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Full Mission Ship Simulation Port of Wilmington ULCV Simulation Study – Turning Basin

Provided by
The Maritime Institute of Technology and Graduate Studies (MITAGS)

November 14, 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.

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RFP Name	**Port of Wilmington ULCV Simulation Study**
Project Location	Wilmington, NC
Purpose	Determine the turning basin dimensions required to safely maneuver a Ultra Large Container Vessel (ULCV)
Customer	Moffatt and Nichol
Customer Representative	Ms. Gwen Lawrence, Moffatt and Nichol
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	January 28, 2019
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.

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1. BACKGROUND AND PURPOSE

With the recent opening of the expanded Suez Canal and nearly completed expanded Panama Canal, The Wilmington Port Authority is evaluating the feasibility of handling larger containerships ships at the Port of Wilmington, North Carolina. To assist in this determination, the Port desires a full-mission ship simulation study to determine the feasibility of handling the ultra large post Panamax containerships (ULCV) from sea to the main container terminal in Wilmington including the turning maneuver.

The turning basin study was conducted at the Maritime Institute of Technology and Graduate Studies (MITAGS) on November 14, 2018.

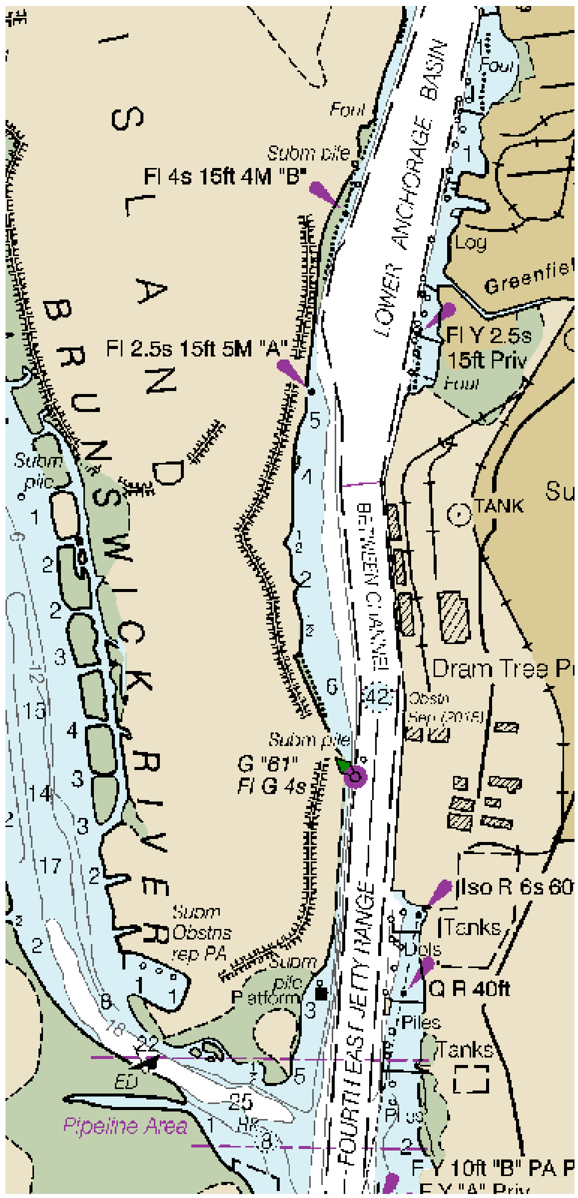


Figure 1-1: Site location (NOAA chart 11537)

1.1 OBJECTIVES

The following objectives were evaluated throughout the study:

- Determine the turning basin dimensions required to safely maneuver the 14,000 TEU container vessel under typical environmental conditions
- Evaluate existing and proposed aids to navigation (ATONs) for the turning basin designs

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 at 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. Only auto-tugs were used for this turning basin simulation effort.

1.3 MITAGS SIMULATION FACILITIES AND PROJECT TEAM

MITAGS used a full-mission ship simulator (FMSS) for the study (November 14, 2018).

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 Wilmington, NC Docking Pilots, MITAGS provided an experienced maritime pilot (Captain Bergin). MITAGS also provided an experienced simulator operator (Second Mate Catie Gianelloni). 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.
Second Mate Catherine Gianelloni 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.

Table 1-2: Participants

Attendees	Company
Captain Clifton Nelson	Hanover Docking Pilots
Captain Glenn Turberville	Wilmington Docking Pilots
Ms. Gwen Lawrence	Moffatt and Nichol
Mr. Jeff Oskamp	Moffatt and Nichol
Mr. Eric Smith	Moffatt and Nichol

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 primary vessel used in this study was the *Kalina* (14,000 TEU). The specific ship parameters are listed in Table 2-1. In each run, four tugs were available. All of the tugs were controlled by the simulator operator using AutoTug mode. The following tugs were used in each simulation - one 60 t ASD tug, one 53 t ASD tug, and two 32 t conventional tugs. Table 2-2 shows the specific vessel parameters for each tug. The pilot cards are available for all vessels in Appendix A.

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
Model Name	Container Kalina_Wilmington
Displacement Loaded (tons)	156,302
Length (m)	366
Beam (m)	51.2
Trim	Even
Load Draft (m)	11.58
Engine (kW)	2 x 73,340
Propeller	Fixed pitch
Bow Thrusters	2 (1700 kW)

Table 2-2: Tug models

Parameters	Z-Tech 60	Z-Drive Tug 1	Conventional Twin Screw 5
Length (m)	30	25.3	32
Beam (m)	12	10.4	9.8
Bow Draft (m)	5	2.7	3
Stern Draft (m)	5	3.9	4.3
Bollard Pull (t)	60	53	32
Modeled Via	Tug 1	Tug 2	Tug 3 & Tug 4

3. DATABASE DEVELOPMENT

3.1 BATHYMETRY

Moffatt and Nichol and MITAGS programmed and validated an 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. Moffatt and Nichol and 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. The authorized depth for the ranges leading up to the turning basin and the turning basin itself is 42 ft MLLW. Portions of the channel and turning basin that were shallower than the authorized depth were deepened to 42 ft.

Four turning basin alignments were used in these simulations – the existing turning basin, Basin 1, Basin 2, and Basin 3 and are shown below. During the annual dredging of the existing turning basin, an additional area is dredged on the eastern side of the basin that is not denoted on the NOAA navigational chart. To account for this additional dredging the USACE February 2018 post-dredge survey was incorporated into the bathymetry. The simulator operator roughly drew in a line denoting the 42 ft MLLW contour as shown in Figure 3-1.

Figure 3-1: Turning Basin Existing and Basin 1 designs (provided by Moffatt and Nichol)

Figure 3-2: Turning Basin 2 & 3 designs (provided by Moffatt and Nichol)

3.2 ENVIRONMENTAL PARAMETERS

3.2.1 WIND PARAMETERS

Wind speeds ranging from 5 kts to 20 kts were simulated from either the SW or the NNE. The wind was simulated as a static wind.

3.2.2 CURRENTS/TIDE

Several current regimes were used including slack, 1 hour before maximum flood, maximum flood, 1 hour after maximum flood, and maximum ebb. The maximum flood and maximum ebb timing was based on the currents in the middle of the turning basin.

A tide of 2.5 ft was added to MLLW for all of the simulations.

3.2.3 WAVES

No waves were used in the turning basin simulations.

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 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.

4.1 SWEPT PATH ANALYSIS

In this section, each run's swept path is plotted. Each run is shaded according to its speed over ground throughout the run where dark red represents the highest speed and dark green represents the lowest speed in the run. Tug 1 (60 t ASD), Tug 2 (53 t ASD), Tug 3 (32 t conventional), and Tug 4 (32 t conventional) are represented by the turquoise, purple, pink, and bright blue tugs respectively as shown in the legend. The light blue lines show the existing channel boundaries and turning basin design. Each ship and tug are plotted in 45 second intervals. The figures show the corresponding turning basin design that was used for each run. As the plots show, the additional space provided from the turning basin designs was used. The white vessels represent Panamax-size chemical tankers (LOA = 183 m, beam = 32.2 m). In all of the runs, two of these vessels were berthed at Berths 3 and 5. In Runs 29 through 32, 2 additional vessels were added at Berths 1 and 2.

Table 4-1: Test matrix

Run	Pilot	Dir.	Turning Basin Design	Water Level	Wind	Current	Notes
21	Cliff Nelson	In	Existing	MLLW + 2.5 ft	5 kts, SW (225°)	Slack	Used additional space on east side
22	Glenn Turberville	In	Existing	MLLW + 2.5 ft	10 kts, SW (225°)	1 Hour Before Max Flood	Grounded; outside of turning basin on west side
23	Glenn Turberville	In	Existing	MLLW + 2.5 ft	10 kts, SW (225°)	1 Hour Before Max Flood	Grounded; outside of turning basin on west side
24	Cliff Nelson	In	Basin 1	MLLW + 2.5 ft	10 kts, SW (225°)	1 Hour Before Max Flood	Used additional space on east side
25	Glenn Turberville	In	Basin 1	MLLW + 2.5 ft	15 kts, SW (225°)	1 Hour After Max Flood	Used additional space on east side
26	Glenn Turberville	In	Basin 2	MLLW + 2.5 ft	15 kts, SW (225°)	1 Hour After Max Flood	Used additional space on east side
27	Cliff Nelson	In	Basin 2	MLLW + 2.5 ft	15 kts, SW (225°)	Max flood	Used additional space on east side
28	Glenn Turberville	In	Basin 2	MLLW + 2.5 ft	20 kts, SW (225°)	Max flood	Used additional space on east side
29	Cliff Nelson	In	Basin 2	MLLW + 2.5 ft	20 kts, NNE (22.5°)	Max Ebb	Used additional space on east side
30	Glenn Turberville	In	Basin 3	MLLW + 2.5 ft	20 kts, NNE (22.5°)	Max Ebb	Grounded; outside turning basin on east side
31	Glenn Turberville	In	Basin 3	MLLW + 2.5 ft	20 kts, NNE (22.5°)	1 Hour Before Max Flood	Used additional space on east side
32	Cliff Nelson	In	Basin 3	MLLW + 2.5 ft	20 kts, NNE (22.5°)	Max Ebb	Used additional space on east and west side

