FILE

Volume III of III

FOREIGN DEEP WATER PORT DEVELOPMENTS

A Selective Overview of Economics, Engineering, and Environmental Factors

APPENDIX D: UNITED KINGDOM
APPENDIX E: CANADA (PORT CARTER)
APPENDIX F: AUSTRALIA
APPENDIX G: JAPAN
APPENDIX H: THE PERSIAN GULF
APPENDIX I: BANTRY BAY, IRELAND

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INSTITUTE
FOR
WATER RESOURCES

DECEMBER, 1971

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

IWR REPORT 71-11

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K B Cooper

K. B. COOPER
Brigadier General, USA
Director

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APPENDIX D

UNITED KINGDOM

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UNITED KINGDOM

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D.1 BACKGROUND AND SUMMARY

British ports are diverse in size, function, organization and ownership. It is interesting that all important towns are not much further than 60 miles from the sea. Numerous ports (1600 ports reduced to 100 ports or groups of ports for National Ports Council statistics) have grown in general to serve a limited hinterland, except for London, which handles most foreign trade and a substantial part of the "inland" transport flow.

The 19th century saw a rapid development of canal and railway systems, followed by road transport, which expanded considerably each hinterland and widened the scope for competition among the major ports. The advent of deep draught vessels is calling for further traffic concentration, which has resulted in 11 major ports now handling 90% of the cargo volume.

Furthermore, there is little evidence of a coordinated general port development plan in the U.K., although the National Port Council (NPC) has the responsibility for advising the Ministry of Transport, now a part of the Ministry for the Environment, as to a national port plan. This lack of concerted action, and the widespread ecological and environmental concern which has forestalled industry development as well as reversed pollution in the Thames estuary, tend to make the U.K. experience more relevant to the United States than its geographical and trade pattern differences would initially indicate. Some of the highlights, noted along on investigations of the literature and our interviews with London and Edinburgh officials, follow hereafter:

- As in the U.S., major U.K. ports have an industrial-urban basis and are managed by a local public body, but some recent deep water terminals are owned by companies (Port Talbot, Finnart).
- Since 1966, 20% of the cost of new infrastructure and superstructures that are deemed of national benefit to Britain's foreign trade has been granted by the government, but dredging is carried out by contractors at the port's expense.

- Interport competition is particularly keen for container terminals, including deep-sea-to-feeder service. The recently forecast jump in draft beyond 40', should, however,result in only 3 or 4 major ports (London, Southampton, Liverpool, Greenock), assuming that they improve their image and quality or service.
- Two major terminals for large tankers -- Milford Haven (200,000 dwt) and Finnart (250,000 dwt) -- are linked with pipelines to inland refineries. They are being further developed to accommodate 300,000 dwt and 500,000 dwt vessels. Milford Haven itself houses three major refineries and requires substantial dredging while Finnart is a pure trans-shipment terminal with more than 120 feet of natural depth.
- Waterfront steel plants are being created around ports capable of handling 100,000-150,000 dwt ships. In the future Hunterston will accommodate 300,000 dwt ships for cargo trans-shipment, and will be zoned for a planned major steel plant, along with Immingham, Teesport and Medway.
- Two major grain terminals were recently developed for 60,000-75,000 dwt vessels. However, much grain is still trans-shipped from Rotterdam in smaller ships.
- In the U.K. inland waterways play a minor role in inland transportation.
- The concept of Maritime Industrial Development Areas (MIDA concept) has raised both concern and hopes in the U.K. but so far has failed to foster industrial development schemes similar to those in Fos or Dunkirk, France. The basic reason is the lack of a national policy in the face of strong environmental concern and interport competition.
- The procedure for gaining a planning and development permit is complex but flexible. Therefore, many controls over land development and any investment greater than $1.2 million require an act of Parliament.
- In the U.K., environmental concern has begun to be reflected

to some degree in development planning, as illustrated by several case descriptions in this report (Clyde, Medway, Thames). A combination of the "least social cost" (Pr. Weddle) approach and a "cost/benefit" method (Pr. Preston) is being worked on in the Universities of Sheffield and London and in Eastern Canada.

- Investment into "amenities" includes the preservation of old historic towns (Dover), landscaping and effluent control in refineries and power-plants (Fawley-Southampton), and airport location in deserted areas (Foulness) rather than close to cities. Pollution is actually reversing in the tidal Thames waters as a result of sewage and industrial waste treatment facilities.
- On the negative side, besides the MIDA controversy, new coastal refineries are being turned down systematically. A large-scale expansion of existing refineries will have to fill the increasing petroleum product deficit. The grounds for rejection are land, water, air pollution, and road congestion in urban areas (Glasgow, Southampton) or lack of comprehensive local-regional planning (Hunterston).
- In Finnart, Wemyss Bay (Clyde), and Bantry Bay, however, terminals for the sole purpose of transshipping oil have been allowed to proceed despite the trauma caused by the "Torrey Canyon" catastrophic spill. Similarly, a general port and ore transshipment harbor at Hunterston has been accepted, while the proposed refinery and steel mill have been refused.
- Existing ports should be deepened only under extreme necessity, and a good "prospective" (to at least 100-110 feet for 500,000 dwt) natural site is ideal. Lack of natural depth is forcing Milford Haven to deepen at a high cost, in order to keep four refineries competitive.
- Apart from "diaphragm walling" for quays, U.K. engineers see little prospect for new techniques to counterbalance their rising labor and equipment leasing costs. However, improved collaboration and timing at the design stage, more rugged

equipment, and an integrated national plan allowing better equipment depreciation would help.

- Jetties and single point morring buoys seem to be taking the lead for super tanker berths and slurry piping appears economically attractive. Half of the vessels under construction throughout the world are still less than 20 feet draft and 4000 dwt, and must be accommodated in some way, with roll-on, roll-off developing for voyages of less than 3000 miles.

D.2 PORT MANAGEMENT AND FUNDING

D.2.1 Port Management

British ports may be managed by any of the following groups: a local public utility body (trusts), a state agency (the result of post-war nationalization of railways), a municipal agency, or a private company. Private-company ports, with a few exceptions such as Port Talbot, generally are small. The plan to reorganize the 11 main ports, representing 90% of Britain's traffic, under the ownership of a National Port Authority (outlined in a January 1969 Government White Paper) has been shelved by the present Tory government. As a result of the 1962 Rochdale Committee report, however, the 1964 Harbours Act created an advisory National Ports Council to formulate and keep under review a national plan for the development of harbors in Great Britain (exclusive of Northern Ireland and the Channel Islands), as well as to provide research, training, statistics, finance and organization assistance.

D.2.2 Sources of Finance

As is mostly the case worldwide, port revenues are not a major source of finance for large-scale improvements. Government loans and grants, and open market borrowing (at close to government borrowing rate) are the main sources. In 1966, a system of government grants (Port Modernization Grants) was provided for 20% of the cost of any new harbor works and cargo handling plant and equipment that benefit Britain's national foreign trade. This amount is much less than has been the case in most other maritime countries where infrastructure and channel

maintenance grants are typically greater than 50%. However, recent decisions (Japan, LeHavre) indicate that in other countries, subsidies for deep bulk terminals may be reduced to 15-20% on the ground that these terminals usually directly benefit only a few private companies.

D.3 ECONOMIC ASPECTS

D.3.1 Commodity Traffic and Patterns

Table D-1 summarizes 1968 traffic data (the latest available) at 17 important ports. According to this data one-third of these ports' trade was coastal and two-thirds foreign.

TABLE D.1

TRAFFIC AT THE MAJOR PORTS OF GREAT BRITAIN, 1968
(Million metric tons)

	Coastwise				Foreign				
	Inwards		Outwards		Imports		Exports		Total
	Fuels	Non-fuels	Fuels	Non-fuels	Fuels	Non-fuels	Fuels	Non-fuels	
Total	45.4	5.8	50.8	6.0	104.6	71.0	18.5	23.2	325.2
London	14.5	1.5	3.4	0.5	19.1	13.1	1.0	4.1	57.3
Medway	0.6	0.1	4.3	--	13.6	1.2	6.7	0.1	26.8
Southampton	1.7	0.1	8.2	0.1	15.8	1.0	0.9	0.5	28.2
Bristol	2.8	--	0.2	0.2	0.8	3.4	--	0.2	7.7
Newport	0.3	--	--	--	--	3.7	--	0.8	4.8
Cardiff	0.4	--	--	--	0.5	1.4	--	0.2	2.5
Port Talbot	--	--	--	0.1	--	3.3	--	0.2	3.6
Swansea	0.3	--	3.4	--	0.4	0.4	1.7	0.4	6.6
Milford Haven	0.4	--	6.8	--	19.0	--	3.5	--	29.8
Liverpool	2.7	0.5	1.1	0.4	11.6	8.8	0.2	4.4	29.7
Manchester	2.6	0.3	2.1	0.1	5.5	3.7	0.5	1.2	16.0
Clyde	1.6	0.3	0.4	0.1	5.1	4.5	--	0.8	12.7
Forth	0.9	0.3	2.2	0.3	0.7	2.3	0.5	0.6	7.9
Tyne	1.2	--	4.2	--	0.2	2.0	0.4	0.1	8.2
Tees & Hartlepools	0.4	0.2	2.8	0.6	7.6	4.7	0.8	1.6	18.7
Hull	1.6	0.1	0.7	--	0.4	3.6	0.1	1.1	7.6
Immingham	0.6	0.1	2.0	0.1	3.0	2.7	1.6	0.6	10.6

Source: National Ports Council Annual Digest of Port Statistics, Oct

According to Table D-2, crude petroleum, ores and cereals are the major bulk commodities imported; two neo-bulk commodities, wood & cork, and pulp & paper each equal about 6-8 million tons, and coal exports are expected to pick up from stagnation. Fertilizers, sugar and clay are in a lower category (2 to 5 million tons per year).

TABLE D-2

IMPORTS AND EXPORTS FOR GREAT BRITAIN, 1965, 1968 and 1973
(Million metric tons)

S.I.T.C. (Rev.)	Imports	1965	1968	1973
	Dry cargo			
04	Cereals	7.9	7.4	6.3
06	Sugar	2.7	2.5	2.2
28	Ores and scrap	21.3	20.2	26.3
27	Crude fertilizers and crude minerals	4.3	4.4	4.7
24, 63	Wood, cork and manufactures	7.6	7.4	9.8
25, 64	Pulp, paper and board	5.5	6.1	8.2
	Other dry cargo	20.3	23.0	25.3
	Total dry cargo	69.6	71.0	82.7
33, 34	Petroleum	83.8	104.6	149.2
	Total	153.4	175.6	231.9
	Exports			
32	Coal, coke and manufactured fuel	4.9	3.7	5.2
276.2	Clay	1.9	2.3	3.6
	Other dry cargo	18.1	20.8	24.1
33, 34	Petroleum	10.9	14.9	18.0
	Total	35.7	41.7	50.8

Source: J. Morris Gifford, "Port Planning in Britain."

Deep-Sea General Cargo (Figure D-1)

It has been something of a political battle to attempt to rationalize deep-sea container port facilities. Two major economic forces have been

in evidence. First, the Minister has allowed the ports of London, Liverpool, Southampton and Greenock (Glasgow) to develop major deep sea container facilities, which implies that ship operators will call there. Second, many smaller ports -- e.g., Felixstowe, Harwich, and Falmouth -- have set up or propose to set up to service container feeder services to the Continent so these particular deep-sea vessels will not, in fact, call at any of the major U.K. container ports. These two opposing forces prevent the realization of the full economics of centralized container services. However, the pressures to support the feeder ports are based on delays, congestion with transport and equipment and labor troubles in the major ports. Hence, this backlash from centralizing deep-sea container services at four major ports, which is really a criticism of the planning for infrastructure, transport and management of U.K. major new docks. Eventually, however, the four major ports should provide satisfactory service, although there is some doubt as to Liverpool's future (at the new Seaforth Docks).

Obviously, major container ports are selected in conjunction with the ship operators who analyze their optimum port calling pattern as part of their least cost through transport system.

Oil and Petroleum Products (Figure D-1)

Crude oil and petroleum products are the largest category of bulk commodities arriving in the U.K. Vessels discharge their cargoes at several major areas.

- The Thames Estuary, which has received half loaded 210,000 dwt Shell tankers, services Shell and BP refineries.
- Southampton serves Esso's Fawley refinery and can handle medium-sized vessels fully loaded (120,000 dwt, 49 ft draft available).
- Milford Haven (S. Wales) can accommodate the large vessels fully laden up to 200,000 dwt. BP and Texaco have refineries there; Gulf Oil refinery is higher up in the estuary, capable of only 120,000 dwt. Development for 300,000 dwt is being considered for the future.

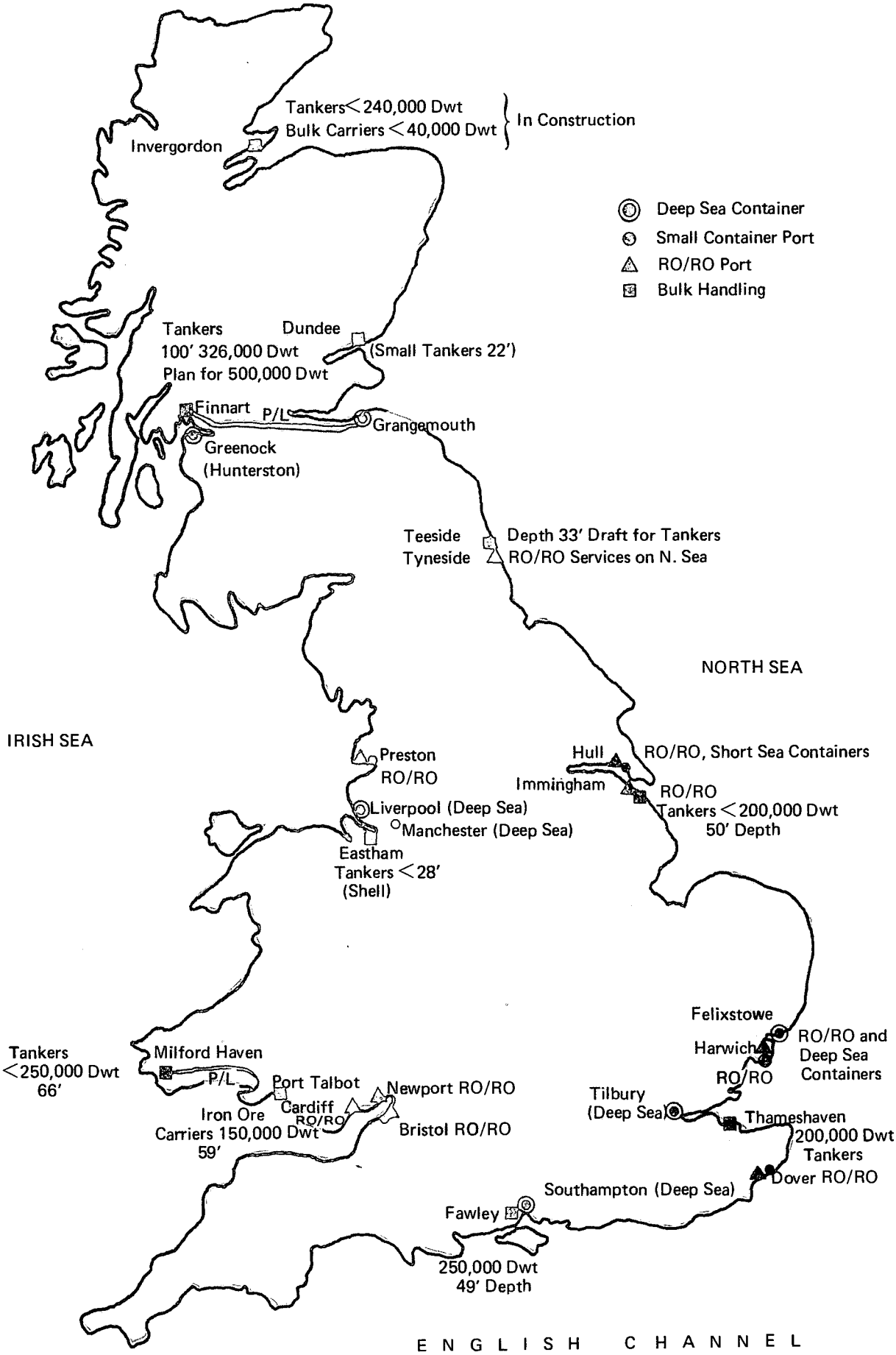

FIGURE D-1 BRITISH MAINLAND PORTS

- Shell's Stanlow refinery (near Liverpool) can accommodate only medium vessels, or partly loaded larger vessels.
- Tees is being deepened by 10-12 feet to the new Red car ore terminal for large ore carriers.
- Tyneside can handle only medium-size vessels (33 ft maximum draft).
- Finnart (Clyde) which handles 250,000 dwt and is linked by pipeline to a BP refinery at the smaller port of Grangemouth.

Crude arrives in the U.K. in three ways:

1. Supertankers are lightened of perhaps half their load out to sea so that the lightened vessel can enter, say, the Thames Estuary. Shell uses this method.
2. Supertankers arrive at Bantry Bay for transshipment to Milford Haven via 80,000-100,000 dwt tankers.
3. Large tankers discharge at Milford Haven and Finnart directly, or medium vessels at Fawley, Grangemouth, Stanlow, etc.

Really deep water exists off the West Coast of Scotland (e.g., the Clyde Estuary) and new refineries will undoubtedly be developed in this area. It is also an area of outstanding amenity value and will be discussed in Section D later.

Refined product is shipped in and out of the U.K. Supertankers are not usually engaged in this trade as most shipments are to Europe or purely U.K. coastal. This trade is not expected to grow more than 3% per annum and will still center on 'handy size' vessels (10,000 to 60,000 dwt but, mostly 17,000 to 35,000 dwt).

The growth of crude oil imports is liable to change for various reasons, not the least of which is the development of the oil strikes in the North Sea. Scottish refinery development may well be affected by this factor.

Further influence on crude oil movement will come from the development of pipelines. It has already been suggested that it is cheaper to

discharge supertankers in Milford Haven and pump the crude to the London Thameside area than to dredge and develop the Thames Estuary. Thus, future U.K. refineries may not be deep water based.

Dry Bulk

The British Steel Corporation (BSC) has several new sites for steel making under review. Port Talbot (in S. Wales) can now receive 120,000 dwt bulk carriers and a few other main ports are likely to be developed to supply nearby steel plants around the coast of the U.K. -- Teesport, Immingham (on the East Coast) and perhaps the Medway Estuary (in Kent). Only Hunterston (Clyde) has been considered so far for 300,000 dwt.

Grain and sugar are less significant bulk cargoes; both have been experiencing a declining trend. They will probably be centered on Liverpool and London, both of which have new grain terminals to enable 50,000-60,000 dwt carriers into Tilbury-London and 75,000 dwt into Liverpool. Much of the London grain may continue to be transshipped from Rotterdam.

Bauxite is handled through the private facilities of the aluminum companies directly associated with the smelters; at Invergordon, Scotland, for example, bulkers up to 40,000 dwt will soon be handled. (A refinery there may soon be able to handle 250,000 dwt tankers.)

Short-Sea Services

There is a proliferation of ports all round the U.K. offering passenger car and RO-RO cargo services to Europe. Unitization and RO-RO services have proved successful if the past growth rate is any indication. The largest single operator is British Rail. RO-RO is proving very popular with exporters since delays are really minimized. In fact some of the routes enable such rapid transport to be made that air cargo between, for example, London-Paris, London-Frankfurt, etc. has been affected. Highway networks linking ports with their inland areas allow fast transit times in express trucks.

Some of the main ports in this short-sea trade are: Leith, Tynemouth, Hull, Immingham, Felixstowe, Harwich, Dover, Folkestone, Newhaven, Southampton, Bristol, Newport, Cardiff, Swansea, Holyhead, Preston, and Stranraer.

D.3.2 Inland Transport

There are no comprehensive data on the means of transport used by port cargo to and from points inland. However, 80-90% of non-bulk traffic probably moves by road. The introduction of freightliner trains is expected to stop or even reverse the decline of the railroad share. Inland waterways will continue to play a very minor transport role, contrary to what occurs in Northwest Europe.

Iron ore and bauxite are generally used by waterfront plants. A third (28 million tons) of the imported crude moved inland by pipeline was from Milford Haven and Finnart in 1968.

D.3.3 Industrialization

Ports have played a major role in U.K. industrialization. Although there has been a lack of national coordination in port development, their importance has been recognized in the recent Maritime Industrial Development Areas (MIDA) concept. (See Section D.7.) However, MIDA has not yet resulted in any major undertakings.

D.3.4 Port Planning Methods

Each main port in Britain has come into being through an act of Parliament, primarily because the coastline below high water is owned or controlled by the "Crown Estate Commissioners." In each port, major developments (those costing over $1.2 million) require a further act of Parliament to enable the development to proceed. Thus, each major port in the U.K. has several Parliamentary acts associated with its past and present development.

The planning procedures for a particular development are quite complex

and will vary with the nature of the development. Let us look at two alternative possibilities:

Development within a port boundary

Each port authority owns a certain quantity of land that is associated with its port and possibly within a large area under port control, but directly outside existing dock facilities. The Clyde Port Authorities, for example, control the shoreline development of scores of miles of the Clyde Estuary. If a development is to take place entirely on land or water owned within the dock perimeter, the local planning authority (town or county authority) has no direct control over that development. If the development is large enough to require an act of Parliament, objectors can petition against the bill and a public inquiry will be held. Such objections might come from local authorities or residents, on amenity or environmental grounds. The conditions of other authorities such as:

- Crown Estate Commissioners
- Board of Trade
- The relevant estuary authority
- The relevant river authority
- The Water Resources Board,

must all be satisfied with regard to standards of effluent, air pollution, navigational hazards, etc.

An example of the outcome of such an inquiry was the direction from the Government inspector to the British Steel Corporation to prevent iron ore dust being blown from a new unloading facility at Bristol Deeps, across the Bristol Channel to the resort town of Weston-Super-Mare. New types of hoppers and handling equipment had to be designed.

Development of a port facility which overlaps with other authorities

Proposed development of a new docks facility outside of an existing port boundary will necessitate permission from the local city and county authorities and Parliament and the Minister (for the Department of the Environment). This is a more complex process than the former example.

Briefly, the procedures would be as follows:

a. A general outline of the proposed development is submitted to the local county council planning authority, which has powers under the Town and Country Planning Act of 1947 to authorize the development. If it is a small scheme the local authority may handle the whole matter. If it is a large scheme -- e.g., a greenfield site development for a berthing facility, a steel works, or a petrochemical complex to be associated with the berth -- regional development department probably will be involved; also the Minister, as well as the port authority. Such a scheme, if over $1.2 million, will also require the blessing of the NPC. There will be mutual agreement between the authorities and the Minister that a public enquiry should be held to consider the generalized scheme. Recent examples of such enquiries are:
   - The Roskill Commission on the siting of London's third airport,
   - The Hunterston development, and
   - New power station sites, which, whether coastal or not, almost invariably result in a major enquiry.

   If local authorities try to reject such an enquiry (e.g., because it takes a long time), the Minister has powers to order such a procedure. His representative at the enquiry is a Government inspector.

b. A Court of Enquiry will be held, with the developers presenting their case to the authorities. Both sides produce expert witnesses on economic, industrial, technical and environmental factors.

   At this stage, the inspector may drop the whole development (if objectors, for example, can show that a better alternative site exists), the scheme may be modified, or permission to go to the next planning stage may be granted. Let us assume the last.

c. The scheme is now drawn up in more detail and planning permission may well be sought from the Minister to accept the scheme <u>in principle</u>. For example, by presenting the Port Authorities Bill in Parliament. If he gives this acceptance, conditions from all the local interests must now be met by the developers.

d. A further public enquiry to consider all the details must now be held. At this enquiry all the authorities, with overlapping interests, will ensure that their various conditions are met. Members of the public -- e.g., those whose property may be affected -- can also have their say.

e. When all the details are worked out, the Minister will finally approve or disapprove the plans. He has the powers to reverse the Court's decision, "in the national interest," if he so desires. The final decision is thus basically a political one.

There are many variations on these basic planning procedural steps. But, the public generally have two enquiries at which to be heard -- the general one and the detailed one -- and the Minister makes the final decision.

Professor Weddle (see Section D.4.1) describes the British procedures as flexible, overlapping and highly effective compared to other countries. He believes the U.K. has probably the best controls on land development and utilization of any country (not necessarily the strictest). He believes that being flexible is the key to success, because it allows all interested authorities to work out the best solution for any particular scheme and to amend legislation on planning control in a continuous, dynamic way. Planning for the environmental factors in a formal way is relatively new, but is rapidly becoming an accepted and necessary part of port and industrial planning. (See Section D.4.)

Planning For Works Above High Water Mark

Most planning permission above high water and outside the port authority boundary is now granted or amended by county council planning authorities who have such powers under the Town and Country Planning Acts of 1947. This process involves the correct advertisement of the scheme, the making of objections, and, perhaps a public enquiry. By tradition, adjacent planning authorities have no voice at these enquiries. If a port development requires planning permission by the county authority

for access roads, pipelines and services, these elements will be subject to the usual procedure once they cross the port perimeter. This is, of course, usually the case.

Planning For Works Below High Water

The Coastal Protection Act of 1937, Section 34, is concerned with any works round the coast of the British Isles which could obstruct the rights to navigation. A department of the Board of Trade (B.O.T.) is responsible for administering the Act. The department acts as the planning authority and even though, for example, a port scheme Bill has passed through Parliament successfully, work cannot commence below High Water Mark without B.O.T. approval.

Land reclamation, below high water mark needs B.O.T. approval and control, until the retaining wall is built. Dredging operations, and also the disposal plans of the liftings, need B.O.T. approval. The construction of cables and/or bridges over channels and estuaries needs approval. The construction of underwater outflows or intakes for power stations, industry ports, etc., needs B.O.T. approval. The B.O.T. will take advice, where necessary, from the Crown Estate Commissioners on any ownership problems. Its jurisdiction now extends to the U.K.-controlled part of the Continental Shelf in the North Sea where oil and gas exploration is undertaken. The U.K. Chamber of Shipping will inform U.K. shipping interests of any schemes to obtain objections, if any. All schemes must be advertised in Lloyds List and the local newspapers.

Effluent, pollution or environmental problems associated with any such projects come under the control of the appropriate Estuary authority, Ministry of Agriculture, Fisheries and Food (M.A.F.F.) and the particular port authorities themselves. They will lay down the limits on various kinds of effluent discharge.

Control of discharges or effluent into the sea (as opposed to rivers or estuaries) is more by voluntary cooperation with industry, etc. than

by statute, although the MAFF does monitor water for radioactivity on a regular basis. There is, at present, discussion about whether discharge into the sea should be controlled by statute. The whole state of environmental pollution and control in the U.K. is detailed in the Royal Commission report, published in February 1971.

D.4 ENVIRONMENTAL PLANNING AND PROBLEMS

D.4.1 Planning Methodology

Professor Weddle, an architect, and head of the department of landscape architecture at the University of Sheffield and a recognized authority on environment and land use, has used systematic (rather than truly analytical) approaches to environmental planning (EP). He has attempted to list all the main factors relating to the environment of a project, e.g.:

- scenic effect of project
- effect on the surrounding land
- noise effects
- air pollution
- employment changes
- effluent generation
- climate

Then attempts are made to rank these factors for the project alternatives that exist, e.g., differing locations, and differing chimney heights. The alternative which gives the lowest social disruption is deemed to be the best. This alternative he calls "Least Social Cost Analysis." This approach is well documented in the Metra/Weddle Report for the Hunterston scheme. Such an approach is perhaps the most simple one.

Another approach is the cost/benefit method (as illustrated by the Roskill Commission). The methodology of this approach is given in the NPC report on the MIDA concept by Peston and Rees. The problems of the method relate to the difficulties of attaching realistic and meaningful costs to all factors. Professor Weddle believes there is much merit in attaching monetary values whenever reasonable, but that frequently this

is impossible. Consequently, a mixed approach between 'Least Social Cost' and 'Cost/Benefit' is perhaps the most realistic.

A further step called "continuum listing," is to develop 'linked' lists of all the environmental factors. This means that the linkages show logical dependencies between the factors.

The next step, now under development, is to be able to mathematically express these linkages and factors in two and even three dimensions, i.e., to develop analytical modelling techniques to be able to evaluate the wide range of alternatives associated with any project.

In the U.K., Sheffield and London Universities provide formal courses on these topics. Such courses are increasing the awareness of the relationships between human and habitat factors.

D.4.2 Examples of Environmental Planning

a) Professor Weddle has written part of the Metra/Weddle report on Hunterston. This report provides a good case example of the method used and the part played by environmentalists in decision making, and is discussed in section D.5.

b) Some county planning authorities now have an environmental planning department. Indeed, considerable efforts in environmental planning have gone into the Medway MIDA Scheme in Kent; for example, landscape and agricultural experts were employed to help identify the areas of the countryside which should be preserved or developments which should be controlled to a very high amenity standard. Areas of the land and coast are to be set aside for leisure pursuits only. (See section D.6.)

c) Over the past 10 years, the Thames estuary pollution has been reversed. (See section D.7).

d) Development plans for Dover (a very busy cross-Channel port) are costing much extra money to by-pass the historic town with a complex road system. The benefit to tourism is seen as one method of justifying the cost of preserving the town.

e) Southampton docks and Hampshire County Council planners have been concerned with the Fawley refinery developments. Southampton is essentially zoned on each side of the water; the east side is residential and recreational, while the west side is industrial. It contains the Fawley refinery, still expanding onto 500 acres of reclaimed land, and two large power stations. Elaborate precautions have been taken to design smokestacks that will eliminate local fallout from the smoke. Noise and vibration levels are also being monitored and equipment is to be designed to within a noise standard. Esso must pay $2.4 million extra to landscape refinery extensions before planning permission will be granted, and the proposed Chevron/Caltex refinery has been turned down, mainly because:

- Congestion on Southampton water would result;
- Too high a concentration of air pollution would result;
- Not enough industrially zoned land available;
- Local road congestion could occur.

f) London's third airport, after two extensive public enquiries and a Royal Commission under Roskill, which suggested an inland site near London, is now likely to be placed in a near deserted area of the coast, by decision of the Minister. Such a change is likely to cost an <u>extra</u> $300 million, but such is the cost of preserving amenity and the inhabited environment!

g) Almost every power station is now designed (external appearance and siting) by eminent landscape architects. The Central Electricity Generating Board (CEBG) has had an environmental planning unit since 1960. The CEGB is deeply involved, from the preliminary design studies onwards, with all new power stations and transmission lines. The previous head of this organization has just joined the B.S.C. to start up a similar unit for steel mill design.

h) The brick, sand and gravel industries have studied land economy and amenity rather well. They leased the excavated holes in the ground to the CEGB who filled the holes with ash and now some of the areas are being turned into golf courses and recreational areas: three incomes from one area of land.

i) Finally, the Ministry of Transport uses an advisory committee to study the routing and plan the landscaping of all major new roads. Again, such a committee is an integral part of the design and planning process.

It is evident that more and more developers and planners are seriously considering amenity planning as part of the design process and are, in fact saving time in the overall planning process by correctly planning for environmental factors at an early stage. This is saving much re-planning as a result of public enquiries and pressures from the local communities.

D.5 ENGINEERING CONSIDERATIONS

D.5.1 General

A fundamental difference to some London consulting engineers between European ports and American ports is in the use of quayside cranes. The European ports believe in their extensive use, while U.S. ports do not to the same extent.

A fundamental question is why deepen ports. The only valid reason is to accommodate very large bulk carriers. They believe it is then generally economically sound to send these large vessels to available new deep water, rather than deepen a lot of existing ports.

General cargo vessels can navigate into existing ports without extensive deepening programs. Many bulk carriers will not need extensive port facilities. With new jetty techniques and single-buoy moorings (SBM), large carriers need only very rudimentary berths, so port should not be deepened except under extreme necessity.

In the U.K., Hunterston is a good example of this philosophy.

D.5.2 General Cargo Quays

The construction system known as diaphragm walling is not new to civil

engineering, but relatively new to port construction. Such a system allows concrete reinforced panels to be constructed in the ground without having to put in temporary works to keep the ground open, i.e., no strutting, no sharing, etc. The whole of the structure is built from the surface and made stable before the excavation is carried out. The sides of the trench are held open by a thixotropic material, bentonite mud. The advantage (and cost saving) of this system is the great reduction in temporary works that would otherwise be required. Such a method of construction has been applied to build the new Seaforth docks at Liverpool, with a saving of some 40% on the civil construction. It is also the proposed construction method for the Bristol West Dock 2 scheme. Apart from this technique, no major economies of construction are in view for the U.K. and a period of rising costs is expected from now on. However, NPC just received a report by Bertlin & Partn. recommending a closer look at some Continental practices. NPC has another study to evaluate by computer the relative merits of the various known methods of port construction, but the Contractor -- Rendel, Palmer and Tritton -- expects few differences to show up.

In port work, for example, precast concrete structures never achieve the theoretical savings potential, basically because the throughput of units is never large or fast enough to recover the double overheads involved. The concrete plant has overheads, so does the site construction company. To obtain a return on precast concrete structures requires a doubling or tripling of the construction rate.

The same contractor sees a trend for the U.K.'s berths to be tidal rather than locked, but these berths will still depend on tides and weather elements. The contractor recommends that

> the civil engineering constructors should work more closely with the design engineers and the consultants, because the constructors can contribute a fund of knowledge about the practice of construction and thus help to make more <u>economic</u> designs. Moreover, he believes that in the U.K., too much emphasis is placed on sophisticated design of port

structures, whereas, for example, the U.S. takes a more rugged approach, which may be the trend in the '70s for the U.K. This change will mean that labor -- a critical cost element -- can be used more effectively on-site.

Most important of all, as the contractor sees it, is to develop a cohesive plan for port development so contractors will see a work program ahead of them for years to come, and hence will be prepared to invest in the large machines needed to obtain the productivity benefits of a more mechanized approach. The U.K. approach at the present is to tackle each project separately. An integrated plan will have a much greater effect on port construction economics than the development of fancy designs.

D.5.3 Special Berths

There is much need in the U.K. to develop deep water berths for vessels of 250,000 dwt and up. The U.K., in particular, has to cope with large tides and rough weather conditions; thus their quay and jetty construction necessarily have to withstand higher stresses, etc., than, say, the equivalent structure in Scandinavia. Complex port facilities are not likely to be required for large bulk carriers of the future. Rather, jetties and single buoy moorings (SBM) will set the pattern for the future.

One comment was that much more attention should be paid to overall project economics, especially the timing of the job. It is now generally the cheapest or, at times, the quickest that wins a tender. For example, the special berth situation at Hunterston should be phased as a project into the BSC plans, the run-down at Glasgow City Docks, the local housing and employment program, etc., so that it is not necessarily the shortest construction time that is the most economic.

D.5.4 Technical Trends

According to a leading port engineering contractor, three types of vessels

will require different technical solutions:

(1) Vessels with a draft of 20 feet or less. A recent survey suggests that 50% of all vessels under construction are still less than 4,000 dwt and less than 20 feet draft.

(2) Container ships. Although some recently built have a draft of 35-42 feet, many people feel these ships will continue to have a draft not substantially greater than 32 feet.

(3) The large (greater than 100,000 dwt) bulk cargo vessel.

The technical developments, which are already under way, are really as follows:

For the small vessels, the prime development still going on is for roll-on roll-off berths for short and medium sea routes, a prime choice for voyages of less than 2,000-3,000 miles.

The celular ship comes into its own economically on voyages greater than 3,000 miles and we have already seen the kinds of container berths being built for these vessels. This area is probably the most fully advanced of the new port techniques to be developed and has been discussed in Section D.3.2.

For the bulk vessels, a considerable expansion of the SBM techniques is expected to fields other than oil, e.g., slurries for iron ore. Such a system, of course, requires considerably less capital layout than do conventional docks.

It was noted that ports, if they are to be deepened, should not make the great blunder that Southampton did in incurring dredging costs of $432,000 a year just to receive one vessel (the old Queen Elizabeth) to go in and out of the docks. Thus, if American ports are to be deepened by dredging, the economics should be carefully weighed against the number of vessels calling at the port.

D.6 THE CLYDE ESTUARY

D.6.1 Introduction

This section presents a brief case study of the history, development and present activity of the River Clyde. This river is a particularly interesting area to look at from the point of view of environmental planning because industrial development -- in terms of oil refineries -- has recently been turned down on the grounds of amenity value. The significance of this decision, the way in which it was reached, and its implications are described within the general context of the history and geographical location of the Clyde.

D.6.2 Brief History of the Clyde Port Authority

The 106-mile long Clyde, with the greatest commercial estuaries in Scotland, is both the principal river of Scotland and one of the most important industrial rivers in the world. Formed by the junction of Daer and Portrail Water, the Clyde flows through the city and port of Glasgow to the Firth of Clyde (Figure D-2). During its course, it passes through some particularly picturesque areas.

Some 250 years ago, to take advantage of trade with the colonies, the Clyde River was first dredged and bigger ships started coming up to the city of Glasgow. In 1858, the Clyde Navigation Trust took over management of the city ports from the city administration, and operated for more than 100 years as the major port authority. It was a successful body, attracting much support, but with a 42-member board it was somewhat unmanageable.

At the other end of the river Clyde, a smaller administrative body, the Greenock Harbour Trust, operated in a similar way for roughly the same length of time. There also existed in the earlier days the Clyde Lighthouse Trust, a lighting/conservancy authority. Several attempts were made to merge the three trusts, but all were unsuccessful.

During the war, the river's excellent strategic position brought a boom

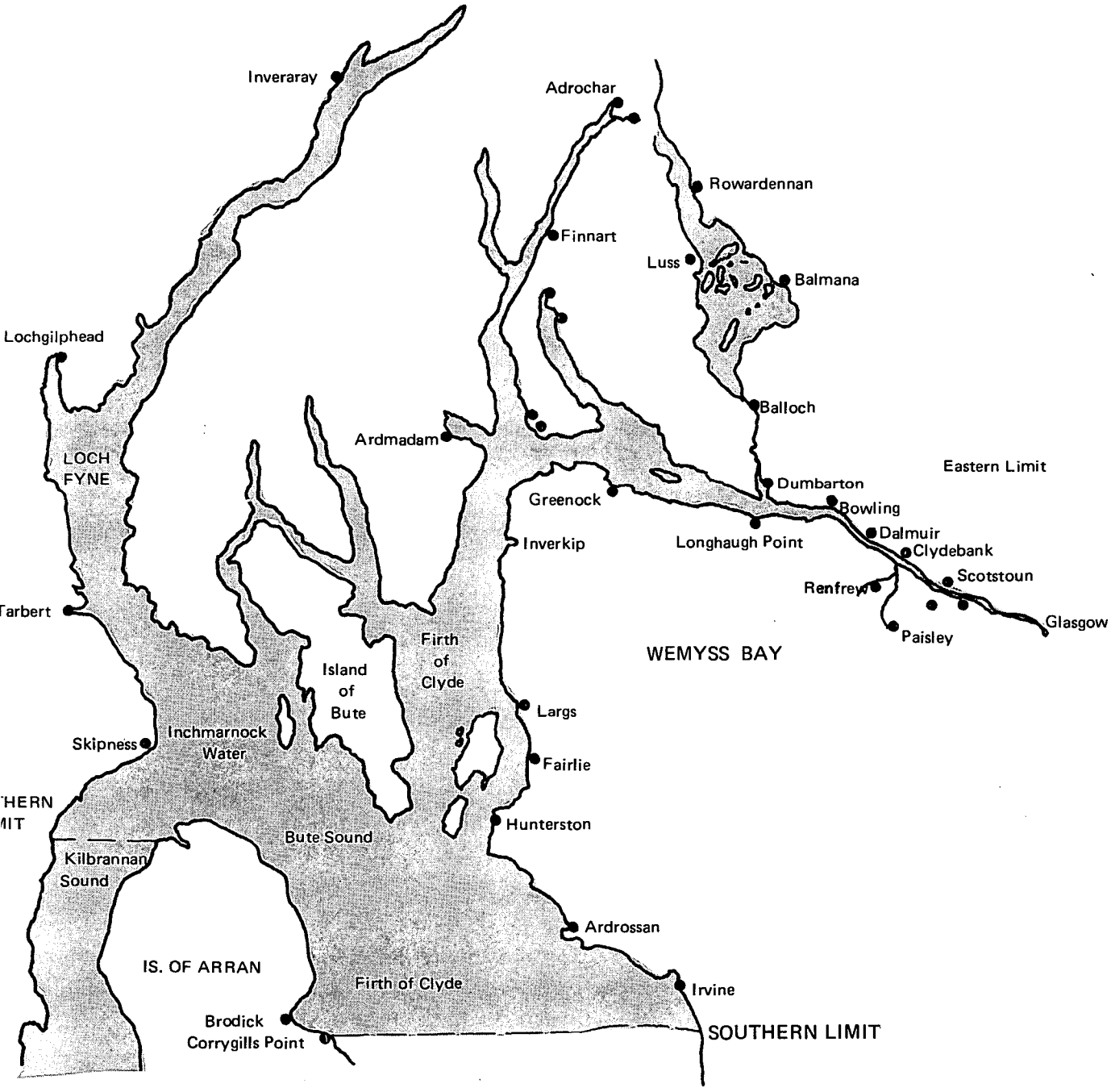

FIGURE D-2 CLYDE PORT AUTHORITY

period. The Clyde was operated under defense regulations: all geographic and port boundary regulations were swept aside, and all port facilities were placed under a single control. This unitary control was very successful, and at the end of the war a committee was set up under the late Lord Cooper to see if this control should be continued. It was agreed that it should, but there were many difficulties, e.g., finance. Consequently, nothing happened until publication of the Rochdale Report in 1962 and its recommendation that estuarial ports should be under one control.

Over the last 20 years, trade has moved from general to bulk cargo; the size of ship has gone up rapidly; major port activities on the Clyde have moved out of the city.

The Clyde Authorities preferred to create this ruling body themselves rather than have it imposed, and by the end of 1965 agreement had been reached and the Scottish provisional order lodged. This order, made law in 1966, established a unified authority with complete navigational and port control from Glasgow to the Cumbraes. This control was subsequently extended to Ardrossan, Ayrshire and the Isle of Arran. Thus the Clyde Port Authority now has 400 square miles of water under its control. By comparison, Leith-Edinburgh and Grangemouth, who share 50% of the Forth Harbor Authority and the many smaller harbors in the Forth, move slowly and with much bickering.

Early in 1966, the CPA decided to develop a container terminal and this was established at Greenock in March 1969. An extension is now being built. Consequently activities are now mainly concentrated there, to the detriment of the smaller ports up-river which are being eliminated. The policy is to establish fewer more concentrated units; the Queen's and Prince's docks are to be closed.

D.6.3 The Clyde Area: What it has to Offer

The Clyde is a highly developed industrial area, but unemployment is high, 7%, and new industries are welcomed.

The Clyde estuary's natural deep water -- 80/90 ft -- makes it suited for those industries which depend on commodities imported in bulk, where large ships are being utilized increasingly. Among the possible industries, as reported in the study by Metra Industrial Consultants, are those that import petroleum, iron ore, grain, bauxite and alumina, phosphate rock, sugar and forest products.

In view of the trend to inland oil refineries, the Clyde would seem ideal because of its deep water. British Petroleum (BP) has already recognized the possibilities of this area. Its oil terminal at Finnart takes 250,000 dwt tankers with no dredging and could take bigger ones very quickly. In 1970, 20 tankers of over 200,000 dwt came into the Clyde fully laden, drawing about 68 feet, with 49 ft of water below. Ten completely discharged at Finnart into the pipeline leading to the oil refinery at Grangemouth; the others were lightened so they could go on.

However, there are three basic drawbacks to developing industry in the Clyde:

(1) There is little flat land near the deep water.

(2) The Clyde is badly located geographically, relative to industrial markets.

(3) It is scenically a very beautiful area.

The Clyde is not a very likely potential MIDA area, because the specifications for such an area are 5,000 acres of flat land with 60 ft of high water. The best possibility, Hunterston (Figure D-1), has only 1,500 acres of flat land and another 1,000 acres that are directly reclaimable. Furthermore, although the beach suddenly shelves down to give very deep water, the beach is covered for quite a distance at high tide.

