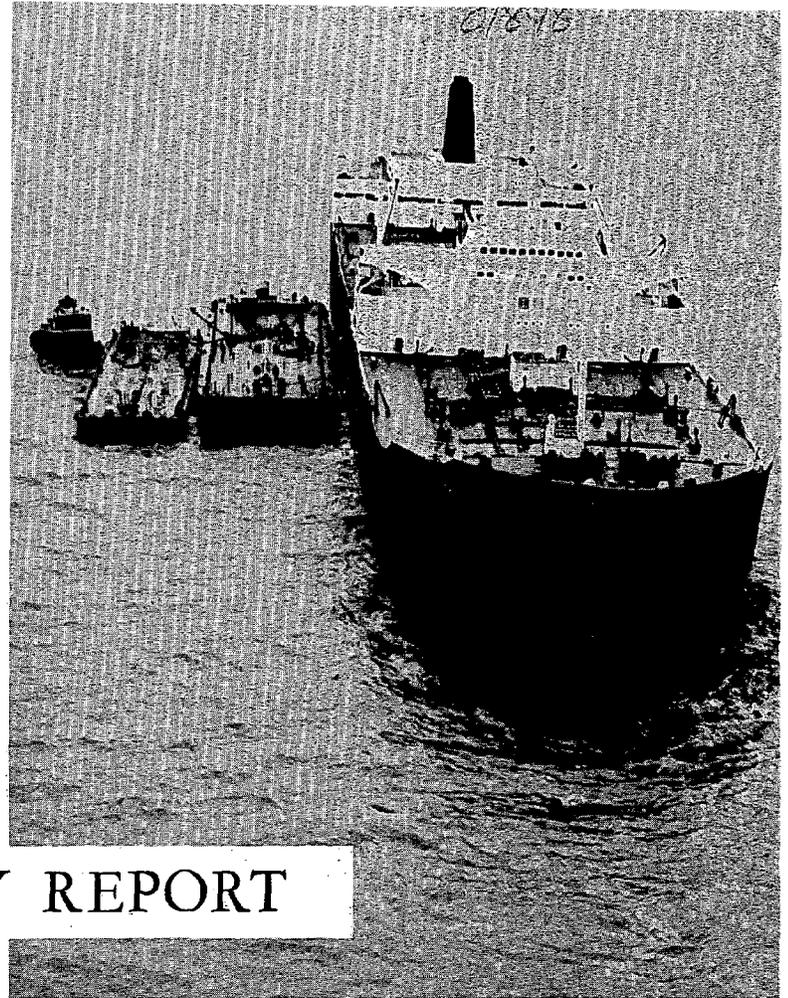


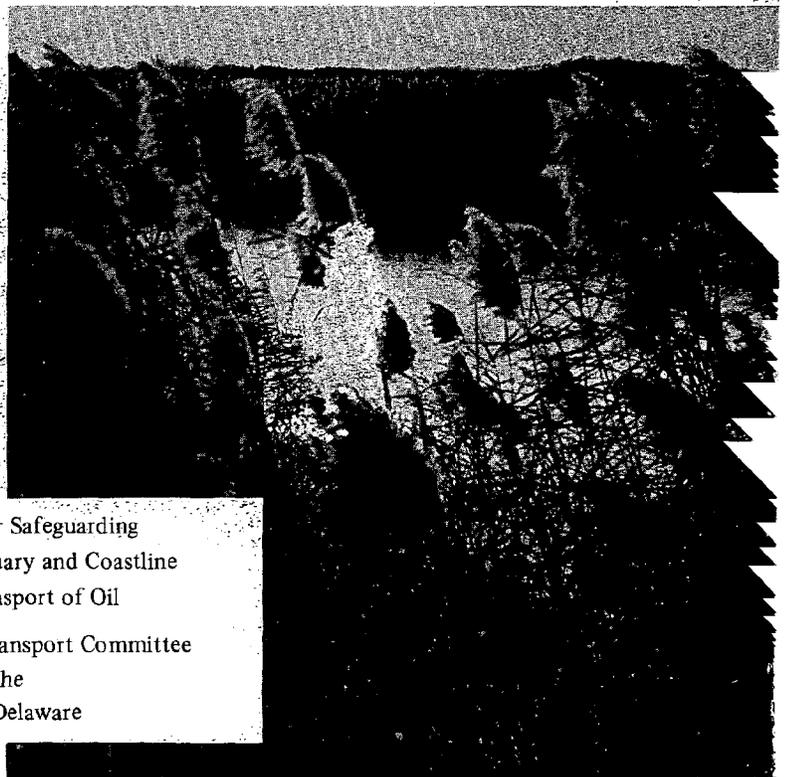
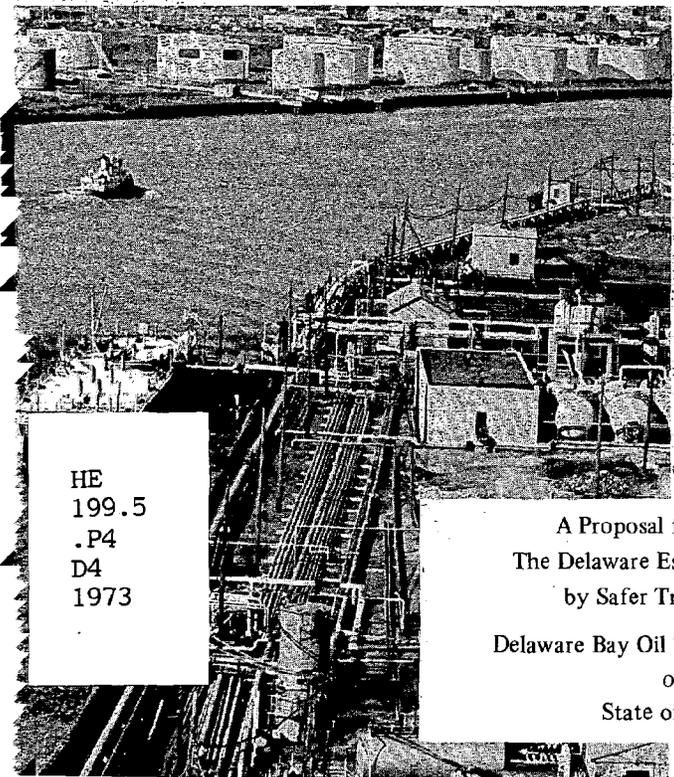
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SUMMARY REPORT

ENERGY, OIL, AND THE STATE  
OF DELAWARE



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A Proposal for Safeguarding  
The Delaware Estuary and Coastline  
by Safer Transport of Oil  
Delaware Bay Oil Transport Committee  
of the  
State of Delaware

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**ENERGY, OIL, AND THE STATE OF DELAWARE**



**A Proposal for Safeguarding  
The Delaware Estuary and Coastline  
by Safer Transport of Oil**

[Summary Report]



by the

**Delaware Bay Oil Transport Committee  
of the  
State of Delaware**

**Dover, Delaware**

**January 15, 1973**

U. S. DEPARTMENT OF COMMERCE NOAA  
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DELAWARE BAY OIL TRANSPORT COMMITTEE

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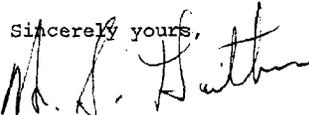
Dear Governors Peterson and Tribbitt:

I have the honor to submit to you the report of the Delaware Bay Oil Transport Committee.

The Committee was appointed in response to House Joint Resolution No. 18 and was to *study the logistics of transport of oil to and from Delaware River and Bay port facilities and to prepare within one year a recommendation for developing and operating oil terminal facilities that would provide for much increased protection from spills and thereby safeguard our Coastal Zone and its recreational potential.*

We are convinced that our coastal zone is in serious jeopardy due to the large quantities of crude oil now being transferred and transported in the Bay. The problem is not whether to have oil move up the Bay but how to move it more safely.

This report is presented in two parts. The first part is a summary report which contains recommendations for action by the State of Delaware. The second part is a technical report which contains detailed information developed in this study.

Sincerely yours,  
  
W. S. Gaither  
Chairman

January 15, 1973  
Enclosure

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## ACKNOWLEDGEMENT

The Committee was supported in its work by Bechtel Incorporated of San Francisco, California. Special recognition is due Frank F. Watters who served as program manager for the Bechtel team.

The Committee is also grateful to Jane Aughey who served as recording secretary for the Committee and Richard Schliem III who served as counsel from the Office of the Attorney General. Marianne Ottolini of the College of Marine Studies handled all Committee correspondence and arrangements.

Meeting space for Committee work was provided by the Department of Highways and Transportation.

Many individuals and organizations contributed generously to the information presented in this report. For their assistance the Committee is grateful.

## FOREWORD

In the late spring of 1971 the Delaware Legislature passed House Bill 300 which included a ban on deep water port facilities and other heavy industry in the coastal zone. This was signed into law by the Governor on June 28, 1971. Shortly thereafter, and as a logical sequel to House Bill 300, the Legislature passed House Joint Resolution 18. This resolution requested the Governor to appoint a Delaware Bay Oil Transport Committee.

The resolution recognized clearly the magnitude of the east coast petroleum problem and also the pivotal role of the state of Delaware due to the natural deepwater channel within its boundaries. The preamble of the resolution observed:

First, that approximately 70 percent of all the oil that is delivered to the east coast of the United States moves by water up the Delaware Bay and River; and

Also, that much of this oil is transferred several miles off the coast or in the mouth of the Bay from large deep draft tankers to barges or to smaller tankers so as to reduce the draft of the vessels to allow navigation up the Bay and River to unloading docks; and

Further, that such lightering operations are hazardous and provide a potential threat of a catastrophic spill that could seriously contaminate our waters and beaches; and

Fourth, that the volume of oil transported up the Bay is destined to increase markedly in the future even with no new refineries in Delaware; and

Fifth, that the U.S. Department of Commerce is vitally concerned about providing an adequate supply of oil to the eastern United States, and has been studying bulk transfer terminals in the Delaware Bay and is now launching a study of the practicality and feasibility of a terminal at sea on the continental shelf; and

Finally, that the trend in ocean shipping is to ever larger tankers of deeper draft.

Accordingly, the resolution requested that the committee "study the logistics of transport of oil to and from Delaware River and Bay port facilities and to prepare within one year a recommendation for developing and operating oil terminal facilities that would provide for much increased protection from spills and thereby safeguard our Coastal Zone and its recreational potential."

The Resolution further stated "that the Delaware Bay Oil Transport Committee is requested to

work as closely as possible with the U.S. Department of Commerce so as to be able to make maximum use of their findings.”

The Committee was appointed in the fall of 1971 and held its first meeting on November 10, 1971. The first task of the Committee was to define the scope of work necessary to be responsive to the requirements of House Joint Resolution 18. This resulted in a request for Proposal to Conduct Studies for the Delaware Bay Oil Transport Committee dated January 6, 1972. It was apparent to the Committee that professional assistance would be required to complete the work defined. With the Governor's concurrence the Committee invited proposals from nationally recognized consulting firms which are expert in the field of petroleum transportation. Eight proposals were received. The Committee reviewed each proposal and met with representatives of each firm, including their proposed program manager. The Committee selected Bechtel Incorporated of San Francisco, California.

Based on the fee proposed by the consultant, the Legislature provided a supplemental appropriation of \$130,000 to carry out the work of the Committee. Bechtel Incorporated began work as consultant to the Committee on April 3, 1972. The study proceeded in the systematic way described in the Statement of Work and has resulted in this Summary Report and a second, and more detailed, Technical Report.

The Summary Report is intended to present the reader with the major issues and the results which emerged from this study. Further, it contains the recommendations of the Committee.

The Technical Report provides the reader with detailed information which supports and expands on the material presented in the Summary Report. This includes relevant legislation, detailed environmental and economic information on the alternative systems considered, and other material necessary for the step by step analysis carried out by the Committee and its consultant. Also included is a list of agencies contacted.

The Committee made full use of interviews and information gathered by the Task Force on Marine and Coastal Affairs which issued its preliminary report dated February 18, 1971 and its final report dated July 1972.

It is the intention of the Committee to present to the Governor, the Legislature, and the people of Delaware a recommended plan for action which is responsive to the legislative charge. We believe that this plan is a rational balance between our environmental aspirations and the economic realities which exist in the United States and in the world. If adopted, we believe that it will provide the State of Delaware with the legal and administrative means to continue to be the First State in the management of its coastal zone resources.

William S. Gaither

John A. Bivens, Jr.

Jane B. Aughey

John O. Hiding

James Beebe, Jr.

Charles H. Mason, III

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Technical Report—Issued as a separate volume

## Chapter 1

### INTRODUCTION

Delaware has been strongly influenced by shipping since it was first settled in the early 1600's. The nature of this influence has changed with the evolution of ships, of markets, and of commodities produced. Early sailing ships were of shallow draft and called at many river towns in Delaware to take on agricultural products. Farther up river, where streams tumbled out of the Piedmont and offered water power, colonial manufacturing began and population centers grew. Traffic also passed by Delaware on its way to the up-river cities, Wilmington, Philadelphia, and Trenton. With passing decades and centuries, ships became larger and ports with shallow water access were abandoned. This trend has continued with the inevitable result that ports served by 40-foot deep channels are now passing into obsolescence in favor of new ports which will permit ships with deeper drafts to enter. In a matter of twenty years, bulk carriers for coal, ore, and petroleum have been increased in size to realize lower shipping costs, and the drafts of such ships have increased from 35 to 40 feet to the present 60 to 90 feet.

Petroleum has been important in the Delaware Valley since the middle of the nineteenth century. Refineries in the Philadelphia area started in the days of sailing ships but increased at a quickening pace through the close of World War II. During this period of growth, waste discharges from industrial and domestic sources steadily degraded the quality of water in the estuary.

Over a decade ago the construction of the Getty refinery in Delaware heralded the movement of the petroleum industry down the Bay toward deeper water. Soon thereafter, tankers with loaded drafts greater than the channel depth entered service and lightering began in the lower Bay. Once lightered, these ships could proceed up the dredged channel to the refineries with partial loads. The historical pattern has been to move marine terminals to protected coastal sites where deep water and shelter from storms could be found together. Such a site exists in Delaware waters in the lower Bay.

In the winter of 1969-70 it became obvious that the Shell Oil Company, the Delaware Bay Transportation Company, Zapata-Norness Incorporated, and other industry groups had specific and immediate plans for major industrial developments farther down Delaware's Bay coastline and along the natural deepwater channel. Governor Peterson acted to declare a moratorium on construction in Delaware's coastal zone and simultaneously appointed a Task Force on Marine and Coastal Affairs to "develop a master plan for coastal and bay areas." This Task Force was chaired by Dr. James Wakelin, Jr. In February 1971, the Task Force made a preliminary report recommending, at

that time, against approval of any deepwater port facility, or offshore island, in the lower Delaware Bay.

In the late spring of 1971, House Bill 300 was passed by the Delaware Legislature and included a ban on deepwater port facilities and other heavy industry in the coastal zone.

Shortly thereafter, and as a logical sequel to House Bill 300, the Delaware Legislature passed House Joint Resolution 18. This resolution requested the Governor to appoint a Delaware Bay Oil Transport Committee.

Delaware is not alone in studying the deepwater terminal question. Completed, or on-going, studies of particular importance to the Committee include:

1. A study by Soros Associates for the Maritime Administration of the feasibility of a North Atlantic Deepwater Oil Terminal (NADOT).
2. A study by Robert Nathan Associates for the U.S. Army Corps of Engineers on deepwater terminals.
3. A preliminary design study by Descon Engineers for the Delaware Bay Transportation Company concerned with a tanker terminal in Delaware Bay at Big Stone Beach.
4. An evaluation of the impacts of deepwater terminal construction and operation at east coast sites by the Council on Environmental Quality (CEQ).
5. A study of deepwater terminal potential by the Office of the Chief of Engineers being performed by the Corps' Philadelphia District Office.

The results of the first two studies became available to the Committee late in its working period. The third has been made available by the Delaware Bay Transportation Company in ample time for Committee use. The fourth and fifth studies were incomplete and unavailable at the conclusion of the Committee's work.

