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Navigation Study for Port Jersey 50-ft Channel Improvements, New York Harbor

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Final report

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ABSTRACT: Port Jersey, located in New York Harbor, is being evaluated for deepening and realignment. The purpose of the proposed improvements is to allow a large class of container ships to use the port. The realignment is necessary because the future ships will be too long to use the existing turning basin and will have to back out of the port. To evaluate these improvements a real-time ship simulation study was undertaken. Simulation models were developed for both Port Jersey's present and future conditions. Pilots from New York Harbor operated the simulator as they would in real life. Based upon these simulations, a final improved channel was developed.

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Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
cubic feet	0.02831685	cubic meters
degrees (angle)	0.01745329	radians
feet	0.3048	meters
miles (U.S. statute)	1.609347	kilometers
square miles	2,589,998	square meters

Preface

The model investigation described herein was conducted for the U.S. Army Engineer District, New York, by the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS. The simulator experiments were performed during the period of April 2002 to October 2002 by personnel of the Coastal and Hydraulics Laboratory (CHL), under the general supervision of Mr. Thomas W. Richardson, Director, CHL; Dr. William D. Martin, Deputy Director, CHL; Mr. Donald C. Wilson, Chief, Navigation Branch, CHL, and Dr. Sandra Knight, and Ms. Joan Pope, Technical Directors, CHL.

During the course of the model study, representatives of the New York District and other navigation interest visited ERDC at various times to observe the simulator and discuss tests results. The New York District was informed of the progress of the simulator study through monthly progress reports.

The principal investigator in immediate charge of the navigation portion of the simulator study was Mr. Dennis Webb, assisted by Ms. Peggy Van Norman of the Navigation Branch, CHL, and Ms. Sally Harrison, contractor for Analytical Services, Inc. Mr. Dennis Webb prepared this report.

COL James R. Rowan, EN, was Commander and Executive Director of ERDC. Dr. James R. Houston was Director.

1 Introduction

New York Harbor is located on the eastern shore of the state of New York (Figure 1). Port Jersey is slightly more than 1 mile long and is located on the western side of the Upper Bay in New York Harbor as shown in Figure 2. The port is terminated with a 1,200-ft turning basin. Port Jersey presently services the North East Auto Terminal (NEAT) on its northeastern corner, the Global Marine Terminal (GMT) container terminal on the north side near the existing turning basin, and the currently inactive Military Ocean Terminal (MOT) on its southern side. Port Jersey Channel is currently 38 ft deep. Ships transiting between Port Jersey Channel and Anchorage Channel must negotiate a dogleg that prevents the ship from lining up to enter the channel prior to entering.

The U.S. Army Engineer District, New York, is currently evaluating channel designs to deepen much of New York Harbor, including Port Jersey, to 50 ft. Once the 50-ft project is constructed, new container cranes will be installed on the port's northeast corner (currently occupied by NEAT) and on the south side near the turning basin. The Port Jersey design ship for the 50-ft-deep channel is the *Susan Maersk*. The *Susan Maersk* is a 1,140-ft-long and 140-ft-wide "S" class container/ship and is capable of drafting 47-½ ft. At 1,140 ft, the *Susan Maersk* is too long to use the existing 1,200-ft-diam turning basin. Therefore, the ship will have to either be backed into or out of Port Jersey. However, the *Susan Maersk* is also too long to back through the dogleg at the entrance to



Figure 1. Project location map

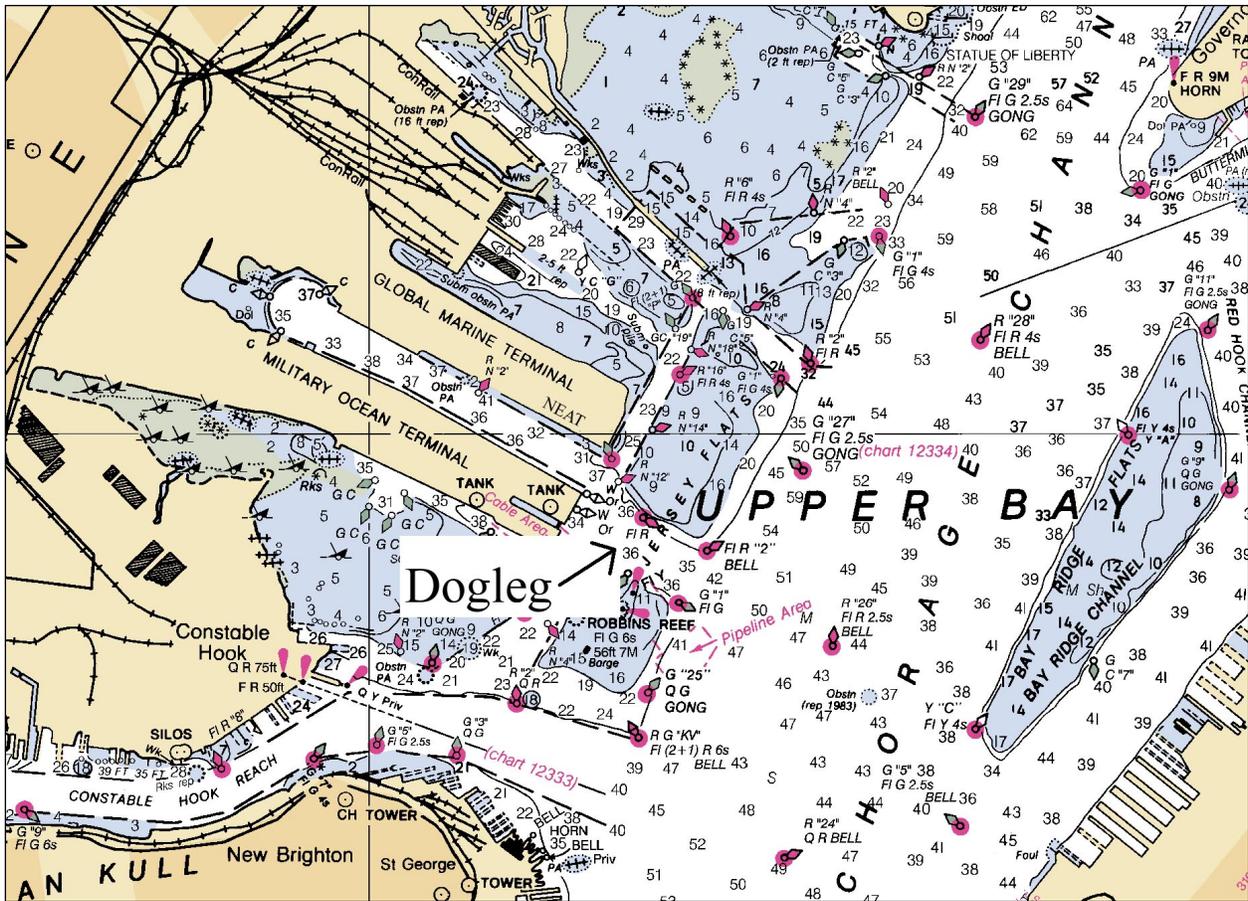


Figure 2. Port Jersey

Port Jersey. The difficulty encountered by ships approaching Port Jersey is illustrated in Figure 3 from the bridge of a car carrier calling at NEAT. The ship is obviously near the entrance to Port Jersey and well south of that entrance.

The New York District proposes two improvements to Port Jersey. The first improvement is to remove the dogleg and straighten the approach. The proposed approach to Port Jersey is shown in Figure 4. The new channel will be 1,600 ft wide where it joins Anchorage Channel. The second improvement is to widen the channel within the protected portion of Port Jersey. The New York District proposes to deepen the area between the northern and southern berthing areas to 50 ft. The berthing areas are approximately 150 ft wide. Therefore Port Jersey Channel will be approximately 500 ft within the protected area. Because the berthing areas will also be deepened to 50 ft, the channel will be 50 ft deep between the northern and southern docks.

The U.S. Army Engineer Research and Development Center (ERDC) conducted a navigation study utilizing real-time ship simulation modeling to evaluate the proposed improvements to Port Jersey. Model development and on-line testing occurred at the Coastal and Hydraulics Laboratory (CHL) during the period from April to June 2002.



Figure 3. Car carrier approaching eastern end of Port Jersey

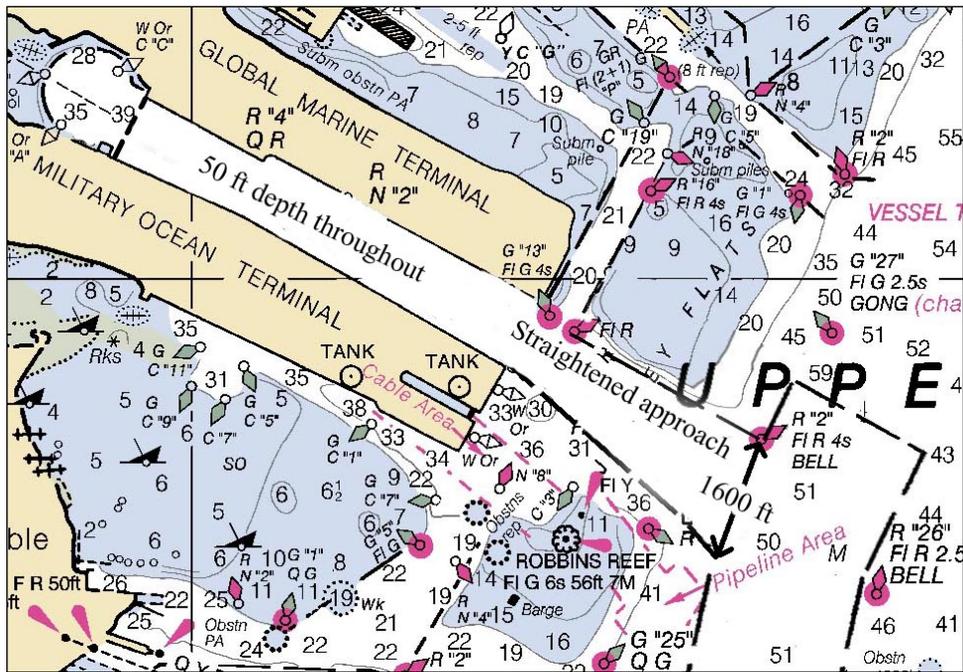


Figure 4. Proposed improvements to Port Jersey channels

2 Reconnaissance Trip

The reconnaissance trip for Port Jersey was undertaken April 30 and May 1, 2002. The purpose of the reconnaissance trip was to observe navigation conditions in Port Jersey. The project site was photographed to update the simulation visual scene.

Representatives of The New York District and ERDC boarded the *Hual Tropicana* (Figure 5) at approximately 0845 on April 30, shortly after the ship passed through the Verrazano-Narrows Bridge. The *Hual Tropicana* is a 590-ft-long, 96-ft-wide car carrier. The *Hual Tropicana* was inbound to NEAT on the end of Port Jersey Channel. Three video cameras were mounted on the ship. One camera pointed forward, across the bow. The other two pointed perpendicular. A hand-held Global Positioning System (GPS) was placed on the starboard wing to record the transit. The camera setup on the starboard wing is shown in Figure 6.



Figure 5. *Hual Tropicana*



Figure 6. Camera setup on port wing

The ship arrived at the dock at approximately 0915. The New York Harbor Pilot was Capt. James Britton and the docking pilot was Capt. Bill Clifford. The New York District / ERDC representatives remained onboard while vehicles were unloaded. The *Hual Tropicana* sailed from the car dock at approximately 1120. The representatives disembarked with Capt. Britton at approximately 1300, and remained on the pilot boat while awaiting an inbound ship.

The New York District / ERDC representatives boarded the *Wallenius WilhelmsenTalisman* at approximately 1610 on April 30. The *Talisman*, a 787-ft-long \times 106-ft-wide car carrier was inbound to NEAT. The *Talisman* arrived at the car terminal at 1800. The video cameras were installed inside, due to rain, thus limiting their effectiveness. The New York Harbor pilot was Capt. Drew Barry and the docking pilot was Capt. Bob Ellis. The *Wallenius WilhelmsenTalisman*, docked at NEAT, as shown in Figure 7.



Figure 7. *Wallenius Wilhelmsen Talisman* docked at NEAT

3 Database Development

Computer Science Cooperation (CSC), under contract to the U.S. Army Engineer Transportation School in Fort Eustis, VA, developed the visual scene for New York Harbor. CSC updated the visuals based upon data collected during the reconnaissance trip and information about the future Port Jersey provided by The New York District. Container cranes were added on the southern side of the port near the turning basin and NEAT was replaced by a container facility.

Currents for the proposed 50-ft channel were calculated at ERDC for the New York and New Jersey Navigation study (1999). The mesh used for the previous study was modified to reflect the proposed channel deepening in Arthur Kill and new currents were obtained. Simulations were conducted for maximum ebb-and flood-tidal currents. The currents used to develop the simulation models are shown in Figures 8 and 9. Wind conditions were chosen to act in the same direction as the currents. Wind gusted around 25 knots for all scenarios.

The channel and bank databases were developed at ERDC prior to the real-time simulation testing. SeaNav developed the Electronic Chart Display and Information System (ECDIS) for the proposed conditions. The U.S. Coast Guard (USCG), First District provided locations of aids-to-navigation (ATONS) for the proposed conditions.

The ATON locations provided by the USCG were for use in proposed condition simulations only, not as a commitment by the USCG for ATON locations.

The *Susan Maersk*, at a draft of 46 ft, was the design ship for all simulations conducted during this study. Designers & Planners, Inc developed the *Susan Maersk* model for use in the 2001 study of Bergen Point for the New York District.

Four thousand-hp tugs were available for the pilot's use. An ERDC employee in the control room controlled the assist tugs. The pilot used a radio to request tug actions.

