Volume II of III

FOREIGN DEEP WATER PORT DEVELOPMENTS

A Selective Overview of Economics, Engineering, and Environmental Factors

APPENDIX—A FRANCE, DUNKIRK AND LE HAVRE
APPENDIX—B BELGIUM, ANTWERP
APPENDIX—C THE NETHERLANDS, ROTTERDAM AND AMSTERDAM

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FOR
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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

DECEMBER, 1971

IWR REPORT 71-11

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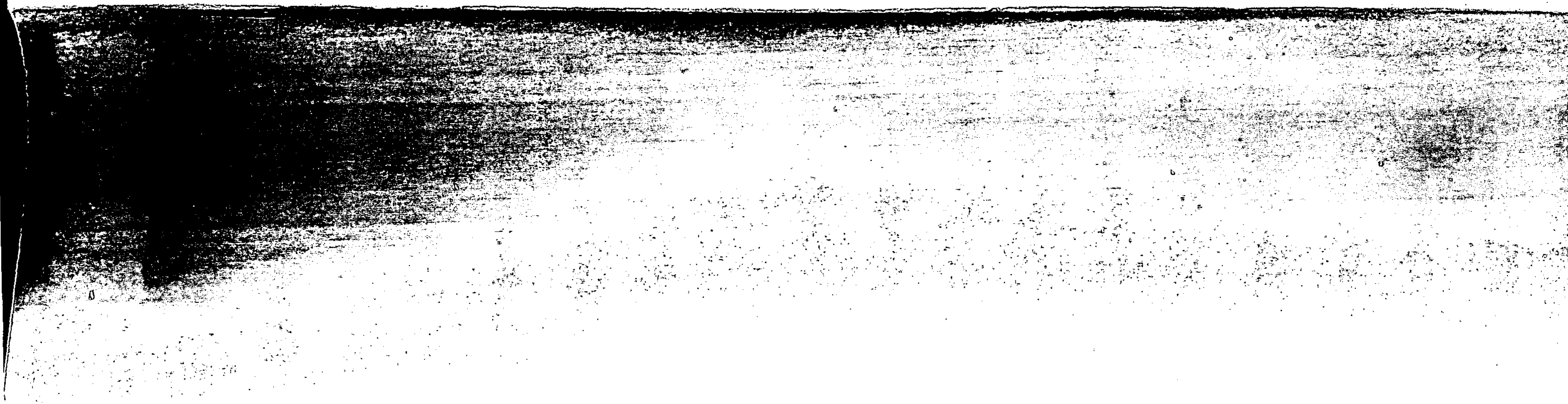
IWR REPORT 71-11 FOREIGN DEEP WATER PORT DEVELOPMENTS VOLUME II OF III



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APPENDIX A

FRANCE
DUNKIRK AND LE HAVRE

APPENDIX A

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A.1 DUNKIRK

A.1.1 SUMMARY

Dunkirk is dwarfed by its neighbor ports, Rotterdam (world's largest), Antwerp (world's second) and Le Havre (France's second), but it is the closest French port to the Golden Delta and the continental interior and it is the most western of the ports directly connected to that area. A military port, recently developed as an iron ore terminal (125,000 dwt) and steel mill, it bases immediate growth on a bauxite terminal (300,000 dwt) and future growth on an offshore island for 500,000 to 1,000,000 dwt crude oil transshipment to northwest Europe.

The Dunkirk port development project is more politically based than either of the other two major French port projects (i.e., Le Havre and Marseilles/Fos). The northern region of France has been heavily oriented towards the coal mining and textile industries. In the last two decades, these industries have experienced a significant decline, with resulting unemployment and social problems. The port development project at Dunkirk is a government attempt to reverse the northern industrial decay and initiate an economic resurgence, the idea being to concentrate a heavy industrial zone in Dunkirk to use the excess labor that is becoming increasingly available in the northern region.

In addition, the port planners in Paris view the Dunkirk development as opening up a new supply route for the heavy industrial areas of Germany. It also offers an alternative to Le Havre in the competition with Flemish and Dutch ports for the European continent including northeast France. Thus, major objectives of the Dunkirk development are to siphon off commodity flows of northern France and possibly Belgium and Germany, which are presently being exported and imported via Antwerp. While the initial economic rationale upon which the port development is based relates primarily to dry bulk imports (iron ore, bauxite), oil is ultimately expected to be the principal product handled. It is planned that, in the future, oil will be pipelined from Dunkirk through Belgium into the Ruhr, to provide Germany with an additional supply route.

In summary, the primary factors which supported Dunkirk's candidacy for a deep water port were:

- Dunkirk already has an established, well-maintained port, presently capable of handling vessels up to 125,000 dwt;
- with moderate financial expenditure, the port is capable of receiving 750,000 dwt vessels;
- It is a good European location for supertankers;
- the port could serve the very large industrial European interior, including the north of France, south Benelux, the Ruhr, and southeast England (through the future channel tunnel at Calais between France & England)
- over the long term, considerable water frontage may be needed for anticipated industry, and a 25-mile strip is available (equivalent in size to Rotterdam's present port) with the cost of land at 1/3 to 1/4 that of the northern lands ports;
- the beach between Dunkirk and Calais is essentially flat and sandy, and is described, because of the climate as being relatively "uninteresting" from a recreational standpoint (however Dunkirk maintains that they have more days of sunshine than Paris);
- the area is said to lend itself well to heavy construction; and
- the region is economically depressed and requires government assistance.

The cost to purchase the 200,000,000 square feet which comprise the present surface of the industrial zone was $54 million, ($0.27/sq. ft. or 1/4 of Amsterdam's new land). The port will own a 300-meter band which will run along the harbor basin. Through lease arrangements industrial users will have access to this land for finished product storage and materials handling concerning exports and imports.

Plans for expansion of the port of Dunkirk include the excavation of new docks westward from existing installations. The new harbor between Dunkirk and Graveline - will be at sea level, without locks, extending up to six miles inland to provide extensive dockside facilities for vessels up to 300,000 dwt, as well as sufficient frontage for industries dependent upon water transportation. Planners expect that the new dock length will also affect, from a Practical standpoint, the landward extension of heavy industry leaving the rest of the inland region to light industry, residential areas, and agriculture. It is also planned to connect the new harbor with the old by a large basin and lock.

A second stage of expansion, details and timing which have not been finalized, would involve constructing either a new port near Calais (similar to the one now planned between Graveline and Dunkirk) or an offshore island about eight miles from Dunkirk. Either of these alternatives would be capable of handling vessels of at least 500,000 to 750,000 dwt. Because no one knows yet which of the two alternatives will be selected, the area between Graveline and Calais will be retained as a potential industrial site until the decision is made.

A computer model has been built and is being used both for long- range planning (Dunkirk vs. competing ports to serve the German oil refineries) and short-range equipment acquisition and use (ship scheduling, cargo-handling and maintenance).

The lock and basin construction methods appear quite advanced in Dunkirk. Although lock construction is not needed in a U.S. port (other than possibly in Maine) certain approaches to heavy construction might be utilized to advantage in the U.S. Some salt water intrusion has occurred from channel deepening, and remedial methods are under consideration to control this condition. Hydraulic modeling should decide the port configuration rather than designing the port and later using modeling to ascertain the design effects as was done in Dunkirk and in many other cases.

Communications and infrastructure in the Dunkirk region need urgent improvement.

Throughout our discussions with port representatives, it was continually apparent that economic development had by far the highest priority, and that environmental considerations in terms of such factors as short and long range land use plans, water quality, air pollution abatement, solid waste disposal, and recreational and conservation activities ranked far below. As far as we could determine, there is little official concern for either solids pollution, noise abatement or visual pollution.

A.1.2 General Area Description

a. Geography

Dunkirk is located on the extreme northern French coast, about 16 km (10 miles) from the Belgian border. It's nearest coastal neighbor is Calais, about 40 km (25 miles) to the southwest. Dunkirk's use as a seaport for northern France dates from the 11th century. Almost completely destroyed during World War II, the port was rebuilt on a more spacious plan in 1954 (visible on the right side of figure A-1). Presently, it is France's third largest port, after Le Havre and Marseille and has ambitious plans for the mid-1970's (shown on the left side of Figure A-1). Sand bars flank a deep water channel running close to the coast. Dunkirk's outer harbor can be entered at any time of the day or night, although access to the port has to be through locks. There are three locks at present, the largest taking ships up to 125,000 dwt.

As a seaport with no river, Dunkirk has less requirement for maintenance dredging than, for example, Rotterdam, and comparative freedom from fog. A further geographical advantage of the port, so far as future development is concerned, is that there is a large unoccupied area of flat land available to the west and southwest.

The region immediately inland from Dunkirk is not as highly developed industrially as are the other major European ports we visited. Nor, at the present time, is its communications network highly developed, but this is being improved.

b. Surficial Character

The northern coast of France, between Calais and Dunkirk, is relatively flat and sandy. As recently as the 19th century, a portion of the existing coast was an embayment -- reaching 10 miles inland from the present coastline but it has been progressively filled by current and tide- deposited silt. The land area (most of which is below high tide level) is thus similar in character to the lowlands of northwest Europe and in effect might be considered a naturally reclaimed polder area. We were informed that bedrock is more than 100 feet deep and that there are no known fresh-water aquifers beneath the immediate area. The offshore is sprinkled with sand banks running parallel to the coast (east-west).

c. Climate

Fog is not a major problem in Dunkirk; visibility is greater than 2.5 miles over 80% of the time, and over 6 miles over half the time. While rain is not excessive on an annual basis (25 inches per year), it does rain about half the time. Temperatures are moderate, ranging between 40 and 65°F, with maximums of 9°F and 86°F. The air is seldom quiet in Dunkirk: southwest winds between 5 and 33 MPH occur 87% of the time. Because of these climate factors, plus the relatively featureless coastline, the Dunkirk/Calais coastal area is not considered prime recreational land. The local population is traditionally not inclined to reserve acreage for trees and recreation parks.

d. Hydraulics

The variations between high and low water at Dunkirk are 17.4 feet (spring) and 11.4 feet (neap). High-tide currents between 1 and 2 knots run west, while low-tide currents run about 1 knot in an easterly direction. Northern storms (winter) may bring substantial swells in the outer harbor.

e. General Land Use

Inland from the Dunkirk-Calais coast, the land is used primarily for agricultural purposes, although in some cases it is poorly drained. Because of the small degree of recreational, tourist, or residential use of the beach zone westward of Dunkirk -- except around the two communities of Gravelines and Fort Philippe -- the entire coastline between Calais and Dunkirk will be industrially zoned up to an inland "depth" of six miles, approximately twice as far as it was originally planned and completely enclosing Loon Plage, as the current zone has enclosed Mardyck township. The present industrial zone extends approximately 14 miles to the west of Dunkirk. Continuing west, another 14-mile strip is available for future industry use.

One of the primary problems has been securing adequate resources to purchase the required land and reserves necessary for the port and industrial zone. For example, if the entire Dunkirk project could be started afresh, the area on which a major steel plant was constructed by Usinor would be re-zoned. This steel plant facility is too far from western deep waters, near the present Dunkirk port and cities, and consumes far too much coastal land as it is presently laid out. The Usinor plant was located at this site over ten years ago, well before any type of national planning regarding port development. The present land which is used by the plant could be more economically used for commercial purposes, with the mill located close to the site projected for the alumina plant further west. But ten years ago, financial resources were limited for land purchase and few people were thinking of long-range planning.

Dunkirk remains a small community even after its recent merging with its eastern neighbor (Malo-Les-Bains) and now has 43,000 inhabitants. It is constricted between the sea and a dozen, independent-minded communities with up to 30,000 inhabitants each. Fortunately, a voluntary grouping occurred (with some government pressure and a lot of public relations work) between the 16 municipalities in the Dunkirk/Calais region. Commercial activities are concentrated essentially around the present community of Dunkirk-Malo as well as in surrounding towns, including Petite Synthe, Grande Synthe, Fort Mardyck, St. Pol-sur-Mer, and Coudekerque.

Despite this grouping there appears to have been relatively little urban planning done by the municipalities in the Dunkerque-Gravelines area. We were informed during our interviews that various leisure time activities such as entertainment, sports, and recreational facilities were viewed as relatively unimportant by the community leaders in the past. The area is quite underdeveloped regarding such leisure activities and this situation could possibly retard the industrial development of the Dunkirk region. Housing requirements have increased rapidly over the past ten years, resulting in tract-type developments (primarily low-income apartments and extensive trailer camps), which are often located in virtually direct contact with large industrial facilities, without visual or other means of separation, and without adequate sewage or septic facilities.

f. Population

The present population of the Greater Dunkirk area, including the cities named above, is approximately 140,000. This population is expected to double over the next 15 years, thereby requiring a major effort to provide the necessary housing, related infrastructure, and higher-education institutions.

g. Port

Maximum draft capability within the present harbor is 48 feet, sufficient

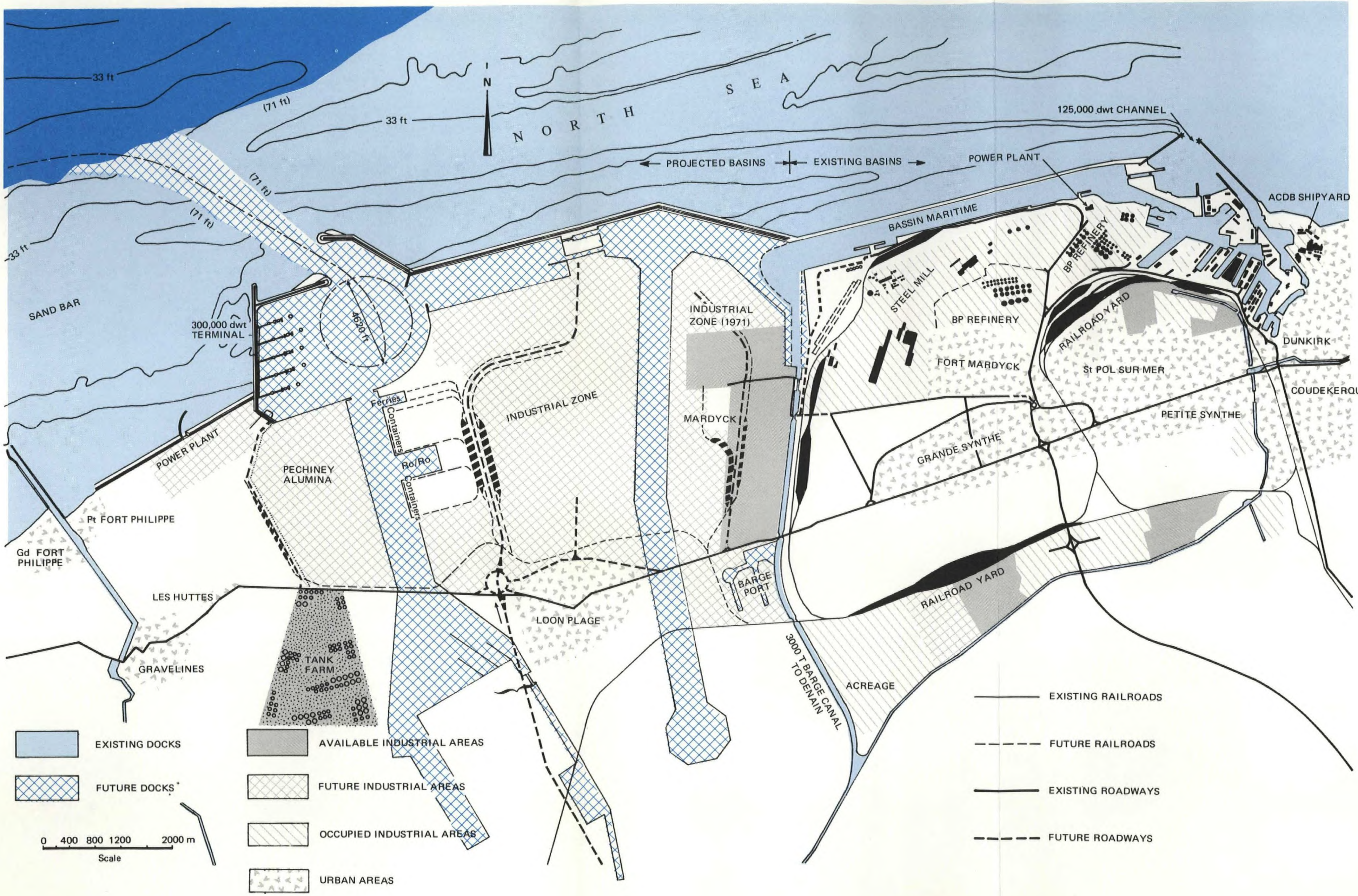


FIGURE A–1 PORT OF DUNKIRK – EXISTING AND PLANNED FACILITIES

to accomodate vessels of approximately 100,000 dwt with current load lines. (An exception is the "Leopold LD", a 125,000 dwt OBO carrier especially designed for the "Bassin Maritime" lock). The new outer harbor facility proposed at the west end of the Bassin, close to Gravelines (figure A-1), will permit entry of 300,000 dwt vessels by 1974. Major commodities handled by the port include crude oil, iron ore, general cargo, petroleum products, coal, sand, and gravel. Little fishing is done, because Boulogne and Calais are foremost in fishing.
Most of the harbor has locks, thereby making the port independent of tidal conditions and maintaining a water level of nearly 20 feet above that of low tide.

A.1.3 Institutions and Financing

The six major French ports -- Dunkirk, Marseilles, Le Havre, Rouen, Nantes/St. Nazaire, and Bordeaux -- now operate under what is known as the regime of autonomy. The object of this regime is that, although the ports are public establishments, they have financial autonomy and are accounted for on a commercial basis. The amount and nature of the investment in the ports are planned at national level by means of five-year plans. The current plan runs from 1971 to 1975 and is the sixth plan.

The Board of Directors of the port of Dunkirk, which is responsible for policy matters, is composed of 24 members

- 8 Representatives of the Dunkirk Chamber of Commerce;
- 7 Representatives of Port Users, appointed by the Ministry;
- 5 Representatives of Central Government Ministries;
- 1 Representive of the Municipality of Dunkirk;
- 1 Representative of the Departement du Nord (County);
- 1 Representative of the staff of the Port Authority; and
- 1 Representative of the Dockers.

The Managing Director of the Port is responsible for the operation of the Port and is appointed by the Council of Ministers on the recommendation of the Minister of Equipment. Some of his staff are civil servants and the others are independently recruited by the Port Authority.

The Port Autonome is thus practically free from municipal boundaries and constraints.

On a regional basis, the most important planning institution is OREAM du Nord, which concerns itself with the northwestern portion of France, and principally with the long-range development of the Nord-Pas de Calais Region. Among the agencies with whom OREAM cooperates are the Cross-Ministerial Delegation for Regional and Land Planning (DATAR), City Planning Agencies -- primarily in Dunkirk and Calais - Ministry of Equipment, Port Authority, state and local Chambers of Commerce, water supply group, and agricultural agencies.

The "Agence Financiere du Bassin de la Region du Nord" concerns itself with approximately the same region as that of OREAM du Nord, but deals only with the water quality of the area. Except for this agency, there is virtually no other organization which deals specifically with the question of environmental quality or pollution abatement, but rather an array of governmental bodies depending on various Ministries. The January 1971, creation of a Ministry of Environment is too recent for the necessary organization to have taken place.

At the local level, the Port Authority has direct charge of port development and operation, which it carries out with assistance from high levels of authority. A "Commission pour l'industrializations" has recently been organized by the Prefet to meet monthly, and includes the following representatives:

- Chambers of Commerce (Dunkirk, Calais, St. Omer);
- Sous-prefets d'arrondissements (administrative subdivision of department);
- Directeurs departmentaux (Nord, Pas-de-Calais) representing the Ministries of Equipment (waterways), Agriculture, Labor, Telecommunications;
- Public utilities, SNCF (railroads), EDF (Electricity);
- The association for regional industrial expansion (DATAR-sponsored

group of urbanists and sociologists); and

- President of the 16 municipalities and mayors of Dunkirk and Calais.

The purpose of this Coordinating Committee is to keep each other informed as to developments and to try and identify potential problems before they occur. The Committee has no direct authority, and acts only in an advisory and informational capacity.

As an autonomous port, Dunkirk benefits from government aid in building infrastructure and in dredging outside the port. The state is entirely responsible for maintenance of the maritime approach channels, the sea walls, the outer harbor, and the access locks from the sea. It also pays for the operation of these locks.

Concerning capital expenditure for such items and excavation of docks, the state contributes 80%, while the port pays 20%. For quays, quay walls, and dry docks, the state pays 60%. The state also contributes to the cost of servicing loans obtained by the port in the past for carrying out such works. For the cranes, sheds and warehouses, however, there is no assistance from the state.

In addition, the state has delegated responsibility to the Dunkirk Port Authority for two annexed services -- the light and beacon service in the maritime approaches, and the canal service immediately inland of the port. The state reimburses the port for the cost of running these services.

Although the state pays these various contributions, the Port Authority is responsible for supervising building both the infrastructure and the superstructure, operating the locks, policing the port itself, and dredging. It is, of course, also responsible for the day-to-day management of the port.

The port authority does not, however, concern itself with handling cargo.

It owns and operates warehouses, cranes, floating docks, silos, etc., but rents them on short or long-term leases. Private cargo-handling enterprises do the actual loading and unloading, and employ the dockers. Cranes are rented complete with operator for four hours or eight hours; warehouses either for the short-term or by the year. The port also grants concessions to investors to construct sheds, silos, and other equipment in the port.

The main financial advantages which Dunkirk receives from the state are :

- The state bears 60% of the cost of quays, quay walls, and dry docks, and 80% of the rest of the infrastructure, including channel dredging. The port does not pay interest on this gift capital.
- The state bears the depreciation charge on its share of the assets.
- The state pays for all maintenance dredging outside the port area.
- The state owns the land, the use of which it grants to the port, rent-free.
- The state pays for the operation and upkeep of the access locks.
- The port pays no municipal taxes.
- The French National Railway Company operates the railway in the port, with no running cost falling on the port authority.

A.1.4 Economic Aspects

a. Historical Development

Dunkirk commercial port was born in the 1800's from a walled fortified town and military base. Its activities were initially based upon commercial trading with the French colonies. In comparison to other European ports, Dunkirk is not an old port.

One can distinguish the following periods in the development of the harbor:

- In 1947-1954 the basic infrastructure of the harbor -- completely destroyed during the war -- was rebuilt; by 1961, total traffic reached the pre-war level, growing at the rate of 4% per year.
- In 1962, a major steel company, Société Usinor, established a steel mill, and the same year, the refinery (SFBP - Société Francaise des Pétrole P.) increased its capacity substantially.

- In 1969, the capacity of the Sociète Usinor steel plant was increased and a coking plant was added; at the same time, the harbor opened roll-on/roll-off (RO/RO) and container terminals.

The imports of iron ore for the Societe Usinor plant and for the steel industry to the East of France caused a substantial increase in the total traffic of the harbor. Port traffic increased from 8.0 million tons in 1960 to 20.8 million tons in 1969 with an average growth of 11.2% per year. Today, Dunkirk is the third largest harbor in France. In 1969, Marseilles handled 65 million tons, Le Havre 49 million tons, and Dunkirk 21 million tons. However, Dunkirk is ranked first when excluding crude oil and petroleum products : Dunkirk with 12 million tons; Marseilles with 8 million tons; and Le Havre with 6 million tons.

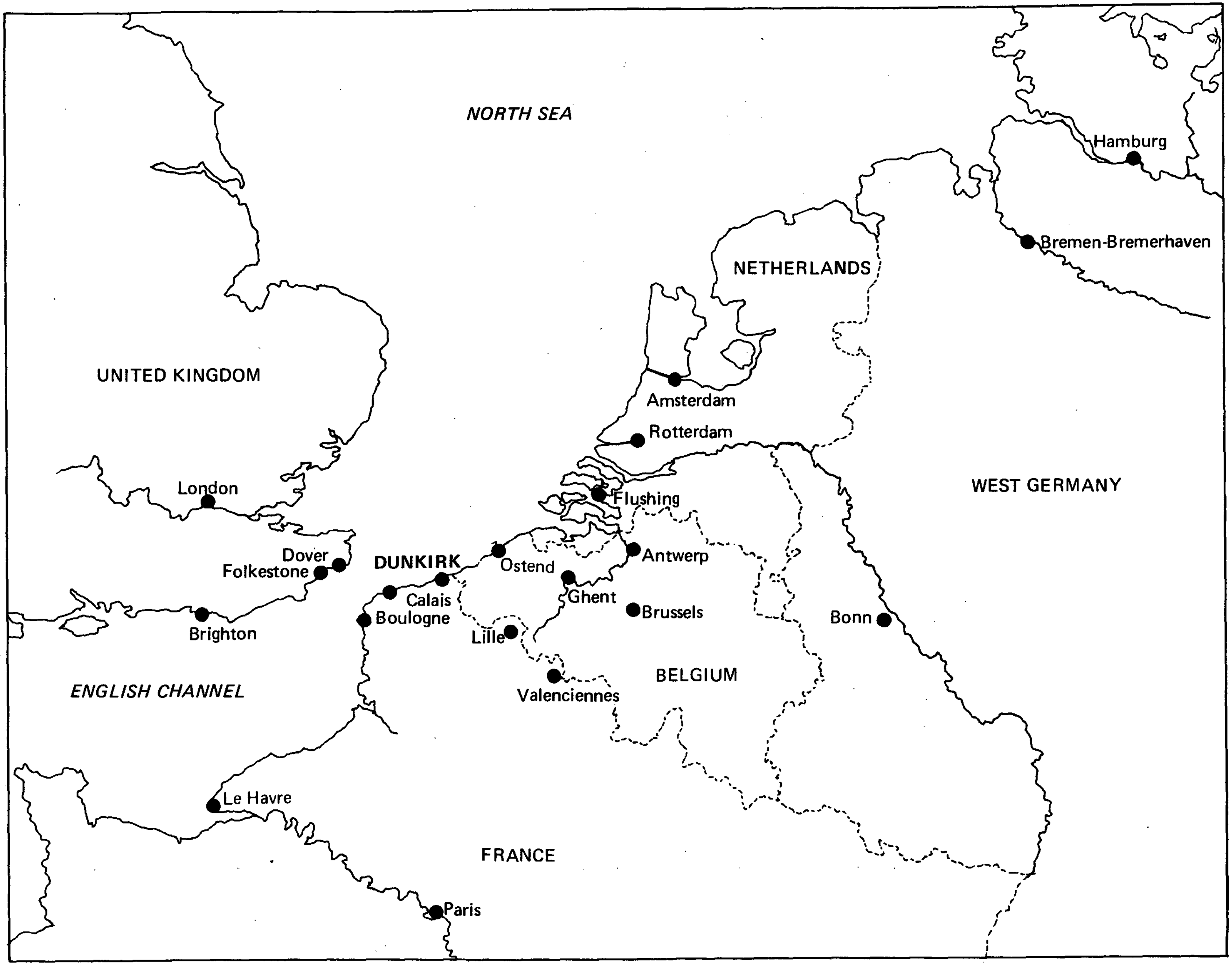
b. The Regional Development Strategy

This northern region (figure A-2) with a population of 4 million, is not important enough in its own right to justify a major deep water port investment. However, the important European industrial areas (Belgium, the Netherlands, the United Kingdom, and Germany) are close, and supertankers could have reasonable access to the Dunkirk facility, whereas Antwerp and the ports to the east have some draft and traffic limitations. Dunkirk is also rail-oriented and could become a heavy rail shipping center for Britain (via the proposed channel tunnel). The English Coast is already heavily overcrowded and for manufacturers who wish to serve the British market, it may be a decided advantage to locate their facilities in the Dunkirk region. They could then serve Britain either by fast RO/RO vessels or through the proposed tunnel (which is still considered for 1980).

The Dunkirk industrial project is apparently well thought of in higher Paris government circles, even though the offshore island concept raises skepticism. The "white book" covering the Dunkirk industrial project is said to have been read and favorably commented upon by President Pompidou.

The development scheme follows the following directives:

FIGURE A–2 DUNKIRK'S POSITION IN NORTHERN EUROPE



- industrial and harbor development will occur between Calais and Dunkirk (with the exceptions of historical sites or cities like Gravelines, Grand Fort Philippe, and Petit Fort Philippe);
- tourist and recreation facilities will be reserved from Dunkirk's eastern edge to the Belgium frontier and to the west and southwest of Calais.

c. <u>The Coastal Inland Zone</u>

The coast will thus be shared among industrialization, urbanization, tourism, and recreation. Somewhat inland, the area centered on Bourbourg will be limited to agricultural development and serve as a "buffer" between the heavy (polluting) industries of the coast and the urban development of the surrounding communities of Guisnes, Ardres, Audruick, Bergues, Crochte, and Pitgam.

This development pattern is an attempt to avoid the development path of Rotterdam, and the urban consequences that followed. If the urban development was concentrated on Dunkirk, it would entail such an unreasonable growth of the urban area that dangerous social and environmental constraints would arise. The city of Dunkirk has been planned not to grow at the same rate as the port, but to connect the port to several peripheral urban centers.

Environmental pollution from the industrial complex make it necessary to locate residential areas some distance from the industrial area. Consequently, urban developments tend to be in the opposite direction as that of the port development. As a consequence, travel distances between residential and industrial areas tend to increase. For these reasons, the urban development for the Dunkirk-Calais area has been based on a multi-urban pole scheme that should disperse residential areas behind the agricultural screen, but still at a reasonable commuting distance from the industrial activity sectors.

The development of the Calais-Dunkirk industrial zone will be directed by the Port Authority, independent of the administrative structure that will take care of the urban areas, but the urban centers are expected to act jointly for the preparation of common development plans. Already, local urban commissions have been organized. Furthermore, a research group of local urbanists and architects will sponsor continuing studies on the urban development. Finally, a central inter-ministry agency at the national level will coordinate communication and collaboration between people working on the national development plan and the Calais-Dunkirk regional agency.

Timing Horizon

By 1975:	New front harbor from Dunkirk to Gravelines, accommodating 300,000 dwt vessels to serve an alumina plant (Pechiney). Societe Usinor will open its second steel plant, creating 7,000 new jobs.
1975-1985:	Completion of communication links between the Dunkirk-Gravelines coastal zone and the Belgian frontier. Two major highways will have been completed: Lille-Dunkirk and Calais-Ostende. The industrialization spread towards Calais will continue. The offshore island may be linked by pipelines to Belgium and Germany and channel tunnel completed.
By 2000:	New front harbor between Calais and Gravelines. Unification of the coastal zone between Calais and the Belgium frontier (industry and recreation), with a coastal-metropolis of 800,000 inhabitants from Bray-Dunes to Calais.

d. The City of Dunkirk

Port development is resulting in significant change for the consolidated town of Dunkirk-Malo Les Bains, (population 43,000) and other area communities. Many new social demands are arising. At the present time,the average income in the Dunkirk area is said to be low, with little opportunity for employment(especially for women).

The city administration's primary concern is to provide additional job opportunities and to upgrade existing jobs. The next major problem is to provide the necessary housing and infrastructure for an expected doubling of population over the next fifteen years in the greater Dunkirk area - from 140,000 to approximately 300,000 people.

Various leisure time activities (e.g., sports stadium, entertainment facilities) were viewed as unimportant by community leaders in the past. It is now understood that the area is quite under-developed (regarding leisure activities, fashion shops, university facilities, etc.) and this situation possibly could retard the industrialization process, since the area is lacking many commonly accepted amenities.

An urban commission (composed of towns surrounding the port-industrial area) was recently formed to collect tax revenue from the industrial zone and split the proceeds among member towns for various social infrastructure facilities. According to our contacts, Dunkirk has received about $2 million over the past six years from the central government, in the form of subsidies for the construction of various municipal facilities. This amounts to approximately one-third of total expenditures during the past six years.

The city administration believes that - as long as industrial development is reasonably well planned, housing is adequate and recreational facilities are made available -- they will have little of the political and social problems which are plaguing other ports in France.

The regional planning agency (OREAM du Nord) - whose objective it is to disperse population and secondary light industry over as wide an area as possible - has had difficulties with the Dunkirk city planners Dunkirk wants to be a big city. This has resulted in the city's own projections of astronomical growth, which OREAM believes will result in significant infrastructure problems for the city. OREAM has attempted to make the city of Dunkirk be more selective in its objectives, concentrating on secondary industries and only that amount which would absorb present excess labor capacity (especially female). One of the basic concepts which the regional planning authority has tried to sell the cities of Dunkirk and Calais is that the port (which was taken from Dunkirk) is now an autonomous port, for both Calais and Dunkirk. This concept is somewhat difficult to sell but progress is being made.

Dunkirk administrative officials were somewhat critical of the regional planning commission covering Dunkirk (i.e., OREAM du Nord). They believe the regional planning commission does not consult the oil companies or other basic industries regarding what they want in industrial sites, transportation infrastructure, and facilities.

e. New Outer Harbor

Approximately $27 million have been invested in extending the Dunkirk port to its present size; including land acquisition for the old industrial zone (which includes 1,235 acres of land for the Societe Usinor steel plant). The new expansionary port development program can be classified as the Second Phase of development. In this phase, there are two steps: first, construction to the west of the new, large outer harbor which is expected to cost approximately $90 million; second, the construction of the necessary infrastructure (i.e., jetties and large locks) which will connect the outer harbor to the old harbor in Dunkirk. This second step is expected to cost an additional $90 million. The rationale for this development consists of:

- approaching saturation of the existing port;
- needed for a new alumina plant project;
- the need for superships up to 300,000 dwt bauxite, iron ore, and oil.
- proximity to Gravelines, eight miles west from the entrance of the existing port limited to 100-125,000 dwt, with good land for six miles inland (up to Bourbourg); and
- shorter access to deep water (75 ft).

f. Port Commodity Flows

At present, the port of Dunkirk is still regional , but the port has more than doubled its volume of cargo handled since 1960 almost entirely by adding ores and crude petroleum traffic. The important growth period was 1962-63, when Societe Francaise des Petroles British Petroleum (oil refinery) was expanded and Usinor steel plant, using basically Mauritanian and Liberian ores, came into operation.

1. Export and Import Trade Imbalance

Export traffic has only increased by 20% while during the same period import traffic increased by 350%. Industry in the port area generated

56% of the import traffic and 40% of the export traffic.

Because of inadequate transportation links with the hinterland and the fact that current industrial operations at Dunkirk depend to a large extent on foreign raw materials, imports represent the major share of tonnage handled at the port (82%) while exports are relatively little (18%). It is hoped that when the transportation links are improved between Dunkirk and the northern regions of France, the export trade will pick up, and a more reasonable balance between exports and imports will be attained. Another reason why the export volume moving through Dunkirk is relatively modest is because of some social and labor unrest in Dunkirk ports. If the problems with labor could be resolved, then the general cargo moving through Dunkirk would increase.

A profile of commodity traffic levels and their historical growth rates (1960-1969) for the port of Dunkirk is illustrated in Tables A-1, A-2, and A-3 and in Figure A-3.

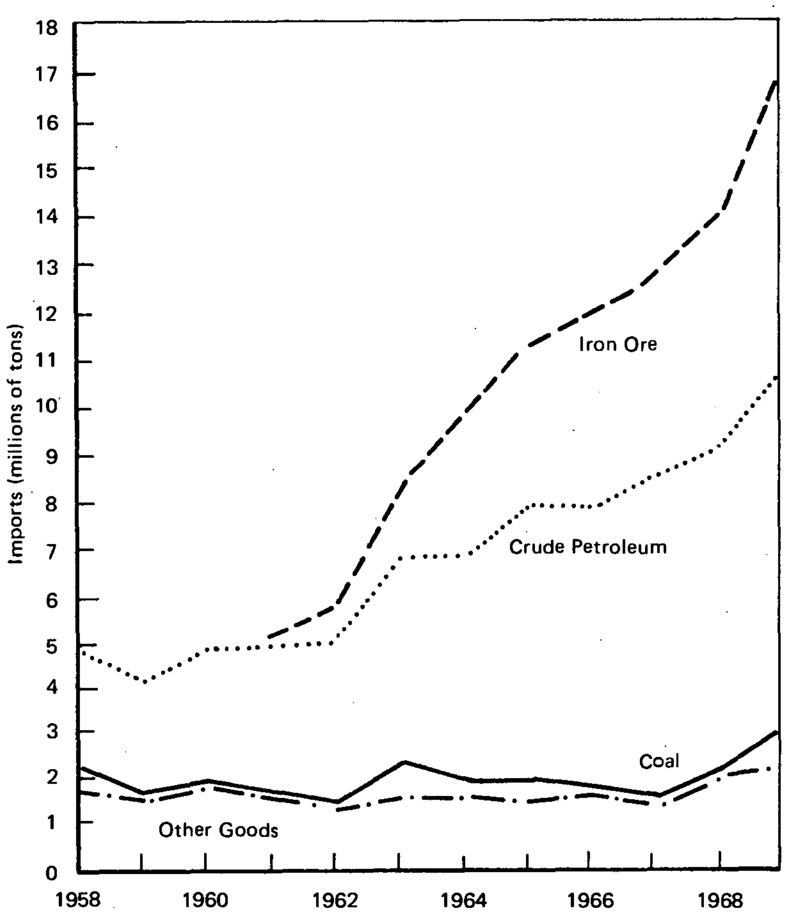
2. Crude Oil and Petroleum Products

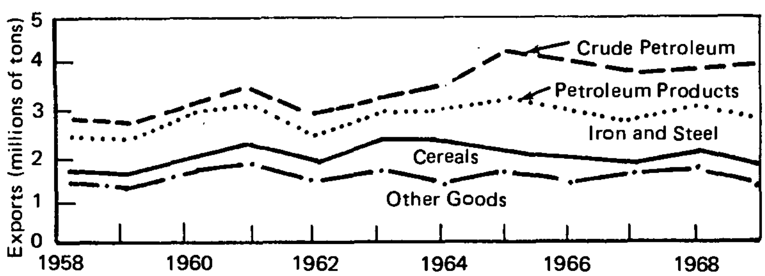
Petroleum traffic between 1960 and 1969 increased from 4.0 million tons to 8.8 million tons, representing a 9.2% annual rate of growth. After iron ore, petroleum is Dunkirk's most important traffic commodity. This relationship of oil to iron ore will be reversed in the next five years. Upon completion of the new deep water port, pipelines are scheduled to be constructed across France, Belgium, and into Germany. Oil imports will then increase very rapidly.

3. Iron Ore

Societe Usinor has been one of the key factors in the development of Dunkirk during the past decade, and growth in traffic is still highly sensitive to the needs of the Usinor plants. Iron ore represented 6.4 million tons in 1969, or 31% of total port traffic. Imports of iron ore increased 16-fold between the years 1960 and 1969, going from 400,000 tons to 6,400,000 tons.

FIGURE A–3 DUNKIRK COMMODITY FLOW HISTORY





Source: Arthur D. Little, Inc., estimates.

TABLE A-1

DUNKIRK TOTAL COMMODITY TRAFFIC
(millions of tons)

	1960	1965	Annual Growth rate 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Exports & Imports)	8.0	15.9	14.7%	20.8	7.0%
Bulk	5.3	12.3	18.3	17.3	8.9
General Cargo	2.7	3.6	5.9	3.5	-0.7
SELECTED BULK COMMODITIES					
Cereals	0.3	0.5	10.8	0.2	-20.0
Wood	-	0.2	-	0.2	N.C.
Coal	-	0.4	-	0.8	19.0
Rubber	-	-	-	-	-
Ores	0.4	3.6	55.0	6.4	15.5
Iron & Steel	0.8	1.1	6.6	1.2	2.2
Non ferrous	-	-	-	-	-
Metalware	-	0.1	-	0.1	N.C.
Machinery	0.1	0.1	N.C.	0.2	19.0
Transportation Equipment	0.1	0.1	N.C.	0.2	19.0
Petroleum	4.0	7.2	12.5	8.8	5.15
Chemicals	0.2	0.5	20.0	0.4	-5.4
Fertilizers	0.1	0.3	25.0	0.2	-9.6
Pulp & Paper	-	-	-	-	-
Cement	0.3	0.2	-7.8	0.1	-15.9

TABLE A-2

DUNKIRK EXPORT COMMODITY TRAFFIC
(millions of tons)

	1960	1965	Annual Growth rate 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Exports)	3.1	4.2	6.3%	3.7	-3.1%
Bulk	1.2	1.7	7.2	1.3	-6.5
General Cargo	1.9	2.5	5.6	2.4	-1.0
SELECTED BULK COMMODITIES					
Cereals	0.2	0.4	14.9%	0.2	-15.9
Wood	-	-	-	-	-
Coal	0.1	-	-	-	-
Rubber	-	-	-	-	-
Ores	-	-	-	-	-
Iron & steel	0.8	1.1	6.6	1.0	-2.35
Non ferrous	-	-	-	-	-
Metalware	-	0.1	-	0.1	N.C.
Machinery	0.1	0.1	N.C.	0.1	N.C.
Transportation Equipment	0.1	0.1	N.C.	0.1	N.C.
Petroleum	0.4	1.1	30.0	1.1	N.C
Chemicals	0.2	0.4	14.9	0.3	-6.9
Fertilizers	0.1	0.3	25.0	0.2	-9.6
Pulp & Paper	-	-	-	-	-
Cement	0.3	0.2	-7.8	0.1	-15.9

N.C. - No Change

TABLE A-3

DUNKIRK IMPORT COMMODITY TRAFFIC
(Millions of tons)

	1960	1965	Annual Growth RATE 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Imports)	4.9	11.7	19.0%	17.1	9.95%
Bulk	4.5	10.6	18.7	16.0	10.8
General Cargo	.4	1.1	30.0	1.1	N.C.
SELECTED BULK COMMODITIES					
Cereals	-	0.1	-	-	-
Wood	0.1	0.2	14.9	0.2	N.C.
Coal	-	0.4	-	0.8	19.0
Rubber	-	-	-	-	-
Ores	0.4	3.6	55.0	6.4	15.5
Iron & Steel	0.1	-	-	0.2	-
Non ferrous	-	-	-	-	-
Metalware	-	-	-	-	-
Machinery	0.1	0.1	N.C.	0.1	N.C.
Transportation Equipment	-	-	N.C.	0.1	-
Petroleum	3.6	6.1	11.1	7.7	6.2
Chemicals	0.1	0.1	N.C.	0.1	N.C.
Fertilizers	-	-	-	-	-
Pulp & Paper	-	-	-	-	-
Cement	-	-	-	-	-

N.C. = No Change

TABLE A-4

IMPORTED IRON
(thousand of tons)

Plant Destination	1967	1969
USINOR Dunkirk	2,335	3,443
USINOR Denain	986	1,362
Plants in the East and North of France	618	974
Sarre	565	412
	4,484	6,191

4. Coal

Coal imports have been increasing because of the new USINOR coking plant and the decline in coal mining operations in the Nord-Pas de Calais region. Coal traffic, 90,000 tons in 1960, reached 745,000 tons in 1969 and may reach 6 million tons in 1975. Most of it comes from the United States (at times transshiped through the ARA- Antwerp, Rotterdam, Amsterdam range) with some from Poland.

g. Industrialization

Industrial planning for Dunkirk started around 1965 (during France's Fifth Plan). In 1969, the French central government gave some $40 million to Pechiney-Kaiser to build an alumina plant in Dunkirk, rather than in Belgium. Pechiney's firm decision to locate the alumina plant at Dunkirk significantly altered the entire planning process at the port and increased the industrialization scope.

Presently, some 2,932 acres of land are being used in the present port, with 1,341 acres available for immediate development. The new industrial zone has a reserve of about 50,000 acres and extends 12.5 miles to the west of Dunkirk until Gravelines is reached. It was recently doubled by addition of acreage south of the Dunkirk-Calais road.

When Dunkirk was selected as the site for the new alumina plant, it was thought that the land requirements would be 250 acres for the entire facility.

However, as the planning proceeded, so has the necessary land requirement which is now up to 1,700 acres (over 6-1/2 times the original estimate). It is Dunkirk's experience (also, Antwerp's and Rotterdam's) that in port and industrial development, planners always need much more land than originally estimated.

Continuing west, another 12.5-mile strip is available for industry in the long-term -- then Calais is reached. It is planned that the agricultural zone located in the south will remain unspoiled at least until the end of the century. Because of the lack of any recreational, tourist, conservational, or residential use of the beach area, the entire coastline is set aside for industrialization, except in the Gravelines area, which is to be retained as a "green belt." Some concern has been raised in national circles about this coastal use for industry. At present there are few relatively large companies located at Dunkirk. These are:

Type	Companies
Iron and steel manufacture	Societe Usinor, C.A.F.L. Dunes Plant
Oil refinery	Societe Francaise des Petroles. BP
Power plant	Electricite de France-Centrale Thermique de Dunkerque
Food, fat products	Lesieur
Plywood	Fontvielle
Petroleum products storage	Antar Compagnie Parisienne des Asphaltes
Shipbuilding	Ateliers & Chantiers de France-Gironde Ateliers Ziegler

Of these nine companies, five constitute the major portion of harbor activity.

Steel Industry: USINOR - today producing 3 million tons of steel, but should reach 8 million during the sixth Plan (1971-1975). This 8 million tons should constitute 20 million tons worth of traffic for the harbor.

C.A.F.L. - produced 800,000 tons of steel in 1968. The production should reach 1,000,000 tons in 1980.

Shipbuilding : France-Gironde - construction of ships of all kinds except war vessels and Ziegler (fishing vessels)

Oil Refinery: BP - an integrated operation with a refinery capacity equal to 6 million tons per year (120,000 bbl/d) or 5% of the total French refinery capacity.

Food: Lesieur - major plant of the Lesieur group.

In addition to the present refinery, power station, steel works, and planned alumina plant, other potential near-term industries to locate in the Dunkirk industrial zone are : aluminum and steel fabrication plants, chemicals and petrochemicals, and smaller industries. Petrochemicals are expected to locate inland and be served by pipeline.

h. Labor

A basic constraint facing the industrialization plan is the lack of local manpower. Transportation facilities will be required to bring workers from surrounding communities, located within a radius of 30-60 miles -- quite a distance for rural France. Housing for new families attracted by the port development is also a major social problem. Various groups are studying the transportation that will be required to bring workers from the eastern coal region to the port area rapidly. East/West transportation links between Dunkirk and Calais are also very difficult (eg., there are neither freeways nor trains) and at the present time, it takes approximately 2.5 hours to commute round-trip (50 miles) from Calais to Dunkirk.

A committee for labor has been established which is evaluating the concept of a manpower training center in Dunkirk. The Ministry of Labor in Paris will underwrite the fixed investment cost for the training facilities. The operating expenses for the training center are planned to be financed by a training tax, to be paid by the industries locating in the port area. Industrial manpower at Dunkirk is expected to be more expensive than Rotterdam, but less than Le Havre.

One of the critical problems viewed by the port administration is in connection with the longshoremen. Last year, about 3 million tons of general cargo (exports) and a significant amount of ore were diverted to other ports because of labor difficulties with dock workers at Dunkirk. Presently, the port administration is thinking about improving the worker's pensions and guaranteeing a week's pay, regardless of the work load (similar to dock worker benefits now in Antwerp, Rotterdam, and Amsterdam). If such a pay and benefits program is implemented, the port administration would expect dock workers to be on-call day or night, depending upon demand.

But since last September 12, 1971, French dockers have refused to work on evenings, Sundays, or overtime. With strikes occurring frequently on Saturdays, French ports have been paralyzed virtually two full days a week. In consequence, merchandise has piled up on the quays. Generally speaking, labor productivity in French ports is deemed less than 33% * as efficient as other European ports.

It has been, for example, conceded to unions that the handling of cement be done by nine-man teams, when a new cement-bag elevator should have reduced the team from ten men to five. The unions have also insisted that pallet size is not to exceed one ton, and that cargo-tank bottom unloading shifts at the ore quays be maintained, although the bulldozers which now gather ore under the mechanized grab can do perfectly without them.

i. Communication Inland

1. Railroads - One of the characteristics of the Dunkirk harbor is the excellent railway connections towards Benelux, Paris, West Germany, and Basel in Switzerland through the North of France and Lorraine. Four

* Source : Three Shipping conferences

marshalling yards are located close to the port (Figure A-1).

2. Water - The harbor is connected through a canal ("Canal a Grand Gabarit") with 3000-ton capacity to Valenciennes, with a 1350 ton cross-over towards Lille and Arras. The Canal is also connected to the Paris region through the St. Quentin Canal and the Northern Canal. Two internal navigation locks connect basins 1 and 2 to the Dunkirk-Furnes Canal, giving access to barges of 280 tons.

The Canal a grand Gabarit and the new lock at Mardyck can accommodate barges of 3000 tons. Because the canal does not yet go very far inland, about 40% of the volume is still handled by 250-300 ton barges.

3. Highways - The Dunkirk-Lille connection (55 miles) has been improved by the construction of two cross-overs; one from Dunkirk to Bergues (7 miles), the other one from Nieppe and Lille (14 miles). The construction of a cross-over from Bergues to Nieppe will be accelerated and the freeway connection to Paris-Lille-Brussels completed in 1973-74.

It seems that Dunkirk suffers from a lack of coordination between the transportation (road and water in particular) requirements of the region and the development of the harbor. For example,there is a lack of coordination between container traffic growth and freeway building. The major freeway for Dunkirk may not be completed until 1974. However, in 1972 the second container crane facility will be installed -- these containers must presently go by rail, which is not as convenient or as efficient as truck trailer transportation. A speed-up in the enlargement of the upstream canal grid is also needed to enable 3000 dwt barges to travel north into Belgium.

4. Pipelines - Dunkirk is connected to the "oxyducs" pipeline network which joins major air-liquefaction plants of the area Dunkirk, Denain, Mons, and Antwerp. From Dunkirk the pipeline is directed towards the southeast, along the French/Belgium border.

A very dense gas pipeline network circulates in the north past de Calais region towards Paris and the Eastern part of France, carrying gas produced in Holland (Groningen) and in the coking plants of the coal mines area of Northern France.

The development of the crude oil terminal in Dunkirk would lead to the construction of an oil pipeline that would connect Dunkirk to Belgium (Liege, Charleroi) and to Germany (Ruhr) (see Figure A-2).

j. Use of Econometric Models

The port of Dunkirk has set up an Economic Study Group, headed by a petroleum economist, formerly in charge of crude supply and transport at the BP refinery, with a staff of 16 people (one economist, one assistant economist, one operations research specialist, 1 engineer and 5 researchers, 1 analyst-programmer, 2 programmers, 1 card-puncher, and 3 typists).

1. Potential Crude Oil market model

Several economic models have been developped for use in port planning. The first model is a projective model of 1970-75 petroleum demand and supply for northwestern Europe (excluding Scandinavia and the United Kingdom.) The model incorporates data on historical petroleum consumption by the major European refining regions (ports are underlined) --

Rotterdam, Cologne, Hamburg, Dunkirk, Karlsruhe--Frankfurt, Bavaria, Le Havre-Basse Seine, Bordeaux and Marseille/Fos

and production by 4 sources--Persian Gulf, Libya, Algeria, and Nigeria.

Ocean transportation is distributed among five classes of ships, I (30,000 dwt), II (60,000 dwt), III (100,000 dwt), IV (200,000 dwt) and V (500,000 dwt). On existing vessels, only breakeven costs are fully considered on new building options. Combinations for Persian Gulf crude are : Suez both ways, Suez ballast only, Suez pipelines, Iraq pipeline kept at maximum capacity.

The simulation makes it possible to determine handling capability and installation requirements. It takes into account time delays by setting up "windows" for large vessel arrivals.

Optimization of cost by linear programming was first tried on a continuous basis, then on a discrete basis. The output is the total operating cost and investment cost (15% capital charges) for the whole supply system to northwest Europe. A shortage of pipelines was detected so five calculations were conducted:

1 = double PLSE capacity (Fos to Switzerland and Bavaria);
2 = P/L Le Havre Karlsruhe;
3 = P/L Dunkerque to Ruhr;
4 = P/L Rotterdam Ruhr (RRP); and
5 = double TAL capacity (Trieste to Bavaria)

The European petroleum supply and demand model was tested against actual historical data (1967) to determine its predictive accuracy concerning petroleum input to Europe. At the total European aggregate level, the model was very accurate in predicting actual events, although it failed to predict accurately the actual petroleum input of each European port. In particular, the introduction of TAL gave the actual PLSE momentary loss of throughput.

The results are in favor of landing crude closest to a consuming center, so that Rotterdam appears the best option. For Karlsruhe, Dunkirk is equivalent to Fos-PLSE (Marseille) and is cheaper for Cologne. If the Libyan production were to decline enough, Dunkirk would beat PLSE on both accounts. Dunkirk is better than Le Havre in all cases except for the Paris basin.

Currently, a sensitivity test to ship cost is being made. The results were not found sensitive to growth in consumption, but quite sensitive to the Libyan output, the growth of which favors PLSE and TAL.

This model is used for internal purposes and to support requests to the Ministry. The saturation of the present outharbor (which motivated the new projects) is evident as the waiting time curve (versus traffic) shows unacceptable delays to big ships, beyond 35 million tons per year crude oil throughput. Oil transfer inland would noticeably improve the economy of the new port, which will be -reated initially for Pechiney's alumina plant. However, development can be restricted to 300,000 dwt (outharbor) without the Ruytingen island project for 750,000 dwt, until more of such ships are around.

Ore basin utilization involves a routine in the model which generates a sequence of ship sizes and arrivals for ore ships (or oil tankers in a subcase handled for BP) and treats it for ship unloading. The output is : total shiphandling time, time of arrival, channeling, docking, unloading start up, and departure; along with a plot of frequency versus time in port.

Every six months, the statistics of the ore basin are entered and tested for actual loading time distribution for each berthing dock. The model is then used to make six-month forecasts, and assess short term impact of gantry crane repair, Sunday shifts, etc.

Another long-term use is to identify constraints (a new dry bulk storage park is being built, but not really because of the model which only confirmed the need), and to adjust capacities of various elements afterwards. A recent game for BP was to determine when they have to move to the new outharbor (by building a pipeline or a new refinery).

In the near future, this model will be used to evaluate the overall comparative economics resulting from increased costs of supertankers compared to the economics of pipelines.

Other Models

A family of simulation routines is being designed to evaluate the port complex itself, the size of a basin(wet dock), and the volume of trade necessary to support the basin.

Another model idea is an attempt to evaluate a container shipping line's decision in terms of relative costs and reliability of alternatives. Another project is related to cost and benefits for port industrialization.

Statistical Work

The economics group keeps six-months' operating statistics for cargo handling equipment, particularly on utilization ratio at maximum capacity, and at various lower capacity levels, looking at both percentage and regularity. We have seen them used in combination with the ore basin routine. The statistics are also used to plan relocation and change of cranes, to make decisions on mobile vs. stationary new equipment, and to reconsider docking priorities at general cargo berths. As complete a sta tistical data file as possible is being built on trade relations with the interior. All national traffic through Dunkirk, Le Havre, and the other major French ports is now known, but foreign trade is quite difficult to handle.

