Modeling Ultra-Large Container Vessels

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MITAGS

a 10-Pound Ship in a 5-Pound Channel

Will this Ship fit in Your Garage?

What is a ULCV?

10,000 TEU or higher

Largest ULCVs Calling in US Waters?

18,000 TEU and getting bigger

On the horizon…

Almost 24,000 TEU

How are ULCVs Different?

- Lower power to tonnage ratio
- Less under-keel clearance
- More sail area

How are ULCVs Different?

- Precision navigation is essential
  - Timing is everything
  - Don’t go too fast
    - A knot too fast is a lot too fast!
    - Nothing faster than a ship that is almost stopped
  - Don’t go too slow

Can it get to your garage?

Is the channel deep enough?

- Squat?
- Rolling?

Can it turn in the channel?

- When to make the turn

Can it turn around?

5.6 TURNING BASIN ISSUES

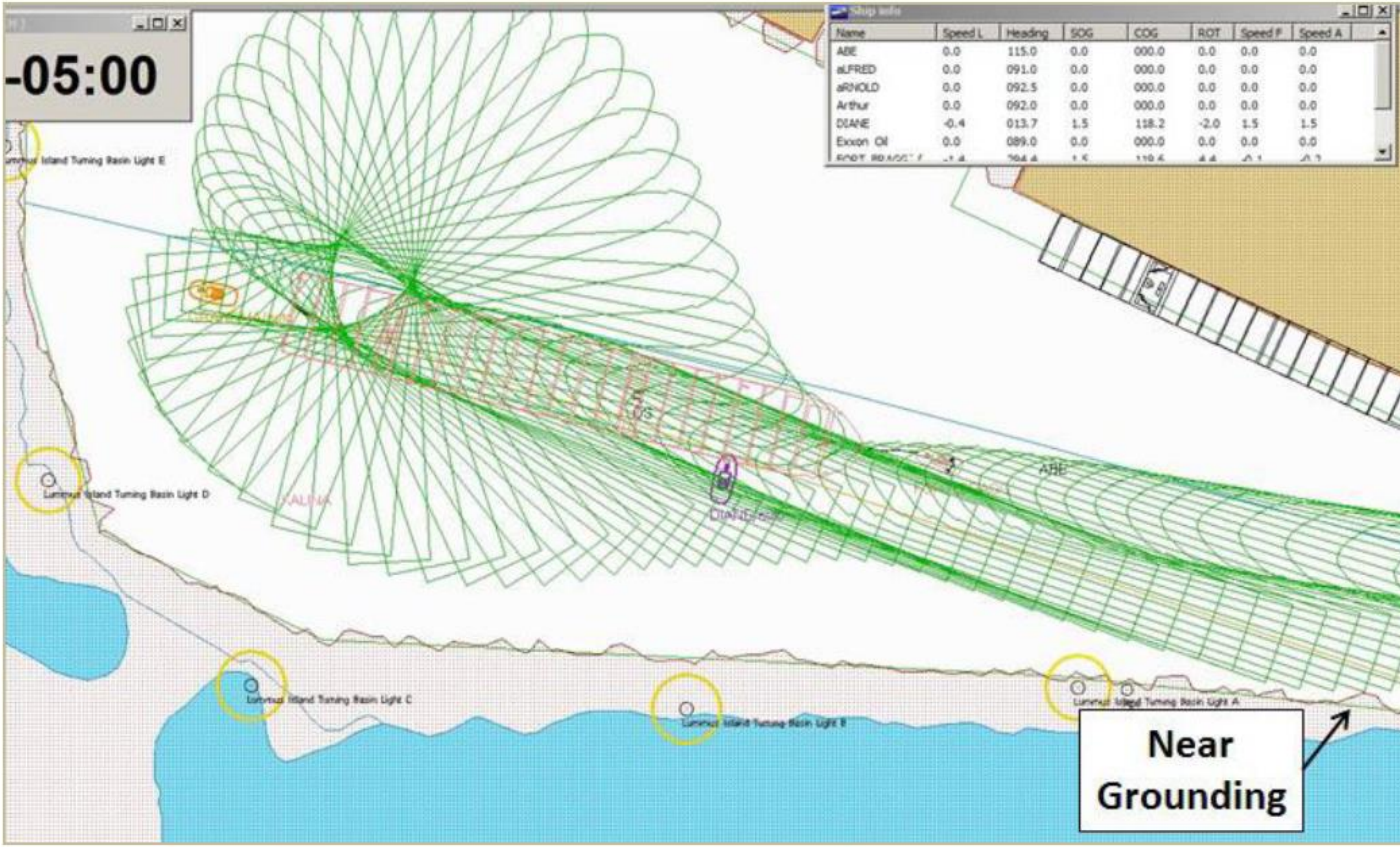


Figure 14: Run 16 - *Kalina* 14m - Wind N-15 – Current #19 - 3-60t ASDs

Can it get to your garage?

How many tugs?

What about:

- Wind?
- Current?
- Traffic?

What if it goes Wrong?

