



DEPARTMENT OF THE ARMY
ENGINEER RESEARCH AND DEVELOPMENT CENTER, CORPS OF ENGINEERS
COASTAL AND HYDRAULICS LABORATORY
WATERWAYS EXPERIMENT STATION, 3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

CEERD-HN-ND

09 MAR 2010

MEMORANDUM FOR Commander, US Army Engineer District, Savannah (CESAS-EN-H/
Mr. Wilbur Wiggins), PO Box 889, Savannah, GA 31402-0889

SUBJECT: Savannah Harbor Entrance Channel Simulations 2010 Report

1. Introduction. During 2002 and 2003 the U.S. Army Engineers, Engineer Research and Development Center (ERDC) conducted a ship simulator based navigation study for the U.S. Army Corps of Engineers District, Savannah (SAS). In November 2009, SAS contacted ERDC to revisit that study and conduct additional simulations for two different alignments for the Entrance Channel (Figure 1). The alignment changes, or doglegs, were proposed so that when the Entrance Channel is deepened, it will reach naturally deep water in less distance. This will reduce dredging costs. Three doglegs were originally proposed. However, this study focused on alignments S-3 and S-8.

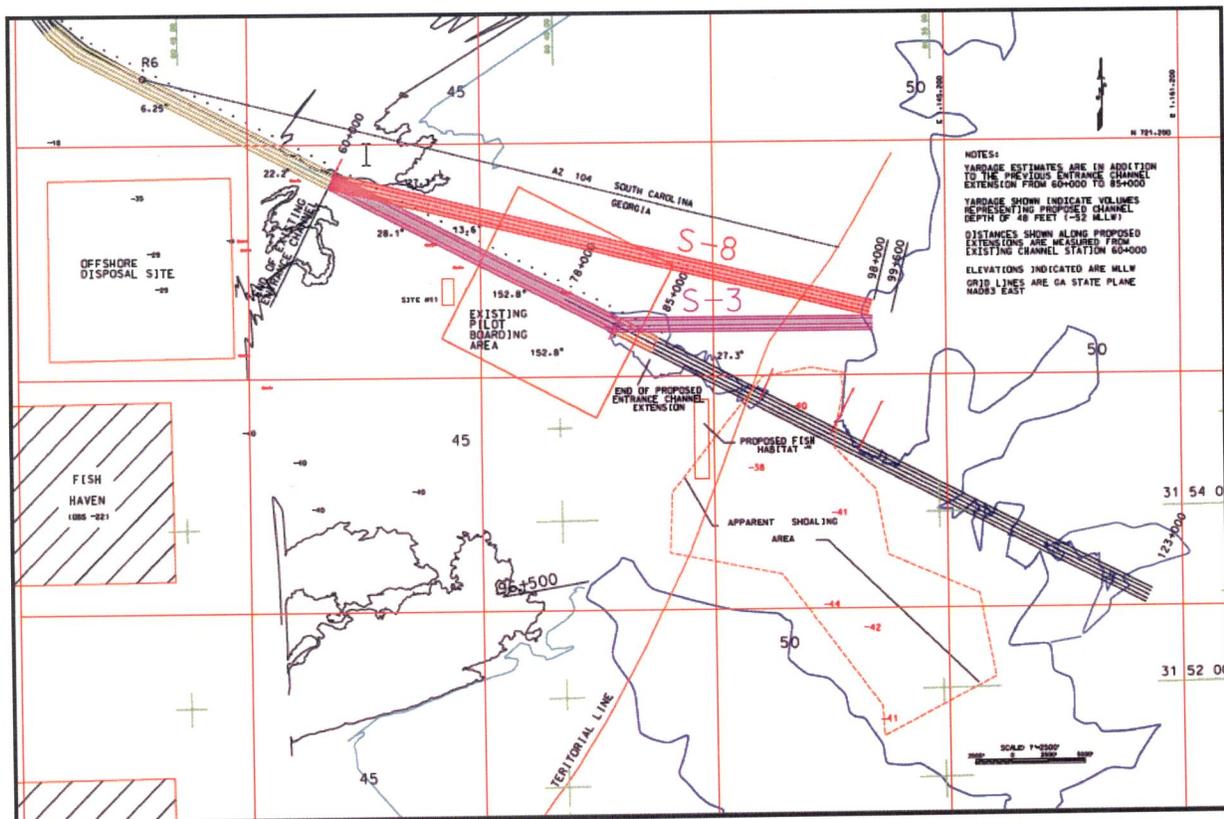


Figure 1. Entrance Channel

2. Model Development. The simulation databases from the earlier study were modified to reflect alignments S-3 and S-8. Currents and waves for the proposed alignments were modeled in separate ERDC studies (Brown, in preparation and Briggs, in preparation). Maximum flood and ebb currents from the hydrodynamic model were added to the simulator database. Bend wideners were added to both alignments (Figure 2). The bend wideners were designed by setting the inside corner back 700 ft on each side and then connecting those endpoints. Inbound ranges were also built for each alignment in the visual scene and radar.

3. Model databases were developed for eight different configurations. They were:

- a. S-3
- b. S-3 with widener
- c. S-3 with ranges
- d. S-3 with widener and ranges
- e. S-8
- f. S-8 with widener
- g. S-8 with ranges
- h. S-8 with widener and ranges

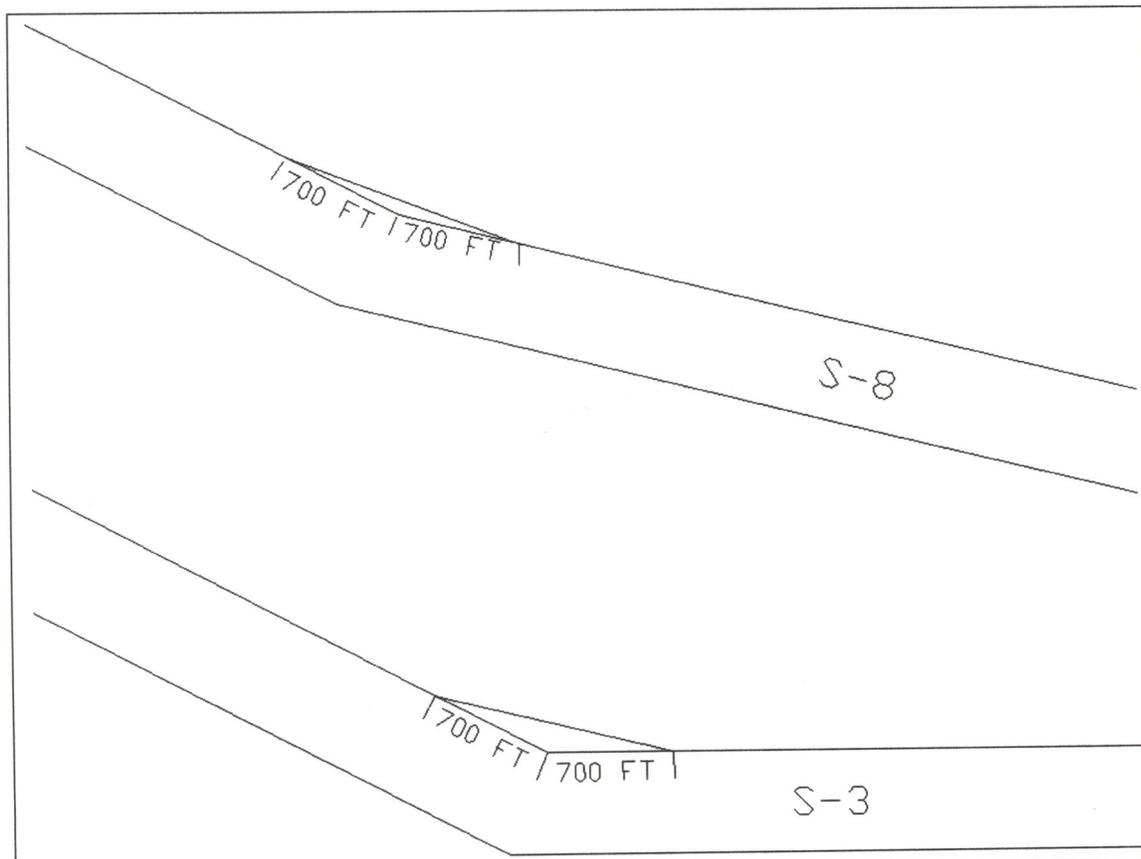


Figure 2. Bend Wideners

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4. Testing. Simulation testing was conducted over a 2 week period at the ERDC Ship/Tow Simulator in Vicksburg, MS. Exercises were run over a 3 day period for each of the 2 weeks. Four pilots participated in the study. They were Captains William T. Browne III, George W. Henry, Jr., Rick Wesley and Trey Thompson. All four are members of the Savannah Harbor Pilots Association.