A sixth study of national scope has been announced by President Nixon:

6. A study of the legal and administrative framework necessary to build and operate a deepwater terminal outside of territorial waters. This is being done by the Council for Economic Development.

The Delaware Bay Oil Transport Committee has considered these and other sources of information in developing the following analysis of the situation. Unlike the other studies cited above, the Committee has considered this matter primarily from the Delaware point of view.

## Chapter 2

### PRESENT STATUS OF OIL TRANSPORT IN THE DELAWARE BAY AND RIVER

#### Refineries

For economic reasons petroleum companies prefer to locate refineries near market areas so that the distribution of refined products can be accomplished in the most competitive manner. Table 1 shows the distance from the Delaware Bay entrance capes to each refinery, and also the barrels per day throughput of each refinery. The location of refineries in the Delaware Valley is shown in Figure 1. Products from these refineries consist of gasoline (50 percent), fuel oil (30 percent), jet fuel (2 percent), kerosene (1 percent), and other products (17 percent) which are distributed to markets along the Eastern Seaboard.<sup>1</sup>

Table 1

#### Petroleum Refineries Located on the Delaware River

<u>Refinery</u>	<u>Location</u>	<u>Miles from the Mouth of Delaware River</u>	<u>Throughput (MB/D)<sup>2</sup></u>
Getty Oil Company	Delaware City, Del.	61.7	140.0
Sun Oil Company	Marcus Hook, Pa.	79.0	158.0
BP Oil Corporation	Trainer, Pa.	80.3	104.8
Mobil Oil Corporation	Paulsboro, N.J.	87.7	90.8
Atlantic Richfield Company (ARCO)	Philadelphia, Pa.	92.5	160.0
Gulf Oil Company	Philadelphia, Pa.	92.5	168.5
Texaco, Inc.	Westville, N.J.	94.3	91.0
	Total		913.1

<sup>1</sup>Source: From Table 8, August 1972, Monthly Petroleum Statement, Mineral Industry Surveys, U.S. Dept. of the Interior, Bureau of Mines.

<sup>2</sup>MB/D = Thousands of Barrels Per Day.

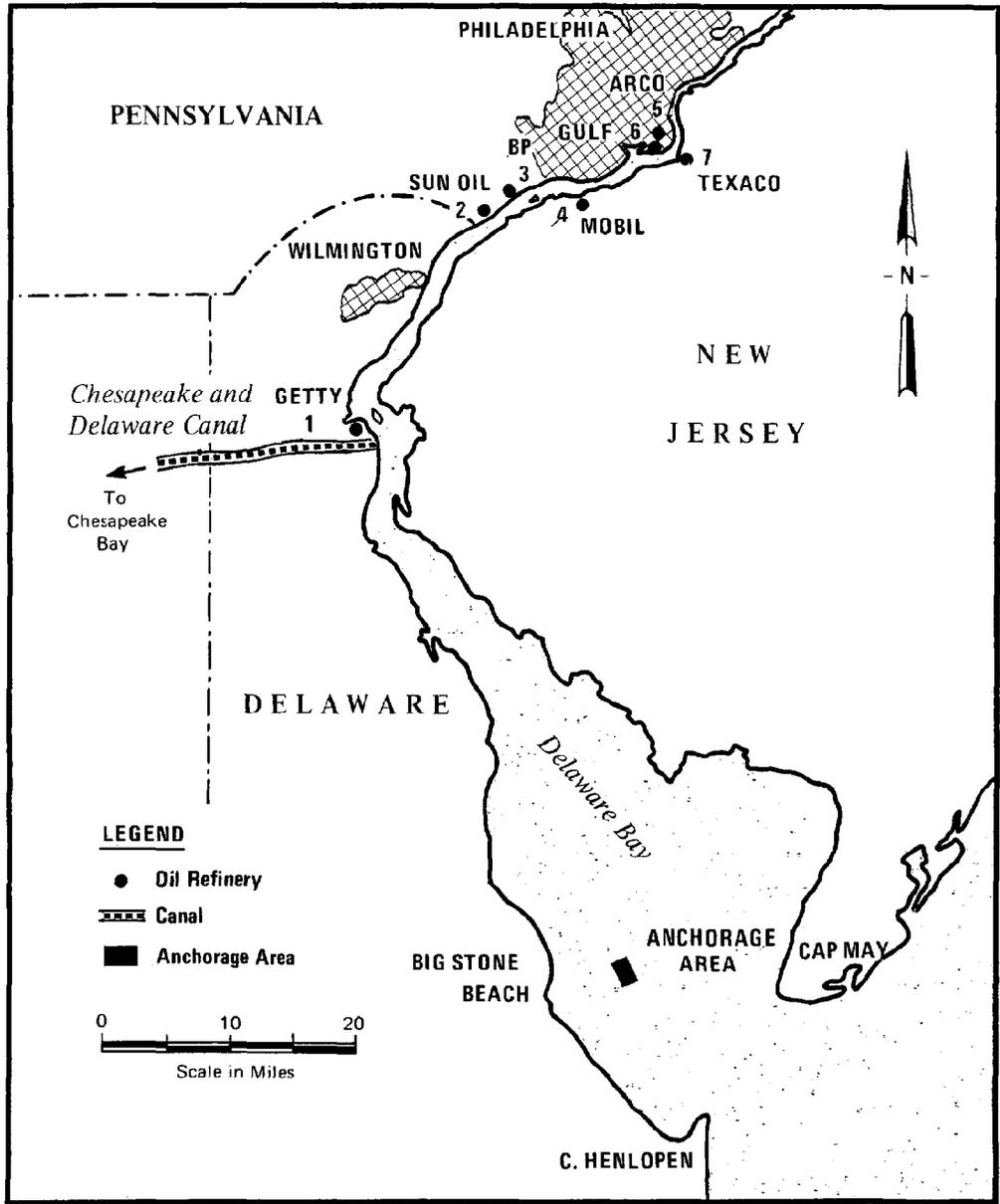
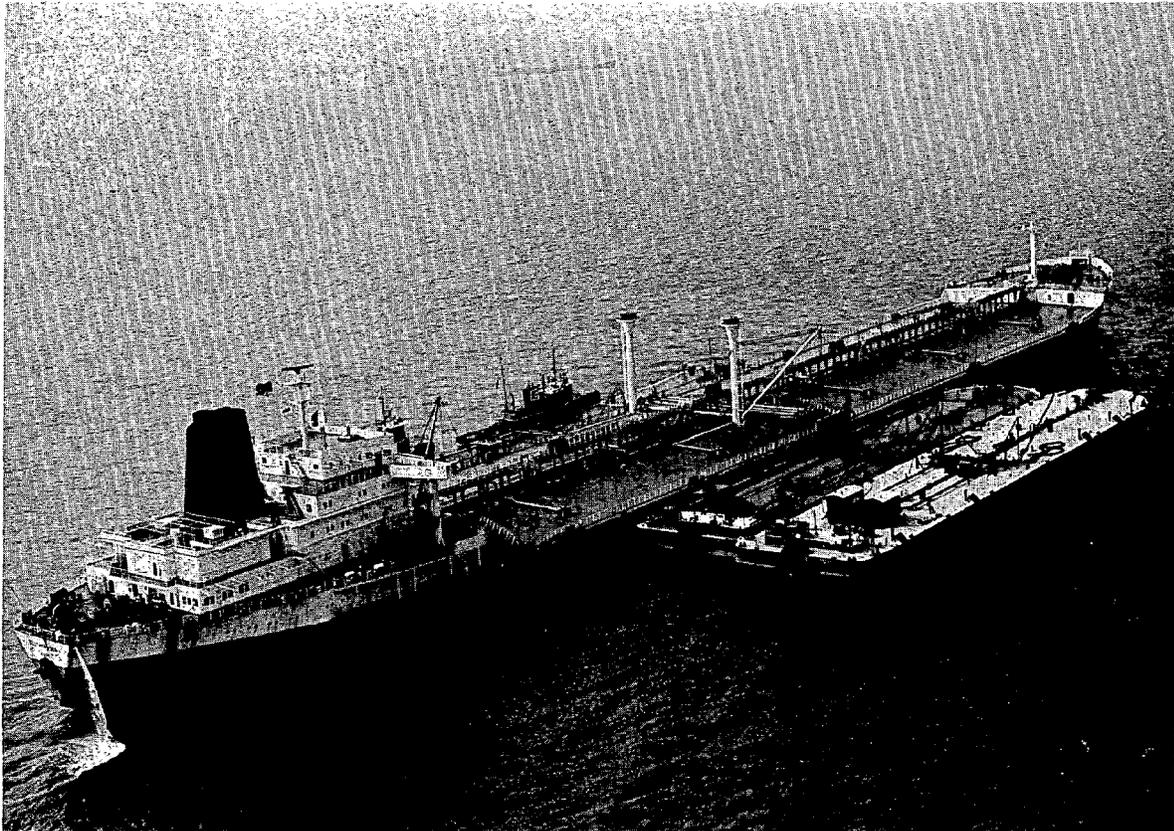


Figure 1 Location Map, Delaware Valley Refineries and Lower Bay Lightering Area



The 95,000 Deadweight Ton Tanker *Southern Sun* Transferring Crude Oil to Lighters Off Big Stone Beach in Lower Delaware Bay.

### River Traffic

River traffic since 1958 is shown on Figure 2. Of particular relevance to this study is the increase in barge traffic which can be attributed to lightering from the lower bay. Also of significance is the increased use of the lightering area off Big Stone Beach in the lower bay. This results in increased ship and barge traffic in the channel to up-river refineries from the lightering area.

### Existing Lightering Operations in the Lower Bay

Few Delawarians realize that an oil transfer terminal has been in operation in the lower bay off Big Stone Beach for over a decade with major growth occurring since 1967. This terminal has no fixed structures to which ships moor, only four buoys marking the corners of a one mile wide by two miles long rectangle in which ships are anchored for lightering. As shown in Figure 1, this area is approximately twelve miles up the bay from Cape Henlopen.

At this point a brief review of the lightering procedure is in order.

The estimated time of arrival of a tanker outside Delaware Bay is known to within a few hours from schedule and radio contact. Several miles outside the Bay a pilot will board the tanker and take her to a convenient location in the anchorage area approximately four miles east of Big Stone Beach. There the ship will lie at anchor, swinging with the tides. Immediately upon anchoring, a U.S. Public Health officer will inspect the ship, and large lighters (i.e., barges) will be brought alongside by tugboats. Typical lighter capacities are now in the 6,500 dwt to 12,000 dwt capacity range. Lighters of up to 35,000 dwt have been used. Small tankers also may be used for lightering.

A typical tanker entering the lower bay will be of 60,000 dwt to 125,000 dwt range and will have a loaded draft of 45 feet to 57 feet. To proceed safely up the dredged channel requires pumping out oil until the ship's draft is reduced to a maximum of approximately 36 to 38 feet.

Once alongside, the lighters are made fast to the tanker and several steel-reinforced rubber hoses of 6-inch and 8-inch inside diameter are bolted to the ship's manifolds and also to the hose connections of the lighters. Manifolds are grouped pipes with flanged ends, normally located amidship, which are connected by pipes to all crude oil compartments in the tanker. As soon as all bolts in the flanges are tightened, valves are opened and oil is pumped from the ship into the lighter until it is filled to capacity or the ship's draft is reduced sufficiently to permit it to proceed safely upriver with the remainder of its cargo. When oil transfer is completed, the valves are closed first on the tanker and then on the lighter and the flexible hoses drained of oil and disconnected. The lighter's mooring lines are then cast off and it is towed, or pushed, upriver to a refinery dock by a powerful diesel tugboat.

At the refinery dock, the lighter is moored and flexible hoses or articulated loading arms are again attached to the hose connection of the lighter and oil is pumped into the refinery tank farm storage by pumps on the lighter.

Once lightened sufficiently, the tanker also proceeds upriver to the same refinery dock and discharges the remainder of its cargo through the same hoses or unloading arms used for the lighter.



In Winter a Powerful Diesel Tugboat Moves a Barge Loaded With Crude Oil Out of the Lightering Area Through Floating Ice.