Feasibility and simulation Studies

Develop “best practices” for safe navigation transits

Simulation Studies

Customers are usually Port Authorities and/or Pilot Organizations

Results are a consensus of experts

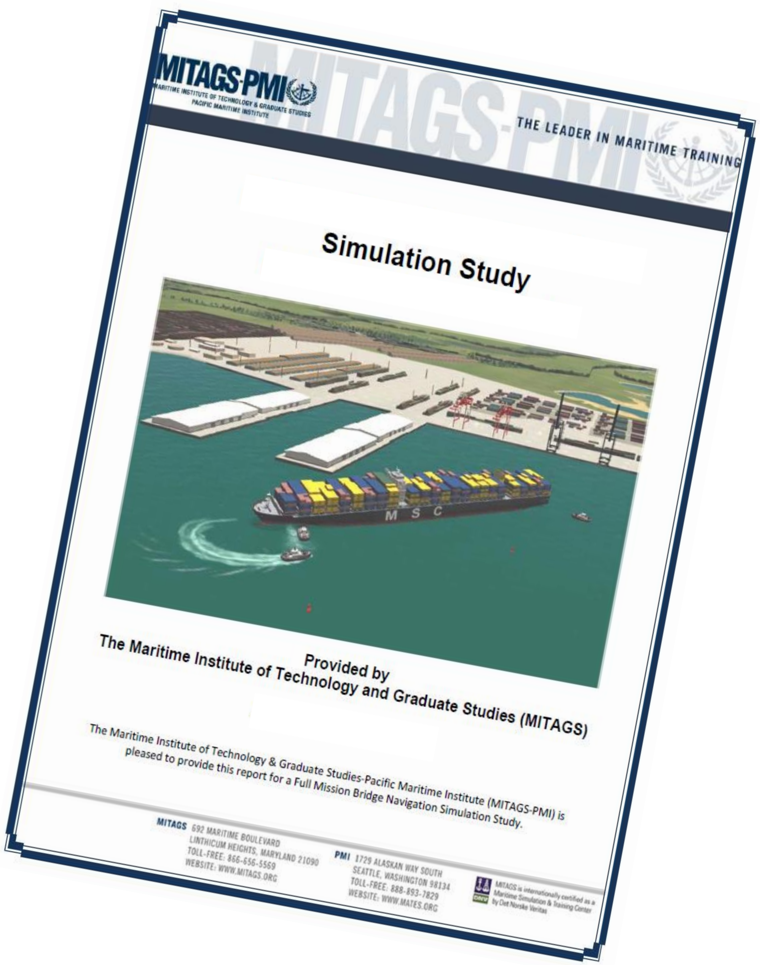
- Ship Masters
- Tug Masters
- Pilots

Simulation Studies

Objective: Actionable Data

- How many tugs?
  - Type
  - Bollard Pull
- Wind Limitations
  - Speed and direction
- Current Limitations
  - Time before and after slack
- Visibility Requirements
  - Day/Night/Fog/Obstructions

Elements of a Simulation Study



Elements of a Simulation Study

Full-Mission Simulators

- Ship bridge
- 2 or more live tug bridges
- Additional tugs operated from the simulator control console.

Table 2-1: Hydrodynamic Ship Models				
	14,000 TEU	16,000 TEU	16,000 TEU	18,000 TEU
Hydrodynamic Model	MSC Kalina Class	Container London	Container Ben Franklin	Triple E
Bridge Location	Mid	Mid	Mid	Mid
Length	366m/ 1,201'	399m/ 1,309'	399.2m/ 1,310'	399m/1,308'
Beam	51.2m/ 68'	54m/ 177'	54m/177'	59m/193.5'
Trim	Even	Even	Even	Even
Load Draft 1	12.8m/42'	12.8m/42'	12.8m/42'	14.9m/49'
Load Draft	14.9m/49'	14.3m /47'	14.9m/49'	12.8m /42'
Engine kW and Propeller	Low Speed Diesel, 73,340kW Single Screw Right, FPP	Low Speed Diesel, 80,080kw Single Screw, Right, FPP	Low Speed Diesel, Single Screw, Right, FPP	Low Speed Diesel, Twin Screw FPP
Rudder Type	1, Semi suspended	Normal Balanced	Normal balanced	2, Semi suspended
Thrusters	Bow 2 @ 1,700kW each	Bow 2 @ 1,800kW each	Bow 2 @ 2043kW each	Bow 2 @ 2,500kW each
Chock and Bitt SWL and bollard pulls	75 mt	NA	NA	NA

Elements of a Simulation Study

Hydrographic Data:

- Latest NOAA electronic charts
- Updated depth contours based on the USACE and/or client soundings

