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Memorandum

To: North Carolina State Port Authority

From: Gwen Lawrence
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Subject: Full Mission Ship Simulations - Turning Basin Expansion

Project: Turning Basin Expansion - 2019

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The North Carolina State Ports Authority is currently evaluating expanding the existing turning basin for the Port of Wilmington to accommodate Ultra Large Container Vessels (ULCV) (i.e., up to 14,000 TEU). As part of this effort full bridge navigation simulations were performed at the Maritime Institute of Technical and Graduate Studies (MITAGS) on November 14, 2018. The purpose of this simulation study was to determine the turning basin dimensions required to safely maneuver a ULCV. These maneuvers evaluated the turning basin maneuver on the existing turning basin and three alternate turning basins. The characteristics of the ULCV model used for this simulation study are listed in Table 1. These simulations were conducted by the local Wilmington docking pilots, Clifton Nelson (Hanover Docking Pilots) and Glenn Tuberville (Wilmington Docking Pilots).

Table 1. Deep Draft Vessel Model

Attribute	14,000 TEU Container Vessel
Design Vessel	MSC Kalina
LOA (ft)	1200.8
Beam (ft)	168.0
Draft (ft)	38
Wind Area [ft^2]	152,535
Engine Power [kW]	67,444
Number of Bow Thrusters	2
Bow Thruster Power [kW]	1,700

This memorandum documents further observations made by Moffatt & Nichol during this ship simulation study which is discussed in detail in "Full Mission Ship Simulation Port of Wilmington ULCV Simulation Study – Turning Basin" (MITAGS, 2019).

The first basin that was evaluated was the existing turning basin. The three simulations evaluating the existing basin simulations were run under mild environmental conditions which included wind speeds of 10 knots or less and the tidal currents either at slack water or prior to peak conditions. For all of the turning basin simulations the pilot had four tugs to use at the pilots' discretion. The four tugs available were a 60 ton ASD tug, a 53 ton ASD tug, and two 32 ton conventional tugs. Of the three simulations only one simulation was performed without a grounding of the vessel. The simulation that successfully completed the turning maneuver required simultaneous use of 100% of the available tug power, 100% bow thruster use and maximum rudder angle. As a result, there was limited to no reserve power and maneuverability in the case of an emergency. Additionally, from the pilot feedback forms for these simulations, one of the two docking pilots stated that they would not perform a similar transit in the real-world without the removal of the derelict Chevron Pier and an expansion of the turning basin. The second docking pilot stated that he would perform a similar transit in the real-world. From these simulations, it appears feasible to perform this maneuver under mild environmental conditions in the short term prior to the turning basin expansion if the Chevron Pier was removed. For this maneuver upgrades to the tug fleet would be needed so that the pilots had reserve power for emergency situations.

The second basin simulated was the Basin 1 Design, which has the smallest dimensions of the three design configurations. This design alternative is an enlargement of the existing turning basin on the east side. In total the maximum width of the turning basin would be 1,524 ft wide at a dredge depth of -42 ft MLLW. The enlargement on the east side of the turning basin would be 500' in length. Additionally, with this alternative a 684 ft length toe wall is included to stabilize the east bank of the river which will be marked by lighted king piles. For the first alternative the maximum turning diameter would be approximately 1,476 ft, which would provide a ratio of 1.23 times the length of the 14,000 TEU vessel simulated. Two simulations were performed on this alternative. Of the two simulations, for only one simulation did the vessel remained inside the turning basin boundaries. During the second simulation, the vessel ran approximately 10 feet outside the turning basin boundary on the southeast corner. The environmental conditions for these simulations were moderate which included wind speeds of 10-15 knots and tidal currents prior to peak flood. Similar to the maneuvers in the existing turning basin, to complete the maneuver safely it required simultaneous use of 100% of the available tug power, 100% bow thruster use and maximum rudder angle. Therefore, there was limited to no reserve power in the case of an emergency. Similar to the existing basin one pilot would feel comfortable performing the transit in the real-world while one stated further expansion was needed. For this basin, upgrades to the tug fleet would be needed so that the pilots had reserve power for emergency situations.

Four simulations were performed on Design Basin 2. Design Basin 2 was the same as Design Basin 1, but further extended the east side of the turning basin to a length of 1,000 ft providing an allowance for vessel drift due to wind and currents. Similar to the first design alternative, the maximum width of the turning basin would be 1,524 ft wide at a dredge depth of -42 ft MLLW. This alternative would allow for a turning diameter of 1,524 ft which would provide a ratio of 1.27 times the length of the 14,000 TEU vessel. This alternative would include a 1,416 ft length toe wall to stabilize the east bank of the river which will be marked by lighted king piles. The environmental conditions for these simulations were high which included wind speeds of 15-20 knots and tidal currents of peak flood and ebb currents. Three of the four simulations were performed within the basin boundaries. One of the simulations ran approximately 75 feet outside the southeast corner of the basin. However, for this simulation the pilot only used three tugs. For three of the four simulations the pilot had reserve power in either tug power or bow thruster. For the simulation where the tug power, bow thruster, and rudder angle were maxed out, the pilot stated he felt the simulation could have been performed safely using 50-75% of the tug power. Both docking pilots felt that this basin was sufficient to safely turn a ULCV and would perform the maneuver in the real-world.

The last basin simulation, Design Basin 3, was the same as Design Basin 2 but included a widening taper on the southwest side of the turning basin. This additional widening was proposed to allow improved passage of the vessel past moored vessels at Berths 1 and 2 while completing the turn. For these simulations Panamax sized chemical tankers (LOA = 183 m, beam = 32.2 m) were moored at Berth 1 and 2 to evaluate the ability of the ULCV to pass these berths. Of the three simulations, two of the simulations were successfully performed within the turning basin boundaries. For the one vessel that ran aground on the eastern edge, the pilot thought vessel would run ahead more than it did. For these three simulations there was always reserve power available from either the tug power or bow thruster in case of an emergency. Both docking pilots preferred the additional widening on the west side of the turning basin which gave them additional maneuvering area and would allow unrestricted use of Berths 1 and 2 when a ULCV calls at the Port of Wilmington.

From this simulation effort, either Design Basin 2 or 3 would be the recommendation for the turning basin expansion with the latter required for unrestricted use of all the berths at the Port of Wilmington, while the former will limit access to Berths 1 and 2 when the ULCV is being turned. Additionally, turns within these basins were able to be performed under high environmental conditions with reserve maneuvering power from tugs and vessel.

References

Maritime Institute of Technical and Graduate Studies Simulation Engineering Department (2019). Full Mission Ship Simulation Port of Wilmington ULCV Simulation Study – Turning Basin. Final report on the ship simulation study performed on November 14, 2018. Submitted to North Carolina State Port Authority.