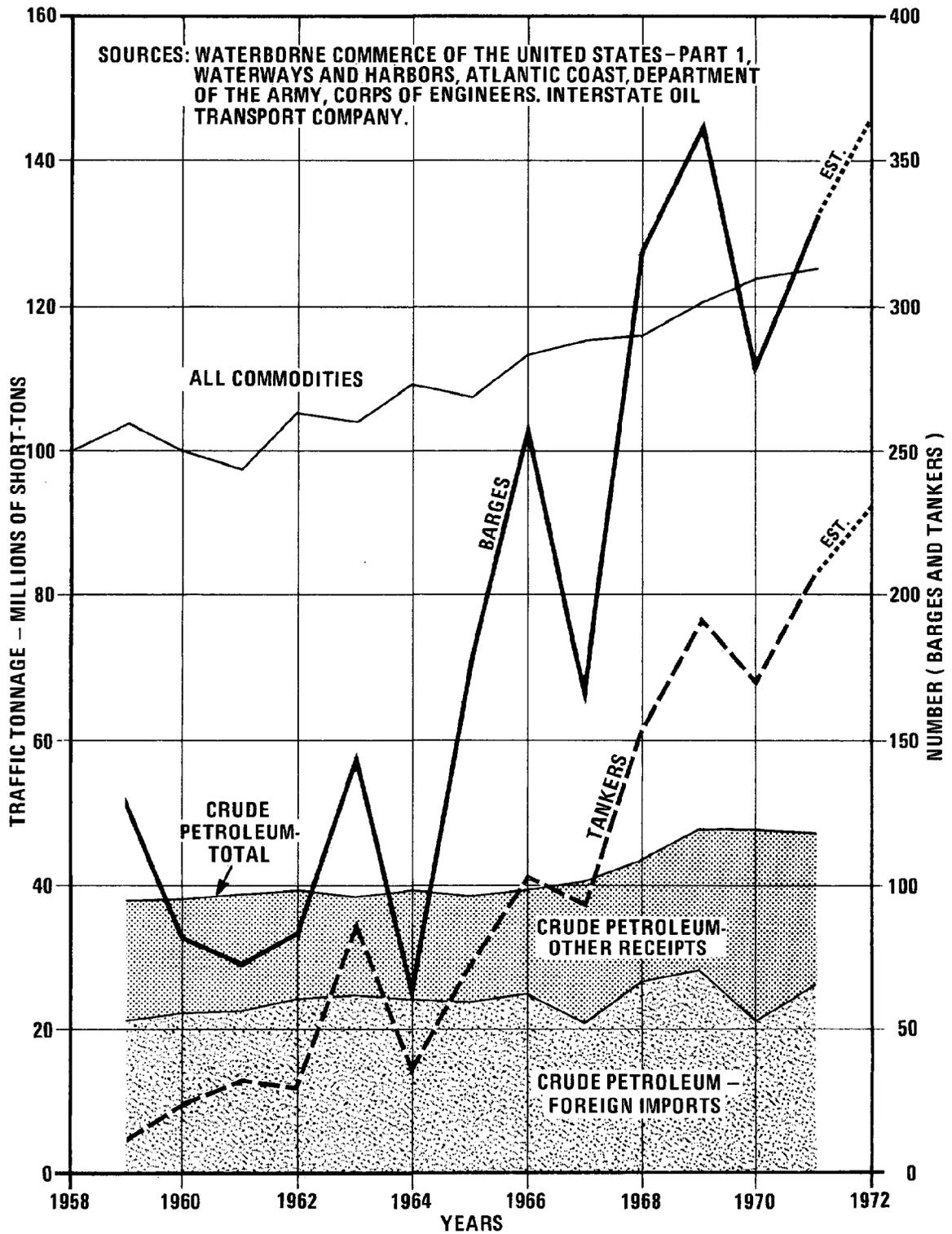
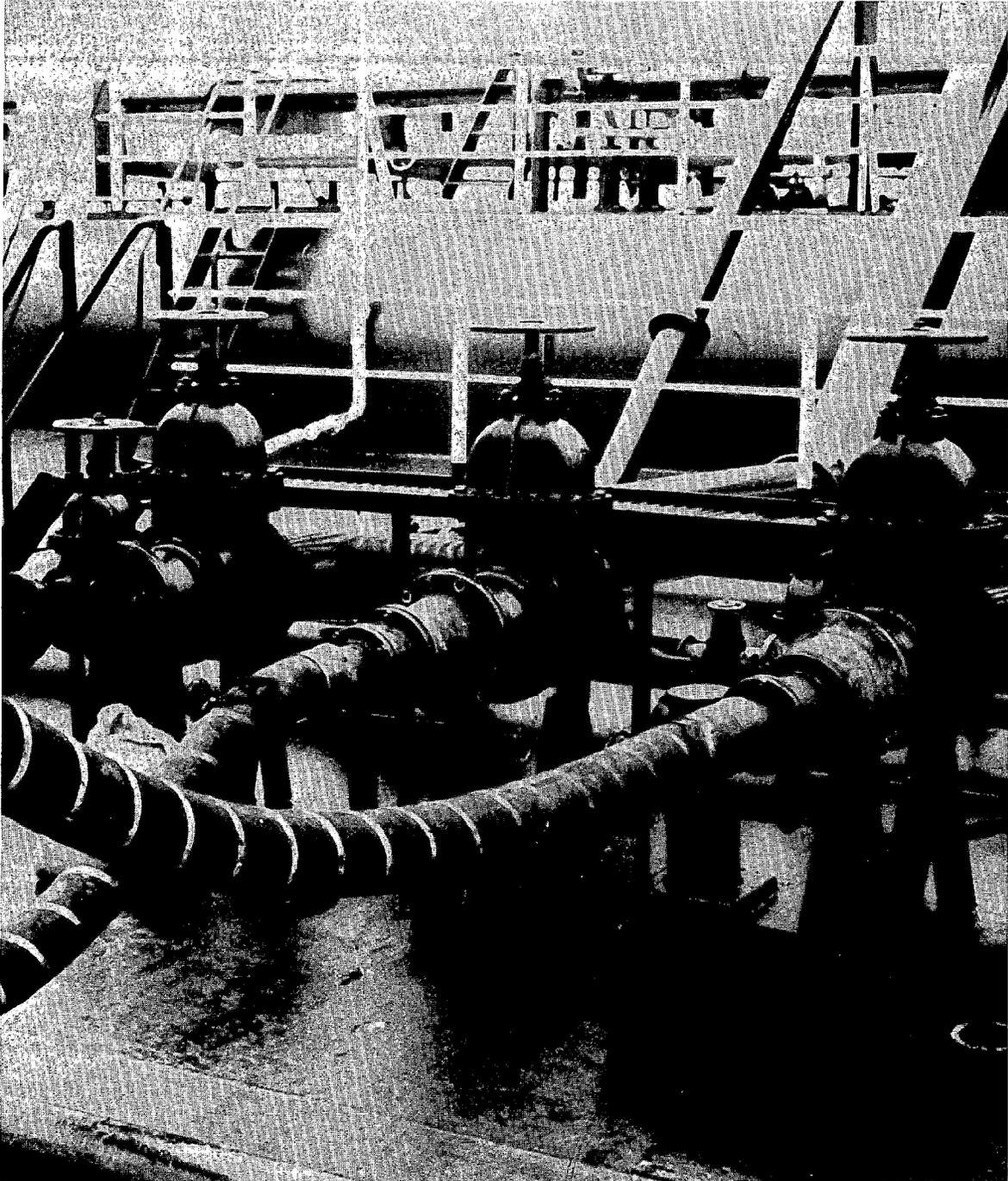
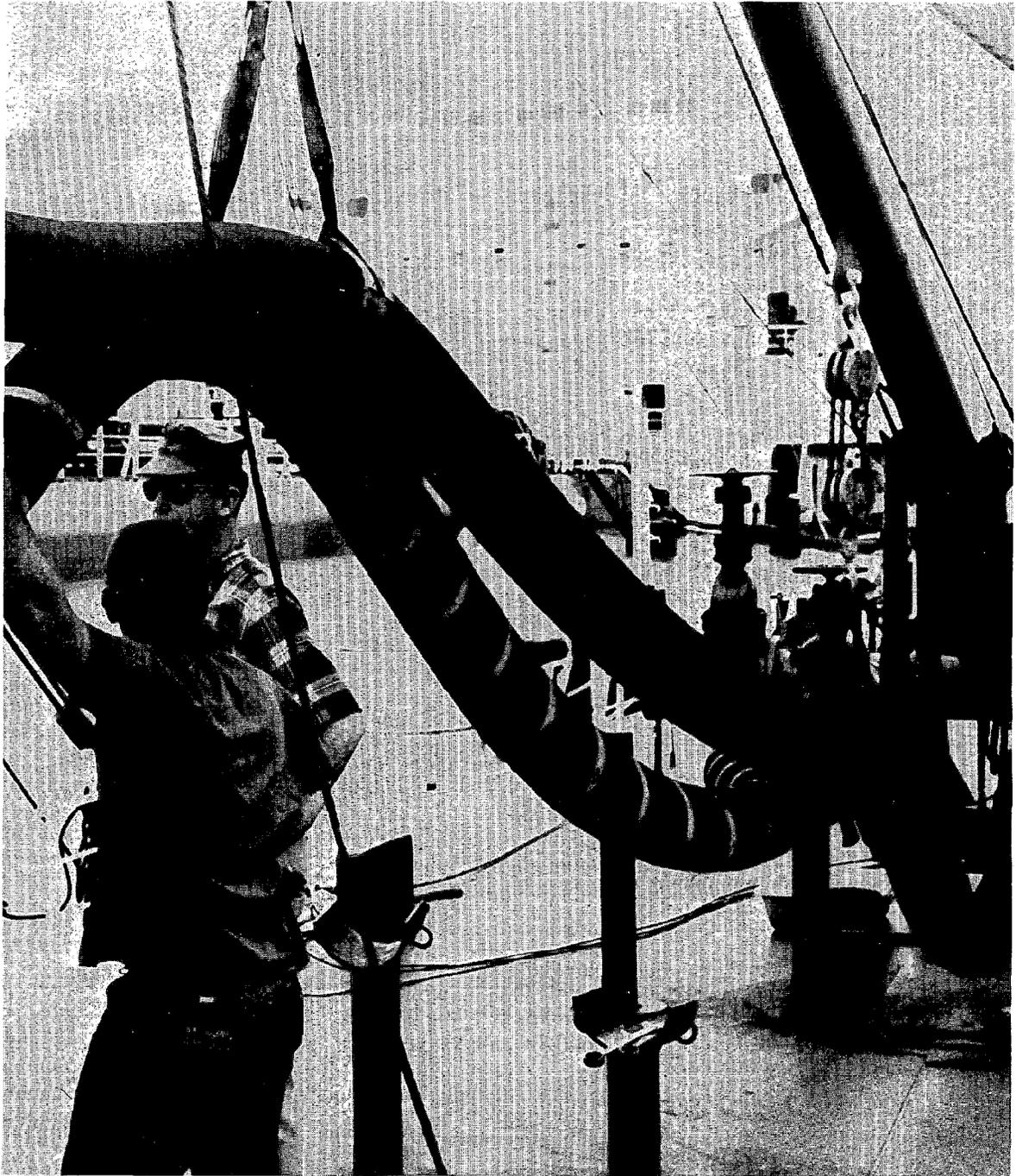


Figure 2 Traffic Tonnage on the Delaware River from Trenton, New Jersey, to the Sea (consolidated report) and Number of Tankers and Barges Using Big Stone Beach Anchorage Area in the Bay



Steel Reinforced Rubber Hoses Attached to the Tanker Manifold  
Are Used to Transfer Crude Oil to Lighters.



Standing on the Deck of a Lighter While Crude Oil is Pumped Aboard in Six Inch (inside diameter) Hoses.

While lightering is a simple bulk liquid transfer process in theory, in practice it is a business which requires good equipment and skillful crews. Further, severe wind and wave conditions increase the difficulty of operations as each vessel rises and falls at different rates due to its different shape and mass.

### Other Methods to Bring Crude Oil to the Delaware Valley

The Delaware Valley is not served by any pipelines for crude oil transportation. Neither railroad tank cars nor tank trucks are used to bring crude oil into the Delaware Valley due to their higher cost over tanker movement.

The Delaware Valley, however, is served by pipelines which deliver refined products. The Colonial pipeline is one example.

### Probability of Oil Spills

Since the beginning of lightering in the lower bay, over ten years ago, no major oil spills have occurred which are attributable to the lightering operation. The probability of future oil spills is difficult to predict with any degree of confidence since it depends on the combined factors of human error, equipment failure, and adverse weather conditions. There are two potential sources of oil spills which may occur in Delaware Bay as a result of tanker operations: (1) collision and grounding of tankers or lighters, and (2) operational oil spills which occur in transferring the cargo. With regard to the first source the Maritime Administration has stated<sup>1</sup> :

“U.S. Coast Guard statistics reveal that within the last ten years, there have been over 500 tanker collisions worldwide with 80 percent occurring while these vessels were entering or leaving ports. It is also reported that spills from tanker collisions average at least a million tons annually (worldwide) causing some \$40 million in damage.”

Operational spills which occur when crude oil is transferred into or out of a tanker also have been examined by the Coast Guard. Based on these data, it has been estimated<sup>2</sup> that we can expect an “average” spill of 5.8 barrels per cargo handling operation for tankers and 32 gallons per cargo handling operation for tank barges. It must be recognized that many cargo handling operations occur without any spills.

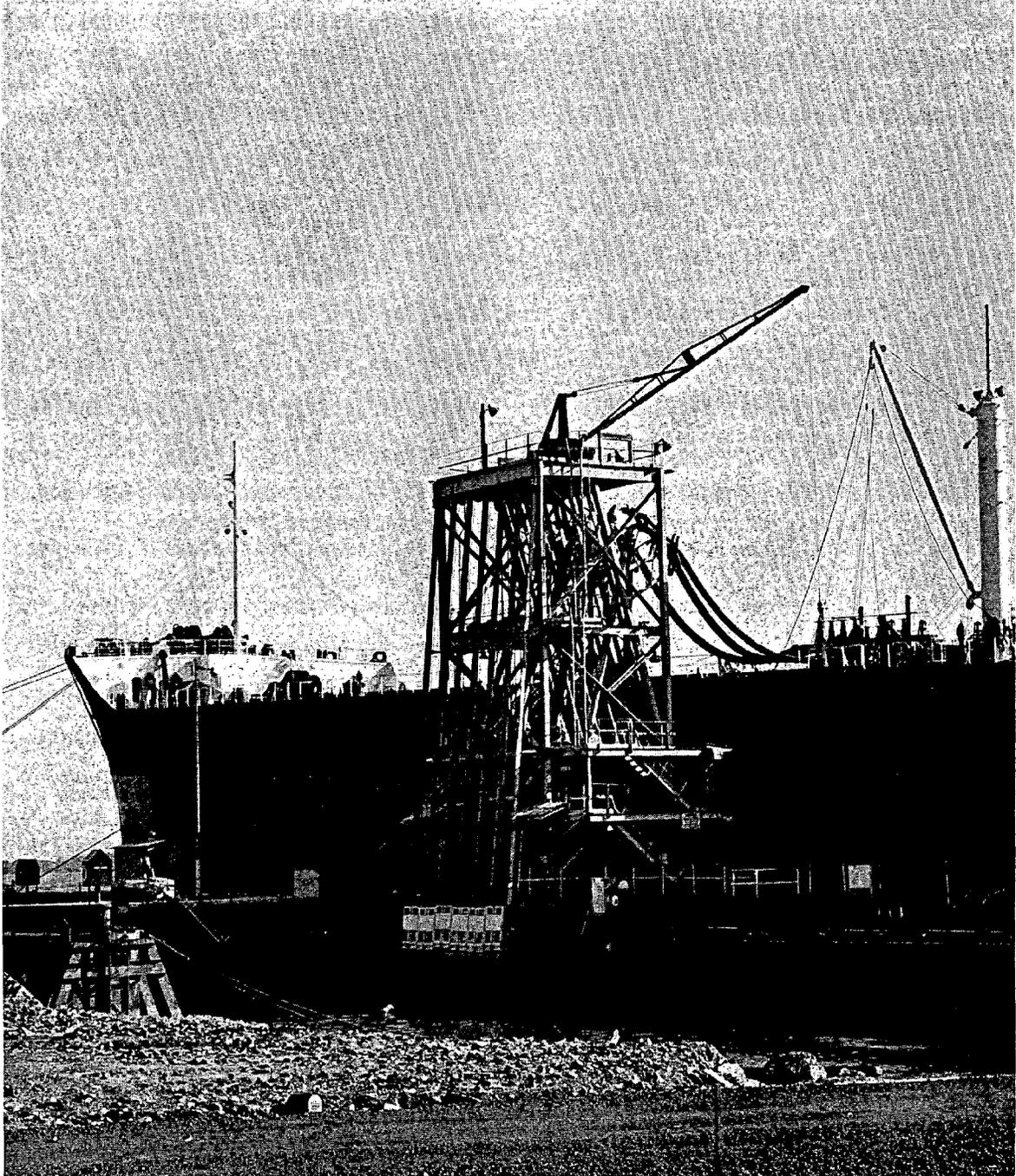
The probability of oil spills from the two sources cited above can be reduced by the following methods:

1. *Collision and Grounding* can be reduced by means of short, wide, and straight approach channels. In these channels, ship traffic should be kept to a minimum and should be managed through a ship traffic control system.

---

<sup>1</sup>*Economics of Deepwater Terminals 1972*, U.S. Dept. of Commerce, Maritime Administration, p. 20.

<sup>2</sup>Porricelli, J. P., V. F. Kieth, and R. L. Storch. Tankers and the Ecology. *Transactions*, The Society of Naval Architects and Marine Engineers, V. 79, 1971: pp. 169-221.



At a Refinery Dock Crude Oil is Pumped Ashore from a Tanker Through Multiple Hoses to a Tank Farm.

2. *Operational Oil Spills* and their effects can be reduced substantially by (a) reducing the number of crude transfer operations between tankers and lighters and tankers and docks, (b) monitoring personnel and equipment to insure that the best operating practice is followed, and (c) placing spill containment booms around tankers during transfer operations and cleaning up all spillage before the boom is removed for the tankers to depart.

To place this matter in proper perspective, all sources of oil pollution which enter the ocean must be considered<sup>3</sup>. Operational spills at terminals account for approximately two percent of the total oil spilled. In addition, ship casualties (collisions and groundings) account for approximately 11 percent of the total oil spilled. Other sources of oil pollution which are largely outside the control of terminal operations account for the remaining 87 percent of the total oil entering the ocean. Sources include highway motor vehicles, industrial plants and machinery, ship bilge pumping, vessel leaks, and tank cleaning to name a few.

### Cleanup Responsibility

At the present time responsibility for cleaning up spilled oil rests with the owner of the affected property. This is typically the State of Delaware or private property owners. Through the courts, damaged parties may seek compensation from the owners or operators of the vessel which spilled the oil.

In the case of the Hess barge grounding at Rehoboth Beach in 1968, an estimated 20,000 gallons of oil were spilled. State forces, including prisoners, were used to clean up the beach. In this case, as in 18 others since 1964, the party responsible for the spill has voluntarily paid for all of the costs.

The discharge of oil and other hazardous substances into tidal and interstate waters is prohibited by the Water Quality Act of 1965 (Public Law 89-234, October 2, 1965, amendments 33 U.S.C. 466). Failure by the party responsible to clean up spills can result in legal action if the sources of the spill can be traced. The Water Quality Improvement Act of 1970 (Public Law 91-224, April 3, 1970, amendments to 33 U.S.C. 446) provides for substantial fines and extensive liability in connection with the discharge of oil harmful to public health and welfare into navigable waterways, adjoining shorelines, and waters of the contiguous zone. Additional important aspects of this federal law state that:

- In case of a discharge of oil into navigable waterways, adjoining shorelines, and the contiguous zone, the designated federal agency (U.S. Coast Guard) must be notified immediately. Failure to do so could result in fines up to \$10,000 and/or imprisonment up to one year.
- A deliberate discharge of oil in violation of the federal regulations can result in civil penalties up to \$10,000 for each violation and the withholding of the clearance of any vessel, the owner or operator of which is subject to the penalties.

