Ship Simulation Study for
Sabine Neches Improvement Project

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March 2003 Report
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ADDENDUM

This Report **"Ship Simulation Study for Sabine Neches Improvement Project – March 2003"** by ERDC was revised as a result of new ship simulation of the proposed entrance channel width-reduction performed during December 2006 and ITR review comments (ITRs in June 2006 and March 2007) by the U. S. Army Corps of Engineers, Mobile District, Alabama (SAM).

In accordance with ER 1110-2-1403, safe operation of deep-draft vessels in navigable channels is required to be established by real-time ship simulations. These simulations were performed by ERDC for design vessels for existing and future conditions and based on that, safe channel widths were established for various reaches of the proposed project.

The original ship simulation for the SNWW project was completed in 2002 and it provided for 700 feet width for Reach 8 (Extension Channel) and 800 feet width for the Reaches 7 (Sabine Bank Channel) and 6 (Sabine Pass Outer Bar Channel). Based on revised economic analysis, new ship simulations of the proposed entrance channel width-reduction were performed during December 2006. This new study consisted of two-way simulations for large loaded tankers and one-way simulations of Liquefied Natural Gas (LNG) tankers. Consequently, the Sabine Bank Channel width was reduced to 700 feet for the entire length except for the upper 5300 feet at its junction with Sabine Pass Outer Bar channel.

The following bottom widths for the base and plan were finally used for the modeling studies for selected 48-foot project, and these widths are the same for the 50-foot project. The dredged depths including over-depth are 50 feet and 52 feet for the inner channel and outer channel respectively for the 48-foot project.

	Base	Plan
Reach 1 and 2	400 ft	400 ft
Reach 3 and 4(Port Arthur and Sabine Pass Channel)	500 ft	700 ft
Reach 5 (Jetty Channel)	800-500 ft	800-700 ft
Reach 6	800 ft	800 ft
Reach 7:		
a. Sta. 18+000 to Sta. 23+300	800 ft	800 ft
b. Sta. 23+300 to Sta. 25+800	800 ft	Transition to 700 ft
a. Sta. 25+800 to Sta. 95+734 (end)	800 ft	700 ft
Reach 8	800 ft	700 ft

Project Plan is shown in Figure 1 below.

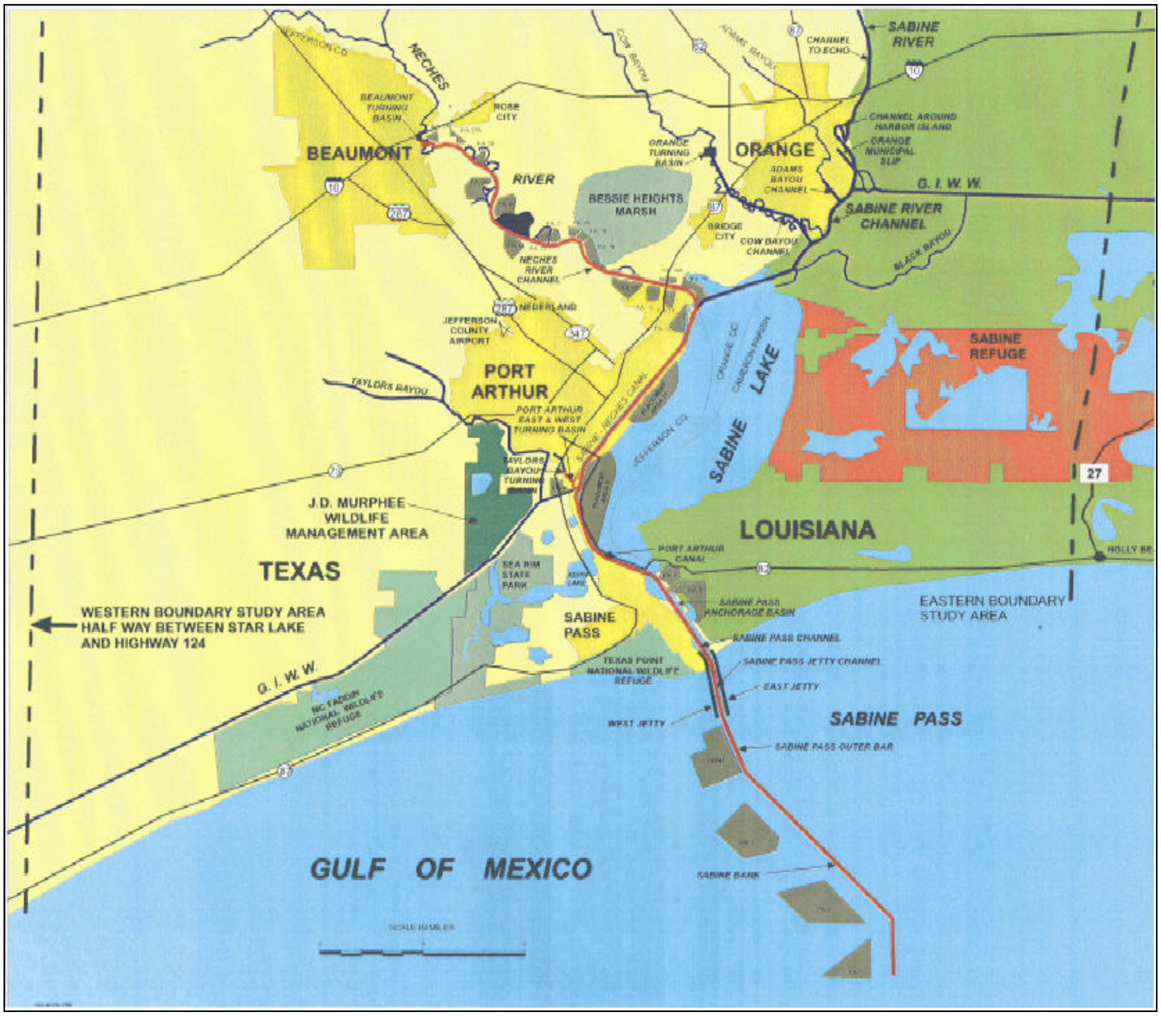


Figure 1: Location Map

Although it is assumed that sometimes, Sabine Neches project incurs 24-hour transits, for both inbound and outbound vessels, historically, the difference in results for night-time and day-time simulations has been minimal. Simulation of night-time runs requires a significant amount of database development for realistic lighting. Also, the increase in size of the testing program usually makes it prohibitive in cost. Further, the 24-hour transits are incurred only for smaller vessels. Larger vessels are limited to day-time only, one-way convoys. This results in lower traffic at night and few safety issues, therefore, no night-time simulation was considered necessary for either with or without-project conditions.

Selection of the design vessels were based on review of the existing practices and anticipated trends. The design vessel of 158KDWT represents the upper end of existing fleet of vessels. The tow size used for the ship simulation is shown below and it represents the upper end of fleet size. It also is within the maximum size allowed by the USCG. The vessel of 110KDWT represents the common size tanker used in simulations. TOW VESSELS Towboat size:1,200 HP, number of barges: three loaded barges, Configuration: Tandem Barge size: three 298’ x 54’barges, Towboat size: 1,200 HP, Number of Barges: three light barges,, Configuration: Two barges double-wide in the back and one upfront, Barge size: three 298’ x 54’barges. For simulation, only loaded barges were considered as the lighter ones were considered too unstable. Tables 8 and 9 in the original Report describe the barge simulation. However, in the final design, the Barge Lane was eliminated as being disruptive to other transiting ships or berthed vessels. The ship simulation initially evaluated an alternative with Barge Lanes, but due to input from the ship industry, the barge lanes were eliminated and it was determined that operators use VTS (Vessel Tracking System) to avoid using the channel at the same time as the larger ships.

New Ship Simulation Study performed in December 2006 is attached with this document. The new study only covers the reach south of Sabine Pass Jetty Channel (i.e. the Entrance Channel) and it supersedes the recommendation in the older Report.

DRAFT Memo
Recommendations..p

Sabine-Neches Improvement Study
Ship Simulation Study

1. Introduction and Study Objectives

The U.S. Army Engineer District, Galveston (CESAW) has proposed channel improvements for the Sabine-Neches Waterway (SNWW), Texas. The Sabine-Neches Waterway (SNWW) is located near the Louisiana-Texas State borders and provides access to the Gulf of Mexico for the harbor facilities of Sabine Pass, Port Arthur, and Beaumont, Texas (Figure 1). The existing project has an authorized depth of 40 ft and includes approximately 65 miles of deep-draft navigation channels. The SNWW is shared by both ship and barge traffic.

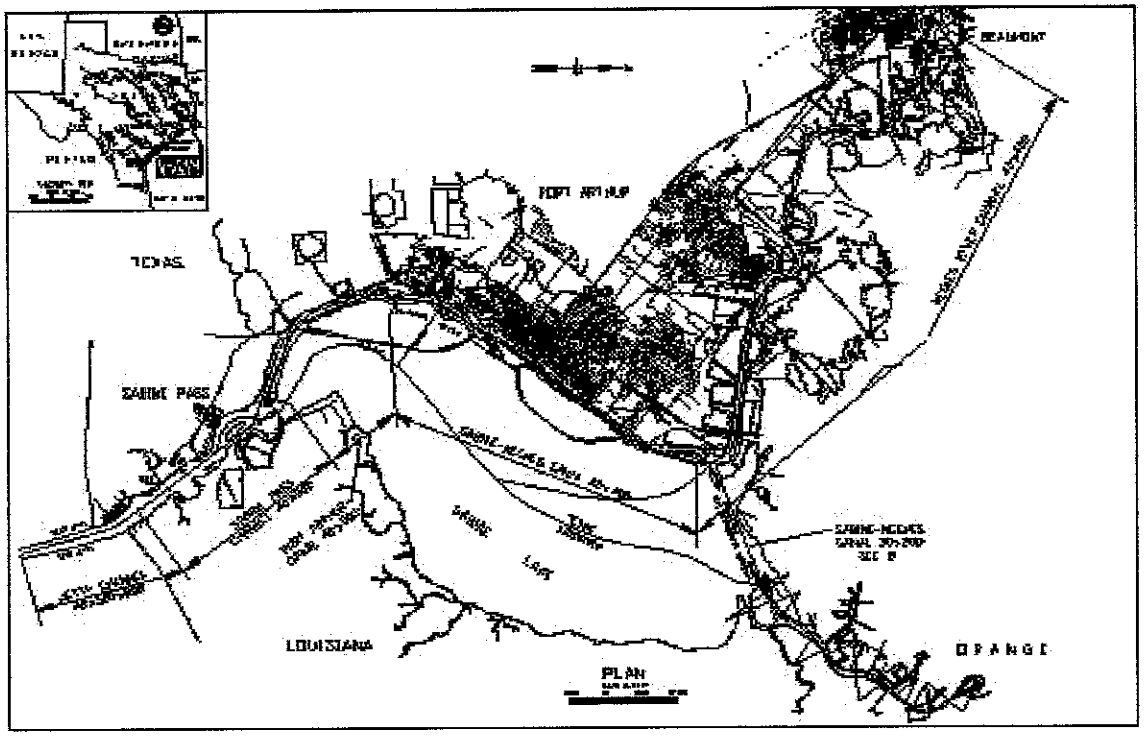


Figure 1. Project Location - Sabine-Neches Waterway

Presently, two-way traffic is restricted to a combined beam of one-half the channel width. Most of the SNWW channels are 400 ft wide. Therefore, the maximum combined beam for ships meeting is 200 ft. Because most the tankers/bulk carriers using the Ports of Beaumont and Port Arthur are wider than 100 ft, nearly all traffic is one-way. The vessels are moved through the SNWW in a convoy. That is, all inbound ships are held in the Gulf of Mexico, until the outbound ships pass the sea buoy. Then, all outbound ships are held at the dock, until the inbound ships are brought in. Sometimes the order is reversed and inbound ships transit first, assuming that dock space is available. Traffic for these large ships is limited to daylight only. It is not uncommon for ships to suffer delays of 24 hours. Tow traffic must wait in the Gulf IntraCoastal Waterway (GIWW) for the ships to pass the Sabine-Neches Canal. They often have delays of up to six hours.

2. Simulator Study.

Seaman's Church Institute conducted the simulations. The work was awarded by competitive contract. The delivery order was DACW42-01-R-0010. The simulations were done in real-time at their Houston, TX facility. Figure 2 shows one of the full-mission bridge simulators used in the study.

Figure 2. Seaman's Church Bridge Simulator.

The simulators included environmental databases, visual scenes, and radar. Currents for the existing and proposed conditions were calculated as part of a separate study conducted at ERDC (Vemulakonda, 2002). Seaman's Church obtained the photographs used to prepare the visual scene during a reconnaissance trip in November 2001.

Once the existing condition models were developed, the models were validated with assistance of pilots from the Sabine River Pilots Association. A licensed towboat pilot validated the towboat response.

All ships transits included in the simulation study were controlled by representatives of the Sabine River Pilots Association. The towboats were either controlled by representatives of Seaman's Church (Figure 3) or were under computer control.

Figure 3. Seaman's Church Towboat Simulator

Simulation Results.

Results from the real-time simulation program will be presented from the Gulf of Mexico, inland. Results are in the form of vessel track plots, pilot ratings, and observations made by engineers during the simulations.

Entrance Channel Extension. Deepening the Sabine Bank Channel to 52 ft will require that the existing channel be extended on its present heading (Figure 4). The simulations in Table 1 were proposed to evaluate width requirements for the Extension Channel. A navigation channel is not presently required in this area because the natural depth is greater than the existing channel requirements. Therefore, no existing condition runs were simulated.

Based upon simulations conducted during the design session, Run E01 was selected as the only scenario to carry forward into the formal testing program. Three E01 simulations were conducted during the formal testing program. The pilots had little or no difficulty meeting in the proposed 700-ft wide Outer Bar Channel. The average clearance (based upon the approximate approach distance) between the ships was 165 ft. The track plots are shown in Plate 1.

Sabine Bank and Jetty Channels. The existing Sabine Bank Channel is 800 ft wide and authorized to a 42 ft depth. The proposed Sabine Bank Channel will remain 800 ft wide and be deepened to 52 ft. This area is shown in Figure 4. Simulations of two-way runs were conducted to evaluate width requirements for the proposed 52 ft depth. Meetings occurred in the Gulf of Mexico, south of the jetties. The simulations in Table 2 were proposed to evaluate width requirements for the Sabine Bank and Jetty Channels.

Based upon simulations conducted during the design session, Runs S01, S04, S07 and S10 were selected to carry forward into the formal testing program. Three runs in each condition were tested for a total of 12 runs. Table 3 shows the runs included in the formal program.

Plates 2 and 3 shows the six runs made in the existing channel depth of 42 ft with the 38-ft draft 158KDWT tanker. For one of the runs on this plot the ship meeting took place in the bend south of the jetty entrance (Buoys 29 & 30) – for the other runs the starting position of the inbound ship was adjusted so as to allow the meeting to take place in a straight reach. One pilot stated that the maneuver he ran would not be safe. This was the run where the ships met in the bend. The ships starting position was adjusted so that ships would no long meet in the bend. On one occasion in the existing channel the outbound pilot was confused about the buoy pattern and thought he was at the turn south of the jetties and ran aground after the ship meeting took place. The average minimum hull-to-hull distance during meetings in the existing channel simulations was 235 ft

Plates 4 & 5 show the six runs made in the proposed deepening to 52 ft. Again, one run met in the bend and the others in the straight reach to the north. Out of four pilots running these scenarios only one stated that the maneuver he ran would not be safe. This run was the one in the existing channel where the ships met in the bend. On one occasion in the existing channel the outbound pilot was confused about the buoy pattern and thought he was at the turn south of the jetties and ran aground after the ship meeting took place. The average minimum hull-to-hull distance during meetings in the existing channel simulations was 235 ft and in the deepened channel was 179 ft. The higher clearance in the existing channel was due to a couple of runs in which the outbound pilot ran out of the channel possibly because of misplaced buoys in the simulation. This increased the distance to the inbound ship but did not cause grounding on the simulator because of the location of the specified top of bank outside of the channel edge.

Jetty, Sabine Pass, and Port Arthur Ship Channels. The existing Jetty Channel is 800 ft wide at the southern end of the jetties and 500 ft wide at its northern end. The Sabine Pass and Port Arthur Ship Channels are 500 ft wide. The Jetty, Sabine Pass, and Port Arthur Ship Channels must be widened if they are to accommodate two-way traffic for the design ship. Two new channel widths were proposed. One plan, the 700 ft channel, will transition the Jetty channel to 700 ft instead of 500 ft. The Sabine Pass and Port Arthur Channel would be 700 ft wide to Texaco Island. The second plan would widen the channels to 600 ft instead of 700 ft. The reach to be widened is shown in Figure 5. Currents in this area are tidal driven and are generally aligned with the navigation channel. However, cross-currents in the lake outlet, generated by the tidal exchange from

Sabine Lake have been estimated by the pilots to be 5 to 6 knots in magnitude. The simulations in Table 4 were proposed to evaluate width requirements for the Jetty, Sabine Pass, and Port Arthur Ship Channels.

Based upon the results of the design sessions, the 600 ft channels were eliminated and the 700 ft wide channels were chosen to simulate two-way traffic for the 158 KDWT tankers. In addition, smaller simulation vessels were chosen to represent two-way traffic in the existing channels. The simulations in for the formal testing program are shown in Table 5.

Two reaches were simulated for this area. The southernmost reach included the Jetty and Sabine Pass Channels while the most inland reach included the Sabine Pass and Port Arthur Channels.

The existing condition simulation runs in the Jetty and Sabine Pass Channels are shown in Plates 6 – 21. The path shows the usual pilot practice of going wide into the Sabine Anchorage, at the upper end, which the pilots said is done to compensate for currents heading into and out of the old river channel to the west. Two outbound ships (Plates 9 and 10) were forced out of the channel due to the inbound ship not leaving the channel centerline. Despite these problems the average minimum hull-to-hull clearance for these existing channel runs was 121 ft, more than one ship beam.

The track plots for the proposed 700 ft wide Jetty and Sabine Pass Channels are shown in Plates 12 – 18. These runs were conducted with the proposed loaded tanker at 48-ft draft. As can be seen the entire channel width was taken up. Pilot comments indicate some disagreement among the pilots as to the feasibility of the maneuver. Two pilots said the speed in the simulation was too high for the surrounding area and that the ships did not respond as expected. However, ships of the proposed tanker's size are not present in the channel currently and it is reasonable to expect that they would be more stable than the lighter ships transiting the channel now. These two pilots stated they did not think the operation would be safe. The other pilots running this scenario thought the operation would be safe. The average minimum hull-to-hull clearance during the meetings for this channel was 124 ft. The lowest clearance of these runs was 78 ft, which resulted from the outbound pilot not moving over during the meeting for unexplained reasons. If this run is eliminated from the clearance calculations the average increases to 158 ft, approximately one beam width. The next two lowest clearances involved the same pilot, which suggests that he was not taking advantage of the wider channel width in the simulation and was piloting in accordance with tradition.

The track plots for the existing Sabine Pass and Port Arthur Channels are shown in Plates 19 – 23. The meeting location just west of the lake outlet was not an optimum spot for meeting because of the prior maneuvering required by the inbound ship, especially during ebbing tide. Pilots made numerous comments that they would not meet at this location although they did say that meeting farther west would be acceptable. The average minimum hull-to-hull distance during meeting was 133 ft; however, the clearance during the one meeting that took place farther west was 183 ft (pilots F&G in flood tide).

The track plots for the proposed 700 ft wide Sabine Pass and Port Arthur Channels are shown in Plates 24 – 30. The meetings occurred closer to the lake outlet than the pilots would have liked. However, the majority of the runs were successful. One outbound ship (Plate 27) ran aground on the north side of the channel at the lake outlet. Being to far south and bank forces turning the ship north caused this. The average hull-to-hull clearance during meetings was 143 ft – the best runs had clearances significantly larger than one ship beam. Elimination of the lowest clearance in the averaging calculations results in a hull distance of slightly less than one ship beam.

Approach to Martin Luther King Bridge. The Sabine-Neches is 400 ft wide through the Martin Luther King Bridge. Widening the Sabine-Neches canal will require a transition to the 400 ft channel, both north and south of the bridge. Replacing or modifying the bridge is not being considered. Widths of 400 and 500 ft were tested for the proposed 50-ft deep channel. Widening will be to the east, not symmetrical about the channel centerline. Simulations were conducted for both the inbound and outbound approaches to the bridge. The 400 ft by 50 ft channel was tested to evaluate approaching the bridge with a heavier ship in the deepened channel without widening. All proposed simulations (Table 6) were for one-way ship traffic. Based upon the results of the design week, all opposing tide simulations were dropped and only fair tide runs included. Fair tide means that the vessel is traveling in the same direction as the current. This is regarded as the more difficult scenario because less water goes past the rudder, making the ship more difficult to steer. The simulation matrix for the formal program is shown in Table 7.

Track plots for simulation of the existing channels are shown in Plates 31 (outbound) and 32 (inbound). Runs were fairly consistent, the pilots kept their ships to the outside on the bends in the S-turn south of the bridge. This is a typical example of pilots using bank effects to feel their way around a turn and increase the overall turn radius. All ships went well outside the channel and used the deep water at the intersection with the GIWW. Outbound runs in the deepened 400 ft wide channel (Plate 33) were similar to those in the existing channel. However, inbound runs (Plate 34) showed ships leaving both the east and west sides of the channel as they approach the bridge. Outbound runs in the 500 ft wide channel (Plate 35) were consistent and stayed to the outside of the bends in the S-turn south of bridge. Outbound runs in the 500 ft wide channel (Plate 36) stay to the outside of the bends as they approached the bridge.

Sabine-Neches Canal. The Sabine-Neches Canal is presently 400 ft wide and 40 ft deep. The scenarios developed for this reach were originally to evaluate a two-mile long, two-way traffic zone. To determine the channel width required for two-way traffic, a two-mile long reach was simulated. The reach and the approximate location of the two-way zone are shown in Figure 6. In addition, a 150 ft wide barge shelf was modeled. Both two- and six-barge tows were simulated during all runs.

Based upon the design session, most of the two-way runs were eliminated from consideration. The pilots felt that two-way traffic may not be possible due the nature of the ship's cargo and the close proximity of residential areas. The 700 ft wide two-way zone was included in the formal simulation sessions to determine the width required, if necessary. New scenarios were developed for one-way traffic requirements. The formal simulation matrix is shown in Table 9.

All track plots show the two-barge tow tracks in addition to the ships. The two-barge tows were human operated, either at the control station, or by having an operator stationed at a tow console. The six-barge tows were computer controlled and Seaman's has not furnished us with the tracks.

Plots of two-way runs in the 700-ft wide proposed channel are shown in Plates 37 – 42. The 700 ft wide channel appears to provide adequate width, even though some ships crossed the channel (Plates 37, 40, 41, and 42). These ships were forced out the channel by the second vessel, which did not get over to their side of the channel, even though there was ample room to do so. The operators observed that the two-barge tow over-reacted to forces induced by the ship traffic.

All one-way runs were conducted for fair-tide only. Composite track plots for the existing condition are shown in Plates 43 and 44. Most of the ships favored the eastern side of the channel and a few crossed the eastern channel edge. The composite plots for the proposed 400-ft channel are shown in Plates 45 and 46. This channel is deepened to 52 ft within the confines of the existing channel. Most of these ships also favored the eastern side of the channel. One two-barge tow (Plate 45) was too close to the ship and swung wildly to the east. The towboat operator not being an experience mariner caused this human error. The composite track plots for simulations of the proposed 500 ft channel are shown in Plates 47 and 48. Although one inbound and one outbound ship did touch the channel boundary, runs in the 500 ft channel typical maintained a very large clearance to the channel's edge.

Humble Island Turn. The turn at Humble Island was simulated to determine the effect of deeper loaded ships making the turn and lining up for the Highway 87 Bridge. All simulations were for one-way traffic. In addition to the existing channel, two deepened channel widths (400- and 500-ft) were simulated. The test matrix for the design week is shown in Table 10. Based upon the design week a new matrix was developed for the formal testing. Formal testing runs were for fair tide only in the existing channel and the proposed 400 ft wide deepened channel. The matrix for the formal testing session is shown in Table 11.

The track plots for simulations of the existing channel are shown in Plates 49 and 50. The ebb tide runs (Plate 49) typically stayed to the north and east side of the channel and made the turn as a swept path. The flood tide runs (Plate 50) stayed to the east side of the channel and made a sharper turn to port near Stewts Island. After passing Stewts Island, the ships went to the west side and then the north side of the channel as they made the turn. Runs in the proposed channel (Plates 50 and 51) made a swept turn similar to the existing ebb tide runs. However, the swept path of the ships was greater than for the existing conditions and several runs crossed the channel boundaries. The swept path just east of the bride was significantly wider for the proposed condition.

Neches River. The original testing program for the Neches River reach was for two-way traffic (Table 12). However, the pilots felt that the Neches River would, for the most part, operate as one-way traffic for larger ships. The formal test matrix (Table 13) focused on one-way width for two reaches and a 700-ft width for two-way traffic in McFadden Bend Cutoff.

Results for one-way simulations in the Magpeco Bend reach of the Neches River are shown in Plates 53 – 58. The pilots operated the three simulated channel in similar manner. That is, they kept the vessel on the outer edge of the channel while transiting the bends. The pilots' referred to this as "going deep in the bends." The runs for existing conditions (Plates 53 and 54), the existing channel deepened to project depth (Plate 55 and 56) and the deepened 500 ft wide channel (Plates 57 and 58) show similar results. Ships in all scenarios left the authorize channel on the outside of the bends.

The plots of the simulations for the Upper Reach of the Neches River show similar results to the Magpeco Bend runs with the pilots going deep in the bends. These results are shown in Plates 59 – 64.

The two-way runs in the 700-ft wide channel are shown in Plates 65 – 67. The 700-ft wide channel appears to provide adequate width for two-way traffic even though the outbound ship ran along the southern edge of the channel. The inbound ship crowded the outbound somewhat, even though they had additional room on the north side of the channel. It should be noted that some of the runs included passing through the bends in a 700 ft wide channel. Even with that much room, the pilots still stayed well to the outside of the bend and crossed the channel limits. This is especially apparent in Plate 65.

Turning Basins. Eight turning areas were tested during the formal program. Due to additional time required for validation, there was not sufficient time to examine the turning basins during the design session. This contributed to the failure of some of the turning basins simulations. These turning basins are new, and the pilots did not have time to practice and develop techniques for using the basins. However, pilot comments indicate that they felt the turning basins were safe.

The track plots for Turning Basin 1 are shown in Plate 68. This basin was operated for both inbound and outbound ships. There were several successful turns for both inbound and outbound runs. All runs left the southern edge of the channel. Either widening the southern edge of the channel, or providing additional width to the basin on the eastern and western approaches could address this.

The track plots for Turning Basin 2 are shown in Plate 69. This basin was operated for both inbound and outbound ships. Most of the runs crossed the turning basin limits on the west side. The one run that did not cross the western limits ran aground on the eastern side.

The track plots for Turning Basin 3 are shown in Plate 70. Two of the four ships were successfully turned, the remaining two ships were unable to complete the maneuver.

Turning Basin 8 is included on the same plate as Turning Basin 3. All of the runs ran aground.

The track plots for Turning Basin 4 are shown in Plate 71. One run let the eastern side of the turning basin. The other three runs used the deep water in front of Sun Oil Docks to widen their turn into the basin. The pilots were able to complete the turn for all ships.

Turning Basin 5 is also shown on Plate 71. The pilots used the deep water in front of the docks on the southern side of the channel.

The track plots for Turning Basins 6 and 7 are shown in Plate 72. Although one run in Turning Basin 7 was successful, most runs in basins 6 and 7 failed. This was because the angle of the basin with respect to the channel was too severe and the basin wasn't wide enough to overcome the angle.

Taylor Bayou. Track plots of Taylor Bayou are presented in Plates 73 – 76. All runs left the channel on the southern side of the channel when entering Taylor Bayou and when entering the turning basin. Even though one ship (Plate 73) went aground when turning, there was ample room in the basin had the ship gone far enough north prior to turning.

Conclusions and Recommendations.

Based upon results of the real-time ship simulation study, the following conclusions and recommendations are made.

1. Entrance Channel Extension. The 700 ft wide Entrance Channel Extension is adequate for two-way traffic of the design ship. The 800 ft wide Entrance Channel Extension was eliminated during the design session because the reach is far enough offshore. The strong longshore currents are significantly weaker in this reach when compared with those closer to shore.

2. Sabine Bank and Jetty Channels. The Sabine Bank Channel, deepened at its present 800 ft width, is adequate for two-way traffic of the design ship. The Jetty Channel, which presently transitions from 800 to 500 ft, should transition from 800 to 700 ft.

3. Sabine Pass and Port Arthur Ship Channels. The Sabine Pass and Port Arthur Ship Channels should be widened from 500 ft to 700 ft. A 600 ft width for both the Sabine Pass and Port Arthur Ship Channel was eliminated during the design session. This report assumes that both the Sabine Pass and Port Arthur Ship Channels will be widened. Due to operational issues such as timing, neither reach would function as a stand-alone two-way channel.

4. Approach to the Martin Luther King Bridge. The approach to the Martin Luther King Bridge should be widened from 400 to 500 ft, transitioning back to 400 ft through the bridge. An alternative to deepen the existing channel without widening was eliminated during the design session.

5. Sabine-Neches Canal. The deepened 500-ft channel provides additional width beyond that necessary for the design ship to transit the canal. However, the existing 400-ft wide channel alignment, when deepened to 52 ft, does not provide adequate width for the deeper-drafted ships. This is due to a number of course-changes in the canal. The combination of bend widening and channel straightening shown in Figure 7 is recommended for the 400 ft wide channel to provide adequate clearance. The barge shelf should be 150 ft wide to ensure that the tow traffic can safely transit alongside ships. The 150-ft barge shelf width is the width from the toe of the ship channel. The pilots stated that would not recommend meeting in this reach due to developments on the west side of the canal. However, the proposed 700-ft wide provided adequate width.

6. Humble Island Turn. The channel through Humble Island turn should be widened to 500 ft and transition back to 400 ft through the bridge.

7. Neches River. The Neches River can be deepened to 52 ft at its present width of 400 ft. If two-way traffic is required, the 700-ft channel provided adequate room. Additional simulations may allow the 700-ft wide two-way channel to be reduced.

8. Turning Basins. It is recommended that Turning Basins 1, 2, 3, 4, and 5 be widened as shown. Simulation of Turning Basins 6, 7, and 8 were unsuccessful. Therefore, modifications to Turning Basins 6, 7 and 8 are proposed based upon the results of Turning Basins 1, 2, 3, 4, and 5. These modifications are shown in Figure 8.

9. Taylor Bayou. It is recommended that Taylor Bayou be widened at its entrance and on the southern side of approach to the turning basin. The Taylor Bayou turning basin is adequate. It is possible that the recommended widening, as shown in Figure 9 can be modified with additional simulations.

Table 1. Simulation Exercises for Outer Bar Channel. Channel depth will be 52 ft for all runs.					
Run	Condition	Current	Wind	Heading	Ship
E01	700 ft width	Westerly	Yes	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	158KDWT Tanker, 899- x 164- 48-ft
E02	700 ft width	Westerly	Yes	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
E03	700 ft width	Westerly	Yes	Inbound	110KDWT Tanker, 830- x 135- x 48-ft
				Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
E04	800 ft width	Westerly	Yes	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	158KDWT Tanker, 899- x 164- 48-ft
E05	800 ft width	Westerly	Yes	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
E06	800 ft width	Westerly	Yes	Inbound	110KDWT Tanker, 830- x 135- x 48-ft
				Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft

Table 2. Scenarios Considered for the Sabine Bank and Jetty Channels				
Run	Condition	Tide	Heading	Ship
S01	Existing	Ebb	Inbound	158KDWT Tanker, 899- x 164- 38-ft
			Outbound	158KDWT Tanker, 899- x 164- 38-ft
S02	Existing	Ebb	Inbound	158KDWT Tanker, 899- x 164- 38-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 38-ft
S03	Existing	Ebb	Inbound	110KDWT Tanker, 830- x 135- x 38-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 38-ft
S04	Existing	Flood	Inbound	158KDWT Tanker, 899- x 164- 38-ft
			Outbound	158KDWT Tanker, 899- x 164- 38-ft
S05	Existing	Flood	Inbound	158KDWT Tanker, 899- x 164- 38-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 38-ft
S06	Existing	Flood	Inbound	110KDWT Tanker, 830- x 135- x 38-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 38-ft
S07	52 ft	Ebb	Inbound	158KDWT Tanker, 899- x 164- 48-ft
			Outbound	158KDWT Tanker, 899- x 164- 48-ft
S08	52 ft	Ebb	Inbound	158KDWT Tanker, 899- x 164- 48-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
S09	52 ft	Ebb	Inbound	110KDWT Tanker, 830- x 135- x 48-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
S10	52 ft	Flood	Inbound	158KDWT Tanker, 899- x 164- 48-ft
			Outbound	158KDWT Tanker, 899- x 164- 48-ft
S11	52 ft	Flood	Inbound	158KDWT Tanker, 899- x 164- 48-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft
S12	52 ft	Flood	Inbound	110KDWT Tanker, 830- x 135- x 48-ft
			Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft

Table 3. Selected Simulation Exercises for the Sabine Bank and Jetty Channels					
Run	Number Tested	Condition	Tide	Heading	Ship
S01	3	Existing	Ebb	Inbound	158KDWT Tanker, 899- x 164- 38-ft
				Outbound	158KDWT Tanker, 899- x 164- 38-ft
S04	3	Existing	Flood	Inbound	158KDWT Tanker, 899- x 164- 38-ft
				Outbound	158KDWT Tanker, 899- x 164- 38-ft
S07	3	47 ft	Ebb	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	158KDWT Tanker, 899- x 164- 48-ft
S11	3	47 ft	Flood	Inbound	158KDWT Tanker, 899- x 164- 48-ft
				Outbound	110KDWT Product Carrier, 814- x 144- x 48-ft

Table 4. Simulation Exercises for Jetty, Sabine Pass, and Port Arthur Ship Channel.					
Run	Condition	Tide	Wind	Heading	Ship
A01	Existing	Ebb	Yes	Inbound	Tanker,
				Outbound	Product Carrier
A02	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A03	600 ft	Ebb	Yes	Inbound	110KDWT Tanker, LOA (815 – 830) beam (131 – 137)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A04	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A05	700 ft	Flood	Yes	Inbound	110KDWT Tanker, LOA (815 – 830) beam (131 – 137)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A06	Existing	Flood	Yes	Inbound	Tanker,
				Outbound	Product Carrier
A07	600 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A08	600 ft	Flood	Yes	Inbound	110KDWT Tanker, LOA (815 – 830) beam (131 – 137)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A09	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A10	700 ft	Flood	Yes	Inbound	110KDWT Tanker, LOA (815 – 830) beam (131 – 137)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A11	Existing	Ebb	Yes	Inbound	Tanker,
				Outbound	Product Carrier
A12	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A13	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A14	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A15	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A16	Existing	Flood	Yes	Inbound	Tanker,
				Outbound	Product Carrier
A17	600 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A18	600 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
A19	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A20	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)

Table 5. Formal Simulation Exercises for Jetty, Sabine Pass, and Port Arthur Ship Channel.					
Run	Condition	Tide	Wind	Heading	Ship
A01	Existing	Ebb	Yes	Inbound	Tanker, 580 x 101 x 38 ft
				Outbound	Tanker, 580 x 101 x 38 ft
A04	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A06	Existing	Flood	Yes	Inbound	Tanker, 580 x 101 x 38 ft
				Outbound	Tanker, 580 x 101 x 38 ft
A09	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A11	Existing	Ebb	Yes	Inbound	Tanker, 580 x 101 x 38 ft
				Outbound	Tanker, 580 x 101 x 38 ft
A14	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
A16	Existing	Flood	Yes	Inbound	Tanker, 580 x 101 x 38 ft
				Outbound	Tanker, 580 x 101 x 38 ft
A19	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 6. Design Week Simulation Exercises for the approach to Martin Luther King Bridge.					
Run	Condition	Tide	Wind	Heading	Ship
B01	Existing	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B02		Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B03		Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B04		Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B05	400 ft x 47 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B06		Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B07		Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B08		Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B09	500 ft x 47 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B10		Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B11		Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B12		Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 7. Formal Simulation Exercises the approach Martin Luther King Bridge.					
Run	Condition	Tide	Wind	Heading	Ship
B02	Existing	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B03	Existing	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B06	400 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B07	400 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B10	500 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B11	500 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 8. Simulation Exercises for the Sabine-Neches Canal
The barge lane will be simulated for the proposed condition only.
Both the 6-pack and 2-barge tandem will be using the barge shelf.

Run	Condition	Tide	Wind	Heading	Ship
C01	Existing	Ebb	Yes	Inbound	Tanker,
				Outbound	Product Carrier
C02	Existing	Flood	Yes	Inbound	Tanker,
				Outbound	Product Carrier
C03	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C04	600 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C05	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
C06	600 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
C07	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C08	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C09	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
C10	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)

Table 9. Simulation Exercises for the Sabine-Neches Canal.

The barge lane will be simulated for the proposed conditions. No barge shelf will be tested with the 700 ft channel.

Run	Condition	Tide	Wind	Heading	Ship
C07	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C08	700 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

One Way Runs.

The barge lane will be simulated for the following proposed conditions. The barge lane is 150 ft wide and 12 ft deep. Both the 6-pack and 2-barge tandem will be using the barge shelf. Both tows should be included in all runs. If the starting/ending points for the runs may need to be adjusted to allow time for both tows to interact with the ships.

Run	Condition	Tide	Wind	Heading	Ship
C16	Existing	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C17	Existing	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C18	400 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C19	400 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C20	500 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
C21	500 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 10. Simulation Exercises Humble Island Turn					
Run	Condition	Current	Wind	Heading	Ship
B01	Existing	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B02	Existing	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B03	Existing	Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B04	Existing	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B05	Proposed	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B06	Proposed	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B07	Proposed	Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
B08	Proposed	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 11. Formal Simulation Exercises Humble Island Turn					
Run	Condition	Current	Wind	Heading	Ship
D02	Existing	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
D03	Existing	Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
DB6	400 ft x 50 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
D07	400 ft x 50 ft	Flood	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

Table 12. Simulation Exercises for the Neches River					
Run	Condition	Tide	Wind	Heading	Ship
N01	Existing	Ebb	Yes	Inbound	Tanker,
				Outbound	Product Carrier
N02	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N03	600 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
N04	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N05	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)

Table 13. Simulation Exercises for the Neches River					
Run	Condition	Tide	Wind	Heading	Ship
N04	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N05	700 ft	Ebb	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
				Outbound	110KDWT Product Carrier (LOA (800 – 815) beam (138 – 145)
One Way Runs. One-way reach 1					
Run	Condition	Tide	Wind	Heading	Ship
N06	Existing	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N07	Existing	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N08	400 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N09	400 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N10	500 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N11	500 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
One Way Runs. One-way reach 2					
Run	Condition	Tide	Wind	Heading	Ship
N12	Existing	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N13	Existing	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N14	400 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N15	400 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

N16	500 ft x 50 ft	Ebb	Yes	Outbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)
N17	500 ft x 50 ft	Flood	Yes	Inbound	158KDWT Tanker, LOA (895 – 900) beam (157 – 164)

HP DeskJet

HEWLETT PACKARD

Expanding Possibilities

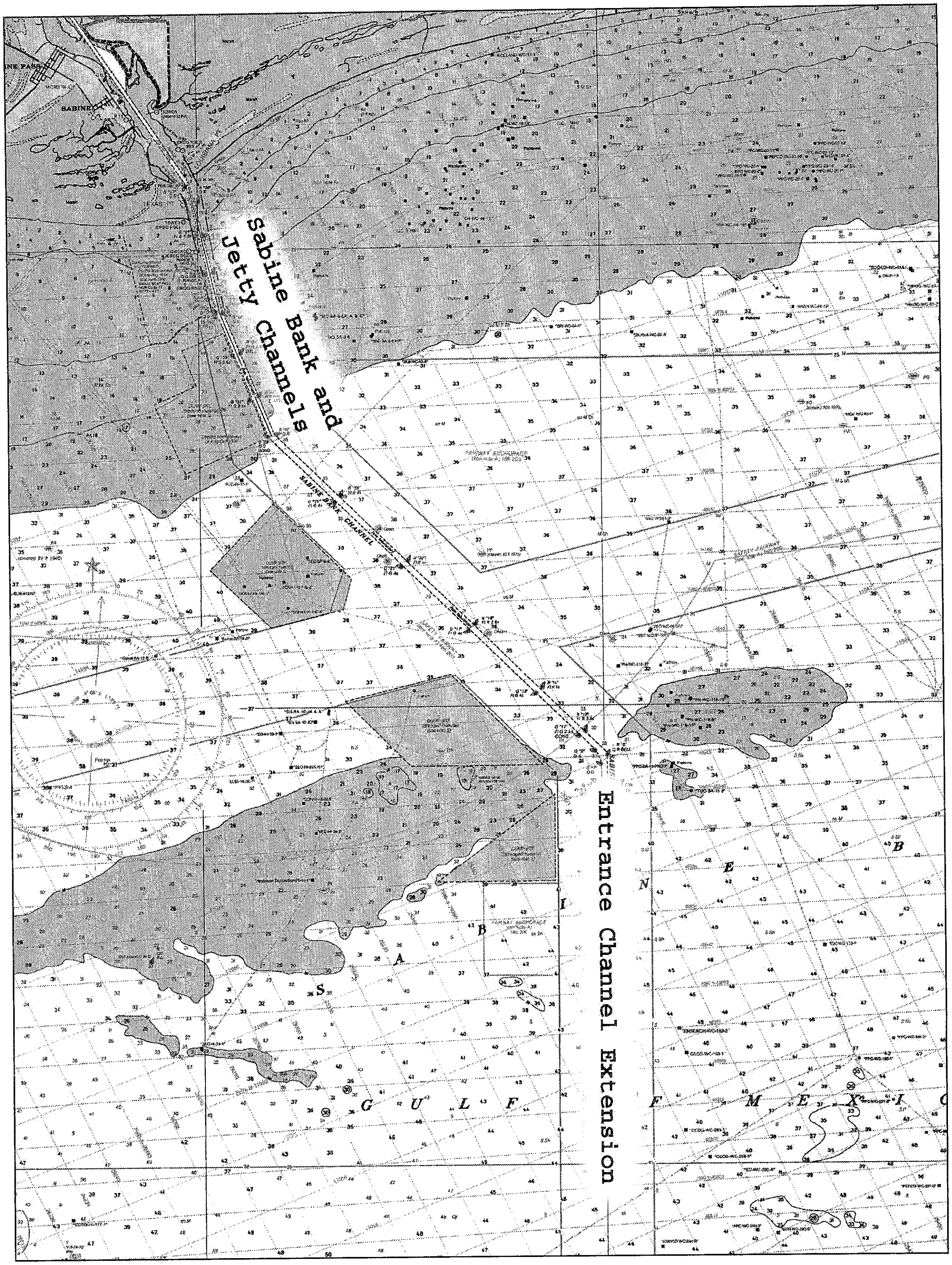


Figure 4. Entrance Channel Extension, Sabine Banks and Jetty Channels

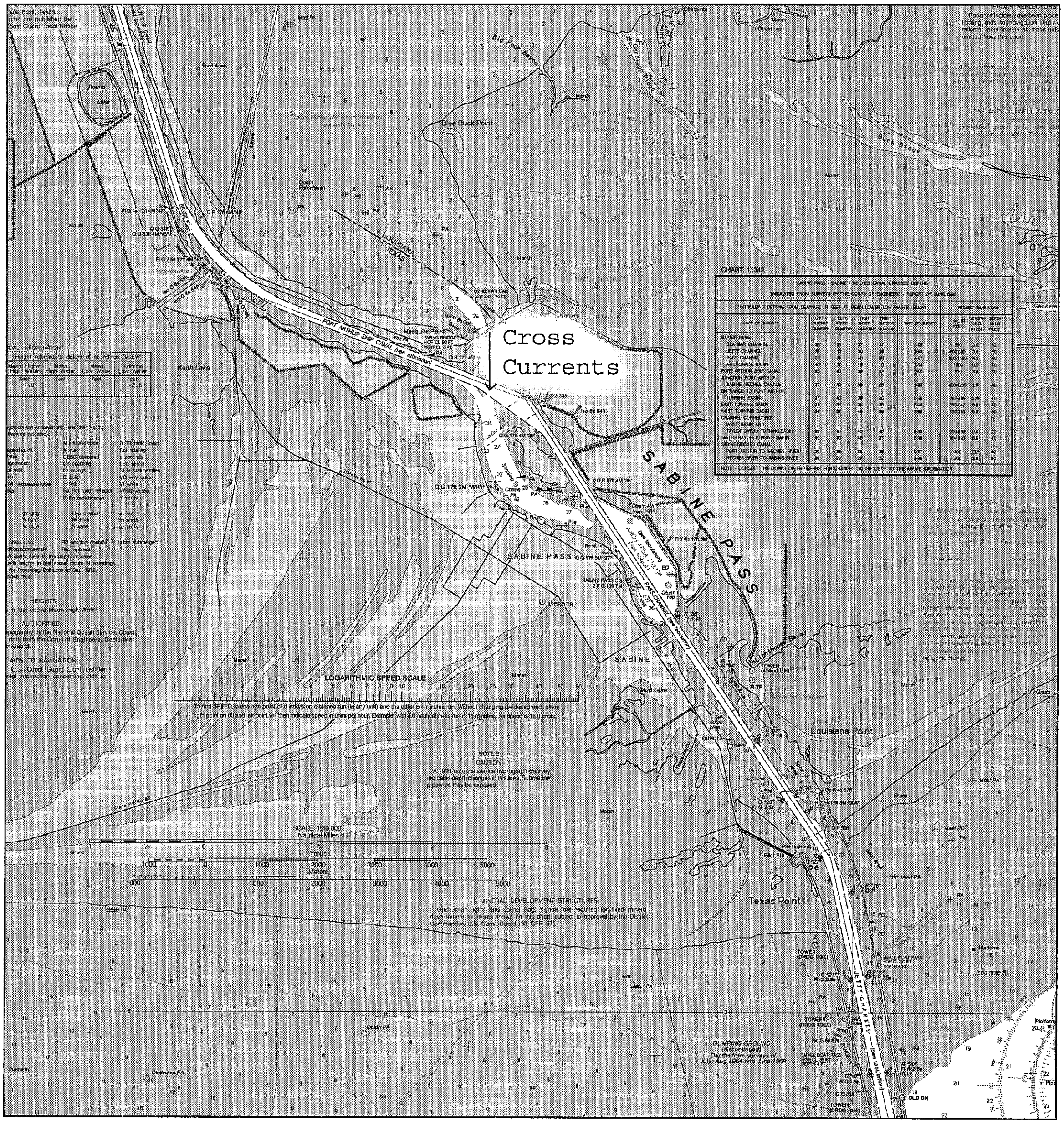


Figure 5. Jetty, Sabine Pass, and Port Arthur Ship Channels

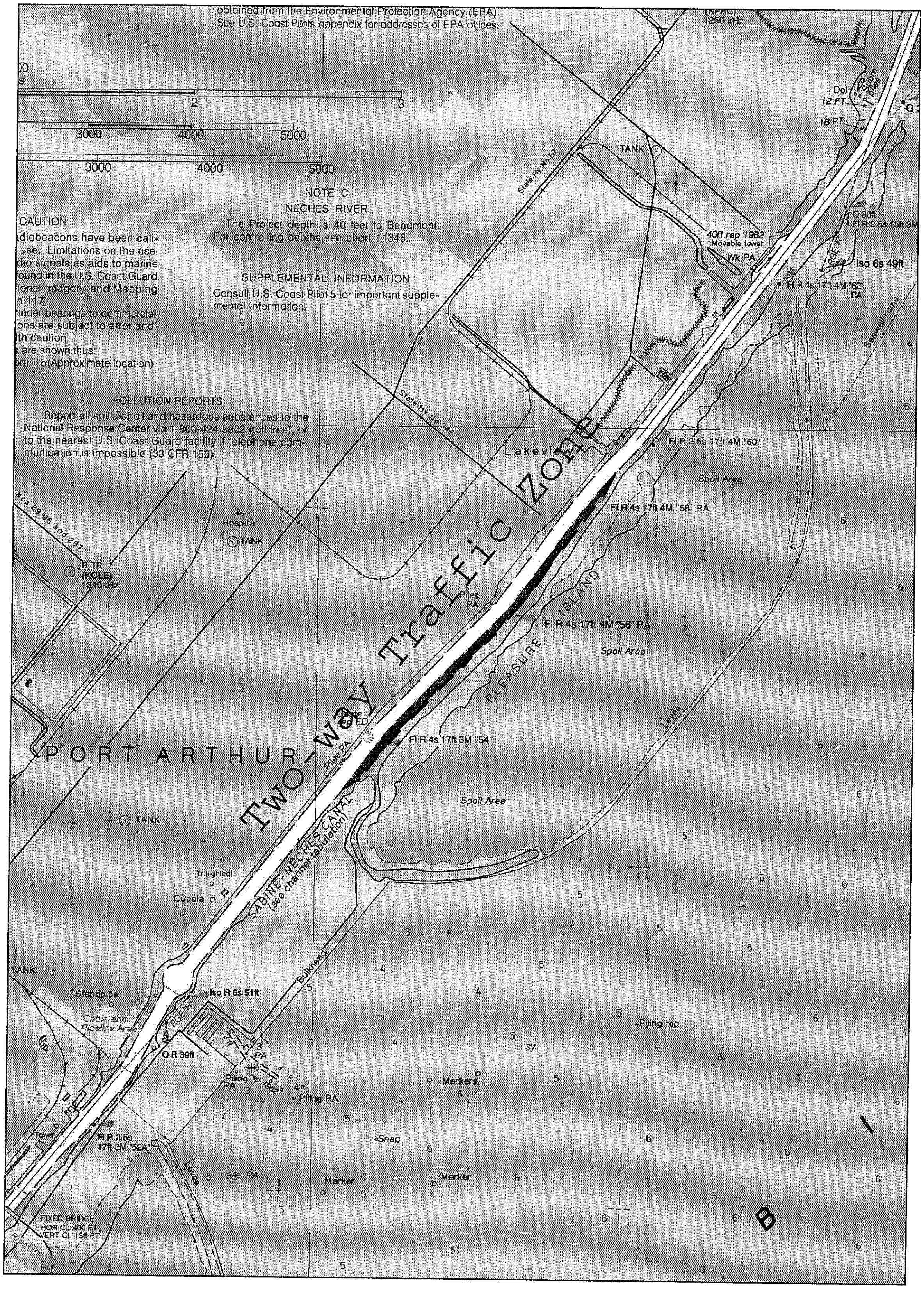


Figure 6. Two-way traffic zone for Sabine-Neches Canal.

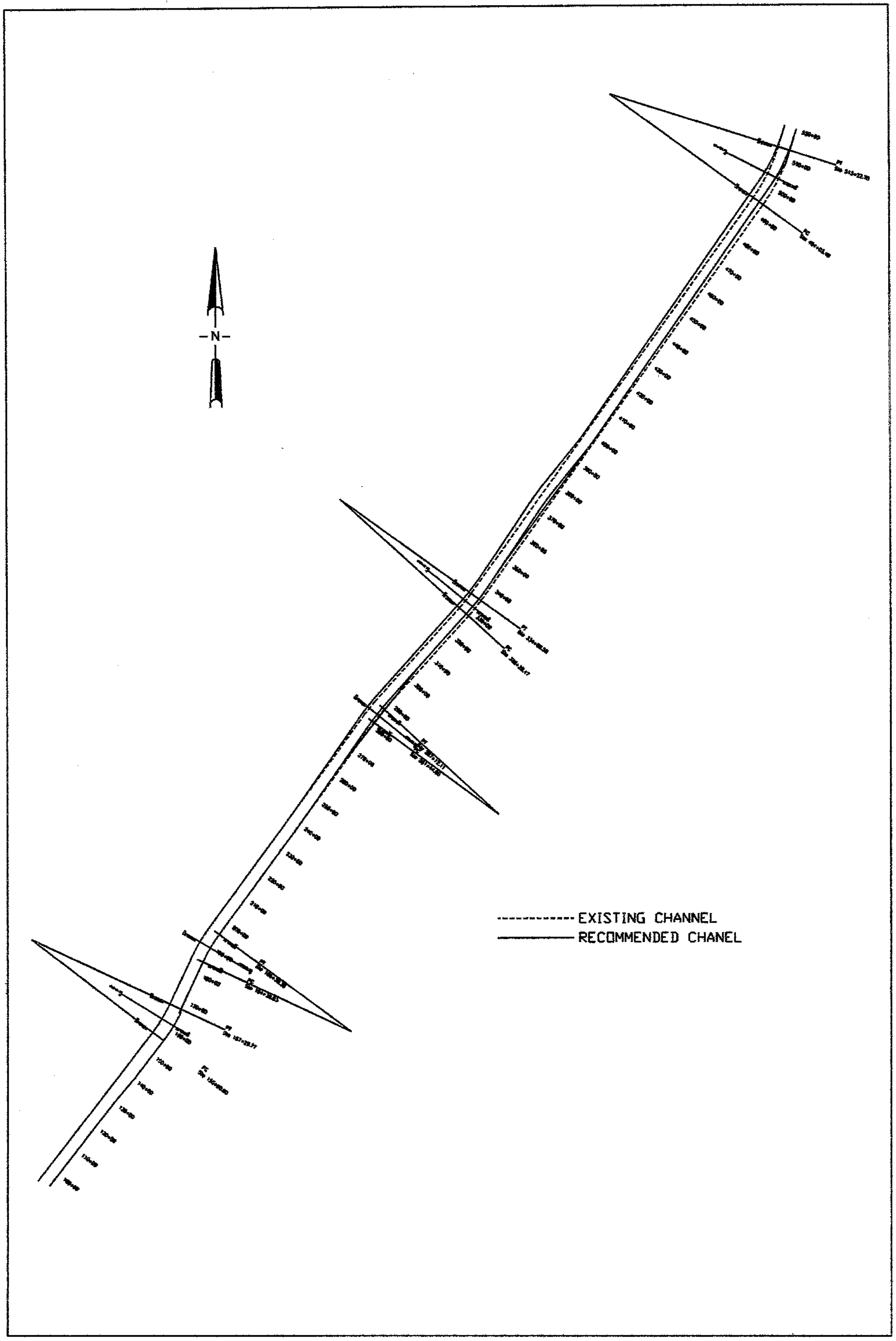


Figure 7. RECOMMENDED SABINE-NECHES CANAL

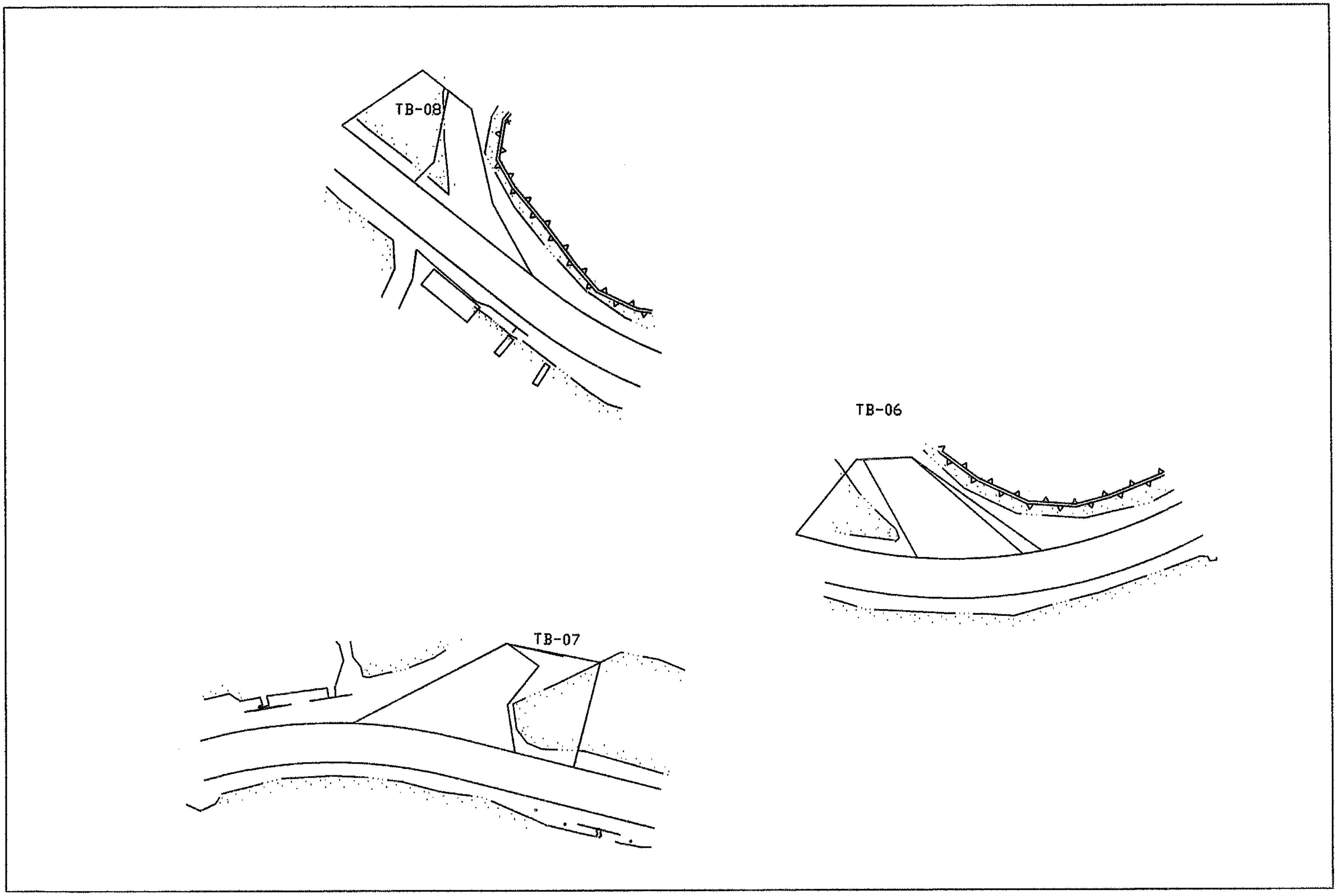


Figure 8 - Proposed modifications to Turning Basins 6, 7, and 8

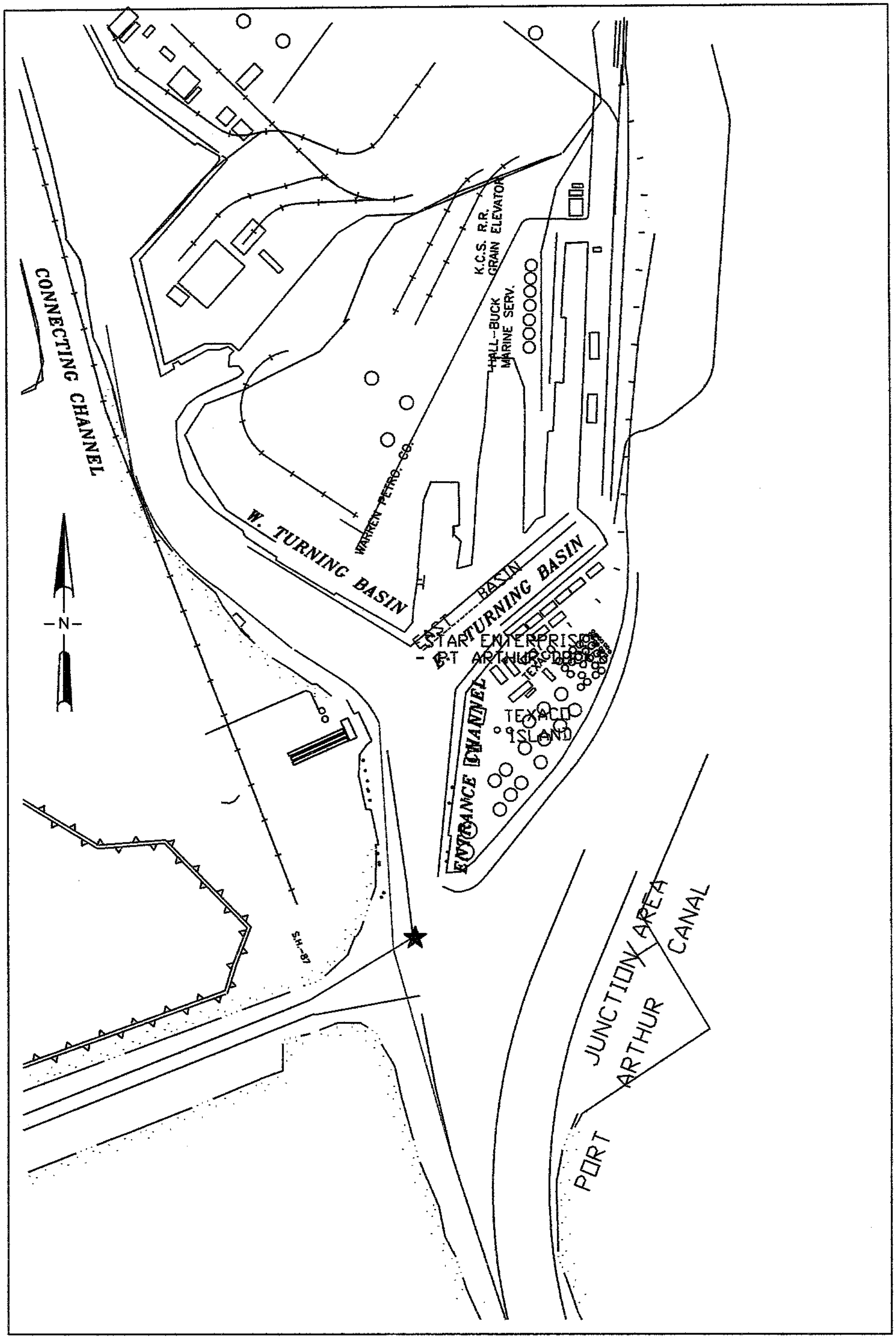
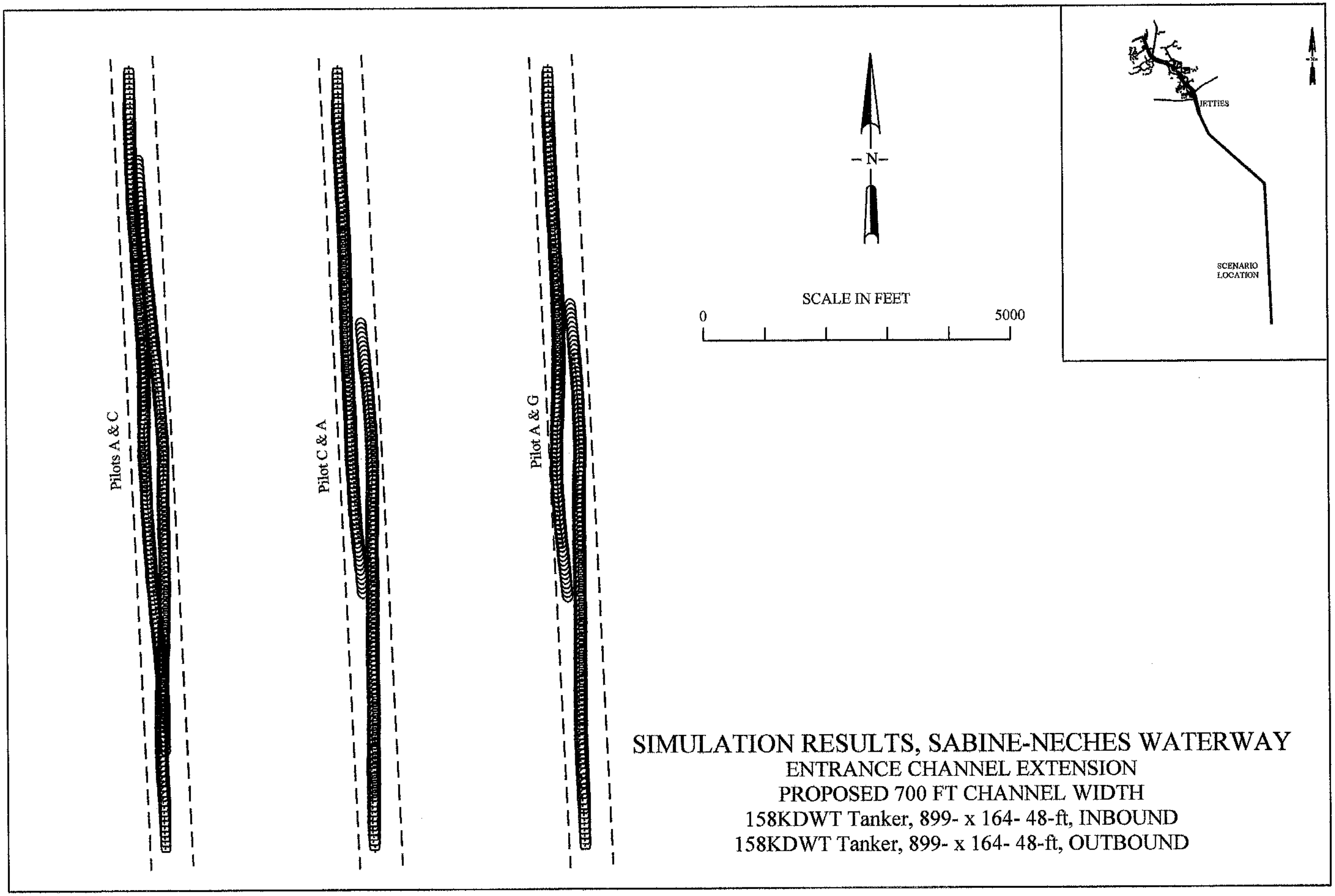
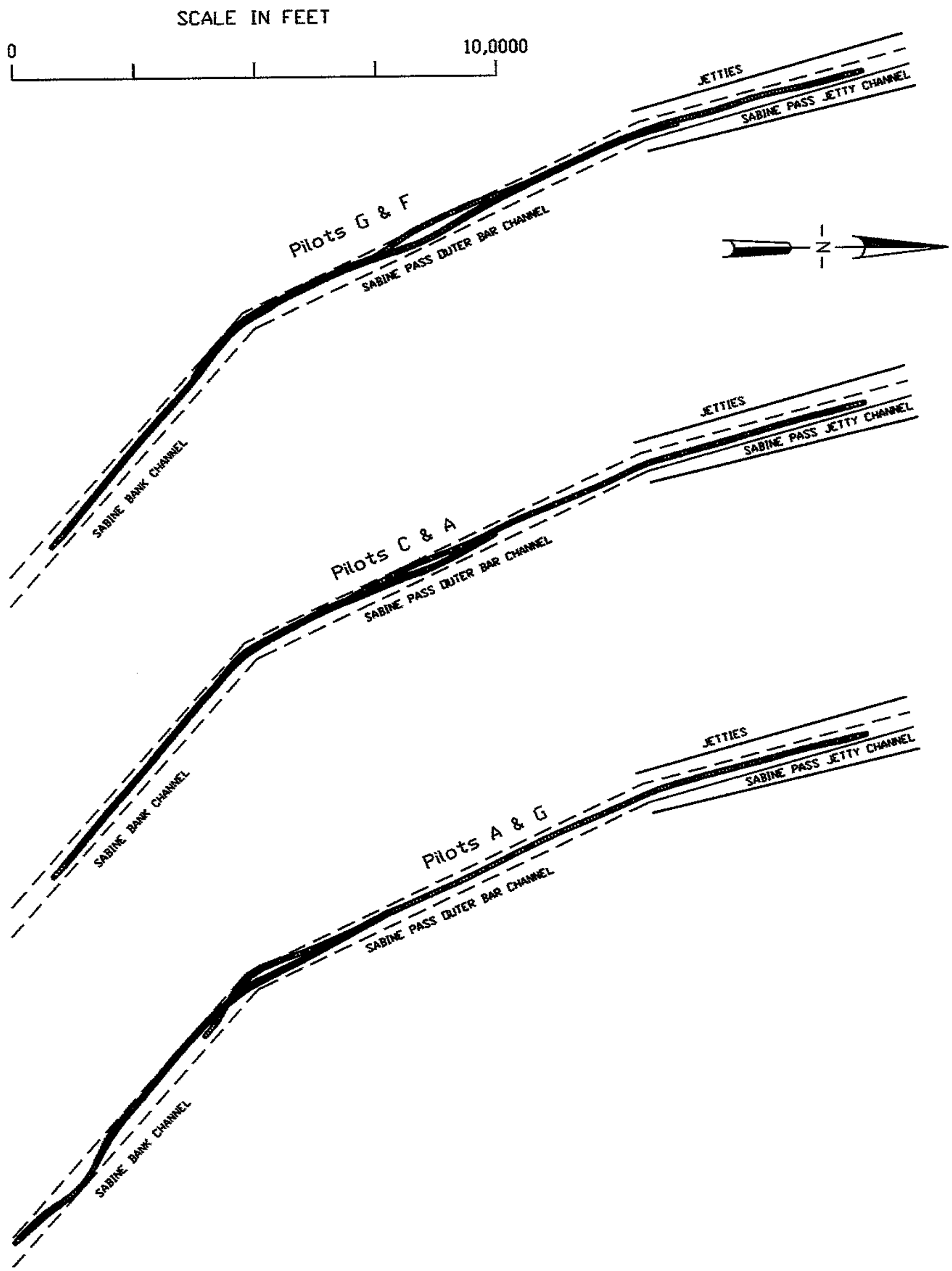


Figure 9. Proposed widening for Taylor Bayou.