The new ERDC Ship/Tow Simulators have been operational since February 2002. The simulators are CSC Virtual Ship 2000 models. The simulators are real-time, i.e. ship movements on the simulator require the same amount of time as in real life. Environmental forces such as currents, wind, bank effects, ship-ship interactions all act upon the vessel during a transit. The pilot controls the simulated vessel's engine speed and rudder. The pilot also has radio contact with assist tugs. The *Susan Maersk* has bow and stern thrusters that are pilot controlled. The two simulators can be coupled together for two-way traffic, but were

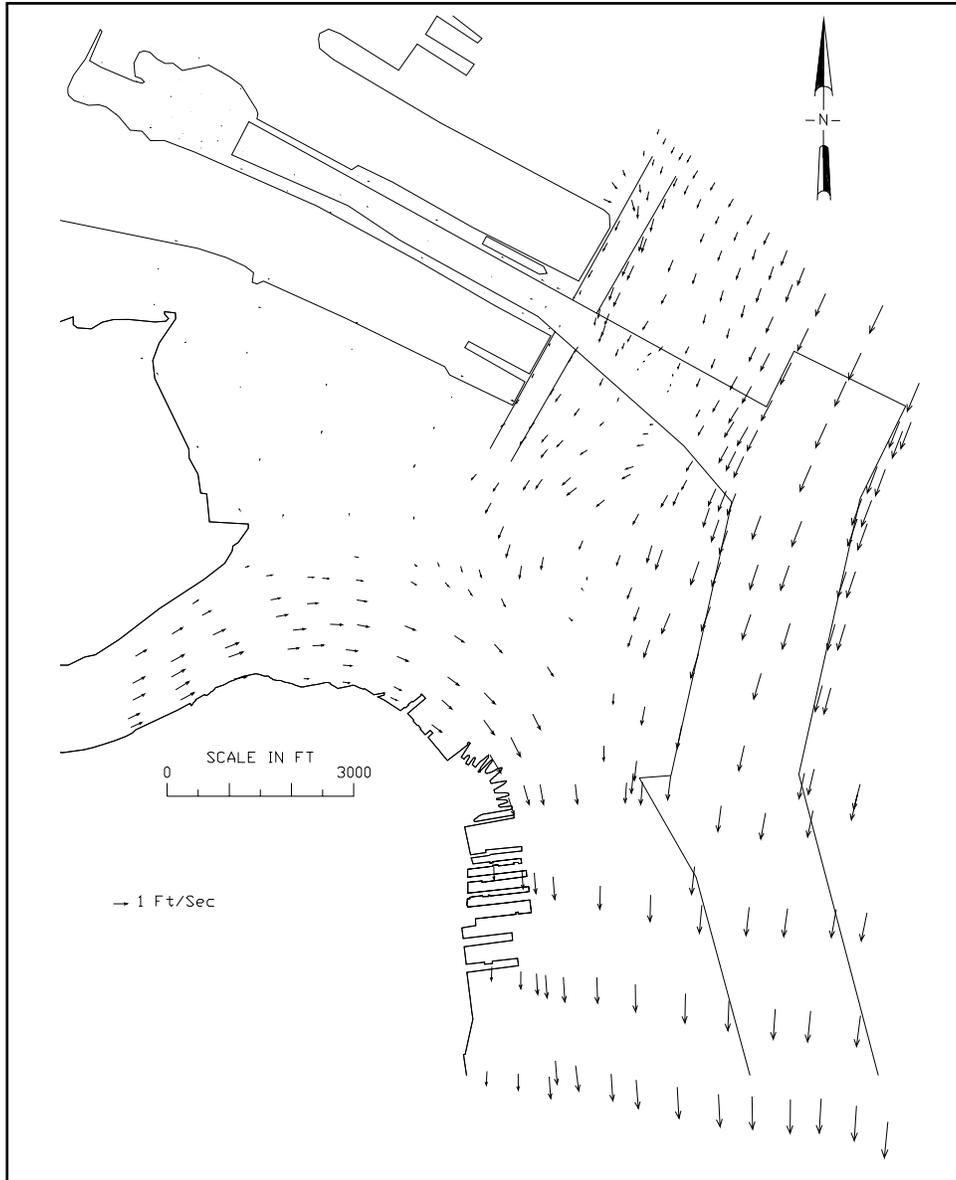


Figure 8. Port Jersey currents, ebb tide

run independently for the one-way Port Jersey simulations. Figure 10 shows the ERDC simulator being operated during validation of the Port Jersey study. The pilot in Figure 10 positioned himself on the port wing for a better view down the ship's side, as he would do in real life.

A plan of the ERDC simulator facility is shown in Figure 11. The facility consists of two bridge modules, a viewing area, a pilot debriefing room and an operator station. An illustration of a bridge module is shown in Figure 12.

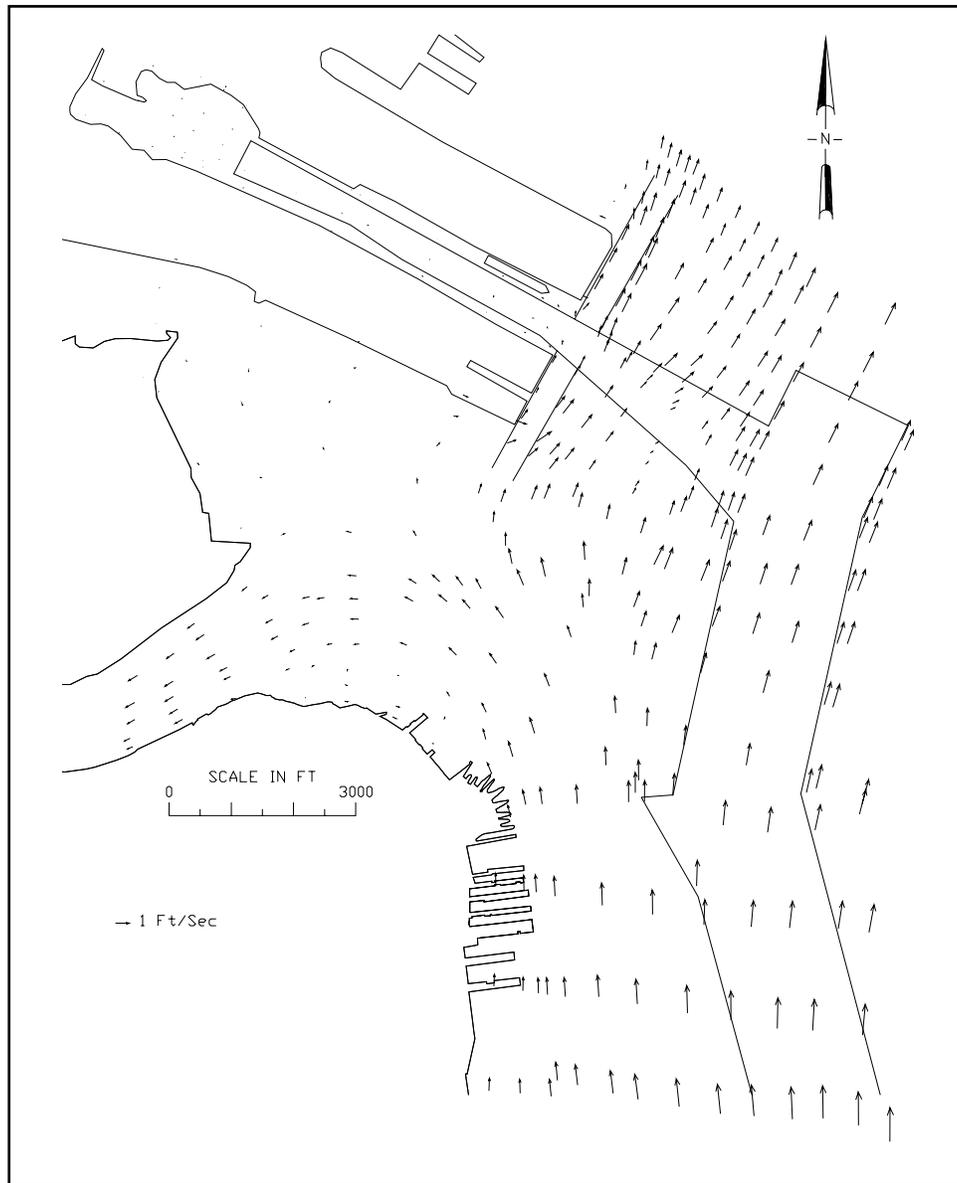


Figure 9. Port Jersey currents, flood tide

Typically, pilots operate the simulator from the bow view as shown in Figure 10. However, for Port Jersey many of the runs required backing the ship. Therefore, many runs were made with the ship's stern displayed in front of the ship console. This is shown in Figure 13, with the pilot's viewpoint on the starboard wing.

The pilots can rotate the simulator view as desired. In addition to the bow and stern views shown in Figures 10 and 13, some of the pilots rotated the view 90 deg to the right. That way both bow and stern are visible on the right and left sides of the screen, respectively. Some of the pilots used this view when backing into or out of Port Jersey Channel. Figure 14 shows orientation of the viewing angle and Figures 15 and 16 show the rotated bow and stern view, respectively.



Figure 10. ERDC Ship/Tow Simulator view from port wing, outbound from Port Jersey