---

<sup>3</sup>See <sup>2</sup> supra.

- The owner or operator of an onshore or an offshore facility is liable unless it can be proved that the discharge was caused by:
  - 1) An act of God, or
  - 2) An act of war, or
  - 3) Negligence on the part of the U.S. Government, or
  - 4) An act or omission of a third party.

The amount of liability is not to exceed \$8 million to the U.S. Government for the cost of cleanup, unless it is shown that the discharge was willful; then there is no limit to the liability.

- If the owner or operator of a vessel, or of an onshore or offshore facility, from which oil is discharged in violation of federal regulations, proves the discharge was caused solely by an act or omission of a third party, then the third party is liable to pay the cleanup costs. If the third party is the owner of the vessel, then the liability shall not exceed \$100 per gross ton of vessel or \$14 million, whichever is less. If it is proved that the discharge was willful, then the owner is liable for cleanup and the liability is unlimited.
- A \$35 million revolving fund was established for purposes of carrying out the cleanup operation.

Because most oil spills are small in size, Delaware's Department of Natural Resources and Environmental Control has assumed responsibility for their tracing and cleanup within the State. If the spill is substantial [10,000 gallons (approximately 240 Barrels) or more in inland waters, and 100,000 gallons (approximately 2380 Barrels) or more in navigable waters] and the state is unable to cope with it, federal agencies (i.e. the U.S. Coast Guard, and the U.S. Army Corps of Engineers) take over under the National Contingency Plan.

The oil industry has a regional task force which assists in cleanup of oil spills by supplying men, materials, and technical advice regardless of who spilled the oil.

## Chapter 3

### FUTURE CRUDE OIL REQUIREMENTS

#### Energy Demand Projections for United States

The economy of the United States has developed over the past two centuries with a seemingly limitless domestic supply of energy at its disposal. This near ideal situation is changing rapidly to a more sobering condition where sources of energy for the future may be both limited and of foreign origin.

Two factors compound the worsening situation. First, our population continues to increase and, second, per capita use of energy is also increasing. Figure 3, from the Chase Manhattan Bank study entitled *Outlook for Energy in the United States* shows the projected increase in per capita energy consumption through 1985. The trend toward substantial per capita increases in consumption is quite clear.

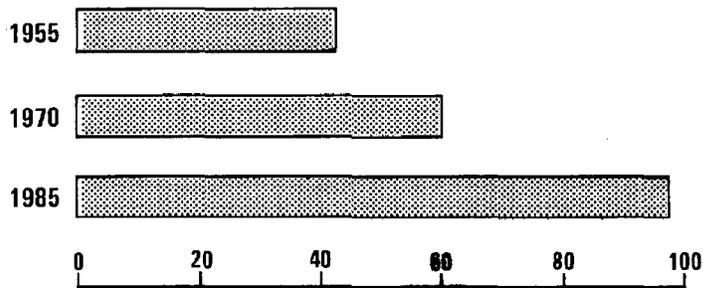


Figure 3 Per Capita Use of Energy in the United States

Next we must turn our attention to the relationship between energy demand and energy supply. In Table 2 this relationship is shown for the period between 1970 and 1985. In 1970 the energy demand is in large measure for gas and oil which account for roughly 75 percent of the total. Coal, which we also export in large quantities; accounts for approximately 20 percent and both nuclear and hydroelectric power account for less than five percent.

Table 2

**U.S. ENERGY SUPPLY-DEMAND BALANCE  
1970-1985  
(Millions of Barrels per Year Crude Equivalent)**

	<u>ENERGY DEMAND</u>		
	<u>1970</u>	<u>1980</u>	<u>1985</u>
Petroleum	5,253	8,150	9,371
Natural Gas	4,012	3,879	3,822
Coal	2,260	3,441	3,974
Nuclear	37	1,646	3,713
Hydro	438	584	620
Total Demand	<u>12,000</u>	<u>17,700</u>	<u>21,500</u>
	<u>ENERGY SUPPLY</u>		
<u>Domestic</u>			
Petroleum	3,983	4,210	4,050
Natural Gas	3,874	3,222	2,730
Coal	2,258	3,441	3,980
Hydro-Nuclear	475	2,227	4,340
Total Domestic	<u>10,600</u>	<u>13,100</u>	<u>15,100</u>
<u>Foreign</u>			
Petroleum	1,258	3,950	5,310
Gas	142	650	1,090
Total Foreign	1,400	4,600	6,400
Total Supply	<u>12,000</u>	<u>17,700</u>	<u>21,500</u>

Source: Table I, from *A Proposed Deepwater Tanker Terminal and Onshore Pipe Line Distribution System*, dated May 1, 1972, Delaware Bay Transportation Company.

Where does our energy come from? As shown in the Energy Supply section of Table 2, approximately 12 percent came from foreign sources in 1970. This is expected to climb to 30 percent of our total supply by 1985. It is generally conceded that by 1985 roughly one half of our petroleum requirements will come from foreign sources.

#### **Crude Oil Import Estimates—East Coast**

Of specific concern in this study is the amount of crude oil that will be imported to the East Coast of the United States, and into the Delaware Valley in particular, by the year 2000.

Projections used in this study were developed by analyzing estimates prepared by a variety of organizations. Sources include the National Petroleum Council (NPC), the Bureau of Mines, Corps of Engineers, the Delaware Bay Transportation Company, and Soros Associates for the Maritime Administration.

Figure 4 shows the estimated imports of crude oil for the Delaware Valley area to the year 2000, together with those for the New York area and Yorktown. These estimates were used by the Committee in its computations. All economic analysis and other growth considerations in this report are based on these projections.

These projections were not derived from original data by the Committee but were, instead, collected from a number of independent organizations, each with its own sources of information. The Committee believes that considerable uncertainty surrounds any import projection, even to 1985. This is due to our increasing dependence on foreign crude supplies and the unpredictability of relations between the United States and foreign governments with crude oil to sell. Another reason for uncertainty in estimating crude oil imports is the accelerating pace of development of alternate energy sources such as nuclear, solar, and hydroelectric (including tidal) power. In summary, the Committee believes that it has developed a sound projection based on available data but that all projections, even to 1985, contain elements of uncertainty and should be used with caution. Also, at this time there are no well developed alternatives to petroleum which appear capable of satisfying our increasing demand for energy.

#### **World Crude Oil Transportation System**

Before examining the question of the economic advantages of alternative terminal and transport systems available to Delaware, it is necessary to look at the total petroleum transportation system used to move crude oil by ship from the producing fields throughout the world to Delaware Valley refineries. Principal sources of crude oil which are now being shipped to Delaware refineries are shown on Figure 5 with sea voyage length noted. For long voyages, such as from the Persian Gulf, major shipping economies can be realized with Very Large Crude Carriers (VLCCs) of 250,000 dead-weight tons (dwt) and larger. Stopping at the Bahamas or proceeding to Canada for transshipment of crude oil to shallower draft ships, which could then proceed directly to Delaware refineries, offers attractive economic opportunities to petroleum companies. In other words, there are reasonable economic alternatives open to petroleum companies if lightering were to be discontinued in Delaware Bay.

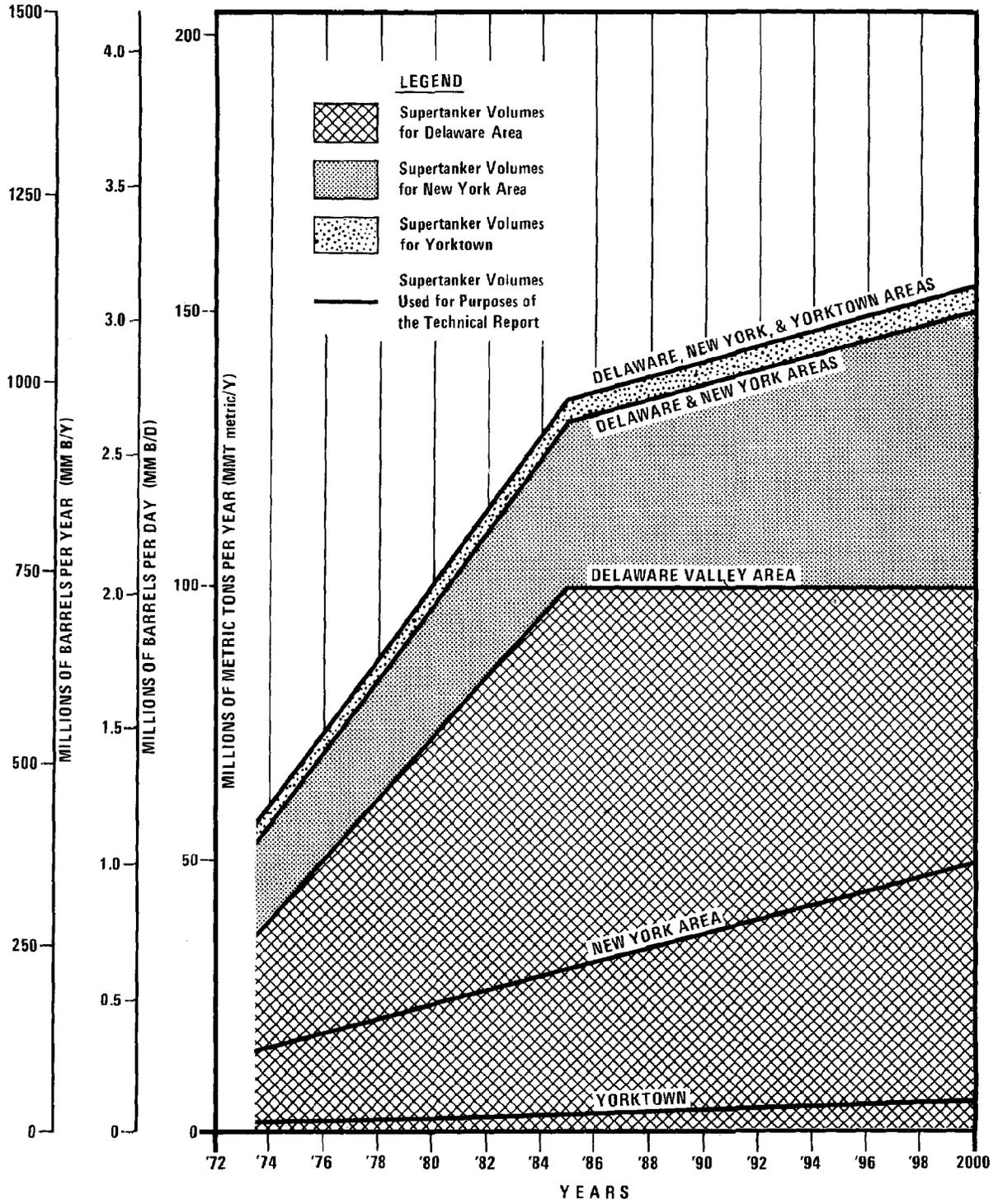


Figure 4 Projections of Crude Oil Imports to the Year 2000 for the Delaware Valley, New York Area, and Yorktown Refineries

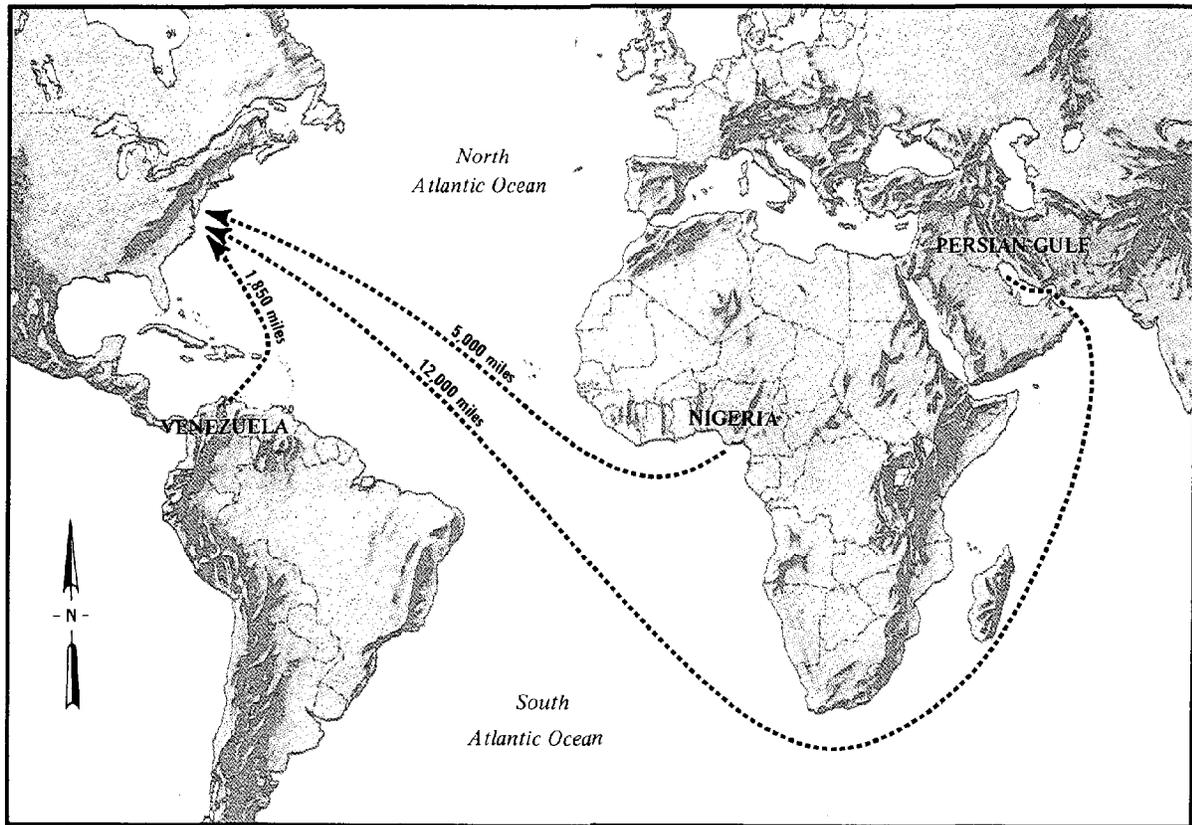


Figure 5 Sea Voyage Lengths From Principal Fields Supplying Delaware Valley Refineries

## Chapter 4

### ALTERNATIVES AVAILABLE TO DELAWARE

#### An Overview

The State of Delaware has taken a legal position via the Coastal Zone Act which bans the construction of a deepwater terminal on State subaqueous lands and also bans the construction of tank farms or refineries in the Coastal Zone. As a result, the citizens of Delaware can consider the several options which are available for safer oil transport and select the one which they believe to be the most beneficial.

A full spectrum of alternatives are available to Delaware. The principal alternatives can be summarized as follows:

1. Attempt to stop all lightering operations in Delaware waters.
2. Allow lightering to continue, with or without controls.
3. Concur with the construction of a deepwater terminal adjacent to Delaware.
4. Establish a legal mechanism to develop and control a deepwater terminal in Delaware waters.
5. Encourage the construction and operation of terminal facilities remote from Delaware.

Each of the five alternatives cited above has several variations. Also, certain options are within Delaware's sovereign power to implement. Other options require action or concurrence by other agencies, states, or the Federal government which are beyond Delaware's authority to control. A further discussion of each alternative is given in the following sections.

#### Stop all Lightering in the Bay

It is not clear that the State of Delaware can, by unilateral action, forbid lightering of ships in the present anchorage area off Big Stone Beach. This is a navigable waterway which falls under the jurisdiction of the federal government. If no permanent structures are installed to accomplish the lightering and no Coast Guard regulations are violated in the transfer operations, there are no established grounds on which Delaware can order the lightering to be stopped.

An indirect method which could be used to reduce or stop lightering would require the enactment of Delaware legislation to control the transfer of crude oil in Delaware waters. Such a law could involve rigid rules of safety and inspection which would be difficult for any transfer operation to

meet in full. This would require a cost to Delaware to provide an inspection force adequate to observe all transfer operations and to enforce regulations. In the interim period, however, the petroleum companies which require crude oil for the operation of Delaware Valley refineries would, in all probability, make other semipermanent arrangements to transfer crude oil into smaller ships or into a pipeline at a location outside of Delaware waters.