2. The Sixth Plan

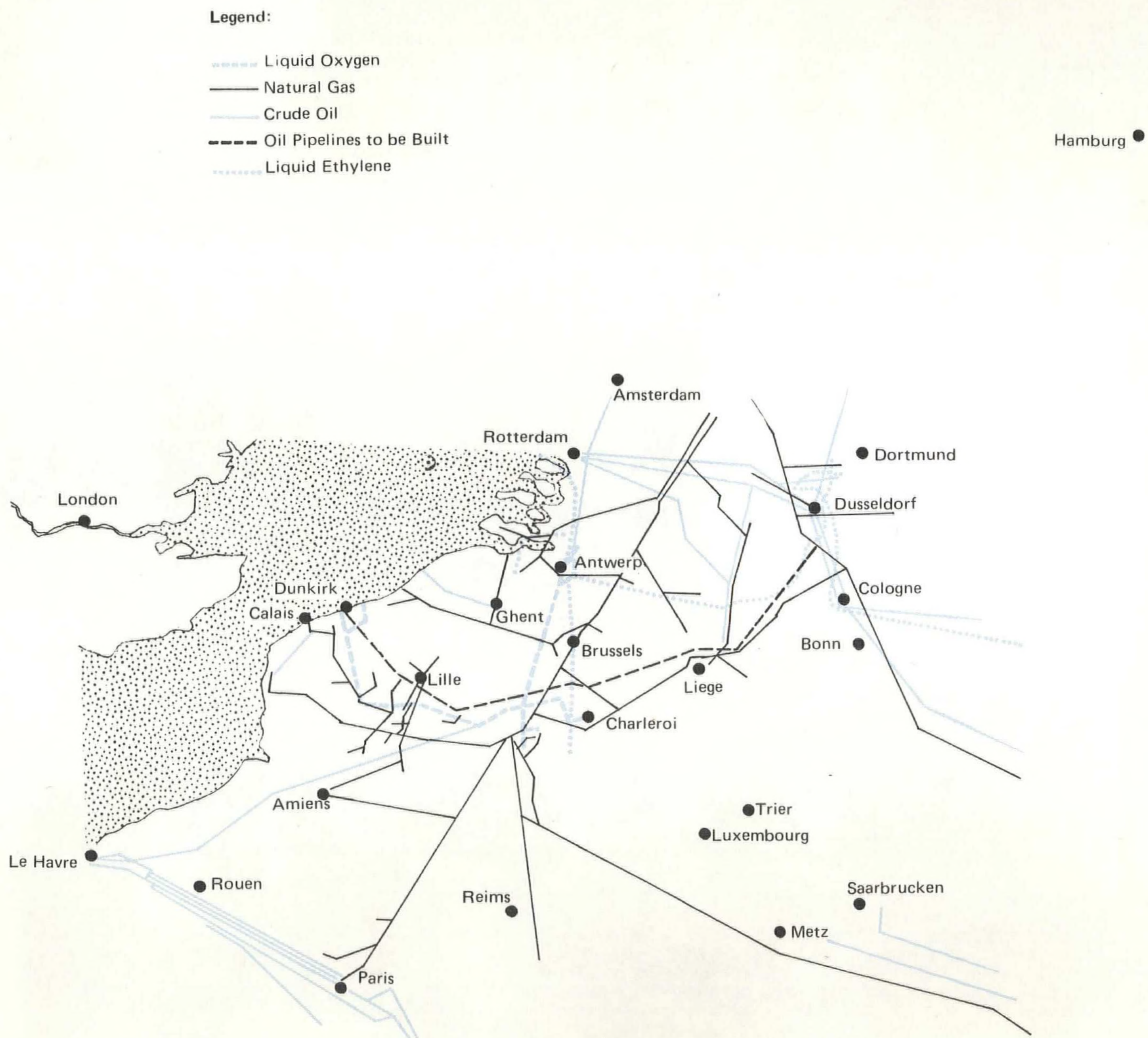
For the preparation of the sixth Plan and the justification of the new outharbor, several economic studies have been conducted, such as the economics of oil, ore and other dry bulks, containers and RO/RO, and trade improvements versus total port investment. National costs and benefits are included.

The oil trade was analyzed and included a comparison of transshipment at Le Havre, waiting-time, and possibility of exports from the BP refinery. Transshipment opportunities in Dunkirk were not considered in the economic evaluation for conservative purposes, but were introduced later to assess technical difficulties; shortage of storage space, etc.

Dry bulk appeared quite promising, thanks to the good economy of railroad transit to the Saar steel industry. Once established, this trade could extend to the Ruhr, which might want to have an alternative to the port of Rotterdam.

The new harbor project would bring tremendous improvements on the container trade and cross-channel roll-on/roll-off. It offers a tidal basin, saving on lock delays, and a shorter channel crossing. In the analysis of unit-cargo inland (Lille, Strasbourg, Paris, and Switzerland were considered), the conventional 1970-80 containerization curve was discarded as too arbitrary, in favor of a line-zone approach to study the redistribution depending on cost, and to obtain the potential flow per line (Australia, the United States, etc.).

FIGURE A–4 LIQUID AND GAS FUEL PIPELINE NETWORK FOR NORTHWEST EUROPE



A.1.5 Engineering

a. Site Selection

The natural channel which leads into Dunkirk increases in width and depth toward the West. Recreational beaches and large waterfront homes are East of the port; and in any case eastward port expansion is limited by the Belgian border, 10 miles away. The dredging required to build the port could have affected the city, since some sections of the city are below sea level. The decision to expand the port originated in the early 1930's; however, work to develop the new two-basin concept was delayed by World War II. The port was completely destroyed during the war, and this to a large extent expedited the action to repair and modernize the facilities.

b. Port Configuration & Construction

The docks extend over 525 acres, and the 6-1/2 miles of wharfs can accommodate 50 ships at one time. There are six conventional dock and general cargo piers at the immediate city waterfront. The water depth in these original docks varies from a minimum of 20 feet to a maximum of 32 feet. In addition, there are three docking areas for barges, fishing boats, and other small craft. There is also a ferry dock and a 2000-foot seawall at the A.C.D.B. Shipbuilding Yard which is located on port-owned property. The Bassin Maritime, newest docking facility, is quite unique. It has greatly expanded the existing port and industrial complex facilities. The new wharfing area has an entrance lock that incorporates numerous safety features to protect the lock and the ships that use it and cost $40 million to build: it is 1,312 feet long, 163 feet wide, and can accommodate ships of up to 48-foot draft. Its construction makes the port independent of tidal conditions (up to 20-foot fluctuation). The tidal action outside the breakwaters produces a westerly current of 1.5-2 knots at high tide. This reduces to less than 1 knot easterly at low tide.

Lock construction involved lowering the ground-water level with 100 well points sunk below the bed of the lock chamber. Each well point pumped water at a rate of 5,284 gallons per hour during the excavation of 393,000 cubic yards of earth. A 6.5 foot-thick bed of rip-rap was laid on the lock floor to protect against propeller damage. For a similar reason, a 3.3-

foot horizontal concrete slab was laid on the sea side entrance to the lock to provide approach protection. To prevent lateral ground-water movement from damaging the lock foundation, sheet piles were driven 20 feet into the floor of the lock chamber, just inside the side walls. The designer contends that this will control ground-water shifts that could affect the base soil under the lock walls and gates.

To protect the excavation site during lock construction, two cofferdams were used to isolate the area. A total of 282,000 cubic yards of concrete was laid for the construction of the lock. Four retracting gates (two of which are safety gates) permit exit out of and entry into the lock, maintaining a water level of 19 feet above low sea level.

The sea walls in the Bassin Maritime were constructed from 45-foot-diameter sand-filled caissons. This reduced the construction cost by 15% compared to straight concrete wall design. The new lock and basin facility controls entrance and egress for 55,000 crude-oil tankers, which load and unload at either of the three piers that provide cargo transfer facilities for French BP and other oil companies. The most recently built oil pier has a capability for receiving tankers in excess of 100,000 DWT. The Port Authority feels that the BP refinery is too near to the original wharfing area and is negotiating with BP for their relocation. No plans for any move have been firmly developed. Further West is the Power Station, followed by the USINOR Steel Plant and the dry bulk (phosphate, coal) receiving facility.

Plans for a new outer harbor just east of Gravelines will answer the need for deeper water (300,000 DWT) and more tidal area for rapid transit. Next, in time, would come a sea island eight miles offshore to serve northwest Europe refineries. The Port Authority has given consideration to an artificial offshore island as an unloading facility. A 28 to 30 meter deep channel (90 to 100 feet) would provide access to the island which would be located 12 km (7-8 mi.) offshore. The natural channel to the proposed unloading site would warrant dredging before it could accommodate 500,000 DWT tankers.

c. Channel and Basin

The Port officials were questioned on the navigation problems recently reported to exist in the Dover Strait, since it provides the main means of entry and exit to and from Dunkirk. It has been reported that the Strait handles as many as 1,000 ships per day. Although twenty miles wide, the navigational width of the Strait is greatly reduced by sands and shoals. North Sea-bound traffic hugs the French coast, while English Channel-bound vessels (outward bound) pass toward the English coastline. Traffic in both lanes are continually confronted with navigational hazards that include dense fog conditions, the meeting of flood tides, and the frequent sailings of ferry boats which ply between the continent and England. These vessels continually cross the main shipping lanes. Collisions in the area have increased by 23% since 1967, and two ships recently sank within a 27-hour period on the English side of the heavily traveled area. The collisions have involved ships traveling straight in the channel, and no cross-channel incidents have been reported. Dunkirk officials contend that the navigational hazards were not as serious as reported, and that an average of 300 ships per day used the Strait rather than the reported 1,000.

Ships wait ten miles offshore to enter Dunkirk, where a pilot boat is on standby to aid the entry of the larger vessels. Tugs are used only at the immediate entrance to the port (none of the visiting vessels are equipped with bow thrusters or active rudders). No dredge maintenance has been required in the main entrance channel where the bottom at a depth of 44 feet is comprised of silt and sand in various grain sizes (no rock is evident in the channel area). The use of the new lock and channel with their increased depth capability has resulted in the need for some continuous dredging (silt and sand moving eastward) to maintain the desired channel depth, and some oscillation problems in the new channel are under study. The port is relatively protected to the north, since it is in the lee of a number of sand banks* and a conventional buoy system is maintained for

*The offshore deepwater island is under discussion for this area.

navigational assistance into the harbor. Turning basins are currently 440 yards in diameter to the east; 550 yards to the west of the Bassin Maritime. Some silt comes from the "watringues" drainage system in the outer harbor.

A new lock-free 1,125-acre outer harbor is being considered at a site some eight miles west of the original harbor. The basic design of the approach channel, breakwaters, and a 1560-yard turning basin has already been selected even though hydraulic, wave, and sedimentation studies are still underway. The effect on the coastline from the new outer-harbor construction will not be fully known for another year. Wave and current studies are largely completed, while sedimentation and long-shore-drift studies continue on two 1 : 150 hydraulic models. It has been decided from the model studies that the new channel can be angled in a way to reduce harbor silting. Channel silting problems are being studied considering tidal currents which are twice as strong in a westerly direction than easterly. The effects of waves which vary from 11.5 to 16.5 ft over a 10-year period are also under study, since the wave force height and reach will control safe entry into the channel. The objective is to design the new harbor so that the currents aid exit and entry - the objective being to permit harbor entrance at any time between mid and high tide.

d. Docking

There are no docking problems in the Port of Dunkirk other than port entry of large ships is currently confined to periods of high tide and the small outharbor is somewhat congested. Fendering in the old and new piers and in the lock area consists entirely of old truck tires.

e. Construction Materials

Construction of the new lock commenced November 1966 and was completed in 1970. The sub-structure and a thick bed of sand over a clay sub-strata were both favorable elements in the project. The lock was built in the shelter of two dikes, one downstream and one upstream in the turning basin of the Bassin Maritime.

The downstream dike, 720 yards in length, was made of circular caissons of sheet piling, 62.8 feet in diameter. The arcs joining the cells have a radius of 78.6 inches, and the angle of the joint with the cells is 20 degrees. Silt and muddy sand found during construction of the dike was dredged and replaced by 16.4 feet of clean sand to form a leveled foundation. The depth of the base of the sheet piling varies from -44 feet to -10 feet at the ends of the dike. The circular caissons were leveled at -33 feet.

The upstream dike, 1420 feet long, is built of supported flat sheet. The cells are constructed on a platform at -17 feet level. Inside, the cell structure is buttressed with sand to a height of -3 feet. The footing of the piling run at levels of -40 feet on the outside and -33 feet on the inside. The cells were leveled at a height of +27 feet. Construction of the cells was accomplished with the aid of templates.

The dikes were completed without incident on schedule. Under the direction of the Central Laboratory for Ponts et Chaussees (Bridges and Roads) and the Regional Laboratory at Lille, stress gauges were installed on the cells of the downstream dike. The data obtained contributed greatly to understanding the behavior of the cells.

Once the dikes were completed, the trench was excavated under the shelter of a breakwater. The breakwater which completely encircled the excavation is composed of two levels at -10 feet and +23 feet. The construction was completed by using pumping units at the bottom of each trench. The submersible pumping units were spaced at 67-foot intervals. When the trench was excavated and dried, concrete pouring began. After several types of concrete were studied the Central Laboratory for Bridges and Roads recommended the following composition:

#1 Mass Concrete (filler)

Cement	12.3%
Cinders (fly ash)	3.3%
Sand	31.2%
Fine gravel (5-25)	15.7%
Course gravel (pebbles 20-60)	30.5%
Water	7.0%

#2 Reinforced Concrete

CHF Cement (seawater setting)	24.2%
Cinder	5.6%
Sand (0-5)	48.0%
Fine gravel (5-25)	10.4%
Water	11.8%

The addition of cinders was most helpful. The cinder dosage in Mix #1 was originally estimated at 350 kg/cm^2 (5000 psi). It was eventually reduced to 300 kg/cm^2 (4300 psi). The solution proved technically and economically good for the project. The CHF cement was mixed with aggregates dredged from the sea. They were washed and screened at a plant established near the construction site, and transportation was provided by a belt conveyor. The mixing plant, located directly within the lock chamber, was equipped with two 2,250-liter tank mixers; each permitting 1,500 liter pours. A maximum of 1,700 M^3 was poured in one work day and an average of 1,000 M^3 was poured daily. The 350,000 M^3 of concrete used on the project was poured by the late summer of 1969, following which the lock gates were installed.

f. Dike Extension

The enlargement of the port basin required the extension of the dike on the seaward side in a southwesterly direction for approximately 1.3 miles. Construction of the dike followed the same design as used in the sections built in 1959.

The dike rises to the +41 foot, level which is about 26 feet above the mean water level of +15 feet. On the seaward side it is constructed of sand protected by bituminous surfacing ranging from 3 feet thick at the foot to 8 inches thick at the top, with a slope of 7:1. The top begins to level off at about the +40-foot level and then drops off on the basin side at a slope of 3:1 to the cell structure at the +31-foot level.

On the seaward side, a footing is provided at the base to prevent wave erosion. A "Larsen" type longitudinal bulkhead was constructed of sheet piling 13.5 feet long, and topped by reinforced concrete. On the inboard side of this bulkhead, a filter and drainage system is provided which consists of precast reinforced concrete sections, a sand and gravel filter medium, and covers of perforated concrete slabs. On the outboard side, the sand was initially stabilized with brush mats which were later covered with rock and bituminous filler. This part of the work could only proceed at low tide.

On the inboard side of the dike, a cellular structure 43-feet wide was constructed of sheet-piling metal. Transverse bulkheads spaced 49 feet apart were put in place first, followed by the convex longitudinal sections. The cells were then filled with sand and surfaced with bitumen. The piling, which goes down to the -5 foot level (20 feet below the water surface) was emplaced by jetting or vibrating. Further fill is provided inboard of the cellular structure. The entire dike, from the outboard bulkhead to the inboard side of the cellular structure is approximately 270 feet thick.

The banks of the marine portion of the canal which enters the basin in the southwest corner are built at a slope of 2:1. A rock-and-pile footing is provided, and the bank is protected to a height of 13 feet by a 0.5-foot thickness of macadam over 0.66 feet of calcareous fill. Above this level, topsoil to provide vegetation cover is used.

The requirements for formulation and application of the macadam surfacing were considered most important. The final formulation consisted of:

Calcareous Gravel 8/16	40%
Calcareous Sand 0/3	35%
Beach Sand	23.5%
Calcareous Filler	1.5%
Bitumen 60/70	7%*
	107.%

This composition provided the impermeability and high density required, could be applied by bulldozers and equipment on pneumatic tires, and could

*Since the total exceeds 100%, it would appear that the bitumen percentage was not included in the mix formula.

be surfaced by vibrating rollers. Particular care was taken at the joints of the macadam and to prevent cracking due to contact with water or shifting of the substructure.

g. Cargo Handling

Dunkirk has no unique cargo-handling equipment that would exceed that normally found in any similar-sized U.S. port. There is 1,700,000 square feet of one-story warehouse space, within which the various cargos are handled by fork-lift trucks or similar mechanized equipment.

Commercial port dockside cranes can be classified as follows:

Electric Cranes	-	39 of 3-ton capacity
Electric Cranes	-	84 of 6-ton capacity
Electric Cranes	-	13 of 10-ton capacity
Electric Cranes	-	3 of 15-ton capacity
Diesel Cranes	-	2 of 7-ton capacity
Floating Boom Cranes	-	2 of 50-ton capacity

The Port also has three floating cranes having maximum lift capabilities of 30, 90, and 250 tons. The new ore and coal berths have a total of five gantry cranes for ship unloading, including three Dravo 15 ton/second gantry cranes and conveyors. In addition, two cranes (30 ton and 50 ton) handle steel products for exports and Kangaroo cranes (10 tons every 30 seconds) handle phosphates. Re-export of ore by rail and barge works well, but displeases the unions because it is too automated.

The Port has been slow in providing facilities for handling containerized cargos, and containers were not even considered when Pier 6, one of the most recently built general cargo piers, was constructed. It has since been adapted to handle a limited number of containers and has a roll-on/roll-off gangway. A 53-ton gantry crane handles containers, and the installation of a second crane is under consideration. This is a temporary facility, erected so that traffic would not be entirely lost to competing ports, until a final facility is put into service in the new outer harbor (1973-75).

The transfer of hydrocarbon products is handled entirely by French BP and the cargo handling/transfer facilities are owned and operated by the refinery.

h. Cost Data

Initial construction costs of the new developments included:

1) Bassin Maritime- USINOR-owned (quays excluded) $30 million, plus 1250 acres of industrial zone loaded to port industry,
2) New Projects-Outer harbor $90 million, connection to above Bassin Maritime $90 million (dike, tidal basin, lock), tidal basins and wet dock $72 million, industrial zone (5000 acres north of RN 40) $54 million

The outside dredging is negligible, thanks to scouring by parallel currents, after the initial "calibrating" dredging when the 55,000 DWT pass was upgraded to 125,000 DWT. Some silting in the outer harbor comes from the Watringues drainage system.

The new port will have two to three miles of oblique channel, now being studied on the Chatou model, with results expected by the end of 1971. Tenders for construction of the outer harber will come in by mid-1971.

i. Problems and Lessons

Better pre-planning was needed prior to Port expansion zoning and land allocation.

The present trend of enticing plant manufacturing facilities to the waterfront locations will invite water pollution problems, unless pollution control planning is commenced immediately.

The Port Authority should concern themselves with in-plant water and air pollution control as part of the leasing procedure.

Hydraulic modeling should decide the port configuration, rather than designing the port and later using modeling to ascertain the design effects.

Better cargo handling facilities are badly needed in the dockside warehouses.

Some salt-water intrusion has occurred from channel deepening. Remedial methods are under consideration to control this condition.

The lock and basin construction methods appear quite advanced. Although lock construction might not be needed in a U.S. port (other than possibly in Maine)the methods and reduced construction costs might be utilized to advantage in the U.S.

The trend is towards the leasing of quay surface to stevedoring companies, as port dues are more profitable than cargo handling operations.

The ore gantry is equipped for transhipment, but cannot operate efficiently as unloading is much quicker than loading.

A.1-6 Environmental Appraisal

Throughout our discussions with port representatives, it was continually apparent that economic development had by far the highest priority, and that environmental considerations in terms of such factors as short- and long-range land use plans, water quality, air-pollution abatement, solid-waste disposal, and recreational and conservation activities, were ranked very low.

No officially recognized air pollution control and monitoring authority has been established in the Dunkirk area, nor have any official emission standards been proposed or accepted. It is quite apparent that the community depends primarily upon southwesterly breezes to carry most of the airborne pollutants out to sea; this is indeed the case when winds are from the correct direction. On the other hand, northerly winds are also common, and these at best serve only to dilute the airborne pollutants from electrical generating plants, the steel mill, and refinery operations.

As far as we could determine, there is no official concern about either solids pollution, noise abatement, or visual pollution.

a. Water Quality

Control over water quality falls under the responsibility of the Agence Financière du Bassin de la Région du Nord. This Agency, set up about 2-1/2 to 3 years ago, has a staff of 12 and, up until the recent formation of the new Ministry of Environment, was essentially autonomous. The Agency's principal concern is with respect to the quality of water in the rivers of the region involved. The region has been divided into three zones or groups, ranked as follows on the basis of water quality:

Group 1 - Essentially the central part of the region out to the coastal areas and especially concerned with surface waters fit for supply purposes; conventional effluent treatment is required, including flocculation, filtration, and chlorination or ozonation, with or without the use of activated carbon.

Group 2 - Primarily along the southern border of the region and much of the northern area bordering on Belgium. This water is acceptable for use by industry and occasionally for municipal water supplies. Waste water must be treated as in Group 1, and also stored for one month or injected into the ground-water supply system.

Group 3 - Primarily in the Lens-Lille-Tourcoing area; the water is not fit for municipal use but only for industrial cooling.

It is the purpose of the agency to either maintain, or in certain local areas to improve, the quality of water. This is to be achieved by working with local authorities, appraising them of the need for improving water quality, providing advice on the best way of accomplishing such an aim, and by the imposition of an effluent tax:

Group 1 - 3 French francs (54¢ U.S.) per year per person;
Group 2 - 2.4 French francs (43¢ U.S.) per year per person;
Group 3 - 2 Grench francs (36¢ U.S.) per year per person.

It is the intention of the agency that either municipal or industrial effluents in the Group 1 inland areas should always be treated with primary and secondary treatment plus lagooning. However, this is not always the case at the present time because facilities are lacking. The effluent taxes obtained by the agency are therefore used to meet the agency's financial requirement in subsidizing the construction and operation of municipal water-treatment facilities. Since the maximum tax of 3 French francs per year is considerably less than the per capita cost of effectively treating municipal effluents - estimated at 14 French francs per year - the agency expects to use its funds in a progressive fashion, starting with those areas that have the greatest need.

In addition to the three water-quality zones for the inland regions, water-quality zones have also been set up along the coast. Coastal facilities -- whether municipal or industrial -- are presently not charged effluent fees. This is particularly true with respect to heavily industrialized regions such as Calais and Dunkirk, where no charges are planned because these have been specified as major industrial areas. The Agency anticipates that over the long run, if the growth of the coastal areas proceeds as planned, effluent treatment may be required of industrial plants to provide a sufficient water supply. However, since coastal industries did not pollute inland rivers, they are at present essentially free to do whatever they wish. Also, the Agency states that it does not yet know what pollution constitutes damage to the marine environment and is therefore unable to set up a rational effluent fee system.

b. Current and Potential Problems

1. Water

At present, Dunkirk obtains its water supply from inland fresh water sources. Although we were unable to obtain specifics regarding water requirements in Dunkirk during our short visit there, we were informed by the Port Authority that no serious problem is anticipated regarding water supply for either the municipalities involved or for industry in the near future. On the other hand, it is expected that there may be increasing application of recycle techniques, primarily for cooling water.

As far as can be ascertained, there is essentially no waste-water treatment either by the industries in Dunkirk or by municipalities, and it is unlikely that stringent waste-water treatment requirements will be imposed in the near future, simply because the area falls within the zone of least priority as set forth by the Agence Financiere du Bassin de la Region du Nord.

A major potential problem with the construction of the proposed new harbor area between Dunkirk and Gravelines is that the water level in these new harbors will be significantly higher than the surrounding land -- on the order of 20 feet -- particularly at high tide, and will extend much further inland -- up to 6 miles -- than the older installations. Therefore, there is a real prospect of salt-water seepage from the new harbor into agricultural or residential areas surrounding them. This possibility has been recognized by both OREAM and the Dunkirk Port Authority, and studies are underway regarding the possible effect of these new basins on the fresh/salt-water interface inland and whether salt contamination will become a problem.

We were informed that no baseline studies as such have been made by which the effect of Dunkirk port development on the marine environment can be evaluated. Although modest compared to Boulogne, Dunkirk is a fishing port -- 814,000 tons of fish were handled in 1969 -- and because of this one would think that some investigation would have been made along the immediate shoreline. However, we were informed that the majority of fishing is done "well off" the immediate coastline and that therefore -- aside from any major catastrophe such as a large oil spill -- no serious effects are expected.

Although no major oil spills were known to have occurred in Dunkirk Harbor or immediately outside the Port, oil is considered to be the main pollutant and an anti-pollution task force is being formed. During a tour of the harbor, oil "rainbows" were seen fairly frequently in the tidal basin. The British Petroleum (BP) loading/unloading facility has an oil spill containment boom, a vacuum recovery barge, and a bubble-curtain mechanism. The Port Authority could not provide any engineering details on the characteristics of the oil-spill containment and clean-up equipment; neither did they know what diking procedures were used around the refinery's bulk storage tanks to contain spills should they occur from a storage source (only a few tanks appear to have dikes).

Bilge pumping and deballasting of ships in the basin itself is forbidden; however no onshore waste-water pumping facilities have been provided. Presumably, major companies such as British Petroleum are more likely to refrain from overt ballast or bilge discharging, but this cannot be said to apply to smaller independent companies.

Rainwater runoff from open storage piles of coal, iron ore and phosphate is allowed to flow directly into the locked ship basins or into temporary storage moats along the quay. Iron ore and coal may fall into the basin during handling, requiring occasional dredging (every few years) alongside the quays to maintain the necessary water depth. This situation is not presently considered a problem, and the volumes of such discharges are unknown.

In a related sense, the "red muds" (Boues Rouges) of Pechiney's alumina plant may constitute a major problem when the alumina facility is built in about three years. Red mud discharges could amount to approximately two million tons per year of waste having a 30% solids content. Investigations are currently underway to develop economical methods of limiting these discharges or of treating the muds before they are discharged.

The state-owned electrical-power-generating plant (EDF) is presently located outside the main harbor area, but another plant will be located within the proposed new port limits. Thermal pollution may become a problem from this plant by virtue of its discharging cooling water on a once-through basis. On the other hand, because of the already polluted nature of the basin, warm water discharges may not be too significant a problem.

2. Air

The open stockpiling of coal and iron ore on the docksides creates an air pollution problem when the fines are windblown. However, because of the generally rainy weather, this ordinarily results in more of a water pollution problem than an air pollution problem regarding nearby residential or commercial areas. Thus far, there are no air pollution control regulations in the Dunkirk area. Problems are being recognized, however, in connection with the USINOR steel mill effluents and those from the electrical generation plant. Although we were unable to confirm this, we suspect that there are relatively few air pollution control procedures in effect at British Petroleum's refinery, either in terms of particulate, gaseous, or odor control. During our field trip; through the area, hydrogen sulfide odors were quite noticeable, as were smoke plumes from several stacks within the refinery property (but refinery employees, who live in a compound close-by never complain...).

To at least some degree, air pollutants are blown out to sea because of the southwesterly winds. However, westerly breezes will adversely affect the greater Dunkirk area, and offshore winds the inland regions. Here again, however, it does not appear that stringent pollution-control regulations are likely to be imposed within the near future because of the overriding concern regarding attraction of new industries to Dunkirk, and the coast and wind.

3. Solid Wastes, Dredging, etc.

Aside from the occasional dredging of spilled ore and coal, and some silt from the drainage canal in the east, there has been no maintenance dredging required in the inner portion of the old Dunkirk Harbor; nor has maintenance dredging been required in the main entrance channel where the bottom (at a depth of minus 45 feet) is comprised of silt and sand various grain sizes.

Aside from the dredging required during construction, the use of the new locks in the Bassin Maritime has resulted in the need for continuous dredge maintenance to maintain the desired channel depth; spoils from this operation are dumped at sea in an area some six miles offshore.

The new lock-free harbor under consideration some eight miles west of the existing harbor will require considerable construction dredging, as well as an extensive maintenance program to maintain the required depth. Wave and current studies are largely completed, while sedimentation and long-shore drift studies continue on the two hydraulic models. It has been decided from model studies that the new channel can be angled to reduce channel silting caused by shoreside currents, which are twice as strong in a westerly direction than the eastward tidal currents.

Hydraulic studies were of first priority, because an evaluation of the shape and magnitude of any currents from waves inside the breakwater area would affect such factors as shipbearing, speed, timing of entry, and degree of assistance required by approaching and departing ships.

As previously indicated, sedimentation studies are still underway with about a year to go. These studies will, among other things, indicate the influence of the new harbor design on coastal configuration, particularly between Gravelines and Dunkirk. It is the Port Authority's tentative opinion that, based upon historical performance, maintenance dredging of the new channel should not be prohibitively expensive and further that the coastline should not be insignificantly altered. (We were told that even if changes occurred in the shoreline as a result of breakwater construction, there would be little negative impact on the environment, since the Gravelines-Dunkirk area, as well as that between the new harbor and the old Dunkirk Harbor, are not recreational or conservation sites.)

The total volume of material to be dredged for the new harbor area is estimated to be approximately 120 million cubic yards--42 million in the turning basin, 60,000,000 in the new channel, and 18,000,000 in the dock areas. All spoil on the seaward side of the new jetty is expected to be used for fill or beach building in an area planned for the construction of a nuclear power plant. Alternatively, spoil may be dumped in one of several fairly deep channels about three miles offshore, such that dumping would not interfere with any shipping and (it was claimed) should have no adverse affect on fish breeding areas.

During our stay in Dunkirk,we learned nothing about solid waste disposal methods as practiced by the municipality, other than being told open dumping and burning in preselected areas was practiced.

4. Noise

This is generally not recognized as a significant problem, particularly insofar as industrial noise effect on residential areas is concerned. Over time, excessive noise related to general problems of overcrowding, construction activity, and repair, may become more significant.

5. Land Use

It appears that the principal locus of planning regarding the Dunkirk-Calais area originated and still exists in the OREAM Nord which cooperates with appropriate city planning agencies -- primarily in Dunkirk and Calais -- the Harbor Authority, Ministry of Equipment, and other agencies.

It is also quite apparent as pointed out in greater detail Section IV of our main report, that the Dunkirk Port Development project is an attempt by the national government to revitalize the northern industrial area by concentrating a heavy industrial zone in Dunkirk and use the excess labor available in the region. An equally important and longer-range objective is to enlarge Dunkirk to the point where it can serve not only northwestern France, but also portions of The Netherlands, Belgium, and Germany, thereby placing France in an excellent position to play an even larger role in the Common Market.

Though perhaps coincidental, it is interesting to note that the 25-mile stretch of coastline between Dunkirk and Calais - up to 6 miles deep - offers about the same acreage as in the Rotterdam Port area; which suggests the scope of the OREAM planning effort. Between Gravelines and Dunkirk, the total expansion area includes facilities already developed in several communities - notably Fort Mardyck, Grande Synthe, Petit Synthe, St. Pol sur Mer, Loon Plage, and Les Huttes.

In addition to what will amount to virtual absorption of several communities over time, planning for the Dunkirk-Calais region has been largely technical in nature (as opposed to environmental). That is, land requirements for primary and secondary industry were carefully assessed (and industries identified) which would be valuable to the region in terms of employment opportunities and as bases upon which to build a broad integrated industrial complex. However, the various planning agencies involved (mostly governmental) do not appear to have analyzed sufficiently certain problems in the immediate area, such as need for a "green belts," recreational opportunities, shopping centers, and population relocation in addition to housing and infrastructure.

With respect to population relocation, Mardyck, for example, with a population of 350 inhabitants in 1960-1964, resisted the industrialization plan and elected to remain as a town. The population is now 250, and when the industrialization zone is finished, the town will be 13 feet lower than its surrounding area. Ultimately, the town will disappear, but probably without the necessary arrangements being made with the inhabitants who have to move. Similarly, Loon Plage, with approximately 2500 inhabitants, is expected to be surrounded by a new 5000-hectare (12,500 acres) industrial extension and become an undesirable place in which to live.

On a longer-term basis, even though Gravelines and Fort Philippe have been identified as "green belt" areas, there appears to be real danger of Gravelines being squeezed out of existence. This is primarily because, when the cooperative effort between Dunkirk and Calais was set up, Gravelines was excluded. Furthermore, if industrialization proceeds as planned over the next one or two decades, Gravelines itself will probably become badly polluted, unless strong measures to prevent such an occurrence are taken. This, plus the possibility of future demand for existing water frontage, would seem to seriously threaten the town's existence.

Up to the present time, another major problem has been the securing of adequate financial resources to purchase the required land and land reserves necessary for the port and industrial zone. In relation to this, too little attention was given in earlier planning stages to the allotment of frontage to industrial "customers" -- primarily USINOR -- which in the view of many officials now occupies far too much frontage land. The steel plant was located over ten years ago - well in advance of any national planning regarding port development - and the present land which is owned by USINOR could be more economically applied to commercial purposes, with the steel plant being located further west of its present site and with a narrower frontage.

c. Future Issues

With the continued development of the Dunkirk-Calais area, hastened by the soon-to-begin construction of the Pechiney alumina facility, Dunkirk will face several issues; among which the most important are the following:

- The rapid growth of Dunkirk and Calais will bring lodging, sociological, land zoning, and pollution problems.
- The ultimate justification of the port will depend in large measure upon the size of the interior it can serve; this inland area will have to extend beyond France's boundaries, and its importance to Dunkirk is in many respects a guess.

- Communications and infrastructure will have to be rapidly improved.
- Development of the seashore and of the immediate interior will have to go through careful selection of industry and its location in terms of their effect upon this environment and the contribution they can make to employment quantity and quality.
- Policies will have to be better coordinated between the towns involved in the development, along with closer ties to the various Ministries.

A-2 LE HAVRE

A.2.1 Summary

The Port of Le Havre started its development in 1517 under King Francois I, and was both a naval military base and a trade center until about the 18th Century, when it developed into strictly a commercial port, including passenger traffic.

Le Havre was 85% destroyed during World War II, and reconstruction was completed only in 1960. Progressive widening, deepening, and construction allowed the port to keep pace with maritime developments, and until about 1960, it was able to operate effectively, meeting the requirements of most vessels. It appears to be an almost universal opinion that Le Havre is about the best natural port the French have and is well situated to serve the densely populated area along the Seine River, up to and including Paris.

The second French port after Marseilles for total volume, Le Havre is the first harbor in France for long-haul traffic. Out of 150 regular lines serving the harbor, only 30 are coastal shipping lines. The harbor function is primarily to accommodate big vessels--oil tankers up to 260,000 DWT and bulk carriers up to 90,000 DWT. Le Havre is also the first French harbor for passenger traffic towards America, receiving regularly "France" and "Queen Elizabeth II."

A literature survey and interviews with the Port Director and various officials from the Port Management, the CFR refinery, and citizens concerned with their environment, yielded the material contained in this section.

A.2.2 Area Description

a. Geography

Located in the estuary of the navigable Seine River, Le Havre serves the Paris basin. Its position as the westernmost major port on the continent of Europe (i.e., closest to the deep Atlantic) has become less viable as ships grow in size and draft, and the Dover Straits become congested. One-hundred-foot depth is available, five nautical miles off Antifer in the north, and 12 nautical miles off Le Havre in the west.

b. Geology

There is a marked difference between the high chalk cliffs of the north side (Cretaceous) and the sandy south coast of the Seine estuary that has clay outcrops of Jurassic age. The bay bottom was investigated in the late 1960's, with three passes of high-definition, electro-seismic sparker tests (IFP process) on a kilometric grid (1300 km) and coring on the two sites, Parfond and Antifer, contemplated for the offshore island. From west to east the substrate consists of: interbedded limestones, and clays of Jurassic age, topped by Lower Cretaceous green sands. Unconsolidated sediments include: bottom gravel (23 to 40 feet thick at 93 to 103 feet deep) with sandy cement; grey organic silt (very fine 5 to 50 microns, from 80 to 93 feet); and coarse or fine sands which make dunes in the river bed. To the north-northeast, towards Antifer, the sediment thickness decreases quickly to a foot or less.

Aquifers exist between Le Havre and Rouen which formerly carried fresh water. These sands are already salty in Le Havre because of previous salt-water intrusion; the precise cause of this intrusion is somewhat conjectural, but is probably at least in part related to the deepening of the Seine estuary.

A recreational beach is located just north of the harbor entrance proper and in front of the town. Other recreational areas include Deauville, several miles south of the town. The latter was said to be in danger of pollution from the harbor and outwash from the Seine River itself. Bottom conditions in the harbor are essentially sandy and the material is said to be easily dredged.

c. Tides and Currents, Sea State

An average 74 coefficient tide gives an additional water height of six feet to 24 feet above chart soundings. Tidal currents reaching 2 knots near and parallel to the shore, reverse themselves depending upon tidal conditions, with a northeastward component being the stronger of the two. Around Antifer, currents are also alternating southwest-northeast, with a maximum intensity of 3 knots at spring and 2 knots in neap tide. Swells follow the wind direction, are highest to the northwest. Significant height could reach 20 feet in ten years (25-foot maximum height) and 29 feet in 100 years.

d. Climate

Fog is not too serious a problem, because visibility is over two miles 85% of the time, over one mile 90%, over 0.5 mile 96%. Winds are variable, but prevail from the southwest quadrant (30%), northeast 28%, and northeast 25%, and the temperature ranges from approximately 10°F in winter to a high of 97°F in summer. Breezy or windy days are common in Le Havre; calm days occur only about 6% of the time (speed less than 4-1/2 mph), while winds between 4-1/2 and 34 mph occur 87% of the time.

A.2.3 Demography and Land Use

A city of 250,000 inhabitants, Le Havre is located at the mouth of the Seine Valley and serves the 3 million inhabitants of the Paris basin within a radius of 120 miles.

Natural and artificial filling behind dikes has provided 1055 acres of tidal basins, 330 acres of locked wet docks and 25,000 acres of industrial land in the estuary. As industry could only expand eastward along the estuary, the residential districts are generally well separated from the upwind industrialized area.

The high hills which constrict Le Havre urban expansion are opened by the Lezarde Valley which provides future expansion possibilities, somewhat less protected from industrial air pollution than the current town. Further upstream, a series of industrial terminals, separated by greenbelts, lead into the river port of Rouen, about 100 km (60 miles) inland.

A.2.4 Management and Financing

Like Dunkirk, Le Havre is one of seven "Port Autonomes" which France has freed from municipal ties since 1925. Local government and interests (Chamber of Commerce) are only represented in the Board. The port facility is controlled by the Ministry of Finance and the Ministry of Equipment, both of which have regional departments. On a regional basis, the most important planning institution is OREAM, which concerns itself with the long-range development of the Lower Seine Valley region.

The Law of 29 June 1965 increased the State financial participation in port operations. All autonomous ports benefit from government aid in the building of the infrastructure and in the dredging necessary outside the port. The State is entirely responsible for the maintenance of the maritime approach channels, the sea walls, the outer harbor, and the access locks from the sea. It also pays for the operation of these locks.

As regards capital expenditure for such items and also the excavation of docks, the State contributes 80% while the Port pays 20%. For quays, quay walls, and dry docks, the State pays 60%. The State also contributes to the cost of servicing loans obtained by the port in the past for carrying out such works. The amount of such contributions increases the cost borne by the State from the 50% of the pre-autonomy days to the rates of 80% and 60% now current. For the superstructure, however (that is to say cranes, sheds and warehouses), there is no assistance from the State.

The Port Autonome at Le Havre pays no taxes to the city of Le Havre for services which the port area needs (i.e., firefighting, etc.). There is one man from the Le Havre City Council who sits on the Board of the Port.

Major taxes accruing from industries located in the Le Havre industrial zone are primarily going to small communities adjacent to the zone. The city of Le Havre believes that it is not getting a sufficient share of this tax revenue to finance the community services which it must provide to the industrial zone. This could potentially be a significant problem unless it is resolved.

A.2.5 Economic Appraisal

a. Commodity Flows

Table A-4 illustrates the variety of commodities flowing through Le Havre, with a total tonnage growing from 16.6 million tons in 1960 to 50.4 million tons in 1969. Petroleum is the major commodity by far, and increased its share of total export and import tonnage, from 77% in 1960, to 80% in 1965, and 85% in 1969, a total of 51 million tons. The petroleum annual growth rate increased from 12% in the first 5 years to 18% in the second half of the decade. Coal, cereals, and chemicals come next, growing respectively to 1.4, 0.6, and 0.4 million tons in 1969; while wood, rubber, metallic ores, and manufactured products have a rather static volume aggregating about 1 million tons per year.

Table A-5 and A-6 separate exports from imports, with exports showing better growth in the second half of the decade than in the first, and (in 1969) accounting for 17% of the cargo tonnage handled. Petroleum and cereals account for most of the export tonnage.

b. Petroleum Products and Pipelines

The largest part of LeHavre's petroleum products storage belongs to C.I.M.* which has a capacity of 15 million bbls. (58 tanks for crude oil containing 14.2 MM bbls. and 45 tanks for white products containing 850,000 bbl). Eight refineries (24% of France's capacity) receive crude oil directly from the C.I.M.'s storage. These are:

- C.F.R.'s Gonfreville refinery (325,000 bbl/d) at a distance of approximately six miles, 2 pipelines (150,000 and 1,200,000 bbl/d capacity);
- Esso's Port Jerome refinery (150,000 bbl/d) at a distance of approximately 22 miles, 3 pipelines (450,000 bbl/d);

*Compagnie Industrielle Maritime

TABLE A-4

LE HAVRE TOTAL COMMODITY TRAFFIC

(millions of tons)

	1960	1965	Annual Growth rate 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Exports & Imports)	16.6	28.0	11.0%	50.9	16.1%
Bulk	13.2	24.3	13.0	45.7	17.1
General Cargo	3.4	3.7	1.7	5.2	8.9
SELECTED BULK COMMODITIES					
Cereals	0.2	0.3	8.5	0.6	19.0
Wood	0.3	0.3	N.C.	0.3	N.C.
Coal	0.2	0.7	28.5	1.4	19.0
Rubber	0.2	0.1	-12.9	0.2	19.0
Ores	-	0.1	-	0.2	19.0
Iron & Steel	0.1	0.1	N.C.	0.1	N.C.
Non Ferrous	0.2	0.2	N.C.	0.1	N.C.
Metalware	-	0.1	-	0.1	N.C.
Machinery	0.1	0.1	N.C.	0.2	19.0
Transportation Equipment	0.1	0.2	14.9	0.2	N.C.
Petroleum	12.8	22.5	11.9	0.2	N.C.
Chemicals	0.1	0.3	25.0	0.4	7.5
Fertilizers	-	-	-	-	-
Pulp & Paper	-	0.1	-	0.1	N.C.
Cement	-	-	-	-	-

N.C. = No Change

TABLE A-5

LE HAVRE EXPORT COMMODITY TRAFFIC
(millions of tons)

	1960	1965	Annual Growth rate 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Exports)	2.5	3.9	9.3%	8.7	22.0%
Bulk	.8	1.9	18.9	5.6	31.0
General Cargo	1.7	2.0	3.3	3.1	11.6
SELECTED BULK COMMODITIES					
Cereals	0.1	0.2	14.9	0.6	32.0
Wood	-	-	-	-	-
Coal	0.1	0.3	25.0	0.2	-9.6
Rubber	-	-	-	0.1	-
Ores	-	-	-	-	-
Iron & Steel	0.1	0.1	N.C.	-	-
Non Ferrous	0.1	-	-	-	-
Metalware	-	0.1	-	-	-
Machinery	-	0.1	-	0.1	N.C.
Transportation Equipment	0.1	0.1	N.C.	0.1	N.C.
Petroleum	0.6	1.2	14.9	4.8	41.0
Chemicals	-	0.1	-	0.2	19.0
Fertilizers	-	-	-	-	-
Pulp & Paper	-	-	-	-	-
Cement	-	-	-	-	-

N.C. = No Change

TABLE A-6

LE HAVRE IMPORT COMMODITY TRAFFIC

(millions of tons)

	1960	1965	Annual Growth rate 1960 - 1965	1969	Annual Growth rate 1965 - 1969
Total Tons (Imports)	14.1	24.1	11.3%	42.2	15.0%
Bulk	12.4	22.3	12.45	40.1	15.8
General Cargo	1.7	1.8	1.1	2.1	3.9
SELECTED BULK COMMODITIES					
Cereals	-	0.1	-	0.1	N.C.
Wood	0.3	0.3	N.C.	.3	N.C.
Coal	0.1	0.4	32.0	1.3	34.0
Rubber	0.1	0.1	N.C.	0.1	N.C.
Ores	-	-	-	0.2	-
Iron & Steel	-	-	-	0.1	-
Non Ferrous	0.2	0.2	N.C.	0.2	N.C.
Metalware	-	-	-	-	-
Machinery	-	0.1	-	0.1	N.C.
Transportation Equipment	-	-	-	0.1	-
Petroleum	12.2	21.3	11.8	38.3	15.8
Chemicals	0.1	0.2	14.9	0.2	N.C.
Fertilizers	-	-	-	-	-
Pulp & Paper	-	.1	-	0.1	N.C.
Cement	-	-	-	-	-

N.C. = No Change

- Mobil's Notre Dame de Gravenchon refinery (78,300 bbl/d) at a distance of approximately 22 miles, 2 pipelines, one is shared with Shell (255,000 bbl/d);
- The Shell Petit-Couronne refinery (189,000 bbl/d) at a distance of 50 miles, 2 pipes, one shared with Mobil (255,000 bbl/d);
- The Elf-Union's Grandpuit refinery (75,000 bbl/d) at a distance of 155 miles and the Porcheville refinery (70,000 bbl/d) at a distance of 62 miles, one pipeline (210,000 bbl/d);
- B.P.'s Vernon refinery (80,000 bbl/d) presently uses the same pipeline as Elf-Union; and
- Antar's Valenciennes refinery anticipates a flow rate of 78,000 bbl/d.

The total crude-oil transportation capacity to the refineries presently amounts to 1,300,000 bbl/d for all nine pipelines, excluding C.F.R.'s direct connection. Natural gas (Algerian LNG transported by the "Jules Verne," and gasified at the methane terminal of the harbor) is sent by pipeline to the Gaz de France underground storage in Beynes).

Transportation of refined petroleum products is done by the Trapil pipeline towards the Paris region and secondarily to Le Havre by a triple pipeline grid. The Trapil pipeline system was completed at the end of 1968:

Le Havre-Rouen-Grigny	154 miles	10"
Gonfreville-St. Ouen	100 miles	12"
Gonfreville-Gennevilliers	100 miles	20"
Grandpuits-Grigny	28 miles	12"

In the tonnage transported to the Paris region in 1967, domestic fuel oil had first place with 2.5 million tons, followed by gasoline with almost 2 million tons (out of a total of 6.2 million tons) or twice the amount transported in 1963, and three times the amount transported in 1957.

In addition, product and coastal tankers can be loaded at four berths and barges (3000 tons) at three berths. C.I.M. finally has a 100-tank wagon spurline and a ramp for simultaneous loading of two large trucks.

In 1968, total traffic with the interior was distributed as follows between four modes of transport (million tons):

	Exports	Imports
Road	19.9	2.2
Rail	16.2	1.7
Water	25.8	1.8
Pipelines	94.3	38.1

c. Containers

After a just period of stagnation in the early 1960's, general cargo is showing some growth, up to 11.6% of export volume. The amount of containerized cargo handled through the port has increased from 58,000 tons in 1966 to 679,000 tons in 1969, while the number of roll-on/roll-off vehicles increased nearly ten-fold from 3,700 vehicles five years ago to approximately 36,000 presently.

Le Havre considers itself, to be the French capital for containers, and to this end it is building a 2,500-foot quay together with a roll-on/roll-off link span and a 30-acre stacking area to handle three container ships simultaneously. In addition, there is to be a 100,000 square foot shed devoted to the purpose of filling and emptying containers. There are plans to eventually build a new container harbor, capable of handling a yearly traffic of up to 16,000,000 tons of merchandise per year, along the central canal. However, the French ports of Le Havre and Rouen are hardly a serious threat to the Belgium/Dutch ports for container traffic. The distances are against the French, as are their lack of major tradition in all the important port activities of shipping, brokering, and forwarding upon which the vitality of ports like Antwerp and Rotterdam depends. The transit traffic which Le Havre is able to secure from Central European countries like Switzerland is marginal.

d. Industrialization

Industrial acreage in Le Havre is located essentially between the canal du Havre a Tancarville and the estuary (Figure A-5). It is distributed as follows:

Space Occupied by Enterprises	2,865 acres
Clear Available Surface	6,649 acres
Clear Equipped Available Surface	1,870 acres
Extension Surface	8,200 acres
Total	19,584 acres

About 18,000 acres are in reserve between the harbor and the Tancarville Bridge.

Table A-7 indicates the enterprises located in the Le Havre industrial zones as of 1970. Several new industrial projects are under way including the construction of a power plant which will produce 3,250,000 KW and use 25,000 tons/day of coal.

The main beneficiaries of the development of the deepwater port at Le Havre are the manufacturing industries which settle in the industrial zone and rely upon imported raw materials. There will be no major governmental incentive offered to industries for location in Le Havre, since it is classified as a major deepwater port, with inherent advantages. There is a small tax incentive given by the city of Le Havre to industries that settle in the light manufacturing area.

Land in the industrial zone is and will be leased to the user industries rather than sold. There have been exceptions to this rule for Goodyear Corporation and Renault who both purchased land, as they would not settle in Le Havre unless they did have a title to the land which they were using. The leases normally run for 50 years with extension clauses. It is also a policy of the industrial development plan that only industries which can prove that they must have access to deepwater facilities will be allowed into the industrial zone. Those industries which do not necessarily have to have prime industrial sites on the water will be able to locate in a large industrial zone outside of the port on a plateau above Le Havre.

e. Regional Development

The development of Le Havre harbor is a major part of a national scheme of regionalization to decentralize the Paris region. But the transfer of activities from Paris to the Lower Seine Valley will be performed in such a way that the industrialization in the Lower Seine will be "self-contained" and not dependent on the development of Paris. This means that the decentralization will take place over a broad range of complementary activities.

Independence will, on the other hand, not mean isolation of the Lower Seine Valley from Paris. Industrialization in the Lower Seine Valley is planned in such a way that Paris will have to rely on certain activities of the Valley.

In addition, the development of the Lower Seine Valley seeks to achieve a large industrial and harbor complex capable of competing with the foreign harbors of the North Sea.

Between Le Havre and the "green belt" on the east, more than 25,000 acres of alluvial lands are available. The urban development in Le Havre will take place towards the northeast, around the Lezarde Valley, a site well protected from the wind and connected to Le Havre by railroads. Population should double to 500,000 people.

Additional urbanization will take place on the South Bank of the Seine although hampered by the high toll of the Tancarville Bridge. In 1985, the capacity of this bridge will be insufficient and a new bridge will be located closer to Le Havre to better integrate the city.

The need for additional land for the development of industry in the harbor seems to exceed the present land availability. Additional land on the South Bank, east of Honfleur is set aside for industrial development. But studies should be undertaken on the possibility of negative effects on the maintenance of the access channel caused by industrialization. Similarly, the development over 100 miles "upstream," through Rouen to Mantes, with a new town at Le Vandreuil, has been studied for the 1985-2000 period.

Already the second, and fastest growing port of France, with access to 250,000 ships, the port of Le Havre has ambitious plans which require spending over $236 million, a large part during the period of the Sixth Plan, which will run from 1971 to 1976. The objective of the port authority is to make Le Havre into a modern port, with an associated deepwater industrial zone capable of handling vessels considerably larger than those now docking at Antwerp and Rotterdam. Officials of the Port Authority believe that the saturation of Antwerp and Rotterdam over the next decade will give Le Havre the opportunity to close the gap. The project to be undertaken provides for the development of a vast deepwater industrial zone, the adaptation of the port to new transportation techniques such as containerization and barge carrying and roll-on/roll-off methods, the modernization of existing installations, the creation of a major ship-repairing center, and the building of an artificial island--to receive the future generation of supertankers (500,000 to 1,000,000 DWT)--and related land facilities.

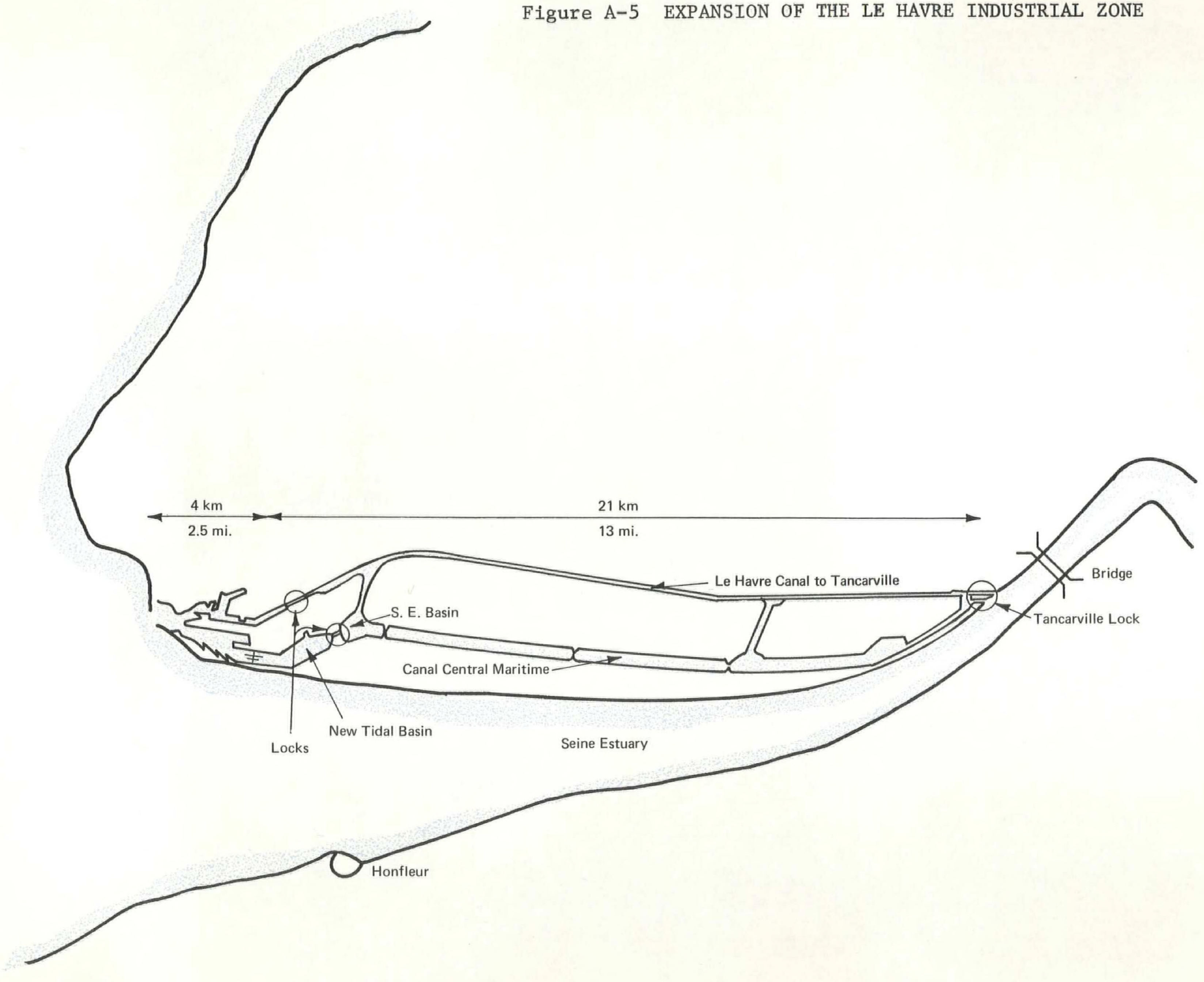
Two important development projects have to be carried out; the first one, which is already very advanced, consists of the eastward extension of the harbor toward the alluvial plain; the other consists of deepening the approaches and the Tidal Basin, building new oil wharfs, and developing unloading installations and crude oil storage.

Extension Toward the East of the Industrial Zone (Figure A-5)

To connect the alluvial plain that stretches east of Le Havre harbor to the existing installations, the whole extension zone had to be protected by a closed sea wall, behind which new platforms and new basis are constructed. The developments are:

- The new "Bassin de Marée" (Tidal Basin) with a 300-acre surface, the bottom of which has been deepened from 37 feet to 50 feet in 1970;
- A constant-level basin, called South-East Basin, with a 130-acre surface, and 15-foot depth;

Figure A-5 EXPANSION OF THE LE HAVRE INDUSTRIAL ZONE



- A group of three locks that will connect the "Bassin de Maree" with the constant-level basin. The first of these locks is being built, with a 222-foot beam and 47-depth; it will allow the passage of 200,000 DWT ships.

A junction canal, 4000 feet long and 670 feet wide, connects the South-East Basin to the Tancarville canal in the north. A Central Maritime Canal, 1260 feet wide, implanted in the alluvial plain and on the banks of which waterfront industries are developing, is already being dug to a 6 miles length (with a width reduced to 400 feet) at a level of -7.3 feet in a first phase.