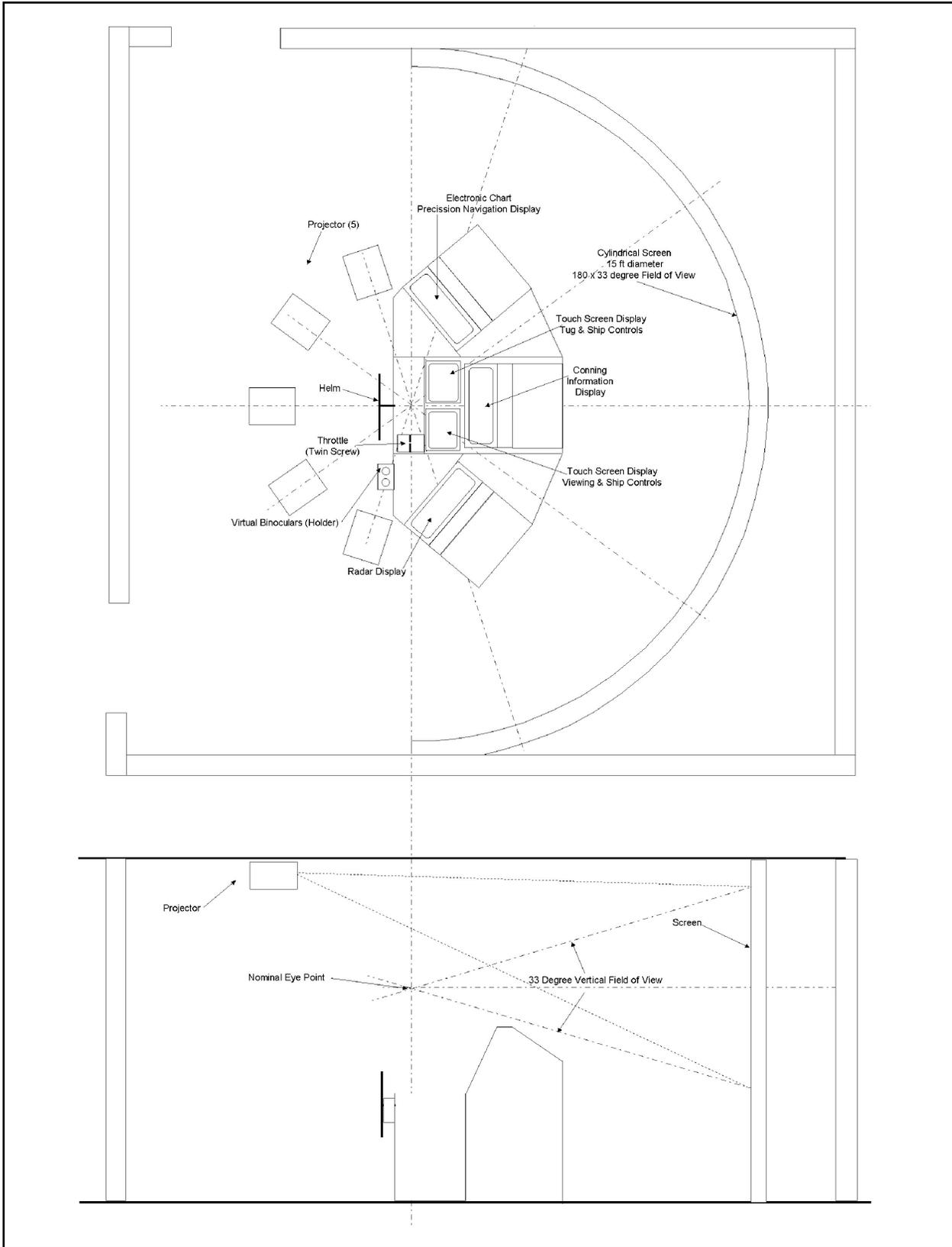


Figure 11. ERDC simulator layout

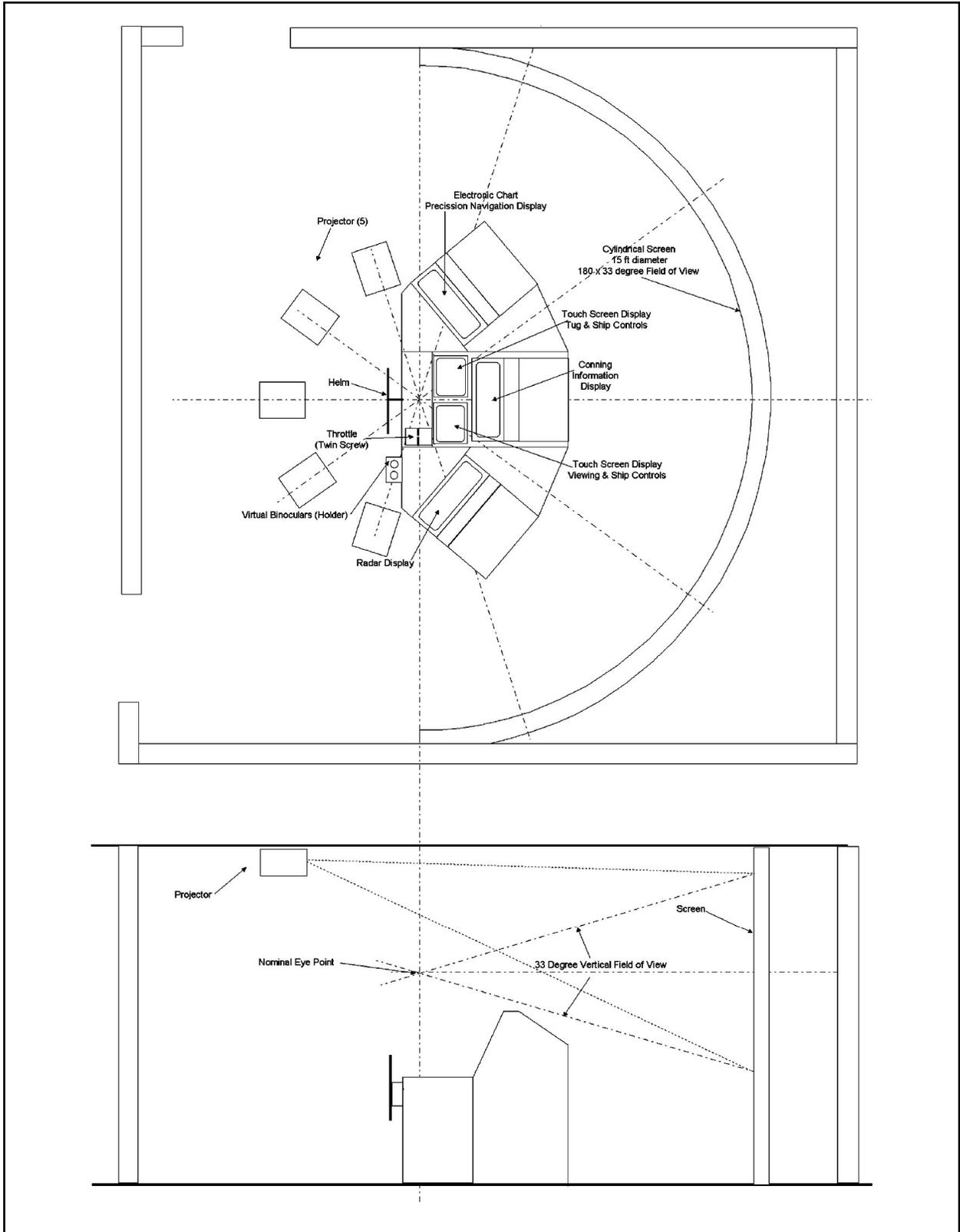


Figure 12. Arrangement of ERDC Ship/Tow Simulator bridge module



Figure 13. Stern view from starboard wing, backing out of Port Jersey

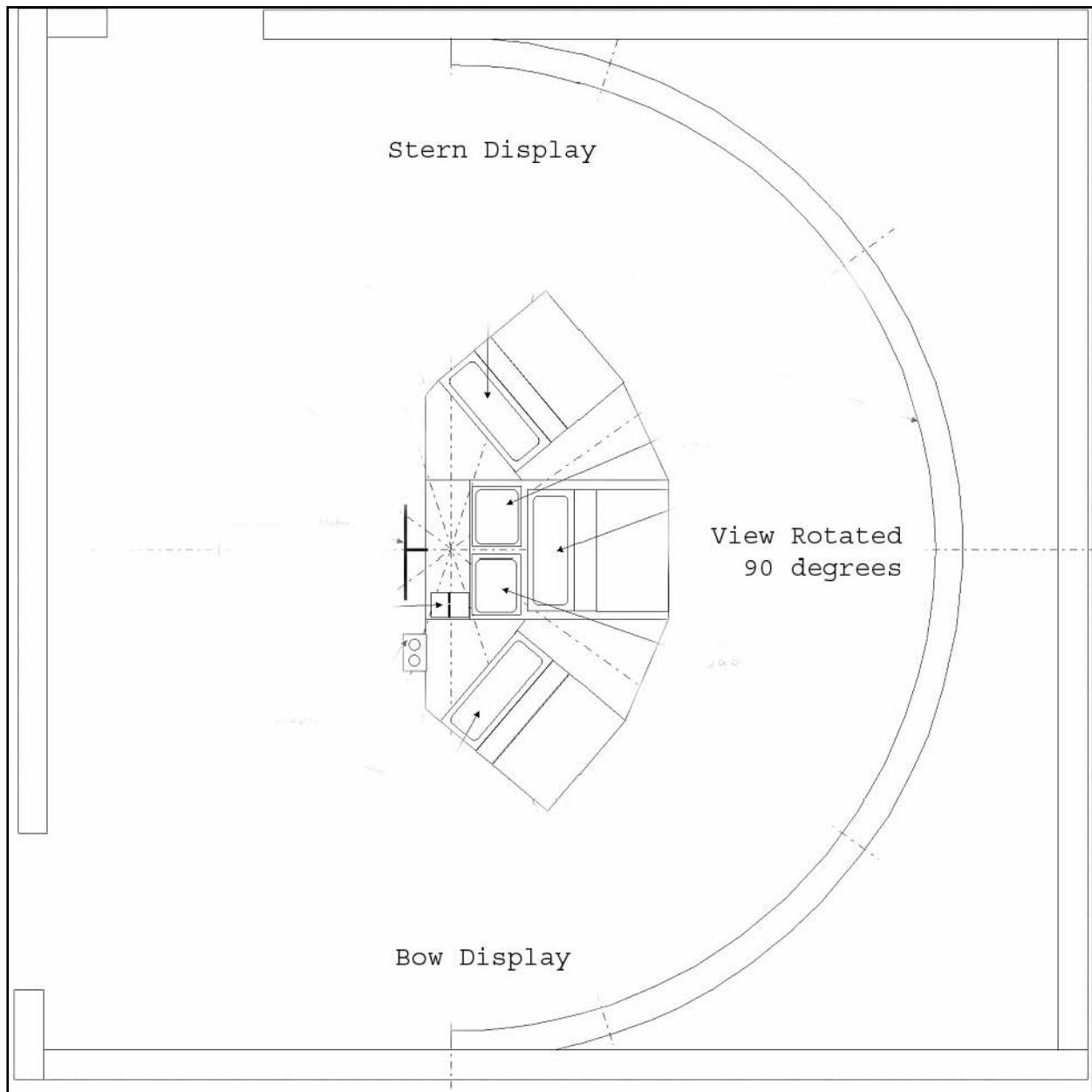


Figure 14. Viewing angle orientation used for backing in Port Jersey Channel



Figure 15. Rotated bow image on right side of screen

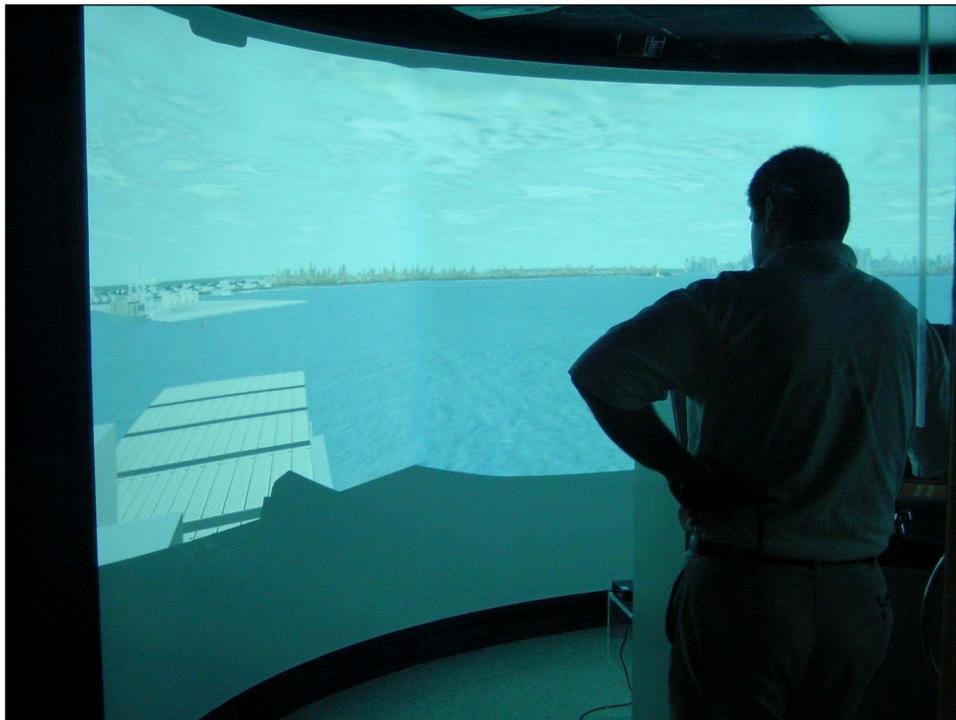


Figure 16. Rotated stern image on left side of screen

4 Study Results

Navigation study results are presented in the form of track plots and pilot opinion. The track plots show the ship's position and heading at 1-min intervals. At the end of each simulation, the pilot was given a form to record his thoughts on the exercise. These forms are used during the analysis of the track plots. The pilots were also given a final questionnaire at the end of their simulation session. The completed questionnaires are included as an appendix to this report.

Five pilots participated in the study. The simulator work required 2 weeks of real-time pilot testing. The first week, May 28 - 31 included 2-days of validation and was attended by one pilot. Four pilots attended the second week. Pilots 2 and 3 operated the simulator from June 3 to noon on June 5. Pilots 4 and 5 worked from noon on June 5 to June 7. Four of the pilots were New York Harbor docking pilots and one was a state harbor pilot licensed for New York Harbor.

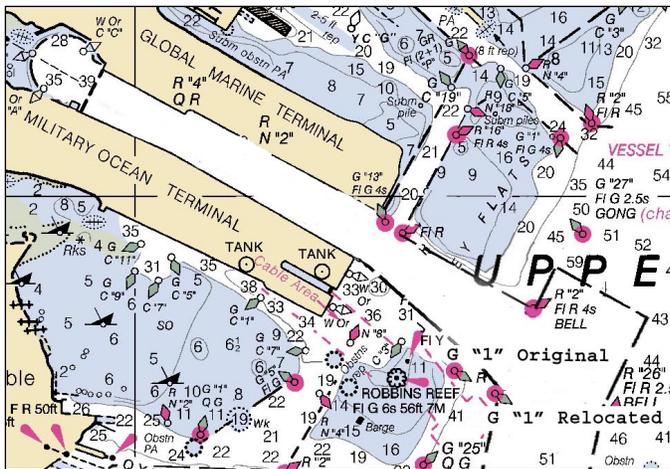


Figure 17. Buoy G "1" moved to channel's edge

Buoy G "1" was kept in its present location for simulation of the future deepened channel. This ATON marks the water 35 ft deep, or the current depth of Port Jersey. All the pilots participating in the study requested that the buoy be moved to the edge of the 50-ft channel, (Figure 17). Most runs with pilots 4 and 5 were conducted with the buoy at the channel's edge. Therefore, most track plots for pilots 4 and 5 will be plotted on a different background than pilots 1, 2, and 3.

No runs were made into the existing condition model of Port Jersey. Sufficient existing condition runs were made in 1996 an earlier ERDC study (Thevenot 1996)¹.

Inbound, flood tide, bow in. The track plots of ships transiting the realigned channel in flood tide are presented in Plate 1 for the original buoy position and Plate 2 with the relocated buoy. One of the ships in Plate 1 left the south side of

¹ Thevenot, Michelle M (1996). "Ship navigation simulation study, Port Jersey Channel, Bayonne, New Jersey," Technical Report HL-96-19, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

the channel when making the turn into the eastern end of Port Jersey Channel. The track plots of four pilots are shown in Plate 1. With the G “1” buoy moved to the channel edge, the pilots were able to rely on it to show deep (50-ft) water. Neither ship in Plate 2 left the channel. All pilots stated that the realigned Port Jersey Channel was a significant improvement over the existing one. The track plots of two pilots are shown in Plate 2.

Inbound, ebb tide, bow in. The track plots of ships transiting the realigned channel in ebb tide are presented in Plate 3 for the original buoy position and Plate 4 with the relocated buoy. Only one pilot ran this scenario with the modified ATONS. The other four ran with the original channel marking. All runs conducted in this scenario were successful. The pilots felt that the *Susan Maersk* was more influenced by current than ships they presently take into Port Jersey and that the realigned channel was essential.

Inbound, flood tide, bow out. The track plots of ships transiting the realigned channel in flood tide are presented in Plate 5 for the original buoy position and Plate 6 with the relocated buoy. Turning the ship in Anchorage Channel and backing into Port Jersey is considerably more difficult than the bow-in scenario. Several of the pilots requested a third tug due to the size of the *Susan Maersk*. One of the three ships in Plate 5 left the western side of Anchorage Channel while turning. Three runs were conducted with the buoy moved because one pilot requested a repeat run. All three runs (Plate 6) were able to stay away from the channel corner marked by G “1”. The pilots felt that while this was a more challenging situation than going bow-in, it was possible with the realigned channel.

Inbound, ebb tide, bow out. The track plots of ships transiting the realigned channel in ebb tide are presented in Plate 7 for the original buoy position and Plate 8 with the relocated buoy. This is a fairly extreme condition and once again some of the pilots requested a third tug. Three of the four ships in Plate 7 came very close to, or actually crossed, the authorized channel limits. There were two completely successful runs for this scenario, one in Plate 7 and the other in Plate 8. Both of these pilots began turning their ships in the center of Anchorage Channel, just north of buoy R “2.” The pilots felt this was the most difficult scenario they ran on the simulator and that the realigned channel was essential.

Outbound, flood tide, bow out. The track plots of ships transiting the realigned channel in flood tide are presented in Plate 9 for the original buoy position and Plate 10 with the relocated buoy. None of ships had any problem successfully completing this scenario.

Outbound, ebb tide, bow out. The track plots of ships transiting the realigned channel in ebb tide are presented in Plate 11 for the original buoy position and Plate 12 with the relocated buoy. Although the pilots regarded the ebb tide as more difficult than flood, none of the ships had any problem successfully completing this scenario.