#### Allow Lightering to Continue

This option could obviously be adopted with no action on Delaware's part. If the safety record of the lightering operation continues to be as good in the future as it has been in the past, little harm would come to Delaware.

A desirable modification to this stance by Delaware would involve the requirement that positive containment be provided around ships while being lightered and that inspectors be on board all ships to observe that specified regulations and procedures were followed.

#### Concur with the Construction of a Deepwater Terminal Adjacent to Delaware

Several proposals have been made to construct a deepwater terminal outside of Delaware waters. These include the Maritime Administration plan to construct a North Atlantic Deepwater Oil Terminal (NADOT) approximately eight miles east of Rehoboth, a First State Pipeline Company proposal to locate a monomoorings east of Cape Henlopen, and a Corps of Engineers proposal to construct an island offloading terminal on Crow Shoal immediately to the west of Cape May.

Delaware could take either a passive position or an active position with respect to these, and similar alternative plans, to construct and operate a deepwater terminal immediately outside of Delaware waters. A passive position would involve:

- Not promoting federal legislation which would give veto power to states potentially affected by spills from such a terminal.
- Not offering or allowing a pipeline right-of-way through state lands.

Active concurrence would involve:

- The passage of favorable legislation in Delaware to encourage the construction and operation of a pipeline through the state.
- The development of service craft facilities on shore to supply provisions and personnel to an offshore terminal structure.

#### Establish a Means to Develop and Control a Terminal in Delaware Waters

This would involve the formation of an authority or other legally constituted body to build, or cause to be built, an oil transfer facility, with or without pipeline, in Delaware waters. This would also involve the passage of legislation to amend the Coastal Zone Act to allow the construction of a deepwater terminal in the Coastal Zone, and, if a pipeline were selected for the movement of oil to the refineries, provision for both offshore and onshore pipelines as well as a tank farm in the Coastal Zone.

## Encourage the Construction and Operation of Terminals and Refining Capability Remote from Delaware

This alternative, while attractive from the environmental point of view, has two significant drawbacks:

1. Delaware has no power to act outside of its boundaries. Accordingly, it could not guarantee that any action would be taken.
2. Terminals constructed in remote locations could result in increased petroleum ship traffic in the federally controlled navigable waters of Delaware Bay. This solution could decrease the safety of operations in the Bay.

On the positive side, there are several economically viable alternatives open to petroleum companies which would reduce petroleum transfer and transport in Delaware Bay and would thus indirectly provide for increased protection from oil spills.

These include:

- Supply crude oil to the Delaware Valley refineries by pipeline from New York, New Jersey, or other potential port locations
- Supply crude oil and/or refined products from the Gulf area, the Bahamas, or Canada through the Delaware Valley by pipeline

## Candidate Petroleum Transfer Systems

The Committee, for this study, identified all known deepwater terminal and transport systems which would, if constructed, have a major effect on the movement of crude oil in Delaware Bay. These systems were grouped by type and location for review and evaluation. Geographically the grouping included:

- Sites in lower Delaware Bay near the present anchorage area
- Sites in lower Delaware Bay around Cape May
- Offshore sites outside of Delaware Bay in the Atlantic Ocean
- Sites outside of New York harbor which would supply the Delaware Valley refineries by a pipeline across New Jersey to the upper end of the Delaware Valley

Once grouped by type of terminal and by geographic location, 21 separate system options resulted. For the purpose of evaluation, these 21 options were compared using the criteria discussed in the following chapter.

## Chapter 5

### CRITERIA FOR COMPARING ALTERNATIVE TERMINAL SYSTEMS

In the original statement of work prepared by the Committee, factors were identified which were thought to be potentially important when comparing alternative petroleum transport systems affecting Delaware. The purpose was to provide a checklist and a means to make a qualitative comparison of alternative terminal and transport systems. It was not feasible in some cases to make a quantitative comparison between various factors or, for that matter, to make an in-depth study of each. Rather, the Committee, and its consultant evaluated and weighted each terminal and transport system against each of the following factors:

#### Operational Factors

Operational aspects are addressed to the design of the terminal and its operating characteristics. Factors considered include: capacity for spill retention, capacity for spill removal, maximum allowable operational loss, redundancy of the system (i.e., what backup systems are available if the primary system fails), emergency cleanup provisions, risk of failure of system, and the possibility for terminal relocation or removal.

#### Environmental Considerations

Here each alternative system was examined to evaluate the following factors: effects on marine life, physical effects on the marine environment (i.e., what permanent changes will be required), visual effects (i.e., is the terminal unsightly from shore), frequency of failure of the system, and secondary effects such as associated land use.

#### Economic Factors

Economic factors are amenable to quantification, particularly in the areas of construction and operational costs. This is particularly important for use in determining which system offers the greatest potential for lowering petroleum transportation costs. Factors included were: return on investment to the owner, life of the facility, potential reduction in return on investment in other enterprises (i.e., would the Delaware tourist industry or fishing industry suffer and offset any potential economic gain resulting from construction and operation of a petroleum terminal), affect on adjacent land use, cost of environmental damage, potential revenues (at state, county, municipal, and local levels), and employment (i.e., what would be the employment picture during both construction and permanent operation.)

### Legal Considerations

The following legal factors were considered in the comparison of alternative systems: adherence to the 1970 Federal Water Quality Act, import transfer charges, interstate commerce charges, the formation of a state or regional port authority, regional regulation, federal regulation, cost allocation, and responsibility for emergency measures and cleanup.

### National Defense

Factors considered include: vulnerability of system to attack, protection from attack, and alternate systems available in a crisis.

### Regional Economic Considerations

From a regional point of view several economic factors were considered including the effect of a regional deepwater port: on consumer prices, on Delaware Valley industry, and on the growth of nuclear powered electrical plants.

As stated earlier, the preceding factors were used as a basis for comparing the original 21 alternative oil terminal and transport systems. By assigning a one to ten value scale to each factor, nine of the 21 alternate systems were eliminated and 12 representative systems were selected for more detailed evaluation. The primary purpose of the terminal and transport systems considered was to serve Delaware Valley refineries in the safest and most economical manner. However, two other refinery locations could also be serviced from a deepwater port in the Delaware Bay vicinity. These are the refineries in the New York area and the single refinery at Yorktown, Virginia.

Also considered was the multiple use of deepwater terminal facilities for petroleum, coal, grain, and other bulk products. No significant economies or added safety was found to accrue to the operation and, invariably, a larger marine terminal site was required.

### Systems Selected for Further Analysis

The 12 systems selected for further study and analysis are shown on Figure 6. The following options, and their identifying numbers correspond to the systems shown in Figure 7(a,b,c). An analysis of each of these systems is presented in the Technical Report in greater detail.

- Option No. 1.a. Fixed pier in Delaware Bay for crude oil only (as proposed by Delaware Bay Transportation Company) with tank farm in, or behind, the Coastal Zone area, serviced by pipeline to Delaware Valley refineries.
- Option No. 1.b. Fixed pier in Delaware Bay for crude oil only (as proposed by Delaware Bay Transportation Company) with tank farm in, or behind, the Coastal Zone area, serviced by barges to Delaware Valley refineries.
- Option No. 2.a. Storage island including piers and tank farm for crude oil only on Old Bare Shoal (similar to NADOT terminal with no breakwater), serviced by Delaware pipeline to Delaware Valley refineries and barges to New York and Yorktown.

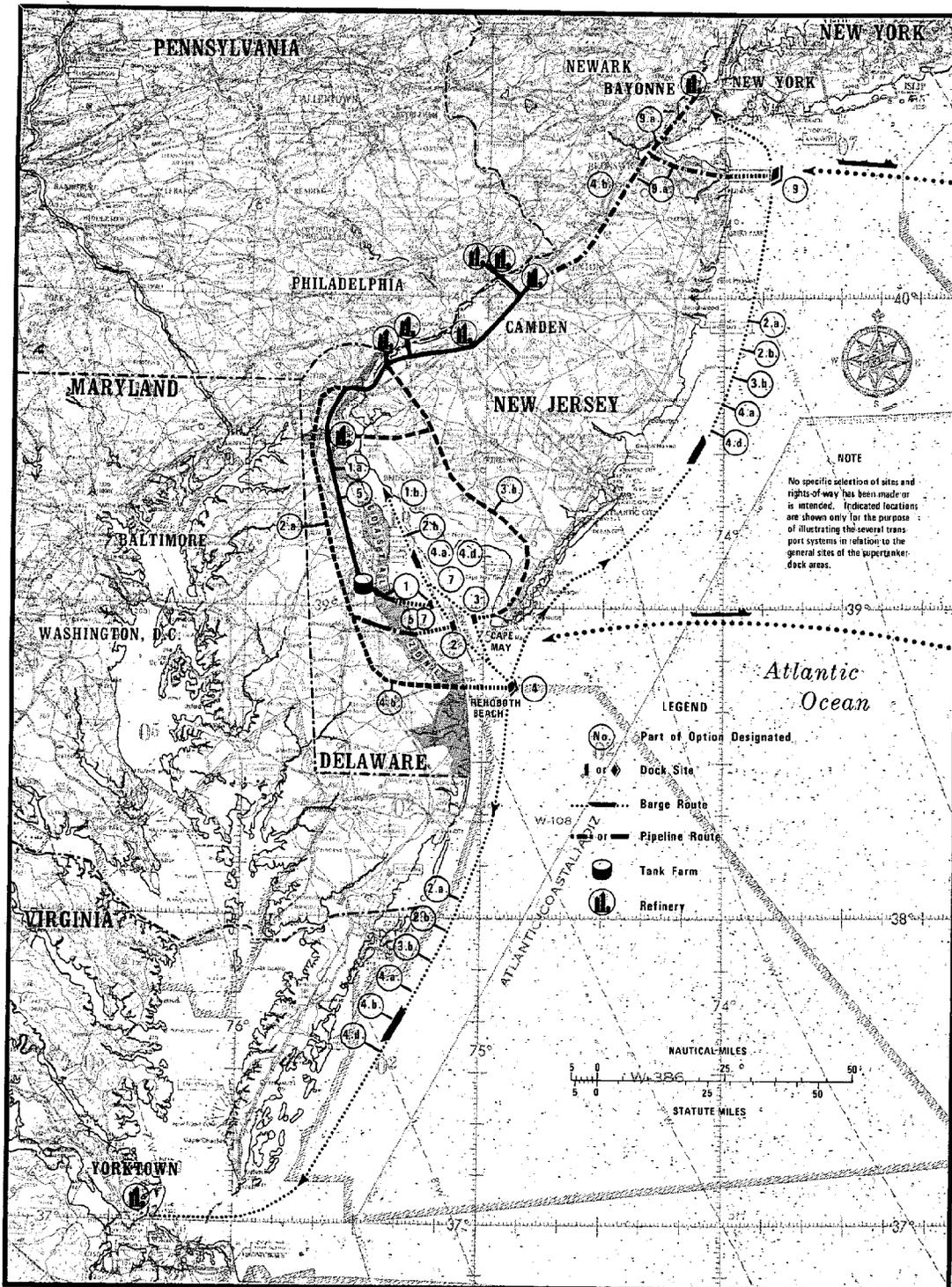
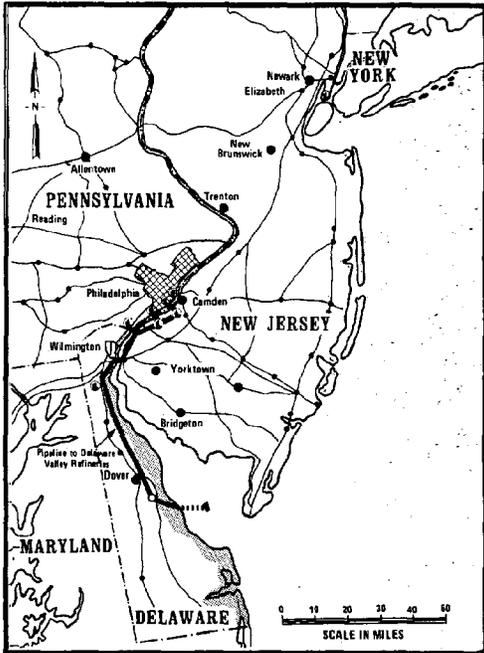
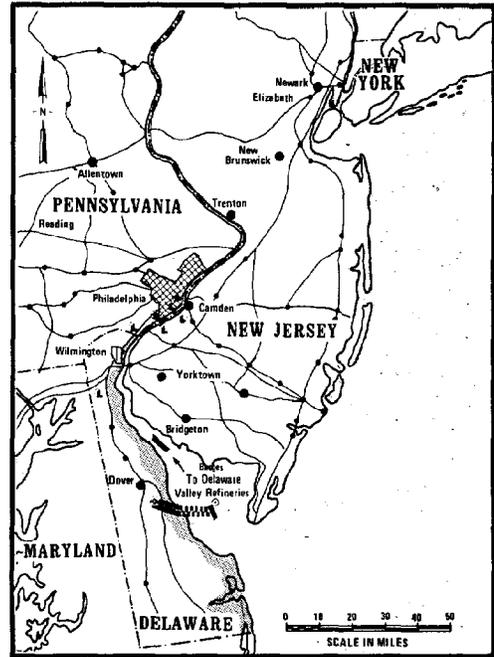


Figure 6 Selected Transfer Systems Location Map



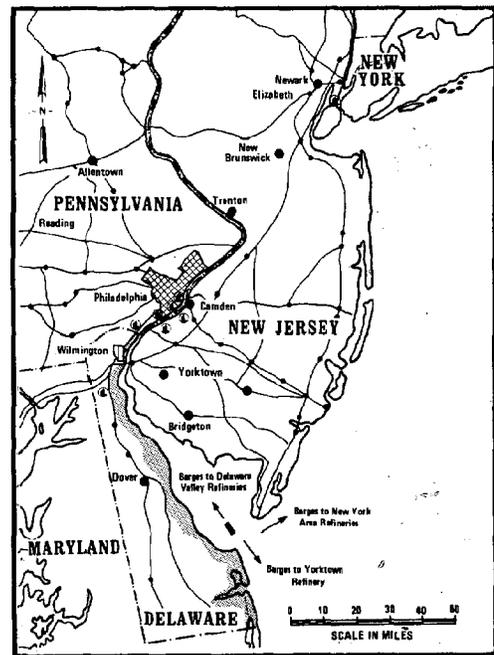
OPTION NO.1.a. - DELAWARE BAY  
FIXED PIER TERMINAL



