft dredge depth for the federal channel footprint is within 158 feet of the southeast corner of the pier. If a 3:1 side slope is used, the slope intersects existing river bottom approximately 64 feet horizontally from the edge of the 50-ft channel, or 94 feet from the pier, see Figure 4 below. If a 5:1 side slope is used, it intersects existing river bottom approximately 113 feet from the edge of the 50-ft channel, or 45 feet from the pier, see Figure 5, below.

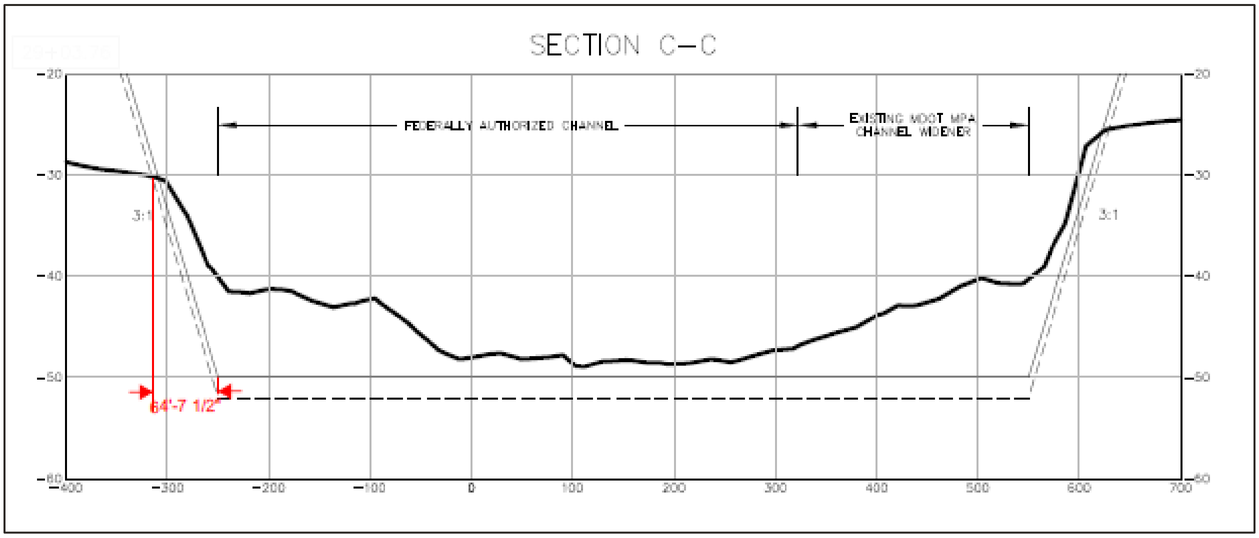


Figure 4 – Dredge Section C-C – 3:1 side slope

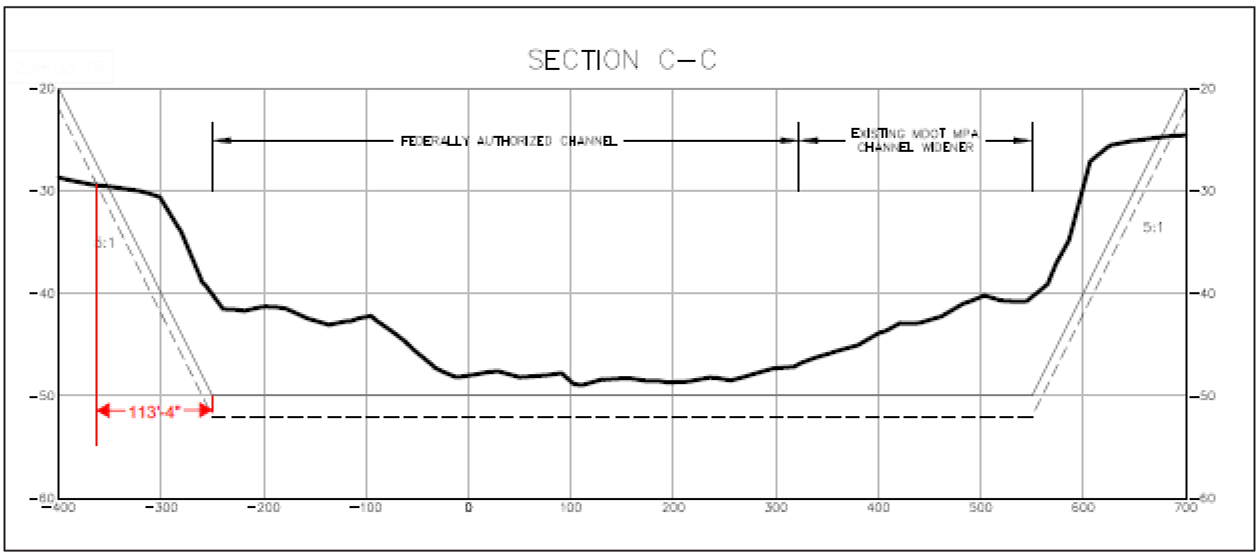


Figure 5 – Dredge Section C-C – 5:1 side slope

Proposed Dredge Impact on Canton Marine Terminal Pier 13

As noted above, the depth to fixity and resulting passive soil wedge for Pier 13's timber piles was compared to the proximity of the proposed dredge profile. As timber piles are relatively flexible compared to concrete or steel piles, the depth to fixity was relatively shallow at seven feet below mudline.

A pile diameter of 12 inches was used along with the modulus of elasticity for a new timber pile. The modulus of elasticity is a measure of a material's resistance to being deformed; stiffer materials have a higher modulus of elasticity. It should be noted that due to the age of the timber piles at Pier 13, the current modulus of elasticity is likely significantly reduced from this value, making it more flexible. Sampling of timber piles from nearby Dundalk Marine Terminal originally installed in 1929 were found to have a residual modulus of elasticity 65% that of a new pile. An excerpt of the testing report is included in Attachment C to this memo.

Using the seven-foot depth to fixity, a passive wedge with a horizontal projection of approximately 10 feet was calculated. Two conditions for the passive wedge were considered, a short term and long term (drained) condition. In the short-term, undrained condition, the soil has an effective angle of internal friction (phi) of zero. In the drained condition, the soil would have an angle of internal friction estimated at 20-degrees; this value was taken from a geotechnical report prepared for Seagirt Marine Terminal Berth 4, excerpt included in Attachment C to this memo. A third estimate of passive wedge width was made assuming a soil with a high angle of internal friction. If the soil were sand with a phi of 34-degrees, the passive soil width would be approximately 13 feet.

As the nearest potential dredging is 45 feet from Pier 13, no effect on the pile's lateral support, and resulting capacity, would be expected.

Seagirt Marine Terminal Berths 1 and 2

Seagirt Marine Terminal Berths 1 and 2 consist of prestressed concrete piles supporting a concrete low-deck, approximately two feet of ballast, and a paved surface. The landside edge of the structure is supported by steel cofferdam cells. The structures were built under the same contract in 1986. The construction drawings note the design dredge depth as 42 feet. A typical section of the structure is shown in Figure 6, below.

The current dredge profile includes a depth of 45 feet (plus two feet overdredge) approximately 64 feet from the face of the structure. The depth at the face of structure is approximately 37 feet, based on the sections in the Seagirt West Loop dredge plans, resulting in an approximate 6:1 average slope to the existing channel.

The proposed 50-ft dredge depth within the federal channel footprint is within 120 feet of SMT Berths 1 and 2. If a 3:1 side slope is used, the slope intersects existing river bottom approximately 103 feet outboard of the berthing face of Berth 1 (108 ft outboard of Berth 2), see Figures 7 and 8, below. If a 5:1 side slope is used, the slope intersects existing river bottom approximately 92 feet outboard of the berthing face of Berth 1 (103 ft outboard of Berth 2), see Figures 9 and 10, below.