Outbound, flood tide, bow in. The track plots of ships backing out of the realigned channel in flood tide are presented in Plate 13 for the original buoy position and Plate 14 with the relocated buoy. All of the ships remained in the

southern half of the channel. This was done to allow for the flood currents to push to the north. All runs were successful and the pilots felt the realigned channel was essential for this maneuver with such a large ship.

Outbound, ebb tide, bow in. The track plots of ships backing out of the realigned channel in flood tide are presented in Plate 15 for the original buoy position and Plate 16 with the relocated buoy. Although the pilots considered ebb tide as more difficult than flood tide, all runs were successfully completed.

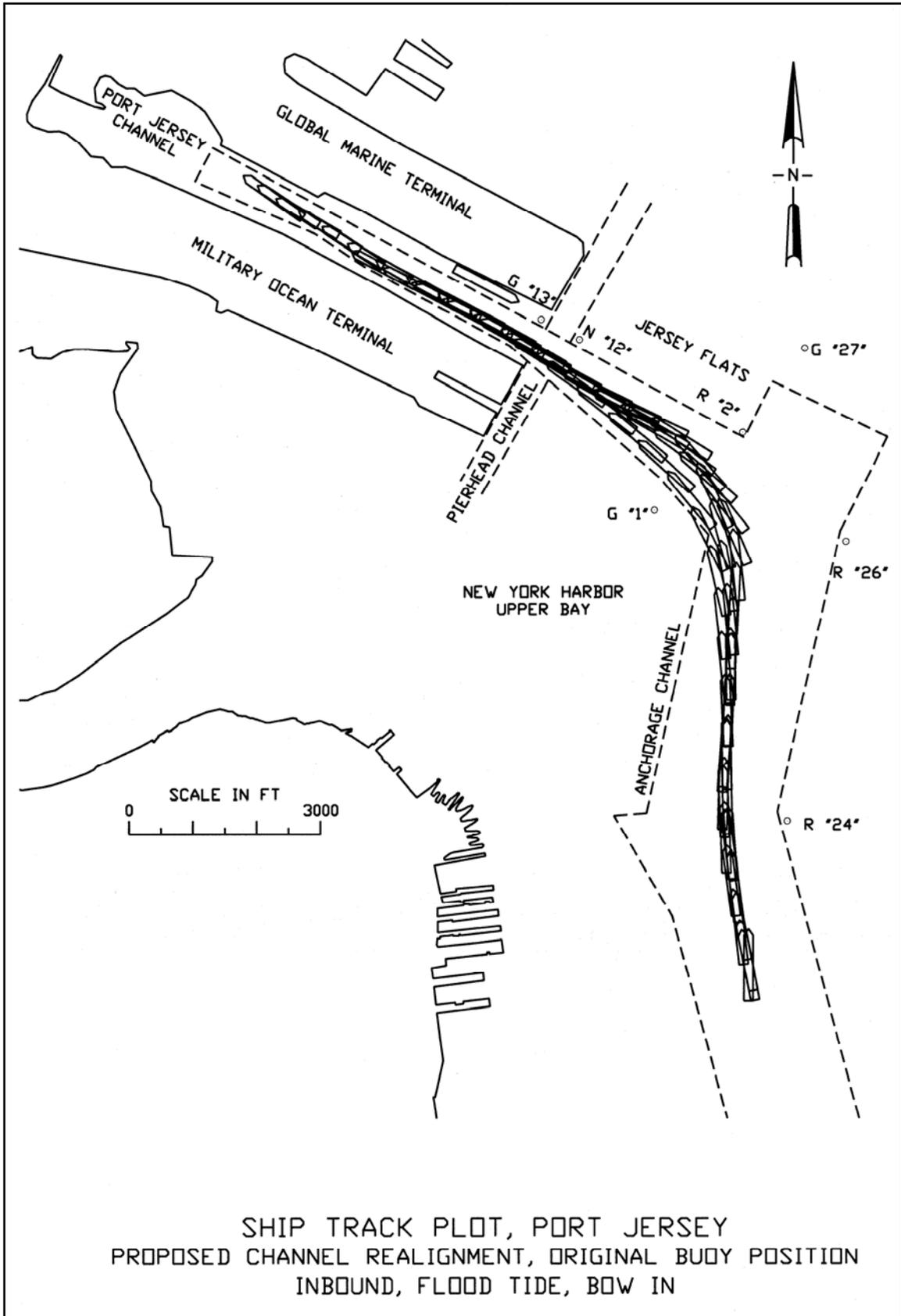
Final questionnaires. The pilots' final questionnaires are included as an appendix to this report. The pilots were unanimous in their support of the realigned Port Jersey Channel. They all supported moving buoy G "1" from its present position to the channel corner.

5 Conclusions and Recommendations

The *Susan Maersk*, at a draft of 46 ft, is significantly larger than container/ships presently using Port Jersey. The proposed realigned channel is essential to allow the *Susan Maersk* to call at Port Jersey once the channel is deepened to 50 ft. Presently, if tugs are used, the assistance of two tugs is required. It is possible that three tugs may be necessary for some maneuvers. Moving buoy G “1” from its present position to the channel corner as simulated for some of the pilots appeared to give the pilots a better feel for their ships’ locations.

It is recommended that Port Jersey Channel be realigned as proposed.

It is the responsibility of the USCG to mark navigation channels. It is recommended that their New York District office be provided with a copy of this report so they can evaluate the position of ATONS for the realigned Port Jersey Channel.



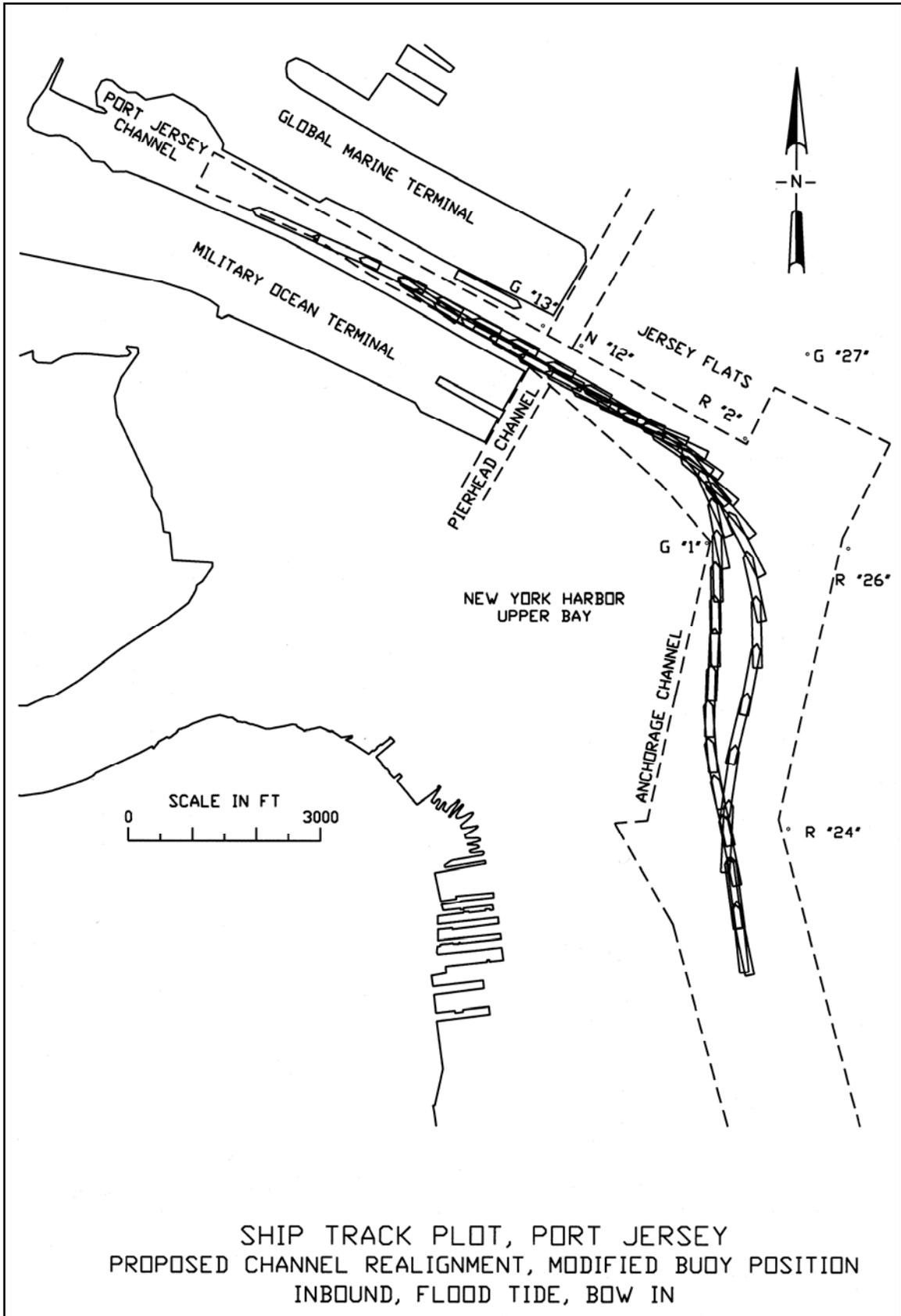
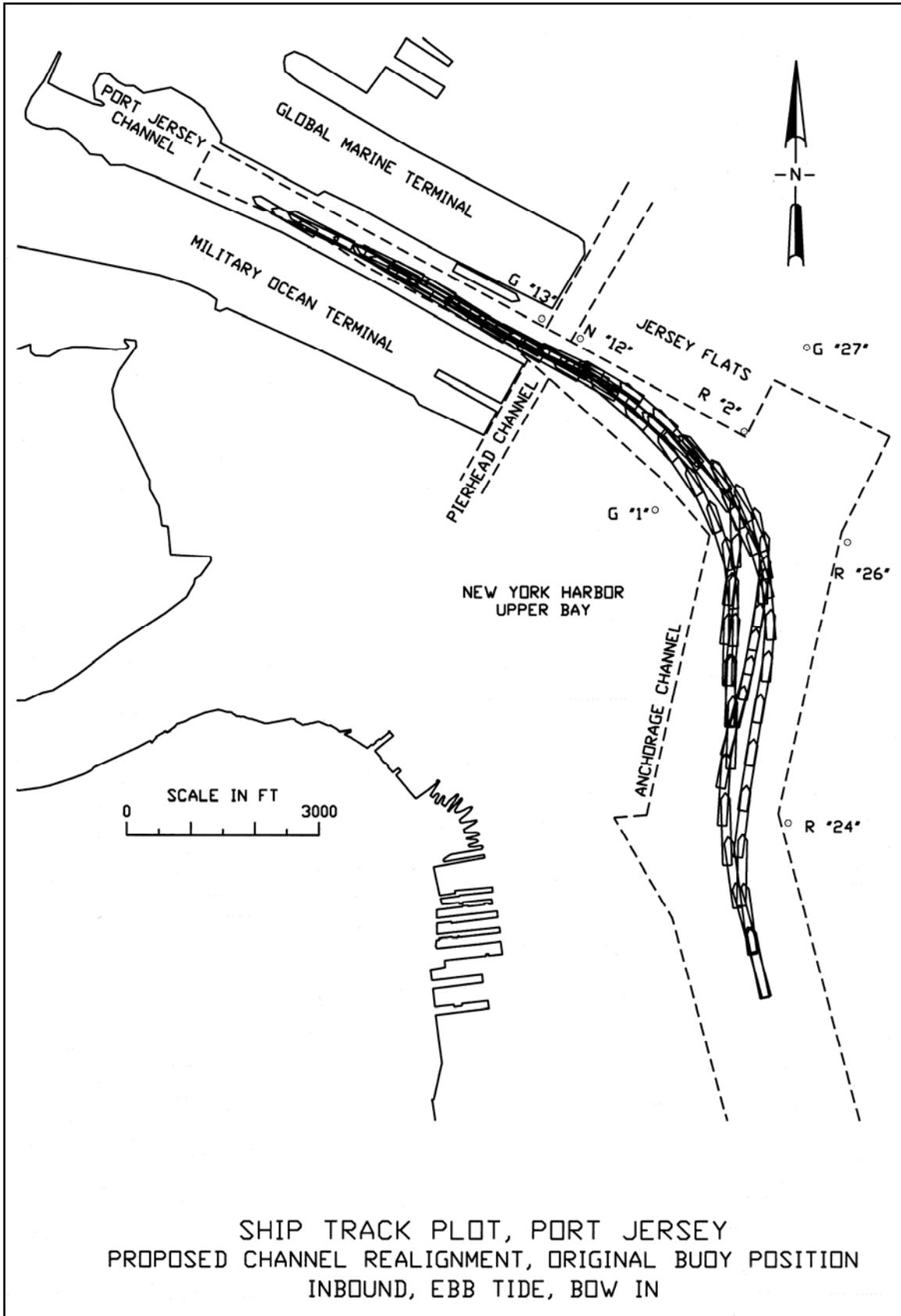