The basic infrastructure will of course be completed according to traffic development, by new railroad and road connections and by docking berths. For example, on its north bank, the new Bassin de Maree made room, in 1968, for a wharf, particularly organized to welcome vehicle carriers and container ships. The south bank will be reserved for the development of the petroleum harbor and for the raw materials necessary to the industries that will settle on the new acreage. The north side of the South-East Basin and the west bank of the Canal de Jonction will come by a public wharf 4,300 feet long, serving a transit and warehousing zone larger than 130 acres. The west shore of the Canal de Jonction and the shores of the Canal Central Maritime will be adaptable to the installation of industrial piers.

Adaptation of the Port to Large Oil Tankers

The whole Bassin de Marée was deepened to 50 feet, the access channel widened (from 830 feet to 1000 feet) and deepened to 52 feet, and since July 1970 vessels up to 250,000 DWT enter the harbor.

Shortly, the harbor will accommodate vessels up to 300,000 DWT, but in the long run, this will not be quite sufficient. The port is evaluating plans to accommodate 1,000,000 DWT vessels by constructing an artificial offshore island at Antifer.

The Parfond site has been also investigated, but it had the great disadvantage to be right in the middle of the Le Havre access channel and too close in case of oil spill to the famous beaches of the "Basse-Normandie" coast from Deauville to Cabourg.

The government has not yet given the authorization for the Antifer offshore island. There is some concern about communication difficulty between the coast and the island, so that a project of an oil terminal on the coast, between Bruneval and St. Jouin, is reactivated.

Harbor Connections with the Interior

The principal projects are:

- Inland Waterways--a large-scale connection (3000-ton convoys) through the north of the Paris Basin to Eastern France, with the Seine, Oise, and Aisne Rivers and a canal from the Aisne to the Marne River to Reims.

- Parts of this connection will be included in the Sixth Plan. A more ambitious project, also under study, pursues this development to Lorraine (Mosel Valley).

- Freeways--the connection of Le Havre to the Normandy autoroute A 13 is a high-priority operation and is included in the Sixth Plan.

Rationale for an Offshore Island in Antifer

A study has been conducted by the Port Autonome to justify this project. Western Europe consumed about 570 million tons of petroleum products in 1969. The forecast is that the need will grow to between 800 and 900 million in 1975 and 1300 million tons in 1980. The consumption growth rate (about 12% per year between 1960 and 1969) has been estimated between 7% and 9% for 1969-75, and between 5 and 6.5% for 1975-80. Out of the total of 1300 million tons of crude oil necessary in 1980, about 625 million tons will come from the Middle East, and 86 million will go into the Paris Basin (and perhaps 180 million in 2000). Savings obtained from large tanker sizes are estimated in Table A-8.

TABLE A-8

ROUTE SAVINGS USING LARGE TANKERS
(Reference = 200,000 dwt - Francs per ton)

Tanker Tonnage, DWT	Le Havre/ Persian Gulf	Le Havre/ Nigeria	Le Havre/ East Coast Mediterranean	Le Havre/ Libya
240,000	2.00	0.80	0.65	0.52
300,000	3.70	1.51	1.24	0.82
400,000	5.31	2.23	1.82	1.26
500,000	6.31	2.64	2.16	1.62

A recent study from the central committee of French shipping companies is even offering estimates 50% higher than the ones above.

Although works of huge magnitude have already been undertaken by the ports of the European north shore (Rotterdam, Antwerp, and Dunkirk) Le Havre is maintaining that only the English Channel and Atlantic coast can offer a depth that would correspond to the 85-foot draft of the 500,000 dwt oil carriers.

To avoid the costly dredging of compact marlbeds, solutions outside the harbor were investigated. Construction is considered in five phases, totalling $250 million, as shown in Table A-9 and Figure A-6.

TABLE A-9

FIVE PHASES OF OFFSHORE BERTH CONSTRUCTION

Phase	1	2	3	4	5
Dikes, length, feet	5240	2700	3660	5440	4000
Number of berthing points	1	1	1	1	1
Sea-line diameter	1 x 48"	1 x 48"	1 x 48"	1 x 48"	1 x 48"
Storage Capacity, m^3	600,000	750,000	750,000	750,000	750,000
MM bbl.	3.75	4.5	4.5	4.5	4.5
Pipelines diameter	1 x 34"	1 x 34"	1 x 34"	1 x 34"	1 x 34"
Maximum Traffic (MMT/y)	40	80	120	160	200
Cost in MM francs	300	240	240	380	180
MM dollars U.S.	54	44	44	70	33
Cumulative	54	98	142	212	245

The oil traffic going through Antifer has been estimated as :

	1974	1980	1985	1990
Low Estimate	22	67	90	124
High Estimate	36	83	114	150

The return on investment will reach 13% in 1974, with a low traffic estimate (and about 45% for a traffic of 40 million tons), and would be about 50% for a traffic of 20 million tons.

f. The Port of Rouen

1. Physical History and Commodities. When roads were few, uncertain, and slow, and overland vehicular transportation was limited, Rouen was a major port for the importation of coal. In 1930 the imported coal tonnage handled was 5.3 million tons out of a nationally imported total of 10 million tons.

In port-war years the Port Authority gradually rebuilt and developed facilities for handling cargoes other than coal. The diversification was accelerated by the 1965 law that provided more help and autonomy to leading French ports. The new status transformed the port into a public administration distinct from the municipality, with civil responsibility and financial autonomy. This provided greater ease of administration and permitted direct contact with the users of the Port.

Despite the problems of navigating the 80-odd miles of the meandering Seine River to enter Rouen -- the most inland port of France -- the commodities and tonnages handled have increased annually, making Rouen the fourth largest port in France after Dunkirk. (Table A-10)

Total trade is expected to reach 14 to 18 million tons by 1975, including 10-13 million tons for industrial traffic. The 1968 traffic with the interior was mostly by barge (6.25 million tons) and road (4.5 million tons) and about 60% was oil products. Railroad traffic was only 1.08 million tons.

TABLE A-10

ROUEN MARITIME TRAFFIC, 1968-69
(Tons)

Nature of Goods Handled	Imports 1968	Imports 1969	Exports 1968	Exports 1969
Agricultural products and Live Animals	460,004	596,093	1,545,300	1,748,989
Foodstuffs and forage	352,438	311,333	293,510	289,299
Solid fuels	1,079,522	970,907	53,820	63,255
Crude oils	716,234	693,292	-	-
Refined oils	655,813	877,762	3,114,870	3,090,869
Iron ores and waste for foundry use	4,675	800	2,029	4,950
Non ferrous ores & waste	15,812	16,061	3,820	4,744
Ferrous metal products	47,977	41,982	85,412	82,008
Non ferrous metal products	12,457	17,973	8,169	10,581
Crude or manufactured minerals & building mat'l	128,560	124,802	320,940	364,837
Basic raw material for chemical industries	238,771	237,989	235	149
Fertilizers	1,093,084	1,089,133	97,616	59,739
Raw chemical products	143,369	106,422	87,371	108,535
Pulp paper, cellulose	289,006	244,398	4,075	4,206
Other chemical products	23,647	10,732	59,669	53,059
Agricultural machinery	3,017	2,152	58,317	65,681
Machinery and metal goods	11,179	7,111	74,178	77,215
Glass	514	294	9,405	12,537
Other manufactured articles	240,368	260,355	80,536	80,852
TOTALS	5,516,447	5,609,591	5,899,272	6,121,505

2. Industrialization. The industrialization of the lower Seine Valley is essentially centered around Le Havre. But industrial land availability is limited. It is therefore mandatory that the expansion be carried all the way to Rouen to reach the 20,000 hectares (50,000 acres) deemed necessary for a major complex. Accordingly, the harbor of Rouen wants to expand into the following acreage, some of which is already eyed for Le Havre expansion.

TABLE A-11

POSSIBLE ROUEN HARBOR

Expansion Areas (acres)

Harbor Location	Occupied Zone	Zone for Extension	Zone Reserved for Further extension	Total
Grand Rouen	6800	2200	1950	10,950
Anneville-Yville	-	-	10,600	10,600
Le Trait-Yainville	975	1870	-	2,845
Port Jerome	5200	5870	13,400	24,470
Honfleur	425	6590	2,870	9,885
	13,400	16,530	28,820	58,750

The industrialization of the Rouen area will be focused on light industry simply because the navigation conditions in this area limit the vessel size. Rouen will see the growth of transformation industry mainly bound to the consumption of the Parisian district.

One of the critical elements in the development of Rouen and of Le Havre is the limited industrial interior, confined to Haute-Normandie and the Parisian Basin which accounts for 90% of the total traffic of the two harbors. A better highway network and a maritime connection bewteen the Seine and the East of France, at "international barge" size are mandatory if overcrowding of the Le Havre region is to be avoided.

Oil refineries represent one of the major sources of export traffic. The combined runs of the 3 refineries account for 20% of France's crude consumption, practically all through pipeline from Le Havre.

TABLE A-12

ROUEN REFINERY CAPACITIES
(tons/year)

	Refinery Capacity	Refined Product, 1969
SHELL (Petit Couronne)	9,200,000	8,300,000
ESSO (Port Jerome)	7,200,000	5,900,000
MOBIL	3,600,000	2,900,000
Total Rouen	20,000,000	17,100,000
Total France	105,000,000	90,300,000

Coal used to represent a very important share of Rouen traffic, but the switch to other energy sources has reduced quite significantly the importance. The paper industry represents another important sector for Rouen. The plants in Rouen use 20% of the wood and 20% of the paper pulp produced in France. They deliver 12% of the paper produced in France and 16% of the national production of pulp. The chemical industry represents another important sector, with the production of 20% of the fertilizer produced in France.

3. Le Havre-Rouen Competition. There is significant competition between Le Havre and Rouen for priority in the industrial development scheme and for commodity traffic. Rouen has significant liabilities in that it can presently only take 35,000 dwt ships and does not have the inherent site advantages that Le Havre has for industrialization. However, it is the capital of the province and has exerted significant political influence to obtain funding for its development. Instead of trying to concentrate on complementary activities which would flow from Le Havre industrialization projects, it attempts to compete and not develop any particular specialized function. The Government position seems to be that Le Havre will develop the capability to take large petroleum tankers, large dry-bulk carriers, and fast container ships. Rouen will accommodate the smaller type of vessel, roll-on/roll-off, containers, and general cargo, with specialized trades, as well as product exports.

A.2.6 Environmental Impact

The following notes refer often to the CFR refinery, because the company was most helpful during our short field trip. However, they are by no means the only polluter in the area. A cement plant, a nickel smelter enclosed by the city expansion and shipping pollution have been criticized by the local press.

a. Water Pollution

One of the largest users is the "Compagnie Francaise de Raffinage" (CFR) which requires 12 million cubic meters per year of fresh water, and 90 million cubic meters per year of salt water which it obtains from the Tancarville Canal. Decanting basins are used to control effluent discharge. Phenol is the most difficult effluent to control and the CFR is preparing to reinforce its bacterial filter.

Fishing is forbidden in the polluted Canal de Tancarville around the industrial zone. However, the fish periodically choke the intake grid of the intake condensers and mussels proliferate in the warm water discharged as well as in the pipes handling this discharge. An electrical barrage has been successfully used to solve this problem.

Several times a year the prefect of Seine Maritime makes a control of the quality of water around the refinery. Some problems have been encountered and a study is in process to reinforce the bacterial filters. CFR controls itself by analysis at five points of discharge once a week. In addition, the research center of Gonfreville makes a continuous monitoring of phenol at the west and south units.

The executive arm of the prefecture is the local technical officer, head of Circonscription des Mines. He is in charge of controlling the application of the various decrees concerning water pollution. Since 1964, a system of fees (redevances) to the Agence de Bassin, has been set up for both improvement of pollution control and water quality in a given river basin, and as a receiving end for fines and penalties for polluting accidents.

More generally, since 21 February, 1962, the local prefecture has classed the refinery among "dangerous, unhealthy, or disturbing establishments" and subjected the refinery to the Ministerial Instruction of June 1953, on residual water discharge by such establishments. However, it considers that the receiver has a relatively low industrial pollution load so that the limits are not the most severe; there are two more levels of severity : (b) for important pollution load and (c) extreme pollution load or localization close to water intake, beaches, shell beds, or salmon reserves.

To calculate the annual effluent fee, the Agency considers the categories of polluting activities, the unit or quantity characterizing each polluting activity, and the specific quantity of polluting effluent allowable per unit of the former characteristic, expressed in total solid suspended and in oxidable material content. For example, a refinery is characterized by the number of people it employs and will release 3000 grams per day of suspended solids as well as 3000 grams per day of oxidable materials per employee. According to company data, the continuous annual fee paid by CFR was 20,000 francs in 1970; i.e., about $4,000 calculated with the following formula:

$$R - .62(N.T.S.)$$

N. is the maximum number of people employed

S. is the weight of waste per person, which is 3 kilograms per day

T. is the rate which depends on the type of zone and the existing pollution in the environment

Domestic water needs of 28 billion gallons per year covered for 1970, but the 1985 consumption of 48 billion gallons may oblige Le Havre and Rouen to rely on water reserves located further north, at Etretat and Yport for Le Havre, and Cailly and Andelle Valleys for Rouen.

The industrial needs have been evaluated as follows:

	1970	1985	2000
Surface Water	118	284	570
Underground Water	83	79	66
	201	363	636

There have been no salt intrusion problems as in Etang de Berre, but some potential problems. The two aquifers, located in deep gravel layers below a protective clay, show a 40% pressure fluctuation in phase with tides. The last dredging program increased the fluctuation from 40 to 70% as it gouged further into the layer of clay. The increasing concentration of industrial water drawings from the underground reserves create a real danger of spoilage caused by infiltrations of the Seine water. As a result industry has been encouraged to rely essentially on surface water.

For example, in the Lillebonne-Port Jerome area the overexploitation of the water beds increased the salinity to a point where the water has become unusuable. One plan is that in 1973 water will be pumped out of the river at Villequiers where the salinity of the sea is insignificant and be sent to Port Jerome and Le Havre by an 80 million g.p.d. pipeline.

In the Rouen area, the underground water beds are overexploited and very serious pollution from the Seine water infiltrations are registered. A series of measures will be taken to remedy this stiuation, among them drawing water from the Andelle and the Eure.

A major problem here, of course, is the pollution of the Seine. To stop the degree of pollution it is planned to alternate industrial urban areas with recreational areas that would give the river the opportunity to clean up; however, whether this approach will have the desired results remains to be seen. The Seine, in addition to being polluted by sanitary and industrial waste, suffers from thermal pollution caused by central power stations located on the river.

Commercial and even recreational fishing activity in the Le Havre area appears negligible. Fishing is specifically prohibited in the port area itself (although it does occur), and fishing vessels based in Le Havre work either in the North Sea or to the west off the coast of England.

b. Air Pollution

Electricity of France (EDF) is a major contributor to air pollution through its 2850-megawatt power plant, scheduled for expansion to 3600 megawatts. Since 1966 it has been making daily measurements and calculating average daily quantities of sulfur dioxide (SO_2) and dust content of the air. The measurements have been made since 1966 on nine locations and the first report dates from 1967. EDF is in the process of installing automatic measurement equipment to measure SO_2 every quarter hour. This equipment does not measure dust, but studies of dust sedimentation from fumes have been made by EDF.

CFR is now installing also equipment for measuring SO_2 at the request of DICA, a government authority on oil and petroleum products which asked this action through the Chambre Syndicale. This latter organization will gather the results and communicate them to DICA (Direction industrielle des Carburants). SO_2 contents are lower than or close to 90 micrograms per cubic meter of arithmetic annual average, 400 to 600 micrograms for daily maximum over 3% of the cases, and less than 50 micrograms in 60 or 70% of the cases. Dust measurement shows, in the town only (they have not yet been measured in the refinery), 50-60 micrograms per cubic meter. This pollution is still acceptable and no worse in the refinery area than in the center of town because of many other polluters, such as industrial fuel users, cement plants, the St. Gobain glass works, sulfuric acid plants, etc., in addition to EDF. The stack of EDF is 240 meters high in an effort to send the gases beyond the plateau which overlooks Le Havre. The stacks of CFR are generally limited to 50-80 meters in height.

The above numbers seem to be acceptable and the windy weather combined with the rather wet climate help in this case. However, what will happen when industrialization is fully developped is open to question and deserves planning.

Petroleum product vapors were picked up at CFR refinery by a special collector pipeline long before World War II.

There are no specific controls or specifications at all. If a new plant is built, plans that the operator may have for any air pollution control are reviewed by the government, but no specifications are imposed upon the plant. Acceptance of the new plant is purely a subjective matter, and is quite likely. An environmental group within the port management has recently been assigned to look into the question of industrial pollution control within the developed area of the port -- both air and water -- and in the expected growth of the harbor in the years ahead. Ultimately, it will define rules on what type of industry may locate, and where, and may even go so far as to specify air and water effluent criteria.

For such suggestions to have any weight, however, legislative, regulatory, and enforcement authority must at least be at the Prefect level. Without some national type of control, various prefects would then compete among themselves with less stringent environmental regulations to attract industry. It is therefore specialists' opinion that environmental control specifications must be at the national level.

c. Solid Waste

In the past, "discoloring earths" from refining operations had to be disposed of once they were loaded with 30% in weight of crude oil or oil. They were used for land fill and it was admitted that the aquifer was already salty and polluted underneath the marsh. Hydrofinishing now replaces this practice.

The acid tars coming from paraffin and oleum (concentrated sulfuric acid) treating, were burnt, then leached by rain water, and used as land fill. Treatment calls now for about 50 tons of bauxite which are loaded in the process, then recovered every two years and calcined for inerting prior to being used for land fill. Crude storage tank sludge is washed and the residues used for land fill. Catalysts are generally regenerated by the manufacturer or by CFR or sold for recovery of rare metals.

Finally, plastic packaging, which has been developed by the company to make a captive use of ethylene will probably develop into a consumer solid waste disposal problem. The city itself is commissioning a modern sewage-treatment plant, including a powerful sludge unit and estimates the cost per inhabitant at $2 per year for incineration and $3.00 per year for water treatment.

d. Visual Intrusion

CFR is careful to maintain as clean a refinery as possible and to do a good painting job. They also have a tree beautification program which has been imposed by the local town. There have recently been protests against the brilliantly lit refinery because of light intrusion during the night which prevents birds from sleeping.

e. Noise Intrusion

The CFR main water pump was quite noisy and had to be sound-proofed at great cost and pains. In the Provence southern refinery, CFR also had problems with screw compressors for catalytic cracking that had a whistling sound. Routinely they use silencers on cat-cracking equipment, and on the dryers which equip ethylene crackers.

CFR systematically designs the diameter of its torches to reduce the whistling of steam injection, sometimes used to fight black smoke.

In addition to the Concawe Organization which groups refinery capacity, CFR is setting up an information service which will also coordinate the positions of various members of the CFR group within the EEC. This service is financed 50% by the CFR and 50% by CFE, Compagnie Francaise de Petroleum, or TOTAL.

f. Fire Safety, and other Security Problems

The refinery has a good safety history. It has its own fire-fighting equipment and teams with other refineries at Port Jerome and Grand Couronne which will lend men and materials on call. The city fire department will come to help on call, but remains under the order of the refinery team. CFR has conducted training seminars for the city fire department so that mistakes made during the great Feyzin fire will be avoided. In addition, supervisors, foremen, and security operators live in a special housing district, close enough for immediate intervention.

For fire protection, the harbor has fire-fighting vessels and CFR provides fire-fighting equipment and additional protection on the shore side of the terminal. Floating booms made of wood and cork have been on hand for 30 or 40 years and have never been used. For more than 30 years, minor oil spills have been handled by pumping of the filmed water and sinking with cement.

g. Future Issues

There can be little doubt that over the short term, economics and industrial developments of the lower Seine -- as well as that portion of the river between Le Havre and Rouen -- will take precedence over protection or improvement of the environment. Since Le Havre is about the best natural port that the French have, in addition to being well situated to serve the Paris hinterland, authorities intend to expand its tanker handling capability from 200,000 dwt up to 500,000 dwt or more. This will be accomplished by deepening the existing harbor and then probably by constructing an offshore island in the Cap d'Antifer area, about 10 miles offshore in water depth of 100 feet.

Insofar as environmental considerations are concerned, the basic emphasis seems to be on keeping future residential areas "upwind" of proposed industrial concentrations and in maintaining or establishing strategically-located "greenbelts" or green areas which will serve either as recreational sites or visual screens.

Among OREAM officials and in a pressure group(B.A.N.) associated with the local press, the inherent long-term pollution dangers of substantial stimulated industrial growth along the Seine River are recognized, and it is believed that pollution abatement will have to be practiced more thoroughly than it has been in the past. However, except for the Seine itself, pollution is not yet deemed very serious by many people, and waste water treatment is too expensive especially for existing installations. Ultimately, it may be that industrial locations for the industries near Le Havre will eventually have to purify the Seine to use it for their own purposes. The water is too dirty to use at present for virtually any purpose whatsoever, but other reasonably close water supplies are not believed sufficient for expected future demand. It is somewhat ironic that OREAM foresees an eventual requirement for purification of the Seine essentially at its mouth, while upstream, where the majority of pollution presently occurs, there seems to be less pressure for cleanup.

Although perhaps not as much in evidence in the Le Havre area as in the other port regions visited, the regional planning approach -- involving not only the immediate harbor area, but the related hinterland as well -- was very much in evidence.

A.2.7 ENGINEERING CONSIDERATIONS

a. General

The President of one of the leading contenders for the construction of the offshore island discussed with us the philosophy and experience acquired with recent French port development. A first principle is that the port is a rigid structure like a ship hull. The shell of a snail is a good example of the way a rigid structure can grow and expand. This leads to a funnel concept for port planning where the dynamic development can freely move towards offshore deep water, rather than the reverse. Lavera, an oil terminal between Marseilles and Fos, is a good example of the wrong way: at the end of a 2.5-mile-long canal to the Etang de Berre, dredged to 30 feet, piers were built not from the bottom of the harbor towards the outlet but from the entrance of the harbor inward, and the first piers thus preempt future turning basins for larger vessels. The same thing happened in Le Havre, fortunately on a much larger scale and the most recent berth for 250,000 DWT tankers is more than 3000 feet from the turning basin. In a typical coastal Mediterranean port, the dike should not be parallel to the coast but at an angle with the first pier being put in the narrow part, the development moving towards the wider, deeper part of the harbor.

Similarly, wet docks are much more rigid than tidal basins, although the latter has some size limitations introduced by the current in the narrow entrance which should not be higher than 2 knots. Le Havre has been helped by its initial orientation to large transatlantic liners which had great size and windage, so it has much room in the tidal basin. However, the channel is 11 nautical miles long, and the rising tide lasts only 5 hours. Even though the flat top of the tidal curve helps for 250,000 DWT, the manoeuver becomes quite difficult to program, hence the reason for the concept of an artificial island offshore (which may now be linked to shore).

A second principle is the importance of geology in site selection. Channel deepening by natural scouring, encouraged by low dikes in estuaries, has the advantage of favoring the formation of sedimental alluvial plains between the land and the dike. The Le Havre industrial zone was thus partly naturally gained from reducing land fill requirements.

The present channel was changed to north-northwest from west to dredge recent quaternary sediments, rather than a lump of bedrock, so that geology also played an important role here. Another reason for this change in orientation was to bring large-vessel passage away from the coast which is quite residential on the south. Bedrock incidents in particular play a major role in basin and channel design. It is important to make preliminary surveys by first doing some drilling, then conducting a seismic study to look for bedrock, followed by a more systematic drilling program. Sparkers are good, but limited in depth, and electric sounding has problems in salty soils.

Due to the water movement since the last ice cap melting 15,000 years ago, the sediments normally are found down 100 feet from the water level. This search for 100-foot bottoms has led the port of Le Havre to first select the Antifer bar for an artificial island, then the Parfonds, which is more west of Le Havre and further out. During the preliminary inquiry on the basis of an island on Parfonds, CFA proposed again an island on the Antifer site which does not need offshore storage because it has shorter piping distance to the mainland. This shorter crossing distance is also very important for maintenance and service and may ultimately be bridged by a permanent causeway.

The third principle is that current is more important and critical for big ships than swell or wind. The importance of the swell becomes marginal for very big vessels, although tests may still be necessary, like those conducted for Gulf's Kuwait terminals. Wind also becomes marginal for large tankers and bulkers, but is still important for Atlantic liners (which are fast disappearing). In Le Havre, use was made of warehouses and sheds to protect them from the wind effect. This might still be useful for container ships.

On the other hand, a current of 2 knots may give a lateral lift effect of several hundred tons to a vessel approaching a quay at a slight angle with the current parallel to the quay. A one-knot current would give a 500,000 dwt tanker a lift of 200 tons. In the hook-shaped artificial island (figure A-6), a compromise has to be reached to limit current inside the protected area, but also to prevent large eddies at the tip of the island opposite the hook. The design of a perforated dyke at the hook side extremity of the quay had to be carefully optimized for that purpose. A transverse current of 1.7 knots will exert a push of 1100 tons on the same loaded 500,000 dwt.
The fourth principle is that the future is paramount, and the new harbor should not be an annex of the old established smaller harbor. As the basin of La Chaudiere in Marseilles is not an annex of the old port, similarly Fos is not an annex of Lavera or even Marseilles, despite several attempts by local municipalities to do so. In the same vein, deserted virgin sites are preferable to existing harbors, not only because of the flexibility enjoyed by the planner, but because socio-environmental problems can be minimized.

b. Rouen Channel and River

Average tidal fluctuations in Le Havre at the mouth of the Seine are 23 (Spring) to 6.5 feet (Neap), which adds 26 feet (Spring) to 18 feet (Neap) to charted depths. Tidal height declines to 10.5 feet in Rouen. Tidal action extends 20 miles beyond Rouen, but maritime navigation is practically no longer possible above Rouen. The water depth and bridges confine travel to small coasters and barges (3,000 to 4,000 tons pushed).

The present site provides close access to the Parisian basin, which produces a third of the nation's wealth. Within 100-mile radius, Rouen influences 12 million consumers, and 20 million within a 160-mile radius.

From the Seine's estuary into Rouen, ships must traverse 70 miles of winding river. The channel can accommodate 32-foot-draft ships or bulk carriers of up to 30,000 dwt. Port Jerome, which is 50 miles down river from Rouen can accommodate ships of up to 50,000 dwt. Of necessity, inbound vessels move up to Rouen with the 10-knot tidal wave. After taking a pilot (a requirement when ship length exceeds 70 meters), the vessels enter the estuary channel as soon as there is sufficient water depth to accommodate their draft. Vessels of shallow draft can proceed upriver well before high tide at Le Havre; vessels of deep draft or exceptional length enter the channel just before high tide.

River bank degradation from the wash of ships has been a problem, especially in the upper reaches of the river from La Bouille into Rouen. A 10 knot speed limit is strictly enforced in this last 19 mile stretch of river. Otherwise there is no speed limit, and vessels ride the wave to its maximum speed, and a travel time of 6 hours (11 knots average) is normal.

By 1975, radar navigational aids (two existing stations, three more planned), in conjunction with a Toran positioning system at downstream Honfleur, will be available for travel between Le Havre and Caudebecen-caux (about one-third of the way upriver). Plans also include provision of a VHF radio network, complete with emergency channels (channel 9 normal, 11 operations, 16 emergency). Existing navigational aids consist of two radar stations, 38 lighted beacons on the left bank (proceeding down river) and 38 on the right bank with an additional beacon in the inner harbor (St. Gervais Docks). There is a concentration of beacons in the mid portion of the river between Caudebec-en-caux and Dunclair where the river has severe bends.

Channel maintenance is handled by bucket ladder dredges and two 1,000 cubic meter trailing-suction dredges that use a side-arm unloader to pump dredging spoil on a land reclamation area at between Grand and Petit Couronne, the ports and industrial extension area SSE of Rouen. Silt accumulations from upstream sources average 400,000 cubic meters/year. Moreover, the dissymmetry in tidal currents brings in 73 million cubic yards/ year of fine sand (less than 1/10 mm), which are dredged at an average cost of $2 million per year. Spoils are dropped at sea in a special zone. Total silting between 1834 and 1968 is estimated at 1,050 million cubic yards (8.7 million cubic yards/year average). The incoming tide is always stronger than the outgoing, and bottom scouring is reduced accordingly. Extensive dredging at the entrance channel south of Le Havre and low dikes construction have been conducted on the basis of model tests. The Hydraulic Basin of Lower Seine has been extensively modelled to plan the above actions. First, a mathematical model of the channel from Cherbourg, Cotentin, to Calais yielded boundary conditions at the Seine estuary. Then, a physical model was made of the estuary itself. Finally, both models and more mathematical models were tested for 20-year (1962-1982) modifications with various interventions such as low dikes in the estuary, high permanent dikes, dredging, etc. A combination of dredging of the heavy "galets" (riverbed stones) which are not moved by the current, and of low dikes south of Gonfreville has resulted in a depth gain of 8.3 feet. Another system is under investigation to gain a further 6 feet and to develop new land as well as a new Avant Port for Le Havre. Channel maintenance and sidewall stability have also been much improved.

A typical profile for these low dikes are: 33-foot-wide flat summit, 6.6 feet high, with a 10:1 angle of repose.

Traffic control is conducted through on-board pilots and Port launches patrolling the river. Most vessels entering Rouen carry outbound freight, but this is limited to capacities up to 25,000 tons, since the outgoing tide is weaker than the incoming, thereby restricting the channel depth by a reduced tidal wave.

The port turning basin can handle ships up to 760 feet in length. Recently a ship of 710 feet overall utilized the basin.

c. Le Havre

Berth No. 10, for 250,000 dwt 66-foot tankers, was inaugerated in December 1970. A large part of construction cost was the strengthening of the banks by steel sheets prior to dredging the 69-foot excavation.

Four breasting dolphins, covering a 530-foot-long front, are made of steel tube piles carrying wooden shields by means of rubber dampers. The two end dolphins are designed for 300 ton meter, the central ones for 200 ton meter, i.e., a total energy of 1000 ton meter (7.2 billion ft-lb), compared to 800 ton meter for the 200,000 dwt berth No. 8. The tubes are made of special, high-yield-strength steel, allowing movement of 8 feet (end piles) and 6.6 feet (central dolphins).

Nine mooring bollards with a rupture strength of at least 300 tons (nominal strength, 125 tons) are equipped with automatic release hooks. A 340 x 230 foot platform is made of a reinforced concrete slab, with 52 tube piles (steel, 2.5 feet O.D.) and may carry a 30-ton load (in fact, it carries a 20-ton crane with four supports).

Four articulated arms, carrying a 16" and a 40" pipeline connect a ship to the tankfarm. Unloading may proceed at 2.25 to 3.0 million barrels per day. Some 18 new tanks have been added to the tankfarm, each with 530,000 barrel capacity. Retention dikes walls are made with sheet piling, covered with lightly reinforced gunite.

d. Lessons & Problems

- The first container terminal, with 400-foot depth was insufficient. The terminal planned in the new tidal basin will have a depth of 1000 feet before the unloading shed and loading racks, 200 feet overall.

- The turning basin (calculated by 2 x L) seems a bit uncomfortable, and 2.5 x the length of the design vessel should be the norm.

- Locks are inflexible and should be built as big as possible. The new lock system was planned with three parallel locks. The intermediate size was tendered at 150-foot width and 40-foot depth, and estimated at $24 million for a 1200-foot length between gates. The price came to $34 million when the width was increased to 172 feet. Works were started, and the excavation completed, when "a gut feeling" led the port engineers to make the lock the largest possible: 221-feet wide, 48-feet deep, and 1325-feet long, which will be welcome for the new generation of containerships which can now enter two at a time.

- Landfill operations have been delayed, because the building of the dike and the dredging of the tidal basin providing hydraulic fill were handled by two different contractors

- There is time-acceleration, and major changes occur now every 15-20 years rather than every half-century in a port's life. Besides the offshore island, Le Havre is dreaming of a new dike in the estuary, to create a bigger outer harbor and double the land to 50,000 acres and more.

e. Le Havre-Antifer Oil Terminal Project

The French do represent a major threat to the dominance of Rotterdam as Europe's major oil port. Not even mentioning Dunkirk's ambitions, the pipeline connections from Le Havre to Paris and then to northeastern France and into Germany could attract an increasing amount of oil. It is for the handling of tankers and the storage of oil where the biggest developments are taking place in Le Havre. Presently, the harbor is capable of taking 250,000 dwt tankers at any tide and up to 300,000 dwt tankers in some high tides. Tenders are expected in August 1971, for a 500,000 dwt terminal (Figure A-6).

f. Design Vessel in Antifer Project

Preliminary research has shown that a loaded 500,000* dwt tanker has stopping distances of 6000-meters (20,000 feet) at 16 knots (6 x length at 8 knots, 1.5 x length at 4 knots), in 23 minutes (15 minutes and 5 minutes). Tokyo

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* 500,000 dwt, 1325-foot LBP, 1370 feet overall, 211-foot beam, 92.5 foot draft 104-foot depth.

Maru", 150,000 dwt, had a 14,000 ft. stopping distance at 16 knots, and 2,000 ft. stopping distance at 4 knots. Motor ships, generally slower and with more power aft, have shorter stopping distances. Lateral movement reaches 10,000 ft. at 16 knots, 5,000 ft. at 8 knots, 660 feet at 4 knots for the 500,000 dwt ship. Turning diameter is 4,000 ft. in deep water, 8,000 feet in shallow water.

A 3-knot current exerts a 4000-ton action on the ship when perpendicular, a 50-knot crosswind exerts 300 tons on a ballasted ship and 120 tons on a loaded ship. Squat is negligible at 5 knots in restricted channels, and is about 2 feet at 8 knots for a ratio depth/draft of 1.10 and a channel width of 250 meters (830'). A 15-second, 33-foot high swell would give 2 feet additional draft on roll and 3.3 feet additional draft on pitch. A 15% safety margin appears necessary at 5 knots with a 15-second swell, 16.5 feet high; but 10% would be sufficient in a 12-second, 11.5-foot-high swell. In addition, extensive testing with the 213,000 dwt tanker "Magdala" showed that bottom effect is negligible for a ratio 1.3. Finally, a margin of 10% is believed sufficient; channel width must be equal to ship length in straight channels; stopping distance is below 3 lengths at 5 knots but 3.5-to-4 x Length appears preferable with a 1/2 x Length for distance of lateral movement. At 5 to 7 knots, turning diameter is about 5-to-10 x length. Turning basins could be 1-1/2 x length, but should be 2 or even 2.5 x length.

Tugs are not effective, and even dangerous unless the ship has reduced speed to below 3 knots. Securing the hawser takes about 20 minutes, with the ship having progressed 1 mile. Bollard pulls are 35 tons and pushing may reach 40-45 tons. Swells beyond 2-2.5 meters (6.6 to 8 feet) or winds beyond 40 knots render such assistance difficult.

<u>g. Technical Alternatives in Antifer Project (figure A-6)</u>

Antifer has finally been preferred to the Parfond site for the following reasons:

- 100-foot depths are only six miles from the coast, so that the tankfarm may be onshore.

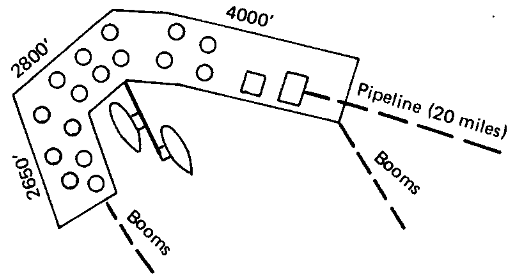
- Currents and swell directions are more favorably combined at Antifer. Currents are stronger, but in a well-defined direction.
- Antifer has more room for maneuvering, is away from recreational beaches
- Antifer is much cheaper than Parfond
- A sand strata, perpendicular to the coast at Antifer, allows consideration of a deep port at the coast.

The alternatives considered then were:

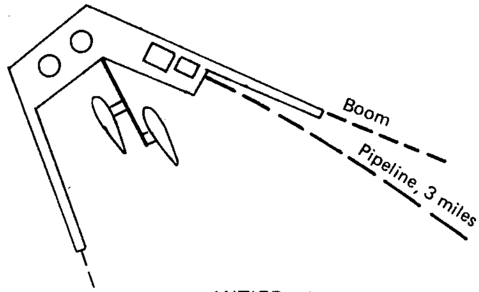
- Protected offshore dike -- straight E-W dike, 5000-feet long in Phase I; then 8000 feet (two berths), etc. with a protective west dike, which in later phases (five berths) constitutes the bottom of a bag open to the east. The west dike may be perforated to reduce eddy currents at the eastern end of the north dike.
- Coastal port which unfortunately must open to the NW -- which is the direction of maximum swells and requires an inner port, with a 3300-foot turning basin, and four 500,000 dwt berths. A construction in two phases has been studied.
- One (then two) SPM, single-point mooring buoys, 50 feet in diameter with 24" and 30" hoses. No optimization of port or island location versus the coast (to balance pipeline and pumping costs versus investment and dredging).

FIGURE A–6 500,000 DWT TERMINAL ALTERNATIVES

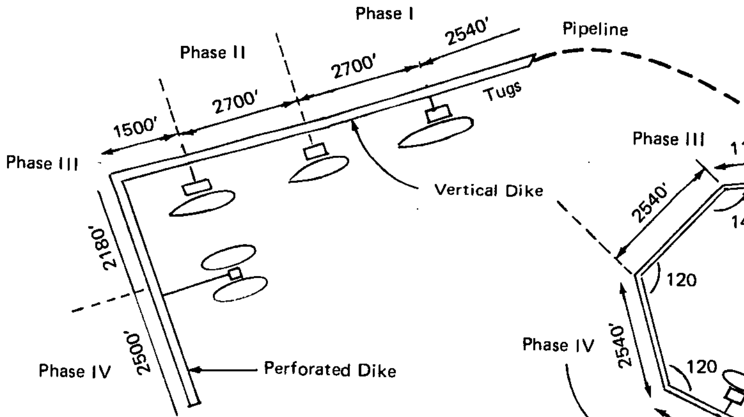
A. OFFSHORE ISLANDS



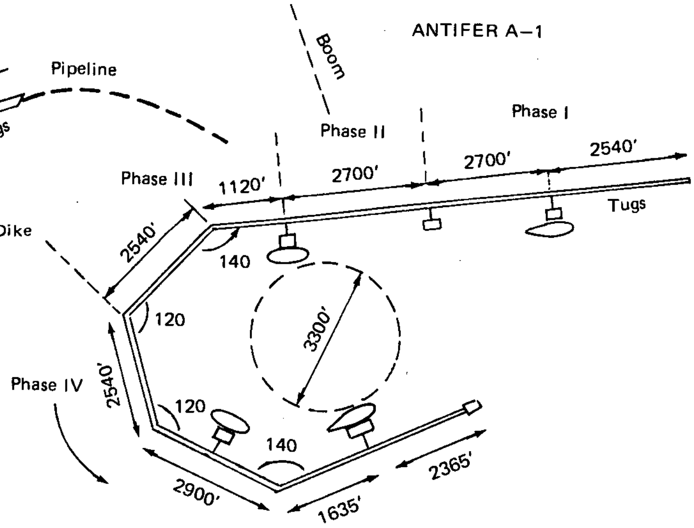
PARFONDS



ANTIFER A–1

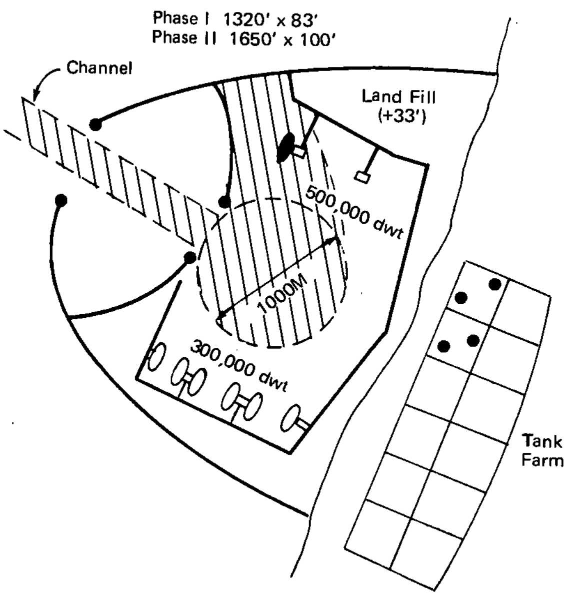


ANTIFER A–2

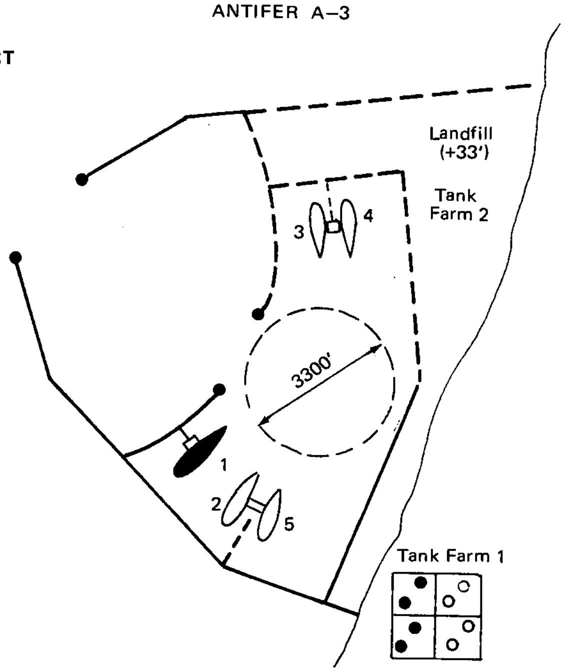


ANTIFER A–3

B. COASTAL PORT



ANTIFER B–1



ANTIFER B–2 { Phase I ——— ; Phase II - - - -

APPENDIX B

ANTWERP

APPENDIX B

ANTWERP

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ANTWERP

B.1 SUMMARY

Based on our field interviews, surveys of the Antwerp port area, and reviews of appropriate documents, we have extracted the following highlights of Antwerp's port experience.

- Antwerp, located 45 miles south of Rotterdam, is the third largest port in the world; in Europe, it is second in size only to Rotterdam (which also serves the Northern European Delta Region). A long and difficult approach of 58 miles up the Scheldt estuary, mostly in Netherlands territory, and considerable distance from the Rhine put Antwerp at a decisive disadvantage as a bulk port in the era of large vessels.

- For these reasons, Antwerp does not plan to develop deepwater facilities (the port will be deepened to take 125,000 dwt, deemed sufficient for ore, vs. 80,000 presently), but will concentrate on expanding the trade value of the port, improving its general cargo-handling function, and expanding its process-oriented industry, while connecting through pipelines to the deepwater oil ports of Rotterdam and Le Havre.

- The Antwerp port represents a major asset to Belgium and is, therefore, of national interest. Perhaps as much as half of the nation's economic activity takes place in the greater Antwerp area. Similarly, some 50% of all economic activities in Belgium are linked to international trade. Approximately 70,000 out of 210,000 workers, or one-third of the people employed in the Antwerp area, are working in port-related activities. This figure does not include the indirect or tertiary employment accounted for by banks, insurance companies, and others who benefit from port-related activities. The main reason for seeking expansion of the port lies with the need (or desire) to promote greater industrialization of the Antwerp region and to provide port facilities that will take advantage of somewhat larger ships.

- Antwerp rose to its present position as the world's third largest port (in tonnage handled) as a result of a rigorous ten-year plan, which began in the mid-1950's and greatly expanded the dock basins, and improved access to the port. The plan included two large new locks, a huge basin and industrialization of the right (east) bank of the Scheldt River. After completion of the ten-year plan, there was a slowdown in port expansion activities between the years 1966 and 1969. However, a new round of port expansion programs is now being initiated.

- The increasing size of vessels and industrial land shortages have forced Antwerp to consider another port deepening and expansion project. Improvements will include extensive dredging of the Scheldt to allow 125,000 dwt access to the docks. Although this plan is complicated, because much of the access lies through Dutch territory, success in current negotiations should allow Antwerp to make the necessary modifications of the Scheldt River. This will also allow cutting the Baalhoek Canal through Dutch territory, which will eliminate the narrow, low-radius Bend of Bath in the river, despite ecological problems caused by cutting through marshlands. A major secondary project is the improvement of the distribution function of the port when the Albert Canal, (which links Antwerp with the Belgian and German interior), has been fully adapted to the use of push-barges, and better connected to the new industrial areas planned for the right and left banks.

- Antwerp's main assets seem to be:
  1) Excellent communications to the interior;
  2) Strong national and local support, including exports for backhaul opportunities; and
  3) Excellent docker-labor situation and efficiency.

  A municipal port (38 townships, 600,000 people), Antwerp receives state grants for infrastructure and channel maintenance. Cargo handling and terminals are now in the hands of private companies. Industrial investment incentives include equity from a national development corporation, training, selection and relocation subsidies. The acquired acreage on the left bank for the new port/industrial expansion is known to be excessive and beyond present needs, and the Port Authority is prepared to initially utilize less land than that plotted for port use. This is a planning measure that will permit future expansion without requiring further legal proceedings to extend port acreage when needed.

- Antwerp has spent significant time, on the subject of land-use planning related to port development. On the other hand, authorities to date appear to have been only moderately concerned with respect to pollution abatement or prevention efforts, in action-oriented programs. Maintaining Antwerp's industrial and economic position within the nation and, indeed, with the European Common Market, is by far the most important consideration. A local spokesman has said, "The effective concern regarding environmental quality can occur only in a rich and polluted society; we haven't been rich quite long enough."

- From an anti-pollution planning standpoint, the most important of the Antwerp commissions is The Center for Prevention of Air and Water Pollution, a municipal organization created in 1968. The Center has three principal tasks: 1) to advise the town regarding air and water pollution abatement procedures to be followed both by the city and industry; 2) to assist in controlling air and water pollution and solid waste pollution; and 3) to sponsor and recommend research programs appropriate to the city's needs. A fourth function which the Center performs is to advise the municipal council as to whether--and under what conditions--applications by industrial firms to build new plant facilities should be approved.

- When the planned development of the left bank of the Scheldt River begins to take place, it is expected that the Center will be considerably more stringent in its pollution abatement requirements concerning new industry that locates on the left bank. (This expectation stems not only from a basic concern over pollution control, but also from officials' belief that the Antwerp Port is in a position to be more selective in identifying and attracting those industries which it wishes to have locate in the Antwerp area.)

- As yet, there are no waste-water-effluent taxes levied in Belgium, although Center officials believe that these may be instituted some time in the not-too-distant future and bear some similarity to those already in effect in France.

- Waste water treatment plants are now being built by most new industrial complexes, and discharges are made into the Scheldt River, synchronized with the outgoing tide. Some harmful products, such as acid, may have to be taken out to sea. Antwerp's municipal sewage treatment capacity is inadequate, as is that of virtually all of the country; only 5% of Belgium's sewage is treated.

- Relocation, because of port development, entails hardship, but is better than subsisting in an industrializing zone. There should be less hardship, with much more planning and individual help, and with replacement housing started <u>early</u> in similar environment. As Antwerp continues to modernize, older, less efficient harbor-related activities will have to either be rebuilt or replaced by some other type of activity. To date, "urban renewal" constitutes only a tiny fraction of the district's planning efforts.

- The bulk-oil-storage-tank failure experienced in Antwerp clearly indicates that piled-earth retaining dikes may be capable of retaining gradually spilled materials, but that all retaining dikes should be evaluated structurally for adequate resistance to dynamic, shock loading of spilled material.

B.2 BACKGROUND

B.2.1 Geography

The city of Antwerp, and its associated port, is located on the upper portion of the Scheldt River estuary in the center of a vast alluvial plain about 55 miles from the North Sea. Most of this distance is in Dutch territory. Though centuries old, the port began its growth after 1863 when Dutch rights to levy toll on the Scheldt were redeemed by purchase.

The land around Antwerp itself, as well as that extending to the North Sea, is alluvial in character, flat, sandy, and essentially featureless. A thick layer of unconsolidated sand lies over thick clay. Much of the area is polder land, and there are no known fresh water aquifers in the region which might be damaged by harbor activities. Fresh water requirements are obtained from inland sources.

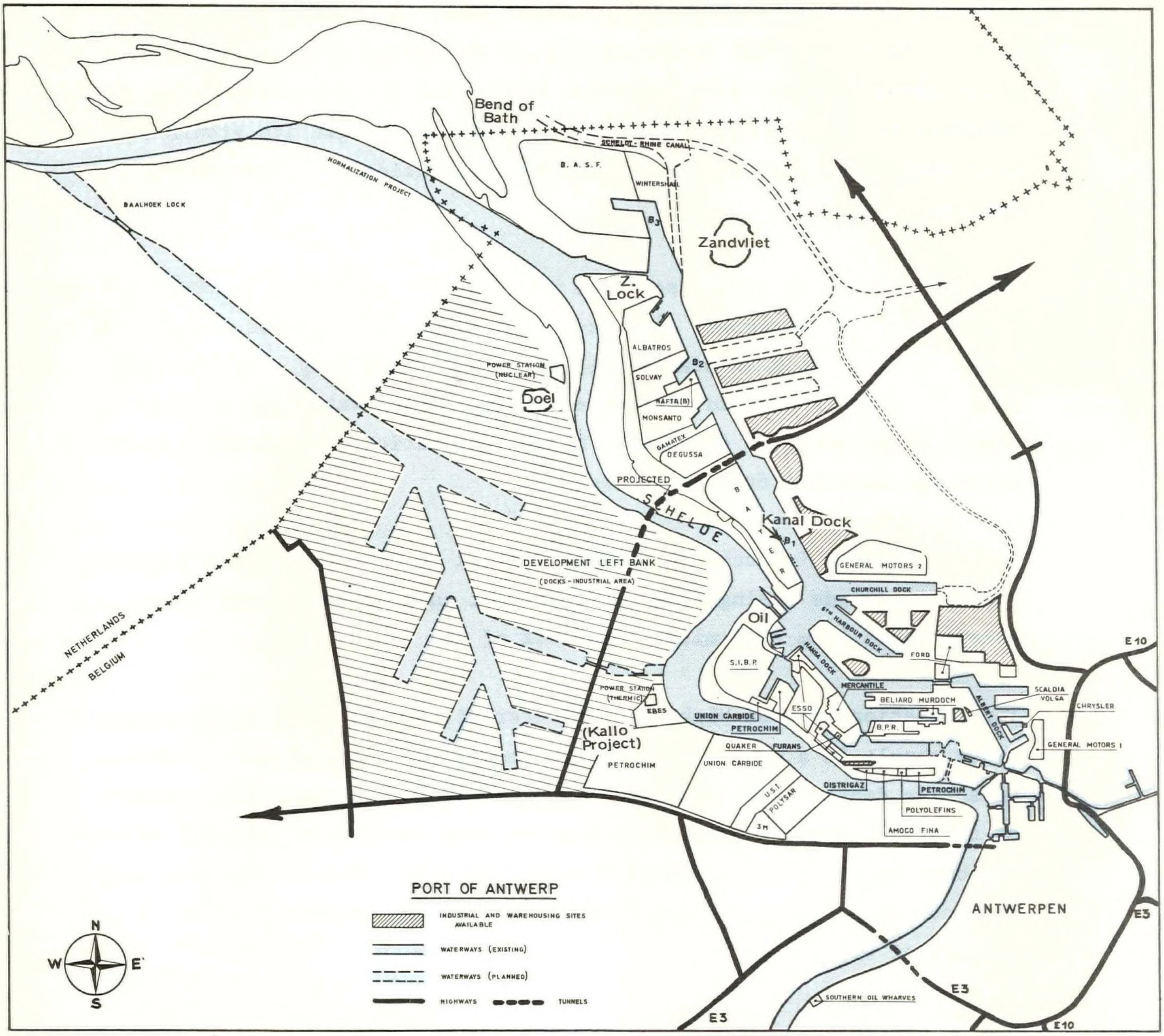
Antwerp climate is much the same as Dunkirk — somewhat wet with strong prevailing winds coming from the southwest quadrant. Visibility is greater than 4 km (2.5 miles) over 80% of the time.

The variation between high and low water at Antwerp is 13 feet; spring tides result in a rise and fall of an additional 3 feet, for a maximum effective depth in the channel of approximately 42 feet. The strength of the river current is insufficient to keep the natural channel clean, and considerable sand is brought in by the tide. Maintenance dredging is a continual large-scale operation to keep the channel depth at a minimum of 42 feet.

B.2.2 General Land Use

As would be expected, the greatest concentration of heavy industrial activity is at the new Kanaaldok basin opened along the right (east) bank in 1967 (Figure B-1). The heaviest population concentration is within the city of Antwerp itself, south and upstream on the same right

FIGURE B–1 ANTWERP HARBOR AND DEVELOPMENTS



bank of the Scheldt, and indeed it is here that the bulk of all commercial activity is also carried on. Around greater Antwerp, which includes up to 38 municipalities, polder farming is the principal activity. These farms are usually quite small by U.S. standards, ranging in size between 20 and 50 hectares (50 to 125 acres).

There appears to be relatively little open land on the right bank near Antwerp, other than a few strips along the Scheldt River, which can be used for conservation purposes. On the other hand, within a distance of about 15 miles northeast of the center of Antwerp, near the town of Kappellen, wild deer are still seen in partially forested or cultivated residential areas.

B.2.3 Demography

Over the years, Antwerp has grown in areal extent by incorporating neighboring villages; since 1959, the city's boundaries have been increased to extend the administrative area from 24 square miles (21,470 acres) to 54 square miles (34,600 acres) with a population of some 600,000 people, for an average population density of 11,000 per square mile. For comparative purposes, Baltimore, Maryland has a 1970 population density of 11,400 per square mile, and Philadelphia, Pennsylvania, had a population density of 14,600 per square mile in 1970.

B.2.4 Port Basin

The port now extends over 12,500 acres, with industrial plants occupying 6,200 acres. Extensive plans are under way to extend port operations over to the left bank of the Scheldt River. The new Kanaaldok basin system has an average depth of 55 feet, and the entrance lock a depth of 44 feet. A partially loaded 90,000 dwt tanker with a fully loaded draft of 42'6", is the largest vessel ever to enter the harbor. Effective tonnage which can be accommodated by the port is about 60,000-70,000 dwt or 80,000 dwt special design.

The proposed new harbor facility on the left (west) bank of the Scheldt, called the Baalhoek Canal, should be able to handle vessels up to 125,000 dwt, depending upon configuration, and will probably be the final depth for the Antwerp port. To utilize this capacity however, the Scheldt itself will have to be deepened at considerable cost, both initially and on an annual maintenance basis.

Antwerp is connected to the Meuse by the Albert Canal and benefits from considerable French and German traffic as the port has closer communications to the industrial areas of Eastern France and Southern Germany than any other Channel or North Sea port.

B.3 INSTITUTIONS AND FINANCING

B.3.1 Institutional Authority

Because of Antwerp's importance to the Belgian economy, basic policy decisions relating to its development and expansion rest with the Ministry of Public Works at the national level, which serves to combine the functions held by the U.S. Army Corps of Engineers and the Department of Transportation. Federal appropriations for port development activities are secured through the legislature on the recommendation of the Public Works Minister. Historically, decisions regarding what was to be done with the port were based primarily on economic, engineering, and political considerations, and environmental matters played a relatively small part. Recently, however, environmental concern, particularly with respect to land use and air pollution, have begun to play a more important role, and accordingly have involved the Ministry of Public Health.

On the regional level, authority rests with the Provincial Government, whose principal responsibility is to assure reasonable consideration of the needs of the people within the province in terms of such factors as job opportunities, public health, transportation, and the like. With respect to environmental matters, the Provincial Government ultimately approves or disapproves applications by industrial or commercial firms to erect and operate manufacturing facilities on public lands.

On a local level, illustrated by Figure B-2, the highest authority is the City Council, consisting of 54 representatives elected by the population for a period of six years. At the present time, the City Council represents some 38 separate municipalities within "Greater Antwerp." The number of members of the City Council is fixed by law according to the number of inhabitants. The Burgomaster, or head of the Council, is appointed by the King on the proposal of the City Council.