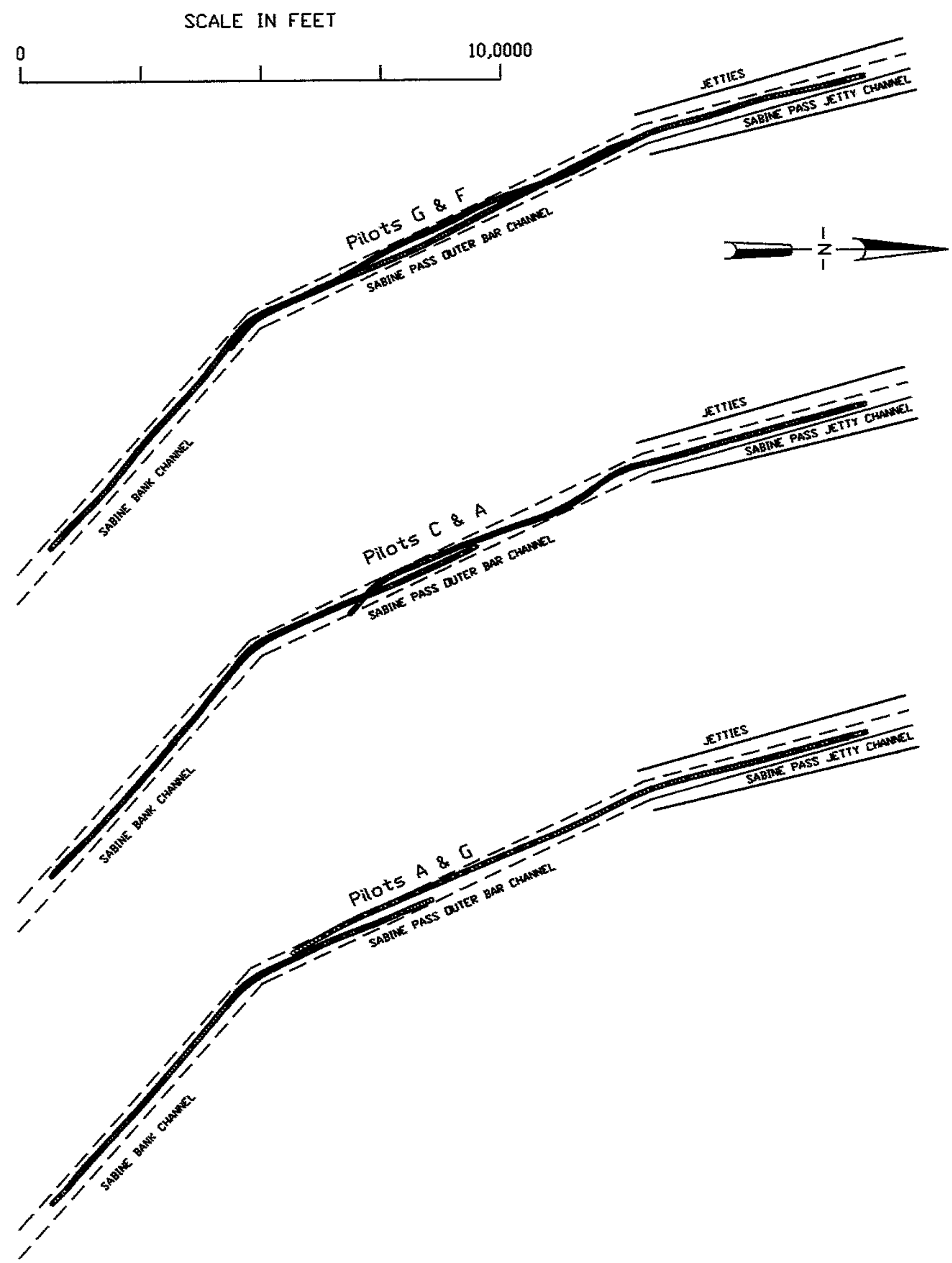
SIMULATION RESULTS, SABINE-NECHES WATERWAY
ENTRANCE CHANNEL EXTENSION
PROPOSED 700 FT CHANNEL WIDTH
158KDWT Tanker, 899- x 164- 48-ft, INBOUND
158KDWT Tanker, 899- x 164- 48-ft, OUTBOUND

PLATE 1

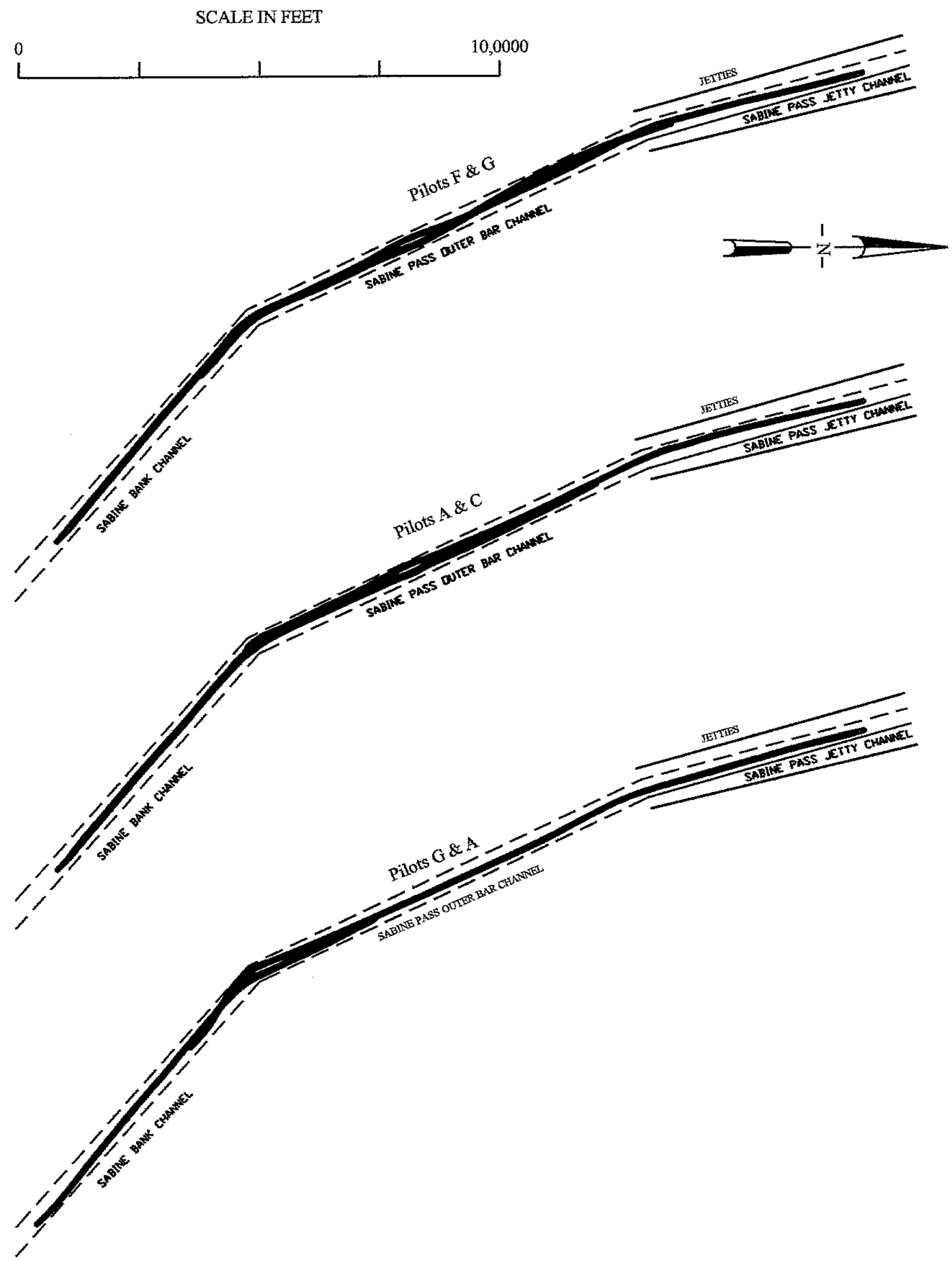


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE BANK AND JETTY CHANNELS
EXISTING CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- 38-ft, INBOUND
158KDWT Tanker, 899- x 164- 38-ft, OUTBOUND

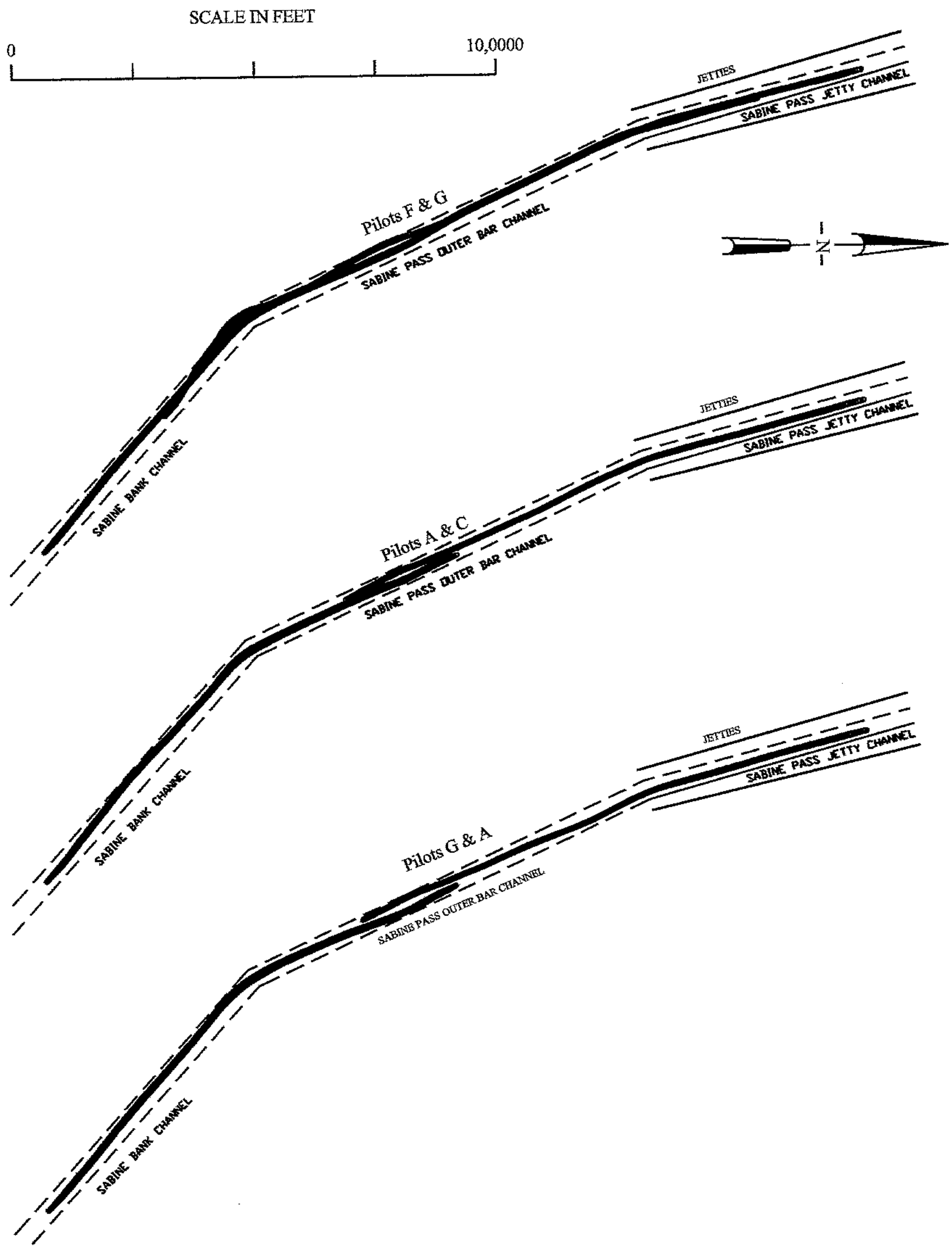
PLATE 2



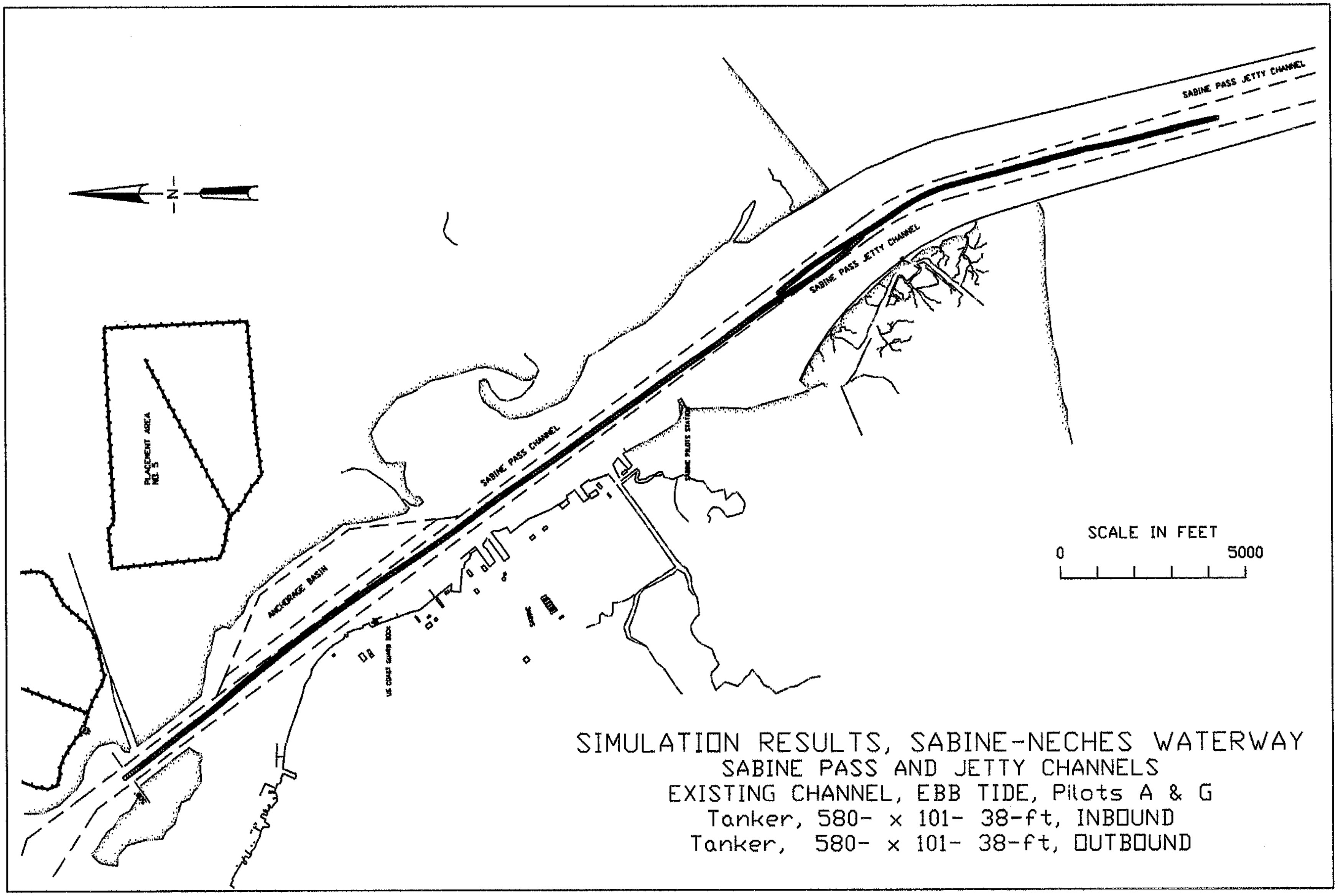
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE BANK AND JETTY CHANNELS
EXISTING CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- 38-ft, INBOUND
158KDWT Tanker, 899- x 164- 38-ft, OUTBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE BANK AND JETTY CHANNELS
PROPOSED CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- 38-ft, INBOUND
158KDWT Tanker, 899- x 164- 38-ft, OUTBOUND

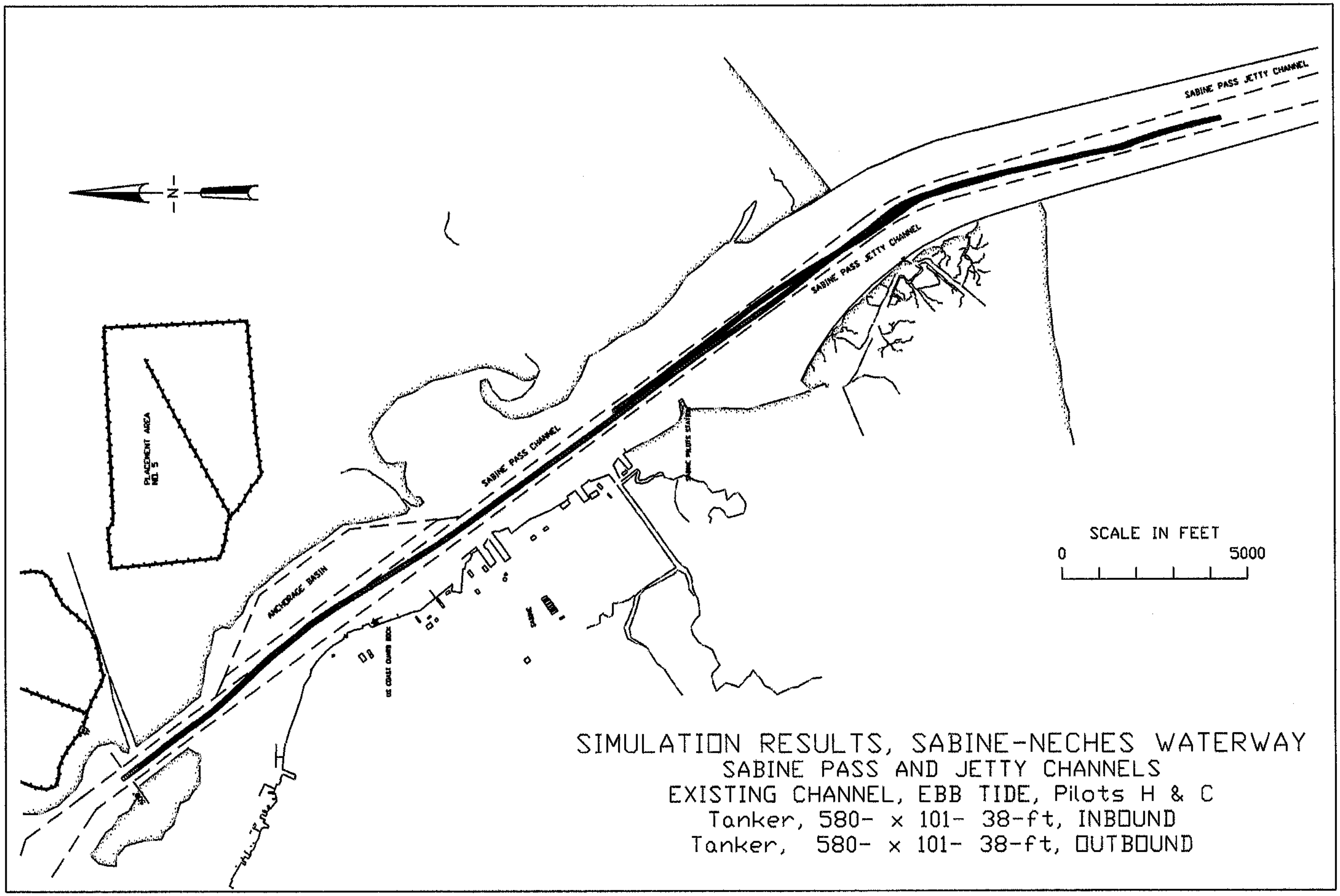


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE BANK AND JETTY CHANNELS
PROPOSED CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- 38-ft, INBOUND
158KDWT Tanker, 899- x 164- 38-ft, OUTBOUND



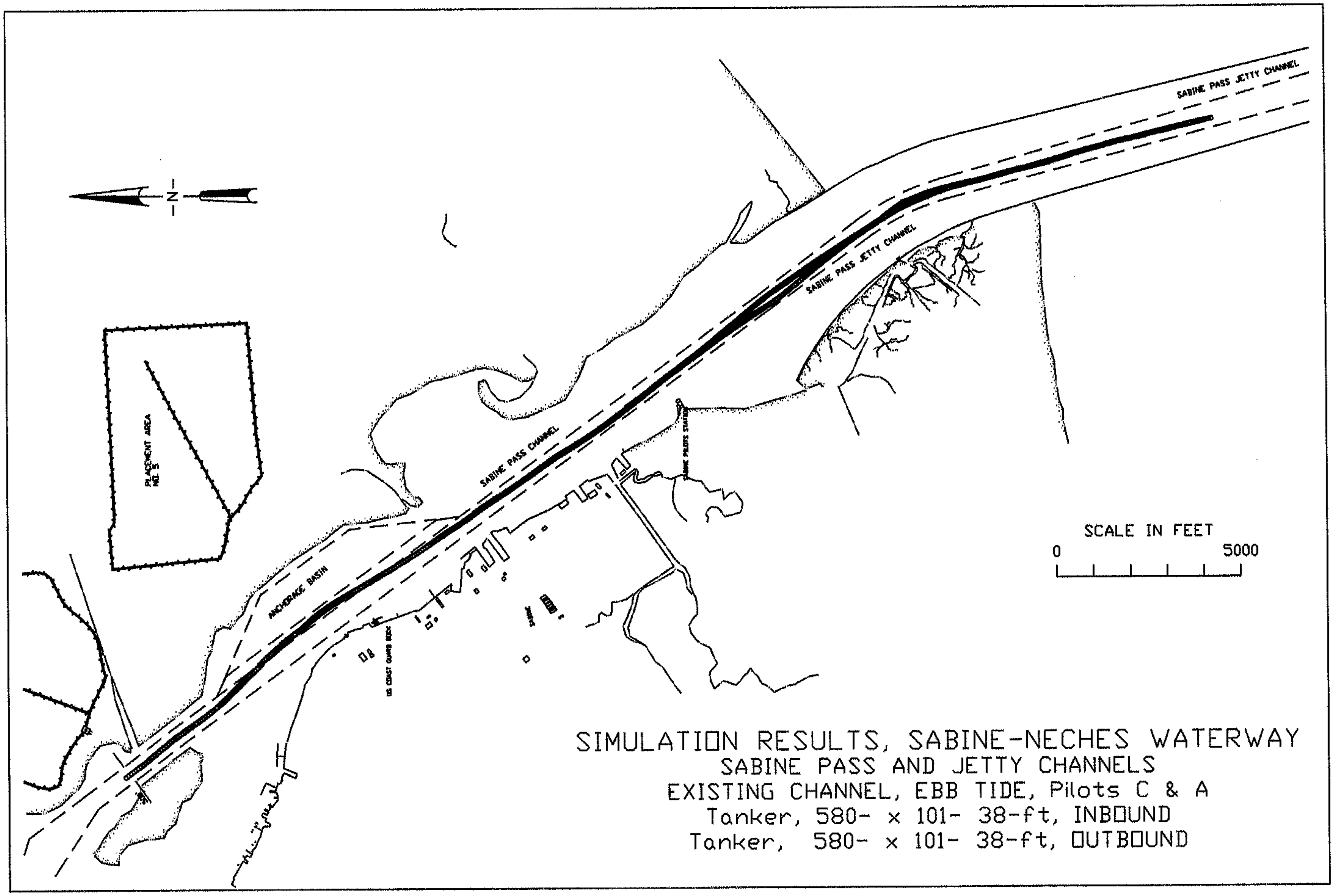
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, EBB TIDE, Pilots A & G
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 6

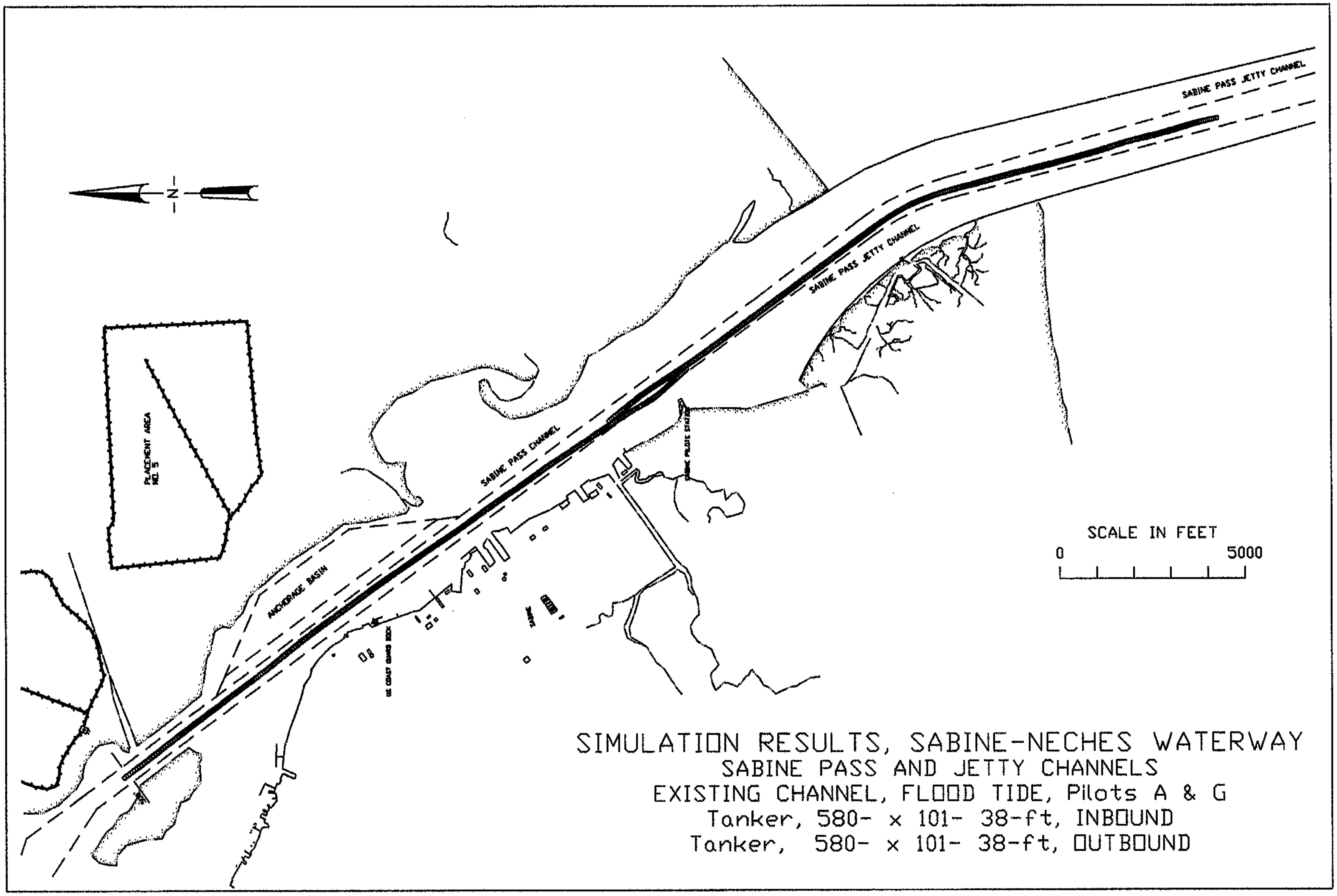


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, EBB TIDE, Pilots H & C
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 7

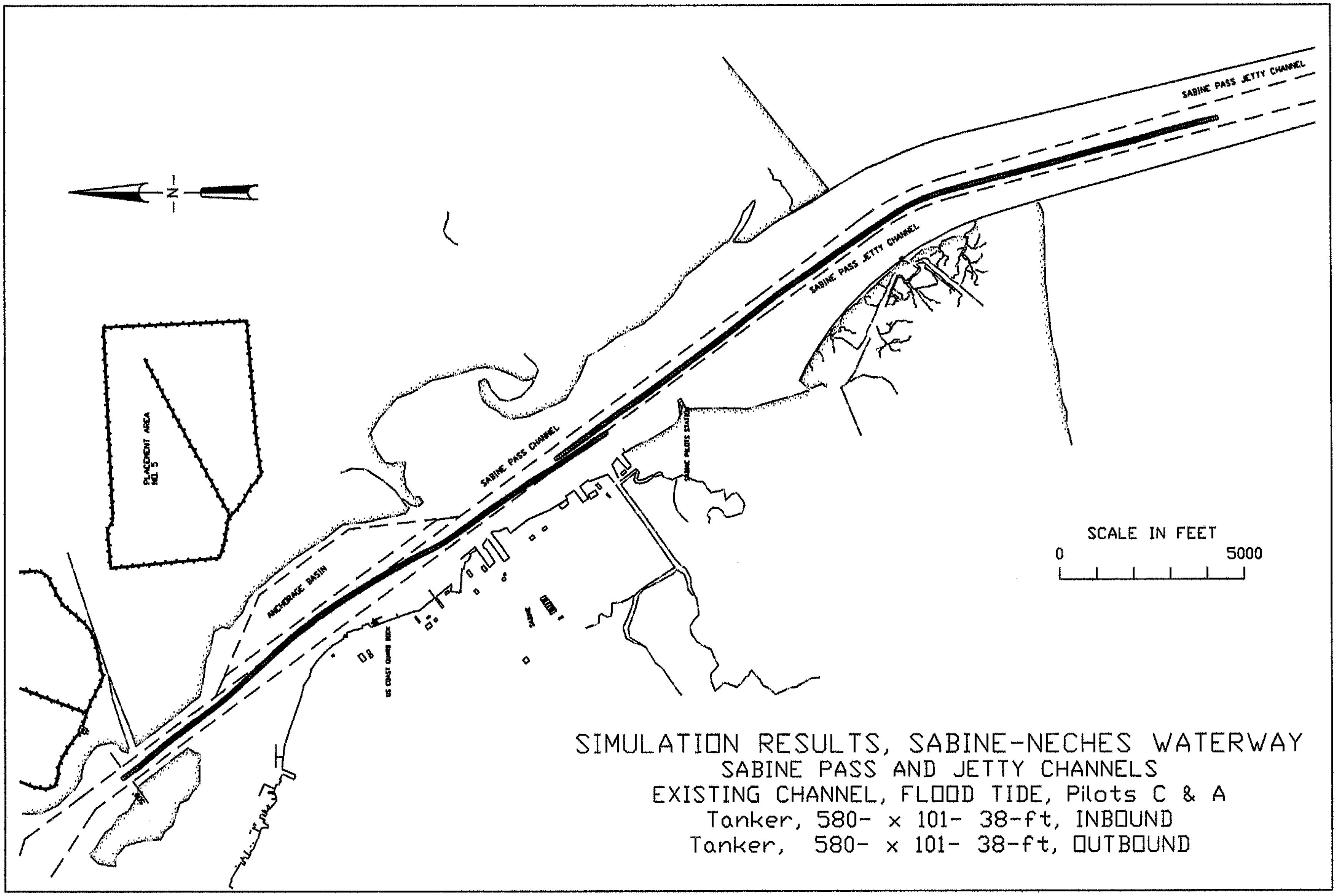


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, EBB TIDE, Pilots C & A
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

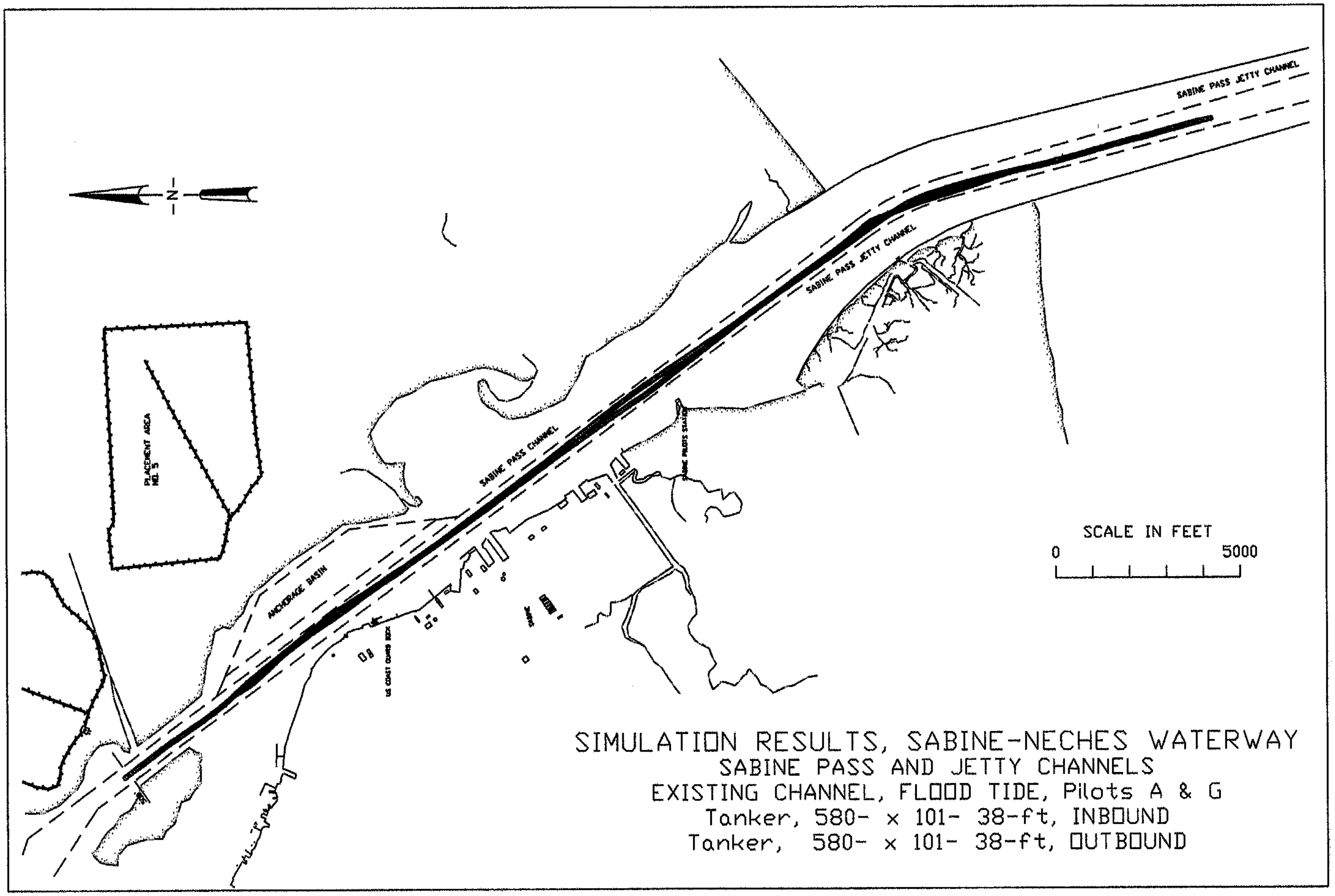


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots A & G
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

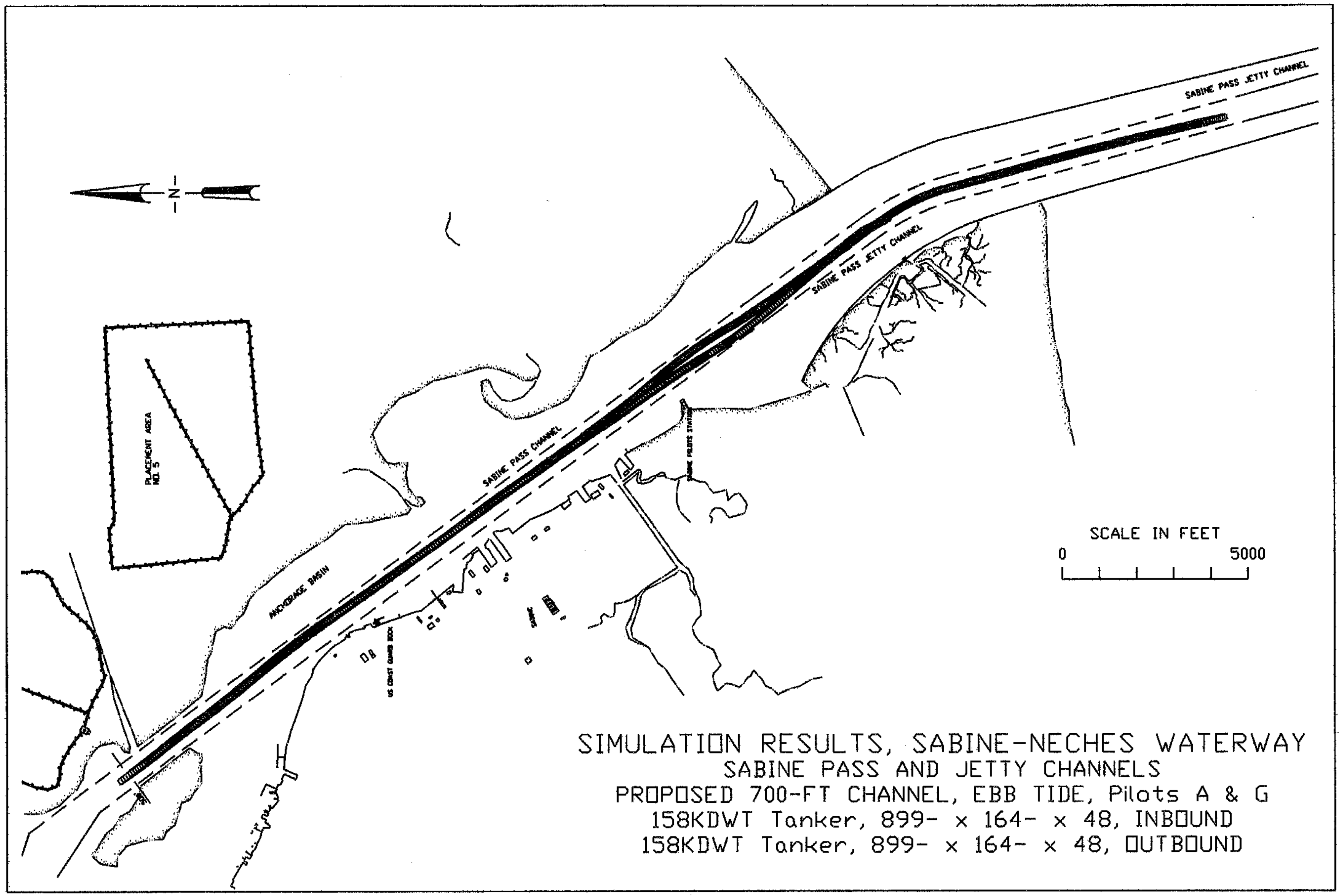
PLATE 9



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots C & A
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

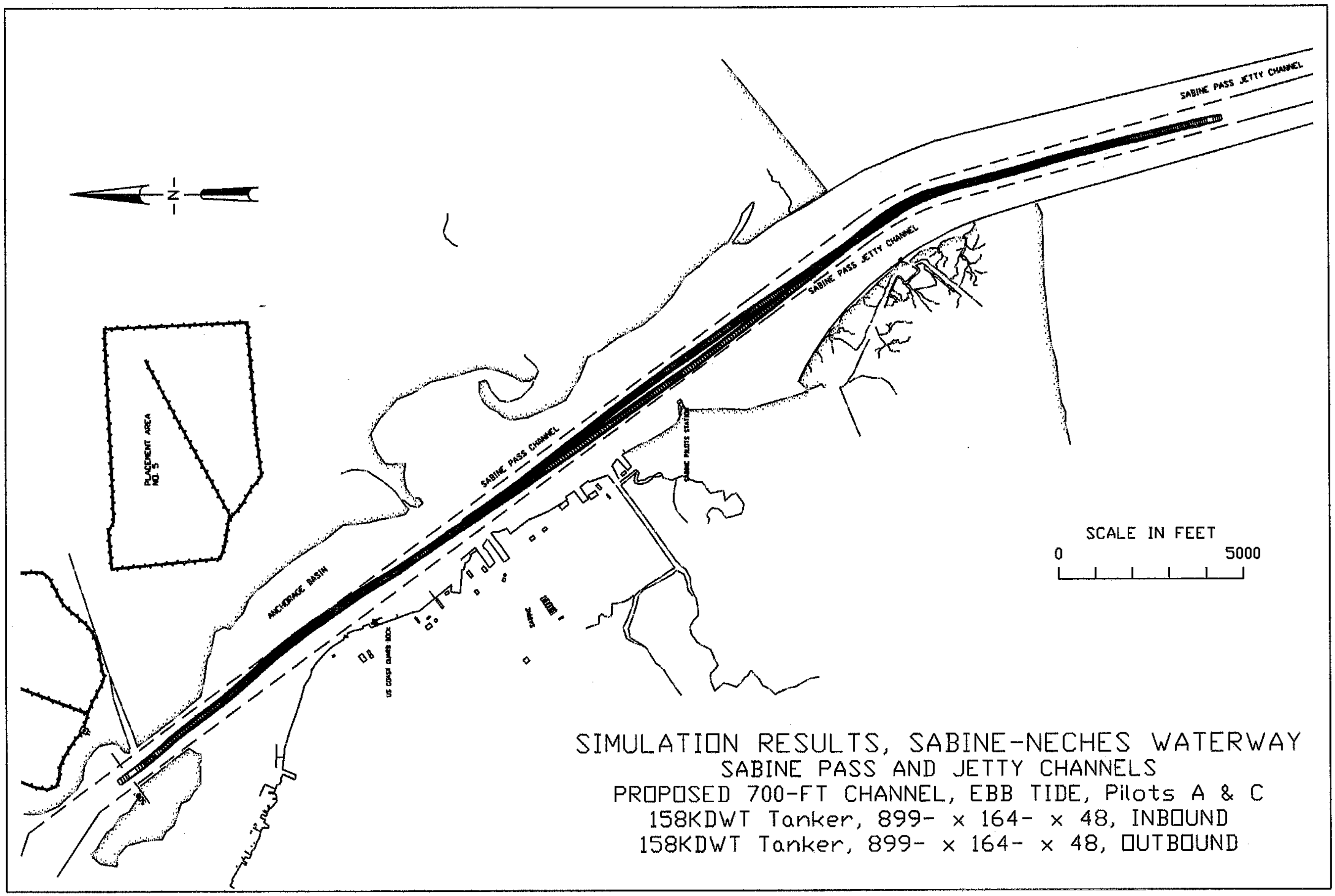


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots A & G
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND



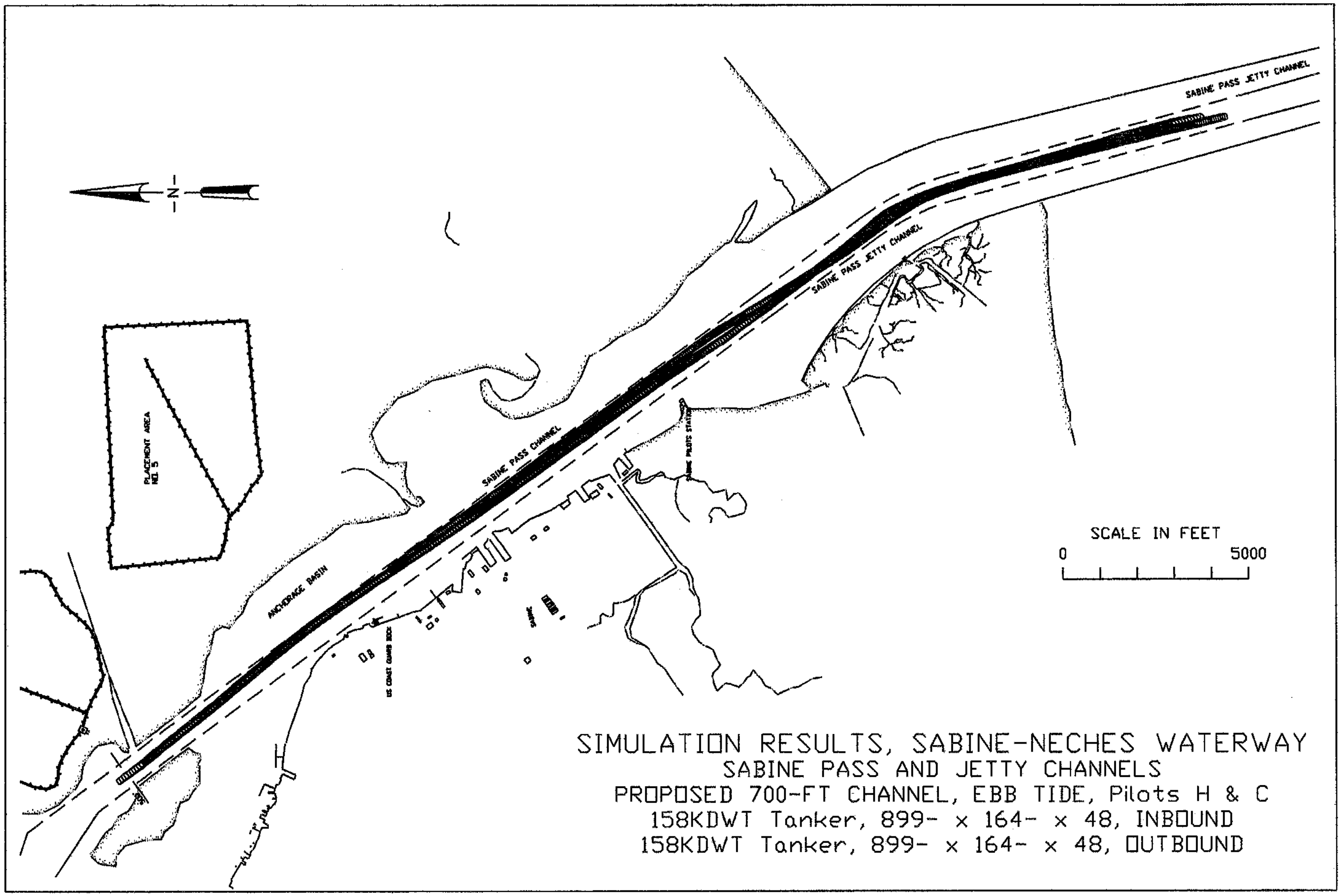
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots A & G
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 12



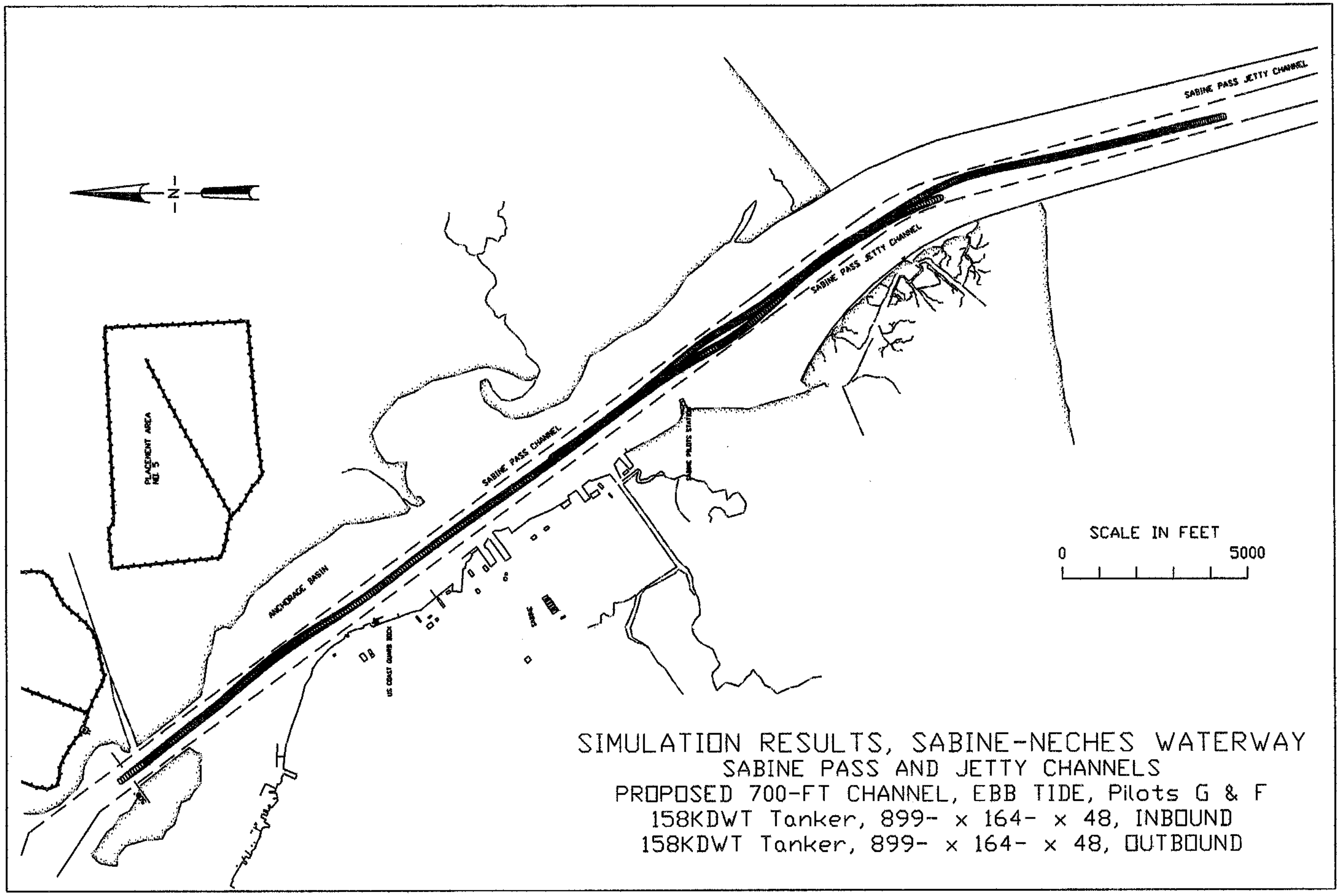
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots A & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 13



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 14



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots G & F
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 15

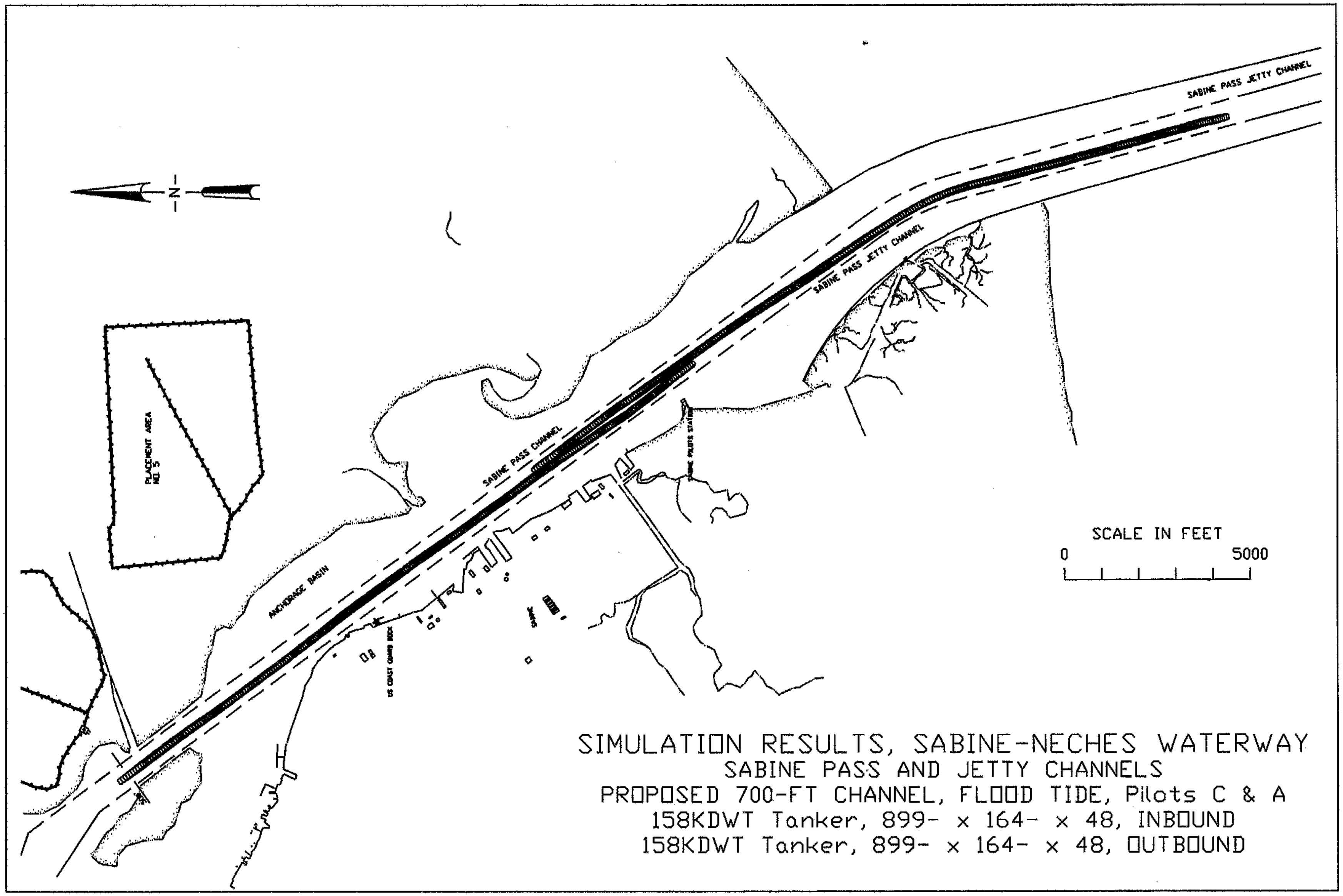

SABINE PASS JETTY CHANNEL
SABINE PASS CHANNEL
ANCHORAGE BASIN
PLACEMENT AREA NO. 5
US COAST GUARD DOCK
SABINE PILOTS STATION
SABINE
SCALE IN FEET
0
5000
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots C & A
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 16

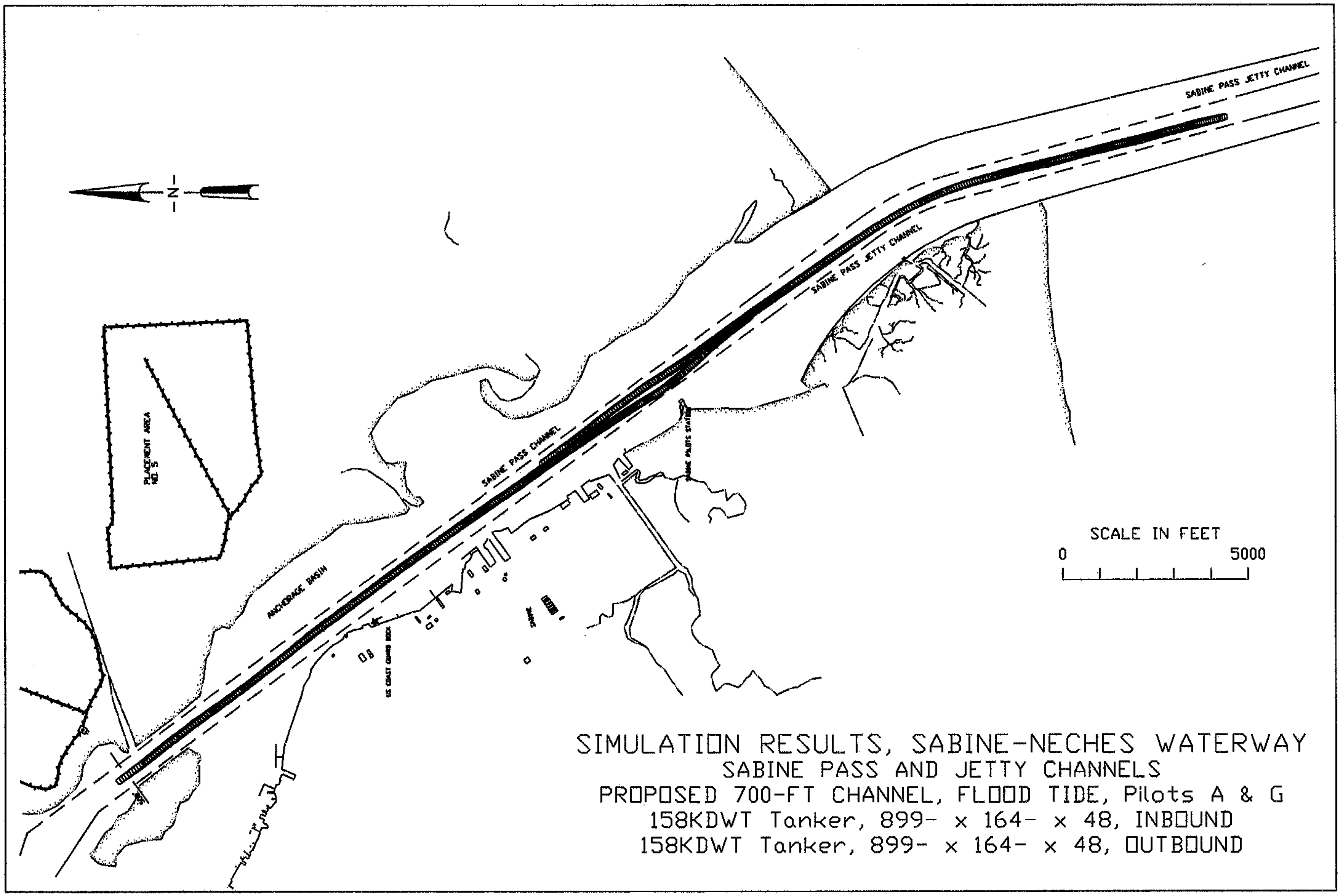
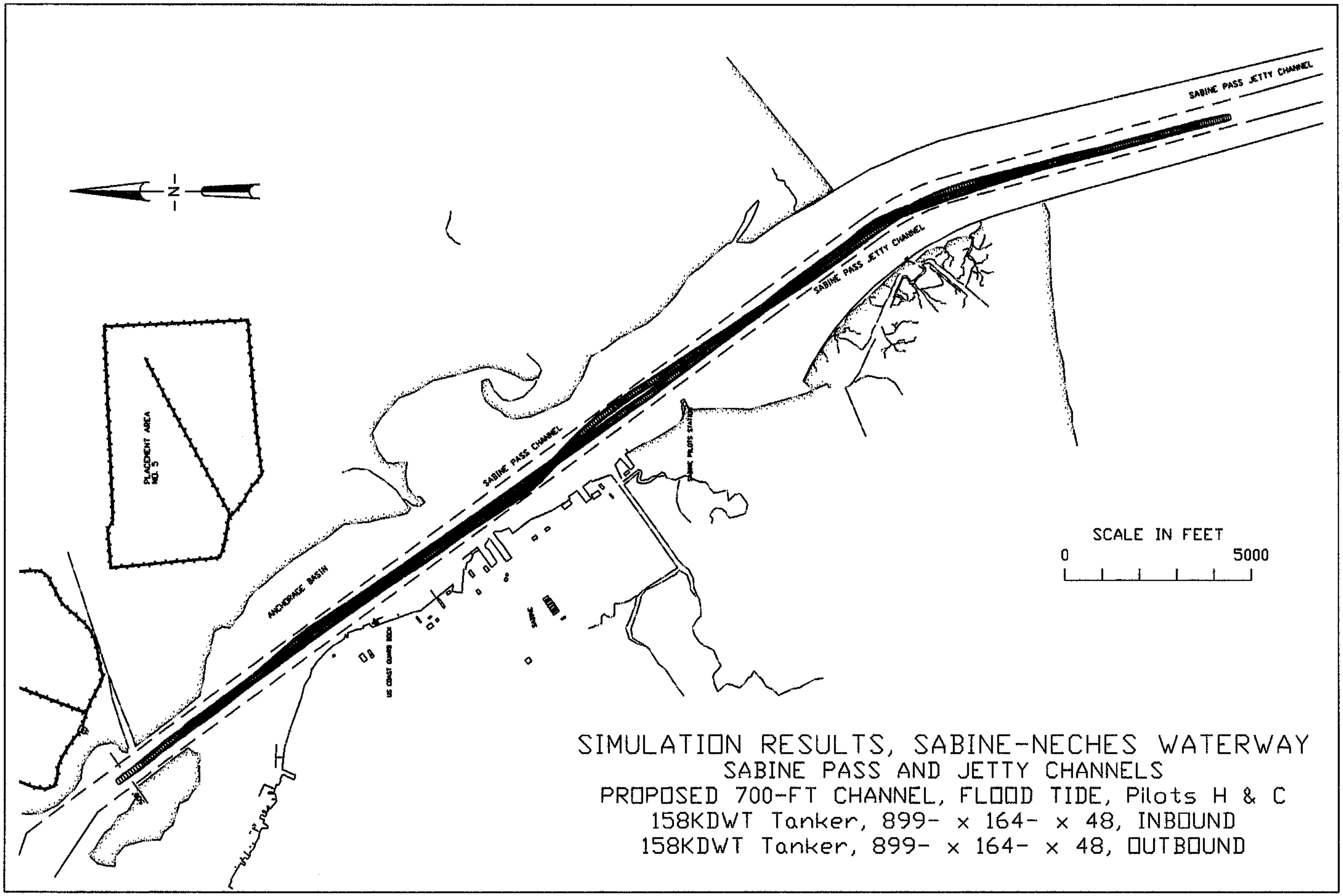
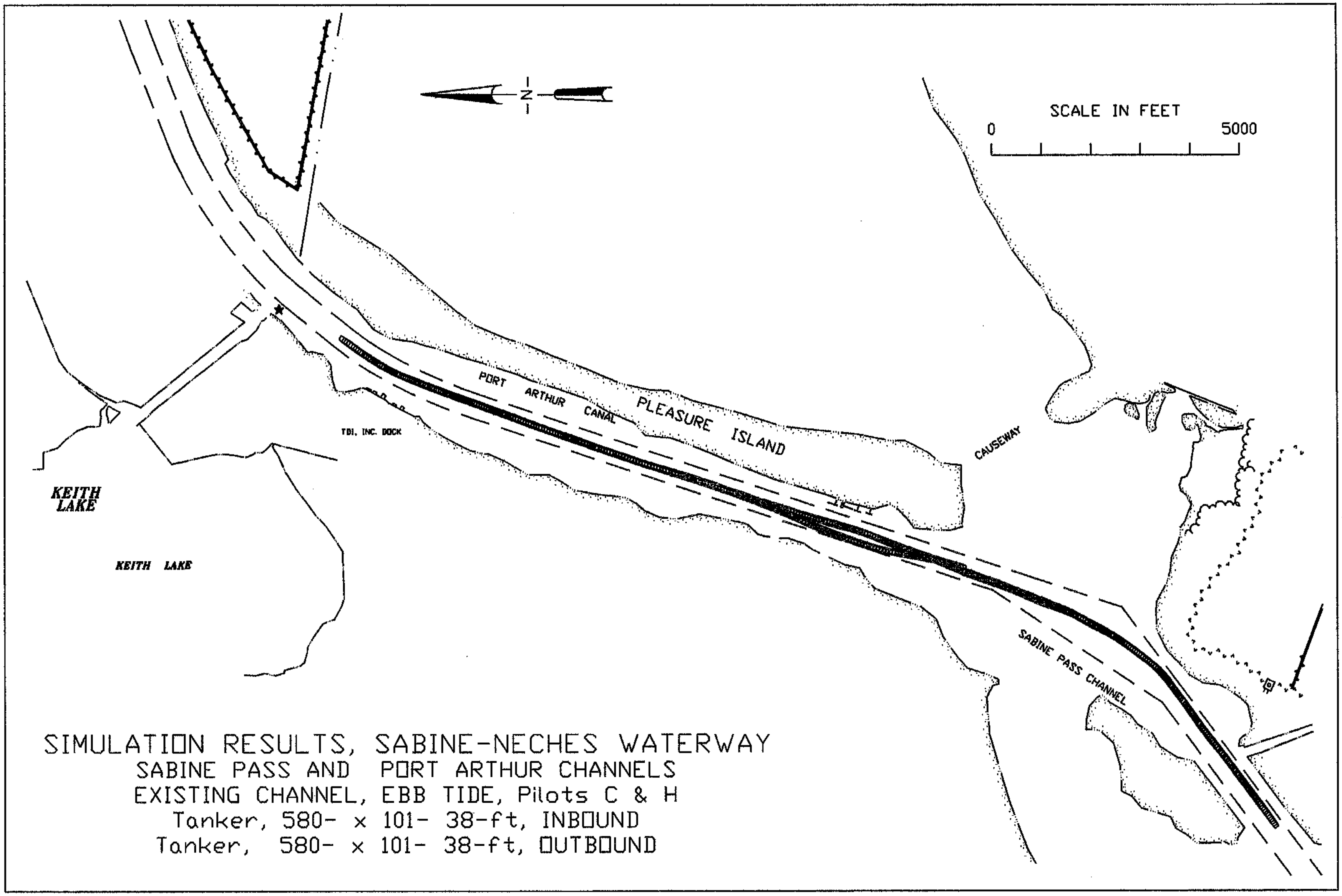

N
SABINE PASS JETTY CHANNEL
SABINE PASS JETTY CHANNEL
SABINE PASS CHANNEL
ANCHORAGE BASIN
PLACEMENT AREA NO. 5
US COAST GUARD DOCK
SABINE PILOTS STATION
SCALE IN FEET
0
5000
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots A & G
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 17



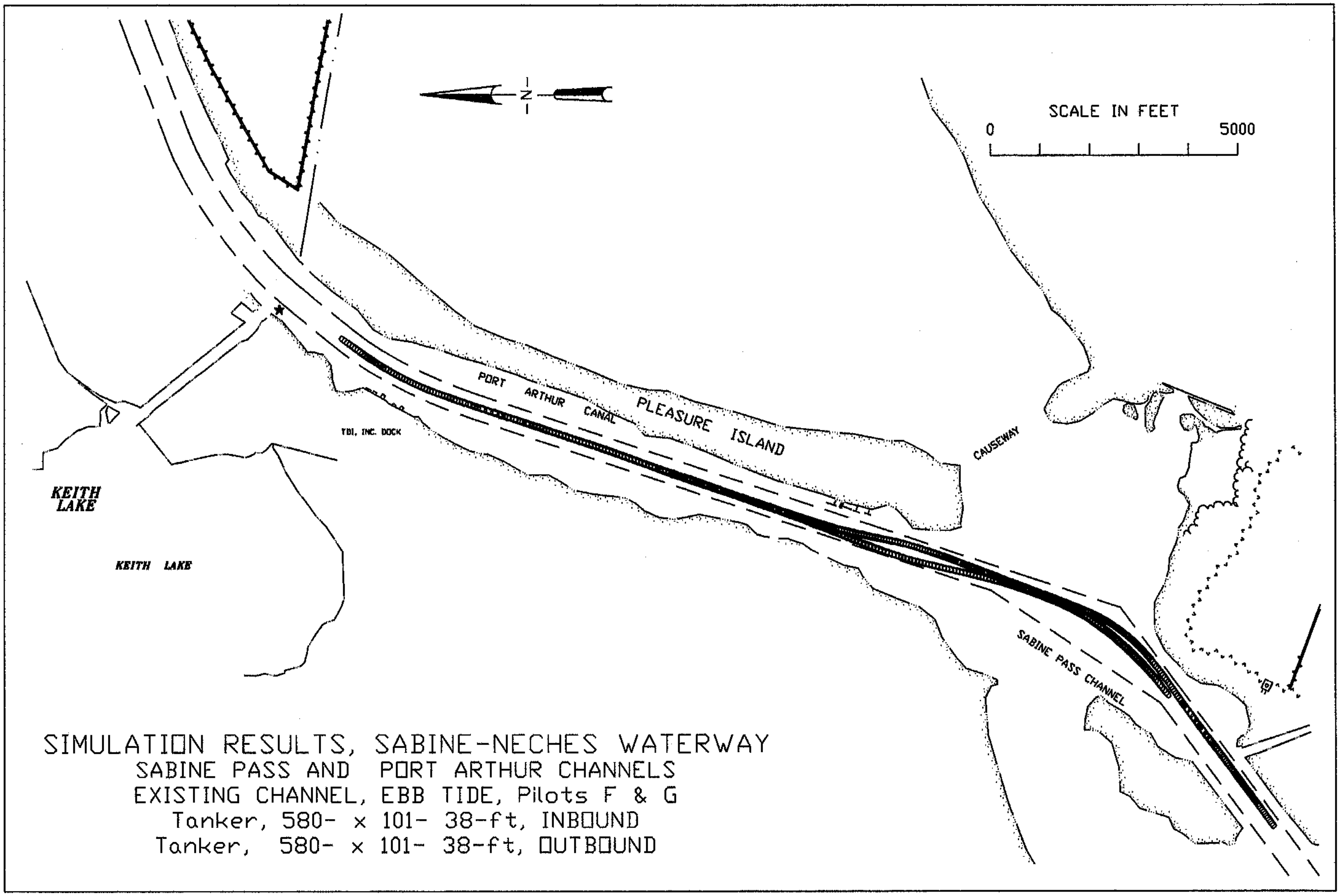
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND JETTY CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 18