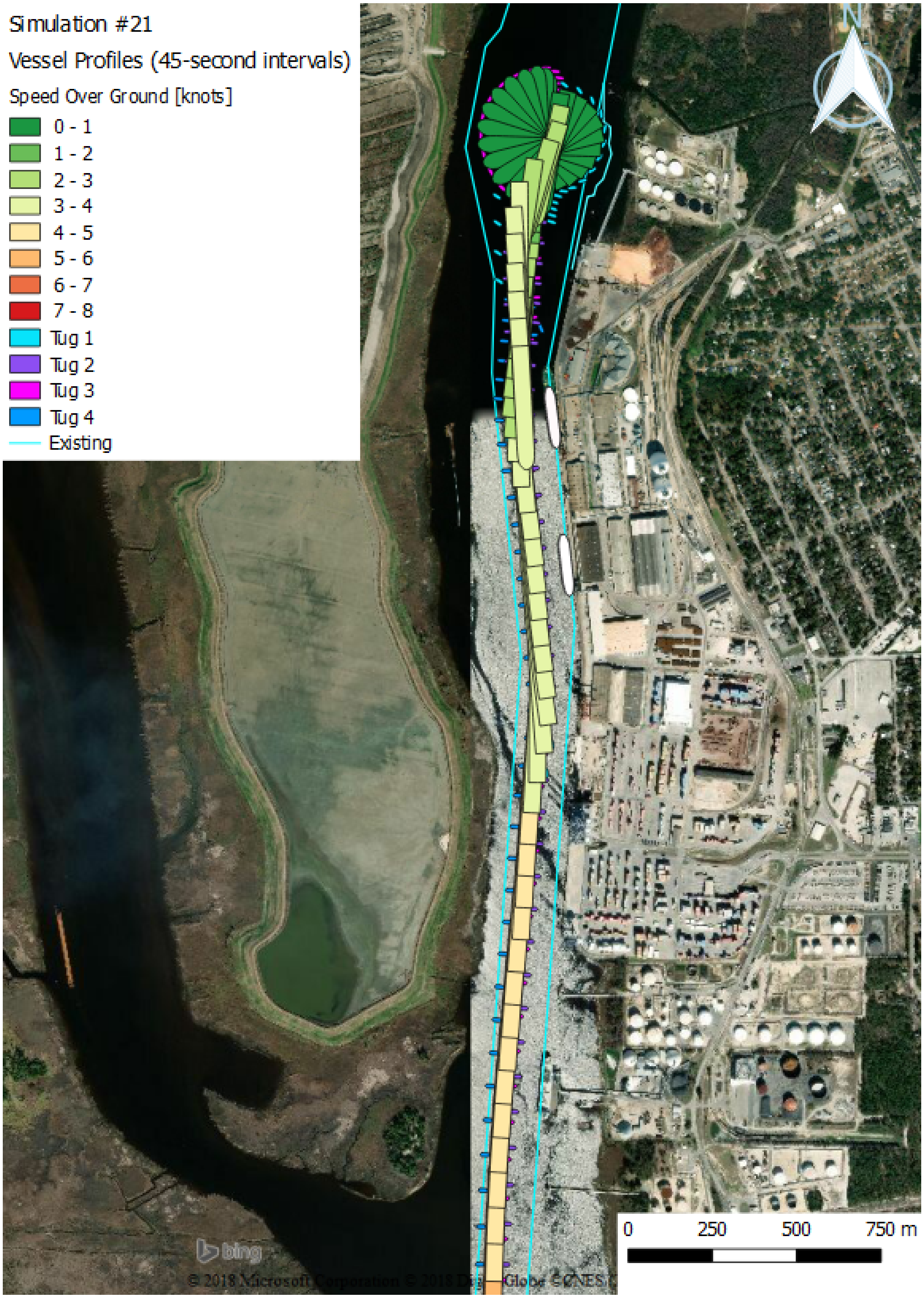


Figure 4-1: Run 21 – swept path

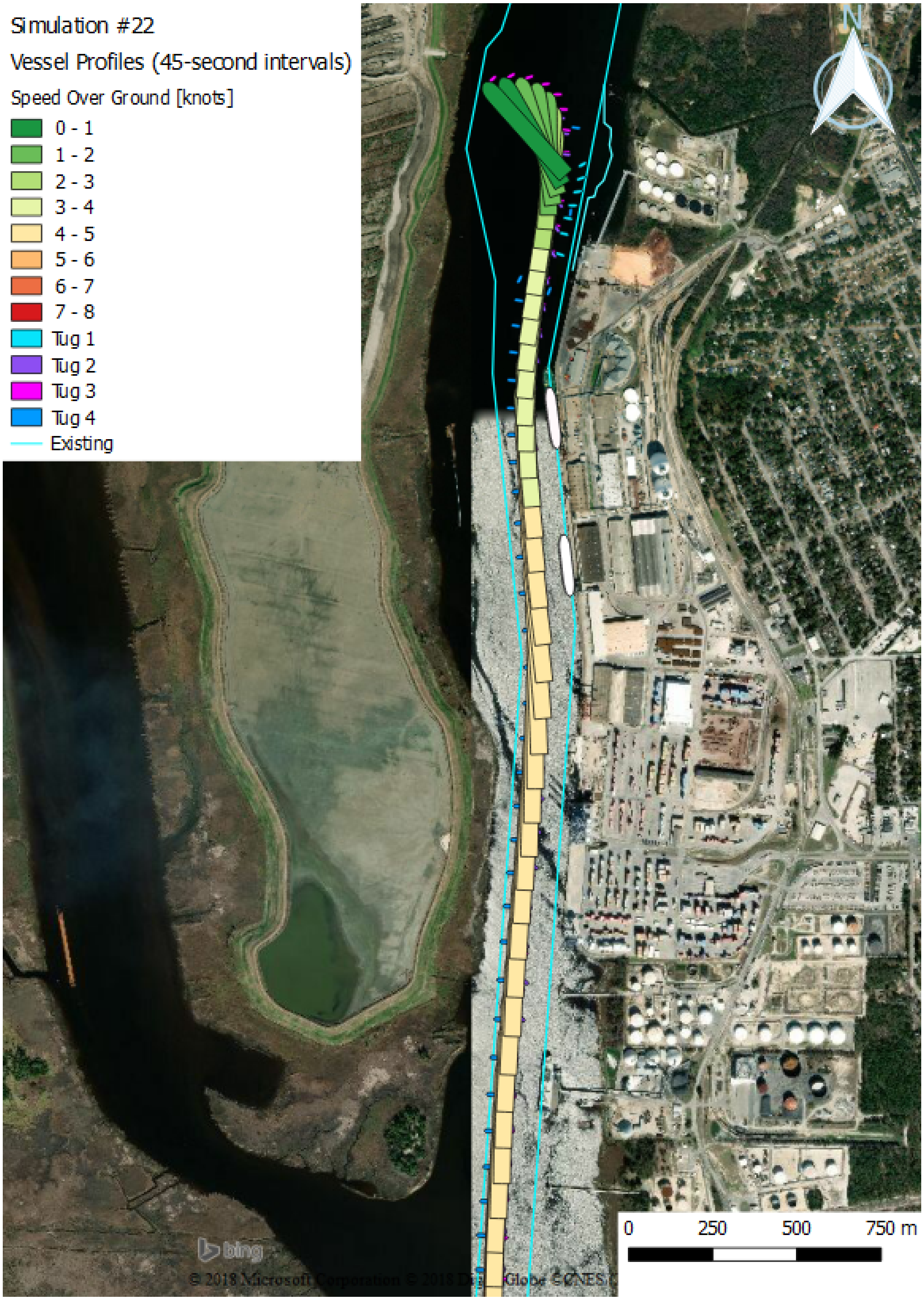


Figure 4-2: Run 22 – swept path

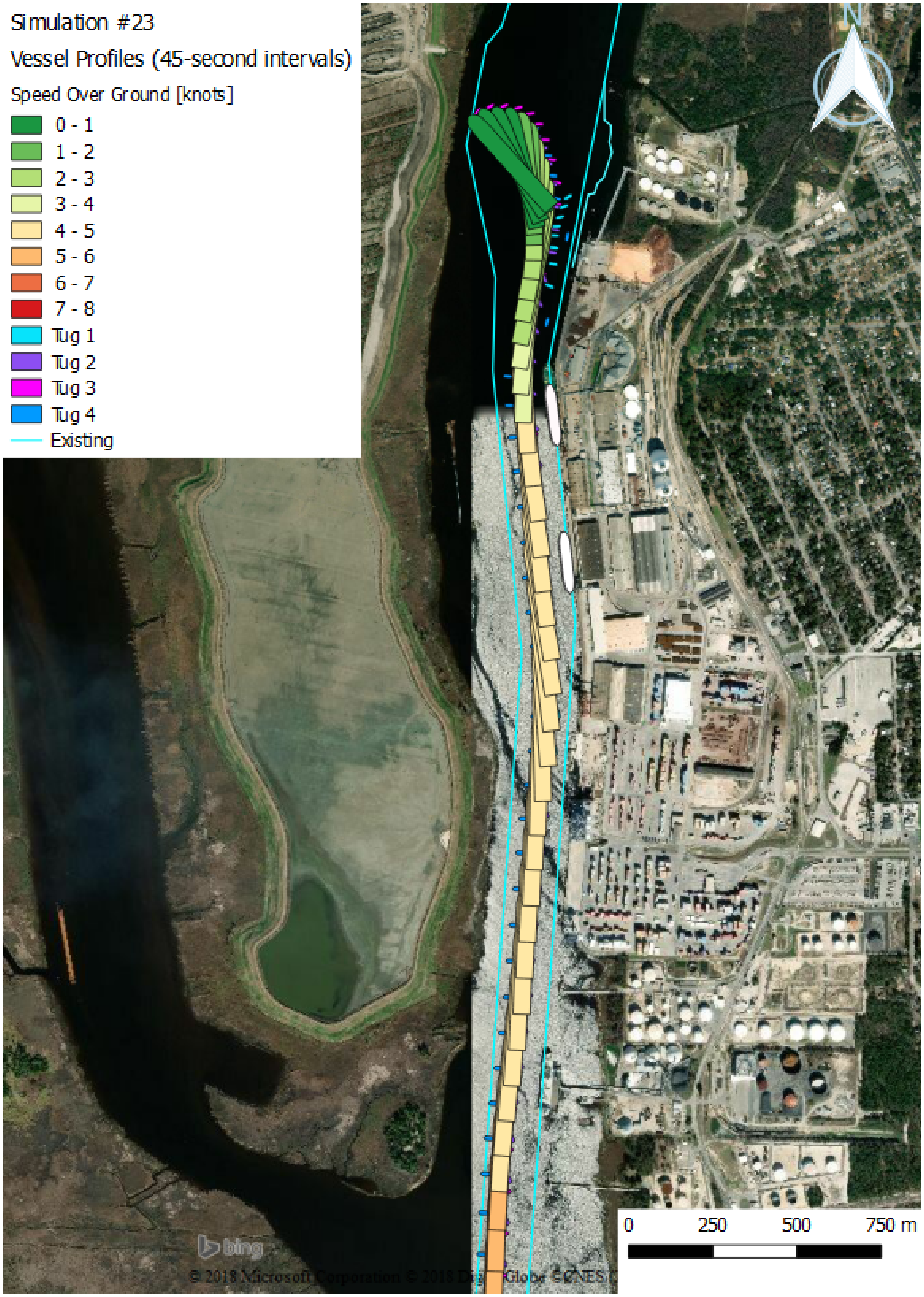


Figure 4-3: Run 23 – swept path

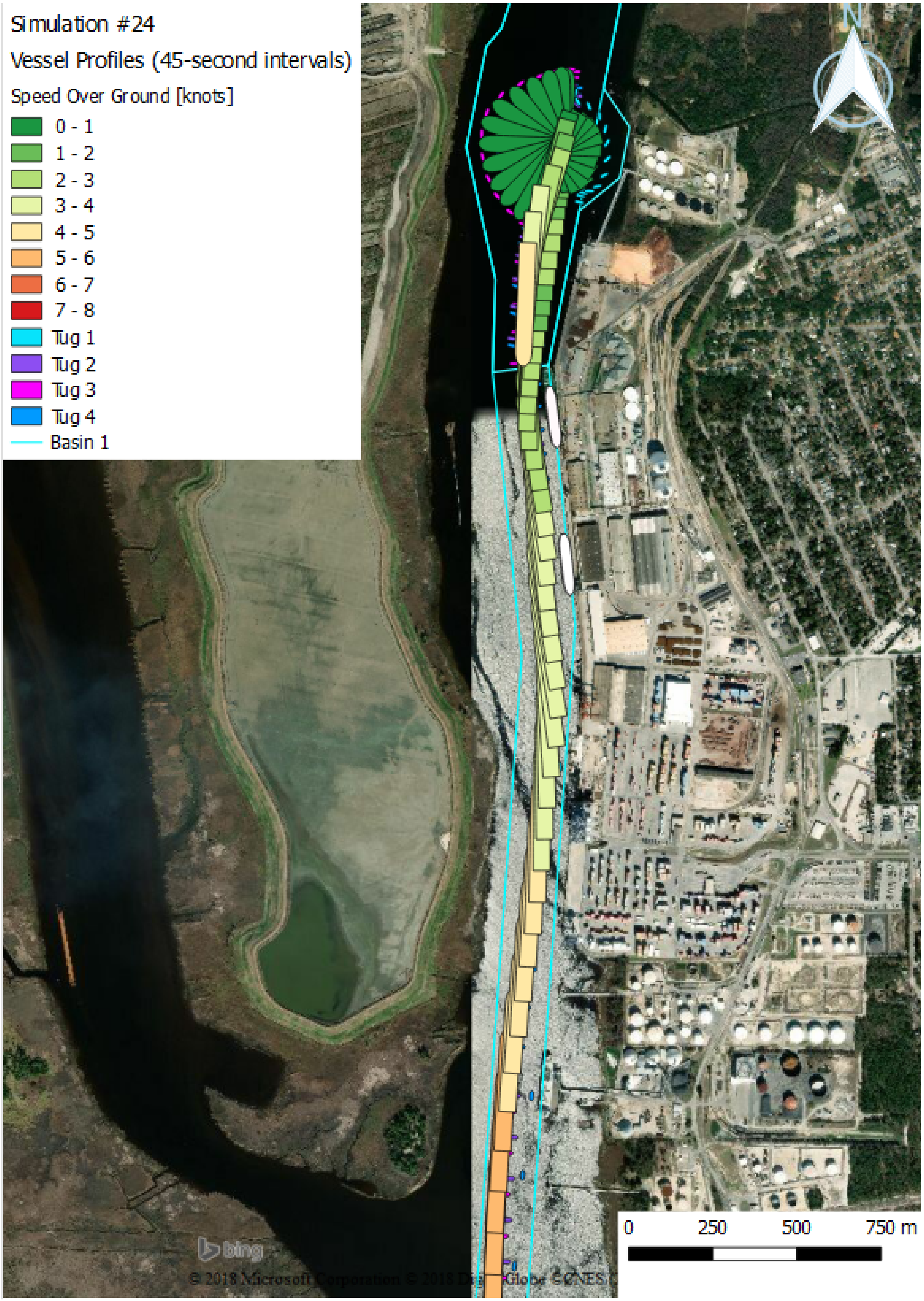


Figure 4-4: Run 24 – swept path

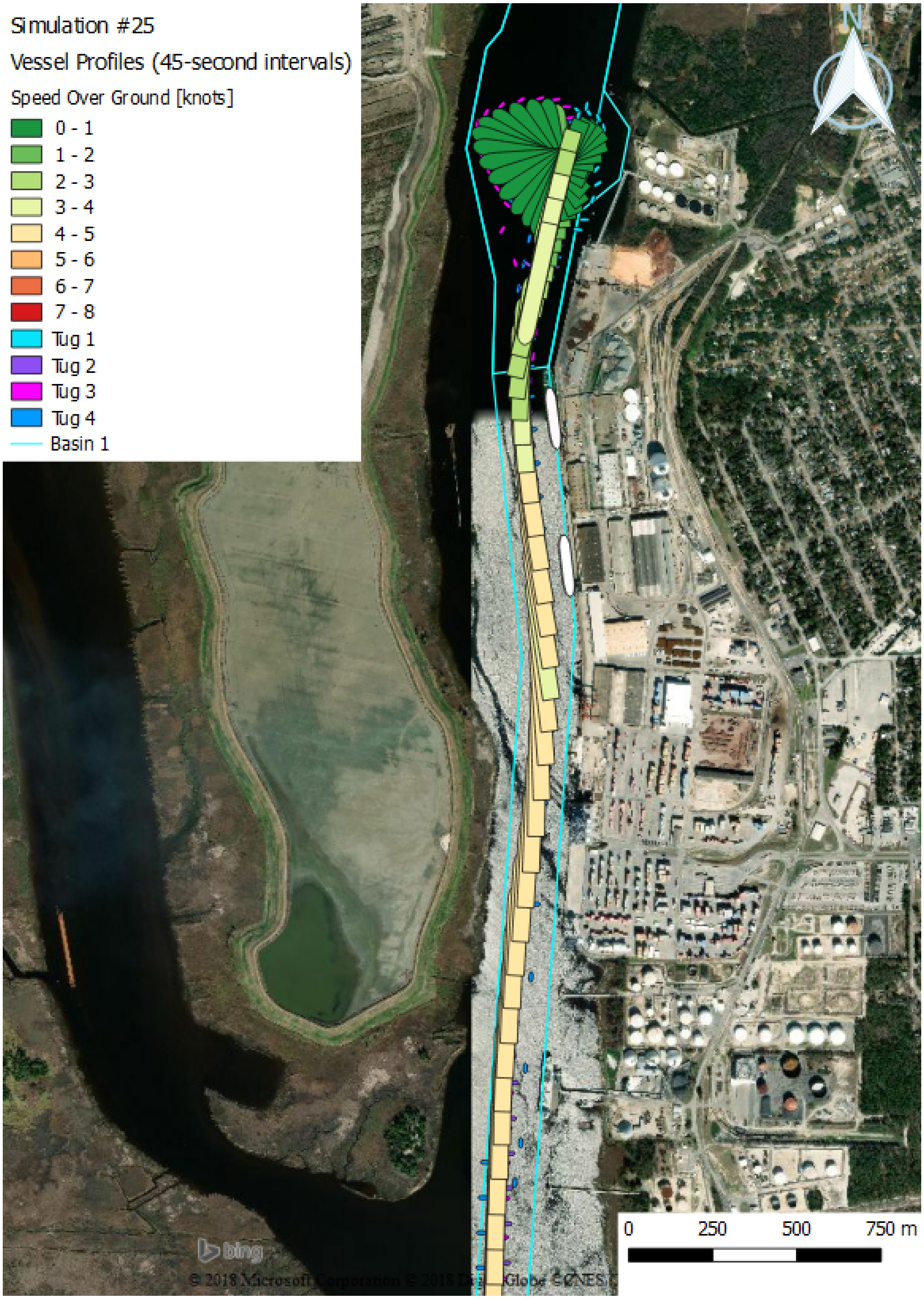


Figure 4-5: Run 25 – swept path

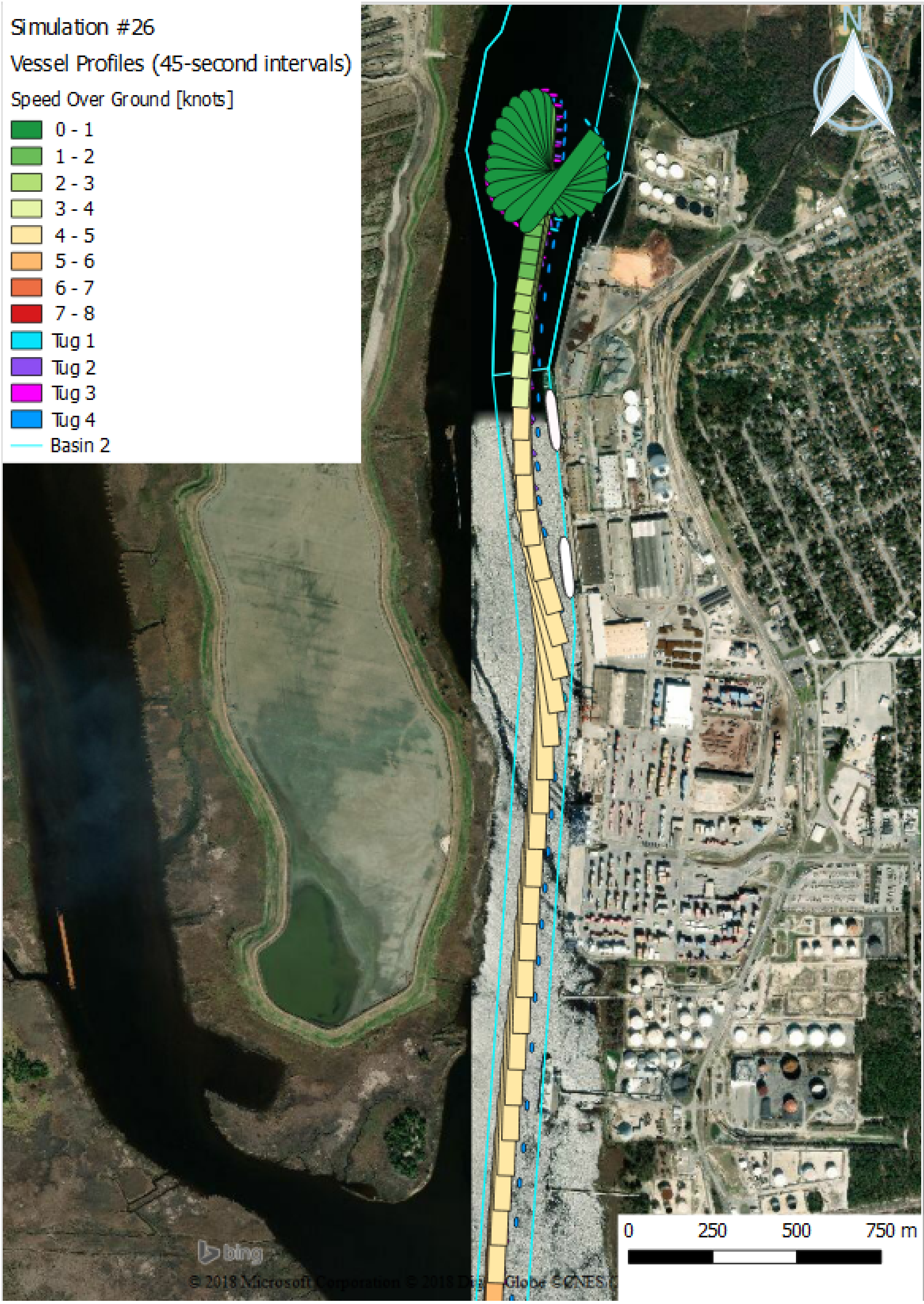


Figure 4-6: Run 26 – swept path

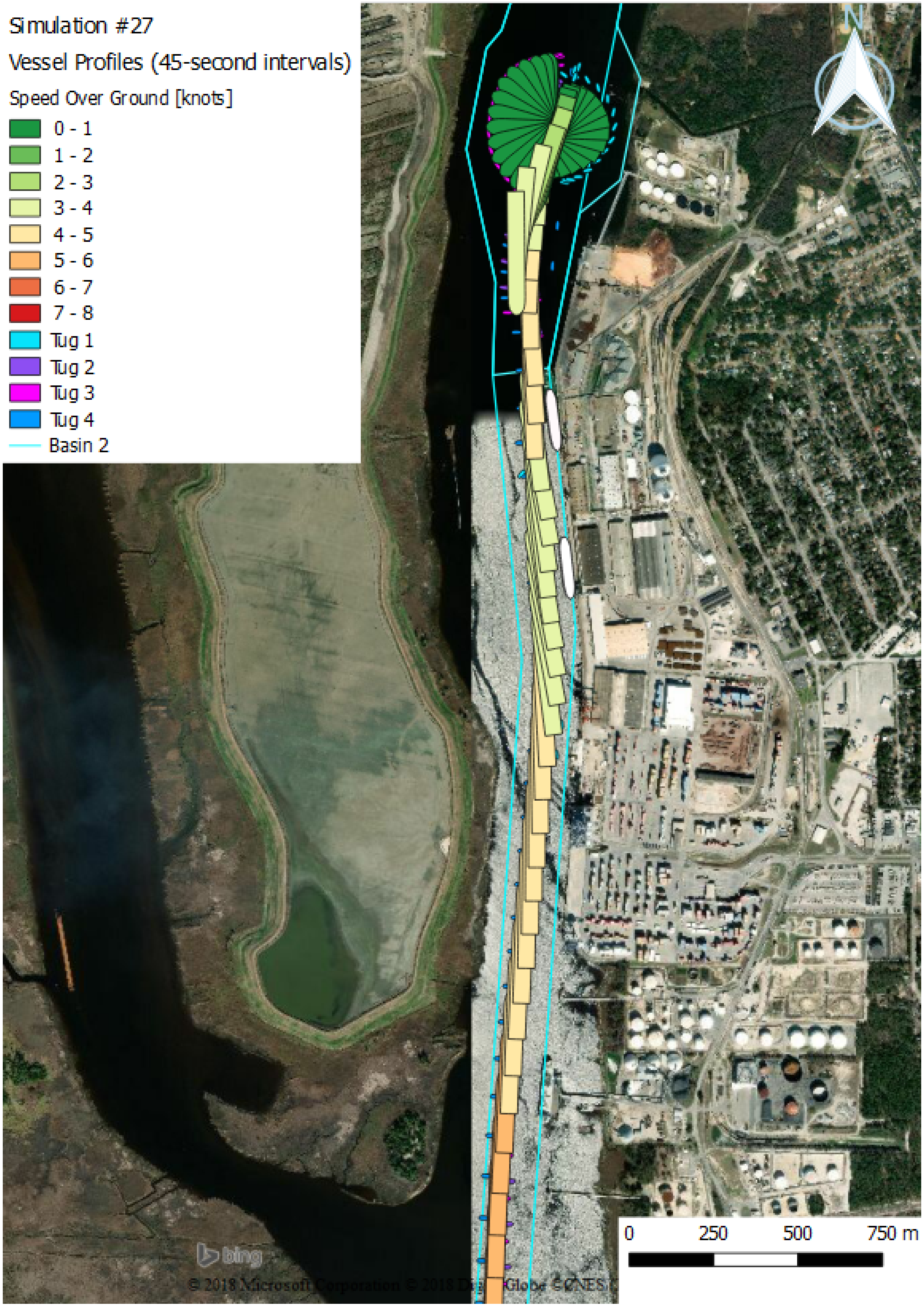


Figure 4-7: Run 27 – swept path

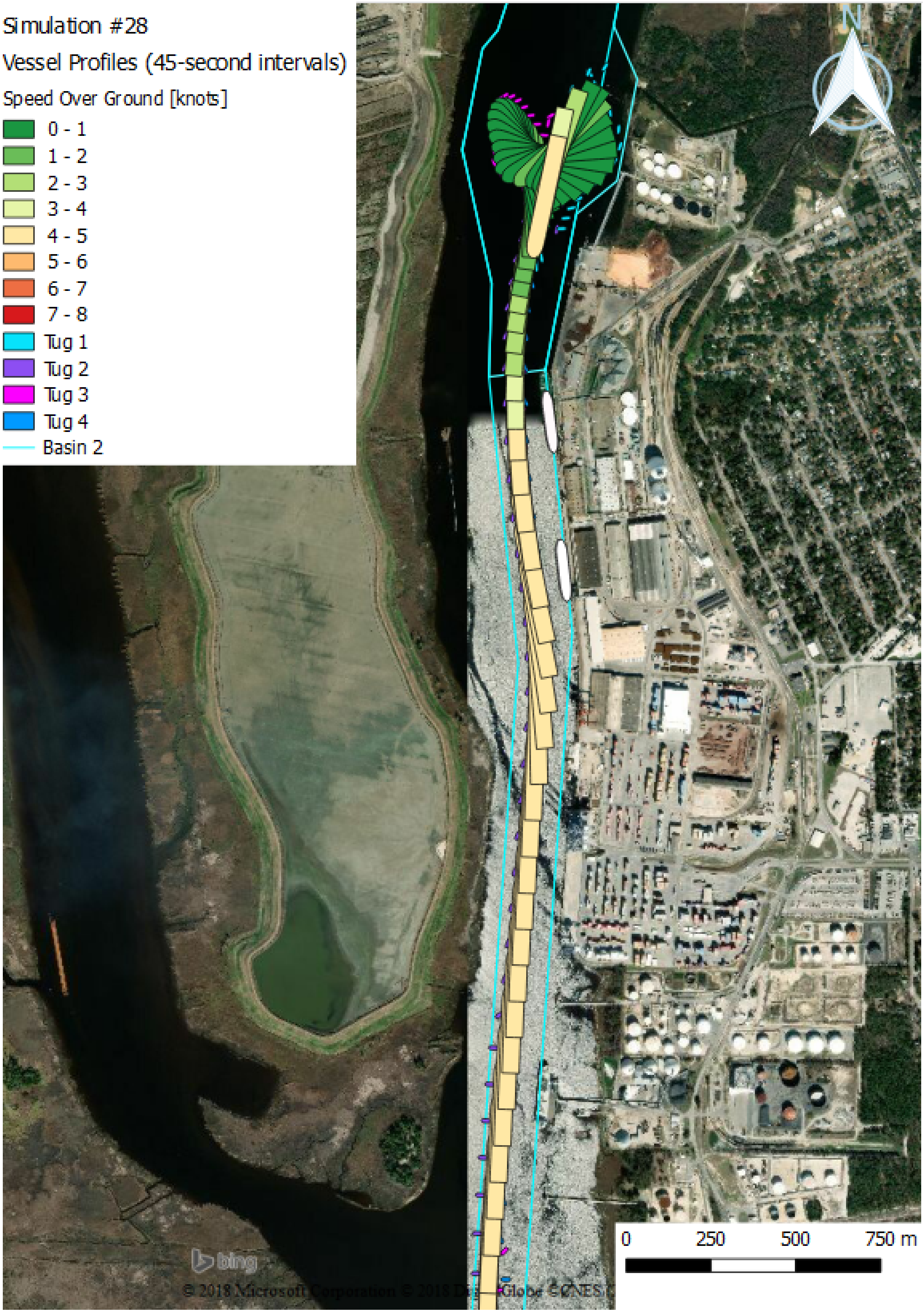


Figure 4-8: Run 28 – swept path

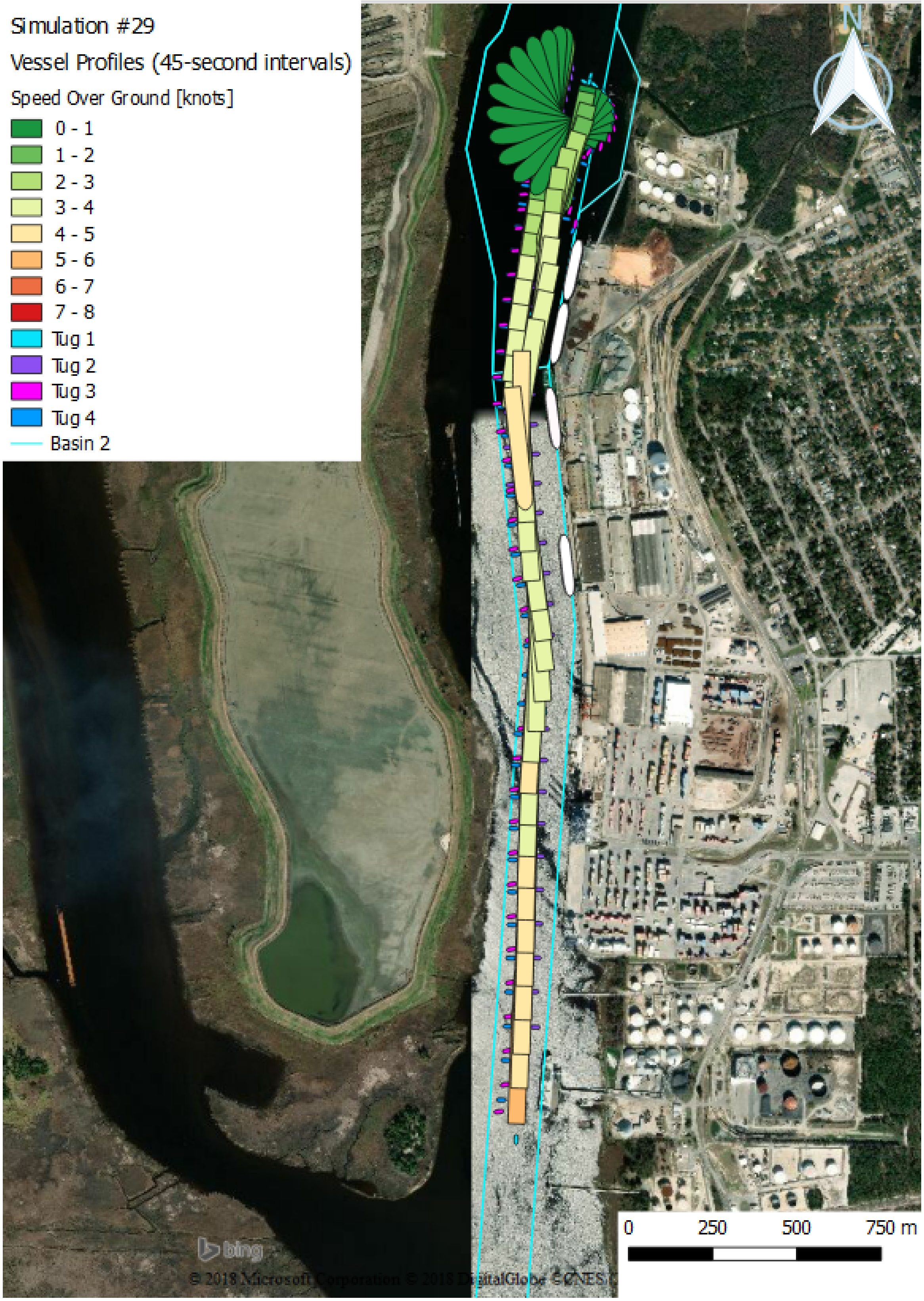


Figure 4-9: Run 29 – swept path

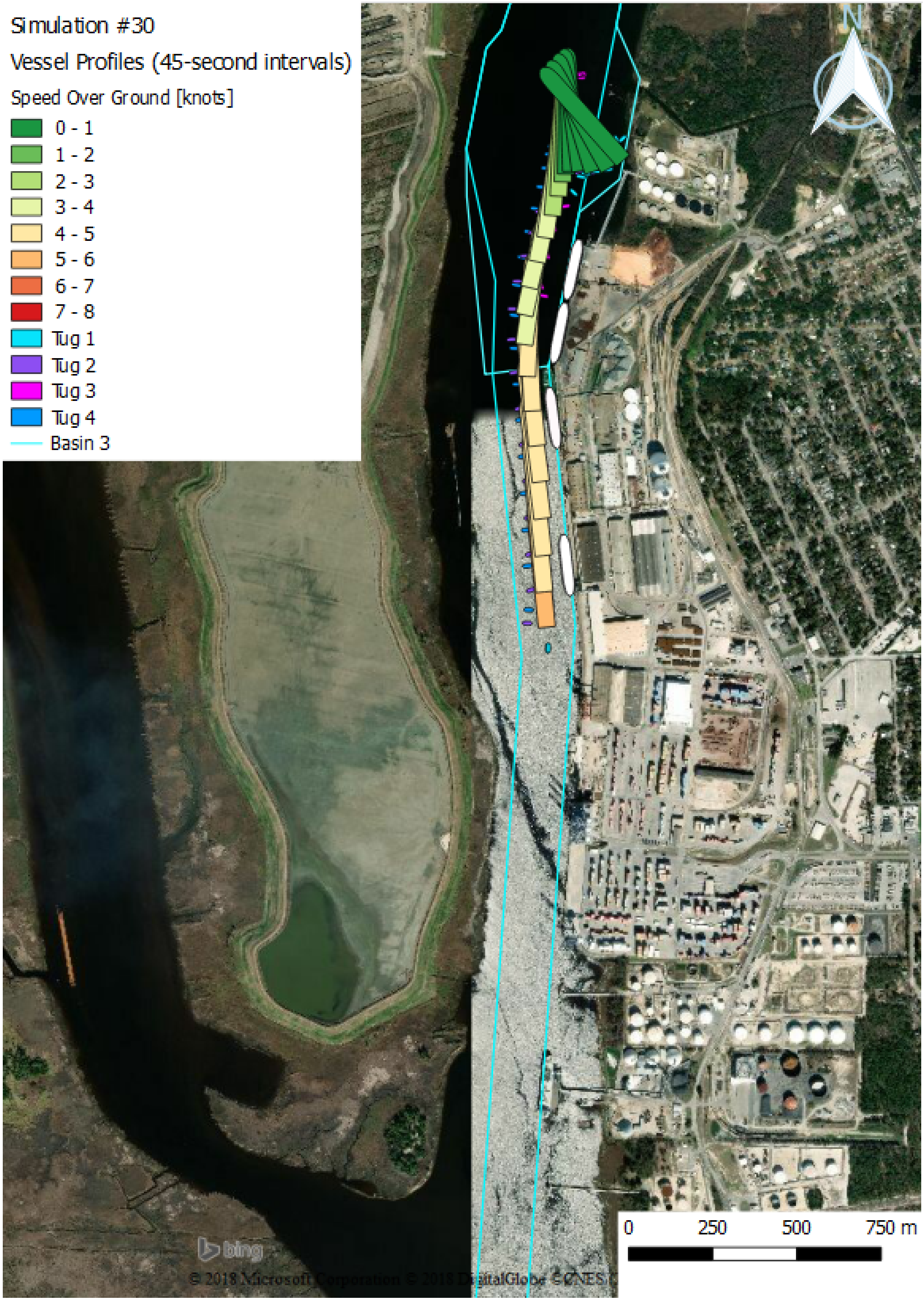


Figure 4-10: Run 30 – swept path

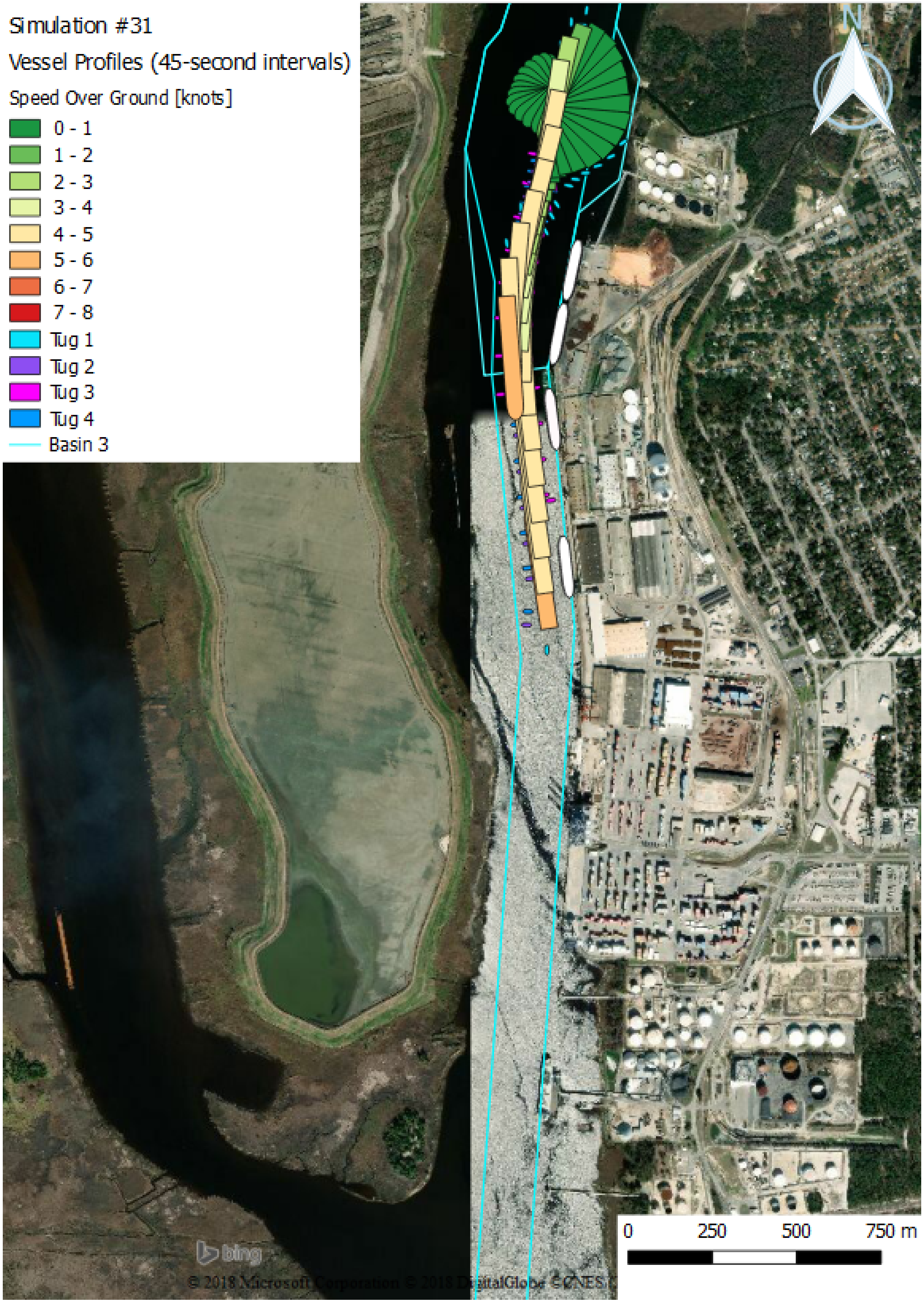


Figure 4-11: Run 31 – swept path

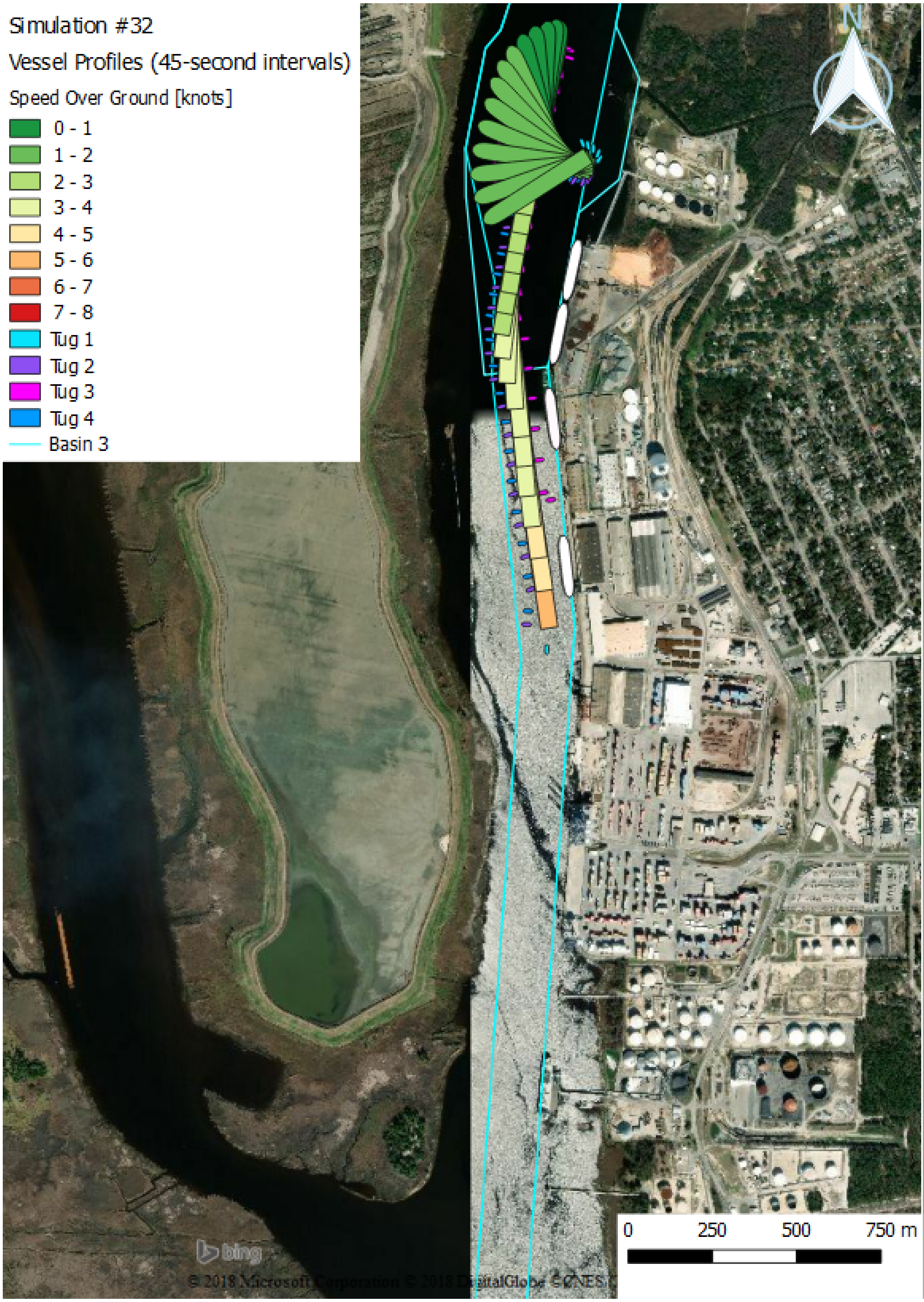


Figure 4-12: Run 32 – swept path

4.2 TURNING BASIN DESIGN CLEARANCES

This section presents the clearances between the ship and the channel boundaries to the west and east within the turning basin as well as to the existing infrastructure (shown in Figure 4-7). The west and east boundaries are defined as the channel boundaries within the turning basin area that the ship got the closest to. This could be anywhere within the turning basin and is meant to capture the smallest clearances to the outside turning basin boundaries. Table 4-2 presents these distances. For the existing turning basin design, two of the three runs (Runs 22 and 23) transited outside of the basin boundaries and grounded. As the simulations progressed through the various turning basin designs, the ship used the available space in each run. The Turning Basin 3 design offered the largest maneuverability area which the docking pilots used.

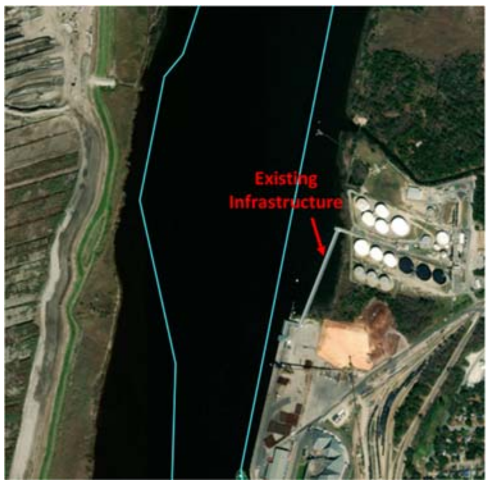


Figure 4-13: Reference point for measurements

Table 4-2: Turning basin clearances to channel boundaries and existing pier

Run	Turning Basin Design	Smallest Distance			Notes
		Between Ship and West Side of Turning Basin	Between Ship and East Side of Turning Basin	Between Ship and Existing Infrastructure	
21	Existing	62 ft	23 ft	250 ft	Used additional space on east side
22	Existing	47 ft over boundary	226 ft	468 ft	Grounded; outside of turning basin on west side