OPTION NO.1.b. - DELAWARE BAY  
FIXED PIER TERMINAL

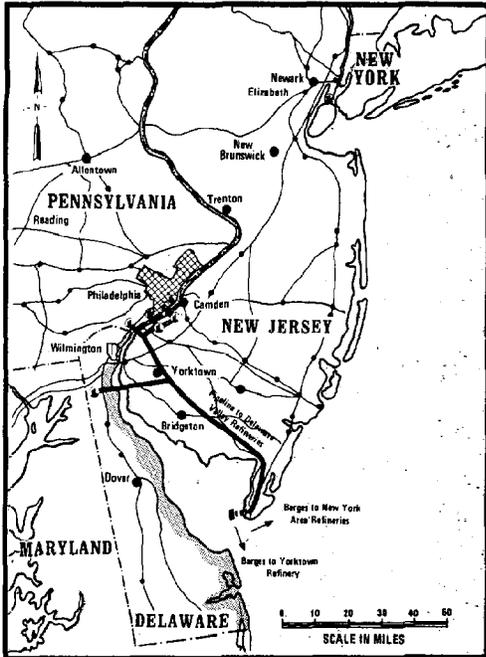


OPTION NO.2.a. - DELAWARE BAY  
ISLAND TERMINAL

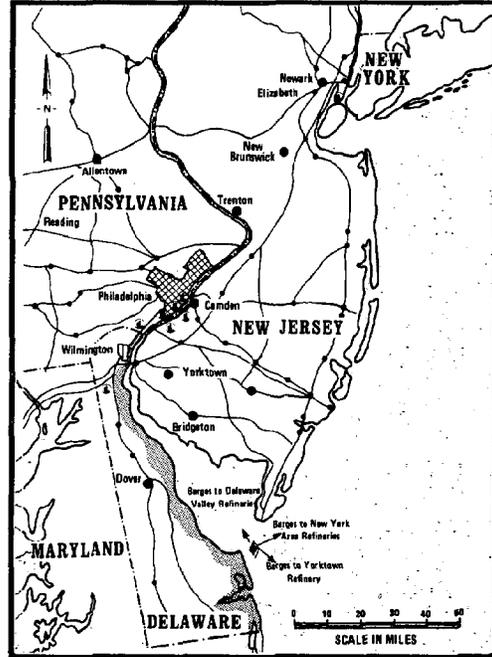


OPTION NO.2.b. - DELAWARE BAY  
ISLAND TERMINAL

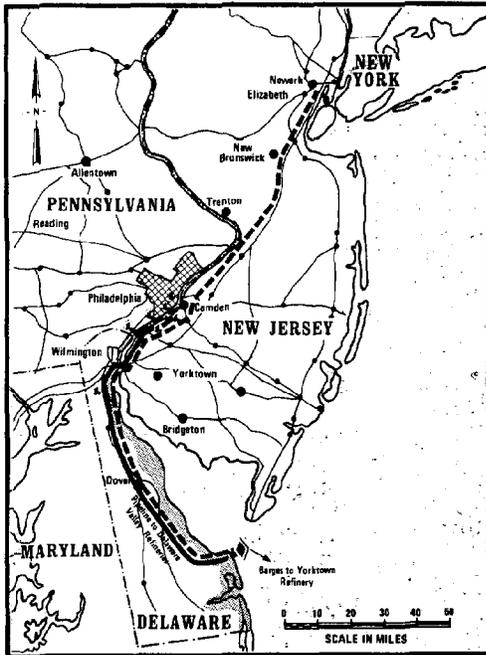
Figure 7a



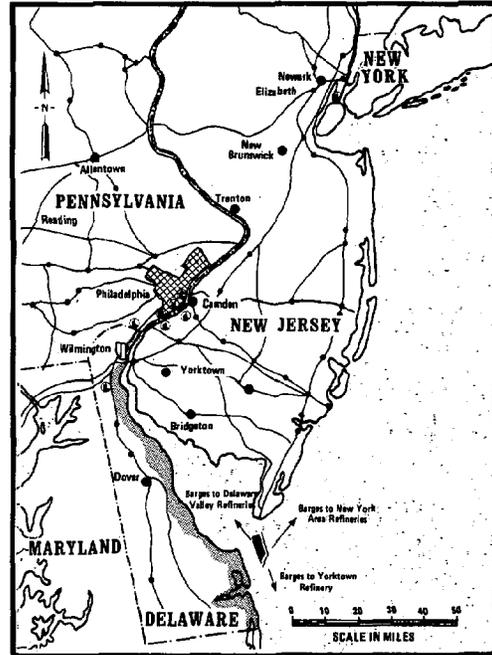
OPTION NO.3.b. – DELAWARE BAY ISLAND TERMINAL OFF CAP MAY



OPTION NO.4.a. – MARAD-NADOT TRANSFER TERMINAL OFF REHOBOTH

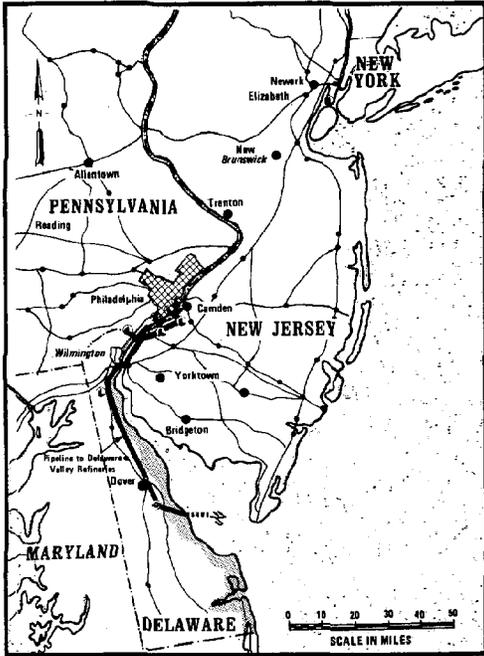


OPTION NO.4.b. – MARAD-NADOT TRANSFER TERMINAL OFF REHOBOTH

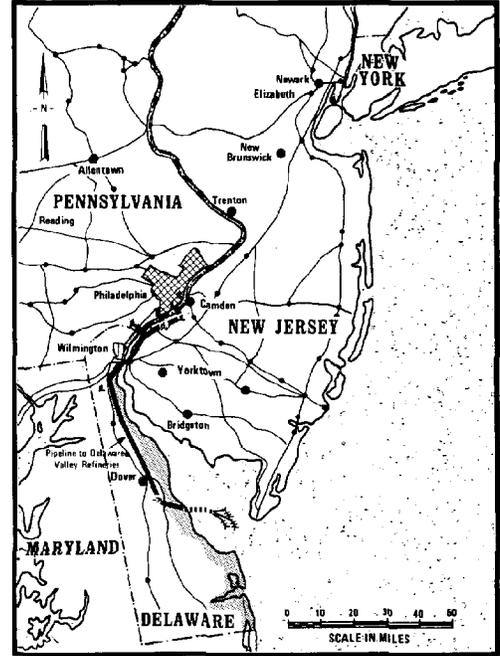


OPTION NO.4.d. – MARAD-NADOT MULTIUSE TRANSFER TERMINAL OFF REHOBOTH

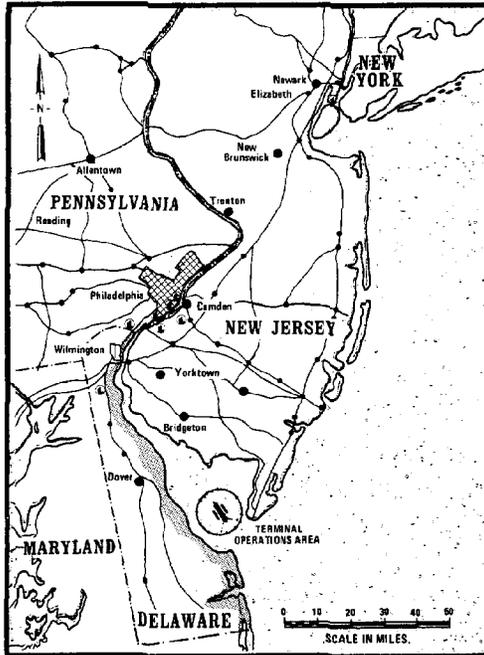
Figure 7b



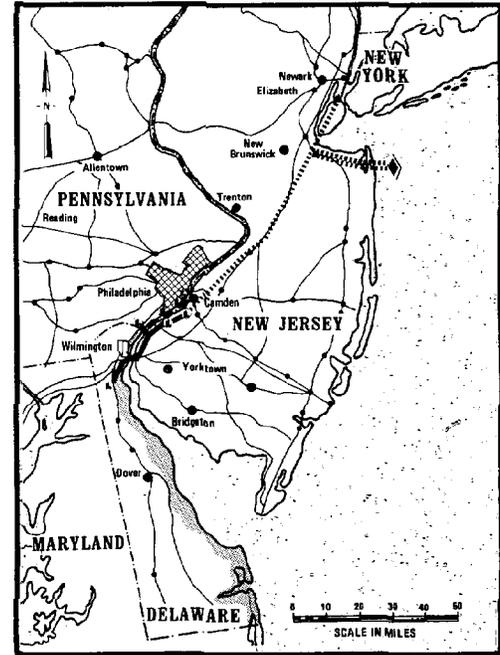
OPTION NO.5.a. – DELAWARE BAY  
MONOMOORNING TERMINAL



OPTION NO.5.b. – DELAWARE BAY  
SPREAD-MOORNING TERMINAL



OPTION NO.7.b. – DELAWARE BAY  
CONTINUE AND EXPAND EXISTING  
LIGHTERING WITH ADDITION OF SPILL  
CONTAINMENT BOOMS



OPTION NO.9.a. – MARAD-NADOT  
TRANSFER TERMINAL OFFSHORE  
OF SANDY HOOK

Figure 7c

- Option No. 2.b. Storage island including piers and tank farm in Delaware Bay for crude oil only on Old Bare Shoal (no pipeline ashore), serviced by barges to Delaware Valley refineries, New York area and Yorktown.
- Option No. 3.b. Storage island including piers and tank farm on New Jersey side behind Cape May in Delaware Bay on Crow Shoal, serviced by New Jersey Pipeline to Delaware Valley refineries and barges to Yorktown and New York area.
- Option No. 4.a. NADOT Island with breakwater outside of Delaware Bay (approximately 8 miles off Rehoboth), serviced by barges to Delaware Valley refineries, Yorktown, and New York area.
- Option No. 4.b. NADOT Island with breakwater outside of Delaware Bay (approximately 8 miles off Rehoboth), serviced by Delaware pipeline to Delaware Valley refineries. New York serviced by pipeline across Delaware and New Jersey to Bayonne, New Jersey. Barges to Yorktown.
- Option No. 4.d. NADOT Island with breakwater outside of Delaware Bay (approximately 8 miles off Rehoboth), for crude oil and other bulk commodities (coal, iron ore), serviced by barges to Delaware Valley, Yorktown, Norfolk, and New York area.
- Option No. 5.a. Monomoorings in Delaware Bay deep channel for crude oil only with tank farm behind Coastal Zone Area, serviced by Delaware pipeline to Delaware Valley refineries.
- Option No. 5.b. Spread moorings in Delaware Bay deep channel for crude oil only with tank farm behind Coastal Zone Area, serviced by Delaware pipeline to Delaware Valley refineries.
- Option No. 7.b. Continue and expand existing lightering operations in Delaware Bay deep channel with addition of spill containment booms around all transfer operations.
- Option No. 9.a. NADOT-type island with breakwater outside New York Harbor off Sandy Hook, serviced by submarine pipeline to shore to New Jersey refineries. Delaware Valley refineries serviced by pipeline across New Jersey to Philadelphia.

It is the opinion of the Committee that all of the 12 alternative oil terminal and transport systems listed above offer some degree of improved safety for Delaware over present lightering operations.

## Chapter 6

### CONCLUSIONS

Two types of alternatives have been discussed in the preceding chapters. These are:

1. Alternative courses of action available to Delaware in the form of policy positions on a deepwater terminal in Delaware waters, and,
2. Alternative petroleum terminal and transport systems which could be built and operated to provide increased protection from spills.

It is the purpose of this chapter to integrate these two types of considerations and distill the information into rational conclusions. In reaching these conclusions it was the Committee's purpose to represent the best interests of Delaware citizens and to be responsive to the legislative charge to the Committee enunciated in HJR 18. The heart of this charge lies in the following words:

“—to prepare—a recommendation for developing and operating oil terminal facilities that would provide for much increased protection from spills and thereby safeguard our Coastal Zone and its recreational potential.”

Based on this charge, two basic conclusions emerge which establish the framework for the other conclusions which follow. These basic conclusions are:

1. Delaware can bring about the development and operation of oil terminal facilities that would provide for much increased protection from spills under State of Delaware control. This can be most readily accomplished within the boundaries of the State.
2. If Delaware chooses to forbid oil transfer within its boundaries it will probably have little or no voice in the alternate methods selected by the petroleum companies to supply the Delaware Valley refineries. While some alternatives which the companies might select would be safer than a terminal in Delaware waters, other solutions would be less safe.

#### Continued Lightering vs Other Solutions

As discussed in Chapter 4, *Alternatives Available to Delaware*, the Committee recognizes that the State could either:

- (1) Attempt to stop all lightering in the Bay, or
- (2) Allow lightering to continue and grow with specified safeguards and inspection to insure maximum safety of operation.

The Committee does not believe that the first is legally feasible, economically practicable from the cost of enforcement point of view, or responsible, regionally or nationally.

The second alternative has been set aside as less than optimum because the operation is (1) intrinsically less safe than offloading tankers in a properly equipped terminal,<sup>1</sup> and (2) lightering involves both increased river traffic and several more cargo transfer operations to both lighters and refinery docks for each arriving tanker. For both of these reasons continued lightering is considered to be an unsatisfactory long term alternative. In the short term, however, until improved permanent facilities are provided, or petroleum transfer operations decrease, lightering operations should be carried out under State control, employing containment during cargo transfer operations.

### Operational

It is clear that the lower Delaware Bay is one of the few locations on the East Coast of the United States where deep draft tankers can enter sheltered water for unloading.

The deepwater terminal concepts considered in this report are of conventional design and accordingly are within the present state of the art. Positive containment devices for use in sheltered locations appear feasible if planned as an integral part of a new terminal structure. On the other hand, the containment devices proposed for the NADOT terminal are massive and of a new design. Accordingly, developmental testing would be required to insure smooth operation. Both spill retention and spill cleanup inside of a containment structure appear to be feasible.

Operational loss of oil in a well designed fixed terminal with specified safety procedures can be maintained at a near zero level of environmental risk. For any new facility, however, engineering development, testing, and demonstration will be required to insure trouble free and safe operation.

Safety of oil transport will be increased by transferring oil directly from deep draft tankers into a pipeline to be pumped directly to the refineries. This is due to three factors.

- (1) Pipelines are buried beneath the ground onshore and beneath the sea-floor and beach offshore. Accordingly, a properly designed pipeline is not subject to storms and other extreme natural events as are barges and ships on the sea surface.
- (2) Attaching and detaching hoses from ship and barge manifolds has elements of risk in each cargo transfer operation. In the lightering process oil is transferred from loaded tanker to lighter and from lighter to refinery dock. Finally, the tanker moves upriver to the refinery dock and pumps out the remainder of its cargo. A pipeline from a down-bay or at-sea terminal would involve only one hookup of unloading equipment to each tanker and thus reduce the risk of human error or of equipment failure.

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<sup>1</sup>By terminal is meant a totally enclosed transfer operation with fixed facilities of the type described as Option No. 1.a. of this report. This would include automatic safety equipment and operational safeguards, as well as navigational traffic control.

- (3) Unload deep draft tankers as well as smaller crude tankers directly into a pipeline in the lower bay would, in the long term, significantly reduce crude-oil-carrying ship traffic from the ship channel to Philadelphia.

Navigation is an important aspect of operational safety. The NADOT site located approximately eight miles east of Rehoboth is designed to be served by a special approach channel. The channel would be wide (in the order of one mile) and short (in order of 20 miles). By the use of a ship traffic control system similar to that employed for aircraft control the probability of collision or grounding would be virtually zero.

Delaware is fortunate in that all lower bay and continental shelf bottom material is of a sedimentary origin and is either sand or soft material. Accordingly a grounding would not normally endanger the structure of a tanker to the extent that a tank would rupture. Further, modern tankers are compartmented so as to minimize loss of cargo should there be a rupture of the hull.

Navigation to an in-Bay terminal would add approximately twenty miles of distance in a channel beyond that required to reach the NADOT site. This channel would be approximately one mile wide to reach a terminal site on the Delaware side. On the New Jersey side, approaching the Crow Shoal site, the final few miles would no doubt be much narrower (probably in the order of 600 feet to 1000 feet) since it would be a dredged channel constructed specifically to serve the deepwater terminal.

Again, a sophisticated ship traffic control system should be installed to insure maximum safety of operation.

In summary, from an operational point of view, there are no clear and compelling reasons to recommend an in-Bay terminal over the NADOT site outside the Bay. The factor which favors an in-Bay site is the sheltered water. The counter argument is the longer approach channel and the potentially greater environmental risk associated with regular spills or a collision which would release crude oil in the Bay.

### Environmental

The optimum environmental solution from Delaware's point of view, to increase the safety of petroleum transport in Delaware Bay, is to eliminate as much of the petroleum traffic as possible and to make as safe as possible that petroleum traffic which remains. This can be accomplished by at least two methods. First, Option No. 9.a. would locate a deepwater terminal of the NADOT type off New York Harbor and would supply Delaware Valley refinery needs by a pipeline across New Jersey from the north. This would essentially eliminate lightering in the lower bay.