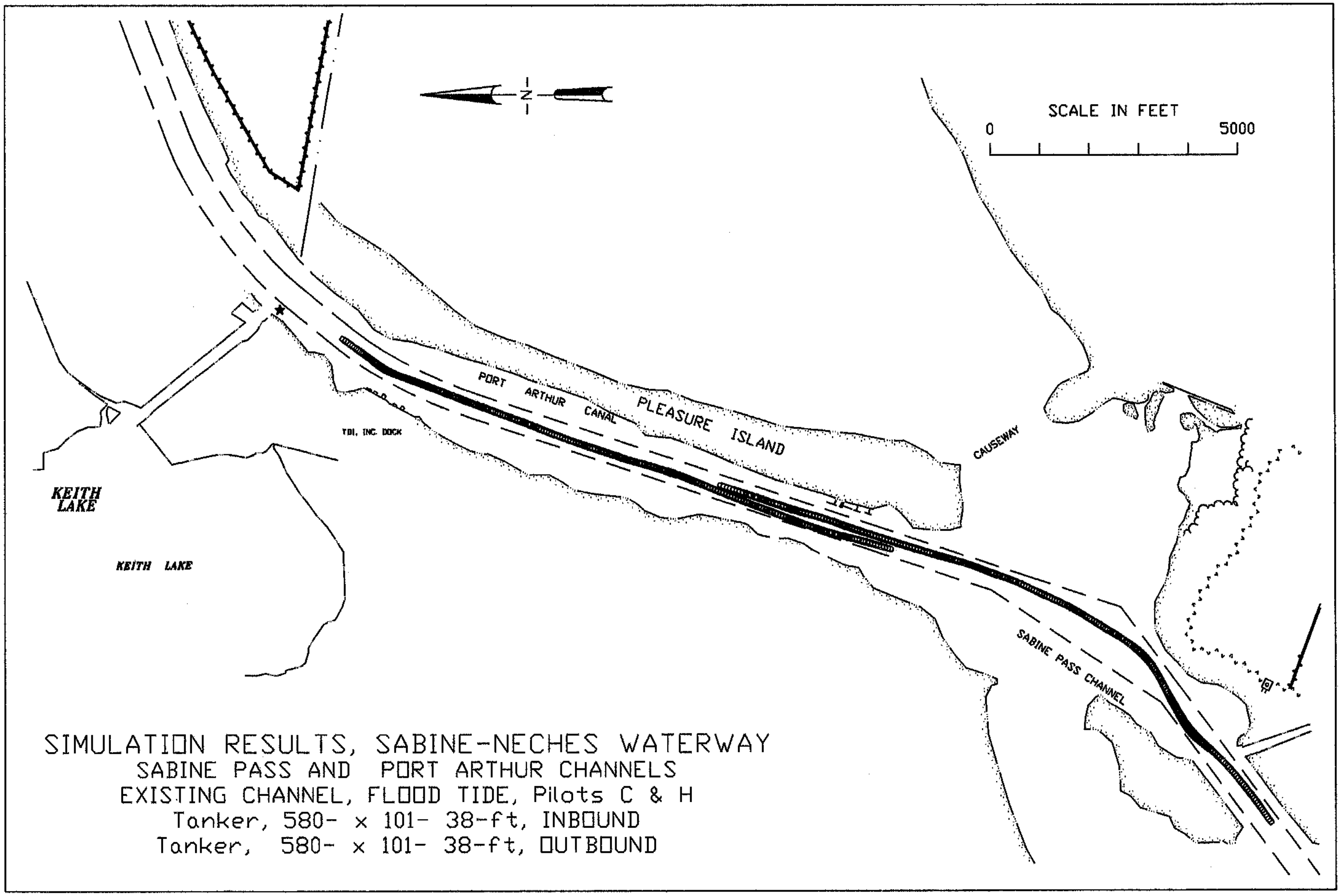


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
EXISTING CHANNEL, EBB TIDE, Pilots C & H
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 19

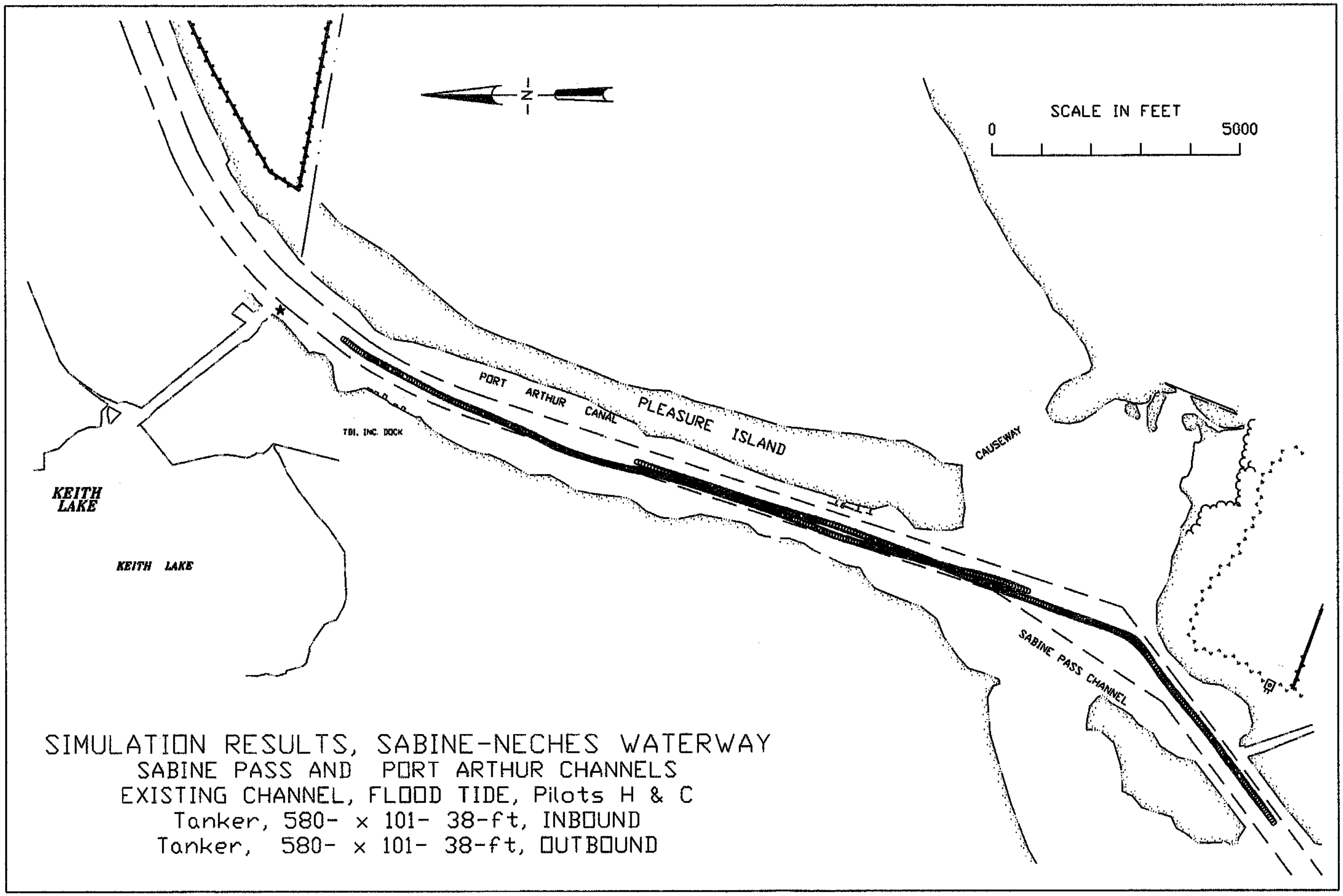


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
EXISTING CHANNEL, EBB TIDE, Pilots F & G
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND



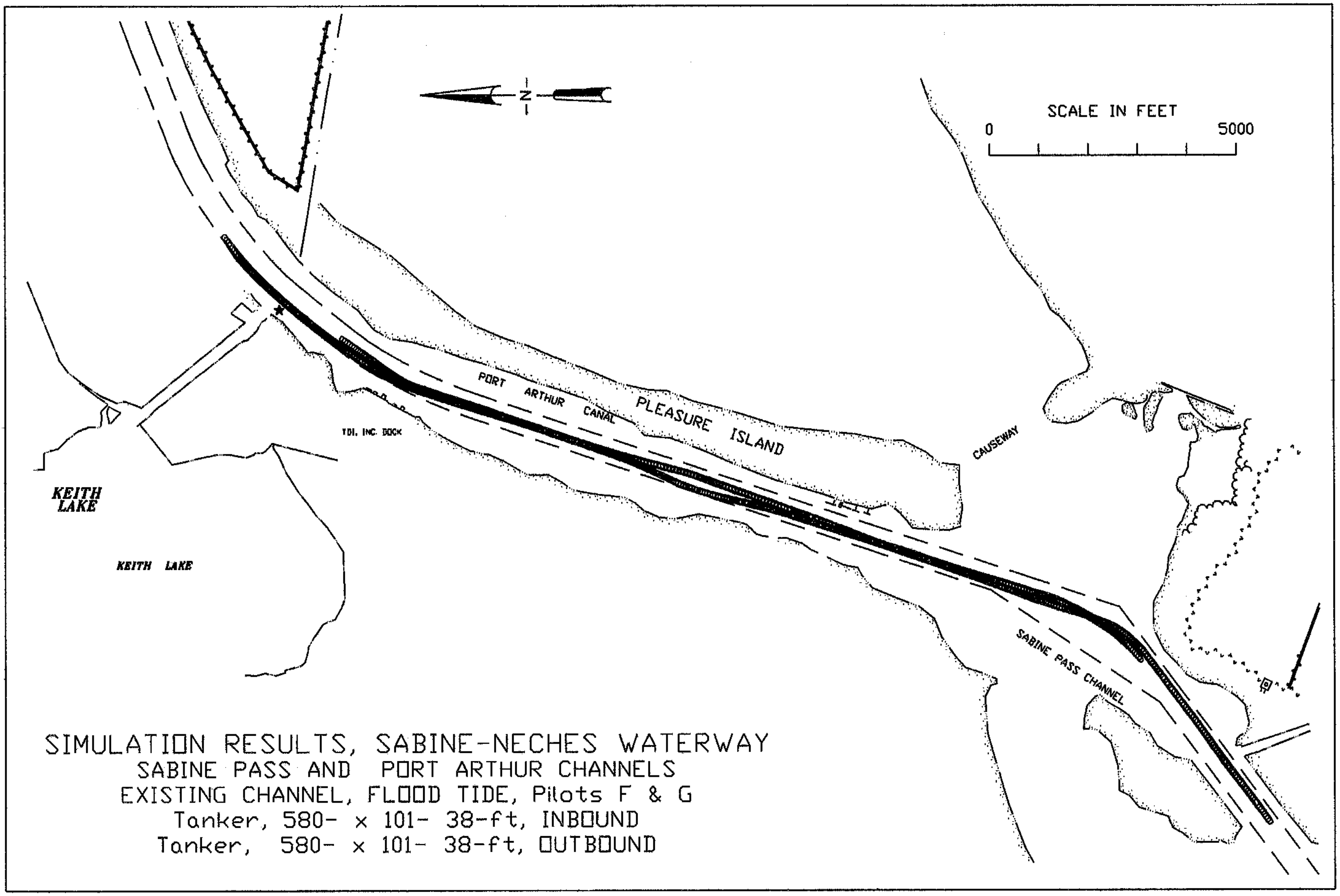
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots C & H
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 21



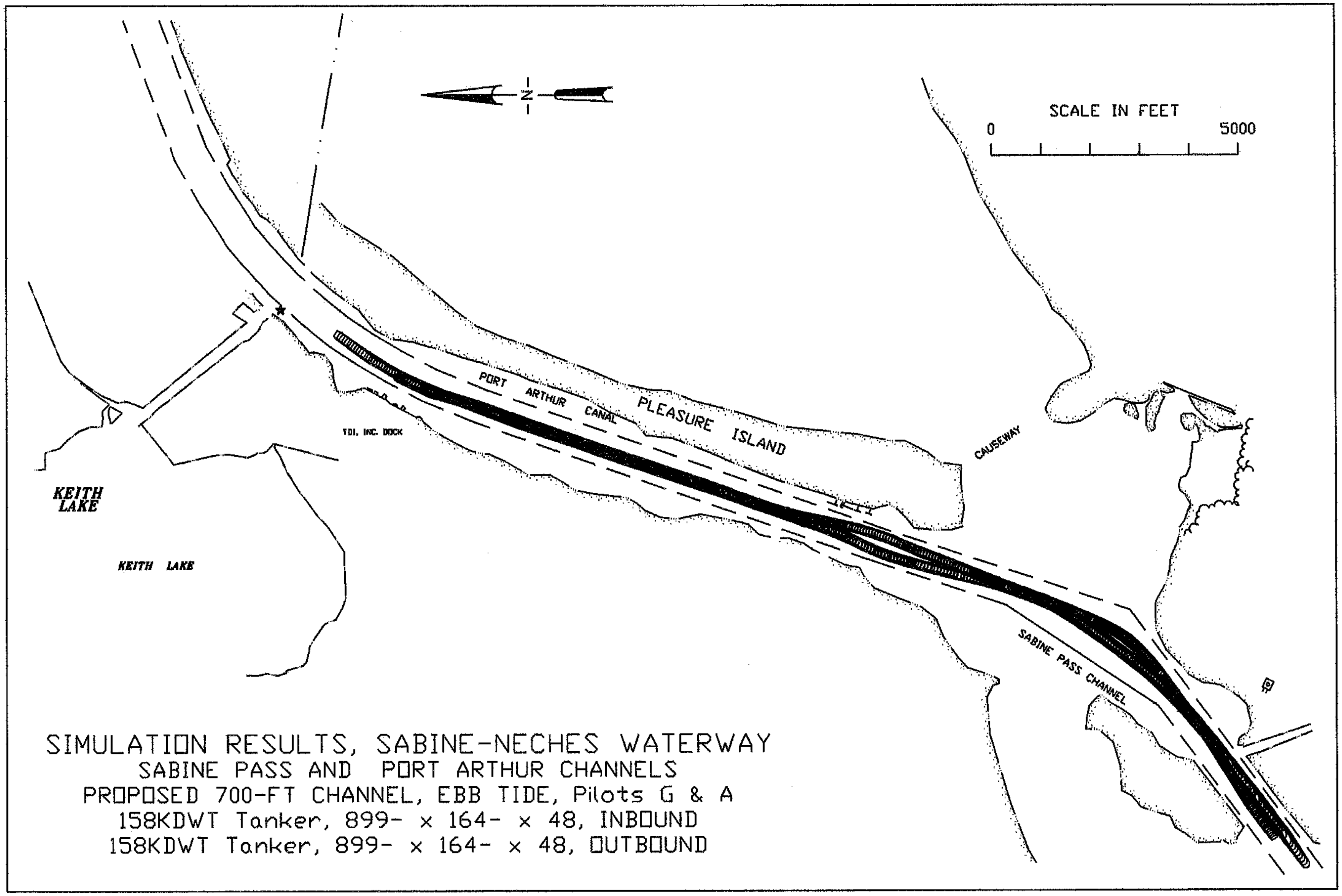
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots H & C
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 22



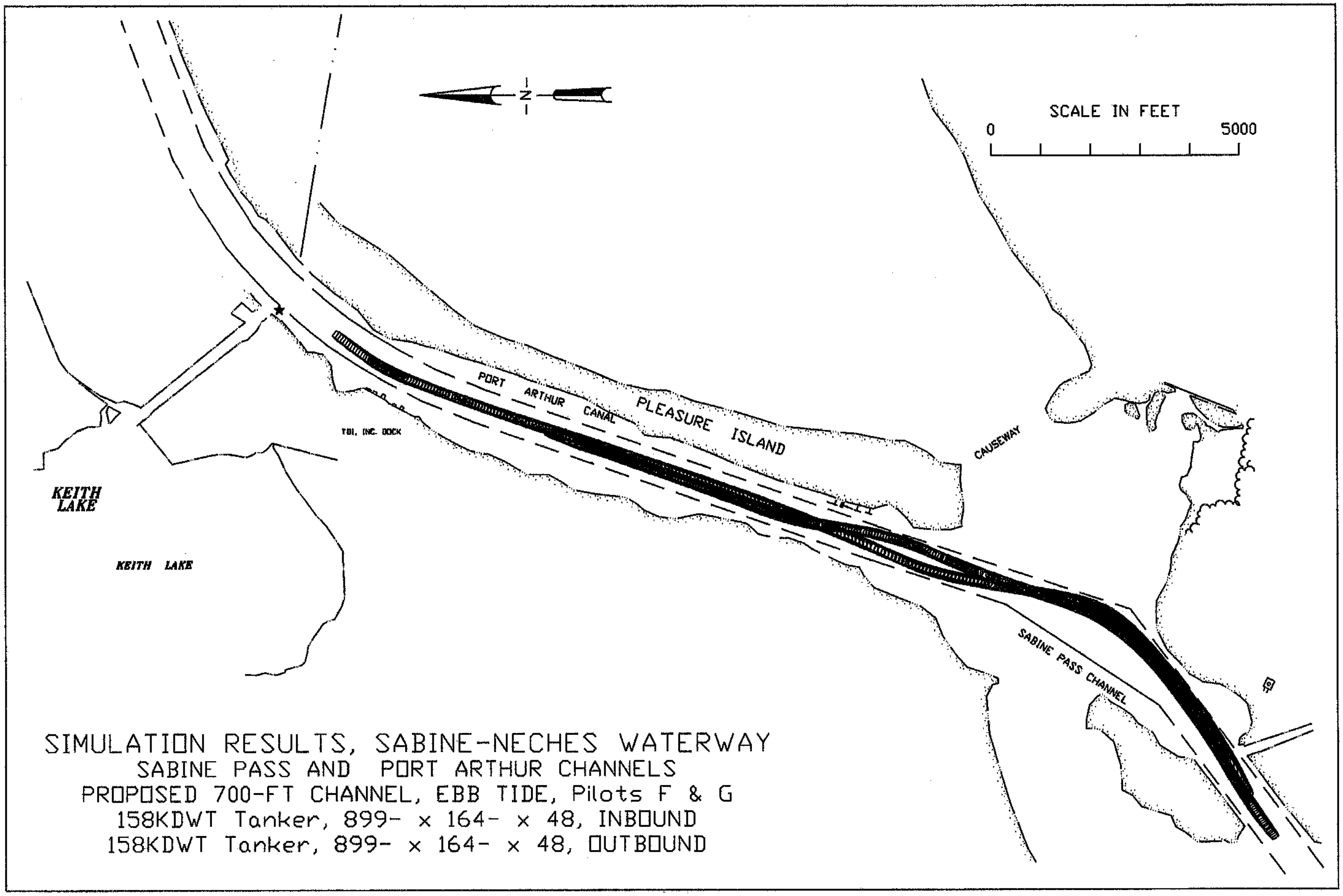
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
EXISTING CHANNEL, FLOOD TIDE, Pilots F & G
Tanker, 580- x 101- 38-ft, INBOUND
Tanker, 580- x 101- 38-ft, OUTBOUND

PLATE 23



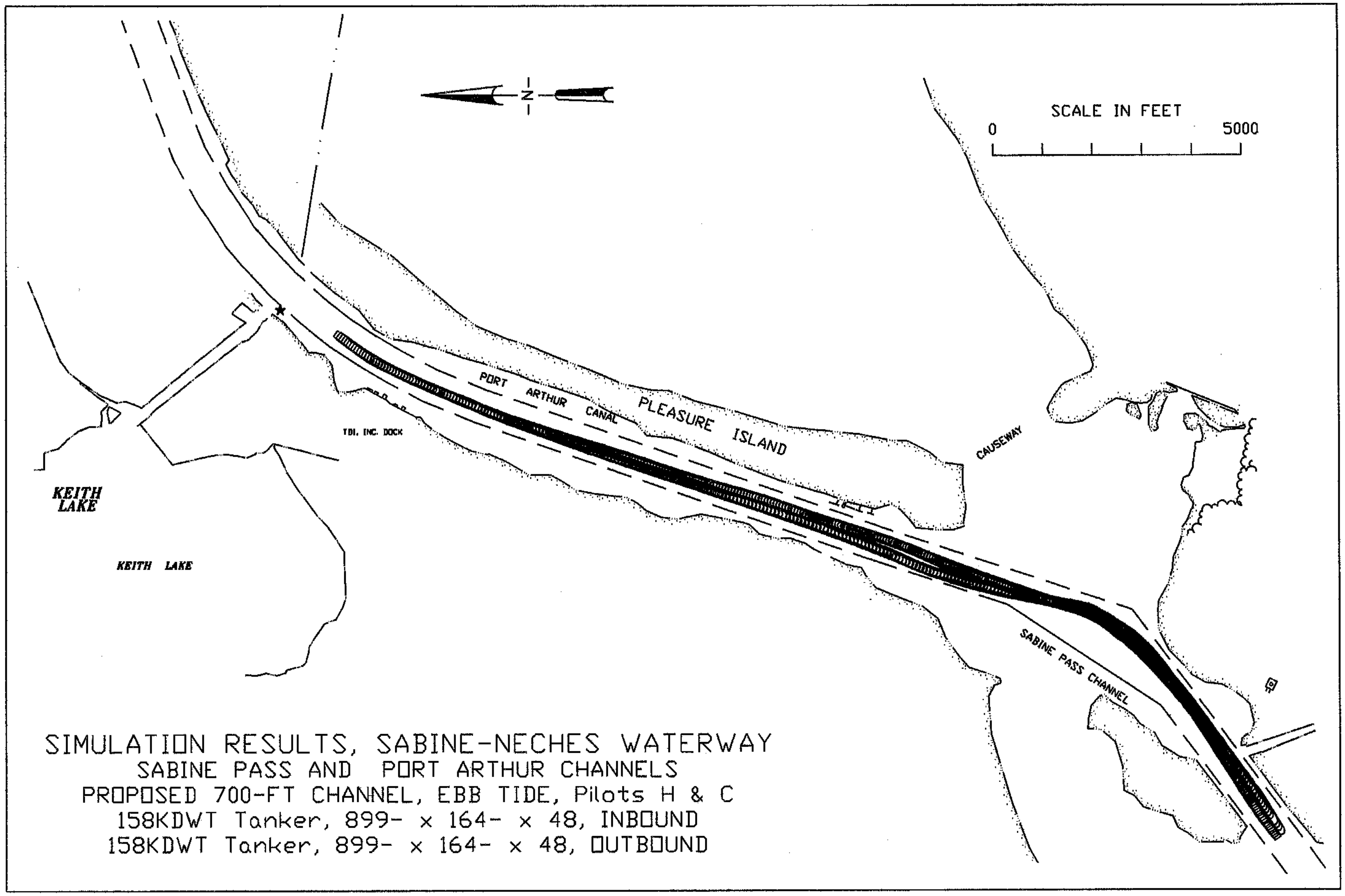
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots G & A
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 24



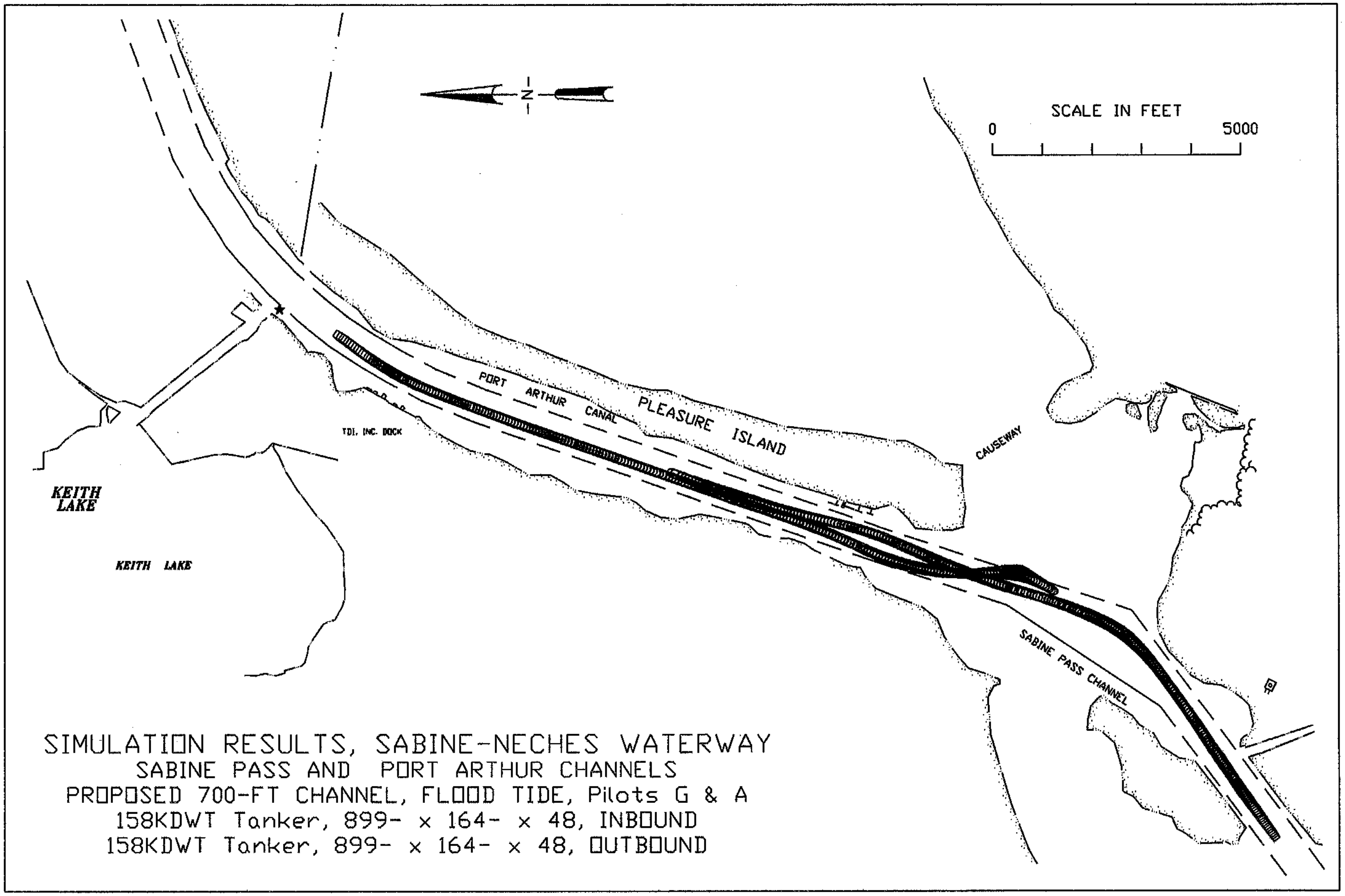
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots F & G
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 25

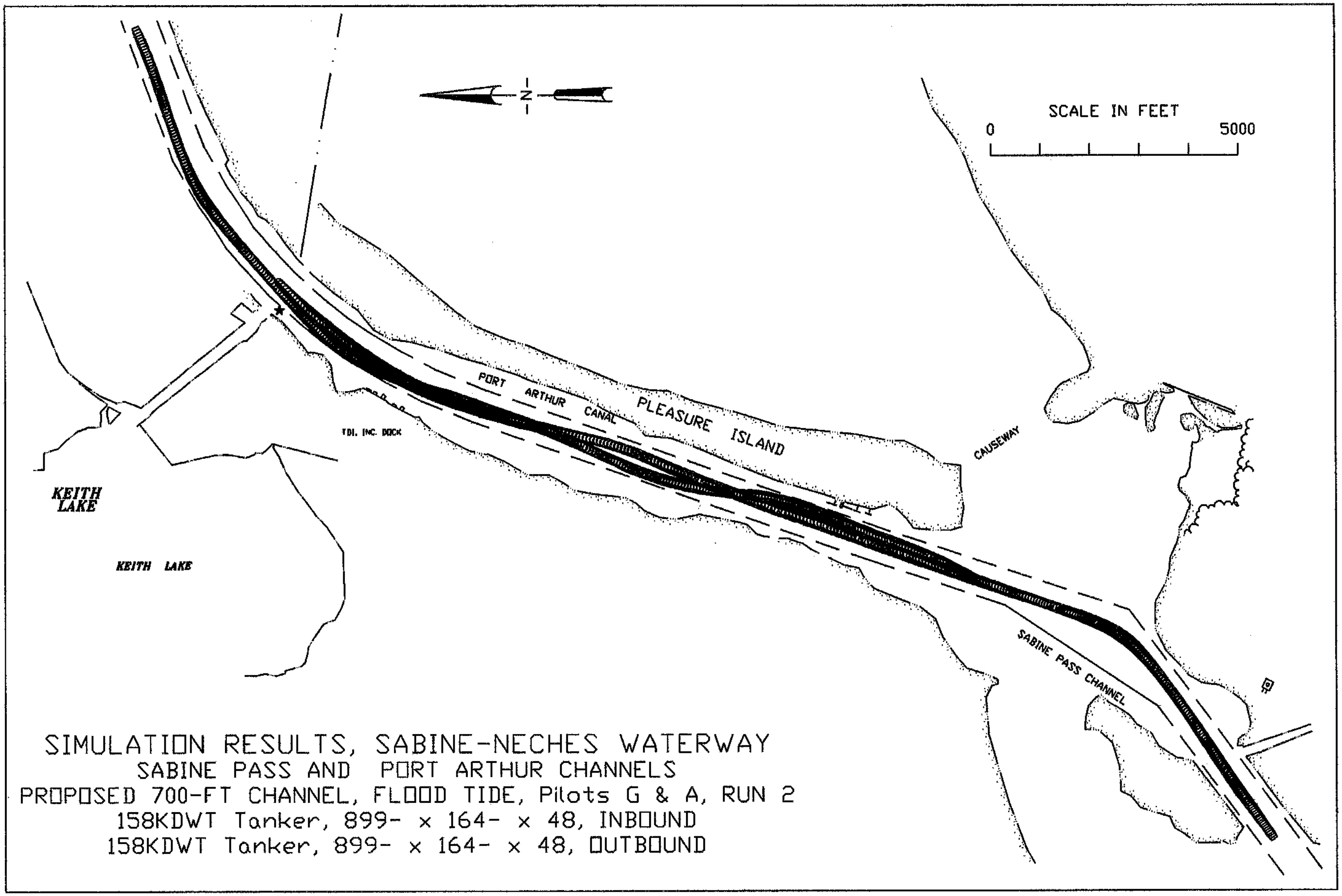


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 26

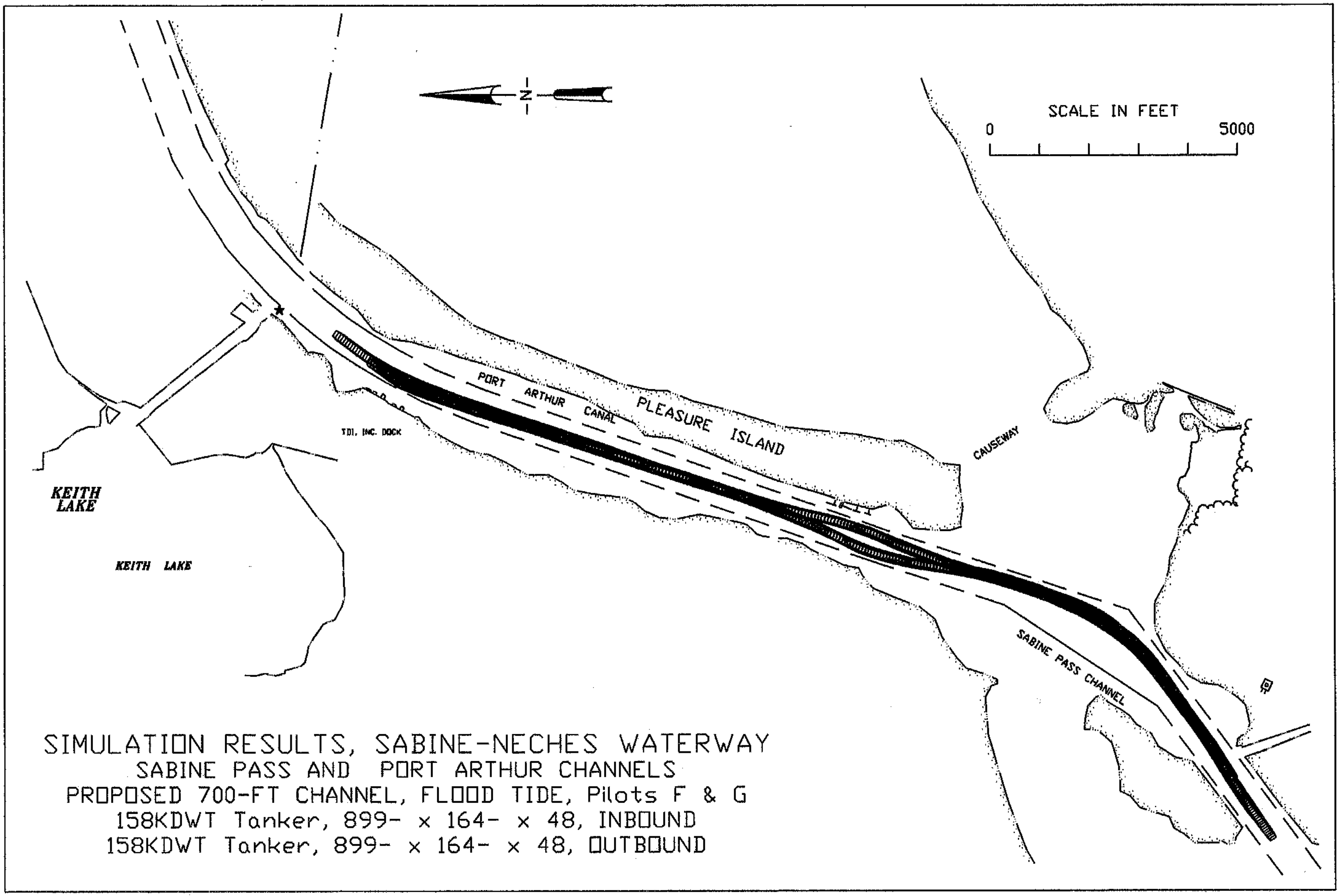


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots G & A
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND



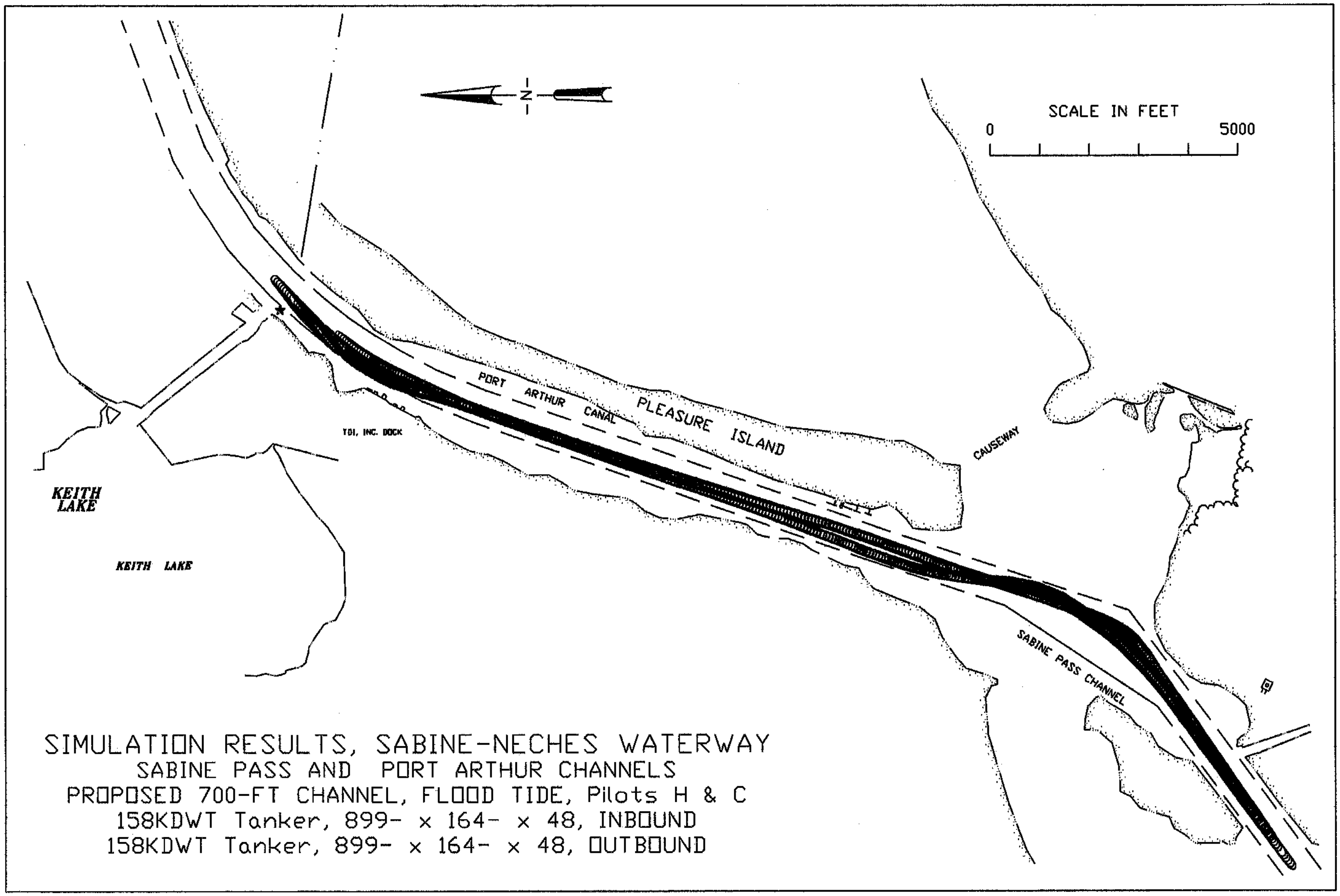
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots G & A, RUN 2
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 28



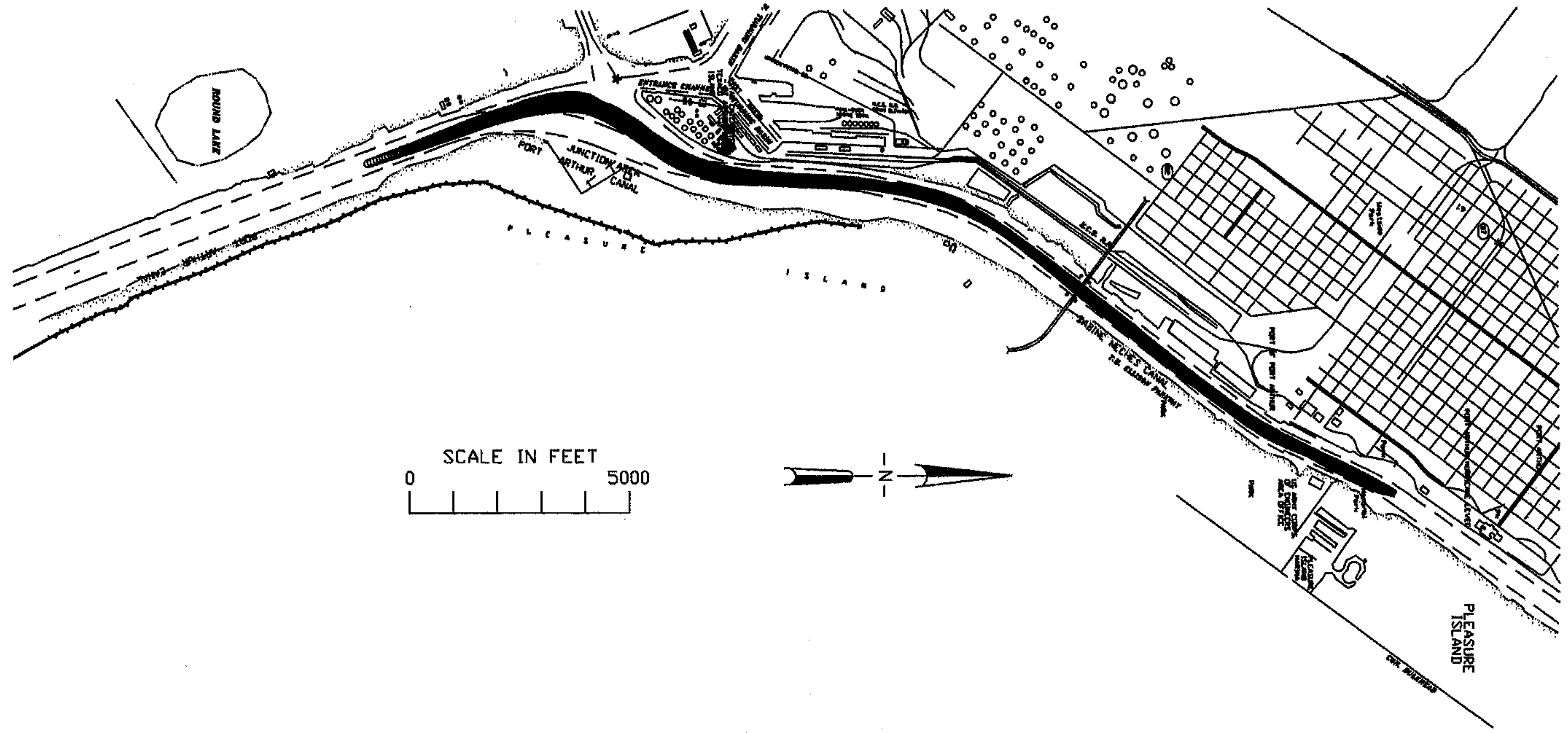
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots F & G
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 29

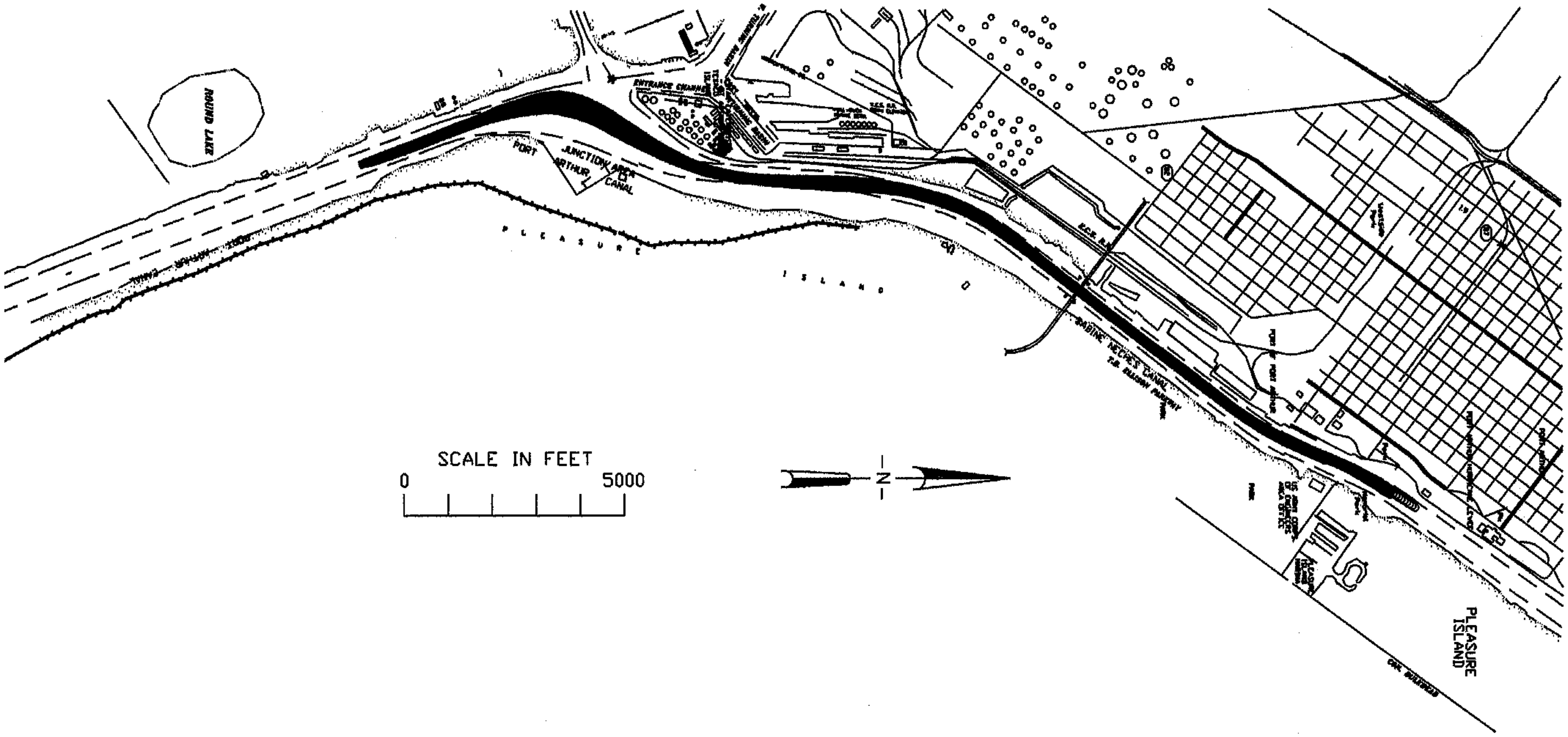


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE PASS AND PORT ARTHUR CHANNELS
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

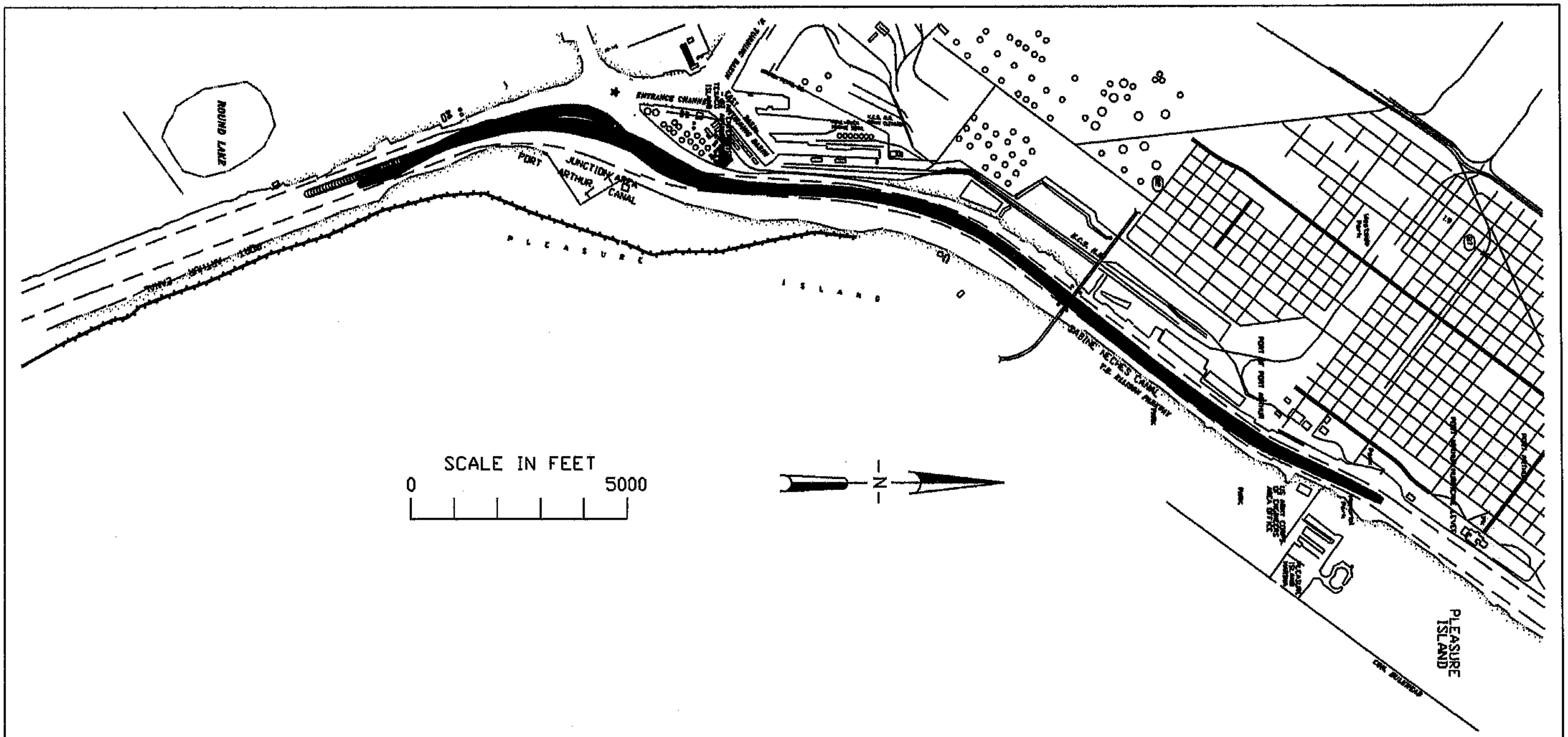
PLATE 30



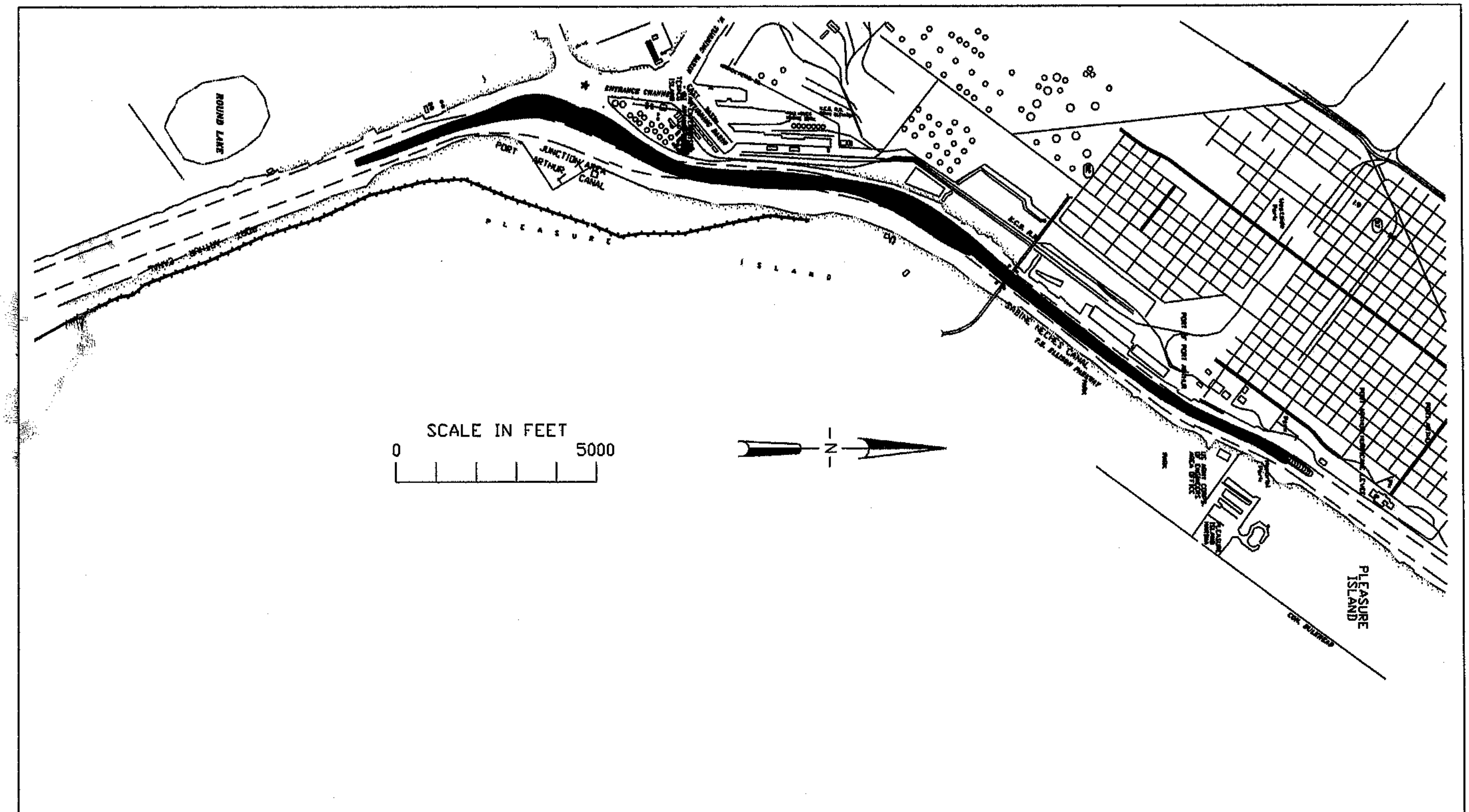
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
EXISTING CHANNEL, EBB TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 38



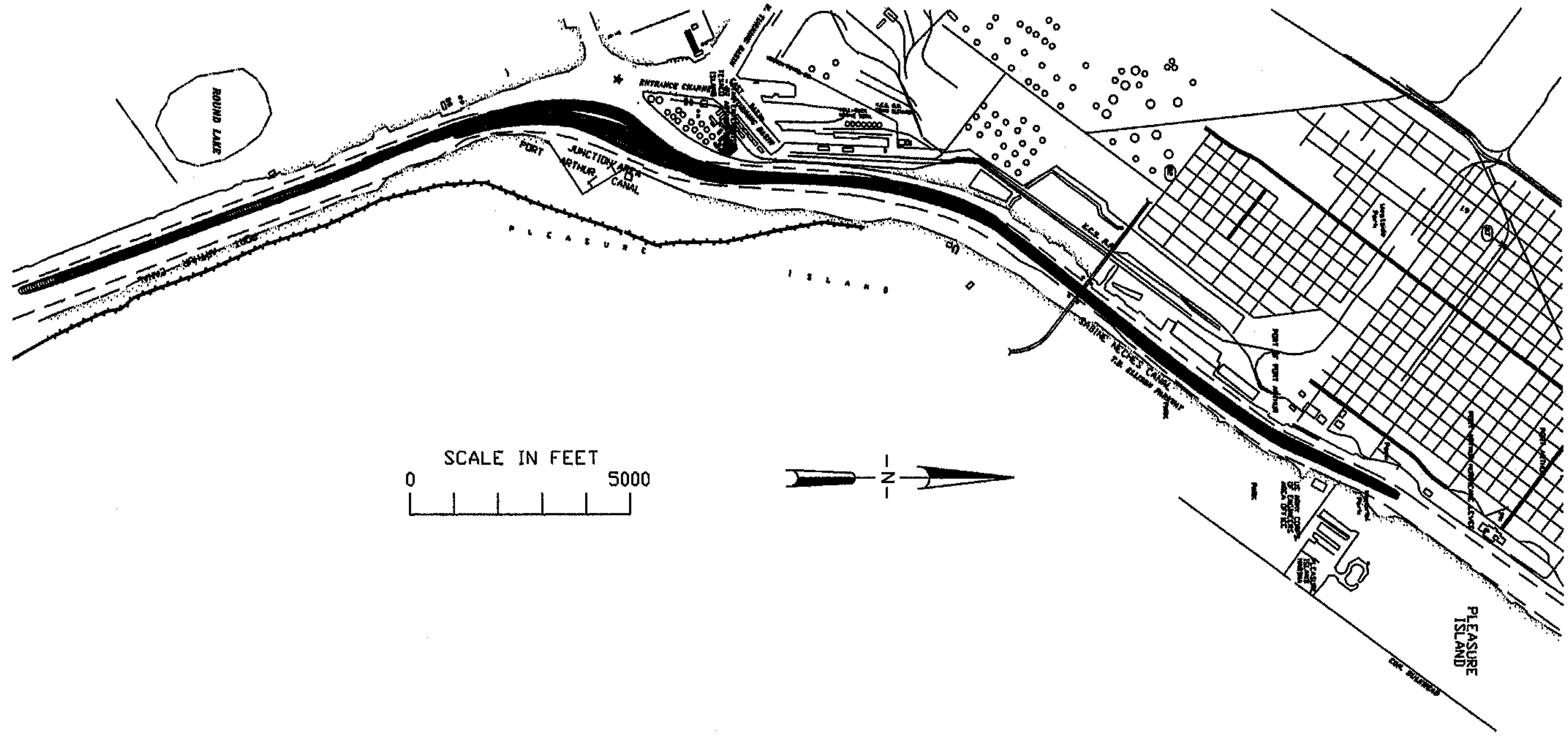
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
EXISTING CHANNEL, FLOOD TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 38



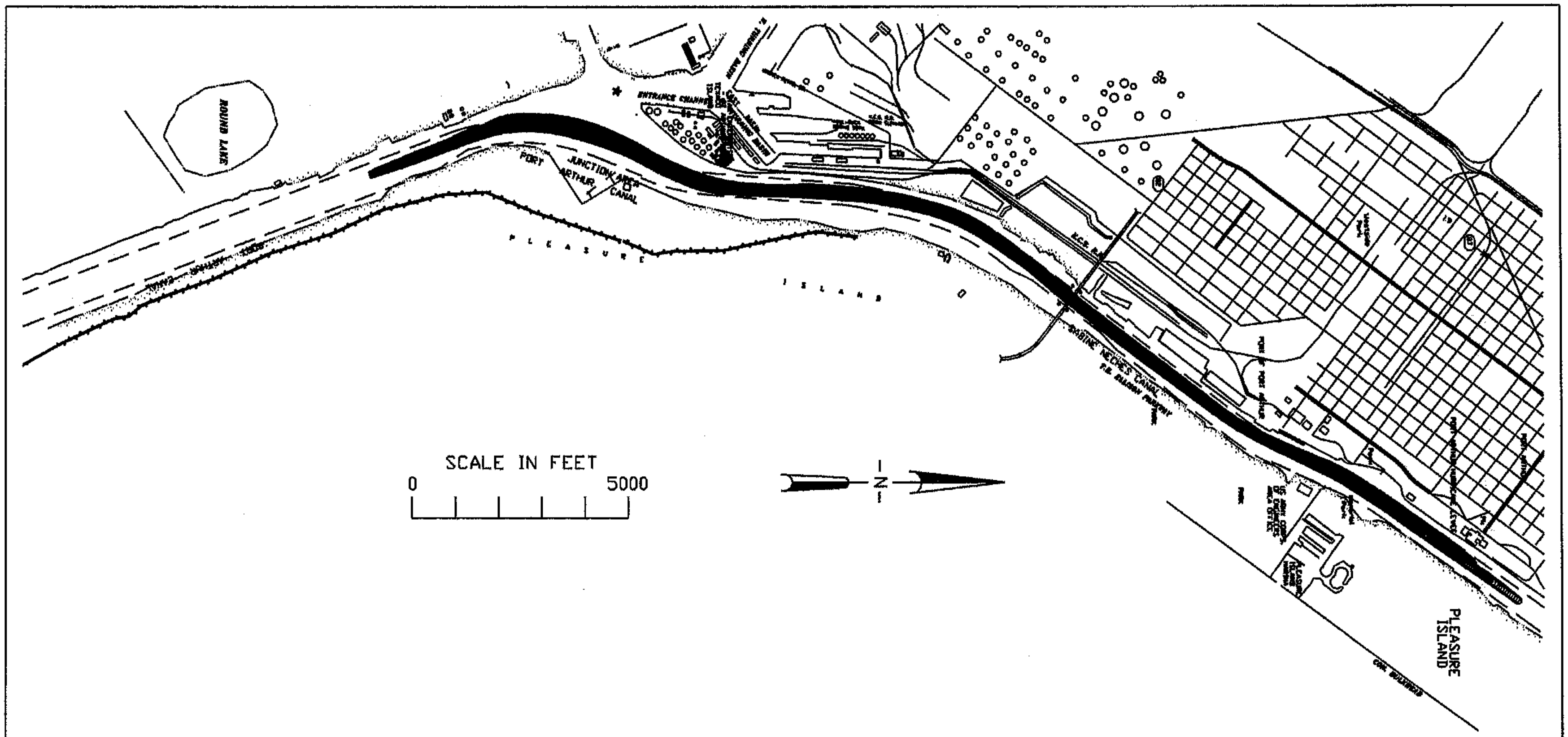
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
PROPOSED 400-FT CHANNEL, EBB TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 48



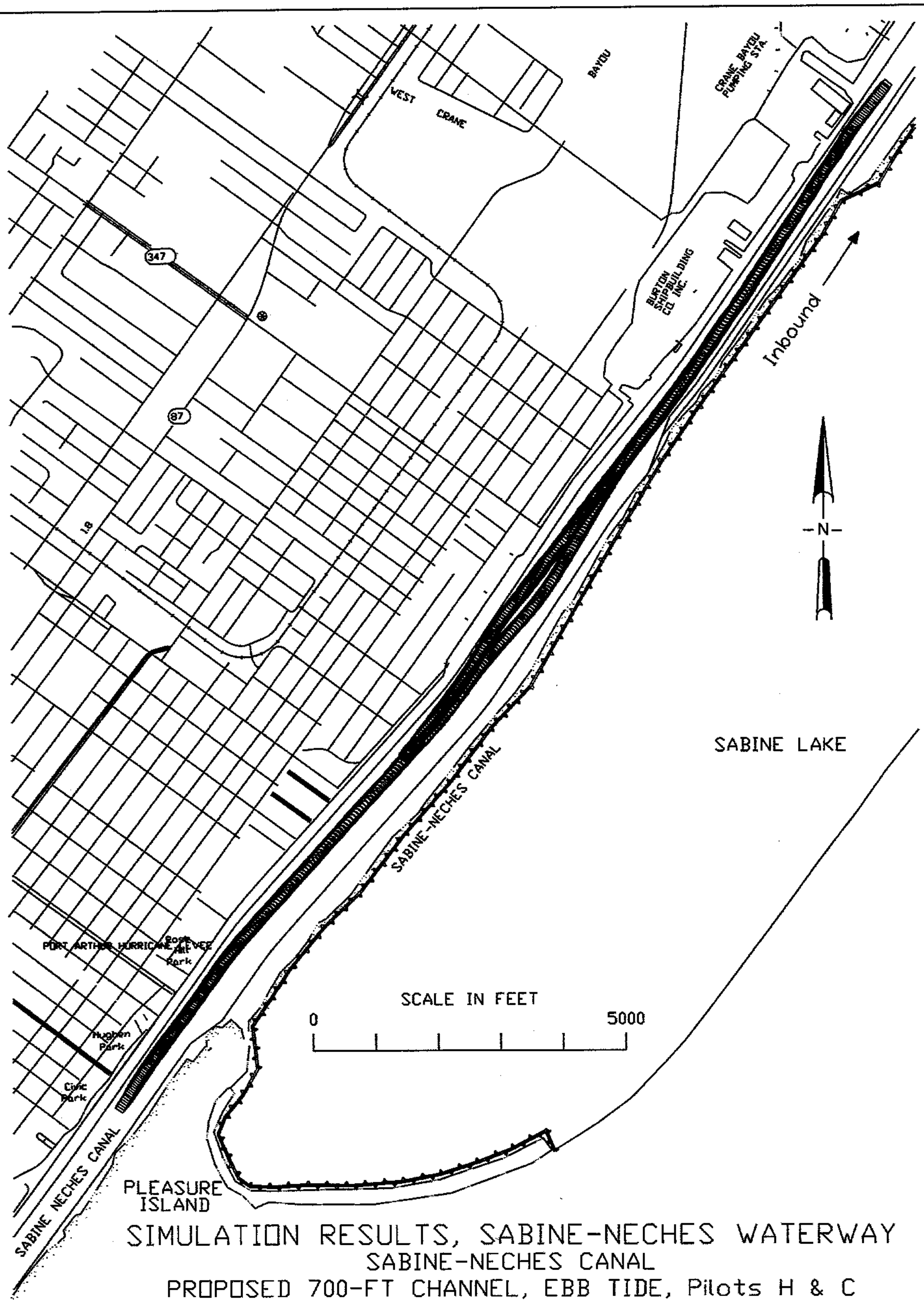
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
PROPOSED 400-FT CHANNEL, FLOOD TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 48



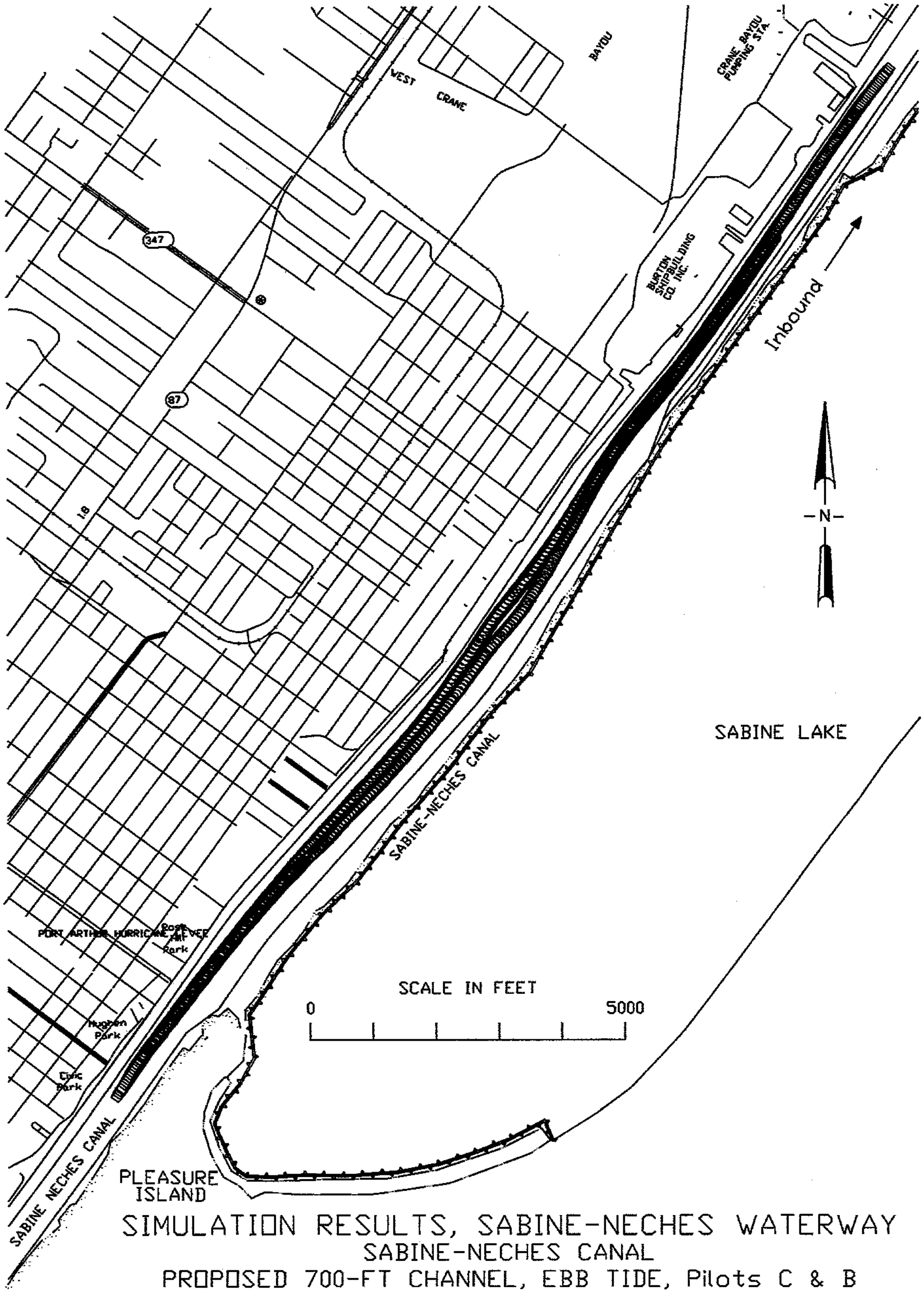
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
PROPOSED 500-FT CHANNEL, EBB TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 48