23	Existing	48 ft over boundary	243 ft	454 ft	Grounded; outside of turning basin on west side
24	Basin 1	96 ft	129 ft	251 ft	Used additional space on east side
25	Basin 1	29 ft	10 ft over boundary	207 ft	Used additional space on east side
26	Basin 2	202 ft	77 ft over boundary	92 ft	Used additional space on east side
27	Basin 2	129 ft	171 ft	274 ft	Used additional space on east side
28	Basin 2	184 ft	24 ft	67 ft	Used additional space on east side
29	Basin 2	96 ft	129 ft	344 ft	Used additional space on east side
30	Basin 3	534 ft	52 ft over boundary	100 ft	Grounded; outside turning basin on east side
31	Basin 3	293 ft	8 ft	231 ft	Used additional space on east side
32	Basin 3	63 ft	251 ft	264 ft	Used additional space on west side

4.3 POWER RESOURCES ANALYSIS

Table 4-3 shows the maximum percentage of power used for each tug, ship's engine, and bow thruster. 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.

To fully understand the reserve power capacity, all three variables need to be analyzed together. In Table 4-3, the column titled "Power Used Simultaneously?" contains three 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 sub-column describes if all four tugs were used at the same time, and the third sub-column lists the duration that all four tugs were used simultaneously. 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 simultaneously at 100%. However, in four of the runs (Runs 21, 24, 25, and 29), all four tugs were used at 100% simultaneously during the maneuver leaving no reserve tug power.

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. Tugs 1, 2, 3 and 4 were operated as autotugs and had respective bollard pulls of 60 t, 53 t, 32 t, and 32 t. With the exception of Runs 30 and 32, one tug was used at 100% in each run.

The container ship's maximum engine order is listed for both ahead (positive engine orders) and astern (negative engine orders) power. The ship's engine was never used at 100% ahead or astern. 70% and 80% were the maximum engine ahead and astern power used in any of the runs.

The last columns describe the ship's bow thruster orders. The table does not denote the difference between the positive orders (thruster used on the starboard side) and negative orders (thruster used on the port side); however, these directions are shown in the power plots. Due to hardware calibration issues, full bow thruster use was limited to 99%. 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.