5. The simulation design vessels were the *Susan Maersk*, a 1140- x 140- x 47.5-ft post-Panamax containership and the *SL Performance* a 950- x 106- x 33 ft Panamax containership. Exercises were run inbound and outbound for both maximum flood and ebb currents.

6. Results. Results are shown in the form of composite track plots and final pilot questionnaires. The questionnaires are enclosed. The track plots do not show the entire simulation run. The plots are zoomed in to better show the turn and the approach to the turn.

7. A composite track plot of all inbound runs conducted in the S-8 channel without ranges is shown in Plate 1. One ship left the channel by approximately 25 ft. The composite plot of the same condition for the S-3 channel is shown in Plate 2. Ships left both the north and south side of the channel as they approached the turn. Ships also left the south side of the channel after the turn.

8. A composite track plot of all inbound runs conducted in the S-8 channel with ranges is shown in Plate 3. None of the ships had difficulty making the turn. The composite plot of the S-3 inbound runs with ranges is shown in Plate 4. All ships were able to stay in the channel and make the turn.

9. A composite track plot of all outbound runs conducted in the S-8 channel without ranges is shown in Plate 5. All ships made the turn. The pilots deemed that this run was easy enough without the ranges that there was no need to test the S-8 outbound with ranges. The composite plot of the same condition for the S-3 channel is shown in Plate 6. Seven of the runs left the channel after making the turn. Most left the channel by a large distance. The most any ship left the channel was 250 ft. Runs conducted in the S-3 channel with ranges are shown in Plate 7. They show a significant improvement over the S-3 without ranges, but still some of the ships left the channel.

10. A composite track plot of all inbound runs conducted in the S-8 channel with bend widener and ranges is shown in Plate 8. All runs were successful and the ships remained close to the center of the channel. A composite track plot of all inbound runs conducted in the S-3 channel with bend widener and ranges is shown in Plate 9. One run left the channel by approximately 30 ft.

11. A composite track plot of all outbound runs conducted in the S-8 channel with bend widener and ranges is shown in Plate 10. All runs were successful and the ships remained close to the center of the channel. A composite track plot of all outbound runs conducted in the S-3 channel with bend widener and ranges is shown in Plate 11. Two runs left the channel by approximately 30 ft.

12. A composite track plot of all two-way runs conducted in the S-8 channel with ranges is shown in Plate 12. The ships meet near the bend due to their starting locations. One ship left the channel by about 70 ft. The composite plot of the same condition for the S-3 channel is shown in Plate 13. Several runs left the channel limits, with one ship going completely out of the channel.

13. A composite track plot of all two-way runs conducted in the S-8 with widener channel with ranges is shown in Plate 14. One outbound ship left the channel by approximately 40 ft. A composite track plot of all two-way runs conducted in the S-3 with widener channel with ranges is shown in Plate 15.

14. Conclusions. Based upon the simulation results, both trackplots and pilot questionnaires, the following conclusions are drawn.

a. Without ranges, alignment S-3 was not adequate for these ships. This is true for the alignment with and without the bend widener. One pilot commented that if no ranges were built he would rather be without ranges for the shortest amount of time. However, he did state that ranges were a necessity.

b. The addition of inbound ranges improved both alignments.

c. Alignment S-8 appeared to be adequate for one-way traffic, even without ranges. The addition of ranges and the bend widener allowed for meeting of a Panamax ship with a post-Panamax ship.

d. Crabbing occurs in adverse wind conditions. Under the conditions tested crabbing was not a serious issue. Neither alignment made crabbing more severe.

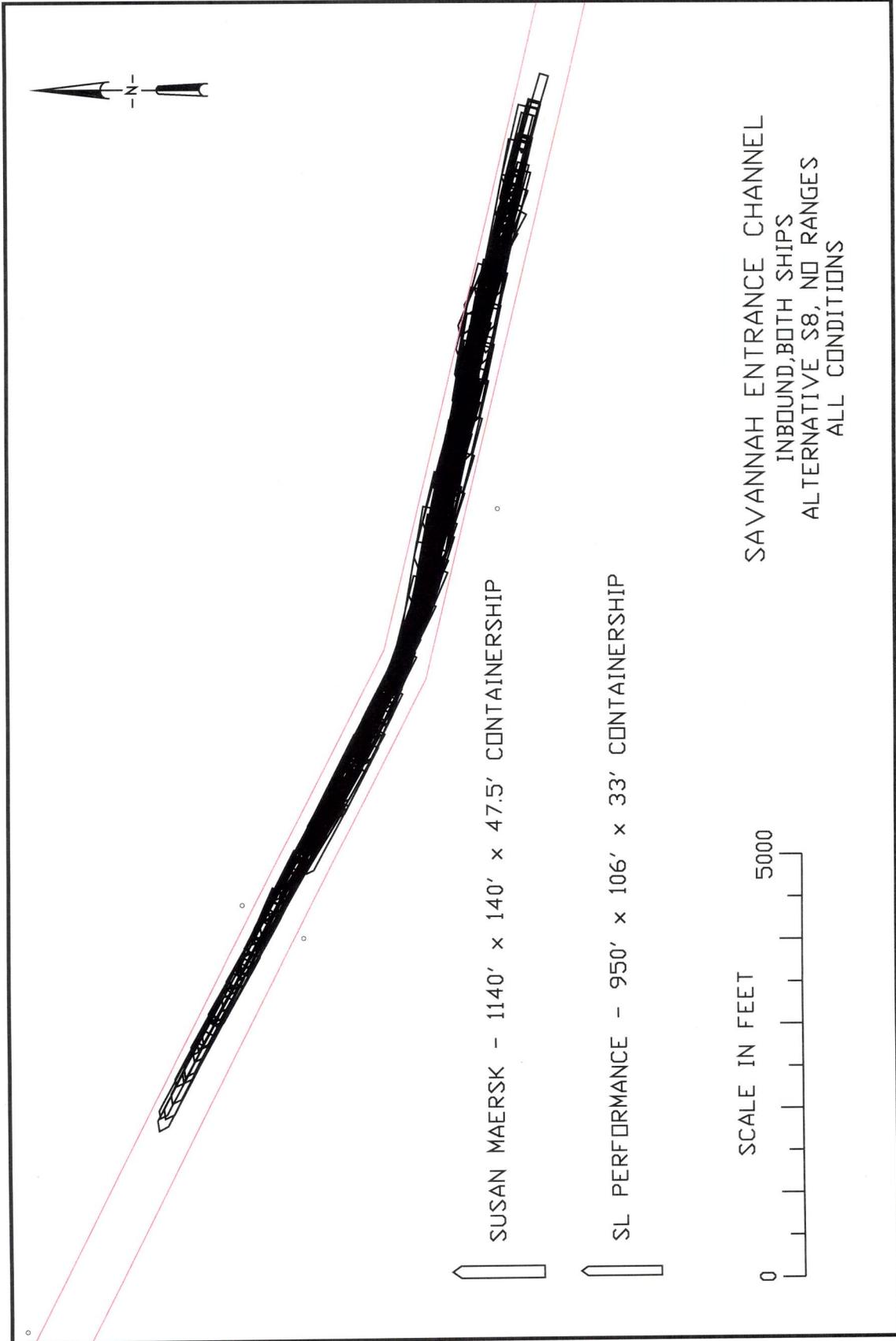
15. Recommendations. Alignment S-8, with ranges and the bend widener, is recommended.

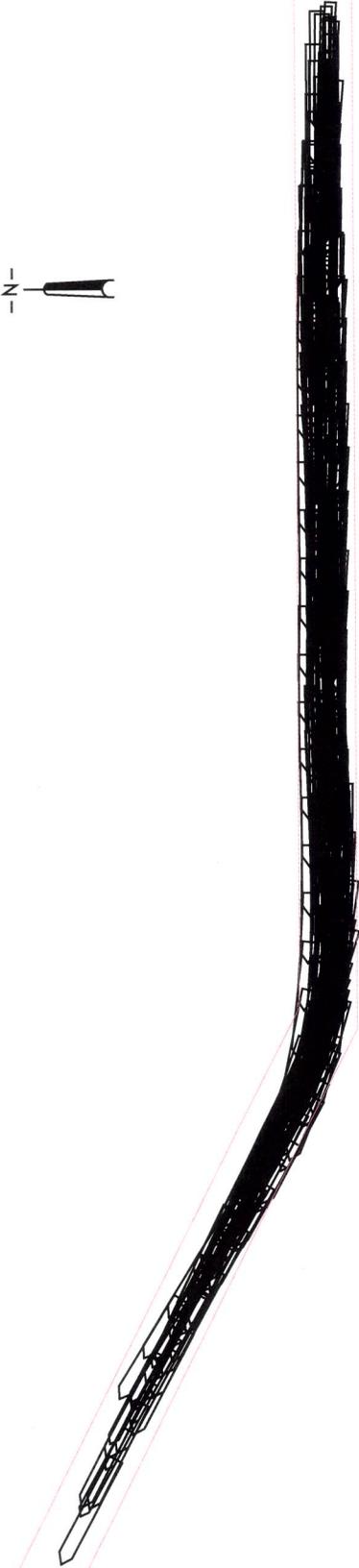
16. If you have any questions contact Mr. Dennis W. Webb at 601-634-2455.