Plate 2



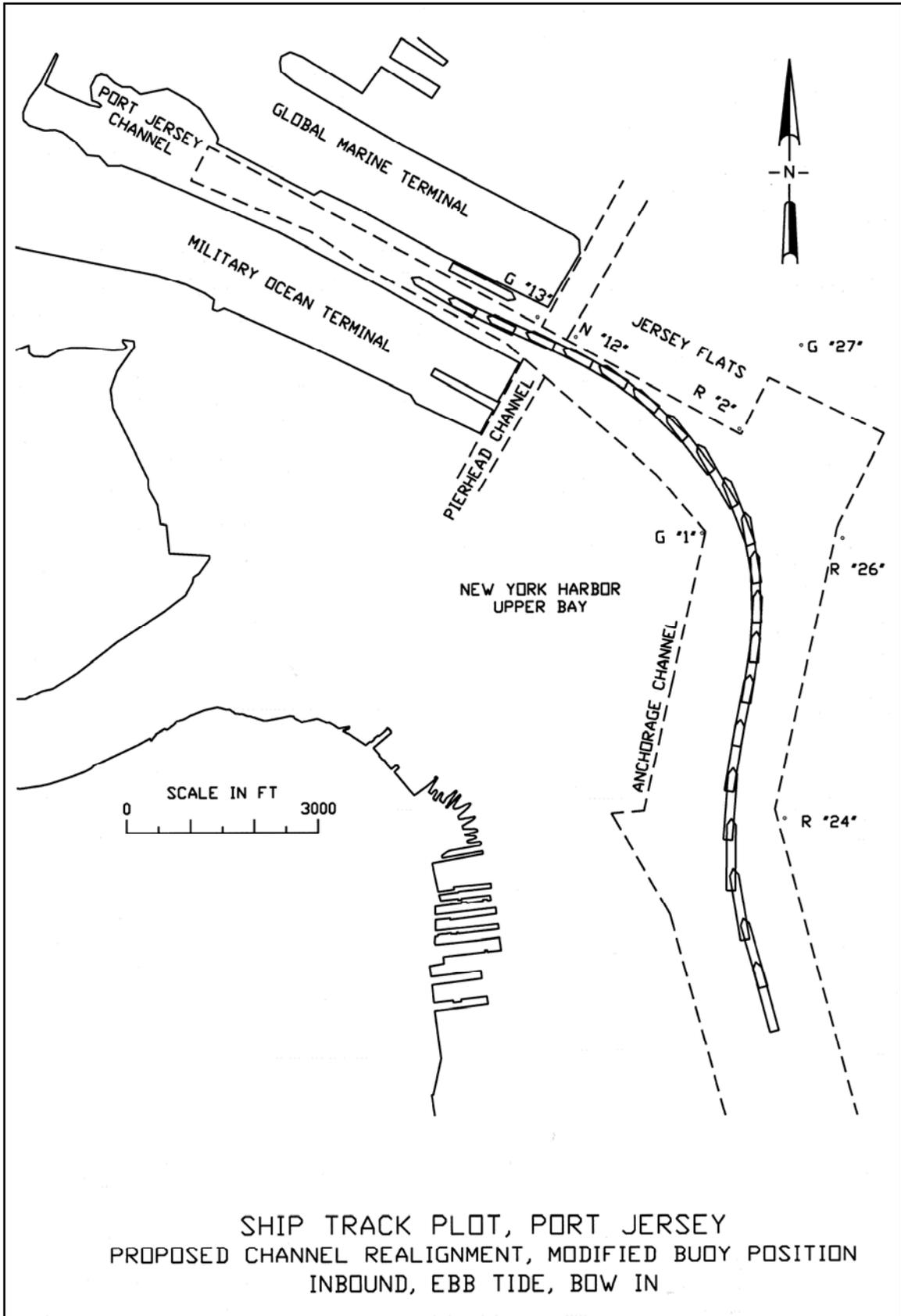
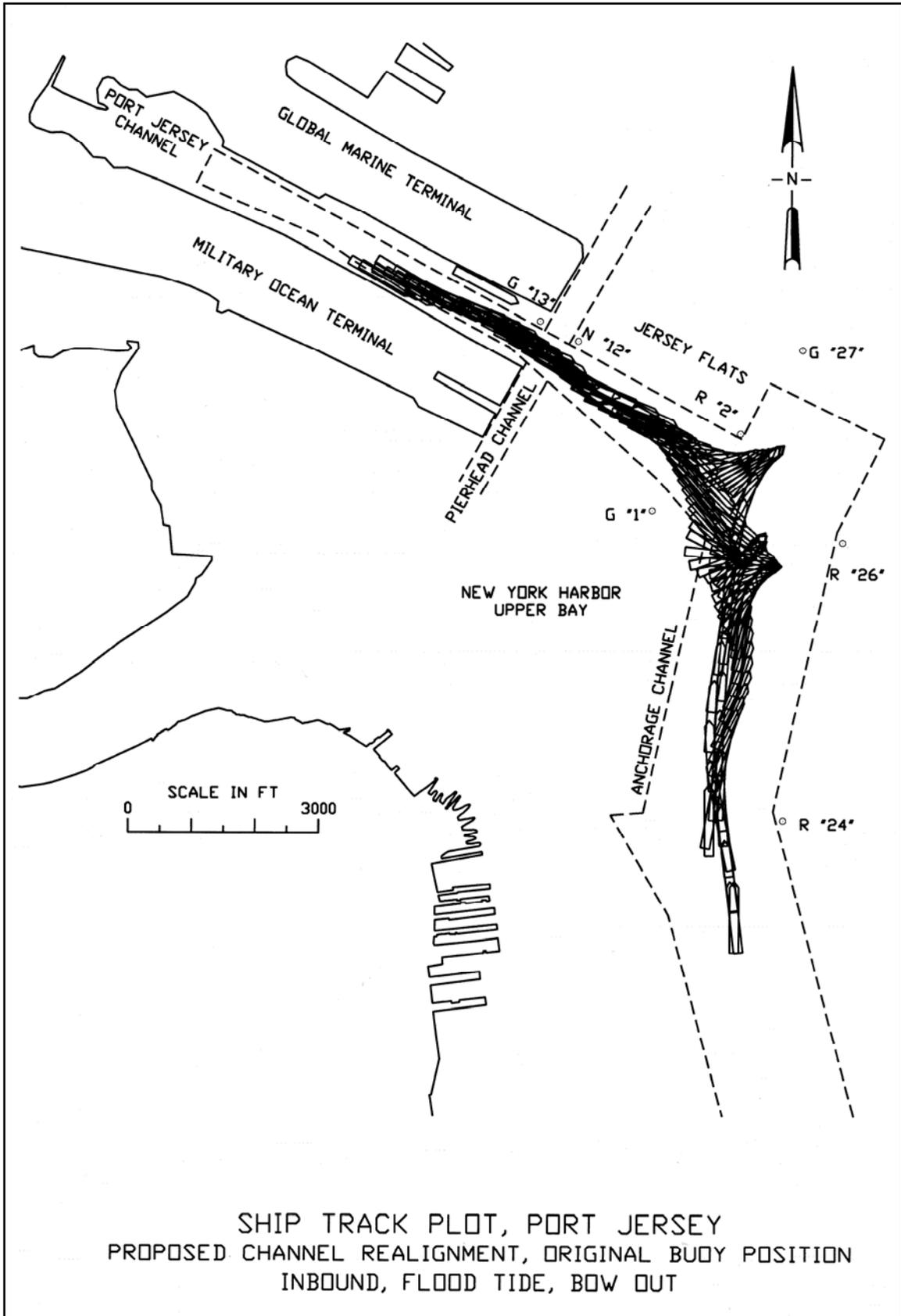


Plate 4



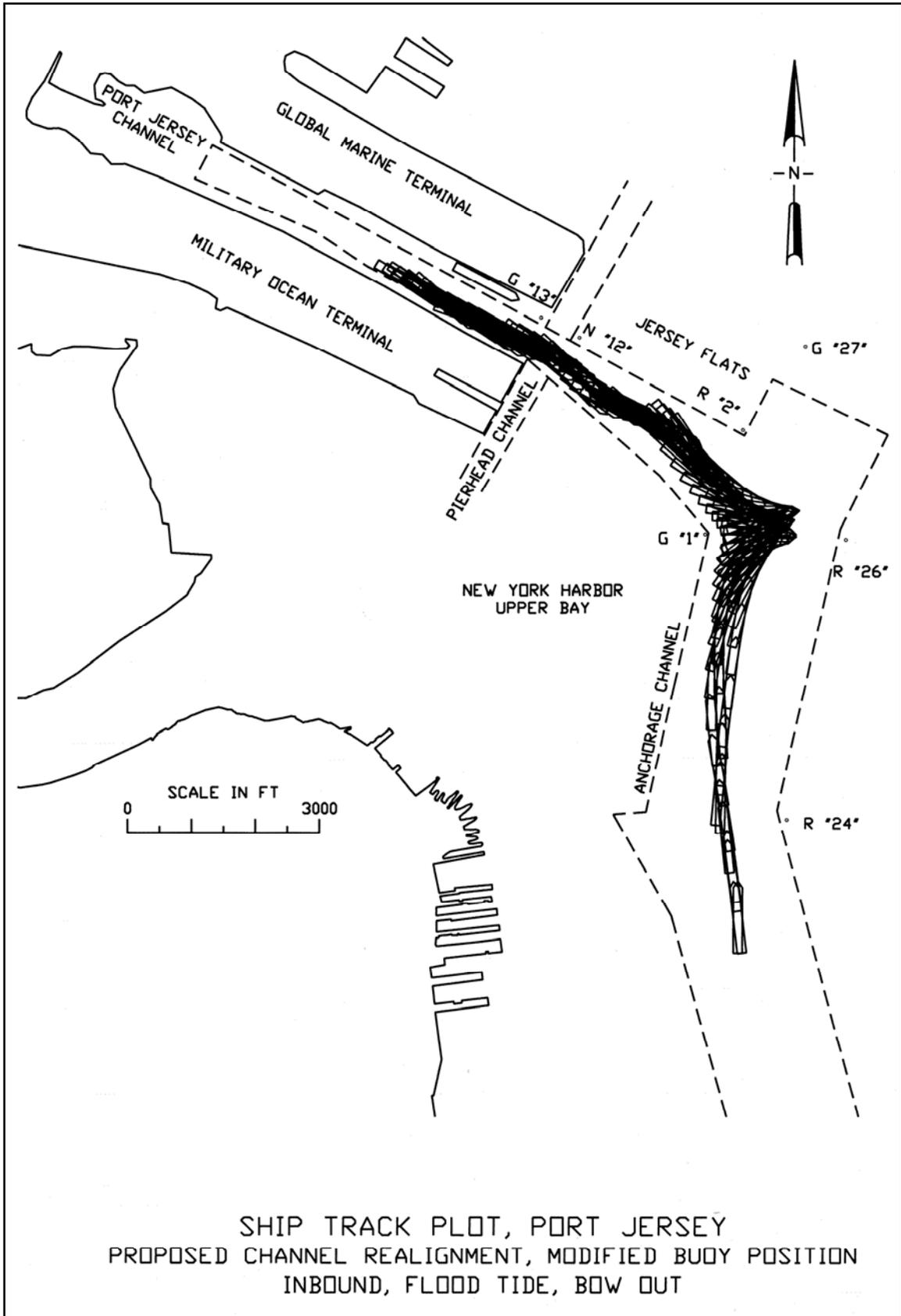
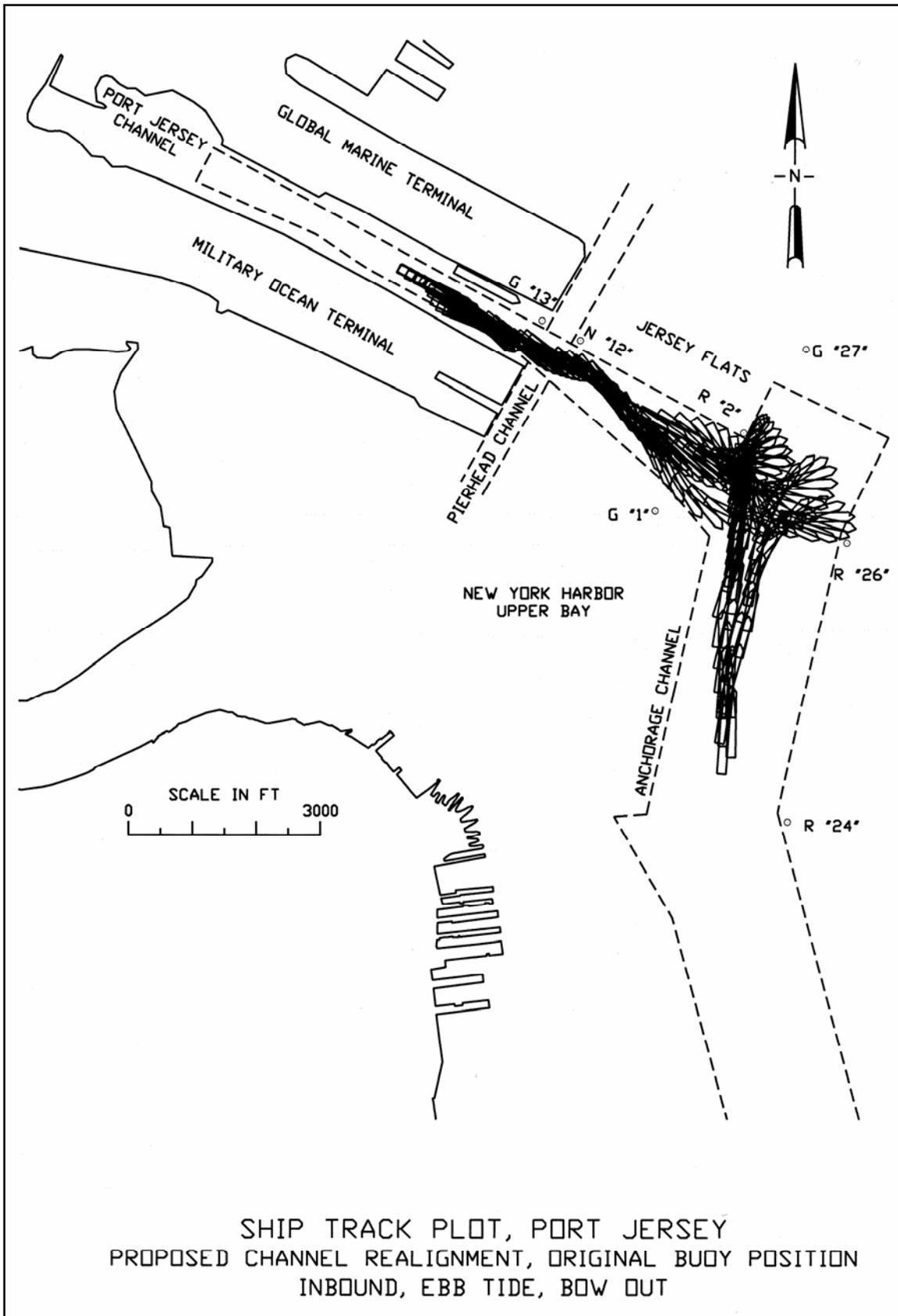