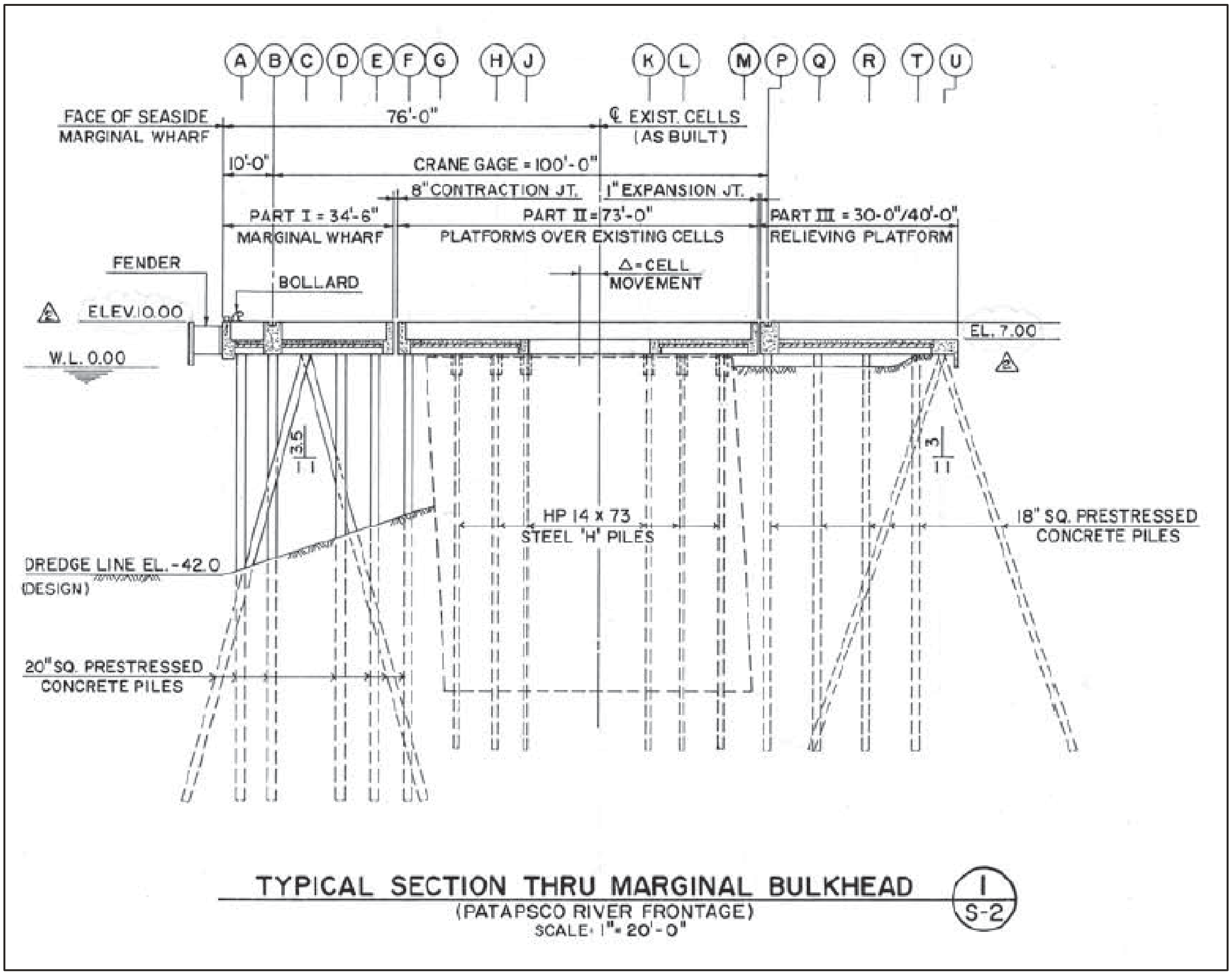


Figure 6 – Typical Section – SMT Berths 1 and 2

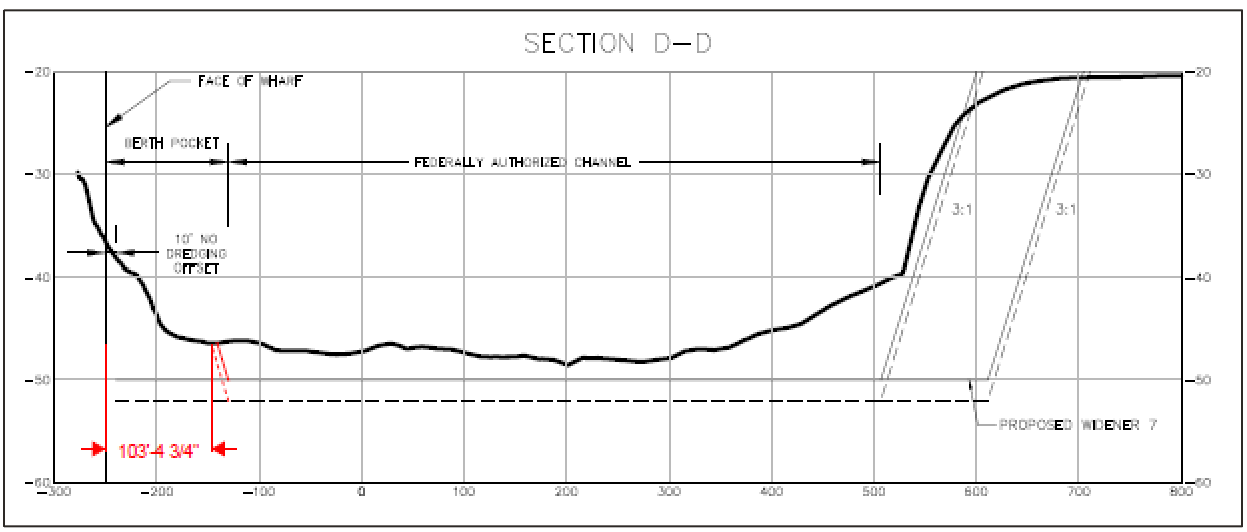


Figure 7 – Proximity of 3:1 Side Slope to SMT Berth 1

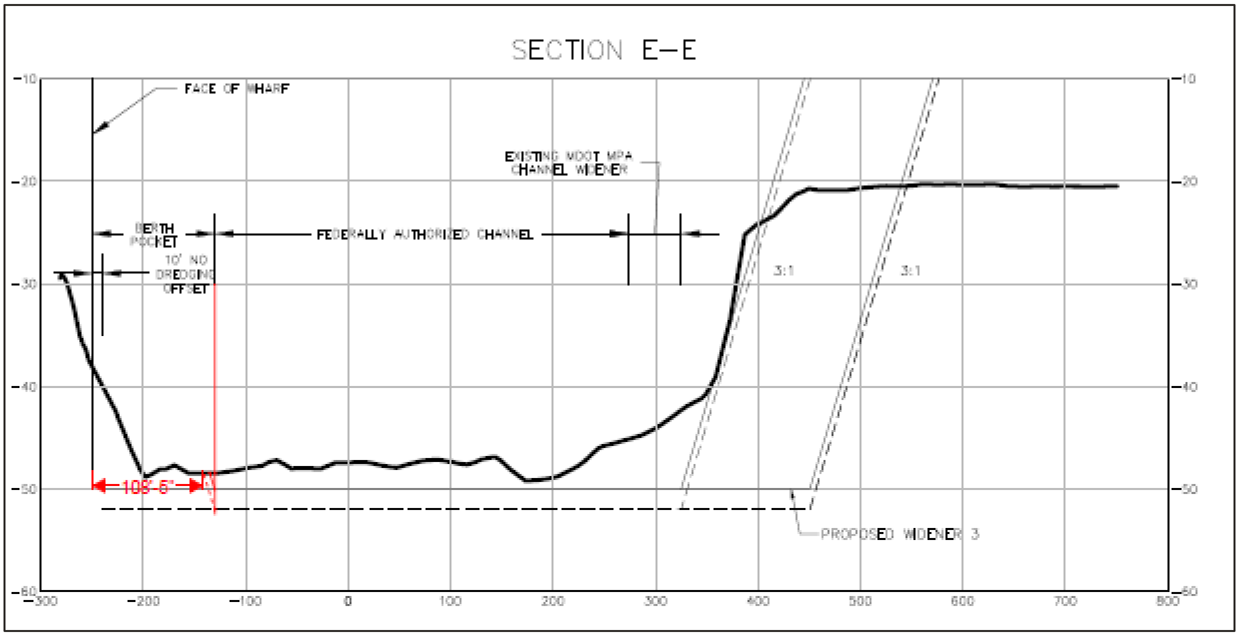


Figure 8 – Proximity of 3:1 Side Slope to SMT Berth 2

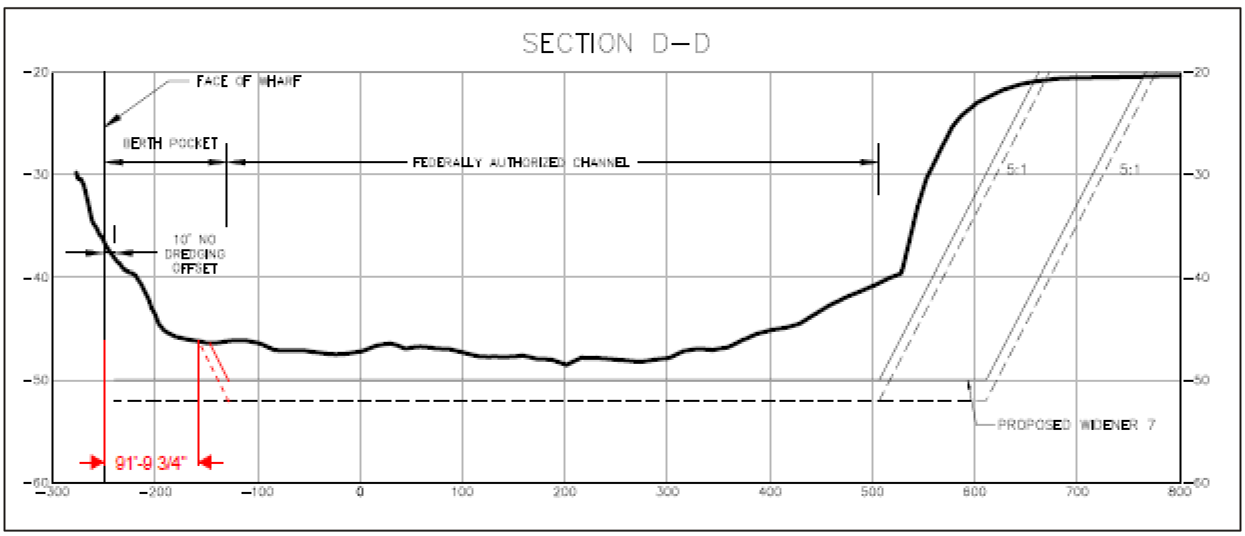


Figure 9 – Proximity of 5:1 Side Slope to SMT Berth 1

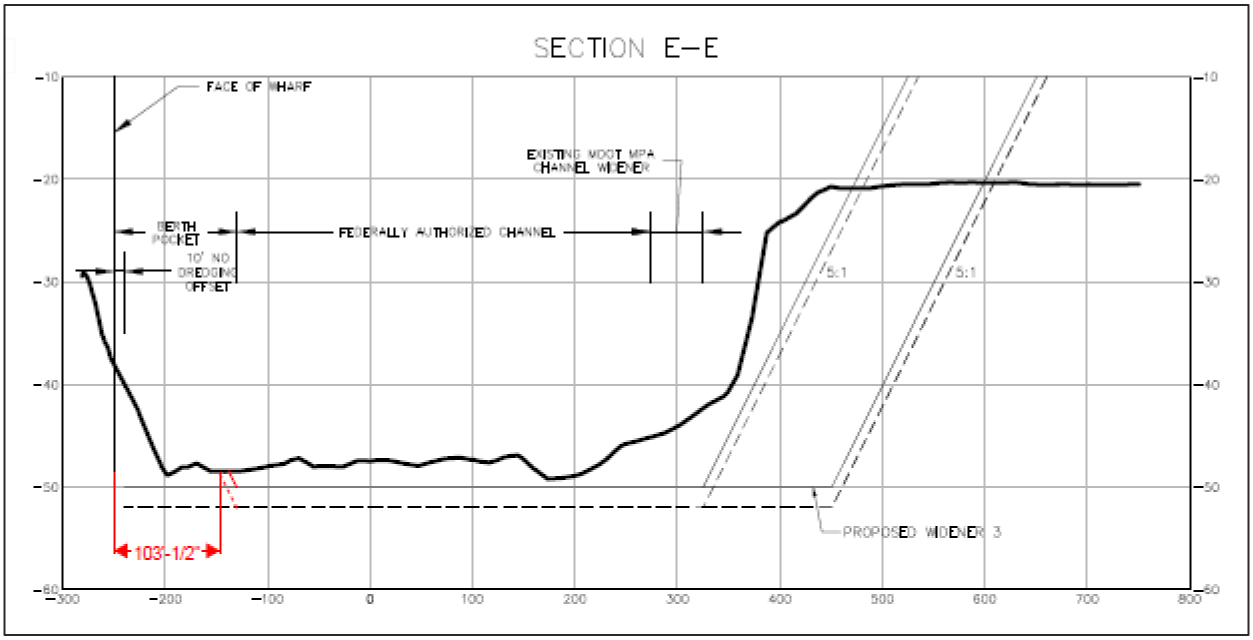


Figure 10 – Proximity of 5:1 Side Slope to SMT Berth 2

Proposed Dredge Impact on Seagirt Marine Terminal Berths 1-2

As noted above, the depth to fixity and resulting passive soil wedge for SMT Berths 1-2 concrete piles was compared to the proximity of the proposed dredge profile. As concrete piles are relatively stiff compared to timber piles, the depth to fixity was deeper than that calculated for Pier 13, at 17 feet below mudline.

The piles are 20-inch square with a compressive strength of 5,000 psi, as shown in the contract drawings, excerpt included in Attachment C to this memo. Modulus of elasticity was calculated per ACI 318-14 for normal weight concrete using the compressive strength specified in the contract drawings.

Using the 17-foot depth to fixity, a passive wedge with a horizontal projection of approximately 24 feet was calculated. Two conditions for the passive wedge were considered, a short term and long term (drained) condition. In the short-term, undrained condition, the soil has an effective angle of internal friction (phi) of zero. In the drained condition, the soil would have an angle of internal friction estimated at 20-degrees; this value was taken from a geotechnical report prepared for Seagirt Marine Terminal Berth 4, excerpt included in Attachment C to this memo. A third estimate of passive wedge width was made assuming a soil with a high angle of internal friction. If the soil were sand with a phi of 34-degrees, the passive soil width would be approximately 32 feet.

As the nearest potential dredging is 92 feet from Berths 1-2, no effect on the pile's lateral support, and resulting capacity, would be expected.

SMT Cofferdam Stability

The west end of the proposed dredging fronts SMT Berths I and II. The inshore toe of the Federally Authorized Channel is approximately 115' offset from face of berth. An allowance for 2.0' for overdredge takes the permitted depth to -52.0 MLLW. Existing mudline elevations within the existing channel vary, but typically average -47' MLLW. See dredging cross sections in Attachment A.

Local and global stability analyses were performed to assess the 3:1 proposed dredging pocket slope and the impact of deepening the Federally Authorized portion of the channel on the structural stability of the existing cofferdam.

Design Assumptions

The local and global stability analyses were performed at cell #50 (bent #95) located in Berth II, which roughly aligns with Section E-E shown in Figure 1. Data sources include:

1. The configuration of the berth is taken from the construction drawings for Berths I, II, III Marginal Wharf, dated 1986.
2. Existing bathymetry is taken from cross-sections prepared by Gahagan & Bryant Associates, dated 2021, supplemented by cross-sections under the berth taken by WSP, dated 2019.
3. Subsurface stratigraphy was based on soil profiles contained in the construction drawings for Berths I, II, and III, dated 1986. Soil properties for the various strata are tabulated in the output file included in Attachment B.
4. The 'pinning' action of the piles inboard and outboard of the wharf was not accounted for.
5. A uniform live load of 600 psf was applied behind the inboard relieving platform.

Local and Global Stability Analysis

The 3:1 slope of the federal channel deepening was evaluated in terms of local stability from the outboard side of the cellular cofferdam to the Federal Channel using Slope/W (GeoStudio 2020) software program. The minimum factor of safety against slope failure for the proposed 3:1 slope was calculated to be 8.25.

The impact of deepening the federal channel was also evaluated in terms of global stability from the inboard edge of the inboard relieving platform to the Federal Channel using Slope/W (GeoStudio 2020) software program. The minimum factor of safety against slope failure was computed to be 3.10.

Graphical representation of the critical slip surfaces, the critical factors of safety, and the model's output files are included in Attachment D.

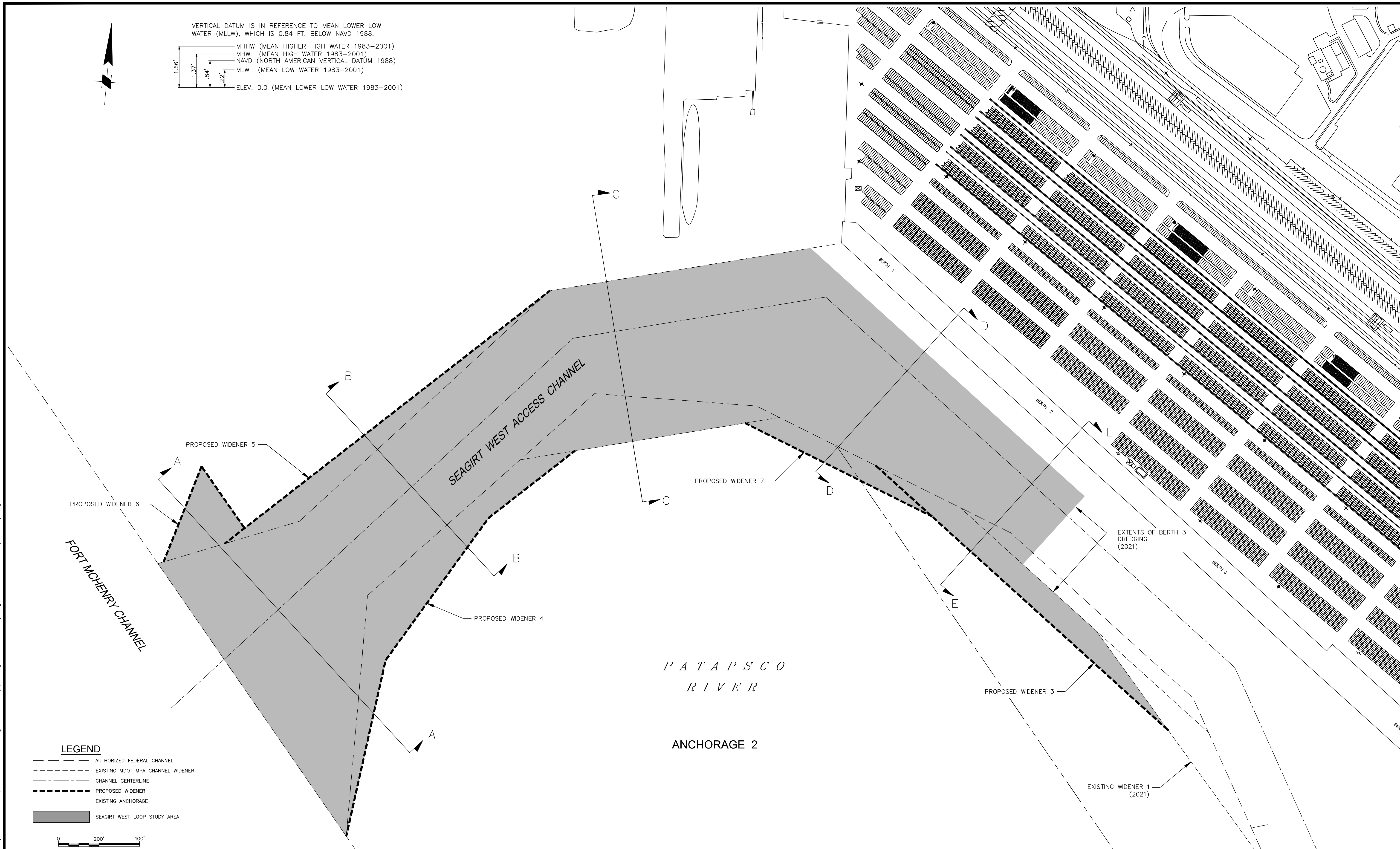
According to USACE publication number EM 1110-2-1902 titled "Slope Stability", a minimum safety factor of 1.5 is considered acceptable for long-term slope stability of excavated slopes. Local and global factors of safety computed exceed the 1.5 minimum, therefore, it can be concluded that the proposed dredging slope is acceptable and the proposed dredged pocket does not adversely impact berth stability.

Conclusion

The proposed dredging within the federal channel limits (including side slopes) is far enough away from the berth and pier structures that the pile support would be unchanged from its present condition. Calculated factors of safety for the cofferdam stability models exceeded requirements by more than two times when the proposed dredging is considered.

The proposed federal channel dredging for the Seagirt West Loop would not have any detrimental impact on the existing structures adjacent to the channel.

ATTACHMENT A
SEAGIRT WEST LOOP DREDGE SECTIONS



C:\Users\gba289\Desktop\FROM SERVER\SEAGIRT\2021_Seagirt_5-to-1\2) Seagirt West Loop\Seagirt_Cross_Sections(5-to-1).dwg

SEAGIRT WEST LOOP
CROSS SECTIONS

BALTIMORE, MD

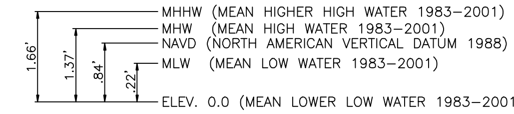
DRAWING DATE:	JUNE 2021
DRAWN BY:	C. MANUEL
CHECKED BY:	L. FOLKERT
DRAWING NAME:	Seagirt_Cross_Sections(5-to-1).dwg
DRAWING SCALE:	1" = 200'
SHEET NUMBER:	1 OF 3

CONDITION SURVEYS	
SURVEY DATE:	OCTOBER 2020 (GBA) & JANUARY 2021 (CENAB)
HORIZONTAL PROJECTION:	MARYLAND STATE PLANE
ZONE:	1900
VERTICAL REFERENCE:	MEAN LOWER LOW WATER (MLLW)
SURVEY UNITS:	U.S. SURVEY FEET

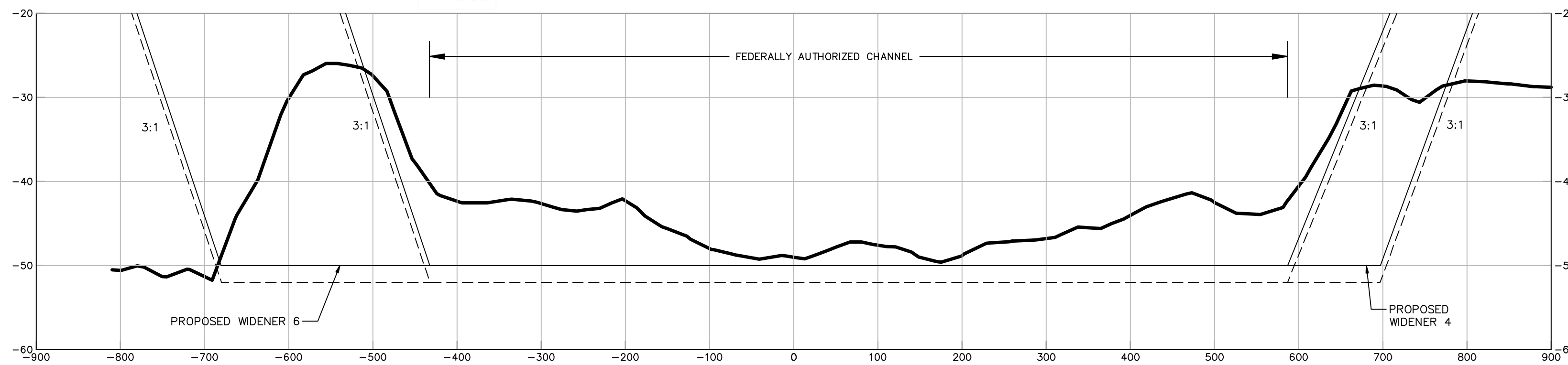
NOTES:
1. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULT OF SURVEYS MADE ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITION EXISTING AT THAT TIME.
2. PLANIMETRICS INDICATE THE APPROXIMATE LOCATION OF FEATURES AS PROVIDED BY THE USACE BALTIMORE DISTRICT.
3. SURVEYED OCTOBER 2020 BY GAHAGAN & BRYANT ASSOCIATES, INC. & JANUARY 2021 BY CENAB.
4. TIDES WERE OBTAINED FROM NOAA TIDE STATION 8574680 BALTIMORE, FORT MCHENRY.
5. THE PLANE OF MLLW IS 0.84 FEET BELOW NAVD88.