A second method to achieve the goal of eliminating crude oil shipment and transfer in Delaware Bay can be accomplished, in part, by encouraging the development of transshipment terminals in Canada or the Bahamas. This would also reduce lightering in the lower bay. It would not, however, reduce ship traffic in the estuary to the refineries as small or shallow draft ships from foreign transshipment

ports would still enter the Bay with crude oil. Also, if Delaware Valley requirements for refined products are met by foreign refineries, product-ship traffic would no doubt increase.

While either the construction of a terminal off New York or transshipment terminals in Canada or the Bahamas would reduce or remove hazardous operations from Delaware Bay, Delaware has little ability to make either come to pass. Accordingly, the Committee has its attention on those solutions which both increase the safety of petroleum transfer operations in the Bay and which also are within the power of the State of Delaware to put into effect. These fall into the two following categories:

(a) Terminals Outside of Delaware Bay

Terminals located outside of Delaware Bay either eight or twenty miles off the Cape Henlopen-Rehoboth area have been proposed. Studies by faculty members in the College of Marine Studies at the University of Delaware indicate the following:

1. A major spill would probably not enter Delaware Bay unless blown by a steady wind from the east through southeast.
2. Currents along the coast would gradually move an oil slick south. (These currents are not to be confused with the near shore currents along the Delaware shore caused by wave action which move sand north to Cape Henlopen.)
3. In the summer when prevailing onshore winds are from the southeast a slick would move toward the New Jersey shore.
4. In the winter when prevailing onshore winds are from the northeast a slick would move toward the lower Delaware-Maryland shore.
5. Beaches do not harbor significant quantities of biological life and as a consequence oil would have little effect on marine life.
6. Beaches are used for recreation and have a high commercial value, particularly in the summer. Spills on beaches have, however, been successfully cleaned up and the beaches returned to recreational use in a relatively short time.

(b) Terminals in Delaware Bay

Two areas inside of Delaware Bay have been proposed as sites for a deepwater terminal. One is on the Delaware side in the vicinity of the present lightering area. The second is on the New Jersey side near Cape May on Crow Shoal.

The Cape May site is less attractive from a Bay-wide environmental view point since it would require substantial construction dredging and would also be located in productive oyster grounds near Crow Shoal. Due to the presence of extensive oyster beds the site would also be vulnerable to low level operational spills.

The Delaware sites along the existing channel off Big Stone Beach are more attractive from a Bay-wide environmental point of view since natural deepwater now exists. A carefully sited platform type structure could be installed with minimal bottom disturbance. An access channel of

65 feet referenced to Mean Low Water (MLW) now exists and could be deepened to 72 feet with modest dredging. No commercial shell fisheries need be disturbed by such channel dredging.

Terminal sites in Delaware Bay possess one attractive and one unattractive feature in common. The attractive feature is shelter from ocean storms and severe wave action, although swell can reach both sites in the lower bay.

The unattractive feature is that to build a deepwater terminal in the lower bay requires that tankers enter the Bay and thus subject the Bay to potentially catastrophic spills as well as to regular operational spills. A massive spill of 100,000 or more barrels of crude oil would remain in the Bay for several weeks. The general counterclockwise circulation pattern would distribute the oil throughout the Bay and thus affect the Delaware shores as well as the New Jersey shores. The only exception to this outcome would be a strong steady wind blowing generally from the northwest which would carry the spill directly out of the Bay to sea. The probability of a favorable wind of adequate duration coupled with a favorable ebbing tide is quite small, however.

#### (c) Toxic Effects of Petroleum

Spilled oil can damage marine and marsh life in three ways:

1. By direct contact crude oil, and more volatile products, coat marine organisms, birds, and animals. Certain animals will be suffocated and birds, when preening, swallow oil and often die.
2. Long term effects of spilled oil include the persistence of oil in marine sediments where it becomes accessible to the marine food chain. Through the food chain petroleum derived hydrocarbons may ultimately accumulate in marine organisms which are consumed by humans.
3. The cleanup of spilled petroleum can be damaging to marine and tide marsh life. This can result from the use of detergents and emulsifiers and also from personnel and equipment used in cleanup operations.

#### (d) Visual Effects

The effect of the curvature of the earth is quite noticeable at sea. An observer looking out to sea at approximately water level cannot see an object 0.7 feet above the water surface at a distance of one mile. At a distance of four miles the object at sea must be 10.7 feet high to be visible. At eight miles, objects of less than 42.6 feet in height will not be seen by the observer.

This means then that from Delaware shores, a terminal at Cape May would be difficult to discern. Although the NADOT terminal itself would be largely hidden from view from the Boardwalk at Rehoboth, the ships when empty would be visible. The entire terminal would be visible from the upper floors of hotels, however.

A terminal located near the existing anchorage area off Big Stone Beach would be visible from the shore in much the same way that ships being lightered at present are visible.



Contrasting Coastline Usage

(e) Probable Effects on Land Use

Delaware has been subjected to growing pressures for petro-chemical industrial development. It seems logical that the transport of additional volumes of crude oil will increase the pressure for land use conversions to petroleum related industrial uses. Only the Coastal Zone Act currently stands in the way of a rapid move towards industrialization of the coastline.

The only alternative that would relieve industrial development pressures on Delaware is Option No. 9.a., a terminal outside New York Harbor off Sandy Hook, with a pipeline servicing Delaware Valley refineries.

A pipeline running through Delaware would have the highest potential for changing land use. If land use decisions were left solely to the responses of the market place, a pipeline would surely be accompanied by expansion and creation of oil refineries.

Increased water borne oil traffic would bring a similar land use response for selected sites that have river access.

Delaware is in a unique position to estimate the effect on associated land use if a deepwater terminal is constructed in the Bay or at the NADOT site off Rehoboth. As noted earlier, a crude oil transfer operation of major proportions has operated for over a decade in the anchorage area off Big Stone Beach. As a result it seems likely that whatever effect such an operation has on adjacent land use and price has already occurred. If the Committee's appraisal is correct, any terminal option with a pipeline connection to shore would increase safety and lessen environmental risk, thereby improving the potential for improved adjacent land use.

The terminal site at Cape May is believed to be too remote from Delaware to have any direct effect on Delaware land use.

The NADOT site off Rehoboth presents a less well defined situation. All tanker unloading at a NADOT terminal site with well designed spill protection equipment should reduce casual spillage as well as reduce the threat of a catastrophic spill. It does not seem probable that such a terminal would have any adverse effects on land use along Delaware's ocean beaches.

In summary, the Committee believes that the most serious consideration from Delaware's point of view is the potential for uncontrolled development of refineries and other heavy industry in the Coastal Zone. It does not believe that any greater adverse effects would necessarily accrue to the state from a well designed and operated petroleum transfer facility in Delaware waters since extensive crude oil transfer operations are now carried out near Big Stone Beach.

(f) Pipeline Construction

The environmental effects of pipeline construction are of a short-term nature and would be healed in a period of one to three years in both offshore and onshore locations. The pipeline sizes projected are 36-inch to 48-inch diameters. Actual construction involves heavy trenching and backfilling equipment, coating and wrapping equipment, bending machines, and pipelaying tractors. For operation, pumping stations are required at intervals along a pipeline.

Well designed and operated pipelines have good safety records. Even when broken, pipeline spills can normally be contained by block valves and automatic equipment to minimize pipeline drainage.

### Economic

Figure 8 provides a comparison of total transportation costs between Persian Gulf producing fields and Delaware Valley refineries. As can be seen, the greatest saving results from the use of VLCC's on the long ocean voyage. Savings in the order of 38¢/bbl would be possible by 1985 if a 250,000 dwt tanker is used instead of an 85,000 dwt tanker.

The potential saving by 1985 between unloading at a Delaware Bay terminal and transshipment at a Bahamian terminal is in the order of 9¢/bbl for 250,000 dwt tankers. Further, the economic difference is approximately the same (15¢ (bbl)) between the most economical Delaware alternative (Option No. 1.a.) and the least economical (Option No. 9.a.) alternative offloading terminal considered to handle Delaware Valley crude oil requirements. Table 3 summarizes unit costs for alternative terminal-transport systems. Basic financing data assumptions used in this study are provided in the Technical Report.

#### (a) Potential Income to Delaware

What income could be realized by the state if all or part of a deepwater terminal and pipeline were located in Delaware? First and foremost, it would depend on what alternatives are available to the petroleum companies. From the preceding paragraphs, it is apparent that several reasonable alternatives are available outside of Delaware's control. The actual income which Delaware could derive would depend on direct negotiations with one or more groups who are interested in moving crude oil through a Delaware terminal. Several organizations have prepared deepwater terminal plans which state, or imply, such interest. The possible gross charges which could be negotiated by Delaware are in the range of less than 1¢ per barrel to nearly 9¢ per barrel, though the latter figure appears to be unlikely. The results of such negotiations would depend on many factors including the extent of services provided by Delaware and financing, operating, and inspection arrangements. From such gross charges would come the cost of operation, debt service, inspection activities, and the creation of a contingency fund for oil spill cleanup.

This means that the net revenue potential which Delaware might obtain is in the fractions of a cent to one or two cents per barrel. This converts to possible net revenues of from zero to more than 7 million dollars per year based on mid-1970's throughput.

It is the Committee's conclusion that income to the state from oil transfer or transport operations is not the most important consideration for Delaware. The first consideration is to provide for safer operation than now exists. If this requires inspection and other costs connected with control, monitoring, and cleanup, charges should be made to meet these costs. Revenues over and above these costs should be regarded as a by-product.

### Legal

There are three principal types of legal problems which must be considered in connection with oil transfer and transport in Delaware Bay. These are concerned with (1) the rights of private citizens

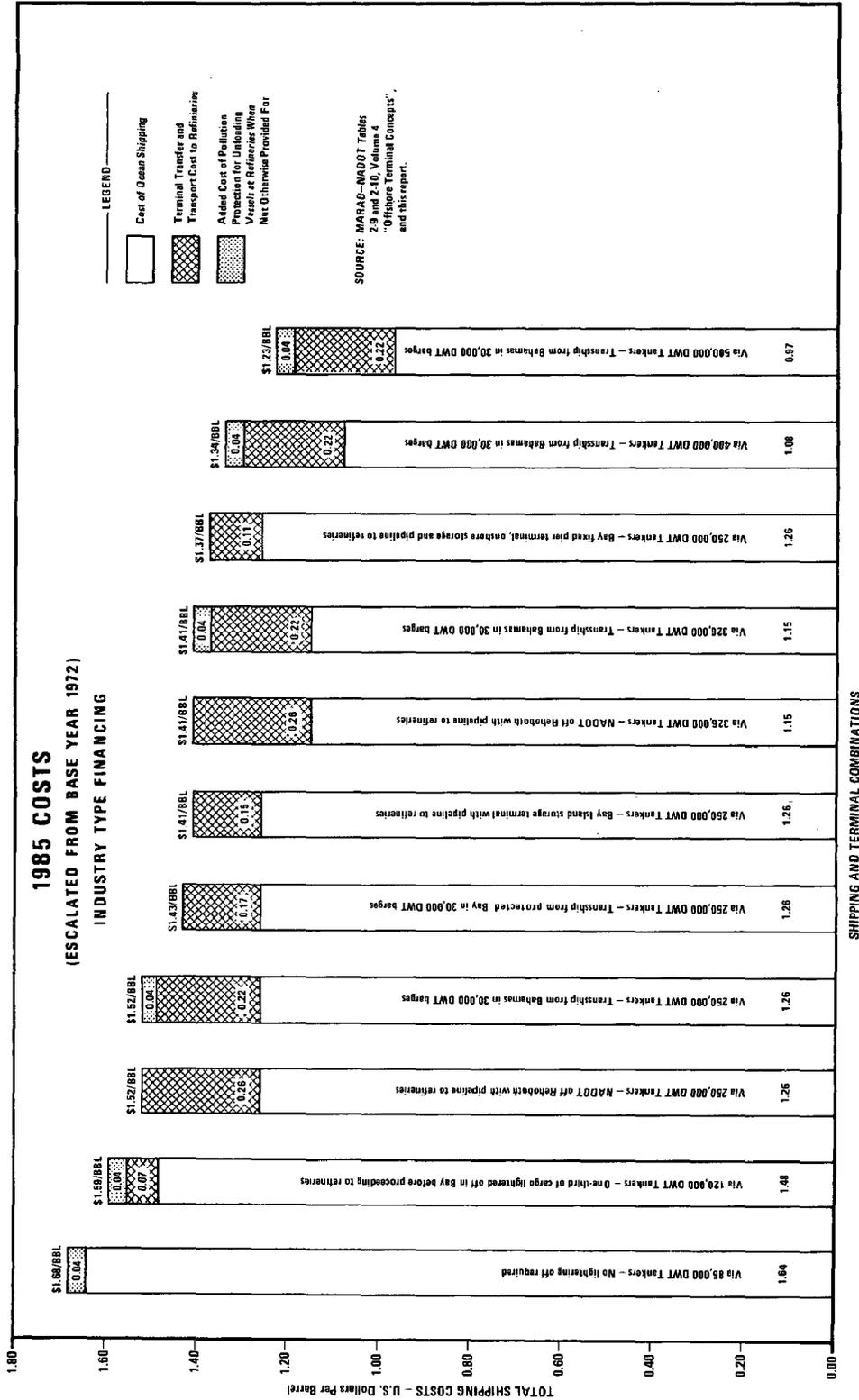


Figure 8 Total Cost of Shipping Crude Oil from the Persian Gulf to the Delaware Valley Refineries Using Several Size Tankers in Combination with Selected Terminal Options

Table 3  
**SUMMARY OF AVERAGE UNIT COST  
 (ESCALATED AND ACCUMULATED BASIS)  
 CRUDE OIL TO DELAWARE VALLEY REFINERIES**

<u>Option No.</u>	<u>Financed by</u>	<u>Options Based on Deliveries to</u>	<u>Initial Year</u>	<u>1980</u>	<u>1985</u>	<u>2000</u>	
( Cents per Barrel )							
1.a.	Industry	Delaware	(1976)	12.1	12.4	11.9	11.5
	Port Authority	only		7.0	7.2	7.2	9.0
	Federal			6.4	6.5	6.6	8.5
1.b.	Industry	Delaware	(1976)	12.9	13.9	14.0	14.5
	Port Authority	only		8.0	8.7	9.1	11.7
	Federal			7.4	8.0	8.4	11.0
2.a.	Industry	Delaware,	(1977)	17.2	17.0	16.1	15.6
	Port Authority	New York &		10.2	10.1	9.9	12.3
	Federal	Yorktown		9.3	9.2	9.1	11.5
2.b.	Industry	Delaware,	(1977)	14.3	14.6	14.8	15.2
	Port Authority	New York &		8.6	8.9	9.4	11.8
	Federal	Yorktown		7.9	8.2	8.6	11.2
3.b.	Industry	Delaware,	(1977)	16.4	16.2	15.4	14.9
	Port Authority	New York &		9.6	9.6	9.4	11.6
	Federal	Yorktown		8.7	8.7	8.7	10.9
4.a.	*Industry	Delaware,	(1977)	22.5	24.4	24.7	24.1
	Port Authority	New York &		13.0	14.1	14.5	18.0
	Federal	Yorktown		11.7	12.8	13.2	16.7
4.b.	*Industry	Delaware,	(1977)	24.6	26.2	26.4	24.9
	Port Authority	New York &		13.9	14.9	15.3	18.3
	Federal	Yorktown		12.5	13.4	13.8	17.0
4.d. +	*Industry	Delaware,	(1977)	20.5	21.8	22.2	22.3
	Port Authority	New York &		12.0	12.9	13.3	16.9
	Federal	Yorktown		10.9	11.7	12.2	15.8
5.a.	Industry	Delaware	(1976)	12.9	13.2	12.6	12.3
	Port Authority	only		7.6	7.8	7.8	9.7
	Federal			6.9	7.1	7.2	9.2
5.b.	Industry	Delaware	(1976)	12.4	12.6	12.2	11.9
	Port Authority	only		7.4	7.5	7.5	9.4
	Federal			6.7	6.8	6.9	8.9
7.b.	Industry	Delaware	(1975)	16.1	16.8	16.9	19.0
	Port Authority	only		12.5	12.9	13.2	16.9
	Federal			12.0	12.4	12.7	16.5
9.a.	*Industry	Delaware &	(1977)	26.5	28.1	27.9	25.9
	Port Authority	New York		14.8	15.8	16.0	19.0
	Federal			13.3	14.2	14.5	17.5

+Crude oil only.