Encl


WILLIAM D. MARTIN, PhD, PE
Director

PLATE 1



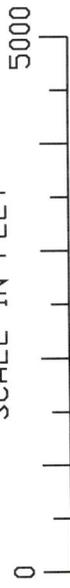


SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S3, NO RANGES
ALL CONDITIONS

SCALE IN FEET



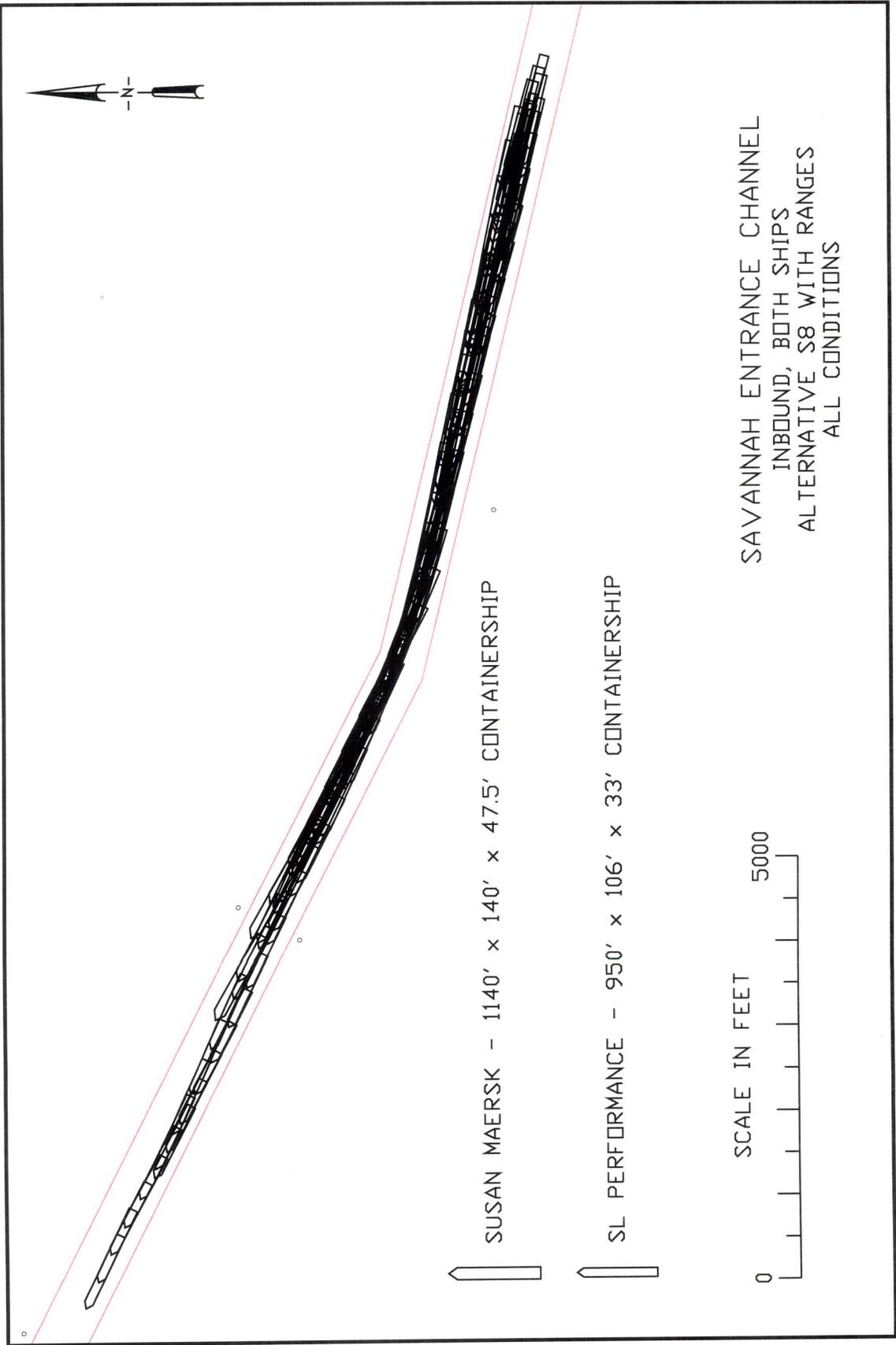
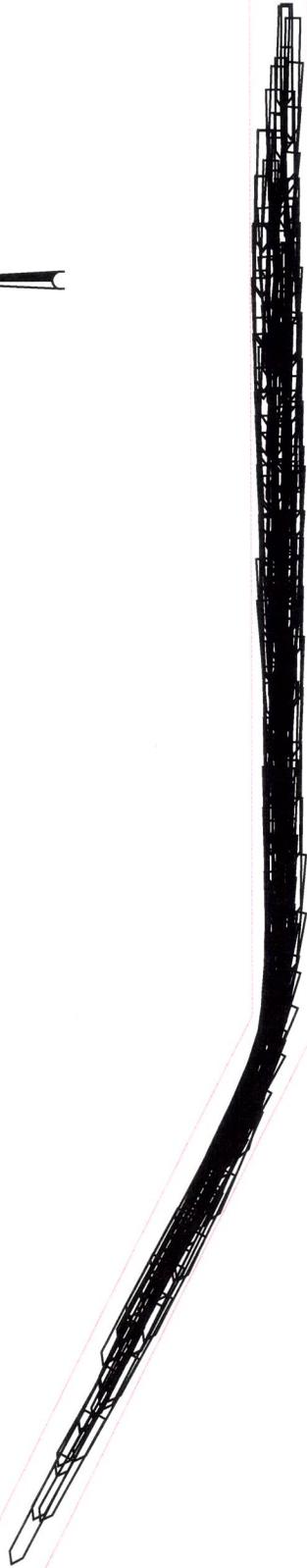