Plate 6



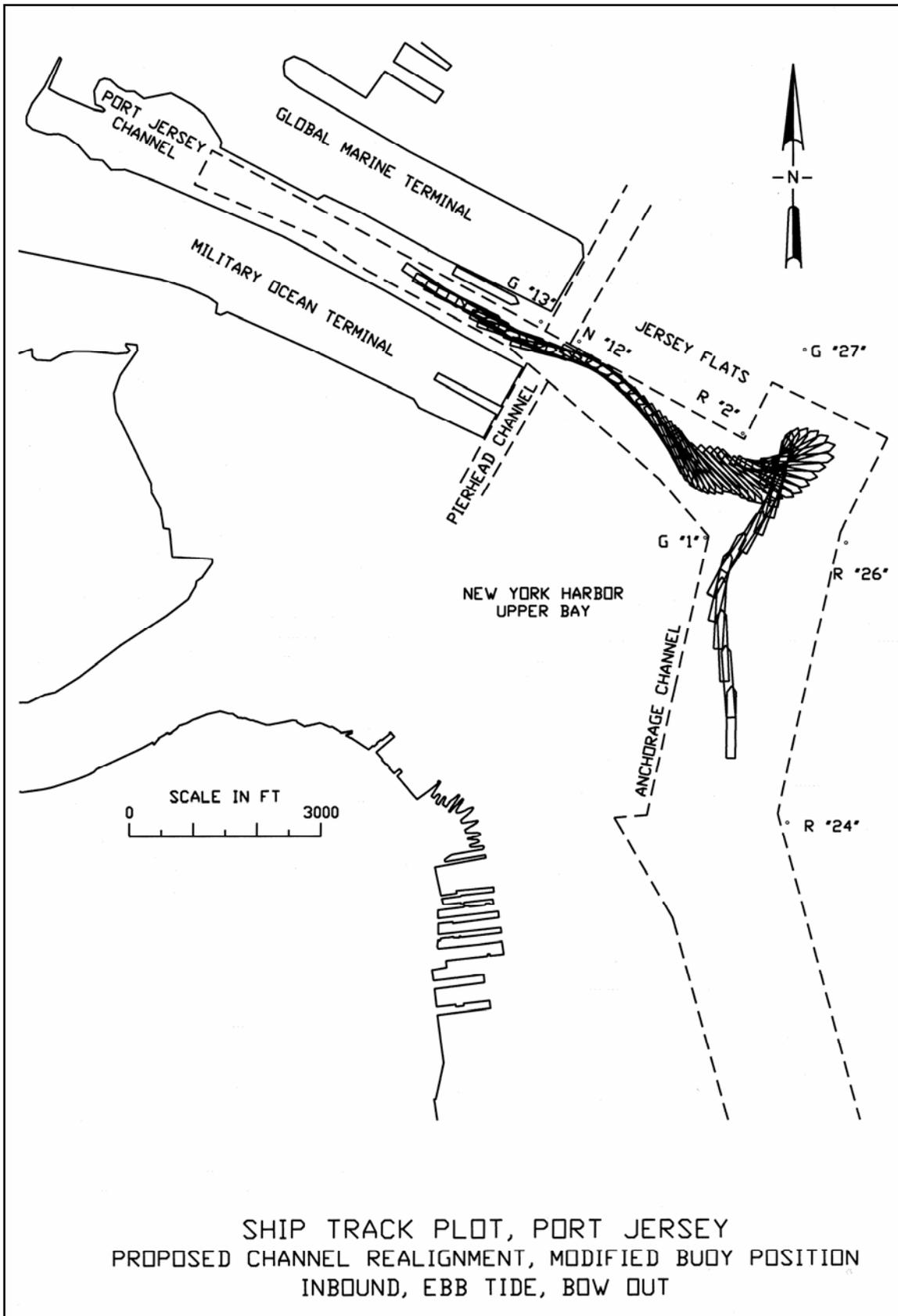
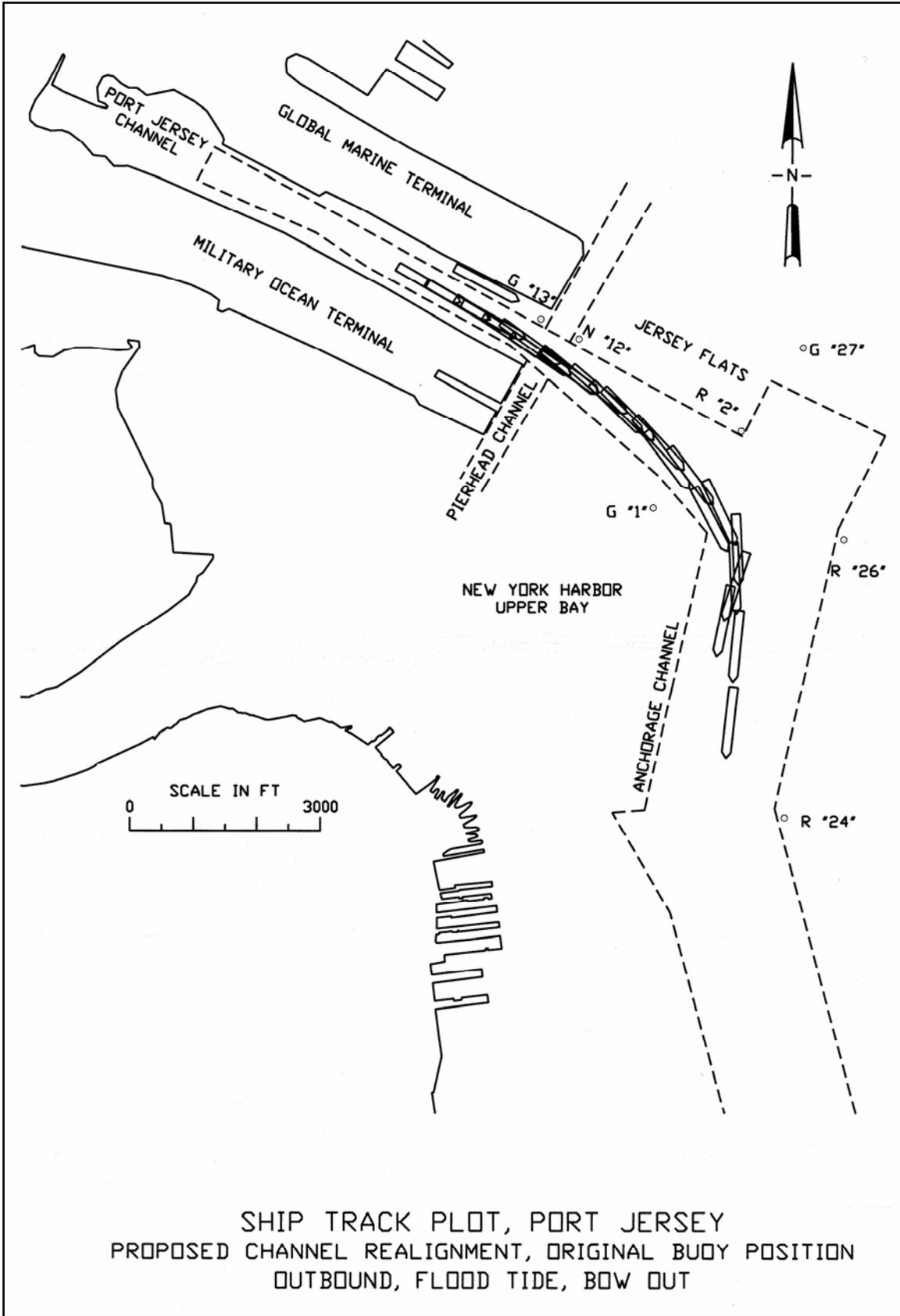
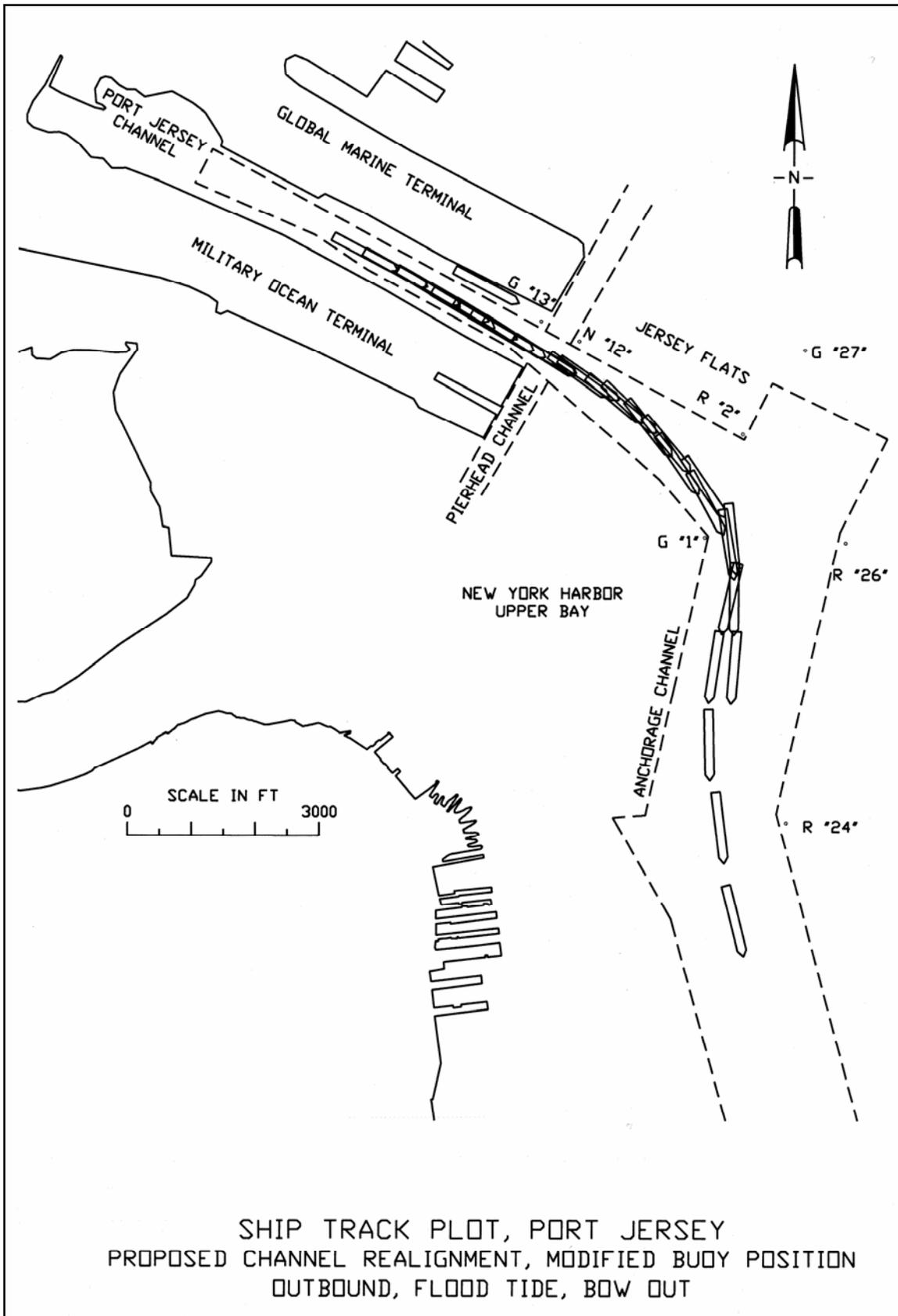
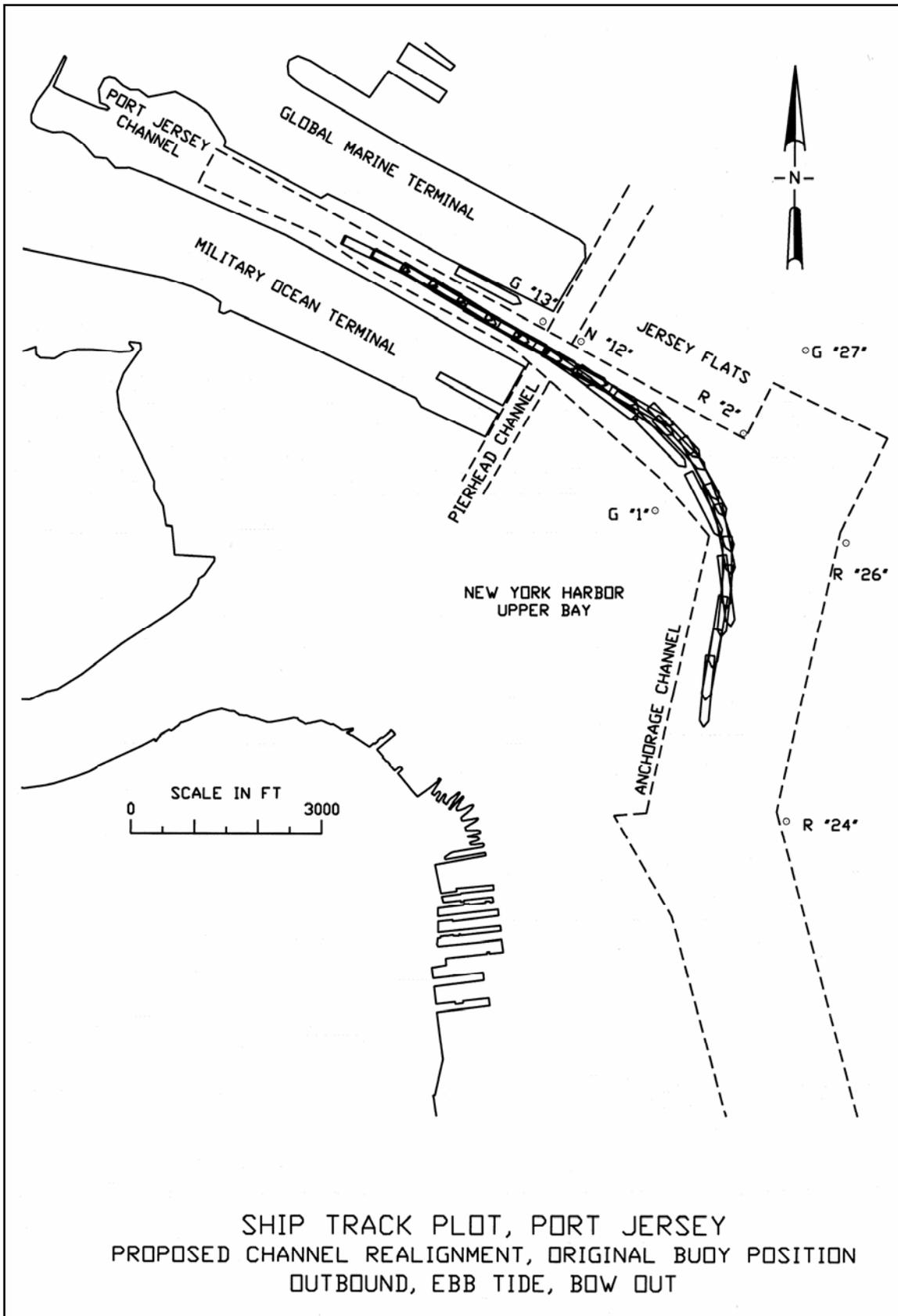