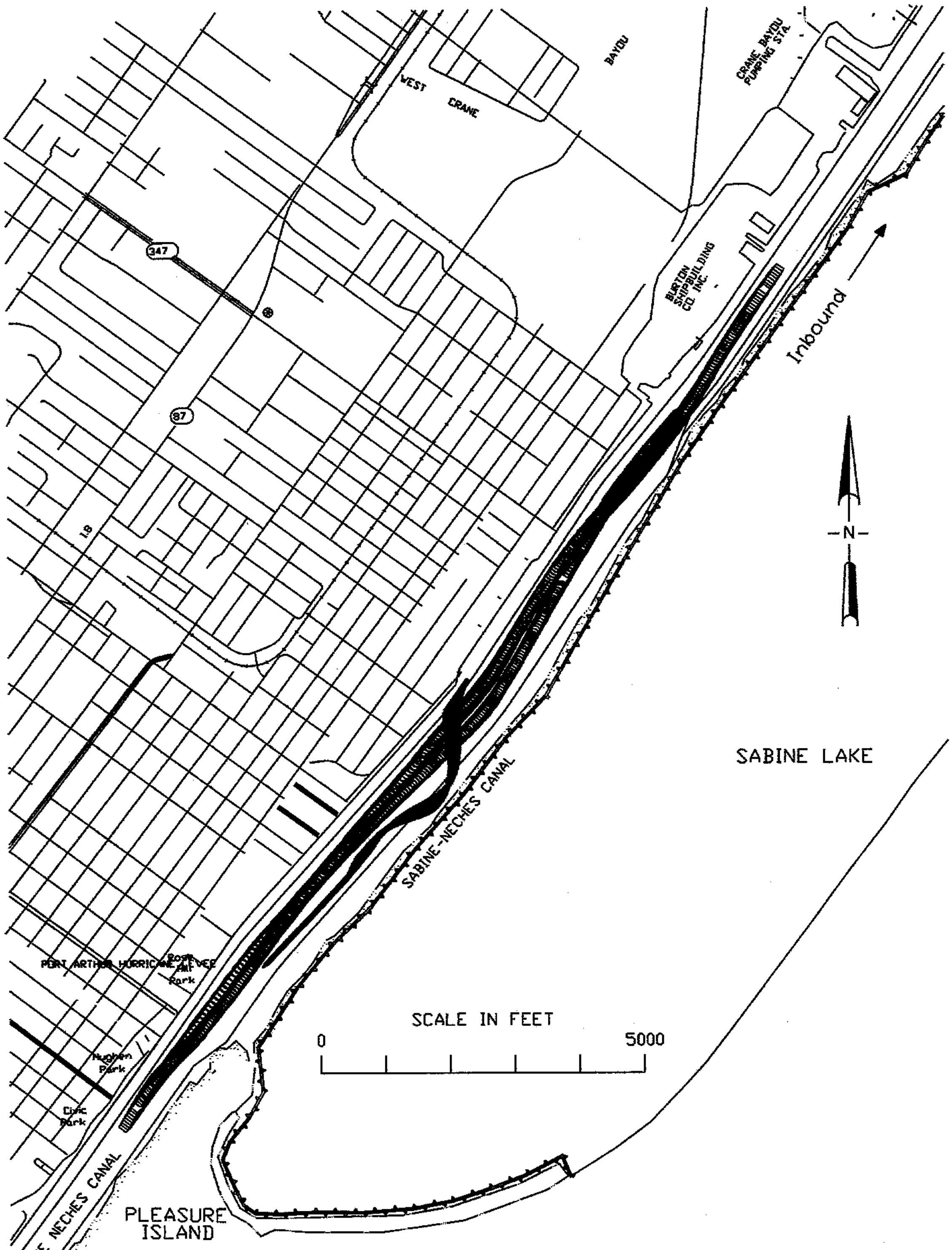
SIMULATION RESULTS, SABINE-NECHES WATERWAY
APPROACH TO MARTIN LUTHER KING BRIDGE
PROPOSED 500-FT CHANNEL, FLOOD TIDE, COMPOSITE PLOT
158KDWT Tanker, 899- x 164- x 48



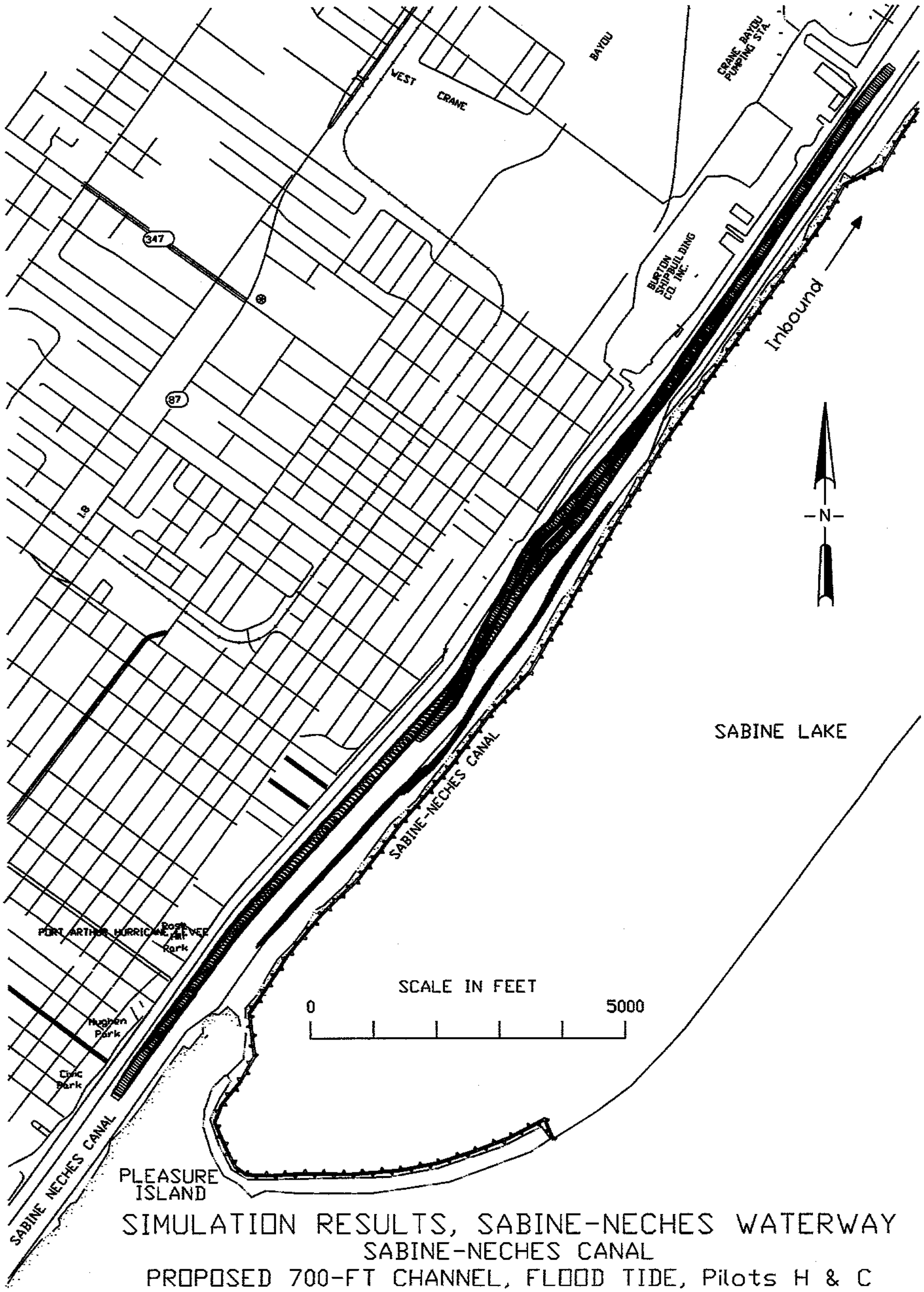
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



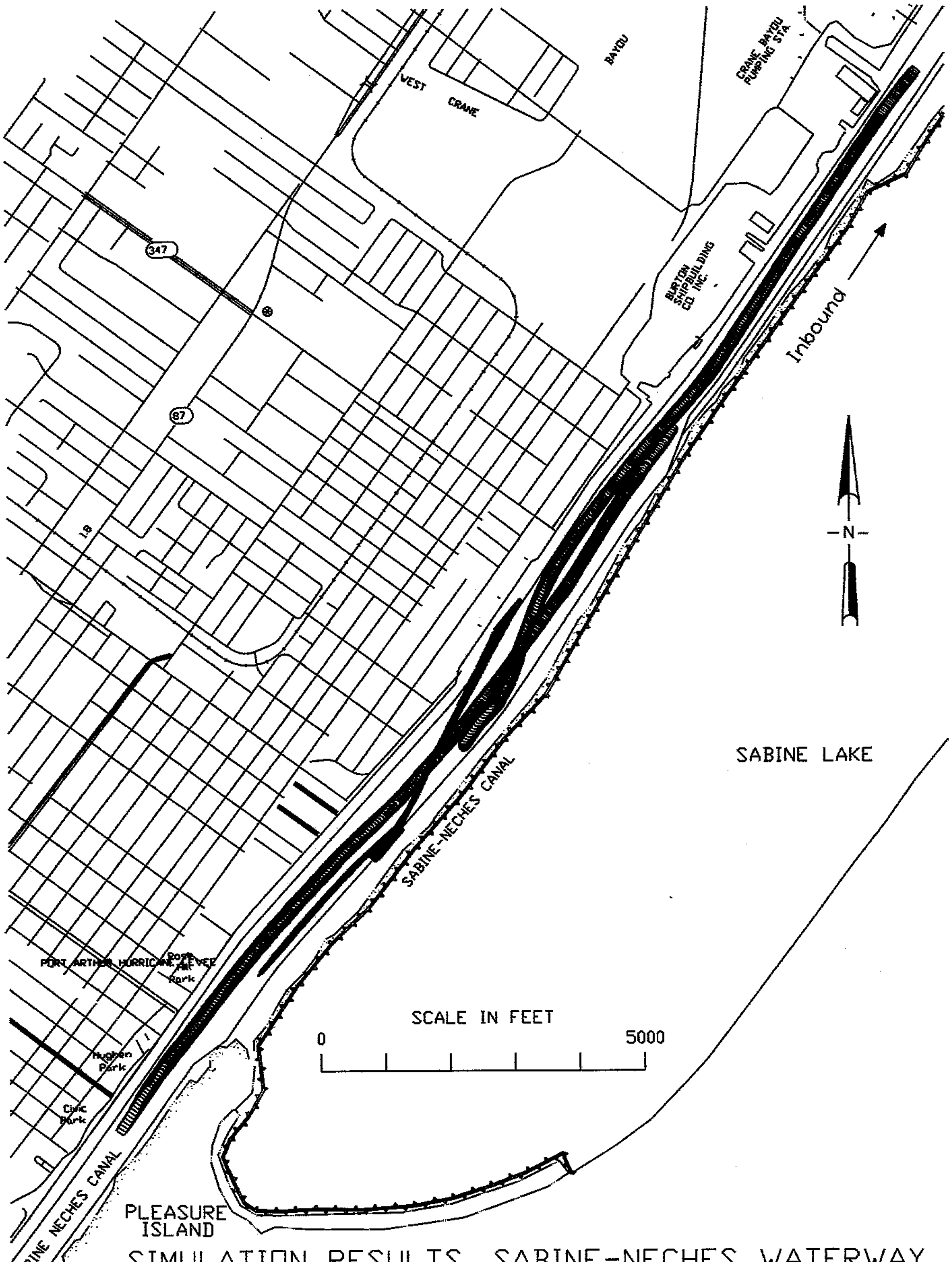
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots C & B
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



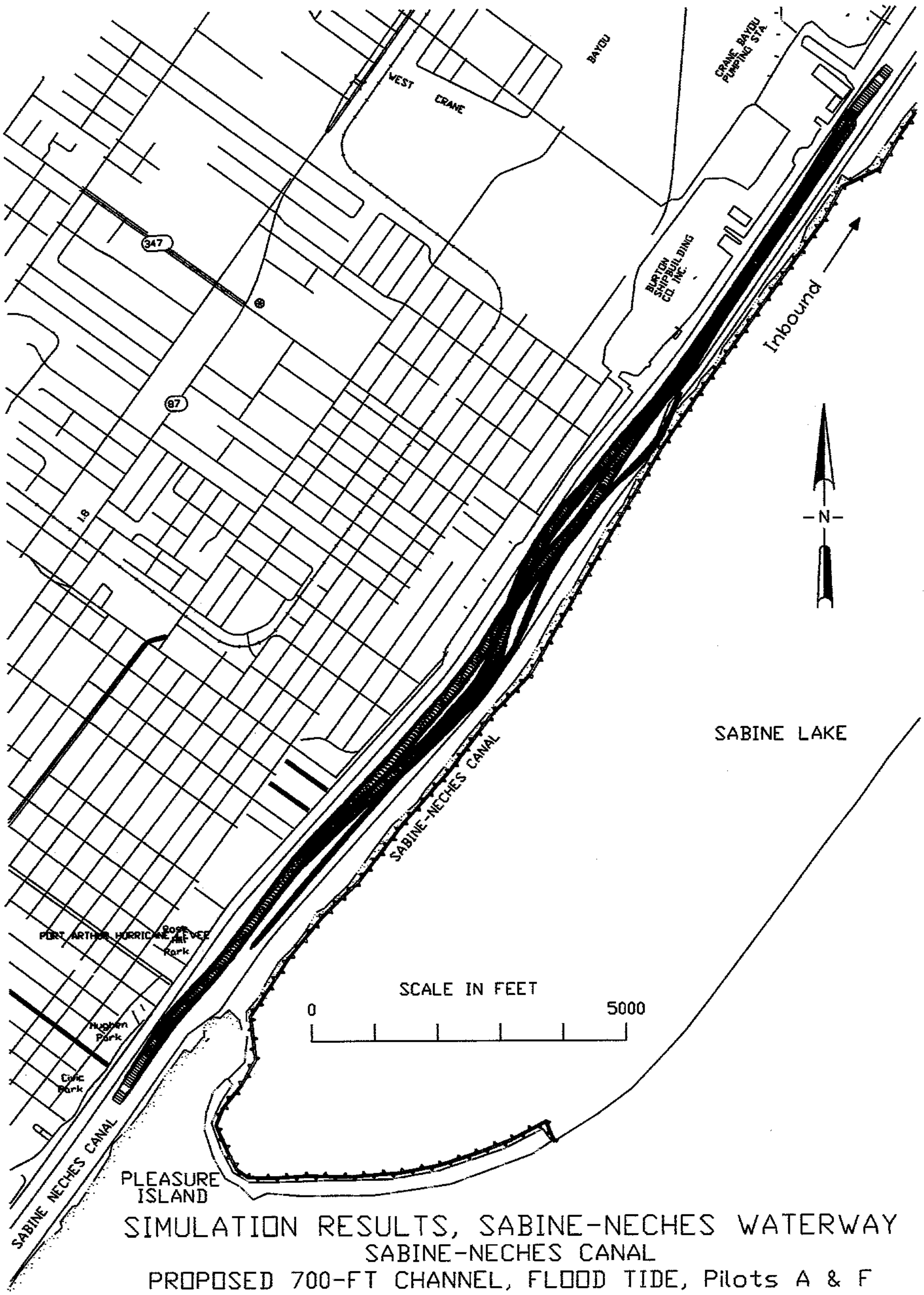
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots F & A
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



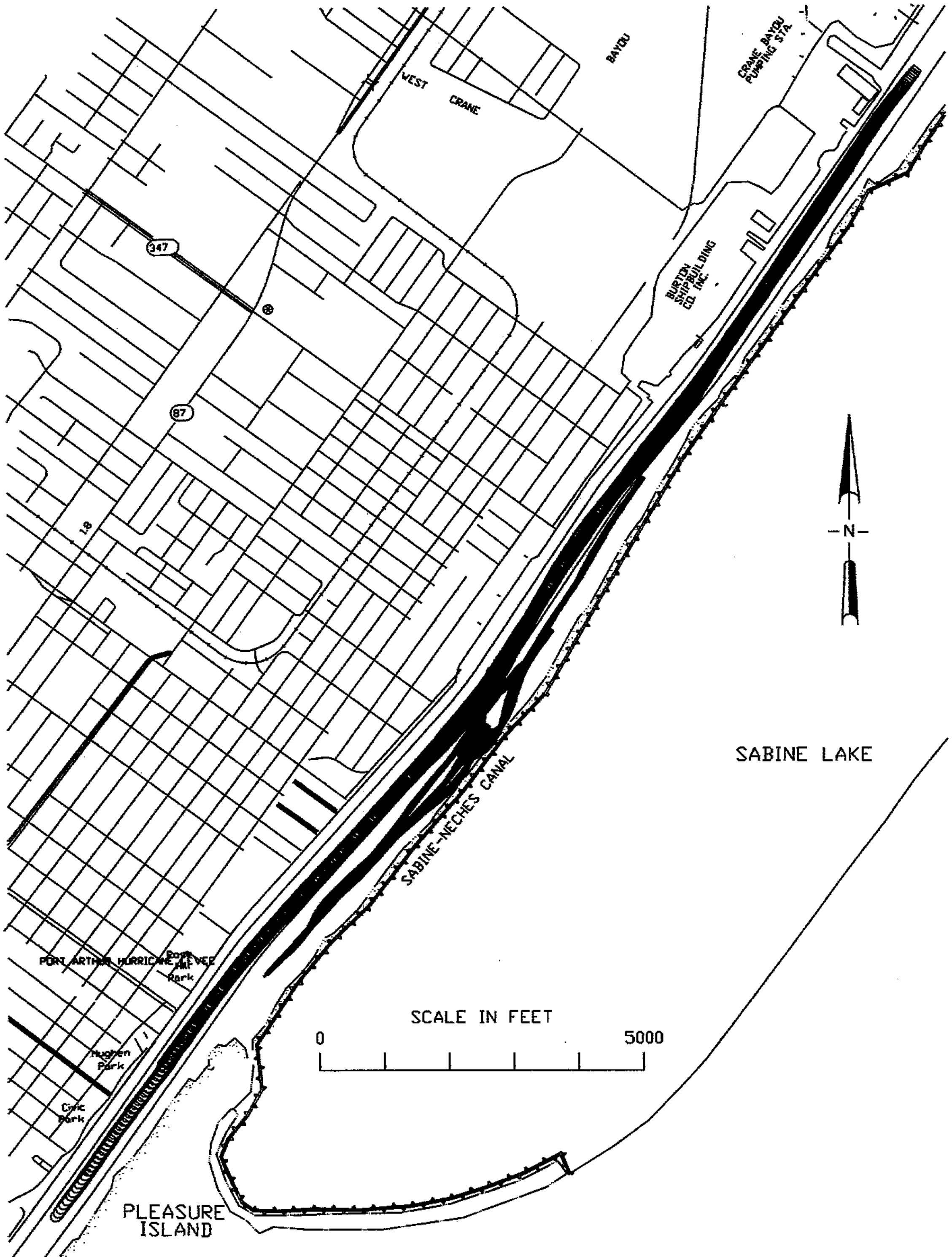
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



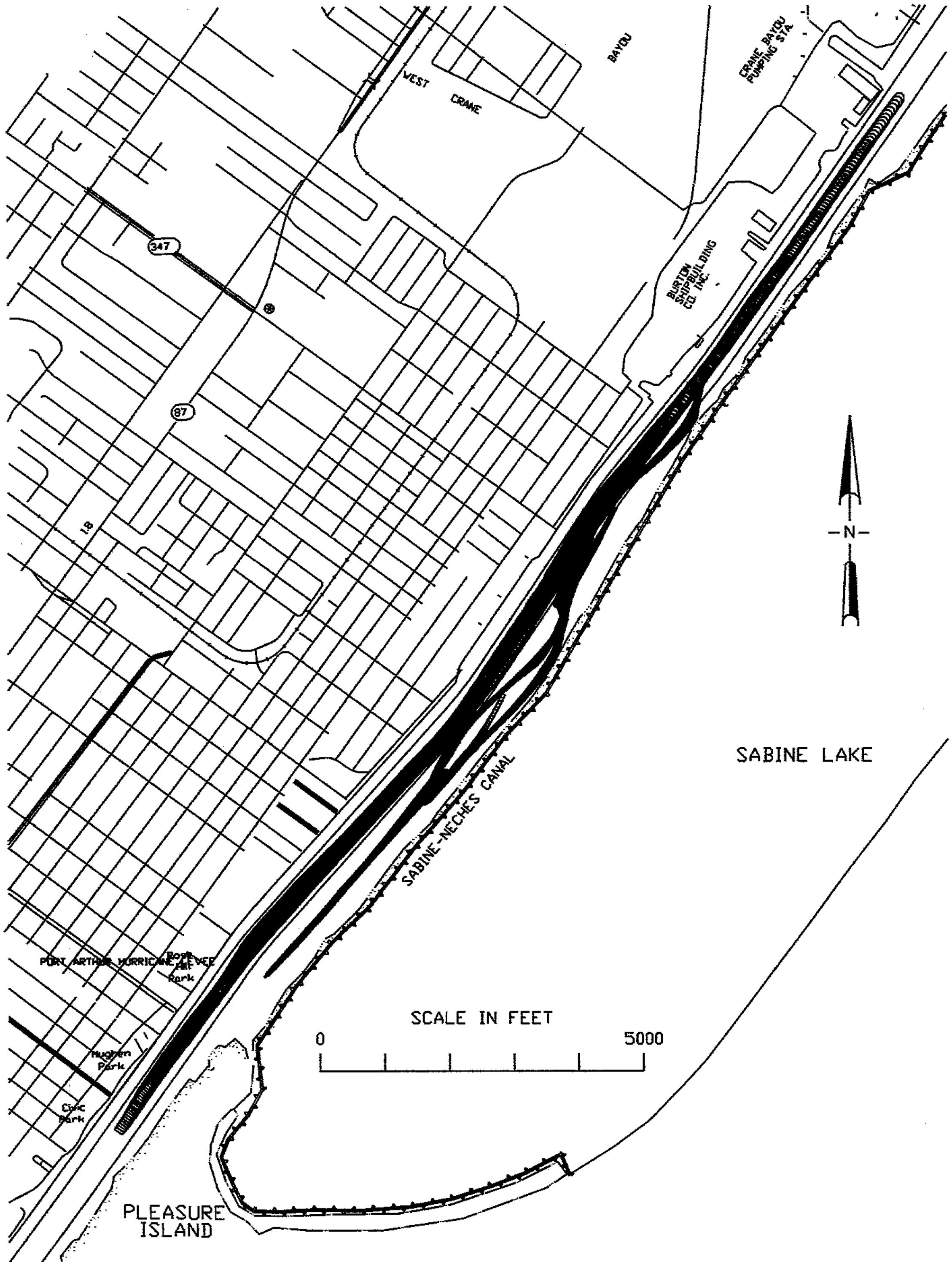
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots C & B
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



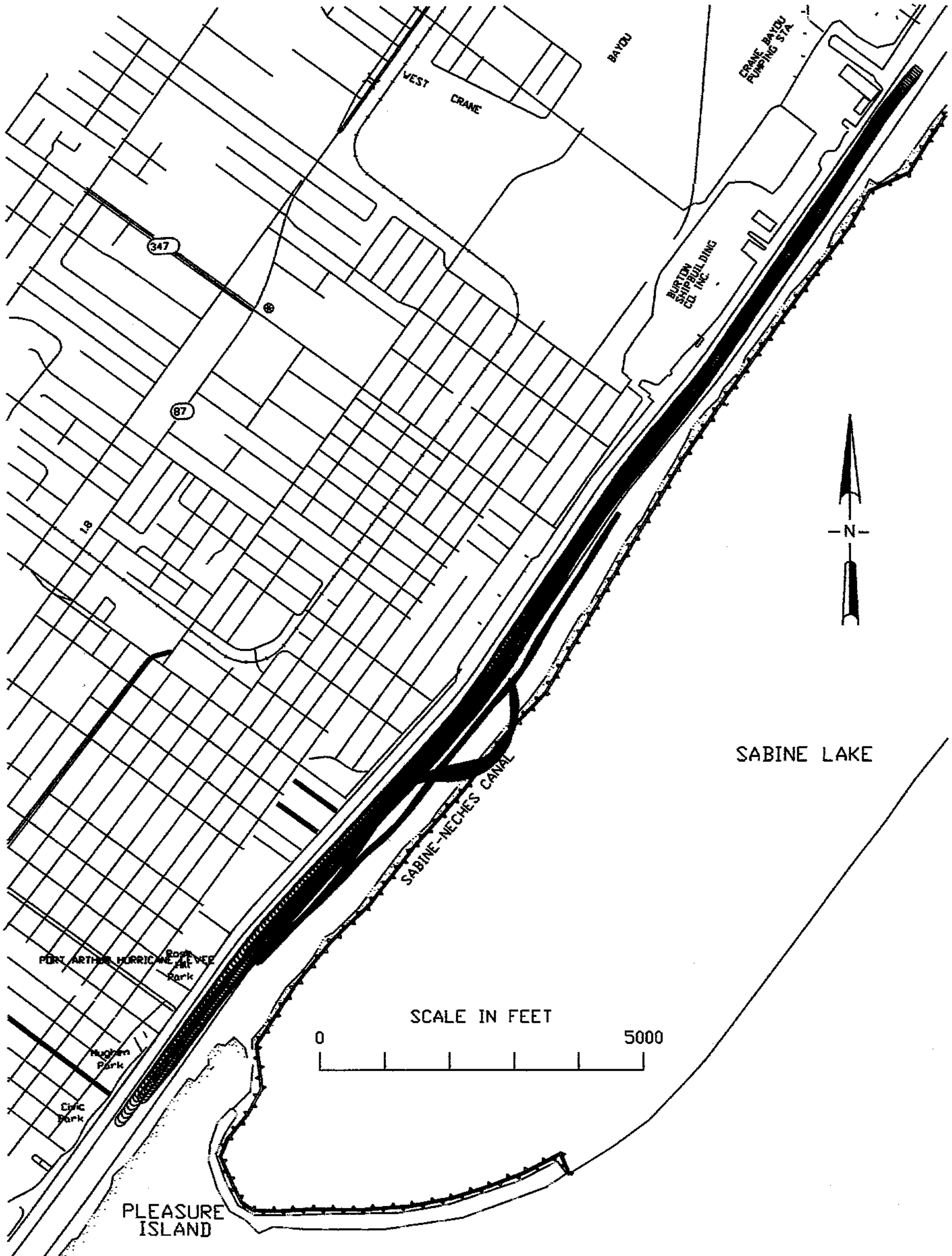
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 700-FT CHANNEL, FLOOD TIDE, Pilots A & F
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
EXISTING CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 38, OUTBOUND
Two-barge tow, INBOUND

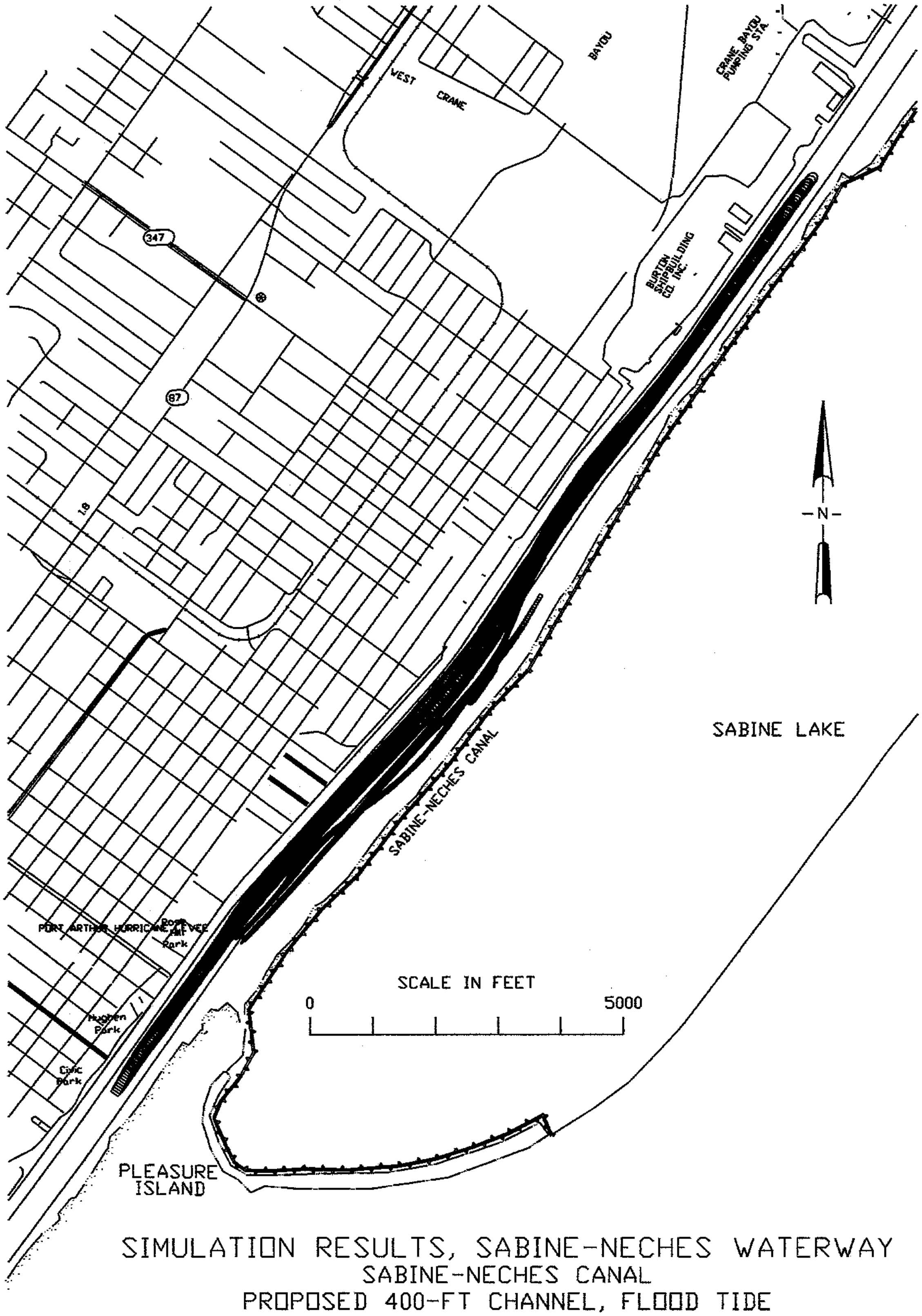


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
EXISTING CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 38, INBOUND
Two-barge tow, INBOUND

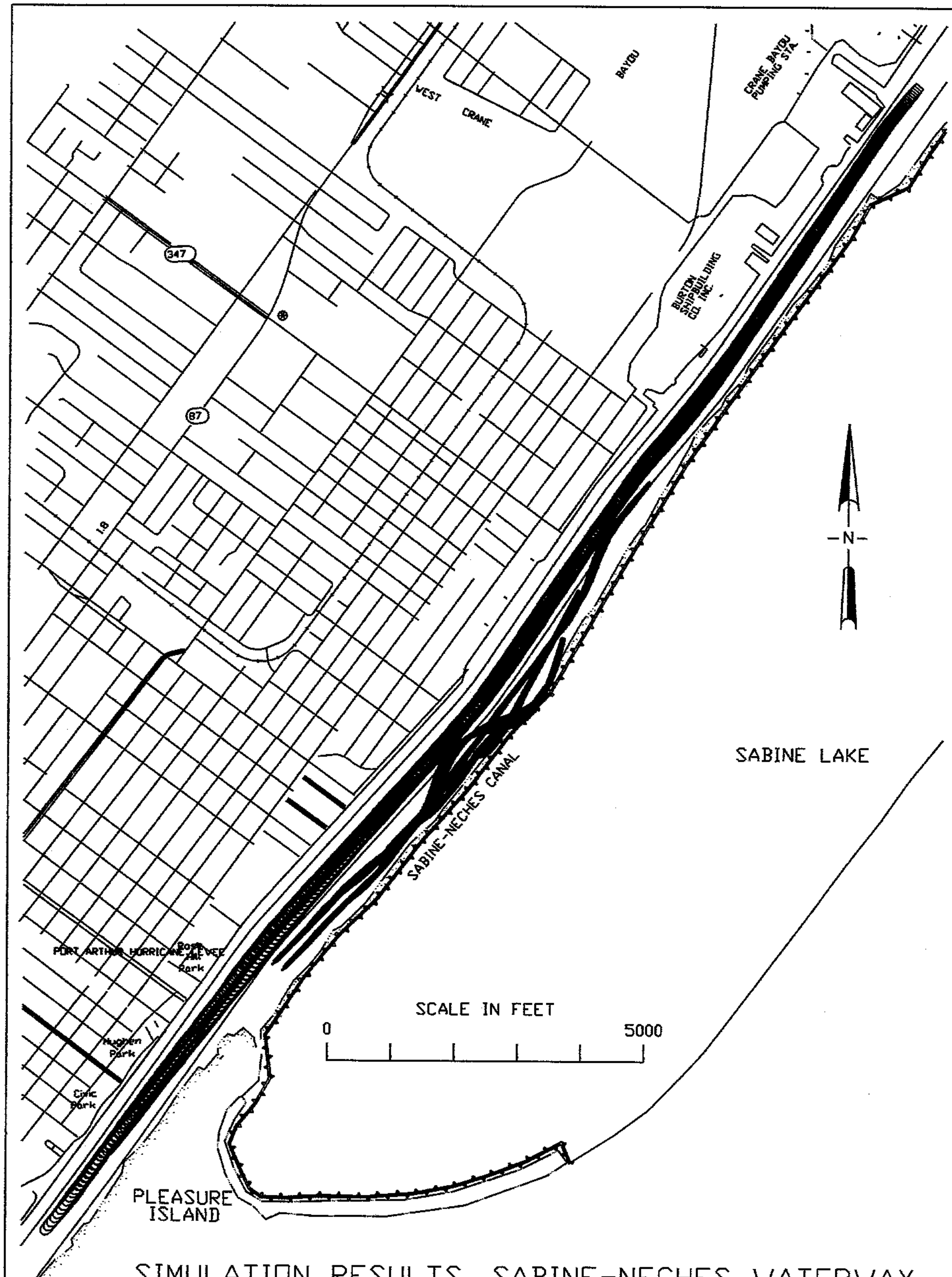


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 400-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND

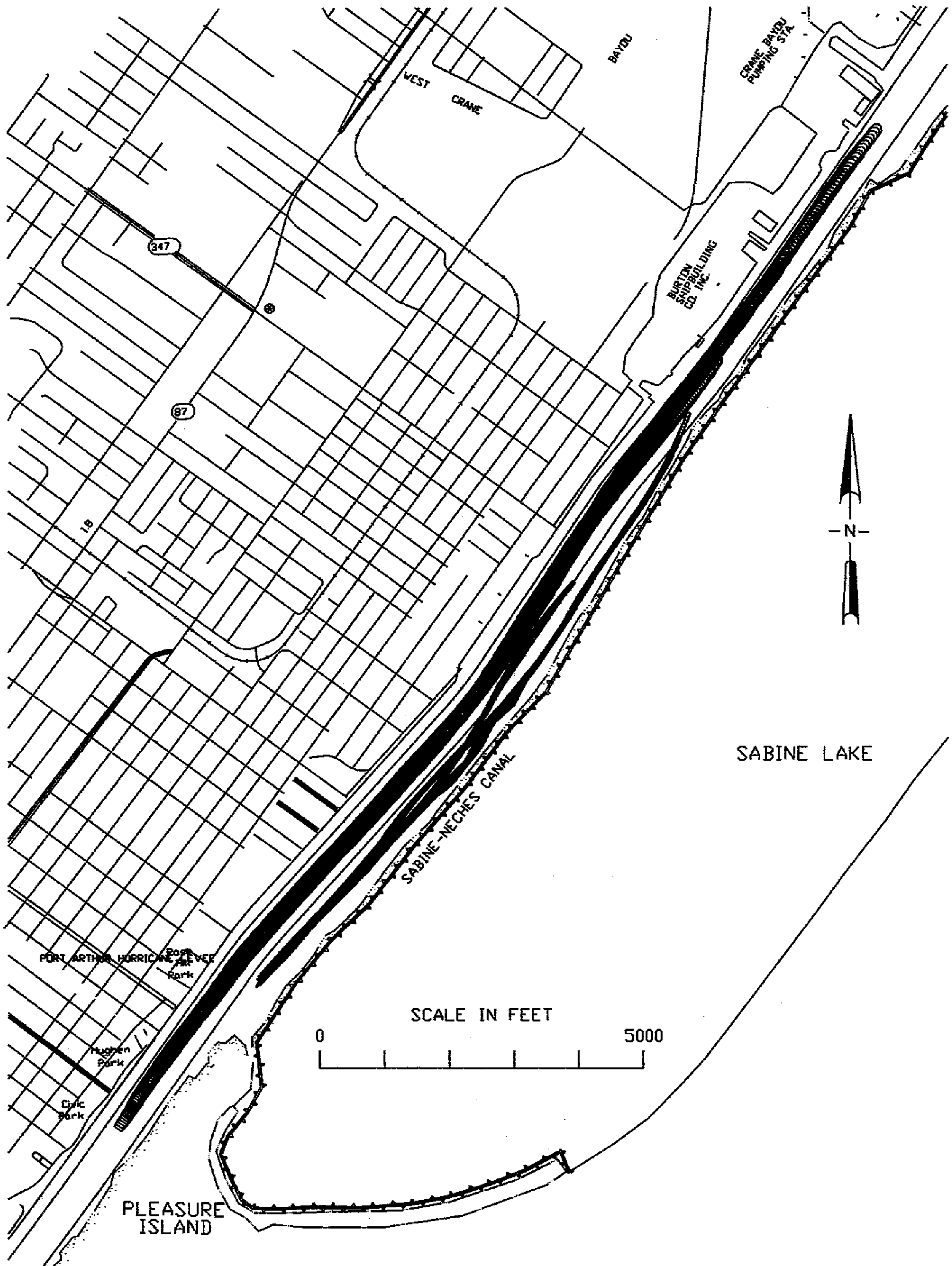
PLATE 45



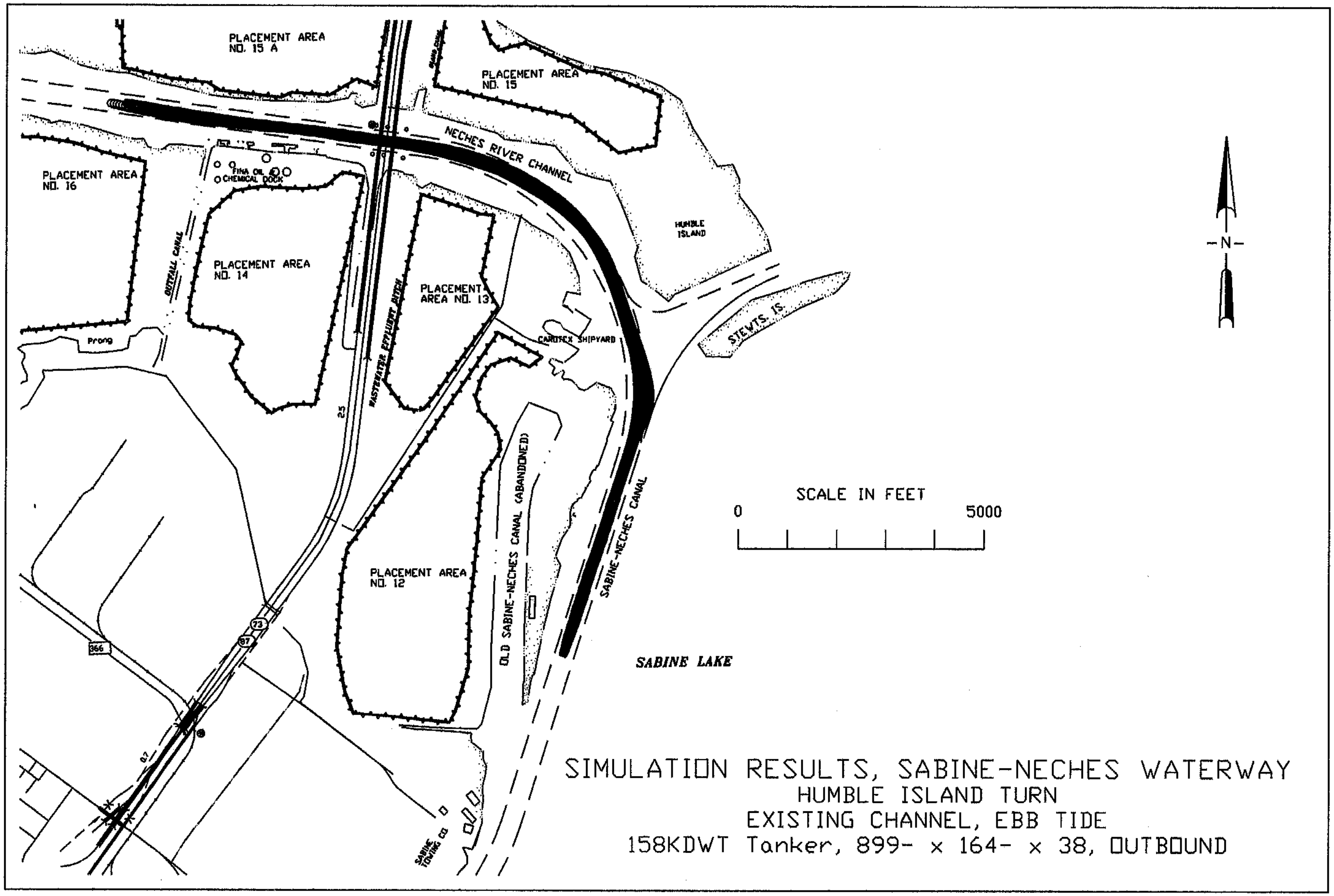
SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 400-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND
Two-barge tow, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 500-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND
Two-barge tow, INBOUND

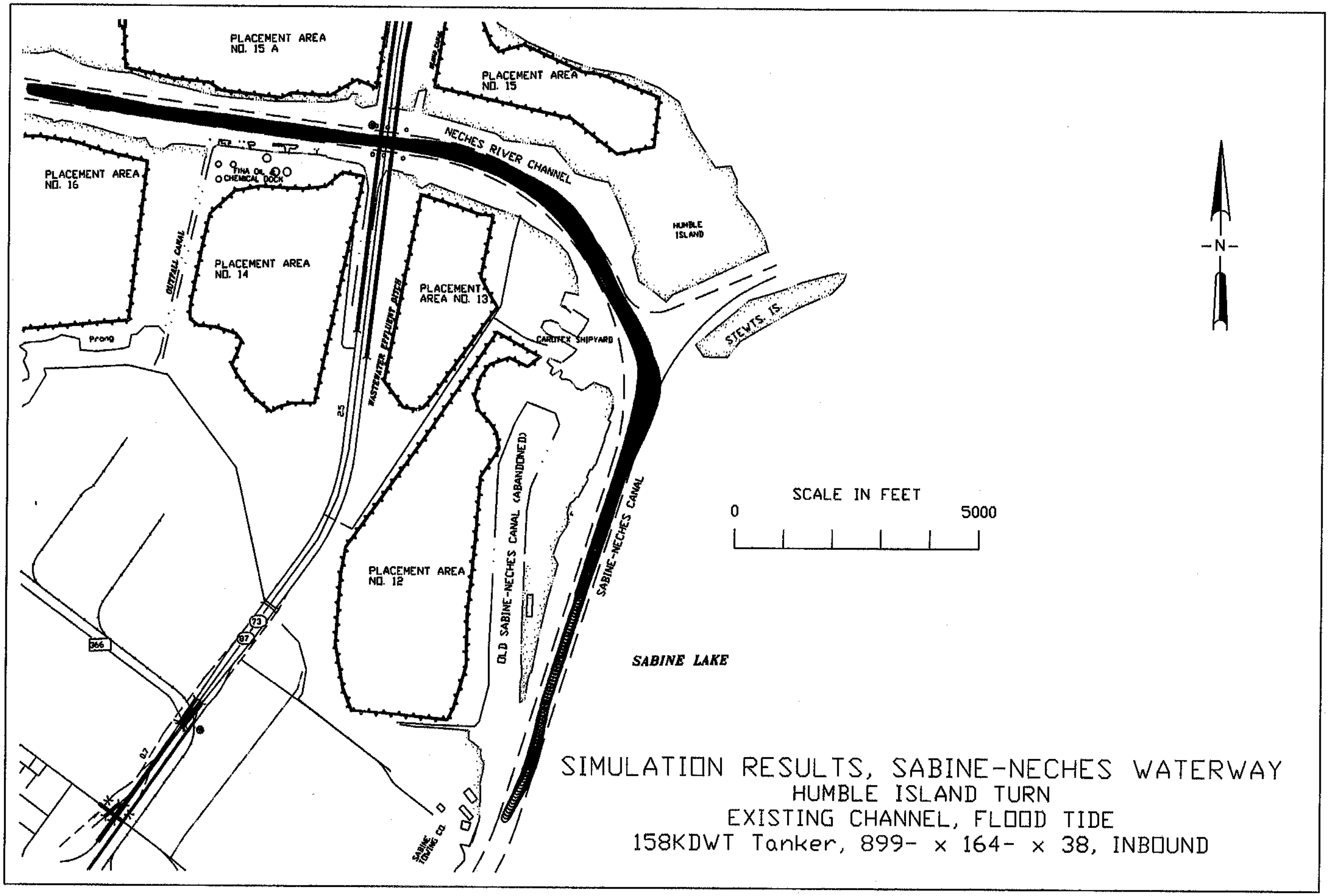


SIMULATION RESULTS, SABINE-NECHES WATERWAY
SABINE-NECHES CANAL
PROPOSED 500-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND
Two-barge tow, INBOUND

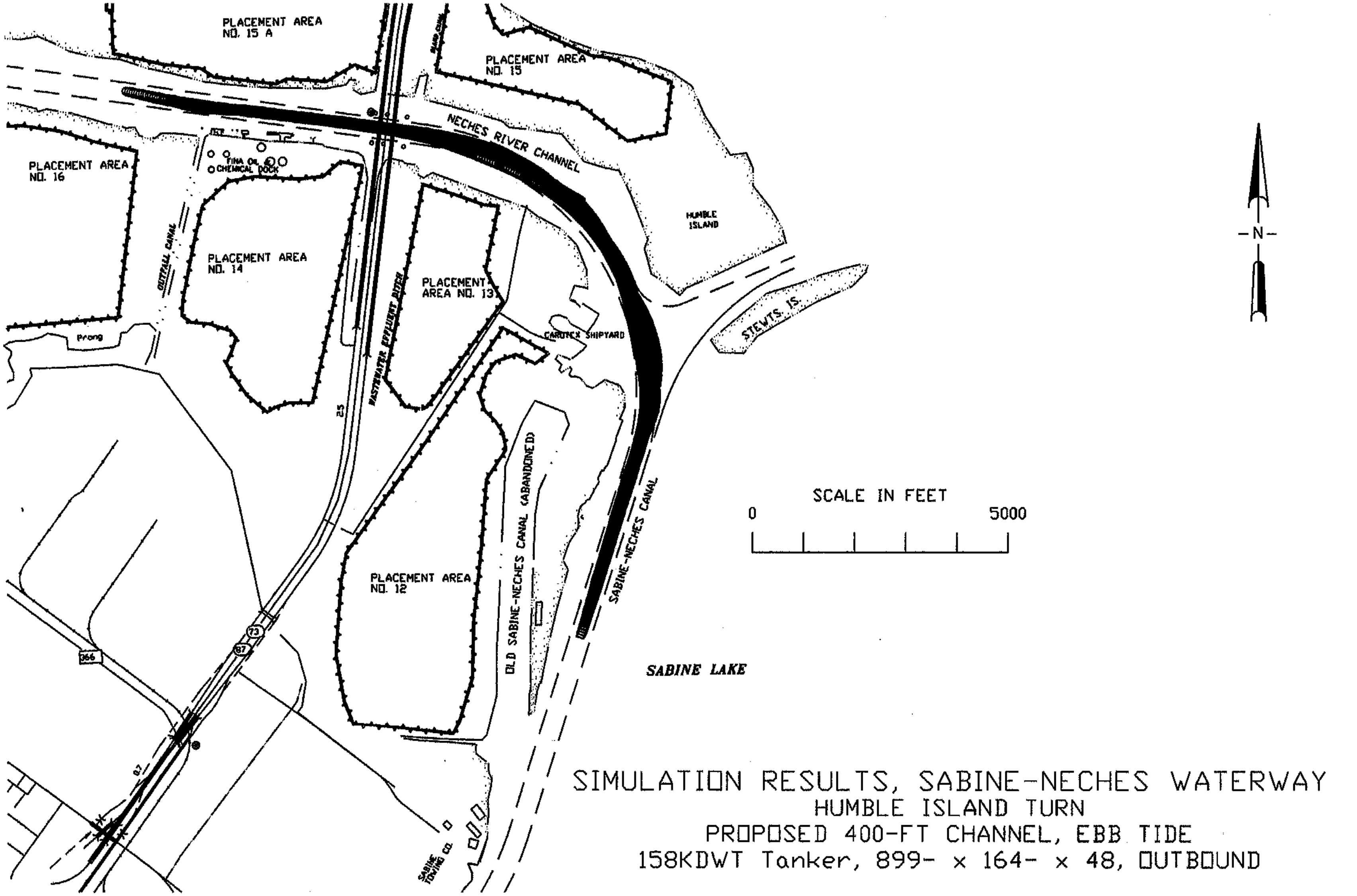


SIMULATION RESULTS, SABINE-NECHES WATERWAY
HUMBLE ISLAND TURN
EXISTING CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 38, OUTBOUND

PLATE 49

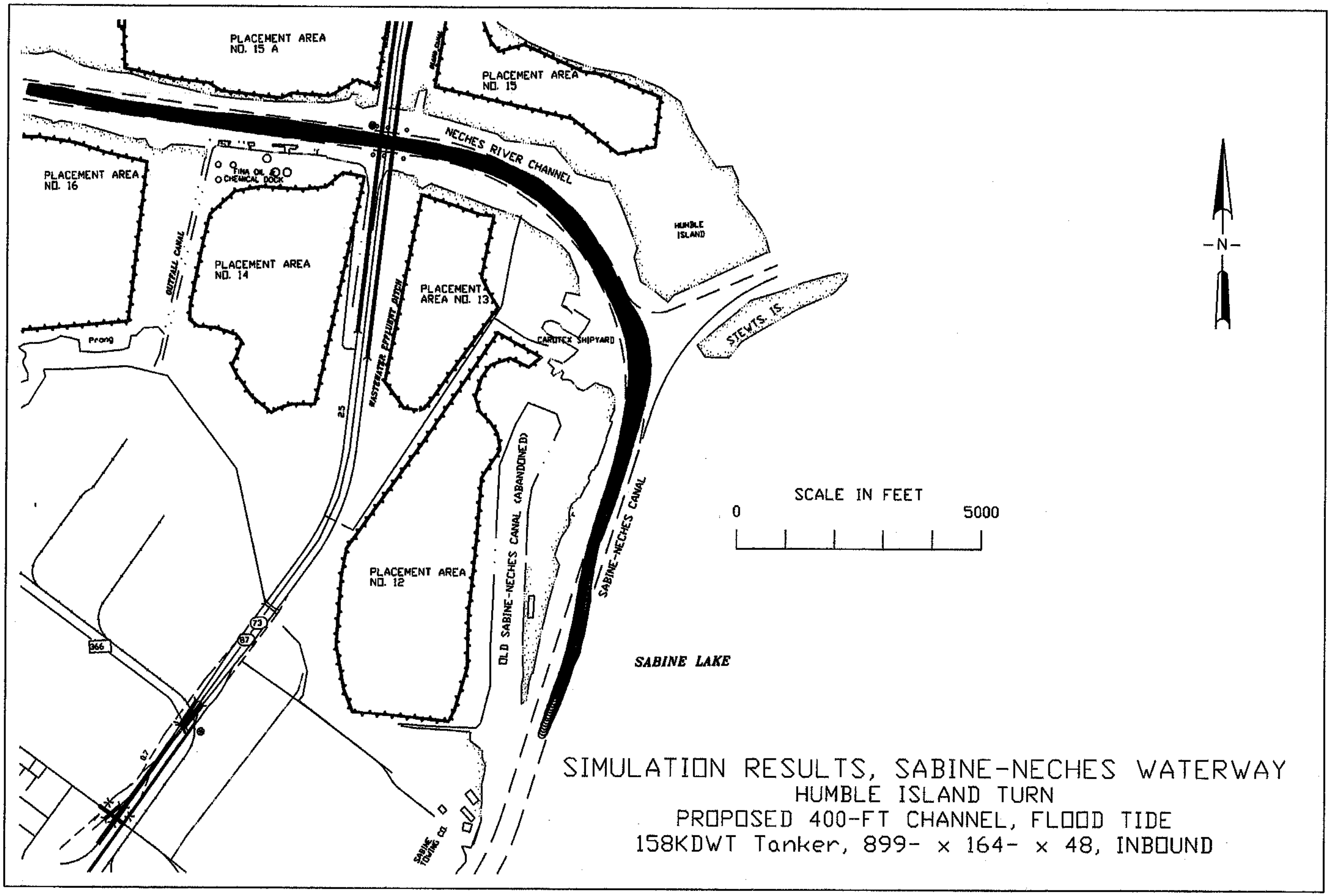


SIMULATION RESULTS, SABINE-NECHES WATERWAY
HUMBLE ISLAND TURN
EXISTING CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 38, INBOUND



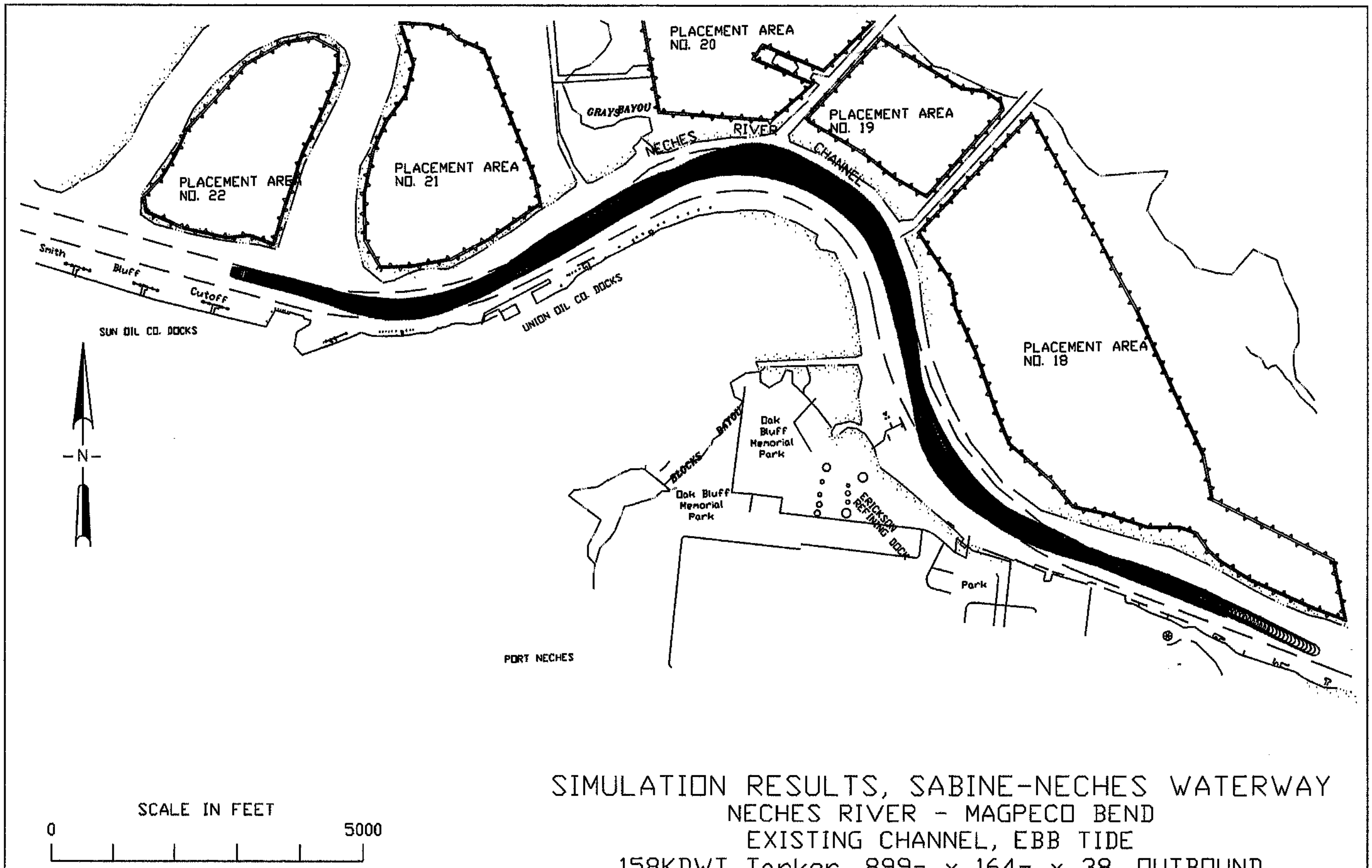
SIMULATION RESULTS, SABINE-NECHES WATERWAY
HUMBLE ISLAND TURN
PROPOSED 400-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 51

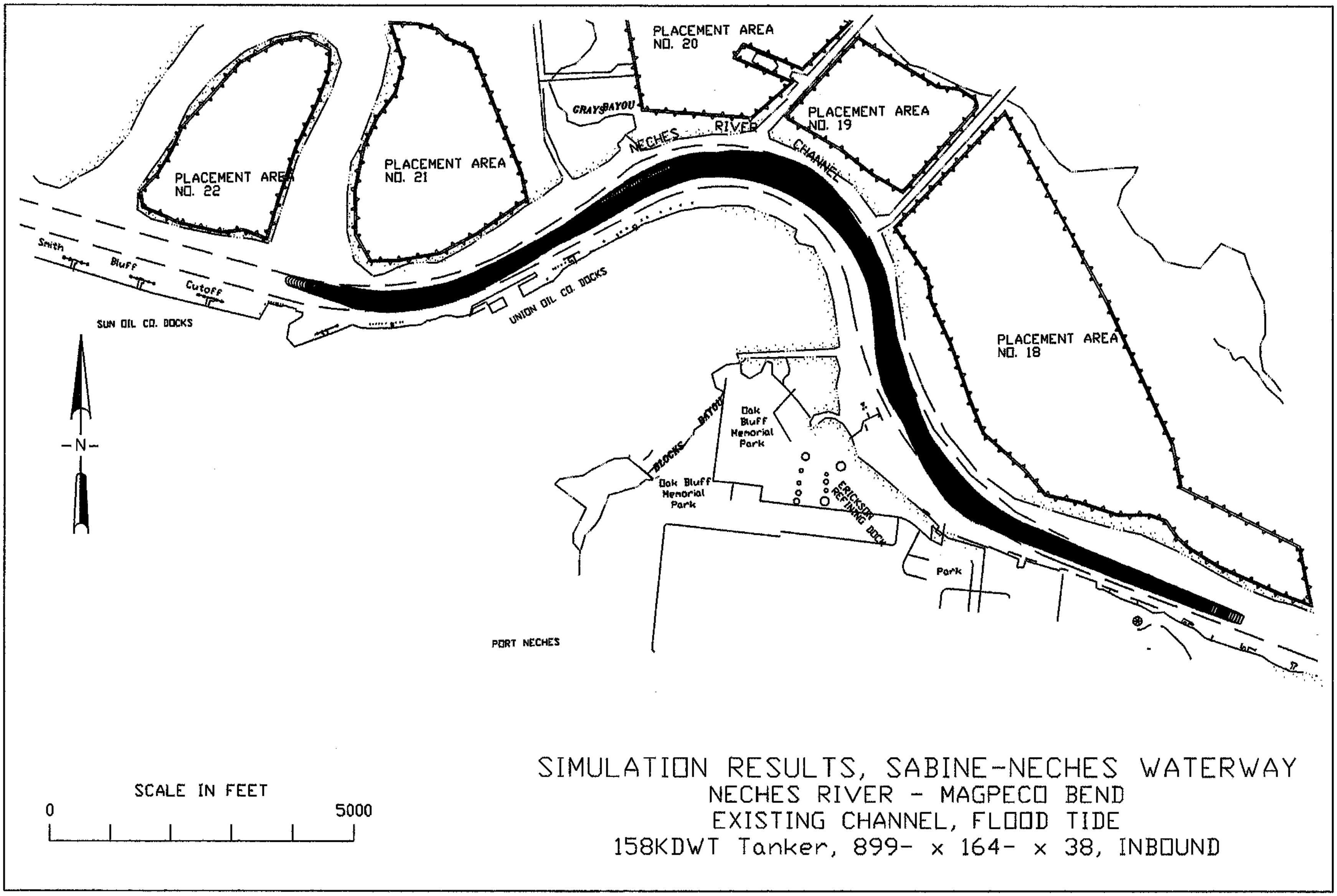


SIMULATION RESULTS, SABINE-NECHES WATERWAY
HUMBLE ISLAND TURN
PROPOSED 400-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND

PLATE 52

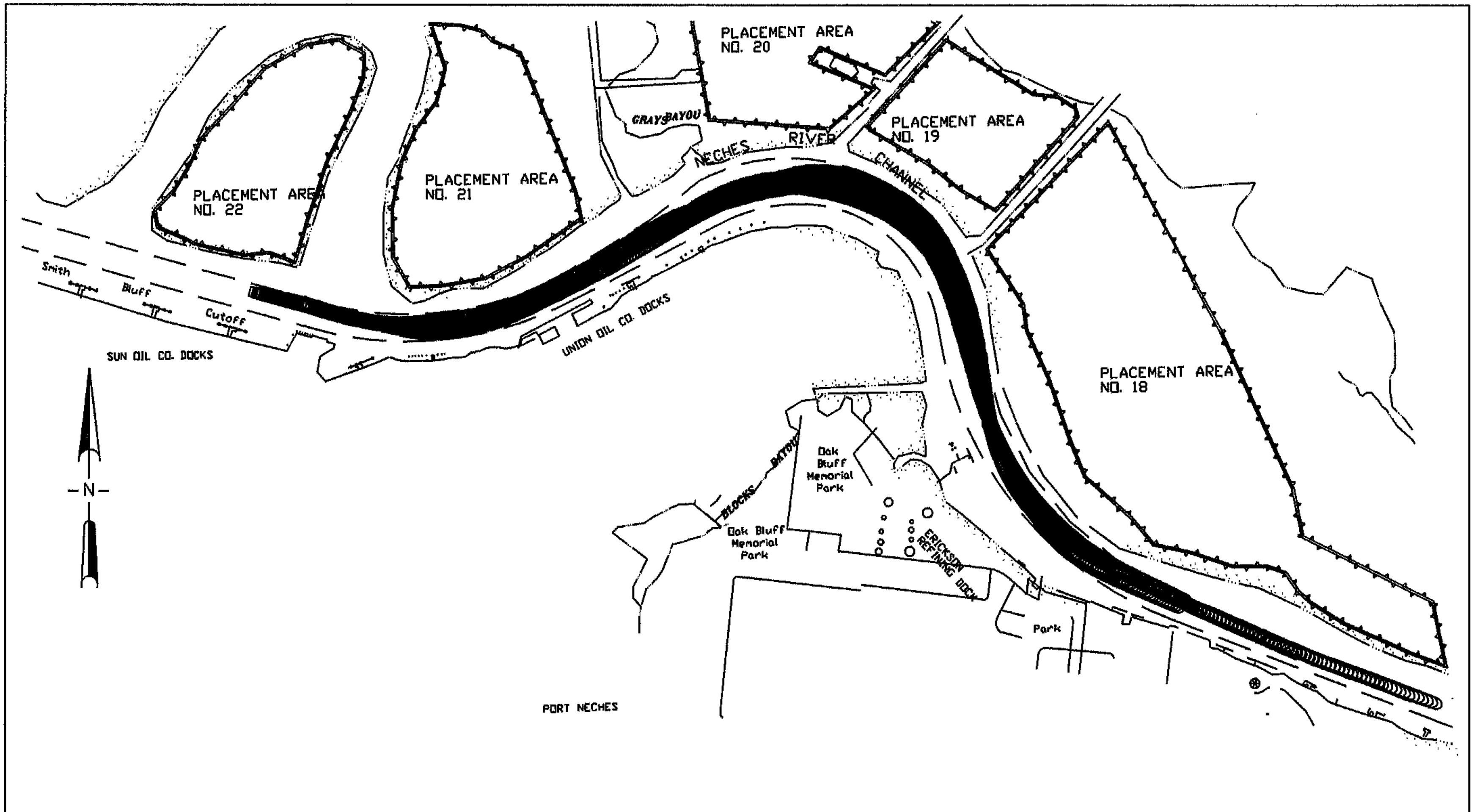


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
EXISTING CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 38, OUTBOUND



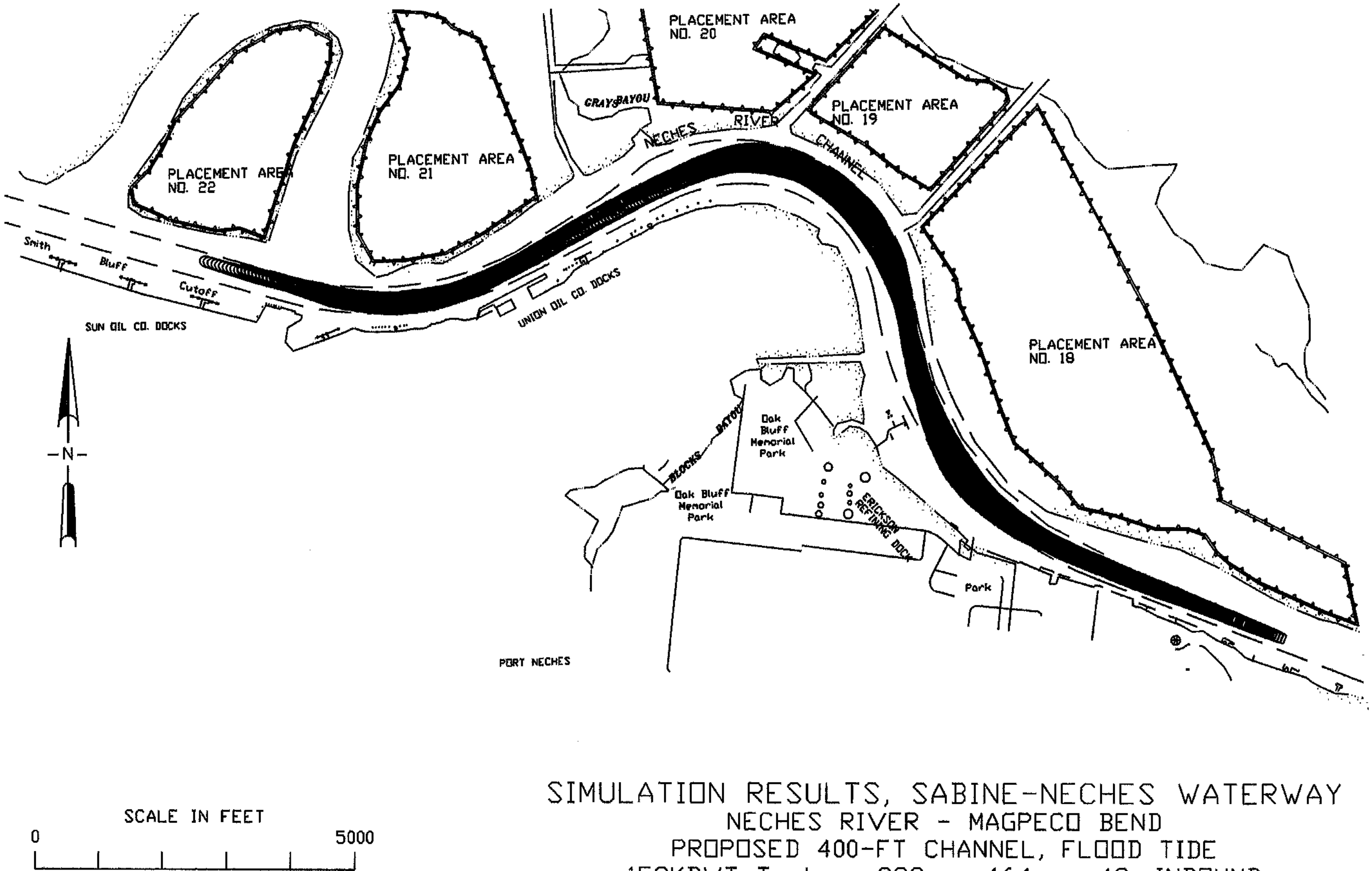
SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
EXISTING CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 38, INBOUND