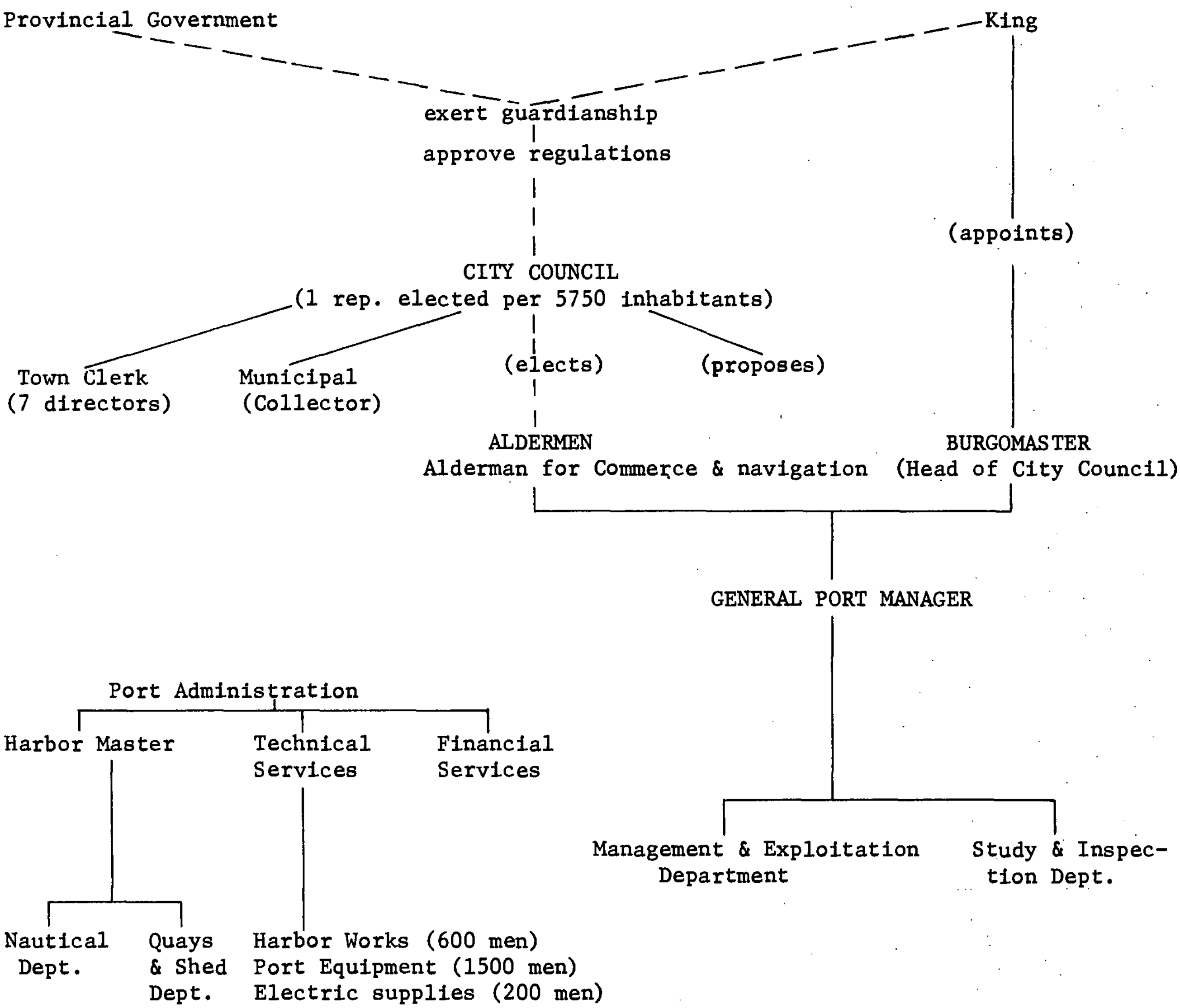
The city of Antwerp owns the dock, the port area, and the port equipment, and the city expands its boundaries to suit port expansion. Direct daily administration of the port is headed by a General Manager, who controls the activities of the approximate 2,300 administrative and technical staff personnel. It is primarily through the City Council and its various commissions and aldermen (including a new alderman for environment) that the final details of port development and operation are worked out.

B.3.2 Development Financing

Since World War II, the state has financed practically 100% of basins, locks, and quays, and granted them to the city, particularly the 2,000 hectares (5,000 acres) extension on the right bank (Kanaaldok) which was voted in 1956. Land fill is done by the city, the state, or private interests depending on the case. Private industry will finance site preparation and handling equipment (formerly fitted by city) against 15-to-40 year site leases which thus far have been renewable without problems. Two major exceptions to the practice of land rental are Bayer and BASF (Badische Anilin Sodawerke Fabriek) which were the first two companies in the new Kanaldok development and which insisted on purchasing their land.

A major group of beneficiaries appear to be the citizens, as a 22% unemployment ratio in 1955 has evolved into a tight labor market. The state also receives a 7% transfer tax for each transfer of property and volume of cargo trading. Manufacturing industries have earned about

FIGURE B-2 ANTWERP: PORT AND CITY GOVERNMENT



three times the 10 billion Belgium Francs (BF) invested. Finally, the nation has kept export traffic which might have been lost.

Officials at Antwerp believe that their port receives the least financial aid of any other major European port. They also believe that they are handicapped by the following factors:

- Interest on and repayments of loan capital are charged to revenue;
- Losses are carried forward, bear interest, and must be made good;
- The port has to bear the cost of police, fire brigade, and street maintenance in the port area; and
- The port has to pay for the building and operation of locks.

But, we believe the above factors are overshadowed by the following financial advantages which Antwerp has:

- The central government paid for $140 million worth of fixed assets, for which the Port of Antwerp has neither to pay interest nor to charge depreciation; and
- The central government pays for dredging in the river.

B.3.3 Post-World War II Development

Within a radius of 300 km (180 miles) from Antwerp, there are about 100 million inhabitants and one of the most dense industrial concentrations in the world. Since 1870, the port traffic has increased on an average of 44% per decade. The last ten years has seen the greatest expansion in port activities, and since 1960 goods traffic has increased by 90% in volume to make Antwerp the world's third largest port.

Before World War II, the port operated largely as a commercial and traffic center. Since the War, the demand for petroleum and chemical products has resulted in a rapid growth of industrial complexes, which in turn greatly stimulated port operations.

Major dates and events in the Port of Antwerp's expansion are as follows:

- 1955 -- an investment law providing for a Development Plan involving government appropriations to the amount of $100 million during the period 1956-1966;
- 1960 -- opening of the Fifth Harbor Dock and connected Industrial Basin;
- 1962 -- opening of the dock for oil tankers;
- 1964 -- opening of 6th Harbor Dock;
- 1967 -- opening of the Canal Dock, the Zandvliet Lock and the Churchill Dock (Kanaaldok basin system);
- 1969 -- opening of Scheldt tunnel and circular speedway Europe-3 (Route E-3); and
- 1971 -- planned port expansion to the Left Bank.

The 1956-1966 development of the Port of Antwerp was essentially designed to implement regional industrial development goals.

The Ministry of Public Works has spent over $200 million since 1956 implementing the Antwerp Port plan. About $70 million of this was for expanding waterways, such as dredging the waterways of the Scheldt basin. Little money as yet has been allocated for the development of the left bank -- the big problem is that it is partly in Dutch territory. The Dutch are, of course, not particularly interested in furthering Antwerp's competitive stature without receiving some type of compensation.

B.4 ECONOMIC FUNCTION OF THE PORT

The attraction of the Antwerp Port makes itself felt far beyond the frontier of the Belgian-Luxembourg Economic Union. As a matter of fact, it extends into the populous parts of West and Central Europe, which are part of one of the most intensely industrialized regions of the world. Antwerp owes its original attraction to a favorable geographical position in relation to the industries of Western Europe. The development of Western European industry meant a parallel development of Antwerp as the most important port for exports of industrial products (in terms of value) on the European continent. The volume of goods handled in the Port of Antwerp has been doubling every 10 years since World War II. This is due to several factors, some of which are favorable geographical location, excellent road, rail, and canal links with the interior, close cooperation of the port authority with the firms using the port, a good business climate, and strong national support.

This dominant position as a port for general cargo exerted strong attraction on the world's merchant fleet. Antwerp has become the main liner port of the continent, with approximately 300 regular shipping lines. There has also been increasing growth in container and roll-on/roll-off traffic. The automobile industry inside the port area is well established; GM's Antwerp plant (established in the early 1920's) is producing 230,000 automobiles annually, while the nearby Ford plant produces 30,000 agricultural tractors each year.

Bulk cargoes--petroleum, ores, grains, coal, phosphate, and chemicals--increased from 22 million tons in 1960 to over 52 million tons in 1969. Petroleum refineries in the port's industrial zone develop an annual output of refined products that represents the single most important import, which presently amount to 24.5 million tons. General cargo handled has increased from 15 million tons in 1960 to over 20 million tons in 1969, of which approximately 14 million tons were for export.

B.4.1 Sea-Borne Traffic

In 1969, a total volume of 73 million tons was handled, as against 21.5 million tons in 1950. This growth is due to a continuous increase of inward traffic, which (in 1969) amounted to about 48.9 million tons (versus 10.6 million tons in 1950). The outward traffic, on the other hand, has tripled since 1950, and presently amounts to 24.1 million tons. The ever-growing demand by the continental industries for raw materials, and the growth of sea-going trade, are the main forces underlying this evolution.

B.4.2 National Traffic

The importance of a port as a link between inland traffic and sea traffic depends mainly on the economic and geographic structure of its hinterland. Thus, the economic interdependence between Antwerp and its national interior -- in fact, the territory of the B.L.E.U. (Belgian/Luxembourg Economic Union) -- is of basic importance. This interdependence rests upon two main factors:

- If the standard of living of the Belgian population is to be maintained, very great quantities of raw materials have to be imported from overseas (namely, oil, ores, coal, cereals), and at the same time, exports to overseas markets are indispensable, since trade must be in rough balance; and

- It is of vital importance for a world port to have national traffic, which guarantees that port equipment will attain maximum efficiency.

In these two factors, one finds a remarkable correlation between the increase in Belgian economic activity and the increase in port traffic at Antwerp. In recent years, national traffic (imports and exports) reached up to 54 million tons. This means that 90% of the total overseas trade of the B.L.E.U. is handled by Antwerp. It is this national traffic, and its relative stability, that has attracted foreign shipowners, who are particularly interested in general return cargo.

B.4.3 Main Commodities

With the growth of West European industry, the port of Antwerp has gradually become the most important general cargo port of the continent. The share of general cargo varies between 65% and 70% of total outgoing tonnage. In 1969, overseas general cargo traffic approximated 20.6 million tons (see Table B-1). Although Antwerp is a typical general cargo port, transshipment of bulk cargoes is very important, especially for incoming commodities.

a. Import Traffic

Mineral oil, ores and phosphates, chemicals, cereals, and coal are (when measured in volume) the most important of the goods brought to Antwerp (see Table B-2). Certain traffic patterns underwent striking evolution in the course of the postwar period. For instance, incoming petroleum has increased threefold since 1960; Antwerp has evolved as a center of refineries and petrochemicals, the ever-increasing demand of the hinterland was 24.5 million tons in 1969. The growth of ore traffic is mainly a structural phenomenon and a direct consequence of increased steel production (1969: 14.3 million tons). Other important products are chemicals, fruit, fertilizers, grain and coal; but quantities are much smaller.

b. Export Traffic

The greatest share of the outward traffic is in iron and steel products. Though B.L.E.U. products of heavy industry are the basis of this traffic, an important part also comes from France and West Germany. The large number of sailings and the specialized handling facilities attract steel forwarders of neighboring countries. This traffic, which regularly reaches between 6 and 8 million tons per year, makes up 25 % to 35% of total outgoing traffic and much of it goes to The Great Lakes on backhaul with coal or ore carriers. Other important outgoing commodities are fertilizers, mineral oils, and chemicals (see Table B-3).

B.4.4 Traffic By Barge

Every year, some 60,000 barges enter the port. In 1969, they aggregated 35 million tons (Table B-4). Since 1960 this barge tonnage has increased by 60%. About 60% of barges entering Antwerp are Belgian registered, the remaining 40% are Dutch, Swiss, French, or German.

TABLE B-1

ANTWERP TOTAL COMMODITY TRAFFIC
(Millions of tons)

	1960	1965	Annual Growth Rate 1960 - 1965	1969	Annual Growth Rate 1965 - 1969
Bulk	22.1	40.6	12.9%	52.4	6.6%
General Cargo	15.4	18.8	4.1	20.6	2.3
Total Exports & Imports	37.5	59.4	9.6	73.0	5.3
MAJOR COMMODITIES:					
CEREALS	2.2	3.2	7.8	1.5	-17.3
WOOD	0.6	0.6	N.C.	0.5	- 9.6
COAL	1.4	2.0	7.4	1.3	- 8.2
RUBBER	-	0.1	-	0.1	N.C.
ORES	5.1	10.3	15.3	13.4	6.8
IRON & STEEL	6.7	8.1	3.9	7.7	- 1.3
NON FERROUS	0.6	0.7	3.0	0.7	N.C.
METALWARE	-	0.4	-	0.4	N.C.
MACHINERY	-	0.9	-	1.0	2.7
TRANSPORTATION EQUIPMENT	-	0.6	-	0.5	- 4.45
PETROLEUM	8.5	19.6	18.2	28.0	9.3
CHEMICALS	0.8	1.7	16.3	10.3	55.0
FERTILIZERS	2.8	2.6	-1.5	3.7	9.2
PULP & PAPER	-	0.3	-	0.3	N.C.
CEMENT	-	0.4	-	0.3	- 6.9

N.C. = No Change

TABLE B-2

ANTWERP IMPORT COMMODITY TRAFFIC
(Millions of tons)

	1960	1965	Annual Growth Rate 1960 - 1965	1969	Annual Growth Rate 1965 - 1969
Bulk	17.1	34.7	15.2%	42.4	5.1%
General Cargo	4.9	5.6	2.7	6.5	3.8
Total Imports	22.0	40.3	12.9	48.9	5.0
MAJOR COMMODITIES:					
CEREALS	2.1	2.7	5.15	1.3	-16.7
WOOD	0.6	0.6	N.C.	0.3	-15.9
COAL	0.6	1.9	26.0	1.2	-10.9
RUBBER	-	0.1	-	0.1	N.C.
ORES	5.1	10.2	14.9	13.4	7.1
IRON & STEEL	0.4	0.3	-5.6	0.9	32.0
NON FERROUS	0.4	0.5	4.6	0.5	N.C.
METALWARE	-	-	-	0.1	-
MACHINERY	-	0.4	-	0.4	N.C.
TRANSPORTATION EQUIPMENT	-	0.3	-	0.2	-9.6
PETROLEUM	8.1	18.5	18.0	24.5	7.3
CHEMICALS	-	0.5	-	8.0	100.0
FERTILIZERS	0.5	0.7	7.0	1.4	19.0
PULP & PAPER	-	0.3	-	0.3	N.C.
CEMENT	-	-	-	-	-

N.C. = No Change

TABLE B-3

ANTWERP EXPORT COMMODITY TRAFFIC
(Millions of tons)

	1960	1965	Annual Growth Rate 1960 - 1965	1969	Annual Growth Rate 1965 - 1969
Bulk	5.0	6.0	3.7%	10.0	13.6%
General Cargo	10.5	13.1	4.5	14.1	1.9
Total Exports	15.5	19.1	4.3	24.1	6.0
MAJOR COMMODITIES:					
CEREALS	0.1	0.5	38.0	0.3	-12.0
WOOD	-	-	-	0.1	-
COAL	0.7	0.1	-32.0	-	-
RUBBER	-	-	-	0.1	-
ORES	-	-	-	-	-
IRON & STEEL	6.2	7.8	4.7	6.9	-3.0
NON FERROUS	0.2	0.3	8.5	0.3	N.C.
METALWARE	-	0.3	-	0.4	7.5
MACHINERY	-	0.5	-	0.7	8.8
TRANSPORTATION EQUIPMENT	-	0.3	-	0.4	7.5
PETROLEUM	0.5	1.1	17.1	3.5	33.5
CHEMICALS	0.8	1.3	10.2	2.3	15.3
FERTILIZERS	2.3	1.9	-3.7	2.3	4.9
PULP & PAPER	-	-	-	-	-
CEMENT	0.4	0.4	N.C.	0.3	-6.9

N.C. = No Change

TABLE B-4

TOTAL GOODS TRAFFIC BY BARGE
(million tons)

Year	Unloading	Loadings	Total
1960	11.1	13.7	24.8
1965	12.6	23.9	36.5
1969	14.3	20.9	35.3

Canal transportation networks towards Liege (Albert Canal), Brussels-Charleroi (Rupel River and maritime Canal) and France (Meuse, Marne to Rhine Canal, Sambre, Escaut, and Lys) are in most instances old and a number of the canals are in very critical condition.

B.4.5 Railway Traffic

Antwerp has evolved into a major railway port because of its inland location, its growing importance as a loading port for finished and semi-finished products of West-European industry, and the density and continuous modernization of the Belgian railway network. The development of railway traffic has increased 100% since 1960, to over 17 million tons, of which national traffic accounts for 80%.

TABLE B-5

TOTAL GOODS TRAFFIC BY RAIL
(million tons)

Year	Unloading	Loading	Total
1960	4.8	4.0	8.8
1965	5.3	8.7	14.0
1969	5.0	12.8	17.8

B.4.6 Highway Traffic

Road traffic has taken an ever-increasing part of inland transport in the national hinterland over the distances for which trucking is more competitive (up to 185 miles) than traffic by rail or barge. Since 1960, tonnage of transit traffic moving by road has increased from 348,000 tons to 1,540,000 tons.

TABLE B-6

TOTAL TRANSIT TRAFFIC BY ROAD
(tons)

Year	Unloading	Loading	Total
1960	201,000	147,000	348,000
1965	382,000	323,000	705,000
1969	789,000	751,000	1,540,000

B.4.7 Container Traffic

Besides traditional port traffic, modern methods of integrated transport (roll-on/roll-off containers and unit loads) are developing rapidly. In 1969, container traffic amounted to 650,000 tons. It is mainly the traffic with North America which is being containerized; in 1969 this traffic accounted for 69% of total container shipments.

Today, container ships represent a heavy investment, and the cost of operation increases with transportation distances. However, land modes are even more expensive. Antwerp is in a favorable location compared to other harbors, because it is located closer to the interior. However, it is possible that Antwerp could lose this competitive advantage, because eventually the largest vessels will not fit the Scheldt River, and the long, fixed delay to reach the Churchill Basin (through the long river channel and locks) will not be acceptable to shippers.

B.4.8 Transfer Function vs. Industrialization

Historically, Antwerp has provided a transfer function by receiving and dispatching commodities between hinterland and foreland areas. After World War II, world trade expanded dramatically under free trade policies fostered by the West. With the increasing importance of world trade, heavy industry began to settle in port areas to achieve maximum economies in transportation. The increasing influx of heavy manufacturing facilities to the port area has resulted in industrialization requirements, (land, labor, infrastructure, etc.), of a higher priority than the traditional transfer function provided for the hinterland. Some observers believe that the port authorities of Antwerp and Rotterdam have allowed inland transportation links and services to erode through over-concentration on port industrialization.

B.4.9 Antwerp Dock Workers

The Antwerp docks have not faced the same labor shortages as other European ports. Special respect is given to the Antwerp dock worker, who is treated as a major craftsman. Jobs are handed down from father to son, and a statue honoring the dock worker is on the principal city square. The unions work closely with management in all-important port decisions, and upper management often appears at the docks. Consequently, Antwerp has the advantage of having sufficient, highly-trained dock workers at hand. These men run the port on a 24-hour basis, throughout the week, and on Sundays and holidays, when required. Productivity premiums have not been found necessary, and might even be harmful.

The dock workers' salary status is regulated by collective agreement between workers' and employers' delegates. In 1928, when the first collective agreements were reached, the basic salary was fixed so that four days of work would insure a weekly living minimum. In 1946, a special indemnity was introduced for the days on involuntary unemployment. This special indemnity consists of assistance money in case of unemployment (just as for other workers in Belgium), plus a special contribution from port employers. By contrast, French longshoremen have just obtained some form of income security, but it will take about a generation to be truly effective.

In Antwerp, the basic wage is fixed as a function of the normal workday. Also, the basic wage is linked to the national index of retail prices. The "Shifts" (night shift, Sundays and holidays) are paid extra. There are also premiums and compensation for overtime work, heavy duty, etc.

In 1964 the enlistment system was thoroughly revised and the five-day week was introduced, probably as a compensation for streamlining and mechanizing the port operation.

Since the 1968 "May Revolution," the five-day week is guaranteed at 7.5 hours per day, along with wage increases, the right to shift preference, and freedom to work on Saturday (pay plus 50%) and Sunday (pay plus 100%). Automation in the port is handled through a Commission Paritaire (50% labor, 50% management) with mutual trust and informality. Dockers are 100% unionized and labor turnover is remarkably low; every year Antwerp takes in only 500 new dockers (versus Rotterdam's 10,000) thanks to this good labor/management climate.

B.4.10 Land Ownership

In general, land in the port area on the right bank of the Scheldt River has only been available on long-term leases. In a few cases, where the land was situated on the outskirts of the port area, land has been sold. In this way, the West German companies, Bayer and BASF, were able to purchase large sites although the strip of land adjacent to the water area was only given on a long-term lease. However, on the left bank of the River, companies have been able to purchase land directly from the government. This latter area--previously lying outside the boundary of the City of Antwerp--was acquired when the government served compulsory purchase orders on the former land owners.

The length of a lease, generally 15 to 40 years, depends on the investments made by the firms involved. The big petrochemical companies may obtain factory-site leases for periods up to 80 years. After a lease expires, the leaseholder normally has the option to renegotiate.

B.4.11 Insufficient Land Facilities

Development of the port facilities and the industrial areas has been rapid during the past two decades. The port area occupied by industry has grown from 320 acres in 1950, to 7,000 acres in 1970 (Table B-7), a growth factor of 22.

TABLE B-7

LAND OCCUPIED BY INDUSTRIAL USES INSIDE THE
ANTWERP PORT AREA*

1900	--
1940	200 acres
1950	320 acres
1960	1500 acres
1968	5800 acres
1970	7000 acres

Source: Antwerp Port Municipality
*Includes those new industries on the left bank industrial zone.

The available space on the right bank of the port is today nearly exhausted. To meet increasing demands, the "Baalhoek Canal Plan" would create new facilities and new industrial sites on the left bank of the river, opposite the city of Antwerp. Already, USI Europe, Polysar, Union Carbide, and Petrochim have acquired industrial sites of considerable importance on the left bank.
power stations are planned; one based on refinery gas, and the other on atomic power.

B.4.12 Port Expansion

The only possible site for an extension of the industrial area lies on a relatively large tract of land (30,000 acres) on the left bank of the Scheldt, shown in Figure B-1. This land is largely below sea level and the existing polders (reclaimed land) are used exclusively for agriculture.

Presently, many communities on the left bank are independent of Antwerp, but there is a general consensus that the development of the left bank (St. Nicholas parish) must be coordinated with the needs of the existing port on the right bank. If two independent, competitive ports were to arise--one on each bank, perhaps even charging varying dues--chaos would result. Not only would many port services have to be duplicated, but a rational use of the available facilities would be rendered impossible, especially for firms established--as some already are--on both banks of the Scheldt.

It is Antwerp's position that both banks should be under the control of one local authority, whose task it will be to carry out decisions efficiently and rapidly. Thus, this will involve Antwerp's incorporation of the communes on the left bank, an idea which is still being fought by villages such as Doel, and is not facilitated by the fact that most of the new land is in a different province.

Of the more than 16,000 acres projected for the first development phase of the left bank, only 10,000 acres will ultimately be available for industry: 1,250 acres of recent housing area across the Scheldt from Antwerp will not be expropriated (Kallo), 2,500 acres reserved for greenbelts, and 2,500 acres for transport and utility infrastructure. (There may be 13,500 acres for further expansion westward, by successive additions of 5,127, then 5,485, and finally 2,915 acres of raw agricultural land).

This possible extension of the Port of Antwerp on the left bank has been under discussion for a number of years. The successful development of a new complex of docks and industrial sites depends essentially on the means of access, for which a completely new sea lock would be required.

The siting of this lock is determined not only by the general course of the Scheldt, but also by the position of the main channel. The lock must be sited where the navigable channel is nearest to the the river bank. Such large locks are also generally constructed in line with the flow of the river (i.e., not perpendicular to the channel). To allow access to sea-going vessels of as large a size as possible, and to keep river-dredging expenses to a minimum, the lock will be constructed as far downstream as possible.

A preliminary investigation, based on a purely Belgian land-use solution, suggested a lock near the Dutch frontier, north of Doel. The principal objection to this scheme is that ships entering the new dock facilities on the left bank would still have to come around the narrow "Bath curve", which remains a navigational hazard.

However, within the broader scope of a plan embracing the Benelux countries, there arose the idea of building a sea lock, on the left bank, much further downstream in Holland near Baalhoek. Such a lock scheme--$29 million for the lock----has already gained widespread approval in Belgium, but depends on the approval of the Dutch Government.* The two governments have already started preparatory negotiations on the project. Though political and economic factors seem under control, considerable concern has been evidenced by the Dutch regarding the effects of the proposed project on adjoining marshland.

Another large excavation work will be the paring away of outjutting land at the Bath Bend, not far from the Antwerp's dock complex. Unfortunately, this piece of land is on the same Dutch marshlands and again, until the negotiations with the Dutch government are completed, work cannot start. But $58 million has been set aside for land purchase that is planned to be pared away.

Despite the fact that negotiations have not yet been completed, factories and plants are already under construction in the 10,000 acres set aside for industrial purposes along the left bank. Belgium is therefore going ahead with the "Kallo" lock development, which will open the backyard of the Balhoek Canal to the Scheldt, across from the main Antwerp oil terminal.

If this project can be realized and if a new complex can be created on the left bank of the Scheldt, the Port of Antwerp could really be said to have come closer to the sea. Its realization would certainly be an

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*There is some frail hope that the Netherlands may share the cost of the Baalhoek lock which would open a four-mile "Kanaal Dok" equivalent in their territory, downstream from the Belgian plan.

important landmark and a major step forward in the development of the port as a whole, even though it has been limited to ships in the 125,000 dwt range.

B.4.13 Foreign Investment

As far back as the 19th Century, people in Antwerp tried to speed up the city's development by attracting foreign investment, which not only created jobs but also strengthened the technology of the local community. Even before 1925, Ford and General Motors were established in Antwerp. More recently, foreign investors such as BP, Esso, Amoco, Phillips, Rhone-Poulenc, Monsanto, Union Carbide, Bayer, and BASF have all played an important part in the industrial development of Antwerp. This extraordinarily rapid development in about ten years has been made possible by a liberal attitude towards foreign investment.

The Ten-Year Plan which began in 1956 was a major factor in this attraction. In the ensuing years, private investment in industry in the port area has exceeded $1.2 billion. A further $760 million in capital investment is scheduled to be spent by industry in the next two years on projects now under construction or those definitely committed. This figure is bound to increase as present projects are expanded and other new installations are planned.

At present, there is considerable American industrial investment in the Port of Antwerp area. More than $450 million has been invested by American industrial interests here since 1956. Belgian and German investments both follow closely the level of American investment.

Thus, total investment since 1956 will exceed $2.1 billion within the next three to four years. Total American investment will soon be overtaken by Belgian commitments in the area. Existing private Belgian investments plus those scheduled total $716 million; West Germany will have invested $688 million; and the United States, $551 million, in the next two years.

Foreign investment in the Port of Antwerp receives considerable aid from the local banks, including branches of foreign banks and the semi-public institutions, such as the National Society for Industrial Credit (Nationale Maatschappij voor Krediet aan de Nijverheid - Société Nationale de Credit à l'Industrie). Under certain conditions, the interest rates can be reduced for a limited period of time under the laws designed to promote investments.

Special mention must be made of the National Investment Corporation (Nationale Investeringsmaatschappij, NIM). This semi-public institution may participate in the initial capitalization of a newly-formed company or in an increase of the capital of an existing corporation. NIM's equity participations are temporary, unless decided otherwise, and are not restricted to a specific proportion of a company's capital. As a general rule, however, such participation cannot exceed 80%.

A less-known type of governmental help is technical training assistance. The National Employment Board may assist financially in the selection, retraining, or relocation of workers and may assume, for example : 1) 25-35% of the cost of training production personnel; and 2) as much as 50% of the cost (including travel and remuneration) of bringing foreign technicians to Belgium or sending Belgian workers abroad for training. To obtain such advantages, the new enterprise must file a formal application with the National Employment Board, before the period of training begins. The subsidies received do not have to be repaid.

In addition, the recently-passed Belgian "law of decentralization" has created three economic areas -- Souther (Walloon), Antwerp (Flemish), and Brussels -- which are being given unprecedented powers to attract foreign industry, as well as commercial establishments. While every company contemplating location in any of the areas is treated as a special case, incentives and grants are largely determined by the area itself with consideration given to the number of people who will be eventually employed.

Tax holidays are a part of the plan, and temporary -- up to five years -- American managers usually receive special benefits.

B.4.14 Industrialization

Small industrial workshops and plants settled originally in and around the port of Antwerp. The industrial function of the port, however, was generally limited to specific port industries such as shipbuilding and ship repair. Between the two World Wars, other industries such as motor-car assembly plants, sawing mills, and a few small refineries were set up. In 1950, the industrial sites in the port totalled only 320 acres. Since then, the industrial function of the port has changed in such a way that Antwerp has become a major industrial port. This metamorphosis was caused by the well-known European phenomenon of industrial migration to the coastal zones.

An example of how the location choice of a production center in Europe is influenced by the cost of transport would be a fertilizer plant. Phosphate rock can be obtained from Russia, France, or the United States. As an example, if the phosphate rock is purchased in the United States, the price for a specific P_2O_5 content is $7.30 per ton f.o.b. and the sea freight cost to ship it to Antwerp is $4.90 per ton. However, unloading and shipping several hundred miles into the hinterland adds a further $2.20 per ton to the cost. Therefore, the additional cost of phosphate rock several hundred miles inland is about 18% higher than the cost in Antwerp. With a plant capacity of 300,000 tons per year this difference in transportation costs amounts to $660,000 per year. Moreover, if a major percentage of the fertilizer is to be exported and shipped out of the interior, this cost difference would increase. With a production center at a port such as Antwerp, all the raw materials, fuel oil, phosphate rock, sulphur, and pyrites can be supplied by sea, thereby creating substantial savings.

Basic industries are still transferring from the interior to the sea ports, because continental raw material reserves are being exhausted, and growing quantities of oil, ores, chemicals, etc., are being imported from overseas countries. It was in Antwerp's interest to put appropriated new industrial sites at the disposal of these industries -- as an important part of the port extension programs -- because it would strengthen the economic expansion of the area.

The industrial sites (including present industries on the left bank of the Scheldt) totalled 7,000 acres in 1970. Several factors contributed to this expansion:

- the favorable geographical location in the heart of the Common Market;
- the appropriate infrastructure (resulting from the port extension program 1956-1966);
- the liberal Belgian laws on economic expansion;
- the existence of sufficient labor;
- the existence of industries which could supply feedstock, or purchase production in a frame of industrial interdependency; and
- the possibilities of waste water disposal and the availability of cooling water. (See Section B.6.4.)

The industrial sector breakdown of Antwerp is shown in Table B-8 below:

TABLE B-8

INDUSTRIES IN THE ANTWERP PORT AREA

	Area (in acres)		New Investments since 1950 (millions)		Number of Persons Employed	
Petroleum refining (1)	1200	(21%)	$266	(29%)	2,475	(10%)
Petrochemical	1430	(25%)	239	(26%)	2,308	(9%)
Chemical (2)	2330	(41%)	252	(27%)	2,205	(9%)
Motor Vehicle Industry (3)	590	(10%)	140	(15%)	13,000	(53%)
Ship Repairing	170	(3%)	26	(3%)	4,500	(18%)
Total	5720	(100%)	$923	(100%)	24,488	(100%)

(1) tank storage plants not included.
(2) including the Solvay and Degussa plants under construction
(3) not including the storage and distribution centers.

Source: Antwerp Port Municipality and Arthur D. Little, Inc.

Forecasts by the Port Authority for the year 1975 estimate an industrial area of 22,000 acres versus the present 7,000 acres. The left bank of the Scheldt, where thousands of acres are still available, will play the major role in these expansion plans. Table B-9 gives the principal industries that are presently established on both sides of the Scheldt River.

TABLE B-9

ESTABLISHED INDUSTRIES IN THE ANTWERP PORT ZONE, 1970
(Left and Right Banks of the Scheldt)

Survey of the Principal Installations

Firms	Annual Capacity in Tons per Annum	Number Employed	Surface Area in Acres	Investments in Millions of Dollars
1. OIL REFINERIES				
Société Industrielle Belge des Pétroles n.v. S.I.B.P.	15,500,000	920	466	$174.0
Esso Belgium n.v.	5,000,000	385	321	65.5
Belgische Petroleum Raffinaderij n.v. R.B.P. (formerly British Lianosoff White Oil Cy)	4,600,000	395	76	45.0
Albatros BNV (formerly Redeventza)	3,250,000	280	342	47.0
Anglo Belge des Pétroles n.v. (formerly Radian)	40,000	93	17	6.0
Gamatex n.v.		40	116	5.0
Nafta (B) n.v. (Belgo-Sovjet Co.)		100	70	18.0
Chevron Oil Belgium s.a.	40,000		155	14.0

Firms	Annual Capacity in Tons per Annum	Number Employed	Surface Area in Acres	Investments in Millions of Dollars
2. CHEMICAL AND PETROCHEMICAL INDUSTRY				
Union Carbide Belgium n.v. (1968) (formerly Cobenam)	891,000	900	519	$ 86.0
Amoco Fina n.v. (controlled by Amoco Chemicals Corp. and Petrofina	17,000	85	24	5.0
Petrochim n.v. Petrofina n.v. Phillips Petroleum Cv Bartlesville USA Others	1,242,000	750	603	N.A.
Distrigaz n.v. Esso Shell Staat Privately owned		80	15	15.0
Belgechim	150,000			9.0
Polyolefins n.v. Rhone-Poulenc Phillips Petrol. Petrofina	55,000	121	15	18.0
Polysar Belgium n.v.	180,000	325	15	25.0
U.S.I. Europe n.v. (formerly Atlantic Polymers) (European branch of N.D.C.C.)	154,000	445	82	40.0
U.S.I. in cooperation with Esso Chemicals n.v.				
Bayer Antwerpen n.v. (branch of Farbenfabriken Bayer AG, Leverkusen)	1,276,000	1,100	940	172.0
Bayer-Shell Isocyanates n.v. n.v. Bayer 50% Shell 50%				

Firms	Annual Capacity in Tons Per Annum	Number Employed	Surface Area in Acres	Investments in Millions of Dollars
2. CHEMICAL AND PETROCHEMICAL INDUSTRY (CONT'D)				
Quaker Furans n.v.	11,000	33	4	$ 2.0
B.A.S.F. Antwerpen n.v. (Badische Anilin- & Soda-Fabrik AG, Ludwigshafen)	2,954,000	2,400	1,124	200.0
L'Air Liquide			N.A.	10.0
Badiphil n.v. (a joint branch) Phillips Petroleum Co. 50% B.A.S.F. Antwerpen n.v. 50%	72,000		N.A.	7.5
Monsanto Europe n.v.	45,000	500	252	60.0
Solvay & Co.	921,000	526	247	38.0
Degussa-Antwerpen n.v. (Deutsche Gold- und Silber-Scheideanstalt) (Formerly Roessler)	134,000		267	44.0
Minnesota Mining and Manufacturing Co.		60	20	12.0
Johann Haltermann		180	104	4.0
3. MOTOR VEHICLE INDUSTRY				
General Motors Continental	549,000	8,700	406	110.0
Ford Tractor Ltd. Belgium	30,000	2,500	126	50.0
Ford Motor Co. Belgium n.v.		450	56	2.0
Chrysler Belgium		140	5	1.0

Firms	Annual Capacity in Tons Per Annum	Number Employed	Surface Area in Acres	Investments in Millions of Dollars
4. SHIP REPAIRING				
Mercantile Marine Engineering & Graving Docks Co. n.v.		2,500	101	$ 20.0
Beliard - Murdoch n.v.			68	21.0
5. ELECTRICITY SUPPLY FOR THE INDUSTRIES IN THE PORT ZONE				
(excluding firms producing their own electricity)		200	335	342.0
TOTAL		25,936	6,891	$1,168.0

*Includes reserves of private companies.

Source: Antwerp Port Municipality and Arthur D. Little, Inc.

B.4.15 Petroleum Industry

Petroleum refineries have played a central role in the post-war economic development of the Antwerp port area. Antwerp had little war damage as compared to Rotterdam and benefitted from the five-year plan necessary to reconstruct Rotterdam after World War II. The development of the petroleum industry in a country or particular region is usually described in terms of the number of barrels or tons of refinery capacity. To understand the importance of the petroleum refinery sector to the economic development of the Antwerp region, one must nevertheless go further than a purely quantitative analysis of production.

Most refineries have been established in the port area because the location had two main advantages: first, it benefits from direct access (via the Scheldt) with the open sea; and second, it is linked with the major consumption centers by a transport system which is among the best in Europe.

Table B-10 shows how the capacity of the Antwerp refineries has developed with the petroleum requirements of the country and the demand for oil and fuels.

TABLE B-10

NATIONAL PETROLEUM REQUIREMENTS AND ANTWERP REFINING CAPACITY
(thousand tons)

Years	1948	1953	1958	1963	1965	1969*
National Consumption	1,434	2,959	5,648	9,750	13,765	20,239
National Exports	268	383	519	1,053	2,100	3,129
Total	1,702	3,342	6,167	10,803	15,865	23,368
Antwerp Refining Capacity (December 31)	370	4,210	7,450	13,650	16,800	25,000

*Estimated

Source: European Chemical News and Arthur D. Little, Inc.

Between 1953 and 1969, total port traffic of Antwerp increased by about 45 million tons, of which 23 million tons (more than half) was attributable to petroleum. Thus, in 1969, petroleum represented 50% of the total unloading and 14.5% of loading carried out in the port. This considerable increase in maritime petroleum imports is attributed to the crude oil requirements of the Antwerp refineries.

Contrary to the situation in oceanic traffic, loading has the lead over unloading of petroleum products in the international coastal and barge traffic of the Port of Antwerp, as Belgium is a net exporter of refined petroleum products. Table B-11 details the large increase that has taken place in loading and unloading since 1953.

TABLE B-11

EVOLUTION OF LOADING AND UNLOADING
(thousand tons)

	HIGH SEA TRAFFIC					INTERNATIONAL COASTAL AND BARGE TRAFFIC				
	1953	1957	1961	1965	1969	1953	1957	1961	1965	1969*
ALL GOODS										
Unloading (imports — unloaded in transit)	14,417	21,937	23,347	40,390	48,900	4,691	5,686	7,388	8,368	9,456
Loading (exports — loading in transit)	13,767	14,724	15,425	19,050	24,100	3,946	5,828	4,982	6,207	7,697
TOTAL	28,184	36,661	38,772	59,440	73,000	8,637	11,514	12,370	14,575	17,153
Petroleum Traffic										
Unloading (imports -- unloaded in transit)	3,866	6,922	9,148	18,618	24,500	662	1,066	1,526	1,075	N.A.
Loading (exports -- loading in transit -- bunkering)	1,112	825	1,284	2,893	3,500	1,025	1,904	1,827	2,500	N.A.
TOTAL	4,999	7,747	10,356	21,511	28,000	1,687	2,970	3,353	3,635	
Percentage Share of Petroleum in the Total										
Unloading	27.0	31.6	39.2	46.1	50.0	14.1	18.3	20.6	12.8	N.A.
Loading	8.1	5.6	7.8	15.2	14.5	28.5	32.7	36.7	41.2	N.A.
TOTAL UNLOADING - LOADING	17.7	21.1	26.7	36.2	38.3	19.5	25.8	27.1	24.9	

Source: Antwerp Port Administration

B.4.16 Petrochemical Industry

In recent years, a major part of the expansion in organic chemistry in Western Europe has been in petrochemicals based on by-products from petroleum refining. Much of this development has been due to the large increase in refining capacity which has resulted in increasing quantities of raw materials for the petrochemical industry being made available. Prices have also decreased as the scale of production has increased. The Belgian petrochemical industry developed later than in most European countries, because, historically, the Belgian chemical industry has been coal-based.

This development and diversification into petrochemical manufacture obviously ran parallel with a considerable increase in the availability of feedstocks. The resulting petrochemical growth has concentrated around the petroleum refineries.

There is a significant advantage to Antwerp's geographic location, which permits finished products to be distributed easily to Northern Europe, inland, and overseas. The characteristics of the petrochemical industry tend to make the most of the advantages offered by Antwerp. Large-scale manufacturing, typified by the size of ammonia units and naphtha crackers, is very dependent on any economies of transport that can be made. Moreover, in a relatively small, well-located country such as Belgium, these industries tend to be export-oriented. The proximity of port facilities, as available at Antwerp, improves their competitive positions in the international market.

Following the establishment of a petrochemical industry, there is a market interdependence between the production units. The products or by-products of one industry often serve as feedstocks for other industries. Besides this, the production of numerous petrochemical products in one area increases the demand for certain mineral-based chemicals (such as sulphuric acid and chlorine), to such a level that manufacturing units for these products may be set up. Total petrochemical investment of $380 million was reached for this industry in 1970. Antwerp is now one of the principal European petrochemical centers, with almost the entire gamut of petrochemicals and intermediates.

The petroleum refineries have acted as a center for industrial development, not only on a regional, but also on an international basis. Nevertheless, the petroleum industry can only continue in this role if it is able to supply petrochemical feedstocks at prices comparable to those of competitors. To meet this requirement, the petroleum industry must be able to obtain its crude oil supplies under favorable conditions and be able to carry out its refining business under fiscal and institutional conditions similar to those enjoyed by refiners in neighboring countries.

B.4.17 Regional Planning

Regional planning was introduced formally in Belgium by a 1962 law. First, an extensive inventory and 1980 forecasts for the Scheldt-Dijle region (i.e., the province of Antwerp, plus St. Niklaas Parrish) were completed, followed by land-use planning, which is expected to be approved by the 38 municipalities this year. (See Section B.6.4.) An input-output model has been established to study both industry structure and labor markets. Problems with zoning and real estate speculation are raising controversy. A royal decree enforces application of the sector plan, once approved, but municipality burgomasters are quite powerful politically. The following extracts from the "Regional Master Plan," published in 1969, give the scope and the flavor of the work performed and conclusions reached, even though some, based on 1960-1965 data, are already obsolete:

> "The Master Plan is a summary of the survey of the regional characteristics, their evolution and the development that may be expected. It suggests solutions to the resultant problems within the separate plans covering the different fields with which an adjusted planological model co-ordinates.

POPULATION

"The region includes the large-town sphere of influence of Antwerp, consisting of 198 municipalities with a surface area of approximately 3,600 square kilometres, grouped in 4 regions: the Antwerp, Mecklin, Waas and Campine region, 14 regional sectors and 9 regional subsectors. In 1965 the region had a population of 497 inhabitants per square kilometre -- whereas the national figure was 311 -- and it had a total population of 1,768,457, of which 53.39% lived in the Antwerp area, 22.13% in the Campine, 13.87% in the Mecklin area and 10.61% in the Waas area. By 1980 more than 2 million inhabitants are expected, with marked increases especially in the Campine (+80,000), in the Antwerp agglomeration (+80,000) and in the Mecklin agglomeration (+30,000).

"The main portion of the survey area runs from north to south over thirty kilometres and is formed by one of the most important development axes of Belgium: Antwerp - Brussels - Charleroi. It is supported by an important hydrographic net and by a hinterland with 60 million inhabitants, one of the greatest economic concentrations in the world. The structure of the town system grafted on this development line is of a polycentric nature. The Antwerp agglomeration fulfils the function of a metropolis and thus polarizes the whole survey area. Lier, St. Nicholas, Mecklin, Turnhout and Herenthals-Mol form the regional centres; Geel, Heist-op-den-Berg, Schoten, Boom, Willebroek, Duffel, Beveren and Temse make up the subregional centers, whereas a group of other municipalities offer local significance.

SOIL

The soil conditions are, as a rule, favorable for agricultural and building purposes, but vary due to the water-supply systems.

WATER

The Scheldt, the Rupel, the Nete, the Eijle, the Demer and the Durme are rather badly polluted, but the conditions of the canals are fairly sound. It is anticipated that this state will be improved by installing proper purifying plants and an industrial collector on the Albert Canal.

AIR

The air pollution resultant from domestic and industrial causes is creating problems especially along the Antwerp-Mecklin axis and needs to be remedied by the industrial enterprises and by designating specific "green-belt" areas.

"The socio-economic sphere, whose dynamic influence greatly determines the development of the region, will be characterized by an increase of the gross

INDUSTRY

regional product from 98.4 milliard (U.S.: billion) in 1960 to 216.8 in 1975, an increase of 120.3%. In

1960 the gross value added per regional inhabitant was already higher than the national average. The industrial sector (40.7%) and the trade and service sectors (40.1%) make up an important part of the regional product (public servants and domestics not included). As compared to the State, the activity of the region is less directed to agriculture, but, it is on the contrary, very explicitly directed to the service sectors. In 1975 the contribution of the industrial sector will have risen to 44.8%, in contrast to the service and agricultural sectors whose contributions are falling. Due to the open nature of the regional economy, as a result the trade balance showed a deficit of 1.1 milliard (billion) francs in 1960.

LABOR SUPPLY

"Between 1960 and 1975 an increase of labor supply of 85,700 men and 60,200 women is forecast. This also partly due to the migration from the depressed sectors. Taking into account the demand, a labor shortage of 14,700 units may result from this, in fact a shortage of 28,800 men and a surplus of 14,100 women. In the agricultural sectors the employment opportunities will further decrease from 38,656 units in 1960 to 16,100 in 1975. This retrenchment of man-power will be strongly felt especially in the Campine region, in which a relatively large part of the working population is still employed in agriculture. At the same time, however, the position of agriculture will have to be strengthened by structure-improving measures like redistributions of land holdings, an appropriate hydraulic engineering system, country-road improvements, economic reconstruction of the enterprises, stimulation of auctions and the creation of information centers. In addition the raising of the standard of education would help.

LABOR DEMAND

"In 1960 the industry employed 275,112 people; another 84,400 are expected by 1975, but 17,200 existing employment opportunities will have disappeared. Due to the spontaneous expansion of the Antwerp metropolis, 30,000 new opportunities will be created. The layout and equipment of industrial sites will have to keep pace with the spontaneous industrial growth, which implies that on the left bank of the Scheldt 6,300 hectares must be set aside, of which 3,500 hectares of industrial grounds must be reserved for the use of deep-dockage industries. Other industries, however, can be partly directed to other nuclei in the survey area, where a great labor supply may be expected. This will promote the polycentric development of the region and keep the number of long-distance commuters within reason. Mecklin, Turnhout-Beerse, Geel and St.-Nicholas will be considered the regional nuclei of the industry, whereas complimentary sites in the region of the Rupel, Mol, Herenthals, Essen, Heist-op-den-Berg, Hamme and Bornem will be able to fulfill a supporting function.

"The employment in the trade and service sectors, numbering 190,581 units in 1960, will be increased by 76,200 units in 1975. More than 43,000 employment opportunities will be created in the Antwerp sector, however, the service functions of other centers will also be strongly stimulated. Antwerp will be considered the metropolitan region, Mecklin, St.-Nicholas, Turnhout and the component town Herenthals-Geel-Mol will develop as regional service centers, whereas Hamma, Wuustwezel, Oostmalle, Heist-op-den-Berg and Londerzeel should be raised to the level of subregional centers.

HOUSING

"In the socio-cultural field the necessity of building 13,647 houses a year between 1966 and 1975 will be needed. In order to obtain this end the present rate of building should be increased by 28%. This would necessitate a yearly allocation of 546 hectares for building sites, of which a minimum of 1/3 should be reached through land management. Next to the above, the housing conditions of the existing patrimony need improvement, especially in the Waas region, the conditions being the most favorable in the Campine region. The equipment of the dwellings must also be adapted, especially in the Campine region. In the micro-planological field one will strive for better livable housing entities by centralized implantings which would also have a better sociological structure. In the marco-planological field one will attempt to hold in check the disorderly expansion of the Antwerp agglomeration by opening up residential zones on the axes linking this nucleus with other poles and which will be integrated in a hierarchic interdependent structure.

EDUCATION

"In the province of education one will endeavor to expand university and higher non-university education in Antwerp, so as to stimulate the participation of youth in this type of education, which up to now has been small in comparison with the national population. As for secondary school education a greater task will be assigned to the centers of the regional sectors to secure the population's education. In view of the necessity to supply the school population an education more adapted to the socio-economic life, one will also strive to reduce the number of vocational schools for girls and integrate them in another system of education.

"As to the medical facilities, a special effort must be made to reach a normal medical treatment of the population by 1980, especially in the Antwerp areas, where the obsolescence of the existing institutions offers additional problems, and in the Campine, particularly the Southern Campine. Generally speaking there is a shortage of institutions for non-acute illnesses. There is especially a quantitative

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shortage of institutes for the welfare of the old-aged persons in the Antwerp region. Geriatric institutes are practically non-existent. In the sector of social housing it will be necessary in the future to build adequate dwellings for old-aged persons. As far as children care is concerned, there is a definite shortage of institutes for socially unadapted and for physically or mentally handicapped children. The cultural equipment will be more and more developed in the form of integrated cultural centers. In this field a considerable leeway must be made up especially in the border communes of the Antwerp area, in the Campine and in the Waas region. The sports equipment is on the whole unsatisfactory, particularly in the Haacht, Bornem, Hoogstraten, Geel, Zandhoven, and Heist-op-den-Berg sectors. In the infrastructure the provisions of equipment for youth movement activities are in most cases inadequate or the infrastructure itself is used for other ends. Due to the disorderly town planning, the outdoor recreation for youth is becoming a problem, especially in the Antwerp agglomeration, Mecklin and the Rupel region. The corrosion of the remaining green zones by the disorderly conversions of land into sites and by ribbon building offers an earnest problem. This is also the case with the city parks within the great agglomerations. In the survey area, especially Kalmthout Heath as well as the nature reserves of both Netes and of the Scheldtland should be kept reserved for green zones. Green buffer zones along the important industrial zones are being planned.

TRANSPORT

"Transport, particularly the harbor activity, is a specific activity of the region. It is significant both nationally and internationally: 10% of the freight transport by sea of the E.E.C. countries passes through the Antwerp harbor; also more than 10% of the employment in the region is connected with the Antwerp harbor. However, the increase of the shipping tonnage, in comparison with the accessibility of the Scheldt, on which calibration and rectification works are necessary, raises a serious problem. This increase of shipping tonnage for petroleum-tankers puts such exigencies that they cannot be met. The solution would be the connection with the West European net of pipelines.

(WATER)

In the framework of the international harbor competition, industrial grounds with deep-water frontage must be opened up; both the left and the right bank of the Scheldt are suitable. The inland navigation has a particular significance for the connection of the Antwerp harbor with its hinterland. The plan urges the necessity of the construction of the Scheldt-Rine Canal, of the communication canal between the harbor area of Antwerp North and the Albert Canal and the Nete Canal. It also indicates that the Albert Canal should be modernized. As to the capacity of the harbor itself, 2 new docks must be constructed for the handling of general cargo.

(ROAD)

"In the field of road traffic, one will have to consider the fact that the fleet of private cars in the survey area will have increased from 154,800 in 1962 to 440,200 by 1975. The suburban traffic on the fringe of the Antwerp agglomeration and the through traffic to Brussels, Mecklin, Ghent, Lier and Herenthals is very dense, as well the cross-frontier traffic to Breda. Another very acute problem in the Antwerp agglomeration is parking. The proposals for the infrastructure of the roads are designed to relieve the present and the future saturated roads by new or improved plans and by increasing the number of parking places. As to the passenger transport by rail it is assumed that by added comfort, better service and higher speed, the passenger transportation will remarkably increase, particularly on the Antwerp-Brussels section which is already thickly crowded.

(RAIL)

To enable this increased efficiency a restructuring of the railway net will be necessary for convenience as well as a co-ordination with the town and bus traffic. This adjustment will be spread over a ten years' period. The Antwerp town center will thus be opened up by a "pre-metro", and the connection with the suburban communes needs to be secured by tramway lines, in their own "beddings."

(AIR)

"Also the necessity of an air-port near the seaport of Antwerp is stressed. The airport of Deurne, however, does not satisfy the requirements of commercial traffic any more and this for several reasons. Therefore the plan foresees a new airport at Oostmalle at a 20 kilometers distance from Antwerp and connected with the metropolis by the motor-way E-3.

UTILITIES

"In the sector of public utility new electric-supply stations would be erected at Doel and Kallo to satisfy the increased industrial and home consumption. The electric-supply net is satisfactorily spread, whereas the inter-regional feeding-net between the stations of 150 kV meets the requirements. As far as the gas supply is concerned, radical changes may be expected in the near future, i.e., the supply stations will be closed down and replaced by earth-gas from Holland. It will be introduced into the survey area through two feeders. The water-supply is fed by the Albert Canal, but new water reserves are necessary to meet increased consumption. One will be able to reduce the pollution of the surface water by working systematically and processing the sewerage-system, and also by constructing refuse pulverizing plants.

"The planological model for the survey area is a poly-centric hierarchical model, according to which the Antwerp metropolis would be primarily developed as a supra-rational center, and subsequently the four regional centers as urban nuclei, viz. Mecklin, St.-Nicholas, Turnhout and Herenthals-Geel-Mol. These nuclear communities are situated on the development axes connecting them with Antwerp. Other nuclei will be assigned a function on a lower level. The inter-mediate green spaces and agricultural zones will, however, be safeguarded as much as possible.

"The planning of the Antwerp region is based upon the opening up of the city and the harbor area, whereas the metropolitan area, the suburban zone and the intermediate centers "Voorkempen", Beveren-Melsele, Boom-Willebroek and Lier will be developed as residential areas. The Mecklin region is based on the expansion of -- next to the regional center of Mecklin itself -- Lier and Heist-op-den-Berg. The Waas region includes St.-Micholas, Lokeren and Temse, which ought to be further developed as regional centers. In the Campine region there are especially Turnhout and Herenthals-Geel-Mol, next to Westerlo as sub-nucleus."

Each community traditionally establishes a general plan for communal orientation, and a special municipal zoning plan. This is integrated by sector, then by province, and finally at the state level (which do not always correspond to one arrondissement,* province, or other administrative division) where it comes back to the people for discussion prior to approval.

Problems often arise from discrepancies between administrative subdivisions and sector subdivisions, and Antwerp's St. Niklaas Parrish is just as responsible as the Dutch for the delay in Left Bank development.

Another example of the frustration of regional planning is the Hoboken riverside oil storage terminal, south of Antwerp, at the site of the already closed Albatross refinery. The regional plan had decided that this area should be turned into a waterside residential area. Terminal operators and heating-oil distributors succeeded in marshalling the Chamber of Commerce, which in turn was able to keep the land as a storage zone. The winning argument was that despite the attractiveness of the zone for residential housing (once the river was cleaned), the main problem in Antwerp is the lack of industrial land; the right bank is practically saturated, and the left bank development is not started. Thus the Hoboken plan will not be implemented, at least until new industrial acreage is made available.

Still another problem is the competition for industry and its unbalanced distribution. There are talks of Antwerp taking over the suburbs for administration services (as well as taxes) to avoid the classic distortion between tax income and services rendered (particularly in higher education, communications, etc.). Actually, Antwerp is on the verge of becoming more selective in its screening of industry, because of land shortage, environmental concern, and the city's obvious locational advantages for industry. Antwerp has started promoting decentralization of certain industries, southeast on the Albert Canal

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*Similar to a district.

(Amoco and Goodrich Petrochemicals in Geel, 20 miles away towards Liege), and on the Terneuzen-Ghent canal now developed for 50-60,000 dwt vessels. At the European level, long range planners envision cooperation between Rotterdam and Antwerp to fully exploit the Golden Delta (the area between Rotterdam and Antwerp) and to become the two largest and richest ports of the world: Antwerp for cargo handling, and Rotterdam for big ships.

B.4.18 Future Outlook

The growth of the Port of Antwerp in the 1950's and 1960's was rapid, but expansion plans for the current decade will be even more pervasive. The port's future economic growth will result from two major interacting forces:

- First, the port will continue to attract commodity traffic, in its role as a major continental distribution point for world trade, and as the major port and city in Belgium, with perhaps 50% of national economic activity;
- Second, the city should develop industrially at a rate close to the past decade's 6% to 7%; increased industrial production should contribute measurably to the overall development of traffic flowing through the port.