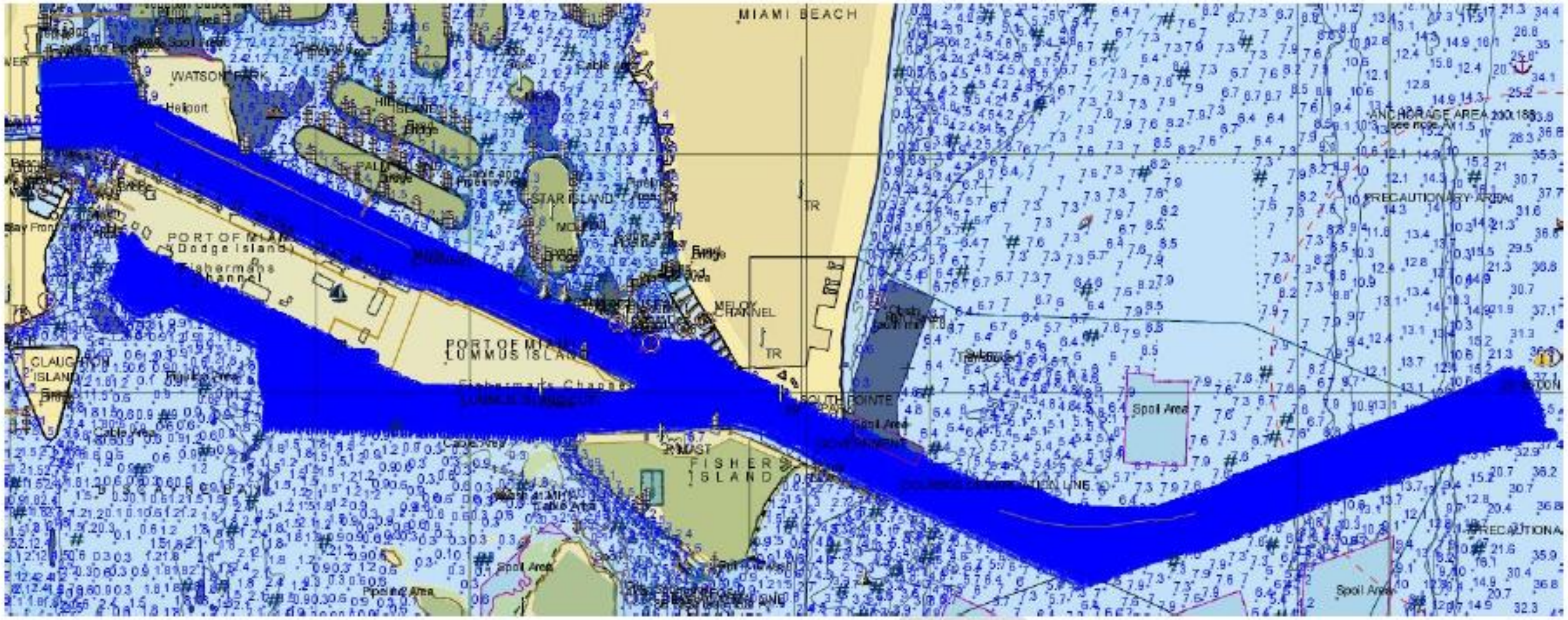


Figure 3-1: Display of database incorporating recent bathymetric survey (shown by high density of blue points)

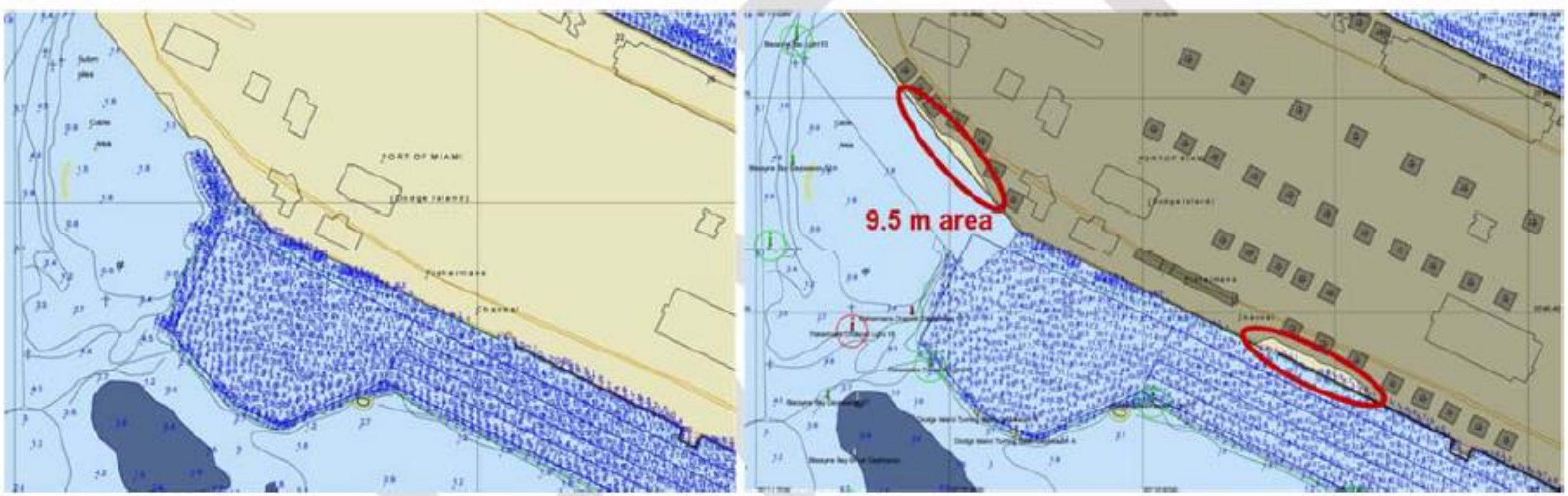


Figure 3-2: Database adjustments

Elements of a Simulation Study

Hydrographic Data:

- Water current models
  - USACE
  - Waterway Simulation Technology, Inc.