PLATE 54

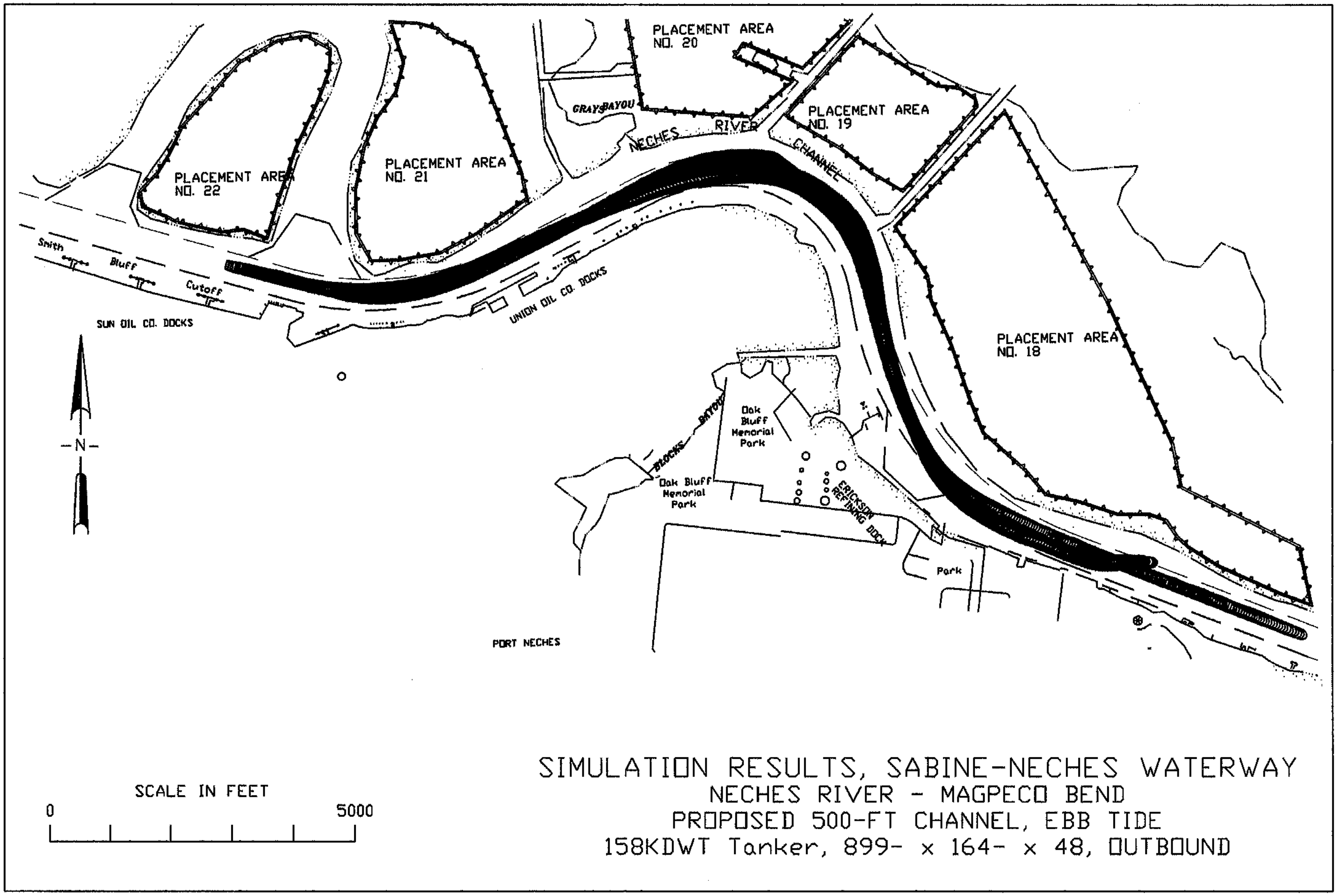


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
PROPOSED 400-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 55

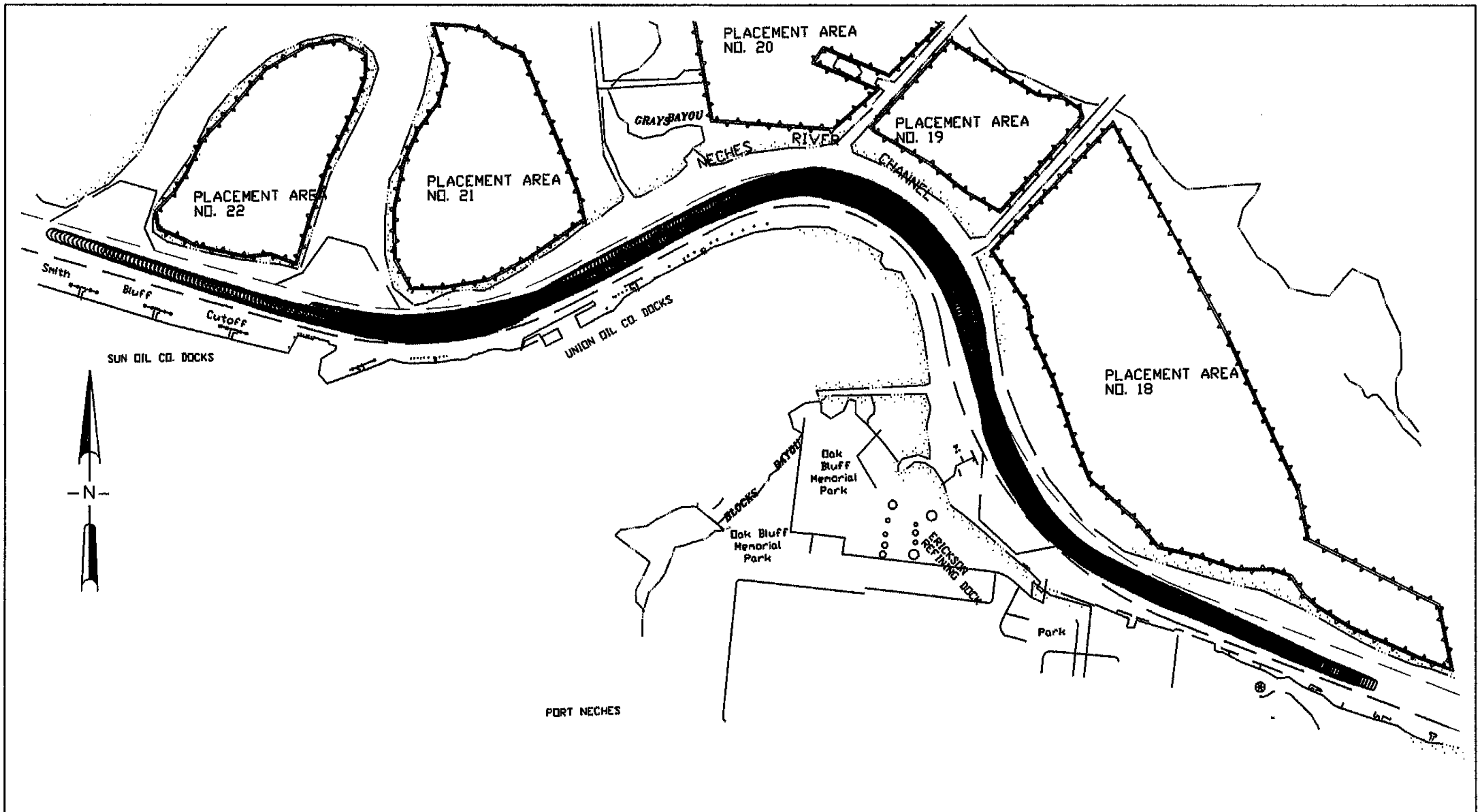


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
PROPOSED 400-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
PROPOSED 500-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 57



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MAGPECO BEND
PROPOSED 500-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND

PLATE 58

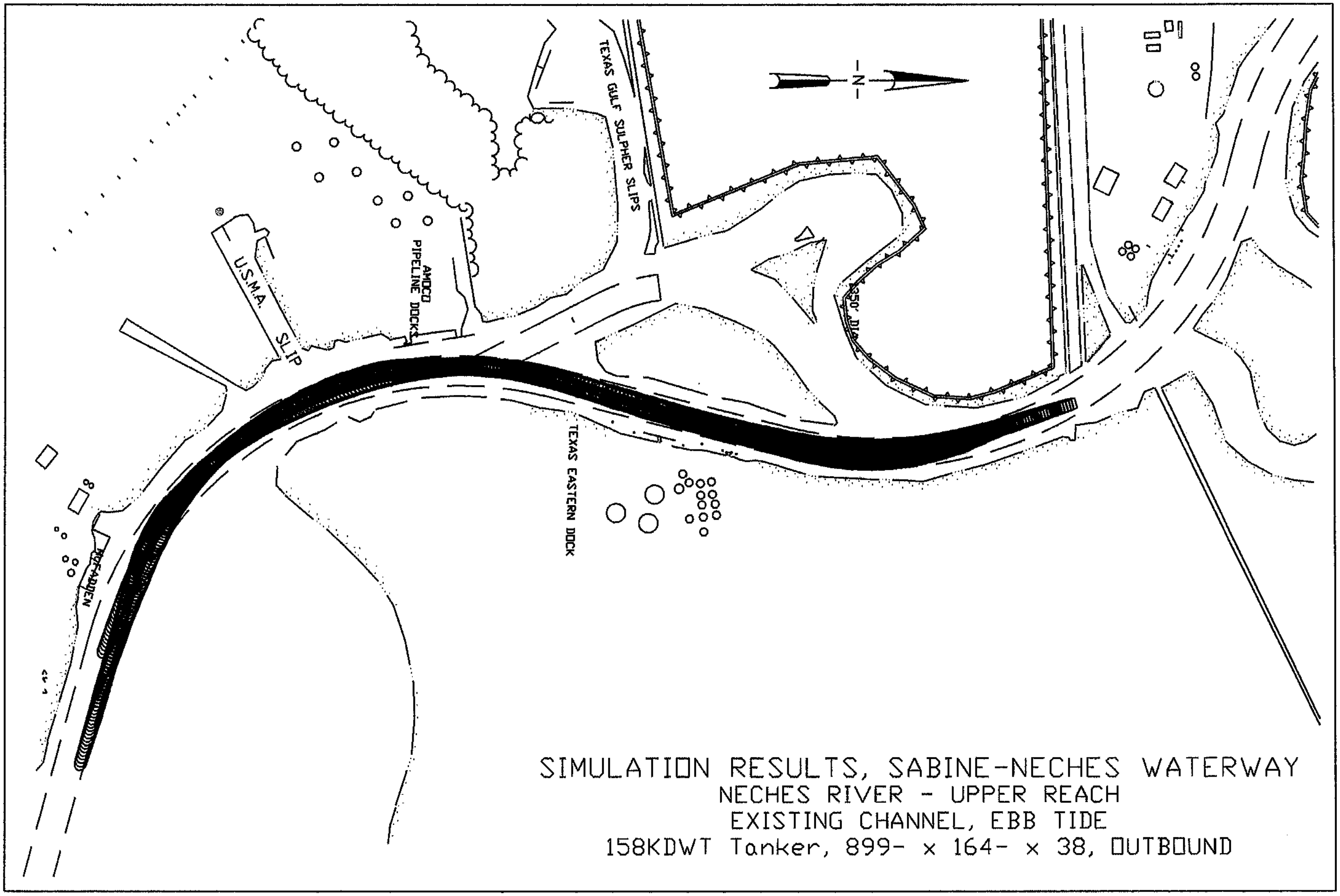
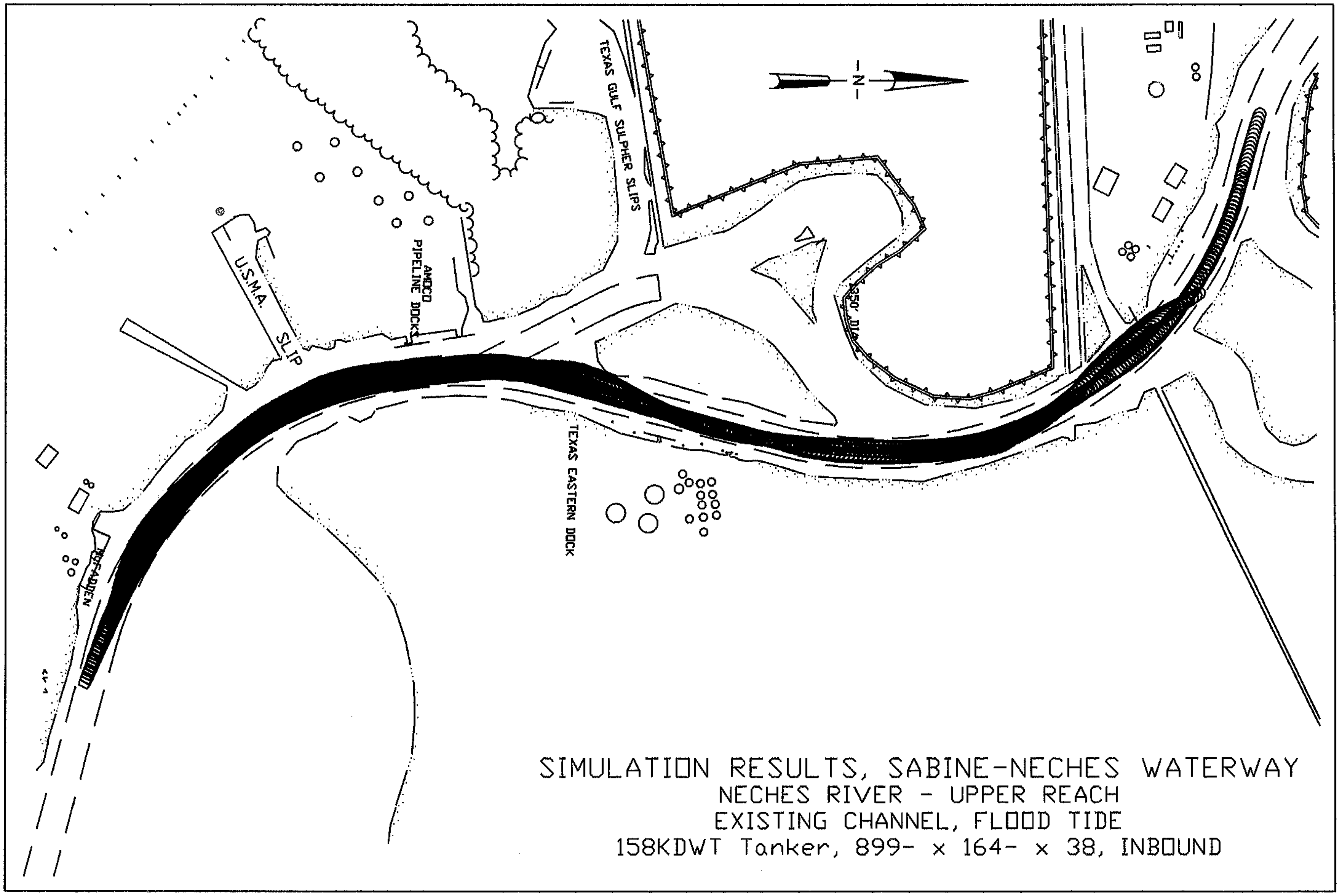
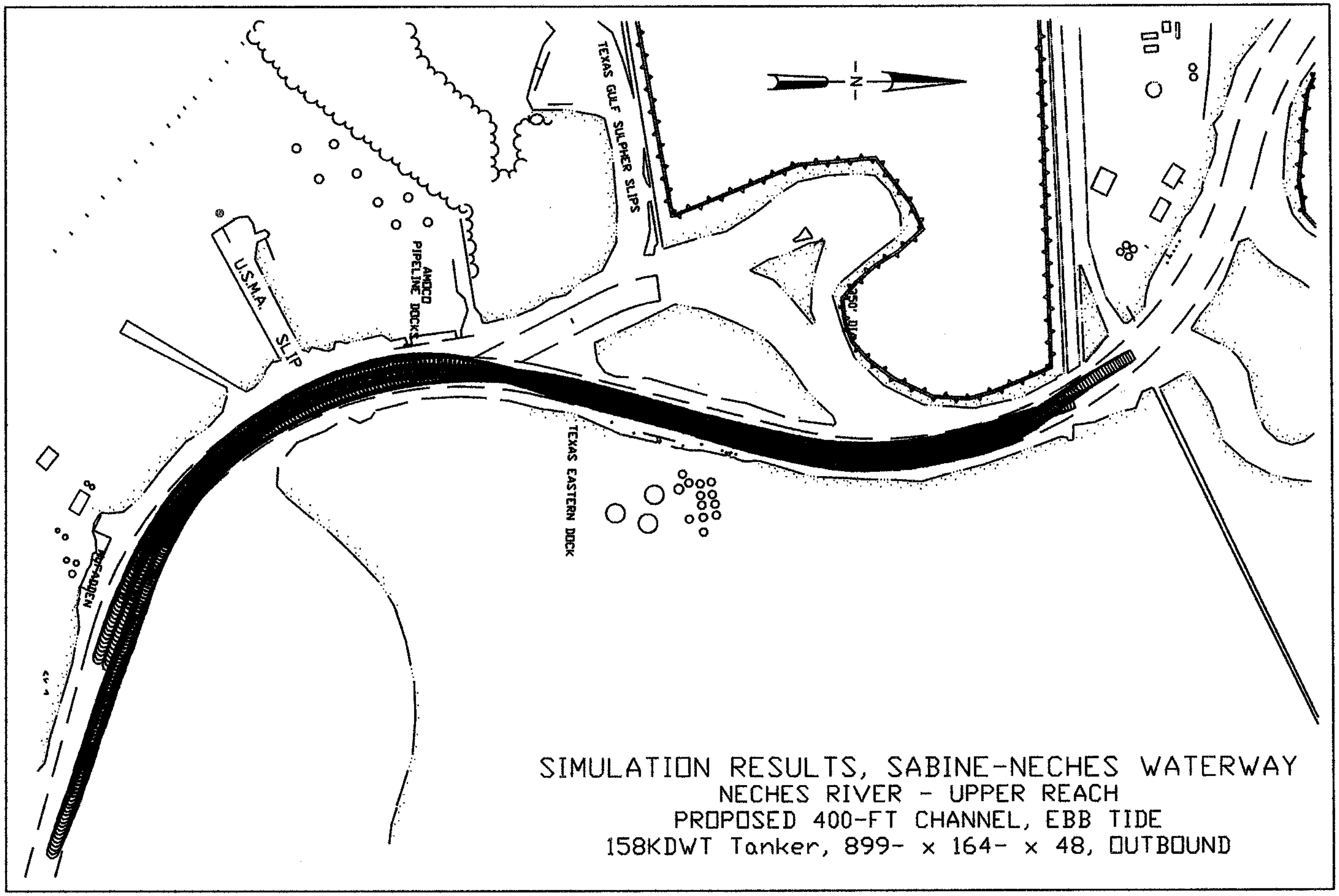

N
TEXAS GULF SULPHER SLIPS
U.S.M.A. SLIP
AMOCO PIPELINE DOCKS
TEXAS EASTERN DOCK
350' DIA
MCFADDEN
SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
EXISTING CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 38, OUTBOUND

PLATE 59

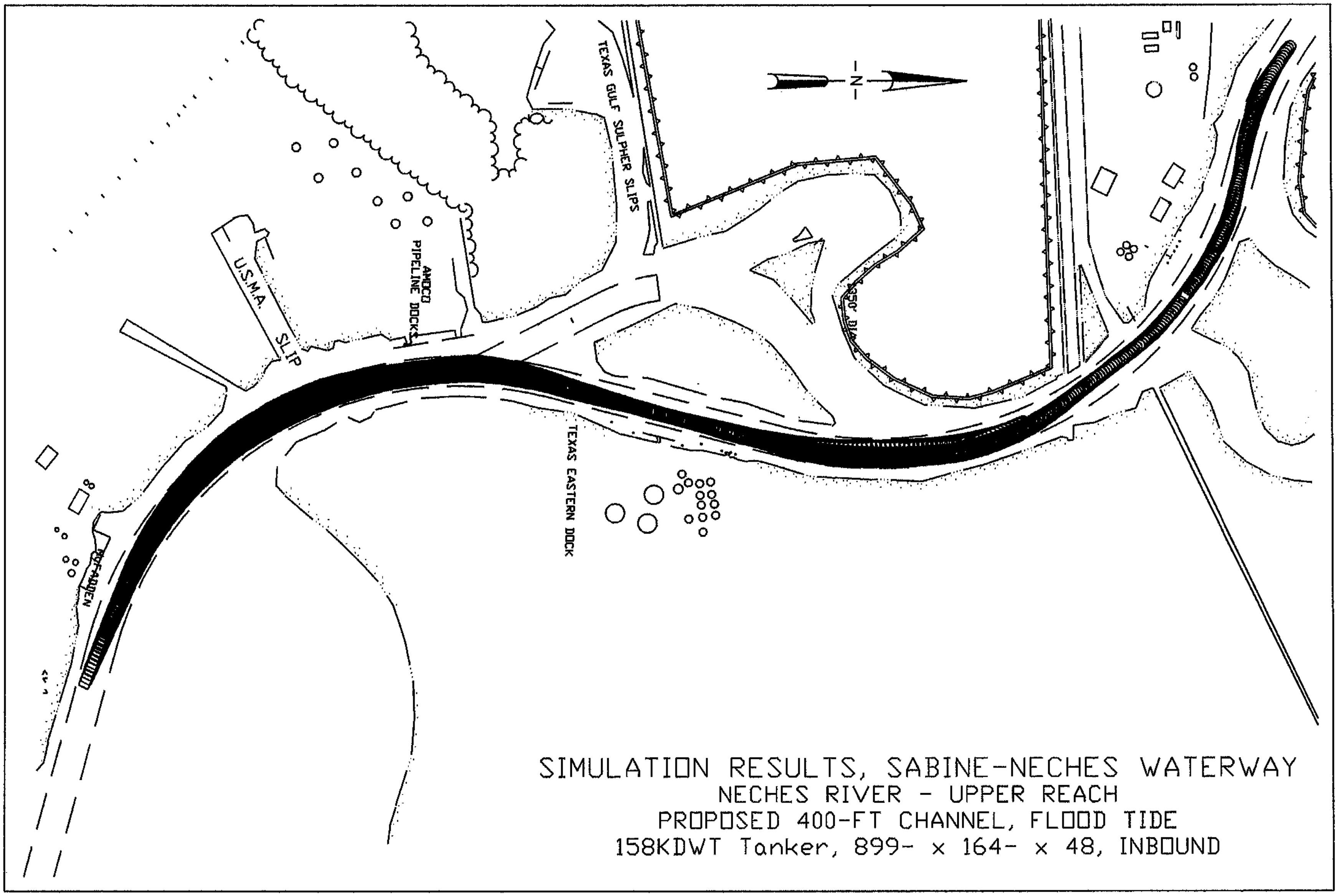


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
EXISTING CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 38, INBOUND

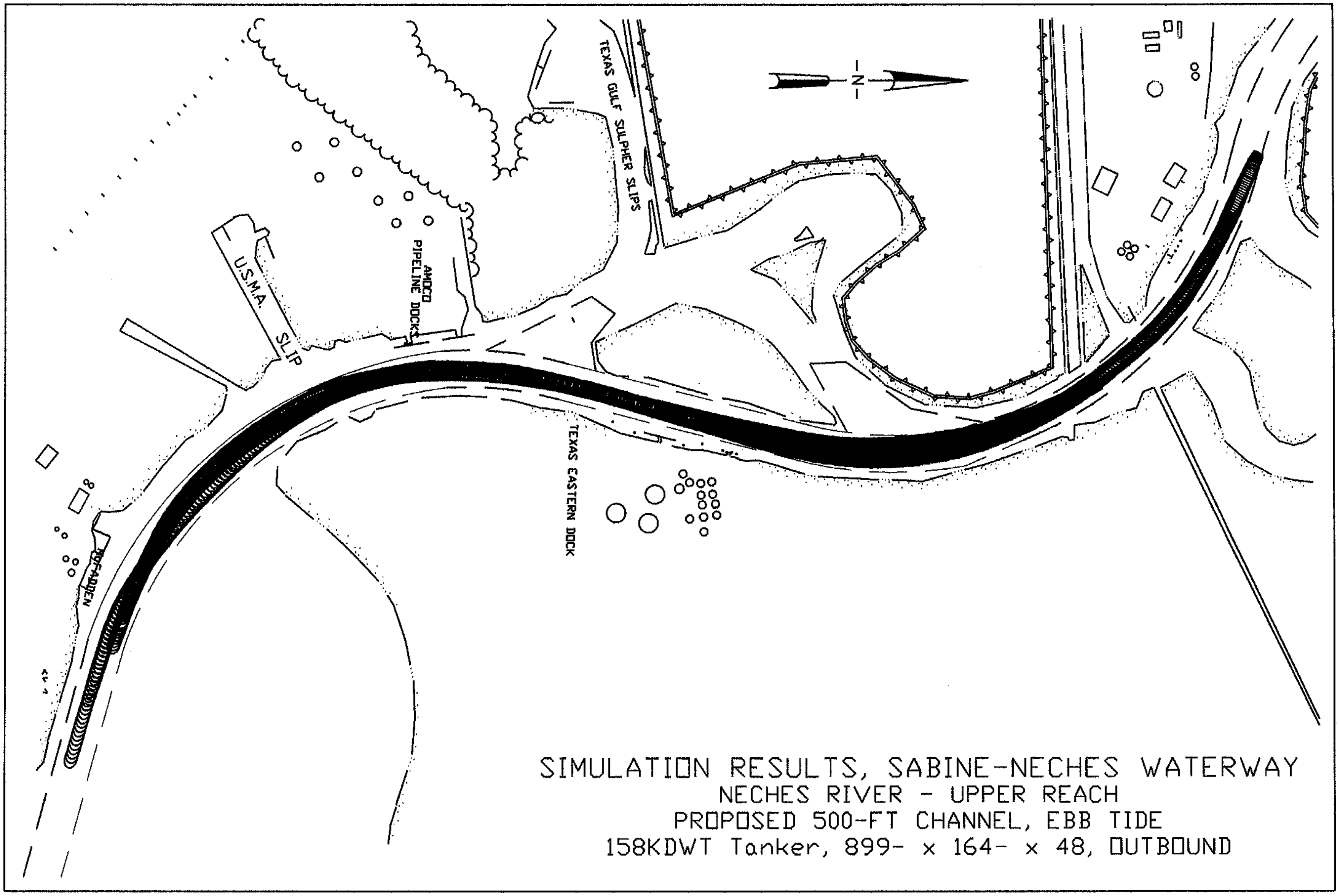


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
PROPOSED 400-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

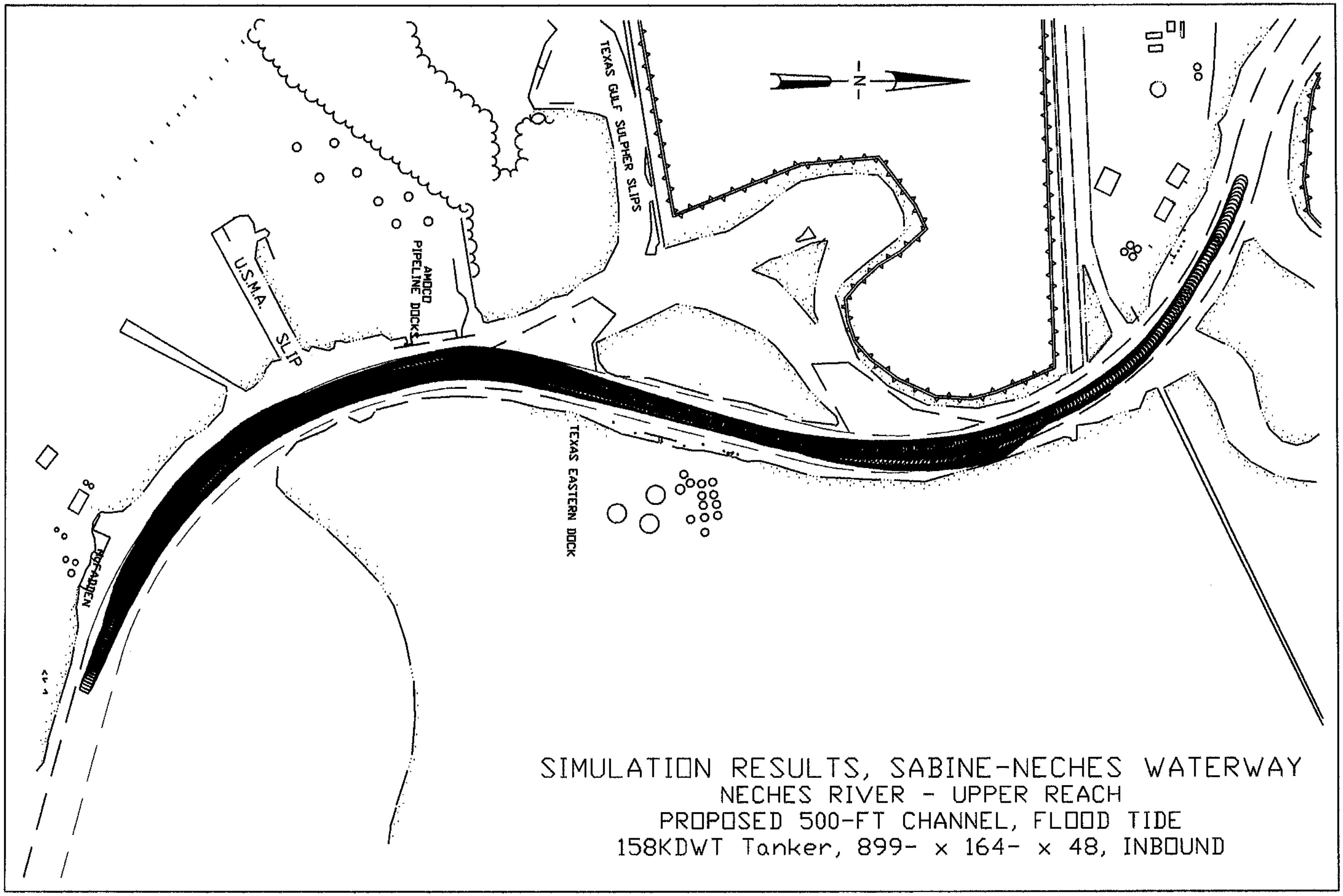
PLATE 61



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
PROPOSED 400-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND

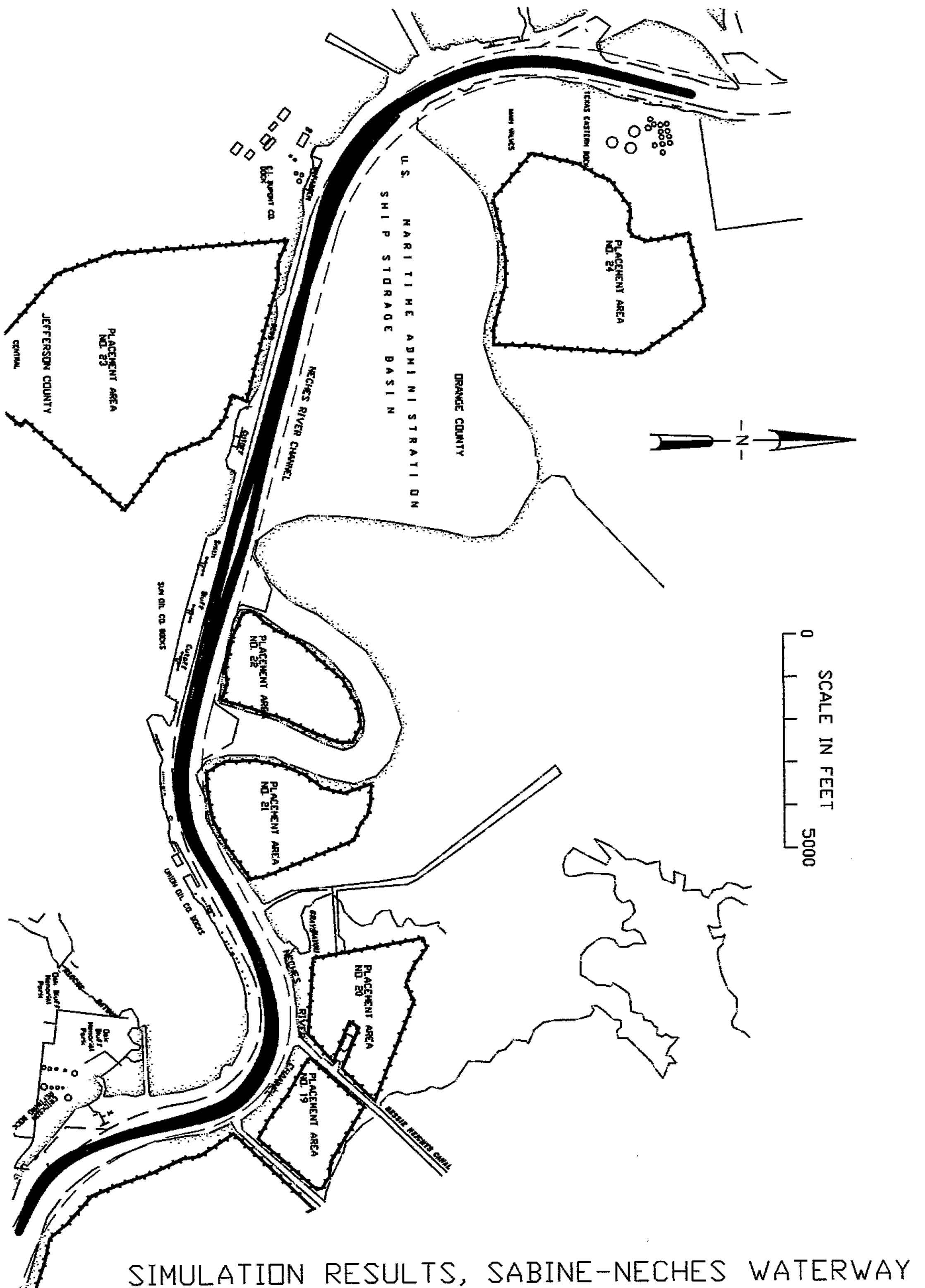


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
PROPOSED 500-FT CHANNEL, EBB TIDE
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

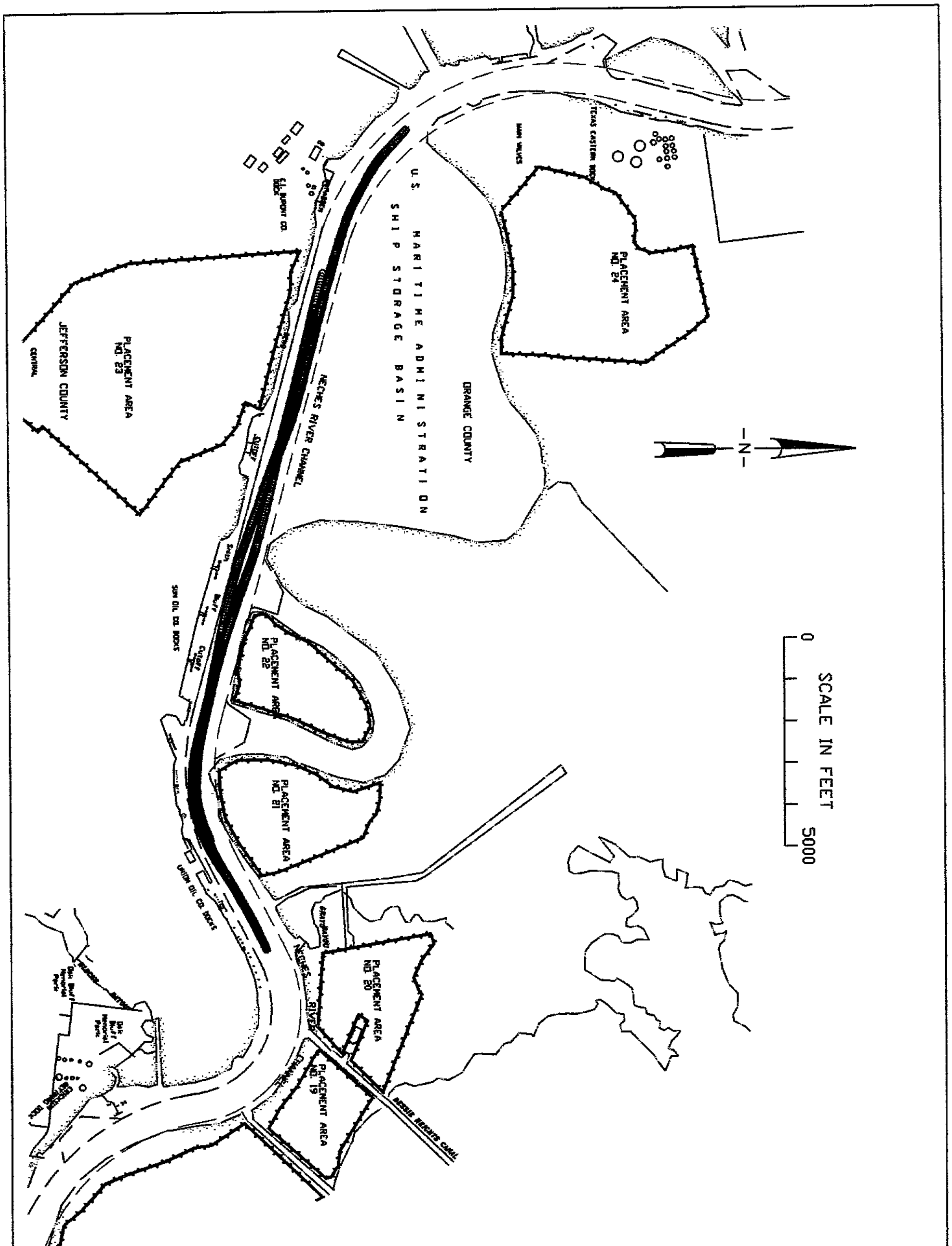


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - UPPER REACH
PROPOSED 500-FT CHANNEL, FLOOD TIDE
158KDWT Tanker, 899- x 164- x 48, INBOUND

PLATE 64

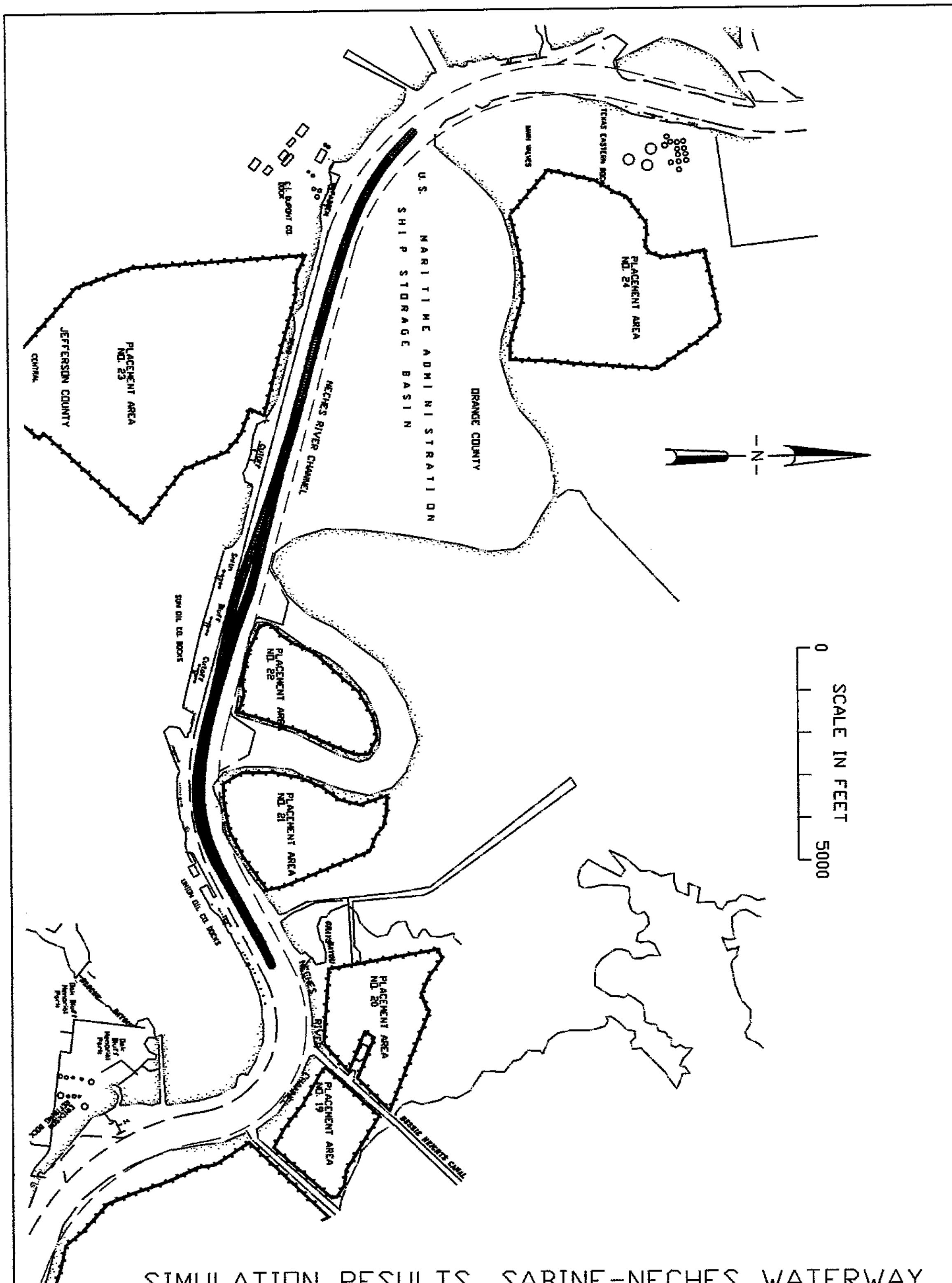


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MACFADDEN BEND REACH
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots I & E
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

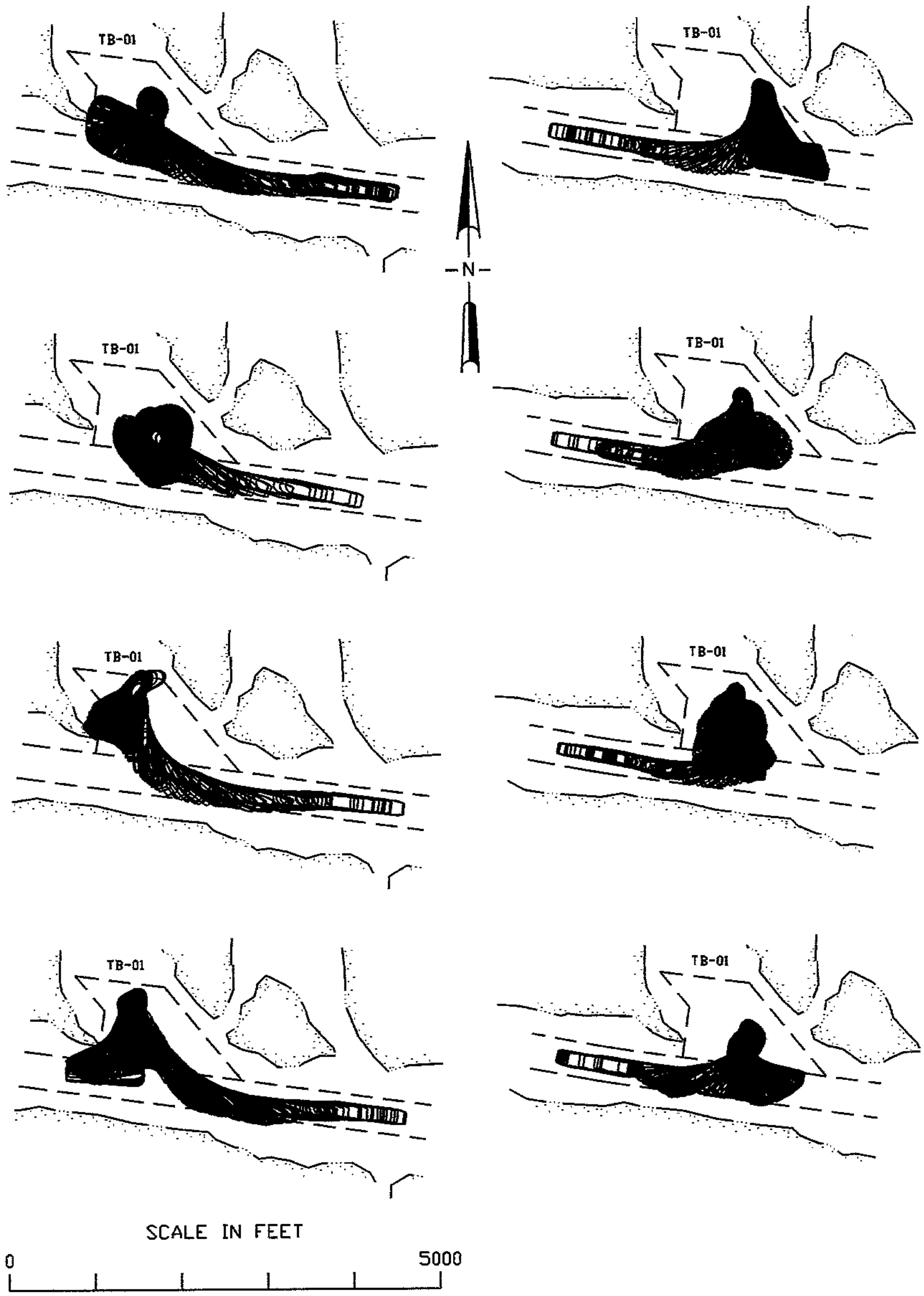


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MACFADDEN BEND REACH
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots H & C
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

PLATE 66

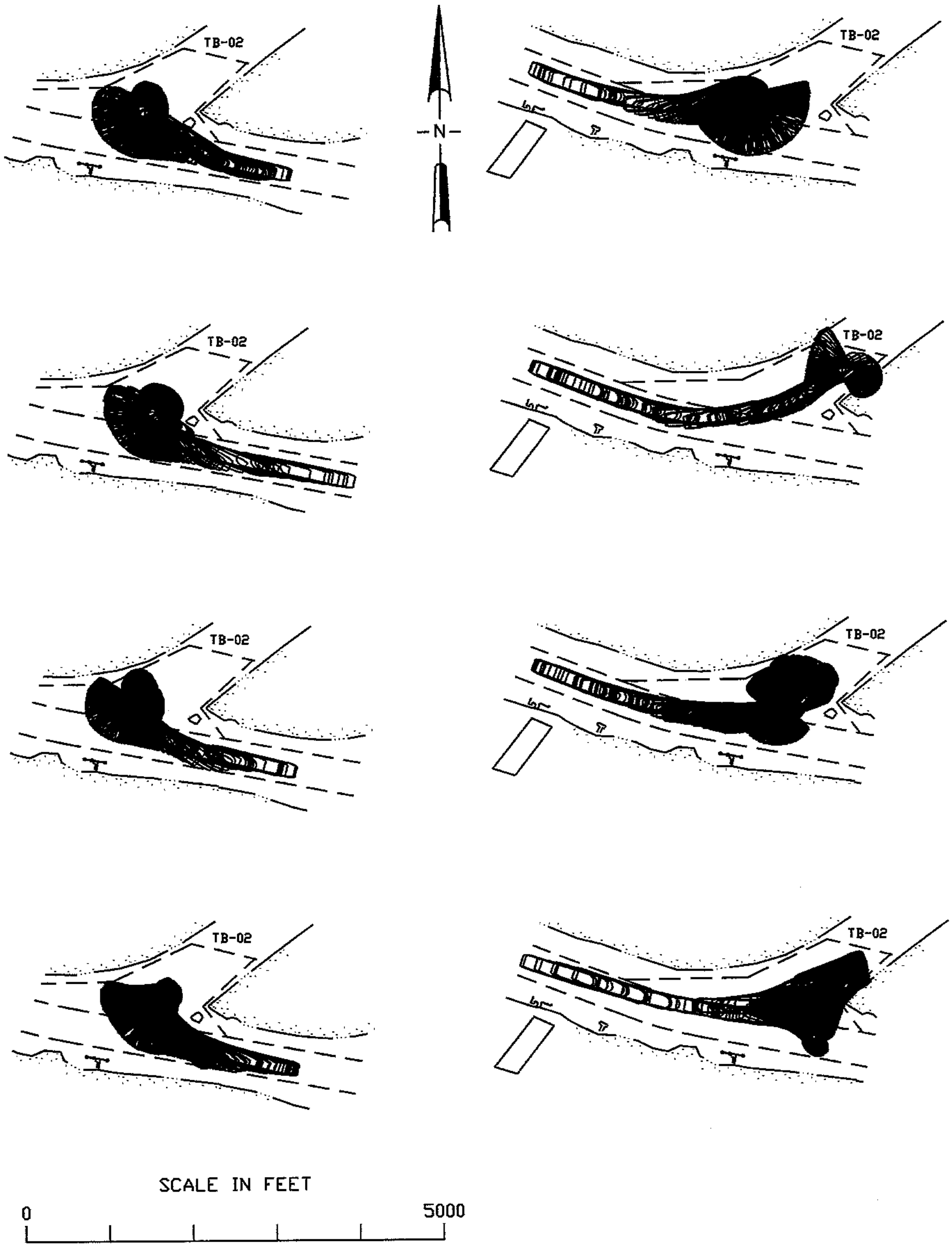


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER - MACFADDEN BEND REACH
PROPOSED 700-FT CHANNEL, EBB TIDE, Pilots C & A
158KDWT Tanker, 899- x 164- x 48, INBOUND
158KDWT Tanker, 899- x 164- x 48, OUTBOUND

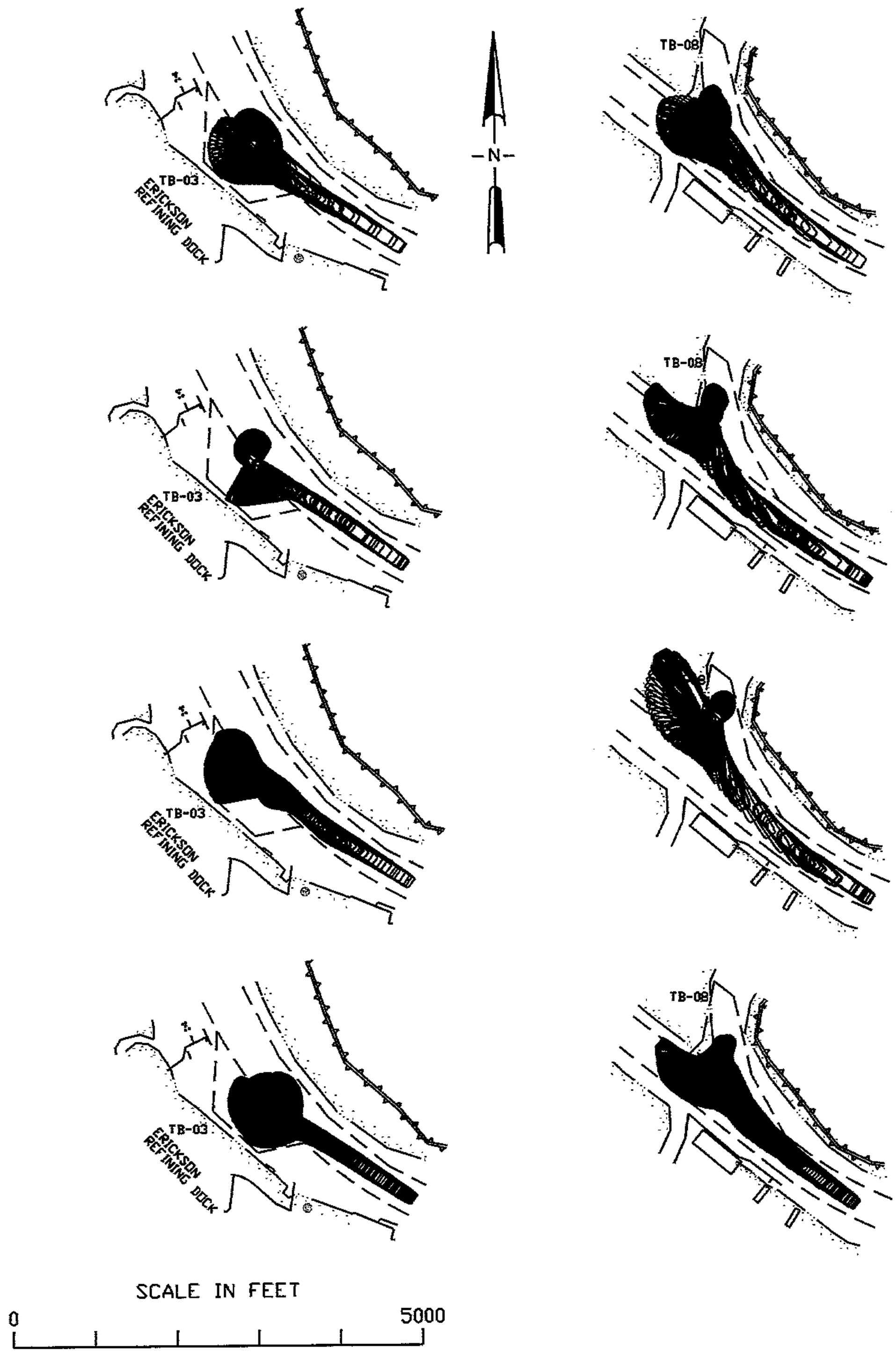


SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER
TURNING BASIN 1
158KDWT Tanker, 899- x 164- x 48

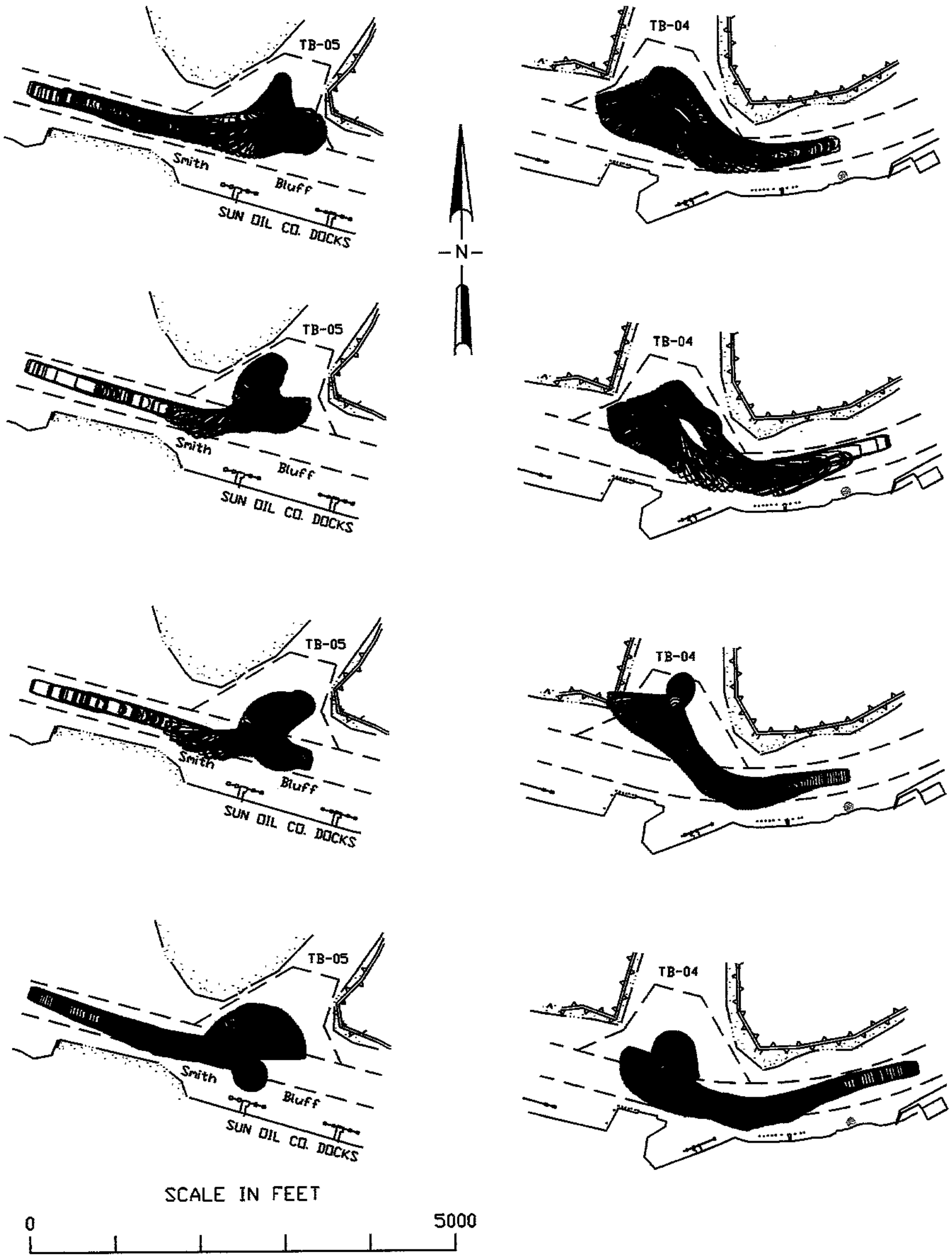
PLATE 68



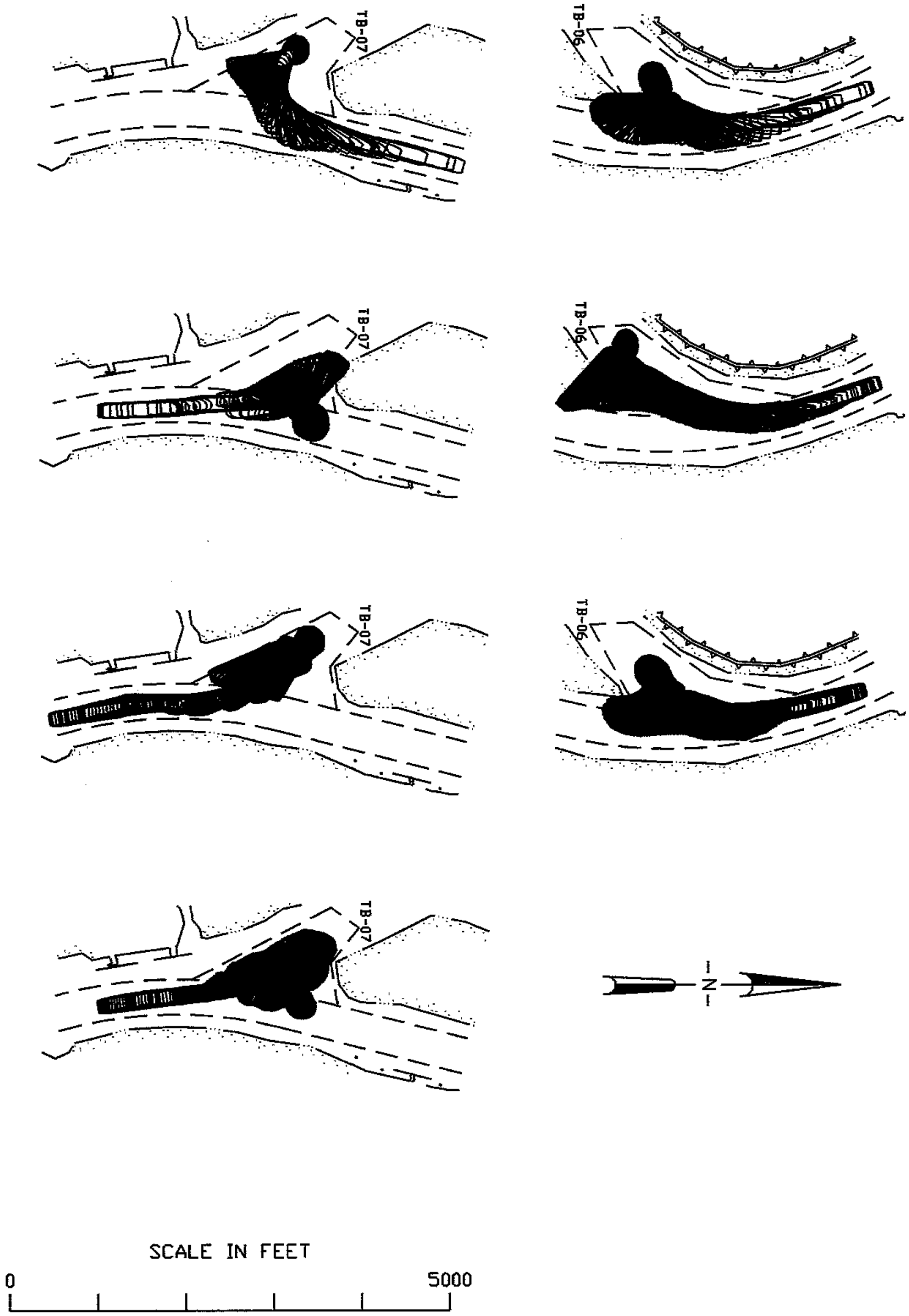
SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER
TURNING BASIN 2
158KDWT Tanker, 899- x 164- x 48



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER
TURNING BASINS 3 & 8
158KDWT Tanker, 899- x 164- x 48



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER
TURNING BASINS 4 & 5
158KDWT Tanker, 899- x 164- x 48



SIMULATION RESULTS, SABINE-NECHES WATERWAY
NECHES RIVER
TURNING BASINS 6 & 7
158KDWT Tanker, 899- x 164- x 48

Table 5 – Pilot Questionnaire Summary

Channel	Tide	Scenario	Ship/Draft	Pilot & Rep.	Travel Dir.	Realism Rating	One-way Difficulty	Two-way Difficulty	Safe Operation?	Pilot Comments
Proposed Extension - Reach E										
700ft x 52ft	-	E01	158KDWT/48ft	A1	Out	9	1	3	Yes	
				B1	In	8	2	3	Yes	
				A2	Out	10	1	1	Yes	
				B2	In	8	2	3	Yes	*(Increased ship speed in ship model - JCH)*
				A1	In	10	1	1	Yes	
				G1	Out	5	2	3	Yes	
				C1	In	8	2	2	Yes	
				A3	Out	10	1	1	Yes	
				A4	In	10	1	1	Yes	
				C1	Out	9	3	3	Yes	
700ft x 52ft	-	E02	158KDWT/48ft	B1	In	8	2	3	Yes	
			110KDWT/48ft	A1	Out	9	1	3	Yes	
Sabine Bank & Jetty Channels – Reach S										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
800ft x 42ft	Ebb	S01	158KDWT/38ft	G1	Out	2	2	3	Yes	Not as realistic as other simulations - no bank effect felt.
				A1	In	10	1	1	Yes	
				A1	Out	10	1	1	Yes	In the simulation I thought I was at 29-30 and I got too much swing to recover.
				C1	In	8	3	3	Yes	
				F1	Out	6	3	4	Yes	Similar to existing channel. No westerly set as is the norm across the jetties. Speed was slower than actual.
				G1	In	5	3	3	Yes	Would not recommend meeting inthis reach, bu could be done.
800ft x 42ft	Flood	S04	158KDWT/38ft	G1	Out	6	6	6	No	Need to meet in a straight section of channel.
				A1	In	10	1	1	Yes	It would have been better to delay so as to meet in a straight reach rather than at the turn.
				A1	Out	10	1	1	Yes	
				C1	In	8	3	3	Yes	
				F1	Out	3	6	4	Yes	Same as ebb. Channel Skewed to the east (reds) which was tough to visualize if you did not run exactly by the ECDIS.
				G1	In	5	2	2	Yes	Buoy line out of place in relation to channel.

Table 5 – Pilot Questionnaire Summary (Continued)

800ft x 52ft	Ebb	S07	158KDWT/48ft	A1	Out	10	1	1	Yes	The simulation is about perfect.
				G1	In	3	2	3	Yes	
				C1	Out	9	4	4	Yes	
				B1	In	8	3	4	Yes	
				C2	Out	9	2	4	Yes	
				A1	In	10	2	2	Yes	
				C3	**Out**	**9**	**2**	**2**	**Yes**	
				A2	**In**	**10**	**1**	**1**	**Yes**	
				C1	Out	9	4	4	Yes	
				B4	In	8	3	4	Yes	
				C4	Out	8	2	2	Yes	
				A3	In	10	1	1	Yes	
				A1	**Out**	**10**	**1**	**1**	**Yes**	
				G1	**In**	**3**	**2**	**3**	**Yes**	
				C2	Out	9	2	4	Yes	
				A1	In	10	2	2	Yes	
				C3	Out	9	2	2	Yes	
				A1	In	10	1	1	Yes	
				G1	**Out**	**4**	**2**	**2**	**Yes**	**Ship simulation too responsive as would be expected in reality for such a draft.**
				F1	**In**	**6**	**3**	**4**	**Yes**	**Close to current situation of 40' 70K meeting 40' look outside of 29-30B's. Channel closer to accurate position.**
800ft x 52ft	Flood	S10	158KDWT/48ft	**A1**	**Out**	**10**	**1**	**1**	No	**The turn in the channel is not a good place to meet.**
				G1	**In**	**3**	**2**	**3**	No	**Would not meet in a turn/bend.**
				C2	**Out**	**8**	**4**	**5**	Yes	
				A2	**In**	**10**	**1**	**1**	Yes	
				G1	**Out**	**4**	**2**	**2**	Yes	**Same as previous scenario *(S07)*.**
				F1	**In**	**6**	**3**	**3**	Yes	**Doable**

Table 5 – Pilot Questionnaire Summary (Continued)

Sabine Pass - Reach A										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
600ft x 50ft	Ebb	A02	158KDWT/48ft	A1	In	9	1	2	No	It seemed that #32 buoy was not out to the new channel width.
				C1	Out	8	5	7	No	
				A2	In	10	1	3	Yes	Along this area we reduce our speed because of docks and the slower speed allows the ship to settl down so to speak. Slow speed approx. 6 knts.
				C2	Out	8	4	5	Yes	
				A3	In	9	1	1	Yes	
				C3	Out	9	4	7	Yes	
500ft x 40ft	Ebb	A01	580x101x38	**A1**	**In**	**10**	**1**	**1**	**Yes**	
				G1	**Out**	**4**	**2**	**2**	**Yes**	
				C1	**In**	**8**	**3**	**3**	**Yes**	
				A1	**Out**	**10**	**1**	**1**	**Yes**	
				H1	**In**	**7**	**5**	**3**	**Yes**	
				C1	**Out**	**8**	**2**	**3**	**Yes**	
500ft x 40ft	Flood	A06	580x101x38	**A1**	**In**	**10**	**1**	**1**	**Yes**	
				G1	**Out**	**3**	**2**	**2**	**Yes**	
				C1	**In**	**8**	**3**	**3**	**Yes**	
				A1	**Out**	**10**	**1**	**1**	**Yes**	
				H1	**In**	**5**	**3**	**3**	**Yes**	**In reality you run ships into Sabine Anchorage to play the currents. You cannot run the ranges and not go aground.**
				C1	**Out**	**8**	**3**	**3**	**Yes**	

Table 5 – Pilot Questionnaire Summary (Continued)

700ft x 50ft	Ebb	A04	158KDWT/48ft	**A1**	**In**	**10**	**1**	**1**	**Yes**	
				G1	**Out**	**7**	**3**	**3**	**Yes**	
				C1	**In**	**8**	**3**	**4**	**Yes**	
				A1	**Out**	**10**	**1**	**1**	**Yes**	
				G1	**In**	**2**	**2**	**2**	**No**	**Speed was too high. Vessels did not respond as they would in reality.**
				F1	**Out**	**3**	**5**	**5**	**No**	**Speed required to meet in the pass channel would be unsafe for anything moored alongside from USCG Station to Pilot Station. Vessel handles too well. Hydraulics would be more powerful and less forgiving.**
				H1	**In**	**2**	**5**	**4**	**Yes**	**The anchorage area in Sabine is normally where we run loaded ships into when transiting. We never run the ranges near Dick Dowling Park.**
				C1	**Out**	**8**	**4**	**4**	**Yes**	
700ft x 50ft	Flood	A09	158KDWT/48ft	**A1**	**In**	**10**	**1**	**1**	**Yes**	
				G1	**Out**	**5**	**2**	**5**	**Yes**	
				C1	**In**	**8**	**3**	**4**	**Yes**	
				A1	**Out**	**10**	**1**	**1**	**Yes**	
				H1	**In**	**5**	**5**	**9**	**Yes**	**Safe Because there is enough room to recover. The ideal solution is to reduce speed to reduce suction and then increase speed to overcome. However, you cannot do this on a simulator. Also, you cannot run vessels too close together in order to allow recover time and room.**
				C1	**Out**	**8**	**5**	**5**	**Yes**	

Table 5 – Pilot Questionnaire Summary (Continued)

Port Arthur Ship Canal - Reach A										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
500ft x 40ft	Ebb	A11	899x164x38	A1	In	10	1	10	No	My ship was set down in the current and I was unable to see the ranges astern.
				C1	Out	9	5	8	No	Passing too close to mouth of lake.
			580x101x38	**C1**	**In**	**9**		**2**	**Yes**	
				H1	**Out**	**7**	**3**	**4**	**Yes**	**I slowed down to meet in an area other than the lake, where current would not compound the situation.**
			899x164x38	A2	In	10	1	10	No	The current and slow speed made an unsafe situation.
				C2	Out	9	7	8	No	
			580x101x38	**A3**	**In**	**10**	**1**	**1**	**Yes**	
				C3	**Out**	**8**	**3**	**3**	**Yes**	
			580x101x39	**F1**	**In**	**6**	**2**	**4**	**Yes**	**Existing Conditions. Ship handles too well for a loaded condition.**
				G1	**Out**	**4**	**2**	**2**	**Yes**	**Existing meeting scenario but would not take place in same area.**
500ft x 40ft	Flood	A16	580x101x38	**C1**	**In**	**9**		**3**	**Yes**	
				H1	**Out**	**5**	**3**	**3**	**Yes**	
				F1	**In**	**5**	**4**	**6**	**Yes**	**Status quo for our channel. Flood did not set us into the lake as would occur in reality. Channel runs too close to Mesquite Point Shrimp Boat Docks.**
				G1	**Out**	**2**	**2**	**2**	**Yes**	**Existing conditions and scenario is feasible. Flood tide not very strong.**
				H1	**In**	**6**	**6**	**4**	**Yes**	
				C1	**Out**	**8**	**4**	**3**	**Yes**	
600ft x 50ft	Ebb	A12	158KDWT/48ft	A1	In	10	1	9	No	In a real situation we would not meet that close to mouth of the lake and we would have full speed on the engine.
				C1	Out	8	5	7	No	Meeting and passing too close to Sabine Lake.
				A2	In	10	1	10	No	The mouth of the lake is not a good area for meeting and passing.
				C2	Out	9	5	8	No	
600ft x 50ft	Ebb	A13	158KDWT/48ft	A1	In	10	1	1	Yes	
			110KDWT/48ft	C1	Out	8	3	4	Yes	

Table 5 – Pilot Questionnaire Summary (Continued)

600ft x 50ft	Flood	A18	158KDWT/48ft	A1	In	10	1	1	Yes	
			110KDWT/48ft	C1	Out	9	4	4	Yes	
700ft x 50ft	Ebb	A14	158KDWT/48ft	G1	In	4	3	4	Yes	
				A1	Out	10	1	5	Yes	In normal meeting, this is not a chosen spot.
				F1	In	3	8	9	No	Both loaded, this would not work, especially meeting at Mesquite Pt. alongside the shrimp docks. Ebb tide not realistic in that it would hold the ship down (I.e. south) of the causeway more than it did here.
				G1	Out	2	2	2	No	Bank effects not realistic/meeting area not safe.
				H1	In	6	8	8	Yes	Difficulty meeting can be handled by increased width in order to recover. But you need good speed to handle this draft effectively.
				C1	Out	8	6	6	Yes	Would try to pass farther up from Sabine Lake.
700ft x 50ft	Flood	A19	158KDWT/48ft	G1	In	5	3	4	Yes	
				A1	Out	10	1	7	No	The current (flood) presented a problem.
				G2	In	6	3	4	Yes	Better place to meet than previous scenario [First A19].
				A2	Out	10	5	2	Yes	While running alone before the meeting, I was using a lot of right rudder.
				F1	In	3	5	7	No	Same as with ebb. Combined draft would preclude this scenario.
				G1	Out	2	2	2	No	Same as previous scenario-tide direction makes no difference. Bank effects not realistic.
				H1	In	6	5	7	Yes	
				C1	Out	8	7	7	No	Passing too close to lake.
Texaco Island Reach - Reach B										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
400ft x 40ft	Ebb	B02	158KDWT/38ft	E1	Out	9	3		Yes	Routine passage in this waterway.
				C1	Out	8	7		Yes	
				C2	Out	8	3		Yes	
				I1	Out	8	3		Yes	This was what is done on a regular basis, visual and chart were the best of any which I have done this far.