Most of the industrial expansion will be in the petrochemical and chemical sectors, but concentration of allied industries is expected as well, particularly in the rubber, plastics, and fibre-transforming industries. Industries needing water front facilities -- refining and petrochemical installations -- will settle around the port itself. This will probably lead to a concentration of secondary processing industries in outer districts in a pattern of concentric circles rippling out from Antwerp.

B.5 ENGINEERING FACTORS

B.5.1 Site Selection

The river profile, the city's developed areas, and the population settlement control the selection of sites for port expansion, since the land is essentially flat. The water frontage increased downstream from 24 to 54 miles (mostly in a northerly direction) on the right bank during the past ten years. Future development of the Baalhoek project is planned on 30,000 acres of low polder land on the left bank of the Scheldt River. The acreage is below high-water level twice daily when an average 4.80 meter (15.4 foot) spring tidal range is experienced. The acquired acreage is known to be excessive and beyond present needs, and the Port Authority is prepared to utilize less land than that plotted for port use. This is an advance planning measure that will permit future expansion without requiring further legal gymnastics to extend port acreage when needed.

B.5.2 Configuration

Basin facilities are behind river quay walls and date from the Napoleonic era (1805-1810) when the Bonaparte and Kattendjik barge locks were constructed. In 1906, the Royers lock was constructed for coaster-size vessels. A major step was taken in 1925 with the opening of the Van Cauwelaert lock six miles downstream. In 1949, a petroleum dock with two finger-type piers was constructed. By 1955, the parallel Bonde lock was completed, and a fifth Harbor Dock (11.75 m or 39 feet deep) was added. Another major change occurred in 1967, when the new Kanaal Dock was officially opened (see Figure B-1), linking the two previous locks with the Zandvliet lock twelve miles downstream. The new dock resulted in the development of an industrial island which accommodates the plant facilities of Albatros (a refinery), Solvay, Monsanto, Degussa, and Bayer (chemicals). Access to the island is gained by a double bascule, twin track, railroad bridge, and a traffic tunnel. The bridge has a vertical clearance of 31 feet when down and 270 feet when open. The lesser dimension provides adequate clearance for normal daily river traffic. The bridge was arranged to handle both vehicular and railroad traffic until the vehicular tunnel was opened. The new Kanal Dock has a total length of five miles and has an average depth of 16.75 meters (55 feet), with wharfage and dikes sharing the eastern side. On the west side, three insert docks provide access into the industrial island in addition to regular seawall frontage. The canal/dock is depth-limited at the entrance lock by the lock's depth of 18.5 meters (61ft.) at mean high tide.

Some 3.5 miles of quayage are also available at the riverside, which permits coaster-type vessels to load and unload without using the lock-enclosed facilities. However, seawall use entails precise entry and cargo discharge to suit tidal conditions.

TABLE B-12

Dimensions Of Locks

	Length		Width		Depth*	
	m	ft	m	ft	m	ft
Zandvliet (1967)	500	1,650	57	188	18.48	61
Boude (1955)	360	1,188	45	149	15.23	50
Van Couwelaert (1925)	270	891	35	116	14.73	49
Royers (1906)	180	594	22	73	11.31	37
Kattendijk (1810)	110	363	24.8	82	8.31	27
Bonaparte (1805)	---	---	17.4	57	7.39	24

*At mean high tide.

B.5.3 Channel And Basin

Entry into the port of Antwerp involves navigating 50 nautical miles of the Scheldt River from the North Sea entrance at Vlissingen. The tidal range averages 11.6 feet at the river mouth, and increases upstream to an average of 15.5 feet at Antwerp. Spring tidal ranges result in a rise and fall of additional meters as shown below:

	Average		Neap	Spring
	ft	m	m	m
Scheldt Mouth	12.0	3.7	3.0	4.5
Antwerp	15.5	4.7	3.3	5.7

The channel meanders with about six knots of tidal flow. Average flow rates of one billion cubic meters per second have been recorded at the mouth (30% more in spring, 25% less in neaps, and 90% less at the Dutch border, one mile below Zandvliet lock).

Sandbanks are visible at low tide, but are fully submerged at high tide. Most of the channel passes through Dutch territory, and the Belgians have a permit to maintain the channel. Fine-particle (150 micron) sand is brought in by the tide, and, since 1925, has required maintenance dredging in the channel and at the Antwerp docks by the Water Works Department. Four bucket-ladder dredges are in continuous operation, and the dredging spoil is deposited in secondary channels or at a land reclamation project.

Plans are ready to straighten out the hazardous Bend of Bath in the channel at the immediate entrance into the port. This would entail dredging on Dutch marshland. Model studies for the channel modification were completed one year ago, and the final report was sent to the Dutch Government. As far as is known, the Dutch have no real objections to the channel change, but want a more northerly, but less efficient location to protect wildlife in the salt marsh at the proposed dredge site. The new channel would be diked during construction to permit a continuous dredging operation. The disposal of spoil creates some problems, since the Belgians would have to purchase Dutch land to gain a disposal area, but the location is such that few Dutch citizens would be expatriated by the action. The present situation effectively prevents the passage of ships longer than 900 feet.

The 185 staff and employees of Waterbouwkundig Laboratorium van het Besturir der Waterwegen (Borgerhout) conducted extensive hydraulic studies to determine the effects of channel straightening. With the exception of a very slight change in tidal time and ecology, plus a slight tidal rise and fall increase (less than one foot), no adverse effects are anticipated, and channel maintenance should be reduced by virtue of accelerated flow in the new channel section. The hydraulic model was built ten years ago, and it encompassed 20 miles of river from Antwerp to Hanswert. This was later extended to include the inland section of the river into Ghent, and the latter portion was labyrinthed to conserve laboratory space. The model scales 3:1000 horizontal and 1:100 vertical.

Tests showed that the existing channel would still have to be dredged to aid water movement and that an underwater dike (covered from half to high tide) would be needed. Some bottom duning is also anticipated which, by extrapolation from the model, could go up to ten feet. Two such dikes were effectively built, with 4/10 slopes, before the proposal to cut the Bath Bend changed the picture (if the proposed cutting occurs, the tide may change by one foot).

The new locks and harbor (Balhoek to Kallo) facilities planned for the left bank will not affect the river, according to model tests. The Laboratorium reports no bedrock down to 83 feet, only unconsolidated clay and sand. Spoil material is good, clean sand of which 420 million cubic feet were dredged last year at a cost of $4 million (1¢ U.S./cubic foot), mostly for maintenance.

Considerable dredging is required at the river mouth, where two channels (26.5 and 26 feet) converge, with sandbanks between them. Continual dredging is being done in the estuary area at six miles, dredging to 30 feet. Current and wave direction should reduce maintenance, but no model was built. The Port of Antwerp does not own or operate any dredges, so to maintain the main channel, contractors use 10,000 to 30,000 cubic feet per hour bucket dredgers and trailing suction-hopper dredges.

Spoils are now dumped southeast of Churchill Dock for land fill. There have been problems with vessels "squatting" on the bottom in narrow sections of the river, and in some cases, a passing-suction situation has occurred in the narrow reaches of the river; one bad collision occurred in the early 1960's when a 40,000-ton tanker collided with a 30,000-ton tanker. The pilot situation is now such that three pilots join a ship at the sea buoy to the area of Flushing, then one river pilot takes over and guides the vessel through the locks. Some of the tankers are now equipped with active rudders and bow thrusters of up to 1,500 horsepower capacity.

Turning basins have 2300 and 2650 foot diameters for the 1650-foot long Zandvliet lock. The Kanal Dock takes in fresh water, which is sent to the Scheldt by a pumping station.

B.5.4 Navigational Aids

Navigational aids consist of floating lighted buoys and fixed beacons. It was anticipated that a radar navigational system would have been available by October 1970, but the Dutch have purposely been holding up any discussion on the system; they do not want to discuss navigational radar with Antwerp, contending that it could affect Holland's national security by becoming a spying system on their nation. Additional aids, other than the buoyage system, consist of VHF radio with two channels (12 and 14) keeping in constant contact with a vessel. There is a restricted radio chain between the Belgian and Dutch borders. The Dutch plan to install a Decca Hi-Fix navigational system at the river entrance some time next year.

The submerged dike that will be used in conjunction with the final channel modification will be signalized with propane-gas-lighted buoys. On the Belgian side of the river the buoys are surveyed twice a week. Some of the buoys are equipped with radar reflectors. No audible system, bells or horns, are used on the buoyage system.

B.5.5 Docking

Pilot and tug assistance is mandatory for the entire length of the river and in the confines of the inner harbor. A partially loaded 90,000 dwt vessel was recently docked in the port, and departure was facilitated by the 2650 foot turning basin now available in the new canal/dock.

B.5.6 Cargo Handling

Although last year Antwerp took the record for cheapest European cargo handling port from Rotterdam, there does not appear to be any major breakthrough in cargo handling. Standard dockside cranes are available in the original basins (pre-1967) and the new canal/dock has 15- to 25-ton cranes capable of discharging general cargo at a rate of 60,000 tons per 48 hours.

Warehouse facilities are generally built by the user, and there is a trend toward single-story steel structures which are more economic. City-owned buildings are mainly of concrete construction for 20 to 40 year payout, though steel is better for short payout, at the cost of more maintenance. Few, if any, of the buildings are sprinklered for fire safety.

TABLE B-13

Port Equipment

Port area	10,633 acres
Water area	1,306 acres
Length of quays	98.7 km (60 miles)
Drydock facilities	17
Quay cranes	592
Mobile cranes	235
Ore handlers	14
Container cranes	7
Grain elevators (floating)	12
Grain elevators (quay)	9
Floating cranes	28
Tugboat berths	47
Mineral storage	200,000 m^2 (2 million sq ft)
Cold storage	2.2 million sq ft
Oil tank capacity	42 million barrels
Covered warehousing	20 million sq ft
Length of railway	500 miles

Design for flexibility is important. Container gantry cranes have a hook for coils, and some can hoist a 40-ton bloom. Billets, blooms, coils, etc. are currently handled at the rate of 1600 to 2000 tons per shift by 10-ton lift, high-rotation-speed cranes, each hauling 300 tons per day. Stevedoring companies were allowed to build their own handling terminals only in 1960. Nevertheless, according to one of the major companies, they spent $60 million and now handle 60% of general cargo on 50% of quay length.

Hazardous cargoes are not segregated in the port, but are unloaded according to special rules by specially cleared stevedores. Only explosives are handled in barges at a special mooring buoy outside Zandvliet. An explosion incurred recently on a German chemical ship was not serious enough to upset this system.

More generally, Antwerp's performance in cargo handling is attributed to:

- good labor and careful management, and informal and positive relationships ("We would never introduce a change if not backed by unions" declared a top executive);
- terminal specialization. Steel breakbulk can be mixed with containers, but not with light fruit pallets which cannot be handled the same way. The specialization trend is increasing as large ships are developed which need both quick turn-around and ample storage space, which the receiving or shipping industry is not always ready to provide. This storage function will increasingly become a port responsibility. A standard container terminal is now 200 meters long and 400 meters deep (660 feet by 1300 feet). However, terminals 300 meters long and 800 meters deep (1000' and 2600') may be necessary for the next two decades. Another reason for specialization is the influx of heavy equipment. Some companies doubled output in three years and tripled output in four years. This increase was possible with only a 50% increase in acreage and with the same labor force. One of these companies predicts another 50% productivity increase.
- flexibility. The ten-year plan is an information-pooling operation for budget appropriations (valid for ten years, rather than a constraining one-year period). Flexibility appears also in labor-management relations and company-state-city interactions, thanks to the municipal environment and the relatively small scale of the country.

B.5.7 Communications

In a previous section (B.4.17), the economic importance of water, rail, and road transportation has been stressed, because Antwerp is the major port of Belgium and a major outlet for the industrial interior.

A major recent development is the construction of oil pipelines, which was started in 1965 with the reservation of a 33-foot-wide land strip (originally thought to be overly conservative). Three times as much land now appears necessary: a major underground (4.7 feet deep) crude pipeline (not heated, so that some crudes must still come directly to Antwerp) is being built by oil companies and Dutch contractors to Rotterdam, (the alternative finally preferred over the further channel deepening or an offshore island by Zeebrugge for very large tankers); ethylene and ammonia pipelines take much more room than expected. Several canals and rivers require underground tunnelling. The announcement of the oil pipeline to Rotterdam triggered several requests from local Antwerp refineries to double their output. The period 1975 to 1980 could see the completion of a link to a new European system, starting from a major terminal in Le Havre for 500,000 to 1,000,000 dwt tankers.

Other major bulk commodities are iron ore and coking coal, for the supply of the Wallon Steel Industry. Unit trains (1500 tons) still compete well with towed barges, despite huge works on up-country waterways.

However, straightening the Albert Canal for pushed barges may improve the competitive position of water transportation. This would also involve a direct leg to the right bank's Kanal Dock, circumventing Antwerp by the north.

A new canal, from the Scheldt to the Rhine is also being pushed. Many officials regret that no canal links Antwerp to the Golden Delta in Belgian territory. Extensive land speculation is taking place along the path of this potential new canal and the new Albert Canal leg, but the government cannot directly block land sales. It can only discourage land development by declaring the area a greenbelt, which requires that access and feeder roads be cleared by the government and built before the acreage is split into lots for residential or other uses, a procedure which effectively maintains the status quo.

Other recent or planned improvements, resulting from improved regional and land-use planning are: the construction of tunnels under the Canal Dock and the Scheldt, between Hoboken and Antwerp, the completion an efficient highway beltway system.

B.5.8 Cost Data

To finance the port expansion program, a royal decree appropriated the following monies in the sixties:

- Three billion Belgian Francs ($60 million) for terminal facilities, to be spent over a ten-year period; and
- Ten billion Belgian Francs ($200 million) for the port itself. Initial estimates for $120 million on the right bank and $30 million for the Zandvliet lock were exceeded by $30 million.

For the July 1969 six-year improvement plan (1970 to 1975), a total of $235 million was appropriated for waterway improvements. The breakdown by specific locations of improvement were:

1. Upper River Scheldt -- $33.6 million
2. Meuse River -- 64.8 million
3. Central Canal -- 28.8 million
4. Charleroi/Brussels/Rupel Canal -- 48.0 million
5. Dutch Section of River Scheldt -- 60.0 million

B.5.9 Problems and Lessons

Although there is a channel depth limitation and a need for constant channel maintenance and Antwerp continues to be a port of major importance, the harbor has difficulty accommodating vessels in excess of 65,000 dwt due to the shallow meandering channel. However, the proposed development of the port's left bank should permit entry of 125,000 dwt vessels, the maximum size being considered for the future. Further expansion will have to take place in Rotterdam (linked by pipeline), Dunkirk-Le Havre, or offshore Zeebrugge.

Wet docks are better than tidal quays in the five-meter tide range and tidal currents, except for short-haul shipping (coasters, U.K. trade, roll-on/roll-off),but the lock must be big (Zandvliet was the world's largest for a long time). Thanks to good sandy soil, the Port Authority has developed a fast system of seawall construction that eliminates the need for pile driving. About 2,000 cubic feet of concrete can be poured daily to construct gravity-type seawalls, as illustrated in Figure B-3.

From an environmental control standpoint, the bulk-oil storage-tank failure experienced in Antwerp clearly indicates that piled-earth retaining dikes may be capable of retaining gradually spilled materials, but that all retaining dikes should be evaluated structurally for adequate resistance to static and shock loading of spilled material.

Along with some U.K. experts, Antwerp believes that ore carriers will not go beyond 125,000 to 150,000 dwt in size. Because of the increasing size of oil tankers, Antwerp decided to link by pipeline to Rotterdam, which it preferred to Dunkirk for political and labor reasons, as well as pressures of BP and Esso who have refineries in both Antwerp and Rotterdam. The Zeebrugge offshore island project is not expected to have a chance for development during the next decade. The winding channel in Dutch territory is a problem which has brought on the 125,000 dwt future limitation But general cargo exports from the hinterland, expanding port industry, and good oil links (pipeline and shuttle tankers) to deep water terminals will carry the port forward.

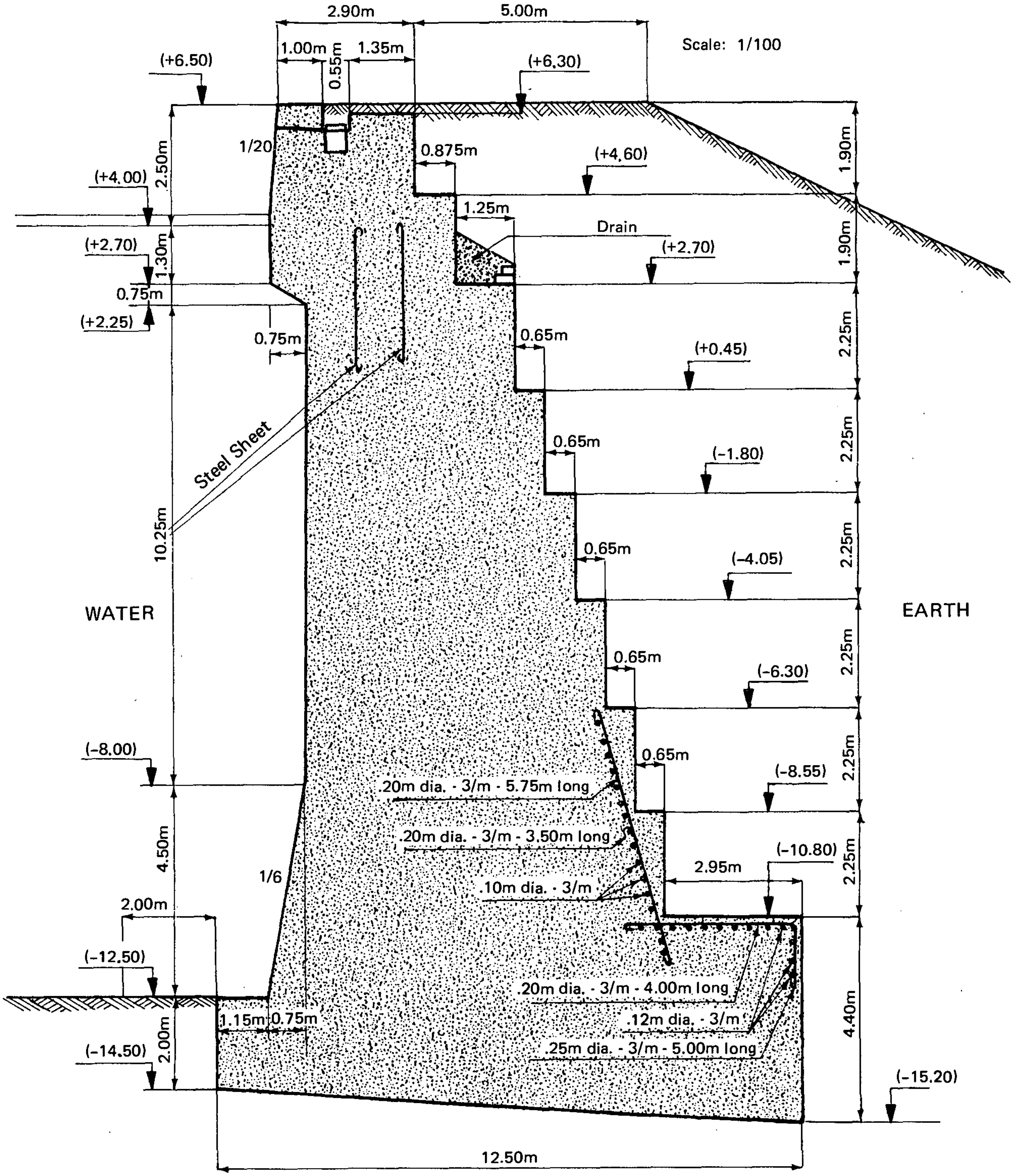


FIGURE B–3 TYPICAL GRAVITY SEAWALL

B.6 ENVIRONMENTAL IMPACT

B.6.1 Environmental Management Efforts

Antwerp has spent significant time, compared to other ports, on the subject of land-use planning related to port development. On the other hand, authorities to date appear to have been only moderately concerned, with respect to pollution abatement or prevention efforts, in action-oriented programs. Maintaining Antwerp's industrial and economic position within the nation -- and indeed the European Common Market -- is by far the most important consideration, as illustrated by the comment by a local spokesman: "Effective concern regarding environmental quality can occur only in a rich and polluted society; we haven't been rich quite long enough."

On the other hand, Antwerp has had considerable success in attracting industrial firms to the port on her own terms. Previous comment to the contrary, there is a growing awareness on the part of many concerned officials of the necessity for more effective environmental management, and we believe it likely that increasingly stringent, though perhaps informal, controls will be applied. Public consciousness has been aroused in particular by chemical odors from the BASF, Bayer, and other plants, the shrinkage of the romantic polder and marshland on the right bank, and the disappearance of river fishing. Recent municipal elections led to the election of an "Alderman for Environment" who took over some of the duties of the Public Health alderman; the latter had set up a sulfur dioxide monitoring system.

From an environmental standpoint, the most important of the Antwerp commissions is the Center for Prevention of Air and Water Pollution, a municipal organization created in 1968. The Center has three main tasks: 1) advise the town regarding air and water pollution abatement procedures to be followed both by the city and industry; 2) assist in controlling air and water pollution and solid waste pollution; and 3) sponsor and recommend research programs appropriate to the city's needs. A fourth function which the Center performs is to advise the municipal council as to whether and under what conditions applications by industrial firms to build new plant facilities should be approved. (This function will be described in greater detail later.)

B.6.2 Organizational Structure

There are no officially recognized air quality standards in Belgium, either on a national or local basis. The basic air pollution control law is the Clean Air Act, initiated by the Ministry of Public Health in December 1964, which provides the framework for subsequent decrees to bring into effect its very broadly written provisions. These provisions include: granting the King the power necessary to take all appropriate measures to prevent or fight atmospheric pollution, defining atmospheric pollution, establishing the means by which royal decrees can be put forth, and assigning to the Ministry of Public Health the responsibility of coordinating follow-on efforts to abate atmospheric pollution.

Follow-on decrees have been few; a 1966 decree was set forth establishing requirements for the approval of laboratories or institutions to undertake official air pollution work. It was by virtue of this decree that the Antwerp Center for Prevention of Air and Water Pollution was created in 1968.

A 1950 water-quality law requires that every industrial facility obtain a waste-water discharge permit from the Authority controlling the river into which the discharge is to be made. It is left up to each Authority, however -- again with no specifics defined -- what specifications or treatment methods are to be followed. The Ministry of Public Works is the governing authority for the Scheldt River, outside of the municipality of Greater Antwerp. For the dock area within the port of Antwerp, the city is the governing authority. The Ministry of Agriculture also plays a role in protecting water and land use, and the Inter-Ministry Commission for Economic and Social Coordination provides the coordination. There is no national legislation about solids pollution, only local laws which may vary from one town to another.

Industry has reacted by creating the Pollution Consulting Center under a special association. Furthermore, the Antwerp and Rotterdam Chambers of Commerce have a permanent exchange agreement which includes environmental matters. Presently, the Advisory Health Board, which includes everyone who has a say in air and water quality, is the big hurdle for building and operating permits.

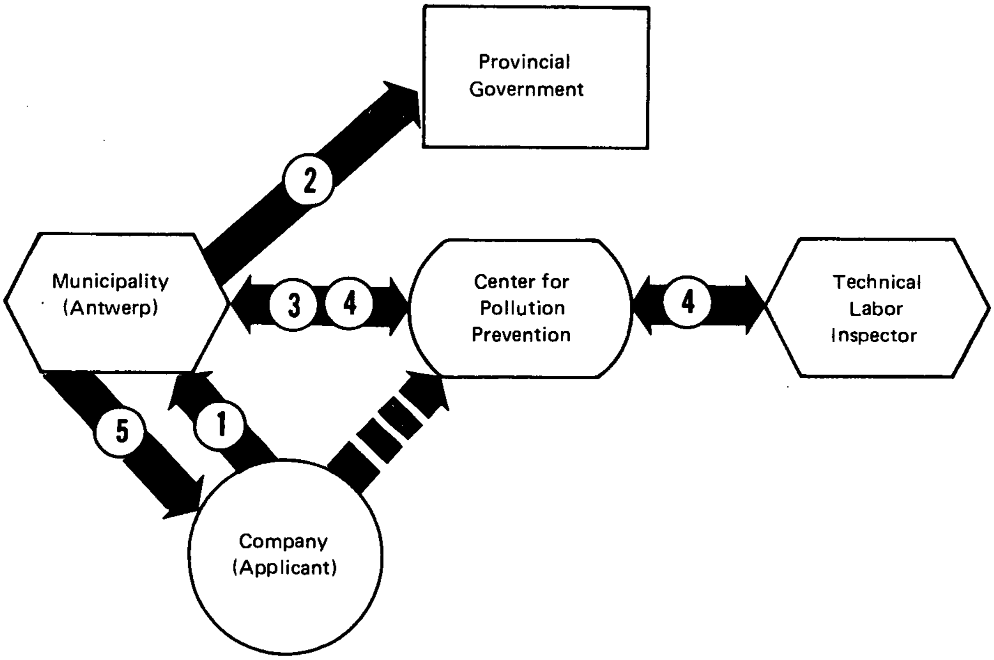
B.6.3 The Center for Prevention of Air and Water Pollution

Members of the Center include university professors, port authority officials, municipal officials, and a delegate from the Provincial Government of Antwerp. Although it is in fact a municipal organization, the Center's activities and influence extend, from a practical viewpoint, over the entire Antwerp Province, primarily with respect to the problems associated with air pollution.

The following hypothetical example illustrates how the Center functions. To locate in Antwerp, an industrial firm must first apply to the College of Mayor and Alderman (i.e., the Municipal Council) for a land concession. The firm is a tenant, not an owner of land, and would, therefore, be subject to certain conditions laid down by the municipality. In reviewing the concession application, the College would seek the advice of the Center regarding health and environmental matters. In preliminary discussions with the applicant, the Center would review general plans of construction and operation with the candidate industry and discuss the overall philosophy which the company expected to follow with respect to pollution abatement. On the basis of these discussions, the Center would advise the College whether a concession should be granted.

Assuming a favorable recommendation, the concession would be enacted between the candidate industry and the Antwerp municipality. Included in the concession agreement are broad conditions regarding air, water, and solid pollution abatement -- requiring, in effect, that the industry conduct itself in a manner deemed appropriate by the town. The implication is that the concession can be revoked at any time if the

FIGURE B-4. PORT CONCESSION AND PERMIT PROCEDURES



1. Company Applies for Concession and Permits.
2. Municipality Notifies Provincial Government of Applicant's Intention.
3. Municipality Seeks the Center's Advice.
4. Labor Inspector Reviews Permits.

3,4 Center Reviews Applicant's Intentions, Building, and Operating Plans.

Center Remains in Contact with Municipality Throughout Processing.

5. Municipality Approves or Rejects Company's Application.

industry does not comply with the conditions subsequently set forth in the building and operations permits.

After obtaining a concession, the company would ask the College for a building permit. The College would again consult the Center, which would make a detailed review of the company's construction, operations specifications, and plans, including examination of production details, effluent details (e.g., chemical nature, amounts, toxicity, concentration, periodicity, etc.), and effluent treatment program. The Center might make suggestions to the company regarding the pollution abatement program, which the company would probably accept. Assuming all went well, the Center would recommend to the city that the building permit be granted. In due course, permission would be granted (all other factors assumed favorable), but with a specific caveat to the company that it must build the plant to avoid pollution, so as to not subsequently lose its operating permit.

With the building permit granted, construction proceeds. Then the operational permit is applied for and presumably granted; the ultimate decision being based upon previous discussions and the understandings reached. If the company in question does not adhere to previous agreements, its concession can be revoked (we were unable to learn of any permit which has been revoked).

Because there are no formalized air quality standards in Belgium, the Commission depends to a considerable extent on the VDI (Verein Deutscher Ingenieure) standards regarding such considerations as maximum emission concentrations and stack heights. Other sources may be used whenever applicable. The Center may also invite a representative of the Technical Labor Inspector (TLI) because this organization is concerned with the health conditions under which the candidate company's workers will operate. While the TLI's concern is specifically connected with the operation of the plant, the Center recognizes that their approval should be gained at this point, rather than waiting until actual operation is under way and risking delays at that time.

According to the 1950 law, an industrial facility must get a discharge permit from the controlling authority of the river into which any waste water discharges are to be made. For example, the authority for the Scheldt River is Belgium's Ministry of Public Works. For the dock area within the Port of Antwerp, the city of Antwerp is the governing authority. Before granting a discharge permit, the authority in charge is required to consult with the State Health Ministry which reviews effluent characteristics and specifies treatment methods to which the company must agree (based upon precedent or existing law).

The role of the Center for Prevention of Air and Water Pollution is a rather passive one in this case: it invites a representative of the Ministry of Health to its meetings, at which it informs the representative of the desires of the Center, including recommendations concerning how discharges should be handled in the area of the Center's concern -- in this case, that portion of the Scheldt flowing through Antwerp, including the dock area.

There is greater uncertainty regarding solid-waste handling. The Center studies a given solid-waste-disposal problem and makes suggestions, but in general allows a given company to handle its own problems as long as they are not deemed directly harmful to the environment. For example, the Center advised one refinery rather strongly that it should discontinue dumping tank bottoms on open land, an action which, if continued, could result in groundwater pollution.

The above procedures relate primarily to "grass-roots" installations built since 1968, the date of the Center's formation. However, the Center has some control over industry built prior to 1968, since rebuilding or modification of existing plants is subject to the Center's review.

Of particular interest is the rather informal manner in which the Center operates and, within the context of Antwerp's environmental concern, the perceived degree of success which the program has enjoyed.

While there are no legislative standards or specifications to which a company must adhere regarding pollution abatement, only those which the Center may recommend in its review of a specific situation, Center officials feel that through this kind of procedure, an applicant comes to know where the town of Antwerp stands and what the company must do to be a "good neighbor." Of course, the threat of concession revocation always lurks in the background if a company does not match its statements of good intentions with appropriate action. Since the Center has staff qualified in economics, engineering, and environmentally related areas, citizens tend to feel that their interests are reasonably well protected and there has been little incentive or reason to form ad hoc groups to question the suitability of a candidate industry.

Because it is a municipal body, the Center is undoubtedly affected by the city's desires whether or not to have a candidate locate within its boundaries. Employment potential, tax revenue, second and third-order industrial effects, and other factors undoubtedly play a part in the Center's deliberations.

However, the dialogue established between the Center and the candidate is also extremely important, particularly since it is established at the very beginning, thereby making the town specifically aware of any risks that it may be taking, as well as offsetting or partially compensating benefits (e.g., employment opportunities) which may be derived. (This same attention to early and continuing communication between various interests is also given extreme importance regarding the question of land-use development by the municipal council, as will be described later on.) Regardless of such questions as effluent specifications, air and water quality criteria, or specific land-use practices, the central point is that virtually all representative interests are involved in a given project from the very beginning. It is this practice which we firmly believe the Federal Government should follow in its review of and development of the deepwater port sites in the United States.

B.6.4 Current and Potential Problems

a. Water

At the present time, Antwerp obtains its fresh water supplies from inland sources and from an area southwest of the city, across the Scheldt River. As far as we could determine, no problems are anticipated regarding water supply, for either the municipalities involved in the Antwerp district or for industry in the near future. Since no fresh water aquifers are known to exist beneath the Scheldt River or the dock areas, it is felt that construction in maintenance dredging will have little if any direct effect on water quality.

Waste-water treatment plants are now being built by most industrial complexes, and discharges are made into the Scheldt River, synchronized with the outgoing tide. Some harmful products such as acid, may have to be taken out to sea. Antwerp's municipal sewage treatment capacity is inadequate, as is that of virtually all of the country; only 5% of Belgium's sewage is treated.

As yet, there are no waste water effluent taxes levied in Belgium, although Center officials believe that these may be instituted some time in the not too distant future and may bear some similarity to those already in effect in France.

The development plans for the left bank (Baalhoek Project) could have an undesirable effect on the immediate land and water resources.
The area, which is largely polder land, would be filled and a new deep channel dredged from the Scheldt to serve the new facilities. Such development of the left bank may eventually expose new land areas to possible salt water contamination and might also adversely affect the quality of water supplies in the Fort de Haasdonk area. However, port

authority officials don't expect drainage problems, since at low tide the water of the Scheldt is below the level of the surrounding land and drainage will be toward the river. If necessary, intercept dikes will be built around the reclaimed area, to catch saline water and allow it to be pumped into the Scheldt and drain to the sea.

With one notable exception, no major oil spills have occurred in Antwerp. In 1967, a new oil storage tank on the Esso Refinery property catastrophically ruptured at the base. The resulting tidal wave of oil (approximately 100,000 barrels)* broke through the standard earthen dike surrounding the tank and then entered the storm water system of the refinery, eventually finding its way into the harbor. Since the harbor was locked, little or no oil entered the Scheldt River. During the next six or seven days, the majority of oil was recovered from the harbor area by a fleet of barges and pumps brought in from Holland and France to supplement equipment on hand. The precise cause of the accident and financial responsibility for the spill is still in litigation.

Harbor equipment for oil spill cleanup includes a small self-propelled oil (skimmer) barge purchased in 1955. A barge is also available for taking on bilge pumpings from small vessels, and early in 1971 a bilge cleaning operation was initiated near the Zandvliet lock. Most of the refineries have ballast-handling facilities and are also serviced by Societe Maritime de Degazage, a private French firm from Le Havre. This firm--which has a virtual monopoly on bilge/water handling--has its rate schedule controlled by the Antwerp Port Authority. An oil containment boom is available to isolate unloading vessels; the boom has a steel skirt of 6.5 feet with a freeboard of 3.3 ft. It will soon be doubled by an air-bubble curtain. This kind of equipment should normally be sufficient for small spills; however, the 1967 spill demonstrated that substantial additional equipment is needed if a major spill is experienced.

* According to a personal communication received from Esso R&E (USA), the tank was approximately 190 feet in diameter and 64 feet high; when it ruptured during filling, it contained about 20 feet of oil.

b. Air

The prevailing winds are south-southwesterly, but only blow in this direction about 25% of the time, according to officials at the Center for Prevention of Air and Water Pollution. Even with this, air pollution from the industrialized portion of Antwerp can adversely affect the downwind communities of Berendrecht, Stabroek, Hoevenen, and others.

In contrast to the situation at Dunkirk, there is relatively little open stockpiling of raw materials (ores, coal, etc.) in open unprotected areas, and consequently dust plumes are relatively infrequent.

Through the offices of the Center for Prevention of Air and Water Pollution, reasonably effective measures have been carried out with respect to industrial particulate control, especially for new plant construction or plant additions. Industrial emissions of sulfur dioxide are combatted primarily through the construction of higher stacks to disperse emissions. There is no restriction on the sulfur content of fuel burned in Antwerp, and SO_2 levels are described as "too high," using a base concentration of 150 micromilligrams per cubic meter. Twenty-six stations in Antwerp currently are monitoring SO_2, CO, and smoke-concentration levels. This service was set up by the Alderman for Public Health prior to the election of the Environmental Alderman.

Though concerned about SO_2 levels, town officials appear to be looking forward to increasing use of virtually sulfur-free natural gas from the North Sea as the ultimate solution to the problem, rather than imposing more stringent SO_2 control procedures (either in the form of low-sulfur fuel oil or the installation of SO_2-recovery equipment).

When the expected development of the left bank of the Scheldt River begins to take place, it is expected that the Center will be considerably more stringent in its pollution abatement requirements concerning new industries that locate in this new area. This expectation stems not only from a basic concern over pollution control, but also from officials' belief that Antwerp Port is in a position to be more selective in identifying and attracting those industries which it wishes to have locate in the Antwerp area.

c. Solid Wastes

Dredging and spoil disposal practices have been discussed in the engineering section.

Municipal solid waste generated in the Antwerp district is first milled near the Albatros refinery site, and then taken to open clay pits near Boom, about 12 miles south of Antwerp, where it is dumped in a landfill operation. City officials are concerned about the long-range problems of solid waste disposal in the Antwerp district, but other than the identification of new landfill sites, little formal planning is being done. Closed steel containers, available on port quays, are picked up regularly by a private contractor.

Industrial solid wastes are handled by the companies themselves; they are either burned on site or landfilled in a north side dump. Improved methods (e.g., the construction of a large clean-burning incinerator) are under consideration, but no formalized alternatives have been developed to meet the current inadequate situation.

d. Noise

Noise is not considered a significant problem at this time, at least from the specific point of view of port development. Downtown Antwerp, like any other major city, can be quite noisy, but this is not necessarily the fault of the Port Authority.

e. Land Use

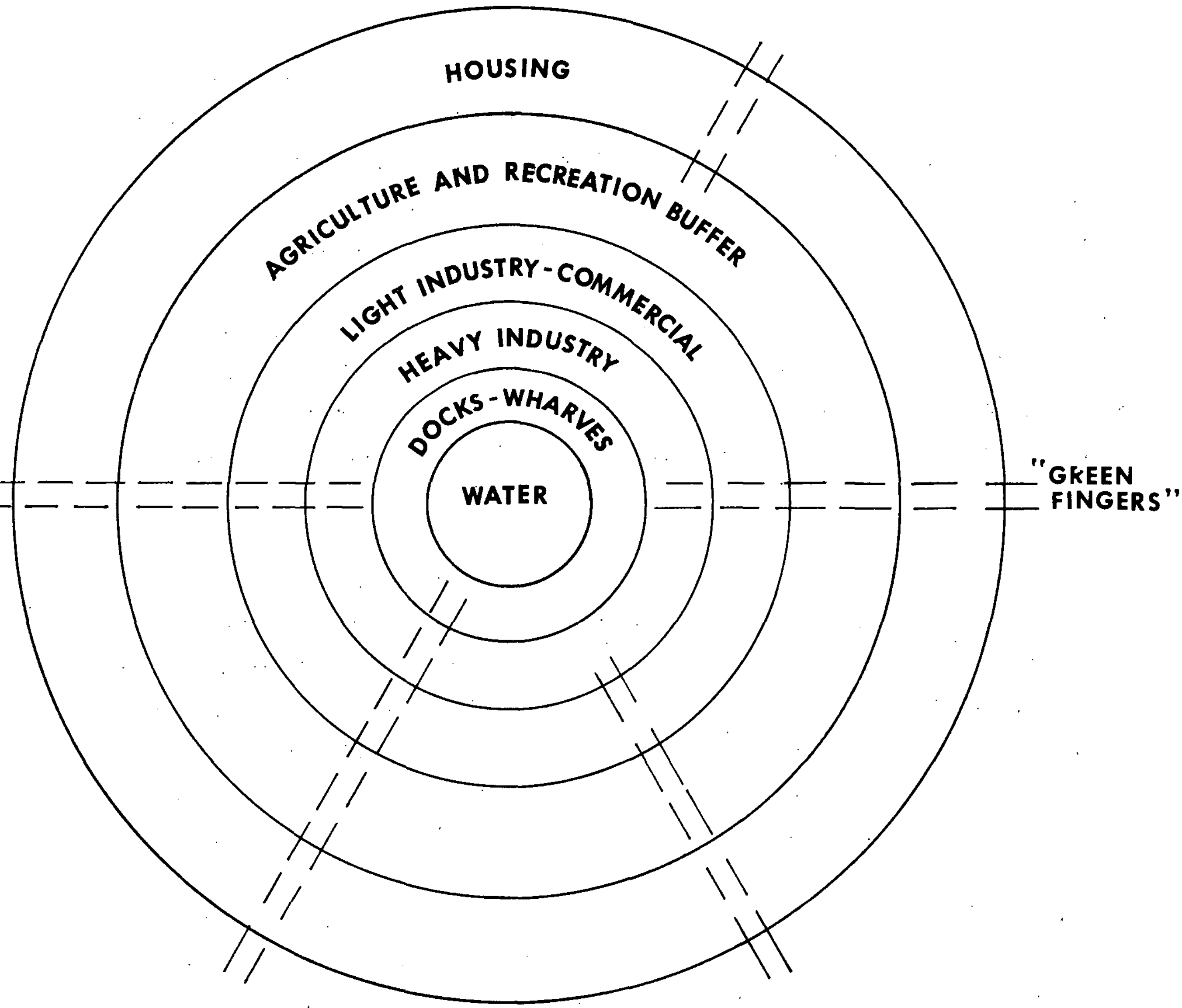
Because of Antwerp's rapid growth and its importance to the Belgian economy, a major and a continuing problem is the availability of desirable industrial sites and the required expansion of the port area to obtain such sites.

Another major difficulty which Antwerp has always had to face is that the ownership of the land on either side of the Scheldt estuary: downstream is primarily in Dutch hands, and that of the left bank belongs to another municipality and province. This means that regional planning, transportation planning, land acquisition, and development is a long job, sometimes involving international negotiations which are slow and cumbersome. To some extent, the same situation might appear in the United States where two or more states might become involved in the construction and operation of a deepwater port -- or where, for example, in Puget Sound -- the United States and Canada might be involved.

Because of draft limitations on the Scheldt, Antwerp certainly cannot be considered a truly deepwater port in terms of depth capability of other ports (e.g., Rotterdam, Dunkirk, LeHavre, and Marseilles-Fos) and has in fact resigned itself to a 125,000 DWT limit with a pipeline to Rotterdam. On the other hand, the extent to which Antwerp's land-use program for both banks of the Scheldt -- now in effect on the right bank -- may provide lessons which might be applied in the United States.

The Gwestplan developed for the right bank is a land use or occupation plan through the year 1980 which was recently approved by the Antwerp District (38 municipalities). In general, the Gwestplan may be considered a series of concentric circles, as shown in Figure B-5, with the docks and water-dependent industry in the center, surrounded by light industry and commercial activity, then agricultural and a "green" buffer zone, and finally housing. "Fingers" of green belt or recreational acreage frequently extend across two or more of the concentric

FIGURE B–5 DIAGRAMMATIC REPRESENTATION OF ANTWERP DISTRICT PLAN FOR THE RIGHT BANK



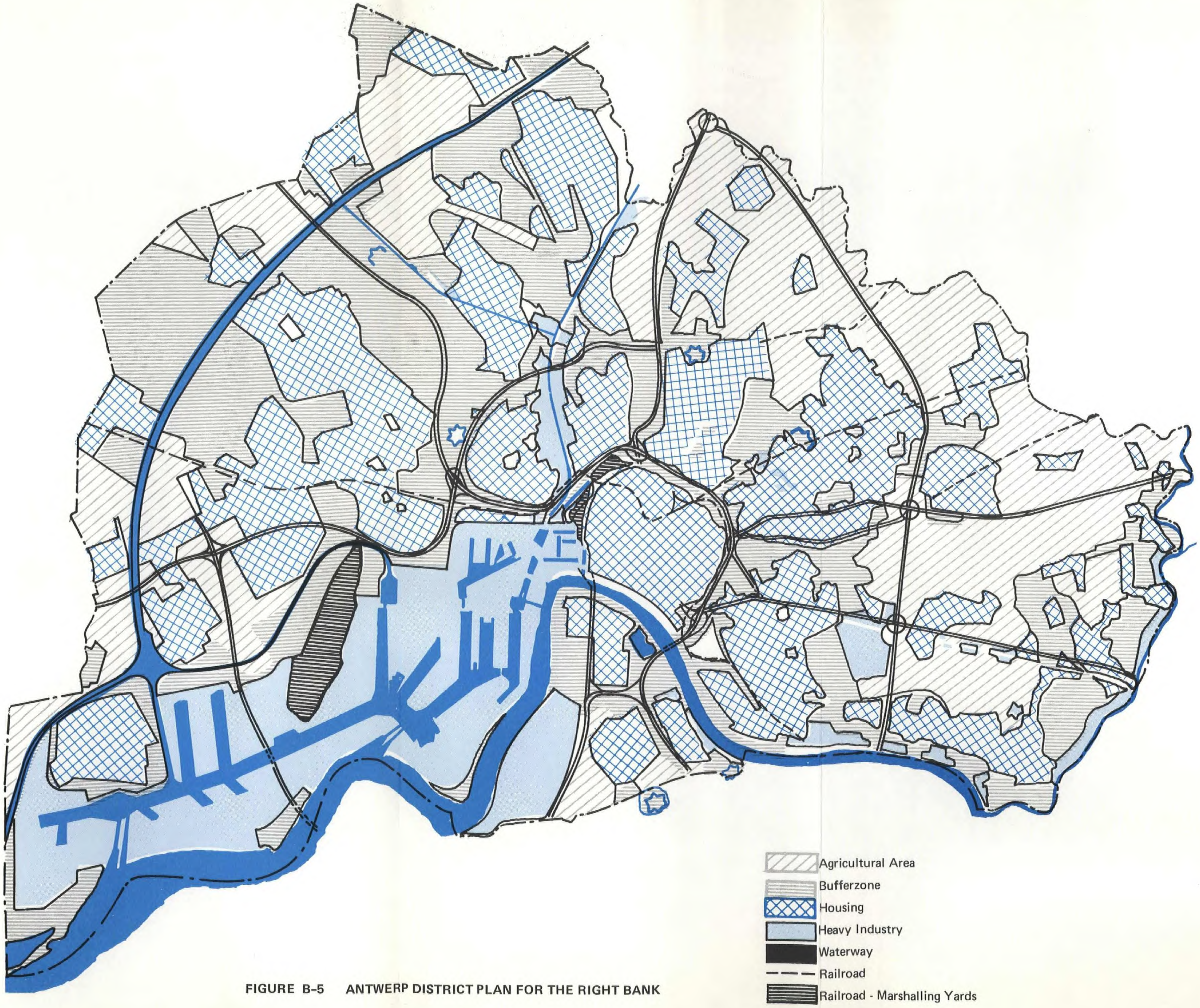


FIGURE B-5 ANTWERP DISTRICT PLAN FOR THE RIGHT BANK layers to improve communications to the industrial center and provide visual and aesthetic relief. Restricted building activities are allowed to occur in certain "green" zones. Used as buffers, these areas might include office buildings, schools, recreational facilities, and the like. There are parks with only recreational buildings, and natural conservation areas where nature cannot be altered. Depending on population density, certain residential areas may also contain light industry or commercial activities. Although there seems to have been relatively little consideration given to the intrinsic suitability of the land itself for the various uses specified, the Gwestplan appears to be quite well conceived and amenable to reasonable changes in the future, so long as the basic concept of separating different kinds of land use is not violated. In fact, practically all industries located within the city have been moved out. Expropriation is carried out by the government, and the city reimburses displaced individuals and companies.

During 1971, residents of the 38 communities involved will have an opportunity to review the Gwest plan and request changes which might be made. A potential problem is that several townships want income-generating industry on their own property, and greenery and agriculture on their neighbor's - an interesting contrast to most situations in the U.S. By the end of 1971, it is expected that the plan will receive official approval from the National Ministry of Public Works.

A similar plan has been prepared, but not yet passed, regarding the left bank development, which, when it takes place, will serve to effectively double the port and industrial capacity of Antwerp and possibly include an international airport (although the latter idea is still controversial). Antwerp officials are particularly concerned about the expropriation and relocation of residents in the areas affected, because there is a widely held opinion that the right bank land acquisition program could have been carried out with greater sensitivity to the needs of the affected people.

An example is the experience of the residents of Berendrecht which is some distance to the north of Antwerp itself and close to Kanaaldock D-3 and is now surrounded by industry. By 1958, Antwerp's harbor had been expanded substantially and it became apparent that further expansion would be required if it were to maintain its position as a leading European harbor. Therefore, the government planned to take an additional 6200 acres of farmland north of town for the new Kanaaldock area, which would also make available sufficient acreage to attract new industrial firms. This area, including the towns of Berendrecht and Zandvliet, were annexed by Antwerp.

In the first plan of development, the entire area was to be industrialized, with complete relocation of any communities in the way of the project. This concept was fought by the two communities because workers in the small communities surrounding the new area needed to be closer to their jobs than the 20 miles or more that the plan required. As a result of this resistance, a High Court decision allowed both Berendrecht and Zandvliet to remain. However, many farms outside of the communities were expropriated without sufficient appreciation for the farmers' historical traditions of working the land; furthermore, the authorities devoted insufficient effort to thoughtful relocation of the expropriates and to efficient management of indemnification monies.

The city also put up a number of low- to middle-income housing projects in Berendrecht and Zandvliet. While this allowed workers to remain relatively clost to their jobs, it altered their environment and subjected both old and new residents to significant amounts of air pollution, some water pollution, and overcrowding. Thus, while standards of living have unquestionably risen in the strictly economic sense, there is a real question as to whether the social and environmental costs were worth the economic benefits. One municipal official summarized the situation by saying that the planners had paid too little attention to the questions of human relations, and that the citizens had not been warned of their plans. In retrospect, this same official feels that perhaps he should not have fought for the survival of Berendrecht and Zandvliet because it turned out to be a poor environment. His efforts could have been better spent on securing more indemnity and, above all, more help in relocating and readjusting the people.

Looking ahead, as a result of the Berendrecht and Zandvliet experience, a significant proportion of the population on the left bank of the Scheldt River are rather dubious about whether their needs have been taken into account, so that the subsequent industrialization and expansion of Antwerp may in some significant way be hindered by past results. Many people now feel that left bank communities such as el -- which, like Berendrecht, wish to remain relocated -- should be moved now, but be effectively relocated away from pollution, in an environment similar to the old one, with new houses individually built <u>now</u> for the relocated residents. Unfortunately, the left bank plan presently envisions very little relocation of individual homes or small communities, although now is the time to plan for such relocation and assistance to the residents, rather than just give money and push people out or allow the settlements to "die slowly on the vine" as they are progressively surrounded by the heavy industry for port activities. A general lesson drawn by European port planners is to try to expand in virgin areas, where practically no one has to be relocated.

All of these problems are related primarily to an integrated port concept -- that is, a port which is not merely a terminal for handling incoming or outgoing cargoes, but one which is intended to process products (i.e., upgrade iron ore to steel, refine crude oil, manufacture petrochemicals, or other manufacturing activities). If a comparison can be fairly made, it would seem that if properly designed, a strictly transfer operation, such as the one in Bantry Bay, would be far less detrimental to the local physical and social environment than an integrated port. Industries dependent upon the port would then be required to locate at some distance in satellite areas, so that environmental planning could be more effectively carried out. Admittedly, such an approach would be more costly from an economic standpoint, since the advantages of a deep port would in part be negated. To the extent that they could be quantified, however, the social and environmental advantages might well offset the economic disadvantage.

B.6.5 Future Issues

With the continued development of the port, as it becomes more affluent and thus environment conscious, Antwerp will face several issues, among which the most important are the following:

- As Antwerp continues to modernize, older less efficient harbor-related activities will have to either be rebuilt or replaced by some other type of activity. To date, "urban renewal" constitutes only a tiny fraction of the district's planning efforts.
- Increasingly stringent pollution-abatement requirements will have to be passed and enforced.
- More sensitive planning will have to be carried out with respect to communities, farms, or homes which are encroached upon or surrounded by industrial activity.
- As industrialization opportunities expand, new candidates for location in Antwerp will have to be carefully screened for their effect upon the environment and the social contribution they can make, not only to the economy in general but to specific communities.

Presently, the attitude is still sensitive to cost benefits in terms of employment; a relatively small, but "dirty", plant may be denied a concession or building permit, while another larger plant, still "dirty" but providing greater employment potential, would have a greater chance of acceptance.

This could change when the quantity of jobs becomes a hindrance in a labor-shortage situation, and when people start considering life and work quality as prime requisites, instead of advocating additional expansion with foreign labor which has resulted in more crowding. Existing good communications between labor, management, and the state administration must hence be maintained.

APPENDIX C

THE NETHERLANDS

ROTTERDAM AND AMSTERDAM

APPENDIX C

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APPENDIX C

C.1 ROTTERDAM

C.1.1 Summary

Rotterdam is not a new port. Almost totally destroyed in World War II, it capitalized on its geographic position and the need in post-war Europe for efficient port facilities to rebuild into the world's largest seaport. As such, Rotterdam epitomizes many of the conflicts facing port planners today: increasing demands for deep water capability, expanding land requirements, overcrowding, pollution, increasing competition from other ports, and some uncertainty as to "where it will all end".

Rotterdam is situated on the joint delta estuary of the Rhine and of the Meuse; the former is the world's busiest commercial river, while the latter runs through Belgian coalfields and iron and steel industry regions deep in the industrial northeast of France. The Rotterdam region of the Netherlands also has the densest road and canal network in the world, allowing efficient transport of vast quantities of freight to most of the countries of Western Europe. These factors combine to make Rotterdam the most favorably located port in Europe, and first in the world for trade volume.

We have extracted the following highlights of Rotterdam's deep-water port experience, based on a literature survey and a field trip, including the Hague, Schiedam, and the Hook of Holland as well as the ports of Rotterdam and Amsterdam.

- Rotterdam is a municipal port which receives from the state funds for all maintenance dredging and two-thirds of initial deepening costs. In addition, the city budget absorbs each year the deficits from the port, ferries and port railway operations while waiving the local taxes. However, this support remains below what has been enjoyed by directly competing ports in Belgium and France. Rotterdam is trying to muster more support from the state or the province which, since the abandonment of the "monoport policy" concept in 1966, would rather restrict Rotterdam expansion and screen the new trade and industries it seeks to attract. A major area of contention is what deliberate limits, if any, should be set on Rotterdam's needs for deep-water sites during the rest of the century.

- The basic development strategy of the Port of Rotterdam has been to expand local industrialization. Captive traffic is the best way to compete in the Northwest European port competition. The construction of improved deep-water harbors alone without on-site industry is not viewed as the answer, because the diversionary tendencies (from competing ports) will be too strong and will make themselves felt in the next decade.

- Other local planning efforts are primarily carried out through the Rijnmond, an authority initiated in 1965 and embracing 25 municipalities, including Rotterdam. Though it is responsible for the Provincial government, the Rijnmond is virtually an autonmous organization, having authority over two major subjects overall land use and the location of the major land uses. The Rijnmond is more and more in conflict with the Port's strategy.

- Sophisticated techniques are used in national and regional planning. A regional input/output model is in the making, to be updated somewhat less frequently than the national macro-economic model. In the meantime, Rotterdam's many port traffic forecasts use various methods: production/acreage ratios, interviews with major corporations, estimates of induced industrialization, industry/employment/acreage ratios, multiple regression analysis and port area input/output models.

  Input/output techniques have also been used to determine the manpower requirements of major port industries, and compare their return on investment to the national economy. Metallurgical, chemical process and refining operations have been calculated to be the most beneficial activities, with shipbuilding having marginal positive effects.

- Planning for very large ships is aleatory. Maas Vlakte I was planned for 57 ft. vessels in 1963 and modified for 65 ft. vessels after work began on implementation, in 1967. The question of whether tankers beyond 250-300,000 dwt could berth at Rotterdam is still unanswered because it would require much additional dredging, possibly including part of the English Channel. Alternatives are the rerouting of such large tankers around the Scottish Peninsula, or the development of super-tanker hulls with shallow draft - now being investigated with government support.

- The natural coastline ceased to be a boundary some time ago; nearly 6,500 acres of shallow sea off the coast, known as Maasvlakte I, which will yield 4,025 acres of net usable space for port handling facilities and industrial sites, is now being turned into dry land surrounding several huge dock basins. Forty percent (40%) of new land development is generally absorbed by wet or dry port infrastructure and superstructure.

  The Rotterdam authorities believe that all the available industrial space in the Maasvlakte I will have been reserved by companies when the project is completed by 1971. Rotterdam is also convinced that the demand for sites on or near deep water will not be stilled by then. Consequently, Rotterdam is actively studying the technical and economic aspects of extending the artificial Maasvlakte I southward.

  Another possibility is the development of the delta area to the south of Rotterdam. Rotterdam, in fact, foresees the whole area between Rotterdam and Antwerp as developing into a vast and almost continuous port/industrial complex. This concept would dwarf the Dunkirk-Calais project, and has attracted Antwerp's interest despite the traditional rivalry.

- There are two strong obstacles in the way of this Rotterdam plan. One is the overcrowding of the western Netherlands, to which Dutch public opinion is becoming highly sensitive. The other reason is that many see the delta as an indispensable area for Rotterdam City itself and feel its sand dunes, coasts, and open spaces should be developed for recreation, and its population centers expanded further to accomodate Rotterdam's overspill.