Figure 3-3: Current file #7 – ESE max flood, full northerly offshore current

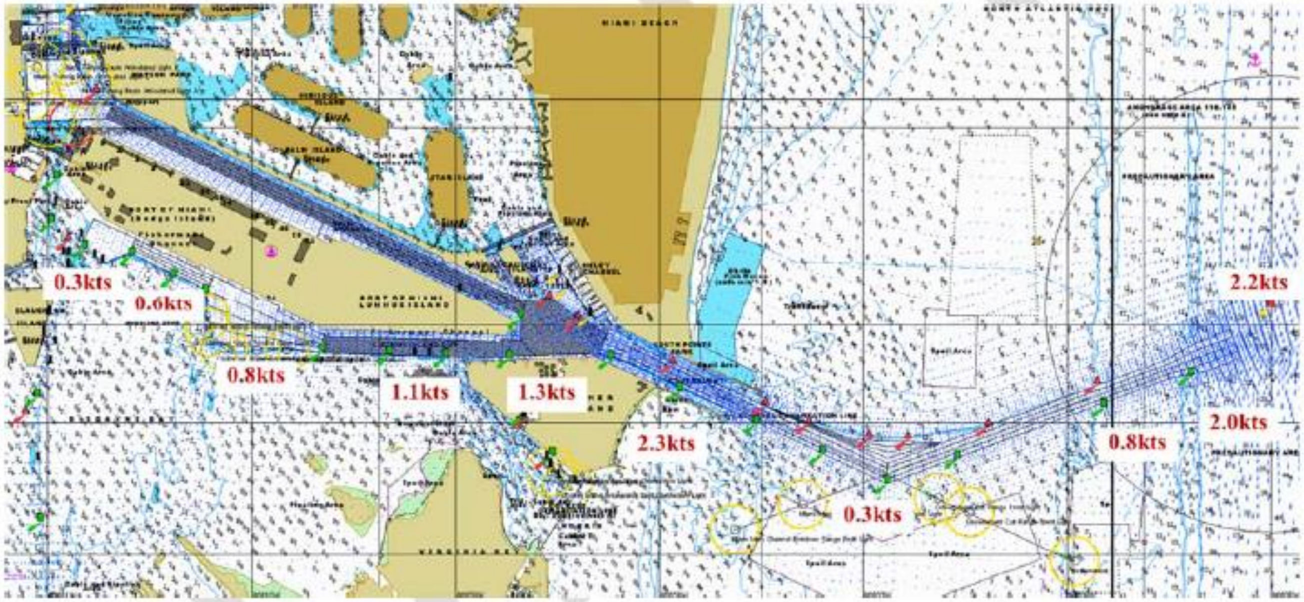


Figure 3-4: Current file #15 – NE max flood, full southerly offshore current

Elements of a Simulation Study

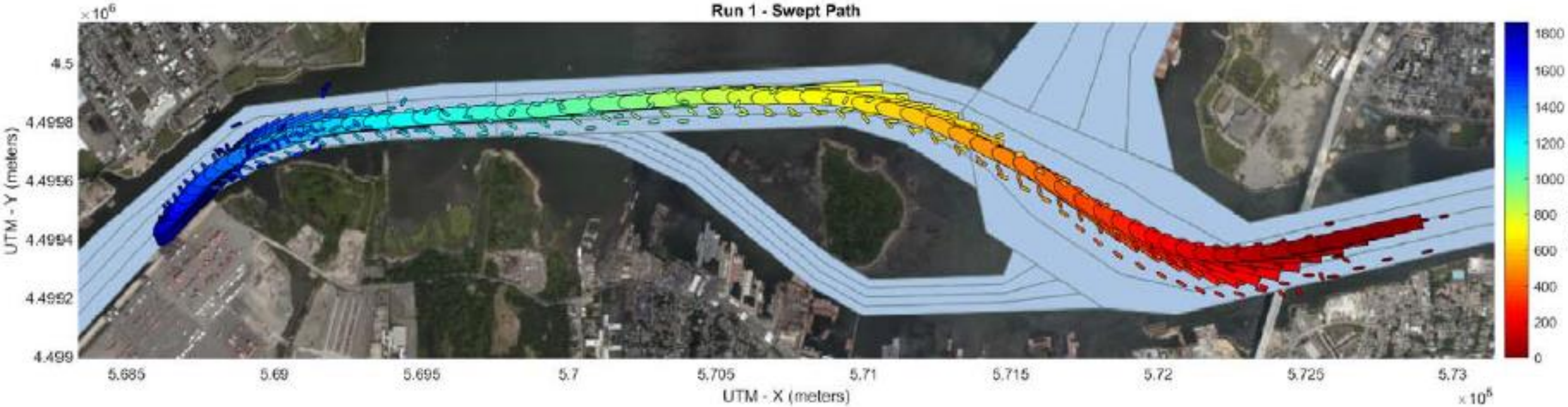
- Client provided data in AutoCAD
- Google Earth