GAHAGAN & BRYANT ASSOCIATES, INC.
BALTIMORE, MARYLAND
(410) 682-5595
GBA
ENGINEERS ★ SURVEYORS

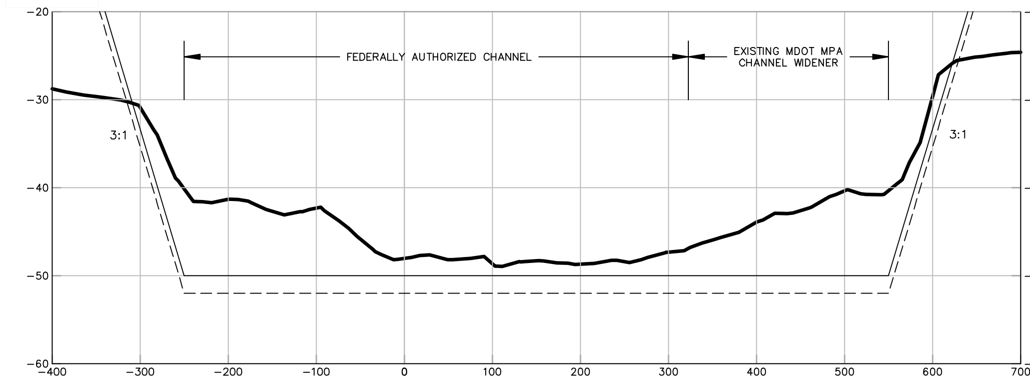
VERTICAL DATUM IS IN REFERENCE TO MEAN LOWER LOW WATER (MLLW), WHICH IS 0.84 FT. BELOW NAVD 1988.



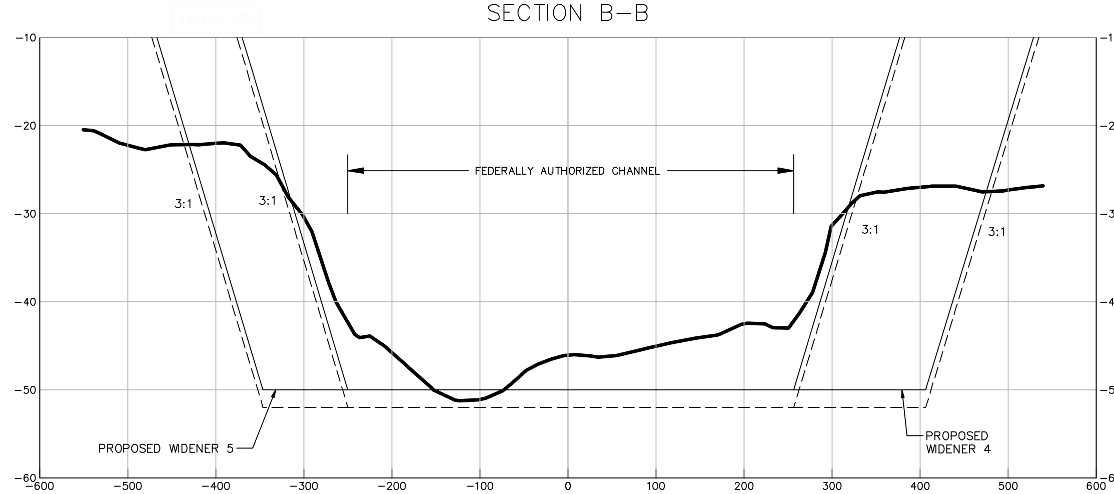
SECTION A–A



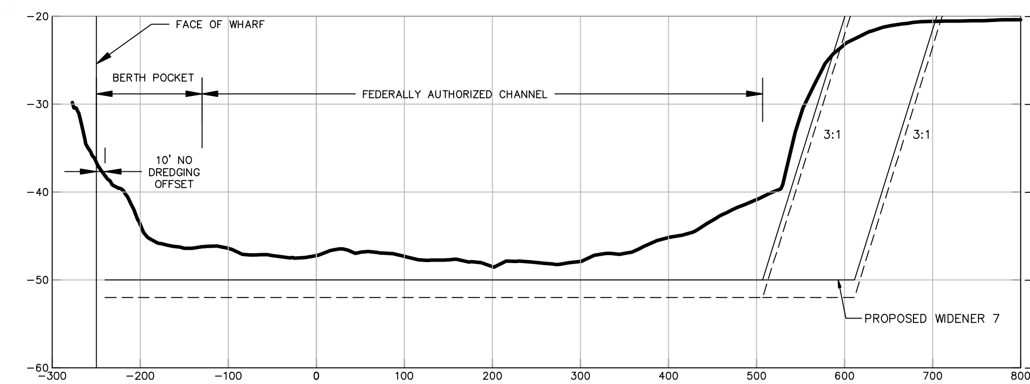
SECTION C–C



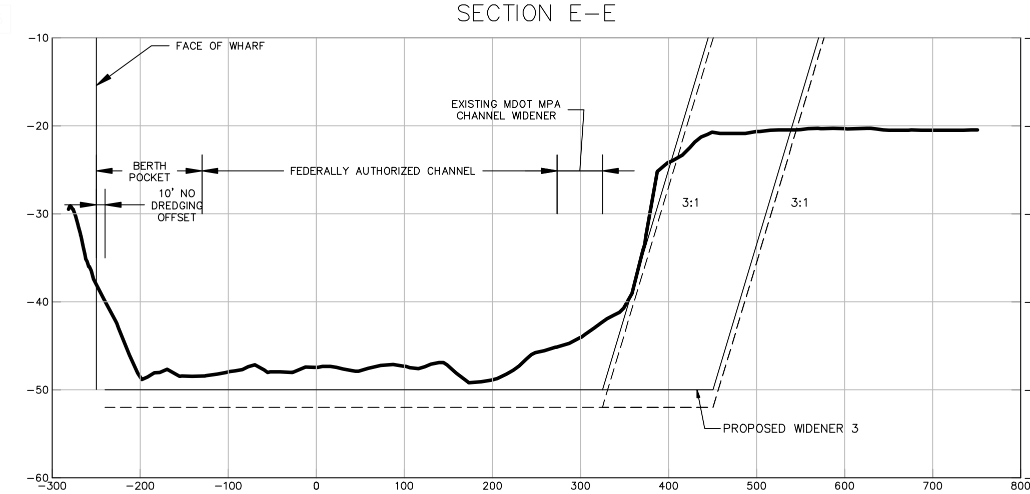
SECTION B–B



SECTION D–D

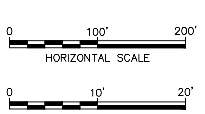


SECTION E–E



LEGEND

- CENAB/GBA COMBO SURVEY
- PROPOSED REQUIRED GRADE (–50')
- PROPOSED OVERDEPTH (–52')



C:\Users\gba285\Desktop\Seagirt Feasability\Engineering\Cross Sections\210520_Harbor_Overlays_Seagirt_West.dwg

SEAGIRT WEST LOOP
CROSS SECTIONS 3H:1V SLOPES

BALTIMORE, MD

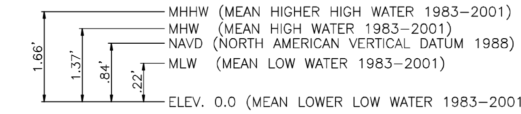
DRAWING DATE:	JUNE 2021
DRAWN BY:	C. MANUEL
CHECKED BY:	L. FOLKERT
DRAWING NAME:	SEAGIRT WEST LOOP CROSS SECTIONS
DRAWING SCALE:	AS SHOWN
SHEET NUMBER:	2 OF 3

CONDITION SURVEYS	
SURVEY DATE:	OCTOBER 2020 (GBA) & JANUARY 2021 (CENAB)
HORIZONTAL PROJECTION:	MARYLAND STATE PLANE
ZONE:	1900
VERTICAL REFERENCE:	MEAN LOWER LOW WATER (MLLW)
SURVEY UNITS:	U.S. SURVEY FEET

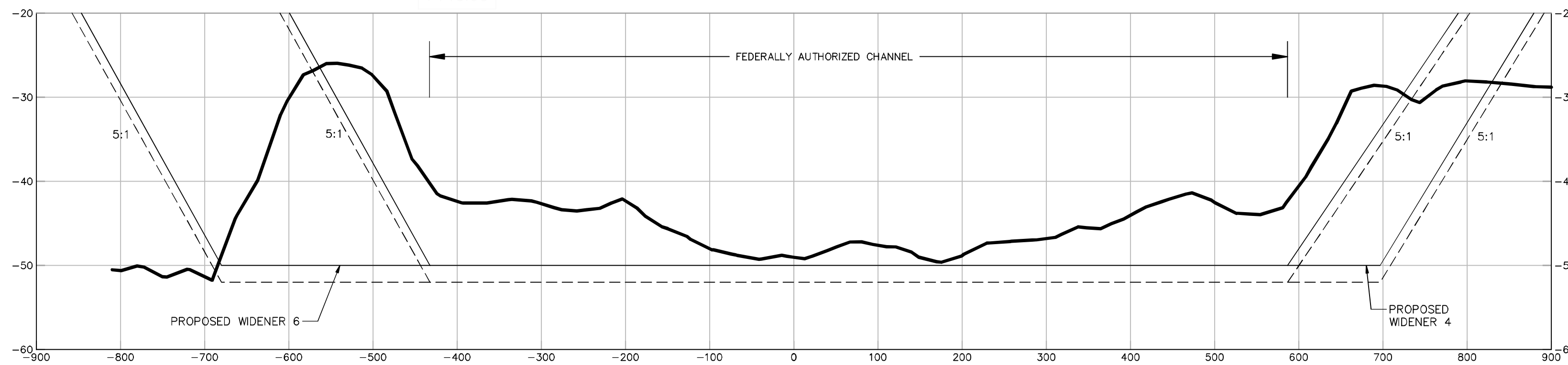
NOTES:
1. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULT OF SURVEYS MADE ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITION EXISTING AT THAT TIME.
2. PLANIMETRICS INDICATE THE APPROXIMATE LOCATION OF FEATURES AS PROVIDED BY THE USACE BALTIMORE DISTRICT.
3. SURVEYED OCTOBER 2020 BY GAHAGAN & BRYANT ASSOCIATES, INC. & JANUARY 2021 BY CENAB.
4. TIDES WERE OBTAINED FROM NOAA TIDE STATION 8574680 BALTIMORE, FORT MCHENRY.
5. THE PLANE OF MLLW IS 0.84 FEET BELOW NAVD88.

GAHAGAN & BRYANT ASSOCIATES, INC.
BALTIMORE, MARYLAND
(410) 682-5595
GBA ENGINEERS ★ SURVEYORS

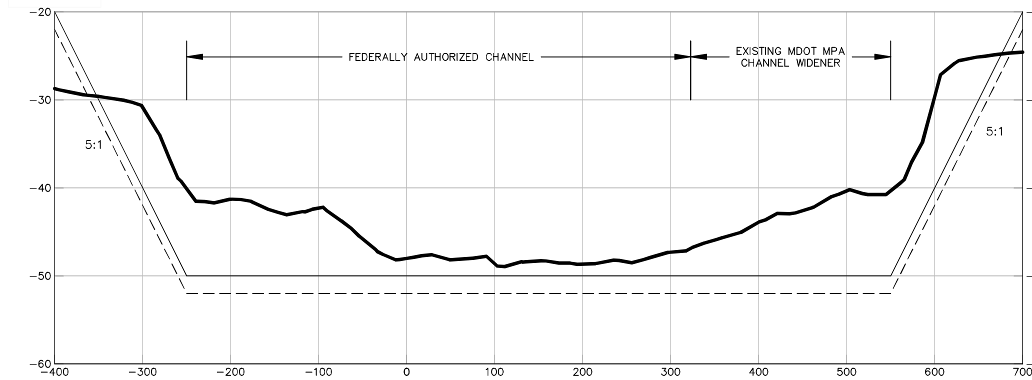
VERTICAL DATUM IS IN REFERENCE TO MEAN LOWER LOW WATER (MLLW), WHICH IS 0.84 FT. BELOW NAVD 1988.



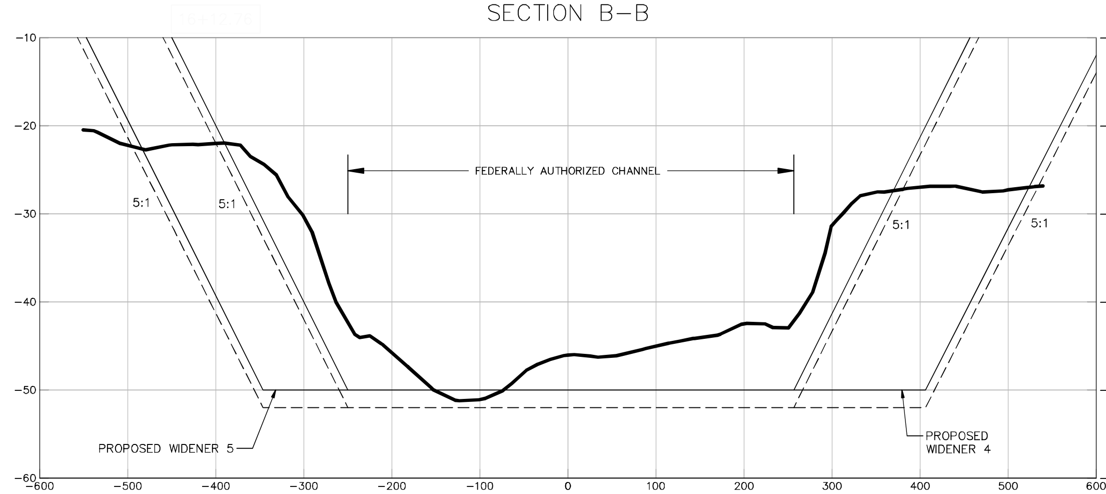
SECTION A–A



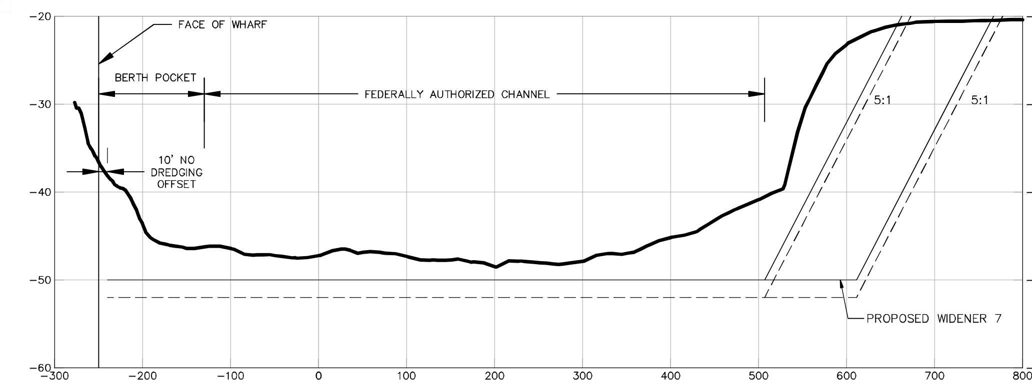
SECTION C–C



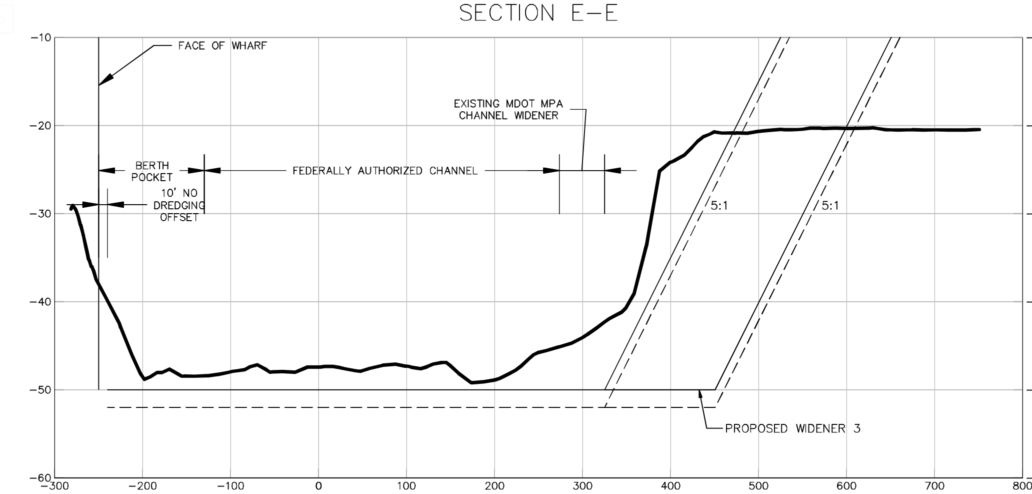
SECTION B–B



SECTION D–D



SECTION E–E



LEGEND

- CENAB/GBA COMBO SURVEY
- PROPOSED REQUIRED GRADE (–50')
- PROPOSED OVERDEPTH (–52')

0 100' 200'
HORIZONTAL SCALE

0 10' 20'
VERTICAL SCALE

C:\Users\gba289\Desktop\FROM SERVER\SEAGIRT\2021_Seagirt_5–to–1\2) Seagirt West Loop\Seagirt_Cross_Sections(5–to–1).dwg

SEAGIRT WEST LOOP
CROSS SECTIONS – 5H:1V SLOPES

BALTIMORE, MD

DRAWING DATE:	JUNE 2021
DRAWN BY:	C. MANUEL
CHECKED BY:	L. FOLKERT
DRAWING NAME:	Seagirt_Cross_Sections(5–to–1).dwg
DRAWING SCALE:	AS SHOWN
SHEET NUMBER:	3 OF 3

CONDITION SURVEYS	
SURVEY DATE:	OCTOBER 2020 (GBA) & JANUARY 2021 (CENAB)
HORIZONTAL PROJECTION:	MARYLAND STATE PLANE
ZONE:	1900
VERTICAL REFERENCE:	MEAN LOWER LOW WATER (MLLW)
SURVEY UNITS:	U.S. SURVEY FEET

NOTES:
1. THE INFORMATION DEPICTED ON THIS MAP REPRESENTS THE RESULT OF SURVEYS MADE ON THE DATES SHOWN AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITION EXISTING AT THAT TIME.
2. PLANIMETRICS INDICATE THE APPROXIMATE LOCATION OF FEATURES AS PROVIDED BY THE USACE BALTIMORE DISTRICT.
3. SURVEYED OCTOBER 2020 BY GAHAGAN & BRYANT ASSOCIATES, INC. & JANUARY 2021 BY CENAB.
4. TIDES WERE OBTAINED FROM NOAA TIDE STATION 8574680 BALTIMORE, FORT MCHENRY.
5. THE PLANE OF MLLW IS 0.84 FEET BELOW NAVD88.