Though the CPA sees great possibilities for developing the Clyde as a transshipment port, this idea is probably realistic at the moment only for the iron ore terminal for which the British Steel Corporation has been granted planning permission at Hunterston. Metra looked at the

Clyde as a transshipment port for grain, petroleum, and iron ore, but considered only the latter to be a serious possibility.

The CPA is sold on the Oceanspan concept: the Atlantic and general bulk trade could come into the Clyde for transshipment or onward passage across to the Furth. An ideal situation for industrial belt development, the CPA is investigating this further. It believes the concept has great possibilities if the U.K. joins the EEC; and in any event congestion in the Channel dictates that new ways of distributing traffic be evolved. However, planning permission has been turned down recently at Hunterston because of the environmental quality of the area, which the Secretary of State for Scotland describes as "itself a valuable economic resource," and Professor Weddle considers the area of outstanding landscape value. Last year, the Murco oil group's proposal for a refinery on Clydeside was rejected, the risk of pollution to the city being considered too great. In May this year the Chevron oil group was refused permission to build a $120 million 100,000-barrel-per-day refinery at Hunterston even though this refinery would have benefited Britain's balance of payments by $24 million a year.

It is interesting that conservationist interests in this area have outweighed the Government's support for increasing the U.K.'s refining capacity. The Government's strategy may then be to allow the limited land at Hunterston to be developed as a fully integrated steel works, alongside the ore terminal.

D.6.4 The Clyde Estuary Development Group

In 1967, the CPA saw tremendous potential as regards the deep-water, but had no direct contact with the land authorities. To overcome this problem, the CPA initiated formation of the Clyde Estuary Development Group with membership as follows:

- Clyde Port Authority
- County Councils

  Argyll
  Ayr
  Bute
  Dunbarton
  Renfrew

- Town Councils

  Dunbarton
  Greenock
  Port Glasgow

- Scottish Development Department

The group soon commissioned a study report by METRA on economic and technical aspects and by Professor Weddle on environmental aspects of the development.

The projects to be considered were:

a. A marine terminal for iron ore with an associated iron ore stocking area and rail terminal at Hunterston.
b. An integrated steel works for the British Steel Corporation capable of producing 10 million tons/year.
c. A marine oil terminal and an associated oil refinery and railway link for Chevron (U.K.) Ltd. with a throughput starting at 100,000 bbl/day of crude oil rising eventually to 200,000 bbl/day.
d. An oil terminal at Wemyss Bay with a pipeline to Longaugh Point inside the Clyde for MURCO.
e. A general use deep-water port with bulk discharging and trans-shipment facilities.

In some instances, the conclusions drawn on the basis of environmental considerations were at odds with those based on technology and economics.

- Both METRA and Weddle agree on the siting of terminals in Wemyss Bay and Hunterston Point (150').
- METRA proposes Inverkip for the power station implantation, which is opposed by Weddle because of the scenic coast.

Professor Weddle recommends instead the Irvine area or the Dundonald area which are both deemed too costly by METRA. The power station is now under construction at Inverkip by the National Electric Authority.

- MURCO had proposed a refinery in Longhaugh, somewhat higher on the Clyde, linked by pipeline to the Wemyss Bay terminal. It was approved by both experts, although they opposed the site of Longhaugh for a power station. However, the MURCO refinery has been opposed on other grounds by the local population and will not be built.
- Another refinery proposed by Chevron at Hunterston Point (the deep water terminal) was supported by METRA but opposed strongly by Weddle, who preferred an inland site for the refinery, mostly on visual intrusion reasons. The project has been postponed.
- Finally, steel works have been proposed by British Steel Corporation at Hunterston. METRA is supporting the site. Professor Weddle agrees that the site is acceptable, especially if the steel works are limited to blast furnaces rather than an integrated steel plant, and certainly better than the alternative site considered at Ardmore.

D.6.5 The Public Inquiry

The County Councils (33 in Scotland) are usually the planning authorities. (In the Clyde's case, the CPA was the link through the counties.) A developer applies to the appropriate County Council for planning permission. The Town and County Planning Act of 1947 has enabled the authorities to zone areas for development. Where Councils are not the planning authority, an application has to be made to the Secretary of State for an alteration to the planning authority if it is in the public interest to do so.

The proposals are then announced and there are, by statute, 42 days to state an intention to object. In this case the main objectors were from West Kilbride, a high amenity area, and a public inquiry was held. The following objections were presented:

- absence of regional planning;
- damage to amenity;
- loss to agriculture;
- impairment of recreational facilities;
- damage to the tourist industry in N. Ayrshire;
- pollution to atmosphere, sea, beach, soil; and
- safety hazards from a nuclear power station.

Testimonies were written by:

- British Steel Corporation, Chevron, and Murco;
- Consultants and officials; and
- Private citizens.

Finally, there is the statement of findings of facts and a final statement by Commissioner Keith. The Secretary of State's "intentions" for Hunterston port are: a go-ahead for all terminal and general users of the port, approval of the zoning for an all-terminal and stocking yard, general user port and future industrial use. The postponement (pending consideration of further evidence) on the zoning of land for an oil refinery, and the leaving open of a way for steel works. Note that this action was taken in December 1970 on a development plan amendment submitted by Ayre County Council in June, 1969 with public hearings held between December 1969 and February 1970.

One of the CPA's main complaints is that the Secretary of State allows only 42 days in which to state the intention to object, while the next step may be delayed as much as two years. A government inspector represented the Secretary of State to get the facts and draw the conclusions. However, the Secretary is under no obligation to accept them. In this case, the Inspector recommended that the land be zoned for the proposed iron ore terminal, associated stocking yards and rail terminal, but <u>not</u> the integrated steelworks. A general user port <u>will</u> be provided for in the Development Plan amendment, and the land zoned for steel in the amendment <u>will</u> be so zoned, but without commitment as to the type of industry for which it may be used. He subsequently refused permission for the Murco oil terminal and the Chevron oil refinery.

The result is that the whole of the Hunterston area has been rezoned for industry, but the Secretary can reserve the right to decide what industry can go there. Most importantly, the area is available if the BSC chose to apply for planning permission for a steelworks.

The CPA feels badly about turning down the oil refineries; it has tried to pursue a rational development, and has succeeded in obtaining potential developers, but Government policy has frustrated these efforts. The CPA feels it is radically wrong to take 2-3 years to come to a negative decision, because so much time and money are involved. Murco, for example, spent $1.2 million presenting its case. Public Authorities should define basic environmental criteria as soon as possible so that both the public and the promoter would have a common ground for prior, non-emotional discussions.

D.6.6 Future Plans

The CPA is preparing a 10-year plan to safeguard the investment in the large granary at Meadowside. This granary has 176,000 tons of storage space but it is too far up-river (limited to 27,000 dwt) for bulk carriers. The grain comes mostly in ships of 15,000-20,000 dwt at the moment, usually direct from Canada or America. There is a depth limitation of 31 feet coming up the river.

Another consideration is iron ore, of which 3 million tons p.a. comes into Glasgow's general terminal quay, 15 miles from the steelworks. This arrangement is good, but it is limited to 28,000 dwt ships, and Australian iron ore requires large vessels, as anticipated by the report of the Benson Committee in 1965. Large carriers of either 250,000 dwt or 350,000 dwt are anticipated eventually at Hunterston for transshipment.

The Chevron project would have seriously inhibited a coastal steelworks development. The CPA feels steel could orientate industry around the Clyde; 350,000 tonners would be possible. Transshipment could be developed to distribute the steel to other U.K. steel plants, or even for distribution of ore to the Common Market countries.

To coordinate planning in the West of Scotland and to identify in advance areas which should be developed for industry, the West Central Planning Group has been formed. Its members comprise the Chamber of Commerce in Glasgow, the CPA and the local authorities, all of whom will make an annual contribution for the next 5 years. The Scottish Development Department has allocated staff to work for this group, and is advertising for a director to lead the team.

It is ironic that the port with practically the deepest available water in Europe, should also be one of the most beautiful areas of the country, and hence inhibits industrial developments.

D.7 ENVIRONMENTAL PLANNING IN THE MEDWAY ESTUARY

D.7.1 Summary

In the Medway estuary, the situation is somewhat different than that of the Clyde, though in both areas, environmental planning has been an important consideration in plans for future development. The Medway is a proposed MIDA and the Kent County Council (Kent C.C.) is extremely anxious that it be selected. To this end, the Council commissioned a report in 1970 by the Economist Intelligence Unit to assess "The Potential of the Medway Estuary as a Maritime Industrial Development Area." They are now getting a cross-section of opinion from all parties concerned, and if the Medway site is selected by the Government, a local public enquiry would probably ensue.

It will probably be at least another year before the Government makes any decision on a MIDA. The Kent C.C., however, is well prepared and using the EIU's Discussion Document as a basis, is consulting with interested authorities, the public and other bodies. All the factors to be considered have been well laid out in this document, the amenity, conservation and recreation factors having been well covered. If the MIDA goes ahead in this area, these elements are likely to suffer; however, the Kent C.C. is making all efforts to lessen the impact of industrial development on them. At this stage, one cannot assess the weight which the conservationists will carry, or whether the "national interest" will win the day.

D.7.2 The MIDA Scheme

The EIU's discussion document defines a MIDA, gives its characteristics and presents the case for one in the U.K.

The idea of a MIDA was put forward by the National Ports Council in 1966. Essentially, the "principle was to establish a site or sites with really competitive physical features -- space, deep water, flat land, and adequate labor, electricity, water and other supplies -- all at as low a cost as possible for the investing industry and for the nation." Pooling of needs and resources was seen as a means to achieving this end, and with Government support and impetus, the U.K. could gain on export and save on import production which would otherwise be lost to the Continent.

The Halcrow Report, identifying potential sites in Great Britain, was completed in 1968; eleven sites were considered technically suitable, the Medway being one of the foremost.

Professor M. H. Peston of London University completed a pilot feasibility study in December, 1969, and in May, 1970 he started a detailed economic cost/benefit study of the MIDA concept; the study will take 2-2 1/2 years to complete.

In the particular case of a Medway MIDA, the main considerations are:

- fairly deep water;
- general cargo increasing significantly to Medway waters;
- B.P. Kent Refinery well established on Isle of Grain: processes more than 11 million tons of crude oil annually, taking tankers up to 80,000 dwt;
- 2,000 MW power station just opened; a 3,300 MW one being constructed;
- important recreational area, e.g., sailing;
- high amenity and scientific interest.

The report comments also on competition, notably from the Humber, the Severn Estuary coast between Cardiff and Newport, and the Clyde:
Humber: less manageable river, possibly more costly transport and urban infrastructure, bad location for Channel Tunnel and EEC trade.
Cardiff/Newport: excessive tidal range and rough weather, far from U.K.'s growing market areas -- S.E. England, Channel Tunnel and EEC.
Clyde: deep water but little adjacent flat land, remote location. Should have good transshipment possibilities.
Foulness now having been chosen for London's third airport, it is unlikely to be chosen for a seaport, too; the noise and congestion would be excessive.

The main disadvantages of a Medway site are as follows:

- Road and rail systems and transport facilities will have to be drastically improved;
- The Medway is on the wrong side of London for distribution to the rest of the country; and
- Extra fresh water will have to be pumped into the area.

D.7.3 Employment Considerations

The level of unemployment in S.E. England has remained consistently below the national average; it has deteriorated over the past few months, but is still favorable compared to that in other regions of the U.K. However, the unemployment rates for Kent (especially East Kent) have been higher than those for the S.E. region: 3.7% compared with 2.4% for the Southeast (based on relating the numbers unemployed to the total number of workers living in the area). This relatively high level of unemployment will continue to be influenced by the general level of activity at national and regional levels. The Kent County Planning Officer believes that the most likely way to ease the East Kent situation is to attract a few large employers to the area, preferably located where they would be accessible to a number of towns.

The Medway MIDA would alleviate the problem to a large extent, even

though the idea of a MIDA is to accommodate a large parcel of basic industry with minimum demands for employment, i.e., to be as capital intensive as possible. Consequently, the EIU has estimated the number of workers needed as follows: 15,000 in 1986 - 25,000 in 1991. In addition, these 24,000 service workers would be required in 1986 and 50,000 in 1991. The EIU does not believe that the creation of a fairly large number of jobs in Lower Medway will obviously help to overcome regional employment problems as it would, say, in South Wales, but the time may be coming when development policies will have to look more to building up new communities to fit the shape of an international grouping of industries, and less to maintaining the employment patterns of the nineteenth century.

D.7.4 Preservation of Places of Tourist Interest

New development is very much a matter of compromise and much thought is given to modernization programs by Kent C.C. For instance, Dover -- a flourishing and significant port, and an old town in itself -- needs a new traffic system to cope with increased traffic flows, larger vehicles and hovercraft traffic. There are two sides to the problem: (a) without a new traffic system, traffic congestion will be unbearable; (b) a new system will require some historical old buildings, tourist attractions in themselves, to be pulled down. To satisfy both aspects of the problem, the Kent C.C. has evolved a complicated by-pass to get traffic down to the docks and to connect with a proposed lorry park.

Old towns and villages in Kent are well protected under the Civic Amenities Act of 1967. Old buildings -- there are about 15,000 in Kent -- are put on a scheduled list. Of Kent's 300 villages, at least 150 are of real interest architecturally. Furthermore, 30 towns in the County have pockets of old buildings which add to their character. Villages such as Faversham and Sandwich haven't changed much over the years; however, Faversham would in fact be affected by the MIDA. By and large, the Kent C.C. tries to keep pressures well away from these places, because they have a cash value as tourist attractions.

D.7.5 The Effect of the Proposed MIDA Scheme on the Environment

The Environmental Planner at Kent C.C. is very realistic when he says that jobs are more important than environment, if the national interest is to be served.

A good deal of forward thinking has nevertheless gone into the proposed Medway MIDA on the environmental and recreational questions. However, the amenity value of this area, as will be reviewed later, will be seriously affected. The proposed site, while it immediately avoids areas of great landscape value and of outstanding natural beauty, seriously infringes on sites of special scientific interest and nature reserves. It also affects existing and potential areas for general water based recreation, notably sailing.

The short summary from the EIU's chapter on amenity and conservation is included here:

> "A considerable part of the countryside is in the study area, particularly the North Downs, is noted for its beauty, much of which is protected in the Development Plan as being of Great Landscape Value and/or of Outstanding Natural Beauty. Planning policy is to protect rigorously the areas of landscape quality from development. As regards the coast, the Development Plan contains policies to protect the remaining undeveloped coastline from unnecessary building, recognising its scientific, landscape or recreational significance. The countryside contains a large number of attractive villages and hamlets, many with substantial numbers of buildings of architectural or historic interest. The accommodation of large increases in population in such settlements would be contrary to current planning policies."

The Kent C.C.'s recent survey of recreational boating facilities on the Kent Coast indicated an existing demand for more and better facilities plus a growing demand for more marinas, boat yards, etc. There is, however, quite a problem in finding suitable locations because of waterwide development of all types. In the EIU report, it was recommended that the Medway Ports Authority and the Medway Yachting Association discuss bringing into use the reserve of moorings in the river in order to rationalize commercial boating developments on this

river, the estuary of which is extensively used for sailing and small boat activities. The MIDA will in fact eliminate the main sailing base.

The Kent area also receives a large number of vacationers and day-trippers. There is a demand for more holiday camps and facilities, especially on the coast. The Kent C.C. is examining the possibility of establishing regional country parks in appropriate locations. The countryside in various parts of Kent is quiet and very attractive, and used for many activities.

All these factors have to be taken into account if the MIDA is approved.

D.7.6 Organization of Kent C.C.'s Planning Department

The County Planning Department has 200 staff, under the County Planning Officer and his deputy, of which two-thirds are technical. The department has two sections:

- Strategic Planning, which deals with population changes, employment issues, etc. This research section does social, industrial and demographic surveys leading to policy plans which generally relate the local population to employment available in the area.
- Environmental Planning which is further divided into:
  (1) Coast, Countryside and Recreational Issues;
  (2) Local Plans and Conservation; and
  (3) Development Control

  The Council gets 15,000-16,000 applications a year asking permission to carry out development, and deals with these. Applications may be ruled out because they are in basic conflict with the Council's published plans.

D.8 POLLUTION CONTROL ON A MAJOR URBAN INDUSTRIAL ESTUARY: THE THAMES

D.8.1 Summary

The Thames is the most important river of England. Its tidal estuary is much polluted although the trend has been reversed in the past decades by energic action, under the sponsorship of the Thames Conservancy -- the oldest known body concerned with pollution control (1857), the Port of

London Authority, and the Greater London Council. The Thames Conservancy is well endowed with pollution knowledge and comprehensive control legislation. Sewage disposal is the greatest polluting source because overloaded treatment plants remove only half of the pollutants. Full treatment is expected by 1974 thanks to a $50-60 million investment.

A 1915 Royal Commission set up a limit of 5 milligrams per liter for 5 days BOD; beyond this limit the quality is doubtful. (Three milligrams per liter is called fairly clean.) Such a standard is not applicable in tidal waters, which may keep a given pollution load for three months and result in an "effective oxygen load" (carbonaceous and nitrogenous water) being measured in the sewage. Weekly surveys and discharge sampling since 1909 and occasional major surveys lasting 10 years or more have shown a continuing improvement of the tidal water quality, especially over the past 10 years.

A reserve of oxygen of 10% saturation at all times everywhere is sought for 1980, to accommodate accidents (shipping collisions, storm discharge, strikes at sewage-treatment plants, etc.).

Reductions in the number of river authorities, drainage authorities and concentration of water supply sources have been recommended throughout the country. The new Ministry of the Environment is preparing a detailed, computerized survey of English rivers, while the Royal Commission on Environment will address itself next year to the subjects of coastal and water management.

D.8.2 The Thames River Personality (Figure D-3)

The Thames is England's longest and most important river, with a total length of 210 miles from its source in the Cotswold Hills to its outflow into the North Sea. It is navigable by ocean-going steamers to the new London Bridge. The Thames is tidal to Teddington (69 miles from its mouth) and forms County boundaries almost throughout its course.

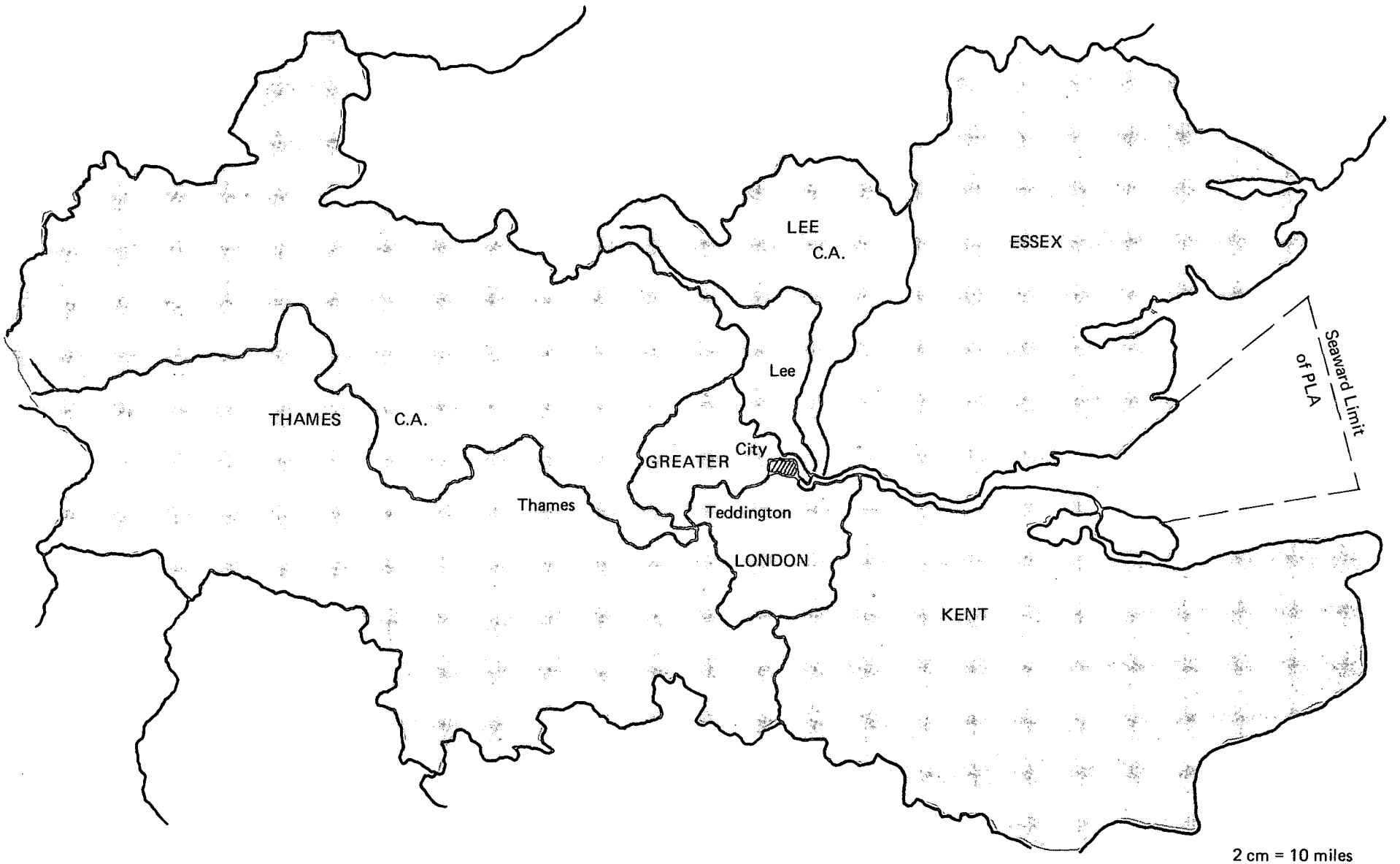

FIGURE D-3 STATUTORY RIVER AUTHORITY AREAS AND CATCHMENT AREAS CONTROLLING THE THAMES

The Thames is London's premier amenity, yet it is also an industrial river which London has to live on: pollution control is very much a matter of balancing up interests. The uses to which the Thames is put are many. Not only is the Thames a major source of water supply for London (300 million gallons per day), it also is the main receptacle for sewage (virtually all of which is treated before discharge). The waters of the Thames are also used for cooling purposes in power stations and industrial plants along the river side.

On the fresh water stretch of the river, 10,000 launches are registered, and more than 250,000 anglers use it. Boat trips up and down the tidal Thames are a big tourist attraction; London life has centered on this river from the very beginning and there is much to see. Houseboats and restaurants are moored along the banks.

The fresh water part of the river is comparatively clean: 60% oxygen saturated as compared with less than 10% in the tidal portion. However, a measure of how much cleaner the Thames has become over the last 10 years is indicated in surveys conducted by Alwyn Wheeler, a Zoologist at the British Museum: in 1958 the river was in such a bad state that from Fulham to Gravesend only eels existed. In the last two years 57 species of fish, both sea fish and euryhaline (sea and fresh-water) fish have been recorded. Recently two sea trout have been caught up-river -- i.e., beyond the polluted areas -- weighing 3 3/4 pounds and 2 1/4 pounds. Thus, the situation is a far cry from that of the mid-19th century when the smell was so bad that Parliament could not meet, and when 20,000 Londoners died in the third cholera epidemic of that century.

D.8.3 Authorities Controlling Pollution in the Thames

The two main bodies concerned with control are the Thames Conservancy and the Port of London Authority (PLA). The Greater London Council (GLC) acts as "agents" for the PLA in certain respects.

The Thames Conservancy, set up in 1857, is the oldest body in the world

concerned with the pollution control function. The Conservators now have jurisdiction over the River Thames from Cricklade in Wiltshire (the source) to Teddington Lock: 141 miles, the area of the watershed being 3,656 square miles. In 1909, the PLA took over all rights, powers and duties of the Conservators with respect to the river below Teddington, namely, that part of the Thames which flows through Greater London, the City, the counties of Essex and Kent, and to the limit of Territorial Waters in the North Sea: 92 miles in all.

The GLC, through its Department of Public Health Engineering, is the enforcement authority for the prevention of pollution in the non-tidal rivers and canals in the London excluded area. (This area is excluded from the jurisdiction of any other river authority or conservancy catchment board. It includes some 410 square miles of Greater London.)

D.8.4 History, Functions and Legal Powers of the Authorities

Thames Conservancy

There has been legislation for the prevention of pollution of the River Thames since very early days, but very little practical results until the Conservators commenced their operations in 1857.

Originally there were 12 Conservators; there are now 39. Their scientific staff comprises 2 chemists, 2 biologists and 4 assistants. They are moving into a new building in Reading in two years time when they will have advanced laboratory services with 20 staff.

The Thames Conservancy Acts and Orders 1932-1966, which are private acts, give the Conservators most of their powers. The Conservancy is also constituted the Drainage Board of the Thames Catchment Area for the purposes of the Land Drainage Acts 1932 and 1966. The Conservators are the Navigation Authority for the river, and under the Water Resources Act 1963, also exercise the new water resources functions of River Authorities (Figure D-3) with respect to both surface and underground water in the Thames Catchment Area and underground water in London (the London "excluded" area), including the prevention of pollution.

As regards pollution control, they exercise jurisdiction over the Thames Catchment Area (both surface and underground water), and over the fisheries in the River Thames from Cricklade to Teddington.

The main water pollution control functions of river authorities are laid down in the River (Prevention of Pollution) Acts of 1951 and 1961. These powers of the Thames Conservancy are supplemented by their private powers. The 1951 Act makes it an offense for anyone to cause or knowingly permit poisonous, noxious or polluting matter to enter a non-tidal stream. It also makes it illegal for anyone to make a new or altered discharge of sewage or industrial effluent to a stream without the consent of the river authority. In granting its consent, a river authority may lay down conditions as to the volume and quality of the effluent.

The Clean Rivers (Estuaries and Tidal Waters) Act 1960 extended the provisions of the 1951 Act to tidal estuaries and creeks. The 1961 Act extended the "consent" procedure to discharges of sewage and industrial effluent which were already being made to non-tidal waters when the 1951 Act came into force. Any discharger may appeal to the Department of the Environment against a river authority's decision, but this is an extremely rare occurrence.

The Water Resources Act, 1963, gives river authorities powers to take emergency action to reduce or eliminate the consequences of any river pollution which has occurred, and to control, by a "consent" procedure, any discharges of sewage and trade effluent passed into the ground.

The river authority can summon to court any discharger who fails to comply with its requirements. Action is free from control by Central Government, unless of course, the river authority fails in its duty, whereupon the Minister for the Environment can step in.

The Conservator's income is obtainable by dues from the Councils of the various counties, county boroughs and London boroughs within the Thames

Catchment Area, from the Greater London Council, from license fees, and from charges for water abstracted. In addition, the Conservators derive income from various navigation tolls, fees, licenses and rents. For 1971 the Thames Conservancy has budgeted £255,860 ($613,000) for river purification.

Port of London Authority

The PLA is the only port authority to hold full pollution control powers, granted in 1909.

The Pollution Control Committee of the PLA is composed of 9 members nominated by the PLA plus representatives of:

- Essex River Authority;
- Kent River Authority;
- Lee Conservancy Catchment Board;
- GLC (2);
- City of London Corporation; and
- Confederation of British Industry.

There are also two advisory bodies:

- The Thames Estuary Study Group, to deal with technical and scientific problems connected with the sea bed and movement of water; and
- The Clean Thames Consultation Panel, to discuss reports on the condition of the river.

The PLA's pollution department is headed by the River Conservator, and two pollution control officers: one for the day-to-day running of the inspectorate and the other for policy, planning, liaison, etc. All three are science graduates. There are also four inspectors with appropriate qualifications; all are members of the Institute of Water Pollution Control. The department also has a consultant analyst, a small laboratory, and consultant chemical engineers to advise on future problems. Until 1964, the PLA derived its powers from a 1920 Act which consolidated the various 19th century acts prohibiting discharges of all

sorts. This act was superseded by the Port of London Acts of 1964 and 1968.

In 1961, River Authorities took over from the Boards, in order to improve the country's water resources; the London Excluded Area remained though the PLA got the same powers of pollution control as the new Authorities. In 1962, the Thames Conservancy was given control of ground water abstractions in the London Excluded Area, the PLA was given control of pollution and abstractions from the tideway, and the GLC was authorized to administer flood prevention and control abstractions from streams. The PLA was also to have the powers which all river authorities had under the Rivers (Prevention of Pollution) Acts 1951 and 1961. These arrangements were all included in the PLA's Private Bill in 1964.

Under the Oil in Navigable Waters Act of 1959, the PLA's jurisdiction was extended over the whole of the river and estuary under its control, but its powers under the Rivers (Prevention of Pollution) Acts do not extend beyond the seaward limit of the port. The PLA owns most of the river bed and foreshore down from Teddington and thus can impose conditions on the use to which this land is put. The income it derives from granting licenses goes to the work of pollution control without subsidy from public funds or local rates.

Greater London Council

The Trade Effluent and Pollution Division of the GLC's Department of Public Health Engineering has a staff of 11 pollution officers and inspectors. The GLC works with the PLA and controls the non-tidal waters that flow into the PLA's section of the Thames. Its powers are contained in the Rivers (Prevention of Pollution) Acts. The GLC works with the local boroughs in tracing the source of any pollution, because all public discharges are its responsibility. In the case of private discharge direct into the river, the GLC deals directly with the person(s) concerned. The GLC also exercises land drainage and flood prevention functions.

D.8.5 Sewage Disposal

The greatest source of pollution in the River Thames is sewage, and there is a marked difference, as indicated previously, between the state of the river above and below Teddington.

Most of London's sewers were constructed in the late 19th century. There was large-scale rationalization of sewage works through the country around 1940, the first regional sewage works being opened at Mogdon for West Middlesex. Beckton and Crossness works treat the majority of London's sewage and between them remove 50-60% of the pollution matter that would otherwise go into the river. Crossness is getting overloaded; it was designed for 70 million gallons per day but frequently deals with far more. About one-third of the sewage going to Beckton gets full treatment, but by 1974 all sewage (220 - 250 m.g.d.) will be getting full treatment at a cost of $50-60 million for an extra plant. Mogdon deals with 90 million gallons per day.

As far as the non-tidal Thames is concerned -- a much cleaner part of the river -- all of municipal sewage and 80% of trade/industrial effluents, are disposed of by the local authority sewage works.

D.8.6 Pollution Measurement

When London's sewers were built in the 19th century, the idea was to wash the sewage out to sea from the Beckton and Crossness outfalls. The theory at that time was that it took five days for an inland river to "process" all sewage, by using oxygen to purify itself. This did not work; because the Thames is a tidal estuary, the sewage could take up to three months to get out to sea, and in this length of time it used up all the oxygen in the river.

In 1915, a Royal Commission set up certain standards:

5 days BOD* (milligrams per liter)	Classification
1	Very clean
2	Clean
3	Fairly clean
5	Doubtful
10	Bad

*BOD = Biochemical Oxygen Demand

However, because the pollution load remains in the Thames estuary for up to three months, the BOD test is virtually inapplicable. Consequently, the PLA uses a parameter called the "effective oxygen load," which measures the carbonaceous and nitrogenous matter.

No single standard is required and the river authorities consider each discharge on its merits. Obviously, there is more tolerance in Canvey than there is in Chelsea, and therefore people in Chelsea have to pay more for sewage treatment.

Of the 220 m.g.d. of sewage and effluents discharged into the non-tidal Thames, about 50% is required to conform with the Royal Commission Standards, while the rest has to conform to a higher standard which deals with everything other than suspended solids and B.O.D.

Various surveys are always going on about the subject of pollution in the Thames. A recent Thames Conservancy Survey indicated that of all the sewage works in the area, only 40% did not reach the standard required 80% of the time: this is considered an improvement.

Other Thames surveys include:

1949 - Thames Survey Committee of the Water Pollution Research Board to study the causes and effects of pollution.

1951 - Departmental committee of the Minister of Local Government and Housing was set up "to consider the effects of heated and other effluents and discharges on the tidal reaches of the

River Thames" under Professor A. J. Sutton Pippard. This turned out to be a very complicated subject and the committee did not report until 1961. The outcome was that the pollution control function should be arranged and organized to prevent offensive conditions.

Both surveys took over 10 years to complete.

Subsequently, there has been continuing improvement in the quality of the tidal Thames waters. The GLC (and the earlier LCC) has carried out weekly surveys for more than 50 years. The PLA has been sampling major polluting discharges since 1909. Many of its powers under the Oil in Navigable Waters Act of 1955 are closely related to pollution control (e.g., navigation, conservancy, hydrographic surveying, river regime functions).

D.8.7 Policy for the Next 10 Years

The PLA is aiming to obtain by 1980 a reserve of oxygen in the river of 10% saturation at all times and in all places. The worst time of the year is the third quarter when the upland flow is at its lowest and the extractions above Teddington (for drinking water) are at their highest.

The PLA is trying to obtain this reserve (in fact, 10% saturation is only about one part per million of dissolved oxygen to accommodate accidents -- e.g., sugar boats or sludge boats sinkings, storm discharges, strikes in sewage-treatment plants, etc.

Other factors which will affect the control of pollution:

- The report of the Central Advisory Water Committee, which has been considering water and water disposal throughout the country. The Committee recommended that:
  a) the 29 river authorities plus PLA be reduced to 7-13 river authorities
  b) the 250 sources of water supply be reduced to 50 undertakings

c) the 1400 drainage authorities be reduced to 50. (There were a variety of suggestions as to how this could be organized and the Minister for the Environment will decide.)

- The Royal Commission of Environmental Pollution, which will look at coastal and esturial pollution next year. (The Commission's work should have far-ranging effects.)
- The Ministry of the Environment, which is bringing out a very detailed and computerized survey of rivers in England.

Thus, pollution control in the Thames has been a matter of concern for many years, is improving radically, and may be an example to other river authorities.

APPENDIX E

PORT CARTIER, CANADA

APPENDIX E
PORT CARTIER, CANADA

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APPENDIX E

PORT CARTIER, CANADA

E.1 SUMMARY

Alcan Shipping Services, a consulting arm of Alcan and Saguenay Shipping in Montreal, appraised a port handling bulk grain and ore in Canada and conducted the research for this report. Data gathering, field interviews and inspections took place in March, 1971.

Most of the 500 Canadian ports are public, and the 11 major ones are administered by a National Harbor Board under the aegis of Ministry of Transport, with advice from the Department of Public Works. Streamlining of this ministerial tutelage with a special agency, and a decentralization of the administration and financing of infrastructures, have been recommended, with private enterprises becoming responsible for all cargo-handling equipment.

The grain and iron ore terminal at Port Cartier was selected for this study because in 1961 it was the largest excavated harbor in the world, and because its rapid growth is now tapering and its future is threatened by competing neighboring ports. The following report raises the following issues:

- Port Cartier was built in 1960 by Quebec Cartier Mining Co. close to a declining lumbering and fishing settlement, located between two existing ports: Baie Comeau and Seven Islands. The extra distance to Baie Comeau, competition with the existing iron ore shipper at Seven Islands, and probably some government pressure to help a depressed area explain the decision. However, local weather and seastate dictated an excavated harbor, which is expensive to extend and deepen, while the natural deep bay at Seven Islands offers much more flexibility for expansion. Port Cartier's iron ore loader, on the other hand, has provision for five-fold capacity increase (40 million tons per year from the current 8 million tons).

- Despite the construction of a grain transshipment terminal with a 10 million bushel silo, the port activity remains essentially centered on iron ore exports. No secondary industry has settled in the area since completion of the iron ore terminal and population remain static. A reactivation of the traditional lumbering activity for a projected dissolving-pulp-mill operation would be a welcome diversification.

- Provincial subsidies have been limited to winter-road clearance, fire prevention and aqueduct operation, for a total varying between $10,000 and $60,000 per year. The $600,000 revenue of 1968 represents a 30% increase over 1962, mainly borne by the residents and is typically spent : 1/3 on technical services, 1/6 on administration, 1/6 on security and welfare, and increasingly (1/6) for servicing the debt ($770,000 in 1970), while capital equipment (1/6) is a variable low item.

  The debt servicing burden is continuously increasing, from 6% of budgetary expenditures in 1962, to 14% in 1968, and a projected 26.5% in 1972. Investment in capital equipment, already irregular, could suffer from this situation, although temporary structures erected during the 1960 boom need replacement by permanent facilities.

- Local commerce and retail trade is sluggish, and suffers from competition by more aggressive enterprises in the two neighbor ports. There is also a lack of integration between the new company settlement and the original village close to Shelter Bay.

- The high unemployment rate (8% plus 6% on pension) is concentrated on original, unskilled residents, who in 1960 preferred high-pay construction jobs to the training school established by Quebec Cartier Mining. The old settlement of Shelter Bay still has an 85% untrained population, and its housing is characterized as medium-to-poor, with crowded conditions, all the more resented since the development of the well-planned QCM Company sector across the creek. There is a need for more

park and recreation facilities, particularly children's playgrounds at the neighborhood level. Sewage disposal close to the beach and traffic congestion are other causes of dissatisfaction.

- As the port is about three miles east of the new, eastern part of town, little inconvenience seems to have resulted from excavation blasting or ore dust, although dust is mentioned by some residents. Reduced ship traffic, and good ore-spillage control have prevented any visible pollution inside and outside the harbor.

E.2 CANADIAN PORT STRUCTURE

Port administration and policy in Canada depend on whether a harbor is privately owned or considered a public or government wharf.

Matters relating to a port when privately owned are the responsibility of the owner, who generally nominates a port manager, to be responsible for day-to-day operations. In Eastern Canada, the major private ports are:

Port Alfred - owned by Alcan
Port Cartier - owned by Quebec Cartier Mining
Sept -Iles - owned by Iron Ore Co. of Canada

The privately owned wharves primarily handle the traffic of one major industry. They have been built by private capital, and government control is limited to navigation.

Since the Canadian Confederation in 1867, 315 harbors have been proclaimed public and come under the Canadian Shipping Act and the Public Harbor Regulation.

Actually, the responsibility for port administration is assumed by the Department of Transport, who appoints the Harbor Master, through the various Harbor Commissions, or the National Harbor Board and St. Lawrence Seaway Authority.

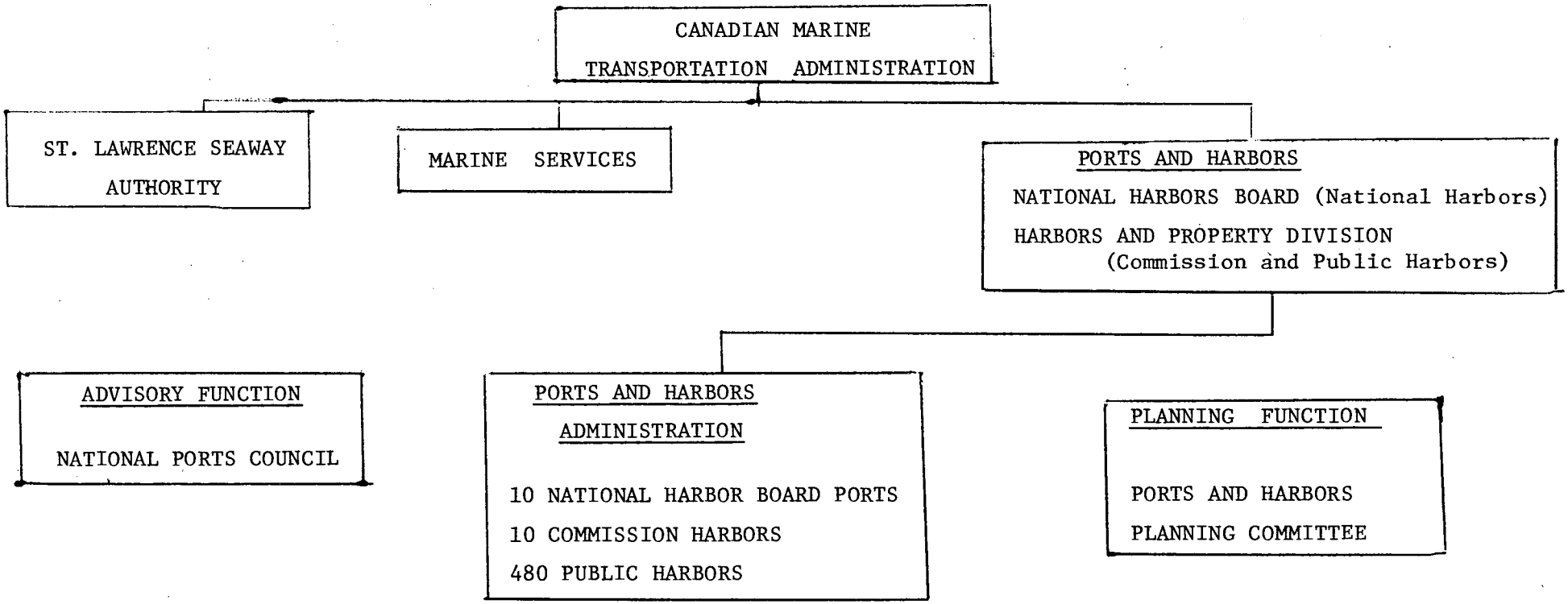
The governing legislation is:

- The Canadian Shipping Act, Part X
- The Government Harbors & Piers Acts
- The Harbor Commission Act 1964
- The Individual Harbors' Commissioners Act
- The National Harbor Board Act 1936
- The St. Lawrence Seaway Authority Act
- The Navigable Water Protection Act

The Department of Transport is directly responsible for ten harbor Commissions, over 300 public harbors and several thousand Government wharves. Eleven ports and two grain elevators are administered by the National Harbor Board since the 1936 disbandment of Harbor Commissions at Montreal, Quebec; Three-Rivers, Halifax; Chicoutimi, St. John; and Vancouver, British Colombia. The N.H.B. is composed of full-time members appointed by the Governor in Council for a ten year period and has power to employ and remunerate staff, to expropriate, to collect tolls, etc. The St. Lawrence Seaway Authority is also responsible for certain public wharves.

The Canadian port administration and policy regarding the management of public and government wharves is currently subject to criticism and revision. The existence of a centralized administration composed of four different federal bodies; Department of Transport, National Harbor Board, St. Lawrence Seaway Authority, and Department of Public Works, complicates management. It has been recommended (by the Glassco Commission Report) to the Federal Government to decentralize to eliminate duplication of work and give more authority to each port in matters relating to its own administration and policy. This will create semi-autonomous Port Authorities which will be responsible to the government but functioning with specific duties and powers that allow the local administrators a considerable degree of freedom. Specific recommendations include:

- A single Government Agency reporting to the Department of Transport should be responsible for Federal action in Harbor administration. An outline of the organization of this administration follows:


CANADIAN MARINE
TRANSPORTATION ADMINISTRATION
ST. LAWRENCE SEAWAY
AUTHORITY
MARINE SERVICES
PORTS AND HARBORS
NATIONAL HARBORS BOARD (National Harbors)
HARBORS AND PROPERTY DIVISION
(Commission and Public Harbors)
ADVISORY FUNCTION
NATIONAL PORTS COUNCIL
PORTS AND HARBORS
ADMINISTRATION
10 NATIONAL HARBOR BOARD PORTS
10 COMMISSION HARBORS
480 PUBLIC HARBORS
PLANNING FUNCTION
PORTS AND HARBORS
PLANNING COMMITTEE

- A Local Harbor Commission under this single agency should be used wherever possible, and harbors meeting the required criteria should be administered locally. The main quality of the agency should be flexibility in matters of operation of various ports. Direct nomination should be made when a local Harbor Commission is not possible.

- The capital expenditures, public borrowing, and user charges should be subject to agency approval, but the local commission should be autonomous in day-to-day operation.

- Responsibility for design and construction of marine work and dredging should be consolidated rather than divided among several agencies.

- Cargo handling equipment, when possible, should be the responsibility of private industries.

- The new agency should be responsible for overall harbor planning and advice on harbor policy.