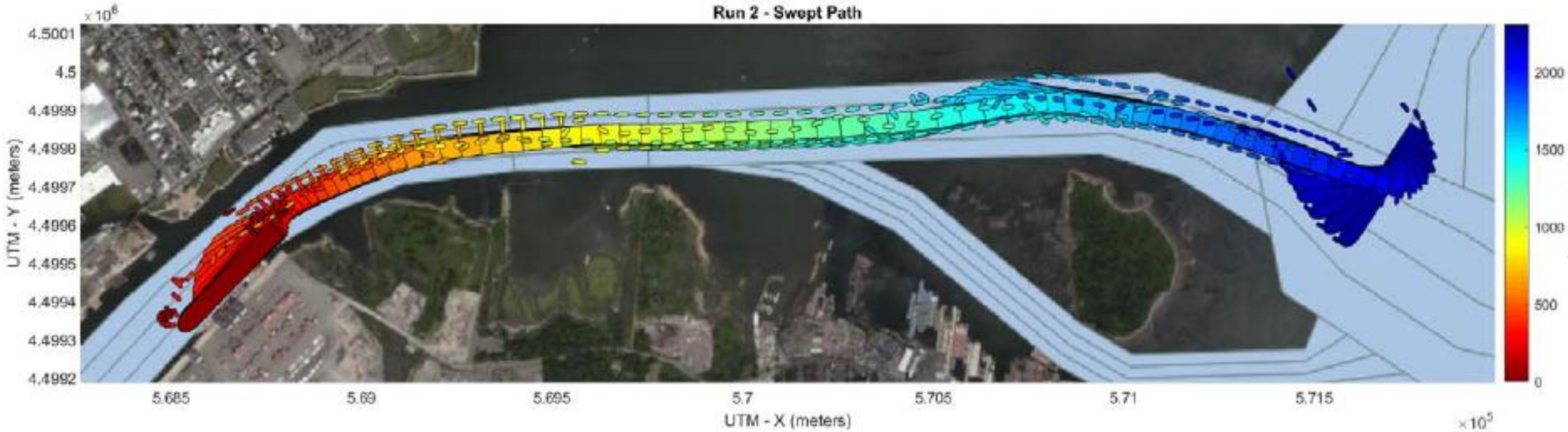
5 TEST MATRIX

Table 5-1: Test Matrix

Run	Model	Draft	Location	Transit Dir	Wind Speed	Wind Dir	Current	Current File	Tide	Pilot
1	Kalina	49 ft		In	0 kt	0	0	0	4 ft	
2	Kalina	49 ft		Out	0 kt	0	0	0	4 ft	
3	Ben Franklin	49 ft		Out	10 kt	W	Flood	3124	4 ft	
4	Ben Franklin	49 ft		Out	20 kt	E	Flood	3123	4 ft	
5	Ben Franklin	49 ft		Out	20 kt	W	Flood	3123	4 ft	
6	Ben Franklin	49 ft		Out	20 kt	NE	Flood	3123	4 ft	
7	London	47 ft		Out	20 kt	NE	Flood	3123	4 ft	
8	London	47 ft		Out	20 kt	SW	Flood	3123	2 ft	
9	London	47 ft		Out	20 kt	NE	Flood	3135(1.25)	2 ft	
10	Ben Franklin	42 ft		Out	20 kt	SE	Ebb	3126(1.25)	0 ft	
11	Ben Franklin	42 ft		Out	25 kt	N	Ebb	3126(1.25)	0 ft	
12	Ben Franklin	42 ft		Out	25 kt	NW	Ebb	3126(1.25)	0 ft	
13	Ben Franklin	42 ft		Out	25 kt	E	Ebb	3126(1.25)	0 ft	
14	London	42 ft		Out	20 kt - 25 kt gusting	NE	Ebb	3126(1.25)	0 ft	
15	Kalina	49 ft		In	20 kt - 25 kt gusting	N	Flood	3124	4 ft	
16	Kalina	49 ft		Out	20 kt - 25 kt gusting	N	Flood	3124	4 ft	
17	Kalina	49 ft		Out	20 kt - 25 kt gusting	NW	Flood / Ebb	3124/ 3126	4 ft	
18	Kalina	49 ft		Out	20 kt - 25 kt gusting	SE	Flood	3124	4 ft	
19	Kalina	42 ft		In	20 kt	SE	Ebb	2357	0 ft	
20	Kalina	42 ft		Out	20 kt - 25 kt gusting	SE	Ebb	2357	0 ft	
21	Kalina	42 ft		In	20 kt	NW	Ebb	2357	0 ft	
22	Kalina	42 ft		Out	20 kt	NW	Flood	3124	0 ft	
23	Kalina	42 ft		In	20 kt	NE	Ebb	2357	0 ft	
24	London	42 ft		in	15 kt	NW	Ebb	2357	0 ft	
25	London	42 ft		out	20 kt	NW	Ebb	2357	0 ft	
26	London	49 ft		In	20 kt	NW	Flood	3124	4 ft	
27	London	49 ft		Out	20 kt	NE	Flood	3124	4 ft	
28	London	49 ft		Out	20 kt	NE	Flood	3124	4 ft	
29	Triple E	49 ft		In	20 kt	SE	Flood	3124	4 ft	
30	Triple E	49 ft		Out	20 kt	NW	Flood	3124	4 ft	
31	Triple E	49 ft		Out	20 kt	NW	Flood	3124	4 ft	
32	Triple E	42 ft		Out	20 kt - up to 25 kt at 12:34	NW	Flood	3124	4 ft	
33	Kalina	42 ft		In	25 kt	NW	None		4 ft	
34	Kalina	42 ft		In	25 kt	NW	None		4 ft	

Swept Path Analysis





Run	Model	Draft	Location	Transit Dir	Wind Speed	Wind Dir	Current	Current File	Tide
23	Kalina	42 ft		In	20 kt	NE	Ebb	2357	0 ft

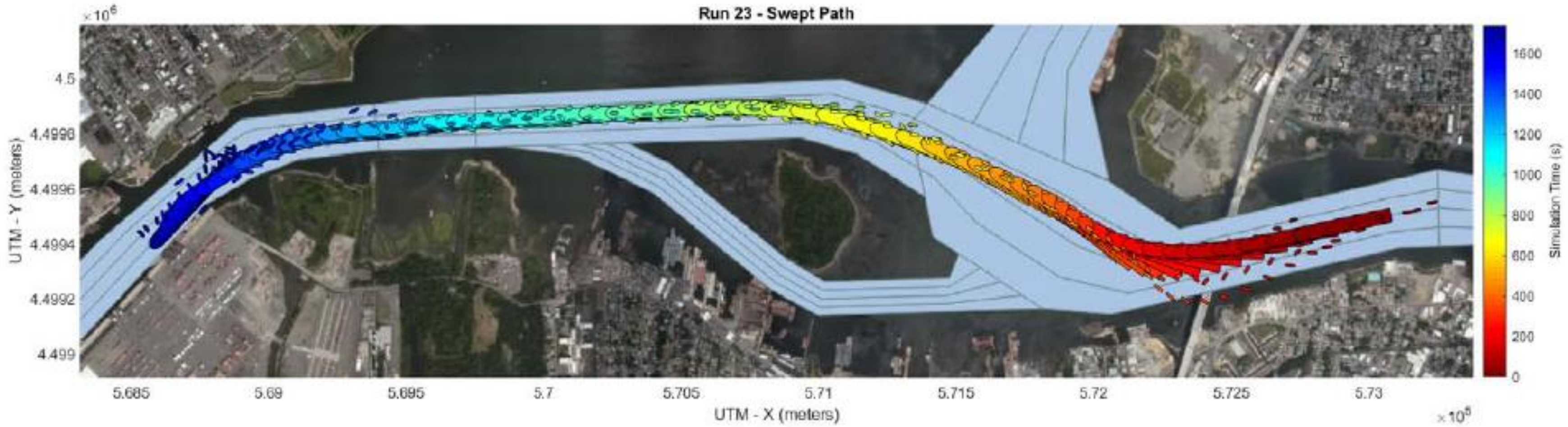


Figure 6-23: Run 23

Run	Model	Draft	Location	Transit Dir	Wind Speed	Wind Dir	Current	Current File	Tide
24	London	42 ft		in	15 kt	NW	Ebb	2357	0 ft