PLATE 3

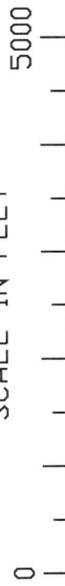


SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

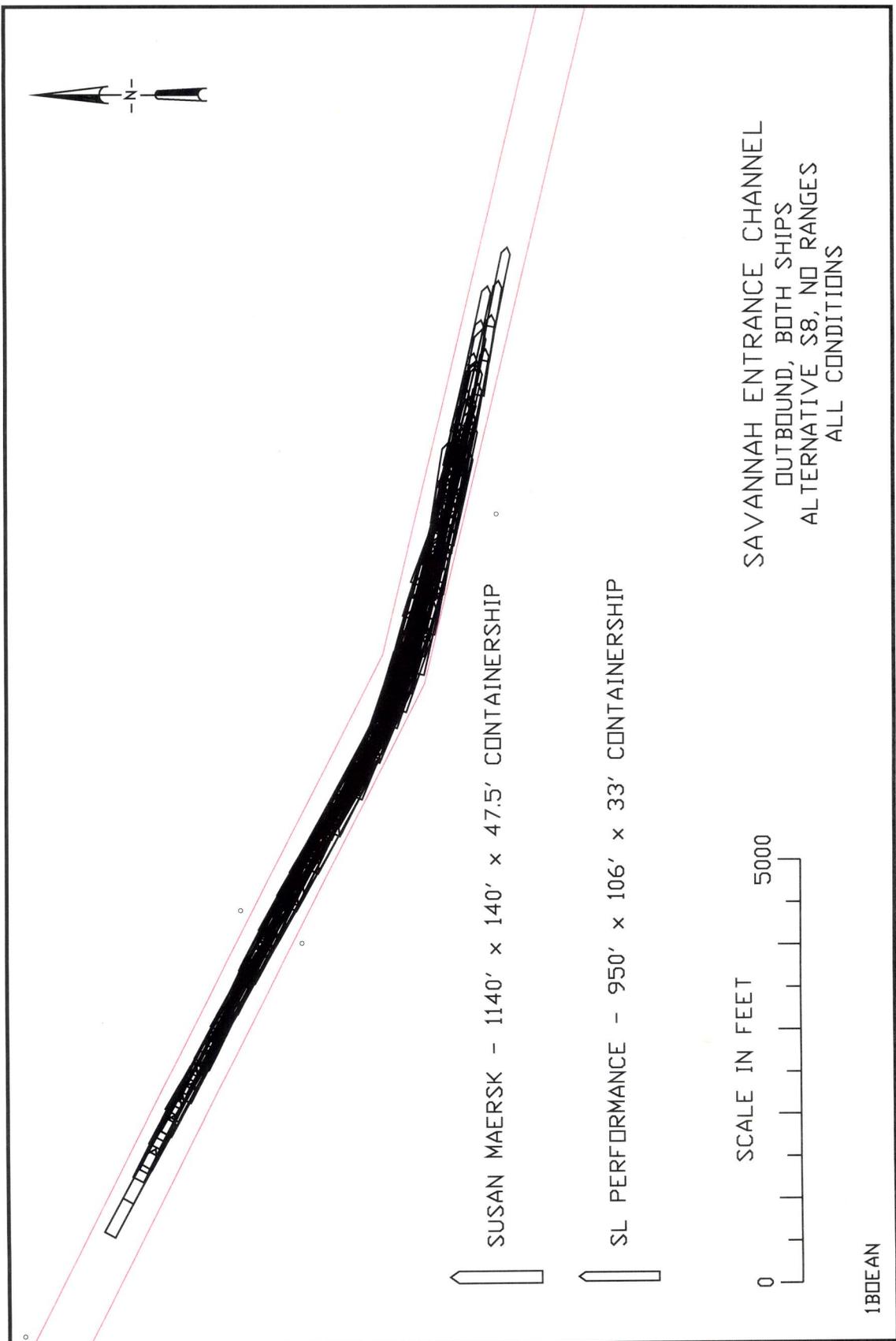
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SAVANNAH ENTRANCE CHANNEL
INBOUND, BOTH SHIPS
ALTERNATIVE S3 WITH RANGES
ALL CONDITIONS

SCALE IN FEET



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SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SCALE IN FEET
0 5000

SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S8, NO RANGES
ALL CONDITIONS

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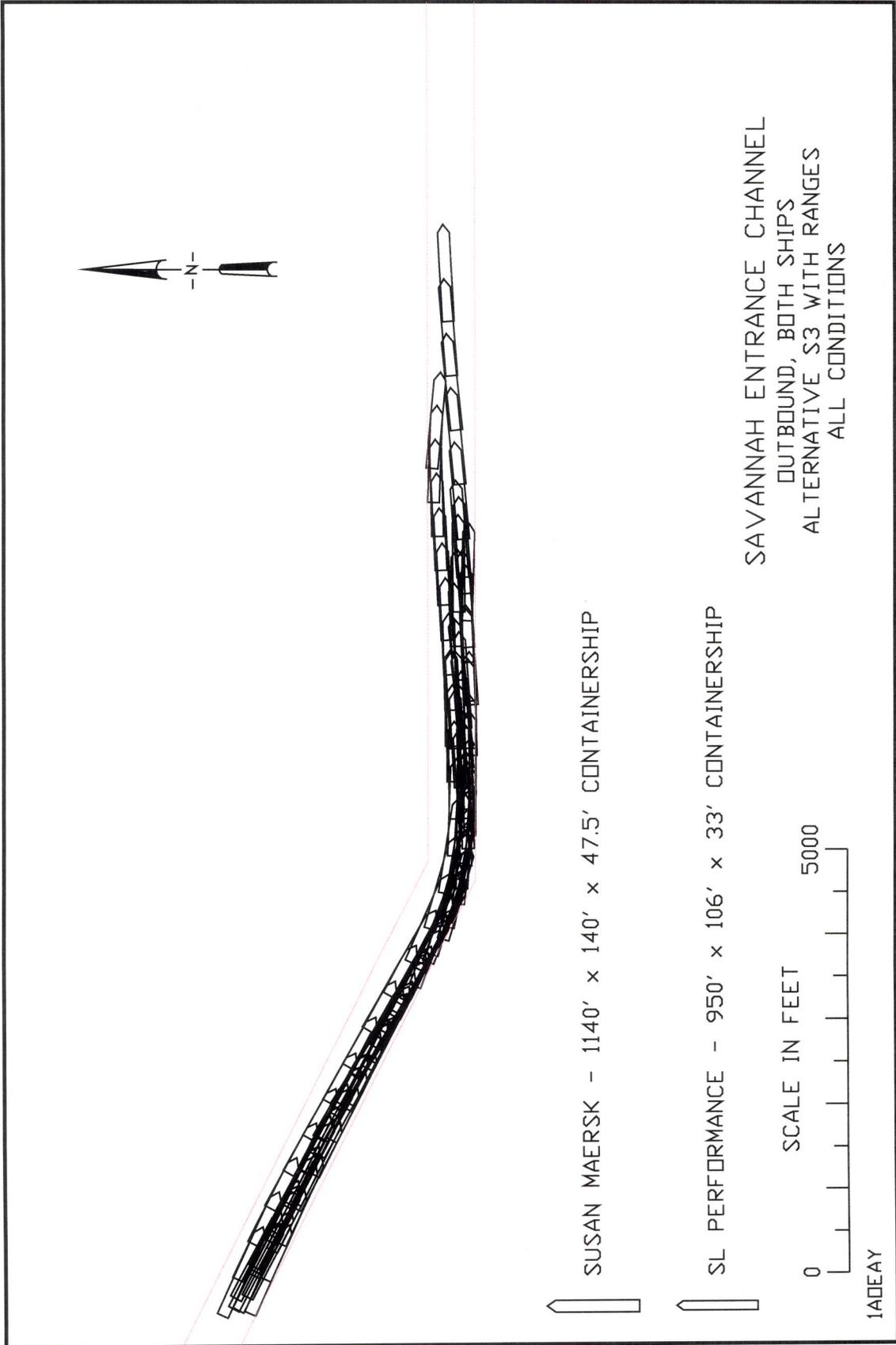
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

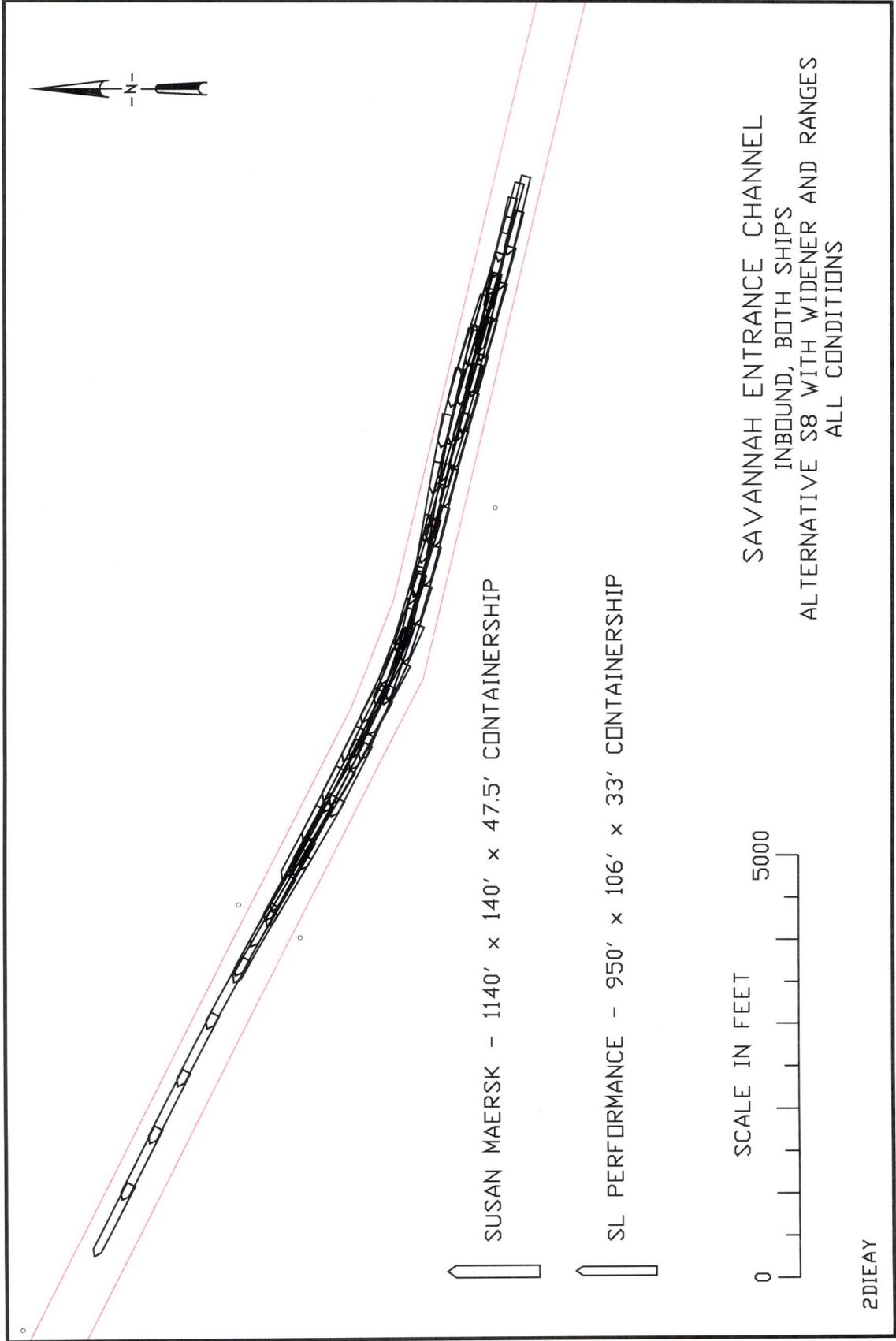
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SAVANNAH ENTRANCE CHANNEL
OUTBOUND, BOTH SHIPS
ALTERNATIVE S3, NO RANGES
ALL CONDITIONS