\*See detail sheets in Technical Report for reduced costs if breakwater and dredging are Federally financed or subsidized.

damaged by oil pollution, (2) compliance with existing or anticipated laws, and (3) the modification of existing statutes to permit the operation and/or control of petroleum transfer activities. Agreements, laws, and regulations which may affect this situation exist, or are being considered, at the international, national, regional, state, county, and local levels.

(a) International

At the international level, the Intergovernmental Maritime Consultive Organization (IMCO) has developed two conventions respecting oil pollution damage and liability for such damages. Neither of these conventions has been ratified by the United States; however, they are now before the U.S. Senate and ratification appears likely.

It should be noted that international treaties are the "Supreme Law of the Land." Accordingly, ratification of the conventions would pre-empt all state laws and prevent remedial measures from being taken by state legislatures in matters covered by the conventions. There are substantial opinions that the provisions of the conventions are inadequate to provide for appropriate compensation to individuals and local government injured by oil spills.

(b) Federal

It will be necessary for any construction in the Bay to comply with the requirements of the Federal Water Quality Act. This will mean the preparation of an environmental impact statement and the public examination of that statement. All construction, or placement of floating obstructions, in a navigable waterway requires a permit from the U.S. Army Corps of Engineers.

The Federal Water Quality Improvement Act of 1970 provides for fines and extensive liability in connection with the discharge of oil, harmful to public health and welfare, into navigable waterways, adjoining shorelines, and waters of the contiguous zone. Additional provisions of this act are given in Chapter 2 of this report in the sub-section concerned with cleanup responsibility.

Jurisdiction over terminals constructed and operated outside of state and federal territorial waters on the continental shelf is not adequately defined. A presidential task force has been formed recently to clarify this matter and recommend appropriate federal legislation. Their report is expected in the spring or summer of 1973.

(c) Regional

The Delaware River Basin Commission (DRBC) has authority over construction in the Bay which will affect water quality. Accordingly, it is anticipated that DRBC approval would be required for the construction and operation of a fixed terminal inside the Bay as defined by a line which connects Cape Henlopen and Cape May.

A second agency, the bi-state Delaware River and Bay Authority (DRBA) involves both New Jersey and Delaware. Its charter is specific in giving that agency control over marine transportation facilities in the Bay. It is unclear whether such transportation facilities must be partly in each state for the DRBA to control. Projects undertaken by the DRBA can be vetoed by either state.

(d) State

The State of Delaware controls all public subaqueous lands within its boundaries through the Water and Air Resources Commission and the Governor.

Environmental standards are administered by the State Department of Natural Resources and Environmental Control (DNREC). A permit would be required from DNREC to proceed with any project involving dredging or the construction of fixed facilities.

The Coastal Zone Act is administered by the State Planning Office. The construction of a fixed terminal facility is forbidden by the act. The construction of a pipeline, either subaqueous or on shore, is not forbidden. If a fixed terminal facility were to be built in the Coastal Zone, it would be necessary to amend the Coastal Zoning Act to allow the facility.

(e) County

County zoning ordinances vary with respect to an offshore terminal, a tank farm, and a pipeline. Kent County has no zoning category for such facilities. Sussex county considers recreational interest, at all times, paramount to industrial interests. New Castle county still has a substantial amount of unused land zoned for industrial development. A further attempt to restrict the use of land in the state "Coastal Zone" was recently defeated in the County Council. There is no current prohibition with respect to utility transmission and distribution lines.

(f) Local

No local ordinances were discovered in the course of the Committee's work which specifically related to petroleum transfer facilities or operations.

(g) Private

Protection for private individuals damaged by oil pollution is at present covered by the 1970 Water Quality Improvement Act. It is the opinion of some legal authorities that the rights of private citizens are inadequately covered by the federal act. This means that special state legislation should be enacted to protect private rights. Otherwise, the only recourse available to a private citizen is at common law such as nuisance, trespass, or in admiralty law under 1850 federal legislation. In this matter Delaware citizens with property exposed to the potential of oil spills are quite vulnerable.

National Defense

The Committee sought but did not receive assistance of the Department of Defense in evaluating national defense aspects of oil transport. No national defense studies or policies concerning deepwater ports were found to exist. Five conclusions have resulted from consideration of this matter.

1. The most vulnerable part of a crude oil transportation system which would include a deepwater port, are the large tankers. These could be easily sunk on the long ocean voyage from the Persian Gulf, Africa, or South America.
2. It would seem unwise to concentrate all deepwater crude importation in a single East Coast terminal. Such a terminal could be put out of commission by direct attack or by scuttling a ship in the terminal or approach channel.

3. A national plan for the location of new refineries and deepwater terminals based on defense considerations does not now exist. Such a plan should be prepared and should be used in planning new facilities.
4. Delaware is not the sole deepwater terminal location on the East Coast. Not all crude oil will be coming by supertankers. Some will come from less distant ports in conventional tankers or new "restricted-draft vessels" that can enter many existing ports. Other terminal sites can be located in protected waters and in less critical areas.
5. Concern has been expressed to the Committee by Delaware residents that the location of a deepwater terminal in Delaware Bay or offshore would make Delaware a target for foreign attack in time of war.

#### Regional Economic Considerations

In the near-term little economic impact on consumer prices would be expected in the Delaware Valley regardless of what course the State of Delaware chooses to follow. This is because petroleum companies have other economically viable alternatives which are outside of Delaware control. Examples include refining or transshipment in the Bahamas or Canada, or, the expansion of refining capacity in the Gulf area with products supplied by pipeline.

In the longer term it is possible that if Delaware does not allow the construction of a deepwater crude oil terminal few if any new refineries will be built in the Delaware Valley. Due to air pollution standards now in effect it would be difficult to increase refining capacity in the industrialized part of the Delaware Valley without exceeding allowable pollution limits. This could have the effect of reducing refining activity in the valley over the next two or three decades.

## Chapter 7

### RECOMMENDATIONS

Problems incident to meeting the energy requirements of the Delaware Valley will continue to grow. Regardless of actions taken by the State of Delaware, petroleum and petroleum products will continue to move in the Delaware Bay and River. Terminal sites are available in both Delaware and New Jersey waters, and federal waters outside of the Bay. Catastrophic and/or operational spills at any of these sites will affect both states, the waters of the entire Bay, and the ocean coasts as well.

The optimum solution for Delaware, in providing for much increased protection from spills, involves two courses of action. The first, interim in nature, is to increase the safety of existing crude oil lightering operations in the lower Bay. The second, of a more permanent or long range nature, is to insure that any permanent facilities designed to handle larger quantities of crude oil, whether constructed and operated in Delaware waters, New Jersey waters, or beyond the jurisdiction of either state's direct control, offer maximum safeguards for Delaware's Coastal Zone.

1. THE COMMITTEE RECOMMENDS THAT THE STATE OF DELAWARE ADOPT AND MAINTAIN THE STRONGEST POSSIBLE PROHIBITION AGAINST ANY NEW OIL REFINERIES IN DELAWARE.

The Committee considers this to be a matter of great urgency. It is of major concern to the Committee that there will be increasing pressure on the State of Delaware to permit refineries and onshore facilities associated with petroleum transportation services. The Committee strongly endorses the position taken by the Coastal Zone Act.

Several approaches could be used to strengthen Delaware's position and to provide adequate safeguards. One possibility would be to prohibit refineries in the Coastal Zone and other areas of the state by enacting a constitutional amendment, although this raises the question of the suitability of using a constitutional amendment to accomplish zoning objectives. On the other hand, the Committee believes that a constitutional amendment to define the basic right of the citizens of Delaware to enjoy a clean, pleasant, and high quality environment could be appropriate. A second method would be to strengthen county zoning ordinances to forbid development which is incompatible with the maintenance of a high quality environment.

The Committee believes this added safeguard is important to insure that future economic pressures resulting from the establishment of any deepwater terminal built and operated in the vicinity, either in Delaware or outside of state waters, does not bring about industrialization of Delaware's coastal zone.

**2. THE COMMITTEE RECOMMENDS THE IMMEDIATE ESTABLISHMENT OF A COMPLETE PROGRAM FOR THE REGULATION OF PETROLEUM TRANSFER OPERATIONS CONDUCTED WITHIN DELAWARE'S JURISDICTION.**

Despite the fact that no major spills have occurred as a result of lightering operations, the Committee believes that potential hazards could be reduced both in the lightering area and at refinery docks. Protective measures to reduce these hazards would include positive spill containment during transfer, standards for operational weather conditions, on site cleanup equipment, and continuous inspection of all tanker and barge transfer operations by the State.

A throughput fee should be established to cover the cost of such activities.

The Committee feels strongly that this responsibility should be assigned to the State's Department of Natural Resources and Environmental Control (DNREC) for implementation. The DNREC has the advantage to Delaware of being under full state control. It will, of course, require additional funds from the state to carry out this new responsibility.

It is possible, under current law, that this function could be assigned to the Delaware River and Bay Authority (DRBA). The DRBA would provide for sharing the control and monitoring with New Jersey. It also has independent resources to support monitoring costs. Disadvantages include loss of certain elements of control by Delaware and potential difficulties in reaching agreement with New Jersey.

Other organizations which should be involved in considering such protective measures include the United States Coast Guard, the Delaware River Basin Commission, the Delaware River and Bay Authority, and the involved industries.

**3. THE COMMITTEE RECOMMENDS THAT APPROPRIATE STEPS BE TAKEN TO ALTER THE TRADITIONAL LIMITED LIABILITY AND STANDARDS OF LIABILITY WITH RESPECT TO DAMAGES CAUSED BY SPILLED OIL SO AS TO PROVIDE AN ADEQUATE REMEDY TO PRIVATE PROPERTY OWNERS.**

As a result of this study, the Committee believes that existing legislation to protect the rights of private property owners harmed by oil spills and related accidents is inadequate. Model legislation has been enacted by the State of Florida (Reubin O'D. Askey, et al. v. the American Waterways Operators, Inc., et al., No. 71-1082 October term 1972 U.S. Supreme Court) which allows private property owners to recover both direct and indirect damages because of harm incurred from spilled oil. This law is now being tested in the United States Supreme Court. If it is upheld, the precedent will exist for such legislation in the State of Delaware.

4. THE COMMITTEE BELIEVES THAT THE MATTER OF PETROLEUM REQUIREMENTS AND THE POSSIBLE NEED FOR A TERMINAL<sup>1</sup> IS A REGIONAL PROBLEM, AND, FURTHER, THAT DELAWARE'S ELECTED LEADERS SHOULD TAKE THE INITIATIVE OF EXPLORING WITH THE STATES OF NEW JERSEY AND NEW YORK THE FEASIBILITY OF CONSTRUCTING A TERMINAL ALONG THEIR RESPECTIVE COASTLINES WHICH WOULD SERVE THE REGIONAL REFINERIES BY PIPELINE AND THEREBY REDUCE THE RISKS INHERENT IN PETROLEUM TRAFFIC IN THE DELAWARE RIVER AND REGION.

IF, IN THE LAST RESORT, IT IS PROVEN TO DELAWARE'S SATISFACTION THAT NO ADEQUATE ALTERNATE LOCATION IS AVAILABLE, AND IT IS DEMONSTRATED THAT THE PETROLEUM RIVER TRAFFIC IS INCREASING BEYOND SAFE LIMITS, THE COMMITTEE RECOMMENDS THAT INCREASED SAFETY OF OIL TRANSPORT CAN BE ACHIEVED BY THE CONSTRUCTION AND OPERATION OF A TRANSFER TERMINAL IN THE BAY WITH A PIPELINE TO THE REFINERIES, AS OPPOSED TO THE EXTENSIVE EXPANSION OF LIGHTERING IN THE BAY.

SHOULD THE CONDITIONS DESCRIBED ABOVE IN THIS RECOMMENDATION BE MET, THE COMMITTEE RECOMMENDS THAT A DELAWARE AUTHORITY BE CREATED TO:

- (1) SERVE AS AGENT FOR THE STATE OF DELAWARE TO CONSIDER PROPOSALS FOR THE CONSTRUCTION AND OPERATION OF PETROLEUM TRANSFER FACILITIES IN DELAWARE BAY OR COASTAL WATERS ADJACENT TO DELAWARE BAY, AND,
- (2) PLAN, FINANCE, CONSTRUCT, OPERATE, AND MAINTAIN SUCH PETROLEUM TRANSFER FACILITIES.

The most desirable method to reduce hazards to Delaware from oil spills would be to remove all petroleum transfer and transport operations from Delaware Bay. The Bay is the most important marine resource to support the marine ecosystems of the mid-Atlantic region and, accordingly, needs strong protective measures.

The Committee is mindful of the fact that the Delaware River and Bay Authority (DRBA) exists by virtue of a compact between the states of Delaware and New Jersey and was recognized by the United States Congress in 1962. The DRBA is authorized by the Compact to operate not only crossings such as the Delaware Memorial Bridges and the Cape May-Lewes Ferry but also terminals and other facilities of commerce. This raises a legal question concerning the right of Delaware to act independently under a new authority and this question must be investigated.

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<sup>1</sup>By terminal is meant a totally enclosed transfer operation with fixed facilities of the type described as Option No. 1.a. of this report. This would include automatic safety equipment and operational safeguards, as well as navigational traffic control.

Under the DRBA Compact, protection is provided to both member states from action which will harm either by the provision of the Compact which states that "The Authority shall not undertake any project or part thereof, other than a crossing, without having first secured approval thereof by concurrent legislation of the two states expressly in implementation hereof."

The Committee believes that petroleum companies now operating in the Delaware Valley, as well as those which are planning the construction of new refineries in the area, have several economically viable alternatives to meet consumer demands of the region. Some of these alternatives would provide increased protection to Delaware from oil spills and at the same time have little effect on consumer prices.

The Committee has recommended the creation of a state authority to receive and examine proposals for terminals and pipelines and make recommendations to the Governor. A number of concepts have been put forth and a few serious plans exist. These should be examined thoroughly with reference to Delaware's needs, requirements, and rights before any action is taken.

The Committee wishes to reemphasize its strong belief that adequate legal and institutional arrangements be developed for protecting the land use in the Coastal Zone (as stated in Recommendations 1.) prior to reaching a decision on any terminal.

**5. THE COMMITTEE RECOMMENDS THAT A NATIONAL PLAN BE DEVELOPED FOR THE LOCATION AND DEFENSE OF DEEPWATER TERMINALS AND NEW REFINERY COMPLEXES WHICH WILL MINIMIZE THE VULNERABILITY OF PETROLEUM TRANSPORTATION AND REFINING ACTIVITIES IN TIME OF WAR.**

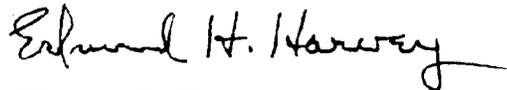
The Committee, in its investigations, was unable to locate any studies or plans which were concerned with the defense of deepwater terminals. Both refineries and the deepwater ports through which crude oil will be imported would be prime targets in time of hostilities. It is of concern to the Committee that no consideration of this important matter has been included in other studies, including those conducted by the federal government, and that no national guidelines for the location or defense of petroleum transport or refining facilities is known to exist. This could well be part of a national energy policy.

## Chapter 8

### MINORITY STATEMENT

The following minority statement has been prepared by an individual committee member. The opinion expressed is solely that of the individual who has signed the statement.

“Because of the legislative charge to the Committee, safer methods of transfer could not be ignored which, of necessity, include the study of in-Bay terminals. However, I strongly believe that because of environmental and ecological considerations that alternative 9. a. (terminal off Sandy Hook) would be the best site for an oil terminal from a Delaware point of view.”

A handwritten signature in cursive script that reads "Edmund H. Harvey". The signature is written in black ink and has a long, sweeping tail that extends to the right.

Edmund H. Harvey

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