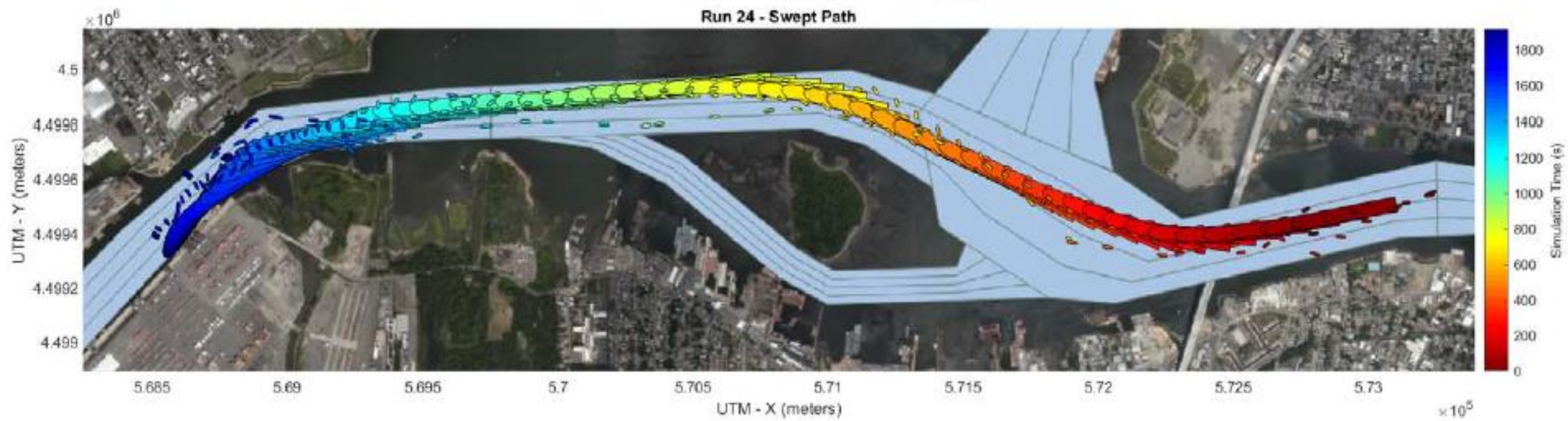
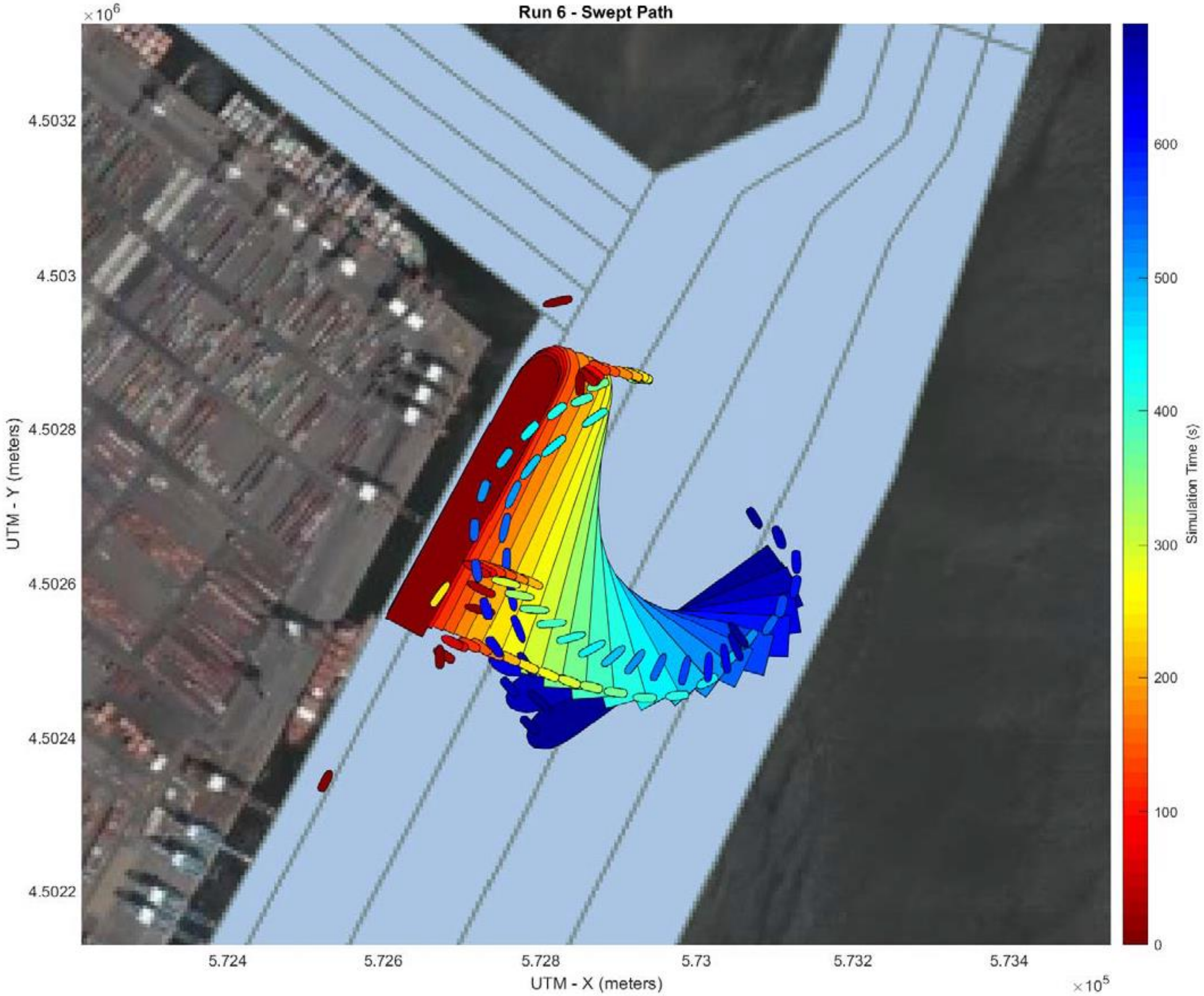


Figure 6-24: Run 24 –


Run 6 - Swept Path
×10^6
4.5032
4.503
4.5028
4.5026
4.5024
4.5022
UTM - Y (meters)
5.724
5.726
5.728
5.73
5.732
5.734
×10^5
UTM - X (meters)
Simulation Time (s)
0
100
200
300
400
500
600