- Up to the present, concern over the quality of the environment has played a relatively small role in the development of Rotterdam. Despite a strong institutional structure, with a Nuisance Act dating from 1875 and encompassing air, water, and soil pollution, noise and odors, fire, safety and radiation hazards (but not yet visual intrusion and aesthetics), the central preoccupation of the Netherlands and Rotterdam continues to revolve around land reclamation and continued economic expansion; an indication of the increased questioning of this policy is the 5,000 annual net emigration balance over immigration in the greater Rotterdam area and the fact that the Rijnmond receives as many as 20,000 anti-pollution calls per year.

- For better overall environmental quality, management, planning and control are being shifted from the local level to provincial and federal institutions. This shift has been completed for water; air management should be transferred by the end of 1971. To date, national air and water quality standards have not been established; flagrant violations are combatted through technical assistance and moral condemnation. It is expected, however, that more stringent regulations will be passed.

- Overcrowding and heavy commuting, inadequate greenbelts, and recreation areas, insufficient revenue from industrial land rentals, pollution and safety hazards, and traffic congestion are characteristic of the Rotterdam area. As Rotterdam continues to expand

and become more densely populated with industrial operations, the pollution potential will not only become greater, but the possibilities will undoubtedly sharply increase regarding accidents involving dangerous materials, explosives, fires and spills.

- The extension of the moles or breakwaters at the harbor entrance is expected to change the pattern of the currents along shore and thereby affect sediment transport. Beach cultivation is underway. Relocation of the beach facilities and an extension of the access roads will be warranted.

- The port has had sloughing and sliding problems for years, and seawall fractures have been common. The deepening of the channel has increased inner harbor wave action, and in combination with the suction of the dredges and tidal seepage forces, has accelerated erosion of the river bottom.

C.1.2 General Area Description

a. Geography

Located on the Netherlands' west coast, the city of Rotterdam is about 20 miles inland on one of the major portions of the Rhine River estuary and is also at the northern extremity of the so-called "Golden Delta" region (see Figure C.1).

A seaport community since before 1300, Rotterdam rose in stature to a major European port in the 1930's. The city and harbor of Rotterdam were virtually destroyed during World War II; afterward, the entire area was rebuilt and extended. With the resurgence of the European economy and Holland's membership in the European Economic Community, Rotterdam has become the world's largest seaport.

b. Surficial Character

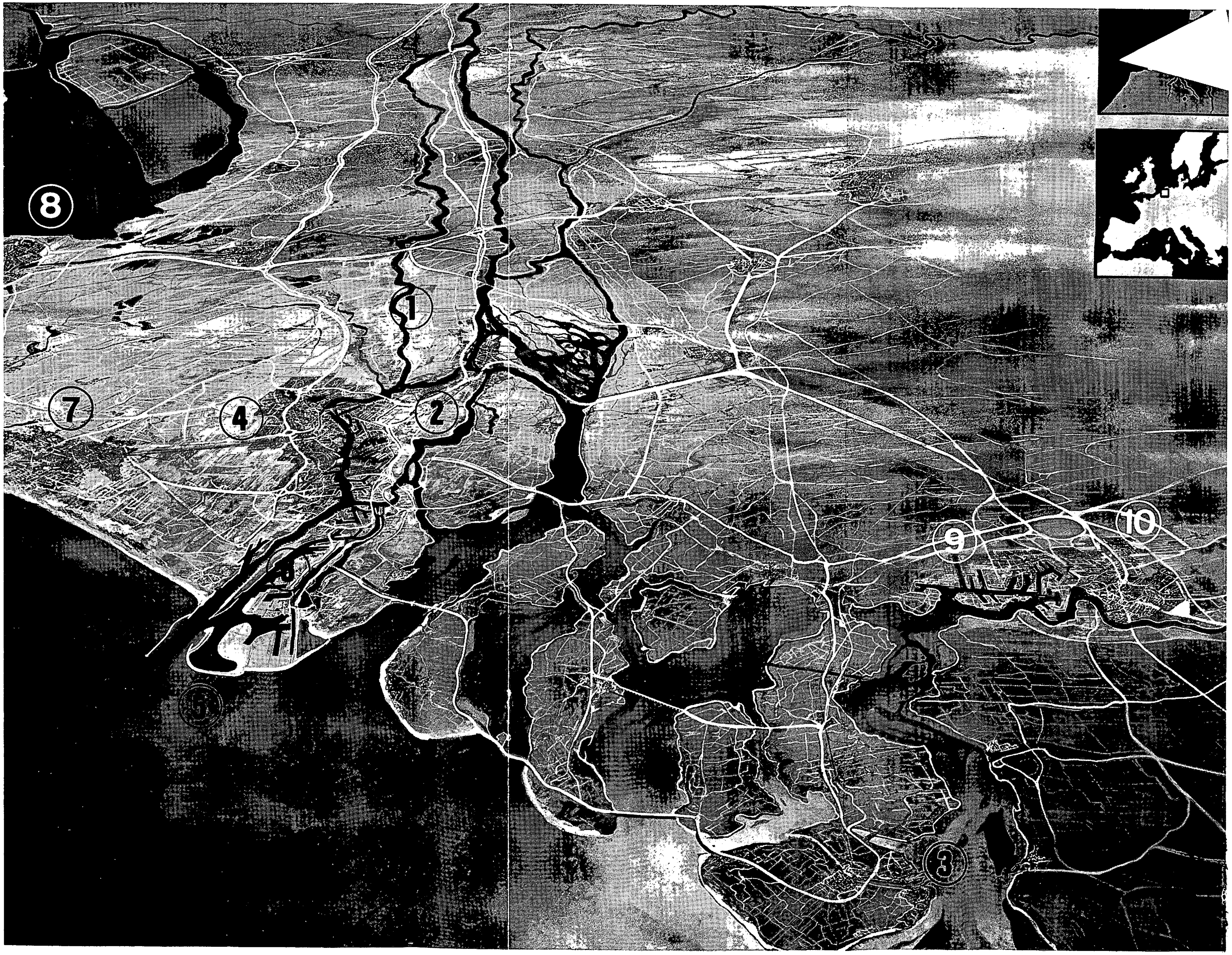
As is typical of much of the Netherlands coastal region, substantial portions of the Rotterdam area have been reclaimed from the North Sea and lie at or below sea level. Sand, clay, and peat are the principal soil materials, forming a layer of quaternary sediments of considerable thickness.

c. Climate

Visibility in the Rotterdam area is 4 kms (2.5 miles) or more over 75% of the time and over 10 kms. (6 miles) at least half the time. Rainfall ranges between 20 and 30 inches annually, temperature is between 30 and 55°F, and the average wind speed is 11 mph. Prevailing winds are southerly about 35 percent of the time.

RHINE-SCHELDT DELTA

FIGURE C–1 ASTRONAUTS' VIEW OF THE GOLDEN DELTA



(1) THE RHINE
(2) THE MEUSE
(3) THE SCHELDT
(4) ROTTERDAM-CITY
(5) MAAVLAKTE I
(6) EUROPORT
(7) THE HAGUE
(8) AMSTERDAM
(9) RIGHT BANK
(10) ANTWERP

d. Channel Hydraulics

At the Hook of Holland, on the coast, the tidal range has a mean variation of 5.3 feet increasing to 5.7 feet with spring tides, while in Rotterdam itself, tidal variations are somewhat less, ranging from a mean of 5.0 feet to 5.3 feet during spring tides. During high tide, cross currents of about 2 1/2 knots occur in the outside channel, running in a westerly direction. These cross currents create a need for heavy maintenance dredging.

e. General Land Use

Virtually the entire left (southern) bank of the waterway connecting Rotterdam with the North Sea is industrialized or committed to harbor use up to a width of about 1-1/2 miles (Fig. C-2). A similar situation exists on the right bank for about half the distance of the waterway from Rotterdam. Principal industries are refining and petrochemical operations.

Several communities, principally Rozenburg and Pernis, both on the left bank, are virtually surrounded by industry, although they are protected to some extent by "greenbelts." These communities, which it is assumed chose not to be displaced by industrial expansion during the development of the Rotterdam area, are seriously threatened from an environmental standpoint, and because of their location on the waterway, are prime candidates for eventual replacement by industrial plants.

There appears to have been a specific intent to limit lateral expansion of industry and instead to restrict it to a narrow belt surrounding the waterway. It is obvious, however, that pressure is increasing to expand the industrial area because existing land sites are limited. A new dock is planned on the right bank between the Hook of Holland and the community of Maassluis.

Because of the need for additional docking area besides that just described, it is also planned to extend Europort seaward by constructing the Maasvlakte, a deep-water port area immediately west of Europort.

f. Population

Present population of the city of Rotterdam is somewhat in excess of 700,000; within what might be called the Greater Rotterdam area, which falls within the authority of the Rijnmond, a population of about 1.2 million lives in an area of some 155,000 acres.

Although the population of Rotterdam is increasing, we were informed that, because of poor or expensive living conditions, insufficient variety, and a "dirty and crowded existence," people are leaving the city in the amount of a net 5,000 per year emigration over immigration. This does not include births within Rotterdam which offset this 5,000 negative figure. The people who are leaving Rotterdam are largely skilled blue collar or white collar workers whose rising standard of living has made them aware of their depreciating environment, and they have therefore decided either to go elsewhere within Holland or to relocate well outside the Rotterdam area but keep the same job. An unsettling result of this population shift is that Rotterdam is becoming increasingly populated with semi-skilled labor, which in turn tends to further depreciate the environment.

The physical and economic growth of Rotterdam plus the shifting patterns of population create rather dramatic pressures in various sub-areas of the Rijnmond region. For example, we were informed by an official of the Rijnmond that approximately 70,000 people are now living in the Voorne area and working in the western portions of the Rotterdam Harbor complex; this official estimated that by 1990, 200,000 people will be living in the same area, for a compound growth rate of approximately 5 1/2 percent.

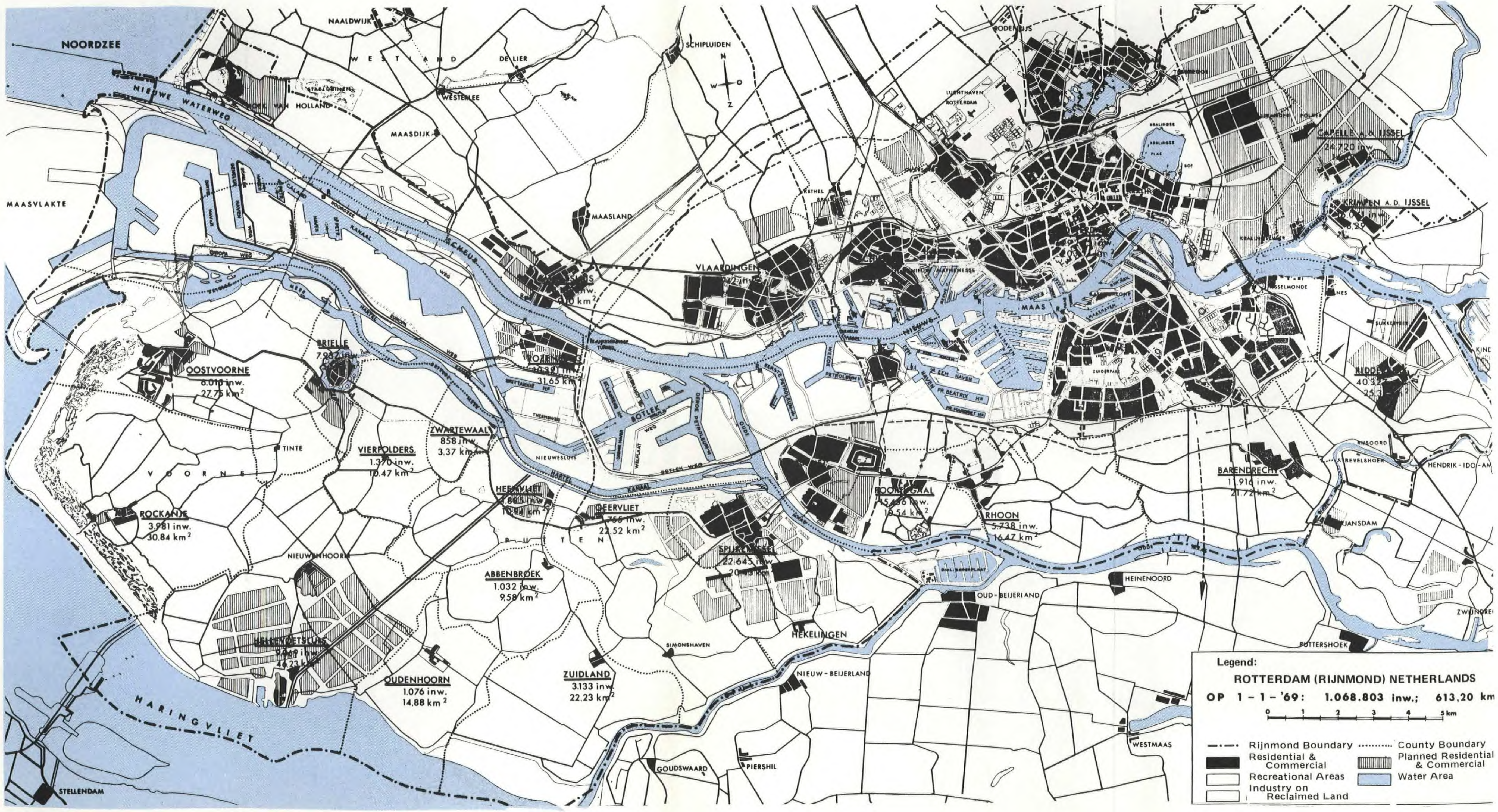
g. Port

Major commodities handled by the Port of Rotterdam include crude oil and petroleum products, ores and coal, fertilizers, and general cargo. The principal commodities handled are crude oil and petroleum products, accounting for approximately 60 percent of the throughput in 1969.

The main access channel to the waterway has a present draft of 65 feet. If a minimum bottom-to-keel clearance of 15 percent of the ship's draft is included, vessels of up to approximately 250,000 dwt can be accommodated at high tide. Vessels have direct access to the port without having to go through locks.

With the construction of the Maasvlakte and related deepening of the access channel, it is expected that vessels up to 300,000 dwt can be accommodated in Rotterdam.

FIGURE C–2 THE PORT OF ROTTERDAM



C.1.3 Institutions And Financing

a. Rotterdam Port and Municipality

Rotterdam is a municipal port. The basins, their quays and most of the land in the port area are owned and controlled by the municipality, although part of the Europoort area lies outside the municipal boundaries. Some of the land in the port area is owned by shipyards and other industrial enterprises, and some by the Dutch Railways.

A municipal port authority, headed by the managing director, appointed by the City Council, is responsible for the day-to-day management of the port. Policy is decided by a Board consisting of the Burgomaster and six Alderman, assisted by an advisory committee for port management, itself presided over by the Alderman responsible for port affairs, and consisting of five other members of the City Council, and six citizens representing the various interested groups in the port, employees as well as employers.

All the capital requirements of the port are provided by the municipality. Any surplus or deficit on the port operations in any year is transferred to the accounts of the municipality as a whole, and is not carried forward in the port accounts.

b. Development Financing

The officials at Rotterdam believed that, under the present legislation in other countries, the port is now receiving the least amount of outside assistance of any port in Europe. The Burgomaster has recently been expressing the same view and contrasting the situation of Rotterdam with other European ports. As far as other Continental ports are concerned, they may well be right, though it is difficult to make direct comparisons between capital and revenue subsidies.

The financial subsidies received by Rotterdam are the following:

- The State pays for all maintenance dredging outside the port area and bears two-thirds of the cost of deepening the channels (except the new 65 feet deep offshore channel). The access channel, the "Caland" and "Beerkanaal" have been financed 100 percent by the Port Authority. The construction of the dams in the Mosan area has been supported two-thirds by the state and one-third by the

Port Authority. The government has since requested that the Port Authority return the funds.

- The operating deficit of the port is written off each year in the municipal accounts. The port is thus receiving an annual subsidy of the amount of the deficit which in recent years has been substantial. In addition, the port does not have to bear the burden of financial charges on the deficit.

  It was pointed out that in the past the port produced surpluses which were paid over to the municipality; however, the current deficits are considerably larger, and to this extent the port is indeed being subsidized and not living on reserves built up in the past and held in the municipal accounts.

  The authorities stated that they expected to make surpluses again in two years' time, but with the Maasvlakte development we believe that the port will remain in deficit for several years to come.

- As a result of accelerated depreciation, the interest charge payable to the municipality is lower than it otherwise would be.

- The port is not subject to local taxes nor does it have to bear the costs of land police or fire brigade services in the port area.

- The port only bears half the operating loss of the railway in the port area.

- The municipality paid two-thirds of the deficit on ferries.

Infrastructure (locks, basins, docks, roads, bridges) are investments financed in totality by the Port Authority. The superstructure (cranes, buildings, etc.) is in principle financed by the private sector. The handling and storage facilities which have been financed in the past by the Port Authority were sold to private industry in 1968.

Rotterdam Port Authority has shown great desire for more government aid to combat the intensifying competition from other European ports. Rotterdam appears to be facing a strong competitive disadvantage compared to the other European ports as far as subsidies are concerned; for example, in Antwerp, the state is funding two-thirds of the investment costs of the harbor entrance to the 20-mile waterway between the city center and the Hook of Holland and in France the state pays 60 to 80 percent of investment costs and covers all maintenance expenditures.

c. Beneficiaries

In the opinion of the Rijnmond economic group, the companies and the nation overall were basically the only beneficiaries of port development. The municipality of Rotterdam is heavily in debt because of its financing of infrastructure in the port, and per capita income in the Rijnmond area is no higher than any other region of the nation.

The Rotterdam area has been particularly attractive to large corporations because of the comparatively low price of land. The companies purchase (also lease) land on favorable terms with a considerable amount of stockpiling. Lease contracts are initially for a 25-year period with two more 25-year options available. An item of high priority should be the reevaluation of this land.

d. Port Labor Force

The port authority does not act as a port operator and consequently does not employ dock labor. All cargo handling operations are carried out by private enterprise companies. Approximately 14,500 dock workers are permanently employed in the port. Of this total, 12,000 are employed by individual employers and 2,500 are in a labor pool. The labor pool basic wage is financed through a surcharge on cargo-handling charges.

There are three labor unions operating in the port as follows:

1) N.B.V. - the largest union (Socialist)
2) C.B.B. - the Protestant union
3) K.B.V. - the Catholic union.

The unions negotiate with the employers as one unit; the standard working week is 40 hours. In 1967, a school for "dockers" was started, and only certificated workers are now added to the labor force. Through the sixties, the pattern of labor relations was good, and Rotterdam enjoyed the advantage of having a highly competitive port labor force. The major reasons advanced for this position were:

- the steadily rising station of dock labor through the introduction of sound training programs;
- sound negotiating practices;
- increasing levels of pay in relation to other sectors of Dutch industry.

In 1970, however, worker turnovers increased and a major strike occurred, due primarily to the wage discrepancy between Rotterdam and neighboring ports, principally Antwerp. As a result, wages were increased substantially, but the yearly turnover rate remains uncomfortably high, while productivity is believed inferior to Antwerp's.

e. Regional Authority--Rijnmond

Prior to World War II, the growth of the port of Rotterdam occurred within the municipality itself, which grew on an "as needed" basis by incorporating small adjoining municipalities in order to acquire the necessary acreage to build port facilities and related industrial sites. Virtually all operations relating to the port were under the control of the Rotterdam municipality.

Following World War II and the reconstruction of Rotterdam, the port began to grow at a much faster rate than in the late 30's, and the municipality found it increasingly difficult to expand its jurisdiction without seriously conflicting with the traditional autonomy and prerogatives of adjoining communities. As a result, it became increasingly evident that a new kind of governmental authority was required which would take into account not only the needs of Rotterdam and the port itself, but also those of surrounding communities which were being or could be affected by port operations, and in so doing, provide a more rational and thoughtful planning framework within which the port of Rotterdam could grow.

After much discussion among authorities at local, regional, and national levels, a solution was agreed upon in 1964, culminating in the formation of the Rijnmond (Rhine estuary area) in 1965. In essence, the Rijnmond is a supra-municipal authority, comprising at present 23 municipalities and covering an area of some 155,000 acres. The Authority is a legal entity, established at Schiedam and consists of a council, an executive committee, and a chairman. The council, consisting of 81 members, is directly elected by the population for a period of four years. The six members of the Executive Committee are appointed by the Rijnmond Council, each for a period of four years, while the Chairman is appointed by the Queen for a period of six years, but is not a member of the Council.

The Rijnmond thus falls essentially between municipal and provincial levels of government, and "reports" to the province of South Holland. It is in effect an autonomous organization having virtually full authority within its region over two major subjects: overall land use, and the location of major land uses. There is no other similar formal authority operating in The Netherlands at the present time, although a similar move seems to be afoot for the Amsterdam area.

In addition to its planning efforts pertaining to its region, Rijnmond personnel interrelate with and advise communities outside the Rijnmond area and also cooperate with neighboring provinces on a "good neighbor basis."

With respect to land use, the Rijnmond Council is obligated to prepare regional plans for the entire area under its jurisdiction or for parts within that area. The regional or sub-regional plan prepared by the Council requires approval from the Provincial Government before it can take effect.

With respect to the municipalities within its jurisdiction, the Rijnmond is empowered to issue guiding directives regarding the following:

1) Dock and industrial site construction,
2) Industrial establishment on appropriate sites,
3) Housing construction and distribution,
4) Open-air recreation,
5) Construction and improvement of roads and waterways,
6) Transportation of passengers and goods,
7) Cross river communications (e.g., bridges and tunnels),
8) Air and water pollution control.

The Rijnmond brings to the attention of the Provincial Government, and to the authorities of the municipalities affected, the results of their studies regarding any of the above subjects; the communities involved have the right of appeal to higher authorities, but if this appeal is denied, the Rijnmond directives have the force of law.

Besides its authority over the Rijnmond area specifically, the Council can on its own initiative tender unsolicited advice or proposals to government officials in the Province of South Holland or to municipalities within the Province. Such advice has no legal weight, but because of the stature and importance of the Rijnmond, it is certainly given consideration in larger areal programs.

The financial obligations of the Rijnmond Council are paid for by the municipalities involved in proportion to their population, with Rotterdam contributing the major share of the monies needed.

As is the case with many authorities of this type, its members often believe that it does not have sufficient authority to carry out the programs in which it believes, nor that it has adequate funding. Accordingly, it is seeking to remedy these two deficiencies by obtaining certain taxing powers as well as to increase its authority in the fields of road and waterway construction, public health, recreation, and cross river transportation.

Obviously, the ascension to greater power by the Rijnmond Council will be somewhat at the expense of the municipalities which it serves and of which it is a part. The degree to which the municipalities involved perceive Rijnmond in a directly beneficial or adverse light regarding their interests will in large measure determine the long-term success of the Rijnmond in its attempts to broaden and increase its powers.

C.1.4 Economic Appraisal

a. National Seaport Policy

In 1966, the major principles for a national seaport were laid down in the "Zeehavennota Report."* In this report, the Netherlands' central government issued an outline of possible future development concerning the nation's seaports and the policy to be followed in order to obtain an optimal solution to the economic and social problems connected with over concentration and development in the Rotterdam area.

The report recognized the significant change in the function of ports** in the national economy. Before World War II, ports served essentially for import and export of commodity cargo, transport of persons, and for transshipment. There also was limited industrial activity. After the war the freight flows increased dramatically, and the transport of passengers almost disappeared. On the other hand, industrial activities in port areas have shown a tremendous increase. Only some 20 percent of Rotterdam port areas is used for transport and transshipment while 80 percent is occupied by port-based industries (e.g., oil refineries, chemical and petrochemical industries, shipyards, etc.).

The two functions which seaports have today make it necessary to make two different kinds of forecasts in order to calculate the required size of port areas in the future. The one concentrates on forecasts of freight flows, the other on future development of port-based industries and the required port areas to locate these industries. Both kinds of forecasts are given attention in the Zeehavennota Report.

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* Zeehavennota: het zeehavenbeleid van de Rijksoverheid, Staatsuitgeverij, 's-Gravenhage 1966.

** In essence Rotterdam, then accounting for 86 percent of national sea traffic.

b. Traffic Flows and Land Requirements

Detailed forecasts were made for various categories of commodities, using several different kinds of forecasting techniques. The results are summarized in Table C-1.

TABLE C-1

FREIGHT FLOWS IN NETHERLAND PORTS, 1960 and 1980, BY COMMODITY CATEGORY

(In Million Metric Tons)

Category	1938	1950	1960	1980	1980 (1960=100)
Coal			8.1	7.6	94
Oil			42.8	145.5	340
Ore			20.2	35.7	177
Fertilizers, etc.			8.8	15.1	172
Seeds			3.2	5.8	181
Cereals			6.2	10.1	163
Wood			2.6	3.8	146
General Cargo			16.4	45.3	276
Total	55.9	40.1	108.5	268.9	248

Source: Zeehavennota Report

According to these estimates oil (and oil products) will constitute nearly 55 percent of total freight flows in 1980, followed by ores and general cargo. In 1960, the corresponding percentage for oil was about 40 percent.

Given the modes of handling the various categories of goods and the handling capacity per square meter, the required port area for the transport function was estimated for 1980. Whereas in 1960, 1,420 acres were available, the forecast for 1980 showed a requirement for 3,125 acres.

c. Land Requirements for Seaport Industries

Generally speaking, basic industries in Europe have shown a definite tendency to move to the coast in order to profit from low transport costs resulting from deep-draft vessels. This movement induced also secondary industries to locate in port areas. This development has shown itself most clearly in the petroleum industry. The increase in the size of tankers, heavily stimulated by the Suez crisis, the shifting of refineries from production areas to consumption areas and the penetration of the oil industry into the petrochemical sector resulted in huge refineries and petrochemical complexes in coastal port areas. Rotterdam--with deep water access--has exemplified this movement.

Taking into account this general industrial movement, the expected increase in production in the specific industries concerned, and the estimated production per square meter, the following requirements for industrial purposes were calculated in the Zeehavennota Report (Table C-2).

TABLE C-2
LAND REQUIREMENTS FOR INDUSTRIAL PURPOSES
IN NETHERLANDS PORT AREAS
1960 AND 1980
(In Acres)

	1960	1980	Addition
Refineries	1,753	3,285	1,532
Chemical/Petrochemical Industry	1,173	6,990	5,817
Metal Industry	3,149	6,570	3,421
Other	1,136	2,000	864
Total	7,211	18,845	11,634

Source: Zeehavennota Report

As can be seen from Table C-2, the chemical/petrochemical industry is expected to become the most important land user in 1980.

Total land requirements are summarized in Table C-3, which includes,

TABLE C-3
TOTAL LAND REQUIREMENTS FOR PORT ACTIVITIES
IN THE NETHERLANDS
1960 AND 1980
(In Acres)

	1960	1980	Addition
General Cargo and Bulk Handling	1,420	3,125	1,704
Industrial Purposes	7,211	18,845	11,634
Required Reserves*	1,482	4,323	2,841
Total Net	10,113	26,293	16,179
Infrastructure	6,916	17,908	10,992
Total Gross	17,029	44,201	27,171

*Reserves held by port authorities in order to accommodate potential clients.

Source: Zeehavennota Report.

as an additional land user, requirement for infrastructure. It was reported that about 40 percent of total port areas is required for infrastructure (roads, canals, pipelines, and the wet-areas). This percentage varies from port to port and is quite different for general cargo and bulk handling (where it is quite high) as compared to that for industrial purposes. The increasing importance of land use for industrial purposes might indicate a lower percentage for infrastructure in total. On the other hand, increasing containerization and the use of roll-on/roll-off vessels puts more emphasis on road and railway connections, while pipelines also demand more and more space and increased size of ships require an increasing portion of wet areas. All these considerations led to the conclusion to keep the net-gross percentage relationship constant until 1980.

d. Supply of Seaport Areas

Each local port authority studying the possibilities of seaport expansion in his respective district provided proposed expansion plans for the near and a more distant time horizon period. Their individual proposals are summarized in Table C-4.

As can be seen from this Table in the near future 76% of planned additions to existing port areas would be located in the western part of the country. In the distant future, expansion would have to take place in the southwest, with the northern part of the country also assisting in creating additional expansion possibilities.

e. Demand and Supply--Policy Conclusions

Comparison of additional demand for seaport areas until 1980 (27,171 acres; see Table C-3) with possible additional supply in the near future (32,307 acres) and another 35,074 acres in the more distant future led to the rather optimistic conclusion that for many years to come no over-all shortage of land was to be feared. Given the national economic importance of seaport activities, the central government could therefore commit itself to assist in implementing the various port plans. This implied improving deepwater access facilities for Rotterdam and Amsterdam, participating in technical and economic studies for the various port areas, and sharing in the expenses incurred in implementing the various plans.

But the balance in supply and demand is strained locally because of deep-water access and the existing infrastructure and facilities. The Rotterdam port area is in great demand by potential users, while the other ports have had major difficulties in attracting new clients. An unrestricted expansion

TABLE C-4

EXISTING AND POSSIBLE FUTURE PORT AREA IN THE NETHERLANDS (IN ACRES)

Access In 1966 (In dwt)	Seaport Areas	Location In The Netherlands	Existing Area (1960 Census) Acres	Possible Expansion Near Future Acres	Possible Expansion Distant Future Acres
150,000	Rijnmond (Rotterdam)	West	10,250	16,920	?
75,000	Ijmond (Amsterdam)	West	5,310	7,410	3,952
20,000	Dordrecht	West	309	395	173
---	Balgzand	West	---	---	---
50,000	Terneuzen	South-West	543	4,075	2,964
50,000	Vlissingen	South-West	358	1,457	5,632
3,000	Bergen Op Zoom	South-West	111	445	1,976
---	Reimerswall	South-West	---	---	12,350
10,000	Delfzijl	North	198	1,358	3,087
---	Harlingen	North	---	247	---
---	Eemshaven	North	---	---	4,940
Total Gross Area			17,079	32,307	35,075
		West	93%	76%	12%
		South-West	6%	19%	65%
		North	1%	5%	23%

Source: Zeehavennota Report and Arthur D. Little, Inc.

? = only seaward expansion possible.

of the Rotterdam port would create the following problems:

- Further concentration of people and of industries which would increase disadvantages such as congestion and lack of recreation facilities;
- Further concentration of heavy industries which would lead to dangerous air and water pollution;
- Increasing depth of waterways which would cause salt contamination of ground water and soil; and
- Further expansion which would destroy a number of rural regions, towns of great historical interest, and irreplaceable wildlife breeding areas.

Given the high and increasing density of the population in the western and southern regions of the country* and the relatively sparse population in the other regions, the central government proposed, in the context of a comprehensive scheme for physical planning of Dutch society up to the year 2000, a redistribution of population (and economic activities) over the country;** as distinct from its earlier "transport" policy. These ideas resulted in the following policy conclusions:

- Expansion of the Rotterdam port area should be restricted;
- Only those potential users should be accepted which need deepwater access or depend heavily on existing industries and port facilities (e.g., general and bulk cargo handling);
- Other potential users should be directed to the Amsterdam area, the southwest and the north. These major principles still hold today in theory.

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*The Netherlands ranks fourth in the world regarding population density per square mile.

**Tweede nota over de ruimtelijke ordening in Nederland, 's-Gravenhage 1966.

f. Rotterdam Confrontation

As soon as this first attempt to formulate a national seaport policy was published by the government, a strong controversy arose, illustrated by some well known reports:

1) Een prognose van de Nederlandse behoefte aan Zeehavenareaal in 1980 (Kamer van Koophandel en Fabrieken voor Rotterdam, 1968).
2) Verkenning van enkele aspekten van de ontwikkelings mogelijkheden voor zeehavens in het Deltagebied. (Rapport uitgebracht door het Overlegorgaan Zeehavenontwikkeling Zuid-West Nederland, 1968.)
3) The Greater Delta Region. (Frederic R. Harris. Holland N.V., 1968).
4) Verkenning van de toekomstige werkgelegenheid in het Rotterdamse haven en industriegebied. (Rapport uitgebracht door de commissie ad hoc aan de commissie van advies voor het havenbedrijf, 1969).
5) Ontwikkeling noordelijke delta: plan 2000+. (In opdracht van het gemeentebestuur van Rotterdam opgesteld door het havenbedrijf en de diensten van stadsontwikkeling en gemeentewerken, 1969).
6) Land Use and Transportation Study, Technical Report, Volume II, Economic Analyses and Forecasts of Port Traffic Flows. (Freemand, Fox, Wilbur Smith and Associates in association with Management Sciences Ltd. 1969).
7) Rijnmond in de delta. Beoordeling der economische ontwikkelings mogelijkheden van het Rijnmondgebied. (Openbaar Lichaam Rijnmond, 1969).

These reports differ in scope and methods: (6) Land Use and Transportation Study is a technical report specifically dealing with forecasts of port traffic flows in the Rotterdam area; (5) Plan 2000+ tries to translate the figures contained in (3) The Greater Delta Region; and (4) Rotterdam Committee ad hoc into a concrete physical plan for the northern part of the Delta. In the reports, different methods were used to estimate the reuqired port area in the future and they are for this reason rather difficult to compare. As extremes, (2) Overlegorgaan and (3) The Greater Delta Region, will be reviewed.

The Overlegorgaan report is based on the hypothesis that the area required for port activities is a simple function of production, and that the productivity of land, just as all other factors of production, will show a steady and continuous increase. On the basis of a preliminary analysis of production and port area in the past, it was assumed that in the long run an increase in production of 10 percent would be accompanied by an increase of 7 percent in the port area required. This relationship and the estimates of possible growth of production in port activities (including general cargo and bulk handling) leads to the following requirements shown in Table C-5 and C-6.

TABLE C-5

TOTAL REQUIRED PORT AREA IN THE NETHERLANDS
1960-2000

	1960		1965		1970		1980		2000
Value Added In Port Activities (in constant 1965 dollars)	$586		$978		$1,567		$3,128		$9,231
Annual Increase (Percent)		10.8		9.9		7.2		5.6	
Required Net Area (In Acres)	8,645		12,350		17,290		28,405		61,750
Annual Increase (Percent)		7.5		7.0		5.0		4.0	
Required Gross Area--Infrastructure (In Acres)	17,043*		27,170*		38,285*		56,810		125,970

*Available Area.

Source: Overlegorgaan.

These figures indicate a demand for seaport areas in 1980, some 12,600 acres in excess of the earlier forecast presented in the Zeehavennota Report (see Table C-4). The proposed distribution over the country is shown in Table C-6.

TABLE C-6

DISTRIBUTION OF PORT AREAS

1960-2000

(IN ACRES)

	1960	1970	1980	2000
Other ports[a]	5,434	9,880	14,820	27,170
In West and South-West of the Netherlands (the Delta Region)	11,609	28,405	41,990	98,800
Total Area Required	17,043[b]	38,285[b]	56,810	125,970

a) Ijmond (Amsterdam) and ports in the northern part of the country (see Table C-4).

b) Available

Source: Overlegorgaan.

According to this study, some 18,525 acres of port area would have to be created between 1970 and 1980, of which 7,400 acres could be located in the Rotterdam part of the Delta, by extension of the Maasvlakte I. Between 1970 and 2000, 70,000 acres should be added to the existing port area in the Delta of which an additional 15,000 acres could be located in Rotterdam. According to these ideas an increasing emphasis should be laid on developing the southern part of the Delta.

The proposed development foreseen by the Overlegorgaan study is generally in accordance with the policy conclusions contained in the Zeehavennota Report. The total required expansion of port areas, however, is estimated higher and more emphasis is put on expansion of existing facilities in the Rotterdam area.

In The Greated Delta Region study, the principal method used was interviewing. The interviews included the major users of port facilities (12 large industrial enterprises which in total use 80 percent of the port area) and potential users known to have an interest in locating in the port area. This method is in accordance with the basic philosophy underlying the whole report, i.e., "...the belief that the future of the port will be determined to a great extent by the specific plans of current and known potential industrial and commercial tenants of the port, supplemented by unidentified users which would be the logical type of firms that would be attracted to the industrial raw material and balance out the industrial complex." The objective of the report was to estimate the size of the potential port defined as "...today's port (the port of of Rotterdam) fully developed plus all new harbor and land facilities which would be required if everything possible were done to develop it, and no restraints or constrictions were imposed."

The forecasts of possible commodity flows were individually analyzed for each category of goods. The historical and projected results are illustrated in Tables C-7 to C-12.

TABLE C-7

ROTTERDAM
TOTAL COMMODITY TRAFFIC
Metric Tons in Millions

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965	Tons 1969	Annual Growth Rate 1965 - 1969
Total Tons (Exports & Imports)	83.4	122.7	8.0%	182.6	10.5%
Bulk	69.1	104.0	8.5	154.7	10.4
General Cargo	14.3	18.7	5.5	27.9	10.5
Selected Bulk Commodities					
CEREALS	5.7	6.1	1.4	4.7	- 6.3
WOOD	1.3	1.0	- 5.1	1.1	1.9
COAL	5.3	5.4	0.4	5.3	- 0.5
RUBBER	.1	1.2	65.0	.3	-29.0
ORES	10.7	14.8	6.7	23.9	12.7
IRON & STEEL	1.7	1.6	- 1.2	2.5	11.8
NON FERROUS	.6	.7	3.1	.9	6.5
METALWARE	.1	.2	14.9	.2	N.C.
MACHINERY	.3	.5	3.1	.8	12.5
TRANSPORTATION EQUIPMENT	.2	.3	8.45	.4	7.5
PETROLEUM	60.1	68.6	2.7	107.3	11.8
CHEMICALS	3.4	5.2	8.9	10.8	20.0
FERTILIZERS	1.6	1.7	1.2	2.2	6.7
PULP & PAPER	.9	1.1	4.1	1.5	8.1
CEMENT	--	--	--	--	--

Totals may not add due to rounding.

Metric Ton = 2,205 pounds.

Source: Rotterdam Annual Reports

TABLE C-8

ROTTERDAM
EXPORT COMMODITY TRAFFIC
Metric Tons in Millions

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965	Tons 1969	Annual Growth Rate 1965 - 1969
Total Tons (Exports)	21.9	27.6	4.7%	44.9	12.9%
Bulk	16.9	21.3	4.7	35.2	13.4
General Cargo	5.0	6.3	4.7	9.7	11.4
Selected Bulk Commodities					
CEREALS	.4	.8	14.9	1.1	8.3
WOOD	--	--	--	--	--
COAL	3.1	.9	-22.0	4.0	45.0
RUBBER	--	--	--	.1	--
ORES	--	.2	--	.8	41.0
IRON & STEEL	1.0	1.0	N.C.	1.7	14.2
NON FERROUS	.1	.2	14.9	.2	N.C.
METALWARE	.1	.1	N.C.	.2	19.0
MACHINERY	.2	.3	8.45	.5	13.6
TRANSPORTATION EQUIPMENT	.2	.2	N.C.	.3	10.7
PETROLEUM	11.4	17.0	8.3	26.3	9.1
CHEMICALS	2.5	3.5	7.0	5.7	13.0
FERTILIZERS	1.6	1.7	1.2	1.8	1.4
PULP AND PAPER	.1	.1	N.C.	.12	19.0
CEMENT	--	--	--	--	--

N.C. = No Change

Source: Rotterdam Annual Reports

TABLE C-9

ROTTERDAM
IMPORT COMMODITY TRAFFIC
Metric Tons in Millions

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965	Tons 1969	Annual Growth Rate 1965 - 1969
Total Tons (Imports)	61.6	95.1	9.1%	137.8	9.7%
Bulk	52.3	82.8	9.6	119.6	9.6
General Cargo	9.3	12.3	5.65	18.2	10.3
Selected Bulk Commodities					
CEREALS	5.3	5.3	N.C.	3.6	- 9.2
WOOD	1.2	1.0	- 3.6	1.1	2.4
COAL	2.2	4.5	15.4	1.4	-26.0
RUBBER	.1	.1	N.C.	.1	N.C.
ORES	10.7	14.6	6.4	23.2	12.3
IRON & STEEL	.7	.5	- 6.5	.8	12.5
NON FERROUS	.5	.6	3.7	.8	7.5
METALWARE	--	--	--	--	--
MACHINERY	.1	.2	14.9	.3	10.7
TRANSPORTATION EQUIPMENT	--	--	--	.1	--
PETROLEUM	28.7	51.6	12.4	81.0	11.9
CHEMICALS	.9	1.7	13.6	5.0	31.0
FERTILIZERS	.1	--	--	.4	--
PULP & PAPER	.8	1.0	4.6	1.3	6.8
CEMENT	--	--	--	--	--

N.C. = No Change

Source: Rotterdam Annual Reports

TABLE C-10

ROTTERDAM
POTENTIAL TONNAGE
1967-2000
(In Million Metric Tons)

	1967	1980	1990	2000
OIL	79	278	398	545
ORE	18	68	100	128
CEREALS	7	15	17	19
FERTILIZERS	5	6	6	6
COAL	6	12	16	20
OTHER BULK	4	13	22	35
GENERAL CARGO				
Total	141	430	614	828

Source: (3) The Greater Delta Region.

In 1970, the total gross port area in the Rijnmond* was estimated at about 20,000 acres. On the basis of the interviews the land requirements were assessed up till 1980, after this year an incremental growth pattern was assumed. The findings are given in Table C-11.

*(i.e., Rotterdam).

TABLE C-11

ACCUMULATIVE TOTAL ADDITIONS REQUIRED ABOVE
LAND LEASED OUT IN 1968
DELTA REGION
(IN ACRES)

	1970	1980	1990	2000
With deepwater facilities	1,828	6,125	9,386	11,980
Next to plants having deepwater facilities	--	5,805	8,892	11,362
Adjacent to existing sites	--	420	642	815
Within 6 miles from existing sites	247	471	716	914
Within 15-19 miles from existing sites	--	3,211	4,891	6,274
Small users, scattered but mostly near Rotterdam	49	1,185	1,803	2,297
New refineries, with pipeline to oil port	--	2,223	3,408	4,347
Chemical and supporting industries near new refineries	148	3,705	5,681	7,262
Net land required	2,272	23,144	35,420	45,250
20% external reserves	445	4,619	7,089	9,040
Total net	2,717	27,763	42,509	54,290
Total gross*	5,434	55,526	85,018	108,580

*Addition of infrastructure

Source: (3) The Greater Delta Region.

In the Zeehavennota Report total additional land requirements between 1960 and 1980 were estimated at 27,171 acres for the whole country (Table C-4). Twice as much would be required for the Delta Region only and in a much shorter period (1968-1980), according to the F. R. Harris Study. The breakdown of land requirements by type of industry is shown in Table C-12.

TABLE C-12

ACCUMULATIVE TOTAL ADDITIONS REQUIRED ABOVE
LAND LEASED OUT IN 1968
TYPE OF INDUSTRY
(IN ACRES)

	1970	1980	1990	2000
Refineries (including oil storage and terminals)	345	2,717	4,150	5,285
Chemical industries	296	8,324	12,720	16,228
Metal industry (supporting chemical industries)	49	617	938	1,210
Basic steel (including direct support)	1,235	3,087	4,717	6,002
Steel fabricating	---	6,792	10,398	13,214
Ship cleaning and repairs	247	741	1,136	1,457
General cargo and bulk handling (excluding ore)	99	568	864	1,111
Container handling	---	296	494	741
Net land	2,272	23,144	35,420	45,250
20% external reserves	445	4,619	7,089	9,040
Total net	2,717	27,763	42,509	54,290
Total gross*	5,434	55,526	85,018	108,580

*Addition of infrastructure

Source: (3) The Greater Delta Region.

Because the various reports on possible port development differ so widely in scope and methods, definitions and area and subjects covered, their results are therefore difficult to compare. Nevertheless, a comparison has been attempted on the following aspects: freight flows, land requirements, employment and economic criteria.

The methods used for estimating freight flows differ. In the Zeehavennota Report a detailed analysis was made. The most detailed and sophisticated study technique was applied in Land Use and Transportation in which multiple regression analysis was used to explain 61 commodity freight flows in the Rijnmond over the past 15 years. The outcomes of this investigation were then used for predicting future freight flows. Dependent variables were import demand for the various categories of goods in the countries of destination, industrial production, cost differences as related to ship size, geographical location, etc. The Greater Delta Region study and Rotterdam Chamber of Commerce study used much simpler methods. The comparative results are summarized in Table C-13.

TABLE C-13

TOTAL FREIGHT FLOWS IN NETHERLANDS PORTS
1980-2000
(In Million Metric Tons)

Report	Port Area Covered	1980	1990	2000
Zeehavennota Report	All Ports	269	--	--
(1) Rotterdam Chamber of Commerce	All Ports	323	--	--
(3) The Greater Delta Region	Greater Delta	430	614	828
(6) Land Use and Transportation	Northern Delta (Rijnmond)	450	666	--

On the basis of Land Use and Transportation, total freight flows in 1980 in all ports can be estimated at about 450 million tons, a figure which also is obtained by using simple extrapolation methods. Accordingly, recent forecasts seem to indicate a freight flow in 1980 about 65 percent higher than that of the Zeehavennota Report made several years earlier. The three 1980 forecasts compared in Table C-14 give total freight flows and a commodity category breakdown, and they differ with percentages varying from 45% to 90%. For 1990,a comparison between the Greater Delta and Land Use and Transportation forecasts is shown in Table C-15 with the second study being even more optimistic than F.R. Harris'.

TABLE C-14

FREIGHT FLOWS IN NETHERLANDS PORTS
COMMODITY CATEGORY
1980
(In Million Metric Tons)

Report	Port Area Covered	oil	ore	cereals	coal	other	total
Zeehavennota Report	all seaports	145	36	10	8	70	269
Rotterdam Chamber of Commerce	all seaports	175	42	13	10	83	323
The Greater Delta Region	greater Delta	278	68	15	12	57	430

TABLE C-15

FREIGHT FLOWS IN NETHERLANDS PORTS
COMMODITY CATEGORY
1990
(In Million Metric Tons)

Report	Port Area Covered	oil	ore	cereals	coal	other	total
The Greater Delta Region	greater Delta	398	100	17	16	83	614
Land Use and Transportation	northern Delta (Rijnmond)	376	140	36			

Nevertheless, given the fact that the above two forecasts were obtained by using different methods and funding levels, the similarity between the two forecasts is rather striking. Significant differences, however, can be noted in the case of ore and cereals. This is due to the fact that in Land Use and Transportation, an increasing transit of iron ore and grain to the United Kingdom is foreseen, based on the assumption that Rotterdam can more readily receive deep draft bulk carriers.

The forecasts of land requirements differ widely as may be seen from Table C-16. The differences are not only due to assumptions in the forecasts of future economic growth in The Netherlands but also in the coefficients used to translate production or number of workers into number of square meters of port area and the coefficients used to transform net area into gross area.

TABLE C-16

TOTAL ADDITIONAL PORT AREA REQUIRED
IN THE NETHERLANDS
(GROSS ACRES)

Report	1968-1980	1968-1990	1968-2000
Zeehavennota	9,633	-	-
Rotterdam Chamber of Commerce	22,477	-	-
Overlegorgaan	22,230	-	91,390
Rotterdam Committee ad hoc	-	91,390	-

*It was assumed that in 1968 total port area in the Netherlands was 34,500 acres.

The differences of opinion are even greater when we look at the forecasts for the northern Delta (i.e., Rotterdam) and the Delta as a whole (Table C-17).

TABLE C-17

ADDITIONAL PORT AREA REQUIRED IN THE NORTHERN DELTA AND IN THE DELTA REGION (GROSS ACRES)

Report	Area	1968-1980	1968-1990	1968-2000
Zeehavennota	northern Delta	7,410	-	-
Report*	Delta	10,127	33,345	-
Overlegorgaan	northern Delta	7,410	-	14,820
	Delta	9,880	-	59,280
The Greater	northern Delta	29,640	47,177	60,268
Delta Region	Delta	55,575	84,968	108,680
Rotterdam Committee ad hoc	northern Delta	-	46,930**	-
Rotterdam Plan 2000+	northern Delta	-	-	45,942
Rijnmond	northern Delta	-	11,115***	-

* In order to calculate additional area required it was assumed that in 1968 19,760 acres were available in the northern Delta and 24,700 acres in the Delta.
** Including all areas for industrial purposes.
***Not including the approved extension of the Maasvlakte I.

In the report of the central government on seaport policy (Zeehavennota) it was argued that to achieve optimal physical planning, expansion of the port area in Rotterdam should be restricted. Reports (2) and (7) above conclude that a greater port expansion is acceptable. The authors of Reports (3), (4), and (5) regard their much more ambitious plans as necessary and acceptable if complementary measures are taken to ensure a sound physical environment.

g. Employment

In all the reports except Rotterdam Chamber of Commerce, attention is given to employment. In Rotterdam Committee ad hoc, employment is the main concern, and from an employment forecast the required seaport area is derived. The common line of reasoning is, however, just opposite. For example, in The Greater Delta Region use is made of key figures of square meters per worker to transform required additional port area into additional employment.

Other key figures--besides square meters per worker--are the indirect employment multiplier (additional employment induced in secondary industries, construction and services) as a consequence of additional employment in basic industries (such as oil refineries, petrochemical, steel fabrication) and the labor force participation rate (percentage of total population employed). The various reports differ, of course, in their views about the correct size of the various key figures. The greatest differences of opinion exist about the indirect employment multiplier.

In (3) The Greater Delta Region, an employment multiplier of 2 is used on the assumption that every worker in port-based industries creates one job in the service sector, and it is assumed that there is one employed worker out of every four persons in the total population. The following results are then obtained (Table C-18).

TABLE C-18

ESTIMATED ADDITIONAL LABOR FORCE,
EMPLOYMENT AND POPULATION IN THE GREATER DELTA

Year	Industrial Labor	Total Employment	Population
1980	116,000	232,000	928,000
1990	135,000	270,000	1,080,000
2000	178,000	356,000	1,424,000

Source: The Greater Delta Region.

In a study concerning the Netherlands long-term economic growth,* it was calculated that from 1965 to 2000 employment increases in the service sector would be four times greater than in industry. This has led to the opinion that an employment multiplier of 4 would be correct.** Using this multiplier and the same labor force participation rate would imply an additional population of 2.8 million in the greater Delta region instead of 1.4 million as shown in Table C-18.

Strong opposition against the development foreseen in The Greater Delta Region was based on the increased population resulting from port expansion with only a multiplier of two, as no one could imagine creating towns and suitable living conditions for additional millions in the Delta region.

An input-output approach to employment multipliers is given in the Rijnmond in de Delta report. On the basis of a regional input-output table

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* Professor C. A. van den Beld: "De Nederlandse economie in het jaar 2000" in "De Nederlanders in het jaar 2000." Haarlem, 1967.

**This is an incorrect inference since comparative growth in employment is no proxy of the value of the multiplier.

and using relationships between production and employment per sector of industry over the period 1960-1965 and a number of other assumptions the multipliers given in Table C-19 were calculated.

TABLE C-19

EMPLOYMENT MULTIPLIERS

	Original Impulse	Induced Employment			Total Employment
		Con-struction	Agri-culture other indus-tries	services	
Oil and petrochemical industry	1	0.9	-0.6	2.8	4.1
Metal industry	1	0.6	-0.4	2.2	3.4
Transport	1	0.3	-0.2	1.1	2.2
Total average	1				3.5

Source: Rijnmond in de Delta.

According to these figures, 1.0 additional jobs in the stimulative or propelling industries would create on the average 3.5 jobs in total. However, results of research conducted by the Central Planning Bureau imply quite different employment multipliers. In order to test the consequences of an additional expansion of port based industries by $1 billion, first the production and employment which would result from this primary industry investment were calculated. Using input-output techniques the secondary effects (backward linkage) on all other industries were estimated. These two effects combined were then fed into a national macro-economic model which took into account the goals of economic policy (e.g., a certain surplus on the balance of payments). Given the fact that in The Netherlands total investment is a fixed percentage of total income, additional investment in the port-based industries lead to a corresponding loss of investment, production, and employment elsewhere in the country. This and all other relevant changes (imports, exports, labor productivity, prices,* etc.) are taken into account by the model, which gives the results of Table C-20.

TABLE C-20

DIRECT AND FINAL EMPLOYMENT MULTIPLIERS

	Primary Impulse	Directly Induced Employment	Subtotal	Rest of the Economy	Final Employment
Oil and petrochemical industry	1.0	0.7	1.7	-0.7	1.0
Steel industry	1.0	1.5	2.5	-1.2	1.3
Average seaport industries	1.0	1.2	2.2	-1.0	1.2

*ADL was told that the price index section of the model is weak.

According to Table C-20, one additional job in port industries finally creates 1.2 jobs in total. The greater multiplier effects which can be calculated by commonly used methods are in reality suppressed by the workings of the national economic system. Ignoring this suppressive effect leads to employment figures which are too high.

One may argue that this may hold true for the economy as a whole but not for a region which, if the prospects are good, can attract as much capital as it wants. It may be that capital is freely moveable within a country, but in The Netherlands labor is not. A Central Planning Bureau regional employment model which describes the development of demand for labor per sector, total employment, total supply of labor, migration and unemployment provides a result close to that of the macro economic model. An initial input in a region will create first some additional secondary employment but the final result is that total employment will increase only a little more than the original input, but with a different distribution over the various sectors of the economy. The reason for this low multiplier is again the suppressive effect--now caused by the labor market. The employment created by the original input will be deducted for the greater part from other industries as the labor supply is restricted and labor mobility is low.

The low employment multiplier agrees with experience. The enormous increase of port activities in Rotterdam has gone together with an increase in total labor force in this region even lower than could be calculated on the basis of demographic trends, because of the loss by emigration.

Excluding the problem of environmental degradation, it may be that even the most ambitious plans of The Greater Delta Region and Rotterdam Plan 2000+ reports are acceptable regarding employment and population.

h. Economic Justification

After reviewing the various reports one immediately reaches the rather astonishing conclusion that none of them contains an economic justification of the proposed plans. In the Zeehavennota Report some figures are given on value added in port activities and sea transport; the importance of sea activities for other sectors of the economy is mentioned, employment figures are given, etc. It concludes the economic section of the report by saying: "As seaports constitute an integral part of the economy it is impossible to imagine a Dutch economy without seaports. This is also the very reason why it is impossible to make a national economic cost-benefit analysis of seaports."

An incorrect economic justification is found in The Greater Delta Region, where total sales of port industries are regarded as a correct measure of the contribution of port industries to gross national product in The Netherlands (p.127).

Rather confusing are sections of _Rijnmond in de Delta._ In this report it is calculated that profits on investments in the Rijnmond area (with its heavy concentration on port industries and activities) is the same as elsewhere in The Netherlands (which has little port industry). Nevertheless, the report favors further expansion of the port area in the Rijnmond, notwithstanding the fact that it recognizes possible disadvantages of this development on favorable living conditions, congestion, etc.

i. The Growing Consensus on Port Industrial Development and Land Use

It is becoming widely recognized that to avoid over-industrialization of the Greater Delta Region, it is necessary to be selective with respect to types of industries that should be admitted. The greatest limitation should be on industries in the areas nearest the port, which should be restricted to:

1) Primary process industries which definitely need deepwater port facilities because of raw materials being received in deep-draft ships;
2) Secondary process and manufacturing industries which for economic, process, or manufacturing reasons need to be close to the primary industries;
3) Secondary process and manufacturing industries which are under the same corporate roof as a primary producer and purely for economic reasons (no process or manufacturing requirements) want to centalize operations.

The tertiary, consumer-oriented manufacturing industries (mostly relatively labor intensive) do not normally require deepwater facilities or proximity to primary industries. As a matter of fact, their preference is usually for location near the consumer areas which saves relatively high transportation costs of valuable finished goods. The location of these tertiary industries away from port areas also fits with the industrial dispersal plans of The Netherlands.

i. Communication to Hinterland

1) Highways--a network of roads, bridges, and tunnels is in the planning stage as there is serious industrial and commuter traffic congestion in Rotterdam, which is expected to increase as expansion of industrial facilities requires additional employees and heavier industrial traffic for support.

The early establishment of any relatively labor-intensive industry on Maasvlakte I will prove disastrous to the traffic situation if this planned system of roadways is not simultaneously supplemented with a system of mass transit to existing and new population centers along with a modern primary and secondary network of roadways to service these centers.