E.3 GENERAL DESCRIPTION

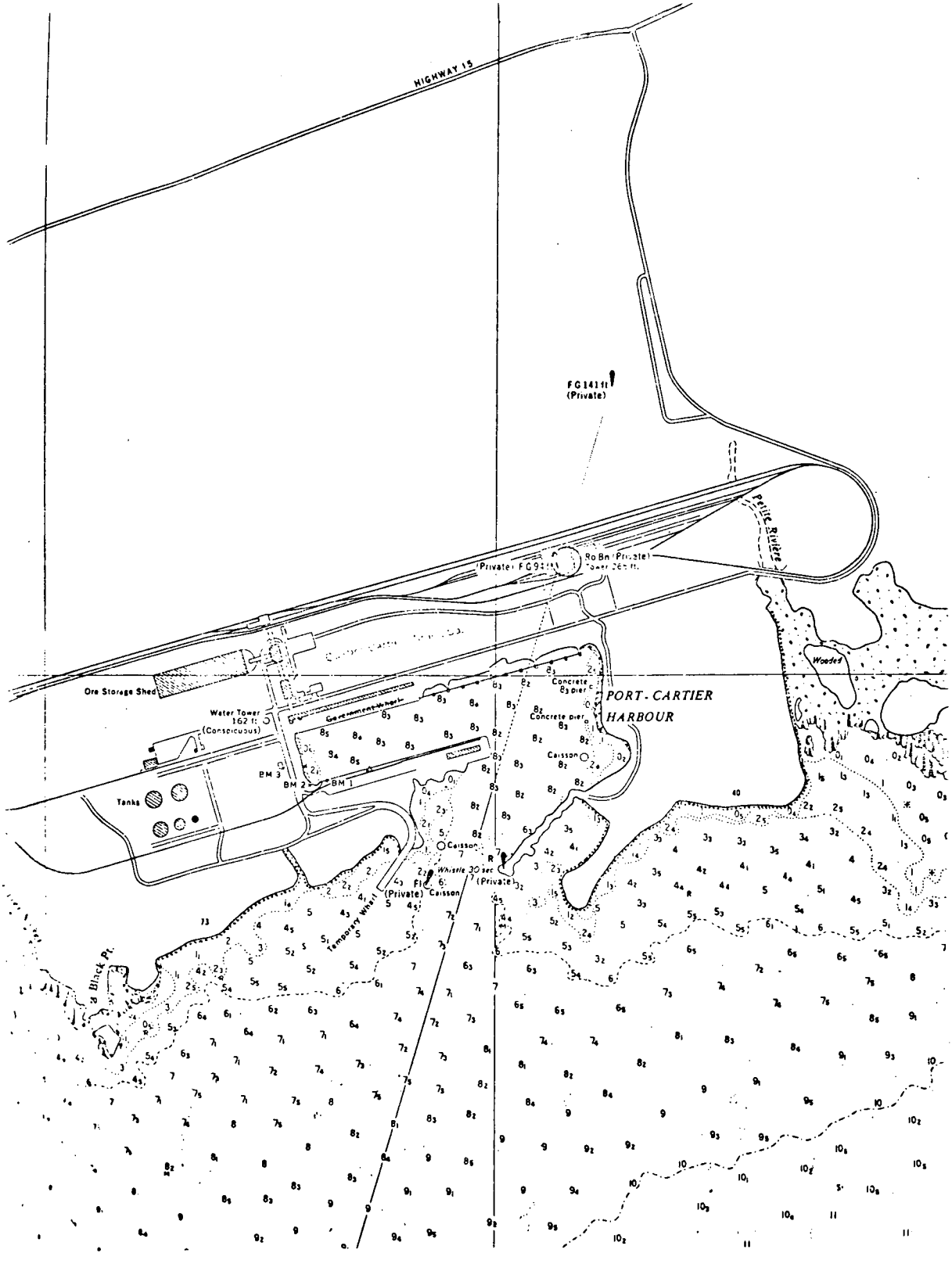
E.3.1 Geography

a. Local

Port Cartier is situated on the North Shore of the St. Lawrence River, between the deepwater ports of Sept-Iles, 38 miles to the east, and Baie Comeau, 110 miles to the west. The town is connected to Gagnon, 191 miles inland, by a railway which is owned and operated by Quebec Cartier Mining. Highway 15, the major North Shore all-weather highway, runs about one-half mile north of the town with exit and entry roads connecting to the town. There are bus and air connections with Sept-Iles, Baie Comeau and with Quebec and Montreal, through Sept-Iles.

Geographically, the village is situated at latitude 50°01' N and longitude 66°55' W and the altitude varies gradually from sea level to 140 feet at the northern boundary shown in Figure E-1. The land slopes towards the

FIGURE E-1 PORT CARTIER HARBOR, CANADA



sea, insuring some protection against the prevailing northwest winds and giving some measure of natural drainage for surface water.

The town is divided by Rivière aux Rochers, a small river originating some fifty miles inland, the two sides being linked by Chemin des Iles, an all-weather paved surface road. The river also acts as a natural drainage basin for both east and west sections. In the east section, the slopes range between 0 and 8% and in certain places there are sandy surfaces which serve as beaches.

The geological formation of the area is essentially Pre Cambrian. The basic sub-surface rocks are crystalline phase with some gabbro and granite. Much of the surface rock is post-glacial deposits from the Champlain plain. The central islands, river basins, and a large portion of the west sector near the boundary shown outside the built-up area are composed of porous rock and are favorable for heavy construction. The remaining surface areas are either marine clay and silt, or sand and gravel favorable for light construction.

b. Inland

The whole area is rocky terrain - with sedimentation, including ores, minerals, sands, and gravel, in the escarpments - and is dissected by rivers flowing into the St. Lawrence Gulf, which not only carry huge amounts of water during the spring thaw, but also serve for floating logs downriver. The surface of the terrain is heavily wooded - a typical Laurentian North-Shore backwoods scenery - with about 65% spruce, 27% fir, and 8% birch and aspen.

The faults and escarpments contain considerable iron ore, at a distance of about 200 miles from the city. The mine at Lac Jeannine covers an area of 330 acres. The stratum of this open-cut mine is specular hematite and quartz, and the cut is 800 feet long, 2,300 feet wide and 1,000 feet deep. Reserves presently being worked are estimated at one billion tons, and given the current rate of production it can be roughly assumed that the

the deposits will be worked out within thirty years. Production is continuous at around 60,000 tons of mineral and 40,000 tons of sterile rock per day. The concentrator produces about 24,000 tons of iron ore concentrate per day and some eight million tons per year. The ore is railed to Port Cartier harbor where it is stockpiled and loaded on bulk carriers by a sophisticated, highly automated system. Plans have been made to integrate ore from another mine, some 30 miles from Gagnon, into the system.

c. Climate

Temperatures range from a mean maximum of 42.6°F to a mean minimum of 25.4°. Monthly averages are:

January	7° (av. min.)
April	30°
July	60°
September	50°
December	10°

Snow and rain precipitation data are not available for Port Cartier, but Sept-Iles and Baie Comeau give a rough regional indication.

	Rain (Inches)	Snow (Inches)
Sept-Iles	31.26	155.8
Baie Comeau	24.16	127.4

Wind direction is predominantly from the northwest and a year-long observation gives the following percentages:

Northwest	44%
East	20%
North	18%
NE and SE	10%

The northwest wind direction would suffice to disperse seaward any airborne pollution such as dust, odors, or toxic elements which could come from the port located several miles to the East. The village then, seems reasonably well protected from pollutants.

d. Land Use

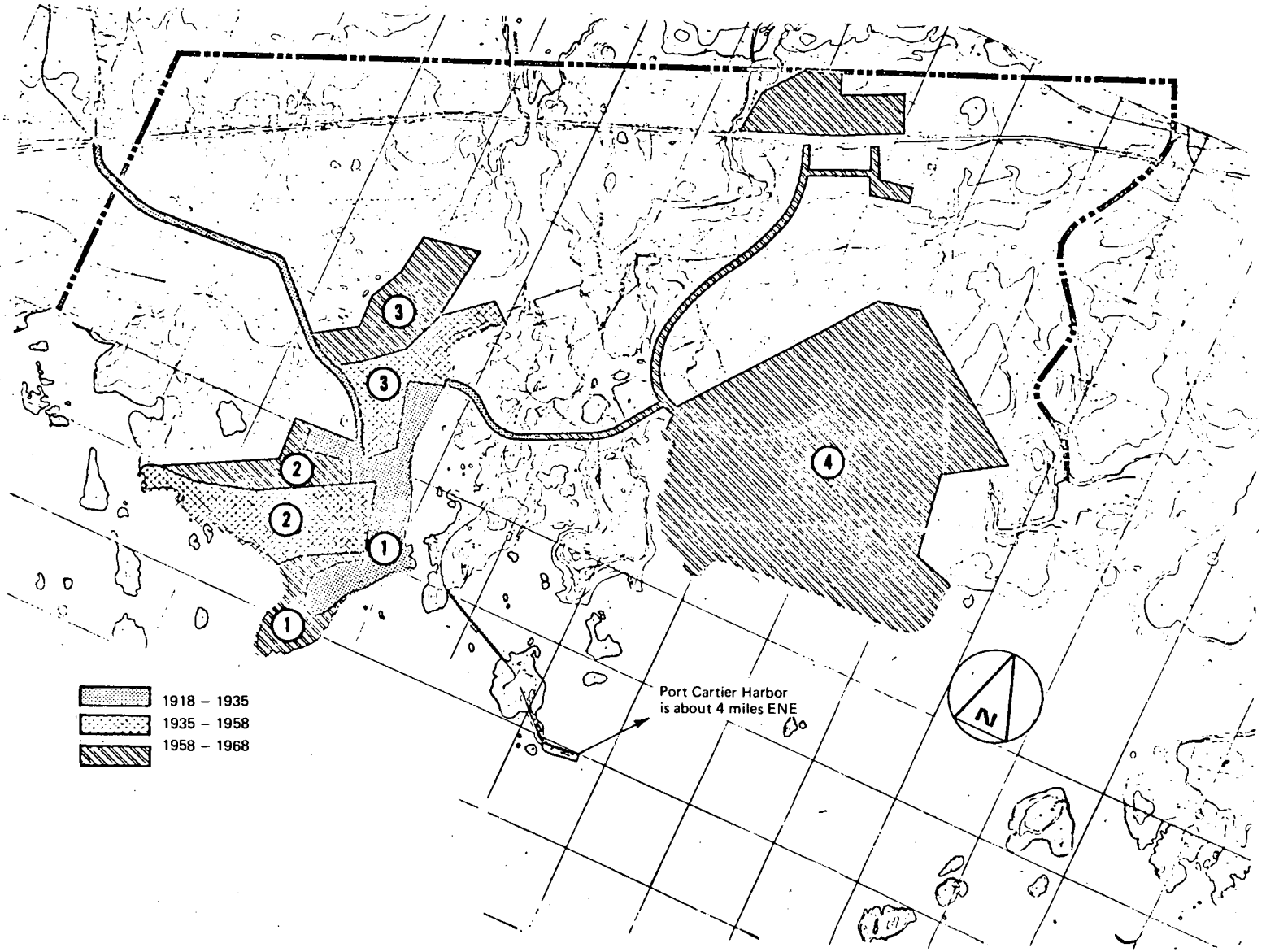
Within the built-up area, shown on Figure E-2, there are as yet 126 acres of vacant lots; 108 acres residential, and 102 acres taken up by commerce, industry (practically concentrated around the marshalling yard north of the new town), roads, and public services. There are 31 acres of "green belt", a 20-acre trailer park and 14 acres for schools, with 7 acres for churches. This seems to indicate a shortage of school space when the large number of school children is considered (45% of the population is 19 years old or less). The area used for residential purposes represents 26.2% of the area containing buildings and construction, and according to the 1970 Bemer, Inc. Survey (Dossier Urbain Concept) contains 497 buildings that are:

Single family	466 buildings
Duplex	24 buildings
Multi-family	7 buildings

This gives a population density of 27.5 persons per acre, which is considered fairly light. Of the 9.75 acres ascribed to industrial use, 8.5 acres are occupied by the Quebec Cartier Mining offices. The other 1.25 acres are occupied by a fishing cooperative (20 members) and a small woodworking concern in West Port Cartier. The trees in the built-up area of the west sector were cleared during construction works, thus removing some of the natural protection from the bitter winter winds. Two islands located in the river mouth are wooded, as is the north section of the town, and a good measure of the surrounding area.

The green belt (31.25 acres) includes L'Ile de la Cité (29.25 acres). There are several plans by public and private organizations to increase the green space and recreation areas of the town. This year, the Lions Club began development of a children's playground and picnic area in the angle of Rue des Pins and Rue des Peupliers. Another long term project is the planning stages is the development of L'Ile de la Cité into a multifaceted, open-air sports ground. The plans include a running track, tennis courts, baseball field, arena, and restaurant. It is possible that this centralization of community, sport, and activity centers would be detrimental if done at the expense of small neighborhood playgrounds.

FIGURE E-2 PHYSICAL EVOLUTION
GROWTH OF PORT CARTIER TOWN



There is one 15-bed hospital serving the district, that is owned by Quebec Cartier Mining. The mining company is anxious to dispose of its interest in the hospital to the jurisdiction of the Provincial Government.

e. Sewage and Sanitation

Port Cartier draws its drinking water from Rivière aux Rochers. The water is slightly acid, with seasonal traces of yellowish, organic matter and fits the general composition of this type of hydrological basin. The water is treated with chlorine at the pumping station before distributinn.

Sewage is disposed of via pumping stations, through an undersea outlet pipe, some 50-100 feet offshore.

E.3.2 History

a. The Town

Apart from isolated Indian communities, there was no settlement as such until 1916, when the Quebec North Shore Paper Company (an affiliate of Ontario Paper) obtained a lease to exploit the timber in the Rivière aux Rochers basin.

Shelter Bay village was founded to house the people working in the forests and to provide the shipment facilities to move felled timber to market. A wharf was built at the mouth of Rivière aux Rochers and timber was floated down river to the town, stripped by a work team, and loaded on board inland coastal vessels. The timber exploitation radiated inland from the town, and the Quebec North Shore Paper Company's activities supported the entire economy of the village until 1950.

Although it was known that large deposits of iron ore existed in the Quebec Labrador peninsula, mining on a large scale did not begin until 1950. A growing world demand for this commodity spurred the rapid development of the Quebec North Shore deposits and in 1954 the harbor of Sept-Iles (Seven Islands), built to accommodate 75,000 dwt bulk ships, was es-

tablished as the first loading port for the ore. Finally, in 1957, Quebec Cartier Mining was incorporated to mine the Lake Jeannine deposits. This company founded two new towns: Port Cartier (with a 100,000 dwt loading terminal) and Gagnon, 191 rail miles away at the minehead.

The name "Port Cartier" was granted with the city charter, incorporated March 5, 1959, by which the former "Shelter Bay" area on the west bank, and the urban cell built by Quebec Cartier Mining on the east side of the aux Rochers river, were merged. The town planning and landscaping of the new east side was done by the C. D. Howe company, the port engineers; and Quebec Cartier Mining carried out the actual construction using local and some imported labor for the project.

The city area extends over 19,200 acres; the boundary runs along the river for 15 miles, with a depth of 4-5 miles towards the northwest. The inhabited and industrial area comprises about 7% of the territory.

The physical evolution of the town is shown in Figure E-2. Its economic and socio-environmental problems are described in the next two sections. The old harbor facilities of Shelter Bay are still in existence at the mouth of Rivière aux Rochers, but since the construction of the new port, these wharves have fallen into disuse.

b. The Harbor

Two sites, some 3 1/2 miles east of the town, were considered for the deepwater harbor. The basic requirements were year-round safe loading, adequate berths, and docks capable of handling vessels from 3,500 to 100, 000 dwt capacity with maximum 48 foot draft. The shore area also had to be large enough for the railway terminus and provide facilities for freight handling, receiving of petroleum products, and bunkering of vessels.

C.D. Howe were contracted to choose the location of the port and design the facilities. They carried out extensive hydrological and topographical tests on the two sites and instituted testing on a scale model.

The contract for the harbor was awarded in January 1959 and, despite the vastness of the project, less than 2 1/2 years later in June 1961 the first ore carrier was loading at Port Cartier.

Although not provided for in the original concept of the port, a grain storage and transfer station was the next significant addition to the harbor, when the Louis Dreyfus Company established these facilities because of attractive transportation cost benefits.

Currently plans for diversification into yet another field exist with the proposed establishment of a pulp-mill at the port. More details on the port are given in Section E.6.

E.4 ECONOMY

In 20 years, Port Cartier went from a sleepy lumbering and fishing village to a maturing one-company town, located between two dynamic port cities, in a generally underdeveloped area. The two centers of economic activity in Port Cartier are the port and the railroad, both associated with the operations of Quebec Cartier Mining. Including the repair shops and ancillary operations these are the two major employers. The building of a grain silo by the Louis Dreyfus Company, with a capacity of more than 10 million bushels, only marginally assists in providing increased continuous employment. The town needs to attract more industries if it is to flourish. However, the proximity of the far-better-developed centers at Sept-Iles and Baie-Comeau-Hauterive, is a disadvantage. A prospective dissolving-pulp-mill operation, studied by Rayonnier, is an example of the exploitation of a natural resource (forest), given the convenience of transportation, which could help the town.

E.4.1 Municipal Government and Town Budget

The functions and responsibilities of municipal government in a time of rapid economic expansion due to a major one-shot investment inflow, is certainly a matter requiring thorough economic analysis. The influx of capital, the inflow of a working force, the setting up of infrastructures,

the liaison between this major new industry and the administration of the town, the demand for housing, all provide for long-term secondary and tertiary effects.

Unfortunately, in this particular case, no information is available about the set-up of the municipal government of Port Cartier (the number of departments, the number of employees in each, areas of responsibility and decision-making, the growth of individual departments), which would assist in comparing the growth of the town with the growth of the administrative apparatus of the municipal government.

The budget, as one aspect of the financial structure, permits us to investigate the past income flows and expenditure patterns, and to predict these flows in the future, within the context of the evolution of municipal government planning and policies.

Our main observations about the municipal budget of Port Cartier are as follows:

a. Budgetary revenue

The two main revenue groups analyzed were endogenous and exogenous. The endogenous group contains a general section (property tax, drainage tax, commercial licenses and permits) and an aqueduct section (water tax, special taxes); while the exogenous group also contains a General Section (sales tax, amusement tax, rentals and services, fines, earned interest, and subsidies) and an Aqueduct Section (subsidies).

Property taxes in the General Section of the endogenous group have increased from $151,009 in 1962 to #388,100 in 1968, a growth of 157%. To be sure, this very rapid six-year growth was due to an increased assessment rate, rather than to dynamic building activity and an increase in the real value of assets. It also reflects increased income of the population and the increasing needs of the town over the same period. The major share of property-tax payments derives from industry and commercial establishments.

The drainage tax fluctuated quite significantly during this period, and decreased 8% between 1962 and 1968, from $14,573 to #13,500.

Commercial license and permit collections decreased 26% from $13,336 to $10,000. As we may assume that the rates have not decreased, this might be due to the decrease in the number of commercial establishments which followed the period of commercial activity linked with the construction of the port, and of the current stagnation in that activity.

The Aqueduct Section revenues (water tax collection) increased 18% from $29,503 in 1962 to $35,000 in 1968, reflecting an increase in both the rate and the number of dwellings.

Sales tax revenues in the General Section of the exogenous group increased from $60,904 in 1962 to $111,180 in 1968, an increase of 82%. (This tax is a specific problem because it relates to the financial policy of the Provincial Government). Part of this increase reflects a general rise in prices during the time period.

Interest gained, amusement tax, fines, etc., are rather irregular revenue items, and only contribute about 3% of total revenue.

Subsidies contain provincial subsidies to municipalities for special purposes, sometimes on a cost-sharing basis. (Again, its amount is likely to vary from one year to another, but winter-road clearance subsidies are quite normally granted, as is fire prevention.) The value of subsidies received in 1962 amounted to $13,757, but the subsequent amounts fluctuated from a high of $55,845 in 1963 to a low of $5,769.

Subsidies on aqueduct account also varied, but have been decreasing, from $8,307 in 1966, to $5,500 in 1968.

The total of budgetary revenues, including all endogenous and exogenous items, increased 28%, from $465,226 in 1962 to $602,715 in 1968. Since

the population increased hardly at all, the increase in the revenue burden, mainly from the taxable revenue of the population, seems quite significant.

This point will be elaborated upon somewhat more fully later, when the specific services provided by the city administration are discussed.

b. Budgetary expenditures

Six expenditure groups were analyzed, on the presumption that in a developing municipality, new construction, including sewers, roads, utilities, and service extensions represent a heavier burden and occupy a much more significant share in municipal expenditures than is the case with old settled communities. Port Cartier, with its development phase in 1958-1968, shows an increasing debt structure and an increasing burden due to social welfare and administrative expenses. The major expenditure items are:

1. Administration
2. Technical Services
3. Security
4. Welfare and Recreation
5. Debt payments
6. Capital Outlays

Administration. Total expenses rose slightly from $99,980 in 1962 to $103,700 in 1968, but they varied from a low of $92,705 in 1964 to a high of $125,091 in 1965. This variation derives from increases or decreases in spare-time or professional services; salaries have been going up steadily, showing a total increase of 65.7% from 1962 to 1967. This may be an indirect welfare subsidy to local residents, but it is felt that the administration could try to improve the efficiency of its services and should concern itself much more with forward planning.

Technical services. The largest expenditure item, this pertains to services which the city provides in road clearance and maintenance, refuse collection, etc. The total outlay varied from a high of

$264,048 in 1966, to a low of $139,700 (estimated) in 1968. While salaries were rising, road repairs, winter snow removal, and machinery maintenance were the most unstable items.

Security. The largest expenditure item in this area is made up of salaries, which increased from $42,657 in 1962 to $55,363 in 1967; the maintenance of vehicles, the second-largest item, showed a doubling of cost in the same time period.

Social Welfare and recreation. This is a relatively minor item ($5,106 in 1967), but recreation now occupies a pre-eminent position in budgetary expenditures. Whereas the total outlay on both of these amounted to $2,720 in 1962, this sum increased to a total of $91,791 in 1967. For 1968, the budgetary allocation for both items decreased to $51,300, and is said to be planned to remain at that level. We might mention here that unemployment is a federal matter and that social welfare payments pertain to provincial jurisdiction.

Debt payments. These payments comprise interest payments and bond redemptions, and reflect some of the development problems of the city. The total value of interest paid increased from $19,179 in 1962 to $41,606 in 1967; the redemption of bonds increased from $1,500 in 1962 to $19,600 in 1967. We must also emphasize that the total indebtedness of the city increased significantly during the period in question, the total amount outstanding in 1970 amounting to $769,500. The share of the debt-servicing burden in the total budgetary expenditures increased from 6% in 1962, to 14.2% in 1968. This burden will continue increasing until it reaches 26.5% in 1972 (projected).

Capital equipment. Outlays on capital equipment varied significantly, from a low of $25,068 to a high of $90,589 in 1964. It seems that this variance shows a lack of forward planning, which would permit the administration to budget its resources more efficiently, by way of a continuous but slow rate of growth for the acquisition of capital equipment.

Having, in a sense, become a "mature" town (after the completion of the Q.C.M. investment project), at least from the viewpoint of that phase of its development, the town now faces the task of replacing temporary structures (wooden bridges, sidewalks, etc.) by permanent structures (concrete bridges, etc.)

E.4.2 Trade and Commerce

The infrastructure reflects the changeover from a traditional village to a modern point of loading of staples and unloading of merchandise and goods, which are required to sustain this operation and to provide the population with the requirements of daily life.

The development of commerce in Port Cartier has been subject to the competition of the establishments in Sept-Iles. Data, gathered from questionnaires, indicate that Port Cartier retailers lose substantial trade to competitors in Sept-Iles or by way of catalogue selling. It seems that the major problem lies in the fact of a relatively young population with sufficient income, being faced with old-fashioned merchandising by indigeneous tradesmen, which results in spending the incomes earned in Port Cartier in outside centers.

Census data indicate that the total value of retail sales in Port Cartier amounted to $2,091,000 in 1961, in 23 stores, for a population of 3,458. Baie Comeau, with a population of 7,956, accounted for retail sales values of as much as $11,050,000. Sept-Iles, with a population four times that at Port Cartier, had retail sales value of $21,916,000 in 1961. These comparative figures indicate the relatively ineffective and uncompetitive nature of Port Cartier commercial enterprises (given that the income levels in the three areas are comparable.)

E.5 SOCIAL-ECONOMIC-ENVIRONMENTAL CHARACTERISTICS

E.5.1 Background

The North Shore of the Gulf of St. Lawrence is an underdeveloped area, consistently dogged by high unemployment and (until the 1960's) limited

investment capital. The employable inhabitants were engaged in small foresting operations, harvesting the wealth of natural forest in the area or existing at a subsistence level on hunting and trapping in the interior and fishing in the salt water of the Lower St. Lawrence River. By 1930, however, most of the young men were working in the new pulp mills dotted along the coastline. Interest in fishing for a livelihood began to decline and today the attractions of higher wages, an easier life in industry, and the prohibitive costs of shipping small parcels of fish to distant markets has relegated the fishing industry in Port Cartier to little more than a local operation.

In Shelter Bay, wood-cutting and ship-loading operations of Quebec North Shore Paper provided reasonably steady employment for a good percentage of the village, but the waning interest in world markets for this commodity and the growing inaccessibility of new stands of timber were making the Port Cartier location more and more unattractive to Quebec North Shore Paper. In 1957, the Company decided to abandon their operations in Shelter Bay and moved to the Manicouagan and Outardes basin.

In the meantime, American capital has been flowing, in increasing volume, into the development of the huge Eastern Quebec and Labrador iron-ore deposits. Sept-Iles, Wabush, and Shefferville were opened up, and when Quebec Cartier Mining decided to locate their mining headquarters and shipping facilities in Shelter Bay, there was no doubt that the decision was welcomed by the majority of residents.

Unfortunately, human frailty was to play a major part in frustrating some of the high expectations of the villagers. One of the problems which emerged from interviews with Quebec Cartier Mining officials was that of integrating the then-existing work force into the new jobs which had become available on the railway and in the port and offices. Quebec Cartier Mining instigated a program of industrial re-training to enable the residents to take up their new positions. At the same time, labor was urgently needed to carry out the many building projects associated with the new developments. The training program was, therefore, not as successful

as anticipated, because the local people elected to abandon the training school in favor of the fast money to be obtained on the construction sites. When construction began to taper off towards completion, these laborers demanded jobs within Quebec Cartier Mining's operations. However, they were unskilled and the company refused to employ them, suggesting they resume their training. Unfortunately, skilled immigrants had replaced them in the training schedule and the local inhabitants were relegated to their original unemployment state.

The limited ability of the industry to absorb unskilled labor - because of the high degree of automation employed in both the rail and port operation - did nothing to alleviate the situation. Even the expansion of the port, by the incorporation of the grain transfer installation, required only an additional fifteen men.

In 1970, the Municipality of Port Cartier initiated a socio-economic study to be prepared by Bemer, Inc. The purpose of the study was to gain an understanding of the physical and socio-economic structure of Port Cartier, preparatory to the yet-to-be-published companion volume "Concept d'Aménagements" which will present a master plan for future development.

The impact on the population of the Quebec Cartier Mining operation and the new port comes through in the social inventory of this study and it can be seen that the transition from small village to town was not a smooth one for the local inhabitants. Furthermore, Port Cartier seems to have reached a stagnation point, because no major industrial enterprise, was attracted; the port is not becoming a major harbor for grain transshipments; and no major subsidy programs were forthcoming. However, the port capacity is only half utilized; opening of the planned new mine means an expansion of the port activities is imminent; and a dissolving-pulp-mill operation by Rayonnier (a branch of I.T.T.) involving a total investment of $500 million by 1986 was recently announced.

E.5.2 Demography

The town was divided into four areas, numbered 1 to 4 on Figure E-2, roughly parallel to the evolution of the village. This division is a fortunate one, as it emphasizes the differences of environment, social background, wealth, and development, as well as the geographical differences within this small town. A sample crossection of residents representing the population density in each area were issued simple questionnaires. The results were processed by computer and in March 1971, the final report was submitted to the Municipal Government.

For easy reference, Sector 4 comprises the entire Q.C.M. development on the eastern side of the river, and of the three remaining sectors on the western side, Sector 3 represents Q.C.M.-influenced expansion.

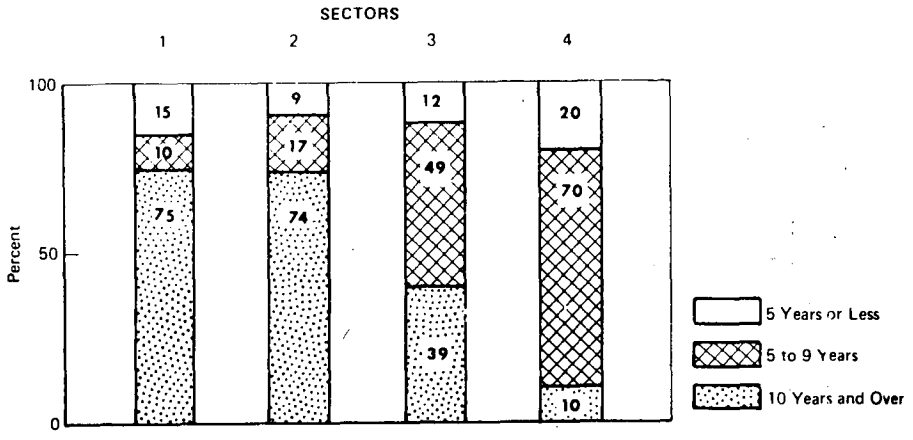
a. Population

Port Cartier's population has been quite stagnant since 1961; from 3,458 in 1961, to 3,547 in 1966 (and a projected increase to 3,618 in 1971) -- about 6% during a ten-year period -- is not the sign of a flourishing, dynamically growing industrial community. Compared with the rate of growth of Sept-Iles, of over 250% during the same period, Port Cartier seems regressive.

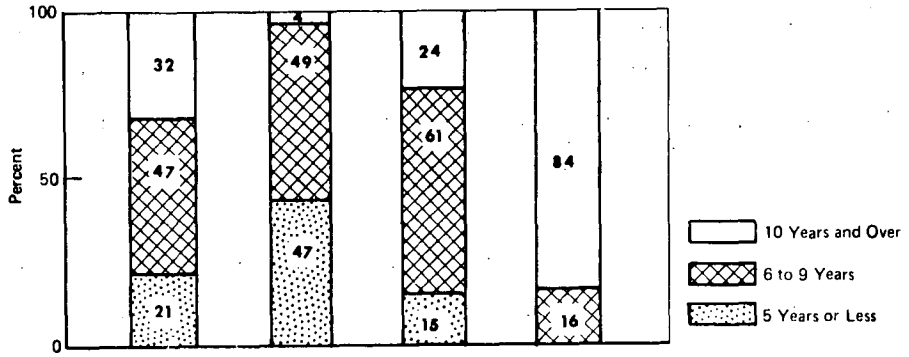
	1956	1961	1966
Sept-Iles	5,592	14,196	18,950
Port Cartier	N/A	3,458	3,537
Baie Comeau	4,332	7,956	12,236

However, since the major boost in its development was due to the Q.C.M. project, including the port facilities, any additional rapid rate of increase in the population, would have to depend on the inflow of additional (possibly manufacturing) industries. The analysis of Port Cartier's population is available in some detail. Some 70% of the families now residing in the town came from outside the "North Shore" area:

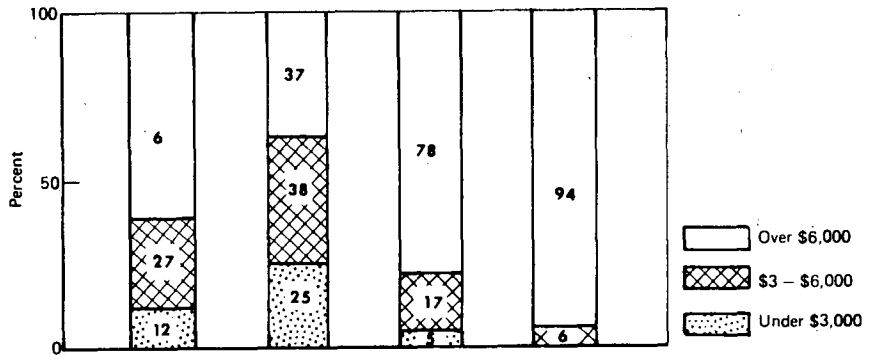
FIGURE E-3 DEMOGRAPHY OF PORT CARTIER TOWN



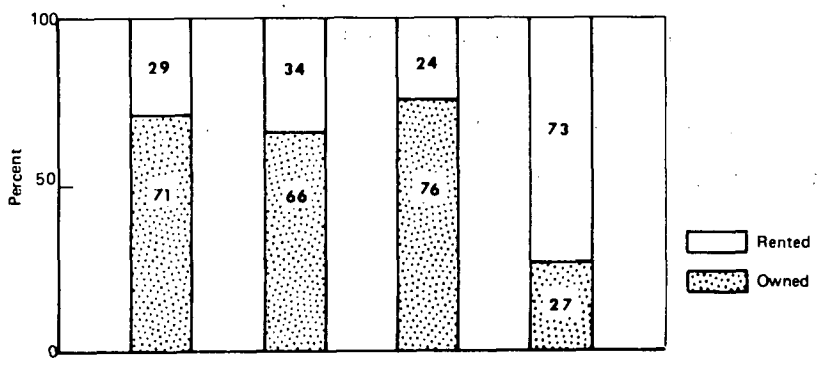
a) Years of Residence in Port Cartier



b) Education of Head of Family



c) Incomes



d) Home Ownership

North Shore	30%
Gaspe	14%
Quebec City	10%
Maritimes	8%
Lower St. Lawrence	8%
Saguenay/Lac St. Jean	6%
South Shore	5%
Montreal	3%
Others	16%

The large-scale migration into the town in response to the new industry is, therefore, readily apparent. However, Montreal and Quebec City accounted for only 13% of the population's origin. Figure E-3 shows the distribution through the sectors of those families by years of residence in the town. The original inhabitants have opted to remain in the old Shelter Bay settlement.

The immigrants were young and they settled into the newer sectors (3 and 4) bringing the average age of heads of families for Port Cartier to:

Less than 34 years	38%
35-54 years	41%
55 years and over	21%

The town is now composed of young married couples, and their children are putting an increasing strain on the schools and recreational equipment, which are already inadequate.

b. Employment

The educational disparity between the sectors appears clearly in Figure E-3b. The Bemer Report states that the educational level of heads of family in Sector 2 has caused numerous economic and social problems. In this sector, 85% of the population do not possess specialized training, and their chances of obtaining even semi-skilled work are limited. According to the questionnaire returns, heads of families in Port Cartier (in 1968) had the following education:

junior matriculation or more	24%
10th grade and 11th grade	14%
6th to 9th grade	42%
5th grade or less	20%

Those below 34 years of age have a higher level of education than those above 34. The level of education descends with the age of the population. Women have mostly between 6th and 9th grade, but the younger women also have higher levels of education. It is interesting to observe that the labor force with the highest level of education prefers living in Sector 4 of the town.

As to professional training and qualifications, the largest number of the labor force comprises blue-collar workers (50%); the second largest are white-collar (23%); then the group of professionals and technicians (22%); and, lastly, sundry and unaffiliated (5%).

Of the population 82% were reported to be employed; 8% were reported unemployed; 6% were reported on pension; and 4% were reported incapacitated.

Of the labor force, 39% worked in Port Cartier itself, and 44% in the port or for the railways, while about 9% of the labor force reported having second jobs.

The distribution of earnings for heads of families (Figure E-3c) is as follows:

Less than $3,000	17%
$3,000-$6,000	18%
$6,000 or more	64%
Not declared	11%

Sector 4 of Port Cartier is inhabited by the highest income group; Sector 2 by the people of the lowest income group. The older age group also belongs to the lowest income group, probably because it has the lowest education level. Unemployment in 1968 amounted to 14% mostly in the older age group, and again predominantly in Sector 2.

c. Housing

The dwellings in Sectors 1 and 2 of Figure E-2 are the oldest in Port Cartier. Principal construction material is timber and shingles. The outside appearance and general quality of buildings is distributed almost uniformly by sectors. In Sector 2, 40% of the housing is more than 35 years old and their state can be called medium-to-bad. In Sector 1, the proportion is 23% and the state is medium-to-good, as it is in the older southernmost half of Sector 3. The other half of Sector 3 and the whole of Sector 4 are in good condition. 58% of the population own their own home. The balance rent their housing principally from Q.C.M. which is responsible for most of the new housing construction in the town.
The proportion of privately-owned dwellings is increasing as a result of purchase agreements between the residents and Quebec Cartier Mining. Figure E-3d shows the ownership by area. In Sector 4 -- the highest rental area--the cost of rent is relatively low for the type of housing available.

Housing quality then, tends to accent the socio-economic gaps between the east and west sides. The careful planning encompassing shopping amenities, green spaces, and recreational centers in Sector 4 differ sharply from the unplanned and crowded conditions existing in Sectors 1 and 2. Sector 4, which is very much a Company sector, is segregated into top, middle, and lower management by street, housing quality, and location in relation to seafront.

d. Integration

The majority of families in Port Cartier immigrating into the area settled into Sectors 3 and 4. These immigrants retained a degree of flexibility in their choice of location and when questioned, 76% (Sector 3) and 57%(Sector 4) expressed the intention of remaining in the town. Those intending to leave gave as reasons:

1) the need of higher education for the children; and
2) desire to live in a larger city.

The people in Sectors 1 and 2 were more content to remain in Port Cartier and the percentage increased sharply with age.

There seems to be little social integration between the east and west side of town, the original residents maintaining a closed circle of friends, while the immigrants, separated by background and language, tended to form their own friendships through the working milieu of the heads of the house.

An interesting statement on environmental conditions arose when the residents were questioned on re-location within the town. The foremost reason for re-location was dissatisfaction with the environment, followed by dust pollution, and size of housing, with Sector 2 expressing the greatest discontent.

This feeling has arisen with the advent of new and better houses in the east side giving some basis for comparison.

e. Leisure

Family entertainment in Port Cartier is centered around the home and family. The following list gives the leisure occupations most enjoyed by the population:

		Regularly	Occasionally
1.	Television	83%	16%
2.	Lectures	52%	39%
3.	Leisure Driving	45%	39%
4.	Evening with Friends	22%	71%
5.	Hunting & Fishing	42%	26%
6.	Evening with Relatives	22%	46%
7.	Spectator sports	28%	33%
8.	Sports Activity	30%	26%

Although lectures rank high on the chart, this may be a distorted response as it is hard to reconcile the high lecture attendance with the population composition. Visiting with family and friends seems to form a very important function in the integration of the townspeople.

f. Recreation

When Q.C.M. planned the new east side of Port Cartier, provision was made for recreation centers. The existing equipment in the east is located in such a center containing a gymnasium, bowling alley with four lanes, billiard room, and library. Exterior facilities consist of tennis courts, children's playground, and a baseball field which in winter converts to a skating rink. During the summer the center is monitored by eight supervisors. This center is owned and operated by Q.C.M., but there are no restrictions or membership requirements and the center is open to the entire town.

Compared to those in the east, the west side facilities, which are owned by the Municipality are sparse indeed. Outdoors they consist of a schoolyard with conventional children's playground equipment and a baseball field, while a gymnasium borrowed from the school commission serves as the indoor recreation center. This is monitored by one supervisor. A vacant lot on Quebec North Shore property provides the only winter skating facilities.

Surveys reflected the lack of equipment: green space was the primary requirement of areas 3,2,1, and 4, in that order. About 57% of the population would like to see more parks in the municipality, 42% would like more group entertainment facilities, and 36% want more children's playgrounds. On the neighborhood level, children's playgrounds seem to be the most urgently required facility, particularly in areas 1,2, and 4.

g. Municipal Services

At the village level the services causing the most dissatisfaction were the beach, traffic control, and parking. Some 49% of the population expressed unhappiness with the beach, but no reason is given in the Bemer Report. A study of the sanitary water disposal map, however, shows that most of the village's waste is pumped directly into the sea 50 to 100 feet offshore. When we visited the village, the prevailing weather conditions (heavy snow) did not enable us to evaluate the beach condition. It seems there is still some littering of the beach by pulpwood bark, des-

pite the long interval since Quebec North Shore suspended operations.

E.6 ENGINEERING APPRAISAL

When Quebec Cartier Mining was faced with mining and shipping Lac Jeannine iron ore deposits, the first stage was to bring the ore down from the remote interior to tie in with the transportation network operating around the St. Lawrence River.

Basically, only two alternatives existed, linking with the established railway system, or shipping through a point on the North Shore of the St. Lawrence. Existing rail services on the North Shore came no further east than the Saguenay River, and tying in on the Gaspe side would have involved a ferrying operation across the St. Lawrence. Quoted costs for building railroads in the terrain involved, run as high as $1 million/mile. Additional overseas shipment would have required either deepening and expanding an existing port, or creating a new harbor.

A railroad had to be established between the minehead and the shipping point. The additional distance to reach Baie Comeau made it economically unattractive. To make use of Sept-Iles would have necessitated building a completely new wharf in the bay, or going in as a second (and possibly junior) partner in an expansion of the existing iron ore shipment facilities.

The Schefferville Railroad and the port were already running at a high percentage of capacity. From Lac Jeannine, the natural routing of the railroad came out in the vicinity of Shelter Bay close to both a shoal area and a section with deep water to the shore line. Both of these were suitable sites for establishing a new deepwater port.

Despite disclaimers from company officials to the contrary, it is unlikely that there was no government influence either directly or indirectly in Quebec Cartier Mining's decision to locate in the Shelter Bay area, thus effectively replacing the departing Q.N.S. paper company.

E.6.1 General Description

The port is situated 3 1/2 miles east of the old Shelter Bay settlement at Rivière aux Rochers. It consists of an A-shaped man-made excavation, with one arm parallel to the shore line providing the berthing area, the turning basin forming the apex, and the other arm providing the access channel protected by a breakwater in the woutheast.

The two iron-ore berths (loading and stand-by) form the north wharf, while grain vessels and tankers use the two southern berths. Anti-freezing bubbler systems have been installed over the floor of the harbor basin. The rail terminus is situated at the port site, and there is a general cargo operation to serve the isolated population.

E.6.2 Design Concepts

The most significant single factor which determined the final design of the port layout was the prevailing weather in the area. The harbor had to provide year-round accommodation for vessels up to 100,000 dwt that require a minimum of 50 feet depth at low water, with a 1,000-foot berthing length.

Although the initial annual tonnage was 8 million, provision had to be made for expansion to 40 million tons per year. Freight handling, receipt of petroleum products, and the ability to bunker vessels also had to be incorporated.

a. Weather

Analysis of the weather conditions was based on the preceding 50 years' records, with special emphasis on the last ten years.

These studies revealed that for 78% of the year, the weather was not likely to cause delay, but that of the remaining 22% any combination of following winds over 35 m.p.h. from any direction; or crosswinds exceeding 20 mph, on the approach channel; less than one mile visibility; and waves of eight feet or more, outside the harbor, would close the port. This was considered

acceptable.

In winter, the prevailing NW wind would tend to minimize ice conditions at the harbor entrance. Also, during the summer months, SE winds were sufficient to build up waves which could have seriously affected the harbor operation.

b. Choice of Site

The hydrographic charts of the area showed that deep water approached the shore a few miles east of the old village of Shelter Bay and that a few thousand feet east of this, there was shoal water offshore. These two circumstances were of interest as they both offered the possibility of a harbor site. The land space required for the railway terminal and the port equipment was sufficient in both cases and the area was reasonably level. Intensive study was undertaken on both sites, consisting of both echo and seismic sounding to establish depths and study the geological composition of the bottom. Information collected by these studies led to design of a possible terminal layout.

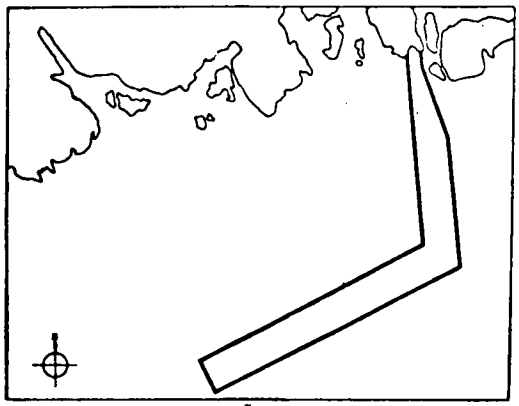
c. Evolution of the Harbor Concept

The study produced 15 different layouts of the harbor, of which eight were of interest, as shown in Figure E-4. The proposal for the first site was to build a harbor consisting of a dock protected by a breakwater shown on sketch 1. The port installation was to advance into the river, turn west and run parallel to the shore for 2,000 feet. It was decided that the bottom could not support such a heavy structure, and both the site and proposal had to be abandoned.