Table 5 – Pilot Questionnaire Summary (Continued)

400ft x 40ft	Flood	B03	158KDWT/38ft	**E1**	**In**	**9**	**3**		**Yes**	**Regular situation in the waterway overtaking of large tows with this size vessel should be avoided.**
				H1	**In**	**8**	**4**		**Yes**	**At day only, the vessel is too large to safely navigate the existing channel at night.**
				C1	**In**	**9**	**4**		**Yes**	
				I1	**In**	**8**	**4**		**Yes**	**Normal Operation**
400ft x 50ft	Ebb	B05	158KDWT/38ft	A1	In	9	1		Yes	The portion of the channel that I was piloting, I would be on slow speed, bringing the speed up to half occasionally.
				D1	In	9	5		Yes	Very much like a normal run with 40' on 158 Kton. Range lights looking up under the bridge are offset too much to the left on 040 deg T on centerline.
400ft x 50ft	Ebb	B06	158KDWT/48ft	**E1**	**Out**	**9**	**6**		**No**	**The 50'x400' channel made every movement of the rudder and engine very critical and thus makes the vessel on the brink of going out of control almost constantly.**
				C1	Out	8	5		Yes	*(Slow Speed about 4-5 knts. Rudder not operating properly toward end of run. JCH)*
				C2	Out	9	4		Yes	
				C3	**Out**	**9**	**5**		**Yes**	
				C4	**Out**	**8**	**4**		**Yes**	
				I1	**Out**	**7**	**9**		**No**	**Not impossible but very difficult. Large amounts of rudder needed to control the vessel If slightly off the center line hard to reposition the vessel as needed. With the chart position and visual bank nearly the same better than runs at NRI.**
400ft x 50ft	Flood	B07	158KDWT/48ft	A1	In	9	1		Yes	The current (flood) did present a problem at the slow speed but an increase in speed would have helped.
				D1	In	8	5		Yes	One way only, daylight!
				E1	**In**	**9**	**6**		**No**	**You cannot control the vessel properly to meet or overtake tows in the 400' wide 50' deep channel. You must also go very slow to make it work reasonably well!**
				H1	**In**	**6**	**7**		**Yes**	**During daylight in existing channel.**
				I1	**In**	**7**	**9**		**No**	**Large amounts of rudder needed to maintain control of the vessel. Slight distance off the center line of the channel has a dramatic effect.**

Table 5 – Pilot Questionnaire Summary (Continued)

400ft x 50ft	Flood	B08	158KDWT/38ft	C1	Out	9	7		Yes	
				C2	Out	9	2		Yes	
500ft x 50ft	Ebb	B09	158KDWT/48ft	D1	In	7	8		Yes	This is the first simulator I've been on. Impressed with realism. With channel wider the ranges are more offset and should be brighter & clearer. The difficulty was impressive, I've had 150KDWT ship that handled equally.
500ft x 50ft	Ebb	B10	158KDWT/48ft	C1	Out	9	4		Yes	
				C2	**Out**	**9**	**5**		**Yes**	
				I1	**Out**	**8**	**4**		**Yes**	**With the 500-ft channel steering of the vessel was what would be expected. Postion changes could be made with relative ease. And if off the center line only small rudder angle needed to maintain course. From Beacon 50 down around Texas Is intersection it is possible to cut the point but hopefully we could utilize what we have here now. This was better than the 38ft in 400 ft channel.**
				H1	**Out**	**6**	**4**		**Yes**	**Due to draft, I reduced speed while meeting to reduce suction.**
500ft x 50ft	Flood	B11	158KDWT/48ft	D1	In	7	5		Yes	Only in daylight @ this time.
				H1	**In**	**5**	**4**		**Yes**	**Daylight with passing any traffic.**
				I1	**In**	**7**	**4**		**Yes**	**Rudder angles were what should be expected. The position of the vessel can be corrected with minimum effort.**
				C1	**In**	**8**	**4**		**Yes**	
500ft x 50ft	Flood	B12	158KDWT/48ft	C1	Out	9	3		Yes	

Table 5 – Pilot Questionnaire Summary (Continued)

Sabine-Neches Canal - Reach C										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
600ft x 50ft	Ebb	C03	158KDWT/48ft	E1	In	8	5	7	No	Still the beam combination exceeds 1/2 the channel, but with the 600 ft there is more water between the ships and between the ship's side and the banks. Still the difficulties for meeting and passing had to improve substantially to make it a safe passage.
				F1	Out	8	2	6	Yes	Doable, but not as a common practice. This seems to be right at the limit of actually being able to carry out the scenario. The existing combined beam not to exceed 1/2 the width of the channel rule should hold.
700ft x 50ft	Ebb	C07	158KDWT/48ft	E1	In	8	5	6	No	But getting better, either I'm getting better or the simulator is getting more familiar. However, it would take a lot of practice to get real comfortable doing it in the real world.
				F1	Out	7	3	5	Yes	Timing would have to put the meeting in a reach, not a bend. The extra channel width greatly improves the viability of this scenario.
				E2	In	8	3	5	-	When you have more definition as to where the side of the channel is your're able to miss the large ship. However, the recovery time from the maneuver makes avvoiding a following vessel problematical.
				F2	Out	8	3	5	Yes	Timing and speed are critical to make this maneuver work. Still somewhat pressing the limits of combined draft. Safer to have one vessel in ballast, I.e., lighter draft.
				H1	**In**	**3**	**6**	**4**	**Yes**	**The extra 100' makes a difference but the 2 meeting vessels should have had more stern suction.**
				C1	**Out**	**7**	**3**	**4**	**Yes**	
				C1	**In**	**9**	**3**	**4**	**Yes**	
				B1	**Out**	**6**	**3**	**5**	**Yes**	**Feel rudder acts too effectively.**

Table 5 – Pilot Questionnaire Summary (Continued)

700ft x 50ft	Ebb	C07	158KDWT/48ft	F1	In	8	2	6	Yes	Only if the meeting can be timed in the straight reach. Meeting off of the Pump Station (even though the turn here is only 10deg) with this size vessel is not desirable. A long (3+ miles maybe) straight reach would make this scenaric work. Also, this would probably not happen in real life, i.e., one ship would most likely be in ballast meeting the loaded ship. Bank effect was not very realistic during the meeting and the interaction between ships was not as pronounced as it would be in reality.
				A1	Out	10	1	1	No	The meeting of the two ships on the turn is not realistic.
700ft x 50ft	Flood	C08	158KDWT/48ft	H1	In	8	8	6	No	Safe passing with tows should be at most 4kts, better at daylight with meeting traffic.
				C1	Out	9	4	8	Yes	Only in daytime.
				C1	In	9	3	4	Yes	
				B1	Out	8	5	8	No	
				A1	In	10	1	1	No	I do not know after passing the tow in what position my ship would be.
				F1	Out	7	6	9	No	This time the ships interacted properly and the outbound vessel missed the inbounder yet failed to recover after the meeting. Two steps t passing ships successfully 1) miss the other ship, 2) recover and stay in the channel without hitting any traffic following the ship. This stretch of the waterway with the subtle "wiggles" does not lend itself to a passing area. Simulation was more realistic this time in regards to bank/hydraulic effects.
400ft x 50ft	Ebb	C15	110KDWT/48ft	E1	In	6	4	9	No	
				F1	Out	6	3	10	No	Beam constraint makes this scenario unrealistic an impossible.
				E2	In	7	3	9	No	Two very deep wide body ships meeting in the 400f channel in the real world, they can't build a rudder big enough, fast enough and an engine as quick responding and powerful enough to overcome the forces involved.
				F2	Out	3	8	10	No	Bank effects due to draft/beam make this meeting situation unpredictable, therefore, unsafe.

Table 5 – Pilot Questionnaire Summary (Continued)

400ft x 40ft	Ebb	C16	158KDWT/38ft	C1	Out	9	4		Yes	
				C2	Out	9	3		Yes	
				A1	Out	10	1	1	Yes	
400ft x 40ft	Flood	C17	158KDWT/38ft	H1	In	8	5		Yes	**Speed down less than 4kts for safety in overtaking.**
				B1	In	7	4	4	Yes	
				F1	In	9	5	6	Yes	**This condtions is currently encountered with 150K DWT ships inbounding part loaded (about 33ft to 37ft). Overtakig of doubled up tows to be avoided with these ships. Bank effect somewhat inaccurate, I.e. opposite of what you would expect in certain instances.**
400ft x 50ft	Ebb	C18	158KDWT/48ft	E1	Out	8	3		Yes	**One way in 400 ft with large vessels daylight only will work. With deeper draught the amount of displaced water will generate more suction on the banks.**
				C1	Out	8	4		Yes	
				F1	Out	9	4	4	Yes	**Felt very real and close to running the lightering ships (85K-150KDWT) in existing channel with 40ft draft. Plenty of rudder needed (as would be expected) yet controllable. Simulation was the best yet. Bank effect was predictable.**
400ft x 50ft	Flood	C19	158KDWT/48ft	H1	In	9	6		Yes	**Speed no more than 4kts with 48' draft successful in overtaking safely. Requires more rudder with deeper draft in existing channel, 100' wider makes a great difference.**
				B1	In	7	4	4	Yes	
				A1	In	10	1	1	Yes	
500ft x 50ft	Ebb	C20	158KDWT/48ft	E1	Out	9	3		Yes	**The 500 ft channel is markedly superior to the 400 ft. There could be a need for additional aids to navigation.**
				B1	Out	7	4	4	Yes	
				F1	Out	9	2	3	Yes	**Extra width 400ft-500ft added more maneuvering room and decreased the hydraulics.**
500ft x 50ft	Flood	C21	158KDWT/48ft	E1	In	9	2		Yes	**With the 500ft the operating is considerably safer so long as the 1/2 beam width and daylight for large vessels is maintained.**
				C1	In	8	4	5	Yes	
				A1	In	10	1	1	Yes	

Table 5 – Pilot Questionnaire Summary (Continued)

Humble Island Turn, Rainbow Bridge - Reach D										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
400ft x 40ft	Flood	D01	158KDWT/38ft	G1	In	7	7		Yes	
400ft x 40ft	Ebb	D02	158KDWT/38ft	**A1**	**In**	**10**	**1**		**Yes**	
				I1	**In**	**5**	**3**		**Yes**	**This is a normal transit for us - Some difference between visual and charted positions.**
				C1	**In**	**8**	**5**		**Yes**	
400ft x 40ft	Flood	D03	158KDWT/38ft	**E1**	**Out**	**9**	**4**		**Yes**	**Routine operation on Sabine Neches waterway in daylight.**
				G1	Out	7	5		Yes	
				I1	**Out**	**5**	**4**		**Yes**	**This is very much like what is done on a regular basis - Again there is some difference between visual and the charted channel.**
				C1	**Out**	**8**	**4**		**Yes**	
400ft x 50ft	Flood	D05	158KDWT/48ft	E1	In	8	3		Yes	This can be safe so long as the speed and swing can be kept with the ship's capability, the 400ft channel doesn't allow for a lot of recover ability.
				E2	In	8	3		Yes	So long as rudder and engine power can be maintained at sufficient capacity to overcome the forces.
400ft x 50ft	Ebb	D06	158KDWT/48ft	**A1**	**In**	**10**	**1**		**Yes**	**I did allow the ship to get too deep in the [bend] and the ship grounded.**
				A2	**In**	**10**	**1**		**Yes**	
				F1	In	7	6		Yes	Limited speed is the key, may require tug escort. Fairly accurate with bank effect and channel shape
				I1	**In**	**5**	**8**		**No**	**Nearly an impossible task at this draft. Not able to make this vessel steady on a course without holding constant rudder one direction or the other. Again visual and chart not the same. On visual the approach to the bridge showed vesse well to the left but chart location was to the righ of center.**
				C1	**In**	**8**	**5**		**Yes**	

Table 5 – Pilot Questionnaire Summary (Continued)

400ft x 50ft	Flood	D07	158KDWT/48ft	E1	Out	3	7			Can't make a good observation on this run as there seemed to be a reverse on the expected commands.
				E2	**Out**	**8**	**8**		No	**50ft, 400ft wide channel, the vessel cannot be continually kept under control. It seems, to go to 50 ft you need 500ft min. yo maintain one wa control. Meeting situations with smaller vessel would have to be coordinated.**
				I1	**Out**	**6**	**9**		No	**Almost impossible to control the vessel. Lots o rudder needed. Just a small distance off center line causes severe effect.**
				C1	**Out**	**8**	**4**		**Yes**	
400ft x 50ft	Ebb	D08	158KDWT/48ft	F1	Out	6	8		Yes	Speed was realistic as was bank effect. Ranges below bridge were off, putting the channel centerline towards the Fina docks.
				F2	Out	6	5		Yes	Speed would be compromised, keeping half or full bell until you need it to check the swing or start a turn. Lateral position below the bridge seemed off. I thought I was in the middle but the monitor showed me on the left bank.
500ft x 50ft	Flood	D09	158KDWT/48ft	E1	In	8	3		Yes	If I remember to get a little closer to center of bridge span after rounding the turn and aiming under the Rainbow Bridge
500ft x 50ft	Ebb	D10	158KDWT/48ft	E1	In	8	3		Yes	All things being equal a safe situation. However the only thing that can cripple you would be a slow rudder.
500ft x 50ft	Flood	D11	158KDWT/48ft	F1	Out	8	4		Yes	Tried more speed which seemed to work ok and di not compromise steerage. Bank effect appears reversed after marker 65 below Neches River intersection.
500ft x 50ft	Ebb	D12	158KDWT/48ft	F1	Out	8	2		Yes	500ft is much easier to control the rate of swing wit less rudder. This is more realistic since you don't have to run 4.5 kts and be exactly in the right spot through the whole bend. Stll having trouble judging lateral position below the bridge. Could be placement of forward outbound range below the bridge. This aid is also used as a passing beacon.

Table 5 – Pilot Questionnaire Summary (Continued)

Neches River - Reach N										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
600ft x 50ft	Ebb	N02	158KDWT/48ft	A1	In	9	1	7	No	I was coming out the bend and was not lined up with the range.
				C1	Out	9	3	5	No	Meeting too close to the bend, one ship too slow.
				A2	In	9	1	1	Yes	In real situation the use of more speed would be available. [meeting place moved]
				C2	Out	8	3	5	Yes	
600ft x 50ft	Ebb	N03	158KDWT/48ft	A1	In	9	1	1	No	With the ships at the docks, it would not be a good meeting spot.
			110KDWT/48ft	C1	Out	8	4	5	Yes	
700ft x 50ft	Ebb	N04	158KDWT/48ft	**I2**	**In**	**5**	**2**	**3**	**No**	**For vessels of this size the coordination to effect a meeting in this short of a distance would be difficult. Also this number of docks in the area usually with ships alongside should be considered. Meeting area should be a minimum of 3 miles in length.**
				E2	**Out**	**8**	**3**	**4**	**Yes**	**With the seven hundred feet and daylight; however, proximity to Sun Oil docks and distance from Sun Oil to [?] makes meeting in this area while possible it would be very impractical.**
				H1	**In**	**6**	**4**	**6**	**Yes**	**Prefer daylight exp with additional traffic to meet or pass.**
				C1	**Out**	**8**	**4**	**4**	**Yes**	
				C1	**In**	**8**	**3**	**3**	**Yes**	
				A1	**Out**	**10**	**1**	**1**	**Yes**	**The ship ws on full speed. I would be on slower speeds.**
400ft x 40ft	Ebb	N06	158KDWT/38ft	**I1**	**Out**	**4**	**5**		**Yes**	**Existing channel we actually make this maneuver on a regular basis.**
				H1	**Out**	**2**	**6**	**5**	**Yes**	**We run this scenario now - but no meeting. The existing channel shoud be deeper in the bend, the bank suction is accurate.**
				C1	**Out**	**8**	**7**		**Yes**	**Too much speed, ship sliding in turns.**
				B1	**Out**	**7**	**4**			

Table 5 – Pilot Questionnaire Summary (Continued)

400ft x 40ft	Flood	N07	158KDWT/38ft	**E1**	**In**	**8**	**3**		Yes	**38' - 158 tons in existing channel is done regularly in daylight.**
				C1	**In**	**8**	**4**		Yes	
				I1	**In**	**7**	**6**		Yes	**About like normal operation. The visual and charted position around the bend seemed to be a little out of perspective but vessel handled as expected.**
				B1	**In**	**7**	**5**		Yes	
400ft x 50ft	Ebb	N08	158KDWT/48ft	**I1**	**Out**	**6**	**5**		Yes	**This scenario feels like a loaded 40' 80,000 ton grain ship.**
				C1	**Out**	**9**	**3**		Yes	
				H1	**Out**	**7**	**7**		Yes	**7 kts speed too fast - 4 to 5 kts with two tugs**
				B1	**Out**	**7**	**4**		Yes	
400ft x 50ft	Flood	N09	158KDWT/48ft	**E1**	**In**	**8**	**2**		Yes	**It felt like the vessel was actually easier to control, probably because the 50'deep, 400 wide channel quickly equalizes both sides.**
				H1	**In**	**7**	**8**		Yes	**Due to the size & the narrowness of the channel & tow traffic, daylight only. Requires large amounts of rudder, esp. with additional 10' draft**
				I1	**In**	**7**	**6**		Yes	**Because of the extra width that now exists around the bend this was much like what happens today.**
				B1	**In**	**7**	**5**		Yes	
500ft x 48ft	Ebb	N10	158KDWT/48ft	**E1**	**Out**	**9**	**4**		Yes	**500 ft channel allowed for a more smooth swing through the bend.**
				H1	**Out**	**8**	**6**		Yes	**It still takes a lot of rudder with the additional 100' width, but you have more room to recover. Additional width makes you more comfrortable with traffic.**
				I1	**Out**	**7**	**6**		No	**Need to maintain at least the width that exists now. Lots of interesting things happen around this bend now without cutting it down-Before the big bend 500' seemed to work well.**

Table 5 – Pilot Questionnaire Summary (Continued)

500ft x 48ft	Flood	N11	158KDWT/48ft	I1	In	8	4		Yes	Only would question with a new channel why it would cut the point around such a large bend [Magpeco Bend].
				H1	In	5	4		Yes	The extra 100' width gives more room to maneuver. Mag-Peeo-Bend should be deeper bendwise, ships favor the bend side, not the point, esp. for meeting.
				C1	In	6	4		Yes	
400ft x 40ft	Ebb	N12	158KDWT/38ft	E1	Out	8	4		Yes	This seemed to work ok, but I ran at a slower speed, requires constant attention to helm and keep speed modest!
				C1	Out	8	4		Yes	
				I1	Out	7	6		Yes	This is about normal for outbound loaded.
400ft x 40ft	Flood	N13	158KDWT/38ft	I1	In	6	7		Yes	Other than this bring a larger vessel than was run in this area it was much like what does happen.
				H1	In	7	5	5	Yes	Daylight only, because with meeting & passing traffic it would be necessary and safer & the scenario is run today during daylight. Due to the narrowness of the channel.
				C1	In	8	8		Yes	Too much speed, about 4 to 5 kts.
400ft x 50ft	Ebb	N14	158KDWT/48ft	I1	Out	6	6		Yes	This can be done as long as the ship is in the exact middle of the channel with no outside factors.
				H1	Out	6	8		Yes	This 48' requires a lot of rudder, excess 20 deg to handle, and this was at 7.0 knts speed. At lower speeds we might not have enough rudder This size needs to be during daylight as there is limited room to handle safely and very little margin of error - notice there was no tow traffic or vessels at berth.
				C1	Out	8	7		Yes	
400ft x 50ft	Flood	N15	158KDWT/48ft	E1	In	9	3		Yes	However speed must be controlled to a finer degree. Need to vary speed more.
				C1	In	8	5		Yes	
				I1	In	7	8		No	Rudder angle always quite large to maintain position in channel. If postion is always correct it is possible to do but with nothing extra to contend with.

Table 5 – Pilot Questionnaire Summary (Continued)

500ft x 48ft	Ebb	N16	158KDWT/48ft	E1	Out	9	2		Yes	500 ft channel seems to be considerably easier to maneuver with.
				C1	Out	8	3		Yes	
				I1	Out	8	4		Yes	The extra 100' of channel width makes a world difference. Vessel position can be corrected with ease. Also there is not the constant fight with the banks. This actually seems easier than 38' in 400' channel.
500ft x 48ft	Flood	N17	158KDWT/48ft	I1	In	7	3		Yes	With ease.
				H1	In	8	5		Yes	Additional 100' width provides increased room to recover, 48' is best kept in the middel exp. With trtaffic and then to move over sufficiently.
				C1	In	8	8		Yes	

Turning Basins

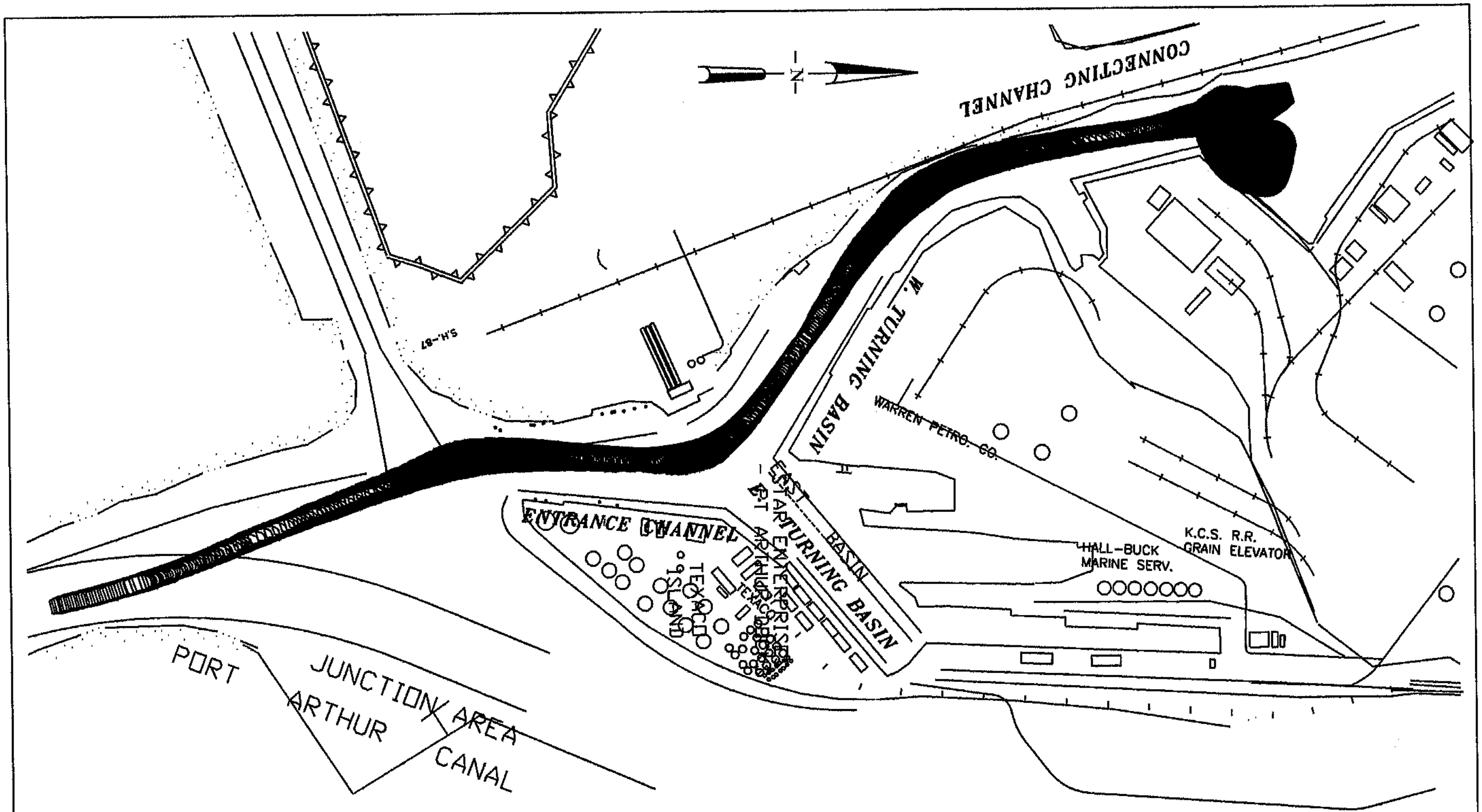
Channel	Tide	Scenario	Ship/Draft	Pilot & Rep.	Travel Dir.	Realism Rating	One-way Difficulty	Two-way Difficulty	Safe Operation?	Pilot Comments
400ft x 50ft	Ebb	T1I	158KDWT/48ft	I1	In	4	6		Yes	The way the ship turned with the tug assist would make me believe that the tug power is greater than 1700 hp, maybe 1700 each engine.
				F1	In	6	6		Yes	To turn a fully loaded 150K tanker would require at least 3 tugs. 99% of our turn arounds are with light vessels or part loaded at least.
				B1	In	7	4		Yes	
				H1	In	8	5		Yes	Plenty of room for maneuvering within the turning basins.
400ft x 50ft	Ebb	T1O	158KDWT/48ft	I1	Out	5	8		Yes	This would only be done in a very rare situation and would use three tugs.
				F1	Out	7	7		Yes	Not recommended without more tug assist. Dimensions of vessel OK but draft makes this a rare if not "never" scenario. Usually turn light vessels of this size. Tugs difficult to use effectively.
				B1	Out	7	4		Yes	
				H1	In	7	4		Yes	
400ft x 50ft	Ebb	T2I	158KDWT/48ft	I1	In	6	5		Yes	This is a very well designed turning area. Possible could relieve the point and downstream side.
				C1	In	9			Yes	
				B1	In	7	6		Yes	
				H1	In	7	5		Yes	

Table 5 – Pilot Questionnaire Summary (Continued)

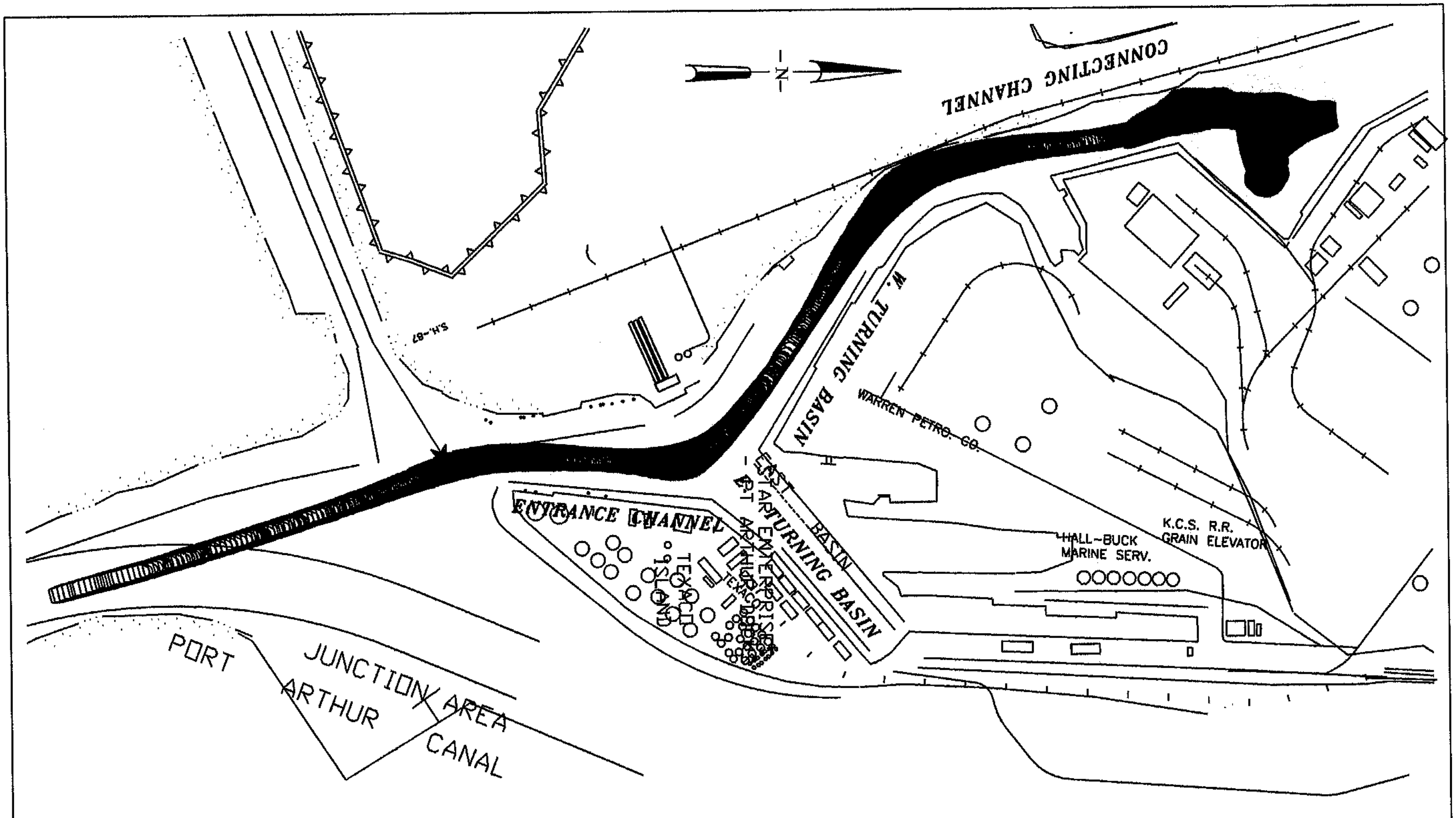
400ft x 50ft	Ebb	T2O	158KDWT/48ft	**I1**	**Out**	**6**	**8**		Yes	**This downbound turn around is very hard to make and with a ship at the Hunstman dock adds to the excitement.**
				C1	**Out**	**9**			Yes	
				B1	**Out**	**4**	**6**		Yes	
				H1	**Out**	**7**	**5**		Yes	**Sufficient room to maneuver.**
				A1	**Out**	**10**	**1**		Yes	
400ft x 50ft	Ebb	T3I	158KDWT/48ft	**I1**	**In**	**6**	**6**		Yes	**This is ok but again somewhat more width of the channel as we approach the basin.**
				C1	**In**	**9**			No	**Wrong place for turning basin. Turn off old rive with right hand turn turning to right places sterr into damage.**
				B1	**In**	**8**	**5**		Yes	
				H1	**In**	**6**	**5**		Yes	**This anchorage/turning basin needs to be deeper closer to the east bank, needs to be widened.**
400ft x 50ft	Ebb	T4I	158KDWT/48ft	**I1**	**In**	**6**	**7**		Yes	**Most turnarounds with this size ship would be with 3 tugs. Basin is good size ample room to complete the turn completely in the basin.**
				C1	**In**	**9**	**5**		Yes	**To far in bend, slow backing on ship.**
				B1	**In**	**7**	**3**		Yes	
				H1	**In**	**7**	**4**		Yes	**Sufficient room to maneuver, and anchorages are big enough to maneuver with 1 tug.**
400ft x 50ft	Ebb	T5O	158KDWT/48ft	**I1**	**Out**	**6**	**7**		Yes	**Turning basin is of ample size that this maneuver can be made.**
				C1	**Out**	**8**			Yes	
				B1	**Out**	**7**	**5**		Yes	
				H1	**Out**	**7**	**4**		Yes	**Sufficient room to safely maneuver.**
400ft x 50ft	Ebb	T6O	158KDWT/48ft	**C1**	**Out**	**9**			No	**Ship too long to make turn.**
				B1	**Out**	**7**	**7**		Yes	
				H1	**Out**	**6**	**4**		Yes	
400ft x 50ft	Ebb	T7I	158KDWT/48ft	**C1**	**In**	**8**			No	**Outbound tide, tug unable to push stern upstream.**
				B1	**In**	**7**	**6**		Yes	
				H1	**In**	**7**	**4**		Yes	**Enough room to safely maneuver.**
400ft x 50ft	Ebb	T7O	158KDWT/48ft	**I1**	**Out**	**6**	**9**		No	**Downbound is not possible without adding some width to the channel on the east side above the turning area.**

Table 5 – Pilot Questionnaire Summary (Concluded)

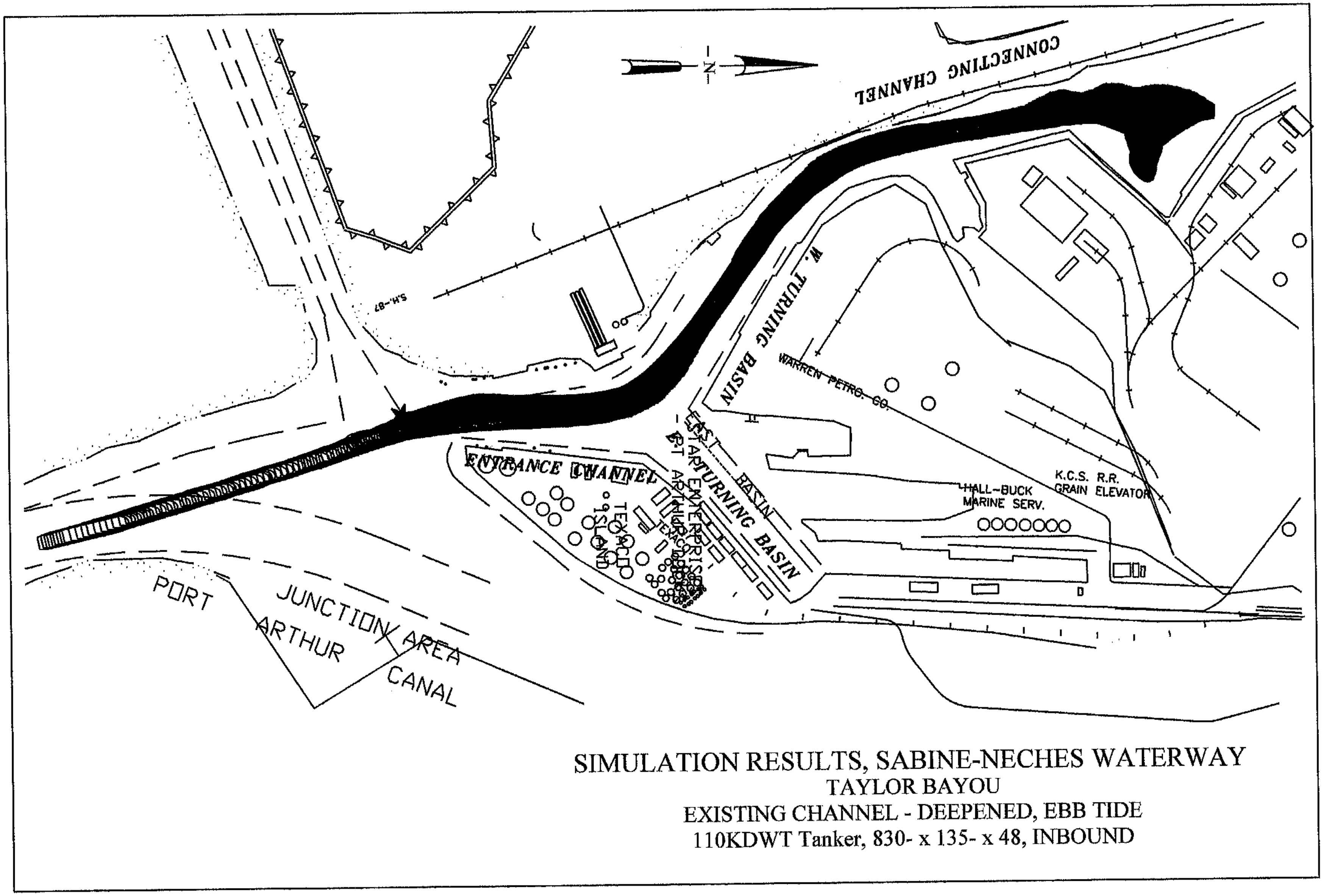
Channel	Tide	Scenario	Ship/Draft	Pilot & Rep.	Travel Dir.	Realism Rating	One-way Difficulty	Two-way Difficulty	Safe Operation?	Pilot Comments
400ft x 50ft	Ebb	T8I	158KDWT/48ft	**I1**	**In**	**6**	**8**			**Like with the other basins the channel needs to be wider as it nears the basin to allow for the stern of the ship swing room as the turn is mad[e] into the basin. Good holding area.**
				C1	**In**	**8**			**No**	**Ship does not back.**
				B1	**In**	**7**	**8**		**Yes**	
				H1	**In**	**7**	**4**		**Yes**	**Good size anchorage with sufficient room to turn.**
Taylor Bayou										
Channel	**Tide**	**Scenario**	**Ship/Draft**	**Pilot & Rep.**	**Travel Dir.**	**Realism Rating**	**One-way Difficulty**	**Two-way Difficulty**	**Safe Operation?**	**Pilot Comments**
400ft x 50ft	Ebb	TAB	110KDWT/48ft	**B1**	**In**	**-**	**-**		**-**	
				B2	**In/Out**	**7**	**6**		**Yes**	
				A1	In	10	5		Yes	The scenario has to have tugs to assist and we had a mixup on the tugs.
				A2	**In**	**10**	**1**		**Yes**	
				F1	In	3	8		No	Vessel too large (LOA and Beam) to make bends within an acceptable margin of safety. Vessels at Motiva #1 & 2, Great Lakes Carbon load & discharge docks, TDI lay berth, all encroach on the channel. In my opinion there is no room to expand this channel without setting docks themselves back
				C1	**In/Out**	**8**	**4**		**Yes**	
				A1	Out	10	1		Yes	I say yes because I felt that I let my ship extend toward the Motiva dock to far and I did not get the way off completely. Our harbor tugs have a full astern which is adequate to get the ship dead in the water & I should have come astern on the ship then let the tugs push the ship around.



SIMULATION RESULTS, SABINE-NECHES WATERWAY
TAYLOR BAYOU
EXISTING CHANNEL - DEEPENED, EBB TIDE
110KDWT Tanker, 830- x 135- x 48, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
TAYLOR BAYOU
EXISTING CHANNEL - DEEPENED, EBB TIDE
110KDWT Tanker, 830- x 135- x 48, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
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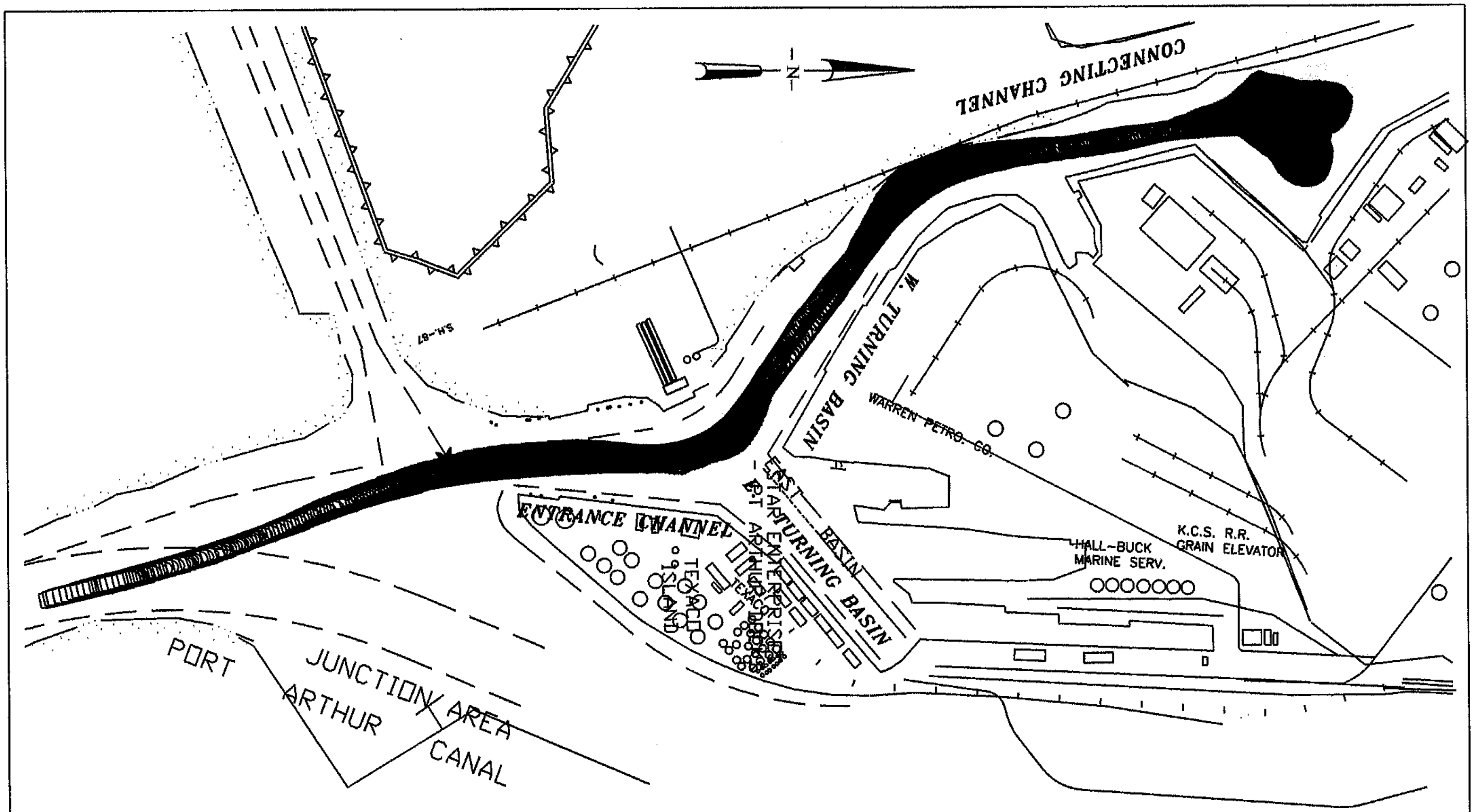
EXISTING CHANNEL - DEEPENED, EBB TIDE
110KDWT Tanker, 830- x 135- x 48, INBOUND



SIMULATION RESULTS, SABINE-NECHES WATERWAY
TAYLOR BAYOU
EXISTING CHANNEL - DEEPENED, EBB TIDE
110KDWT Tanker, 830- x 135- x 48, INBOUND

DRAFT

MEMORANDUM

FROM: Dennis W. Webb CEERD-HN-ND

TO: Baldev Mann CESWG-EC-EH

SUBJECT: Results of Sabine-Neches Waterway Entrance Simulations.

1. Real-time ship simulations of the proposed entrance channel width reduction for the Sabine-Neches Waterway (SNWW) were completed during December 2007. This is follow-up to a navigation study conducted in 2002. The 2002 study was conducted under contract by Waterway Simulation Technology (WST), using the simulators at Seaman's Church International (SCI). The 2002 study was contracted because the Engineer Research and Development Center (ERDC) was in the process of replacing their simulators.

2. The 2006 study was also contracted to WST to make use of the 2001 study's databases. The contract number was W912HZ-07-P-0039. This study consisted of two-way simulations for large, loaded tankers and one-way simulations of Liquefied Natural Gas (LNG) tankers. The two-tanker simulations were conducted at the SCI simulators facility and the one-way LNG simulations were conducted at the ERDC Ship/Tow Simulator.

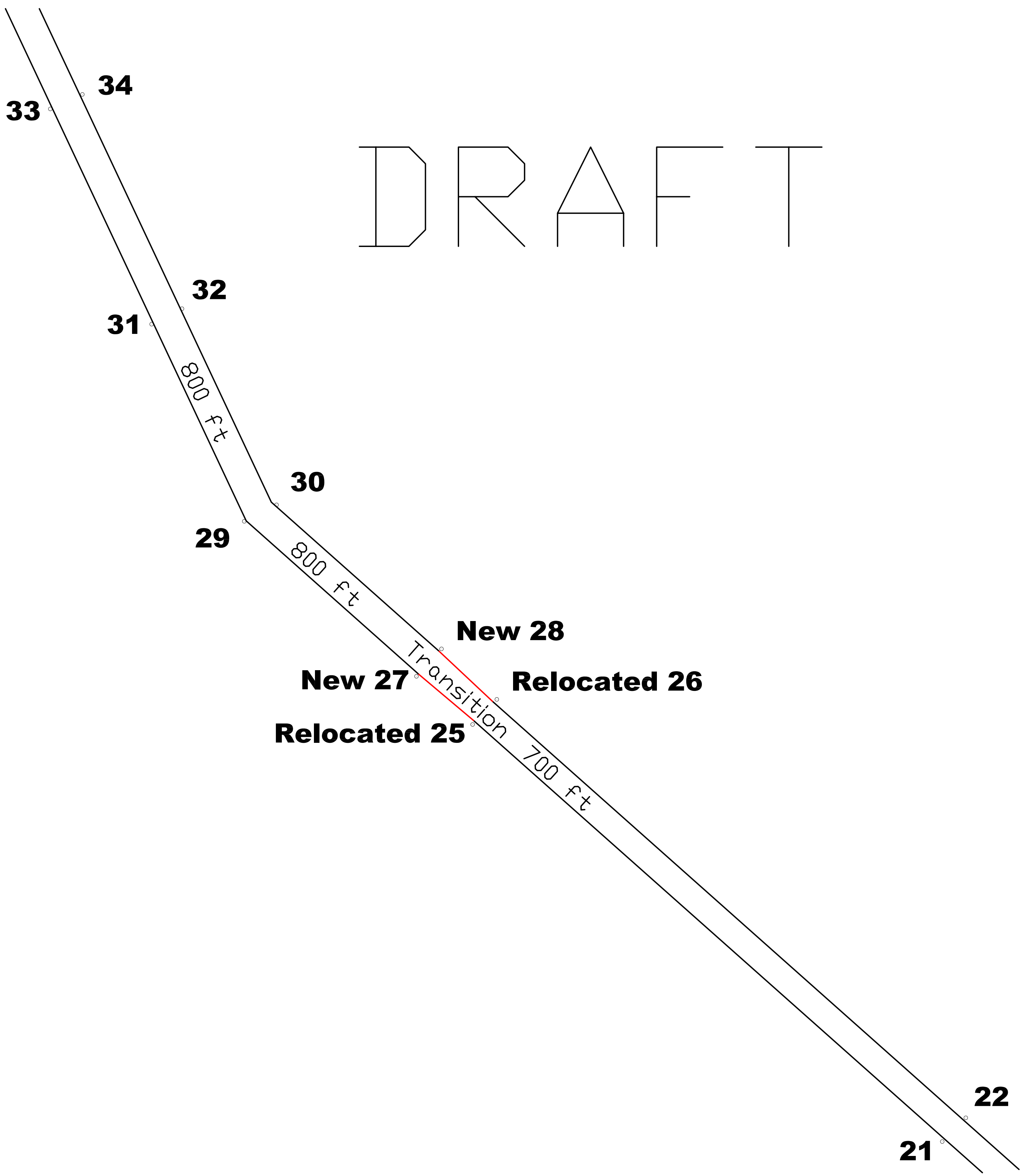
3. Results of the simulations are contained in the observer's report, Appendix A. This report includes a description of the tests conducted, ship track plots, and pilot ratings. An analysis of approach distances for the two-way runs is also included in Table 1. It should be noted that the average approach distances are skewed by a few very large distances, especially the exercise shown in Figure 3. If the largest approach distance is removed from each average, the averages are 89 ft for the 800- x 42-ft channel, 124 ft for the 800- x 52-ft channel, and 100 ft for the 700- x 52 ft channel. It should also be noted that on the final questionnaire that the pilots felt the 700 ft channel was unsafe. However, Table 3 summarized the forms the pilots completed after each run. They stated three of the five 700-ft runs were safe, one was not safe, and the split on the other. The pilots also split on whether or not two of the 800- x 52 ft were safe. They felt one run in the existing condition was unsafe.

4. Pilot comments for the one-way LNG tests are shown in Table 5. The pilot felt all scenarios were safe. One run (Figure 26) shows the vessel leaving the channel after making a turn. This is because the pilot thought the run was over and he experimented with the ship.

5. Recommendations are as follows:

    a. For <u>one-way</u> traffic of the design ships tested a 700-ft channel width is adequate for all offshore reaches of the Sabine-Neches Waterway.
    b. For <u>two-way</u> traffic of the design loaded petroleum tankers a 700-ft channel width is adequate for Sabine Bank Channel seaward of the bend at buoys 29 & 30 and for the channel deepening extension reach south of the existing sea buoy (approx. 19 nautical miles). These reaches are long and straight and provide ample meeting/passing setup distance without significant cross current.
    c. For <u>two-way</u> design tanker traffic in the Sabine Pass Outer Bar Channel (between the jetty end and buoys 29 & 30) the existing toe-to-toe channel width of 800 ft should not be reduced for the deepened channel. This reach is approximately 3 nautical miles long and experiences a frequent strong cross-channel component to the current. Meeting and passing in this reach is presently avoided by the pilots; however, circumstances dictate changes to this practice on occasion. The poor results in simulated meeting/passing maneuvers during the study (see report) may have been partially a consequence of the pilots' inability to identify vessel positions in the visual scene. In the deepened channel pilots will most likely continue to steer clear of meeting/passing in this reach; however, the 800-ft channel width should be maintained so that the reach does not function as an unavoidable bottle-neck to shipping operations. The recommended channel configuration is shown in Figure 1.

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


DRAFT
34
33
32
31
800 ft
30
29
800 ft
New 28
New 27
Transition
Relocated 26
Relocated 25
700 ft
22
21

Appendix A
Observer's Report

Sabine-Neches Waterway
Entrance Channel Simulations

January 15, 2007

for
USAE Engineering Research and Development Center

by
Waterway Simulation Technology, Inc.

Background

A vessel maneuvering simulation study for the USAE deepening project on the Sabine-Neches Waterway (SNWW) – near Port Arthur, Texas - was conducted in 2002[1]. In this original study the proposed deepened channel was tested at a toe-to-toe width of 800 ft (also, the existing width) through the bends immediately south of the jetty entrance in the Sabine Bank and Sabine Bar Channels – Figure 1. For the study presented here a reassessment of the width for these sections of the channel resulted in a requirement to simulate loaded tankers in meeting/passing maneuvers and LNG tankers in one-way transit. The simulations for the two-way tanker traffic were conducted at the Seamen's Church Institute (SCI) training facility in Houston, Texas. The one-way simulations with LNG tankers were conducted at the USAE Engineer Research and Development Center (ERDC) in Vicksburg, Mississippi.

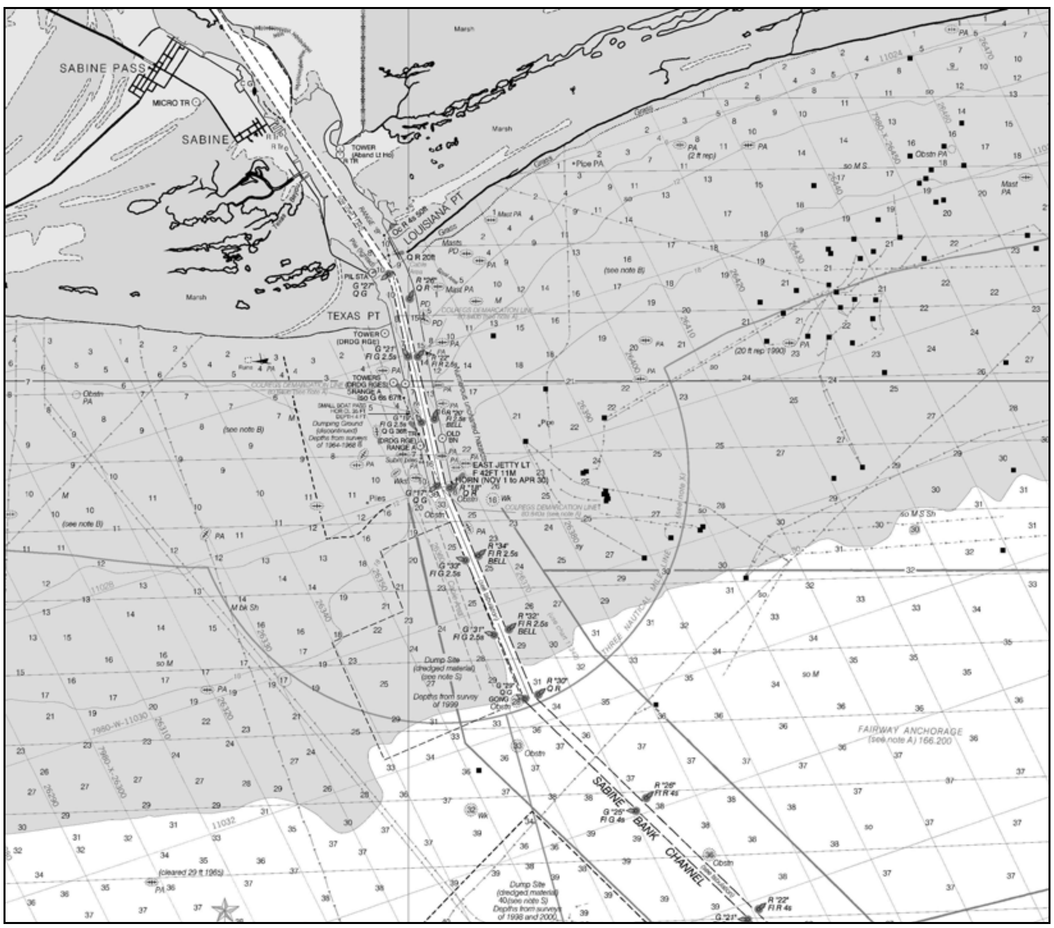


Figure 1: Jetty Entrance Portion of Sabine-Neches Waterway

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[1] *Ship Simulation Study for Sabine Neches Project***,** Coastal and Hydraulics Laboratory US Army Corps of Engineers Engineer Research and Development Center, Vicksburg, Mississippi, 2003

Two-way Tanker Simulations

Database Development and Test Conditions

The simulator database at SCI's facility required minimal modification for the conduct of the subject simulations. The primary aim of the scenarios was to test meeting/passing maneuvers in a channel width of 700 ft. To accomplish the aim three channel geometries were simulated, listed below.

1. Existing Channel: 800-ft toe-to-toe width, 42-ft depth.
2. Original Proposed Channel: 800-ft toe-to-toe width, 52-ft depth
3. Modified Proposed Channel: 700-ft toe-to-toe width, 52-ft depth

The design ship remained the same as for the original study: a 158K DWT tanker with a length of 899 ft, a beam of 164 ft and with loaded and ballasted drafts of 48 ft and 38 ft, respectively. The ballast condition was used for simulations in the existing channel for the purpose of familiarization runs for the pilots and to establish a configuration baseline for comparison of other runs.

Since a simulated environment in the open test reach would normally provide limited distinguishing characteristics between the three channel configurations, the aids to navigation were used in a way to signify differences in alignment to the pilots. For most of the runs in the two deepened channel configurations the buoys in the simulation visual were placed directly over the toe of the 800- and 700-ft channels. The aids to navigation in the existing channel simulation were placed as charted – approximately 150 ft outside of the 800-ft channel toe. In addition to the navigation aids being moved closer for the simulations in the 700-ft channel, the position of the top of the banks adjacent-to and outside-of the channel toe were relocated to simulate a narrower channel. However, since the underwater bank angles were (and are) gentle and the adjacent water fairly deep (on the order of 25 to 30 ft), the ships did not experience significant bank effect forces.

The foundational current data used for the present simulations were the same as for the original study. The two-dimensional depth-averaged RMA2 numerical current model for the SNWW was not run with boundary conditions conducive to the development of critical cross current in the channel segments just outside of the jetties. Therefore, from the seaward end of the jetties outward the cross channel component of the current vectors had to be estimated based on the experience of the pilots. This process resulted in similar current magnitude for the present and original study – 0.75 to 0.8 knot. The critical measure used in this process was the comparison of the ship's drift angle in the Sabine Bar and Bank Channels relative to the pilot's experience. At the beginning of the simulations a current magnitude of 1.1 knots was used and resulted in an approximate 10-degree drift angle, which the pilots said was too severe. The current speed was reduced so that the maximum drift angle experienced was on the order of 4 to 5 degrees which is the normal situation. The offshore current angle in the simulation was from a general northeast direction. Flood and ebb tide conditions were run during the simulations; however, since the focus of the tests was well offshore the cross current was little affected by the tidal fluctuations.

Two-way Simulations

Table 1 summarizes the approach distances recorded from the SCI simulations of the two-way scenarios. Table 2 shows the results of the final pilot questionnaire. Table 3 summarizes all the two-way tests run at SCI and includes the results from the post-scenario questionnaires handed to the pilots after each run. For the questionnaire ratings shown on Table 3 realism and difficulty ratings ranged from 1 to 10 with higher numbers signifying better realism and more difficulty, respectively. Figures 2-15 show the trackplots of the two-way tanker runs. The closest approach noted on each trackplot figure denotes the minimum hull-to-hull distance between the ships, and its location during the meeting/passing maneuver (see Table 1).

Two warm-up runs and the runs shown on Figures 2, 3 and 6 were conducted with a cross current of 1.1 knot at a 205-degree true heading. During these runs the strong westerly cross current caused both ships to drift toward the western side of the channel forcing the outbound ship outside of the toe of the submerged slope. These runs convinced the pilots that the simulator cross current magnitude was too large compared to reality and subsequent runs were conducted with a 0.8-knot magnitude at the same heading.

Table 1: Approach Distances

Two-way Scenarios		Shown on Figure	Closest Approach Hull-to-Hull (ft)	Avg	Channel Dimensions (ft)
Inbound	Outbound				
S1EX1AINE1	S1EX1BONE1	2	92	170	800x42
S1EX1BINE1	S1EX1AONE1	3	412		
S1EX1BINE2	S1EX1AONE2	4	78		
S2EX1AISF1	S2EX1BOSF1	5	98		
S3P12AINE1	S3P12BONE1	7	242	153	800x52
S4P12AISF1	S4P12BOSF1	8	159		
S3P12BINE1	S3P12AONE1	9	109		
S4P12BISF1	S4P12AOSF1	10	104		
S3P11AINE1	S3P11BONE1	6 (Ballast Ship)	214		800x52
S5P22BINE1	S5P22AONE1	11	123	108	700x52
S6P22AISF1	S6P22BOSF1	12	105		
S5P22AINE1	S5P22BONE1	13	176		
S6P22BISF1	S6P22AOSF1	14	72		
S5P22AINE2	S5P22BONE2	15	67		

Except for the run shown on Figure 6 the meeting/passing location was between Buoys 29-30 and the jetties. This is a segment which is normally avoided by the pilots for meeting of deep-draft vessels. The approach distances shown in Table 1 indicate a decrease in meeting/passing suitability for loaded tankers in the deepened channel and a further decrease in the 700-ft channel. However, the trackplot figures show that in most of the simulation runs – regardless of channel width or depth - the toe of the channel was crossed by the outbound ship. These results indicate why the pilots usually avoid this reach for meeting and passing while transiting the actual waterway. Ships only in the runs with the smallest hull-to-hull approach distances shown in Table 1 actually cleared the channel edge. Neither of the pilots thought that meeting/passing maneuvers in the tested 700-ft wide reach between deep-draft tankers were safe (see Table 2). Even in the 800-ft wide channel the outbound pilot rated the situation as unsafe for several of the runs noting his close proximity to the channel edge or markers (see Table 3; runs 6 & 8).

Table 2: Two-way Tanker Simulation Final Pilot Questionnaire

SCI – Pilot Final Questionnaire – Tanker Meeting/Passing Simulations					
Pilot	**Meeting Realism**	**Overall Realism**	**Handling Difficulty**	**700-ft Channel Safe?**	**Comments**
A	7	6	5	No	I feel as ships are getting bigger reducing channel width is not the answer. Instead of reducing risk it's increasing risk for collision.
B	7	6	5	No	Channel ledge: I feel that the ledge will fall down to the bottom of the channel which will have to be dredged out – more maintenance problems.