Recommendations

Based on the information gained from:

- Local Pilots
- Tug operators
- Experienced Masters
- Multiple runs under varying conditions

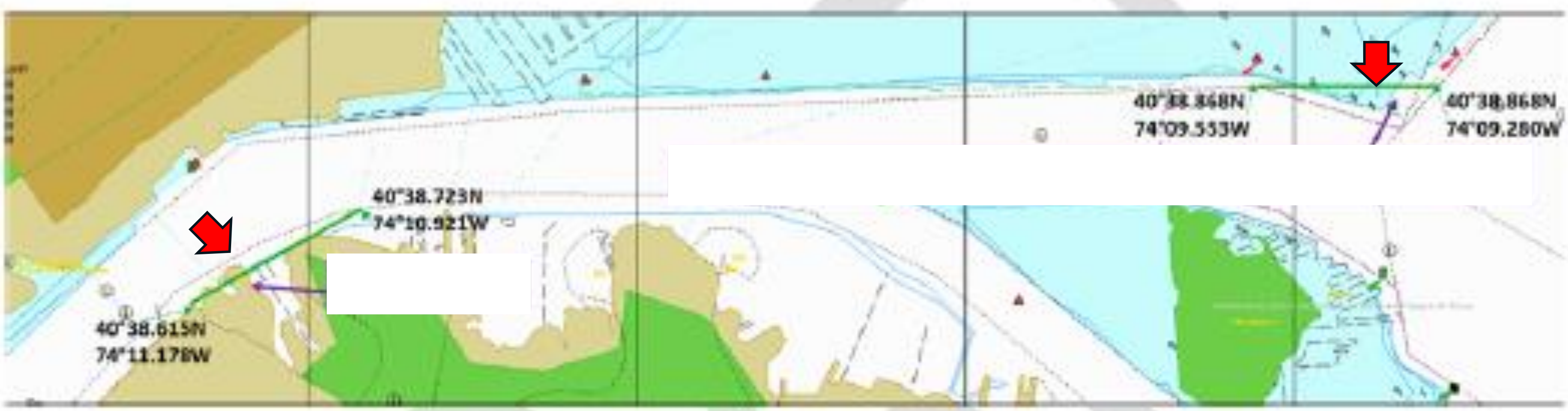
7 FINDINGS CONCLUSIONS AND RECOMMENDATIONS

7.1

Based on the local pilots' input, the following are recommendations :

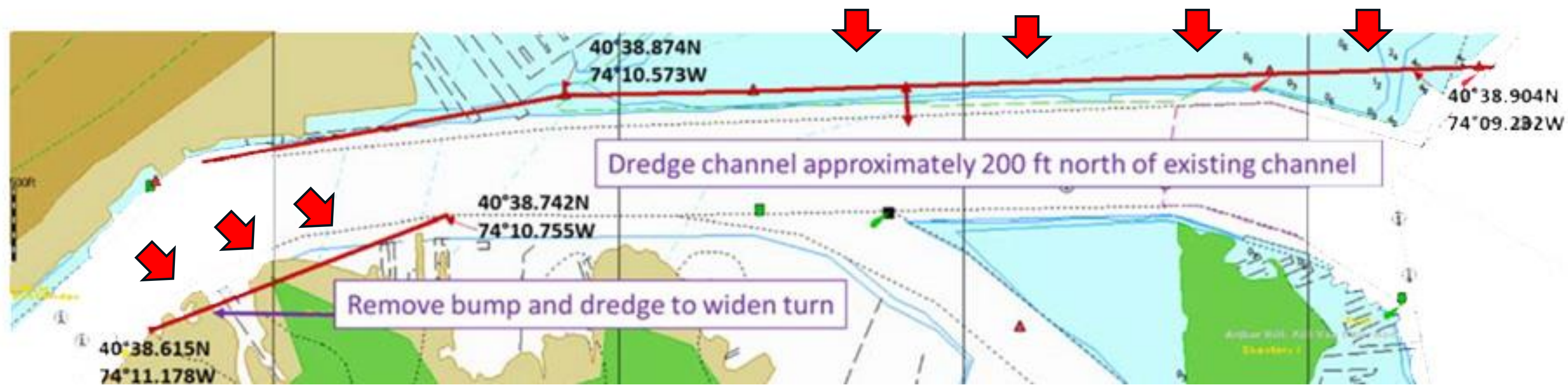
For 14,000 TEU vessels :

- Tugs - 2 conventional (45 t or greater) and 2 tractor (75 t or greater)
- Wind: 20 kts or less
- Current: 1 hour on either side of slack water
- Visibility: 1.5 nm or higher
- Channel modifications: (as shown by green lines in image below)
    - Remove bump
    - Remove notch



For 16,000/18,000 TEU Vessels

- Tugs - 4 tractor (65 to 85 t)
- Wind: 20 kts or less
- Current: 1 hour on either side of slack water at
- Visibility: 1.5 nm or higher
- Channel modifications: (as shown by red lines in image below)
    - Remove bump
    - Widen and deepen



8. APPENDIX C – 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		Yes	4.2 SOG	NA	I believe tug effect was exaggerated - fwrd centered tug not realistic	Yes	Slightly left of path at Bergen Point approach	1	Tugs displayed more than available if more than one ship moving	8	3	
2		Yes	NA	NA	Yes	Yes	No	8		3	8	
3		Yes, set approaching terminal bridge with flood and a lot of		Turning into E Channel North Set was significant	Yes	No turning into PE Channel North set was significant	Closer to corner at PE	8		8	7	
4		Yes	4-5 kts	NA	Yes	Yes	No	10		2	9	None at this time
5		Yes	4 SOG	NA	I believe ROT increase faster than realistic	Yes	No	9		5	8	
6		Closer to shoal than comfortable. Flood was increased above what is usual	3.5 - 4.5 kts	NA	Yes	Marginal	Yes, less current	8		8.5		Runs should be done with real time current
7		Yes	3 SOG	NA	Yes to current; do not think wind effect was accurate as compared to real conditions	Yes	No	7	Conventional tugs used at 1/2 power to make effect realistic	8	4	