New roadways must also be constructed to connect the hinterland of the Netherlands and northwest Europe with the Greater Delta Region. The need already exists, and the advent of containerization will greatly add to the urgency. Failure to create such improvements may in fact become a serious deterrent to development for the Port of Rotterdam.

With the forecast industrialization of the Greater Delta Region, comments similar to those above apply for the entire region. A road and highway network well beyond that currently envisaged should be developed to avoid strangulation of the expected industrial potential.

2) Railroads--the existing port is served by a double track line, now terminating in Europort. It is intended to extend this line to Maasvlakte I now that the land development is completed. This rail line has adequate capacity to serve all current port users and the intended occupants of Maasvlakte I, (even when all industrial sites are filled). It is believed that, if and when Maasvlakte II, or even Maasvlakte III, is created and industrially developed, an extension of the double track line should still be sufficient to provide adequate capacity for the expected goods traffic.

3) Inland Waterways--as shown in Table C-10 above, the cargo tonnage to be handled by the port is rapidly increasing. The associated barge traffic using the inland waterways connecting with the port is also expected to increase, but at a much slower rate than the increase in port tonnage. There are several reasons for this:

- much of the oil and oil products shipped inland from the port is being diverted to the more economical pipelines;
- relatively larger portions of the bulk raw materials which formerly (and currently) were shipped to the hinterland for processing will remain in the greater port region*;
- general cargo is increasingly being containerized. Movement of containers away from the port by barges would defeat the purposes of the entire containerization system of rapid point-to-point goods transfer.

Slowly increasing tonnage that is expected to be handled by barge, coupled with improvement in barge traffic practices (particularly the increasing conversion to push boat technology), leads to the belief that the inland waterways system with its barge traffic is expected to be adequate for the needs of the port in the foreseeable future.

Port officials already claim that the barge canal is too far away from the ocean loading-unloading areas and that a material handling problem has resulted. A new canal would create traffic problems warranting extensive bridging to control.

*These will be used in the new industries which are expected to be established as well as in industries that are relocating from the hinterland to the coastal areas. The products of these coastal industries lend themselves more to containerized movements by rail and truck than by barge.

4) Pipelines--Table C-10 indicated that the port is forecast to handle 278 million tons of oil and oil products in the year 1980, and it was also indicated that refining capacity was expected to be 140 million tons in 1980. Twenty percent of this capacity, or 28 million tons, is expected to be consumed for internal refinery use and chemical raw materials production, leaving 250 million tons to be handled in and out of the port. Of the 250 million, 69 million tons were forecast to be re-exported by sea, leaving 181 million tons to be shipped to the hinterland. Current pipelining capacity out of the port is 80 million tons per year (Rhein-Ruhr pipeline, 40 million tons crude, 20 million tons product; and Rotterdam-Amsterdam pipeline 20 million tons crude per year). Within the next few years the Rotterdam-Antwerp pipeline is expected to be completed, adding a capacity of 30 million tons per year for a total of 110 million tons per year pipeline capacity out of the port.

However, in the year 1980, a need will develop to construct a liquid transportation system for an additional 61 million tons. Although some of this may be shipped by barge, rail, and truck, plans are needed for two additional crude lines and one additional product line leaving the port.

Furthermore, some of the new refineries, by the oil industries' own forecasts, are expected to be located in the southern point of the Greater Delta Region (i.e., Vlissingen). This would require a crude line from Rotterdam, passing south through the delta region.

After 1980, the forecast oil tonnage to be handled by the port continues to increase. Examining the figures in Table C-10 and assuming that the Greater Delta Region port will maintain its relative refining and re-export-by-sea position, it can be seen that by 1990 another two pipelines would be needed, and by 2000 two additional pipelines would be required. No attempt has been made to forecast the ratio between crude and product-lines of these new lines. The ratio would depend upon the oil companies' refining policies at those periods of time. The lines can always be alternated from one service to the other within a short period of time. The important fact is the realization that about seven additional pipelines are required to service the Greater Delta Region's infrastructure over the next 30 years, adding one approximately every four years.

k. Economic Studies

There are two kinds of basic studies performed today in the Netherlands which relate to Rotterdam port industrialization:

- Macro-Economic Studies performed by the Central Planning Bureau, the Hague; and
- Micro-Economic Studies performed by Rotterdam organizations.

The first series of studies aim at helping the government to formulate a national seaport policy, where the second series of studies, financed by various Rotterdam organizations and authorities, are used either for local planning, to secure additional support from the government, or combat certain government proposals.

The Economics Section of the Central Planning Bureau is working on the construction of a model which evaluates industrial investment alternatives in order to arrive at that balanced mix which will most significantly increase the national income while operating under a number of constraints (i.e., savings rate, labor availability, etc.).

The birth of this model was based on a governmental question: Is it desirable to increase port industrialization?" The economists have tried to answer this question from the economic point of view (which will be only one input in determining what is desirable from a total national viewpoint). From their work they believe that the cost/benefit approach is not the right tool. Cost/benefit is too narrow. What is required is an input/output model of the entire port operation tied to a national macro-economic model.

To determine which industry grouping ("port industries" or "all other industries") was the most important to the national economy, from a value-added standpoint, they divided the model data base into two sectors. Sector "E" was classified as "port industries." To be included in Sector "E" an industry was required not only to be historically port-based, but also to have a high projected growth rate to 1980. Any port-based industry which was projected to have a zero or negative growth rate was dropped from the "E" classification. The remainder of the industrial sectors were lumped into the "all other" category. At this stage, certain investments were fed into the "E" sector and then repeated for the "all other industries" sector. The resulting impact was measured for value-added increases. The findings indicate that national income will grow more if investment priority is placed on high growth port industries rather than in the "all other industries" sector. They found only four industries which are stimulative in their own right; all other industries follow. These four stimulative industries are:

- Metals (particularly iron and steel);
- Oil refining;
- Chemicals (including petrochemicals);
- Shipbuilding (this industry is marginal in its stimulative effects on other industrial sectors).

Transportation (port function included) was not found to be stimulative, but grows under the demand effect of other industries. Unfortunately, only two sectors (the "E" sector and the "all other") have been evaluated. To run other comparisons one would have to sub-divide the "all other" into smaller groups (i.e., electronics) and run the model on a case-by-case basis.

The model has forecast the Rotterdam value-added profile in 1980 for the four stimulative industries as follows:

1) 20% - Metals
2) 40% - Chemicals
3) 35% - Oil
4) 5% - Shipbuilding

After investment levels have been fed into the model, the information output is:

1) National Income (distribution of income)
2) Labor Employment
3) Surplus amount in balance of payments
4) Price stability (this area of the model is very weak)

Officials now state that national income improvement is not really the best measure for investment allocation; rather one should optimize labor needed, capital needed, regional development needs, and environmental costs.

The Central Planning Bureau is also working on a regional model (Inter-Regional Economic Impact Model) which breaks down the Netherlands into forty regions. The purpose of the model will be to measure investment projects within the Netherlands and measure the resulting labor requirements, commodity flows, investment flows, etc., to the various regions. They are about one-third completed and we were informed that the model would be finished in 1971.

Regional data has been a major problem. For many important statistical indices which are taken for granted in the United States, bureau planners are being forced to make educated guesses. They have been successful in obtaining regional labor statistics for the years 1950-1966. They have also developed investment by region and by major industrial sectors for the years 1955-1969, although the impression was that there were shortcomings in this area.

Every year the national Input/Output Model is updated and plans are to update the Regional Input/Output Model (when it is completed) every five years for 40 regions covered.

Although still far from completed and in the theoretical stage in many aspects, this Model will be valuable aid to the Central Government in its economic planning activities.

One of the purposes of this Model will be to evaluate the heavy concentration of population and production in the Rijnmond area and to analyze various alternatives and techniques to spread the population and industrial growth throughout the country.

C.1.5 Engineering

a. Configuration

The newly dredged 65-foot-deep channel now provides direct access from the North Sea into the old and new port areas. The industrial land and dock area is bounded to the south by an existing barge canal and to the west and north by the new "Caland" and "Beer" Canals. Finger piers are provided at four hydrocarbon transfer facilities. The inner,or old, harbor has numerous general cargo piers on both banks of the river with the main piers located on the south or left banks of the river. The total quayage now available in the port has increased to 107,900 feet and the port water area encompasses 4,955 acres. The directional move to the west for deeper water was also determined by geographical necessity as lack of land and industrial space warranted the reclamation of submerged North Sea land.

b. Channel and Basin

The new outer approach channel is 18 miles long and 4,000 feet wide. The new inner entrance canal has a length of 9 miles and its width decreases slowly from 2,000 to 1,300 feet. It takes about three hours to sail from the channel entrance to the Europort entrance. The bottom of the outer canal is sand waved (duned) while the bottom of the inner channel stays flat. Water depth measurements in Holland are measured at "mean-level"--this being the water level at a midpoint between high and low water. The tidal range at the Hook of Holland has a mean variation of 5.3 feet increasing to 5.7 feet with spring tides, with cross-channel currents of 2.5 knots at high water. From the entrance at the Hook of Holland there is a tidal range decrease into the old port. The tidal variation in Rotterdam itself ranges from a mean of 5.0 feet to 5.3 feet during spring tides. Large tankers normally enter at high water which gives almost three feet above mean water level so that 250,000 dwt tankers might be accommodated. A minimum bottom-to-keel clearance of 15% of the ship's draught is mandatory.

A publication, "PIAC 1969 Report", details soil and submerged wreck conditions encountered while dredging the channel. At no time did the dredges hit bedrock. Cutterhead dredges were used to cut through the clay (a 3 to 6 foot thick layer at -67 feet) and peat bottom in the inner channel, and trailing suction hopper dredges completed the dredging operation, never encountering bedrock.

As an experimental procedure, pits (catch-basins) were dug at specifically selected locations in the channel. The sites were selected from past experience at known sediment accumulation areas. It is anticipated that the pits will aid in collecting and entrapping sediments to reduce channel maintenance costs. A maximum of 20 dredges work on contracts to maintain the channels into Rotterdam. The dredges range from hoppers to endless bucket dredges, with some suction and floating pontoon systems. Clamshell dredges are used in front of the jetties and quaywalls to permit a "close in" dredging operation, i.e., within 15 to 30 feet, from the seawall.

Submerged wrecks were physically removed to clear the site of the outer channel whereas, in the inner channels, areas were excavated near the wrecks in a mannner that permitted the wrecks to slide into the excavation.

The behavior of channel bottom turbulence was tested in the Netherlands ship model basin (116'x216") under a program called "Bottom Wash". The study revealed that, under beam winds of up to 6 to 8 Beaufort scale (11.6 foot waves), the bow section of mammoth tankers requires a greater water depth. The wave size, period and direction becomes critical to safe entry. Long waves from the north are extremely critical and tankers, working in close coordination with the meteorological station which can provide a three-to-four-day advance warning, may have to anchor outside. A three-ship capacity emergency anchorage is also provided in the inner harbor. A total of 200 mammoth tankers were accommodated by Rotterdam in 1970, and an increase to 300 is anticipated for 1971.

The navigational aids were increased to ensure optimal safety in navigation for the deep-draft vessels entering the port, as the approach into Rotterdam extended outside the visibility range of lighthouses and other landmarks. A combination of conventional and electronic navigational aids is now provided for safe entry. For the approach to Europort, the Decca Navigator chain 5B/MP (British chain) is used. The southern side of the Euro channel is marked by conventional light buoys equipped with radar reflectors, spaced every two nautical miles approximately, and a Decca Navigator chain 2E can be used in the entire Euro channel under all visibility conditions. For periods of reduced or bad visibility, a system of seven shore-based radar stations has been operational for several years. The navigational system has also been of considerable assistance to the dredges in the channel. It has provided a pin-point aid for positioning the stone needed for construction of the entrance breakwaters. The 2E Decca chain is a temporary installation, using one master and two slave stations, with three patterns. By 1975 a new system will be extended further to sea, probably using an artificial island. The radar system will also be extended.

For direct entry into the port, two white lighted towers provide a centerline range into the breakwater area. Entrance into Europort is then guided by two green lighted towers, and entrance into the old port is guided by a similar type range with red lights. The entrance harbor lights (fixed lighted beacons) also provide navigational assistance.

About 200 ship movements per day occur in the inner channel, and deep-draft ships are currently limited to one-way traffic.

c. Docking

Dutch pilots can be taken aboard off the coast of France near Calais, or alternatively, they can be flown out to join a ship in American-built Sikorsky helicopters, which proved to be practical in all weather conditions and during night hours.

Once within the lee of the moles in the outer harbor, the major problem caused by the average 200 ship movements a day is the heavy traffic in the confined waters of the inner harbor. This is currently aggravated by a fleet of dredges working on the new Europort approach canal.

Ample tugs are available to aid in the final docking procedure. The number of tugs depends on the wishes of the ship's master, whose opinion is largely based on that of the harbor pilot.

Pier fendering consists mainly of vertical wood fenders mostly fabricated from African tropical wood, locust or similar.

d. Cargo Handling

The available warehouse space within the port is now in the vicinity of 10 million square feet. Cold storage space is available in 4.8 million cubic feet of warehouse volume. Grain silo capacities are given at 331,600 tons, and 4.8 million tons of dry bulk cargo can be accommodated. Bulk liquid storage facilities are rated at 20,273,900 tons.

The following equipment comprises the port's major cargo handling equipment:

Loading Bridges..........	28
Cranes..................	461
Floating Cranes..........	33
Floating Elevators.......	31
Shore-Based Elevators....	15
Container Cranes.........	6

The warehouses and cargo handling equipment originally belonged to the Port Authority, but were sold to private industry in 1968. As the new industrial complexes progress in the new Europort area, there will be a considerable increase in warehouse space and cargo handling equipment.

e. Problems and Lessons

1) Changed Current Patterns--the extension of the moles or breakwaters at the harbor entrance changed the pattern of currents along the short. This had direct effect on sediment transportation to the northwest. The current that normally transports the sand onto the northern beaches will eddy around the 3-km-long northern mole or breakwater. This will result in an accumulation of 60 to 80 million cubic meters of sand on a recreational beach directly north of the mole at the Hook of Holland, thereby temporarily "starving" beaches more to the northeast. To expedite this anticipated action and hasten continued nourishment of the northern beaches, 15 million cubic meters of sand fill is being pumped, through three submerged pipelines, onto the recreational beach. Modification of beach facilities will be required.

2) Sloughing and Sliding--the port has had sloughing and sliding problems for years, and seawall fractures have been common. During August 1956, 300 feet of seawall slid into the adjacent slip. The deepening of the main channel has increased inner harbor wave action, and in combination with the suction of the dredges and tidal seepage forces, has accelerated erosion of the river bottom. These factors have therefore aggravated a civil engineering problem of long standing. Extensive sand drains and piling will be necessary, coupled with more gradual sloping of the basin side, 1:5 or more. The latter action will make difficult, if not impossible, the securing of deep draft vessels alongside seawall-type pier facilities.

3) Saltwater Penetration--the deepening and widening of the channel has caused saltwater to migrate further up the river than it had before, and the salt has begun to penetrate into the dikes on both sides of the

river. An experimental attempt to control this problem involves laying filter gravel of varying grade and thickness onto the bed of the channel--the results will be carefully monitored. The problem of water quality degradation due to increased salinity in the upper river is still acute, and a number of corrective measures to improve the gathering and protection of fresh water are under consideration.

4) Ocean-to-Barge Transfer--a material handling problem is being experienced due to the distance between the ocean traffic facilities and the hinterland barge transportation facility. This could be corrected by dredging a new canal in the center of the industrial complex, but the canal would have to be bridged extensively to permit an unrestricted traffic flow.

5) Removal of Submerged Hulks--the method of excavating and sliding submerged wrecks into the excavation to remove submerged navigational hazards originated on the Rotterdam channel project. The method might be used to advantage during the construction of U.S. channels.

C.1.6 Environmental Impact

a. Environmental Management Efforts

While it is certainly true that the subject of environmental quality is becoming increasingly important in The Netherlands--the National Planning Service is adding to its staff to deal with these problems, and proposals have been made to establish a separate Ministry of Environmental Planning at the national level--conscious concern over the quality of the environment has played a relatively small role in the development of both Rotterdam and Amsterdam as major seaports. Numerous studies have been made regarding the need for major port capability in The Netherlands and have related that need to the country's dependence upon maritime trade. Because of this dependence, environmental problems--particularly those connected with pollution control--have been likened to a "fifth wheel" on the development vehicle. Land use-planning has, in the environmental sense, received the majority of attention, but even here it appears to have been predicated on the assumptions that excessive (not defined) controls would inhibit port growth and place The Netherlands at a competitive economic disadvantage. This is a viable assumption, for one can logically argue that if there is not a healthy economy to support the population of the country, the question of environmental quality automatically becomes secondary anyway. (Conversely, the reverse may also be true.)

On the other hand, despite the obvious fact that the central preoccupation of The Netherlands continues to revolve around land reclamation and continued economic expansion, sufficient momentum has been established in Rotterdam's development such that increasing attention--albeit from a small base--is being given to environmental quality.

1) Organizational Structure--the principal means by which pollution control has been and will be carried out in The Netherlands is the Nuisance Act (Hinderwet), first passed in 1875, which forbids manufacturing operations to create beyond the boundaries of a plant any public danger, damage or nuisance, or to be in operation or extend or change operations without a license. Enforcement of this law was to be carried out through municipal agencies (also called Hinderwet) which would have authority within a given town's borders. If manufacturing operations were located on a border between two or more towns, provincial authorities would be involved, and if on a provincial border, national authorities would have cognizance.

   In 1952, the original Hinderwet was updated to include the definition and identification of various industry types and to add new potential "nuisances" such as nuclear power. With the revised law, the Hinderwet covers virtually all manufacturing and commercial activity, and includes such nuisances as air, water, and soil pollution, fire, explosion, noise, radiation, and odors. Visual or aesthetic pollution has not yet been included.

In practice, most Dutch towns are too small to support their own Hinderwet. The effect has been that Hinderwets in major communities such as Rotterdam, The Hague, Amsterdam, and Utrecht, have, to the extent feasible, worked not only within their own community but have also, on request, consulted with surrounding towns.

Through 1970, virtually any new plant or industrial/commercial operation in Holland was required to obtain a permit, granted by the Burgemeister in the community involved, who so granted the permit partly on the basis of advice received from Hinderwet staff. The community might also obtain advice from national officials, such as public health, defense (if applicable), labor safety and RIZA (the Water Pollution Control Board--Rijksinstituut Voor Zuivering van Afvalwater).

2) Hinderwet Review Process--to date, the Hinderwet in Rotterdam has been concerned primarily with reducing air pollution; to this end, emission standards and pollution abatement procedures are set by the Rotterdam Hinderwet on a plant-by-plant basis, based upon a review of the applicant's flow diagrams and operational specifications. The procedure is similar to that followed in Antwerp. There are no formalized emission standards; instead, general emission levels given in the Hinderwet Handbook are used as guidelines. Except on an informal basis, Hinderwet officials seldom recommend specific equipment or procedures to reduce atmospheric

emissions; this is left to the applicant. Occasionally, because of the nature of the operation involved, specifications as shown in the Hinderwet Handbook are modified. For example, the minimum standard on particulate emissions is 150 milligrams per cubic meter. When Hoogovens--the State-owned steel company--expressed interest in constructing a steel mill in the Rotterdam area, Hinderwet reduced the emission levels by a factor of one-half because of the enormous quantity of effluent involved. This reduction in acceptable emission levels was a factor in causing the company to locate its plant in Ijmuiden on the Amsterdam North Sea Canal.

Despite its authority and the fact that continued operation of a facility is tied to its concession permit, we were informed that Hinderwet does not follow a policy of confrontation with an actual or potential polluter resulting in the imposition of a fine, threatening to shut the plant down, or to revoke its permit. Instead, Hinderwet uses direct contact with plant managers on a "be a better citizen" basis. Pollution problems are discussed openly and Hinderwet offers its assistance on a technical basis if this should be needed. The approach was described as having been generally successful, although it may not be so successful elsewhere because of the different philosophical approaches in other areas of the country or within the EEC.

3) Changes in Authority--in December 1970, control over water pollution problems was taken from the Hinderwet and given to two bodies: (1) the national government, controlling all major rivers and all ports or harbors in open connection to those rivers, and (2) the provinces, which control all open waters not under national jurisdiction.

Either national or provincial authorities may delegate power to lower bodies, such as a municipality. The purpose of the new law (Wet Verontreiniging Oppervlaktewateren--Law of Surface Water Pollution) is to improve surface water quality in Holland and accordingly to make available on a wider basis technical and financial assistance to accomplish this end; the Water Pollution Control Board--RIZA--is the principal advisor. Commencing in December 1971, it is planned that no effluent can be discharged into surface streams without a permit. In addition, a method is set up by which effluent fees may be charged, beginning with initial level of 2 guilders (about 55¢) per population equivalent (COD basis) and rising progressively to a level of about $1.00 per population equivalent. Calculation of population levels will be based upon discharge rates and characteristics from the previous year. Tax revenues will be used by provincial and national authorities to establish wastewater treatment plants, starting at the head waters on national streams in Holland. Thus far, population equivalents have not been defined for all industries.

Also in December 1970, a new air pollution control law was passed--Wet Inzake de Luchterontreiniging. In general, this law is the same as the new water law, requiring a permit from an industrial operation which discharges contaminants into the atmosphere. We were informed that other than to move air pollution control activities from municipal levels to the provincial levels in order to provide communities with better control and technical assistance, specific details of this law regarding such questions as emission levels have not yet been established.

Legislation regarding noise pollution and solid waste pollution is being prepared at the present time but has not yet been issued.

Thus, in theory the need for municipal Hinderwet organizations has been eliminated; in practice however, major Hinderwets such as the one in Rotterdam will undoubtedly continue to play an important role in pollution abatement or prevention for some time to come because of their past records of performance and vast experience in dealing with major industrial firms. In addition, the Rotterdam Hinderwet supervises the operation of a municipal air monitoring system consisting of 23 scattered stations each of which takes one sample per day of SO_2 and particulate matter, and three other stations measuring oxides of nitrogen concentration by taking eight samples per day.

In addition to the Hinderwet operation, the Rijnmond because of its direct involvement in port planning and land use, also concerns itself with certain aspects of environmental quality, particularly with regard to air quality. The Rijnmond's authority does not appear to be as great as the Hinderwet's, particularly since the Hinderwet has indirect control over permits and land concessions, but because of its SO_2 monitoring network (described in a later section of this report), the Rijnmond is an air pollution abatement authority with which industries must reckon, and the data which it is accumulating will be invaluable if and when stronger and more comprehensive air pollution abatement measures are undertaken.

We were unable to determine the number or degree of influence of industrially-sponsored organizations in the field of environmental management; certainly however, one of the most widely recognized is CONCAWE (Conservation of Clean Air and Water, Western Europe), founded about six years ago by Shell, British Petroleum and Esso to deal with environmental problems. Today, CONCAWE includes 18 oil companies as members, representing approximately 80% of Western European refining capacity. CONCAWE has three principal functions: dissemination of relevant information among member companies, the provision of a forum from which an industry viewpoint can be given, and the public relations function. Refining operations provide the focus of the organization's work, and deal with air pollution control, liquid refinery effluent treatment and disposal, oil migration in soils, noise pollution, and pollution from pipeline breaks. At present, there is no working group within the organization which concerns itself with the problems of marine pollution such as oil spill prevention and cleanup. Aside from the public relations value, CONCAWE's principal value is undoubtedly that it provides a rapid means of communication between all member companies regarding pollution abatement techniques, process changes and the like which member companies can use in combatting various forms of pollution.

b. Current and Potential Problems

1) Water--because of Rotterdam's location at the mouth of the Rhine estuary, and the large volume of pollution brought down from upstream, wastewater treatment is essentially not practiced by the municipality and to only a modest extent by major industries.

Virtually everyone with whom we discussed the subject agreed that Rotterdam Harbor is "quite" to "extremely" dirty. In addition to discharge of raw or partially treated municipal sewage, industrial plants--primarily refineries and petrochemical operations--contribute large volumes of polluted water, related primarily to cooling water effluents since most plants operate on a "once through system". When the amounts of water involved are taken into account, the volume of oil discharged in this manner can be significant. For example, one refinery discharges up to 70,000 cubic feet per hour of process water effluent having an oil content of approximately 50 parts per million. This content translates to a daily discharge rate of approximately two tons, or 16 barrels of oil; on an annual basis, the refinery discharges about 5800 barrels of oil.

Because of severe space limitations, the installation of adequate water and wastewater treatment equipment for either effluent treatment or for recycle purposes is difficult, and would be costly, particularly with regard to plants which have been in operation for some time. While central treating facilities could probably be installed, the cost would be sizable (no estimates were given), and specific legislation would undoubtedly have to be passed to accomplish this end.

Minor spills of one kind or another and including materials other than crude oil or refined products are common in the harbor. We were informed that hose bursts involving spills up to 40 barrels have occurred, and ballast and bilge pumping is common, particularly by vessels not owned or chartered by major companies.

Major oil companies use the "load on top" system of handling ballast, and in addition most major companies have holding tanks for dirty ballast. Two companies in the Rotterdam area handle ballast on a contract basis.

At present, the Rotterdam Port Authority has no physical equipment for spill cleanup. Aside from one or two small "skimmer" boats owned by private companies, the Port would have no way to effectively combat a major spill should it occur. The Authority is considering the purchase of an oil spill containment boom to divide the harbor into sections, thereby presumably making it easier to combat spills if and when they occur.

A further difficulty regarding harbor pollution control is that monitoring and control authority is divided; the national government has jurisdiction over illegal discharges in the river itself (Nieuwe Waterweg), but in fact exercises very little control. The Port Authority has control over spills and discharges within the Harbor itself, and operates at least 7 patrol boats (several of which are dual purpose, such as firefighting and personnel transfer). Modest fines can be levied against offenders, but only if they are caught in the act of spilling or discharging contaminants into the harbor. With over 50,000 vessel movements per year through Rotterdam, it is obvious that effective control over spills is a difficult task at best, and further that the present program is inadequate.

Outside of the Harbor, the Dutch Naval Air Patrol monitors vessel traffic and utilizes infrared photograph to identify oil slicks and, if possible, their source. In connection with these patrols, a German vessel was said to have been detected carrying out a "massive" dump action about 20 to 30 miles out in the North Sea. Because of the possibility of ecological damage resulting from this action, objections were lodged with the German Government.

Because Rotterdam is not a locked harbor, the North Sea has direct access to the waterway and saltwater penetrates a considerable distance upstream; this condition has been somewhat aggrevated by deepening the westward portion of the new waterway around Europort. While there is some concern that salt or brackish water may migrate laterally through the diking system into the surrounding countryside, this does not appear to have yet occurred to a major extent; it is being closely watched.

There apparently have been no baseline studies done with respect to marine life as it may be affected by pollution from the Rotterdam harbor. This question may have considerable long-range importance because northeastward trending currents may carry pollution products into the Waddenzee area, which has been characterized as the "fish nursery" for the North Sea. On a purely speculative basis, it may be that officials involved in the expansion and development of Rotterdam implicitly felt that the economic impact of this facility was far more important than any presumed adverse affects on marine life. Furthermore, since pollutive substances have long been assaulting the North Sea through the Rhine estuary, the question regarding a baseline study obviously arises as to what original conditions should be or were prior to further construction activities.

Marine baseline studies have been made south of Rotterdam in the Golden Delta region in connection with the extensive damming systems constructed between Veerse Gatdam and Quakjes Water. Such studies were perhaps more feasible in that they concern relatively unspoiled areas and were made with regard to completely changing the ecology of inland areas from marine or brackish to fresh water conditions.

2) Air--despite the fact that industrial and municipal water pollution of the Rotterdam Harbor area is widely acknowledged to be a serious problem, more progress seems to have been made in terms of analyzing the problem with respect to air pollution control. Two atmospheric monitoring systems are operated in the Rotterdam area, one by the Hinderwet and one by the Rijnmond. The Hinderwet system has already been described.

The Rijnmond network consists of 32 SO_2 monitoring stations which are arranged in a rough circular pattern around the most heavily industrialized portion of Rotterdam Harbor; none are within the city of Rotterdam itself. Hourly readings are taken automatically by the monitors and fed into a computer at Rijnmond headquarters. When relative values of SO_2 concentrations from the computer system as computed by the system exceed pre-established averages, Rijnmond notifies up to 22 neighboring petrochemical companies by a taped early warning telephone message. By pre-arranged agreement, the notified companies are expected to modify or curtail certain activities based upon the nature of air pollution occurring at the time.

In addition to the SO_2 monitoring system itself, Rijnmond accepts calls from citizens regarding other environmental pollutants such as smoke, smell, and noise. The number of such calls has been on the order of 20,000 per year. When a sufficient number of calls are made which pinpoint an offender, that organization is called by the Rijnmond.

Interestingly enough, while the network was set up to monitor industrial pollution, a major source of sulfur dioxide contamination has been related to domestic heating and the large number of greenhouses located to the northwest of the central harbor area, all of which use fuel oil containing three to four percent sulfur. It is expected that over the long run, these sources of SO_2 contamination will be gradually eliminated as the Netherlands changes over from fuel oil to natural gas.

While smoke and SO_2 pollution continue to be a problem in the Rotterdam area, Hinderwet officials are of the opinion that the gradual switch to natural gas and high stacks (for dispersion purposes) will in large measure solve the problem for at least the near future. On a longer term basis, however, there seems to be little question that increasing industrialization and urbanization of Rotterdam will cause a gradual worsening of the atmospheric environment unless increasingly stringent measures are adopted. As yet, no air quality standards have been decreed; directives from the Ministry of Public Health and Social Affairs are expected eventually to give the air pollution law some more specificity through the eventual setting of emission standards and correlation with various industries in the setting of specifications as a function of industry type and location.

Of considerable interest is a study on which Dr. L. A. Clarenberg of the Rijnmond Authority is presently working, regarding when a given geographical area might be expected to reach its capacity to absorb given volumes and types of air pollutants. The study is covering all major aspects of air pollution, including oil spills as they will affect air quality in terms of odor and evaporate constituents. Results are expected in 1973, and this report, as well as any preliminary findings published before then, should be a major contribution to environmental planning in Rotterdam.

3) Land and Solid Waste--industrial and municipal disposal in Rotterdam has long been a chronic problem; open burning, poorly operated small incinerators, improper land fill operations, and dumping at sea (or in the harbor) have been common practices. Presently under construction near St. Laurens Haven--near the center of the Rotterdam complex--is a large incinerator scheduled for completion in 1974. Planned for only industrial waste disposal, the capacity of the unit--600,000 tons per year (approximately 2,000 tons per day) is already judged to be too small.

Siltation is a problem in the Rotterdam Harbor, resulting from the combined actions of tidal fluctuations and the sediments brought into the waterway from the Rhine River

System. A fleet of up to 20 contract dredges work to maintain the Rotterdam channels. Dredging spoil is either discharged in selected sites on the harbor bank, or is barged to sea. Whether sea dumping of such material has had an adverse affect on marine life is apparently not known.

With the construction of Europort, moles or breakwaters were extended to protect the harbor entrance, to reduce near shore currents and their effect on transiting vessels, and sedimentation. The construction of these facilities also had a direct effect on the volume and rate of sand transport from south to north along the coast and their impact on the northern beaches is discussed in Section E.1.6. To permit continued nourishment of the northern beaches, up to 15 million cubic meters of sand fill is being pumped through three submerged pipelines on to the Hook of Holland recreational beach. By extending this area faster than would otherwise occur it is expected that northern sand transport will be accelerated.

4) Noise--this factor of environmental quality has received very little attention in the past, and only recently has it begun to be considered in the form of proposed legislation. For the present we were able to identify only one means by which citizens could communicate their dissatisfaction in this area: through the Rijnmond telephone system. The total effect of such noficiation is moot, since most complaints were with regard to plant upsets, which in turn were rather difficult if not impossible to control.

5) Land Use--prior to 1965, Rotterdam experienced virtually unrestrained development of its port activities. Even after the formation of the Rijnmond in 1965, the momentum of development and the perceived need to maintain Rotterdam as a center of world commerce, coupled with the vital importance of international maritime trade to the Netherlands, caused Rotterdam to continue growing seaward and created pressure to grow laterally. Such a process caused the sandwiching of residential communities between industrially zoned areas, the rapid growth of urban areas, and all types of social, labor, environmental and congestion problems. One result has been dissatisfaction on the part of large segments of the population about the quality of life in Rotterdam, and many of these people are migrating to other parts of the country.

This problem has been readily perceived by the Rijnmond, which tries to redirect the expansion of Rotterdam harbor increasingly seaward instead of allowing the harbor to continue to encroach on land areas, particularly in the Voorne region. A result has been the planning of the Maasvlakkte, a seaward and southerly extension of Europort.

c. Future Issues

Many of the problems that Rotterdam now shares with Japanese ports are those which are only incipient in the lesser developed ports such as Dunkirk and Le Havre: over-crowding, inadequate recreational facilities, inadequate infrastructure to supply proper access to the hinterlands, and an unrealistically low value placed upon the land used for industrialization; this latter point is particularly important since the community of Rotterdam is now heavily in debt because of its financing of the superstructure for the port.

Those issues which have been raised with respect to Dunkirk, Le Havre, and Antwerp--improvement of infrastructure, retention of existing and development of more recreational facilities, and closer cooperation among the affected communities--also apply to Rotterdam.

As Rotterdam continues to expand and become more densely populated with industrial operations, the pollution potential will not only become more chronic but the possibilities will undoubtedly sharply increase regarding the accidents involving dangerous materials, and explosives, fires and spills. At present, minor accidents are common occurences in Rotterdam, and it would appear that it is merely a matter of time before a major disaster of some kind occurs.

As industrialization opportunities continue to expand, it is being increasingly felt that only those industries which will suffer economically by not being adjacent to deepwater facilities should be allowed to settle in the Rotterdam area. Other industries which are less dependent upon port activities should be located elsewhere in the country, as should industries which have a high degree of pollution potential.

But even such a highly deep-sea dependent industry as a steel mill, is encountering much difficulty to settle on Maasvlakte, because the people from Rotterdam are increasingly asking themselves: "Where do we stop?" "How long will developing countries allow us to process at home their raw materials?" "Shouldn't we concentrate on electronics and leisure products which alter little the environment?"

APPENDIX C

AMSTERDAM

C.2 Amsterdam

C.2.1 Summary

Amsterdam is not a "heavyweight contender" for a major deep water port. There are hopes, however, of constructing a new outer harbor on the mouth of the North Sea canal that would be capable of receiving 180,000 dwt vessels, shown by various studies to be the bulk carriers of the seventies. Although this new outer harbor will have only 500 acreas of wet and dry surface, the municipality of Amsterdam believes that it will be sufficiently stimulative from an economic standpoint to encourage additional industrialization in the area and to generate additional traffic flow, without bringing the host of environmental problems that plague Rotterdam. The major elements of Amsterdam's port development experience are summarized in the following paragraphs.

- Amsterdam was caught by the economic requirements of Rotterdam approximately twenty years ago and has not yet recovered. Under the "Mono-port concept," Rotterdam convinced the central government that there could only be one major port in the nation and that all national efforts should be focused on this port in order to obtain the maximum economies of scale. Frcm a national viewpoint, a unique and highly successful port and associated industrial complex has been created. However, the question increasingly being asked is: "Has the strategy outlived its usefulness?"

  Amsterdam argues that the law of diminishing returns applies now in Rotterdam (port, land, labor, transport congestion) and that it is time for a more balanced regional approach to industrialization. Amsterdam contends that it is time for Amsterdam to receive priority in development, because without immediate investment in the port areas future cargo flows may very well go to competing German ports. Amsterdam points to the paucity of heavy secondary industries in the region and the very slow growth in general cargo during the past 20 years.

- Amsterdam is basically a city built upon a huge commercial tertiary sector. The city authorities are apprehensive about its long-term economic outlook. In their view, and rightly so, the tertiary sector would better be able to maintain its vitality if it were based upon a larger secondary industrial base. Acting as a constraint on general industrialization is a labor and housing shortage in the Amsterdam area which has led the authorities to investigate the capital intensive process industries in the secondary sector. Those industries would not require large numbers of personnel but would result in high-value added products and a significant commodity traffic requirement for the port. These economic objectives have led sequentially to the proposal that new transit harbor facilities and expanded infrastructure be installed for the purpose of attracting industry.
- Amsterdam's economic rationale for port investment is consistent with the central government's regional equalization policy. But, Rotterdam, anticipating a potential economic threat from French port policy, albeit long range, is making a parallel case for new subsidies from the central Government. The final decision will be political and Amsterdam may well be threatened anew by Rotterdam.
- The organic and inorganic pollutants discharged into the port are cumulative because the locks inhibit tidal flushing and enhance water evaporation, which further concentrates the pollutants. In an attempt to control the situation, the city of Amsterdam continually pumps fresh water through the brackish canal and into the North Sea through the sluices at the canal entrance.

Oil spills from a pipeline leak and a flexible hose rupture call for better design and maintenance. The rupture of a bulk oil storage tank, which washed out the retaining dike (similar to Antwerp's recent experience) in an inland canal, points to the need for better design to resist static and shock loading.

- The water pollution problem within the Amsterdam Harbor is recognized. Aside from the potential threat of major spills of oil, hazardous materials and salt water intrusion, however, water pollution is "minor" in comparison to developing a purely economic program rationale for port expansion and development.
- Amsterdam is more of a dry cargo port and as such has not experienced the rapid growth of petroleum-based industry. Consequently, in the Amsterdam area itself, air pollution has not been judged to be a serious problem, although the Hosgovens steel mill is polluting small communities in the West.
- As a highly viable but slower growing general cargo port, Amsterdam has an opportunity to plan its future growth with greater attention to environmental and sociological considerations. We have the impression that economic growth is of paramount importance, and that industrial expansion is to be achieved as rapidly as possible, perhaps at the expense of a more balanced and environmentally-oriented program to conserve a unique historical and natural city asset.

C.2.2 General Area Description

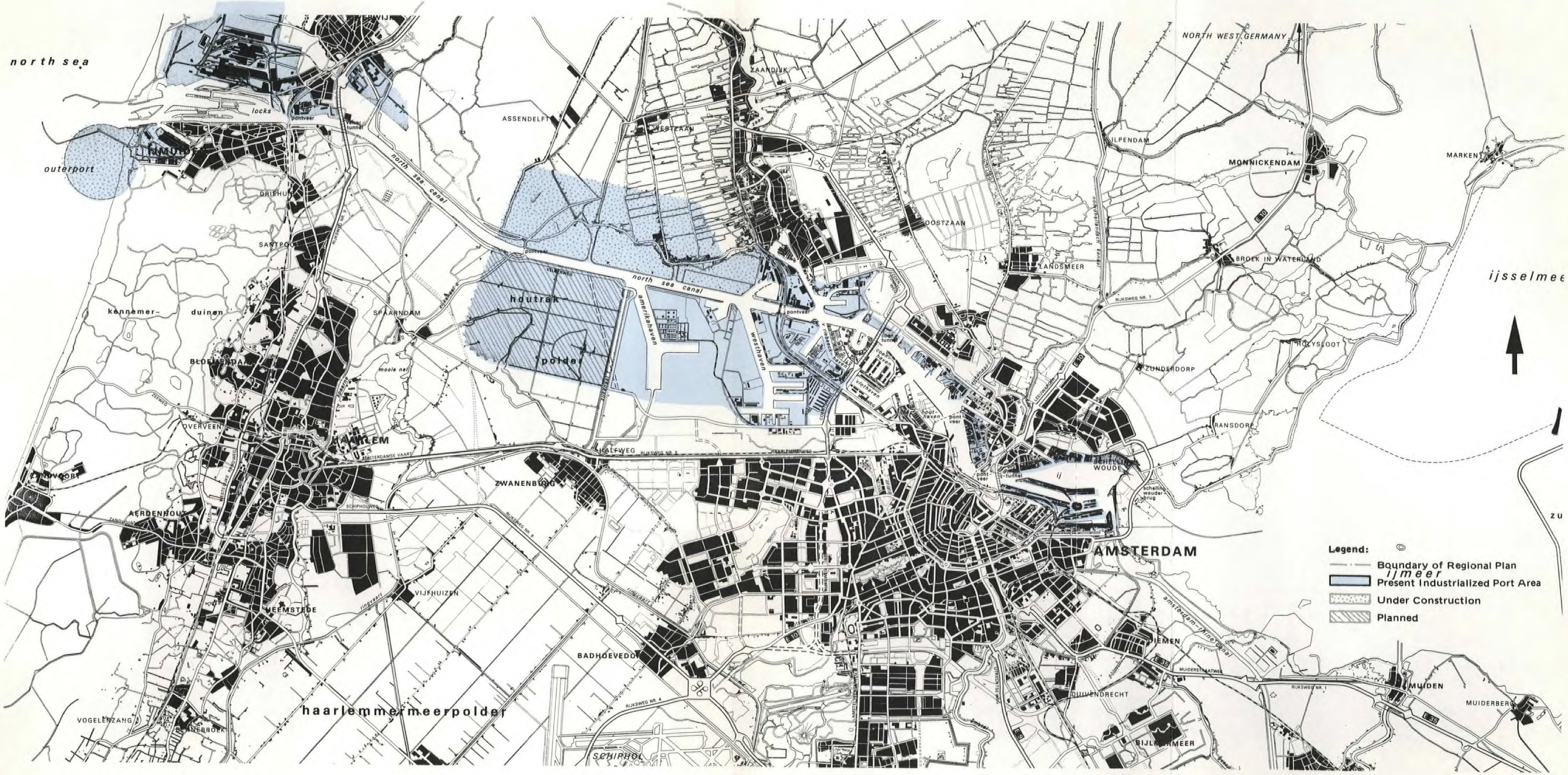
a. Geography

Situated in the province of North Holland, Amsterdam lies at the southwest extremity of the Ijsselmeer inland sea and about 16 miles from the North Sea, to which it is connected by the North Sea Canal, originally constructed in 1870 (Figure C-3).

b. Surficial Character

Founded among swamps and stretches of water, the city has always been built on piles and methodically planned. The soil is essentially fine grained sand, separated by layers of clay and peat; much of the developed acreage in the Amsterdam region and along the North Sea Canal is of

FIGURE C–3 PORT OF AMSTERDAM



polder construction; there are no known fresh water aquifers in the area which could have been affected by canal deepening.

c. Climate

Fog is not uncommon in Amsterdam: visibility is equal to or less than 0.6 miles about 10-15% of the time. But visibility generally exceeds 2.5 miles, and exceeds 7 miles about half the time. Rainfall averages approximately 30 inches annually, and average temperatures range from between 21°F in winter to 68°F in summer. The air is seldom calm; average wind speed is eleven miles per hour, and wind directions are fairly evenly dispersed with the most frequent direction out of the southeast to southwest quadrant.

d. Hydraulics

Tidal variations at the entrance to the North Sea Canal are rather modest, amounting to a total variation between high and low water of 1.6 meters (5.25 feet).

With the exception of the steel works harbor at Hoogovenshaven, the North Sea Canal and Amsterdam Harbor proper are locked, with a maximum depth of 15.5 meters (approximately 51 feet) in the newer portions of the harbor (Amerika-Haven and West Haven) and diminishing to approximately ten feet in portions of the old, inner harbor. As a matter of practicality, the Ijmuiden locks, with a maximum depth of 15 meters (50 feet) effectively control the draft of any vessel capable of entering Amsterdam Harbor. Under normal circumstances, the maximum draft allowed into the Amsterdam port is 31.1 meters (43 feet), but by special permission this draft can be and has been exceeded, the largest vessel to enter Amsterdam Port having a 45-foot draft.

e. General Land Use

Because Amsterdam has not grown as rapidly as has Rotterdam, a significant portion of the land abutting either side of the North Sea Canal remains undeveloped from an industrial standpoint. The bulk of industrialization extends from the center of Amsterdam proper towards the sea approximately 7 miles (of a total distance of 15 miles to the sea) to Amerika-Haven; a separate development on the seaward side of the Ijmuiden locks is located in Velsen and is the site of Hoogovenshaven, the state-owned steel works. Between these two areas, land on either side of the canal is used primarily for agricultural and recreation purposes.

It appears obvious, however, that in response to ever increasing pressure to make available suitable industrial sites with a direct access to the sea, a belt of industrial activity will eventually extend from Amsterdam to Ijmuiden in essentially a continuous line approximately one or two miles wide on either side of the canal. At present, for example, a new 1500-hectare (3750 acres) area immediately west of Amerika-Haven is under development. In addition, plans are being finalized to construct an outer, deep-water port off Ijmuiden that will accommodate vessels up to 60 feet in draft or approximately 180,000 dwt.

As in the other ports we visited, it is readily apparent that economic considerations (i.e., port growth and development) take priority over environmental matters. At the same time, it is also apparent that even considering the premium placed upon economic expansion in the Netherlands, a significant amount of open land remains in the greater Amsterdam region and that great attention is being given to its use, not only to meet economic needs, but also to meet social, recreational, and environmental requirements.

f. Population

The present population of the city of Amsterdam is 861,000, and within what might be called greater Amsterdam (including those communities along the North Sea Canal to Amerika-Haven) the population is about 1.1 million.

Housing is short in Amsterdam; living conditions are overcrowded, and one source estimated that 49,000 are waiting for adequate housing. While it is a prosperous city, Amsterdam by no means is free of environmental and social problems.

g. Port

Major commodities handled by the port of Amsterdam include grains, coal, iron ore, crude oil and petroleum products, and general cargo. For all practical purposes, the North Sea Canal's maximum depth -- and therefore that of Amsterdam inside the Ijmuiden locks -- has been reached. It would be impractical to enlarge the northern lock; furthermore, two tunnels built beneath the canal (in 1947 and 1952) have only 3-5 feet of overburden above them. The cost of deepening these two tunnels has been shown to be prohibitive. Thus, the only reasonably practical alternative for a deeper port is to build a deep outer port near Ijmuiden, and use it primarily as a transshipment facility, rather than as an integrated industrial complex.

h. Institutional Authority

Administration of the port of Amsterdam falls within the responsibility of the municipality of Amsterdam, the government of which consists of a 45-man elected council under the chairmanship of a Crown-appointed Burgomaster. The town council controls the following phases of port operation: port management organization, port usage rates (with royal assent), harbor police, financial management, and port expansion.

An organization similar to the Rijnmond in Rotterdam does not formally exist in the Amsterdam area; the Ijmond is the nearest thing to such an authority and is in reality a loose confederation of four communities -- Haarlem, Zaandam, Amsterdam, and Beverwijk (which includes the two communities of Ijmuiden and Velsen). At present, the planning efforts of these four communities are being coordinated by the North Holland Provincial Government. It is expected, however, that a more formal authority will be created in the relatively near future.

Among its activities, the Ijmond participated in the development of a master plan for the North Sea Canal area, which, in a general sense, provided a plan for the region out to 1990. Among the groups involved in developing this regional plan were the Planning Department of the

Province, the Planning Department of the Public Works Department in Amsterdam, the Port Authority, transportation companies, and the Rijkswaterstaat.

C.2.3 Economic Appraisal*

a. Historical Development of the Port

The history of the Amsterdam port areas started with the construction of a dam in the river Amstel, primarily to protect the surrounding areas against floods from the sea. Subsequently, the dam was used as the first transshipment quay both for seagoing vessels and for inland barges.

During the late 16th century the Amsterdam traders were successful in trading grain from the Baltic to Italy, and the sea routes on the Baltic and on the Mediterranean Seas became very important to Amsterdam. By that time the East Indian trade was established and until the 1950's Amsterdam was the most successful seaport on this important trade route.

In 1824, Amsterdam's sea accessibility via the Zuider Zee was improved for larger ships by the opening of the 'Groot Noord-Hollandsch' Canal to Den Helder. Ships' capacities continued to grow, consequently, the North Sea Canal and the Ijmuiden Locks were constructed about 1875. Over the years the North Sea Canal has been enlarged, new locks have been built -- the Northern Lock was opened in 1930 -- and the Ijmuiden harbor mouth was enlarged between 1962 and 1967. Amsterdam presently can receive ships up to 90,000 dwt.

The inland waterways have also been improved over the years. In 1893 the Merwede Canal was opened, as an improved connection between the Amsterdam port areas and the Rhine, and in 1952 the Amsterdam-Rhine Canal was completed, making Amsterdam accessible for the large Rhine barges.

*The economic information about the port of Amsterdam is based on our field investigations as well as extracts from recent publications by the Amsterdam Port Authority and its consultants, Inbucon, Inc.

In the early 1920's a significant industrial development occurred at Ijmuiden (located at the North Sea entrance of the North Sea Canal) with the establishment of an integrated steelworks. This introduced a new dimension to the function of the port.

b. The Past Twenty Years

Until the early 1950's Amsterdam was the home port of the major Dutch shipowners, and the Indonesian trade route was very important. Through the influence of the Dutch shipowners, however, foreign shipping companies were discouraged from using the port. Therefore the commercial development of the Amsterdam port areas was subject to an artificial constraint. Then the Indonesian trade lost its importance to The Netherlands and the Dutch shipowners became less interested in the Amsterdam port areas and moved to Rotterdam. Amsterdam found itself in a competitive situation with other Northwest European ports, which meanwhile had strengthened their positions by attracting foreign shipping lines. Consequently, there had been an absence in growth of general cargo.

The reasons advanced to explain the absence of growth in general cargo are as follows:

- The absence of sufficient opportunity for Amsterdam-based shipping agents and forwarding agents to take an active interest in canvassing Amsterdam traffic in the hinterland.
- Action and/or absence of action on the part of the shipping companies. This is coupled with the circular argument that more cargo would mean greater interest on the part of the shipping companies with consequent increased service frequency, whereas the opposite is also claimed to be true.
- Lack of sufficient industrialization, at least of the right category, to produce cargo flow.
- Limitations in the provision of barge canal services.
- The Netherlands' policy of not linking financial aid to developing countries with securement of port traffics.
- Reduction in Dutch influence in the East Indies.

The Amsterdam port areas have not been successful in handling general cargo. Annual growth has been approximately 0.5% between 1965 and 1969. Amsterdam lost part of its share of the total amount of general cargo handled to Rotterdam, where the annual growth has been about 10.5%.

The Amsterdam port area has been more successful in handling bulk cargo. Annual growth rate has been about 13%. Hence, Amsterdam's share of total amount of bulk handled has increased slightly.

In addition to shipbuilding and repairs, Amsterdam recognized the importance of modern port-based industries after 1950. Subsequently, one refinery and several small chemical firms have located close to the Amsterdam port area. Apart from these industries, however, the overall rate of port industrialization has been discouraging. About 4,400 acres of land have been designated for the development of port industries.

c. Sea Access

Sea access to Amsterdam port areas is through the North Sea Canal with the locks at Ijmuiden. The capacity of the Northern Lock dictates the size of vessel which can use the North Sea Canal. The limiting dimension is the depth, fifty feet, and the maximum vessel draft permitted through the lock is 45 feet (salt water). This means that while most 85,000 dwt vessels can enter the North Sea Canal, very few vessels of 100,000 could be received fully loaded. (The maximum ship size permissible at Amsterdam and several other European ports is given in Table C-21.)

The implications of this situation are clear. First, the large crude oil carriers cannot use the Amsterdam port areas. Second, the large iron ore and coal carriers now coming into service will not be able to enter the North Sea Canal. Third, other dry and wet bulk carriers ultimately may not have access to the inner port. Somewhat larger vessels can be accepted at Ijmuiden, but the future optimal sized ore carriers may not be able to serve the established steelworks directly because of the limitations of the existing access channel. Finally, some of the grain vessels that will come into operation will not be able to enter the North Sea Canal.

TABLE C-21

MAXIMUM SHIP SIZES FOR SELECTED PORTS
(dwt)

	Current	Planned	Potential
Amsterdam	90,000	150,000	150,000
Antwerp	80,000	125,000	135,000/150,000
Dunkirk	125,000	300,000	750,000
Le Havre	250,000	500,000	1,000,000
Rotterdam Europort	250,000	300,000	?
Rotterdam Botlek	80,000	80,000	80,000

Source: Arthur D. Little, Inc.

Amsterdam does not expect that the size of specialized tankers (i.e., for liquid chemicals) will go much beyond 60,000 dwt, but petroleum products may be shipped in vessels of more than 100,000 dwt; for the established "port of call" operation, however, partially loaded product carriers of this size will still have access to Amsterdam. Thus, the Northern Lock capacities are not expected to be a limiting influence for product carriers. Nevertheless, the present depth of water at Amsterdam is a constraint and this restriction will increase in significance in the near future.

For the above reasons, the Minister of Traffic and Waterways has established a committee to investigate problems of sea access for the Amsterdam port areas. The initial purpose was to study the possibilities of a new lock system; later the possibilities for deepening the North Sea Canal to permit the entry of larger ships were also considered. Because these potential developments were determined to be disproportionately expensive for the likely benefits, alternative plans for an outer port at Ijmuiden were included in the Committee's scope.

Present advantages of the inner port are quiet water and the absence of tidal effects. These are of benefit both to sea access and to the maintenance of the port facilities. A disadvantage, which is of particular significance for some traffic is that the specialized high-cost vessels have to pass through the North Sea Canal lock system and to travel a distance of about 15 nautical miles from the outer buoys to the inner port and handling facilities; this increases the turnaround time and costs.

The access distances of the major ports in the Le Havre-Amsterdam range (Table C-22) indicate that Amsterdam is relatively well placed.

TABLE C-22

SEA ACCESS DISTANCE

Port	Approximate Distance to North Sea* (Nautical Miles)
Amsterdam - Planned Outer Port	1
Amsterdam - West Harbor	15
Antwerp	58
Dunkirk	1
Le Havre	2
Rotterdam Europort	8
Rotterdam Botlek	16

*Reference points: outer buoys.

Sources: Amsterdam Port Municipality/Imbucon and Arthur D. Little, Inc.

Access distances and time are likely to become more important in the near future with the development of very high capital cost vessels for unitized cargo.

d. Mono-Port Concept

The expression "mono-port policy" has been used to describe a policy in which one mammoth port is developed to the detriment of its rivals. It has been said that The Netherlands has pursued such a policy at Rotterdam with a resultant stagnation at the Amsterdam port area.

The National Government's official policy has been to give equal opportunities to the ports of Amsterdam and of Rotterdam. In 1965, this twin port policy underwent some modification when it was decided that only Rotterdam should go ahead in terms of deep water, in order to provide facilities for the giant crude oil carriers, but that equality should be maintained in the capability of handling all other cargo. At that time, the possibility of very large dry bulk carriers was not foreseen. It is now clear that if the Government is to maintain a policy of equality, deep water access at the Amsterdam port areas must be improved.

Despite this policy of equal opportunity, the Rotterdam port has received a much greater share of port investment than the Amsterdam port area. From the national viewpoint, a unique opportunity was taken and a highly successful port and associated industrial complex created. However, the Amsterdam port area has been overshadowed by these developments and its growth rate has suffered accordingly.

Many arguments have been advanced in favor of the mono-port concept, including:

a) economy of scale;

b) protection of existing investments;

c) port alternatives.

Economy-of-scale arguments apply to all aspects of a port's activities, including handling, infrastructure, and frequency of service. This has been a major reason for the rapid growth in the Rotterdam region. However, the law of diminishing returns will apply to this situation as soon as a certain traffic density has been reached. (In the ultimate situation diseconomy of scale arises.)

Amsterdam believes that in the future, the economy-of-scale argument will be much more significant when applied in favor of investment in the Amsterdam port areas. Without immediate investment at the Amsterdam port areas, however, the economy-of-scale arguments will again work against Amsterdam, possibly in favor of competing ports outside The Netherlands (e.g., on the Baltic).

Sizable port investments in Amsterdam are at risk through the mono-port developments. Already a number of Amsterdam port users have transferred some of their operations to other ports and there is a danger that a number of the main terminals in the Amsterdam port areas may be unable to remain operational. Loss in public and private investment, and the social consequences of a disruption in employment could well be the outcome of this situation.

It is a fact that, on occasion, serious delays are experienced by port users at Rotterdam. The costs involved in delaying large ships are considerable and can, if they arise frequently at a port, result in the transfer of some shipping lines to non-Holland ports. Other diseconomies which can arise, though concentrating all major port developments in one area, relate to the availability and costs of the various support resources required. In particular these include land, labor and inland transport links.