Table 4-3: Tug and ship power analysis

Run	Power Used Simultaneously?			Tug 1 Percent of Bollard Pull Used (60t)		Tug 2 Percent of Bollard Pull Used (53t)		Tug 3 Percent of Bollard Pull Used (32t)		Tug 4 Percent of Bollard Pull Used (32t)		Ship's Engine Power Order		Ship's Bow Thruster Power Order	
	All Sources?	4 Tugs?	4 Tugs Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max (%)	Dur. (sec)	Max Ahead (%)	Max Astern (%)	Max (%)	Dur. (sec)
21	No	No	450	100	539	100	512	100	510	100	524	70	40	99	148
22	No	No	--	75	--	100	225	100	225	100	225	20	60	99	7
23	No	No	--	80	--	100	87	100	83	100	85	30	60	99	66
24	No	No	120	100	1696	100	60	100	402	100	396	50	60	99	45
25	No	No	20	100	130	100	174	100	189	100	182	60	80	99	129
26	No	No	--	75	--	100	47	100	47	0	--	60	50	98	--
27	No	No	--	100	310	50	--	50	--	0	--	40	60	99	98
28	No	No	--	75	--	50	--	100	--	75	--	60	40	99	43
29	No	No	400	100	422	100	343	100	453	100	448	40	60	99	99
30	No	No	--	55	--	50	--	55	--	50	--	40	60	99	18
31	No	No	--	75	--	100	40	100	63	100	168	60	40	99	22
32	No	No	--	75	--	50	--	50	--	50	--	20	60	99	66

* Blue text represents a duration of 2 minutes or longer

4.4 PILOT EVALUTATIONS

4.4.1 PILOT EVALUATIONS

After each run, the docking pilot filled out an individual run questionnaire. A summary of the pilot ratings is presented in Table 4-4 while the full comments are shown in Appendix C. One column ranks tug 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. Two different docking pilots performed the turning basin simulations.

The average tug adequacy rating was 7.6 (10 = most adequate). The average overall difficulty was 5.8 (10 = most difficult), and the average safety ranking was 6.6 (10 = most safe).

Table 4-4: Pilot ratings

Run	Tug Reserve Capacity	Overall Run Difficulty	Overall Run Safety
21	8	8	4
22	7	5	7
23	7	5	7
24	5	8	1
25	7	5	5
26	7	6	5
27	10	4	10
28	7	6	7
29	9	4	10
30	8	7	6
31	7	7	7
32	9	4	10

5. CONCLUSION SUMMARY

Figure 5-1 shows a composite of all of the runs. This composite figure shows the use of the expanded turning basin. In at least one simulation the vessel used the eastern and western expansions included in the Turning Basin 3 design.