It became evident that the most practical concept would be the excavation of an artificial harbor on the second site. Two different proposals for the harbor on this site were considered:

1) A slip dock with an arrangement of breakwater at each side of the harbor entrance offered certain economic attraction (sketches 2,3,4,5); and

FIGURE E-4 PORT CARTIER DESIGN CONCEPTS



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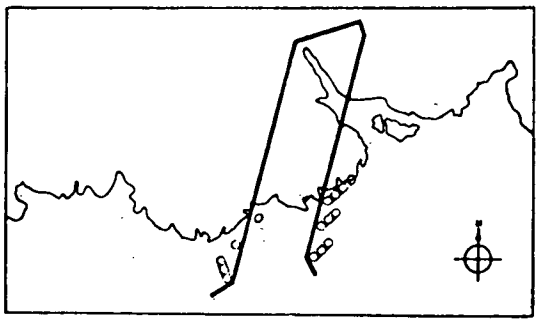

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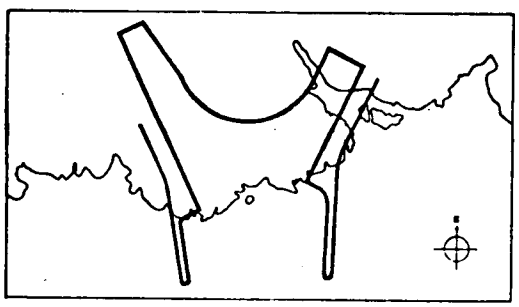

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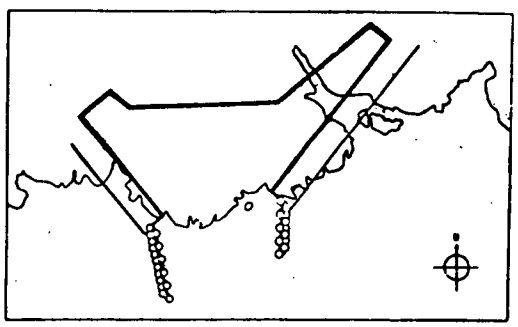

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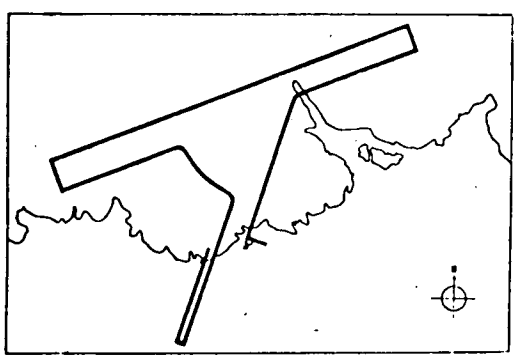

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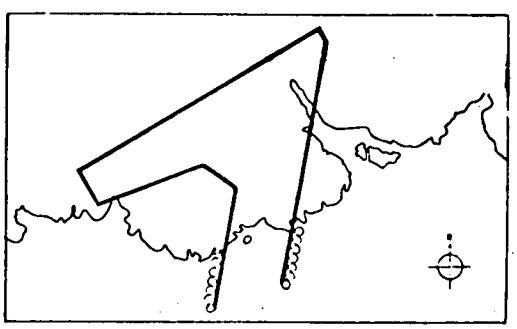

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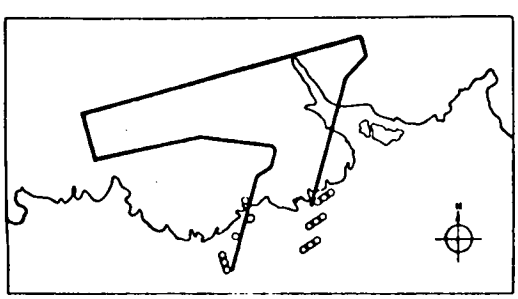

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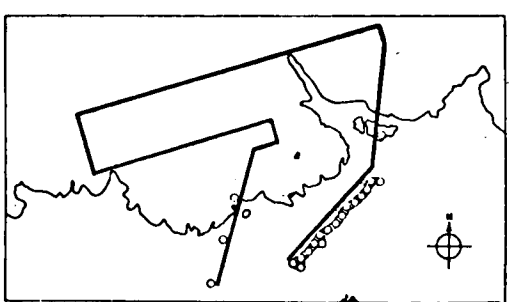

8.

2) The "A" dock, which was chosen because it would provide better protection (sketches 5,6,7,8).

It was then necessary to check the various hypotheses against a scale model to determine wave action in the harbor area and also to study modifications to the harbor configuration. The hydraulic laboratory of the National Research Council, Ottawa built a 1:120 model which consisted of movable concrete sections. The test results were measured, recorded, and analysed; then the outline of the harbor was modified and a new series of tests run. With this material in hand, it was possible to product the final design.

E.6.3 Final Design (Figure E-1)

In the final design, certain modifications had to be made on the beach shape, particularly at the eastern side of the harbor. It was also found necessary to extend the south dock further east (to protect against wave action), and to enlarge the turning basin to facilitate ship maneuvering in the harbor. The final design of the harbor also provided a possibility for future expansion of the facility on the eastern side.

Arriving vessels are maneuvered into berth using two tugs. The bow is positioned into the northeast corner of the turning basin, the stern is swung, and the vessel berths stern first. The south dock knuckle was rounded to act as a pivot for departing vessels maneuvering to line up with the channel. Corrections were also made to the breakwater to direct waves more toward the west beach.

There is very little room for error in either operation, and tugs are essential, especially as the bubbler system discourages the use of anchors, and their effectiveness would be limited by the very nature of the bottom.

The final dimensions of the port, including a wave-absorbent beach, gave a frontage length of 5,500 feet, out of which 4,000 feet were usable as a loading and mooring dock, integrated with 2,600 feet of graded beaches.

The 2,500-foot-long by 450-foot-wide inner harbor consists of two 1,000 feet ore-loading berths at the west end. At present, the south berth has been rented from Q.C.M. for a grain transshipment point and-- with the adjacent 450-foot-dock-- used for unloading freight and petroleum products. The ore loader is located on the north side.

E.6.4 Construction

The berth is built with"Z"-type sheet-steel piling, bolted to three layers of channel waling, dowelled into the rock. The piling was erected close to the excavation and the lower part was filled with lean concrete. The remaining area was filled with rock. The south dock was built with vertical "strong backs" dowelled into rock at the bottom and connected to concrete anchor walls at the top.

A 1,500-foot mooring berth, which is on the northern side, consists of a wave-absorbent beach with concrete piers 130 feet apart.

A 1,000-foot-long breakwater was built of circular sections, 70 feet in diameter, with height varying from 55 to 80 feet at the east side of the harbor. The sections are rock-filled with concrete capping. The excavation necessitated the blasting and removal of 925 million tons of rock. This was approximately the volume required to construct the breakwater in the wharf/breakwater concept, found economically unfeasible. The construction was conducted over a 2 1/2-year period and at the time it was built, Port Cartier was believed to be the largest artificial harbor in the world to be built completely inshore.

E.6.5 Ore-Handling System

Port Cartier handling facilities for concentrated ore can be described by the three major functions:

1) train unloading
2) direction and storage of ore at the harbor; and
3) vessel loading.

A train of cars coming into the system is directed through the dumping house. The flow of mineral is then carried by conveyor either to the storage shed or directly to the oreloader. The ship-loading tower can be fed from both sources or a combination of the two. However, the usual practice is to reclaim the ore from the storage area.

The system permits some saving in operating costs, because shipment of ore does not require utilization of the storage shed, conveyor, and reclaimer system. Its utilization and rational would certainly be proven with an increase in annual tonnage loaded.

Another feature of the system is its high degree of mechanization, requiring only three men to run it. The first operator is located in the dumper house, and retains control over the rate of feed of the train into the rotary dumper and all subsidiary operations. The second operator at the conveyor drive house determines the routing of the ore into the storage or the shiploader, and controls both the feeding to and the reclaiming from the storage building. He also controls the flow of ore from the shed or dumping house to the surge bin. The third operator controls both the loading tower, and the conveyor belts from the surge bin.

a. The Dumper House

The basic idea behind the design of the Port Cartier dumper was to produce a single automatic system to handle the two separate functions of pushing and dumping cars.

The main advantage of this train pusher/dumper is that a train is moved through this operation as a unit without uncoupling of cars and without the use of locomotives. Thus, a train approximately 4,300 feet long, carrying about 11,250 tons of ore can be discharged in about three hours.

When a train arrives, the locomotive is disengaged and passes through to go for servicing. The train is then automatically advanced car by car through the rotary dumper. At this point the ore is screened, and any

rejected ore receives further crushing, before re-entering the system.

b. Transportation and Storage

An overhead conveyor carries ore from the dumper house to the shed. This shed has a capacity of 400,000 tons and is so located that it may be expanded by at least 100 percent. Provision to store ore outside the building has also been made for emergency stockpiling, in case of unforeseen delays in shipping.

From the overhead conveyor -- which covers the full length of the building-- ore is distributed by a tripper which automatically fills the building to a predetermined height.

The ore is reclaimed through 50 vibrating feeders, located in tunnels under the storage building. They withdraw ore from any part of the building and at any rate desired. This operation brings ore to the shiploader gallery conveyor and tipper, which delivers the ore directly to the shiploader. An interesting feature of the shiploader gallery is a radioactive sensing device which moves the tripper in unison with the shiploader, eliminating any mechanical connection between the two.

c. The Shiploader

The shiploader, consisting of a vertical swing boom, retractable shuttle, and stationary hoist tower unit, was chosen because of its ability to move, and its flexibility to suit a great range of vessel dimensions. It is designed for a loading speed of 6,370 tons/hour of concentrated ore. The structure, which moves horizontally on rails, is 118 feet long by 48 feet wide and weighs some 650 tons. It can move at a speed of 76 feet/minute parallel to the face of the loading dock.

To give sufficient reach for the larger vessels, the boom is retractable, has an extension range of 50 feet and a maximum reach of 80 feet from dock face. It extends laterally at a speed of 23 feet/minute and can be raised or lowered within a 30° arc. This shiploader has proven suc-

cessful in operation, offering good accuracy for positioning over the hatches and flexibility for trimming the ship.

Port Cartier is a good example of dynamic engineering applied to a ship terminal operation. The modern handling equipment was designed for an initial annual capacity of 8 million tons a year, but provides for an increase in annual shipment up to 40 million tons. This can be done through a stage readaption program, such as the addition of another shiploader and upgrading of the mechanical plant.

All conveyors are covered, to facilitate ore handling during winter. The maneuverability of the loading tower, and the ship size currently calling in Port Cartier eliminates both ore spillage during loading and any dredging to recover it.

E.6.6 Harbor Pollution

Our efforts to obtain information on remembered or documented pollution of Port Cartier Harbor turned up only negative evidence. There does not appear to be a "resident ecologist", and the corporate nature of the town would tend to make the obvious sources of information on the village level, such as Town Council, city fathers, and harbor personnel, reluctant to divulge what they may know. Again, the private ownership of the port means it is outside the jurisdiction of any National or Provincial Harbors Board. Actual water pollution within the Seaway and St. Lawrence River comes under Federal Government control but to our knowledge, there have not been any studies conducted in or around Port Cartier.

When we brought up the topic of pollution with Quebec Cartier Mining officials, they were quick to reassure us that there had been no pollution from any of their operations and that they were quite ecology-minded. The newness of the facilities, the semi-automatic loading gear, and the 50% utilization of the port would seem to bear out this claim. When we visited the port, the "Chelsea Bridge" was loading iron ore for shipment overseas. Visual observation detected no obvious pollutants such as oil slicks or floating debris, which sometimes accompany

ships.

Indeed, it is difficult to see in what manner the harbor could be polluted at this stage of the development. The number of vessels calling at the port during a year is such that any human effluent discharged within the harbor would tend to be dispersed with little or no damage to the marine ecology.

In summation then, we must reach the tentative conclusion that no serious pollution occurs within the harbor.

We did notice non-toxic grain dust around the grain elevators, but the location of the port relative to the town (3-1/2 miles distant) should allow the dust to dissipate before it reaches the town. However, there were complaints concerning dust from some residents.

E.7 SHIPPING ECONOMICS VIA PORT CARTIER

E.7.1 Iron Ore

The relative stability which had prevailed for a long time in iron ore trade, with traditional partners trading in logical geographical patterns , has recently been upset. The remoteness of Japan (a major consumer) and Australia(a new major supplier) was the basis for a snowballing sequence of events which has propelled the shipping of iron ore into the super-carrier range. Australia could have supplied Japan at competitive rates in moderate sized vessels, say 30,000 tonners. However, new, large scale deposits permitted Australian producers to create super ports at the start allowing them to sell economically to the more distant markets. The side efect of this was to give Japan very favorably priced ore, and consequently steel, as transportation is a relatively large portion of the ore's delivered cost. Economies of scale had to be introduced by the other consumers to remain internationally competitive. Super ports are now being created in the major steel producing areas in Japan and Europe, a lesson not to be lost on the U.S., and the source countries are being obliged to match

this to remain competitive. Basically, then this means that Canada has the opportunity to sell to previously non-traditional markets if it can keep abreast of the super-carrier revolution.

Besides some scattered deposits in British Columbia, where iron ore is mainly a by-product, Canada possesses two major workable reserves of iron ore. One is in northern Ontario and the other on the Quebec-Labrador border. Low transportation costs make the Labrador Trough the major and largest Canadian source of ore exports.

This ore is loaded at the Northern St. Lawrence ports of Sept-Iles and Port Cartier, the greater part being destined to the U.S. Great Lakes, in vessels suitable to the St. Lawrence Seaway. The balance has moved principally to Western Europe and to the East Coast of U.S.A.

When created, Port Cartier was, for that period, a super port. Although tanker sizes were growing rapidly, the concensus then was that dry bulk vessels would not keep pace, especially with the slowly increasing capacity of European countries which had limited facilities capable of handling vessels of 60-100,000 dwt.

These limitations were not serious at the time since the U.S. East Coast ports were also restricted to about 60,000 dwt bulk carriers.

Establishing a super port on the U.S. east coast with reasonable access to the major steel producing area, could tip the relatively delicate balance which presently favors shipment via the St. Lawrence Seaway.

In this respect Port Cartier could find itself in a relative backwater. The port was developed with the capability of handling 100,000 dwt carriers compared with 75,000 dwt at Sept-Iles. Two major contracts with Japan and Europe, for Canadian ore, have recently been negotiated. These involve a total of 150 million tons ex Sept-Iles over 15 years, and six million tons ex Port Cartier over five years. Thus was prompted

the large expansion project of Sept-Iles, at a cost of $290 million, to handle up to 250,000 ton vessels.

The shipments from Sept-Iles to Japan will be tied in with crude oil backhaul, feeding the new Golden Eagle Refinery at Quebec, and provide Sept-Iles with an opportunity to install a "lightening" or transshipment facility for the inbound tankers which have draft limitations to Quebec.

Compared to Sept-Iles, it appears that the cost of the planned expansion to bring Port Cartier into the super-carrier age will be high. The cost of the necessary excavation to the east could be offset by leasing the existing ore-dock to the I.T.T. for the pulp mill. Of the original harbor, only the approach channel and turning basin area would be used by Q.C.M. which casts a doubt on the decision to locate at the site rather than extending the railroad approximately 15 miles to the deep water in Sept-Iles Bay. Furthermore, as pointed out in Section E-5, in the long run little was done to alleviate unemployment at Shelter Bay. Finally, excavated harbors appear somewhat inflexible, thus vulnerable to unforeseen technological change.

In order to test the economies of scale we have calculated the savings for a range of bulk carriers on various routes with Canadian iron ore and grain shipments ex Port Cartier. This has not been confined to ports that could handle specific classes and size but makes hypothetical assumptions to determine the size of carriers that could generate transportation savings.

For transport to New Orleans, Philadelphia, Rotterdam Range and Yokohama Range, we have tested bulk carriers ranging from 30,000 tons deadweight to 250,000 tons deadweight, at a speed of 15 knots. Our approach has been to analyze these vessels on each of the routes for the round voyage. We have not introduced any backhaul cargoes in our calculations such as oil from Persian Gulf to U.S. or Europe for vessels trading to Japan. We have assumed new vessels, operated under British Flag rather

than vessels under flag of convenience which would have had lower daily operating costs. The following daily cost have been estimated (Table E-1).

TABLE E-1 : Bulk Carriers Daily Cost , U.S.$

D.W.T. SIZE	TYPE	SPEED	DAILY COST (Excl. Fuel)
30,000 dwt	bulk carrier	15	$ 3,850
50,000 dwt	""	15	4,380
70,000 "	"	15	5,490
100,000 "	"	15	6,135
150,000 "	Ore/Oil	15	8,515
200,000 "	" "	15	10,175
250,000 "	" "	15	12,020
24,750 "	Lake Bulk Carrier	15	5,420 (Canadian flag)

For vessels up to 50,000 dwt trading to Japan, we have assumed routing via the Panama Canal both ways whereas 70,000 dwt would go via Panama in ballast only. In the loaded condition vessels of 70,000 dwt and over are routed via Cape of Good Hope and Malaca Strait. The 250,000 dwt ship would be routed via Lombok Strait when fully loaded but could ballast via Malaca Strait.

The following costs cannot be compared to present day freight rates as they do not introduce market fluctuations nor do they include the operator's profit margin.

TABLE E-2 : Ore Transportation Costs

(U.S.$ Per Long Ton of Iron Ore)

Port Cartier to:	N.Orleans	Phildelphia	Rotterdam	Yokohama
Distances	2,700 miles	1,400 miles	3,000 mi.	10,500 - Panama 15,200 - Cape
Size of Carriers				
30,000 dwt	$ 3.11	$ 2.21	$ 3.22	$ 11.82 *
50,000 "	2.24	1.63	2.34	8.29 *
70,000 "	2.07	1.52	2.15	8.55 **
100,000 "	1.72	1.29	1.78	7.71
150,000 "	1.71	1.33	1.77	7.16
200,000 "	1.68	1.34	1.75	6.68
250,000 "	1.74	1.40	1.80	6.54

* Panama Canal

** Loaded Via Cape

It is obvious from the above figures that the relationship between distance and port time on the various routes is a very important factor which sets the different optimum sizes for each. For instance the above table indicates that vessels of over 100,000 dwt from Port Cartier to New Orleans and Philadelphia are not attractive, even without including inventory and storage costs. On the Rotterdam movement, marginal savings are possible up to 200,000 dwt, but the 100,000 dwt here again could hold its own. Definitely, 250,000 dwt vessels reduce substantially the transportation costs on the Port Cartier/Japan route. With an ore/oil carrier of this size, backhaul cargo such as oil from Persian Gulf would further reduce the ore costs by about $1.00 - $1.50 per ton.

Rates from Sept-Iles to Japan should be identical to those produced for Port Cartier.

E.7.2 Grain

Both U.S. and Canadian grain exported via the Seaway and the St. Lawrence are potential business for the Port Cartier facilities. The Canadian Wheat Board has options on a large percentage of the Port Cartier storage but as these are not always taken up, considerable U.S. corn passes through the port. Competing alternatives exist but the case is more clear cut with U.S. origin grains. The destination is of course a prime factor, but potential alternatives are by rail to Atlantic ports or by barge via the Mississippi to Gulf ports. U.S. grains tend to follow the least cost route whereas the fate of Canadian grain is, until loaded on the ocean vessel, in the hands of the Canadian Wheat Board, whose selling policy can offset geographical differences in delivery cost: it is not unusual for European-bound grain to be shipped via B.C. ports. This can mean the loss of what could have been potential traffic for the St. Lawrence system and consequently Port Cartier. In our calculations we have only compared Port Cartier to other St. Lawrence route alternatives.

Basically the entire St. Lawrence River area is considered as one origin for grain fixtures. The normal freight differential on St. Lawrence grain runs between $3.50 and $4.30 compared with shipments ex Great Lakes. Port Cartier grain is offered at a further 15¢ to 35¢ freight reduction to the ship, and this has been maintained even when fixtures have included Baie Comeau in the options.

This is no inducement for vessels to fix ex Port Cartier especially as the majority of the vessels, loading grain out of the St. Lawrence River are "open" from their previous trade in the area. In addition, the average grain cargo size runs around 20,000 tons and therefore suffers no draft restriction. Finally, Port Cartier may be considered in practice as a one stevedore port, which further discourages some shipowners from taking a fixture there on a "gross basis."

Port Cartier's potential at the moment is in vessels fixed from outside the U.S. Gulf area, and in the future will be realized to an even greater extent when larger carriers come into the trade. Unfortunately, the lack of a rail connection to the west limits grain to a seasonal operation, as barge and laker operations are stopped in winter.

To illustrate the economics of Port Cartier for large bulk carriers, we have calculated the transportation savings on Canadian Grain from the Lakehead (Fort William, Thunder Bay area) when shipped via Port Cartier.

Using the same type of vessels as on the iron ore trade, we have assumed that the 30,000 dwt vessels, with the Seaway limitations could load port cargo in the Lakes, i.e., up to maximum draft of about 25 feet and then would top-off in Port Cartier to full draft.

Normally, bulk carriers (specially designed) for the Seaway and Great Lakes, carrying the grain down to the lower St. Lawrence deep ports, are restricted to 34-35 feet channel depth as far as Quebec. These same vessels backhaul iron ore for Canadian and U.S. Lakes ports.

Our calculations indicate that a typical Lake bulk carrier of 24,750 dwt at $5,420/day can carry grain from Lakehead to Port Cartier and return in ballast for $5.60 including discharging in Port Cartier, seaway tolls, insurance, etc. Present freight rate from Lakehead to Port Cartier is quoted at about $5.50/ton discharged in Port Cartier. Reloading charges into Ocean vessels in Port Cartier is about $0.40 per long ton.

It must be understood that freight rates for grain are quoted basis Port Cartier only, and smaller vessels could quote for a differential if loading at Lakehead. Physically, Port Cartier can handle the 50-60,000 ton grain cargoes required to compete with the topping off system and it is possible albeit bold to visualize many larger cargoes to one specific area at a time.

TABLE E-3 : Grain Transport Costs

(U.S. $ Per Long Ton)

I. 30,000 dwt Loading in the Lakes, topping off at Port Cartier

Port Cartier to:	Rotterdam	Yokohama Range
Bottom cargo	17,200 T	17,200 T
Top-off	12,000 T	11,375 T
Basic haulage cost	$6.19	$15.32
Top-off cost @ $6.00 over whole cargo	2.47	2.39
	$8.66	$17.71

II. Full Grain Cargo ex Port Cartier in larger ocean carriers with $6.00 Surcharge

Port Cartier to:	Rotterdam	Yokohama Range
Size of Carriers		
30,000 dwt *	$ 9.44	$ 18.40
50,000 dwt	8.60	15.01
70,000 dwt	8.47	15.41 **
100,000 dwt	8.13	14.66

* For smaller sizes it is more economical to load bottom cargo in the Lakes than to load full cargo in Port Cartier

** Via Cape of Good Hope.

APPENDIX F

AUSTRALIA

APPENDIX F
AUSTRALIA

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APPENDIX F
AUSTRALIA

F.1 SUMMARY

A literature survey and a brief exchange of correspondance has yielded a limited picture of the fast-changing situation at Australian bulk ports. Over the past decade, Australian ports have been confronted with two major changes: the unitized general cargo (to which they responded most effectively), and a huge increase in long-haul ore and coal exports, first to Japan and now to Europe. Contrary to the experience of other countries, port deepening and new deepwater terminals were not supported by long-haul crude oil (which is imported in limited quantities), compared to the movement of coal, iron ore, bauxite, and their concentrates or derivatives.

The increase in size of bulk carriers has been generally ten years behind that of tankers, but the advent of combination carriers (ore/oil, coal/oil, and ore/bulk/oil) has accelerated this evolution over the past few years. Australia expects 250,000 to 300,000 dwt vessels, but the 100,000 dwt class will provide the bulk of the fleet, particularly for domestic traffic, unless the Great Barrier Reef Pass is deepened considerably.

Most ports are public, and administered by the seven individual States, or the Federal Government for the Northern Territory. Local authorities belong to three types: autonomous Harbor Trusts, a Maritime Board supervising several major ports (New South Wales), and Harbor Boards elected by local interests. National coordination appears limited to liaison through the Australian Port Authorities Association. Government (mostly State) subsidy plays a substantial role which has not been quantified, essentially in the financing of infrastructure.

Dampier and Port Headland are the deepest of the new ports, but their most recent experience could not have been appraised without a field trip. Of the three ports contacted--Newcastle, Port Kembla and Gladstone--each handling coal and ores at more than 10 million tons per year, only Gladstone sent data in time.

Although Gladstone is not a very deep port (two berths have 40-foot depth, with 9 feet to 11 feet more at high tide), the authorities are considering dredging it for 100,000 dwt. The port is interesting because of its rapid growth from a sleepy 12th place (in 1968-1969) to a current 4th in cargo traffic, and the variety of commodities handled (coal, bauxite, alumina, and grain). Queensland Alumina, Ltd (Q.A.L.) invested $240 million in an alumina plant between 1964 (600,000 T/y) and 1970 (1,275,000 T/y), and plans to again double plant size by 1972 (at $150 million additional cost). This, and the reopening of two coal mines (in 1961 and 1965) for the Japanese export market have been the mainstay of this growth. An additional $20 million growth in fertilizer and chemical (H^2SO^4) plants, clay brick works, and mineral sand extraction, during the past two years have added to port expansion, along with two power stations (in 1968 and 1974).

Q.A.L. choose Gladstone because of a protected natural harbor, good plant sites (including open-air red-mud disposal areas), low capital costs, and low fuel and power costs. There is an attractive climate and good living conditions for the 7,500 population (1963), with daily rail and road connections to Brisbane. Brisbane (600,000 inhabitants), a strong contender in the site selection, was discarded because of dredging problems (beyond 25,000 dwt) and long-term, red-mud-disposal problems. The Queensland Harbor Board subsidized about one quarter of the required wharf and navigation-aids infrastructure.

Gladstone was an agricultural town and port in 1963, and is now a dynamic town of 13,000 that is still growing by leaps and bounds. There is a tight housing situation, which could grow worse, as additional industrial acreage

(1,850 acres) is being offered by the government, while the Harbor Board has reclaimed additional mangrove land between the existing coal terminals.

Raw landfill, huge coal stockpiles, petroleum tanks, and an absence of vegetation (destroyed during development) leave the port with a desolate appearance, in full view of a new residential development. The rest of the town is somewhat recessed towards an inlet, developed as a recreational area and marina. An anti-pollution committee has recently been formed to review new projects and combat incipient pollution. The alumina plant is reducing its dust emission, but coal dust and Q.A.L. caustic effluents are yet untouched. University of Queensland students are trying to find which vegetation will grow on the red mud "burgs". There is a shipwaste incinerator, and the new power plant site was changed to isolate thermal pollution.

There have been upward real estate reassessments, and the tax rate has gone sky-high to support developments in municipal services and infrastructure. Many of the original residents have been hard hit and would like industry to foot part of the bill. Reversal of stagnation, employment, and growth potential are the counterparts of these environmental and economic hardships. New employment and decentralization, and exploitation of coal and bauxite resources are of benefit to the State.

On the technical side, coal handling berths have traveling gantry loaders: 370 feet long and 800 tons per hour at Auckland Point; 1,520 feet long and 2000 tons per hour at Barney Point. Two similar loaders 550 feet long and 1200 tons per hour handle alumina at Southtrees Q.A.L. berths, with a bauxite unloader. A 10,000-ton silo was equipped with modern loading facilities in 1970.

A survey is being conducted to determine the most economic way of accommodating 100,000 dwt bulk carriers. Contrary to the town, which is chronically short of cash, the financial position of the Harbor Board remains healthy--the ratio of liabilities to assets has actually decreased from 0.91 to 0.83 in the past five years.

The Port of Gladstone appears to fulfill its new role of industrial center for northern Queensland, but now has to consider harbor deepening again to remain competitive. Its booming growth since 1963 has created some hardship for those real estate owners who did not cash in on the industrial development. A tight housing situation, and incipient air, land, and water pollution are other complaints. Pollution is now officially considered by an ad hoc committee. There has also been a recent ban on oil drilling within the Barrier Reef, a major decision for Queensland, still struggling to escape its rural state.

F.2 AUSTRALIAN PORT DEVELOPMENT AND STRUCTURE

F.2.1 General

An island continent, Australia has an economy which depends heavily on coastal and overseas trade: ports, therefore, are vital to its life, and exports make up 12% of GNP. As shown in Figure F-1, there are 66 ports serving the coastal and overseas trade--a large number, considering the 1969 population of 12,250,000 and the unique problems created by a continent.

In most of these ports, trade is good, because of expansion in primary and secondary industry, and development of mineral resources. Cargo-handling statistics show a booming economy. So also do the ports themselves, which are being transformed (and, in some cases, created) to serve a fast-developing nation.

There is very little competition between Australian ports for cargo, because great distances separate the general cargo ports. Where ports are closely situated it is because they are catering for specialized trade. Every year more than 100,000,000 tons of cargo, about two-thirds of which is for overseas trade, moves through the ports.

The first ten major ports of Australia, in terms of tonnage of cargo handled for the year 1967-1968, are: Sydney (14,800,000 tons), Melbourne (11,923,787 tons), Newcastle (11,792,575 tons), Fremantle (11,304,895 tons),

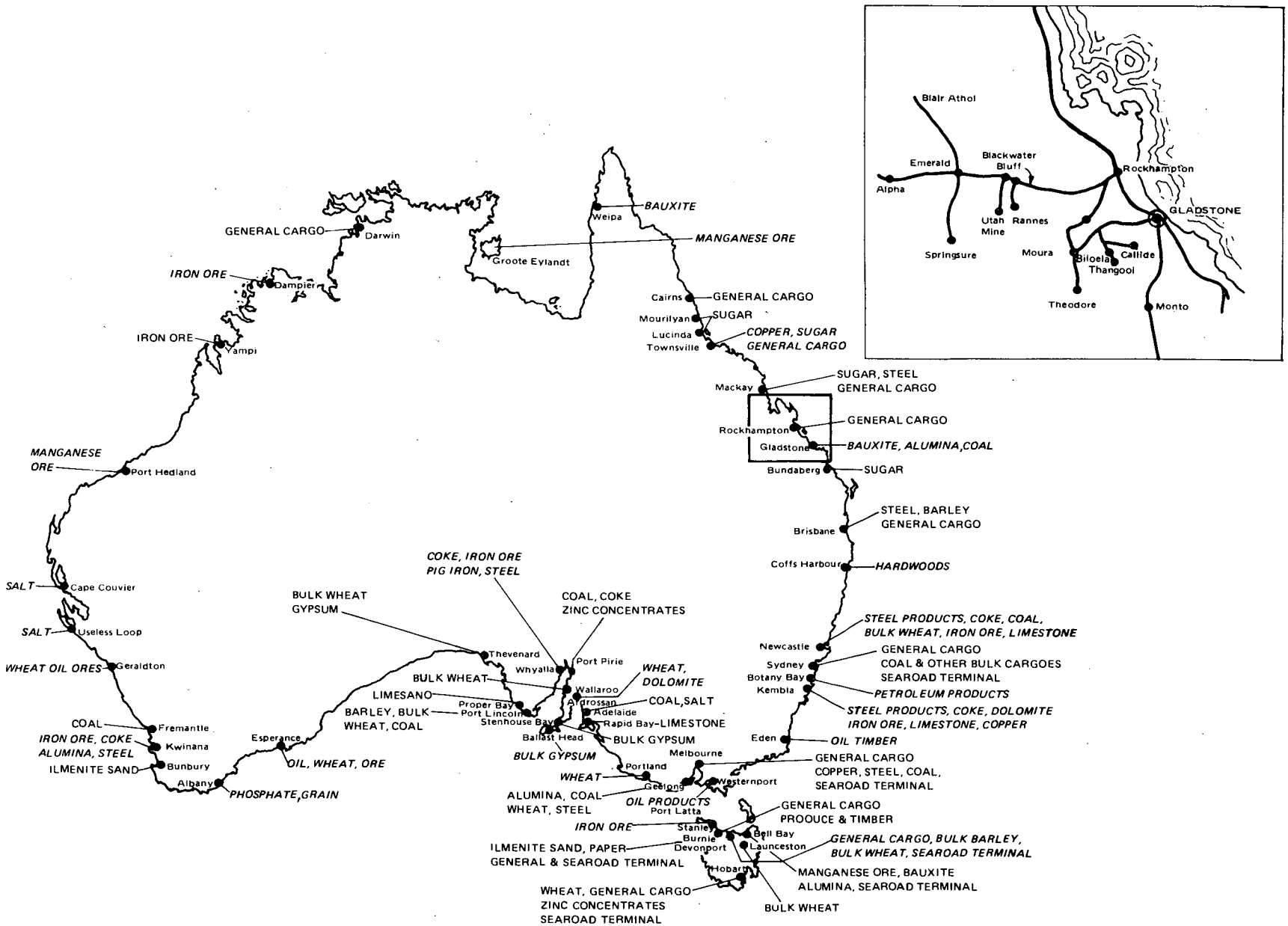


FIGURE F–1 AUSTRALIAN AND TASMANIAN PORTS OF CALL AND CARGOES HANDLED

Port Kembla (10,098,657 tons), Adelaide (6,678,465 tons), Whyalla (5,954,380 tons), and Brisbane (5,229,506 tons). Since then, Gladstone has jumped from 4.8 million tons in 1967-1968 to fourth place; with 7.7 million tons in 1969, and 10.1 million tons in 1970.

Throughout the ports, a revolution in cargo-handling methods has been going on for more than 12 years. Virtually all the general cargo in the coastal trade now moves in container, unit-load, or roll-on/roll-off systems. In the ports of the island State of Tasmania, for instance, roll-on/roll-off handling has reduced shipping costs by about 40% and tripled traffic in 19 years. The stevedore work force on the Australian waterfront now totals about 22,000 men, most of whom are now employed on a permanent basis--recently introduced to replace a system of casual hiring. By 1978, due to changes in cargo-handling methods, this work force is expected to be reduced to between 11,000 and 12,000.

F.2.2 Bulk Ports

Parallel to changes in general cargo-handling, another transformation in the Australian maritime scene has been the result of mineral development--the most dramatic aspect of the nation's economy in the past ten years. Vast deposits of iron ore, bauxite, and coal are being exploited for shipment to Australian mills and overseas--mostly to Japan, and soon to Europe. The result has been the creation of new ports in isolated corners around the Australian coastline, and dramatic expansion of existing ports.

Weipa (see Figure 1) sprang into existence--almost overnight it seemed--to handle bauxite shipments at the rate of 3,500,000 tons a year from Queensland's Cape York peninsula, to serve both the export trade and an alumina plant in Gladstone. A similar development occurred on the northwest coast of Australia at Dampier(7.5 million tons per year), Port Headland (4 million tons/year) to serve iron ore discoveries, and at Port Latta in Tasmania for iron ore pellets. Port Headland was a pastoral town of 1,000 inhabitants--jumped to 6,000 in five years as development for 100,000 dwt ore carriers took place, and it could reach 12,000 inhabitants in the next five years if

development for 300,000 dwt takes place. (A site is being sought on the Pilbara coast).

Coal shipments to Japan have made Newcastle the third port of Australia, and the small city of Gladstone on the Queensland coast jumped from 12th place to 4th in 1969, because of the volume of coal, bauxite, and alumina handled.

We expect that the number and size of bulk carriers in the Australian overseas trade can be expected to increase in conjunction with the capacity of ports to accept them. Certainly bulk carriers of 250,000 dwt will not be uncommon, and ships of 100,000 dwt will provide a large proportion of the total. Already bulk carriers of 100,000 dwt are calling at Port Headland and Port Dampier where the trade to European and Asian Ports (particularly Japan) is not limited by the depth in the Torres Strait.

A similar increase in the coastal trade can be forecast, with a balance being struck between an optimum stockpile and regular replenishment. Unless voyages from east-coast ports of Australia to the west coast, and vice versa, are unrestricted by depth of water (the Great Barrier Reef pass is limited to 35-39 feet draught), we estimate that the economical bulk carrier for most routes will be 100,000 dwt.

Dampier and Port Headland being too recent to document without a field trip, a selection of more established bulk handling ports--e.g., Newcastle, Port Kembla, and Gladstone--were questioned by mail, but only Gladstone responded in time for this study.

F.2.3 Port Management

a. Administration

In Australia, port administration is the responsibility of the six states, with the exception of the Northern Territory where ports are administered by the Federal Government. The administrative arrangements vary from state to state. Some ports, like Melbourne, are controlled by Harbor Trusts; government instrumentalities with a high degree of autonomy. Other ports

are administered jointly by one authority--as in the case of Sydney, Newcastle, and Port Kembla under the Maritime Services Board of the State of New South Wales. In other states, both systems operate side by side, and the Harbor Board is elected by interested communities (such as at Gladstone). A few ports are under private control. Yampi Sound is an iron-ore port controlled by the Broken Hill Co. Pty., Ltd., to supply its steel mills at Newcastle and Port Kembla.

There is no overall coordinating authority for the ports, but liaison is maintained through the Australian Port Authorities Association. Although it is a purely consultative body which can only make recommendations, the Association has achieved uniformity of practice in many aspects of port operations.

b. Financing

Government subsidy plays a role in port development, but generally only for infrastructure. Dredging (estimated at $1.30 per cubic yard removed beyond the 35-foot depth in Port Stevens channel) is proceeding at Port Kembla, funded within a $17.5 million grant of the New South Wales Government, as part of a $200 million expansion program of Australian Iron and Steel Property, Ltd., and some roll-on/roll-off berth improvement. New South Wales says it will spend $200 million on developing its ports in the next ten years; mostly at Port Kembla, Botany Bay, Newcastle, and Port Stevens. Queensland has spent $130 million in the past ten years. Dredging is expected soon in Gladstone and Brisbane which handles 25% of this state traffic.

British shipping companies have invested about $20,000,000 in container terminal facilities at the ports of Fremantle, Sydney, and Melbourne. Another $3,200,000 in private capital has been spent on container facilities in Brisbane. Port authorities, meanwhile, have begun large-scale complementary projects on dredging, docks, cranes, sheds, and depots. They are committed to spending at least $21,500,000 under contracts existing in 1969 and further heavy investment was then planned.

F.3 PORT OF GLADSTONE, QUEENSLAND

F.3.1 Background

Until the 1960's, Queensland drifted slowly along on an agricultural economy of beef and sugar, a slight tourist industry (to Barrier Reef islands), and marginal fruit and grain production. The young gravitated to the cities in search of work, and the Australian-wide pattern of centralization of population in the capital cities seemed to be repeating itself in Queensland.

In the late 1950's and early 1960's Japan's escalating role in Australia's trade patterns--as a result of proposed British entry into the Common Market--prodded mineral prospecting to meet the huge Japanese demand for raw materials. In 1949, the Queensland Coal Board instigated programs of drilling to determine coal reserves throughout the state. The Moura fields, which were to be one of the principal reasons for Gladstone's development and prosperity during the 1960's, were mapped out during this time.

Mining companies were also active in other areas. Bauxite was found on the inaccessible Cape York Peninsula; ilmenite, tin, and phosphate bodies were located; and oil was discovered at Poma. International corporations, long bedevilled by unstable political climates in the countries supplying raw materials, were encouraged to spend large sums developing mines and building processing complexes in the area. In this atmosphere of economic rejuvenation, Gladstone was born as a major port.

Gladstone, in the late 1950's and early 1960's appeared to be stagnating. The sugar belt was too far north to be of much benefit to the town, and any production south of Gladstone was drawn to the rum distillery in Bundaberg. The important rail connection with the interior terminated at Rockhampton 69 miles north, and a meat-processing factory was the only industry (along with small local farming operations) to provide employment. Queensland itself was too far from the important industrial centers of Melbourne and Sydney to attract any major manufacturing concerns, and

although Gladstone had a fine, natural, deepwater harbor, tonnage moving over the wharves actually decreased slightly during the years 1954-1961.

Coal had been discovered at Blackwater as early as 1928. A labor strike in the Victorian coal mines promoted temporary development of the field in the thirties. A crane was installed on Auckland Point Jetty to handle the coal loading. When the strike broke, the coal demand tapered off except for intermittent shipments over the years to interstate users.

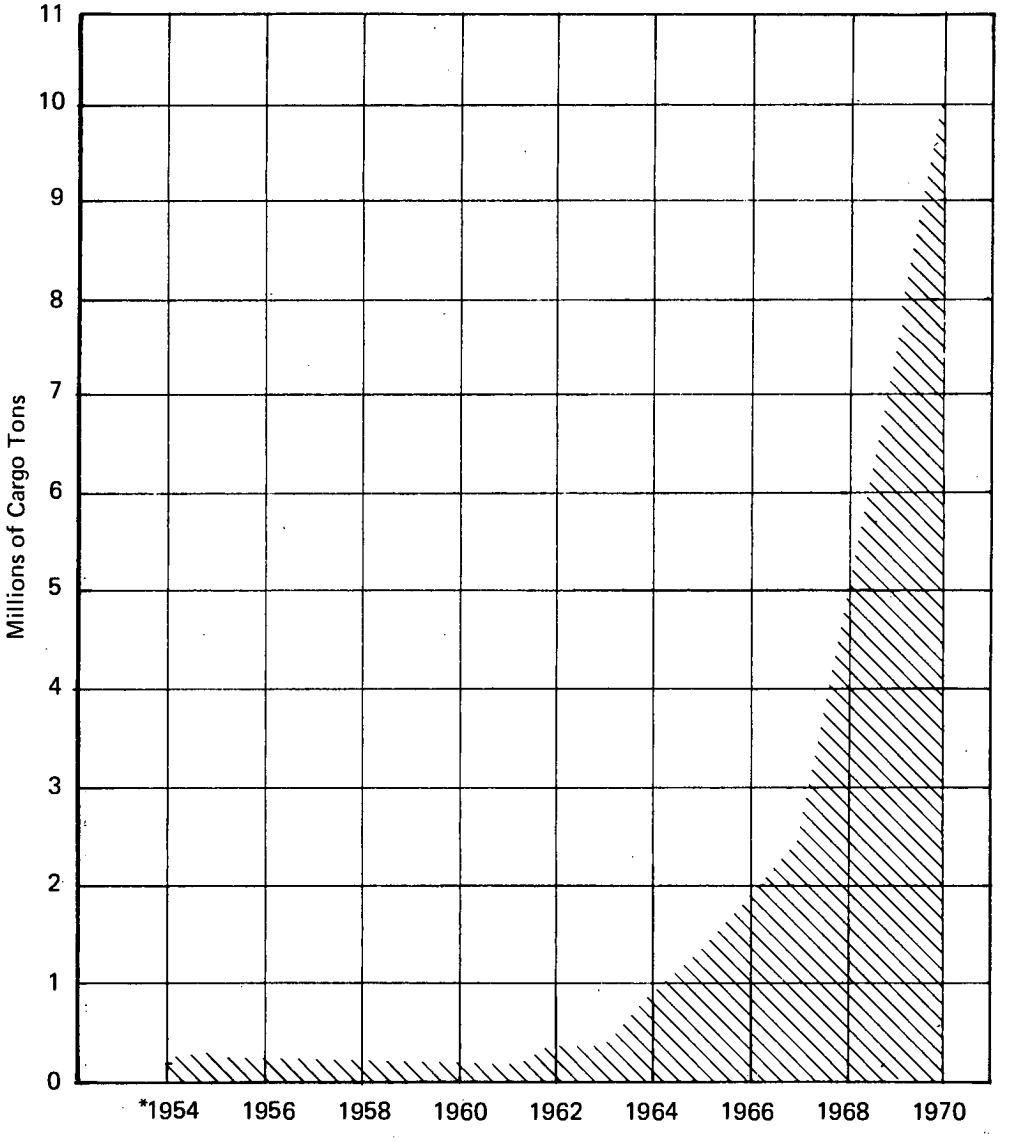
By 1960, several small coal mines, a local meat-packing industry, a co-operative dairying association, and the port provided the only secondary industry. Figure F-2 shows the 1954 to 1970 cargo flows from the port, reflecting the town's development. More detailed data appear in Table F-1.