Table 3: SCI Tests – Meeting/Passing Tankers

Run	Fig.	Channel Width & Depth (ft)	Ship	Pilot	Dir	Cross Current (knots) /Tide	Wind (knots)	Scenario Pilot Questionnaire				
								Overall Realism	Meeting Realism	Difficulty	Safe?	Comments
S1EX1AINE1	2	800 x 42	899x164x38	A	In	1.1 / Ebb	20 NW	7	7	7	No	Meeting in a turn is not a safe operation
S1EX1BONE1			899x164x38	B	Out			8	8	8	No	Would not meet @ buoys 29 & 30, meet on east side of 29 & 30
S1EX1BINE1	3	800 x 42	899x164x38	B	In	1.1 / Ebb	20 NW	8	8	7	Yes	For me, I felt I was in good position
S1EX1AONE1			899x164x38	A	Out			7	7	2	Yes	Did seem a bit unreal, I was on the west edge of channel w/no depth change and no pressure
S1EX1BINE2	4	800 x 42	899x164x38	B	In	0.8 / Ebb	20 NW	8	8	6	Yes	
S1EX1AONE2			899x164x38	A	Out			8	7	6	Yes	
S2EX1AISF1	5	800 x 42	899x164x38	A	In	0.8 / Flood	20 SE	8	8	6	Yes	
S2EX1BOSF1			899x164x38	B	Out			8	8	6	Yes	
W1P11AI0E1	N/A	800 x 52	899x164x48	A	In	1.1 / Ebb	0	N/A	N/A	N/A	N/A	
W1P11BO0E1	N/A	800 x 52	899x164x48	B	Out	1.1 / Ebb	0	7	N/A	1	Yes	
S3P11AINE1	6	800 x 52	899x164x38	A	In	1.1 / Ebb	20 NW	7	8	3	Yes	Distance between vessels seemed safe distance apart.
S3P11BONE1			899x164x38	B	Out			8	8	5	No	I came over too much & got closer to inbound ship
S3P12AINE1	7	800 x 52	899x164x48	A	In	0.8 / Ebb	20 NW	7	8	4	Yes	Safe distance between vessels, no pressure
S3P12BONE1			899x164x48	B	Out			8	8	4	Yes	No pressure from bank or ship
S4P12AISF1	8	800 x 52	899x164x48	A	In	0.8 / Flood	20 SE	7	7	4	Yes	
S4P12BOSF1			899x164x48	B	Out			8	8	6	No	I ran over buoy, showing no signs of press off bank

Run	Fig.	Channel Width & Depth (ft)	Ship	Pilot	Dir	Cross Current (knots) /Tide	Wind (knots)	Scenario Pilot Questionnaire				
								Overall Realism	Meeting Realism	Difficulty	Safe?	Comments
S4P12BISF1	9	800 x 52	899x164x48	B	In	0.8 / Flood	20 SE	8	8	6	Yes	
S4P12AOSF1			899x164x48	A	Out			8	8	6	Yes	
S3P12BINE1	10	800 x 52	899x164x48	B	In	0.8 / Ebb	20 NW	8	8	6	Yes	
S3P12AONE1			899x164x48	A	Out			8	8	5	Yes	
S5P22AINE1	11	700 x 52	899x164x48	A	In	0.8 / Ebb	20 NW	7	5	3	No	Channel limits had to be reset
S5P22BONE1			899x164x48	B	Out			8	8	8	No	Channel limits had to be reset
S6P22BISF1	12	700 x 52	899x164x48	B	In	0.8 / Flood	20 SE	8	8	7	Yes	
S6P22AOSF1			899x164x48	A	Out			7	4	4	No	Distance between vessels passing was too close
S5P22BINE1	13	700 x 52	899x164x48	B	In	0.8 / Ebb	20 NW	8	8	6	Yes	
S5P22AONE1			899x164x48	A	Out			8	8	6	Yes	Normal rudder commands to meet
S6P22AISF1	14	700 x 52	899x164x48	B	In	0.8 / Flood	20 SE	7	7	4	Yes	No pressure when passing noted
S6P22BOSF1			899x164x48	A	Out			8	8	6	Yes	
S5P22AINE2	15	700 x 52	899x164x48	A	In	0.8 / Flood	20 NW	8	8	6	Yes	
S5P22BONE2			899x164x48	B	Out			8	8	6	Yes	

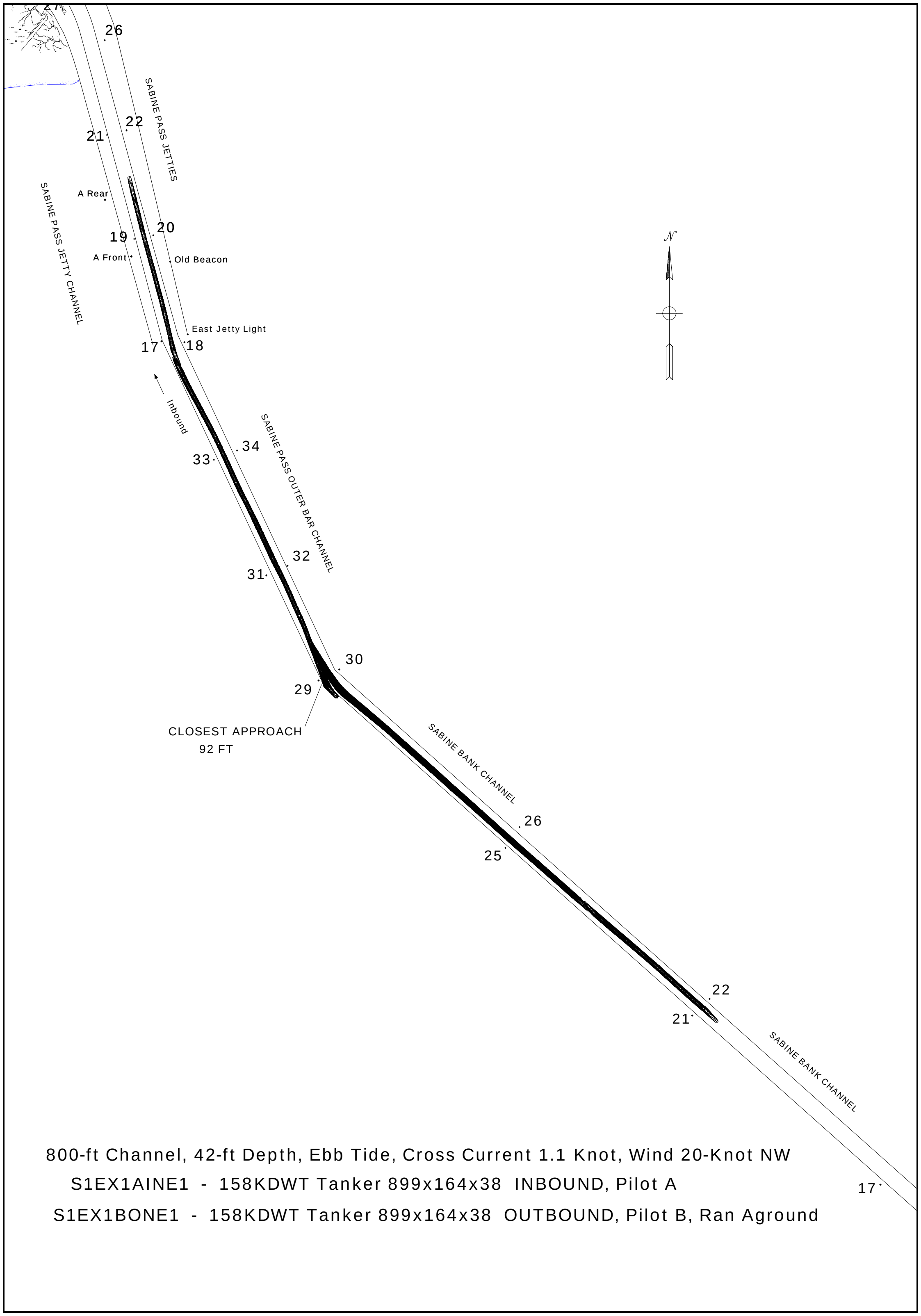

Figure 2: Two-way Run 2, Existing Channel

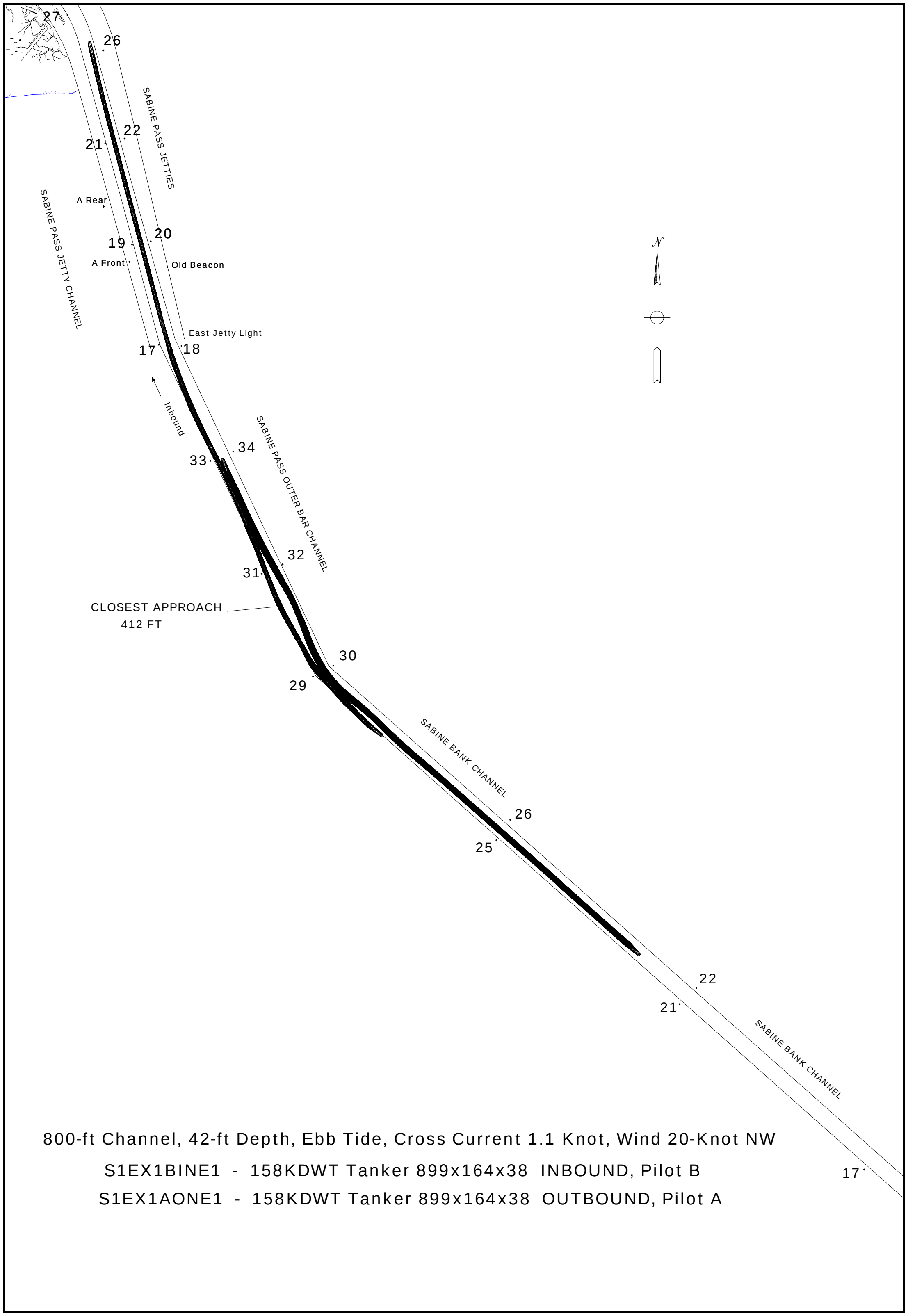

Figure 3: Two-way Run 3, Existing Channel

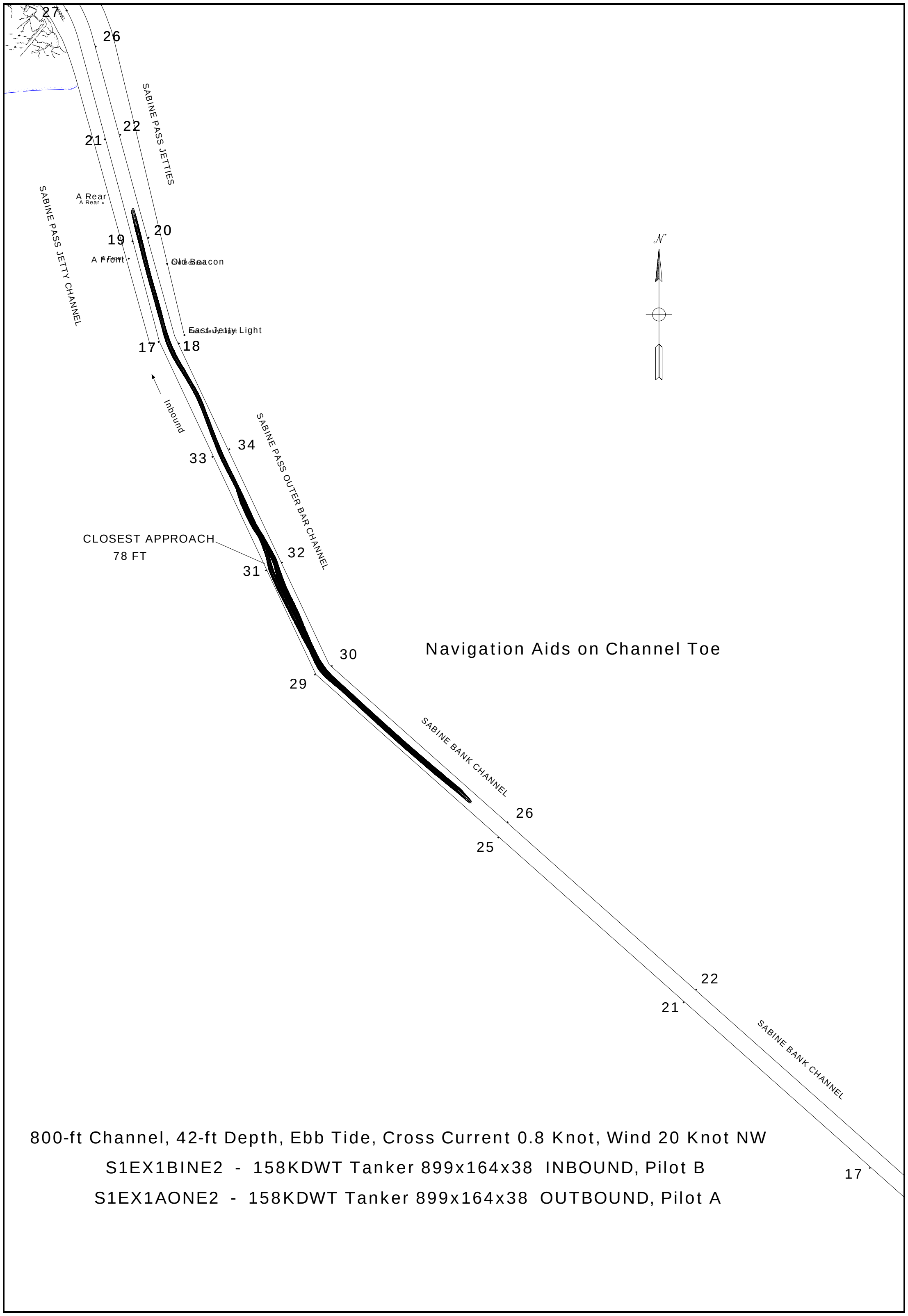

Figure 4: Two-way Run 13, Existing Channel

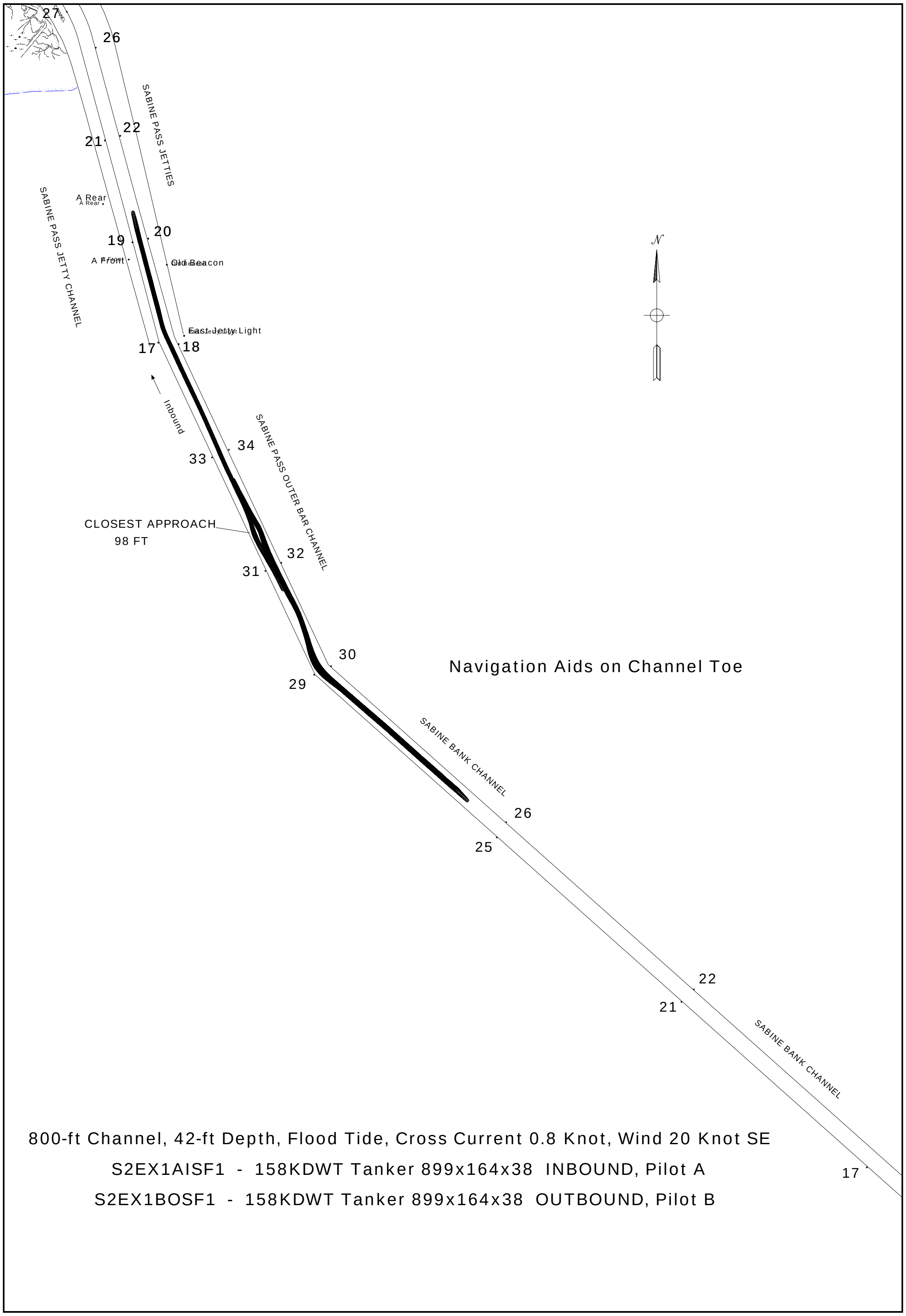

Figure 5: Two-way Run 14, Existing Channel

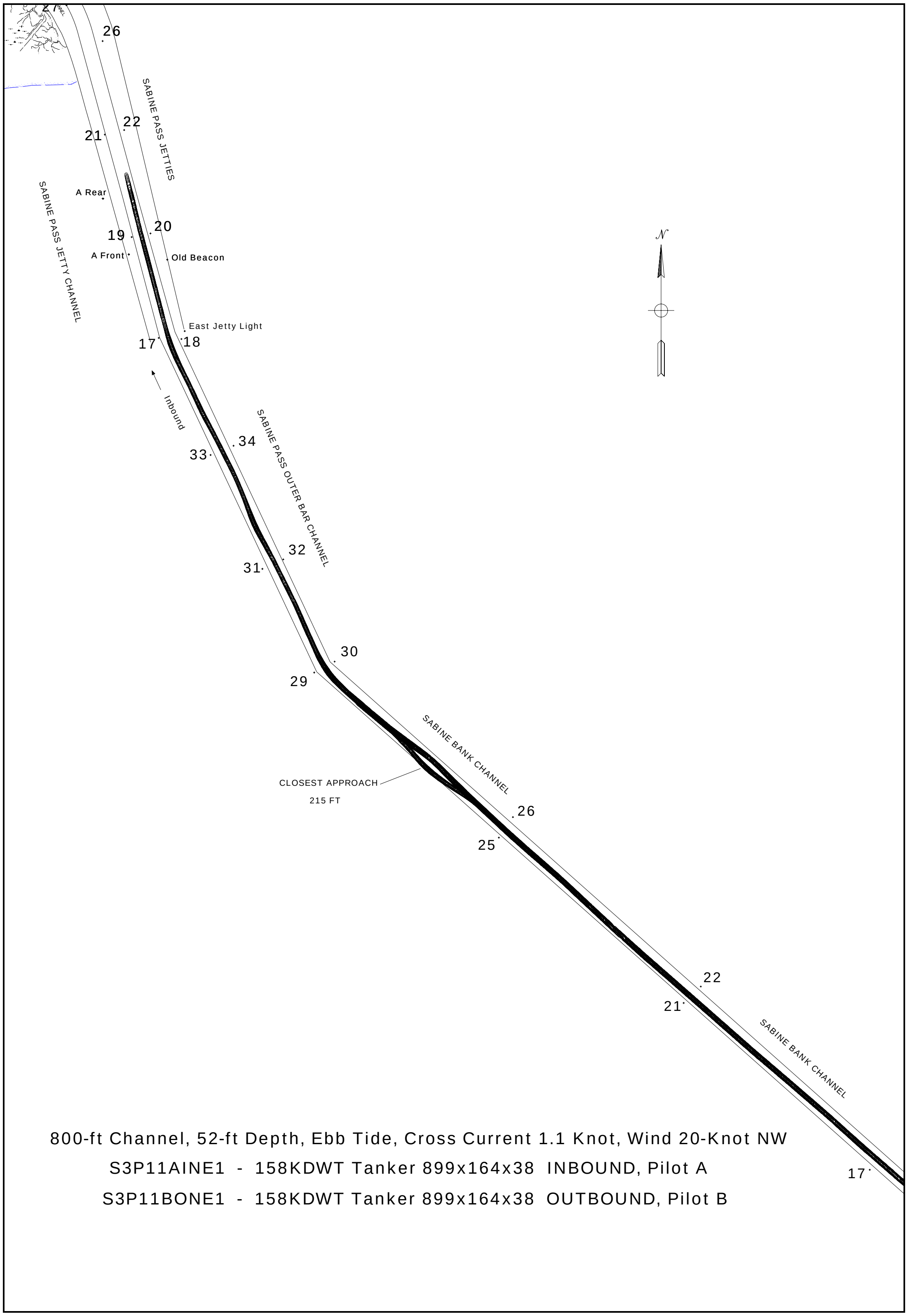

Figure 6: Two-way Run 1, 800 x 52 Channel

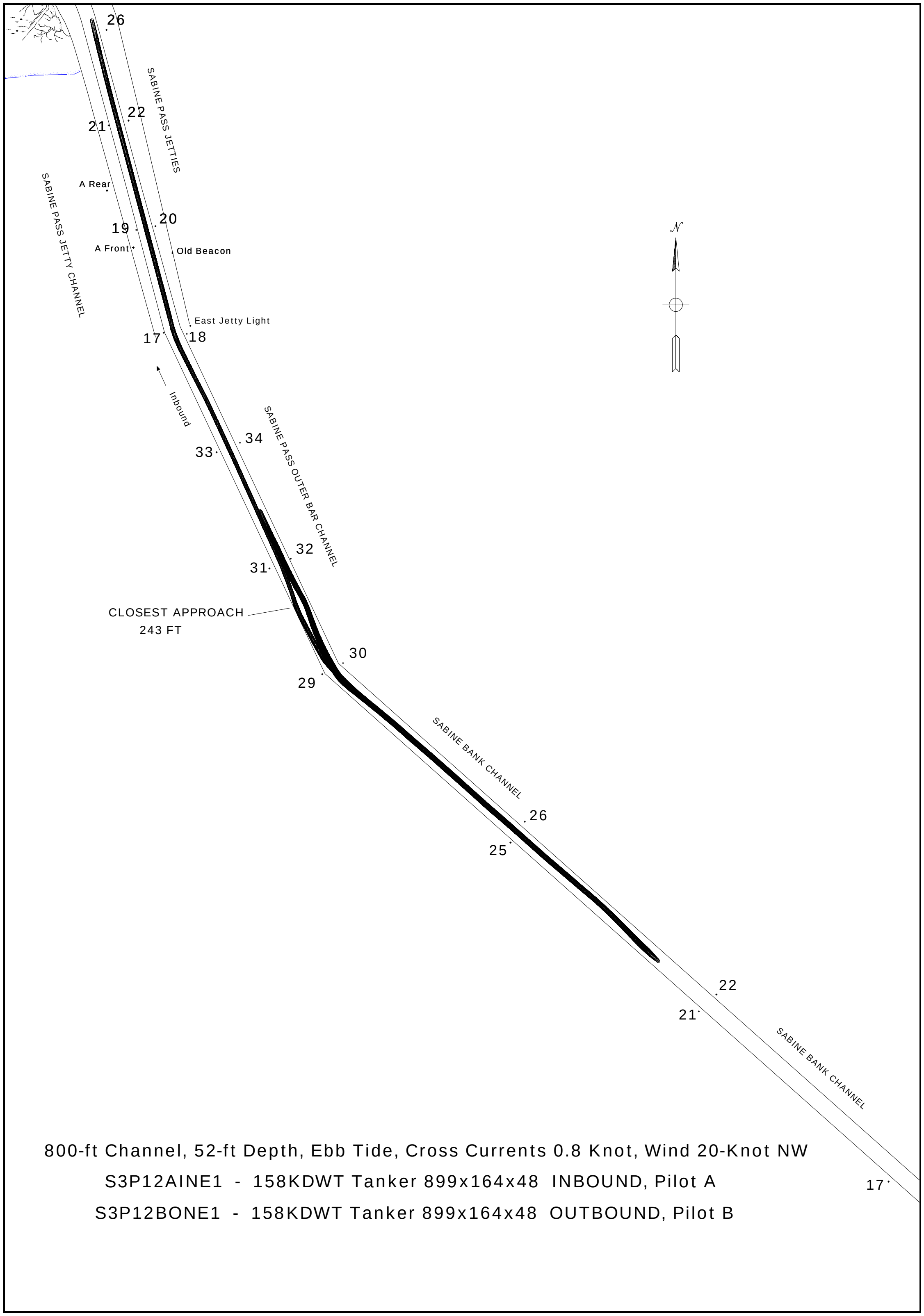

Figure 7: Two-way Run 4, 800 x 52 Channel

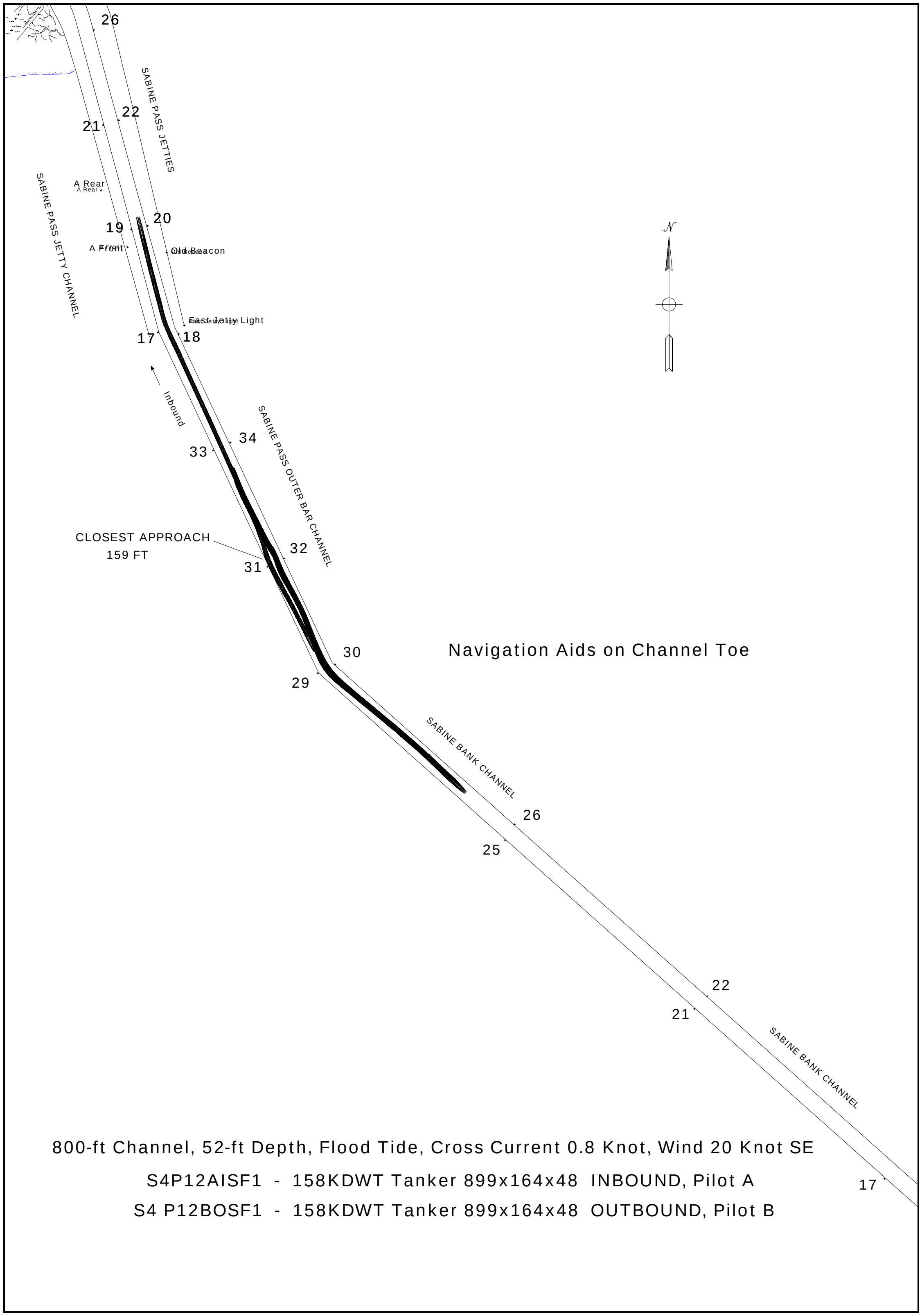

Figure 8: Two-way Run 9, 800 x 52 Channel

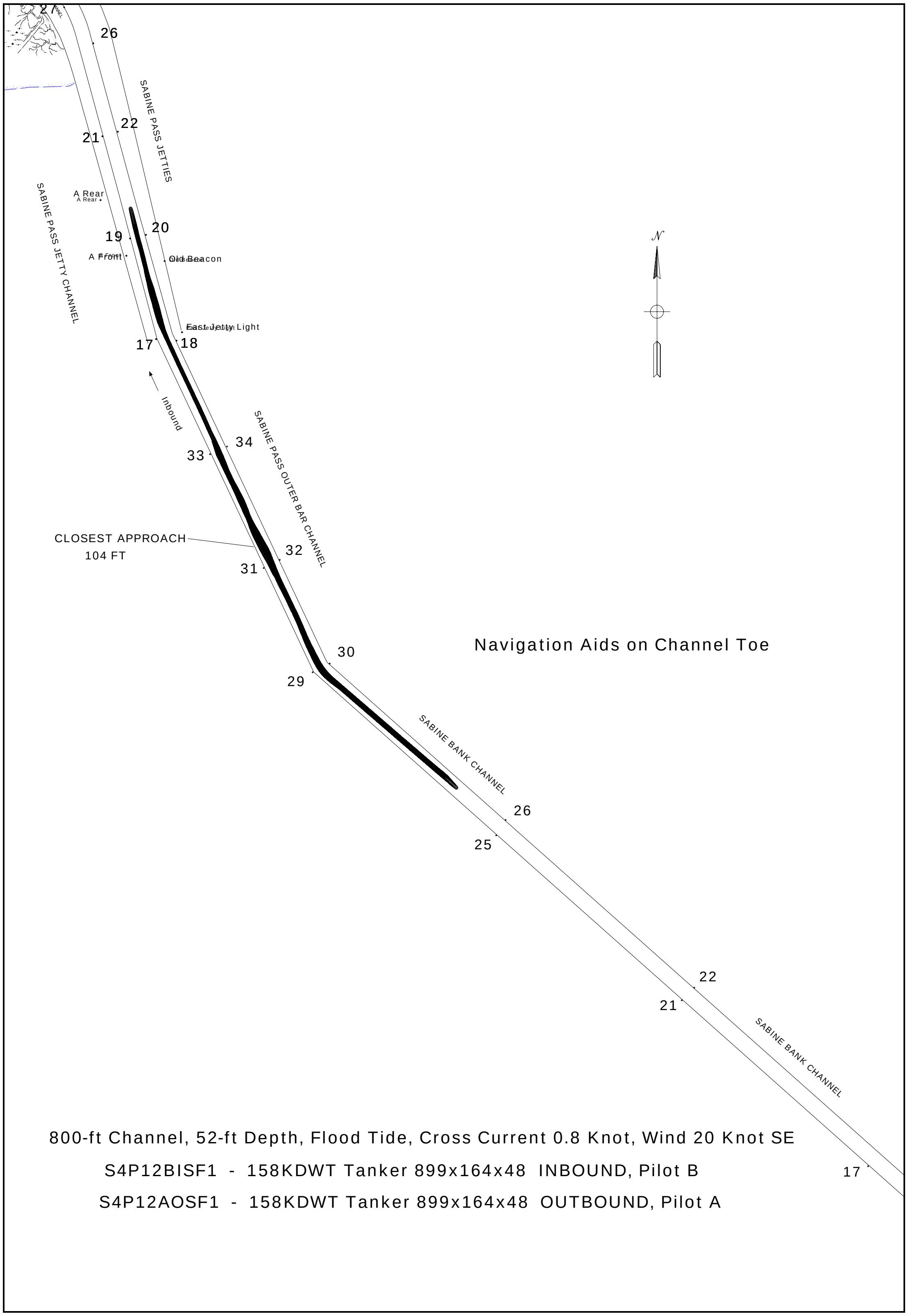

Figure 9: Two-way Run 10, 800 x 52 Channel

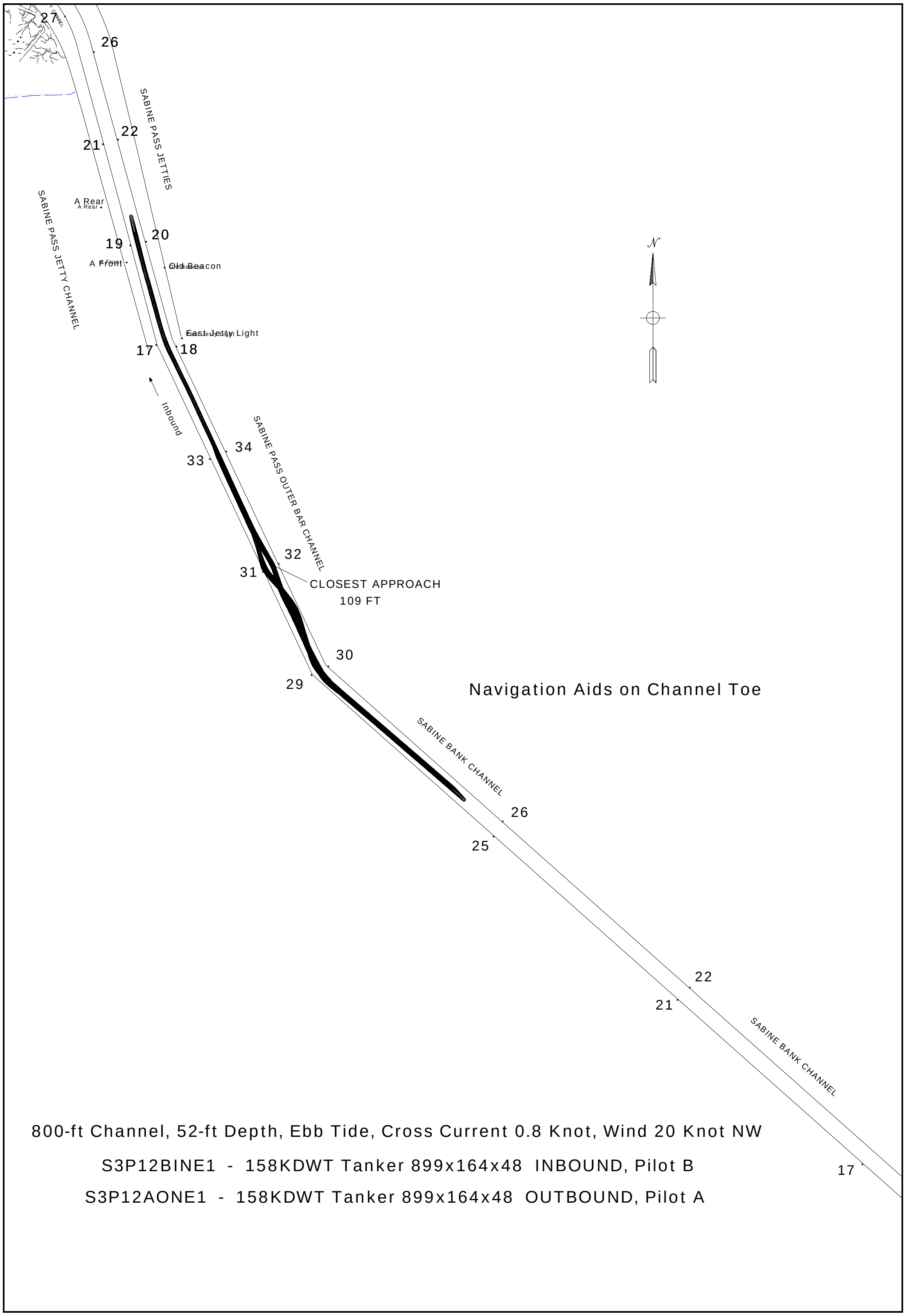

Figure 10: Two-way Run 12, 800 x 52 Channel

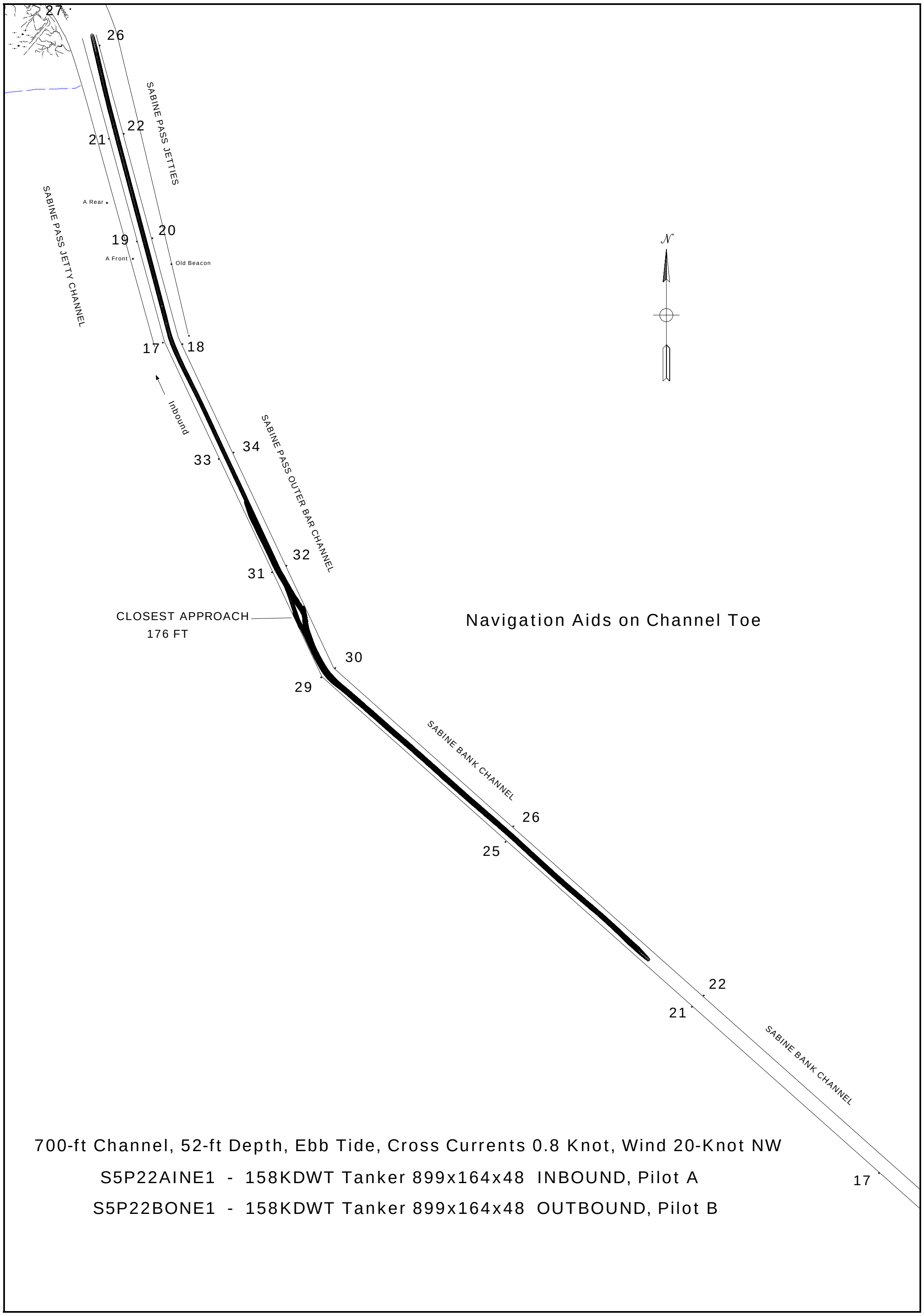

Figure 11: Two-way Run 5, 700 x 52 Channel

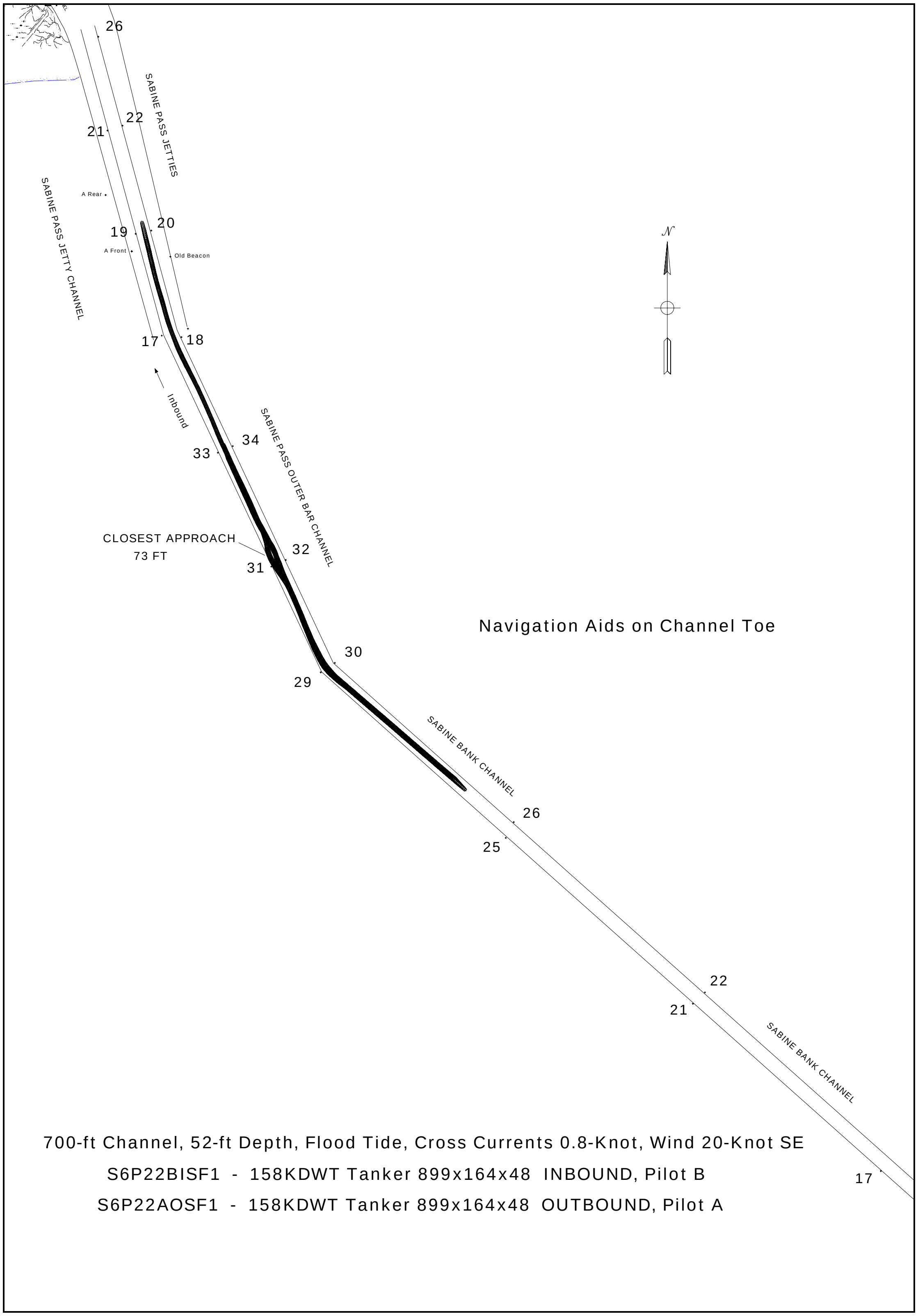

Figure 12: Two-way Run 6, 700 x 52 Channel

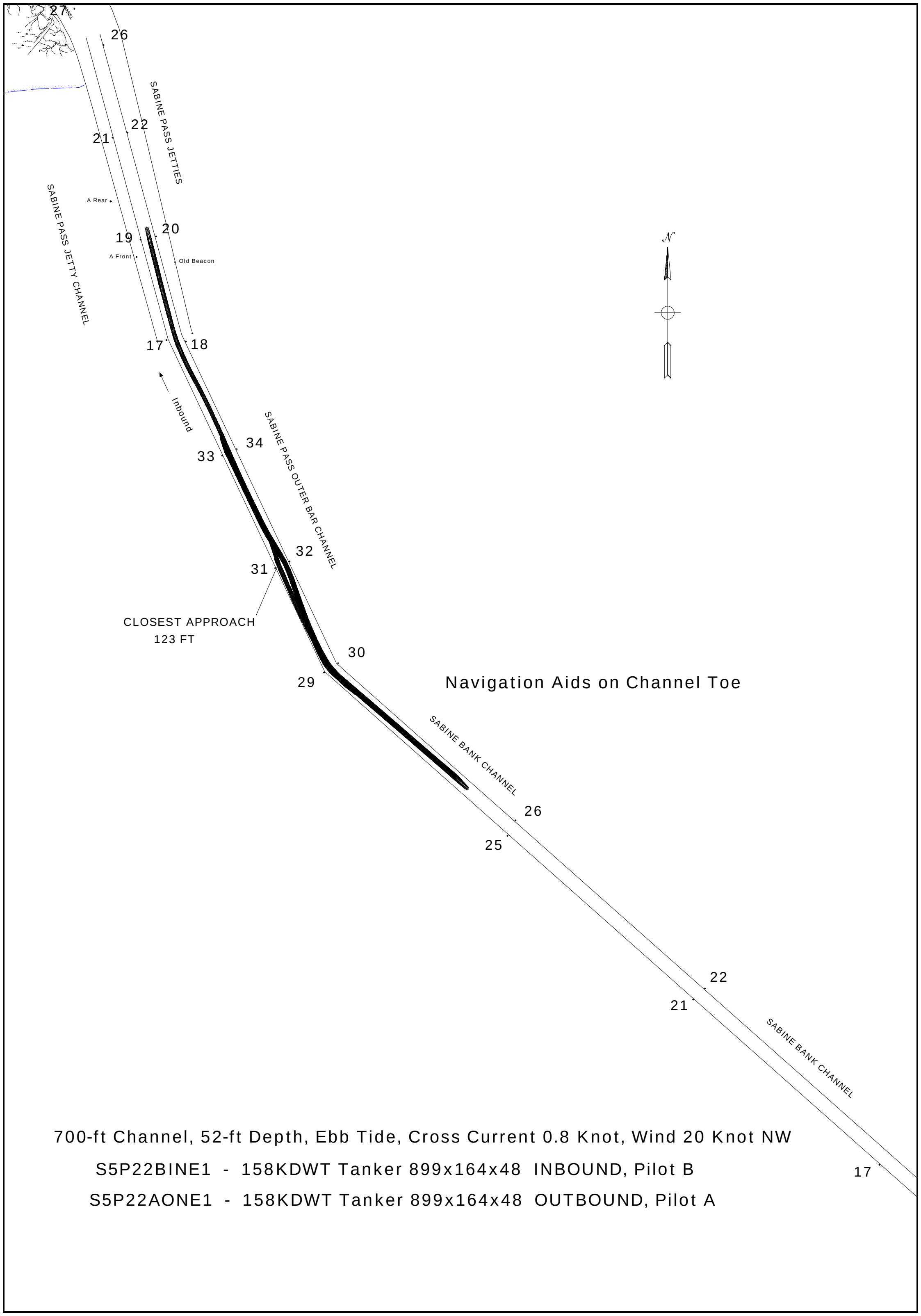

Figure 13: Two-way Run 7, 700 x 52 Channel

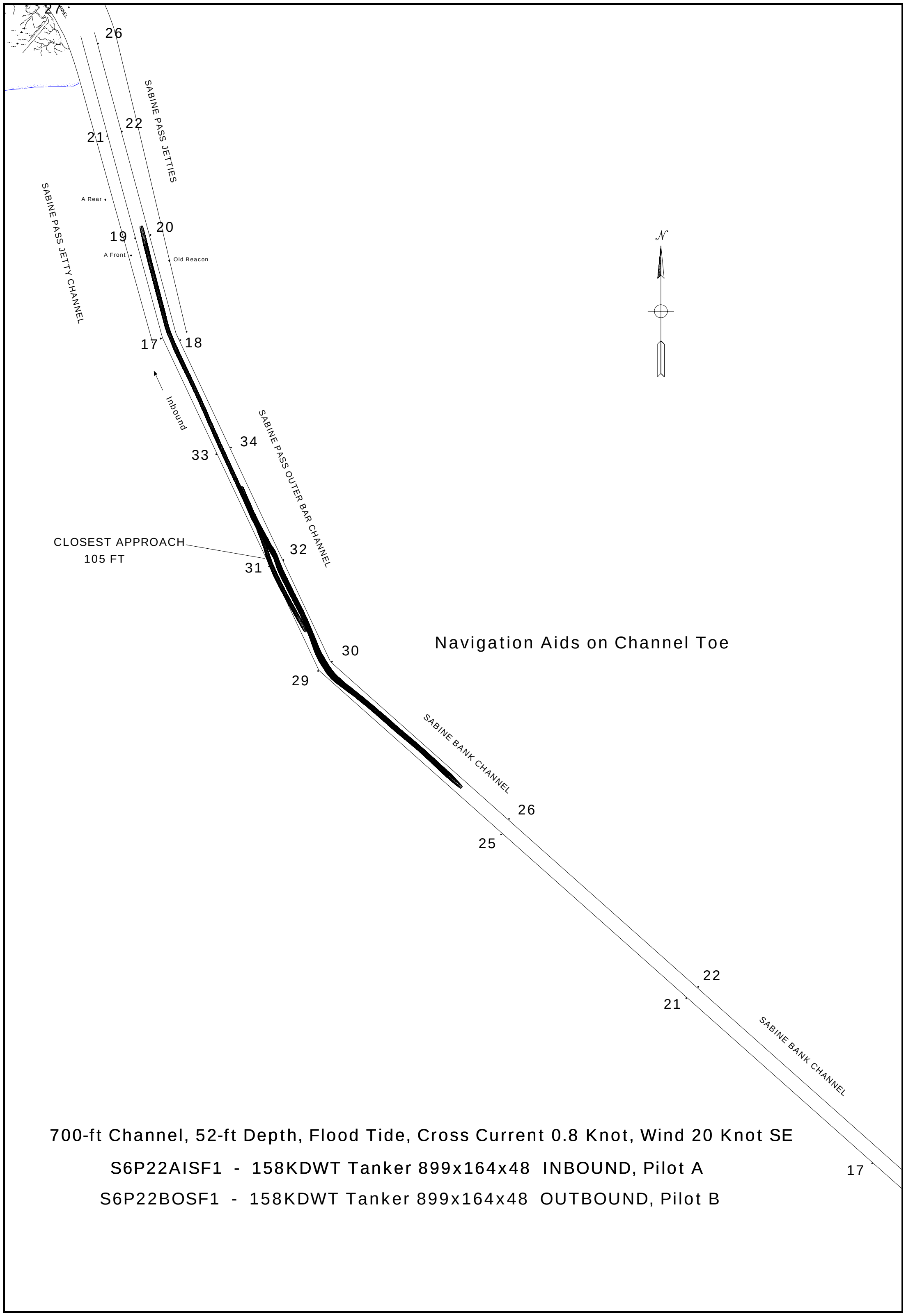

Figure 14: Two-way Run 8, 700 x 52 Channel

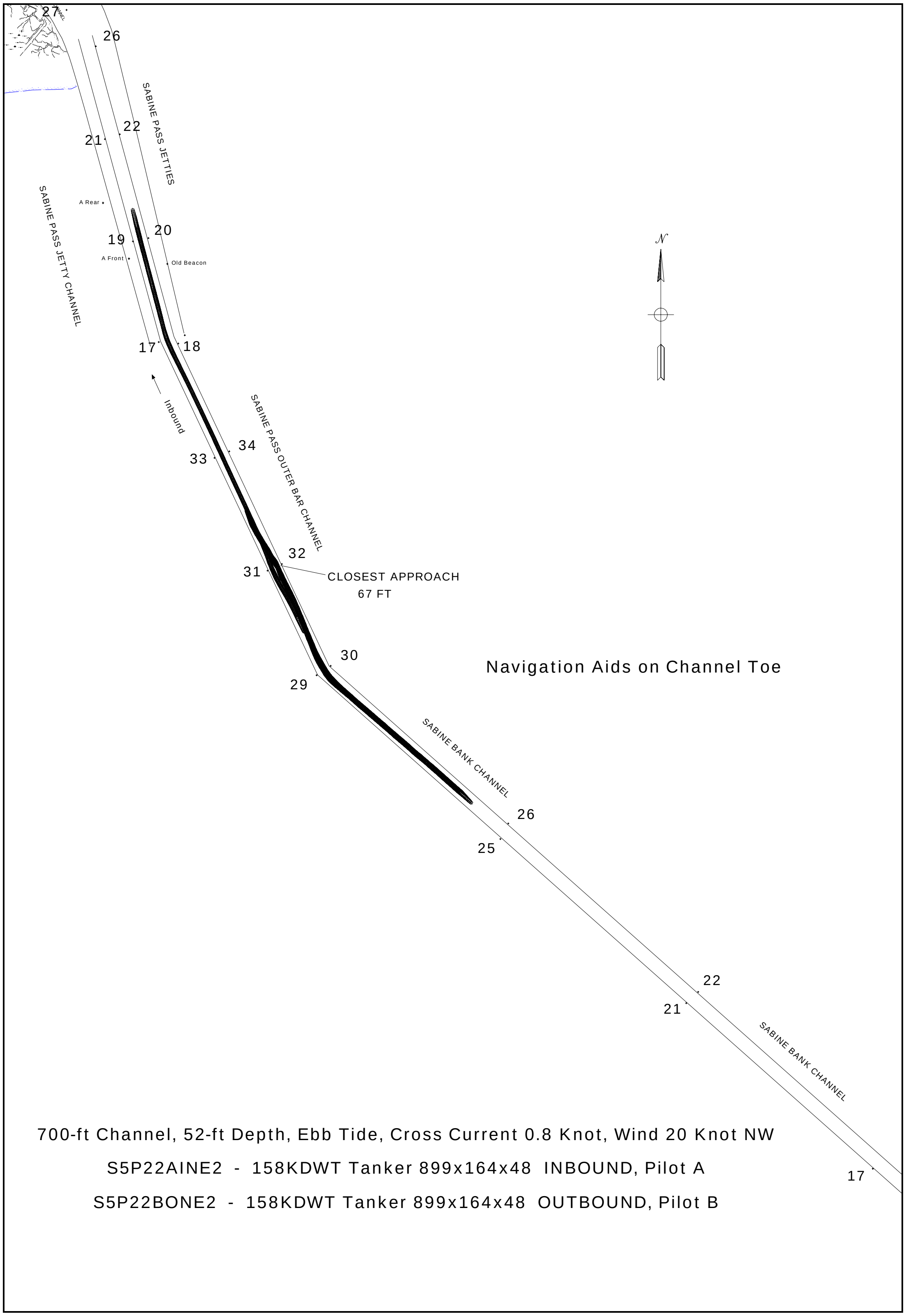

Figure 15: Two-way Run 11, 700 x 52 Channel

One-way LNG Tanker Simulations

Database Development and Test Conditions

Simulations of existing and future LNG tankers in the SNWW entrance channel were conducted at the ERDC simulator. Earlier studies of proposed LNG terminals in the area used several LNG tanker designs; therefore, no modification of ship numerical models was necessary for the entrance channel tests. The ships used for the present study consisted of 1) a 140,000 cubic meter spherical-tank-type vessel (MOSS) 920 ft long, 142 ft wide and 37.4 ft in draft, and 2) a proposed 250,000 cubic meter membrane-type tanker 1126 ft long, 177 ft wide and 39.4 ft in draft.

Since the earlier LNG studies at ERDC focused on proposed terminals in-shore of the SNWW jetties, the simulator database for the present study had to be extended through the jetties and offshore channel segments, including the channel extension beyond the existing sea buoy associated with the proposed deepening. The currents used for the ERDC simulations were extracted from a two-dimensional depth-averaged finite element model (TABS2) similar to the model used for the currents implemented in the SCI simulator. This model was run under spring tide conditions and maximum ebbing and flooding current were extracted for the design conditions. However, as with the SCI database, the current in the offshore channels for the ERDC simulations had to be modified because the current model was not designed to adequately represent the cross-channel circulation patterns in the Gulf of Mexico. The current database modifications for the ERDC simulations focused on the directional transition of flow at the jetty entrance, which was the most critical location for one-way traffic. Figures 16 and 17show the simulator ebb and flood current vectors, respectively, in the vicinity of the jetty entrance.

All the scenarios were found to be safe regardless of channel depth and width or vessel type and draft. The most significant finding by the test pilot was that the current data used in the simulations did not affect the ship in the same fashion as the pilot had experienced in real-life. His opinion was that the cross- channel effect on the ship of the ebb current at the entrance to the jetties was more reminiscent of flood current effects. In the same fashion, the pilot also thought that the reverse was true as well. The current magnitude and direction in the straight reaches of the channel outside of the jetties was modified to match – as closely as possible – the cross-channel current set in the two-way simulations at the SCI simulator. Several iterations of current vector modification were attempted on shorter runs (Figures 33-37) through the jetty entrance; however, the pilot continued to have the opinion that the modeled ebb current affected the ship more like a flood current at the jetty entrance. There was not sufficient time during the study to complete a comprehensive adjustment of the jetty entrance current pattern to match the pilot's experience; however, the primary factor of critical cross-current leading into the jetty was simulated adequately without any handling difficulty noted by the pilot for any of the tested scenarios. Table 4 shows the pilot's overall opinions regarding reduction of the proposed channel width in the offshore reaches of the SNWW – as related to one-way traffic. Table 5 summarizes all the runs conducted during the ERDC phase of the study and includes pilot responses to the post-scenario questionnaire.

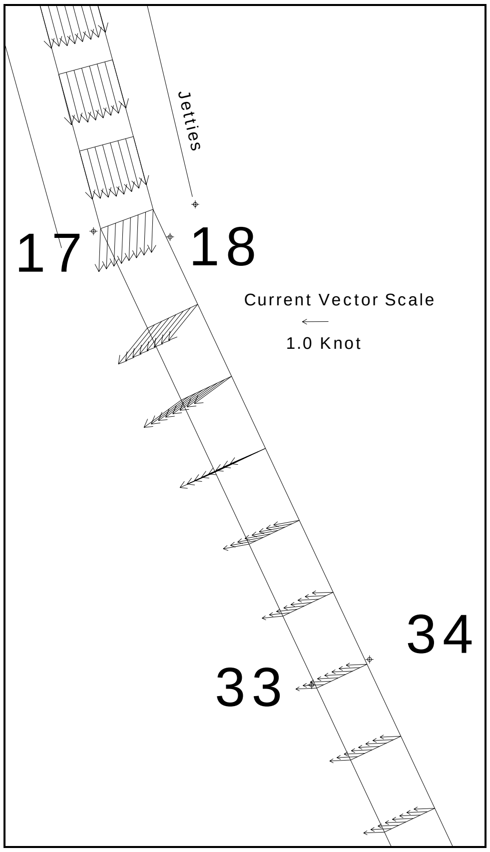

Figure 16: ERDC Simulation Current at SNWW Jetty Entrance – Ebb Tide

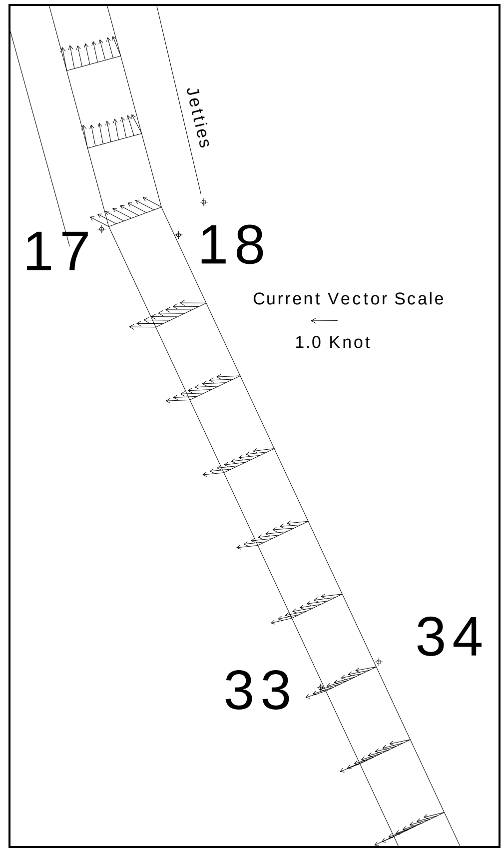

Figure 17: ERDC Simulation Current at SNWW Jetty Entrance – Flood Tide

Table 4: LNG Tanker Simulation Final Pilot Questionnaire

ERDC – Pilot Final Questionnaire – One-way LNG Tanker Simulations				
Pilot	**Overall Realism**	**Handling Difficulty**	**700-ft Channel Safe?**	**Comments**
C	7	3	140KCM: Yes 250KCM: Yes	The [vessels tested] would be safe to operate on the basis of one-way (non-meeting) traffic and the simulated conditions. None of the simulations involved opposing/meeting traffic.

Table 5: ERDC Tests – LNG Ships

Run	Fig.	Channel Width & Depth (ft)	Ship	Pilot	Dir	Cross Current (knots)/Tide	Wind (knots)	Scenario Pilot Questionnaire			
								Overall Realism	Difficulty	Safe?	Comments
EX1CISF1	18	800 x 42	920x142x37.4	C	In	0.8 /Flood	SE20	8	5	Yes - One-way traffic in good visibility provided no apparent difficulties maneuvering the simulated vessel. I did not experience any type of cushion effect or, at the least, was not apparent. The scenario would be considered safe based on simulated conditions.	Red buoys appeared unlit and difficult to see. Speed did not significantly reduce, as anticipated, when large courses changes were made.
EX1CINE1	19	800 x 42	920x142x37.2	C	In	0.8/Ebb	NW20	7	4	Yes – Ebb tide effects appeared stronger than experienced. Western set stronger than anticipated for given conditions but were manageable.	Range lights difficult to distinguish.
EX1CONE1	20	800 x 42	920x142x37.2	C	Out	0.8/Ebb	NW20	8	4	Yes – Currents in jetty reach weaker than typically observed. Stronger than typically observed cross current at end off jetties. Simulation conditions would be generally considered safe for this scenario.	Transition from jetties to Bar Channel not simulated accurately, in the opinion of this pilot.
EX1COSF1	21	800 x 42	920x142x37.4	C	Out	0.8/Flood	SE20	8	4	Yes – Currents and simulation typical of real life conditions.	
EX2CINE1	22	800 x 42	1128x177x39.4	C	In	0.8/Ebb	NW20	7	7	Yes – It would be safe, basis no opposing outbound traffic. Currents between jetty entrance and buoys "33-34" seemed a-typical for given conditions of scenario.	
EX2CONE1	23	800 x 42	1128x177x39.4	C	Out	0.8/Ebb	NW20	7	3	Yes – Given existing channel specs and simulated conditions, scenario would be safe.	
EX2CISF1	24	800 x 42	1128x177x39.4	C	In	0.8/Flood	SE20	8	3	Yes – Given existing channel configuration and simulated conditions, scenario would be deemed safe.	
EX2COSF1	25	800 x 42	1128X177X39.4	C	Out	0.8/Flood	SE20	8	3	Yes – Given scenario parameters, and one-way traffic, this scenario would be deemed safe.	
P12COSF1	26	800 x 52	1128x177x39.4	C	Out	0.8/Flood	SE20	7	3	Yes – Given simulated conditions and one-way traffic, in the 800 ft channel, this scenario would be deemed safe.	
P12CISF1	27	800 x 52	1128x177x39.4	C	In	0.8/Flood	SE20	7	3	Yes – Given one-way traffic with 800 ft wide channel and simulated conditions, this scenario would be very safe.	

Run	Fig.	Channel Width & Depth (ft)	Ship	Pilot	Dir	Cross Current (knots)/Tide	Wind (knots)	Scenario Pilot Questionnaire			
								Overall Realism	Difficulty	Safe?	Comments
P12CONE1	28	800 x 52	1128x177x39.4	C	Out	0.8/Ebb	SE20	8	4	Yes – Basis one-way traffic and simulated conditions, the scenario in the 800 ft channel would be deemed safe.	
P12CINE1	29	800x52	1128x177x39.4	C	In	0.8/Ebb	NW20	6	4	Yes: One-way traffic and simulated conditions would provide for a safe transit	Ebb conditions continue to act more like flood.
P22CINE1	30	700 x 52	1128x177x39.4	C	In	0.8/Flood	NW20	7	6	Yes – One way traffic with given conditions would allow for a safe passage.	"Currents across channel between Jetty Entrance and Buoys "33-34" not accurate given ebb conditions as simulated. Pressure felt at Buoys "29-30" while making turn.
P22CISF1	31	700 x 52	1128x177x39.4	C	In	0.8/Flood	SE20	6	3	Yes – No apparent pressure resulting from channel width. However, the simulator does not accurately represent the effects of bank cushion/suction, again, given simulated conditions, this scenario would be safe.	Westerly set not accentuated by flood tide as is typical in real life.
P22CONE1	32	700 x 52	1128x177x39.4	C	Out	0.8/Ebb	NW20	7	5	Yes – Given the conditions as simulated, and one-way traffic, this scenario would be deemed safe.	
P22CISF2	33	700x 52	1128x177x39.4	C	In	0.8/Flood	SE20	6	3	Yes – No apparent difference in modified flood current, scenario again deemed safe.	Modified flood currents near jetty
P22COSF1	34	700 x 52	1128x177x39.4	C	Out	0.8/Flood	SE20	7	3	Yes – Given one-way traffic and simulated conditions, scenario would be deemed safe.	
P22CISF3	35	700 x 52	1128x177x39.4	C	In	0.8/Flood	SE20	7	3	Yes – Given currents and simulated conditions, and basis one-way traffic, this scenario would be deemed safe	No appreciable change noticed with modified flood conditions.
P24CISF1	36	800 x 52	790x138x39.6	C	In	0.8/Flood	SE20	6	3	Yes – Given vessel and conditions, scenario would be considered safe.	
P24CISF2	37	800 x 52	790x138x39.6	C	In	0.8/Flood	SE20	5	3	Yes – Given currents and parameters of this simulation, it would be deemed a safe scenario.	