GAHAGAN & BRYANT ASSOCIATES, INC.
BALTIMORE, MARYLAND
(410) 682–5595
GBA
ENGINEERS ★ SURVEYORS

ATTACHMENT B
EXCERPTS FROM REFERENCE MATERIAL

CECW-ED Engineer Manual 1110-2-2504	Department of the Army U.S. Army Corps of Engineers Washington, DC 20314-1000	EM 1110-2-2504 31 March 1994
	Engineering and Design DESIGN OF SHEET PILE WALLS	
	Distribution Restriction Statement Approved for public release; distribution is unlimited.	

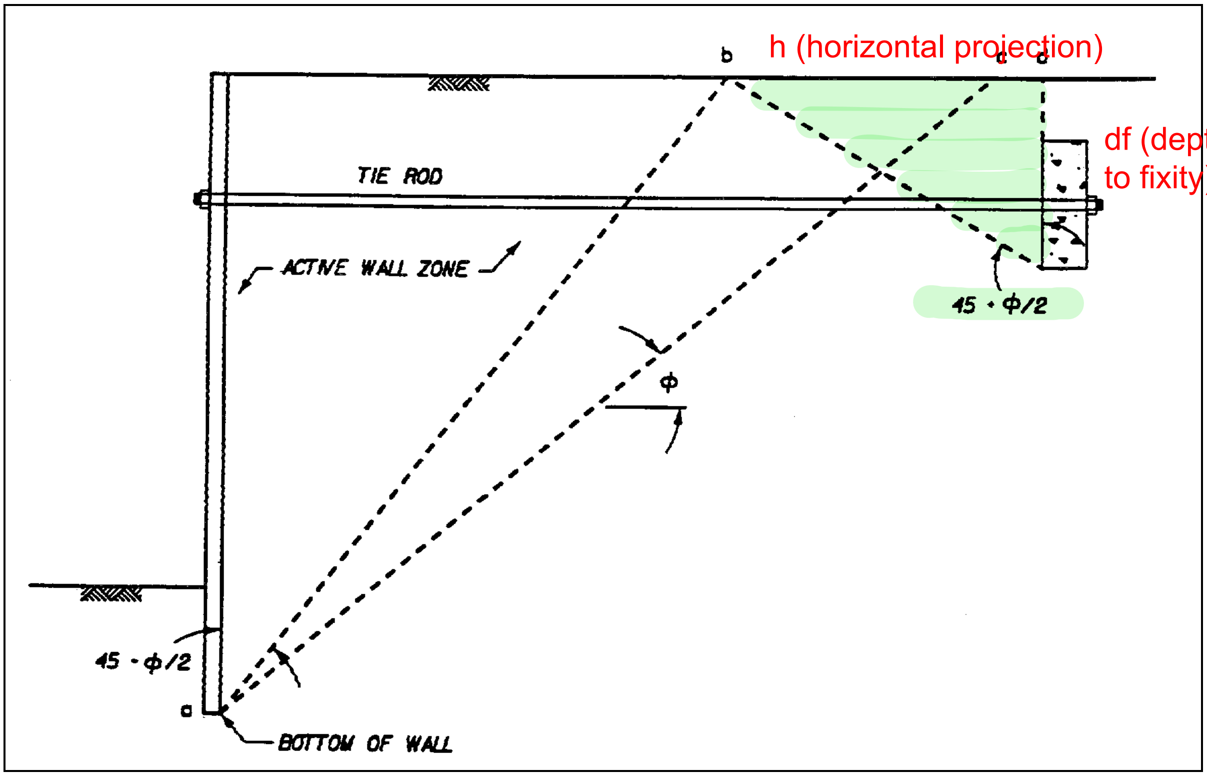


Figure 5-8. Minimum anchor - wall spacing for full passive anchor resistance in homogeneous soil

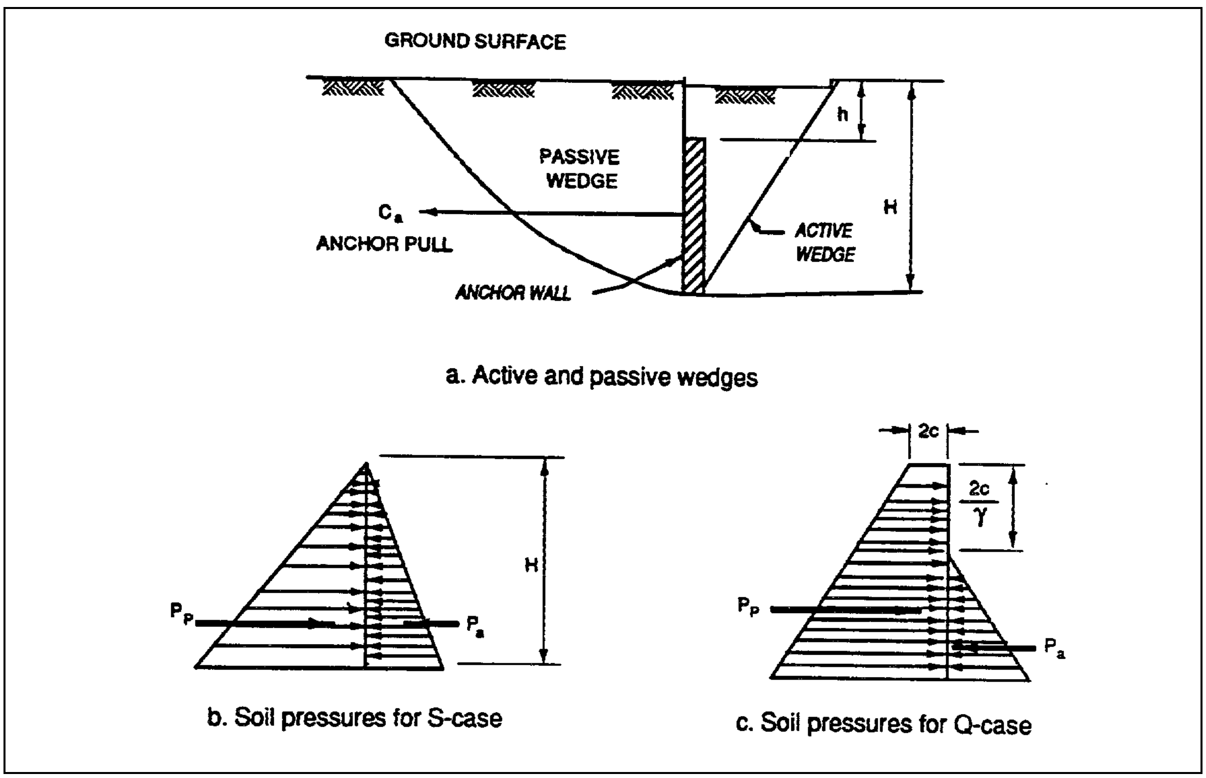


Figure 5-9. Resistance of continuous anchor wall

SUBSURFACE STRATA DESCRIPTION

GF	GRANULAR FILL CONSISTING OF GRAVEL AND SAND WITH SOME INCLUSIONS OF CLAY.
SL	DREDGED SPOIL (SLURRY) CONSISTING PREDOMINANTLY OF VERY SOFT SILTS MIXED WITH VARIABLE AMOUNT OF CLAY AND FINE SAND.
SF	SAND FILL CONSISTING OF GREY, BROWN, MEDIUM FINE SAND.
O-F	BLACK TO DARK GREY, VERY SOFT TO MEDIUM STIFF, ORGANIC CLAYEY SILT TO SILT.
O-2	GREY, SOFT TO MEDIUM STIFF, SILTY CLAY TO CLAYEY SILT.
C-1	GREY, BROWN, MEDIUM STIFF SILTY CLAY.
C-2	BROWN, STIFF SILTY CLAY.
C-3	RED, HARD CLAY.
S-1	GREY LOOSE TO MEDIUM DENSE, FINE SAND TO SILTY SAND.
S-2	GREY, BROWN, DENSE COARSE TO FINE SAND.
S-3	LIGHT BROWN, GREY, VERY DENSE, COARSE TO FINE SAND TO SILTY SAND.

LEGEND

WL S SW	BORINGS PERFORMED BY PITTSBURGH TESTING LABORATORY FROM NOV. 1982 TO JAN., 1983 UNDER THE INSPECTION OF STV/LYON ASSOCIATES
S	BORINGS PERFORMED BY PITTSBURGH TESTING LABORATORY IN SEPT. & OCT., 1983 UNDER THE INSPECTION OF STV/LYON ASSOCIATES.
CSM LSM PSM WSM SD	BORINGS PERFORMED BY FROEHLING & ROBERTSON, INC. FROM JULY, 1985 TO DEC, 1985 AND FROM APRIL, 1986 TO MAY, 1986 UNDER THE INSPECTION OF EBA ENG., INC.
	PIEZOMETER
	SETTLEMENT PLATE OR SETTLEMENT MONITORING DEVICE
	PRESSURE LOAD CELL
	INCLINOMETER

NO.	DATE	REVISION	BY

MARYLAND TRANSPORTATION AUTHORITY
AND
MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

BORING AND INSTRUMENT LOCATION PLAN

STV/LYON ASSOCIATES.
ENGINEERS, ARCHITECTS & PLANNERS.

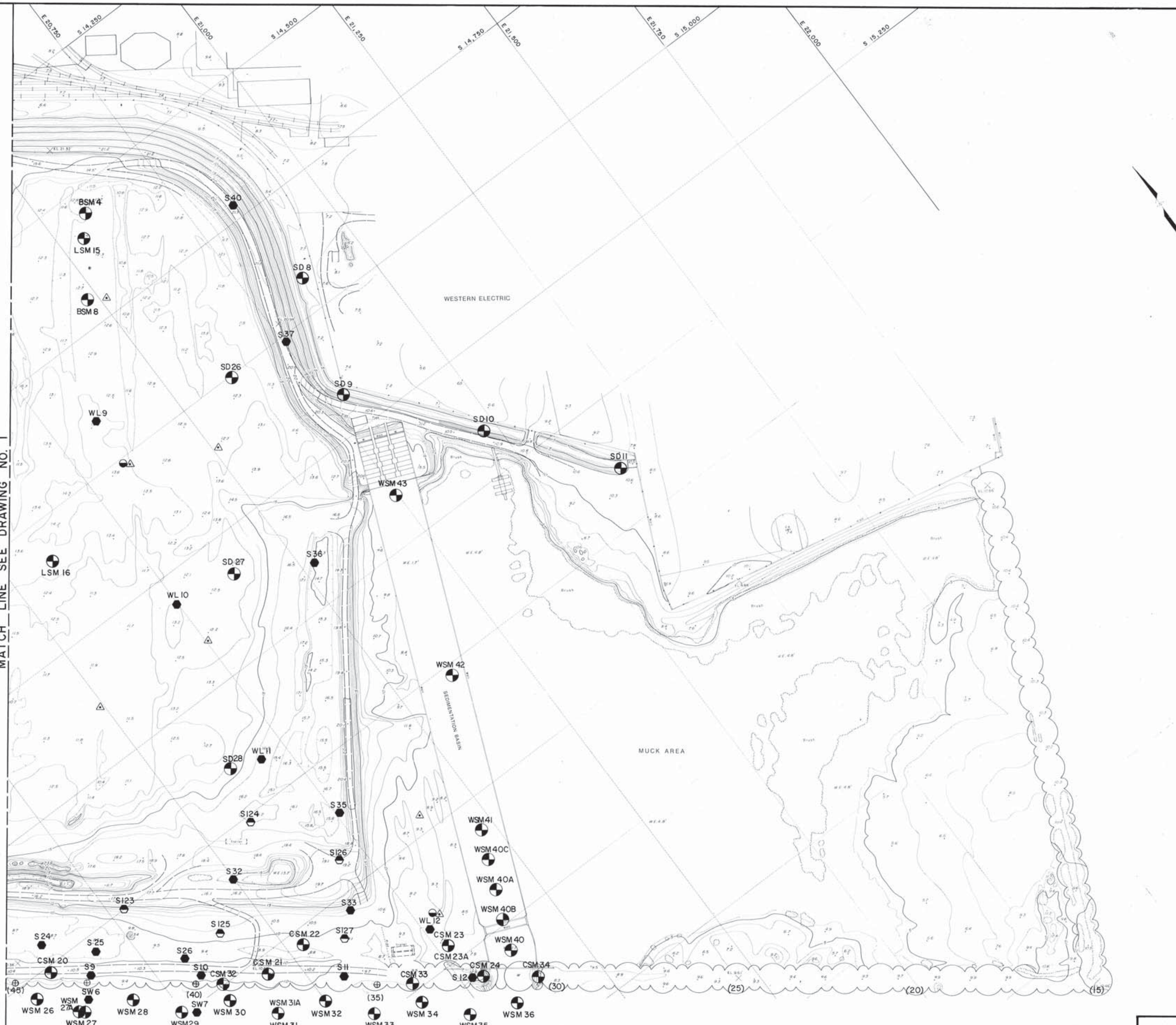
SHEET NO. G-1

MARYLAND PORT ADMINISTRATION
REVIEWED BY: [signature]
DIRECTOR OF ENGINEERING
DATE: 10-9-86

DATE: OCT. 1986 SCALE: 1"=100'	CONTRACT NO. 287911	DRAWING NO. 96

SURVEYED BY:
DESIGNED BY:
DRAWN BY:
TRACED BY:
CHECKED BY:

PF-5-12/4-45



LEGEND

- WL, S, SW — BORINGS PERFORMED BY PITTSBURGH TESTING LABORATORY FROM NOV. 1982 TO JAN., 1983 UNDER THE INSPECTION OF STV/LYON ASSOCIATES.
- S — BORINGS PERFORMED BY PITTSBURGH TESTING LABORATORY IN SEPT. & OCT., 1983 UNDER THE INSPECTION OF STV/LYON ASSOCIATES.
- CSM, LSM, WSM, SD — BORINGS PERFORMED BY FROEHLING & ROBERTSON, INC. FROM JULY, 1985 TO DEC., 1985 AND FROM APRIL, 1986 TO MAY, 1986 UNDER THE INSPECTION OF EBA ENG., INC.
- PIEZOMETER
- SETTLEMENT PLATE OR SETTLEMENT MONITORING DEVICE
- INCLINOMETER

SURVEYED BY: ______
DESIGNED BY: ______
DRAWN BY: ______
TRACED BY: ______
CHECKED BY: ______

NO.	DATE	REVISION	BY

MARYLAND TRANSPORTATION AUTHORITY
AND
MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

BORING AND INSTRUMENT LOCATION PLAN

STV/LYON ASSOCIATES.
ENGINEERS, ARCHITECTS & PLANNERS.