In 1961, occurred the first of the two major events destined to change the face of Gladstone. As a direct result of Japan's increasing demand for coal, the company of Thiess Peabody and Mitsui was formed to develop the Moura coal fields. The plans called for port facilities to handle the proposed output and the Gladstone Harbors Board (GHB) began plans for a huge expansion of the port area. T.P.M. later built their own wharf under the aegis of the GHB, but early shipments went over the Auckland Point Jetty.

The second major event was the decision of Queensland Alumina, Ltd., to establish the world's largest bauxite treatment plant at Parson's Point, Gladstone to process the Weipa bauxite deposits. The decision process involved in the selection of Gladstone is described later in this section.

The last decade has been one of extraordinary development as industry, population influx and attracted industry have escalated. The rapid series of events must, at times, have outstripped the townspeople's ability to comprehend or cope with the transformation which propelled their sleepy little town into being both Queensland's major port (by tonnage) and a booming industrial center in little more than six years.

FIGURE F–2 TOTAL CARGO PASSING THROUGH GLADSTONE 1954 to 1970



*Year ended June 30th

CARGO STATISTICS, PORT OF GLADSTONE
1959 to 1970
(thousand tons)

EXPORTS	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Beef Products	18	10	4	12	11	9	not	4	4	4	4	3
Grain	44	28	-	27	77	39	A	33	83	89	173	46
Pyrites	14	19	20	16	26	31	V	4	0	0	0	21
Coal	20	39	47	292	240	828	a	1714	1701	2312	4050	5654
Butter, Wool	3	4	3	4	4	4	i	2	3	1	0	0
Alumina	-	-	-	-	-	-	L	-	35	569	934	1117
Bunker Fuel	-	-	-	-	-	-	a	-	-	19	25	40
Nickel Ore	-	-	-	-	-	-	b	-	-	-	-	7
Ilmenite	-	-	-	-	-	-	l	-	-	-	-	23
General Cargo	5	1	2	-	-	-	e	-	-	1	2	-
Coke	-	-	-	-	-	-		-	-	-	-	10
TOTAL	104	101	76	351	358	911	-	1757	1826	2995	5188	6921
IMPORTS												
Petroleum Prods.	79	95	87	86	77	71	not	106	129	133	138	143
Caustic & Fuel Oil	4	5	6	5	7	6	avail-	-	162	202	332	391
General	3	1	-	1	3	-	able	26	12	3	3	6
Bauxite	-	-	-	-	-	-		-	415	1520	2118	2628
Min. Concentrate	-	-	-	-	-	-		-	-	-	5	45
TOTAL	86	101	93	92	87	77	-	132	718	1858	2596	3213

Fiscal years' end June 30th.

We do not have the exact dates on which the various industries presently located in Gladstone decided to site their operations, but the following chart gives a rough chronological history of capital investment in the area during the 1960's.

Table F-2

Capital Investment In Gladstone, 1960 to 1970

DATE	COMPANY	INTEREST AND INVESTMENT
Early 1960's	Thiess Peabody & Mitsui	Coal mining in Moura deposits, est. reserves 1.75 billion tons
April 1963	Thiess Peabody & Mitsui	Operations with heavy machinery begun
1963	Queensland Alumina, Ltd.	Bauxite reduction to alumina announed intention to establish refinery at Gladstone
1964	Queensland Alumina, Ltd.	Primary plant costs $130 million ground first broken Sept. capacity 600,000 tons per year
1967	Queensland Alumina, Ltd.	First shipment of alumina
1968	Utah Development Co.	Coal mining in Blackwater deposits, est. reserves 1.85 billion tons
1968	Callide Power Station	Sited on inland open cut coal field, completed 1968/1969 Supplies Rockhampton, Gladstone, Q.A.L., Moura, & Blackwater mines Cost $37.5 million
1968	Queensland Alumina, Ltd.	Expansion of plant to lift production capacity by 50% Cost $59 million, 900,000 tons per year capacity

Table F-2 (Continued)

Capital Investment In Gladstone, 1960 to 1970

DATE	COMPANY	INTEREST AND INVESTMENT
1969	Murpheyores Holdings, Ltd.	Mineral sand mining and processing to produce 93,000 tons per year in initial stage, cost $2.2 million
1969	A.C.F. Shirley Fertilizers, Ltd.	Super phosphate plant, cost $4 million
1970	Central Queensland Acid Pty., Ltd.	Built on reclaimed land at Barney Pt., sulphuric acid plant will use 250,000 tons of pyrites per year from Mt. Morgan, capacity 1,000 tons per day, cost $13 million, commencing production 1970
1970	Capricornia Industries, Ltd.	Clay brick works at Calliope, 12 miles SW of Gladstone, cost $430,000
1970	State Government	Confirmed construction of 1,100-megawatt powerhouse to be completed by 1974
1970	Grain Board	$2 million bulk grain storage and terminal, construction begun
1970	Queensland Alumina, Ltd.	Production increased to 1,275,000 tons per year, cost $69 million
	PROJECTED	
1972	Queensland Alumina, Ltd.	Production increase to 2 million tons per year approximate cost $150 million.

This chart would indicate that a chain reaction took place, beginning with Thiess Peabody & Mitsui, Ltd.'s mining and need for a deeper harbor. With development plans for the harbor underway, Queensland Alumina, Ltd., for reasons detailed further in this study (but principally dealing with port and labor supply), began their plant construction. These two industries attracted small supportive industries such as trucking and real estate development, and interacted in some measure with each other (e.g., a coal supply for the alumina plant operations).

The Callide Power Station, and a now-established port and labor supply set the stage for a burst of development in the late 1960's, which has not yet reached full fruition.

While we have little information on the reasons leading to the siting of Thiess Peabody & Mitsui's operations at Gladstone, we do have precise data on the site selection for Queensland Alumina, Ltd.'s giant bauxite-processing plant.

With this information and the qualitative criteria laid down by the consortium in selecting an optimum site, we may draw fairly accurate assumptions regarding the movements of other groups into the area.

Thiess Peabody & Mitsui, Ltd. could have been attracted to the town by five important factors:

1) Japanese demand for coal for the steel making process,
2) Large deposits of coal adaptive to strip mining,
3) The presence of a natural harbor in reasonable proximity to the mine,
4) Willingness of the Gladstone Harbors Board to develop the port sufficiently to handle the coal,
5) State government's policy of decentralization and development of rural areas which would ensure a comfortable political climate in which to operate.

F.3.2 Queensland Alumina, Ltd.

In 1959, large deposits of commercial bauxite were discovered at Weipa on the lonely Cape York Peninsula. A consortium of four companies--Kaiser Aluminum (U.S.A.), Aluminum Company of Canada, Pechiney (France), and Comalco (Australia)--was formed to mine the deposits and process the raw bauxite to alumina. This consortium was to be known as Queensland Alumina, Ltd. It became imperative to find a suitable site to locate the plant. A total of seven plant locations were examined, and comparative data was assembled. By 1963, the decision which was to be so vital to both Gladstone and the future of Central Queensland had been made. Table F-3 is a comparative listing which delineates the criteria established by the consortium and the rating of each site.

Table F-3

Queensland Alumina, Ltd., Plant Site Criteria

	Weipa	Towns-ville	Mackay	Flock Pigeon Island	Port Alma	Glad-stone	Brisbane
Established Community & Labor Supply	P	G	G	P	P	G	VG
Deep draught harbor	F	P	G	G	G	VG	G
Red mud disposal	VG	F	F	F	F	G	P
Fuel Costs (Fuel Oil & Coal)	P	P	F	P	G	VG	G
Electric Power	P	F	F	P	F	VG	G
Plant Sites	G	F	G	F	P	G	G
Water Supply	F	F	P	P	P	G	VG
Transport & Communications	P	G	G	P	F	G	VG
Plant Costs	P	F	G	P	P	G	VG

Table F-3 (Continued)

Queensland Alumina, Ltd., Plant Site Criteria

	Weipa	Towns-ville	Mackay	Flock Pigeon Island	Port Alma	Glad-stone	Brisbane
Bauxite Supply Costs	VG	F	F	F	F	F	F
Shelter from Cyclone	F	F	P	P	F	F	F

VG - Very Good
G - Good
F - Fair
P - Poor

Following is a site description for each area investigated and an appraisal of its locative advantages and disadvantages.

a. Gladstone

The town, with a 1963 population of 7,500, has a pleasant climate and attractive living conditions suitable for retaining a stable labor supply. The protected natural harbor can be expanded to accommodate the number of vessels and draught requirements which would be used to transport bauxite and alumina. Two good plant sites are available in proximity to a red-mud disposal area. Plant capital costs would be lower than any other site, excluding Brisbane, and fuel costs from coal and electric power would be the lowest of all sites considered. Bauxite supply costs would be practically equal to any east coast location.

b. Weipa

High plant capital costs, remoteness, and inaccessibility for the maintenance and stability of a labor force make this site unattractive.

c. Townsville

Townsville is the second largest city in Queensland with a 1963 population of 52,000. High plant costs, lack of red-mud disposal area, and lack of a

suitable harbor would offset the labor supply, pleasant living conditions, and road and rail transport availability. The harbor is artificial, with a channel 26'6" deep, and would require extensive dredging to accommodate vessels over 10,000 dwt capacity.

d. Mackay

The artificial harbor at Mackay would need extensive dredging, and major extensions to the water supply would be necessary for the plant. On all other points, Mackay would rate close to Gladstone or Brisbane with a 1963 population of some 17,000 and good plant site and red-mud disposal area. Plant capital cost would be only slightly higher than Gladstone.

e. Flock Pigeon Island

This virgin site offered a deepwater port and the possibility of a coal shipment terminal in the event of Blair Athol deposits being developed. Labor and utility supply and shelter were poor.

f. Port Alma

Port Alma is the deepwater port for the city of Rockhampton, 35 miles from the town. The port offered a possible terminal for Moura-Callide coal, but as the port is surrounded by mangrove and mud flats with no reasonably close community, it would be unsuitable.

g. Brisbane

Brisbane, with 600,000 population offered the best potential labor supply, plant capital costs, transportation, and water supply. The port can handle vessels up to 25,000 dwt, but extensive dredging of the Brisbane River would be necessary to bring in larger ships. The problem of red-mud disposal areas was, however, seen as a prohibitive long-term problem which could probably require barging the mud to sea for dumping. This factor then tended to offset the advantages of a Brisbane location, which ranked --along with Gladstone--far above all the others. Queensland Alumina, Ltd. gave the following estimated capital costs for the initial Gladstone plant development beginning in 1963. These costs, taken from an inhouse study,

are given in percentages of the total as it was not possible to obtain actual detailed costs.

Table F-4

Plant Capital Costs

	PERCENT
DIRECT COSTS	
Alumina plant proper, including site preparation	59%
Engineering, Administrative, Personnel, and Productive Services	3%
Wharf Approach	1%
Bauxite Stockpile	2%
INDIRECT COSTS	
Construction Management & Services, Design Engineering and Procurement	9%
Escalation and Contingency	13%
ADDITIONAL OWNER CAPITAL COST	
Permanent Staff Housing	1%
Site Purchase	1%
Hospital Subsidy	--
Other Costs, including Administration, Start-up, Capital Spares, Interest on Funds, etc.	11%
TOTAL	100%

Costs to others were estimated to be approximately $7 million, broken down roughly as follows:

	PERCENT
Wharf and navigation aids	25
Public build-up, School extensions	
Access Road & Railroad	3
Employee housing	34
Water Supply	37
Power supply & communications	1
	100%

We are unable to ascertain at this time whether these costs were borne by Municipal, State, or private enterprise. However, it is our understanding that the Queensland Harbor Board did begin work on the wharf partly or wholly supported by government funds. When the costs ran over the $2 million budget, funds were cut off and Q.A.L. took over and completed the work. The wharf is now owned and operated by Q.A.L.

F.3.3 Geography and Surficial Character

Gladstone is located on the central Queensland coast, approximately 330 rail miles north of Brisbane, 86 road miles south of Rockhampton (a city of some 45,000 population), and 146 miles northwest of Bundaberg (population 23,000). Queensland's state railway provides transport north and south on six days a week. Bruce Highway, the major State highway, connects Gladstone to all the major coastal towns. Chi Transport Services operate daily runs from Brisbane except Sunday.

Gladstone has a mild semi-tropical climate making living conditions exceedingly pleasant. Farenheit temperatures range between a maximum of 85° and minimum of 52°.

The coal deposits at Moura and Blackwater, and ilmenite deposits near Gladstone comprise the mineral source for the town. Small farms are dotted through the fertile Callide and Dawson Valleys, and some small timber concerns operate a little further inland. Coal reserves are estimated to be 1.85 billion tons at Blackwater and 1.75 billion tons at Moura. A power station at Callide provides a high voltage power to Rockhampton, Gladstone, Q.A.L., and the Moura and Blackwater mines.

The bauxite source is some 1,200 miles from Gladstone at Weipa on Cape York Peninsula. Bauxite is shipped to Gladstone where it is refined to alumina at the Q.A.L. plant.

F.3.4 Demography

Central and Northern Queensland is, as previously stated, a largely agricultural area. Until the discovery of minerals, employment was patterned after the growing and processing of beef, sugar cane, fruit and grain, with tourism taking a small but growing part in the economy. There was a drift of population to the cities as the land reached its optimum growth capabilities and itinerant labor was forced from the cane fields by automation. Unemployment could not be considered a problem, as the population was relatively mobile and could relocate in other areas.

In the early 1960's, Swift's meatworks, the only large secondary industry in Gladstone, decided to close its plant and relocate elsewhere, leaving the town with no appreciable source of secondary employment. Development of the Moura coal fields and Q.A.L.'s plant opened up a new source of employment for the residents of the town, and the prospects of an increased prosperity for local small businesses.

At the present time, the population of Gladstone stands at approximately 13,000. New industries and the expansion plans of present plants are expected to contribute to the growth of Gladstone's population for some time yet.

Construction of Queensland Alumina, Ltd.'s plant employed some 650 men and the completed plant absorbed all labor available at the time. The Gladstone Harbors Board is operated by 47 men, approximately 20 of whom are engaged in the handling of the Blackwater coal. Other industries account for the remainder of the working population. Rapid growth of industry continues to attract new labor and there appears to be no backlash of unemployment as occurred in Port Cartier, Canada, on completion of construction work. In fact, there appears to be a mild labor shortage.

F.3.5 Land Use

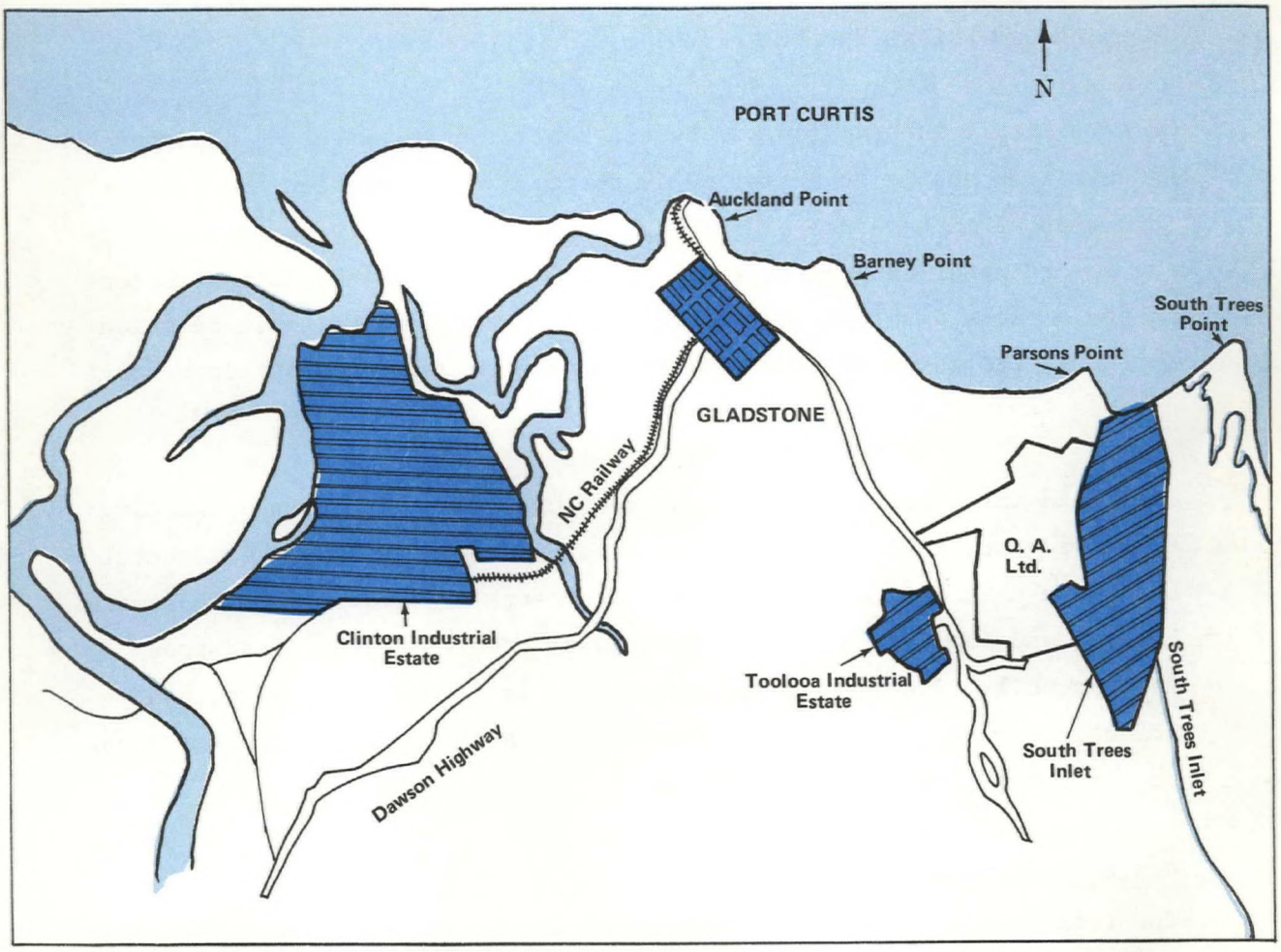
The rapid growth of Gladstone and a pressing need for industrial land brought about two interesting schemes to cater to both existing industry and potential industries.

The Gladstone Harbor Board engaged in a series of land reclamation operations as early as 1965 near the harbor and other potential deep-water sites. This land is now, for the most part, available for rental or purchase to any industrial concerns attracted to the area by the proposed $200 million power plant.

The second scheme was that of the Queensland State Government. Aware of the potential of Gladstone, and anxious to establish an industrial center in Northern Queensland, the State reserved 2,000 acres of prime industrial land as a basis for three Industrial Estates near the town (see Figure F-3). The Toolooa estate covers 150 acres on the main highway south of Gladstone near Q.A.L.'s plant. The estate is already partly serviced, with roads, water, power, and drainage, and houses, several light engineering, building materials, and food-processing plants. The 600 acre South Trees site is being reserved for a large plant capable of utilizing the whole area.

Clinton Industrial Estate, which is being retained for heavy industries is northwest of Gladstone and consists of roughly 1,250 acres. Roads

FIGURE F–3 GLADSTONE ZONING FOR INDUSTRIAL EXPANSION



and other facilities were due to be constructed following construction of an access bridge in early 1970.

We have little information on the residential development of Gladstone. We have been unable to determine if there is any direction to the construction of much-needed housing. A study was recently commissioned by the Co-ordinator General of Public Works, to examine the infrastructure of the rapidly developing town and to make recommendations in relation to future provision of services. We have been unable to obtain a copy of this study.

The rapid influx of labor to Gladstone outstripped the town's capacity to provide suitable housing. Few properties were available for rental and those that were commanded very high rentals. Provision of adequate housing and facilities has become a major problem for the Gladstone Town Council. The greatly increased demands for basic service, and inadequate funds to meet these demands, is a source of discontent among the original residents of the town.

F.3.6 Environment

The residential and business section of Gladstone is set back, somewhat, from the port area. Auckland Point, a large bluff, and the coal railway line, form the present limits of the town.

Much of the Auckland Point terrain has been or is in the process of being reclaimed by landfill. The area between Auckland Point and Barney Point previously had been low-lying mud and mangrove swamps--familiar along these coasts. A large area behind the Auckland Point Wharf is used for the stockpiling of Blackwater coal. The only other structures, other than terminal sheds close to the wharves are huge petroleum storage tanks. Aesthetically, Auckland Point looks barren and ugly, because all natural vegetation was destroyed during the development process, and has not been replaced.

The Barney Point development, originally separated from Auckland Point Wharf by shallow sea water and swamp, has been linked by a causeway (Macfarlan Road) to Auckland Point. Landfill already in progress will eventually reclaim this area for industrial development, but the huge coal stockpiles and raw landfill still give the port a desolate appearance. The Barney Point coal stockpile is in rather close proximity to a new residential housing development.

South Trees Point is approximately two miles from the town, linked to Q.A.L. by a conveyor-belt bulk-handling system. Some natural foliage has been left on the foreshore, but there seems to be no intentional beautification of the area.

While these three points certainly had little to recommend them as local beauty spots in the past, their appearance has not been improved by recent activities.

However, attempts have been made to beautify the foreshores of Auckland Inlet, the town's principal recreational area, and a small-crafts harbor has been built by the G.H.B. In 1969, the Central Wharf in Auckland Inlet was repaired and reconstructed at a cost of $7,240.

F.3.7 Costs and Benefits

Funds for municipal works programs were raised from rates and taxes levied against the local population's real estate. These properties were re-assessed every eight years, the last time in 1960. From the time of the 1960 assessment to the next reappraisal of property values, the little township had become a boomtown. Real estate values rose astronomically without a corresponding increase in rates. Concurrent with the rise in real estate values, the demand for municipal services, principally sewage facilities, roads, and related services, had also increased drastically. The Town Council became chronically short of funds long before the new assessment date and the new rates imposed to cover costs to some degree hit not only those who had been able to

capitalize on the boom--such as owners of rental properties and vacant real estate, or owners of profitable commercial businesses--but also those who were retired, or were small wage earners long established in the town. Some rates were reassessed as high as 1,200% and the original inhabitants, hard hit by the new rates, feel justifiably unhappy with these circumstances.

The Council is still short of funds and there is some feeling that the large industries should help out with at least $2 million to enable the town to provide essential services.

The social benefits to the State seem to have been:

a) decentralization of population, and
b) employment;

and to the town:

a) reversal of stagnation,
b) employment, and
c) growth potential for small businesses.

The social cost would be some measure of financial hardship to established small wage earners brought about by increased rates and taxes; the natural disruptions brought about by a greatly increased demand placed on recreational and municipal facilities; the unsettling effects of a large influx of people into a quiet rural community; and environmental pollution.

F.3.8 Port Developments and Operations

a. The 1960's

The signing of long-term contracts by Thiess Peabody & Mitsui to export 45 million tons of hard coking coal to Japan over a ten-year period provided the necessary boost required for development. Immediately after the contracts were signed, the Gladstone Harbors Board began improving the bulk-loading facilities at Auckland Point (Figure F-2). The fixed-head loader was converted to a travelling-gantry loader, a new wharf was constructed, and stockpiling and unloading facilities were improved.

Queensland Alumina, Ltd., provided their own facilities for the loading and unloading of alumina and bauxite at South Trees Island.

In the early 1960's, the port could accommodate vessels of 23,000 dwt. The increased demand for coal and the economies to be gained from larger vessels induced the G.H.B. to carry out deepening work. By 1966, the port was able to accommodate vessels of 35,000 dwt, and by 1968 vessels of 55,000 dwt capacity were able to use the port daily.

In 1967, Thiess Peabody & Mitsui shifted to a new facility at Barney Point. A new, shorter railway line (built at a cost of $28 million) linking Gladstone and Moura reduced the haulage distance from 170 to 112 miles. The railway terminated at Barney Point, where two 40-foot-low-water-depth berths are used to ship coal and mineral sands (Figure F-3).

In 1968, the Utah Development Co. began exporting coking coal to Japan through a further-improved Auckland Point bulk loader.

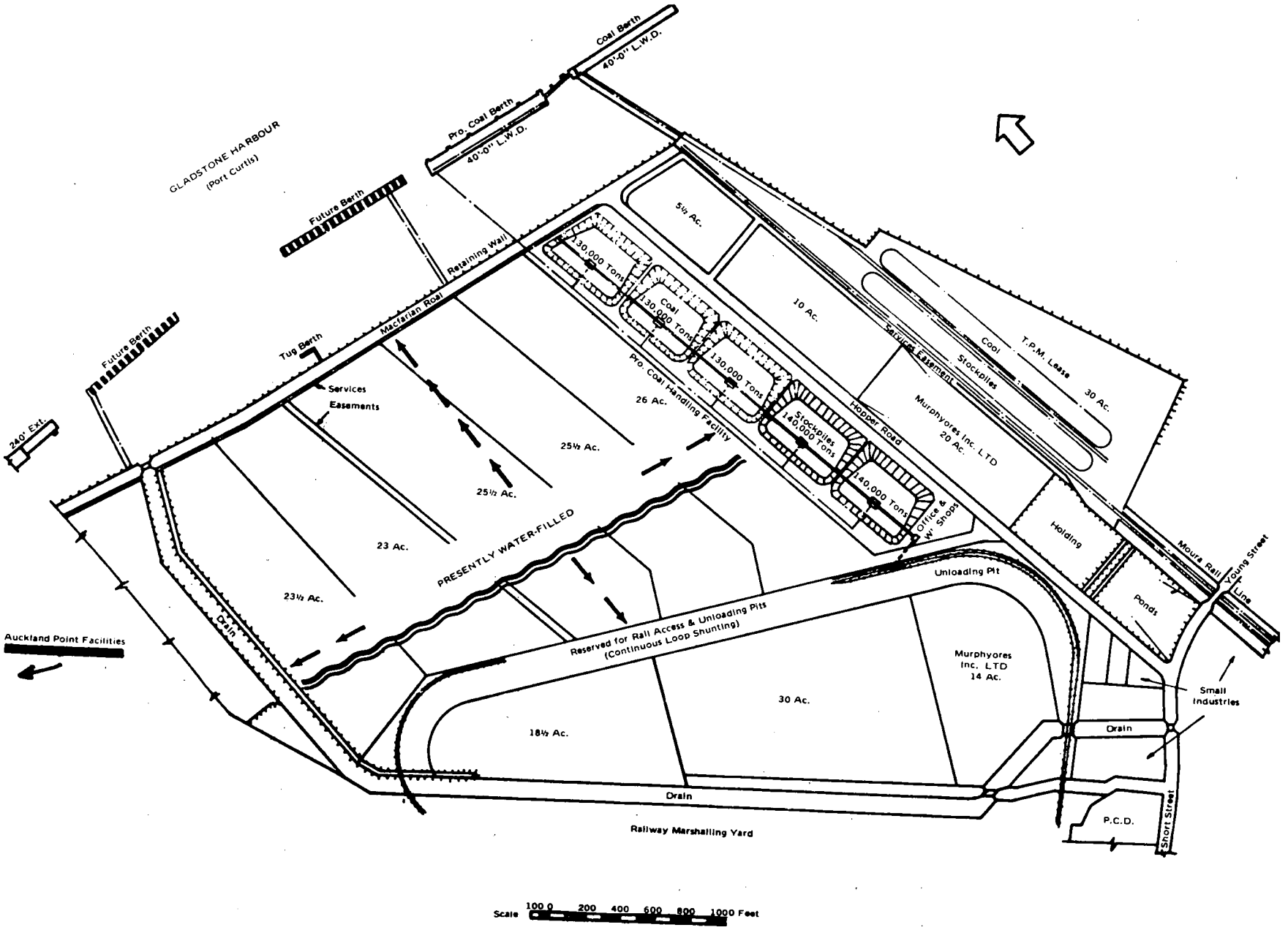
Grain-handling facilities, erected in 1962, were expanded in 1965. The storage shed has a capacity of 15,000 tons and is equipped with inloading and outloading conveyors.

Concurrent with the expansion of wharves and facilities, the Gladstone Harbors Board embarked on a land-reclamation scheme. In 1965, a scheme was begun to reclaim 300 acres of land between Auckland Point and Barney Point, as illustrated in Figure F-4. Another project on the western side of the town brought a further 50 acres of land into use by 1970.

b. Work in Progress and Future Plans

A geophysical survey and test-boring program is being carried out to determine the most economical approach to the Port for vessels of 100,000 dwt capacity. Q.A.L.'s South Trees wharf is being expanded, and bulk facilities enlarged. Two land-reclamation schemes are proposed, one in

FIGURE F–4 AUCKLAND POINT/BARNEY POINT DEVELOPMENT



the port area to provide a further 250 acres, and another eastward into the Auckland Inlet/Calliope River area, adjacent to the new power site, to reclaim a further 1,600 acres.

Tenders have been let for a bulk ship loader linked to the grain storage sheds and for a new silo complex (10,000 tons capacity). Tenders have also been let for major reconstruction and extension of the Auckland Point Wharf.

c. Port Facilities

The port facilities in Gladstone comprise three berths with an approach channel. This channel is some six miles long, with a bottom width of 600 feet dredged to 34 feet at low water. The tide fluctuation between high water neaps and springs is from 9 to 16 feet.

1. Auckland Point, owned by Gladstone Harbors Board has three berths. The bulk-handling plant is equipped with a travelling-gantry loader which traverses No. 1 berth for a length of 370 feet. A telescopic chute fixed to the boom on the loader can be moved out 50 feet from the wharf face, and a trimmer mounted on the telescopic chute is capable of throwing 50 feet in any direction. The loader is connected to the stockpile area by a 36-inch conveyor, and loading capacity is 800 tons per hour.

2. Barney Point, which has a single berth, is the property of Thiess Peabody & Mitsui, Ltd., and has a travelling-gantry ship loader that traverses the wharf for a length of 520 feet and is designed to load 60,000 dwt vessels at a rate of 2,000 tons per hour.

3. South Trees, for alumina handling, consists of two berths owned by Queensland Alumina, Ltd. The eastern section of the wharf is equipped with a loader which has an outreach of 75 feet and a loading rate of 1,200 tons per hour. A similar one was to be installed in 1970. Both the loader and bauxite unloader traverse the wharf for a length of 550 feet.

d. Management

Most Australian harbors are managed by trusts or boards whose members are elected by interested persons, or are appointed by the state government. Gladstone harbor is administered by a board consisting of:

- Five members representing the shires of Miriamvale, Calliope, Banana and Monto;
- Two members representing the Town of Gladstone; and
- Two members representing the Queensland government;
- An Engineer/Manager is responsible for the actual operation of the Gladstone Harbors Board's Auckland Point Wharf.

The Board has full jurisdiction over the two private wharves, Barney Point, and South Trees, but seldom interferes with the management of these wharves; preferring to work co-operatively with the owners, Q.A.L., and Thiess Peabody Mitsui.

The financing of port operations is carried out with funds earned through harbor dues and various wharf charges and by government approved low interest bank and treasury department loans. All surplus funds are re-channelled back into harbor improvements and foreshore development.

e. Port Finances

A comparison of 1964 and 1970 fiscal year balance sheets shows the rapid development of the port and the financing of this development. Loans increased from $2 million in 1964 to $5 million in 1970. Inscribed stock showed a very sharp rise from $0.9 million to $5 million. The Board's policy of developing foreshore land by reclamation greatly increased the value of such land, from $1.2 million to $4.7 million. The reclaimed land will be used principally for ancillary light, medium, and heavy industry. The sale or rental of this land will put the Board in a strong revenue-earning position allowing continued expansion of the port and facilities.

Revenue emanating directly from the port services (harbor dues, tonnage rates, fees, and licenses, etc.) has more than tripled during this period. The large investment in improving the wharf and storage and handling facilities resulted in a value increase from $2 million to $7.3 million. The position of the Gladstone Harbors Board is a healthy one. Liabilities in the form of loans, stock, and debentures have risen somewhat from $3 million to $10 million (i.e., 241%) from 1964 to 1970, along with the value of the fixed assets, land and wharves, from $3.3 million to $18 million (i.e., 267%).

Table F-5

Revenue Account For The Port Of Gladstone
(Australian Dollars)

INCOME		
Sale of land & property, reclamation refunds	A.$ 62,437	--
Harbor dues, tonnage rates, rents, conveyor handling charges, plant hire, mooring fees, licenses, interest on investments, etc.	606,591	A.$1,956,063
Sundries	932	--
	669,960	1,956,063
EXPENDITURES[2]		
Administration	19,786	71,275
Repairs & maintenance, gen. expenses	252,845	76,188
Interest, Redemptions	145,745	408,634
	418,376	556,097
Excess of Income over Expenditure	A.$251,584	A.$1,399,966

[1]Year ended June 30th.

[2]Does not include purchase of land, equipment, development expenditures, or depreciation.

Table F-6

1964 Balance Sheet for the
Gladstone Harbors Board

LIABILITIES		ASSETS	
Creditors	12,760	Debtors	42,099
Contractors Deposits	4,690	Harbors Fund	75,428
Treasury Dept. Loans	507,000	Loan & Trust Funds	56,154
Inscribed Stock	724,680	Interest Bearing Deposits and Loans	284,000
Debenture Loans	1,034,646	Plant & Stores, Office furniture & equipment	208,193
Capital A/C	914,350	Land	894,564
		Buildings	1,637,668
		Petty Cash	20
	A.$3,198,126		A.$3,198,126

Table F-7

1970 Balance Sheet for the
Gladstone Harbors Board

LIABILITIES		ASSETS	
Creditors	25,609	Debtors	163,987
Rent P/A	38,552	Harbor Fund	127,256
Treasury Dept. & Loans	1,632,035	Interest Bearing Deposits	1,024,000
Commonwealth Gov't. Loans	125,500		
Inscribed Stock	3,832,243		
Debenture Loans	2,137,412	Unexpend. Loan Funds	
		Bank A/C	97,516
		Interest Bearing Deposits	475,500
		Plant, Stores, Office Furniture	312,172
		LAND less advances	3,602,642
		Wharves, buildings, harbor installations	5,648,022
Capital A/C	4,861,456	Investments, State Electricity Comm.	40,000
		Petty Cash	20
		Sinking Fund Balance	14,856
		Roads & Developmental Dredging	1,146,836
	$12,652,807		$12,652,807

F.3.9 Pollution

Information so far received on pollution is sketchy and inconclusive. There appears to be some measure of air, sea, and land pollution in Gladstone from the various operations in and around the town. An anti-pollution committee has been formed, but we know little of its operations except that any new project must be reviewed by the committee.

Emissions from the Q.A.L. plant, and coal dust from stockpiles, are the major source of air pollution. Q.A.L. has taken steps to reduce the emissions.

Q.A.L. disposes of red mud from the alumina reduction process in huge earth-enclosed burgs near the plant. As the burgs fill up they could eventually become an aesthetic eyesore. University of Queensland students are carrying out experiments with the mud in an attempt to find some form of vegetation which will grow successfully on the burgs.

There is a ship's-waste incinerator on the wharf to treat ship's garbage. No major oil spills have occurred along the shore line from ships calling at the port.

Caustic is discharged from the Q.A.L. plant directly into the sea, but no scientific experiments have been carried out to determine the effects of the caustic on marine life.

There is little or no commercial fishing in the waters off Gladstone, and "Sunday fishermen" are divided as to the effects of the caustic; some claiming it improves the fishing, others claiming that the fish "taste", and are not as prolific as in previous years.

The anti-pollution committee was effective in changing the selected location of the proposed Gladstone power plant. The dangers of thermal pollution at the original site were such that a new location had to be found.

Any discussion of sea pollution must take into account the Reef. This natural and beautiful barrier of coral islands and submarine reefs stretches from New Guinea to south of Gladstone, forming a natural blockade to both ships and violent wave action. Once inside the reef there are few exits to the open sea, except through Torres Strait between Cape York Peninsula and New Guinea, which has a limiting draught of 30 to 35 feet.

Ships transporting bauxite from Weipa must come down inside the reef, and ships delivering or taking alumina and coal oil must pass through the Capricorn Channel near Gladstone. The reef-strewn waters make navigation tricky and the increase in vessels using these waters as a result of the Gladstone development multiply the chances of spills. No special efforts have been made by the Gladstone Harbors Board or industries associated with the port to reduce the chance of an accidental spill, but should such an event occur there would be a wide-spread public outcry. Furthermore, industrial development on the coast could increase effluent discharge, such as Q.A.L. caustic, to a dangerous level.

An attempt to drill for oil in the waters between reef and mainland was finally defeated through the intervention of the Queensland government. The decision was a major one for this development-conscious state, so reliant on new industries to escape from its agricultural bondage.

Should pollution occur, therefore, State and public pressure would probably combine to enforce changes to ship design, optimum ship size, and navigational aids, as well as industrial waste disposal methods, sufficient to directly affect the port and town of Gladstone and other northern Queensland ports.

APPENDIX G

DEEPWATER PORTS OF JAPAN

APPENDIX G -- DEEPWATER PORTS OF JAPAN

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APPENDIX G

DEEPWATER PORTS OF JAPAN

G.1 SUMMARY

Based on a literature survey and a few short interviews with top representatives of the Bureau of Port and Harbors, Ministry of Transport, and Tokyo Tanker Co., Japan ports appear to be a mainstay of remarkably dynamic economy and of an active regional development policy. Given the high population and activity concentration, and the constricted land and coastal environment, plagued every other year by some major disaster, it is not surprising that the local environment has often been severely affected, to a degree unknown elsewhere.

From this brief survey, we have extracted the following highlights of Japan deepwater port experience.

- Although foreign trade accounts only for 10% of Japan's GNP, the shipping industry and ports are closely knit together, mostly because the country is 95-100% dependent on overseas sources for major raw materials (crude oil, iron ore, coking coal) and the limited flat land is available only at seaside.

- Population and activity are concentrated in a 450-mile-long cluster of "Progressive Zones" (18% of Japan's area, containing two-thirds of the national production and 60% of the population) around three bays (Tokyo, Ise, Osaka) and the Inland Sea.

- Municipal ports, with public and private terminals (handling 70% of all cargo), are subsidized by the Japanese government in variable ratios:
    - depending on importance to the economic, social and regional policy (40-100%); and
    - decreasing with depth for bulk terminals (from 50% for less than 40 feet to 10% beyond 53 feet).

- Congestion is chronic in both ship and cargo handling. Traffic has outstripped for 10 years the forecast growth and budgeted improvements, and in urban-industrial development Tokyo Bay is "choked".

- Land shortage is acute (now reclaimed at $35,000/acre versus $5,000 in 1955).

- Ships under construction draw up to 95' for oil (500,000 dwt), 80' for ore (300,000 dwt), and 40-45' for containers.

- Lack of deepwater natural sites has led to the use of excavation techniques on flat unprotected coastline, and offshore islands or sea berths, which have helped reduce channel congestion.

- Strong engineering experience has been acquired on deep dredging, deepwater and soft-ground construction, and storm-tide protection. Extensive research has been carried out on tugs and superships, lateral resistance of piles, underwater concrete and soil packing, model tests, and site testing of dikes.

o As earthquakes, stormtide or tsunami cause extensive damage almost every other year, Japan has only recently become sensitive to man-made aggressions to the environment:
  - excessive ground water pumping by industry causes ground subsidence in the "Progressive Zones";
  - marine pollution, stemming from industrial plant effluents, dry bulk storage run-off or fertilizer leaching by rain, has caused a variety of diseases in people and seafood;
  - Oil spills, bilge pumping, raw sewage and solid waste discharge, and dredging-polluted silt have all affected the quality (odor, taste) and/or the volume of seafood catches.

- Current planning calls for increased attention on environmental matters and foresees:
  - new industrial ports for a) decongestion of progressive zones,
  - b) transport efficiency; and
    c) balanced regional development
  - energetic action on industrial bays to:
    a) specialize piers, ports and zoning (confine heavy industry and hazardous cargo handling);
    b) rationalize communications to hinterland;
    c) improve water quality and living amenities; and
    d) build outside congested bays; offshore islands to keep tankers out, and distribution ports to serve the hinterland from behind, with products manufactured in the new industrial ports.

Tokyo Bay, the worst area in which air pollution and urban congestion are added to extreme marine pollution, is expected to be closed to all tankers as soon as the Futtsu terminal is completed outside the bay and the canal to New Kashima port on the Pacific coast, east of the bay, is put into operatinn.

G.2 BACKGROUND

The economy of Japan is the most dynamic economy in the world (over 10% annual growth for the past 10 years) and is tightly linked to coastal industry and port development under a wide array of constraints.

In an area barely larger than Norway or Montana (140,000 square miles), slightly more than 100 million inhabitants and 27,000 square miles of cropland coexist on only 29,700 square miles of flat land, leaving just 2,700 square miles for dwellings and industrial uses.

The high average population density of 690 people per square mile (the U.S. average is 57 overall, 370 in Middle Atlantic States) is further concentrated by geography and industrialization in four major areas within 450 miles of the southern ocean front, as shown in Figure G-1.

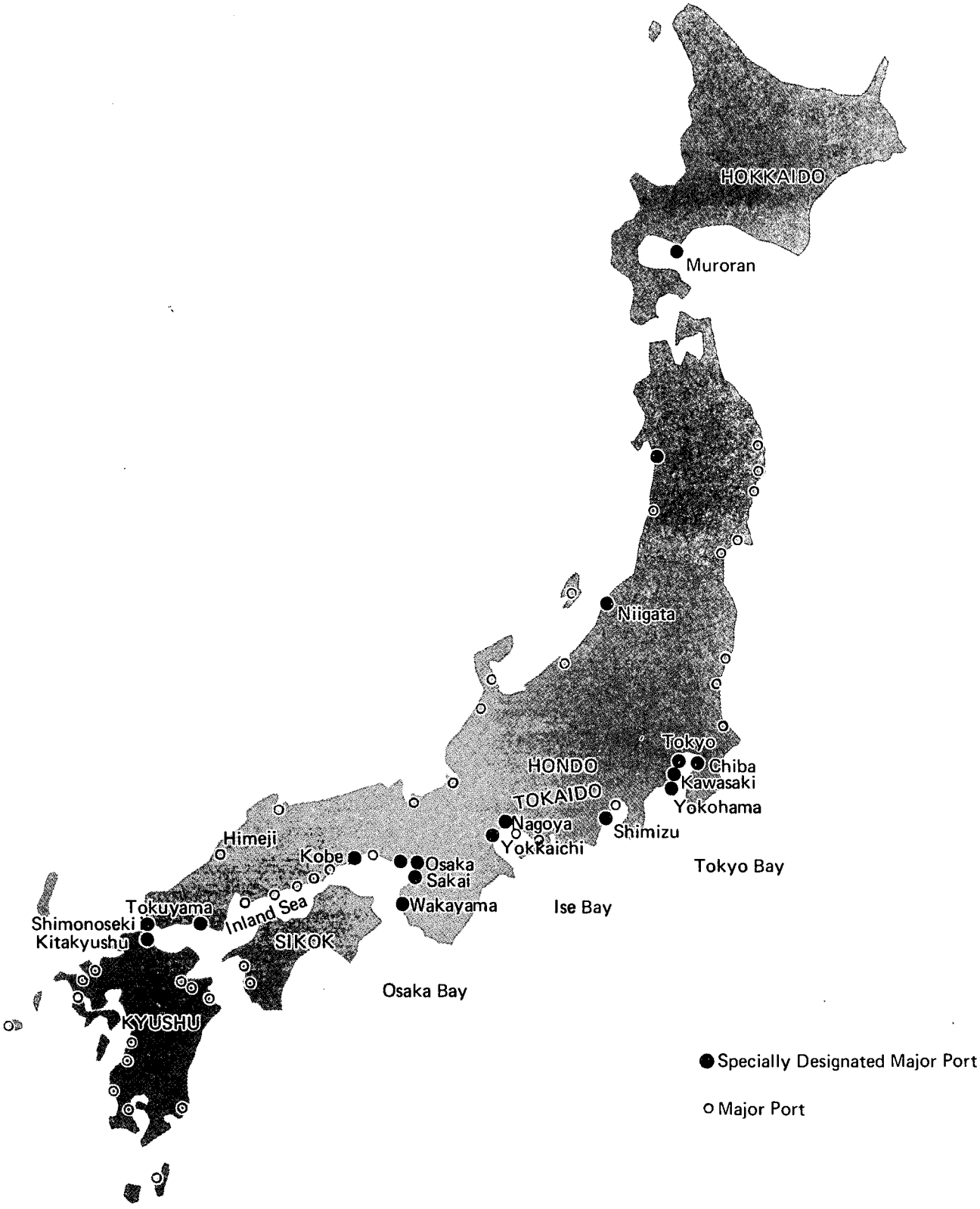

FIGURE G-1 MAIN PORTS OF JAPAN

The climate in Japan is generally temperate and rainfall is abundant. Agriculture has concentrated on cultivation of rice as a prime crop since ancient times, and fishing is a major industry and source of food. Mineral resources are scarce, and 95% or more of the iron ore, coking coal, and petroleum must be imported.