Plate 8







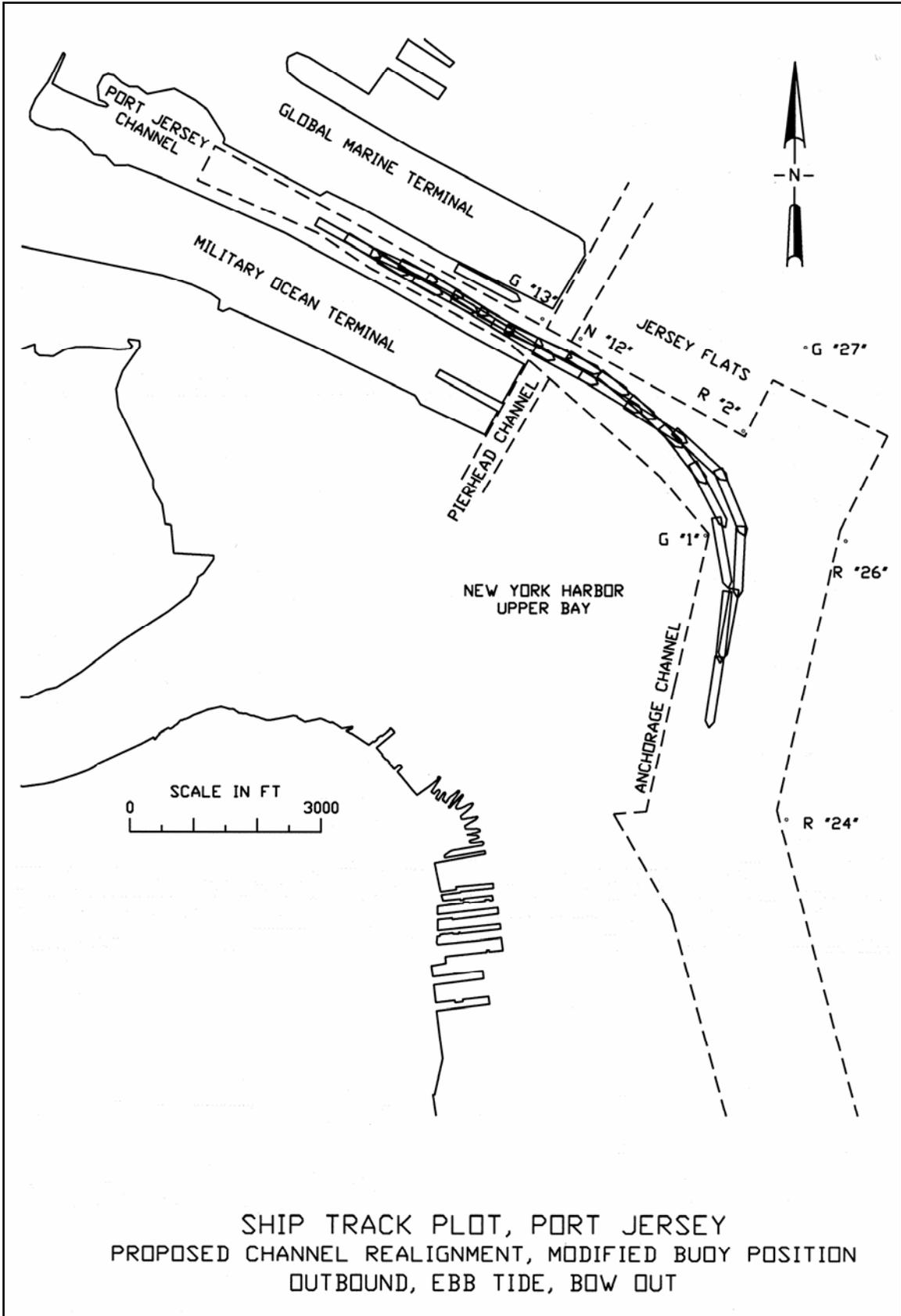
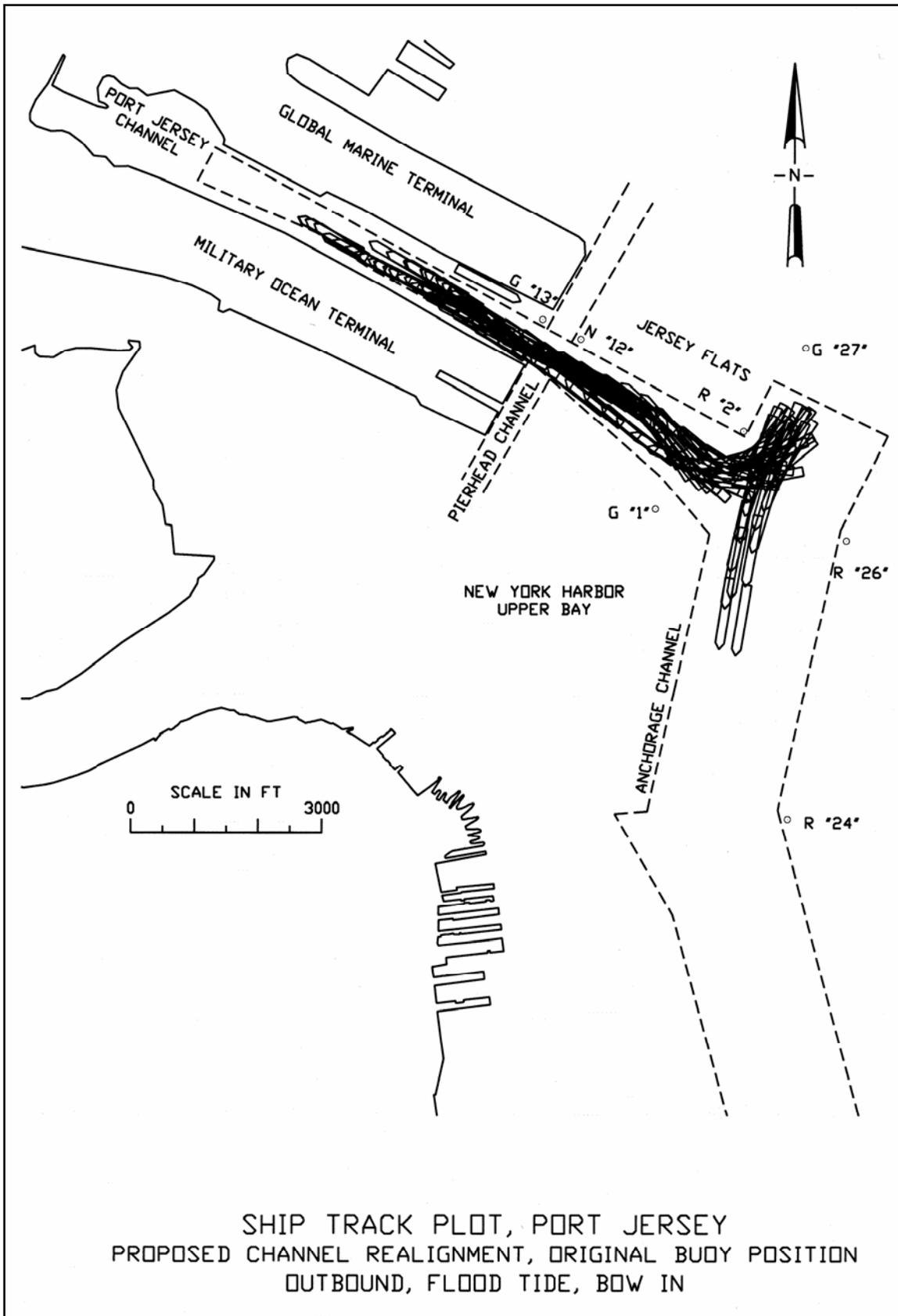


Plate 12



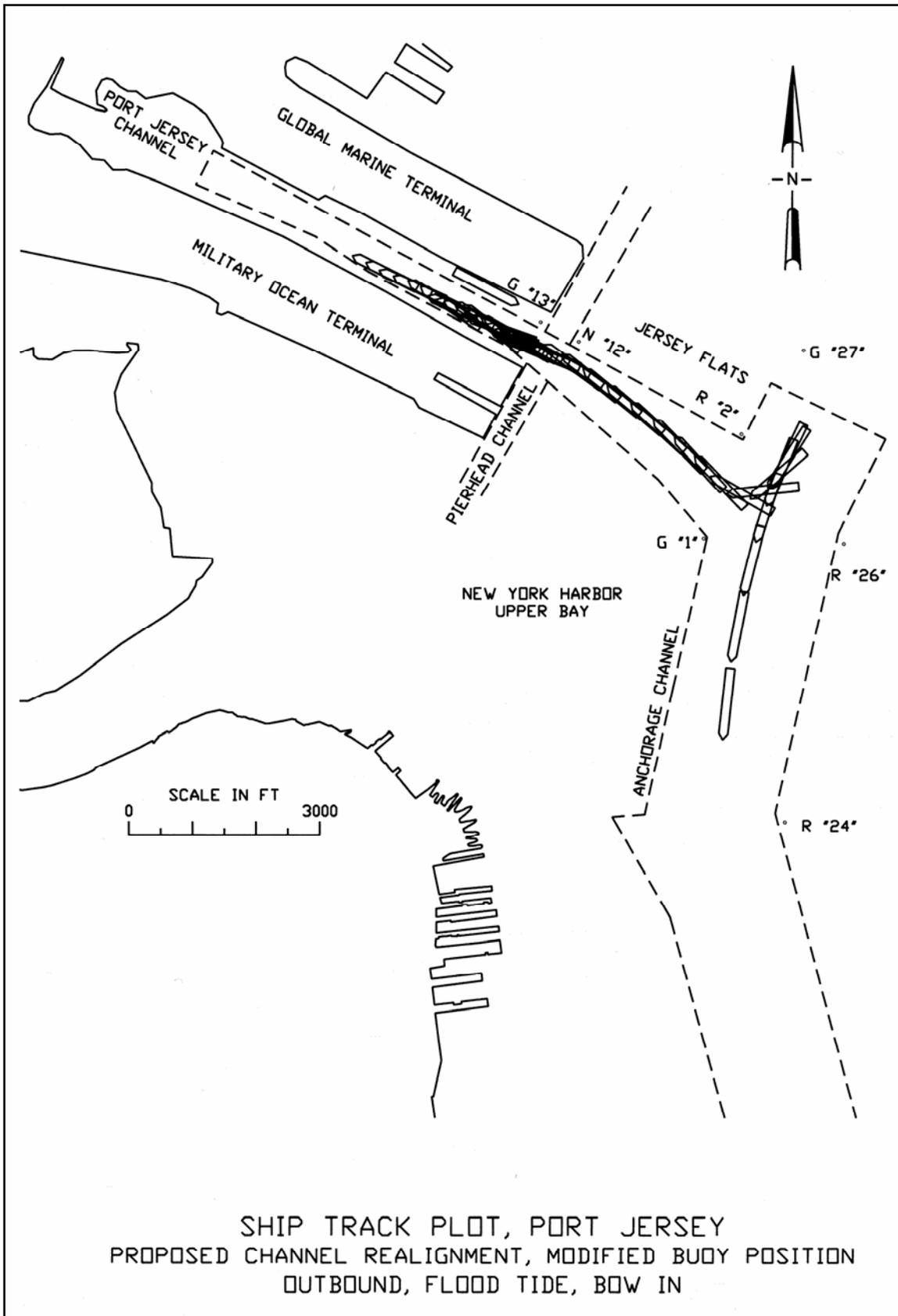
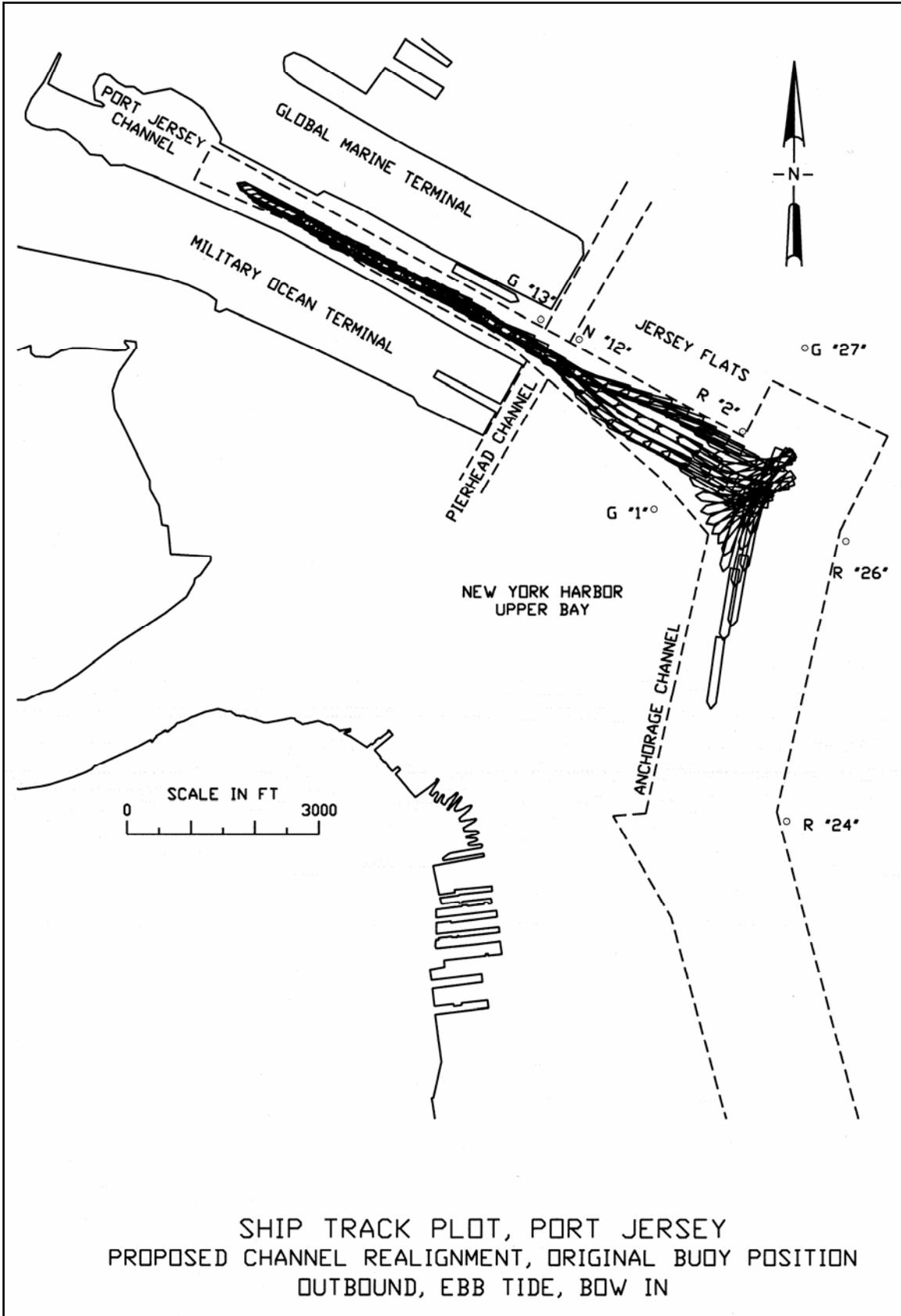