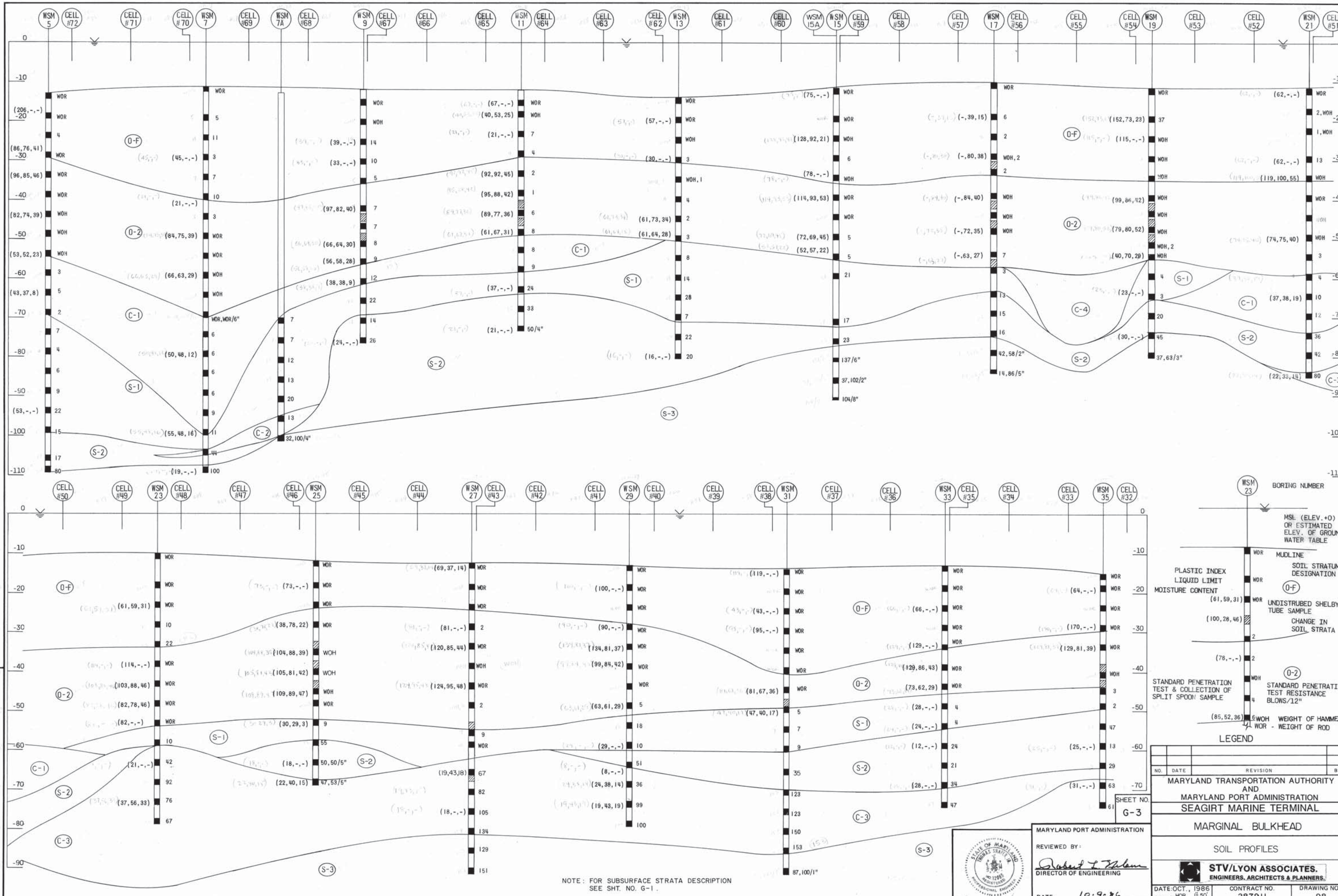
SHEET NO. G-2

MARYLAND PORT ADMINISTRATION
REVIEWED BY: Robert L. Nelson
DIRECTOR OF ENGINEERING
DATE: 10-9-86

STATE OF MARYLAND — THOMAS SHAFER JR. — NO. 12015 — REGISTERED PROFESSIONAL ENGINEER
Thomas Shafer Jr

DATE: OCT. 1986	CONTRACT NO.	DRAWING NO.
SCALE: 1" = 100'	287911	97

PF-5-12/4-46



SURVEYED BY:
DESIGNED BY:
DRAWN BY:
TRACED BY:
CHECKED BY:

MARYLAND PORT ADMINISTRATION
REVIEWED BY:
DIRECTOR OF ENGINEERING
DATE: 10-9-86

NO.	DATE	REVISION	BY

MARYLAND TRANSPORTATION AUTHORITY AND MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

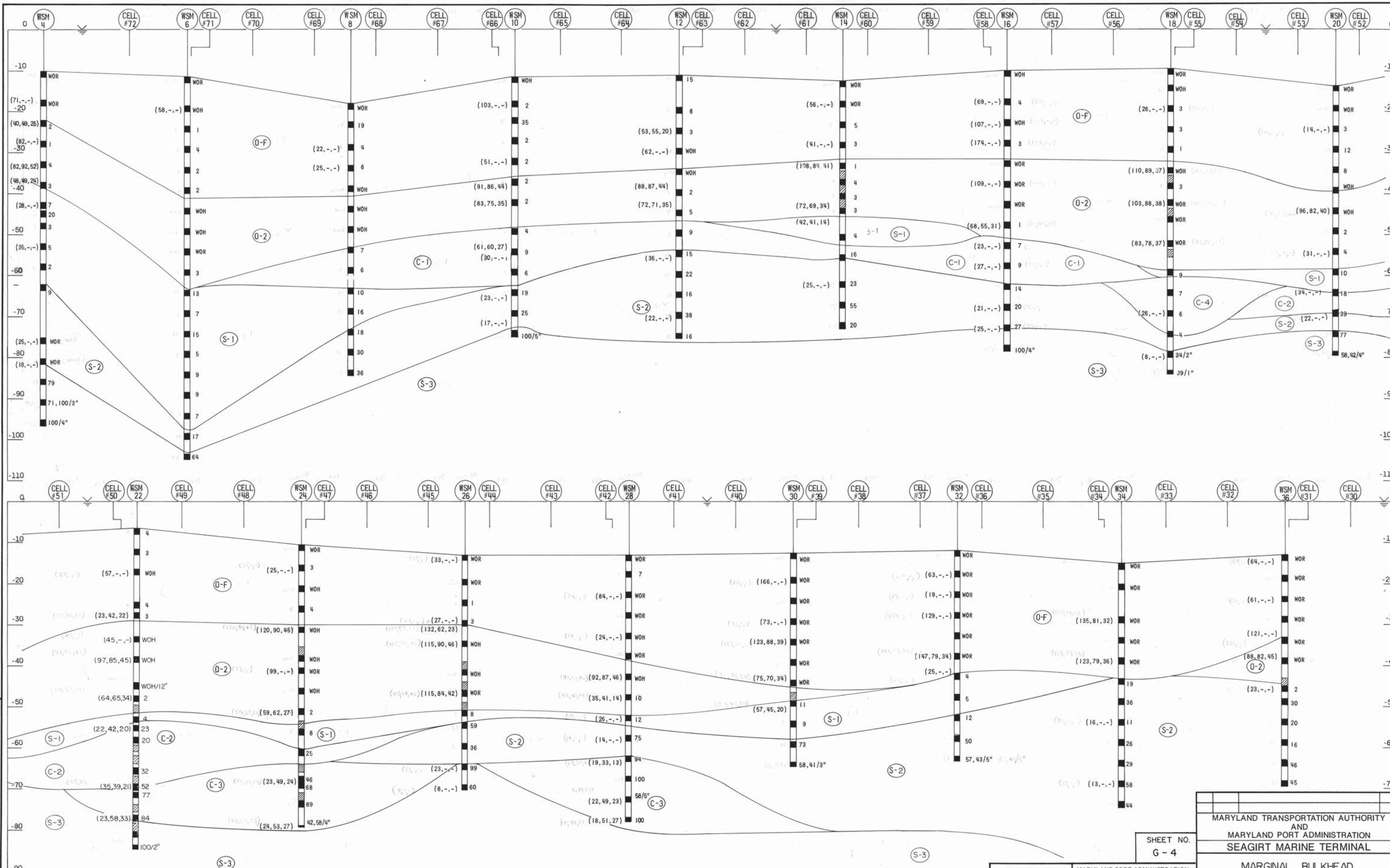
SOIL PROFILES

SHEET NO. G-3

STV/LYON ASSOCIATES.
ENGINEERS, ARCHITECTS & PLANNERS.

DATE: OCT., 1986
SCALE: HOR. 1"=50' VERT. 1"=10'
CONTRACT NO. 287911
DRAWING NO. 98

PF-5-12/4-47



NOTE: FOR SUBSURFACE STRATA DESCRIPTION SEE SHT. NO. G-1

SURVEYED BY:
DESIGNED BY:
DRAWN BY:
TRACED BY:
CHECKED BY:

MARYLAND PORT ADMINISTRATION

REVIEWED BY:

Robert L. [signature]

DIRECTOR OF ENGINEERING

DATE: 10-9-86

SHEET NO. G-4

MARYLAND TRANSPORTATION AUTHORITY AND MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

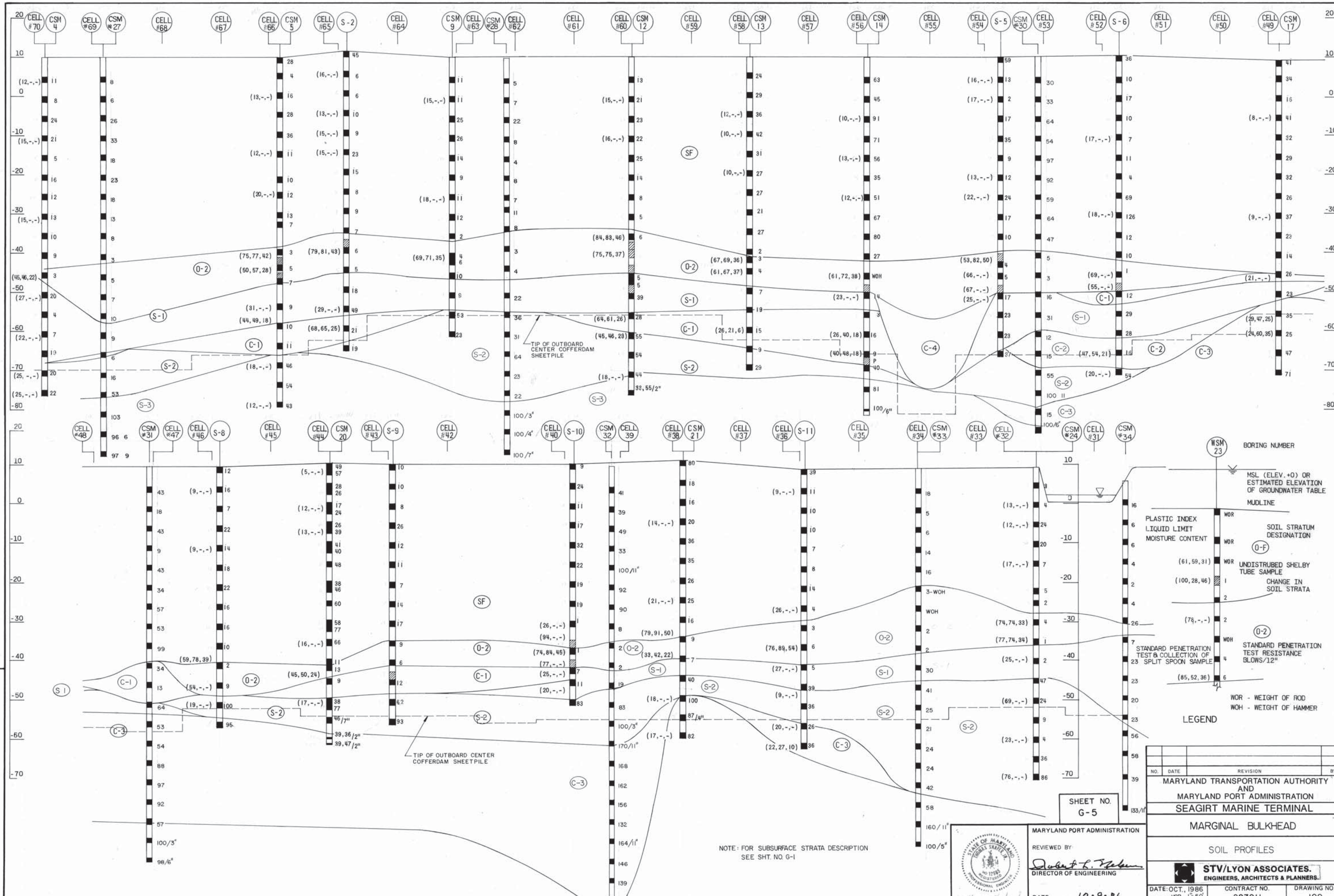
MARGINAL BULKHEAD

SOIL PROFILES

STV/LYON ASSOCIATES.
ENGINEERS, ARCHITECTS & PLANNERS

DATE: OCT., 1986 SCALE: HOR. 1"=50' VERT. 1"=10'	CONTRACT NO. 287911	DRAWING NO. 99

PF-5-12/4-48



SURVEYED BY:
DESIGNED BY:
DRAWN BY:
TRACED BY:
CHECKED BY:

SHEET NO. G-5

NO.	DATE	REVISION	BY

MARYLAND TRANSPORTATION AUTHORITY
AND
MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

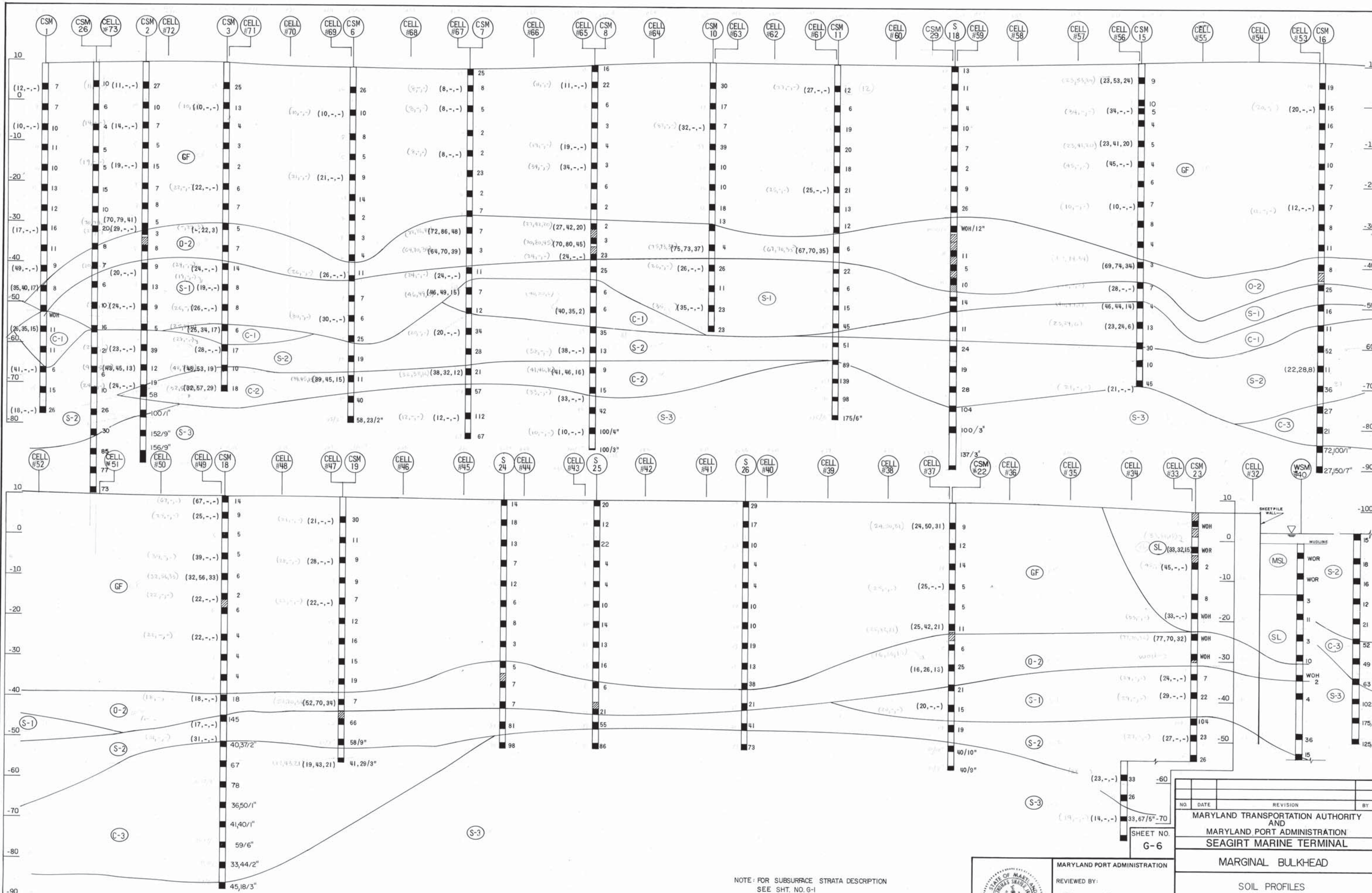
SOIL PROFILES

MARYLAND PORT ADMINISTRATION
REVIEWED BY:
DIRECTOR OF ENGINEERING
DATE: 10-9-86

STV/LYON ASSOCIATES.
ENGINEERS, ARCHITECTS & PLANNERS.