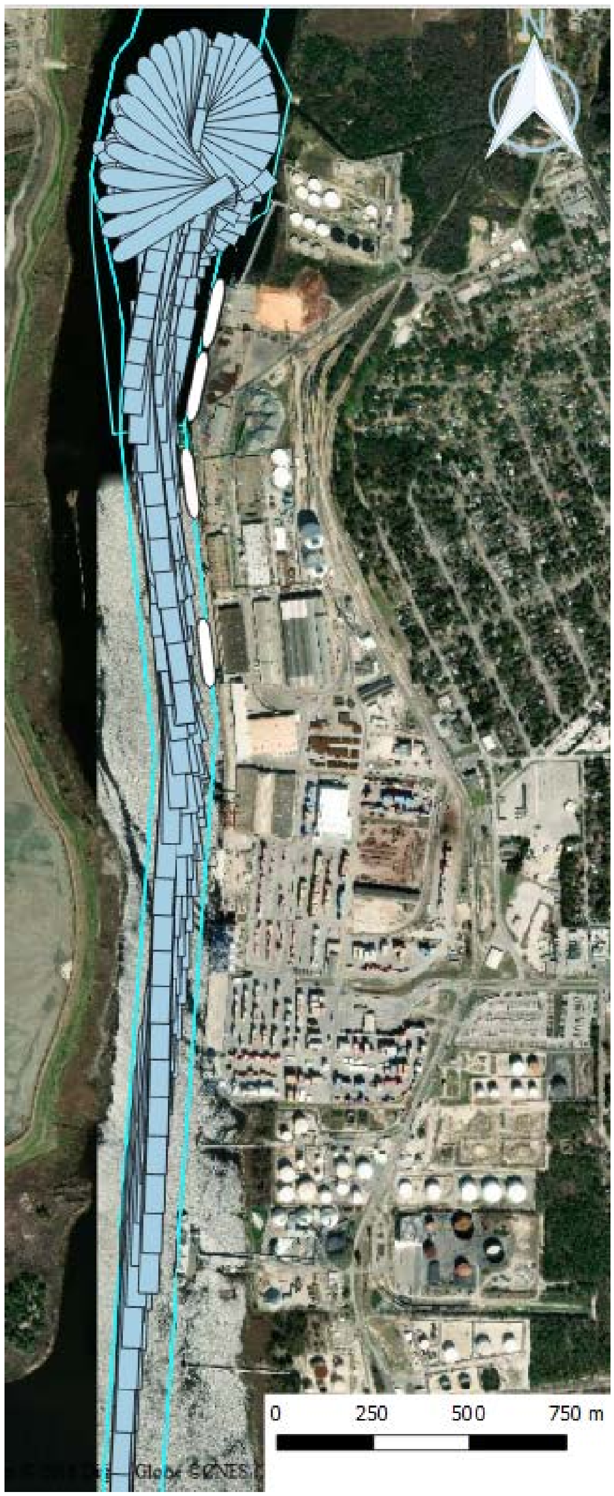


Figure 5-1: Summary of all runs with Turning Basin 3 design outline

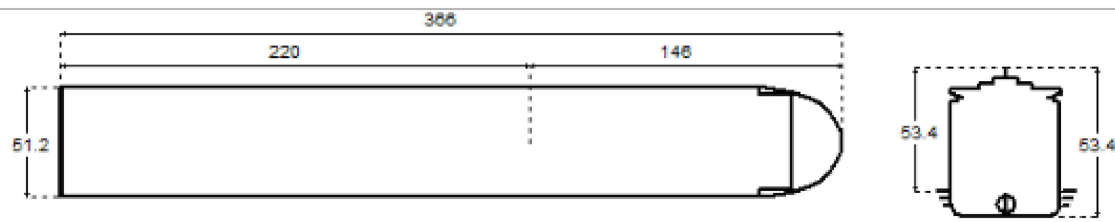
For safe maneuvering within the turning basin, the Wilmington, NC Docking Pilots made the following recommendations determined from this study:

- Transit speed when entering the turning basin:
  - 3 kts or less
- Environmental conditions:
  - Wind: 20 kts or less
  - Current: Maximum flood or ebb or less
- Tug requirements:
  - Upgrade to ASD tugs with greater bollard pull
- Daylight transits only
- Use Turning Basin 3 design
  - Additional dredging on west bank would be desirable while passing Berths 1 & 2
  - Remove Chevron pier and expand turning basin

6. APPENDIX A – PILOT CARDS

PILOT CARD					
Ship name	Container Kalina_Wilmington 3.0.53.0 *			Date	05.11.2018
IMO Number	N/A	Call Sign	N/A	Year built	1995
Load Condition	Partial Loaded 1				
Displacement	156302.15 tons		Draft forward	11.58 m / 38 ft 1 in	
Deadweight	135460 tons		Draft forward extreme	11.58 m / 38 ft 1 in	
Capacity			Draft after	11.58 m / 38 ft 1 in	
Air draft	53.42 m / 175 ft 8 in		Draft after extreme	11.58 m / 38 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	0.19 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	419.6 s	9.27 cbls	Advance	5.41 cbls
HAH to HAS	486.6 s	8.62 cbls	Transfer	2.07 cbls
SAH to SAS	586.6 s	8.66 cbls	Tactical diameter	5.12 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	82 % ahead	Min. RPM	21
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
"FSAH"	25.9	65282	101	1.03
"FAH"	18.3	22622	71	1.03
"HAH"	14.7	10913	56	1.03
"SAH"	12.1	6257	45.5	1.03
"DSAH"	8.1	1540	28.4	1.03
"DSAS"	-3.6	1858	-28.1	1.03
"SAS"	-5.8	7606	-45.3	1.03
"HAS"	-7.1	13842	-55.4	1.03
"FAS"	-8.3	22789	-65.5	1.03
"FSAS"	-11.4	60374	-90.8	1.03

PILOT CARD					
Ship name	Z_Tech_60t 3.0.52.1 *			Date	09.11.2018
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full Load				
Displacement	483 tons		Draft forward	5 m / 16 ft 5 in	
Deadweight	105 tons		Draft forward extreme	5 m / 16 ft 5 in	
Capacity			Draft after	5 m / 16 ft 5 in	
Air draft	14.2 m / 46 ft 8 in		Draft after extreme	5 m / 16 ft 5 in	

Ship's Particulars			
Length overall	30 m	Type of bow	-
Breadth	12 m	Type of stern	U-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	11 / 11		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	10.2 / 10.2		

Steering characteristics			
Steering device(s) (type/No.)	Azimuth thruster / 2	Number of bow thrusters	N/A
Maximum angle	180	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	5 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	10.7 s	0.16 cbls	Advance	0.18 cbls
HAH to HAS	10.7 s	0.15 cbls	Transfer	0.06 cbls
SAH to SAS	11.8 s	0.13 cbls	Tactical diameter	0.13 cbls

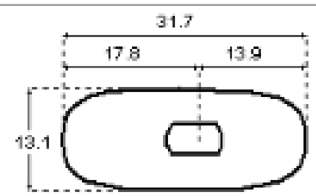
Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Left/Right
Maximum power per shaft	2 x 2250 kW	Propeller type	Azimuth FPP
Astern power	0 % ahead	Min. RPM	84.86
Time limit astern	N/A	Emergency FAH to FAS	11.7 seconds

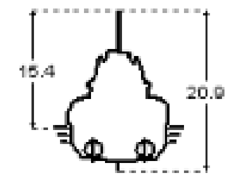
Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"100%"	12.5	4226	235	1
"90%"	10.7	2446	195.8	1
"80%"	9.9	1988	182.8	1
"70%"	9.2	1592	169.7	1
"60%"	8.5	1252	156.7	1
"50%"	7.8	965	143.6	1
"40%"	7.1	725	130.6	1
"30%"	6.4	528	117.5	1
"20%"	5.4	249	91.4	1
"10%"	5	199	84.9	1

PILOT CARD					
Ship name	Ra3200 (bp 82t) 3.0.57.0 *			Date	19.05.2017
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full Load				
Displacement	770 tons		Draft forward	5.5 m / 18 ft 1 in	
Deadweight	219 tons		Draft forward extreme	5.5 m / 18 ft 1 in	
Capacity			Draft after	5.5 m / 18 ft 1 in	
Air draft	15.5 m / 50 ft 11 in		Draft after extreme	5.5 m / 18 ft 1 in	

Ship's Particulars			
Length overall	31.78 m	Type of bow	-
Breadth	13.18 m	Type of stern	U-shaped
Anchor(s) (No./types)	2 (PortBow / StbdBow)		
No. of shackles	11 / 11		(1 shackle =25 m / 13.7 fathoms)
Max. rate of heaving, m/min	10.2 / 10.2		





Steering characteristics			
Steering device(s) (type/No.)	Azimuth thruster / 2	Number of bow thrusters	N/A
Maximum angle	180	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	4 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	9.6 s	0.19 cbls	Advance	0.3 cbls
HAH to HAS	10.7 s	0.17 cbls	Transfer	0.12 cbls
SAH to SAS	12.9 s	0.15 cbls	Tactical diameter	0.29 cbls

Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Left/Right
Maximum power per shaft	2 x 2465 kW	Propeller type	Azimuth FPP
Astern power	0 % ahead	Min. RPM	106.92
Time limit astern	N/A	Emergency FAH to FAS	9.8 seconds

Engine Telegraph Table

Engine Order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"100%"	14	4782	270	1
"90%"	13	3882	251.9	1
"80%"	12.1	3103	233.8	1
"70%"	11.2	2436	215.6	1
"60%"	10.2	1872	197.5	1
"50%"	9.3	1403	179.4	1
"40%"	8.4	1019	161.3	1
"30%"	7.4	713	143.2	1
"20%"	6.5	475	125	1
"10%"	5.5	297	106.9	1

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PILOT CARD					
Ship name	Conventional twin screw tug 5 (bp 32t) TRANSAS 2.31.12.0 *			Date	06.06.2013
IMO Number	N/A	Call Sign	N/A	Year built	N/A
Load Condition	Full load				
Displacement	535 tons		Draft forward	3.05 m / 10 ft 0 in	
Deadweight	N/A tons		Draft forward extreme	3.05 m / 10 ft 0 in	
Capacity			Draft after	4.27 m / 14 ft 0 in	
Air draft	18.01 m / 59 ft 2 in		Draft after extreme	4.27 m / 14 ft 0 in	

Ship's Particulars			
Length overall	32 m	Type of bow	-
Breadth	9.75 m	Type of stern	Transom
Anchor(s) (No./types)	1 (PortBow)		
No. of shackles	9		(1 shackle =27.4 m / 15 fathoms)
Max. rate of heaving, m/min	30		

Steering characteristics			
Steering device(s) (type/No.)	Suspended / 2	Number of bow thrusters	N/A
Maximum angle	45	Power	N/A
Rudder angle for neutral effect	0 degrees	Number of stern thrusters	N/A
Hard over to over(2 pumps)	23 seconds	Power	N/A
Flanking Rudder(s)	0	Auxiliary Steering Device(s)	N/A

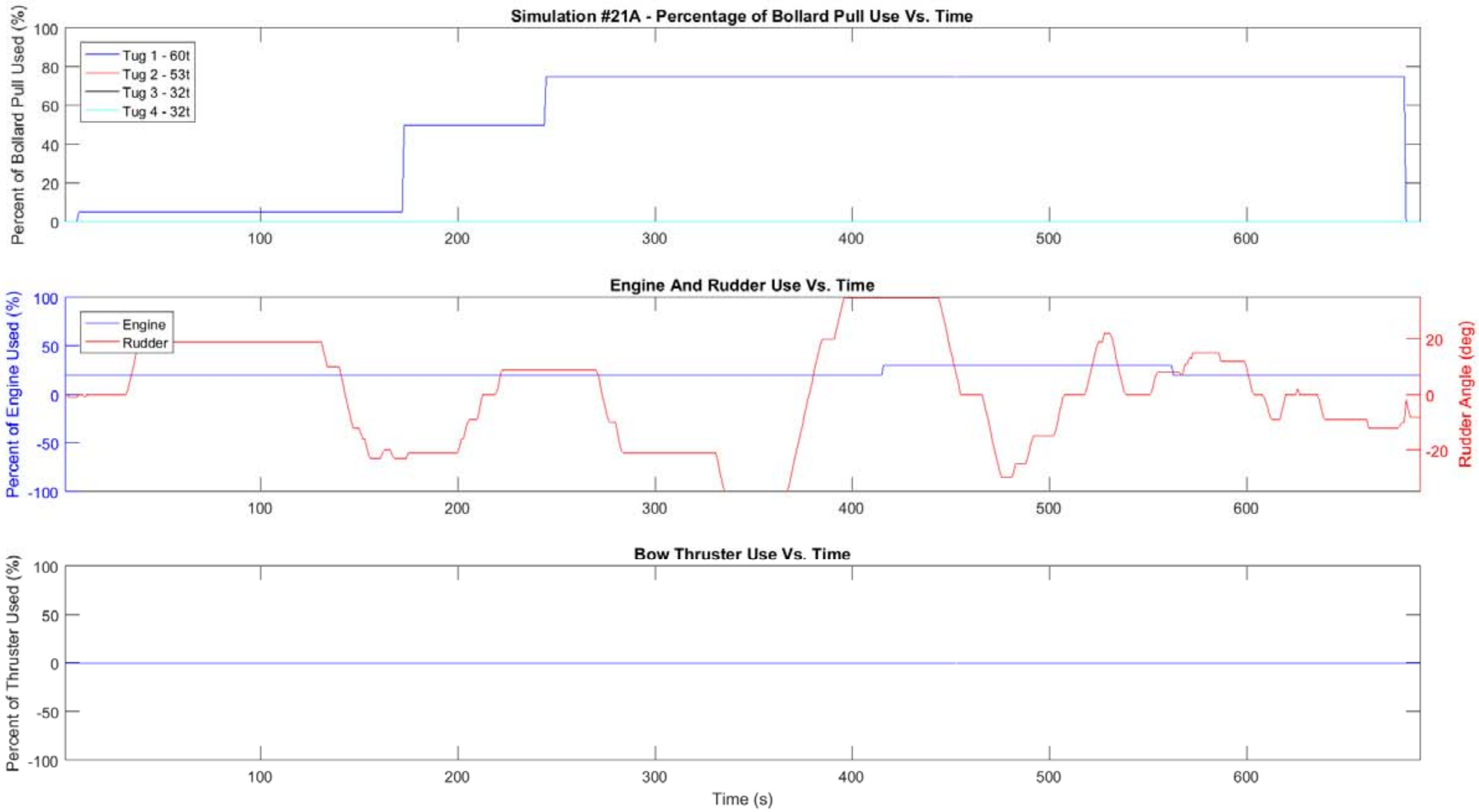
Stopping			Turning circle	
Description	Full Time	Head reach	Ordered Engine: 100%, Ordered rudder: 35 degrees	
FAH to FAS	38.6 s	0.67 cbls	Advance	0.49 cbls
HAH to HAS	33.35 s	0.5 cbls	Transfer	0.24 cbls
SAH to SAS	27.25 s	0.3 cbls	Tactical diameter	0.51 cbls

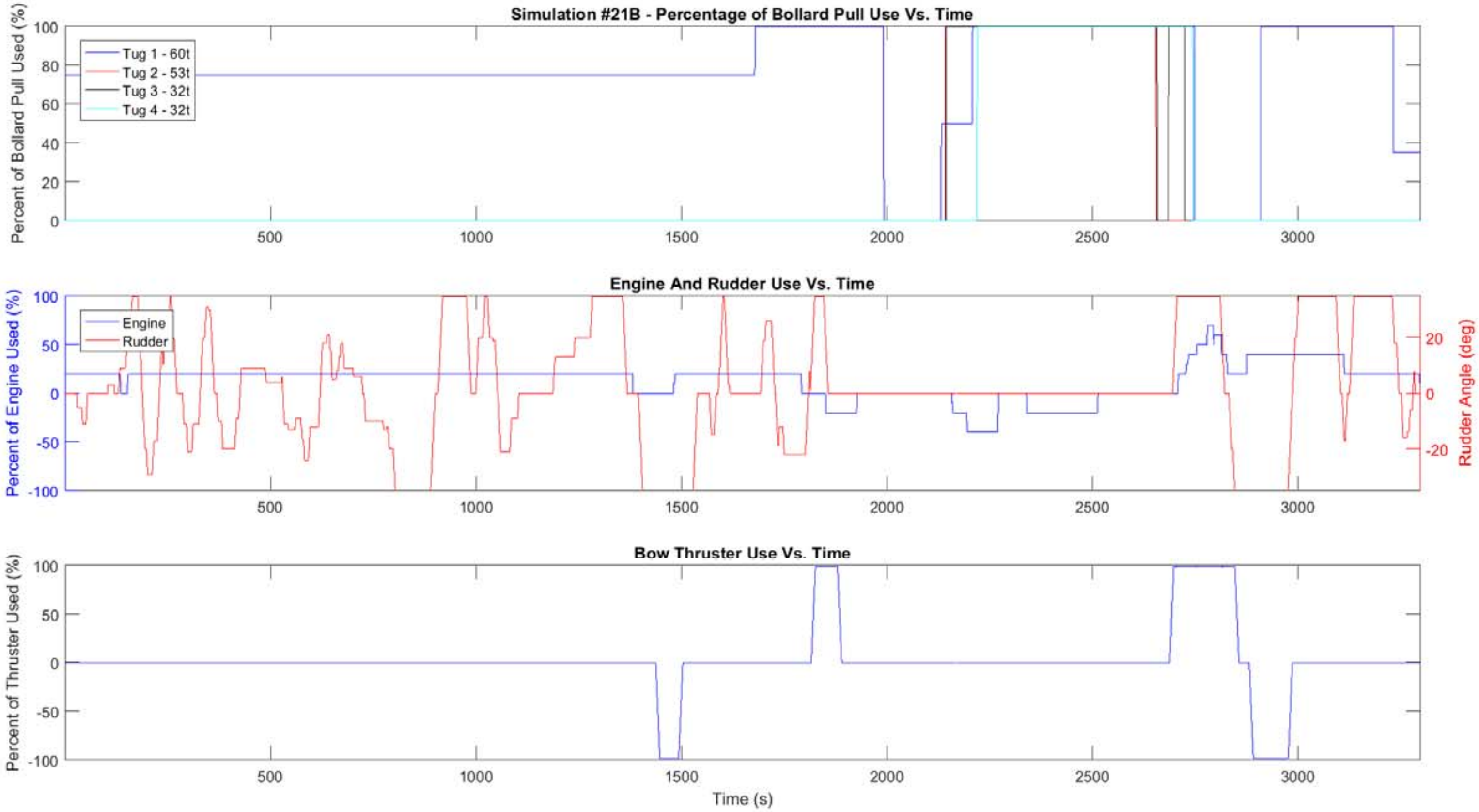
Main Engine(s)			
Type of Main Engine	High speed diesel	Number of propellers	2
Number of Main Engine(s)	2	Propeller rotation	Inward
Maximum power per shaft	2 x 1104 kW	Propeller type	FPP
Astern power	80 % ahead	Min. RPM	5.83
Time limit astern	N/A	Emergency FAH to FAS	5.15 seconds