Many individuals in Amsterdam believe that commercial interests at Rotterdam have attempted to minimize these problems. However, with inadequate port alternatives (for example, deep water access) in The Netherlands, any diversion of traffic and industry from Rotterdam is likely to be for the benefit of port areas outside The Netherlands. This is the Amsterdam argument for national investment to improve the transport function at Amsterdam.

A further argument is that 'regional equalization' is a most important aspect of national policy; by such means, required maximization of national income, high land utilization and stabilization of employment can follow. Within the implementation of regional developments, it is argued that port investment at the Amsterdam port areas should be awarded a high priority.

e. Inland Transportation

Amsterdam, along with the other North Sea ports, enjoys the advantage of easy access to the vast European industrial heartland. This, coupled with the natural advantages of the ports, including the available waterway links, has resulted in considerable traffic growth, but also in an imbalance in cargo flow. There is a product weight and volume loss generally associated with manufacture, which also contributes to the fact that inflows through the Benelux ports significantly outweigh their outflows. However, the balance at Antwerp, about 67% inflow versus 33% outflow, is better than at the Dutch ports, which is about 76% in and 24% out. (It should be emphasized that these figures are for international cargo flows.)

Table C-23 presents the international cargo flows for 1969 for Amsterdam and the main Benelux ports. The table shows the predominant position of the Rijnmond, effectively Rotterdam. Clearly, the waterways are by far the most predominant inland transport mode for international traffic.

TABLE C-23

INTERNATIONAL CARGO FLOWS 1969
(million metric tons)

Port Area	Sea	Inland Water	Rail	Road	Pipeline
Ijmond	29.0	10.6	4.4	2.0	--
of which: Amsterdam	19.8	7.9	2.4	1.2	--
Rijnmond	189.2	66.1	3.3	5.1	20.8
of which: Rotterdam	182.7	60.4	3.0	4.6	20.8
Antwerp	73.0	16.8	2.6	3.2	--

Source: Amsterdam Port Municipality/Imbucon.

However, a number of inland transport developments have been planned for Amsterdam, Antwerp and Rotterdam; these include the Rhine-Scheldt water links, the Hartel Canal and various road improvements. In Table C-24 we compare the anticipated 1990 transport links between the Benelux ports and Duisburg, Germany (a representative locational center for the interior). In this comparison an Amsterdam outer port at Ijmuiden is also assumed.

TABLE C-24

HINTERLAND DISTANCES BY PREFERRED ROUTE [1]
(miles)

From Duisburg to:		Rail	Road	Water	No. of Locks
Present Situation:					
	Amsterdam-West Harbor	126	123	128	2
	Rotterdam-Botlek	153	146	146	0
	Antwerp	171	174	205	4
Future Estimated Situation:					
1990	Amsterdam-West Harbor	126	123	128	2
	Amsterdam-Outer Port	143	140	138	3
	Rotterdam-Botlek	153	136[2]	146	0
	Rotterdam-Europort	161	155[2]	164	1
	Rotterdam-Maasvlakte	167	158[2]	169	2
	Antwerp	171	118[3]	180[4]	2/3[5]

[1] When Amsterdam-Outer Port and Rotterdam-Maasvlakte in operation and following footnotes apply:

[2] Via Zevenaar-Tiel-Gorinchem Highway

[3] Via European Highway No. 3

[4] Via Rhine-Scheldt Link

[5] Eastern Scheldt-Bank, 2, Western Scheldt-Bank, 2.

Source: Amsterdam Port Municipality/Inbucon.

f. Land

In the near future there will be an overall scarcity of land in the harbor areas of The Netherlands. Table C-25 shows how the land prepared for port development has increased in the eight years between 1960 and 1968, and Table C-26 presents figures for prepared land and virgin land at each Dutch harbor area. In addition, Amsterdam has a strong potential by reclamation and natural filling in the Zuider Zee.

TABLE C-25

NET LAND PREPARED IN DUTCH HARBOR AREAS
(Acres)

Harbor Area	1960	1968	Increase	Growth Index
Rotterdam	6,037	13,345	7,308	220
Amsterdam	3,362	6,143	2,781	180
Scheldt	758	2,942	2,184	390
Northern Harbors	45	2,719	2,674	---
Total	10,202	25,149	14,947	---

Sources: Amsterdam Port Municipality/Inbucon and Arthur D. Little, Inc.

TABLE C-26

NET LAND AVAILABLE TO INDUSTRY AND TRANSPORT IN
DUTCH HARBOR AREAS
(Acres)

Harbor Area	Prepared Land	Virgin Land	Total Free Land
Rotterdam	215	---	215
Amsterdam	825	3,582	4,406
Scheldt	415	608	1,023
Northern Harbors	1,482	756	2,238
Total	2,937	4,946	7,882

Source: Amsterdam Port Municipality/Inbucon.

The total land available is 7,882 acres. Clearly, whatever forecast of land requirement is considered, there is shortly going to be an overall shortage of land in the Dutch harbor areas. Of the land available, more than half is in the Amsterdam port areas, primarily on the south bank of the North Sea Canal and thus, land availability is a very important asset for Ansterdam. In addition, there is land designated for development on the north bank of the Canal.

In principle, the policy of the Amsterdam Minicipality is to lease land to industry rather than to sell it. However, existing port-based industries own some of the land and it is possible for a user to buy an industrial site. Broadly speaking, the companies coming to the port area are given a contract entitling them to use the land for 50 years with an option to renew the contract for a further period. The rent charged to companies leasing land is negotiated initially on the basis of land and infrastructure costs to the port. Thus, users requiring, for example, 300 acres, will pay less per acre than users requiring only a few acres. The reason for this is that the port will incur less infrastructure cost supplying a single lot of 300 acres than would be the case for 15 separate users each requiring 20 acres.

The rent charged at Amsterdam is reviewed every five years in accordance with a specified formula that takes into account inflation. At Rotterdam the adjustment can take into account the increase in land value through scarcity as well as inflations.

g. Labor

There is a serious overall labor shortage in The Netherlands, but the labor situation at Amsterdam is not expected to deteriorate relative to other regions. In fact, with an increasing emphasis on capital-intensive, high-skill industries, the labor availability advantages of the Amsterdam port areas could increase, provided there is sufficient housing. At present, housing is scarce.

The statistics of the labor situation are presented in Table C-27. The last column of the Table shows the demand for labor divided by the number of workers without work. This ratio indicates that the labor shortage is far less critical at Amsterdam than at Rotterdam.

TABLE C-27

UNEMPLOYED LABOR AND JOBS AVAILABLE IN MAY 1970

Labor Area	Supply	Demand	Ratio
North Holland	4,722	15,372	3.3
of which Amsterdam	2,934	7,522	2.6
South Holland	6,125	26,727	4.4
of which Rotterdam	1,940	10,813	5.6
The Netherlands	36,876	93,482	2.5

Source: Amsterdam Port Municipality/Inbucon.

h. General Cargo

The growth of general cargo passing through the Amsterdam port areas has been practically nil, as is shown in Table C-28.

TABLE C-28

GENERAL CARGO TONNAGE
(million metric tons)

Year	Incoming by Sea	Outgoing by Sea	Total
1960	2.4	1.7	4.1
1965	2.5	1.6	4.2
1969	2.6	1.5	4.2
1990	5.9	5.5	11.4

Sources: Arthur D. Little, Inc., and Amsterdam/Imbucon.

In order to achieve a growth rate in line with the overall growth expected in Northwest Europe 15-16 million tons per year would have to be handled by 1990. Port personnel believe that even the forecast 11.4 million tons of general cargo cannot be achieved without significant development of the Amsterdam port areas.

It is the position of the port administration, that with present facilities the Amsterdam port area will not be able to maintain its share of European general cargo traffic. This share has been declining over the past 20 years and this negative trend will be accelerated without the proposed outer port.

i. Iron Ore

Iron ore, a relatively low cost commodity, is coming increasingly from more distant, higher-quality sources and the volume of trade is rising. Accordingly, vessels are expected to increase in size.
The ships in service for particular traffics depend on the harbor facilities available both at the loading and unloading ports, but developments expected in the next few years at ore loading ports, and the current origin of ore supplies, imply that in the near future nearly three-quarters of the requirements of the German steelworks could be supplied in vessels not acceptable at the Amsterdam port area.

Swedish iron ore is important and will probably meet a quarter of the Northwest European demand. In the long term, however, with larger steel-making units, joint buying arrangements and the expected composition of the ore fleet, even this ore probably will be carried increasingly in larger vessels. In 1975 only 40% of incoming transshipment ore might be received at the Amsterdam port area without the construction of an outer port. By 1990, this figure may be as low as 10%. In 1969, 5 million tons of iron ore were imported for transshipment. This excludes seagoing traffic for the steel plant at Ijmuiden of about 8 million tons in 1969, which will probably be doubled by 1990. By 1990, the forecast of imported iron ore to Amsterdam is 11 million metric tons.

In the immediate future, two events will probably enable the Amsterdam port area, with only the current facilities, to continue to retain some of the transshipment trade. The first is the existing fleet of smaller vessels that will be chartered out at rates per ton comparable with the big vessels. The second is the employment of the large vessels only partially loaded because of inadequacies in the port's facilities or because demand was less than maximum.

j. Other Ores

The estimated 1990 net requirements of other ores in West Germany and BLEU* are 10 million tons and 5 million tons, respectively. Although the effect of ship size will not be as significant as for iron ore, cargo flows will tend to be transported through the centers of iron ore handling. Thus, The Netherlands should receive a dominant share of other ore traffic. The 1990 forecast is about 8 million tons; again this is about double the present tonnage.

This tonnage is indirectly dependent on adequate facilities for deep water transport (e.g., iron ore). Hence, should such facilities not be developed in the Amsterdam port areas, anticipated tonnage in 1990 would be only about 2 million tons.

k. Grain and Derivatives

The grain business is undergoing a significant change. Increasingly, so-called "derivatives" are replacing the traditional corn. The demand for "hard" grain for human consumption is static, but the demand for "soft" grain, and increasingly for "derivatives" for animal foodstuff, is growing slowly. The tariff policy of the EEC favors the internal supply of "soft" grain, particularly from France, and at the same time encourages the switch to importing "derivatives." The result is that in Europe the rate of growth of imports in total (grain and derivatives) is slow, and derivatives are growing at the expense of grains. Reduced grain volumes mean that the size of grain vessels is not going to increase as much as was expected. This smaller size will reduce the tendency for transshipment.

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*Belgium/Luxembourg Economic Union.

In 1969, 213 million tons of grain, copra and soybeans entered the Amsterdam port areas and 1.1 million tons of the grain were transshipped onwards. The volume of grain and derivatives incoming by sea is forecast to reach 4 million tons by 1990.

1. Coal and Coke

Coal traffic through the Amsterdam port areas has grown slowly between 1965 and 1969. Tonnage went from 1.4 million tons in 1965 to 1.6 million tons in 1969. Over the long term, the demand for coal depends primarily on the steel industry's requirements for coking coal. At present, coke is not likely to be replaced intensively in the reduction process, although pilot studies using direct reduction and experiments using poorer quality coal are being carried out.

The energy policy of the EEC which protects the European coal industry, also affects the competitive position. Coking coal is in short supply worldwide, which helps to maintain its high price.

These technical, economic, and political uncertainties make it difficult to be confident about long-term predictions. The "best estimates" forecasts for The Netherlands in 1990 are given in Table C-29.

TABLE C-29

COAL AND COKE FORECASTS TO 1990
(million metric tons)

Amsterdam	1.4
Rotterdam	4.6
Imports to Dutch Steelworks	6
Transit to West Germany	7
Transshipment and Other Transit	5
Total:	18

Source: Amsterdam Port Municipality/Inbucon.

The current position in the Amsterdam port areas is not a good indication of future coal and coke traffic. More recent developments indicate the possibility that Australian and Canadian coke may be imported, which would require large vessels, and arguments similar to those described for iron ore would apply. However, the smaller annual tonnages required make the economy of scale less important.

m. Oil

In 1969, 4 million tons of oil (crude and products) were handled at the Amsterdam port areas. Included in this figure is 1.2 million tons of Libyan high-viscosity crude oil going to the existing Mobil Oil refinery. This crude oil cannot use the unheated pipeline from Rotterdam. The tonnage of crude oil handled at Amsterdam in the future will depend on expansion by the established oil refinery and the possible building of new refineries. However, the bulk of the crude oil will come by pipeline from Rotterdam. On the basis of present refinery expansion plans, and without assuming new refineries requiring significant volumes of specialized crude oil, Amsterdam forecasts an import tonnage by tanker of about 2 million tons in 1990. Petroleum products will add another 2 to 6 million tons, depending on port and industry developments.

n. Commodity Flow Forecasts

A review of major commodity traffic is given in Tables C-30, C-31, and C-32.

Without an outer port and without improved traffic flows from industrialization, the commodity flows shown in Table C-33 are expected to occur.

Table C-34 indicates the volume of commodity flows that would be possible after implementation of the outer harbor project and the realization of industrial objectives.

TABLE C-30

AMSTERDAM

IMPORT/EXPORT COMMODITY TRAFFIC

(million metric tons)

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965 (%)	Tons 1969	Annual Growth Rate 1965 - 1969 (%)
Total Tons (Exports and Imports)	10.8	13.9	5.2	19.9	9.4
Bulk	6.7	9.7	7.7	15.7	12.8
General Cargo	4.1	4.2	0.5	4.2	N.C.
Selected Bulk Commodities					
CEREALS	.3	2.6	53.0	3.5	7.7
WOOD	.8	.7	-2.6	.7	N.C.
COAL	1.4	1.4	N.C.	1.6	3.4
RUBBER	-	-	-	-	-
ORES	2.4	2.6	1.6	5.0	17.8
IRON & STEEL	.3	.3	N.C.	.2	-9.6
NON FERROUS	-	-	-	-	-
METALWARE	-	-	-	-	-
MACHINERY	.1	.1	N.C.	.1	N.C.
TRANSPORTATION EQUIPMENT	.1	.1	N.C.	.1	N.C.
PETROLEUM	1.5	2.1	7.0	4.7	22.0
CHEMICALS	.7	.7	N.C.	.9	6.5
FERTILIZERS	.3	.3	N.C.	.2	-9.6
PULP & PAPER	.4	.5	4.6	.4	-5.4
CEMENT	-	-	-	-	-

N.C. = No Change

Source: Annual Reports of the Port of Amsterdam

TABLE C-31

AMSTERDAM

EXPORT COMMODITY TRAFFIC

(million metric tons)

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965 (%)	Tons 1969	Annual Growth Rate 1965 - 1969 (%)
Total Tons	3.0	3.5	3.1	5.3	10.9
Bulk	1.3	1.9	7.9	3.8	19.0
General Cargo	1.7	1.6	-1.2	1.5	N.C.
Selected Bulk Commodities					
CEREALS	-	.7	-	1.1	12.0
WOOD	-	-	-	-	-
COAL	.5	.1	-27.0	-	-
RUBBER	-	-	-	-	-
ORES	-	.1	-	.3	32.0
IRON & STEEL	.2	.2	N.C.	-	-
NON FERROUS	-	-	-	-	-
METALWARE	-	-	-	-	-
MACHINERY	.1	.1	N.C.	.1	N.C.
TRANSPORTATION EQUIPMENT	.1	-	-	.1	-
PETROLEUM	.5	.6	4.7	2.1	37.0
CHEMICALS	.5	.5	N.C.	.6	4.7
FERTILIZERS	.3	.2	-7.8	.2	N.C.
PULP & PAPER	.1	.1	N.C.	.1	N.C.
CEMENT	-	-	-	-	-

N.C. = No Change

Source: Annual Reports of the Port of Amsterdam

TABLE C-32

AMSTERDAM

IMPORT COMMODITY TRAFFIC

(million metric tons)

	Tons 1960	Tons 1965	Annual Growth Rate 1960 - 1965 (%)	Tons 1969	Annual Growth Rate 1965 - 1969 (%)
Total Tons	7.8	10.4	5.9	14.6	8.8
Bulk	5.4	7.9	7.9	12.0	11.0
General Cargo	2.4	2.5	0.8	2.6	1.0
Selected Bulk Commodities					
CEREALS	.3	1.9	45.0	2.3	4.9
WOOD	.7	.7	N.C.	.7	N.C.
COAL	1.0	1.3	5.4	1.5	3.6
RUBBER	-	-	-	-	-
ORES	2.4	2.5	0.8	4.7	17.1
IRON & STEEL	.1	.1	N.C.	.1	N.C.
NON FERROUS	-	-	-	-	-
METALWARE	-	-	-	-	-
MACHINERY	.1	.1	N.C.	.1	N.C.
TRANSPORTATION EQUIPMENT	.1	.1	N.C.	.1	N.C.
PETROLEUM	1.0	1.5	8.5	2.7	15.8
CHEMICALS	.2	.1	-12.6	.2	19.0
FERTILIZERS	-	-	-	-	-
PULP & PAPER	.3	.4	5.9	.4	N.C.
CEMENT	-	-	-	-	-

N.C. - No Change

Source: Annual Reports of the Port of Amsterdam

TABLE C-33

COMMODITY FORECASTS TO 1990
(million metric tons of sea traffic)

Commodity	Sea Traffic Tonnages for Amsterdam Port Areas 1969	1990	Growth Index 1969=100
General Cargo	5.8	10	172
Ore	5.0	3	60
Grain and Derivatives	3.8	4	105
Coal and Coke	1.5	2	133
Mineral Oils	4.0	4	100
Other Bulks and Wood	1.3	3	231
Total	21.4[1]	26	122

[1]Excludes sea going traffic at Ijmuiden, about 8 million tons of iron ore in 1969 which will probably be doubled in 1990.

Source: Amsterdam Port Municipality/Imbucon.

TABLE C-34

FORECASTS FOR AMSTERDAM AND THE NETHERLANDS
(million metric tons of sea traffic)

Commodity Category	Amsterdam Port Areas 1969	1990 Without Outer Port	Outer Port	Industrial-ization	Total	The Netherlands 1990 Forecast*
General Cargo	5.8	10	12	3	25	76
Dry Bulk	11.6	12	25	3	40	272
Wet Bulk	4.0	4	--	10	14	386
Total	21.4	26	37	16	79	734

*Central Planning Bureau, The Hague.

Sources: Amsterdam Port Municipality/Inbucon.

o. Industrialization

One of the major benefits arising from the establishment of an outer port, along with the continual development of the Amsterdam port areas, is the effect on industrialization. The effect works in two ways. First, the existence of a successful deep water port can be expected to encourage port-based industry to locate in the harbor areas. Second, given this development, the industrial traffic generated can be handled by the port.

The industries that locate in harbor areas are also influenced by the presence of linkages to existing industries, or by those industries which are likely to locate in the area in the future. The clearest example is the petroleum industry, which because of the expected increase in size of oil tankers, was encouraged to locate refining capacities at those areas of consumption with deep water facilities. This, coupled with the parallel developments in petrochemicals, has resulted in mammoth oil and petrochemical complexes being established at seaports (e.g., Rotterdam and Antwerp). The current master plan was in fact triggered by the Mobil refinery and its request for 150,000 dwt facilities.

Other likely seaport locational candidates are enterprises within the industrial groups: metal processing (e.g., iron and steel, aluminum smelting), food processing (e.g., grain milling, sugar refining) and processing activities (e.g., timber processing, paper manufacturing).

In regard to port based industry, the developments at the Amsterdam port areas have been discouraging. Areas on both the north and south banks of the North Sea Canal have been allocated for industrial development. Along the south bank about 3200 net acres are available for port-based industries where the primary requirement is access to water berths. Already established is a 130,000 bbl/year crude oil refinery, connected by city and state-owned pipeline to Rotterdam, which has a current, much underused capacity of 20 million tons per year. Other refiners are strongly invited and MURCO is considering a 100,000 bbl/day refinery. The adjacent land in this region offers opportunities for a range of petrochemical industries that would benefit from being sited in the immediate vicinity of the refinery by being guaranteed supply of raw materials. Similarly, the established steelworks offers possibilities for the development of iron and steel finishing and fabricating.

TABLE C-35

DISTRIBUTION OF INDUSTRY BY SECTORS
(%)

	Amsterdam		Netherlands	
	1953	1965	1953	1965
Secondary	40.9	36.2	52.5	52.4
Tertiary	59.1	63.8	47.5	47.6

The status of the secondary sector in Amsterdam is alarming, as shown in Table C-35 and as confirmed by the slow rate at which land has been issued to industry; between 1952 and 1967, only 1500 acres were leased in Amsterdam port areas.

In conclusion, the growth of the secondary sector, specifically seaport industry, has been insufficient to act as a locational stimulus at present. The Amsterdam port areas need high-growth industries coupled with high transport tonnage and rigorous control of pollution effects.

Table C-36 lists selected industrial classifications and provides an assessment of the industrial characteristics by manufacturing category as determined by the Amsterdam Port Authority. Each of the classifications is made up of a number of different industries. Below are examples of industries for each manufacturing category:

(1) <u>Electrical Equipment</u>: Electric power machines, distributing equipment, telecommunications apparatus, domestic equipment, medical equipment, etc. including electronics industry.

(2) <u>Glass and Ceramics</u>: Glassware, glass rods, tubes and plate, refractory materials, ceramic materials, etc.

(3) Machinery: Steam generating machinery, agricultural machinery, metalworking machinery, textile and leather machinery, machine parts, etc.

(4) Metals -- Iron and Steel: Pig iron, iron and steel ingots, iron and steel bars, rods, plates, sheets, rail, tubes, castings and forgings, etc.

(5) Metals -- Non-Ferrous: Aluminum, copper, nickel, and other metal bars, rods, plates, sheets, strip and tubes, etc.

(6) Oil Refining, Petrochemicals and Other Chemicals: Crude petroleum, petroleum products, organic chemicals, inorganic chemicals, fertilizers, chemical products, etc.

(7) Pulp and Paper: Pulp waste, paper waste, chemical wood pulp, sulphate wood pulp, sulphite wood pulp, etc.

(8) Transport Equipment: Railway vehicles, road motor vehicles, other road vehicles, ships and boats, etc.

(9) Wood, Lumber and Cork: Pulpwood, sawlogs, and veneer logs, shaped wood, worked lumber, cork in blocks, plates and sheets, wood manufactures, etc.

(10) Other Industries: Cereals, cereal preparations, sugar, sugar preparations, other food preparations, oil-seeds, textile, rubber manufactures, etc.

The industrial characteristics assessed (relative to land use) in Table C-36 are labor, utilities (electricity, gas, water and effluent disposal) and investment. Important generation factors, stemming from industrialization, are added value and output tonnage; both are presented as proportional to land allocation and added value is also presented relative to employment. Output tonnage is particularly relevant to port based industrialization.

TABLE 3-2

INDUSTRIAL CHARACTERISTICS BY MANUFACTURING CATEGORY

Manufacturing Category	Labour Requirement Per Acre	Utility Requirement Per Acre	Investment Requirement Per Acre	Added Value Per Acre	Transport Tonnage Per Acre	Added Value Per Employee	Industrial Effect On The Environment	
							Air	Water
1. Electrical Equipment	High	Very High	High	Very High	Very Low	Average	*	*
2. Glass and Ceramics	Low	Low	Very Low	Very Low	Low	Low	-	-
3. Machinery	Average	Average	Low	Average	Very Low	Average	*	*
4. Metals -- Iron and Steel	Average	Very Low	High	High	High	Average	**	**
5. Metals -- Non Ferrous	Average	Variable	High	High	Average	Average	**	**
6. Oil Refining	Very Low	Very Low	High	Very Low	Very High	Very High	**	*
7. Petrochemicals	Very Low	Average	Average	Low	Average	Very High	**	-
8. Other Chemicals	Low	Low	Average	Low	Average	High	-	-
9. Pulp and Paper	Low	High	High	Low	High	Average	*	**
10. Transport Equipment	Average	Average	Low	Average	Low	Average	*	*
11. Wood, Lumber and Cork	Average	Low	Low	Average	Average	Low	*	*
12. Other Industries	Variable	Variable	Variable	Variable	Variable	Variable	-	-

- highly variable within category

* less effect on environment than **

Source: Amsterdam Port Municipality/Inbucon.

p. Cost of Outer Port

It is Amsterdam's position that port expansion in the Amsterdam port system should be implemented if port traffic is to be maintained in The Netherlands. A possible method of providing the required facilities for say, 100,000 to 150,000 dwt ships would be to construct a new lock system at Ijmuiden and to deepen the North Sea Canal. The cost, however, would be prohibitive. The only practicable alternative is the building of an outer port.

(1) Investment Costs. An outer port with 250 to 500 acres of dry area is under consideration. The proposed outer port is located to the south of the southern harbor entrance mole and would be entered through a gap in this mole. Land on such an outer port will be costly. It must therefore be reserved for transportation activities and in particular to those activities that would not take place at all, or at least not without a heavy financial penalty, elsewhere.

The larger outer port (i.e., the 500-acre alternative) has the advantage of incurring similar costs for an approach channel and for hinterland transport links, and relatively low extra costs for mole construction, for land and for water basins. The overall cost per acre is therefore reduced significantly.

Cost estimates are listed below for a possible 3-phase program of work for the 500-acre outer port;

Phase I: construction of a 250-acre dry area outer port with an approach channel of about 60 feet.

Phase 2: an increase in the dry area from 250 acres to 370 acres and a deepening of the approach channel from 60 feet to 63 feet.

Phase 3: a further increase in the dry area from 370 acres to 500 acres.

The costs of each phase are presented in Table C-37 classified by source of finance (M: Municipality, S: State). This division is based on the central Government's role in previous investments of this nature, in which two-thirds of channel and sea wall costs have been met by the central Government. The remaining investment is allocated to the Municipality.

The overall cost of the 500-acre project is $74 million. After exclusion of channel costs and the expected State contribution, the land requires a Municipal investment of $30 million, or approximately $1.50 per square foot. This amount compares with an estimated $1.30 per square foot for the Maasvlakte I development at Rotterdam.

(2) Recurring Costs. Once the outer port is established, there will be a number of recurring costs (Table C-38).

q. Financial Cost Benefit Analyses of Alternative Plans

In Amsterdam, a financial cost/benefit analysis concerning the proposed 'outer port' was undertaken, with the costs and benefits of the outer port allocated between the Municipality and the State.

The Municipality would acquire revenue both from harbor dues and from land leases. The State would benefit from increased 'added value' resulting from the handling of transit traffic which would not otherwise pass through The Netherlands.

(1) Municipality. Municipal investments required were for a proportion of the costs related to land, water basins, infrastructure and channel, together with the recurring costs for land maintenance, additional Port Management overheads and marketing of the outer port services. Costs not included were those related to the construction and operation of the port handling terminals. These costs were not relevant, because they were met by private enterprise as a commercial and profitable undertaking not directly involving the Municipality.

An exception was the cost of quay development. Whether these costs were to be met by private enterprise or by the Municipality (and then leased

TABLE C-37

INVESTMENT REQUIRED FOR OUTER PORT DEVELOPMENT
(millions of dollars)

	Investment Source of Finance							
	Phase 1		Phase 2		Phase 3		Total	
Cost Item	M*	S*	M	S	M	S	M	S
Land, Water, Basins and Infrastructure	23.4	13.0	3.3	-	3.3	-	30.0	13.0
Channel	4.6	9.3	5.6	11.1	-	-	10.2	20.4
Total	28.0	22.3	8.9	11.1	3.3	-	40.2	33.4

*M = Municipality, S = State

Source: Amsterdam Port Municipality/Inbucon

TABLE C-38

ANNUAL COSTS OF OUTER PORT DEVELOPMENT
(thousands of dollars)

	Annual Costs			
	Initially		Ultimately	
Cost Item	M*	S*	M	S
Channel Maintenance	-	670	-	1200
Land and Basin Maintenance	420	-	500	-
Mole Maintenance	-	83	-	83
Port Management	83	-	280	-
Marketing Budget	700	-	27	-

*M = Municipality, S = State

Source: Amsterdam Port Municipality/Inbucon to the terminals concerned) they were not included in the cost benefit analyses because of the uncertainty in the layout of the outer port. The alternative adopted was to assume that one-third of the harbor dues plus quay dues would finance the quay walls. Independent analysis indicated that quay costs would vary between $6000 and $8000 per meter.

In Table C-39 the anticipated cash flows are given for the two development programs considered. For Development Plan 1, the lower end of the traffic forecast range was taken; for Development Plan 2, the higher traffic forecast was considered.

These cash flows were summarized over individual five-year periods. In the first five years, considerable investments and costs would be incurred with no compensating revenue. Revenues considered were land lease at $1.40 per square meter ($0.14/sq ft), and two-thirds of the harbor dues taken. Dues were assumed to be $0.27 per ton for container traffic and $0.07 per ton for iron ore traffic.

TABLE C-39

MUNICIPAL CASH FLOWS FOR ALTERNATIVE DEVELOPMENT PLANS
(millions of dollars, basis 1970)

	Plan 1			Plan 2		
Five-Year Periods	Total Costs	Anticipated Revenue	Cash Flow	Total Costs	Anticipated Revenue	Cash Flow
First	30.8	3.8	-97.5	30.8	5.5	-91.0
Second	3.9	14.4	+37.8	12.8	23.5	+38.7
Third	13.3	20.7	+26.5	4.4	28.3	+86.0
Fourth	7.5	29.2	+78.0	7.5	37.4	+114.8
Fifth	3.9	31.6	+99.6	3.9	41.3	+134.3
Sixth	3.9	31.6	+99.6	3.9	41.3	+134.3

Sources: Amsterdam Port Municipality/Imbucon and Arthur D. Little, Inc.

The analysis indicated an attractive overall cash flow situation. However, the initial investment was high and had to be carried for a number of years, with associated interest charges, prior to a return being established.

Consequently, a series of discounted cash flows was calculated.

By this means, each alternative was tested, first to determine whether the investment return was adequate, second, to test how sensitive the results were to changes in assumption. A period of 30 years was considered for each calculation and at the end of this period, a conservative assumption was made that the outer part had no residual or depreciated value. After the first period of 20 years, the further conservative assumption was made that traffic volume would not increase.

On the assumptions of land leases at $0.14 per square foot for only the land leased by the container and the iron ore terminals, and harbor dues of $0.27 per container ton and $0.02 per iron ore ton, the percentage discounted cash flow returns were as follows:

		Container Traffic	
		Low Forecast	High Forecast
Ore Traffic	Low Forecast	8.1	10.1
	High Forecast	9.1	10.9

Source: Amsterdam Port Municipality/Imbucon.

As can be seen, the rates or return on investment are high enough to allow prevailing European interest rates (7-9%) to be acceptable. Under the assumption that harbor dues would be 25% less, the percentage discounted cash flow returns were as follows:

		Container Traffic	
		Low Forecast	High Forecast
Ore Traffic	Low Forecast	6.8	8.3
	High Forecast	8.0	8.4

Source: Amsterdam Port Municipality/Imbucon.

(2) National Aspect. In a way similar to that used to calculate the Municipal cost benefit, the State investments for the proportion of costs related to land, water basins, infrastructure and channel, together with the recurring costs for channel and mole maintenance, were compared with associated benefits on the national level. The same two alternative development programs were assumed.

National income would increase because of this increased transit traffic (Table C-40). The added value was calculated to be $1.00 per ton of ore and $3.00 per ton of container traffic handled by the outer port and transported to/from the national and international hinterland destinations/origins.

TABLE C-40

ADDED VALUE PER TON OF IRON ORE AND OF CONTAINERS

Commodity		(% turnover)	(dollars/ton)
Iron Ore	Handling	60	0.58
	Transport	65	0.42
	Total	--	1.00
Containers	Handling	60	1.25
	Transport	65	1.75
	Total	--	3.00

Sources: Amsterdam Port Municipality/Imbucon and Arthur D. Little, Inc.

In Table C-41 the national income (for both handling and transport) in terms of total added value per five-year period was compared to the total State investments and maintenance costs at the outer port and the channel.

Although return on State investments was not a critically important policy factor, relative to competing requirements, discounted cash flows were calculated. The actual benefit to the State was assumed conservatively to be equal to the current taxation income resulting from the above added values and is as follows:

		Container Traffic	
		Low Forecast	High Forecast
Ore Traffic	Low Forecast	8.4	10.0
	High Forecast	9.2	10.8

Source: Amsterdam Port Municipality/Inbucon.

TABLE C-41

STATE COSTS AND ANTICIPATED ADDED VALUE FOR
ALTERNATIVE DEVELOPMENT PLANS
(millions of dollars, basis 1970)

	PLAN 1		PLAN 2	
Five-Year Periods	Total Costs	Anticipated Added Value	Total Costs	Anticipated Added Value
First	23.0	15.3	23.0	15.3
Second	3.8	118.1	15.4	162.5
Third	15.4	172.2	6.4	220.8
Fourth	6.4	259.7	6.4	316.7
Fifth	6.4	294.4	6.4	366.7
Sixth	6.4	294.4	6.4	366.7

Source: Amsterdam Port Municipality/Inbucon.

(3) Other Benefits of the Outer Port. A number of other benefits associated with the outer port development were identified but not quantified:

a) the benefits arising through avoiding the loss of private and public investment given inadequate developments in the port;

b) the potential development of facilities on the outer port, other than those for containers and iron ore;

c) the availability of a relatively deep water approach channel for the steelworks at Ijmuiden;

d) the interaction of the successful port developments on the acceleration of industrialization;

e) the benefits to other established port users, given the potential growth of port activity;

f) the stimulative effect on commercial activities in neighboring areas around Amsterdam, elsewhere in the region, and in The Netherlands;

g) avoiding the imbalance of port developments in The Netherlands and the risks of diseconomy of scale arising in some areas and effective subsidies necessary in other areas;

h) the total effect of the different developments leading to the consolidation of the Amsterdam port areas as an international multi-purpose port.

C.2.4 ENGINEERING FACTORS

a. Site Selection

Once the original site of the city was established 1000 years ago, the port, through geologic necessity, expanded down the North Sea Canal toward the North Sea. When progressing or extending seaward, the port has about 5 nautical miles of waterfront property on each side of river (total 10 nautical miles) in which to expand. From a cost and technical standpoint an outer port of Ijmuiden appears to be the optimum in port development. Such a facility would provide rapid turnaround for container traffic and cheaper accommodation of deep-draft ore carriers.

b. Configurations

Within the city of Amsterdam there are numerous docks and piers on both the north and south bank of the canal, most of which formed the original port facilities. The newer docking facilities are southwest of the city on the south bank of the canal.

A Mobil Oil refinery docking facility at the "America" and "Australia" harbors has been operational since June 1968. There is one jetty designed to handle tankers of 44'6" draft. The dock has an 8" and a 12" pipeline, and an additional jetty that can accommodate three inland barges. Some 4 million tons of crude oil a year is pipelined to

Amsterdam from the Mobil Terminal at Rotterdam's Europort. The oil is received at rates up to 27,000 barrels per hour. The refinery produces gasolines, kerosines, L.P.G. and various grades of fuel oils that are shipped from the port in tankers, by inland barges, and by rail. The onloading pumping rate ranges between 2,500 and 12,000 barrels per hour depending on the grade of the petroleum product.

The bulk storage capacity at the refinery is 850,000 barrels supported by a 1.5 million barrel storage capacity in Rotterdam.

The Amsterdam Tank Storage Company, "Amatex," an independent tank storage plant at Jan van Riebeeckhavey, has bulk storage facilities for mineral oil, edible oil, creosote, molasses, chemicals, and wine. The liquid storage facilities consist of 260 tanks with a total capacity of 3.15 million barrels. The five jetties have water depths ranging from 31 to 41 feet. Receiving capacity ranges from 400 to 1,200 tons per hour, and the maximum loading rate is 1,000 tons per hour.

Cosmos Tank N.V. at Usselinexhaven has a jetty with 42-ft water depth and 67 liquid storage tanks with a total storage capacity of 1.35 million barrels.

Cindu and DeHumber, two private oil companies at Petroleumhaven, have two 33-ft jetties and 23 tanks with 630,000-barrel total storage capacity.

Smid & Hollander, an asphalt refinery at Southhaven, has a 36-ft jetty and 32 storage tanks with 500,000 barrels of crude oil and asphalt storage.

BP in Usselinexhaven has a 42-ft jetty and 28 hydrocarbon storage tanks with 800,000-barrel capacity.

Shell has two tank installations with two discharge and bunkering 32-ft jetties.

Pankhoed-Tankinstallation has a 20-ft seagoing tanker jetty and 26 tanks with a 70,000-barrel wine, alcohol and fruit juice capacity.

Albatros Superfosfaatfabrieken N.V. is a fertilizer plant situated on the North Sea Canal. The plant has a 1000-ft long jetty, with 32-ft water depth accommodating 25,000 dwt vessels; it can handle 6,500 tons of phosphate rock daily.

The N.V. Houtveem facility, also on the Canal, was built especially for the discharging, trans-shipment, and storage of tropical logs, wood pulp, and packaged timber. A 1000-ft long dock with 33 feet of water and a 500-ft long lighter quay with 13 feet water depth are located on the property.

The N.V. Container Terminal "Amsterdam" is situated on the west bank of the canal in Westhaven, 10 miles from the open sea and 8 miles from the locks of Ijmuiden. The present permissible draft is 45 feet.

At the mouth of the canal, on the north bank, the Royal Netherlands Blast Furnace and Steelworks operates its own port which has a 51.5-ft canal-controlled dock to receive ore carriers of 100,000 dwt on a favorable tide.

c. Channel and Basin

The channel starts at about 9000 feet from the Dutch coastline and the width of the channel at the harbor entrance is 1340 feet. The water depth at the harbor mouth varies from 16 m (52'6") to 15 m (493") below mean sea level between high and low tides (NAP) near the biggest sea lock. The maximum draft allowed into the port under normal circumstances is 31.1 m (43') salt water load line (Plimsoll). By special permission, subject to one week's notice, this draft may be exceeded. The largest vessels to enter the Port of Amsterdam were as follows:

- "Aegier," 81,156 dwt, 45-ft draft (salt water) loaded with 81,407 tons of ore;

- "Skaufast," 100,700 dwt, 39-ft draft (salt water) loaded with 80,250 tons soya beans;
- "Golar Sanko," 80,800 dwt, fully loaded with iron ore (41.67-ft draft).

There are three sea locks: one each for small, medium sized, and big vessels.

The biggest lock ("Hordersluis") has a length of 400 m (1312 ft), a width of 50 m (164 ft), and a depth of 15 m NAP (49 ft 3 in). This depth is controlled, however, by the water level of the North Sea Canal --14.5 m (47 ft 7 in) water depth below NAP. The distance from the lock to the North Sea is 5 km (2.7 nautical miles).

The North Sea Canal has a bottom width of 135 m (443 ft). This will eventually be 170 m (557 ft). The width at water surface is 235 m (771 ft); a width increase to 270 m (886 ft) is in progress. The original dimensions of the canal at Amsterdam, 50-m (162.5 ft) bottom width and 4.2 m (14 ft) water depth, gradually decrease at Tiel (canal terminus) to 41 m (135 ft) bottom width, and 3.2 to 7.75 m (10 to 25 ft), depending on the water level of the River Rhine. The locks at Teal measure 360 x 18 m (1181 ft x 59 ft).

The following improvements are underway to increase the Canal's capabilities:

	Amsterdam	Tiel
Bottom Width	109 m (357 ft)	115 m (377 ft)
Water Level Width	130 m (427 ft)	155 m (509 ft)
Depth	5 m (16 ft)	4.3 m to 8.85 m (14 ft to 29 ft)

New locks will be built at Tiel with a dimension of 275 x 24 m (853 ft x 79 ft). (All of the locks are air ballasted to facilitate raising for repair.)

The navigational aids consist of lighted buoys and fixed lighted beacons on the breakwater's locks and canal banks.

A VHF radio telephone communication system is available between incoming and outgoing ships, the commanding post of the locks and the Coast Station "Pilot Ijmuiden". The government patrol boats are also equipped with VHF installations. ETA messages on VHF channel 12 are requested two hours before arrival to arrange for a pilot, lock and berth.

A harbor radar can be used if visibility is poor (under 3000 ft) to guide incoming ships day or night. For telecommunication, a portable radio is provided by the pilot.

d. Docking

In the harbor of Amsterdam, the maximum speed is 150 m (488 ft) per minute for vessels with a draft of 6.6 feet or more, 200 m (650 ft) per minute for those with a draft of 5-6.5 feet, 250 m (812 ft) per minute for those with a draft of less than 5 feet. Ships with a draft of 2.7 feet or more must fly the blue peter during daylight and display 3 vertical red lights at night.

Pilotage in the estuary, canals, and harbor is a state function and the use of pilots is advised, but not compulsory. Within recent months a helicopter transportation service for pilots was made available to ships that have adequate space for deck landings.

Harbor tugs to assist vessels in the North Sea Canal and in the dock area are stationed at Ijmuiden at the mouth of the canal. There appear to be no fixed rules on tug requirements or on the number of mooring lines used in the harbor.

e. Cargo Handling

The following equipment is a 1969 listing of the main cargo handling facilities in Amsterdam:

Water Area	1037 hectares
Length of Quays	24.1 km
General Cargo Sheds	3,500,000 sq.ft.
Warehouses	2,900,000 sq.ft.
Timber sheds	1,600,000 sq.ft.
Cold Storage Warehouses	2,366,000 cu.ft.
Open Storage (ores, coal & timber)	12,000,000 sq.ft.
Tank Capacity (wines, mineral oils, chemicals)	42,400,000 cu.ft.
Grain Silos	103,000 tons
Grain Elevators:	
Floating	2
Quay	4
Cranes and Gantries	596

f. Environmental Protection

The municipal laws for pollution control are admitted to be weak. The past spill data is quite extensive. One power plant spilled 20,000 tons of crude oil when a bulk storage tank ruptured and demolished the earthen retaining dike to spill the oil in an area designated as a bird sanctuary.

A pipeline corroded at its support and leaked oil into the canal.

In 1969 a flexible hoseline ruptured while hydrocarbons were being transferred from the M/V "Diana" to the Mobil Refinery. In addition to ecological and environmental damage, this spill resulted in fire and explosions which killed 10 persons.

The port operates floating tank cleaning vessels of limited capacity. A privately operated shore-based tank cleaning company can accommodate tankers of up to 820 ft. with a 30-ft. draft. The separator at this facility has a capacity of 1,000 tons per hour and treatment tanks with 8,000 ton capacity. The harbor rules forbid the discharge of ashes, dirt, or waste oil inside the territorial waters. A barge for the removal of pollutants is available upon application to the harbor-master's office.

Present port maintenance--exclusive of work undertaken by the industrial firms--involving the maintenance of sheds, roads, quay walls, pavements, dredging, crane, crane tracks, buoys, etc. is as follows:

	MM Guilders	MM$
1968	3	1.07
1969	3	1.07
1970	3.8	1.35
1971	4.3	1.54

Of the above costing, the dredging budget for 1971 has been established at $400,000, or 26% of the total maintenance budget.

At the moment, the port is in the last phases of constructing a 3750-acre area for industrial plant sites midway between Amsterdam and the North Sea Locks. Another area, across the canal, amounting to about 2500 acres, is scheduled for development when the work on the south side of the canal is finished.

h. Crucial Problems and Lessons

Port expansion is restricted by the concerted effort to develop Rotterdam as the largest port in the world. Unless an offshore port is approved, financed, and built, the port cannot meet the demands of the shipping industry. The port administrators consider that access for 180,000 dwt ships is vital to the port's future.

The port has quay settling problems and must construct quay walls with concrete capped sheet piles, with dockside crane tracks and a railroad system being installed on the capped piles. The dock surface consists of 6 ft. x 6 ft. concrete slabs that can easily be removed and replaced so settled areas can be filled with sand.

C.2.5 ENVIRONMENTAL IMPACT

a. Environmental Management Efforts

As in Rotterdam and most ports visited, concern over the physical environment--indeed even detailed planning regarding the effects of intensive industrialization on social structures--has been given short shrift in comparison to developing a purely economic program rationale for port expansion and development.

One outgrowth of this perceived lack of concern is the Kabouter, a recently formed organization in Amsterdam. Its main concern is the reduction of harbor pollution and its stated goals include the banning of heavy industry near cities, the alleviation of the acute housing shortage in Amsterdam, and a more effective program against excessive drug availability and usage. Members of the Kabouter organization have run for public office and five have won seats on the Amsterdam city council; the organization claims to now have the fourth largest political organization in the city. Perhaps more than any other event, the growing influence of this organization seems to have recently stimulated municipal and provincial officials to include in their planning programs more specific and detailed attention to environmental and sociological matters.

As in Rotterdam, the Hinderwet constitutes the basic framework within which pollution control and prevention efforts are carried out; thus far, these efforts have been devoted primarily to air pollution control (especially particulates and SO_2). Unless the Ijmond, Amsterdam analog to the Rijnmond is soon set up formally, it is reasonable to expect that as a result of the new water and air pollution control laws passed in December 1970, the North Holland Provincial Government will play a proportionately larger and more important role in future pollution abatement programs. The Ijmond covers the townships of Amsterdam, Zaandam, Haarlem, Bevorwijk and Ijmuden, now in loose confederation.

b. Current and Potential Problems

(1) Water. Visual inspection and discussions with personnel in the

Amsterdam Port Authority indicate without question that the water in the Amsterdam harbor is polluted. Aside from the discharge of raw or partially treated industrial and municipal waste water into the harbor and North Sea Canal waters, a major contributor to the build-up of pollution is the fact that Amsterdam is a locked port with limited drainage. Furthermore, raw sewage is discharged directly into the 50 miles of municipal canals that lace the city; at night, locks are opened which permit these canals--essentially fresh water based--to drain into Amsterdam Harbor.

A water analysis for the main harbor area of Amsterdam Table C-42. Several comments may be made regarding this analysis. First, the water is obviously saline (2000 mg/liter) because of the influx of sea water through the Ijmuiden Lock system when these locks are open to permit vessel passage. It has been estimated that 100 kilograms (220 pounds) of common salt flow into the North Sea Canal per second when the lock gates are open. Reduction of salinity in the North Sea Canal--or its continued maintenance at a low level--is of the utmost importance because of the possibility of contaminating the fresh water canals, which are tributary to the Canal, and also because of lateral migration of salt water through the dike system, to contaminate adjoining farm land. For this reason, the North Sea locks have been fitted with "bubble screens," which have approximately halved the influx of salt water.

The considerable amount of suspended matter (3500 mg/liter) in the harbor water is not necessarily a positive indicator of water pollution per se. A large percentage of this material may be bottom sediments placed in suspension by the action of passing vessels. Furthermore, the comparatively low fi e-day BOD (4 mg/liter) suggests that the suspended matter is probably not sewage. Nevertheless, because of the high turbidity of the water, it is extremely unlikely that a fish population of any significance and quality could be supported, despite the high oxygen content of the water (8 mg/liter) which approaches saturation for fresh water and is probably close to saturation for brackish water of this type.

TABLE C-42

ANALYSIS OF WATER FROM THE AMSTERDAM - MAIN HARBOR AREA
Mean Values for the Year 1967

	Mg/L*
KMn 04 use	35*
Cl^-	2000
NO_2^-	40
NO_3^-	7
SO_4^{--}	350
HCO_3^-	180
CO_2 (dissolved carbon dioxyde)	15
PO_4^{---}	850
SiO_2	30
NH_4^+	0.25
NH_4	3.5
Fe^{++}	0.10
Ca^{++}	150
CaO	180
MgO	240
K^+	45
O_2	8
BOD_5^{20} **	4
Suspended matter	3500
Total hardness	45 (German degrees)
Carbonate hardness	11.1 (German degrees)
pH	7.6

*a measure of the oxidizable material, also called C.O.D. (Chemical Oxygen Demand)

**a measure of the Biochemical Oxygen Demand during 5 days incubation at 2°C.

Nitrate and nitrite levels (calculated at approximately 14 mg/liter as N), phosphate content, and ammonia content, indicate that biologically active wastes are present in significant quantities in the North Sea Canal.

Finally, the ratio between potassium-manganese and BOD of approximately nine to one suggests a relatively high concentration of inorganic materials usually indicative of a high degree of pollution by industrial effluents or nonbiodegradable detergents.

The organic and inorganic pollutants discharged into the canal tend to accumulate because there is no tidal flushing of the canal other than when the locks are open or when non-saline water (fresh or polluted) is allowed to enter the canal through one of the tributary locks. In an attempt to control the situation, Amsterdam periodically pumps city canal water through the canal and harbor and into the North Sea through sluices at the lock entrance. No recent data was available on water quality.

As far as we were able to determine, there have been only two notable spills in Amsterdam Harbor (a pipeline leak and a hose rupture which killed 10 persons) but small spills and intentional or accidental discharges of dirty ballast are common. Fines are levied against offenders, but only if they are caught in the act and even then the fines are low--only about 100 guilders (about $28) per offense. Major oil companies have ballast water holding tanks and can also accommodate bilge water. Most dumping in the harbor or North Sea Canal is limited to coastal barges. No skimmer or vacuum craft are in the area, but the only oil company--Mobil--is equipped with oil containment booms--about 300 feet, presumably enough to close off its own dock in the event of a small spill.

During rainy weather, run-off from open storage piles of dry bulk cargo (e.g., fertilizers, ores, and coal) is ordinarily allowed to run directly into the harbor.

In summary, our investigations indicate the definite awareness of a water pollution problem within the Amsterdam Harbor, but aside from the potential threat of major spills of oil or hazardous materials and salt water intrusion, water pollution is of relatively minor concern.

As in Rotterdam, there have been no biological base-line studies either in the North Sea Canal itself or along the coast where the canal empties into the North Sea. Fishing activity is concentrated much further north, and there appears to be little concern over possible effects of discharging contaminatedwater and allowing this water to be carried northward along the coast into the Waddenzee area.

(2) Hazardous Cargoes. Other than requiring the handling of explosives in an isolated spot in the North Sea Canal, hazardous materials (e.g., petroleum products, other inflammables, or highly toxic substances) ordinarily are not separated. It was generally agreed that some means of isolating these cargoes would be desirable, but given the already accomplished development of Amsterdam Harbor and the intermingling of plants--as in other harbors--this undertaking would be extremely difficult. The problem could be handled more easily if a "grass roots" harbor were built.

(3) Air. In contrast to Rotterdam, Amsterdam is more of a dry cargo port with only one refinery, and as such has not experienced the rapid growth of petroleum-based industry its southern neighbor has. Consequently, in the Amsterdam area itself, air pollution has not been judged to be as serious a problem as in Rotterdam; nevertheless, an SO_2 monitoring system, similar to that used by the Rijnmond, is expected to be installed within one or two years. It will be focussed primarily on the western portions of the North Sea Canal and the vicinity of West-Haven and Amerika-Haven, which have the heaviest concentrations of petroleum-based industry.

The principal contributor to air pollution in the entire region is

Hoogovens, the Royal Netherlands blast furnace and steel works, which operates a seven-million-ton-per-year steel plant in Velsen, immediately seaward of the North Sea Locks. Hoogovens originally wished to locate in Rotterdam but went instead to Amsterdam because of emission standards set by the Rotterdam Hinderwet. Considerable quantities of SO_2 are liberated in the coking operations, and particulate emissions are also significant. Because of the essentially prevailing southerly winds, the communities of Velsen and Beverwijk are often adversely affected.

As previously stated, there is as yet no Rijnmond-type authority in Amsterdam; the Ijnmond is the nearest approximately to Rijnmond but does not yet have the authority of the latter. As yet no records have been made concerning the extent of air pollution in Amsterdam to the degree that has been carried out in Rotterdam.

(4) Land and Solid Waste. The disposal of both industrial and municipal solid wastes in Amsterdam is generally unsatisfactory. The city's relatively new incinerator is used for domestic waste combustion and can also accommodate certain types of industrial solid wastes; however, the unit is too small (70 tons per day) to meet the need. Industrial solid wastes are generally burned in the open on a spit of land just east of the town. This area once was used not only by the town itself, but by Germans and Belgians who barged in solid wastes; this latter practice has been stopped. Nevertheless, the situation continues to be unattractive and officials are concerned that no action has yet been taken.

Harbor rules forbid the discharge of ashes, dirt, waste oil, etc. inside the territorial waters. A barge for removal of such pollutants is available upon application to the Harbor Master's office. Solid waste loads of this type are taken out to sea for dumping.

Because the canal is locked, excessive sedimentation in the channel itself is not a problem, and maintenance dredging is relatively minor. Dredging spoil may be dumped into specific storage area, barged out to sea, or used for non-industrial fill purposes.

We were informed that there has been relatively little if any modification of the shoreline due to the construction of the breakwaters leading to the North Sea Canal entrance. Detailed studies regarding construction of the outer port at Ijmuiden are just beginning, and relatively little information is available. It is planned, however, to include in these studies a detailed examination of the extent to which shoreline currents will be further modified by construction of the port and the effect this will have on sedimentation characteristics. The biggest current issue is the momentary suppression of one mile of recreational beach which will be replaced within three years.

(5) Noise/Visual. Except for objections raised by such organizations as the Kabouters, noise pollution and aesthetic problems have received little attention.

(6) Land Use. The emphasis by the Netherlands National Government on development of Rotterdam as Holland's major port facility has threatened the long-term growth and outlook for Amsterdam. Accordingly, by far the greatest priority has been set on improving Amsterdam's role as a major sea port through the development of additional port facilities and industrial sites, both along the North Sea Canal and on the coast. Because much of the land abutting the canal is presently used for agricultural purposes, reclamation of this acreage for industrial sites is relatively less difficult than if large residential or municipal areas were involved.

Of the land available for development in the harbor areas of the Netherlands, roughly one-half is in the Amsterdam port area; this is an important asset to Amsterdam in its efforts to remain competitive.

In 1965, a master plan for the North Sea area was developed with a 10- to 15-year span. An industrialization zone, composed of approximately 2500 hectares of land, was planned immediately west of Amerika-Haven. At present, the port is in the process of purchasing this land and developing roughly one-half of it to meet industrial specifications. The southern half of this area, called the Houtrak polder, contains approximately 1500 hectares and is being filled with sand obtained from the North Sea, which is desalted and then either barged or piped to the site. Approximately 22 million cubic yards of sand will be emplaced at the Houtrak polder and total preparation costs are about 30 guilders ($0.85) per square foot. About one-tenth is for purchasing land, thereby placing a sale value on each 50- to 125-acre farm of $165,000-$415,000, a tidy sum for a Dutch farmer. Members of the older generation who owned their farms have subsequently retired, while many younger farmers have used the proceeds from the land sale to acquire land elsewhere.

According to the development plans, the Houtrak polder will be bounded on its western and southern borders by a large recreational area, approximately equal in acreage to the industrial site. Across the canal from the Houtrak polder, another area (approximately 1000 hectares) is also scheduled for industrial development. This acreage would be bounded on the north and west by agricultural land, and on the east by an already industrialized site.

As is the case with other European ports, the industrial sites are seldom sold to corporations; instead they are rented as concessions for periods ranging 25 to 99 years. This general policy prevails because such acreage is scarce and because it is in effect communal property, since public monies were used to develop the acreage.

(7) Future Issues. Perhaps the critical issue which Amsterdam faces is whether in fact it should endeavor to become a medium-deep-water port through the construction of the outer harbor on the coast, and thereby seek to compete more directly with Rotterdam but take the risk of

building too much capacity too quickly in the Netherlands.

As a highly viable but slower growing general cargo port, Amsterdam also has an opportunity to plan its future growth with greater attention to environmental and sociological considerations and the preservation of its historical beauty (the Northern Venice) if it will only take the time to do so; we have the impression that economic growth is of paramount importance, and that industrial expansion is to be achieved as rapdily as possible, perhaps at the expense of a more balanced and environmentally-oriented program.

Finally, it is readily apprent that the communities located on or immediately affected by the North Sea Canal development will have to work together more closely in the future in planning land use, development of infrastructure, industrial and municipal pollution control, and economic growth.

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13. ABSTRACT

The economic advantages of large scale ocean carriers of oil and ores have developed considerable pressure for the development of a number of deep ports in the United States providing drafts in excess of 60 feet. This report is a study of selected foreign harbors (and off-shore loading and unloading facilities) where the experience was judged to be relevant to the U.S. situation. Specifically, the decision process leading to deep port development is examined, difficulties met and solved in construction and operation, and the relation between anticipations and experience are documented. Impacts on national economic policy, regional development objectives and environmental factors are discussed.

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