Plate 14



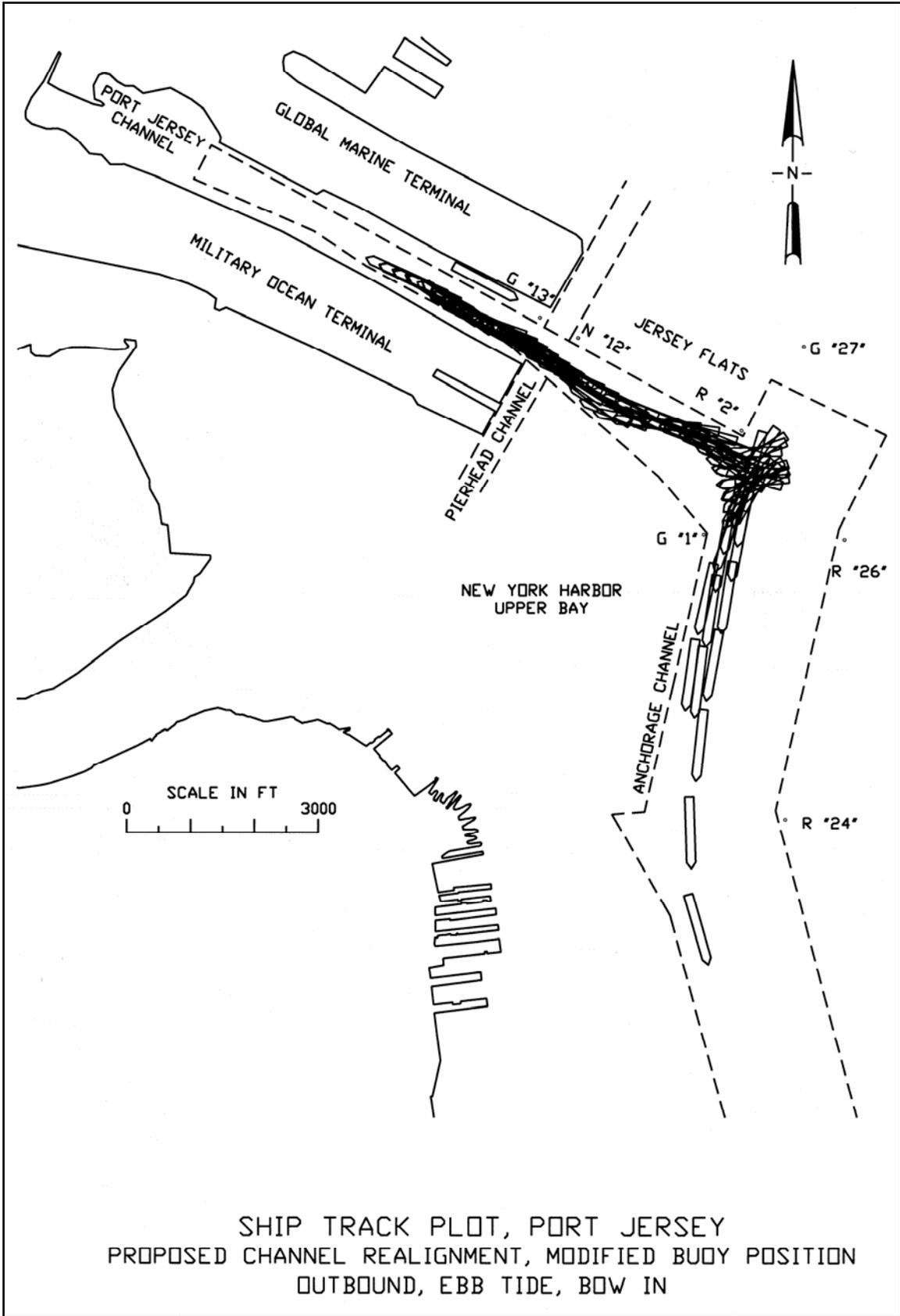


Plate 16

Appendix A

Pilots' Final Questionnaires

1. Do you feel the Anchorage Channel Extension provides adequate room for the S-Class containership entering or leaving Port Jersey? Please comment for both flood and ebb currents. Can the extension be reduced and still provide adequate service for Port Jersey?

- a. *The channel extension does provide adequate room for as S-Class Maersk ship. It is especially important to have this much room on the ebb tide, as the size of the ship presents a large profile to be acted on by the current.*
- b. *I would recommend the flashing Green #1 entrance buoy be moved to mark the southern edge of the 50' channel extension.*
- c. *I do feel the anchorage channel Extension provides adequate room for maneuvering the S-Class vessel. On both flood tide and ebb tide drills, the extension provided enough room for stopping and positioning the vessel for backing in or out of the channel.*
- d. *The channel is sufficient for either in or out, but the best time for backing out or in is 1 hr either side of high water or low water slack. For best results backing move the R"2" west and dredge off a diagonal and move the G"1" to the corner of the dredged channel (see chart 1) The extension cannot be safely reduced.*
- e. *Yes it does. You'll need all that room for the backing in. Especially on strong ebb or flood current.*
- f. *Yes, I believe there is adequate room, although I did use the full width (from the "2" buoy to the outer end of Military Ocean Terminal (MOT) and probably would continue to do so in practice. I did use part of the extension, When I backed out (on the flood), my stern wound up north of the "2". Also when coming in (on the ebb), to back in, I stuck the bow north of the "2" in order to utilize the northern most edge of the channel from the "2" to the "4" to allow room on the set towards Robbins Reef.*

2. Do you feel the flair at the eastern end of the Port Jersey Channel is adequate entering or leaving Port Jersey? Please comment on both aspects of the flair; the straightening of the northern channel limit and the width of the flair. Please comment on the flair's adequacy for both

backing and forward maneuvers and include comments for both flood and ebb currents.

- a. *The flair is adequate for the job. The straightening of the channel on the north side is very important. The flair is more valuable on the ebb tide as you have more room to recover if you start your turn too soon. On the flood tide you have enough room to make a safe entry to the Port Jersey channel. This is most important on stern in or out maneuver*
- b. *The flair is big enough for all the maneuvers but it should be marked so its outer limits are buoyed off. Backing in with a strong ebb tide, the tugs and thrusters were needed to keep the ship in the channel. There was no reserve power left while backing in. This poses a risk of grounding should any of the thrusters or tugs break down. Once the whole ship was in the channel in the lee of the flats the tugs and thrusters were not maxed out and it is a much safer maneuver.*
- c. *Cutting off the north corner would improve safety and ease both backing in and out. Buoys on dredged channel corners are a must.*
- d. *The width of the flair is sufficient. I would just like to see the "1" Buoy moved to the location as shown. Going inbound presents no problems, our major concern is backing in and out.*
- e. *Yes. I think it is adequate. The straightening is essential, if this ship is to back in or out. Going bow in or bow out is no problem, whatsoever, but the backing in or out – the full width of the proposed flair is needed.*

3. Please comment on the behavior of the simulation model of the Susan Maersk. Include the response of the ship to tugs.

- a. *The 500' channel is adequate for this size ship any less would be unsafe. The extended channel width is needed for moving vessels of this size in or out of the Port Jersey Channel. 500 ft seemed to be adequate for all maneuvers (see drawing). Move down the mark northern boundary. Move out to mark edge of channel. Move out to mark center of channel*
- b. *Full width from MOT dock-to-dock line on north is needed to back in or out safely. Yes, then and only then would it be safe.*
- c. *Going astern proposes no problem for docked ship. You must be very careful while moving ahead. I think coming head in to the berth from the main channel would be of greatest concern. You must really watch your speed.*
- d. *Yes, 500 ft is fine.*

4. What is your opinion of the ATONS for the proposed Port Jersey Channel realignment?

- a. *I would move the Flashing G"1" buoy east and north to mark the southern edge on the 50' channel.*

- b. *The southern edge of the channel should be marked so you can tell how much room you really have. The range should be realigned to mark the new center of the channel.*
- c. *Move the G"1" to the corner of the dredged channel (see chart 1)*
- d. *The buoy "1" should definitely be moved to mark the 50-ft channel*
- e. *The dredging and straight shot alignment of the north side of the channel all the way to the anchorage is definitely necessary.*

5. Please include any additional comments you may have on the proposed deepening and realignment of Port Jersey Channel.

- a. *The Corps has done an extremely fine job in realigning this channel. It should serve the needs of the maritime community well into the future.*
- b. *I feel the proposed project will enhance the ability for the port to compete with Port Elizabeth. The changes are excellent and make transiting the channel safer and quicker. I do feel that the aids to navigation should be placed in a location that they mark the limits of the channel on all sides. Consideration should be taken in regards to current when planning some of these maneuvers. I feel that backing across the hop of the tide is probably not wise.*
- c. *I think the channel should be from dock (MOT side) to dock (neat side), especially when backing in or out.*
- d. *I think at certain times you will need a third boat backing in or out of the channel (wind, tide).*
- e. *Backing in and out may be able to be done anytime with added tugs but to be safe 1 hr either side of high water slack or low water slack is by far the best*
- f. *Backing in on the ebb or flood was more difficult than backing out. I used and needed the full width of the flair for backing in.*

6. Do you feel the environment conditions (current, wind, banks, etc.) were accurately simulated and represent navigation conditions under which Port Jersey will operate?

- a. *To the best of my knowledge yes. No one in New York has handled a ship this big or at this draft. So it will be a learning experience for all pilots and tug operators.*
- b. *I felt that the simulations were very accurate to real life conditions of course all drills were done in daylight and there was no other traffic to contend with.*
- c. *Mostly except for the two original ebb tide runs as discussed.*
Note: No way to feel the wind effect and no instruments to indicate the wind direction and strength
- d. *I thought it was excellent.*

e. *Quite realistic.*

7. Please comment on the behavior of the simulation model of the Susan Maersk. Include the response of the ship to tugs.

- a. *I felt I didn't get enough response on the tug I put on the bow of the ship. I felt the ship (bow) should have moved much faster than it did on backing in or out maneuvers. It could be that because of the size and draft of the vessel the tug just couldn't do as I expected possibly 5,000 hp is the answer.*
- b. *The ship handled amazingly realistic. The view from the bridge wing made me feel like I was really on a ship. The tugs worked out well. I tried to use them as I would in real life. They worked out well*
- c. *The S-Class and K-Class Maersk ships back better than the model (more effective) (more powerful) Tugs were excellent.*
- d. *I thought the ship handled well and true to life while backing it felt just like a very heavy ship would and the tugs also were well simulated.*
- e. *Very realistic. The reaction time of the tugs, however, was far better than a pilot could dream of having in real life.*

8. Do you have any additional comments concerning the Port Jersey simulation model or the ERDC Ship/Tow Simulator?

- a. *This is the first time I have been to the new simulator and it is a big improvement over the old set-up. It is more than adequate for what we do. The rotating views you can get of where you are is very good.*
- b. *I was very impressed with the simulator and staff. Both worked well to provide an accurate and productive exercise. The only fault is that the tugs can stay at a 90 degree angle working ahead or astern no matter what the ship speed.*
- c. *Do like that you can change view and move from side to side or midship with simulator.*
- d. *It would be a good idea to indicate when you are at the bridge wing limits and midship.*
- e. *I think everything was a true to life as can be expected. I would hope all future projects would take place here as well.*
- f. *I was very impressed by the simulator Great facility and staff.*