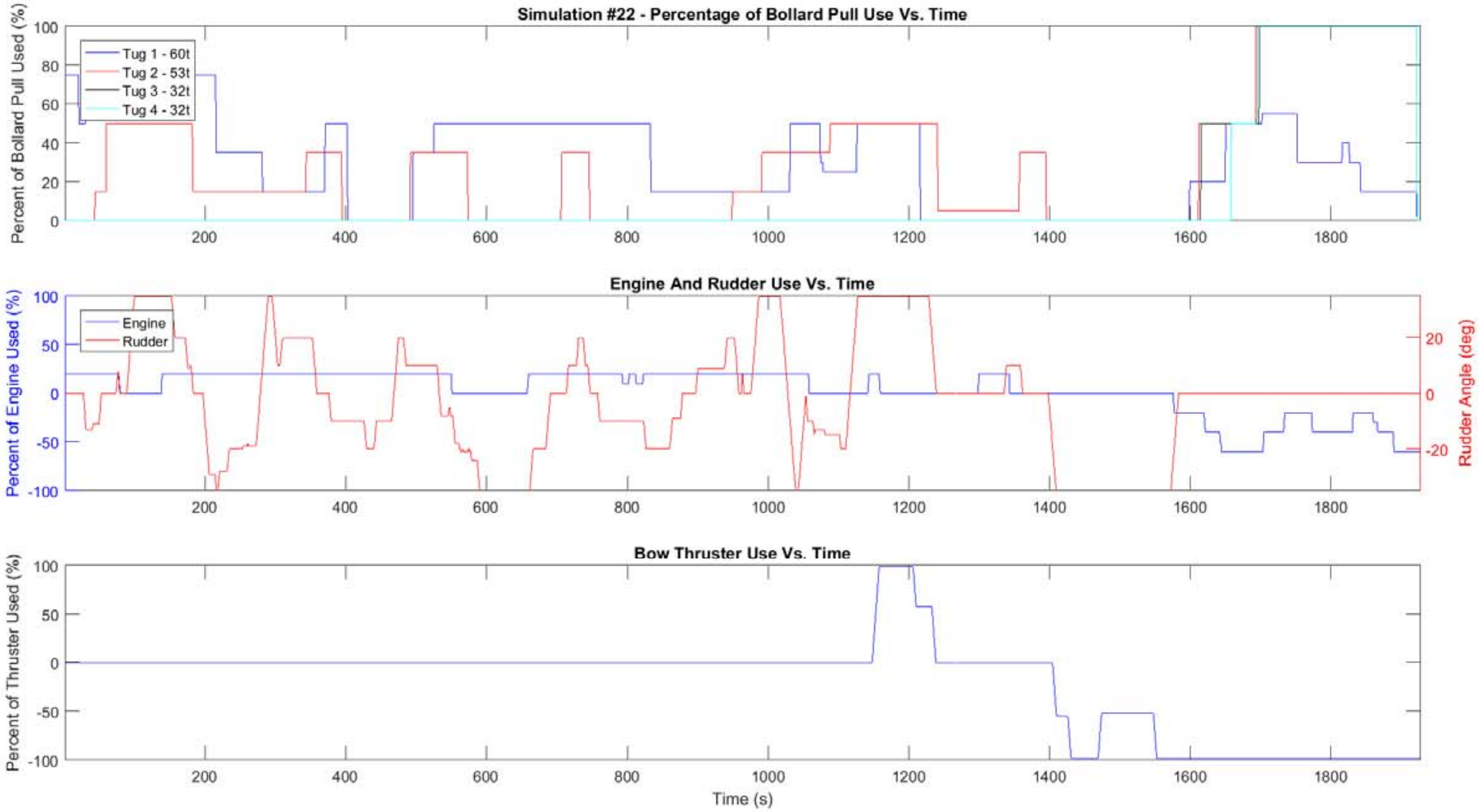
Engine Telegraph Table

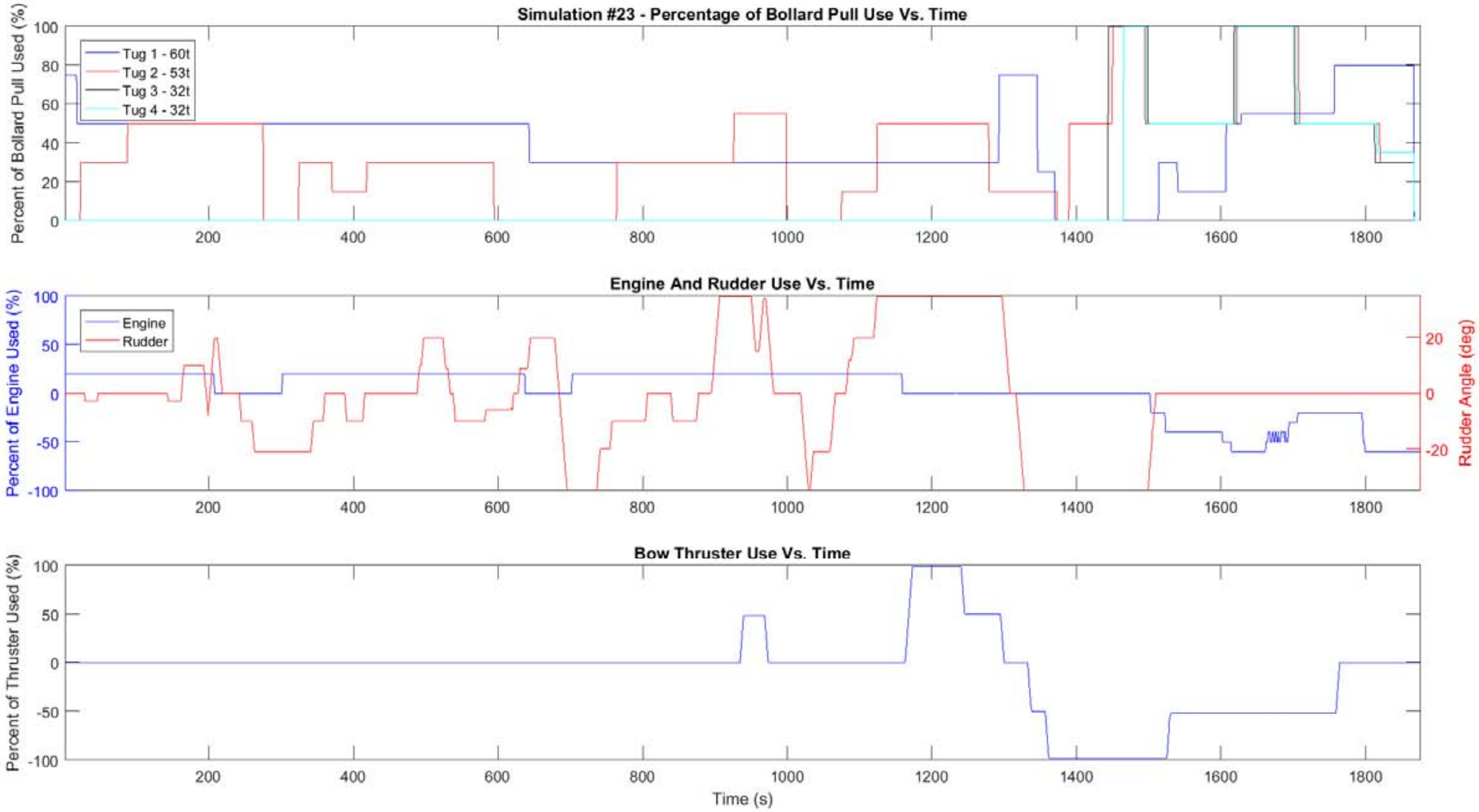
Engine order	Speed, knots	Engine power, kW	RPM	Pitch ratio
"FSAH"	11.8	2098	211.8	0.75
"FAH"	10.2	1374	184	0.75
"HAH"	8.8	820	155.8	0.75
"SAH"	7.2	454	127.5	0.75
"DSAH"	5.6	217	98.5	0.75
"DSAS"	-4.5	406	-91.4	0.75
"SAS"	-5.2	620	-105.6	0.75
"HAS"	-5.9	890	-119.4	0.75
"FAS"	-6.6	1242	-133.7	0.75
"FSAS"	-7.3	1678	-148	0.75

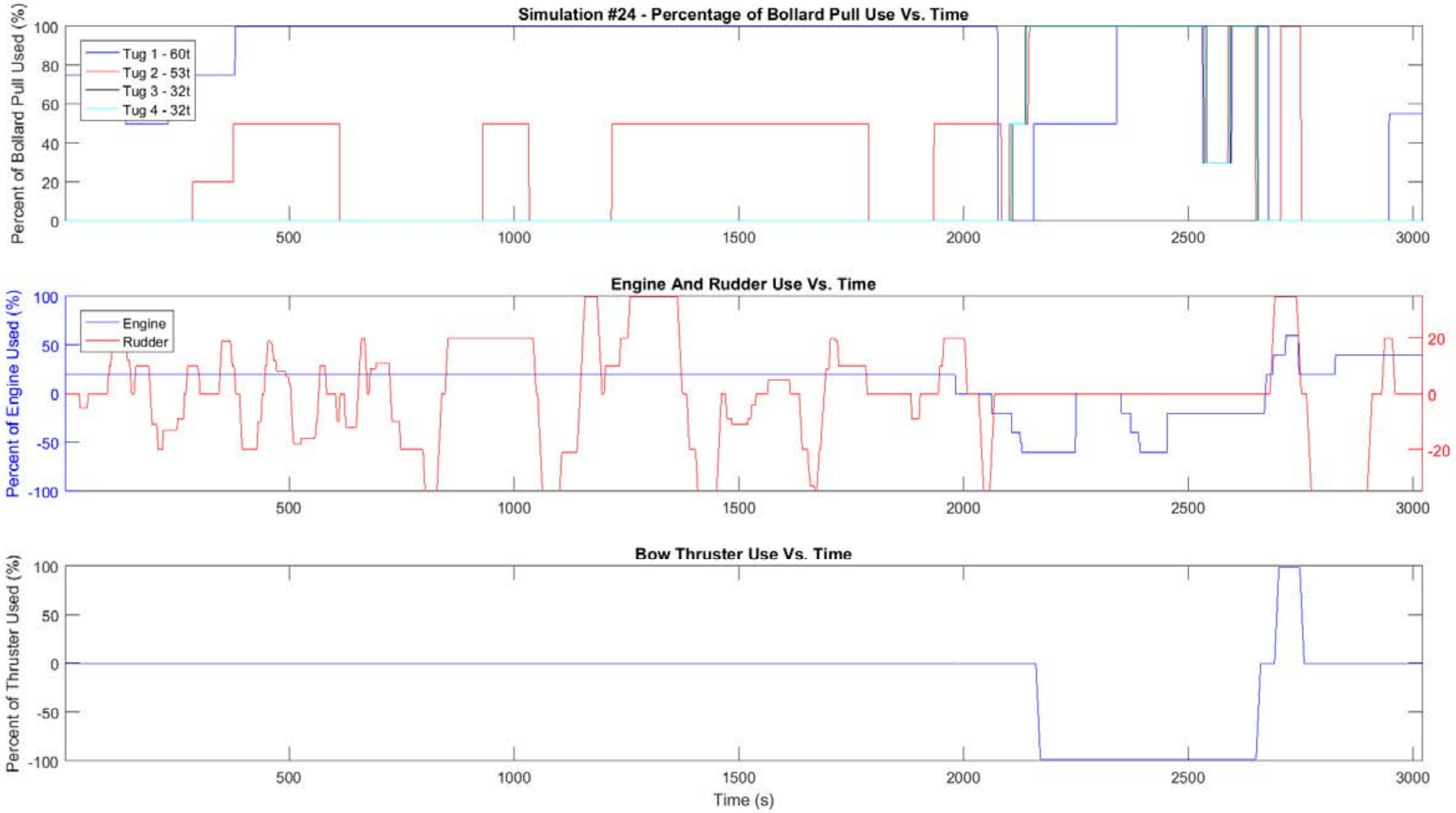
7. APPENDIX B - RESERVE POWER ANALYSIS PLOTS