9. APPENDIX D - TUG MASTER EVALUATION COMMENTS

Run	Captain	1. Able to make fast at requested location?	2. Successfully respond to order?	3. Use full power for more than 5 minutes?	4. Able to maintain a safe CPA from shoals?	5. Tug model respond as expected?	6. Modify approach to run?	7. Tug behavior and reserve capacity	8. Qualifiers	9. Run difficulty	10. Tug safety	11. Qualifiers
1		Yes	Yes	Yes, full power was used as directed by pilot. I feel in real world tug would not have held up as easily	Yes	No, sluggish to respond	No	5	Possible system error; reset router for next exercise	3	8	Keep speed through water below 6 kts
2		Yes	Yes	No	Yes	Yes	No	8		1	9	
2		Yes	Yes	No	Yes	Yes, bollard pull a little low for indirect pull	No	10	ASD tug, centerlead aft, max bollard pull of 60 t; STW 6.5 indirect pull	1	1	
3		Yes	Yes	No	Yes	Too reactive, engineer RPM not right	No	5		1	8	
3		Yes	Yes	No	Yes	Yes	No	10	ASD tug, centerlead aft, max bollard pull of 85 t; STW 2 direct pull	1	1	
4		Yes	Yes	Yes, as given by pilot	Yes	Yes	No	8		1	7	
4		Yes	Yes	No	Yes	Throttles very slow	No	7	Port bow, ebb tide 1.3 kts	1	10	

Garbage in Garbage out

An accurate study requires:

- Accurate ship model
- Channel data
- Tide and current

Limitations of simulation study

Won’t show:

- Actions of other vessels

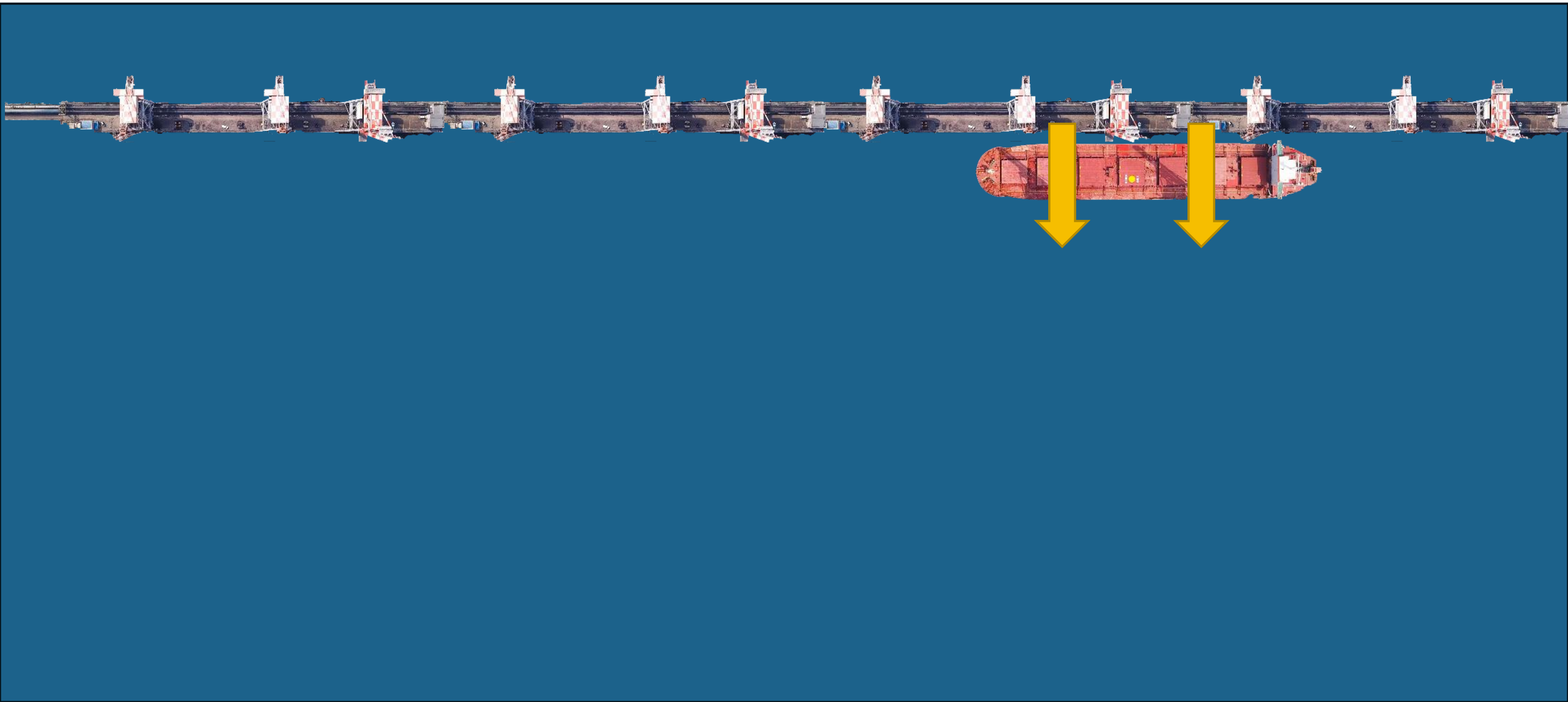
Limitations of simulation study

- Human error

Limitations of simulation study

Won't show:

- Force exerted on moored vessels



The ULCVs are Here!

Tools in the Toolbox

- Make more informed decisions
- Avoid catastrophic accidents
- Prevent becoming famous

Thank You

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