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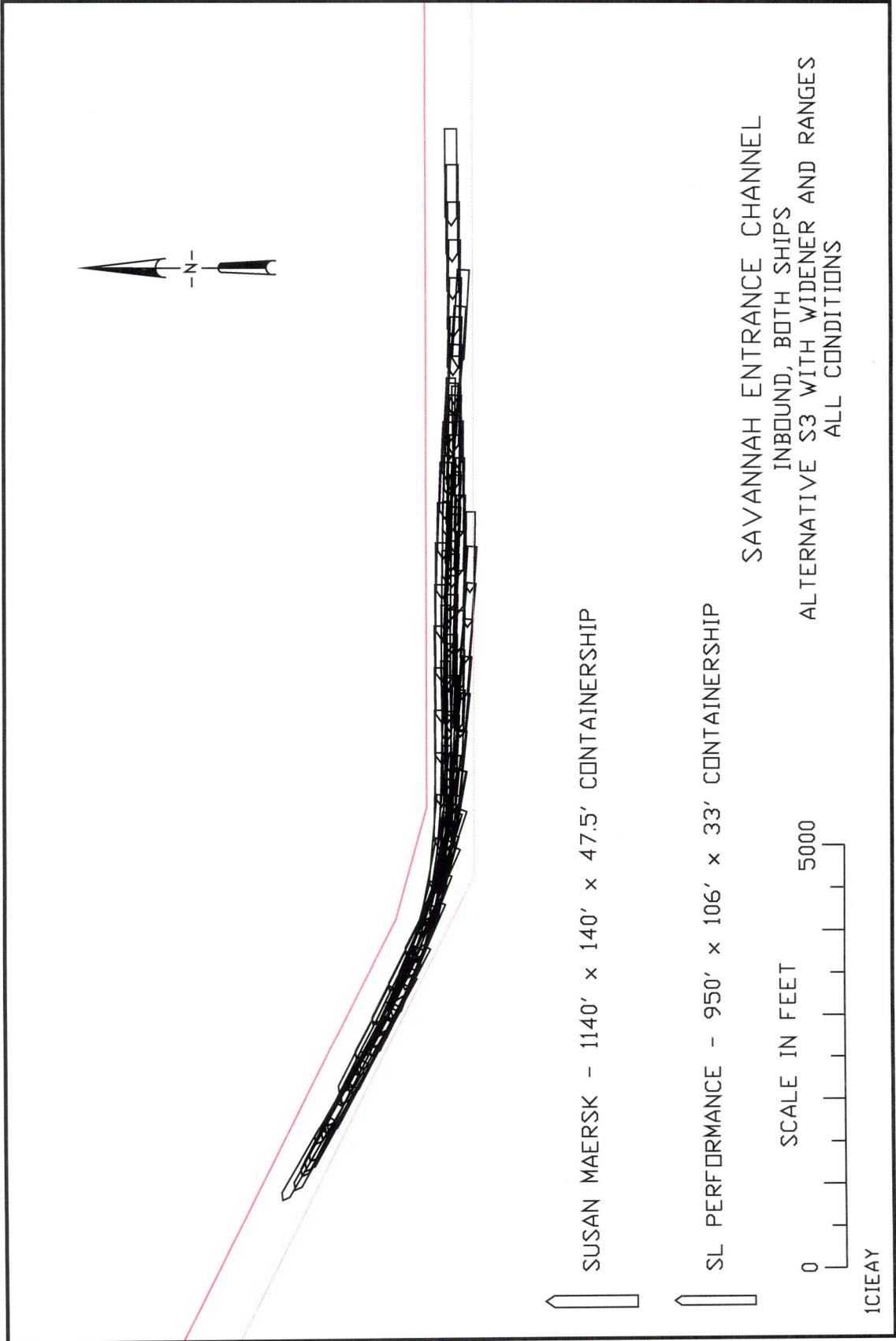
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

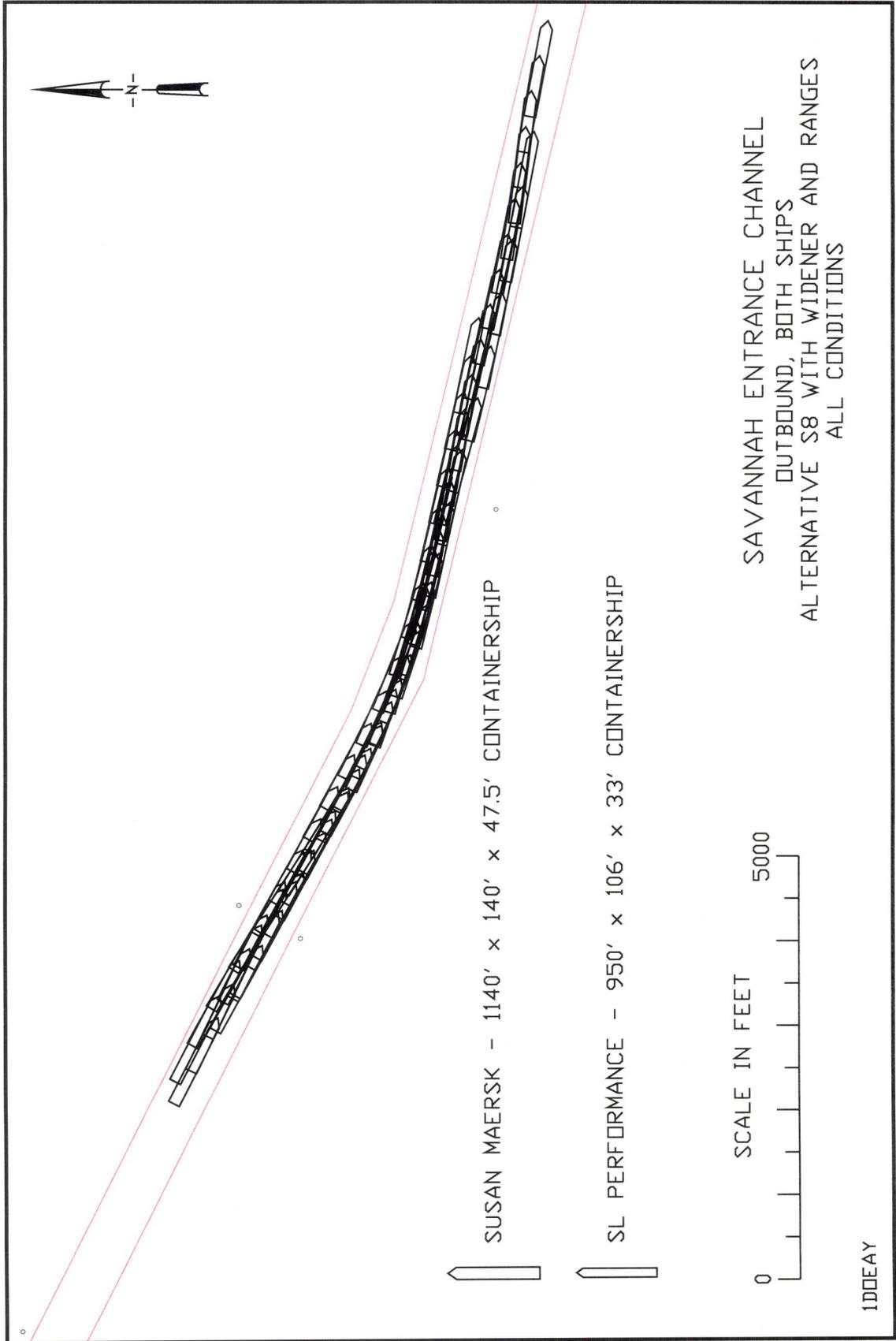
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP



SAVANNAH ENTRANCE CHANNEL
 INBOUND, BOTH SHIPS
 ALTERNATIVE S8 WITH WIDENER AND RANGES
 ALL CONDITIONS

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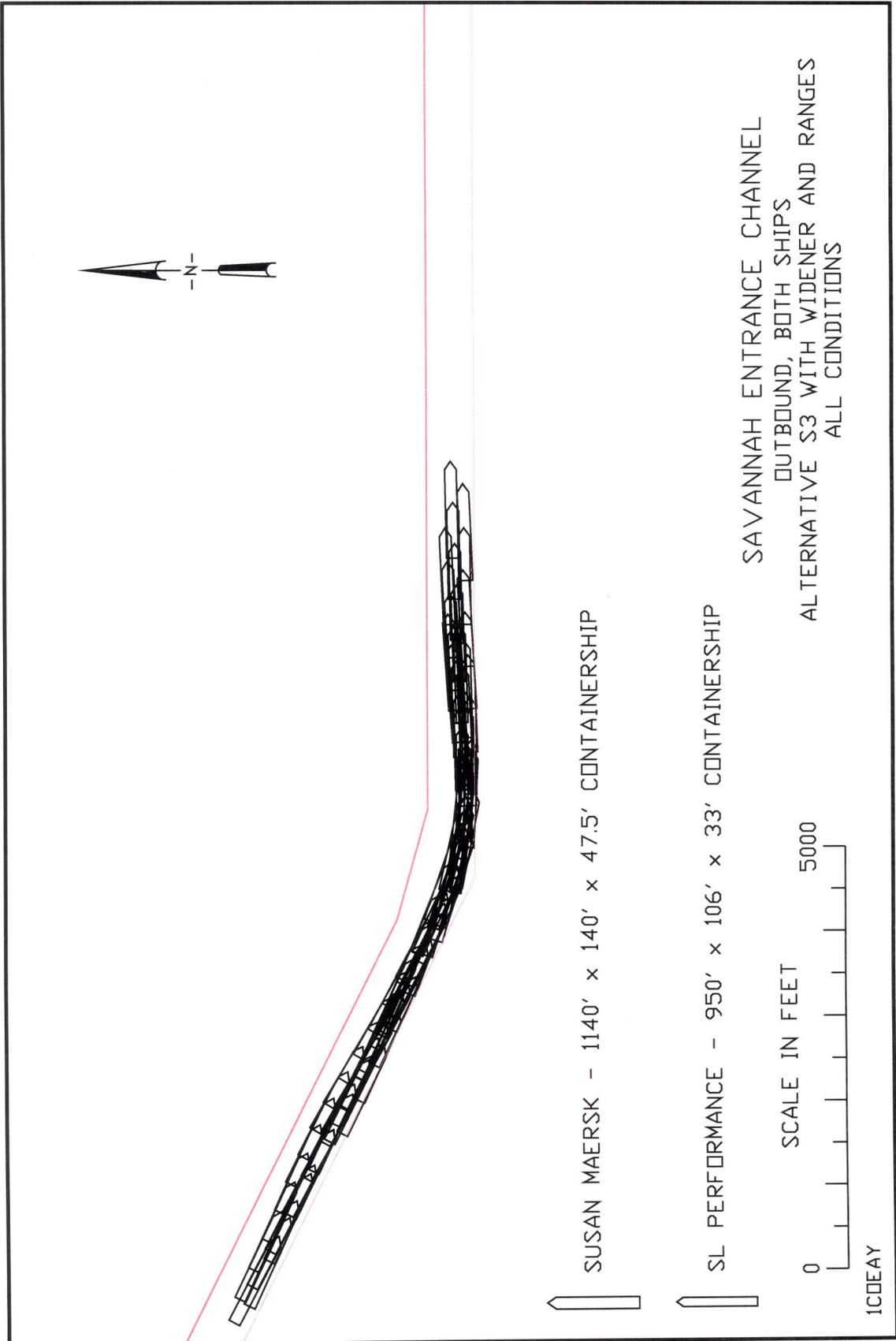
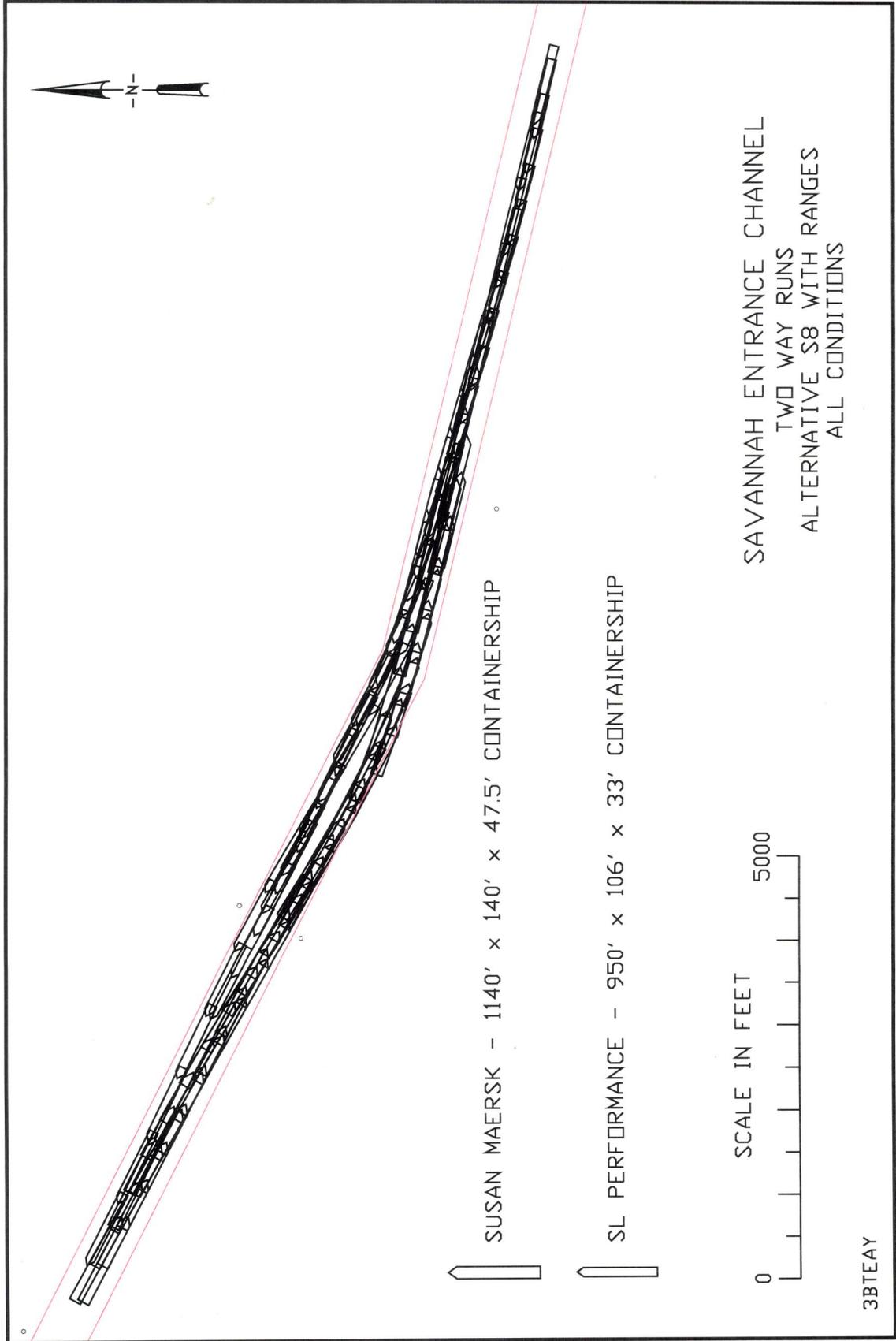