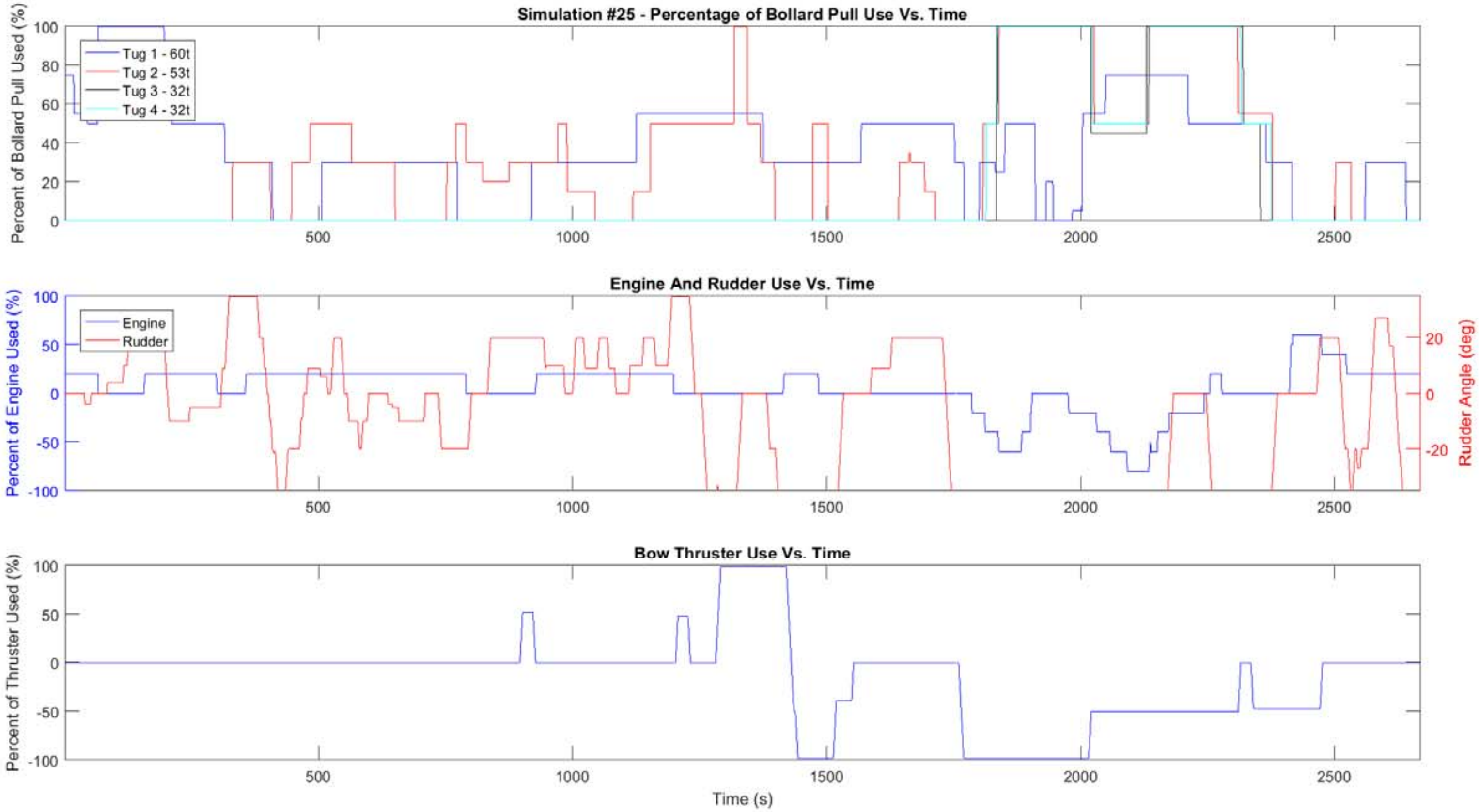


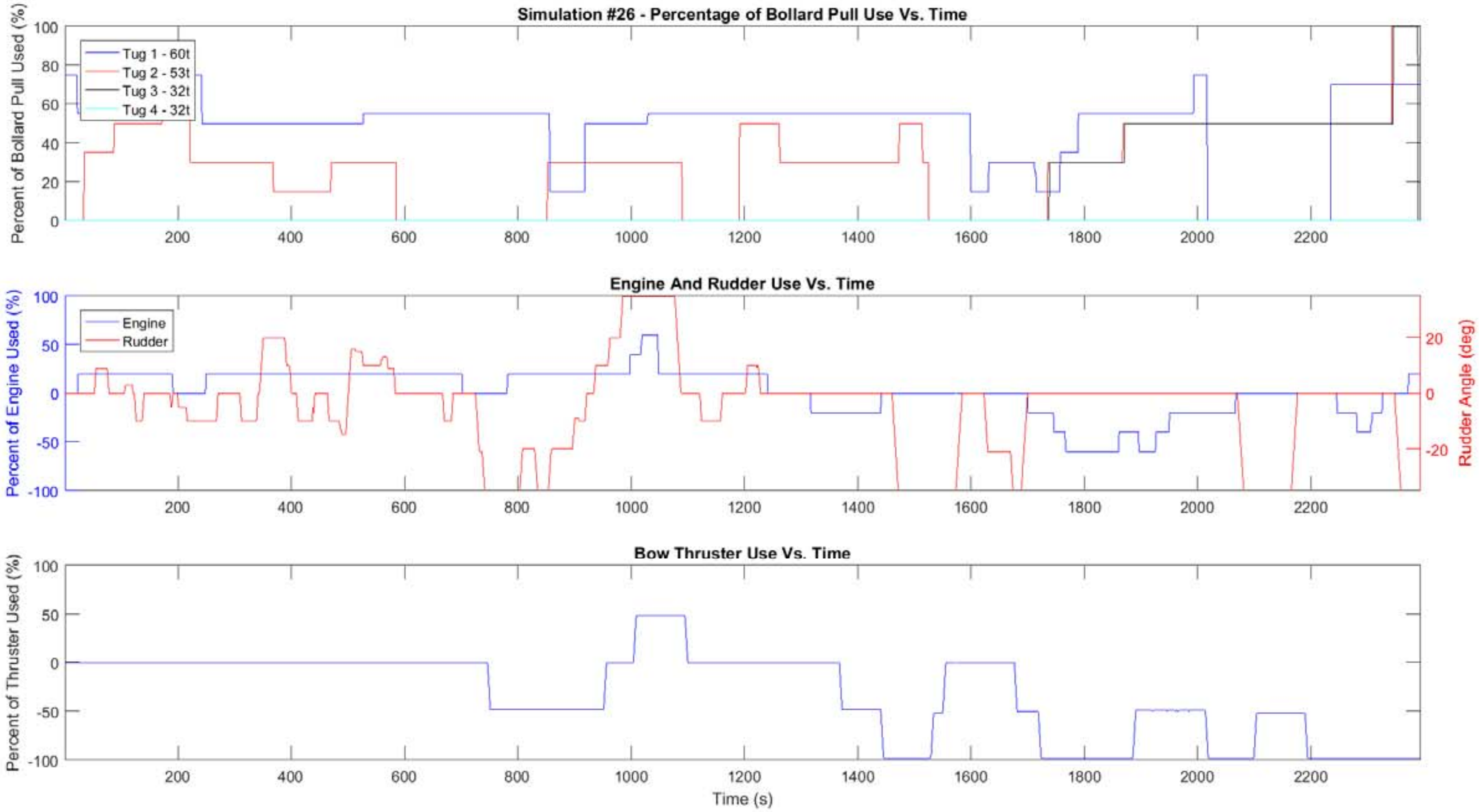

Simulation #21B - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

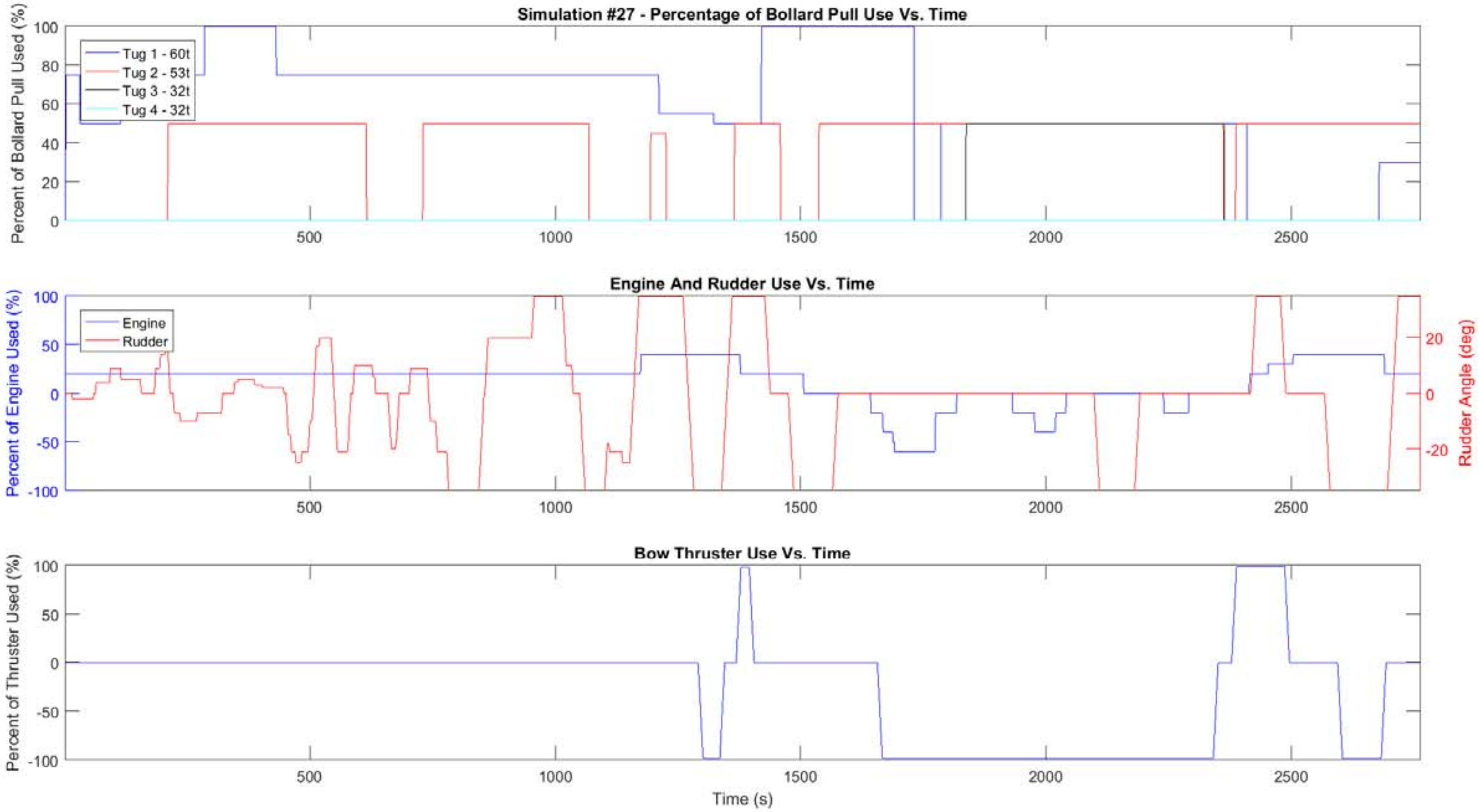

Simulation #22 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

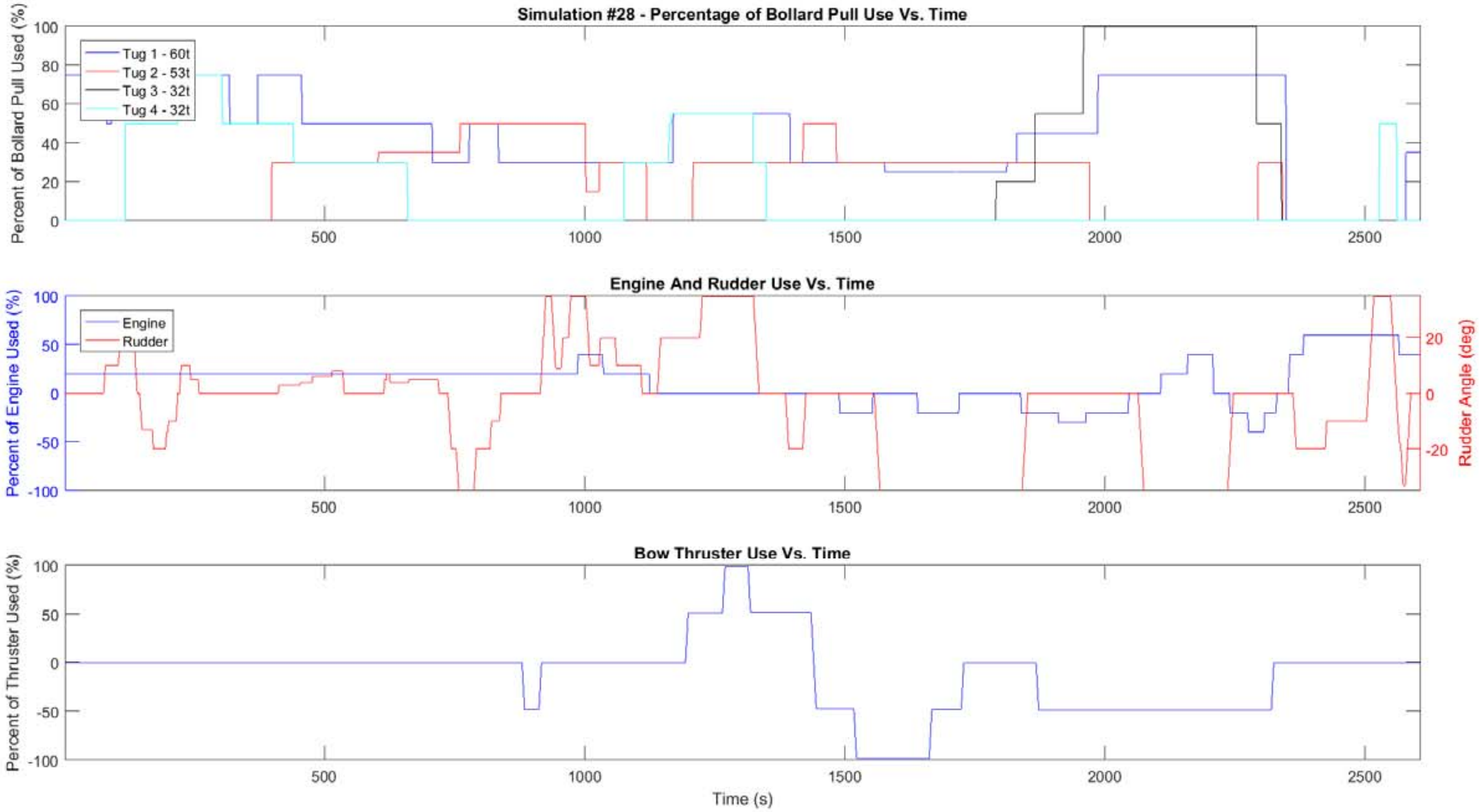

Simulation #23 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

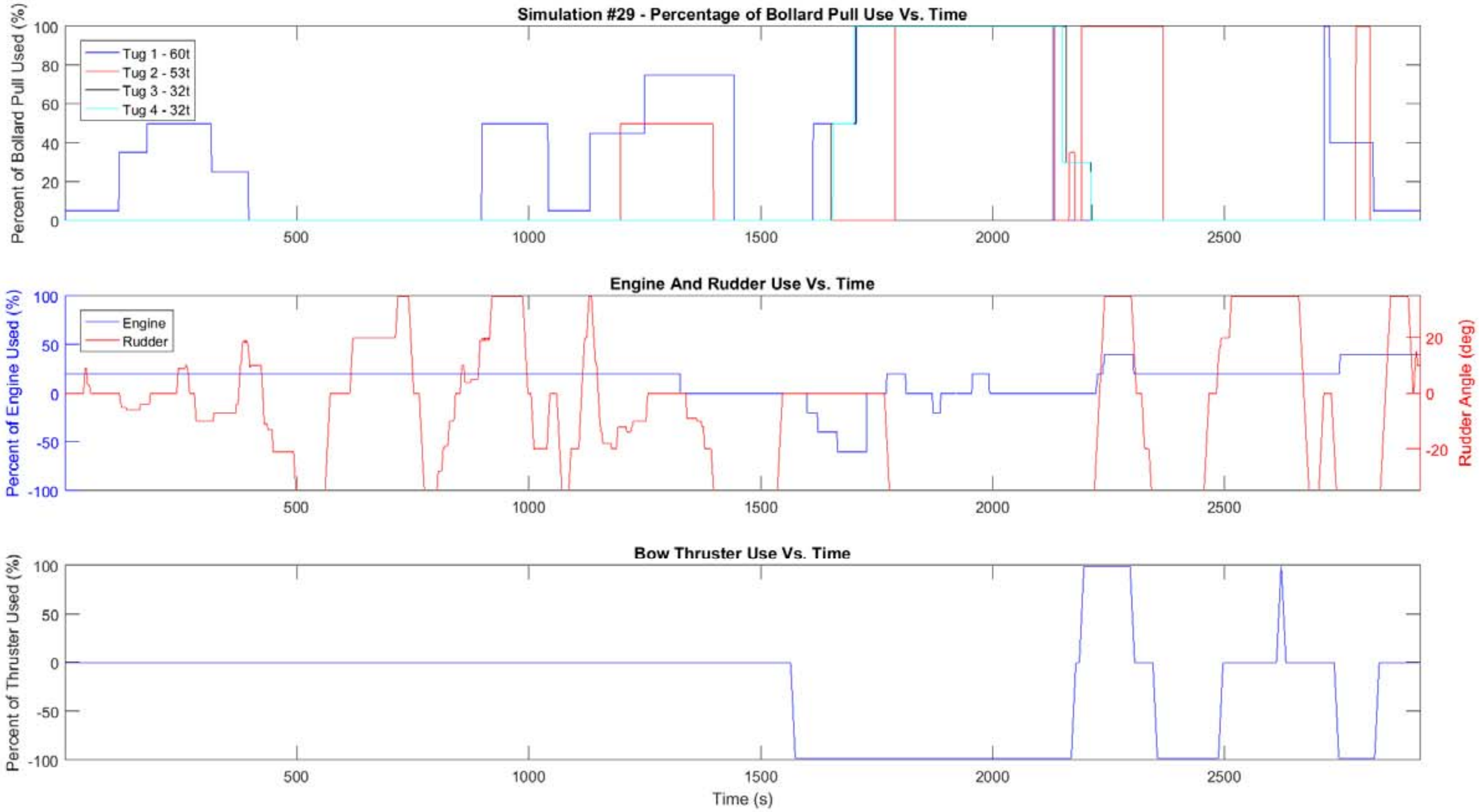

Simulation #24 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

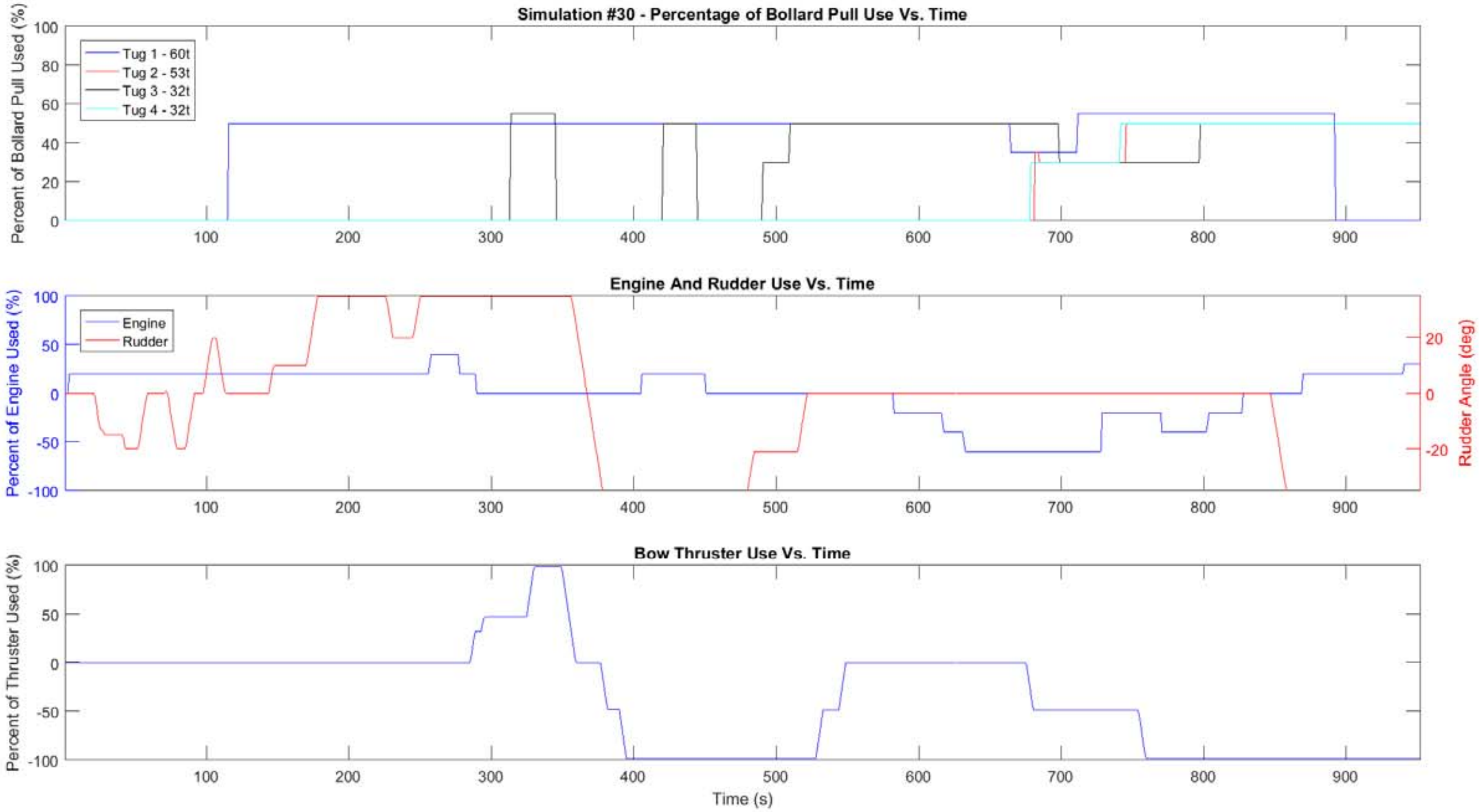

Simulation #25 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Engine
Rudder
Rudder Angle (deg)
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

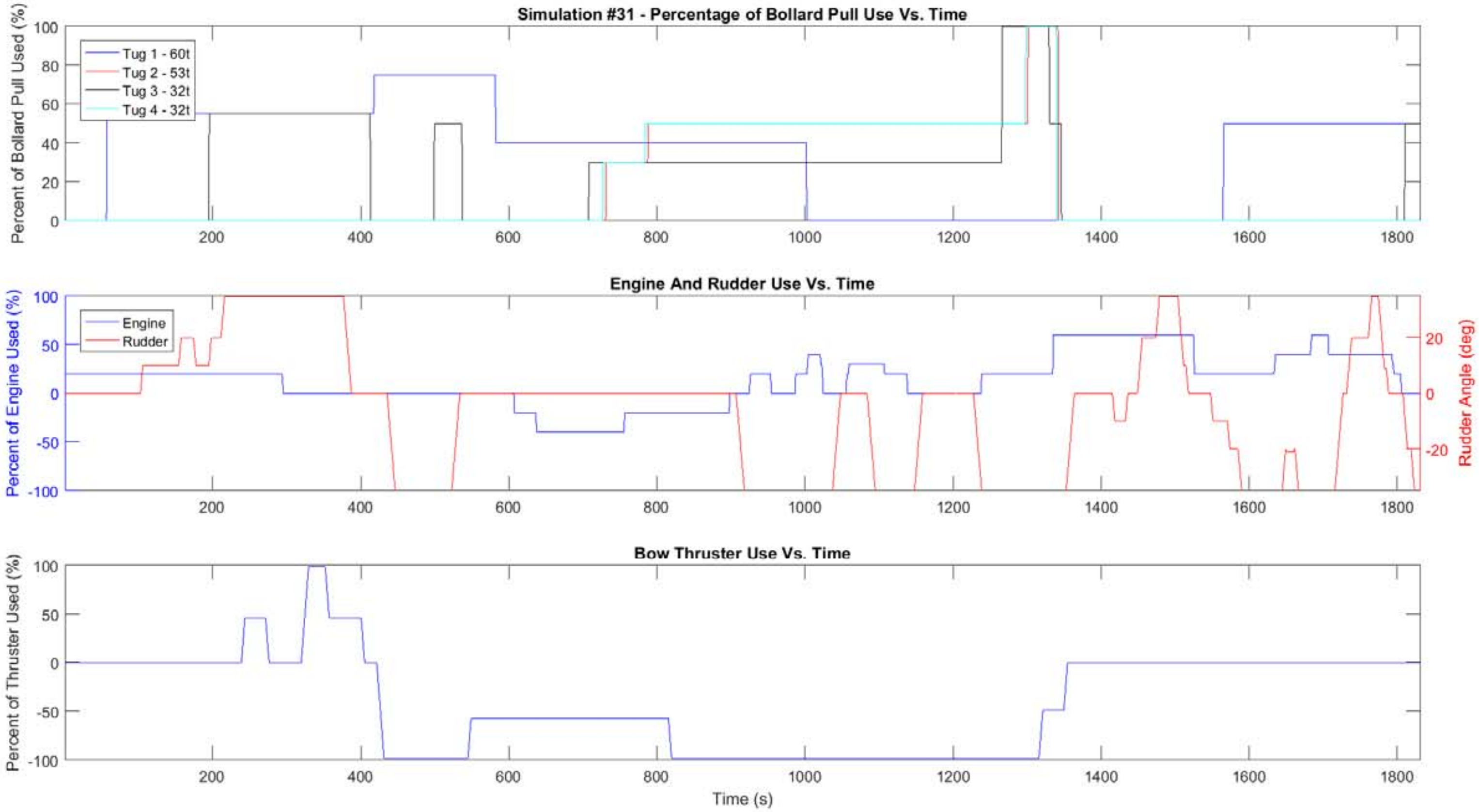

Simulation #26 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

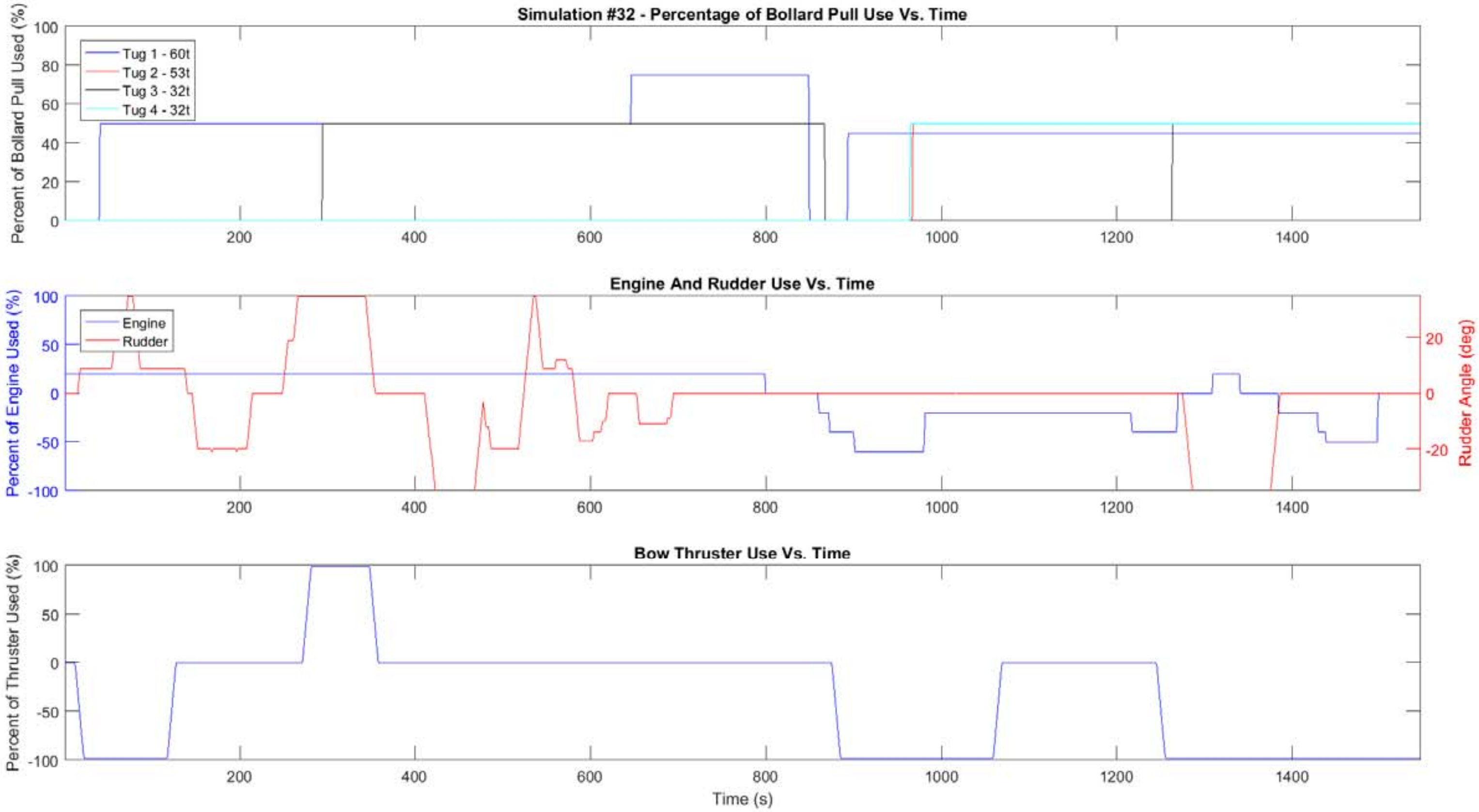

Simulation #27 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)


Simulation #28 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)


Simulation #29 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)


Simulation #30 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)


Simulation #31 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)


Simulation #32 - Percentage of Bollard Pull Use Vs. Time
Percent of Bollard Pull Used (%)
Tug 1 - 60t
Tug 2 - 53t
Tug 3 - 32t
Tug 4 - 32t
Engine And Rudder Use Vs. Time
Percent of Engine Used (%)
Rudder Angle (deg)
Engine
Rudder
Bow Thruster Use Vs. Time
Percent of Thruster Used (%)
Time (s)

8. APPENDIX C – PILOT EVALUATION COMMENTS

Run	Ship	Captain	1. Were you able to maintain the intended track line and voyage plan on this exercise?	2. Was the drift angle or swept path excessive in certain areas?	3. Did the ship model react as expected with given environmental conditions (wind,wave,current)? If no, what was different?	4. Did you maintain an acceptable distance from the shoals/channel boundaries?	5. Did you maintain an acceptable distance from the shoals?	6. Would you modify your transit plan if you repeated this run? If so, what would be the differences?	7. Would you perform a similar transit/ maneuver in a real-world situation? If not, why?	8. Please provide any comments on Aids to Navigation placement	9. Tug Configuration and Reserve Capacity	10. Qualifier	11. Run Difficulty	12. Overall Safety	Qualifier
21	Kalina	Cliff Nelson	Yes	No	Yes	Yes	Yes	No	No - Chevron dock needs to be removed and turning basin expanded		8		8	4	