In the early 1900's, Japan commenced industrialization and advanced from light industry to the more recent heavy and chemical industries. Even though the export trade is less than 10% of the GNP, the biggest reason for Japan's success in industrialization is attributed to the effective utilization of her coastline and coastal areas. Notwithstanding the frequent attack by natural calamities, such as typhoon, earthquake, tsunami, etc., on her land, shore, and sea, the geographical characteristics and topography of Japan allowed the construction of large, deep ports, and ideal seaside industrial zones. This facilitated regular shipping service to bring in raw materials, and export finished products. Consequently, the provision of more new ports and the improvement of existing ports and harbors are of paramount importance. In fact, a linear relationship between cargo handling and GNP is a major factor in national economic and port planning.

Japan has a total coastline extending 16,700 miles and containing 1,058 ports, including 17 specially designated ports (for foreign trade), 80 major ports, and 951 local ones, a ratio of one port per 16 miles of coastline. About 40% of all the cities in Japan have ports, and their population accounts for 60% of the total Japanese population. For example, big thriving cities like Tokyo, Yokohama, Nagoya, Osaka, and Kobe invariably have their own ports.

Harbor facilities were more than 60% destroyed during the latter stages of World War II, and it was not until 1955 that they reached pre-war levels in terms of asset value. Facilities are now four times the 1955 level.

Here, as in Western Eurpoe, crude oil imports have played a major role in fostering the development of deepwater ports and is expected to continue: Japan's oil consumption--about 150 million tons per year in 1970 and growing at 13% per year-- is more than 99% imported.

G.3 PORT MANAGEMENT AND FINANCING

G.3.1 Administration

The 1950 Port and Harbor Law marked an important iilestone in port administration, by replacing centralized, national ownership of ports with port authorities--set up separately by local public entities--to develop or manage the ports in the capacity of "Port Management Bodies."

According to the law, there are three forms of port facilities construction: 1) direct government works undertaken by the central government through the Ministry of Transport (MOT), with the cost shared between the state and the Port Management Body; 2) subsidized works undertaken by the Port Management Body, with only part of the cost supported by the state; and 3) independent works undertaken by the Port Management Body on its own budget. Completed port facilities are placed under control of the Port Management Body (PMB).

The law stipulates that port facilities under control of the Port Management Bodies shall be offered for public use and operated to be available to any person under the same conditions. The Management Body may be provincial in scope (Niigata), or more often municipal (Tokyo, Osaka). State duties are shared by various Ministries; e.g., Ministry of Transport (supervision of PMB for development, financing, cargo handling, safety of navigation, signals, and lights), Ministry of Forestry and Agriculture (fisheries, animal, and plant inspection), Ministry of International Trade and Industry (import and export licensing), etc.

G.3.2. Funding Structure

The MOT Planning Department estimates the typical share of port construction costs as follows:

Breakwaters and structural work	30%
Channel dredging and improvements	30%
Quaywalls and superstructure	30%
Roads and communications	10%

Private investment in cargo handling and warehousing is generally similar to road investment by the government. Practically all of the actual construction work is implemented by private firms.

For basic port infrastructure, including breakwaters and channels, the government (MOT) provides theoretically a variable share of the capital funds, depending on port type:

- Specially designated foreign trade ports (18), 75%;
- Major harbors (80, including 19 beyond 100,000 dwt), 50%;
- Local harbors (951), 40%; and
- Refuge harbors (10), 100%

The actual share is somewhate different depending on location and negotiation. For example, the August, 1967 law for special port project expansion provides for 40% MOT, 40% prospective operator, 10% PMB, and 10% local government shares in loans to ad hoc Development Authorities in Osaka Bay and Tokyo Bay. These reduced 50% subsidy applies to important but congested areas.

Yokohama, an artifical island with 40 foot depth for general cargo and containers, has been subsidized over 75% MOT, "because of the leading position of the port for Japan economy". On the Sea of Japan side, the infra-structure of the East Niigata integrated harbor is 79% subsidized by the state as a depressed area. Reciprocally, the government has lately become concerned over the benefits enjoyed by a particular group of enterprises from the high cost development of deepwater bulk terminals. The share of port infrastructure expenses to be borne by private enterprise has thus climbed substantially, as shown in the fiscal 1970 budget

(Table G-1).

TABLE G-1

1970 DISTRIBUTION OF DREDGING COSTS IN PETROLEUM AND IRON ORE PORTS

Depth	Government	Port Mgt. Bodies	Private Companies
down to -40'	25%	25%	50%
-40' to -46'	20	20	60
-46' to -53'	15	15	70
-58' and deeper	10	10	80

Quaywalls, basins, and reclaimed land related to all four port categories are subsidized in the same amount by the government. But only those facilities administered by the Port Management Bodies receive such a subsidy. Some 70% of the trade volume is still handled in unsubsidized private berths, but this percentage is expected to decline somewhat.

As another illustration, the new port of Kashima (Sumitomo steel plant; 200,000 dwt ore carriers) is being created east of Tokyo to relieve the Tokyo Bay congestion and help a depressed area. About 200 billion yen ($550 million) will have been invested between 1960-75, including 70 billion yen of public investment and 130 billion yen of private investment--a relatively low public share. An additional 800 billion yen ($2.2 billion) in land preparation and utilities will be spent by private interests.

The financial situation of Japanese ports remains precarious. Mooring facilities and storage facilities are deemed a source of revenue by law, but--within the context of public service--the corresponding fees assume the character of commissions and are quite small by world standards. When the initial government subsidy is taken away, consolidated accounts of public ports show 1/3 supported by the sponsoring local public entities and 1/3 stemming from bond floating. This situation is being modified, as in most world ports, in the direction of higher port charges. Between 1955 and 1965, the growth of public harbor assets

averaged 7% annually; and was 9% between 1960 and 1965, lagging much behind the increase in cargo volume handled.

G.4 ECONOMIC FUNCTIONS

G.4.1 Traffic

Japan's ports and harbors are closely associated with economic activities in production and distribution industries. Figure G-2 shows excellent linear correlation between the gross national product (GNP), the index of mining and manufacturing production (IMM), and the cargo volume handled at ports. Namely, there is an increase of about 13 million tons in cargo handling volume for every $1 million increase in GNP, or for every increase of 1 in the IMM index. Table G-2 shows the evolution of cargo volume, with an annual average increase of nearly 15 percent over the 19-year period, 1950-1969. Of the total cargo volume handled by Japanese ports in 1969, 467 million tons (29%) represented foreign trade, while the remaining 1,148 tons were domestic (down from 75% in 1960).

TABLE G-2

CARGO VOLUME HANDLED IN THE PORTS OF JAPAN

(million tons)

Year	Volume
1910	41
1920	78
1930	126
1940	223
1950	108
1955	245
1960	440
1965	808
1969	1,615

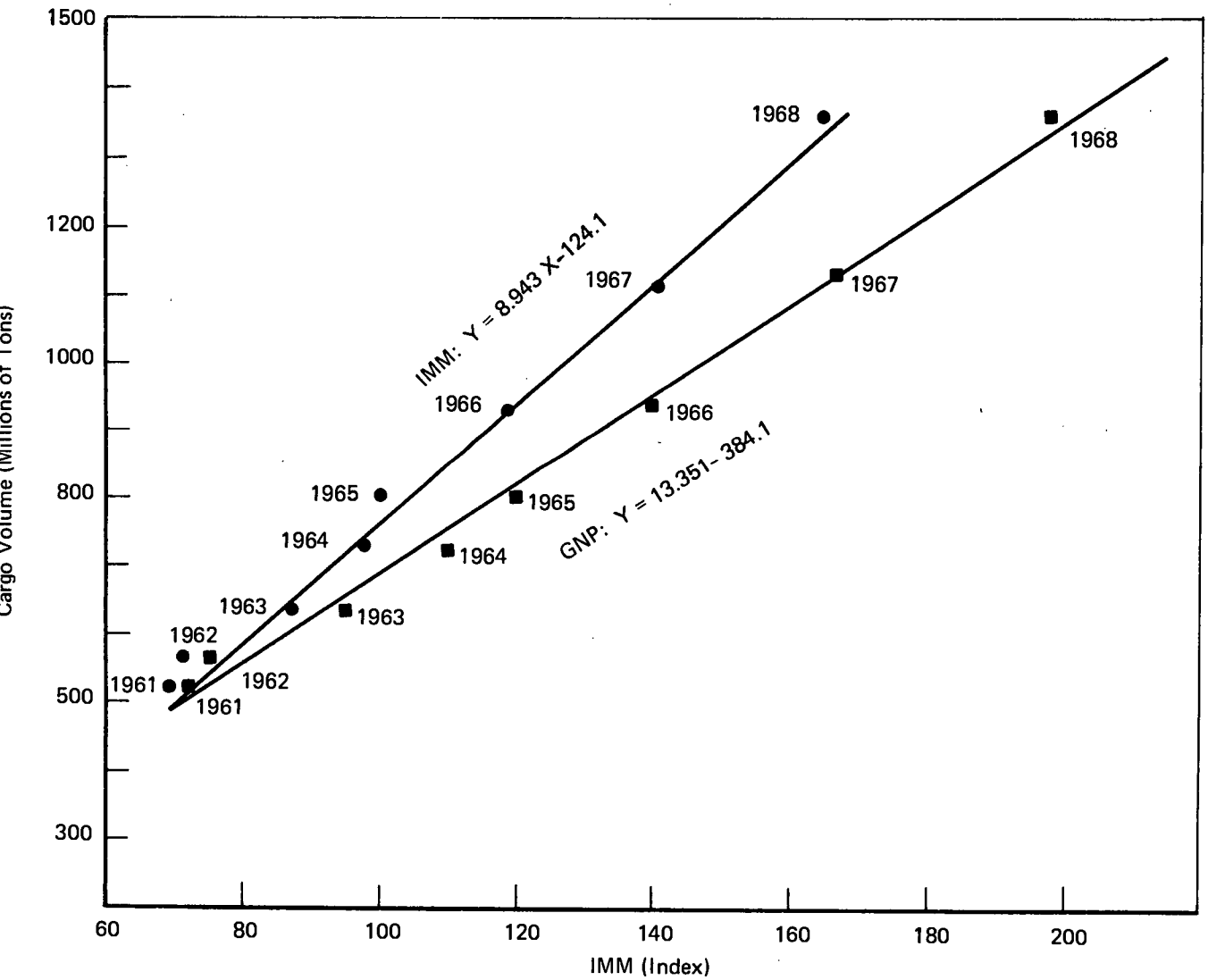

FIGURE G-2 PORT CARGO VOLUME VERSUS GNP AND THE INDEX OF MINING AND MANUFACTURING

Japan relies on imports from overseas for the supply of a wide variety of materials, from staple foods to industrial raw materials including petroleum, iron ore and coal. Table G-3 illustrates Japan's dependence upon foreign sources of supply for major substances. In turn, Japan exports manufactured products to practically every part of the world. Table G-4 shows the 1960 through 1968 statistics for growth in the economy, in port cargos, and in the two major bulk cargos. Crude oil and iron ore imports both increased 4.5 times between 1960 and 1968, to 121.5 and 68 million tons, respectively. In the meantime, the average freight was reduced despite inflation and increase in average distance. The advent of large ships (the average size of bulk carriers ordered in Japan quadrupled between 1960 and 1968, for both oil and ore) about halved the cost of transport per ton-mile. The maximum size of ships cleared by the MOT for construction in Japanese yards in 477,000 dwt for oil and 277,000 dwt for ore.

TABLE G-3

JAPAN

OVERSEAS DEPENDENCE FOR MAJOR RAW MATERIALS

Items	Dependency Rate
Wheat	74%
Salt	80
Coal	51
Petroleum	99
Iron ore	96
Phosphates	100

(1964 data cited from the Foreign Trade White Book)

TABLE G-4

SELECTED GROWTH STATISTICS FOR 1960 through 1968

Economic Growth of Japan

	GNP (millions)	EXPORT (millions)	Production Index of Mine & Mfr. Industry
1960	$ 43,100	$ 4,060	58
1965	88,300	8,450	100
1969	166,400	15,990	186
'65/'60 Ratio	2.1	2.1	1.7
'69/'65 Ratio	1.9	1.9	1.9

Volume of Port Cargoes Handled
(millions of metric tons)

	Overseas Trade	Domestic Trade	Total
1960	107	338	445
1965	242	585	827
1968	397	983	1,380
'68/'60 Ratio	3.7	2.3	3.0

Imported Iron-Ore, Crude Oil

	Volume of Import (1,000 M.T.)	Average Distance of Transport (Sea Miles)	Average Freight ($/Ton)	$/Ton 1000 Nautical Miles
Iron Ore				
1960	15,036	4,404	5.50	1.25
1965	39,018	5,982	5.00	.84
1968	68,143	6,340	3.80	.60
'68/'60 Ratio	4.53	1.44	0.69	.48
Crude Oil				
1960	27,056	6,077	5.82	.96
1965	73,095	6,490	3.81	.59
1968	121,469	6,438	3.45	.54
'68/'60 Ratio	4.49	1.06	0.59	.56

The volume of domestic cargo movement has grown at a slower pace, about 10% per year between 1956 and 1965 (1965 was a recession year). Shipping has maintained a 10% share of national cargo transportation for the first five years, but declining to 7% between 1960 and 1965; while road transport was growing from 68% to 82%, mostly at the expense of rail transport. Shipping remains the cheapest transportation beyond 1000 miles, and its share in ton-miles increased from 36% to 42% during the same period.

G.4.2 Port Congestion

The tremendous increase in traffic has not been without ill effects. When the 7% growth in harbor assets is matched against twice as large a growth in cargo volume, it is not surprising that congestion has become a chronic illness in Japanese ports. MOT plans, for example that public berths of 25 to 35 foot depth should handle 1000 tons per linear meter of quay. The average for all public ports has been rather constant around 1200 tons per meter in the past decade, but major ports are handling up to twice that much (Tokyo: 1,950; Osaka: 2,410). Conversion factors of 1/3 and 2/3 are applied to berths of less than 13 feet, and 13 to 25 feet, respectively, in the calculating of these ratios.

The average waiting time for ships is over a day at the major city ports, despite the fact that offshore barge unloading still accounted for 70-85% in 1965 in Yokohama and Kobe, 45% in Moji and Osaka, and 20% in Tokyo.

Table G-5 shows the average turn-around time of large (60,000 dwt and over) tankers in some Japanese harbors, compared to other world unloading ports. Although some improvement shows in the last year, the average is still higher than Europe and the United States.

TABLE G-5

LARGE TANKERS' AVERAGE PORT TIME

		1966	1967	1968	1969	Average 1969
EUROPE	Gothenburg (Sweden)	-	0.9	1.0	0.9	1.53
	Rotterdam	1.6	1.8	1.6	1.8	
	Antwerp	2.0	1.7	1.8	1.9	
	Le Havre	1.4	1.7	1.5	1.5	
U.K.	Milford Haven	1.5	1.7	1.9	1.8	1.55
	Fawley	1.6	1.5	1.3	1.3	
U.S.A.	Portland, Maine	2.1	1.7	1.8	2.1	1.95
	Philadelphia	1.8	1.9	1.9	1.8	
JAPAN	Yokohama	3.0	3.0	2.9	1.8	2.25
	Chiba	3.1	3.1	2.6	2.6	
	Yokkaichi	2.8	2.6	3.0	2.5	
	Mizushima	2.3	2.5	2.2	1.9	
	Tokuyama	2.5	2.6	2.2	3.0	

Source: Fearnley & Egers, Large Tankers, 1970.

G.4.3 Coastal Industrialization

European migration of industry to the coast is a post-war development fostered by impoverishment of national resources and reduction in shipping costs. In contrast, Japanese industrial establishments industry originally located close to ports to be on flat land and near the overseas sources of raw materials. There is also an historical reason since industrialization proceeded essentially when Japan was opened to foreign (overseas) influence by the Meiji restoration. Development centered in large consumption areas, in the vicinity of what are now called "Progressive Industrial Zones": Kehin (Yokohama, Tokyo, and Chiba), Chukyo (Nagoya and Ise Bay), and Hanshin (Osaka and Kobe) which, with Kitakyushu on the west Inland Sea, presently account for 2/3 of the total industrial production. In these areas, the 1965 ratio of coastal industrial production to Japan production was 46% for the whole industry sector, and was 86% for petroleum and coal products, 75% for iron and steel, and 57% for chemicals.

These industrial zones--which constitute the overpopulated urban centers in Japan--are beginning to feel various restrictions to further growth as industrial districts, owing to the deteriorating situation on the fundamental facilities for industrial activities, as typified by the shortage of industrial water, and the public hazards threatening the living environments of the inhabitants.

Meanwhile, overemphasis on industrial activities in selected areas has brought about a wide economic disparity by regions, particularly in personal income: from one prefecture to another, manufacturing production varies from $100 million to $9 billion while personal income varies from $2 billion to $100 billion.

Consequently, since 1960, a program of regional dispersal of industrial activities has been under way to achieve further growth in national economy through industrial development while at the same time seeking to correct economic disparities without downgrading the living environment of inhabitants in the Progressive Zones.

G.4.4 Land Shortage and Reclamation

The scarcity of flat land and the concentration of population have forced Japan to an intensive land exploitation. Land reclamation is an ancient practice, and the use of dredging spoil began in the early 1900's, as natural deep water sites grew scarce in populated areas; industrial ports like Kobe, Chiba, and Kawasaki have grown that way. Table G-6 shows the growth to the land reclamation program in Japan, in acreage and cost. The increase in unit cost between 1955 and 1965 from $5,000 to almost $30,000 per acre of industrial or city land reflects--more than inflation--the increased depth of fill. Current costs average $35,000 per acre.

TABLE G-6

ANNUAL LAND RECLAMATION

Year	Industrial Acres	Industrial Cost (millions)	City Construction Acres	City Construction Cost (millions)	TOTAL Acres	TOTAL Cost (millions)
1954	200	$ 1.0			200	$ 1.0
1955	320	1.5			320	1.5
1960	2,375	63.5			2,375	63.5
1961	4,710	139.	550	$ 4.7	5,260	144.
1965	6,760	188.	900	26.5	7,660	214.
1964-68*	42,000	1,181.	10,000	486.	52,000	1,607.
1967-71*	52,500	1,528.	17,500	861.	70,000	2,389.

* 5-year plans

G.4.5 Economic Plan and Improvement of Port Facilities

Since 1955, when Japan finally recovered from the war, and harbor assets came back to prewar levels, six National Economic Plans have been launched consecutively. These plans are: the Five-Year Self-Supporting Economic Plan, 1955 the New Long-term Economic Plan, 1957; the Doubling National Income Plan, 1960; the Intermediate Economic Plan, 1964; the Socio-Economic Development Plan, 1966; and the New Socio-Economic Development Plan, 1970. Except for the latest and current one, projected growth rates were outstripped by the actual growth rates, and modifications were required after only two or three years of implementation.

As in France, the national economic plan seeks to direct the nation's general economic policies--serving as a guideline to private enterprise and business activities, without controlling or restricting them. The goal of a five-year plan is adjustable, and the plan itself is flexible and subject to modification in line with changes in international economic situations, trends in equipment investments, and fluctuation of prices.

The New Socio-Economic Development Plan, formulated in 1970 for completion by 1975, has set the actual economic growth rate at 10.6% and the GNP at US$267 billion in terms of the 1957 price level. This plan defines four major tasks: 1) internationalization and streamlining of the economy; 2) price stabilization; 3) promotion of social planning; and 4) maintenance of reasonable economic growth and promotion of economic development. Since these tasks are not independent, but correlated with each other, it is necessary to deal with them comprehensively and systematically for attaining a higher rate of growth and overall efficiency.

In particular, it is recognized that the capacities of ports and harbors are a controlling factor for the distribution of cargoes. The development of industrial ports is a powerful tool for economic growth as well as regional development. Social development, safety and elimination of public nuisance are essential to qualitative improvement of living conditions, not only in city life but in port and transportation activities. Consideration will be given to the reclamation of land that is free from public nuisance, consolidation of port facilities to secure safety, improvement of narrow channels, and provision of facilities to prevent public nuisance in harbors and sea.

G.4.6 Development Planning

The actual planning process may be summarized as follows.

a) First, a macro-economic model, with some 60 equations, will project the GNP and given various assumptions, the optimum amount of government investment.

b) The Ministry of Transport will establish 15-20 year forecasts from the correlation between cargo volume and GNP shown in Figure G-2. From these will be developed a five-year forecast for the port construction program, separated into domestic and foreign trade, and general cargo and bulk. These cargo volumes are then allocated between private company berths and public PMB' berths.

c) MOT will then evaluate technical and budgetary requirements,

starting from specific ratios such as : general cargo to be handled at the rate of 1000 tons per meter of quay length per year for 10 meters or more draft. Bulk cargo will be much larger, and containers may be handled at the rate of 600,000 - 800,000 tons per berth per year. Average budget requirements are approximately 10 billion yen ($28 million) per 1000 meters of quay wall for both infrastructure and superstructure.

In steps b) and c), MOT works with the local port authorities and company ports. There are no formal attempts to regionalize planning programs or to coordinate between competitive ports. In the major trading bays, Tokyo and Osaka Bays, port authorities and government are quite concerned about the need for more coordination. Both bays may even end up by having an area-wide port authority, already created on paper to handle overall government subsidy. But even MOT does not expect it to really work for 10 years, as those proud individual ports are quite jealous of each other. New consciousness about problems such as those encountered in Tokyo Bay -- water pollution, lack of land, sea traffic construction, road congestion, air pollution by industry--may force the issue.

In the meantime, the government, besides giving its subsidies to the Bay Development Authorities (1967 law) rather than to the ports, is considering a new distribution port outside Tokyo Bay, near Kashima, to decongest the Bay. The main function of the port will be to receive and distribute oil products refined in the new refining and petrochemical industrial port planned in the north, in New Tomakomai near Muroran. Pipelines will carry these products inland, into the "backyard" of Tokyo-Yokohama-Chiba. If accepted, the Chiba canal project will provide an additional linkage.

Planning is present on the cabinet level as an attempt to save the major urban areas from choking while promoting the economy of less advanced zones, under the "Master Plan for Developing New Industrial Cities and Special Areas for Leading Industries." Illustrated on Figure G-3, this plan shows almost exclusively the coastal locations.

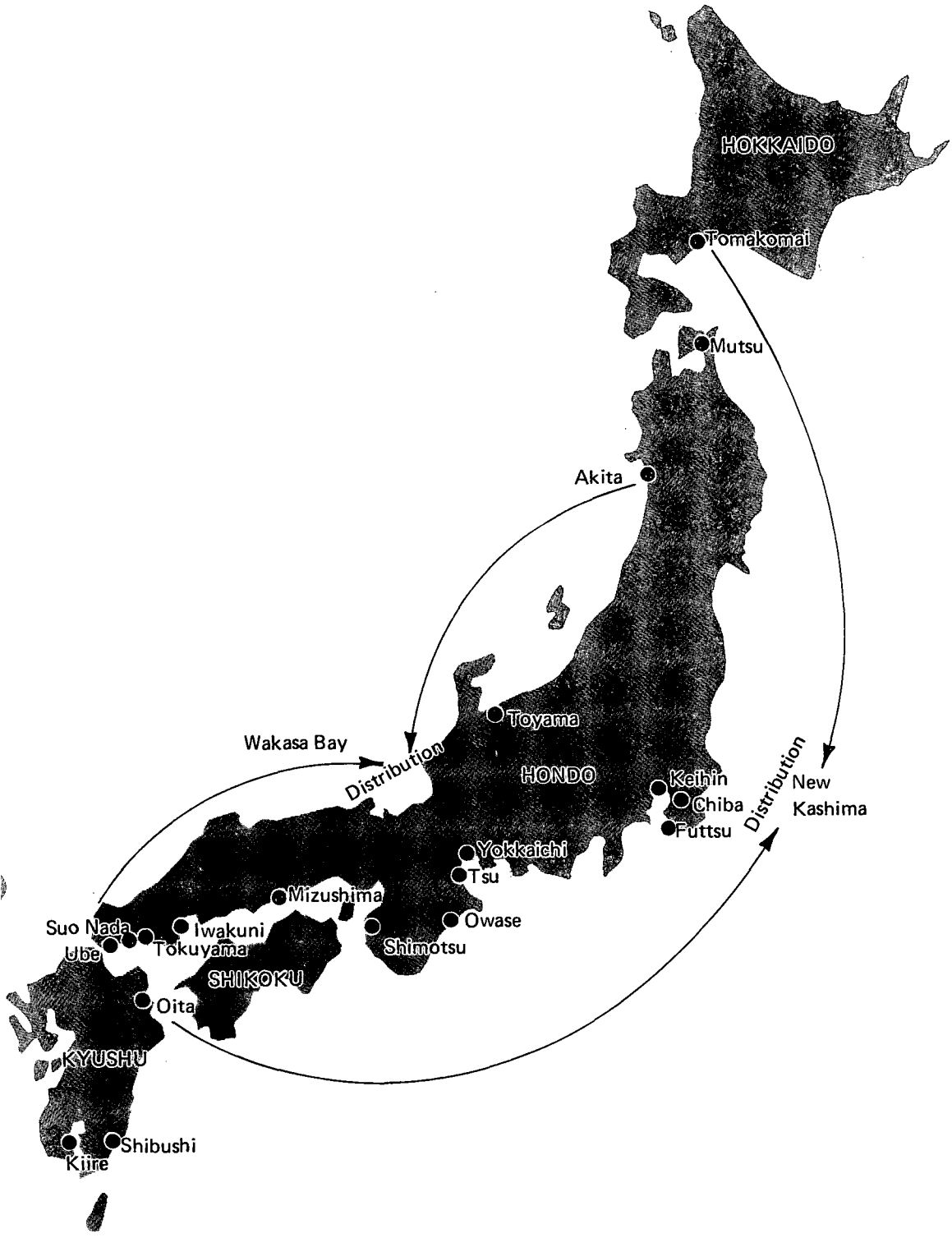

FIGURE G-3 PORT PROJECTS OF JAPAN

As a result of this planning process, total public investment during the six years from 1970 through 1975 was fixed at $153 billion (at the 1965 price level), aiming for $267 billion of GNP in 1975, and a 10.6% annual average economic growth rate.

This investment should cover traffic facilities, land preservation, living environment, education, agriculture, and others and includes $5.3 billion for ports. Although this allocation is not sufficient to meet all the requirements, it was judged as the maximum possible investment considering financial resources and current price levels, despite the recognized important role of ports and harbors in implementing the economic plan.

During the past decade, public investment in ports amounted to $8.4 billion with an additional $1.7 billion for 67,000 acres of seaside industrial land reclamation. We have seen that this amount has not been sufficient to prevent congestion in the major city ports, so that the current plan was revised and a New Five-Year Plan for Ports and Harbors from 1971 through 1975 was drafted. In this plan, the total quantity of cargo handled in all Japanese ports is estimated at 3,380 million tons in proportion to GNP, and the amount of investment is assumed to be U.S. $6.9 billion, based on the policy of the New Socio-Economic Development Plan. The goals of the plan are the development and improvement of: 1) Ports for physical distribution, 2) Ports for regional development, 3) Facilities to ensure safety, 4) Facilities for the prevention of public nuisance, and 5) Facilities for promoting port function (transfer).

By comparison, the third five-year port and harbor improvement plan (April 1965 to March 1970) budgeted $1.5 billion (including $850 million government subsidy) for infrastructure, and 280 million dollars for superstructure--about 1/4 the new 1971-75 plan.

Similarly, following the government's New Plan for Economic and Social

Development (April 1970), the Energy Research Council to the Ministry of International Trade and Industry (MITI) was called upon to revise their last forecast, made in February of 1967. The latest total energy requirement forecast envisions a need for 2.75 billion barrels in oil equivalents for 1975, or 1.42 times the previous forecast, and 5.9 to 6.6 billion barrels of oil equivalents in 1985 or 1.7 to 1.9 times the previous forecast (depending on whether 7.8% or 8.9% is taken as the annual growth rates for 1976 to 1985).

The dependence on imported energy is forecast at 72.8% for petroleum and petroleum products in 1975 and 67.2 to 68.5% in 1985. It is of interest to note that over 10 million tons of LNG imports have been forecast for 1985. Crude oil and fuel oil imports will increase from 1.4 billion barrels in 1970 to 2.1 billion barrels in 1974.

The 1970 forecast indicates that the total requirement for energy in 1975 will be over double, and that for 1985 will be 4 to 8 times the energy required for 1968. The Council in 1970 had reservations as to where all of this energy would come from, and decided to recommend positive measures to develop sources of supply, consider relocation of industries related to energy, and to deal with pollution control.

G.5 ENGINEERING PROBLEMS AND SOLUTIONS

G.5.1 Port Construction Problems

In the course of the past 10 years, Japan has been required to deepen some of the existing ports, to open new industrial ports, to create additional industrial and even residential coastal land, and finally to protect these structures and assets from the assault of the sea, in the constricted and crowded Japanese environment. The Ministry singled out the following problem areas in its 1966-67 Port Annual:

New Industrial harbors

These require proper site selection and a three to five year survey and construction period, in step with plant (refinery or steel mill) erection. Tomakomai, Kashima, East Niigata, New Toyama, Mizushima, and Akita are such examples.

Erection of Structures on Soft Ground

Sites having proper load-bearing characteristics for new ports or old port expansion are becoming hard to find. Displacement of poor material by good sand (100 feet of clay and silt had to be dredged out for the new Kobe breakwater) and the sand drain process (320' wide, 120' deep for Kinio wharf, Nagoya) are popular, but entail long lead time and high costs. Sometimes, a pier-type quay is adopted (Hiroshima). Research is conducted on solidifying the clay under water and on chemical treatments.

Dredging Channels

Because of the decreasing availability of near shore deep water, dredging is being more frequently used to prepare harbor areas. Material handling is often a problem, particularly if spoil cannot be dumped nearby. For long hauls of spoil, a stationary suction dredge may be served by two or three remodeled T-2 tankers (19,200 cubic yard capacity each) moored fore and aft on buoys. For shorter distances, a pusher-tug operates a 960-cubic yard barge (with opening bottom) in up to three-foot swells. Rock cutting has also required various solutions and developments.

Construction in Deep Water

Construction of sea islands and breakwaters in more than 80-100' depth, with 200-foot piles or 3,000 tons caissons as standards, in relatively unprotected waters is a challenge. As in Bantry Bay, much delay may be caused by insufficient floating equipment. These needs are answered in Japan by specialized installations, such as a 138' x 79' x 12' jack-up platforms with 174-foot long legs, to work in 108' of water with a 17-foot clearance.

Construction Materials

Stones, traditionally used for construction are difficult to obtain weighing more than one ton. Reinforced concrete blocks of 1 to 25 tons, are used for wave breaking as well as slope face armour. Among the some 25 types available, the tetrapods, hollow triangles, and six-legged blocks are most popular.

Steel pipes, plates and sheet piles are often replacing concrete in structures, making construction easier and quicker. PVC boards have been used with success to prevent sand and mud seepage through structures. A 3"-thick asphalt mat can prevent the settlement of foundation blocks by increasing frictional resistance to sliding and rotation.

Fishing Rights

Reclamation and channel dredging damage or destroy valuable fishing grounds which must be "bought" from former users. This traditional environmental problem is now only one of many others, borne surprisingly well in such a crowded country (see section G.6).

G.5.2 Alternatives for Port Infrastructure

Since the early 1960's, a considerable number of additional industrial ports have been constructed. Historically, industrial ports developed first in the areas around the ideal harbors with great water depth, such as Dokai Bay and Muroran Port; subsequently, sites were chosen along Tokyo Bay and Osaka Bay. Recently, areas which were previously considered unsuitable have been utilized, first for "reclamation-type" ports and then for "excavation-type" ports. The former is built by reclaiming the shoal with soil and sand obtained from the dredging of fairways and basins (e.g., Kashima and East Niigate). The physical problems involved in such projects are immense, not the last of which is the handling and disposal of vast amounts of excavated material. For example, the MOT must handle 100 million cubic yards of spoil at Kashima and half as much in East Niigata; the material will be disposed of by several means, including beach nourishment, dumping at sea on land reclamation or breakwater sites; raising the land inshore for industrial use, housing, or developments; building road or river banks; etc. The methods chosen are based primarily on convenience, efficiency and cost, rather than the question of environmental suitability.

In the case of petroleum, the traditional practice of mooring 100,000 dwt tankers along the front quay of a plant is giving way to use of jetties or sea berths to avoid ever increasing expenditures for dredging as

200,000 dwt and larger vessels become more common.

Thus, in the ports of Yokohama, Kawasaki, and Chiba along the coast of Tokyo Bay, sea-berths were constructed one after another at 68 to 93 foot depths. The offshore berths contributed in great measure not only to solving the cargo handling of the 200,000 dwt class tankers, but also to maintaining safety in already over-congested channels. Jetties are more expensive, but allow higher unloading rates and may be more economical for high utilization ratios.

G.5.3 Excavated Harbors

Although basin excavation is an age-old technique, it has been recently refined and used in Japan as a systematic technique for new port construction, when natural deep sites with flat industrial land became scarce. Its merits and demerits have been characterized by an MOT technical advisor:

> "On the plus side is the possibility of developing virgin land into a highly productive area contributing to regional economic and social development; obtaining a shorter open water line, with reduced breakwaters and better protection against the sea and wind (an advantage found in major river ports of other countries); gaining reduced maintenance and dredging, except in outer harbors; and providing good land for industry and communications.
>
> "On the other hand, initial (breakwater) construction is expensive and difficult, because the coast line is generally straight and open to rough seas, which means a substantial initial investment that will not be recoverable for some time. Nearby coastal stretches may be disturbed by alteration currents which produces erosion and sand drifting. There is an inherent lack of flexibility for expansion of port configuration, as it is hard to deepen and enlarge basins, or create new ones, if technological change requires it during continued operation. The overall plan must be drawn up with excellent perspective, and one may expect there will probably be changes during construction (Kashima).

Finally, as there is little flushing, some means to keep the basins' water clean must be devised."

G.5.4 Storm-Tide And Tsunami Protection

One cannot leave the subject of port infrastructure in Japan without mentioning the huge storm and tsunami protection works, rendered complex by soil subsidence which is occurring in most of the major industrial cities. In 1966 alone, Japan spent $60 million in levees, breakwaters and gates (compared to $350 million on the U.S. Gulf since 1955). Extensive theoretical and model test work is conducted prior to construction. Recent works of importance include embankments at Nagoya and a tsunami barrier at Ofunato.

G.5.5 Superstructures

Cargo handling methods are generally similar to those used elsewhere. Although Japan has experience in coal slurry pipelining, and closely follows the Marcona ore slurry system performance, we are not aware of firm projects of this type for coal or iron ore.

As early as 1966, a 3300-ton-per-hour unloader with a 27-foot diameter reclaiming-bucket wheel was used at Mitsukojima, outside Kure Harbor, for 140,000 dwt salt carriers. Coal and iron ore may be discharged at 2,400 tons per hour. A 1000-ton-per-hour unloader is accommodating coasters and barges for secondary transport, and a 15-ton bulldozer may be lifted into the ship to help handle cargo. Higher unloading speeds are now available for iron ore at various terminals (e.g., about 4,000 tons per hour at Nippon Steel, Fukuyama).

For quays on soft ground, construction of inclined steel piles with steel plates have often been used. During the 1960s concrete-packed steel cylinders were first used; typically they are 27 feet in both diameter and height, with 0.12-inch-thick walls, but have been made up to twice the diameter and three times the wall thickness. Injected mortar may be made with a mix of 640 parts of cement; 251 fly-ash; 867 sand; 7.68 injection additives.

G.5.6 Port Engineering Research

The Port and Harbor Research Institute, attached to the MOT, is organized as follows:

ORGANIZATION

DIRECTOR	HYDRAULICS DIVISION	WAVE LABORATORY
		SAND DRIFT LABORATORY
		BREAKWATER LABORATORY
		HYDRAULICS LABORATORY
		STORM SURGE AND TSUNAMI LABORATORY
		OBSERVATION AND INQUIRY SECTION
		MODEL TEST SECTION
	SOILS DIVISION	SOIL MECHANICS LABORATORY
		SOIL STABILIZATION LABORATORY
		FOUNDATION LABORATORY
		RUNWAYS LABORATORY
		SOIL TEST AND INVESTIGATION SECTION
	STRUCTURE DIVISION	EARTHQUAKE RESISTANT STRUCTURE LABORATORY
		VIBRATION LABORATORY
		MATERIALS LABORATORY
	DESIGN STANDARD DIVISION	DESIGN STANDARD SECTION
		COMPUTATION CENTER
		TRAINING AND LIBRARY SECTION
	MACHINERY DIVISION	HYDRAULIC TRANSPORTATION LABORATORY
		DREDGER AND CONSTRUCTION EQUIPMENT LABORATORY
		MACHINERY SECTION
	ADMINISTRATION DIVISION	GENERAL AFFAIRS SECTION
		FINANCIAL SECTION
		PLANNING SECTION

In addition to ports, the Institute carries out research on airport civil engineering. In 1966, about 70 of the 200 research staff members held B.S. degrees of higher, and the staff was supported by 71 clerical personnel. Some typical subjects in the late 1960's were:

- Soils Division --model tests and new calculation methods for pile resistance to lateral forces;
- Structure Division --improvement of precast concrete process for better control and execution of underwater concrete structures;
- Machinery Division --improvement of water-jet design for underwater excavation, deep dredging techniques;
- Hydraulics Division --(10 model basins and 6 channel models) tug and supership interactions, with 100,000 - 150,000 dwt field tests in Yokohama, Mizushima, and Tokuyama Ports during 1965 and 1966, followed by model experiments during 1967 and 1968.

In addition, there are five regional port construction bureaus with their own research and design departments, generally with one hydraulic basin per bureau.

In a new port concept, models will be used for the design of protective works, for the study of waves inside the basins, for preliminary estimates of silt and sand transportation, and channel maintenance problems. Because sediment transport cannot be predicted accurately by such methods or by calculation, the next step, when difficulties can be forecast, will be to build a "site-testing dike" before constructing the final breakwater. This amounts to building the most critical part of the breakwater on a preliminary basis and observing phenomena for some time (a year or two) before completing the job or modifying the design. Siltation, sand transportation, and beach conservation are examined. When results are not satisfactory, prevention works are introduced, such as beach stabilizers. In extreme cases, the port development should be cancelled or moved elsewhere.

G.6 ENVIRONMENTAL PROBLEMS

Saddled with unusually severe natural conditions, heavy growth and extreme concentration of industry and population in a few coastal areas, Japan epitomizes most of the environmental features which aroused worldwide concern in the western world in the late 1960's. In fact, one cannot but wonder at the philosophical and traditional traits of character which enable Japanese people to remain most urbane, active and even-tempered under conditions which would severely tax western tempers.

G.6.1 Coastline

Aside from the impact of industrial development, natural forces such as storm-tides, tsunami, earthquakes, and ground subsidence are taking a heavy toll on the Japanese coast.

- The 1969 typhoon storm-tide caused 4,689 deaths and left 298 missing in Ise Bay, damaged 535,000 houses (37,000 totally destroyed), affected nearly two million people and scoured 700,000 acres of farmland. Industrial and agricultural losses were estimated in excess of $175 million.

- The 1960 tsunami caused by the Chilean earthquake inflicted similar havoc in small northeast ports, destroyed 39,000 homes, scoured 23,000 acres of farmland, and affected 156,000 people.

- The Niigata (Richter 7) earthquake killed 446 persons, destroyed 27,000 homes, and inflicted over $170 million in damages. Port operations were completely disrupted for some time.

- Excessive withdrawals of underground water for industrial and other purposes, combined with unstable ground conditions, has resulted in large-scale ground subsidence in some major port cities: a ten-foot subsidence in Tokyo close to the Sumida River over a forty-year period (1918-1958) brought 35 square miles below flood-tide level, and nine square miles below ebb-tide levels; nine feet of subsidence between 1935 and 1965 brought 29% of Osaka city acreage below flood-tide level.

- West Japan is hit by typhoons in the fall, and the Japan sea coast has strong winter winds and swells, causing severe coastal erosion and sand displacement.

To fight these relentless natural conditions, anti-disaster plans have been implemented, and coast preservation work is proceeding. By 1967, some 22% of the coastline was protected, or about half of the length which requires protection. Huge breakwaters (an anti-storm-tide embankment at Nagoya, and a tsunami barrier at Ofunato) have been built, and bigger ones are being considered (across Tokyo Bay and the Kanmon Straits). About $310 million were spent on coast protection in the nine-year period from 1958 to 1966 ($60 million in 1966, alone), including waterline levees, jetties, offshore breakwaters, revetments, gates, and sluices.

In addition to prevention work, local restoration is proceeding at an average of $23 million per year for port facilities alone; i.e., 10% of port construction expenses. This constant preoccupation with hostile natural forces may in part explain the past relative insensitivity of Japanese people to man-made ecological damage.

G.6.2 Marine Pollution

Although confined to limited coastal areas, marine pollution is, however, on the increase. Environmental water-quality criteria are being applied to specified regions, and mapping of the polluted areas is in progress under a five-year plan started in 1968 by the Fishery Agency, which is a major factor in pollution fighting. The following list of problems speaks for itself:

- A decrease in sea transparancy is prominent between Tokyo Bay and the Seto Inland Sea; these two bodies of water are at either end of a 400-mile long narrow plain which produces almost 2/3 of the country's GNP.
- Dark-green coloration in oysters (green oyster) is caused by high copper or zinc content in the sea (0.01 ppm and 0.1 ppm, respectively). This has occurred offshore near copper refineries (Hitachi, Takehara),

Bemberg plants (Nobeoka Bay), and open ore storage (Nagoya).

- The minamata disease, in the early 1960's affected 89 persons with mercury poisoning caused by eating fish and shell fish from Minamata Bay: 36 died. The chemical plant responsible has since treated its methyl mercury effluents with apparent success. The disease broke out again later in the Agano River (Niigata), killing 5 out of 29 patients. While methyle mercury effluents, as well as the use of mercury in agricultural chemicals are now strictly forbidden, fish in the polluted areas have not entirely lost their mercury content after 5 to 10 years, despite removal of the cause.

- Offensive Odors in sea food come from polluted sea water (effluents of oil refineries and petrochemicals, ship bilges) or the sea bed (precipitation, dumping). Fish is often eaten raw in "Sashimi" or lightly fried in "Tempura", which make these odors particularly objectionable in Japan. Oil odor is offensive in Osaka harbor, which does not have a refinery, but the bottom mud contains oil from ship bilges and 0.2% content in mud has been shown to give fish a foreign odor. Off the petrochemical port of Yokkaichi, all the fish caught within 1.3 miles, half of the fish caught between 1.4 and 2.5 miles and several species including sea-eel and flatfish between 2.5 and 9 miles had offensive odors. Studies of this latter example indicated a critical concentration of 0.01 ppm of oil in seawater, which is now the accepted limit for water quality in fisheries. Activated sludge treatment is believed to reduce adverse effects, so that the oil concentration of 1 ppm is accepted in effluents so treated. Oil effluent discharges into the harbor are further restricted during the winter, as fish crowd to warmer port waters, and a reinforcement of odors was noted at that time around Yokkaichi and Mizushima.

- Agricultural chemicals have polluted the Ariake Sea off the Chikugo River Estuary: in 1953, many mysid shrimp died from pesticides, and tide-land soft clams sustained heavy damage in 1962 from PCP herbicide, which is now regulated.