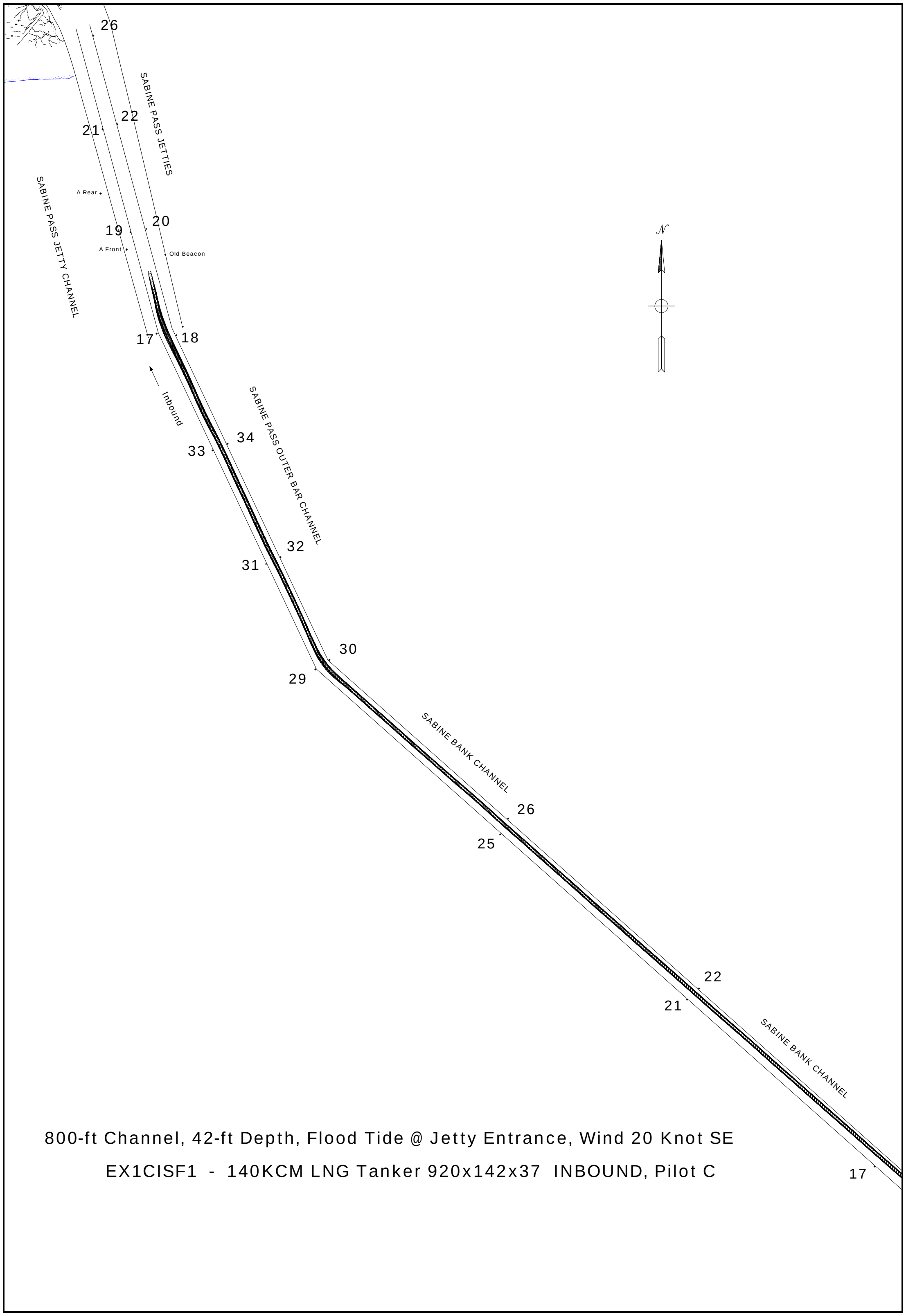

Figure 18: One-way Run 1

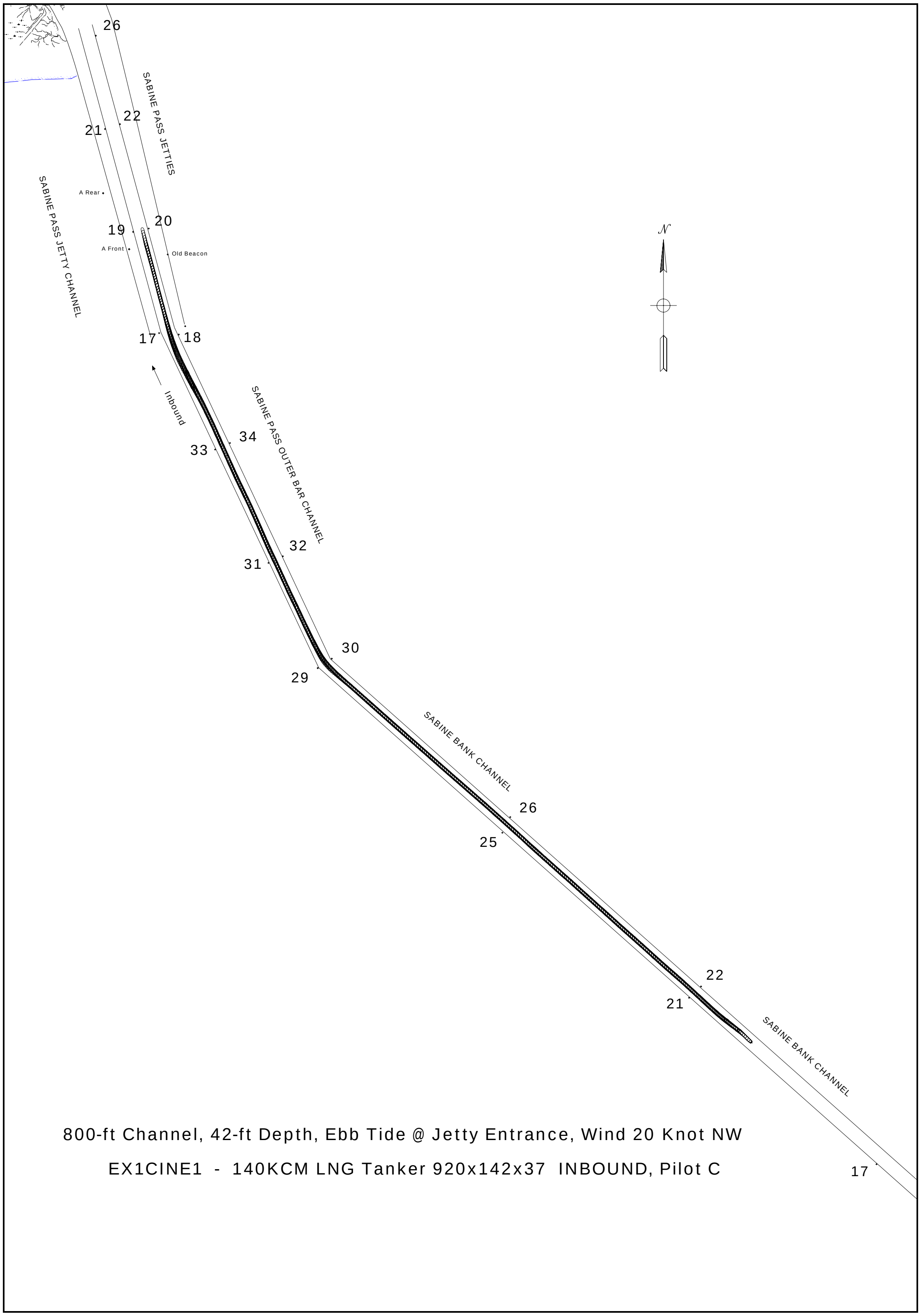

Figure 19: One-way Run 2

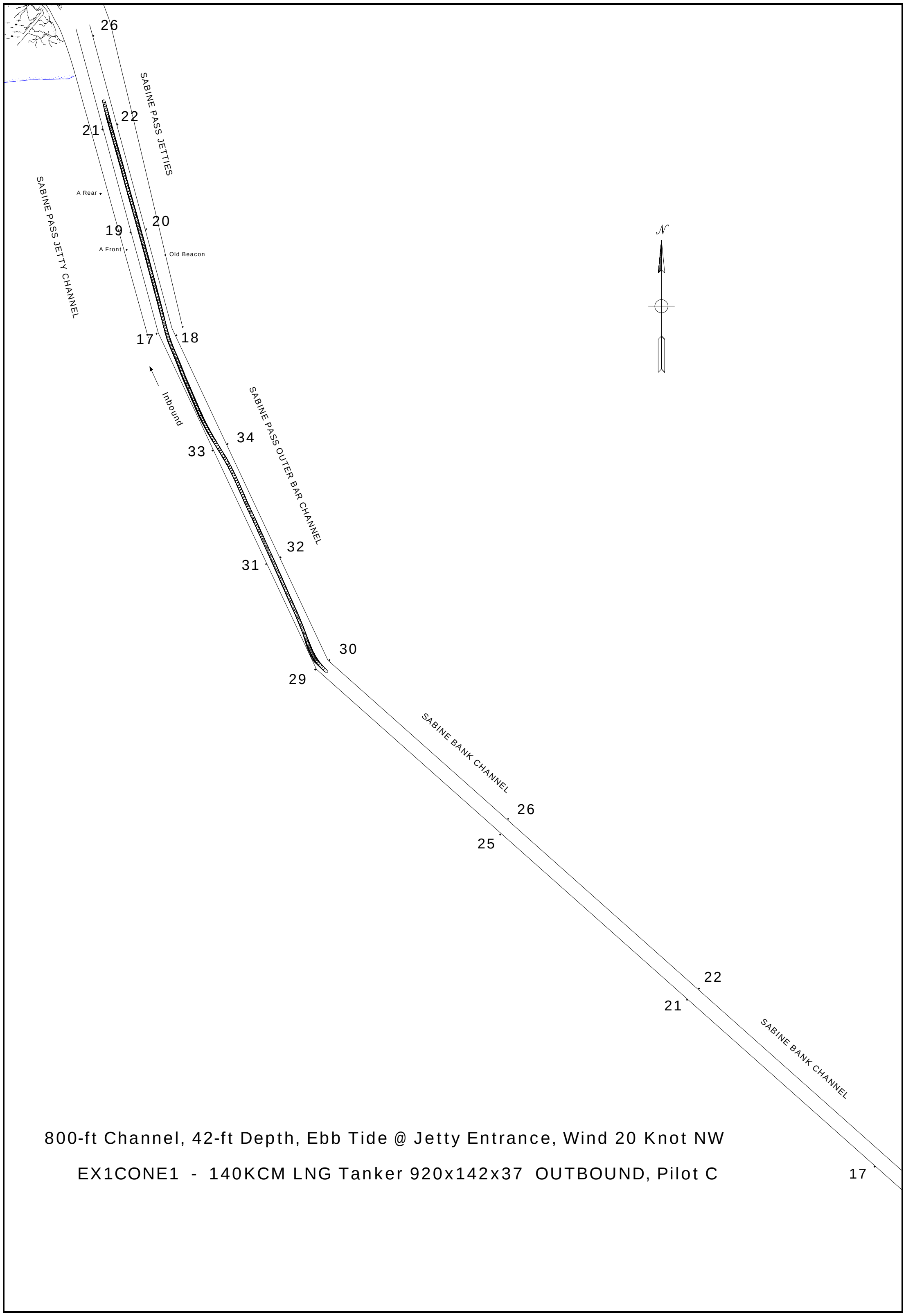

Figure 20: One-way Run 3

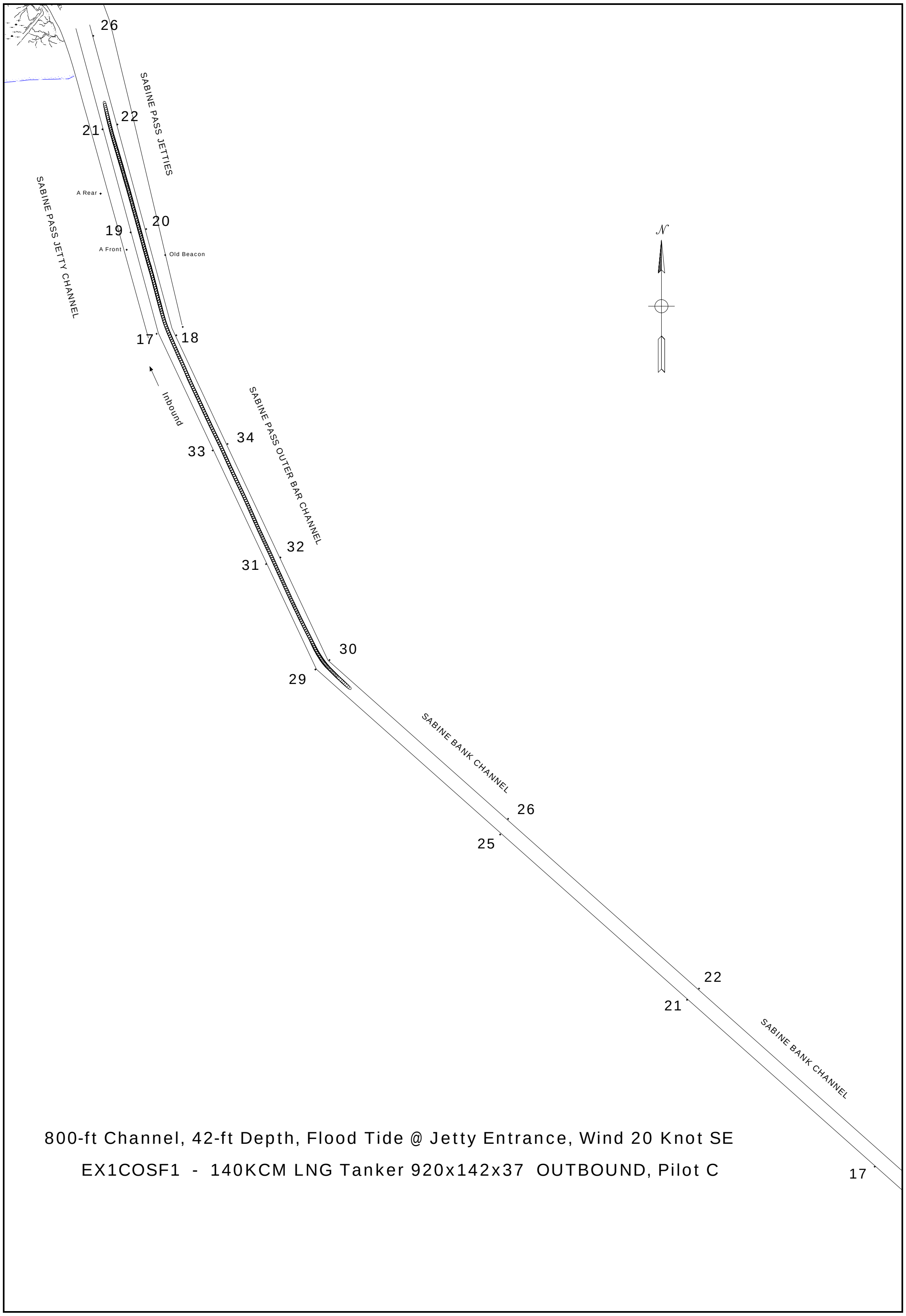

Figure 21: One way Run 4

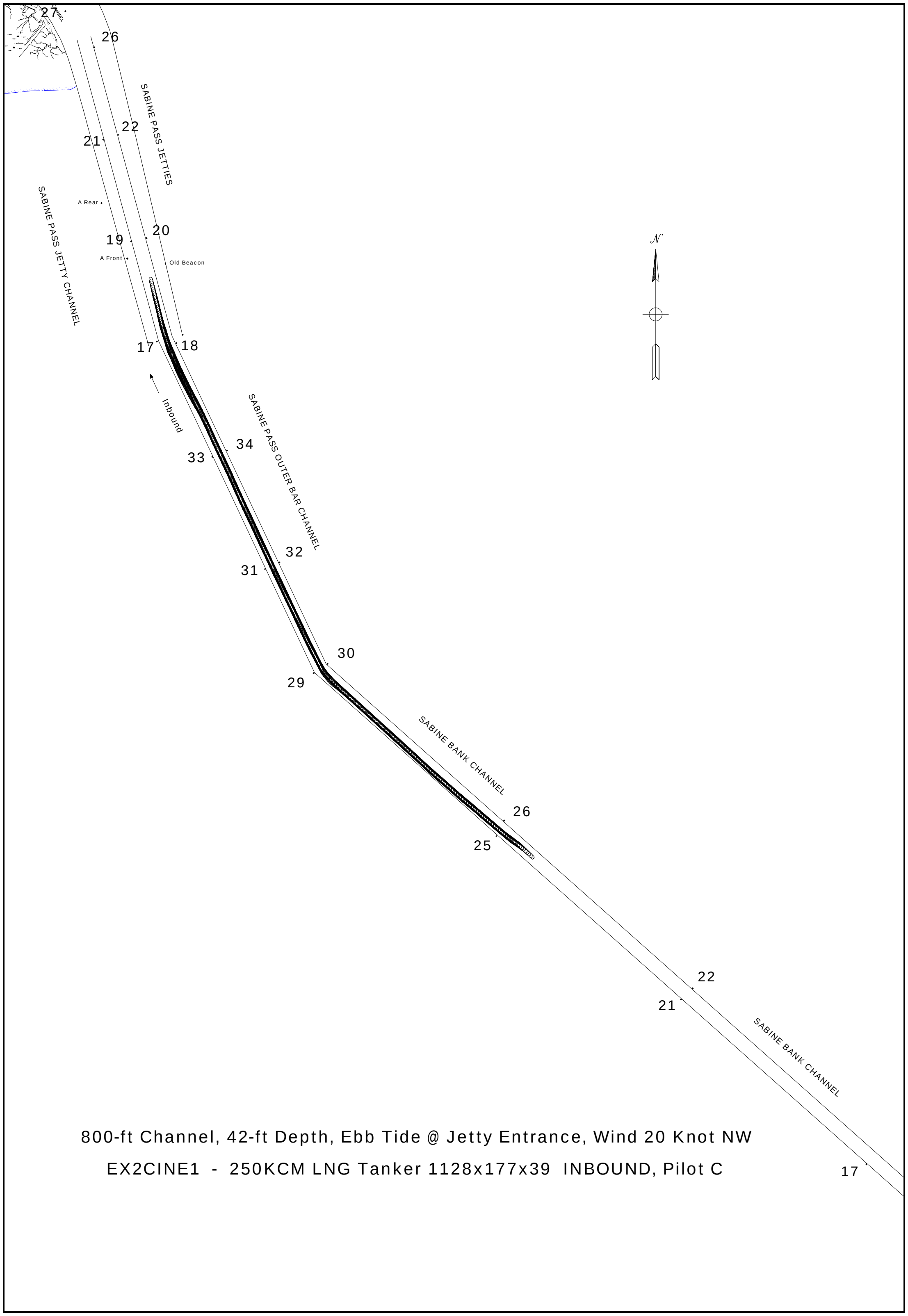

Figure 22: One way Run 5

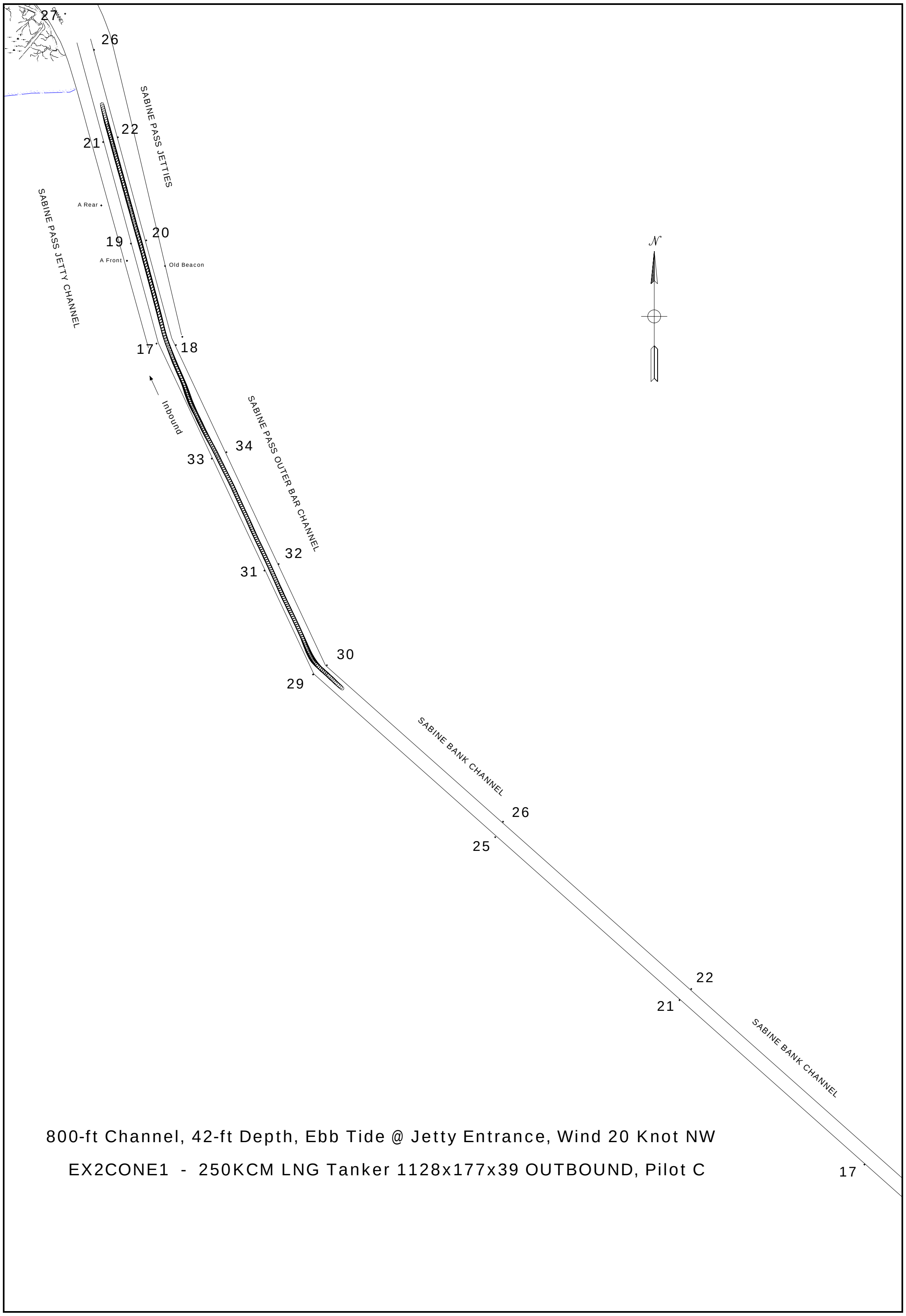

Figure 23: One way Run 6

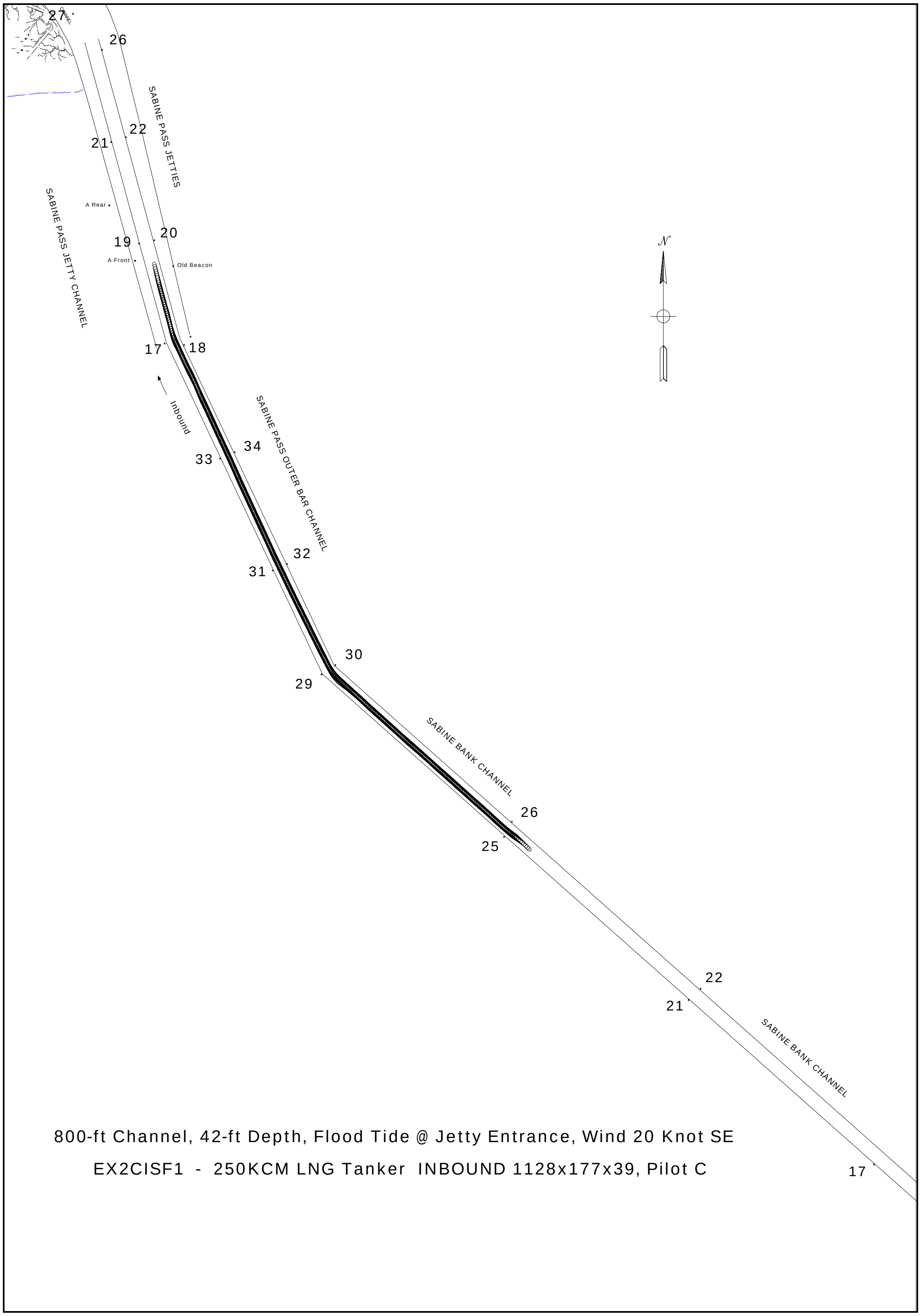

Figure 24: One way Run 7

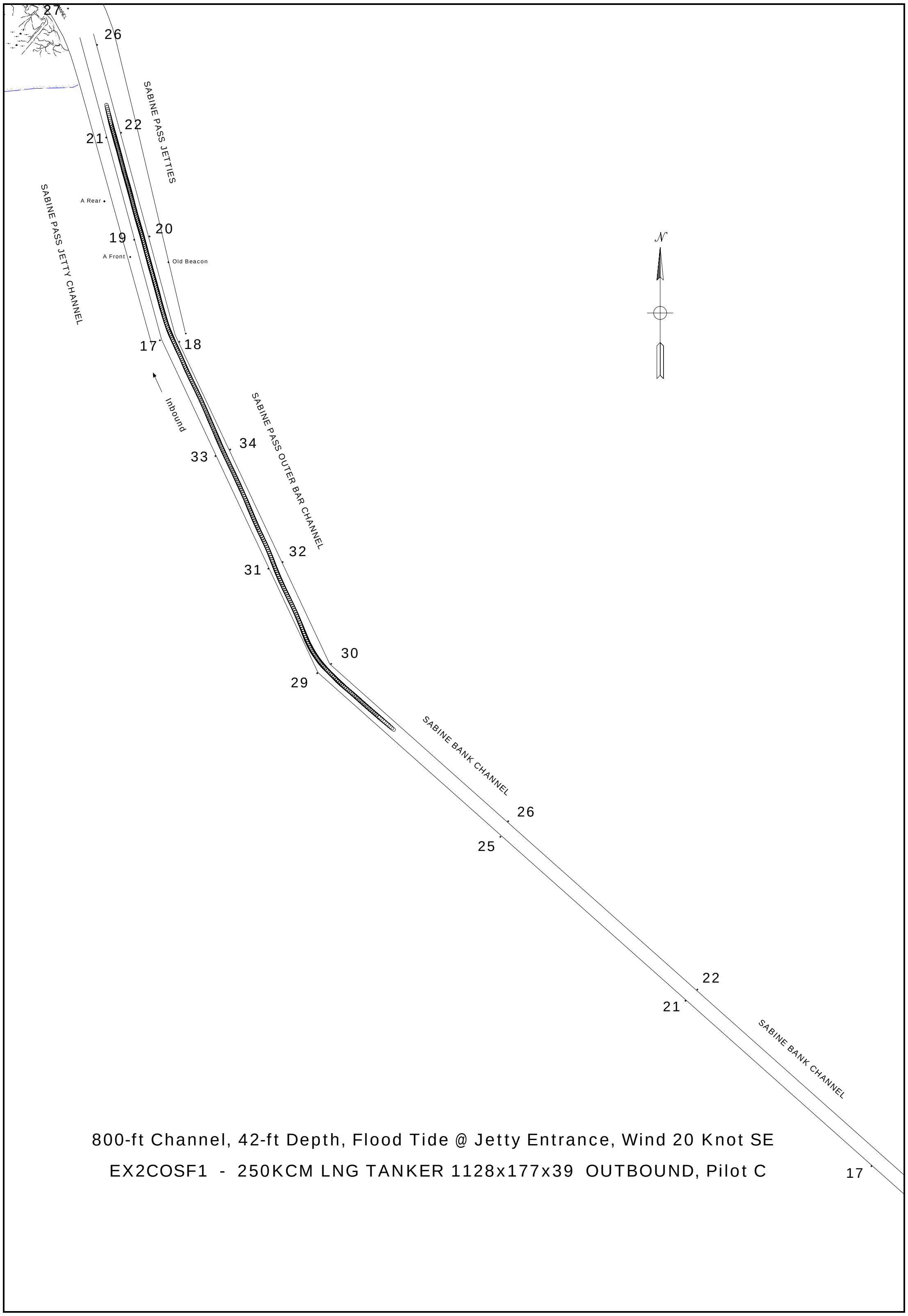

Figure 25: One way Run 8

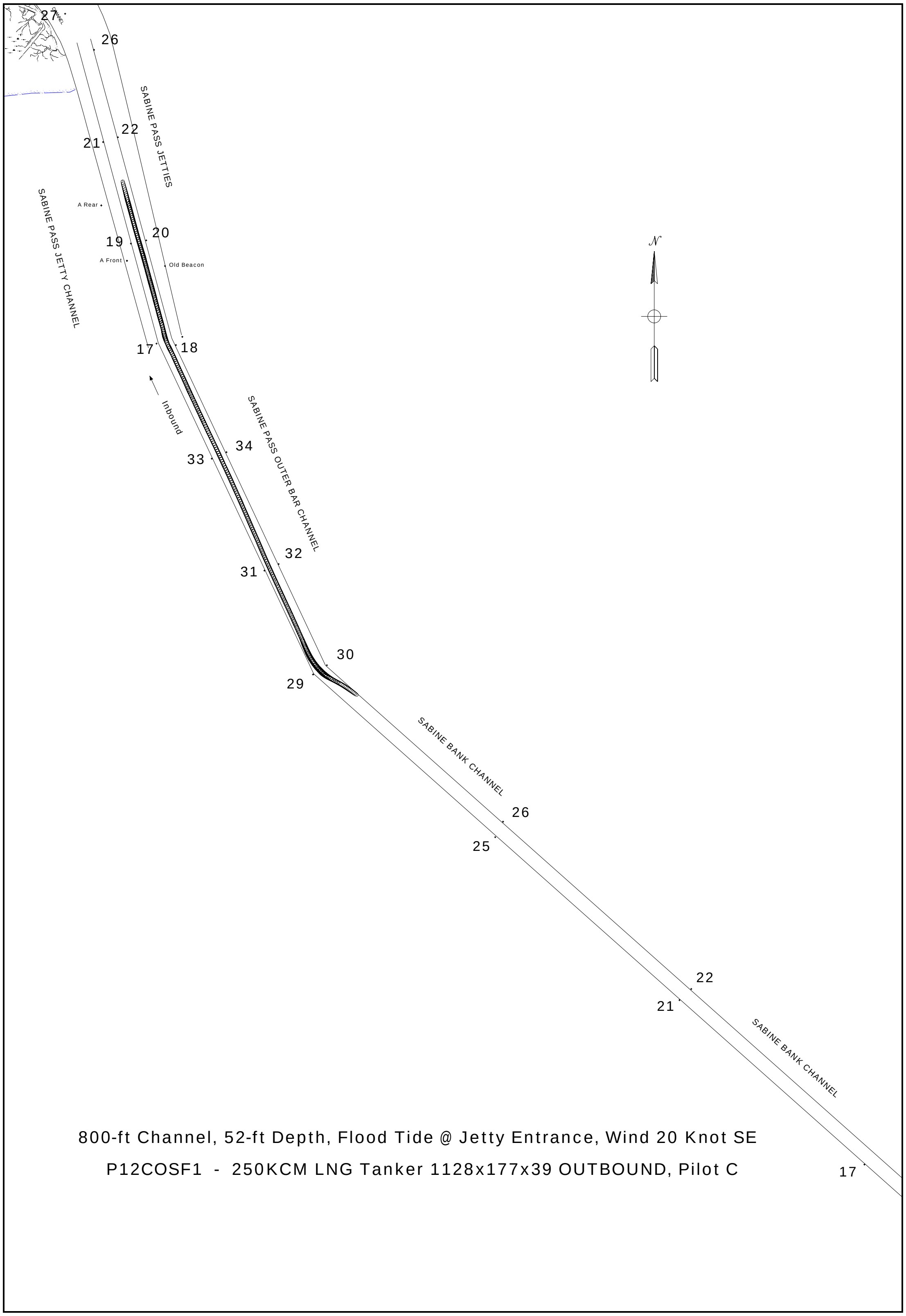

Figure 26: One way Run 9

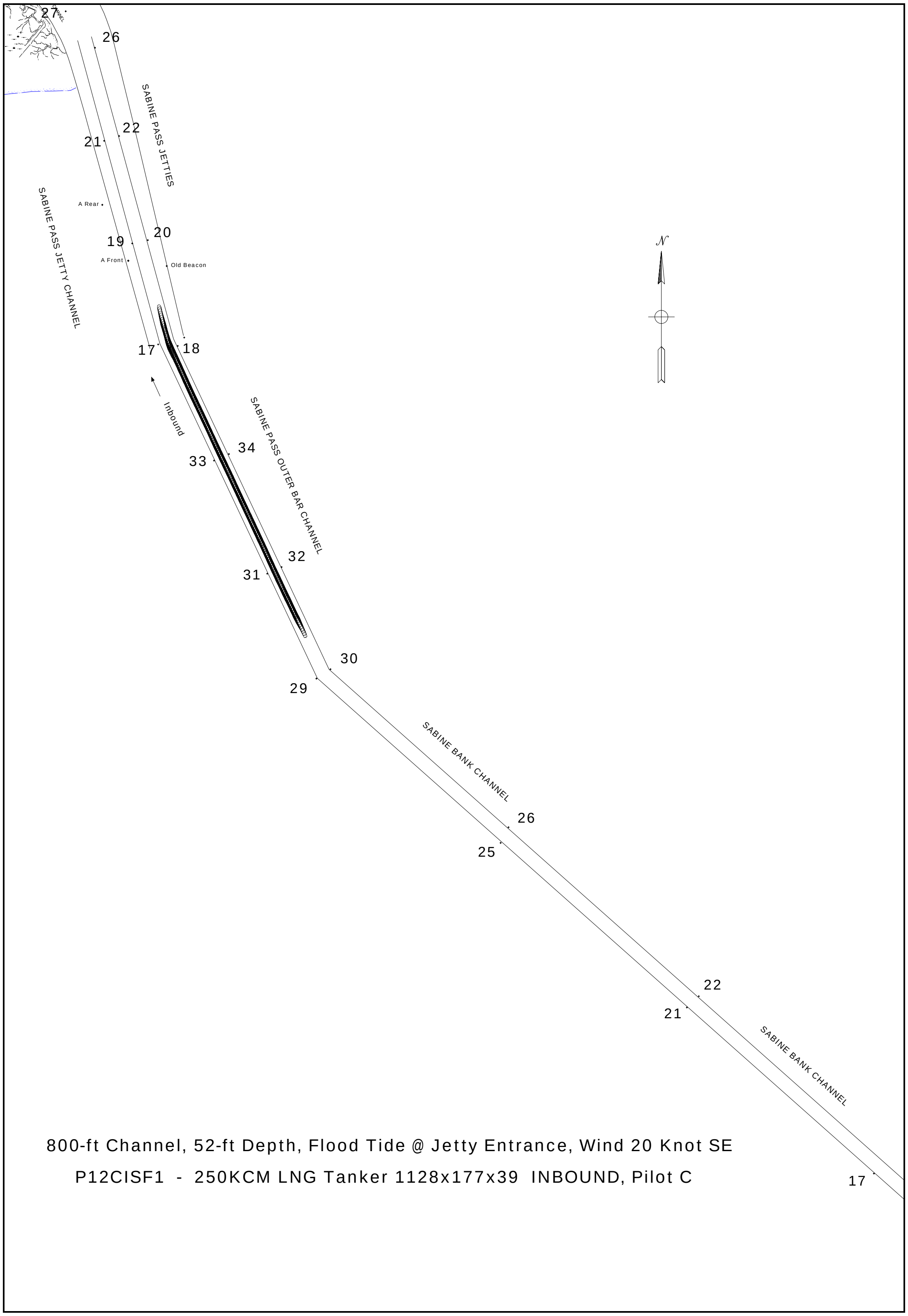

Figure 27: One way Run 10

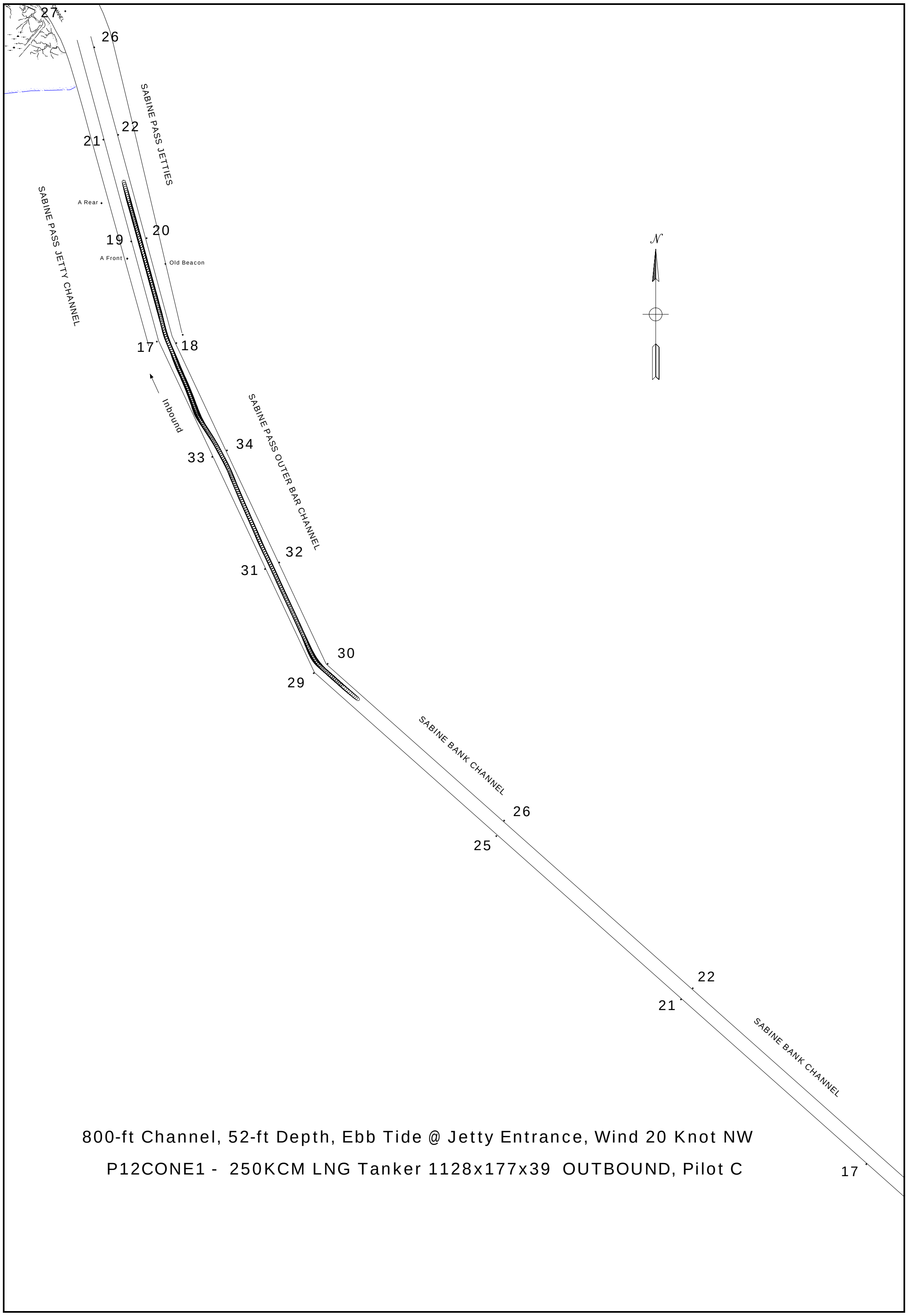

Figure 28: One way Run 11

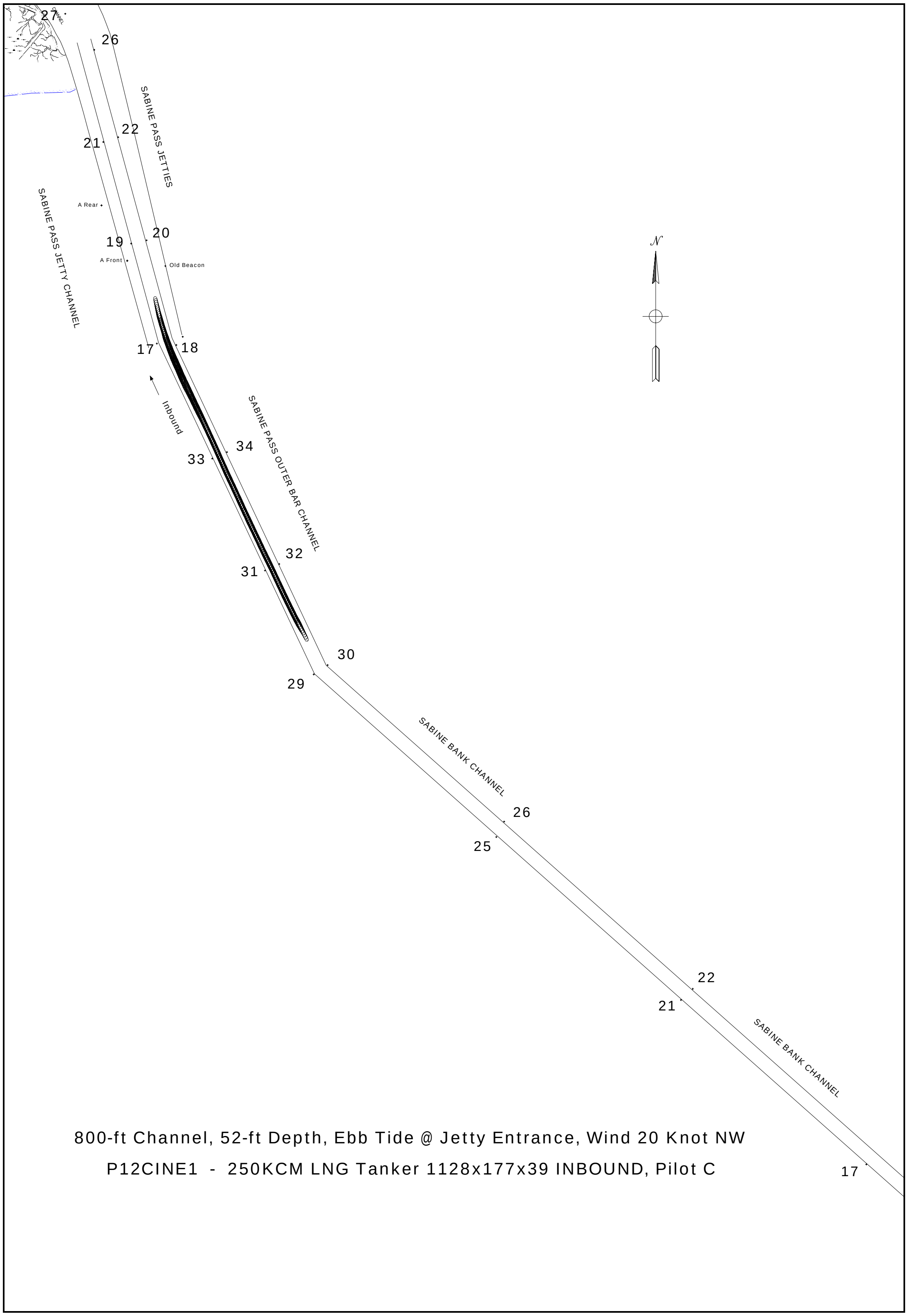

Figure 29: One way Run 12

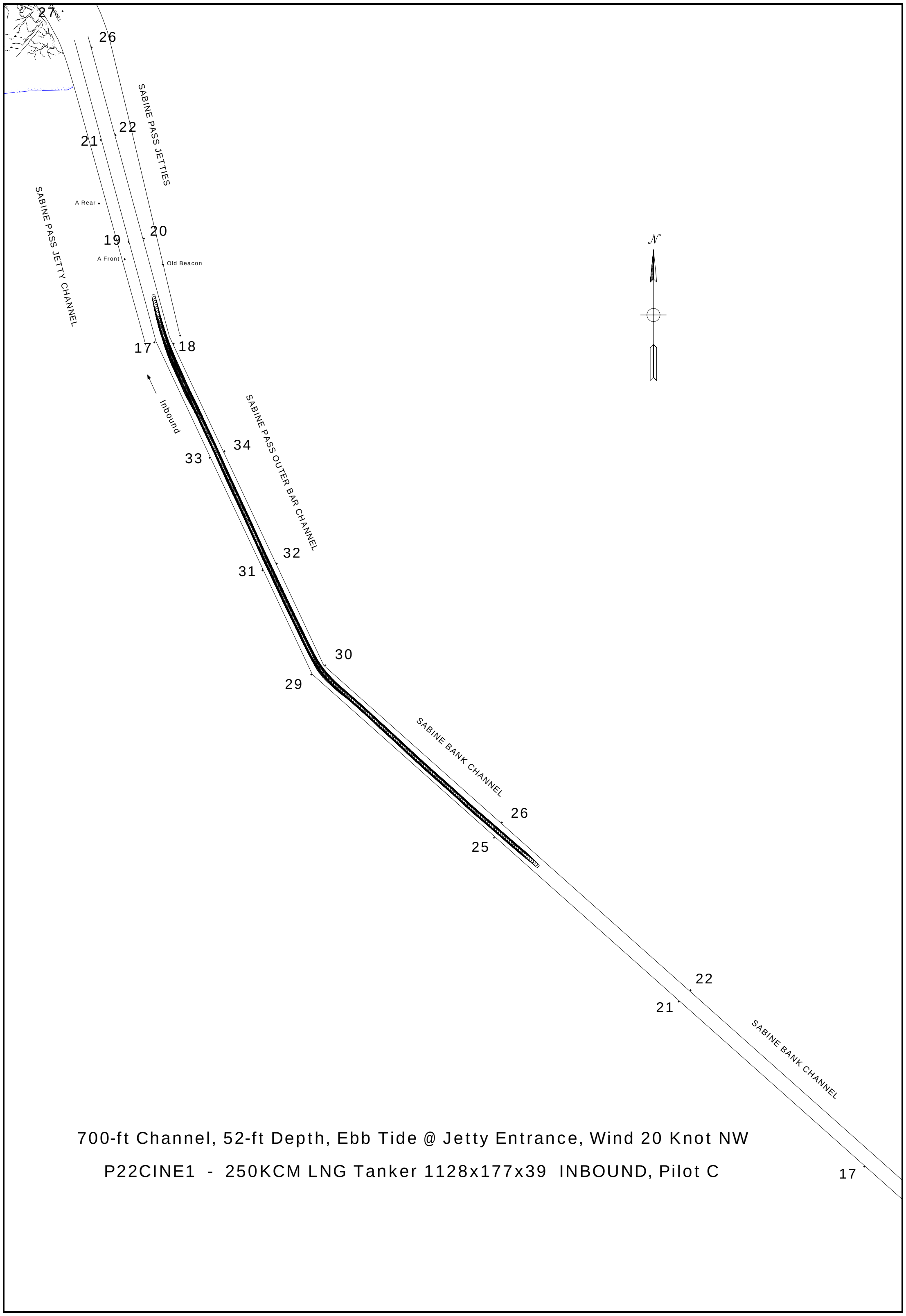

Figure 30: One way Run 13

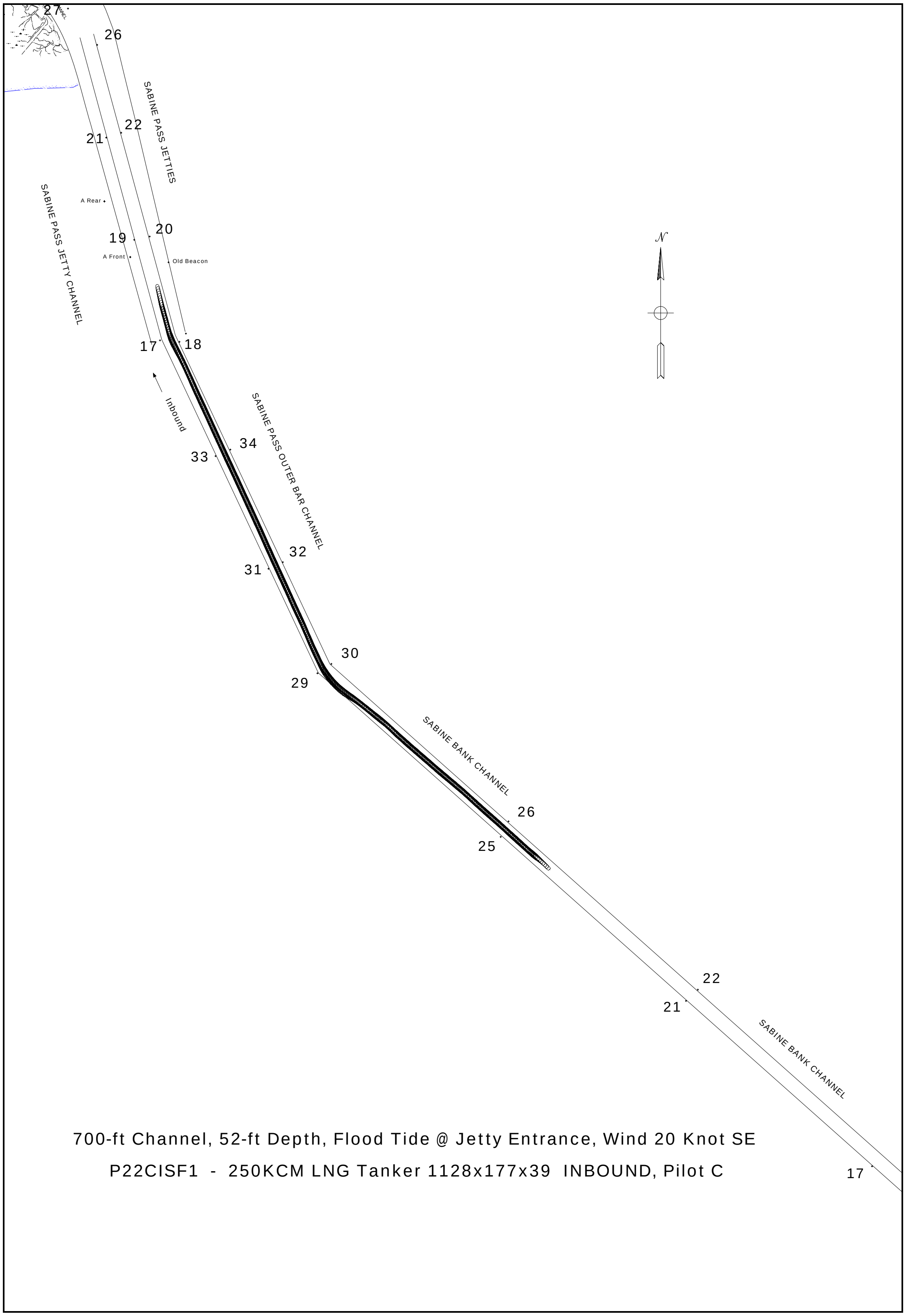

Figure 31: One way Run 14

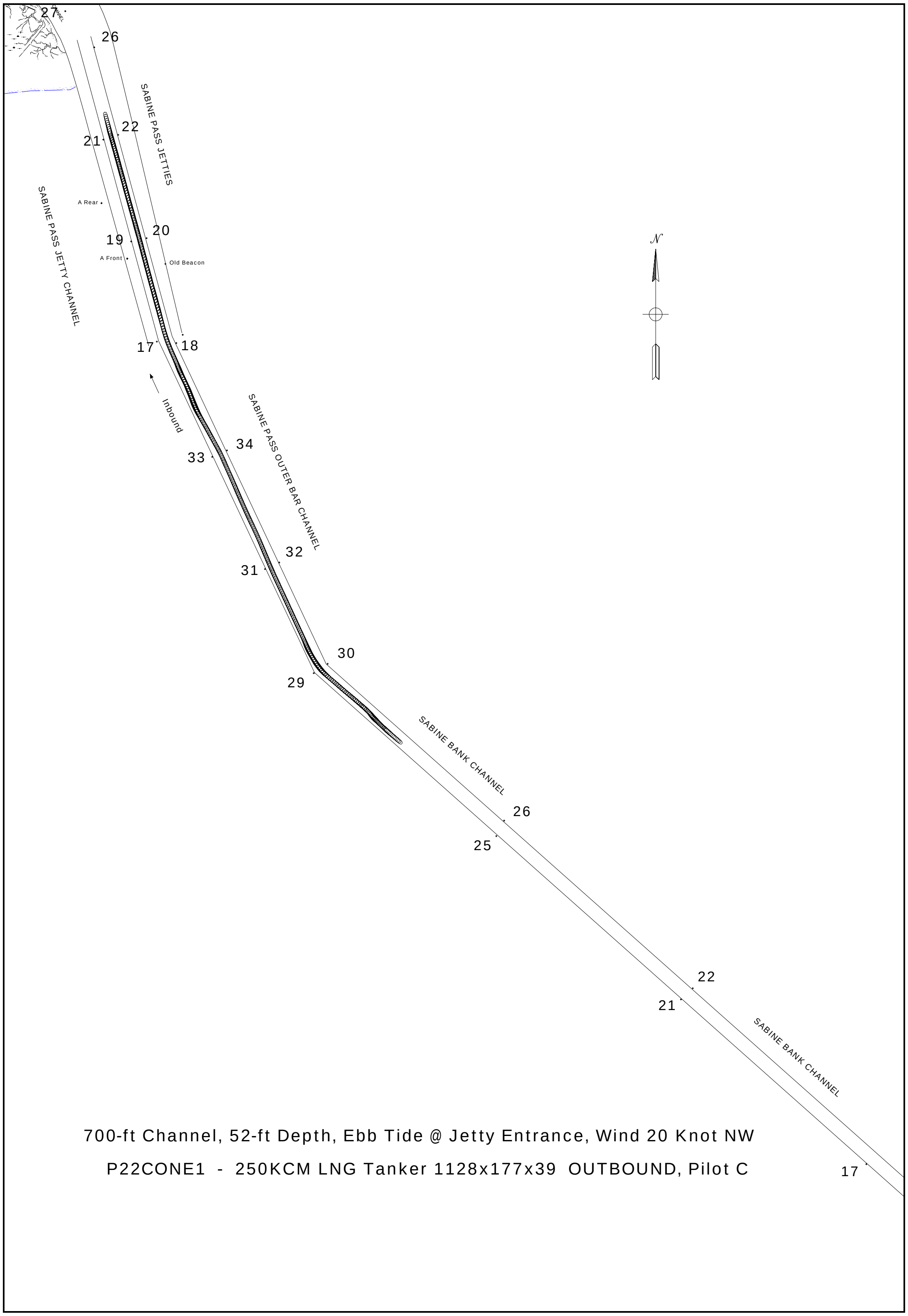

Figure 32: One way Run 15

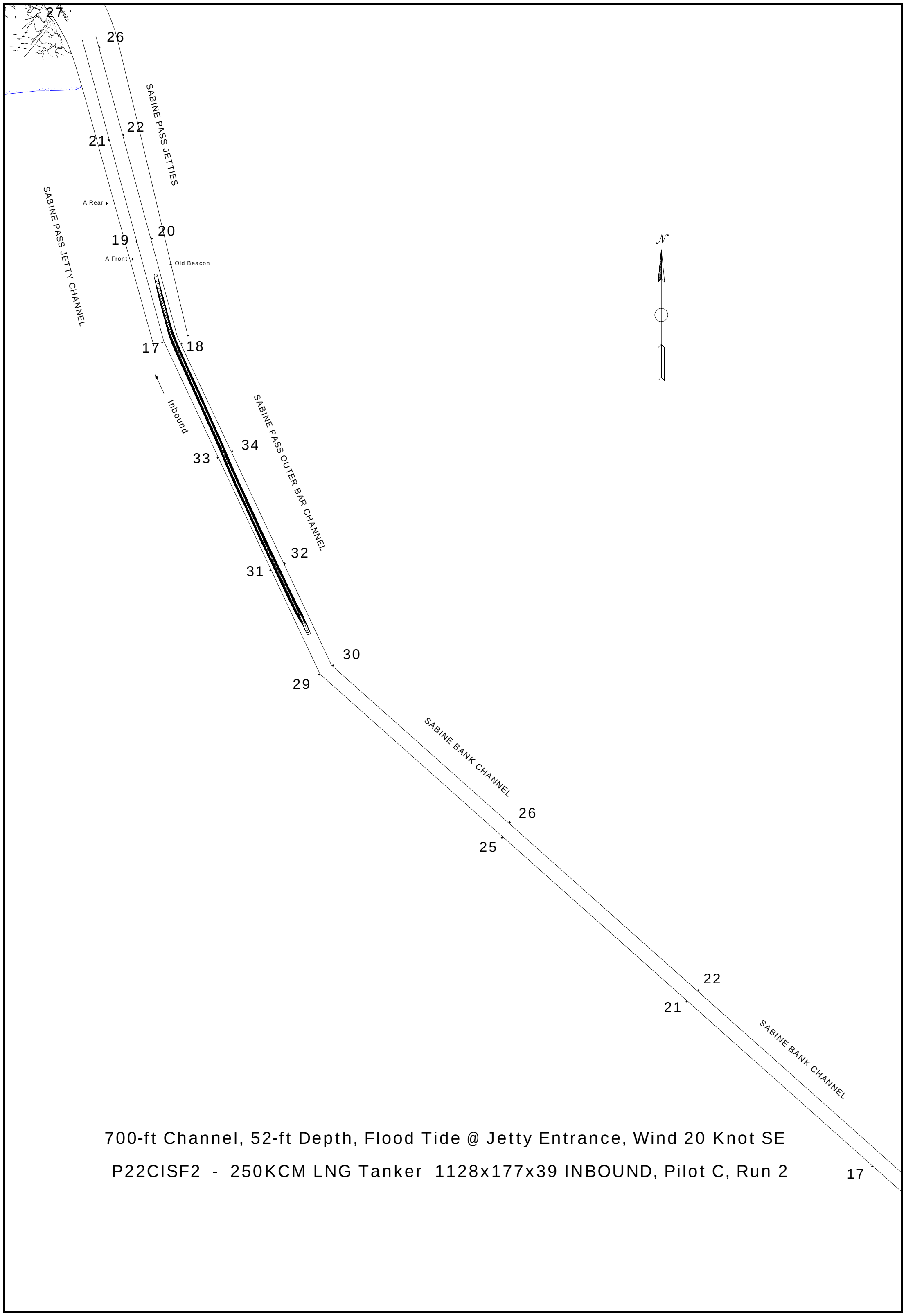

Figure 33: One way Run 16

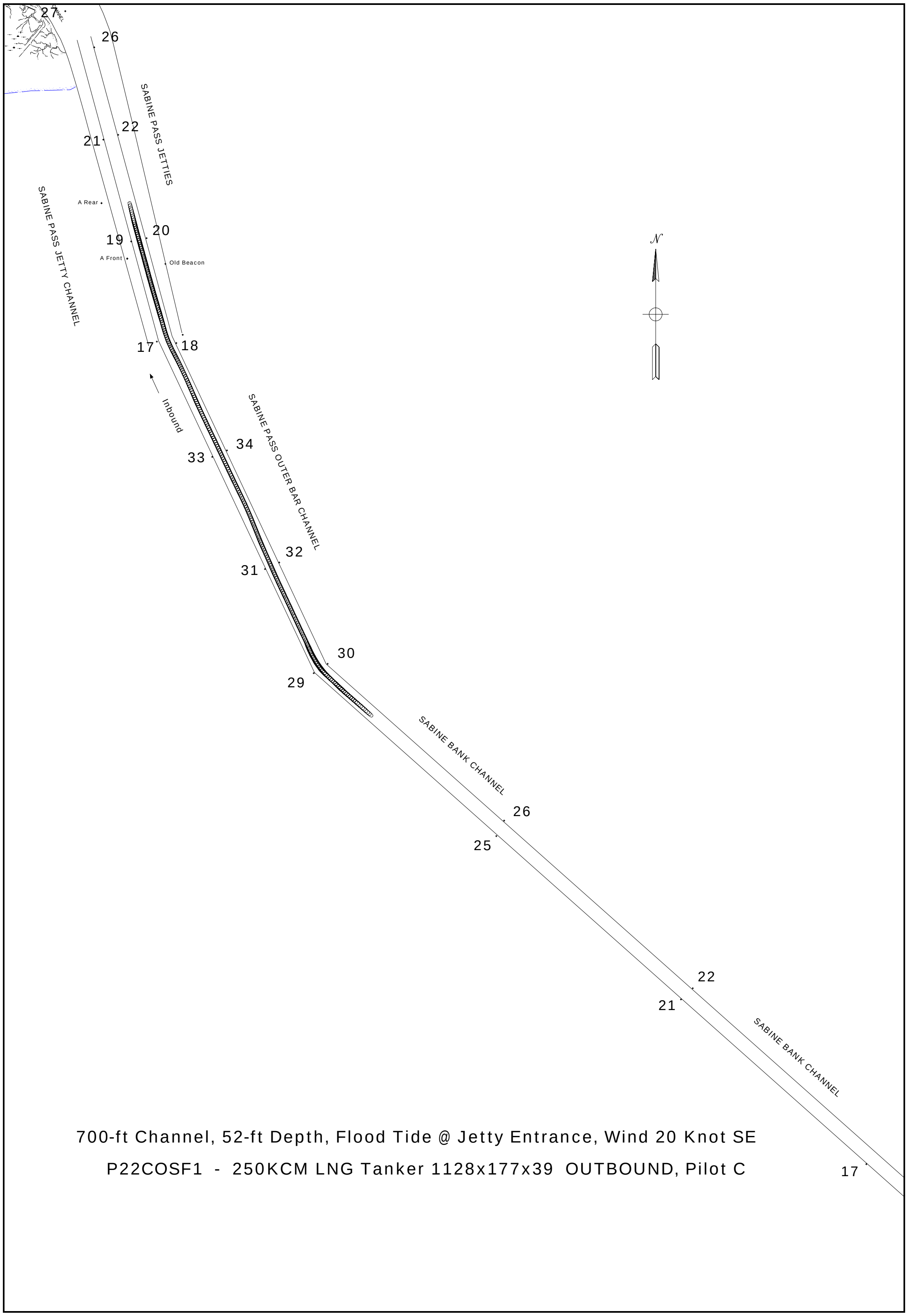

Figure 34: One way Run 17

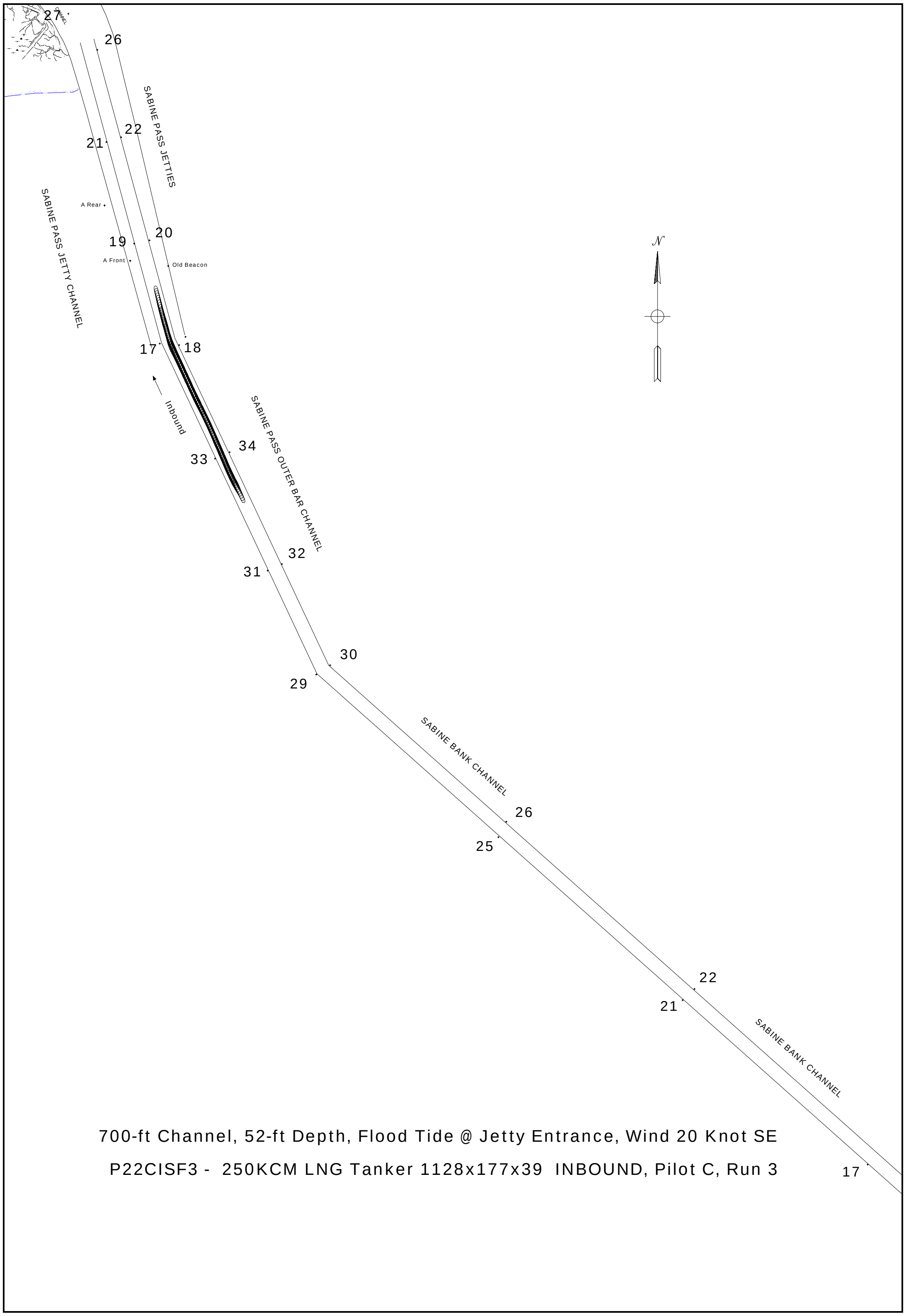

Figure 35: One way Run 18

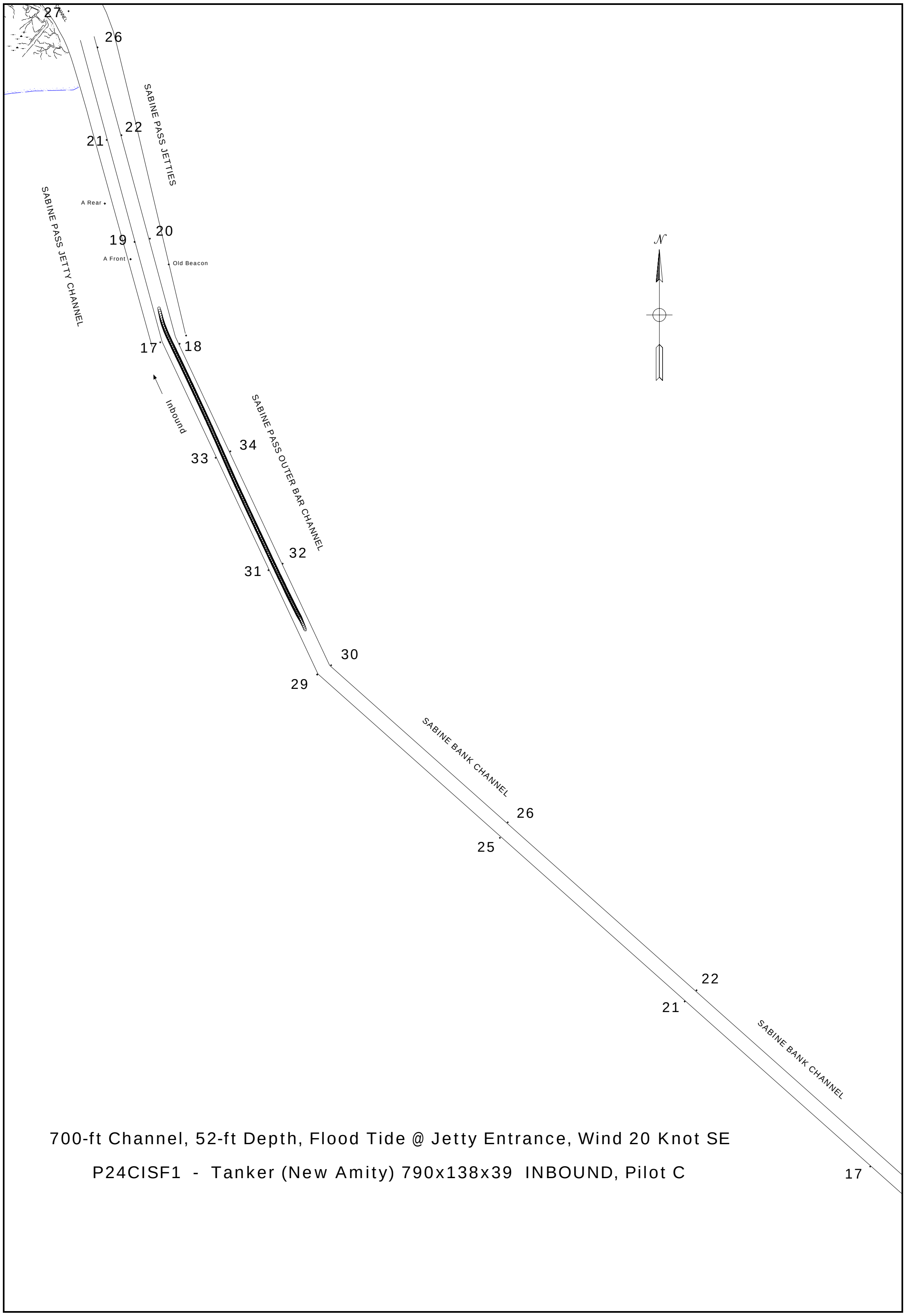

Figure 36: One way Run 19

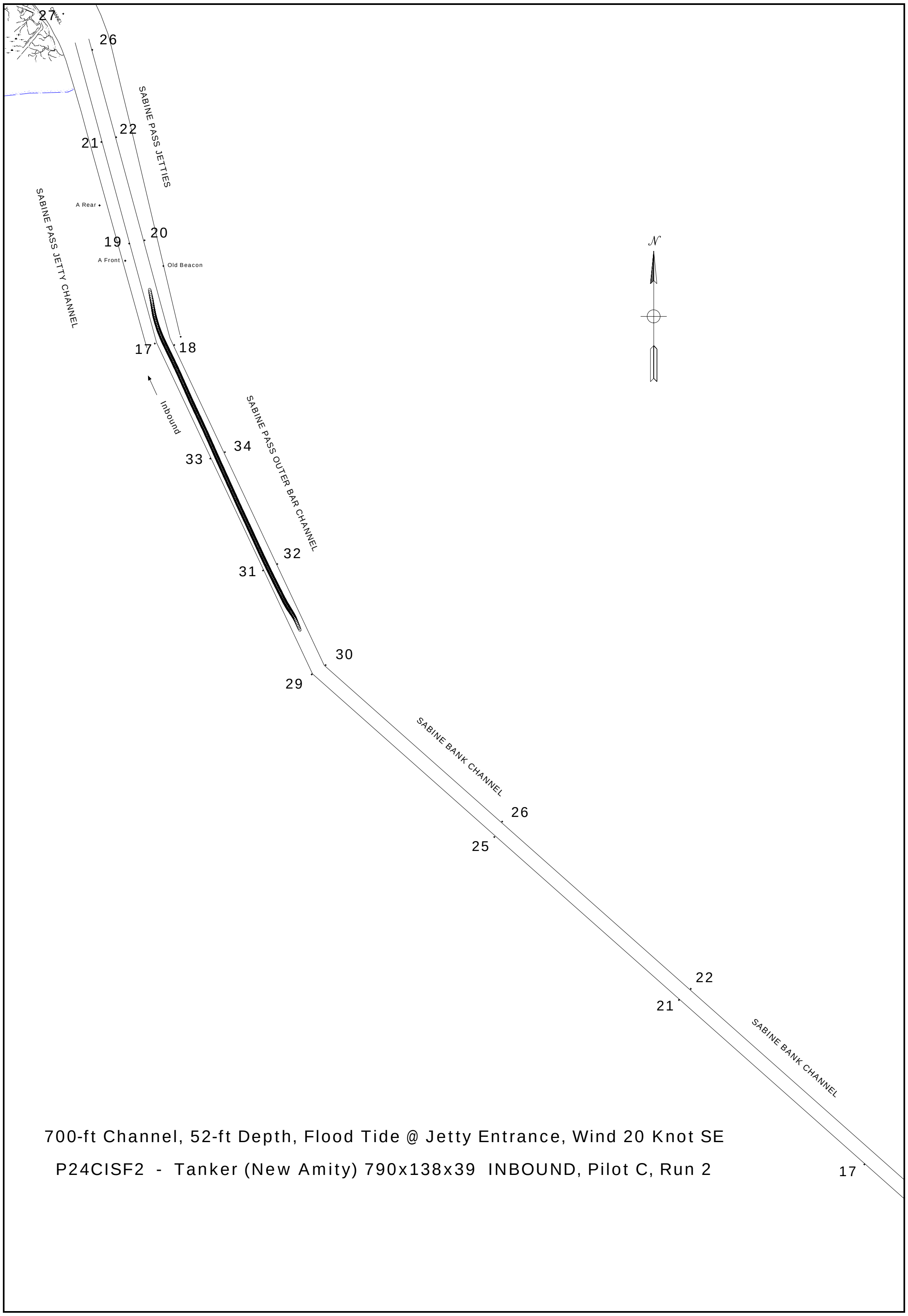

Figure 37: One way Run 20