22	Kalina	Glenn Turberville	Yes	No	No, I found it difficult to get the feel of the ship	Yes, during transit to basin	Yes, until the turning evolution started	Yes, for simulation purposes	Yes		7		5	7	Safe - under these conditions
23	Kalina	Glenn Turberville	Yes	No	No, I expected the vessel to react more substantially to astern power	Yes, during vessel transit to turning basin	Yes, until the turning evolution started	Yes, prior to entering the basin, ship speed less than 3 kts	Yes		7		5	7	Under "normal conditions", the safety factor for this run should be considered safe; daylight only for the first "few" would be recommended
24	Kalina	Cliff Nelson	Yes	No	Yes	Yes	Yes	No	No, Chevron dock needs to be removed and turning basin extended		5		8	1	
25	Kalina	Glenn Turberville	Yes	No	No, weak astern power	Yes, in my mind	Yes	No	Yes		7		5	5	
26	Kalina	Glenn Turberville	Yes	No	No, weak astern bell, torque going astern not felt	Yes	Yes	No	Yes		7	3 tugs used	6	5	
27	Kalina	Cliff Nelson	Yes - southwest wind in channel	Yes	Yes	Yes	Yes	No	Yes		10		4	10	
28	Kalina	Glenn Turberville	Yes	No	Yes	Yes	Yes	No	Yes - only if environmental were similar	quay wall illuminated	7		6	7	
29	Kalina	Cliff Nelson	Yes	No	Yes	Yes	Yes	No	Yes		9	Pilot felt that the maneuver could have been performed not maxing out the tugs. Believes could have done the maneuver with 50-75%.	4	10	
30	Kalina	Glenn Turberville	Yes	No	No, given that there was ebb current, I expected the current to cause the ship to run the vessel ahead much	Yes, until the vessel was in the swing in the basin	Yes until turning	Yes, possible change position of after tug	Yes	NA	8		7	6	Additional dredging on the west bank option 3 would be okay desirable while passing vessels in Berths 1& 2
31	Kalina	Glenn Turberville	Yes	No	No, went into the exercise thinking ebb - model was set-up for flood	Yes	Yes	Yes, be certain of the direction of the current	Yes	NA	7	Because of mix-up of the current direction. It was observed the Option 3 design allow for much more error on a flood current maneuver	7	7	
32	Kalina	Cliff Nelson	Yes	No	Yes	Yes	Yes	No	Yes	NA	9		4	10	

9. APPENDIX D – CURRENT PROFILES AND CORRESPONDING TIMES

Current	
Slack	7:00 AM
1 Hour Before Max Flood	9:00 AM
1 Hour Before Max Flood	9:00 AM
1 Hour Before Max Flood	9:00 AM
1 Hour After Max Flood	10:00 AM
1 Hour After Max Flood	10:00 AM
Max flood	10:00 AM
Max flood	10:00 AM
Max Ebb	5:00 PM
Max Ebb	5:00 PM
1 Hour Before Max Flood	9:00 AM
Max Ebb	5:00 PM

10. APPENDIX E – 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 10-1: Aerial photograph of MITAGS campus and location