PLATE 11



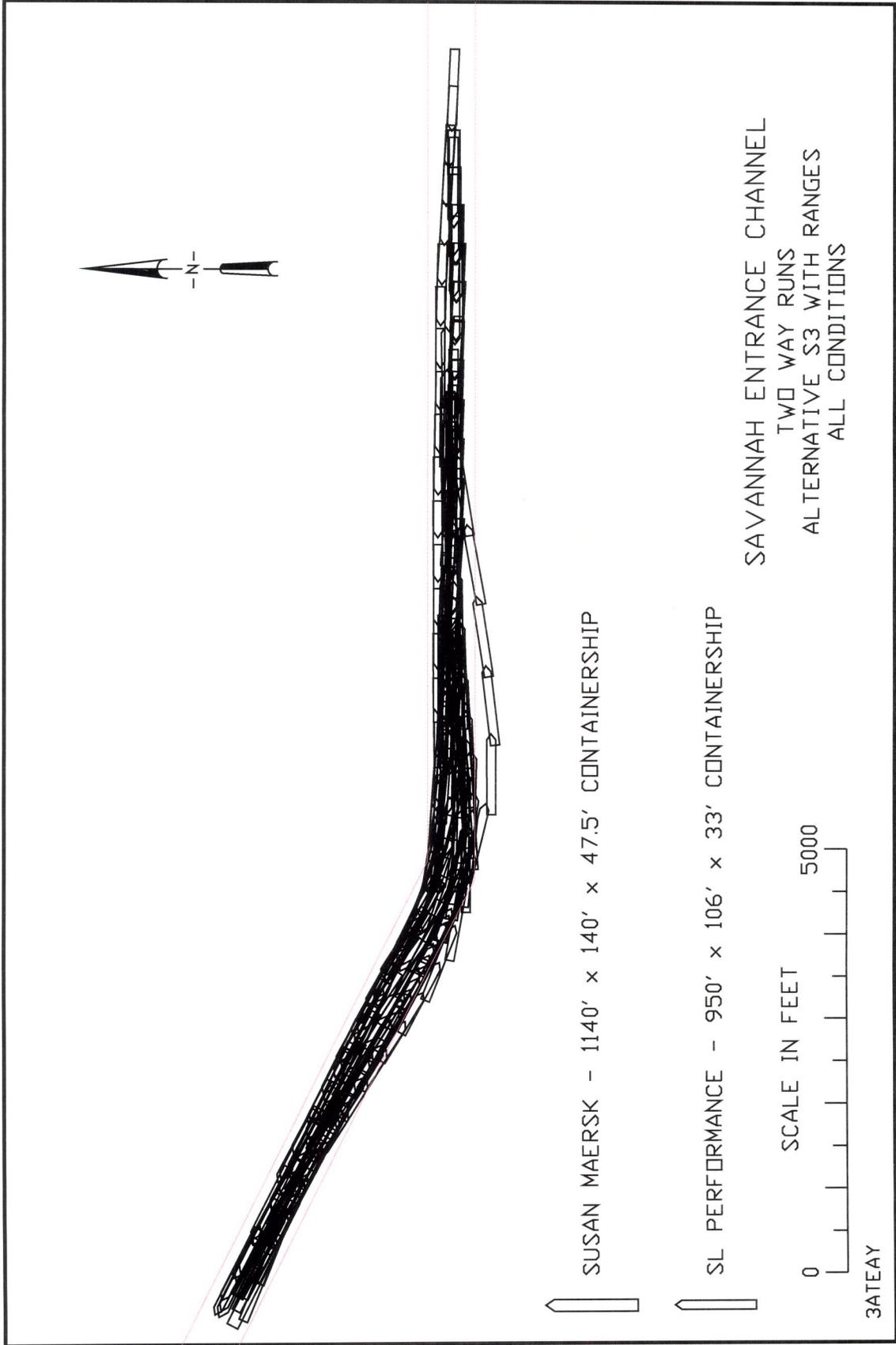
SAVANNAH ENTRANCE CHANNEL
 TWO WAY RUNS
 ALTERNATIVE S8 WITH RANGES
 ALL CONDITIONS

SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SCALE IN FEET
 0 5000

3BTEAY



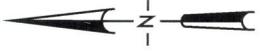
SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

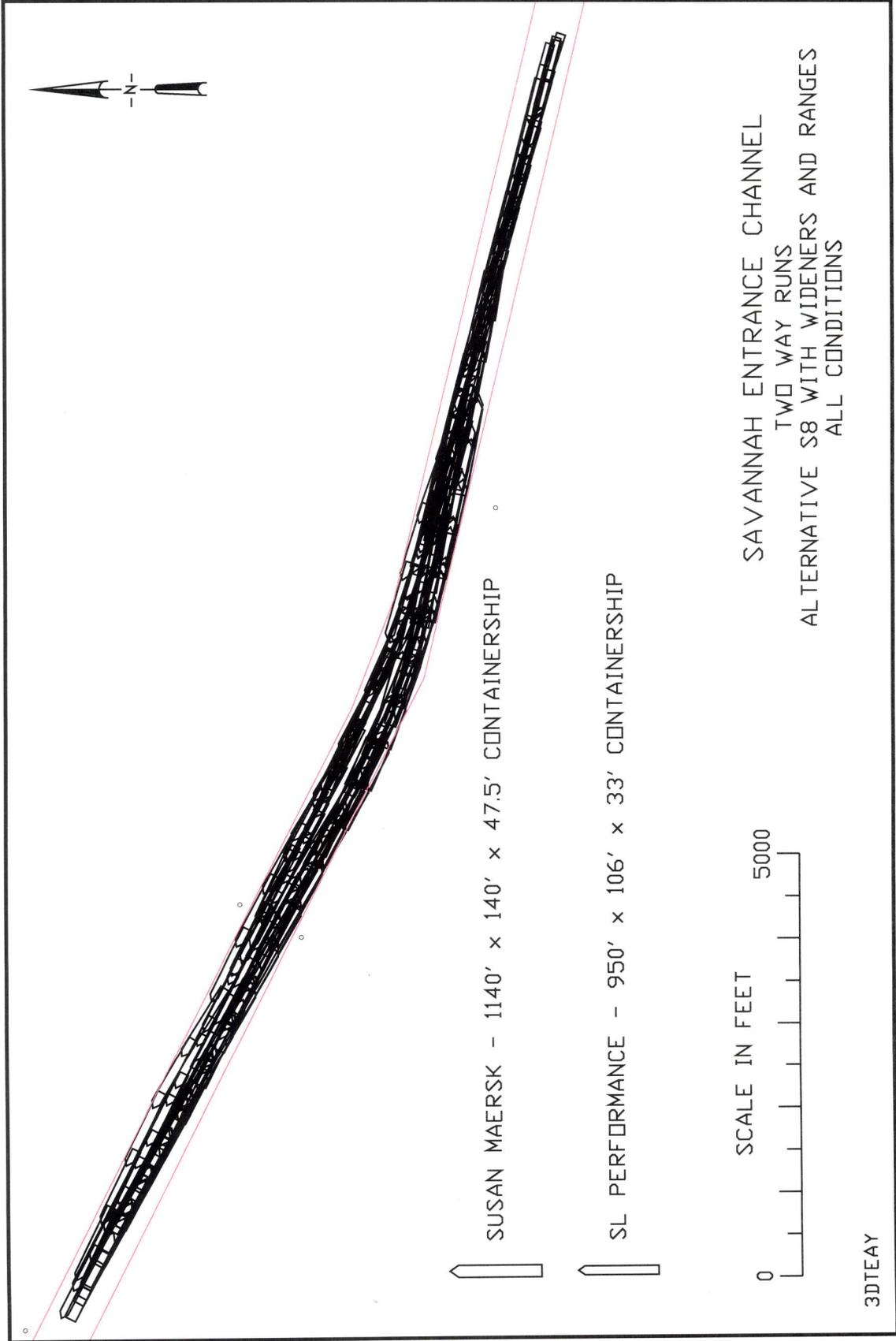
SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