- Matsushima Bay oyster culture grounds have been devastated since 1961 by fish processing plant effluents in Shiogama harbor. In the bottom mud, organic materials have tripled (13% to 41%), and sulfides have increased 27% in 10 years.

- Laver(Porphyra Tenera), a much-priased, edible seaweed, besides acquiring offensive oil odors, has suffered at Nagoya, Tokyo Bay, and off the Ohmuta River can cause a carcinomatous disease linked experimentally to cyanide, phenol, and other chemicals.

- Soft clams in the Ohmuta River estuary have a bitter taste, attributed now to aromatic nitro-compounds in the bottom mud, originating from coal and chemical plants. A 1963 survey showed that 10% of the clams taken within three miles of the estuary are thus affected.

- Twenty-four oil spills in the past 10 years, including six by collision, twelve by stranding, and three deliberate disposals, resulted in heavy casualties, particularly to laver seaweed. Spill volumes ranged from 10 to 26,900 tons and were treated with chemicals. Aircraft monitoring of floating oil now takes place in Tokyo Bay during the laver season.

- Pearl oysters were heavily damaged by dredging operations in the Bisan channel in 1965.

In these cases and others, the Tokai Regional Fisheries Research Laboratory in Tokyo has done considerable research, particularly in severely polluted bays (Tokyo, Ise, and Osaka). Some of the effluents it singles out besides those mentioned above are: lignin from papermills; products from fermentation and fish-processing plants; effluents from chemical fibers plants; wastes from steel, aluminum and titanium mills; and thermal pollution from power plants.

Tokyo Bay is the worst off, and in 1970 all fishing stopped. The metropolis spent $3.7 million and the government $4.7 million that year and formed a Pollution Council. Dredging-spoil disposal was halted inside the bay, and a monitoring system is being set up.

G.6.3 Citizen Reaction

Despite the apparent earlier reluctance of Japanese citizens to complain about their worsening environment, public awareness and resentment is becoming a major force for change. During several days in the early summer of 1971, the following events were reported in local newspapers:

- A Tokyo opinion poll showed of those questioned, 81% resentful of pollution, 29% afraid of induced disease, 55% doubtful about the possibility of future correction. Deficiency was particularly felt in greenery, clear air, and sunlight.

- On June 28, a record 8500 Tokyoites, including 1000 school children, were sent home, suffering from eye irritation, sore throats, and headaches due to photochemical smog. The government had issued its 12th smog warning of the year. Record densities of 0.29 and 0.27 ppm of oxidant were recorded at two locations. Chiba, Saitama, Kanagawa, Yokohama and Kawasaki, all in the Bay, were also affected to a lesser degree. It is not infrequent to see people walking in the streets with gauze masks on their mouth and nose on such days.

- There is concern that the water of Tokyo's Tama River is to blame for Kashin-Beck's disease, a bone ailment (deformed joints, pains) common among local residents. The Tamagawa filtering plant has been closed, and will remain so pending further research.

- MITSUI suffered a loss through court action in Toyama. Although not occurring in Tokyo Bay, the event will have long range effects: Mitsui is to pay a total of $200,000 to a first contingent of 31 victims (8 ill, 6 dead and their families) of the "Itai-Itai" disease which has affected 514 people and dependents along the Jinzu River. This is the first ruling to attribute any environmental hazards to industry and should have far-reaching effects on public attitudes and jurisprudence. Other legal cases pending involve the Minimata disease linked to mercury (see above), and mass outbreaks of asthma in the petrochemical port of Yokkaichi.

Mitsui is appealing the verdict, as it claims that the link to cadmium discharge from its Kamioka zinc-smelting plant is more than doubtful. After some days of hesitation, however, the company agreed to pay the indemnities under protest.

It is remarkable that not all the town residents were happy with the judgement rendered. Some 21,000 work at the plant and many are afraid of reduction in production output, as the city really depends on the plant for a living.

- Finally, an Environment Agency went into operation on 1 July 1971, to unify the fight against environmental disruption.

G.7 THE RESPONSE: PORT PLANNING & DEVELOPMENT OUTLOOK

From the above discussions, one may infer that port development planning is vital to the Japanese economy and that natural and man-made problems put a tremendous strain on planners. The 1960's have witnessed some new approaches in planning for the following reasons:

- Most of the 1940's and 1950's were spent recovering from World War II damage;

- Technological change in transportation is bringing containers and superships; the mid-1970's ports will receive 500,000 dwt tankers (95-foot-draft), 300,000 dwt ore-carriers (80-foot-draft) and 40-45 foot draft containerships, all now under construction;

- Consistent underrating of the rate of economic growth and of cargo handling requirements is resulting in unacceptable crowding and port congestion;

- The MOT has had to consider more and more the efficiency of the total transport and distribution system in planning, along with the industrialization of depressed areas. Over the past year, the latter proposition has been helped by an even stronger requirement: how to

effectively decongest the Tokaido (Tokyo, Ise and Osaka Bays) area;

- Awakening of environmental consciousness in the late sixties, beyond the traditional fishing rights problem, has currently focused attention on water-pollution and land-use efficiency; and

- The transportation system includes not only primary and secondary marine transport, but interactions with airports, road, pipelines, and railroads.

Ports for regional development are designed on a large scale as "Bases for Seaside Industry" and are provided with large-sized, high-efficiency facilities through adequate investment at the outset. Plants will be built for annual steel production of 20 million tons and daily refining capacity of one million barrels of oil. The port-related industrial area should be more than 25,000 acres to receive large-scale industry and foster the advantages of the "Kombinat". Comparatively remote sites from central regions have to be selected for the new ports, because of the strong concern of current large communities regarding air pollution, public nuisance and environmental hazards, as well as for securing safe passages for the 300,000 to 500,000 dwt vessels. Such selection will contribute to regional development.

In the next five years, six new industrial ports, each about three times the size of Kashima, will be started to divert industrial expansion from the now-congested urban areas, along with several distribution satellite ports nearby. Four or five years ago, the justification for these new ports was to help depressed areas: Kashima or Oita, Tomakomai, and East Niigata. Now, however, the primary requisite is location away from large cities, followed by a favorable natural site, and general efficiency in transportation systems.

The new ports are shown in Figure G-3. From SW to NE, they are Shibushi (South Kyushu, 7,500 acres), Suonada (North Kyushu, 75,000 acres, 1 million dwt mooring), Akita and Mutus Bay (North Hondo), New Tomakomai (south Hokkaido, 75,000 acres) and Tsu-Matsusaka (Ise). Each will have a major

refinery (1 million b/d), and probably a steel mill (20 million t/y) or an aluminum smelter. Products from the northern three ports will be exported or shipped to major consumption areas through "backyard" distribution ports: New Kashima for Tokyo Bay, Wakasa Bay for Kobe-Osaka and Ise Bays.

To further help decongestion, major Central Terminal Stations (CTS) for tankers are considered, analogous to the Kiire-Kagoshima terminal. As soon as one such terminal is built at Futtsu (with 25 million tons of crude storage on 25,000 reclaimed acres) at the outer entrance of Tokyo Bay, the bay may be closed to tankers altogether, as its pollution is the worst in the country. Other CTS's will be built for Osaka Bay and the Seto Inland Sea, all with 500,000 dwt to 1,000,000 dwt sea berths.

Inside the bays themselves, each with six or seven major ports, plans are drawn for cooperative specialization with the following aims (Tokyo Bay 1975, 400 million t/y):

a) use of coastline and water to create pleasant amenities, free of public nuisance;

b) specialization of each port by character, eliminating useless overlapping; and

c) rational circulation of goods inland.

In particular, heavy industry will be confined to the southeast, around Kisarazu Port and towards Chiba.

Each pier will be specialized by cargoes, and more efficient systems than "first-come-first-served" are being tried. The handling of hazardous cargoes will be well separated from ordinary goods. Seaside trunklines for road-rail transport, and a mid-bay east-west embankment are planned to improve communications.

The May 1969, "Comprehensive Land Development Program for All Japan" strongly calls for harmony between man and nature. Along with future development of transportation systems and information networks, it aims at expanding land development throughout the country and basically

reorganizing the overall land-use program. Environmental planning should be improved by the creation on 1 July 1971 of an Environmental Agency to group all the environmental activities of the various ministries such as the Ministry of Transport, Ministry of International Trade, Ministry of Welfare, and Ministry of Agriculture and Forestry. For example, MOT wants to preserve the natural coastline areas up to 13,000 miles out of the total 16,000 miles, but many of the currently concerned Ministries disagree with this policy. Inside MOT itself, practically the only work done on sea pollution inside ports is in the Machinery Division and the Shipping Division. An example of precautions taken recently include the quay surface slopes inshore at Oita to avoid run-off (from ore storage and handling spills) into the sea. The Ministry of Public Works is concerned with land use, the Ministry of Welfare and MITI are concerned with air pollution. In the early sixties, when regional development was a prime consideration, along with efficient land use, reclamation and excavation harbors were the preferred alternatives for new port construction. But natural sites became scarce, deeper channels were required and decongestion of the major bays became the prime concern. Offshore sea berths and central terminal stations outside industrial bays, and large industrial harbors in virgin sites coupled with"backyard" distribution ports, are now favored.

When possible, MOT's Planning Division prefers reclamation harbors in a natural site to excavation harbors, because they are cheaper and provide additional land. If one looks at the experience in ports of more than 45 foot depth, the past five-years' experience is in favor of excavated harbors: four of them (Tomakomai, Kashima, Niigata, and Kamasawa) between 1965-70 versus practically no reclaimed and natural-site deep water harbors; and four inland sea types (private companies at Kiire, Oita, Tokuyama, and Keiyo), as well as sea berths and monobuoys in major bays. But when one looks at the next five year plans, only one excavated harbor appears, New Tomakomai, which has been planned to protect good beaches, by opening basins behind them (like at Dunkirk, France). The five other new industrial harbors, although in a less-advanced state of planning, will probably be reclaimed at natural sites.

New artificial islands are planned at Wakayama and Sakaide, with possibly some large islands in Tokyo and Osaka Bay to "get things away from people." The Kiire CTS terminal operating results are satisfactory, but indicate an advantage to jetty mooring over offshore berth for discharge speed, as well as a dire need for faultless handling equipment and efficient oil booms to contain oil spills created by the former.

G.8 SOME JAPANESE DEEP WATER PORTS, 1970

BAY OF ISE

A basic plan has been adapted for the development of 23 ports within the Bay of Ise, with 1980 as the target year. Among the ports are those of Nagoya, Yokkaichi, Mikawa, and Kinuura. Reclamation is underway at these three ports, as well as Atsumi Bay and Matsuzaka Port. The sea land at the mouth of the Bay will be given a sufficient depth for vessels up to 200,000 dwt, with future plans for vessels up to 300,000 dwt.

KASHIMA

This port is claimed to be the world's largest man-made harbor and was officially opened in 1970. When all facilities are completed, in about three years' time, ships of 200,000 dwt can be berthed there. Along these waterways, 7500 acres of industrial land are to be developed. Present depth is 76 feet.

KAWASAKI

This port is included in the development plan for Tokyo Bay. Two sea berths of 20 and 17 meters (65 and 55 feet), as well as a 44-foot LPG sea berth. Plans are to accommodate large-sized vessels with utilization of the land reclaimed from the sea for harbor facilities and redevelopment of the urban area. Total area is about 10,000 acres.

KIIRE (Kagoshima Bay)

A Central Terminal Station was constructed by CALTEX in 1969, on reclaimed land (240 acres) for 500,000 dwt transshipment.

KISASARU (Tokyo Bay)

Nippon Steel Corporation has a 56-foot deep terminal for ore, which it plans to deepen to 83 feet for 250,000 dwt OBO combination carriers.

NIIGATA

The Niigata port faces the sea of Japan. A new industrial zone and new basins are being developed. The depth will be 53 feet in the outer harbor. The area of the adjoining industrial land is about 5,000 acres.

OITA (Kyushu)

Nippon Steel is building a 90-foot offshore terminal for 300,000 dwt OBO.

SASEBO

A fine natural harbor, affording safe anchorage for large vessels with a depth of 168 feet at the entrance, and 76 feet at anchorage, Sasebo Ship Industry is the major activity. Some anchorage areas are controlled by the U.S. Navy (10).

SENDAI

The industrial harbor facilities at Sendai comprise over 1825 acres with holdings of adjacent land for future use. Some two million cubic meters of mud have been dredged out and the plan is for a harbor depth of 57 feet. An oil refinery is to be built in near future. The port is scheduled for completion in 1980.

SURUGA BAY

Tagonura Harbor in Suruga Bay is in the development stage. It is an "excavated harbor," and uses pneumatic caissons for the breakwater.

TOKUYAMA

A sea berth for 200,000 dwt vessels has been installed.

TOKYO BAY

Three sea berths have been provided for large tankers to unload oil through pipes laid on the sea bottom, and construction of four more sea berths is

underway for tankers of 250,000 dwt (68 feet to 93 feet depth). The idea of an oil terminal outside the bay is being considered, from which the oil can be conveyed by pipelines or small tankers.

CHIBA CANAL

There is a plan for a 20-mile canal to join Tokyo Bay to the Pacific Coast near Kashima, through a lake. The depth of the canal is to be 50 feet at low tide. The excavated soil, about 300 to 400 hundred million cubic meters, could be used for reclaiming low areas, and providing space for industrial complexes.

TSURUGA

This port is the center of trade with Asia and the USSR. Maximum depth of the outer harbor is more than 73 feet.

YOKKAICHI (Ise Bay)

In addition to a 200,000 dwt sea berth, the port channel was recently deepened from 40 feet to 60 feet along with land reclamation of 3,100 acres and a new 3000-foot breakwater.

YOKOHAMA

In addition to the 68 to 93-foot berths of Tokyo Bay, two Negishi Refinery piers are 55 feet (crude oil) and 45 feet (fuel oil). The Kokusai Futo Pier has a 58-foot pier for bulk cork carriers. There are extensive shiprepair drydock facilities.

Existing deep water tanker terminals are listed on Table G-7.

TABLE G-7

TANKER BERTHS IN JAPAN (OVER 150,000 DWT)

Port	Name of Oil Company	Name or No. of Berth	Refining Capacity (BPCD)	Berthing Method	Depth of Berth (MLWS)	Tanker Size Draft	Tanker Size DWT
Chiba	Kyokuto Sekiyu	Keiyo Sea Berth	60,000	Alongside	20.50M	19.50M	200,000
	Idemitsu Kosan		180,000				
	Fuji Sekiyu		70,000				
	Maruzen Oil		155,000				
Keihin	Showa Oil	Keihin Kawasaki Sea Berth	99,000	S.B.M.	28.00	20.00	200,000
	Mitsubishi Oil		74,440				
	Ogishima Sekiyu Kichi	Ogishima Sea Berth	CTS	S.B.M.	21.00-25.00	20.00	210,000
	Nippon Petroleum Refining Co.	Berth A	220,000	Alongside	17.00	16.50	160,000
Yokkaichi	Showa Yokkaichi Sekiyu K.K.	Outer Berth	180,000	S.B.M.	21.00	22.00	250,000
	Daikyo Oil	Umaokoshi	105,000	S.B.M.	17.00	17.00	150,000
Owase	Toho Oil	Toho Oil Pier	40,000	Alongside	18.00	16.50	150,000
		Sea Berth			21.00	18.00	200,000
Shimotsu	Toa Nenryo Kogyo	Ogake No. 1 Pier	187,000	Alongside	20.00	19.00	190,000
Mizushima	Nippon Mining Co.	Crude Oil No. 2 Pier	165,200	Alongside	17.00	16.50	180,000
Iwakuni	Koa Oil Co.	Crude Oil Berth	148,300	Alongside	17.00	16.50	160,000
Tokuyama	Idemitsu Kosan	Sea Berth	140,000	Multi-Buoy	20.00	19.00	210,000
Oita	Kyushu Oil	Kyuseki No. 2	100,000	Alongside	21.00-30.00	21.00	210,000
Ube	Seibu Sekiyu	Sea Berth	50,000	S.B.M.	21.00	20.00	210,000
Kiire	Nippon Oil Staging Terminal Co.	No. 2 Berth	CTS	Alongside	18.00	16.50	150,000
		No. 3 Berth		Alongside	28.00	27.00	500,000

Source: The Japanese Energy Problem and Its Shipping Solution," J. S. Kagami, IAPH, London, October 1970.

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APPENDIX H

THE MIDDLE EAST

APPENDIX H

THE MIDDLE EAST

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APPENDIX H

THE MIDDLE EAST

H.1 SUMMARY

Long-haul transportation from the Persian-Arabian Gulf to Europe and Japan was the rationale for the supertanker developments in the 1960's. Crude reserves of 2/3 of the world supply (and production 1/3) make the Middle East a major source of world supply. The initial concentration of production in a few countries, and in the hands of one consortium in each of these countries, helped create major terminals and foster technological developments. Through a literature survey, and brief field trips and interviews in Iran and Kuwait, the following highlights became apparent:

- 250,000 dwt tankers are received by practically all major producers, except for Iraq which pipes much of its current production to the Mediterranean Sea, and has a program to develop a deepwater terminal in the mid-1970's. Two of the three largest producers are preparing for 500,000 DWT in the early 1970's; the third already receives 350,000 DWT tankers. Sizes in the range of 750,000 DWT to 1,000,000 DWT are expected in the late 1970's.
- The producing consortium generally owns and operates the terminal, but the facility may revert ultimately to the host country (as in Iran after ten years), although the oil companies remain as terminal operators.
- The oil throughput is generally the major source of national income by far, in the producing states. Some projects to diversify (Aluminum Smelter plant in Bahrain) have recently picked up strength.
- Site selection depends on port location versus the feeder oil fields, deepwater access, reduced dredging maintenance, gravity-loading capability, and political safety. Computer models are used in the planning and design process, hydraulic models for the actual depth requirements in channels and at berths.

- Extensive experience has been acquired with underwater pipelines up to 48 and 56 inches in diameter, and with various berth structures: single buoy or multi-buoy offshore berth, sea island, jetty and T-piers, and underwater storage.
- Environmental problems still appear around deepwater terminals, possibly due to warm water conditions. Faulty valves, equipment, and human error are the cause of spills, but in much less volume than released by offshore oil-well leaks and operations. Strong action is taken by some governments about spills and bilge disposal in port, while an oil company cooperative is planned for larger spills. Dispersants and burning are common corrective actions.

H.2 PERSIAN GULF LOADING TERMINALS

The Persian-Arabian Gulf is a natural seafront for almost 2/3 of the world's crude oil reserves and about 1/3 of current production, most of which is exported to Europe and Japan. This long-distance haul has fostered the development of Mammoth tankers, and there is a concentration of deepwater terminals analogous to those being developed in Europe and Japan.

Nine countries are producing 17 million barrels per day (May 1971), showing a 20% increase during the five first months of 1971, compared to 1970. Saudi Arabia (4.83 million, 94% ARAMCO), Iran (4.25 million, 91% Consortium), and Kuwait (3.4 million, 93% Kuwait Oil Co.) are the major producers, followed by Iraq (1.85 million), Abu Dhabi (1 million), Qatar (0.47 million), Oman Dubai, and Bahrain. Production in each country is generally held almost entirely by one particular group of companies, except in Abu Dhabi where an offshore group and an onshore group take almost equal shares. It is not surprising then that these groups have developed important terminals to improve the offtake of a vital production. Figure H-1 and Table H-1 show these terminals, and their controlling depth of access channels or berths.

Kharg Island, Iran (67 feet); Mina-Al-Ahmadi, Kuwait (93 feet); Ras Tanura, Saudi Arabia (85 feet) and Das Island, Abu Dhabi (64 feet) serve the major producers; with the conspicuous exception of Iraq, whose ports of Fao and Khor-al-Amaja are limited to 35 feet and 50 feet, but have an outlet through pipelines to the Eastern Mediterranean Sea.

Some special techniques have been tried to respond to the challenge of offshore production and terminals. The sea islands at Mina-al-Ahmadi, Ras Tanura and soon at Kharg are record breakers, and the first under-sea terminal storage was erected at Fateh, off Dubai. Oil terminal improvements are welcome by host governments, who draw a major part of their revenues from oil royalties and taxes. Kuwait and Abu Dhabi have the two highest per capita incomes in the world -- even higher than United States. These revenues trigger much import trade as they are increasingly shared by more of the population, and much general-cargo port development is underway. Diversification is still small, except in Iran and Bahrain (where an aluminum smelter is planned).

The above-listed ports run the gamut of techniques which can be used to berth and load (or unload) a supertanker (exclusive of quay-walls); jetties and T-piers, or sea-berths (single or multi-buoy moorings, and sea islands) connected by underwater pipeline to the shore. Ras Tanura has two T-piers and three sea islands, with an additional sea island projected for 1972, and a new offshore terminal, 80 miles north, by 1975 (500,000 to 1,000,000 dwt). Mina-al-Ahmadi has two T-piers and one sea island. Kharg has one jetty with ten berths (250,000 dwt) and plans for a 500,000 dwt sea island for 1972, with two to four berths. Das Island and Djebel Dhana, Abu Dhabi, each have several offshore mooring buoys.

The choice between the various techniques is complex and Table H-2 lists some of the arguments heard in the field (Kuwait, Iran, Abu Dhabi, and Saudi Arabia). The cost of these facilities may run from $10 to $40 million, but their high rate of use reduces the transfer fee to below $0.02 per barrel.

FIGURE H–1 PERSIAN GULF OIL TERMINALS

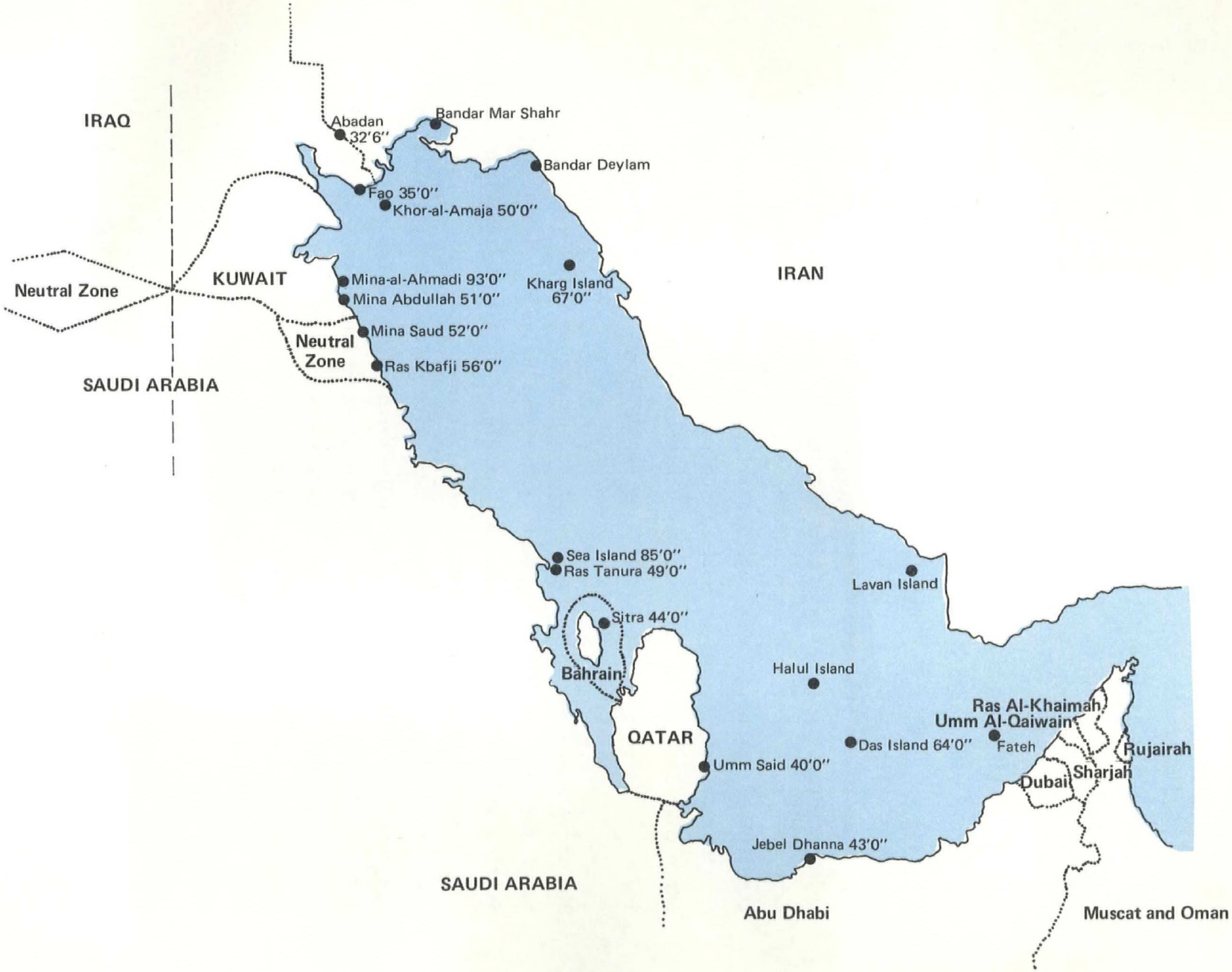

Table H-1

PERSIAN GULF TANKER TERMINALS

Port Terminal	No. of Berths	Maximum Size or Length O.A.	Draught
Abadan	11	600'	32'6"
Bandar Deylam			
Bandar Mar Shahr			
Das Island			
(Berth No. 1)	1	850'	52'0"
(Berth No. 2)	1	1,150'	64'0"
Fao (Berths No. 1,2,3,4)	4	675'	35'0"
Halul Island			
Jebel Dhanna	2	1,100'	43'0"
Kharg Island			
(No. 1)	1	NL	67'0"
(No. 2)	1	700'	62'0"
(No. 3)	1	NL	67'0"
(No. 4)	1	800'	63'6"
(No. 5)	1	NL	67'0"
(No. 6)	1	900'	64'0"
(No. 7)	1	NL	58'0"
(No. 8)	1	780'	58'0"
(No. 9)	1	NL	55'0"
(No. 10)	1	850'	55'0"
Khor-al-Amaja	2	1,000'	50'0"
Lavan Island			
Mina Abdullah			
(Berth No. 1)	1	680'	36'0"
(Berth No. 2)	1	949'	51'0"
Mina-al-Ahmadi			
(Sea Island)	2	NL	93'0"
(North Pier)	4	NL	63'0"
(South Pier)	8	NL	51'0"
(Sea Berths)	6	NL	50'0"
Mena Saud	2	950'	52'0"
Ras-al-Khafji			
(Terminal)	3	NL (207,000 DWT)	56'0"

Table H-1

PERSIAN GULF TANKER TERMINALS (CONTINUED)

Port Terminal	No. of Berths	Maximum Size or Length O.A.	Draught
Ras Tanura	10	940'	49'0"*
(Sea Island)	6	1,200'	85'0"
Sitra (listed under Bahrain)			
(No. 1 [Island] Wharf)	2	900'	44'0"
(No. 2 Wharf)	2	820'	43'0"
(No. 2 Wharf)	2	560'	32'0"
Coastal Tanker Wharf	1	240'	16'0"
Umm Said			
(North Berth)	1	875'	40'0"
(South Berth)	1	1,000'	40'0"

*or up to 51' draught on rising tide. . .

TABLE H-2

PROS & CONS OF SUPERTANKER BERTHS

SPM GRADE	SINGLE-POINT MOORING	SEA ISLAND	JETTY AND PIERS
+	Suited to higher sea state 10-12 Feet to berth 25 Feet once moored	Can be designed for waves 10 Feet longitudinal 5 Foot beam, while moored	
+	Flexible on siting, orientation (ship swings with wind, current)	Orientation condition by wind and wave directions	Same as sea island
+	Less damage prone in poor approach (can be ducked easily and tried again)	Damage to dolphins and platform are costly in time and dollars	Damage at T-pier connections endangers pipelines
+	Less costly for one berth	Less costly than SPM for several berths	Less costly for high loading rates and short offshore distances
-	Access is difficult to crews and supplies	Access somewhat easier than SPM	No access problems
-	Flexible and floating hose, risers are liable to damage (mechanical, fatigue, corrosion) and pollution (drainage difficult)	Steel chicksan arm better than aluminum or flexibles	Same as sea island
-	Loading rate generally lower	Higher loading rates than SPM	No limits on loading rate

Other developments include testing of various types of tug arrangements and propulsion systems: Kort nozzles versus twin-screw/rudder versus Voith-Schneider vertical propeller. No clear superiority of one particular system has yet emerged, as there are trade-offs in maneuverability, bollard pull forward and backward, maintenance, etc., which complicate matters.

Oil spills have been a problem in the Gulf, but the largest volume by far comes from offshore wells. Some parts of the southern coast of the Gulf, between Djebel Dhana and Abu Dhabi town, are uniformly coated with a thin mixture of oil and sand, resembling dark volcanic or mineral sands. However, only scattered damage is visible and clear blue waters, white sands, and good fish and shrimp catches can be enjoyed almost everywhere -- including around large terminals.

Faulty equipment or human error are responsible for the minor spills which do occur in these terminals. Hydraulic cargo valves (overflow) and underwater pipeline control valves (leaks) are somewhat troublesome in this respect. Flexible hoses and aluminum chicksan arms have been known to fail, and drainage of connections and manifolds must be efficient. Strong enforcement action is being taken by several countries in this respect, but there is no deballasting equipment available, as tankers have much time on long voyages to clean their ballast.

H.3 KHARG ISLAND, IRAN

H.3.1 Terminal Development History

After a short field visit and interviews with representatives of the Iranian Consortium operating companies in Tehran, we conclude that Kharg Island (a record-setting loading terminal) will becapable of exporting a substantial share of the world's production.

At the completion of Phase II (1966), crude oil storage capacity was 7,680,000 barrels, and there were four 48" and one 36" loading lines (capable of a 45,000-tons-per-hour total loading rate -- or 10,250 tons

per hour per single ship). It had ten berths on the East Side jetty and was the largest oil terminal in the world (70 feet on outside berths, for 250,000 dwt tankers).

Phase III, completed in 1969/70, brought tankage to 11,180,000 barrels, including the first one-million-barrel tanks ever built (there are now three such tanks and another one under construction), and the total loading capacity to 60,000 tons per hour, or 15,000 tons per hour each for two ships, on both light and heavy crudes.

Phase IV, now proceeding, involves an investment of some $40 million, with a two-berth sea island at 105 foot depth. Two 5,000 foot-long, 56" diameter, underwater pipelines to the west shore, link to two 5,200 foot-long, 78" diameter, onshore feeders from the tank farm. By late 1972, the sea island will handle 500,000 dwt ships on the outside, and up to 300,000 dwt on the inside berth; with 30,000 tons per hour loading capacity on each berth. Future expansion may add two more berths to the 1,800 foot-long sea island.

Average tanker size received was 65,000 dwt in 1969 and 77,000 dwt in 1970 (80,000 dwt in December). Maximum size is currently 250,000 dwt, so that the "Universe" tankers (326,000 dwt) cannot load. Looking beyond the 500,000 dwt berth for 1972/73, the Consortium expects 1,000,000 dwt tankers, although 750,000 dwt may load more frequently.

H.3.2 Site Selection

The decision to develop Kharg Island rested with the Iranian Consortium*, which decided to develop Kharg as its main crude-oil terminal towards 1960. Up to that time, the port facilities at Abadan on the Shatt-al-Arab were used to handle refined products from the local refinery. The facilities at Bandar Mahshahr (to the East of Abadan) were used to handle crude oil from the light crude fields located to the north and to the east. It became evident, at this time, that:

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*British Petroleum 40%, Shell 14%, Gulf/Mobil/Socal/Esso/Texas 7% each, CFP 6%, and Iricon (Aminoil, Arco, Conoco, Getty, Signal, Sohio) 5%; formed in 1955

- Politically, the Shatt-al-Arab presented a problem in that by virtue of a 1935 (or so) agreement between British-dominated Iraq and Iran the river was practically given to Iraq instead of using the thalweg principle. Thus, Iraq has claimed the river, has done all the dredging, and collects all the pilotage and dredging dues. At any time, therefore, the Iraq Government could shut the river down and thus interfere with the movement of oil, the life blood of Iran.
- Although the Bandar Mahshahr oil terminal functioned well, the Khor Musa inlet-river complex was costly to dredge to depths greater than the existing 30-35 feet draft, (vessels up to 45,000 dwt). With crude-oil tanker sizes going up, dredging would become prohibitive in the future.

Thus, a new location was necessary to load refined products and crude oil, as well as to expand the capacity of the loading facilities.

In searching for new locations it was decided that Bandar Mahrshahr could be used to handle refined products from the Abadan refinery, if a pipeline were built from Abadan to Mahshahr. The land was flat and offered no problem in laying the line, and Bandar Mahshahr could offer a loading terminal within the safety of Iran itself and not on an alien, border river. The only terminal needed became that for handling crude oil.

While selecting a crude terminal area the following points were also considered:

- The need for relatively deep water, and expansion possibilities;
- Preference for areas where dredging on a continuous basis would present few difficulties and, most likely not be required; and
- The market swing to heavy crude oil.

The coastline of the Iranian shore on the Gulf is quite inhospitable. It is quite shallow at a considerable distance from shore. Kharg Island was finally chosen because it offered deeper water, relatively easy dredging, and was located within Iranian waters relatively near the heavy crude area. Actually, there were a few locations from which to choose and Kharg stood out like a beacon. Beside being a crude terminal, Kharg also is a bunkering terminal. The fuel is shipped from Bandar

Mahshahr to Kharg and stored in tanks (800,000 barrels of Bunker C; 180,000 barrels of Marine Diesel) awaiting use.

H.3.3 Kharg Operations

The Iranian Consortium invests in and operates (through its Iranian Oil Exploration and Producing Co.) the crude facilities on Kharg. The initial funds for construction of facilities come from the member companies. The Iranian Government, through the National Iranian Oil Company (NIOC), pays the consortium back on a ten-year basis. Therefore, NIOC completely owns all facilities over ten years old, but the consortium operates the terminal with no interference from NIOC.

The cost of handling crude oil through the terminal has been estimated at 1.5 cents per barrel, similar to the marginal cost of transshipment in Bantry Bay. Heavy crude exports went from nothing in 1960 to over 1.1 million barrels per day in 1969, while Iranian Light went from 0.6 to 1.6 million barrels per day over the same period, and crude processing in local refineries was stagnating at 380,000 to 480,000 barrels per day. These benefits which accrue to the Iranian Consortium as well as Iran itself, which has received an average of $0.85 per barrel (before 1970) to $1.30 (1971) and expects $1.50 (1975) for crude production.

The number of jobs created (presently) are estimated to be 326 basic and 189 non-basic, or a total of 515 personnel on Kharg.

On the island, IPAC (NIOC and Standard Oil of Indiana) has LPG and sulphur facilities (100,000 barrels per day) which may or may not have resulted from the decision of the consortium to develop the area.

Sociologically, the old village (250-300 people) on the island now thrives. None has left the island because of the terminal, although the young people still continue to leave because few job opportunities exist and the big cities lure them. Trading has naturally increased in the village: there is now a bazaar and a good school.

The only port in the vicinity of Kharg Island is the general cargo port of Bushehr which has not been affected.

H.3.4 Environmental Impact

There are occasional small oil spills, but the operation appears quite clean. The small, uninhabited island located about two miles to the Northeast of Kharg continues to retain its absolutely clean sand, in spite of the fact that it is on the leeward side of Kharg and subject to the prevailing winds which blow across the oil terminal towards the island. No provision, at present, exists for disposing of dirty ballast. Oil vessels are supposed to be deballasted when they tie up at the jetty.

In contrasting the Kharg terminal, the impact on the marine environment was minimal. Although it was necessary to do considerable blasting while laying the pipelines to the island, apparently fish and other marine life continue to thrive and coral continues to grow. The marine balance has remained.

H.3.5 Engineering on the Sea Island

a. Underwater Pipelines

Iranian Oil Exploration & Producing Company already has experience in laying and operating "large" diameter pipelines. This year it added a 72" loading line to the four 48" and one 26" lines taking oil from the Kharg tank farm to the ten-berth jetty at the island's eastern shoreline.

Submarine lines have been designed for installation by the bottom-pull method. When plans were made for the project, a lay barge had never successfully installed 56" line with a designed negative buoyancy of 110 lb/ft. The contractor is expected to weld the pipe on the beach and use either a specially designed pull barge or a winch installed on a jackup platform for the pulling operation.

Since the concrete-coated 56" submarine lines will weigh about 2,500 lb/ft, and have a relative specific gravity of 1.64 when filled with oil, line stability will be of concern only during construction. Some 500 feet of coral reef will require blasting. The pipelines will be recessed into the seabed by jetting, fluidization, or any other method proposed by the contractor and accepted by the engineers. Pipe cover will be minimal. After the pipes have been laid, coral spoil will be dumped back into the trench to protect the piping through the surf zone. A 36"-thick, 75 foot-wide blanket of coral and indigenous gravel, extending 500 feet from the sea island towards the shore, will counteract propeller scouring at the tanker berths.

Positive protection of underwater lines against galvanic corrosion will be provided by an impressed-current system. The offshore structures will also be protected by a combination of anodes and impressed current.

Transition from horizontal sea lines to vertical risers will be by installing 90° bends of three-diameter radii. With the high fluid velocities involved (10 ft/sec at 225,000 barrels/hr) a long-radius bend will substantially reduce vibration and avoid accumulation of wax and sludge at the bottom of the riser.

Provisions will be made in the piping arrangements for launching and receiving spheres and swabs for line cleaning and test purposes only. These will be removed for normal operations.

b. Offshore Berths

The 1,800-foot-long island consists of a central loading platform, with berthing structures on either side for each tanker berth, and six mooring dolphins. Walkways connect all parts of the offshore structure. The central platform contains prefabricated deck trusses, supported by piles, combined in a twin-template structure. A continuous deck supports all piping and equipment on the platform.

Monobuoys (SPM) were also considered, but the consortium decided on a sea island because they believed that:

- There might be prototype problems with buoys and hoses, rather than dolphins and chicksan arms;
- Rough weather (November-March is the storm season in the area) would undoubtedly cause, at the time in SPM development, pollution at the hose connections, and drainage problems would occur;
- Rough (stormy) weather would cause much stress on the SPM, with a resultant increase in corrosion fatigue, and corresponding problems. (The weather has already had considerable affect on the loading operations. A yearly average of 138 hours delay per month prevails, with December having weather delays of up to 434 hours.)

Actually, the engineers of the consortium were divided about what to build. However, the tested sea-island idea prevailed. The consortium believed that its advantages would compensate for the $10 to 12 million increased cost (part of it unforeseen in engineering estimates) over the SPM. The additional two berths now planned on the sea island seek to improve the economics.

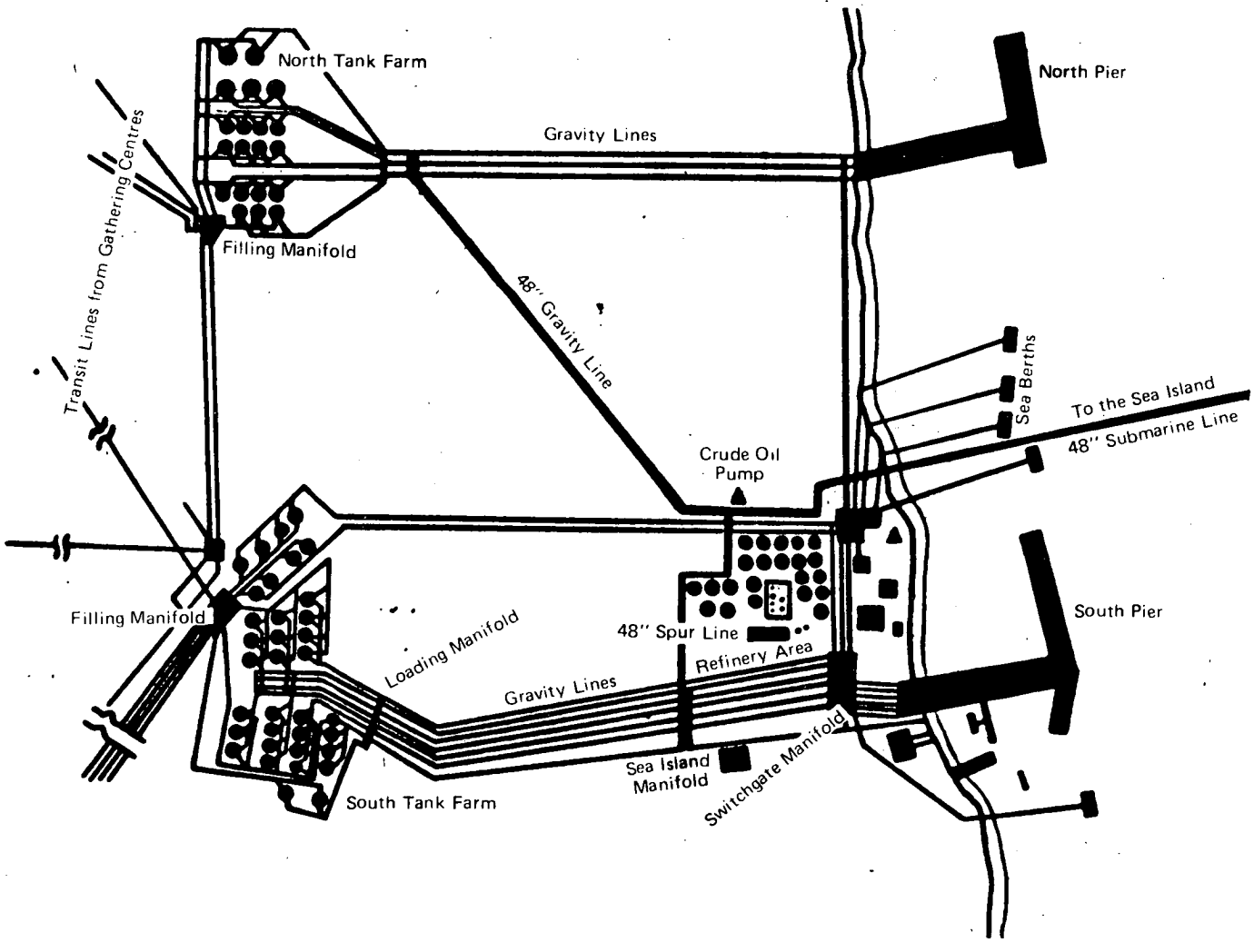
H.4 MINA-AL-AHMADI, KUWAIT

H.4.1 Terminal Development History

The Kuwait Oil Company (KOC), headquartered in London, is owned 50% by British Petroleum and 50% by Gulf Oil (Pittsburgh). In 1934, it was granted concessions (until the year 2020) for prospecting in Kuwait and in 1930 found the Burgan field, world's largest. The export of oil started in 1946 from a one-mile-long, 12" submarine pipeline connected to a hose buoy. KOC crude oil production was 2,575,000 barrels per day in 1969 (3 million per day in December 1969), covering about 93% of the total oil produced in the nation (including the Kuwait/Saudi Arabia Neutral Zone).

There were up to four offshore loading lines at Mina-al-Ahmadi, which have been replaced by the following three permanent installations (Figure H-2):

FIGURE H–2 TERMINAL LAY-OUT OF MINA AL AHMADI, KUWAIT



- South Pier, completed in 1949, to a depth of about 40-49 feet, with three crude berths, two LPG and refined-products berths, and one general-cargo berth. Tankers up to 100,000 dwt are handled;
- North Pier, completed in 1959, to a depth of 50-60 feet, with four berths served by three major loading lines 38"-44" in diameter. Tankers of 200,000 dwt can be received under limited conditions;
- Sea Island, completed in 1968, is located about nine miles offshore with a depth of about 95 feet at the berths, and 93 feet in the 28-mile channel to be used by ships of 70' draught or more. There are two berths, but one main loading 48" line from the shore loads only one ship at a time. Bunker C is available from a 20" pipeline. The island can handle the "Universe" class of tankers at 326,000 dwt for which it was designed.

Storage capacity is 12,500,000 barrels, with 600,000 barrels being the largest capacity tanks in use, although one-million-barrel tanks are considered in the expansion scheduled for 1973, with a second underwater pipeline to the sea island. Crude production is now about 2.7 to 3 million barrels per day, though the loading capacity is greater: over 5.5 million barrels were delivered in one specific day, an average of about 30,000 tons per hour on all berths.