DATE: OCT., 1986
SCALE: HOR. 1"=50' VERT. 1"=10'
CONTRACT NO. 287911
DRAWING NO. 100

PF-5-12/4-49



NOTE: FOR SUBSURFACE STRATA DESCRIPTION SEE SHT. NO. G-1

SURVEYED BY:
DESIGNED BY:
DRAWN BY:
TRACED BY:
CHECKED BY:

NO.	DATE	REVISION	BY

MARYLAND TRANSPORTATION AUTHORITY AND MARYLAND PORT ADMINISTRATION

SHEET NO. G-6

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

SOIL PROFILES

MARYLAND PORT ADMINISTRATION

REVIEWED BY:

DIRECTOR OF ENGINEERING

DATE: 10-9-86

STV/LYON ASSOCIATES. ENGINEERS, ARCHITECTS & PLANNERS.

DATE: OCT., 1986

SCALE: HOR. 1"=50' VERT. 1"=10'

CONTRACT NO. 287911

DRAWING NO. 101

STATE OF MARYLAND · THOMAS SHULER · NO. 12083 · REGISTERED PROFESSIONAL ENGINEER

U.S. Department of Transportation
Federal Highway Administration

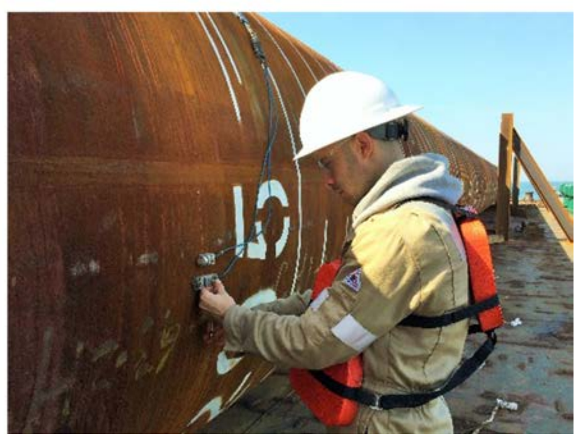
Publication No. FHWA-NHI-16-009
FHWA GEC 012 – Volume I
July 2016

NHI Courses No. 132021 and 132022

Design and Construction of Driven Pile Foundations – Volume I

Developed following:
AASHTO LRFD Bridge Design Specifications, 7th Edition, 2014,with 2015 Interim.

AASHTO LRFD Bridge Construction Specifications, 3rd Edition, 2010, with ‘11, ‘12, ’13, ‘14, and ‘15 Interims.



NATIONAL HIGHWAY INSTITUTE
Training Solutions for Transportation Excellence

The factored resistance must be greater than factored loads applied to the pile. The recommended AASHTO limits for factored pile design stresses will generally keep the driving stresses within recommended limits. Factored loads are covered in Article 3 of the AASHTO Specification (2014) while driving stress limits are presented in the respective pile material sections for concrete (Article 5), steel (Article 6), and timber (Article 8).

8.3.1 Depth to Fixity

The unbraced length, l, or laterally unsupported length is defined by AASHTO (2014) as the distance between two braced points that resist buckling or distortion modes. For embedded piles, the unbraced length is considered for scour and pile stickup through air and/or water. For preliminary analysis, when lateral loads are applied, the effective length, K, for flexural or torsional resistance calculations is taken as the total unsupported length, plus an embedded depth to "fixity." If a lateral pile analysis with p-y curves for soil-structure interaction has been performed as discussed in Chapter 7, the depth to fixity concept is unnecessary. Most software with lateral analysis also includes additional features to determine a pile's buckling capacity given the soil model and a pile model with the expected stick-up above the ground level.

For preliminary calculations, however, the depth to fixity below the ground may be evaluated based on soil type and soil strength parameters as shown in Equation 8-6 for clays and Equation 8-8 for sands. Table 8-4 contains the rate of increase in soil modulus for sands, n_h, and should be used as applicable in the following depth to fixity estimates.

For clays:

$$d_f = 1.4\left(\frac{EI_w}{E_s}\right)^{0.25} \qquad \text{Eq. 8-6}$$

$$E_s = 0.465 s_u \qquad \text{Eq. 8-7}$$

For sands:

$$d_f = 1.8\left(\frac{EI_w}{n_h}\right)^{0.2} \qquad \text{Eq. 8-8}$$

Where:

d_f = depth to fixity below the ground (ft).

E = elastic modulus of pile material (ksi).

E_s = elastic modulus of clay soil (ksi).
s_u = undrained shear strength of clay (ksf).
I_w = weak axis moment of inertia of pile (ft^4).
n_h = rate of increase of soil modulus with depth (Table 8-4) (ksi/ft).

Table 8-4 Rate of Increase of Soil Modulus with Depth for Sands (ksi/ft) (after AASHTO 2014)

Consistency	Dry or Moist	Submerged
Loose	0.417	0.208
Medium	1.110	0.556
Dense	2.780	1.390

8.3.2 Limiting Slenderness Ratio

Piles extending through air or water are unbraced over some length and therefore, for axial compression, the slenderness ratio should be checked during design. For non-composite steel piles, which are not fully embedded, slenderness ratio limits should be satisfied as follows:

$$\frac{Kl}{r_s} \leq 120 \quad \text{Eq. 8-9}$$

Where:
K = effective length factor (Figure 8-4) (dimensionless).
l = unbraced length, or laterally unsupported length plus d_f (inches).
r_s = minimum radius of gyration, $\sqrt{I/A}$ (inches).

8.3.3 Resistance Factors

A discussion and step by step determination of the nominal structural resistance for timber, steel, and concrete piles is provided in the following sections. The AASHTO (2014) specifications form the basis of these respective sections. Following the Load and Resistance Factor Design (LRFD) approach, a resistance factor is applied to the calculated nominal structural resistance.

In practical terms, the imposed factored load must be less than or equal to the factored resistance. Chapter 2 provides a discussion on load combinations in which load factors are applied to respective load effects. The critical load combination is

ATTACHMENT C
CALCULATIONS

Moffat & Nichol
2780 Lighthouse Point East, Suite D
Baltimore, MD 21224

Evaluation of Timber Piles Removed from Dundalk Marine Terminal Berths 1 and 2

Wood Science Consulting
March 12, 2021- Report WSC-21.15.01

4.3 Comparison of 2011 and 2021 Test Results

The pile test data collected from DMT in 2021 was compared to the test data collected in 2011. In 2011, four pilings were also tested, and those results were reported in WAS Report 11.133.01. In 2011 two pilings from the 1929 vintage were tested as well as on from 1961 and another from 1966.

The results from both data sets were grouped into two vintages: 1966 and 1929. The results do no illustrate that the overall strength of the pilings has reduced from 2011 to 2021, however, there is a clear difference in the overall strength of the 1996 vintage pilings as compared to the 1929 pilings. Overall, all three mechanical property value means were higher in the pilings tested in 2021 than those tested in 2011. At this point and based on the limited number of pilings that have been tested there is no evidence that the pilings at Berths 1-4 have lost any strength since 2011. However, there is a clear difference between the mean property values from 1966 versus those from 1929. There was a 17% difference in mean MOR and a 20% difference in the mean MOE and C//.

Table 3. Results of the Wood Pile Testing for DMT Berths 1-4 in 1966 and 1929.

Year Tested	Modulus of Rupture (psi)		Modulus of Elasticity ($x10^6$ psi)		Compression Parallel (psi)	
	1966	1929	1966	1929	1966	1929
2021	5,912	5,016	1.523	1.095	2,541	2,434
2011	5,148	4,470	1.085	1.030	2,039	1,902
Average	5,661	4,743	1.139	1.062	2,486	1,970
Difference	**17%**		**20%**		**20%**	

4.4 Recommended Reference Design Values

Based on the results of the testing from 2011 and 2021 the recommended allowable design values provided in 2011 remain the same. The values provided in 2011 were based on the lowest mean residual design factors that were then applied to the allowable design values published in the NDS. The lowest residual design values were based on the lowest residual values to be conservative. Since there was no reduction in property values found since 2011 based on the recent testing there is no justification to reduce the allowable design values.

Table 4a. Recommended Reference Design Values for the Pilings at DMT Berths 1 and 2, 1966 vintage.

Design Value	Reference Design Value per the NDS	Residual Value per Testing	Recommended Reference Design Value
F_b	2,400 psi	X 0.63	1,500 psi
F_c	1,200 psi	X 0.63	750 psi
E	1,500,000 psi	X 0.65	0.98 x 10^6 psi
E_{min}	790,000 psi	X 0.65	0.51 x 10^6 psi

Table 4b. Recommended Reference Design Values for the Pilings at DMT Berths 1 and 2, 1929 vintage.

Design Value	Reference Design Value per the NDS	Residual Value per Testing	Recommended Reference Design Value
F_b	2,400 psi	X 0.47	1,150 psi
F_c	1,200 psi	X 0.45	550 psi
E	1,500,000 psi	X 0.65	0.98 x 10^6 psi
E_{min}	790,000 psi	X 0.65	0.51 x 10^6 psi

4.4 Degradation Rate Curves

In order to estimate life expectancy over time and reduction in allowable stresses into the future, three degradation rate curves were developed. Rate of degradation over time is very difficult to predict, however, a simplified rate of degradation can be obtained following the concept published in "*A Study of Fracture of Wood Based on the Theory of Stochastic Process*" (Sumiya, 1963 – Wood Research 29:1-24.). An exponential rate of degradation over time is assumed for DMT since the environment has remained constant over time (i.e. the timbers have remained in a wet and submerged condition since the time of construction).

The rate of degradation is expressed as follows:

$$Y_T = Y_o e^{-BT}$$

where:

T = time in service (years),
Y_T = property at time T,
Y_o = property at T=0, and
B = degradation rate constant (calculated using historical ASTM D2555 data and current ASTM D143 test results).

Three curves are provided in Appendix II illustrating the approximate degradation over time for F_b, F_c and E based on the results of the testing at DMT. It should be noted that these are generalized curves and should be used as estimates based on the number of pilings that have been mechanically tested at DMT. The mean property values from 2011 compared to 2021 did not show any evidence of property reductions, however, this may be simply attributed to the samples that were extracted in 2011 and 2021. A general reduction in allowable stresses over time should be assumed.

Geotechnical Engineering Study, Seagirt Terminal, Berth-IV, 2700 Broening Highway, Baltimore, Maryland (DWK Contract Number 09202.P)

4.0 Bulkhead Analysis

4.1 Discussion

A pile supported wharf deck and an inboard sheet pile cut-off wall braced by the wharf deck is planned for the Berth IV construction. We understand that the existing cellular cofferdams will be left in place. A stability analysis of the cellular cofferdam has been performed by others. We understand that improvement of the materials within the cofferdam cell using stone columns is planed to improve stability of the cells. The wharf deck foundation support piles will be installed both within and outside the cellular cofferdams.

4.2 Soil Parameters for Inboard Sheet Pile Cut-off Wall

Based on the soil borings performed and the soil laboratory tests performed for this project and the available empirical relations of soil parameters to the SPT values, we have developed soil strength parameters for the design of the inboard sheet pile cut-off wall.

Estimated Design Parameters of On-Site Soils for Sheet Pile Analysis

Soil Type	Bulk Density (γ)/pcf	Effective Friction Angle (Φ')/degrees	Effective Cohesion (c')/psf
Unsurcharged Muck Slurry (MSL)	100	20	50
Stone Column Improved Muck Slurry (MSL)	115	27	50
Miscellaneous Fill (MF)	110	30	0
Recent Alluvial (O-2)	100	20	20
Stone Column Improved Recent Alluvial (O-2)	115	27	50
Basal Alluvial Sand (S-1)	115	30	0
Recent Alluvial Organic Clay/Elastic Silt (C-1)	110	24	50
Stone Column Improved Recent Alluvial Organic Clay / Elastic Silt (C-1)	115	27	50
Potomac Sand (S-3)	120	34	0
Potomac Clays (C-3)	125	24	100

These values can be used to develop the required soil pressures for analysis of the sheet pile wall. For both the cantilevered construction loading condition and the long term braced condition the stability of the wall needs to be analyzed. It is recommended that the effective soil strength parameters be used in the design of the sheet pile wall analysis as the drained condition is expected to be the critical case. A minimum construction surcharge of 200 psf is recommended to account for the general construction vehicle traffic. Additional surcharge may be required for heavier construction equipment. Two generalized design soil cross sections, one through Cell-19 and another through Cell-29 are presented as Figure Number -2 to this report. These values can be checked against the soil

124050

STRUCTURAL NOTES

I. DESIGN CODES

A. BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE (ACI-318-83) WITH COMMENTARY.

B. STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS, AASHTO, 13TH EDITION, 1983.

C. SPECIFICATION FOR THE DESIGN, FABRICATION, AND ERECTION OF STRUCTURAL STEEL FOR BRIDGES, AISC, 1978.

D. DESIGN MANUALS PUBLISHED BY THE DEPARTMENT OF THE NAVY, NAVAL FACILITIES ENGINEERING COMMAND.

II. DESIGN LOADS

A. PATAPSCO FRONTAGE

1. VERTICAL LIVE LOADS
   - A) UNIFORM LOAD
     - (1) 1000 PSF FOR SUPERSTRUCTURE
     - (2) 800 PSF FOR PILING
   - B) CONTAINER CRANE
     - (1) RAIL MOUNTED 100' GAGE.
     - (2) CAPACITY UNDER SPREADER 55 SHORT TONS.
     - (3) 130 KIP VERTICAL WHEEL LOAD @ 4.5' C-C SPACING.
     - (4) 30% IMPACT.
     - △ (5) 150 KIP UPLIFT FORCE FOR LANDSIDE CRANE TIE DOWNS. 250 KIP UPLIFT FORCE FOR SEASIDE CRANE TIE DOWNS.
   - C) TRUCK LOAD: HS 20-44
   - D) SPECIAL EQUIPMENT LOADS (AS AN OVERLOAD PROVISION): THE SUPERSTRUCTURE WILL BE ANALYZED FOR THE FOLLOWING LOADS IN ACCORDANCE WITH LOADING COMBINATION GROUP IB IN ARTICLE 3.22 OF AASHTO 13TH EDITION.
     - (1) MARATHON LETRO-PORTER MODEL 2782 W/ 251.
       - o 90,000 LBS. CAPACITY AT 48 INCHES LOAD CENTER
       - o AXLE LOAD 226,000 LBS. WITH 30% IMPACT.
       - o TIRE 98 INCHES OUTSIDE DIAMETER - 48 PLY-RATING (2 TIRES PER AXLE) AT 86 PSI.
       - o 175 INCHES FROM OUTSIDE TO OUTSIDE OF TIRES.
       - o CONTACT AREA OF TIRE 1320 SQ. INCHES.
     - (2) CLARK EQUIPMENT, CLARKLIFT CY 700.
       - o 70,000 LBS CAPACITY AT 48 INCHES LOAD CENTER.
       - o AXLE LOAD 166,500 LBS PLUS 30% IMPACT.
       - o TIRE 18 X 25 - 32 PLY TANDEM (4 TIRES) AT 138 PSI.
       - o 81 INCHES FROM CENTERLINE TO CENTERLINE OF INTERIOR TIES.
       - o 127.25 INCHES FROM OUTSIDE TO OUTSIDE OF OUTER TIRES.
       - o CONTACT AREA OF TIRE 300 SQ. INCHES.