0 5000
SCALE IN FEET

3ATEAY

SAVANNAH ENTRANCE CHANNEL
TWO WAY RUNS
ALTERNATIVE S3 WITH RANGES
ALL CONDITIONS





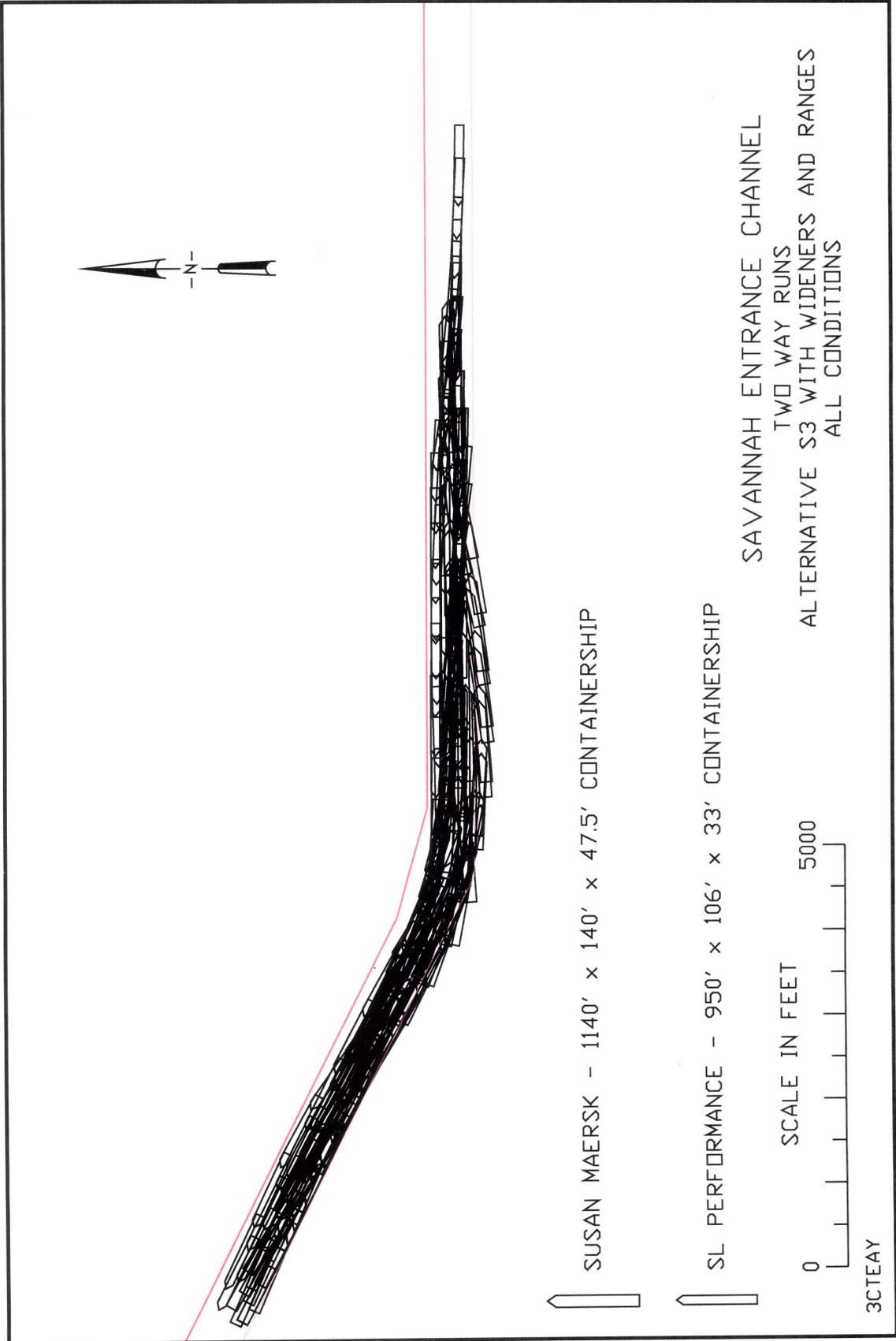
SAVANNAH ENTRANCE CHANNEL
 TWO WAY RUNS
 ALTERNATIVE S8 WITH WIDENERS AND RANGES
 ALL CONDITIONS

SUSAN MAERSK - 1140' x 140' x 47.5' CONTAINERSHIP

SL PERFORMANCE - 950' x 106' x 33' CONTAINERSHIP

SCALE IN FEET 0 5000

3DTEAY



Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot: Rick Wesley

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

S-8 seems to be a gentler turn making it easier. I would expect either turn with wideners & Ranges.

1000 ft wideners
minimum

2. Was the addition of inbound ranges helpful?

Without a doubt!! To continue this project using only moving AIDS which aren't 100% reliable is not safe. Ranges are a valuable part of this transit

3. Was the addition of the bend widener helpful?

Yes, weather conditions vary to much' off shore. The need for this safety feature is necessary.

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4. Did you experience a problem with crab angle for either alignment?

Yes I did, But adjusting for leeway is a factor for most transits with current or adverse weather.

5. How could either alignment be improved?

wider channel

6. Did you experience any problems in the meeting scenarios for either alignment?

only in the turns with no widner.

7. Any other comments?

to continue transiting the SAC River safely with these larger and deeper ships, the widner & Ranges are needed. A wider last Reach also would add to the future safety of the SAC River Traffic.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot: TREY THOMPSON

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

IT DEPENDS ON WHAT IMPROVEMENTS ARE ADDED. I.E. RANGES OR WIDENERS. WITHOUT RANGES, I PREFER S-3 BECAUSE IT WOULD BE A SHORTER RUN WITHOUT THEM. WITHOUT WIDENERS, S-8 IS BETTER BECAUSE OF THE GENTLER TURN. WITH BOTH S-8 IS BETTER BECAUSE OF THE OVERALL SHORTER DISTANCE TO EXTEND COMBINED WITH AN EASIER TURN.

2. Was the addition of inbound ranges helpful?

RANGES ARE A NECESSITY IN MY OPINION. WITHOUT THEM S-3 IS THE BETTER OPTION BECAUSE ITS A SHORTER DISTANCE. IN MORE CASES THAN NOT, I WOULD NOT PASS ON EITHER S-3 OR S-8 WITHOUT RANGES. I WOULD WAIT TO START IN UNTIL THE OUTBOUNDS CLEARED OR I WOULD MAKE SURE I COULD GET ONTO TYBEE RANGE TO MEET.

3. Was the addition of the bend widener helpful?

WIDENERS ARE ALWAYS HELPFUL, ESPECIALLY WHEN PASSING NEAR A TURN. WITH THEM TRAFFIC COULD FLOW A LOT EASIER. WITHOUT WIDENERS, ONCE AGAIN I WOULD HOLD UP MY TRANSIT TO MAKE SURE I DONT MEET NEAR THE TURN.

4. Did you experience a problem with crab angle for either alignment?

NO. CRABBING WAS NEVER AN ISSUE.

5. How could either alignment be improved?

~~IF RANGES AND WIDENERS ARE ADDED TO BOTH SCENARIOS, THE ONLY OTHER IMPROVEMENT WOULD BE TO WIDEN THE WHOLE EXTENSION.~~

6. Did you experience any problems in the meeting scenarios for either alignment?

YES WITHOUT THE RANGES AND WIDENERS, I WENT OUT OF THE CHANNEL A FEW TIMES.

7. Any other comments?

TO SUMMARIZE MY OPINION I PREFER:

S-3 IF NO RANGES WILL BE BUILT

S-8 IF RANGES WILL BE.

WIDENERS ARE NECESSARY ON ANY OFFSHORE TURNS BECAUSE OF THE GREATER EFFECTS OF WIND AND SPEED.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot:

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

S-3 is not as safe as S-8.

-
2. Was the addition of inbound ranges helpful?

Yes

3. Was the addition of the bend widener helpful?

Yes

4. Did you experience a problem with crab angle for either alignment?

NO

5. How could either alignment be improved?

~~NA~~

NO

6. Did you experience any problems in the meeting scenarios for either alignment?

Yes 5-3 was a sharp angle and we had a very close pass.

7. Any other comments?

~~NA~~ ~~THAT WAS A VERY CLOSE PASS~~

5-3 is a difficult turn.

Savannah Entrance Channel Pilot Questionnaire

January 29, 2010

Pilot:

1. Based upon your simulation runs, did you have a preference for either alignment S-3, or S-8?

I believe S-8 would be a better set up.

NAME:

EMPLOYEE:

Pilot:

2. Was the addition of inbound ranges helpful?

yes

NAME:

3. Was the addition of the bend widener helpful?

yes

4. Did you experience a problem with crab angle for either alignment?

No

5. How could either alignment be improved?

AS FAR AS S-3 I don't believe it could be improved enough to make a difference.

S-8 on the other hand is fine the way it is, A nice gentle bend to the right.

6. Did you experience any problems in the meeting scenarios for either alignment?

No problems, but S-3 just seems to SHARP of a turn.

7. Any other comments?

I believe S-8 is the better alignment.