2. LATERAL LOADS
   - A) SHIP BERTHING - 60,000 DWT VESSEL WITH 0.4 FT/SEC. VELOCITY, AND 50,000 DWT VESSEL WITH 0.5 FT/SEC. VELOCITY AT 10° APPROACH ANGLE. 585 T.E.U. CONTAINER BARGE WITH 1.0 FT/SEC VELOCITY AT 45° APPROACH ANGLE.
   - B) MOORING FORCE - 200 KIPS PER BOLLARD. at 30° (from the horizontal)
   - C) WIND LOAD ON CONTAINER CRANE - 350 KIPS ON LANDSIDE RAIL AND 100 KIPS ON SEASIDE RAIL, (BASED ON 50 PSF WIND PRESSURE WITH 1.5 GUST FACTOR).
   - D) CRANE STOPS - BASED ON 1000 TON CONTAINER CRANE TRAVELING AT SPEED OF 150 FT/MIN. MAXIMUM IMPACT FORCE = 150 KIPS.
   - △ E) STOWAGE PINS - 270 KIPS SEASIDE RAIL. 230 KIPS LANDSIDE RAIL.

B. SEA-LAND EXTENSION (TO MATCH EXISTING WHARF)

1. VERTICAL LIVE LOADS
   - A) UNIFORM LOAD
     - (1) 600 PSF FOR SUPERSTRUCTURE.
     - (2) 480 PSF FOR PILES.
   - B) CONTAINER CRANE
     - (1) RAIL MOUNTED 50' GAGE.
     - (2) 73.5 KIP VERTICAL WHEEL LOAD AT 5.0' C-C SPACING.
     - (3) 30% IMPACT.
     - (4) 150 KIP UPLIFT FORCE FOR CRANE TIE DOWNS
   - C) TRUCK LOAD: HS 20-44

2. LATERAL LOADS
   - A) SHIP BERTHING - 3.0 KLF LATERAL FORCE.
   - B) MOORING FORCE - 150 KIP PER BOLLARD
   - C) WIND LOAD ON CONTAINER CRANE - 3.5 KIP HORIZONTAL LOAD AT EACH WHEEL.
   - D) CRANE STOPS AND STOWAGE PINS - TO MATCH EXISTING WHARF.

C. LOAD COMBINATIONS

1. SUPERSTRUCTURE (DECK SLABS, CAP BEAMS, CRANE GIRDERS, ETC.)

LOAD COMBINATION	% ALLOWABLE STRESS
DEAD LOAD + LIVE LOAD (W/IMPACT)	100
DEAD LOAD + LIVE LOAD (W/IMPACT) + BERTHING FORCE + SOIL PRESSURE	100
DEAD LOAD + LIVE LOAD (W/IMPACT) + SOIL PRESSURE + MOORING FORCE + WIND LOAD	133

2. SUBSTRUCTURE (PRESTRESSED CONCRETE PILES AND H-PILES) SAME AS ABOVE EXCEPT IMPACT IS EXCLUDED.

III. MATERIAL PROPERTIES

A. REINFORCED CONCRETE, MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS.

1. f'c = 4000 PSI FOR CAST-IN-PLACE CONCRETE DECK SLABS, BEAMS, CRANE GIRDERS, PILE BENTS AND OTHER STRUCTURAL MEMBERS.

2. f'c = 5000 PSI FOR PRESTRESSED CONCRETE PLANKS AND 18" SQ. PRESTRESSED CONCRETE PILES.

3. f'c = 6000 PSI FOR 20" SQ. PRESTRESSED CONCRETE PILES AND STRUTS.

B. REINFORCING STEEL

1. DEFORMED REINFORCING BARS SHALL CONFORM TO ASTM A615, GRADE 60 (Fy =60KSI), EXCEPT TIES AND STIRRUPS, WHICH SHALL CONFORM TO ASTM A615, GRADE 40 (Fy =40KSI).

2. PRESTRESSED STRANDS SHALL BE SEVEN WIRE, STRESS RELIEVED STRANDS CONFORMING TO ASTM A416 GRADE 270K.

3. WIRE SPIRAL TIES SHALL CONFORM TO ASTM A82.

C. STRUCTURAL STEEL

1. ROLLED SHAPES AND PLATES SHALL CONFORM TO ASTM A36.

2. BOLTS AND ANCHOR BOLTS SHALL CONFORM TO ASTM A307.

3. WELDING SHALL CONFORM TO AWS, ELECTRODES SHALL BE E70XX SERIES FOR A36 STEEL, OR APPROVED EQUAL.

D. PILE CAPACITY, ALL PILES SHALL BE DRIVEN TO A MINIMUM BEARING CAPACITY AS FOLLOWS:

1. 18" SQ. PRECAST CONCRETE PILES - 140 TONS.

2. 20" SQ. PRECAST CONCRETE PILES - 145 TONS.

3. 14HP73 PILES - 130 TONS.

IV. MINIMUM CONCRETE COVER OVER REINFORCING BARS SHALL BE AS FOLLOWS UNLESS OTHERWISE SHOWN ON THE DRAWINGS:

A. CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH	3 IN.
B. CONCRETE EXPOSED TO EARTH OR WEATHER	
1. BOTTOM OF BEAMS AND SLABS	3 IN. (4 IN. BEAMS OVER PILES)
2. TOP OF BEAMS AND SLABS	2 IN.
3. SIDES OF BEAMS AND WALLS	2 IN. (3 IN. OUTSIDE FACE OF FASCIA BEAM)

V. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 3/4" UNLESS OTHERWISE SHOWN.

VI. SEE DRAWING NO. TS-9 FOR FENDER DESIGN REQUIREMENTS.

ABBREVIATIONS

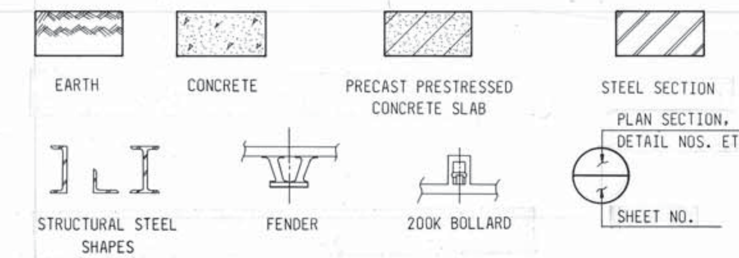
STANDARD

@	AT
ABT.	ABOUT
ADD.	ADDITION
ADDL.	ADDITIONAL
ALT.	ALTERNATE
APPROX.	APPROXIMATE
B	BOTTOM OF
BM.	BEAM
BRG.	BEARING
BETW.	BETWEEN
BOT.	BOTTOM
C.I.P.	CAST-IN-PLACE
CTR.	CENTER
	CENTERLINE
C/C	CENTER TO CENTER
CL.	CLEAR
CONC.	CONCRETE
CONT.	CONTINUOUS
CONTR. JT.	CONTRACTION JOINT
C.J.	CONSTRUCTION JOINT
DET.	DETAIL
DIAG.	DIAGONAL
DIA.Ø	DIAMETER
DIM.	DIMENSION
DO.	DITTO
DWG.	DRAWING
EA.	EACH
EL.	ELEVATION
EQ.	EQUAL
EXIST.	EXISTING
EXP.	EXPANSION
E.S.	EACH SIDE
E.J.	EXPANSION JOINT
FIN.	FINISH
F.S.	FAR SIDE
GALV.	GALVANIZE
GR.	GRADE
GRD.	GROUND
HEX.	HEXAGON
HORZ.	HORIZONTAL
JT.	JOINT
KIP.	1000 POUNDS
KSI.	KIP PER SQUARE INCH
LONGIT.	LONGITUDINAL
MAX.	MAXIMUM
MET.	METAL
MIN.	MINIMUM
N.	NORTH
N.S.	NEAR SIDE
NTS.	NOT TO SCALE
NO.	NUMBER
O.C.	ON CENTER
OPNG.	OPENING
OPP.	OPPOSITE
O/O	OUT TO OUT
PL.	PLATE
PSI.	POUND PER SQUARE INCH
LB.	POUND
P.S.	PRESTRESSED
P.C.	PRECAST CONCRETE
PROJ.	PROJECTION
R.	RADIUS
R/C	REINFORCED CONCRETE
REQD.	REQUIRED
SCH.	SCHEDULE
SECT.	SECTION
S/SHT.	SHEET
SIM.	SIMILAR
SPEC.	SPECIFICATION
SQ.	SQUARE
STD.	STANDARD
ST.	STEEL
STR.	STRUCTURAL
SYM.	SYMMETRICAL
SP.	SPACE, SPACING
STAGG.	STAGGERED
T	TOP OF THICKNESS
THK.	THICKNESS
THRU	THROUGH
TOT.	TOTAL
TS	TYPICAL STRUCTURE DETAILS
TYP.	TYPICAL
TRANS.	TRANSVERSE
VERT.	VERTICAL
W/	WITH
W/O	WITHOUT
W.L.	WATER LEVEL

STRUCTURAL

PART I	SEASIDE MARGINAL WHARF (34'-6")
PART II	PLATFORMS OVER EXISTING CELLS (73'-0")
PART III	LANDSIDE RELIEVING PLATFORMS (30'-0" OR 40'-0")
CB	CAP BEAM
EB	EDGE BEAM
FB	FASCIA BEAM (SEASIDE)
LCG	LANDSIDE CRANE GIRDER
LB	LONGITUDINAL BEAM
PS	PRESTRESSED CONCRETE SLAB
SCG	SEASIDE CRANE GIRDER
SLB	SEALAND BEAM
SLCG	SEALAND CRANE GIRDER
SLLB	SEALAND LONGITUDINAL BEAM
SLTB	SEALAND TIE-BEAM

SYMBOLS



LEGEND

□	20" SQ. PRESTRESSED CONCRETE PLUMB PILES
⊡	20" SQ. PRESTRESSED CONCRETE PLUMB INDICATOR PILES
■	18" SQ. PRESTRESSED CONCRETE PLUMB PILES
◙	18" SQ. PRESTRESSED CONCRETE PLUMB INDICATOR PILES
I	HP 14X73 STEEL 'H' PLUMB PILES
(I)	HP 14X73 STEEL 'H' PLUMB INDICATOR PILES
3:1	3 VERTICAL TO 1 HORIZONTAL BATTER PILE
W.L.	WATER LEVEL

NO.	DATE	REVISION	BY
△	3-87	NOTES CHANGE	N.B.

MARYLAND TRANSPORTATION AUTHORITY AND MARYLAND PORT ADMINISTRATION

SEAGIRT MARINE TERMINAL

MARGINAL BULKHEAD

STRUCTURAL NOTES, ABBREVIATIONS, SYMBOLS AND LEGEND

STV/LYON ASSOCIATES. ENGINEERS, ARCHITECTS & PLANNERS.

SHEET NO. S-1

MARYLAND PORT ADMINISTRATION

REVIEWED BY: Robert L. Nelson

DIRECTOR OF ENGINEERING

DATE: 10-9-86

DATE: OCT., 1986 | SCALE: NONE | CONTRACT NO. 287911 | DRAWING NO. 21

SURVEYED BY: DESIGNED BY: DRAWN BY: TRACED BY: CHECKED BY:

PF-5-12/3-21

SEAGIRT LOOP DEEPENING FEASIBILITY - PILE FIXITY AND PASSIVE WEDGE

DEPTH TO FIXITY FOR CONCRETE PILES AT SMT 1-2

df	**17.10697**	**ft**	per FHWA-NHI-16-009 = depth to fixity
E	4030.509	ksi	per ACI 318-14
Iw	0.643004	ft^4	
Es	0.11625	ksi	per FHWA-NHI-16-009
su	0.25	ksf	interpreted from soil profile
fc	5000	psi	per drawings

df =	1.4((E*Iw)/Es)^0.25		
E =	57000*fc^0.5 =	4030509 psi =	4030.509 ksi
I =	bh^3/12 =	0.643004 ft^4	for 20-inch square pile
Es =	0.465*su =	0.11625 ksi	

Horizontal Projection of Passive Wedge

phi	0 degrees	for clay soil
phi	20 degrees	drained condition (from SMT 4)
h	17.10697	for phi = 0
h	24.43129	for phi = 20 (drained condition)
h	32.17354	for phi = 34 (high phi for comparison)

h = df*tan(45-phi/2)

DEPTH TO FIXITY FOR TIMBER PILES AT CANTON MARINE TERMINAL PIER 13

df	**7.022472**	**ft**	per FHWA-NHI-16-009 = depth to fixity
E	1500	ksi	per NDS
Iw	0.049063	ft^4	
Es	0.11625	ksi	per FHWA-NHI-16-009
su	0.25	ksf	interpreted from soil profile
fc	5000	psi	per drawings

df =	1.4((E*Iw)/Es)^0.25		
E =	1500000 psi =	1500 ksi	
I =	PI*d^4/64	0.049063 ft^4	for 12-inch round pile
Es =	0.465*su =	0.11625 ksi	

Horizontal Projection of Passive Wedge

phi	0 degrees	for clay soil
phi	20 degrees	drained condition (from SMT 4)
h	7.022472	for phi = 0
h	10.02913	for phi = 20 (drained condition)
h	13.20735	for phi = 34 (high phi for comparison)

h = df*tan(45-phi/2)

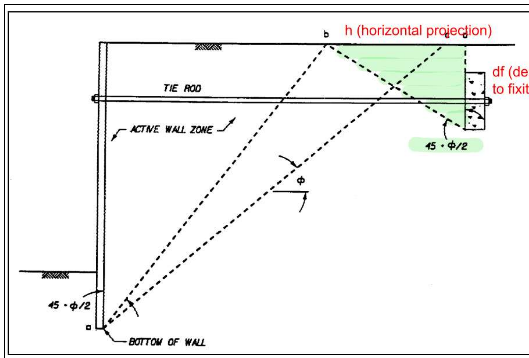


Figure 5-8. Minimum anchor - wall spacing for full passive anchor resistance in homogeneous soil

Estimated Design Parameters of On-Site Soils for Sheet Pile Analysis

Soil Type	Bulk Density (γ)/pcf	Effective Friction Angle (Φ')/degrees	Effective Cohesion (c')/psf
Unsurcharged Muck Slurry (MSL)	100	20	50
Stone Column Improved Muck Slurry (MSL)	115	27	50
Miscellaneous Fill (MF)	110	30	0
Recent Alluvial (O-2)	100	20	20
Stone Column Improved Recent Alluvial (O-2)	115	27	50
Basal Alluvial Sand (S-1)	115	30	0
Recent Alluvial Organic Clay/Elastic Silt (C-1)	110	24	50
Stone Column Improved Recent Alluvial Organic Clay / Elastic Silt (C-1)	115	27	50
Potomac Sand (S-3)	120	34	0
Potomac Clays (C-3)	125	24	100

These values can be used to develop the required soil pressures for analysis of the sheet pile wall. For both the cantilevered construction loading condition and the long term braced condition the stability of the wall needs to be analyzed. It is recommended that the effective soil strength parameters be used in the design of the sheet pile wall analysis as the drained condition is expected to be the critical case. A minimum construction surcharge of 200 psf is recommended

Table 4b. Recommended Reference Design Values for the Pilings at DMT Berths 1 and 2, 1929 vintage.

Design Value	Reference Design Value per the NDS	Residual Value per Testing	Recommended Reference Design Value
F_b	2,400 psi	X 0.47	1,150 psi
F_c	1,200 psi	X 0.45	550 psi
E	1,500,000 psi	X 0.65	0.98×10^6 psi
E_{min}	790,000 psi	X 0.65	0.51×10^6 psi

BALTIMORE HARBOR ANCHORAGES AND CHANNELS (BHAC)

MODIFICATION OF SEAGIRT LOOP CHANNEL

FEASIBILITY STUDY

FINAL INTEGRATED FEASIBILITY REPORT & ENVIRONMENTAL ASSESSMENT

APPENDIX B7:

Capacity Evaluation

Gahagan & Bryant Associates, Inc.
9008-O Yellow Brick Road
Baltimore, Maryland 21237
(410) 682-5595
info@gba-inc.com

GBA ENGINEERS ★ SURVEYORS

MEMORANDUM

Date: July 18, 2022

To: Michelle Osborne.,

From: Lauren Folkert, E.I.T.

Cc: David Bibo, Holly Miller, Brian Newbury, P.E

Re: Seagirt Feasibility Study – Capacity and Phasing Planning

INTRODUCTION

Gahagan & Bryant Associates, Inc. (GBA) was tasked to evaluate the scheduling, sequencing, and available capacity for the modifications being considered in the Baltimore Harbor Anchorages and Channels (BHAC) Modifications of Seagirt Loop Channel, Maryland Feasibility Study. This feasibility study focuses on the deepening and widening of the Seagirt Loop Channels and the deepening and expansion of a federally authorized anchorage. See Attachment A – Location Map for details of the study area. Note that the information presented in this memorandum is based on conditions known as of July 2022. Information presented can be adjusted as assumptions change.

BALTIMORE HARBOR CHANNEL IMPROVEMENTS

Seagirt Loop Channels Deepening and Widening

Seagirt Marine Terminal (SMT) is one of the Port's primary terminals. The channels that serve Seagirt Marine Terminal include the Seagirt West Access Channel, Dundalk West Access Channel, and the Seagirt–Dundalk Connecting Channel. All three (3) channels are currently federally authorized to a depth of -42' MLLW.

In 2013, SMT Berth 4 was deepened to El. -50' MLLW and neo-Panamax cranes were installed to allow larger vessels to call on the Port of Baltimore. MDOT MPA is currently performing channel improvements (deepening and widening) to allow a second 50-foot berth to come online early in State Fiscal Year (SFY) 2022. MDOT MPA maintains the Dundalk West Access Channel and Seagirt-Dundalk Connecting Channel to elevation -50 feet mean lower low water (MLLW) plus 2 feet of allowable pay overdepth (El. -50' + 2' OD MLLW) to allow deep draft vessels to call on Berths 3 and 4. MDOT MPA maintains the Seagirt West Access Channel to a depth of -45'+2' OD MLLW. To allow for 3' of under keel clearance any vessel with drafts greater than of 42' must back out of the berthing areas and exit via the 50' channels.

The proposed modifications to the Seagirt Loop channels will improve existing navigation to accommodate the increased expected traffic and larger vessel sizes calling on SMT. The modifications being studied include deepening the existing channel to EL. -50'+2' OD MLLW and adding channel wideners (EL.-50'+2' OD MLLW). The proposed wideners shown on Attachment A are based on results of a 2022 ship simulation performed at the U.S. Army Research and Development Center (ERDC). Concept volumes for the Seagirt West Loop modifications are based on both 5H:1V side slopes and are shown in Table 1. MDOT MPA in partnership with Ports America Chesapeake (PAC) will plan to develop a third 50-foot berth with improvements to SMT Berths 1 and 2. This effort will be done independently of the Seagirt Loop Feasibility Study, but the volumes for SMT Berths 1 and 2 were considered for capacity modeling.

Table 1: Seagirt West Loop Concept Volumes

Area	Volume (CY)
Seagirt West Access Channel Deepening and Widening	1,942,200
Berths 1 and 2	55,100
Total	**1,997,300**

[1]Volumes presented include 2 feet of overdepth (EL. -50' + 2' OD MLLW).
[2]Planning volumes based on surveys conducted by CENAB in February 2021 & GBA in December 2021/January 2022.

BALTIMORE HARBOR PLACEMENT SITES

The Maryland Department of Transportation Maryland Port Administration (MDOT MPA) maintains the Baltimore Harbor placement sites to accommodate federal, state, and private maintenance volumes and identified federal and state new work projects. The active placement sites for the Baltimore Harbor are the Cox Creek Dredged Material Containment Facility (DMCF) and the Masonville DMCF.

Cox Creek DMCF and Cox Creek Expanded

The existing Cox Creek site includes a DMCF as well as wetland and upland areas. The current dikes are constructed to El. +36' MLLW. MDOT MPA is actively expanding the Cox Creek DMCF. The Cox Creek Expanded (CCE) project consists of raising the existing dikes to El. +60' MLLW and expanding the facility onto the upland portion of the property with a contractual completion date of May 2024. This memorandum assumes that the dike raising milestones shown in Table 2 are met. The milestone dates and elevations up to El. +60' MLLW are assumptions that have been provided by the Cox Creek design team during harbor capacity planning meetings and are subject to change throughout construction.

Table 2: Cox Creek Dike Raising Schedule

State Fiscal Year[1]	Dike Crest Elevation (FT, MLLW)	Maximum Filling Elevation[2] (FT, MLLW)	Capacity (mcy)[4]
Existing	36	33	5.0
2023 (January)	44	41[3]	6.3
2024 (May)	60	57	14.8

[1]Milestone dates are based on information provided at Harbor Planning Meetings. The dates noted for the El. +44 and El. 60 dikes are based on the Cox Creek dike raising to El. +60 dike construction contract required completion dates. The timing does not account for the Maryland Department of the Environment permitting process to get raised freeboards approved.
[2]Maximum filling elevation based on freeboard requirements.
[3]The +41 filling elevation would require raising the north south cross dike. Without any modifications the Cox Creek construction team will only seek permit approvals for a filling elevation of +38.
[4]Capacity values shown are subject to change as preliminary designs and model assumptions are refined.

Masonville DMCF

The existing Masonville DMCF dikes are currently constructed to El. +18′ MLLW. MDOT MPA will begin construction later in 2021 for the raising of the dikes beyond El. +18′ MLLW incrementally to El. +30′ MLLW. This memo assumes that the dike raising milestones shown in Table 3 are met. The available capacity estimates associated with the future dike raisings of Masonville (based on preliminary designs) are also shown in Table 3. Note that the available capacities shown in are subject to change as preliminary designs and model assumptions are refined.

Table 3: Masonville Dike Raising Schedule

State Fiscal Year	Dike Crest Elevation (FT, MLLW)	Maximum Filling Elevation[1] (FT, MLLW)	Capacity (mcy)[3]
2023	18 (with BDW[2])	15	6.0
2025	34	21	7.1
2026	30	27	8.2

[1]Maximum filling elevation based on 3′ on required freeboard.
[2]Base Dike Widening (BDW)
[3]Capacity values shown are subject to change as preliminary designs and model assumptions are refined.

Discussion

Attachment B shows a Baltimore Harbor Dredged Material Containment Facilities Placement Plan for SFY 2022 through SFY 2027. The SFY 2022 cumulative placement values shown for Masonville and Cox Creek are based on actual placement quantities. The projected quantities shown from SFY 2023 through SFY 2027 are based on the planned operations and maintenance (O&M) and new work projects. Note that planned volumes from SFY 2023 to SFY 2027 accounts for federal, state, and private projects.

The remaining Cox Creek and Masonville capacities shown in Attachment B assume the dike raising milestones presented in Table 2 and Table 3 are met. The cumulative cell volumes and capacities displayed for each dike raising milestone are based on preliminary designs. Numbers are subject to change as preliminary designs and model assumptions are refined.

The placement plan shows the quantity associated with the Seagirt West Loop deepening and widening placed in Cox Creek over two (2) inflows. Phase 1 dredging is assumed to deepen the channel and channel wideners to El. -46′ + 2′ OD MLLW (1,175,600 CY) in SFY 2026. Phase 2 dredging is assumed to deepen the channel and channel wideners to El. -50′ + 2′ OD MLLW (766,600 CY) in SFY 2027. It is also assumed that the state will deepen SMT Berths 1 and 2 to El. -50′ + 2′ OD MLLW (55,100 CY) in SFY 2027.

Conclusions

Phase 1 and Phase 2 Seagirt West Loop inflows can be placed in Cox Creek.

- The Seagirt West Loop Deepening and Widening inflow requires all El. +60′ MLLW dike raising to be complete and the borrow area ready to accept dredged material. If the dike raising to El. +60′ MLLW schedule slips, the Seagirt West Loop inflow will need to be deferred until the dike raising is completed.
- If Cox Creek dike raising to El. +60′ MLLW construction is completed when currently planned, Seagirt West Loop deepening and widening can be completed by SFY 2027.

APPENDICES

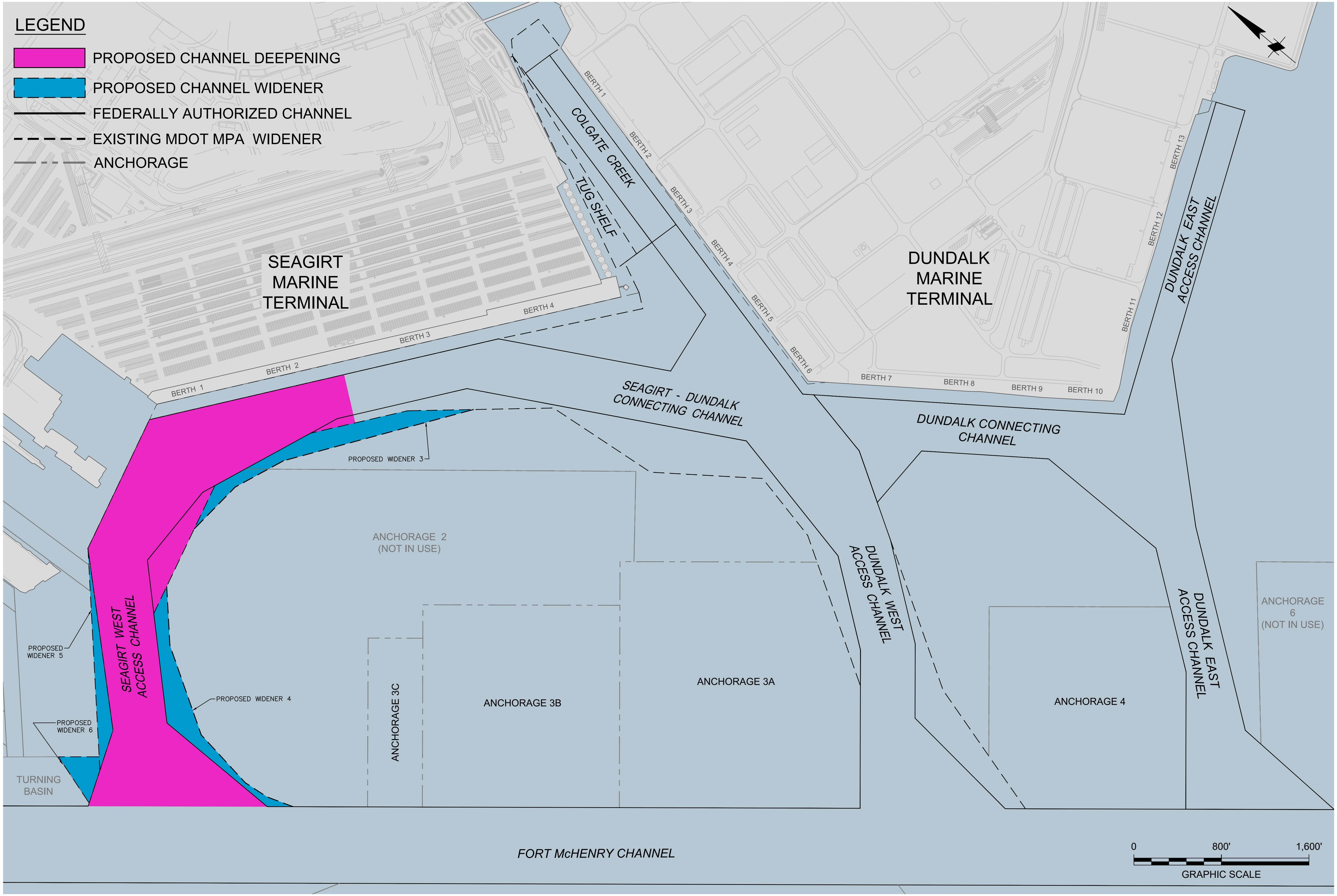
- Appendix A – Harbor Map
- Appendix B – Baltimore Harbor Dredged Material Containment Facilities Placement Plan

Gahagan & Bryant Associates, Inc.
9008-O Yellow Brick Road
Baltimore, Maryland 21237
(410) 682-5595
info@gba-inc.com

GBA
ENGINEERS ★ SURVEYORS

APPENDIX A

Location Map



P:\Seagirt_Dundalk\2020_Seagirt_Loop_Feasibility_Study\04_Engineering\DWG\5) Harbor Map\HARBOR_MAP_2022.dwg

Mark	Description	Date	Appr.	Mark	Description	Date	Appr.

MARYLAND PORT ADMINISTRATION
HARBOR DEVELOPMENT

GBA ENGINEERS ★ SURVEYORS
9008 Yellow Brick Rd.
Unit O
Baltimore, MD 21237
Phone (410) 682-5595

Designed by: –
Dwn by: DCM
Ckd by: VPK
Reviewed by: LEF
Submitted by: LEF
Date: JULY 2022
Rev.
Drawing Name : HARBOR MAP 2022
Scale: AS SHOWN
Plot scale: 1 = 1

SEAGIRT FEASIBILITY STUDY
CAPACITY AND PHASING PLANNING

LOCATION MAP

SEAL

ATTACHMENT A

Gahagan & Bryant Associates, Inc.
9008-O Yellow Brick Road
Baltimore, Maryland 21237
(410) 682-5595
info@gba-inc.com

GBA
ENGINEERS ★ SURVEYORS

APPENDIX B

Baltimore Harbor Dredged Material Containment Facilities Placement Plan

Baltimore Harbor Dredged Material Containment Facilities Placement Plan

(Actual Placement Quantities Through SFY 2022 and Projected Quantities Thereafter)

	Milestone	Cell Volume[2,3] (MCY)	Cumulative Cell Capacity[4] (MCY)	SFY2022	SFY2023[7]	SFY2024	SFY2025	SFY2026	SFY2027
	El. +18' MLLW w/ BDW	4.7	6.0	78,400	442,600	285,000			
	El. +24' MLLW	5.5	7.1				378,000		
	El. +30' MLLW	6.4	8.2					70,000	560,000
	El. +36' MLLW W/ BDW	3.9	5.0	700,000	516,000				
	El. +44' MLLW (January 2023)	4.9	6.3			575,000			
	El. +60' MLLW (April 2024)	11.5	14.8				775,000	1,835,600	921,700

	SFY2022	SFY2023	SFY2024	SFY2025	SFY2026	SFY2027
Cumulative Placement Total[5,6]	7.9	8.9	9.8	10.9	12.8	14.3
Cumulative Placement MV	4.0	4.5	4.8	5.1	5.2	5.8
Cumulative Placement CC	3.9	4.4	5.0	5.8	7.6	8.5
Remaining MV Capacity	2.0	1.5	1.2	2.0	3.0	2.4
Remaining Capacity in %	32.8%	25.4%	20.7%	27.6%	36.5%	29.7%
Remaining CC Capacity	1.1	0.6	1.3	9.0	7.2	6.3
Remaining Capacity in %	22.0%	11.7%	20.8%	61.0%	48.6%	42.4%

(yellow)	Capacity Adjustment due to dike raising milestone
(green)	Inflow includes quantity associated with Seagirt West Loop deepening and widening.

Notes:

1) State Fiscal Year (SFY)

2) Cell Volumes for Masonville to El. +18' MLLW based on AD survey. Cell capacities for future dike milestones are based on preliminary designs.

3) Cell Volumes for Cox Creek are based on preliminary designs.

4) Cumulative cell capacities are determined by with the formula Cell Capacity = Cell Volume /[(1 + e_{final})/(1 +e_{cut})]

e_{cut}= in-situ void ratio = 6.0

e_{final}= steady state void ratio = 4.5

(1 + e_{final})/(1 +e_{cut}) = steady state volume occupied (assume 0.78 steady state volume occupied at Masonville and Cox Creek)

5) Cumulative material placed at Masonville and Cox through SFY2022 is based on actual placement quantities.

6) Cumulative material placed at Masonville and Cox Creek between SFY 2023 through SFY 2027 are based on currently planned new work and maintenance projects.

7) The SFY 2023 volume placed at Cox Creek includes the USACE 2023 maintenance dredging base contract amount of 500 KCY. Contract includes options for up to 700 KCY.

8) The quantity for the Seagirt West Loop Modifications is based on 5H:1V slopes. Seagirt West Loop material is assumed to be placed in two (2) inflows; 1,175,600 CY in SFY2026 and 766,600 CY in SFY2027.

9) Placement plan assumes Seagirt Berths 1 and 2 will be deepened in SFY 2027 (55,100 CY).

10) Placement plan assume 660,000 CY of maintenance material is placed in Cox Creek in SFY 2026 and 100,000 CY of maintenance material is placed in Cox Creek in SFY 2027 in addition to the Seagirt West Loop new work material.