H.4.2 Decision Rationale

Gulf Oil was the most instrumental partner in the creation of the new sea island (for reasons developed in Appendix I: Bantry Bay). The sea island is part of a system incorporating the six giant "Universe" tankers of 326,000 dwt chartered by Gulf from National Bulk Carriers, Ltd. In 1965, Gulf was faced with the prospect of tanker size increasing far beyond the capacity of its European refineries terminals. To keep these refineries competitive, and continue its market expansion, Gulf devised a trans-shipment operations at Bantry Bay, with the largest ships conceived at the time. The system has been branching into two new refinery-deepwater terminal complex: one in Okinawa, to penetrate the

Japanese market; and one in Point Tupper, Nova Scotia, to make fuel oil for the U.S. east coast. Kuwait is the common crude oil origin.

The site of Mina-al-Ahmadi was selected initially because of its focal position versus the oil fields, and the possibility of loading ships by gravity from a 400-foot ridge close to shore. It was just coincidence that some of the deepest water on the Kuwait coast was in the area.

H.4.3 Operations at Mina-Al-Ahmadi

Kuwait Oil Co., Ltd., carries out the operations of exploration, production refining, storage, and loading of crude oil and products, including LPG on behalf of BP (Kuwait), Ltd., and Gulf Kuwait Co. Kuwait Oil Tankers Co. (KOTC) is the general agent.

Since 1946, KOC's crude-oil production has increased at an average 8.6% per year, to 2.575 million barrels per day in 1969. Some degree of stagnation occurred in 1956-1957, 1959, 1961-1963, and 1965-1968, due to the general crude supply/demand situation, to the Suez Canal closures, and to the specific characteristics of KOC oil, a relatively heavy crude with high 3.6% sulfur. A strong rally is taking place in 1970-71. The local refinery processed about 20,000-40,000 barrels per day in 1950-1957, then expanded regularly between 1958 and 1965 from 130,000 to 215-235,000 barrels per day, where it now stands. Another refinery, built by Kuwait National Petroleum Co. (KNPC) took 65,000 barrels per day in 1969, and about 2.3 million barrels per day were exported in 1969; the first full year of operation for the sea island. The U.K. took more than 15%, followed by Italy and the Netherlands and Japan (each about 10%), France (7.3%), and Ireland (6.3%). The United States received 2.8 million tons (or 2.2% of exports).

In 1969, the new sea island loaded 208 tankers, including the six 326,000 dwt "Universe" tankers; and one of them loaded a full cargo of 312,482 tons at a record average rate of 14,204 tons per hour in December, 1970.

H.4.4 Socio-Economic Impact

Gulf Oil's 50% share of KOC's crude production was almost half of its world production, so that the harmonious development of this crude source (as allowed by terminal developments) was crucial to the company. Gulf's share in the sea island investment is about 20% of Gulf's 1969 depreciation and some 2% of its yearly capital expenditures. This is a high percentage -- when added to the rest of the "Universe Tankers" system -- for a captive function like transportation, traditionally not very high on the priority list of oil companies. Benefits to Gulf are discussed later (Appendix I: Bantry Bay). Success was particularly felt by the European marketing organization (as witnessed by refinery expansions) and by Gulf Oil Transportation, whose present performance and future flexibility are enhanced.

As far as the nation of Kuwait is concerned, when oil started to flow, Kuwait economy started to move, and has yielded the highest per capita income in the world for many years. Kuwait's take was around $0.80 bbl in royalty and taxes before the recent Tehran agreement, is now $1.29/bbl, and will escalate to $1.50/bbl by 1975. In 1968-69, transactions in the oil sector made 95% of exports and 40% of the GNP. In addition, Kuwait received an investment tax on terminal construction. Gross investment makes about 25% of the GNP, but savings are still 40% of the GNP, and only 60% of these savings were domestically used.

In 1969, Kuwaitis numbered about 259,000 -- 37% of the total population -- and this percentage is decreasing further as new immigrants arrive. About 70% of the Kuwaiti labor force are on the government payroll, with 87.5% of the officials at the elementary or no-education level. However, an extensive program of education and training, as well as "Kuwaitization of government, commerce, and industry is under way to palliate these deficiencies. Health care is free as well as education, for all Kuwaitis.

Kuwait Oil Co. itself has a permanent staff of 2,000 (72% Arab, 28.6% Kuwaitis), out of a permanent and occasional work force of 5,000 at the

end of 1969. The Arab and local share of staff has increased regularly from 30% since 1963 at the expense of Indian and Pakistani nationals. The supportive work force has decreased from about 5,000 in 1961 to some 3,000 in 1969, mostly at the expense of non-Arabs.

H.4.5 Environmental Impact

Little pollution is evident. Ships can deballast at berths, but must retain dirty ballast, as the Kuwait government heavily fines ships discharging dirty ballast into Kuwaiti waters. An average 5,000 KD ($14,000) per charge is generally levied against the faulty vessel, under a 1968 ordinance which specifies $4,200 to 15,800 for first offense; $7,900 to 15,800 for second offense (within one year from date of first sentence); and $15,800 minimum for third offense -- with a $15,800 "stay of execution guarantee" in all cases.

Minor spills do occur, but apparently are readily dispersed, due to warm-water conditions and the fresh-water inflow from the Shatt-al Arab. The usual "detergents" are used to clean spills.

There were no baseline studies, but no adverse effect on the local marine life has yet been noted in the vicinity of the piers or the sea island on the dredged channel. Kuwait has an active program of shrimp and fish trawling, and no complaints have been heard about odor or taste.

H.4.6 Engineering Aspects

a. Design Selection

The design of the South and North Piers was chosen (based on proven design), because they were more effective than the offshore berths of the 1940's. The sea island was selected over monobuoys because KOC felt that the SPM's couldn't handle more than 500,000 barrels per day and that hose-handling problems would develop.

b. Model Tests

To optimize the depth at the berth and in the departure channel, the

design engineers (Frederic R. Harris) had tests run in the ships model basin at Wageningen, The Netherlands. The results may be summarized as follows:

- Conditions -- 90-foot water depth, 79.1-foot vessel draft, 1:88 scale -- zero speed in head, following, and beam waves (regular) -- 6 to 10 knots in head & following waves (regular);
- Results -- a) at wave height 3.5 meters (11.5 ft) and period up to 14 second, the largest immersion of a loaded ship at 8 knots is 1.8 meters (6 foot) at bow, 1.7 meters (5.6 feet) at stern -- b) largest vertical motions occurred for wave periods of 18 seconds and the model on the bottom (10.9-foot immersion) for zero speed in following waves of 3.5 meters (11.8 feet) high, and at zero speed in beam waves 1.7 meters (5.6 feet) high, with a 16 second period.

c. Construction

No unusual problem was encountered in the construction or operation of the sea island terminal itself. A special jack-up platform, which had been especially designed to facilitate pile driving and concrete injection, was built in Scaramanga, Greece, to be towed through the Suez Canal. The canal closed before it was ready, so the towing had to proceed around the Cape of Good Hope. The platform itself, 160 feet long, 138 feet wide and 12 feet deep, is supported by 6-foot-diameter legs. On each side, six loading arms (four 16" crude, two 12" bunker Chicksan, and their control tower reaching 90 feet above water level) give a maximum loading rate of 15,000 tons per hour (8,000 tons per hour with gravity-loading alone). The Bunker C rate of 800 tons per hour is now considered too small. Fresh water and diesel storage tanks, a slop tank and surge tanks (part of a system which can stop the flow completely in 15 seconds without undue overpressure), are also on the platform.

There are four breasting dolphins (two on each berth) and six moving dolphins (three at each end). Each breasting dolphin is made of three 6-foot-diameter, high-tensile-steel piles, driven vertically 75 feet

into the sea bottom and held together by a top platform holding a large square fender. Each moving dolphin consists of an eight-leg-template structure, secured by 30-inch-diameter piles driven through the legs 100 feet into the sea bed.

Water, air, diesel, fire-fighting foam, and power are supplied on the platform and some dolphins. Connection to land includes a 48" crude line (to be doubled by 1972) and a 20" Bunker C line. The crude pumping unit is driven by a 11,500 BHP gas turbine through a 5000/1430 spin-reduction gear. The two 500-HP pumps for Bunker C are deemed too small.

d. Traffic Control

KOC receives about 8-days notice that a given tanker has been "nominated" for a cargo of Kuwait oil of a particular grade and quantity, and the estimated time of arrival (ETA) of the ship, as well as its ultimate destination. The master of the tankers confirms this nomination 72 hours from ETA, along with the loading rate required for cargo and bunker. He also radios the information to Kuwait Oil Terminal Company, his agents at Mina, along with its conventional requirements (stores, medical, etc.). Upon sighting, the tanker is contacted by Mina's signal section on VHF radio or signal lamp, and given her estimated time of berthing. A pilot then boards the vessel and brings her alongside the allotted berth with tug assistance. After clearance, the loading operator takes over, and is also responsible for inspection of ballast discharges, water, safety, and anti-pollution prescriptions.

Cargo loading rate is adjusted automatically from the shore, and is reduced gradually when nearing completion, or at the request of the duty officer, to minimize the possibility of an overflow during the final "topping off," which is conducted on gravity-flow alone.

The port nautical surveyor then inspects the loaded draft of the vessel, to make sure she is not overloaded. Before the loading hoses are

disconnected, they are emptied to avoid spillage. Cargo documents have been prepared during the loading and receive the final meter readings.

APPENDIX I

BANTRY BAY

APPENDIX I: BANTRY BAY

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APPENDIX I

BANTRY BAY

I.1 SUMMARY

Bantry Bay was the first transshipment terminal built as part of a system involving supertankers that for several years were the largest afloat (325,000 dwt). Gulf Oil has since built similar terminals at Okinawa and Point Tupper (Nova Scotia); each, however, has a refinery rather than mere transshipment storage to serve several refineries saddled with shallow water terminals. Another oil company, CALTEX, has since built a "Central Terminal Station" at Kiire in Japan, and several more are being considered in Japan and in Western Europe. All these terminals are designed essentially to receive 300,000-500,000 dwt tankers out of Kuwait Kharg Island (Iran) in the Persian Gulf. Some ports are planning for an ultimate capacity of one million dwt.

In the particular case of Bantry Bay, the objective was to maintain, with minimum investment, the competitiveness of the company's European refineries, whose shallow terminals were ill-equipped to receive the supertankers being studied by rival oil companies. After 2 1/2 years of experience, one may draw some conclusions about the strengths and weaknesses of the project.

- Economics: Transshipment by 325,000 dwt was determined to be 30-40% cheaper than the use of 80,000 dwt vessels, the maximum size possible in the early 1960's until Rotterdam deepened its port. Direct shipment in carriers of 200,000 - 250,000 dwt is a slightly better economic solution using ports which have since been deepened independently. Another advantage of the Bantry Bay approach was the opportunity to select a virgin site, away from congested routes.

- Environment : The company has employed good environment planning :
  - Ship design includes ballast, bilge and sewage retention, with

cargo tanks smaller than what may soon be required by IMCO, and conservative scantling. Ballast water treatment equipment, capable of reducing water pollutants to less than 4 ppm is a good alternative to the ballast tank system.

- Traffic control is tight, although it does not include a land-based radar system for the very limited traffic involved. The success of the Doppler Sonar Docking System mounted on one ship should determine the installation of a similar system on the sea island, as in Okinawa, Verdon and other ports.
- An effort has been made, at least partially successful, to limit the visual intrusion of the tank farm. Tanks are semi-buried and the spoils used to build a dorsal ridge which further reduces their protrusion. No other social or environmental impact has been noted. Besides the possible opening of the earthen dike in case of catastrophic rupture of a full tank, the only "black spot" is the occurrence of a couple of minor oil spills during cargo handling. Although equipment modification should help in the future, this risk cannot be discarded entirely. A program of water quality and biological monitoring has been initiated by a local college. In the meantime, no water pollution has appeared and the stream trout fishing and resort activities have been proceeding. In fact, the "big ships" have even provided an added tourist attraction.
- No refinery or other basic industry is expected to be allowed in the area, even though a company recently looked at ship repair activities. Dry bulk storage does not seem to have been contemplated.

- Engineering : The sea-island formula has proven viable in 3-foot swells, and 40-knot winds (25-knot beam winds for sailing on ballast), with little current present.

Insufficient floating equipment for survey and construction caused costly delays during pile driving.

I.2 HISTORY AND RATIONAL OF DECISION

In 1965, Gulf Oil had four refineries in Europe, operating or under development all with shallow water terminals : Milford Haven, U.K. (upstream from the recent deep-water, 250,000 dwt developments); Stigsnaes-Gulfhaven, D.K.; Europoort- Rotterdam (there was no talk at that time of the later deepening to 65 and 72 feet); and Huelva, Spain. Gulf had to improve the competitiveness of its crude supply and there were prospects for expansion or additional refineries (now: Emden, West Germany) in the area.

At the time Shell and Esso were talking of 155,000 dwt tankers that could ballast through Suez, but the Gulf Transportation London Group also investigated 255,000 dwt, the maximum conceivable at the time, to avoid the technical limitations (999 ft. length and a cross-section ratio of 1:4), the extra costs (towage, waiting time, ballast free requirements) and the political and war risks. A presentation to Gulf's chairman was well received and a committee was formed -- with P. Binsted (London), R. Cooke (N.Y.), and other transportation experts -- to study the economics of direct movement to each European refinery and the possible alternatives. The objective was to remain competitive at the least capital cost while, in Okinawa, it was to enter a new venture (retailing, third-party crude sales), requiring a refinery adjacent to the terminal.

As work progressed, it became clear that direct shipment by 255,000 dwt brought the maximum savings but at the cost of a huge investment in 59-ft. draft terminals. Initially, the concept was to lighten these ships on their way to Rotterdam, and this solution may still be used now that 65-ft. depth (and soon 72-ft) is available there, unless tanker size again escalates. Such lightening is already involved when one of the "Universe" tankers retains some cargo which she unloads at Huelva on the way back to Kuwait.

Transshipment was also investigated because of favorable experience in Aruba (for exports of Maracaibo crude) and in Rotterdam (to Finland which was icebound in 1962). A system analysis based on loading in Kuwait, and unloading at a deepwater location in NW Europe with 85,000-100,000 dwt shuttle tankers serving the refineries, showed reasonable flexibility, reduced capital requirements and improved competitiveness.

Having thus settled on transshipment, the Commission looked for deepwater sites, away from congested channels and reasonably close to the satellite terminals. In addition to SW Ireland, the commission evaluated the Jersey Islands, the Coast of Wales, Loch Ewe, and Scapa Flow in Scotland were considered, but fog frequency counterbalanced the advantages of a Scottish location (50% investment grant, lower short-to-long-haul ratio, better shelter and land availability).

Then, Gulf Oil quietly acquired land on Whiddy Island after having established preliminary contacts with Irish authorities (Bantry municipality and the central government), none of whom offered or were requested to give incentives. Ground was broken in March 1967. The first unloading took place on October 29, 1968,and formal inauguration on May 6, 1969. Operations have been continuous since October 1969.

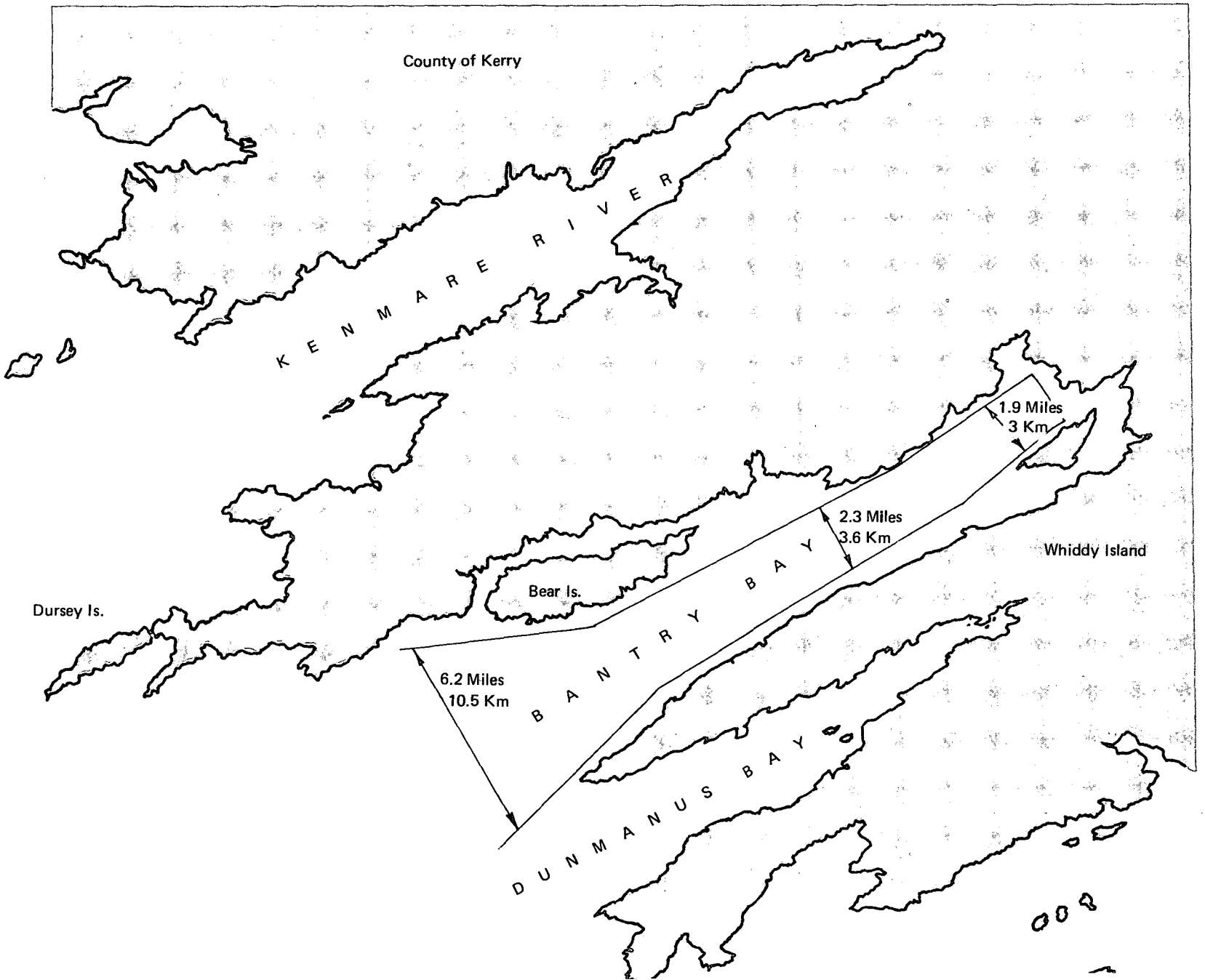
I.3 GENERAL DESCRIPTION

I.3.1 Geography

Bantry Bay is one of several deep bays on the hilly, picturesque Irish coast. The area economy is based mostly on low-density fishing (sea and streams), and rural and resort activities. The hinterland does not offer a strong market for basic industries.

Several islands in the bay offered the necessary location requirements, and Whiddy Island was selected to house a storage farm, linked to a "sea island" by an 1100-ft. underwater pipeline at 100-ft. depth.

FIGURE I–1 MAP OF BANTRY BAY



I.3.4 Channel

A 20-mile natural channel, 180 to 120 feet deep, mostly 2-3 miles wide, is oriented WSW to ENE. Current is limited, but waves do come up to 6 feet in Southwest weather. This caused some trouble during construction because the floating equipment was too small. Tides have a maximum amplitude of 5.5 feet (neap) to 10.3 feet (spring).

I.3.5 Land and Sea Use

One-third of the island has been taken from traditional farmland and moors. The bay is a resort area, and local residents requested that an embankment be built to hide the tanks from the mainland. Gulf used the spoils from excavation to bury part of the tank walls.

Fishing is active but only outside the bay. Local fishermen showed little concern about the effect on marine life in the bay itself. Stream fishing (trout, salmon) did require some attention, but opposition remained limited.

I.3.6 Population

Of the some 150 people who had been living on Whiddy Island's 1500 acres, only about 50 stayed. Some continue to fish or farm. Some are employed in the terminal's 60-man work force.

I.4 INSTITUTIONS AND FINANCING

Gulf Terminals (Ireland) Ltd. was appointed port authority by the Irish Federal Port and Waterways Department, and Gulf made the Port Authority by-laws on the basis of Milford Haven and other terminal experience. These by-laws were approved by the Irish Federal Port and Waterway Dept. and the Irish Tourism Department. Terminal performance is assessed by the Refinery Division (London), now in charge of Marine Terminals, with the Marine Operations Groups of Gulf Transportation,Inc., helping on request. The terminal is leased to Gulf Europe. As mentioned before, Gulf Oil did not receive any government financing, and paid all of the capital costs.

The local management consists of a terminal manager, and an operations manager. Originally the payroll consisted of 48 persons. This has since increased to 60, due to the union pressure for increased operating personnel. (This latter figure does not include the crews on four tug boats.) A typical operating shift, exclusive of office and general maintenance personnel, consists of seven people: dispatcher (1); pumpman (1); assistant pumpman (1); dockman (1); utility people (3). Four shifts permit a 24-hour loading/unloading operation. Of the entire staff, all are Irish and only three were Gulf Oil Corporation employees prior to 1968.

I.5 ECONOMIC APPRAISAL

I.5.1 Direct Benefits and Costs

Because of intra-company transfer prices, it is quite difficult, in an integrated oil company, to ascertain the real values of product and services exchanged. Shipping, in particular, is a captive operation which has little effect on supply and demand balance and, even though Gulf expresses satisfaction with Bantry Bay's economic success, one cannot say that its existence has had a substantial impact on offtake patterns of Kuwait crude, the major crude used by Gulf-Europe (with AgaJari crude a distant second). Similarly, a judgment of what European refinery runs would have been without the trans-shipment system is difficult, and further obscured by the intense turmoil of events which have taken place since 1967 (Suez War, Nigerian War, Tapline closure, Libyan cutdown, Teheran agreement, etc.). Refinery expansions from 40,000 bbl/day to 80,000 bbl/day at Europort and Stigsnaes, and the acquisition at Emden, have probably not been triggered by Bantry Bay, but may have been made easier by its success. Gulf Europe's product marketing activities have been aided considerably, while Gulf Transportation's performance has improved in the past two years. An indication of this success can be seen in the following considerations:

- Gulf Europe refineries appear to have benefitted and expansion has proceeded. We understand that actual economics were quite close to original estimates. In

addition, Gulf Transportation is now well positioned should tanker size increase to 500,000 dwt (but not for a million dwt).

- System output must be about 200,000 bbl/day or slightly more for breakeven, since this is the approximate transport capacity of the six "Universe" tankers. The terminal now handles 250,000 to 300,000 bbl/day and, through use of 100,000 dwt shuttle ships, could go to 400,000 to 500,000 bbl/day without strain. The marginal storage cost of a barrel of oil beyond 200,000 bbl/day should not exceed 1.5 to 2¢/bbl (11-15¢/long ton).
- The Kuwait-Bantry Bay 325,000 dwt could be more expensive than direct shipment to Rotterdam in 200,000 to 250,000 dwt tankers but, at the time, Rotterdam did not talk in terms of these sizes and such tankers acquired now would cost more than twice their 1965-68 price. Even now, however, the "system" is still ahead of direct shipments or lightering at Milford Haven, Huelva and Gulfhaven. Compared to costs incurred with the 80,000 dwt used at the time, transport savings are an estimated 33% or more (Table I.1) with the Bantry Bay system. Direct shipment in 250,000 dwt tankers could bring slightly greater savings, but these would be shaved down by unloading port delays. Given the low cost of the "Universe" tankers, actual savings of at least 40-45% have probably been realized over direct shipment in 80,000 dwt.

Table I-1
COST OF TANKER ALTERNATIVES-$/ton

		Kuwait to Milford Haven and Rotterdam					
		Direct		Direct		Transshipment	
Tanker Size, dwt		80,000		225,000		326,000 + 80,000	
Worldscale, %	100	74	93	56	66	48 + 74	62 + 93
To Milford Haven:direct	8.90	6.59	8.28	4.98	5.88		
Through Bantry Bay	8.74+ .78					4.28+.58 = 4.86	5.41+.72 = 6.13
To Rotterdam: Direct	9.17	6.79	8.52	5.13	6.05		
Through Bantry Bay	8.74+1.23					4.28+.78 = 5.06	5.41+.97 =6.38
Freight Rate Estimate		High	Low	High	Low	High	Low

Savings per ton are $1.73 in the low-rate hypothesis, $2.15 in the higher case. At a throughput of 200,000 bbl/day or 10 million tons/year, $17-22 million appear available for terminal, storage and profit. Current increased output (by 50%) and favorable timing in ship buying enable Gulf to do much better.

I.5.2 Side Benefits and Costs

Having solved engineering problems for the largest ship afloat for several years, Gulf Oil was in a good position when it came time to acquire supertankers. Because of the pioneering character, conservative practice was used (twin screws, tank size less than 12,000 cubic meters) and is paying off now with excellent insurance rates and conformity to pending IMCO's regulations. The ballast water treatment at Whiddy Island and retention of all ship waste during bay transit are becoming standards all over the world.

Construction work benefitted contractors: F. R. Harris (design engineers), an Irish engineering firm, Brown & Root (offshore construction), and the Dutch contractor who built the storage tanks have all improved their images by this pioneering project. Given the low cost of the ships and low

charter rate, neither the two Japanese shipyards nor National Bulk Carriers, the owner, should make much profit beyond the intangible image build-up. Terminal operations give about 30 jobs to local islanders ashore and 30 more on service boats, and Gulf Terminals (Ireland) Ltd. pays taxes to the local and central government.

No complaints have surfaced from former residents (adequately compensated), remaining fishermen (who do not fish much inside the bay anyway), or summer visitors (bayshore real estate prices apparently have not declined and the trout fishing is still good). No Irish tax money has been lost on subsidy. The latter decision seems wise since an Arthur D. Little, Inc., study for the Irish government in the late 1960's showed that trans-shipment (dry and/or liquid bulk) would not bring much public benefits until the local market could justify a refinery or other basic industry, which would be quite objectionable in Bantry Bay. Gulf is prevented by law from storing petroleum products, much less manufacturing them.

Other companies have looked at supership repair activities (without results) but have not yet evaluated dry bulk storage and trans-shipment.

I.6 ENGINEERING ASPECTS

I.6.1 Site Description

Whiddy Island, the site of the terminal, is the innermost of four islands in Bantry Bay. Important elements in its selection were: the relatively protected and isolated location (away from main traffic routes such as Dover Straits); the low fog record; the natural deepwater, maintenance-free, channel that reaches a depth of 100 feet about 1,200 feet offshore; land availability; and the full cooperation of the Irish Government during selection and location. Bantry Bay is also conveniently sited for access to Gulf's European refineries. Gulf owns one-third of the Island, which measures three miles by one mile at its widest points, and has a total area of 1,500 acres. The terminal occupies one-fourth of the portion owned by Gulf. Although Whiddy Island has accessibility problems from the mainland, its remoteness does provide easier handling for safety.

I.6.2 Configurations

During its construction, the actual pier was "T"-shaped with a Bailey Bridge available to gain easy access to the loading/unloading facility. Once the loading platform was fully constructed, the bridge was removed to permit the dockage of 80,000-100,000 dwt coastal tankers at the inshore side of the platform. Currently, access to the platform can be gained only by small boat, which entails a trip of approximately 1,100 feet. Submarine pipelines (submerged for a distance of some 1,300 feet) are provided to transport the crude oil to and from the bulk storage area.

The loading/unloading "sea island" is of concrete and steel construction. It has an overall length of 1,600 feet and maximum width of about 160 feet. The dolphins and the 140 feet x 14 feet central platform are supported by clusters of 36-inch diameter steel pilings, concrete filled. Over 9,000 cubic yards of reinforced concrete were used in the casing shells. The pilings varied in length from 130 feet to 220 feet, because of fissions and cracks in the grey-green slatestone rock that underlies a 5-40 feet layer of (primarily) soft silt.

The product handled is crude oil, from Kuwait and Iran. The terminal has 12 bulk storage tanks, each 262 feet in diameter, 64 feet high, and each having a capacity of 600,000 bbls. Bunker C and diesel fuel oils are also received and stored in a 200,000 and 50,000-bbl tank, respectively. The fuels are used to bunker visiting vessels, tugs and small craft used by the terminal.

I.6.3 Channel and Basin

A preliminary survey was done by Bechtel Corporation but the conception design and engineering was handled by Frederic R. Harris. A naturally maintenance-free channel 100-102 feet deep (mean low water depth) provides safe access for mammoth tankers (90 feet draught) up to the docking area.

Tidal ranges above zero mean level are as follows:

	Mean Spring	Mean Neap
High Water:	12.1 (feet)	9.6 (feet)
Low Water:	1.9	4.1

I.6.4 Design Vessel

The initial 255,000 dwt (59 feet draught) ship was worked up in stages to 276,000 dwt in the shipyard contract with an option to go to 312,000 by use of a 79-foot scantling draught. It was finally carried to 326,700 dwt (81.7 feet draught) by new loadline rules. The 100-feet depth capability was precious through all these changes. There is some regret about not having built the 59-foot draught tanker because they could now go straight into every Gulf terminal except Milford and North Kuwait. However, the present advantage is flexibility for the future, including 500,000 dwt tankers.

The vessel can turn on a 2,150-foot diameter (a T-2 tanker requires 2,250 feet). Stopping distance is 9,000 feet but reaction to astern power is unpredictable, because it depends importantly on wind strength and direction.

Shipboard navigation equipment is normal (10-cm and 3-cm radars, Loran, Decca, etc.), but one of the ships is being equipped with a doppler docking-speed monitor.

I.6.5 Docking

There is no noticeable current in Bantry Bay that would affect safe entry or maneuvering in the channel.

The terminal is equipped with a 4-channel VHF radio, one of them kept under continuous watch. The radio system links the shore (harbor master), ship (bridge, cargo room), tugs and mooring master (aboard tanker) and its capacity is almost doubled through the use of walkie-talkies (explosion proof).

A total of 11 channel market buoys, including a mid-channel line with in-and-out separation, comprise the main navigational aids for channel entry and exit. Gulf also put markers onshore. When visiting vessels reach Buoy 2, twelve miles down the Bay, four tugs and a pilot rae dispatched to the approaching tankers. At Buoy 5 (halfway) two tugs go on the port side of the vessel and two secure to the bow and stern. The vessel enters at a speed of 3-4 knots, although the exact speed is left to the pilot's discretion based on the ship's stopping limit. Once the tanker is broadside, to the pier at about 1,000 feet, two tugs take a push position at the starboard side of the vessel while the other two tugs take a pull position on the port side. The pier approach is then made at a maximum speed of 0.6 feet per second (0.8 design). With the same criteria, a 500,000 dwt tanker would have design and effective docking speeds of 0.33 and 0.25 feet per second, respectively. The mooring master has walkie-talkie communication with each tugboat, and at a given time the pull tugs ease off and move into the push position so that four tugs are pushing the tanker into the pier at the final approach. Before the mooring lines are secured, ship and shore manifolds are lined up by using ship engines. Mooring lines are handled by the tanker's 50-ton capacity tension automatic winches. The lines generally consist of four bow lines, four stern lines, two breast lines and two spring lines. During adverse weather conditions, additional spring and breast lines are used for a total of up to 9 ahead, 10 astern.

The Raykin Fenders (Accordeon rubber 2-3 feet square, mooring in horizontal/vertical directions, with 20 foot square wooden shield) had a little problem with a steel fitting. They deflect 10 inches (with dolphin movement 0.6 inch) at 2 inches/second docking speed. Tugs must push on tug marks (over frames), and the hull has recess with bits to pull from. There are four tugs (2800 HP, 35-ton pull ahead, 22-ton astern) including one stand-by. Fully loaded tankers are not very sensitive to wind: limits are 40 knots, but with 3-foot swells, the tugs cannot push safely. Minimum

draught is 40 feet and sailing limit is 25 knots of beam wind. A berth loading diagram is given in Figure I-2. A twin-screw tug is more maneuverable than a one-screw-kort nozzle tug but has less astern pull.

During a tug strike, a double-ruddered tanker left the pier without tug assistance. Two of the four tugs have booms to service buoys--Gulf also operates two or three boats for line handling and ferrying crews to the mainland.

I.6.6 Materials

Dolphins (4 mooring, 4 breasting on each side of this island) are made of a cluster of 36-inch steel piles filled with concrete. Of the 9,000 cubic yards of reinforced concrete used for casing shells, 6,500 cubic yards were used in dolphin and platform structures. Induced current cathodic protection is used on the steel piles. Steel beams and concrete slab make the top of the island platform 140 feet x 140 feet in the center.

I.6.7 Cargo Handling

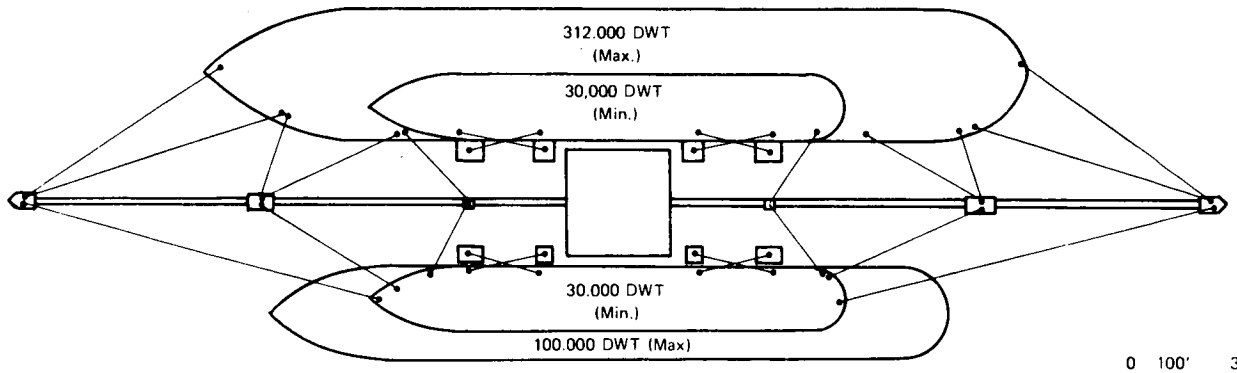
No flexible hose lines are used at the loading/unloading facility. The berths are equipped with hydraulically operated Chicksan Articulated Loading Arms as follows:

North Berth	Four 16" crude/ballast arms
	Two 16" ballast Arms
	Two 12" Bunker C Arms
South Berth	Four 12" Crude/Ballast Arms
	Two 12" Bunker C Arms

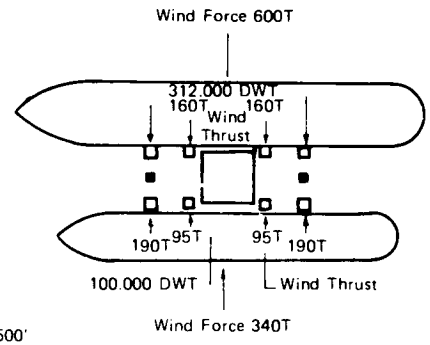
One of the six supertankers has a $50,000 doppler sonar speed-measurement system, designed and manufactured by EDO. After eight months' debugging, it is reliable and has proven useful enough to warrant installing a similar system at both ends of Gulf's Okinawa terminal.

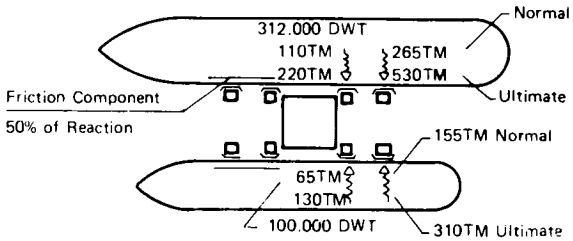
Two-inch diameter submarine pipelines are used to transfer the products and one-inch diameter line is used for ballast. Ships have four pumps of 3,500 m^3/R at 175 psi, with Worthington Vacstrip to prevent cavitation (Mitsubishi stripping pumps are a good alternative); all are remote

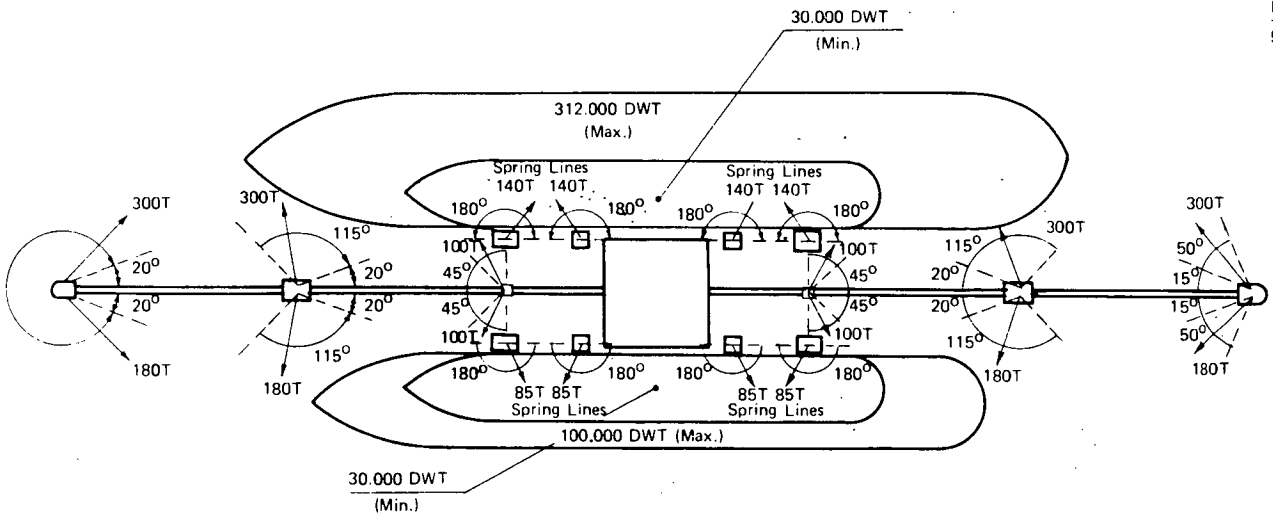
FIGURE I–2 GULF OIL DOLPHIN LOADING DIAGRAM, BANTRY BAY



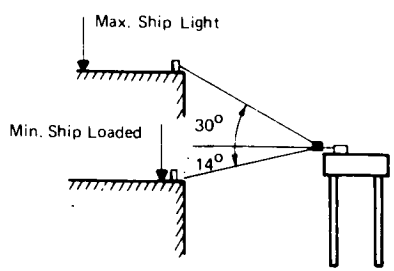
Berthing Alternatives







Berthing Alternatives



Source: Frederic R. Harris (Holland) N. Y., Consulting Engineers.

controlled hydraulically (282-tube bundle).

A central control tower on the dock hydraulically operates all fill lines, while bolted connections are made manually. Plans are under way to convert to camlock flange connections in the near future. The ship's pumps are used primarily to transfer products into the bulk storage tanks and the ship's figures on tonnage transfer are accepted. The Terminal has four 15,000-ton/hour transfer pumps. Maximum loading/off-loading at the mammouth tanker berth is about 100,000 bbls/hour (50,000 bbl/hour ballast). Tankers can also be gravity loaded at a rate of 40,000 bbls/hour.

Tankage consists of twelve 600,000-bbl tanks with floating roof (262-foot diameter, 64 feet high) of strength steel (1.55 to 3/8 inch thick); two 500,000-bbl ballast tanks and two 100,000-bbl bunker tanks with cone roof; and one 500-bbl slop tank.

I.6.8 Cost Data

The entire facility was built at a cost of some $45 million excluding tugs. The original design has proven to be quite satisfactory; only $300,000 has been spent on plant improvements. Some typical improvements are as follows:

1) The ballasting/deballasting system has been improved by an oil reclamation system in which oil is skimmed off the top of the ballast tanks and transfered into a heated 10,000-bbl settling tank. In the latter tank, heat and chemical treatment are used for oil separation prior to pumping the recovered oil into any of the main storage tanks. The 4-ppm design limit still gives a visible film, however;
2) The Terminal's electrical generators were originally cooled by salt water, but this system has been converted to a closed-cycle fresh water cooling system to eliminate salt and seaweed accumulation in the cooling systems.

The initial estimate for the facility was about $32 million ($22-23 million onshore, and $8-9 million for the sea island, depending on alternatives).

Some of the overrun is due to insufficient equipment for pile driving in a sea state and bad labor relations of the Irish contractor. The plant handles an average of one mammoth tanker every ten days, and crude oil handled in and out averages 250,000-300,000 bbl per day. Trans-shipments are normally made to England, Holland, Denmark, France, Belgium and occasionally Spain, and some supplies go to Esso in Ireland. Some trade-offs are also made with other countries.

The cost of maintaining a mammoth tanker while in port has averaged $50 per minute or $72,000 per day. The inflation in transport costs is limited to 5-6% per year of running costs because insurance so far has remained constant. New building costs went from $60/dwt in 1966 (Japan) to $90 in 1968 (Spain, small escalation included) to $125-140 today because of selling margin. This evolution cost is in agreement with the recent Japanese 477,000 dwt tanker: $26 million initially, now $42 million and $52 million if the tank size limitation goes to 15,000 cubic feet.

I.6.9 Crucial Problems and Lessons

Some problems were encountered during construction. Broken subsoil led to the use of floating barges instead of jack-up equipment for pile driving. The barges were too small for swell conditions. Piling which could not be braced underwent fatigue stress of up to 11,000 psi and butt welds failed between 1 and 2 million cycles (35 to 70 days). Heavier equipment was finally brought in.

Surface templates were used economically as pile guides for dolphins. They were set by outriggers from the barge and supported on soldier piles.

The ballasting/deballasting and bilge pumping facilities are worthy of reproduction at any marine terminals in the U.S. More generally, Gulf's

conservative approach in vessel and terminal design is technically and environmentally sounder than many taken since.

I.7 ENVIRONMENTAL IMPACT

I.7.1 Planning and Results

Environmental planning, whether on Gulf's own volition, or spurred by the Irish Tourism Board (Dublin) and Department of Fisheries, seems to have been serious in Bantry Bay's terminal and in ship design. An Air and Water Conservation Advisor is now Informante in Residence in Gulf Headquarters in Pittsburgh. Gulf Energy Environment Services (San Diego) and Gulf Degremont (Liberty Corner, New Jersey) also deal directly with environmental matters. Regulations were submitted by Gulf Oil on the basis of Milford Haven and other experiences and approved by the government. There were no baseline studies, only borings for pile driving, but neither dredging nor fill was needed and there are no traces of irreversible damage by operations such as pipelaying, and island dock construction. Semi-buried tanks and an embankment make a reasonable attempt to reduce the tank farm profile, which has nevertheless raised a few protests.

Not much concern for water pollution was experienced, and local residents were easily reassured by the strict control measures adopted. There was very little complaint from fishermen who fish outside the bay, but some local politicians and the terminal manager called to Town Hall once in awhile. The biggest spill (January 1970) went as far as the Federal Government, which took Gulf to court for a small fine.

More details are given later in a special chapter on environmental protection but the following considerations are of particular interest.

I.7.2 Water

Shuttle ships ballasting from close-by refineries do not have time to clean ballast, so two 500,000-bbl tanks receive their dirty ballast. A separating capacity, built as an afterthought, yields less than 4 ppm oil, but is not often used because it still gives a visible film. Dirty

ballast is routinely loaded into the cargo tanks of superships while they are unloading, to maintain at least a 40-foot draught for windage. It is allowed to settle for 24 hours, then 90% decanted; the remaining 10% goes to a high-capacity, on-deck oil separator (Butterworth), believed to be a first. The separated oil goes to a load-on-top tank. All ballast (normally 30-foot draught) is clean by the time the ship reaches Capetown.

Ballast lines, as well as two permanent clean tanks, are coated in and out. Half of the cargo tanks are coated on horizontal surfaces with Demetkote 2 and vinyl. A garbage-sewage tank on-board retains ship waste during bay transit. Each tug also has a garbage and sewage processing facility.

A student, under the supervision of Dr. Crapp, professor at the University College, Swansea, has been hired by the Irish Department of Fisheries to observe the biological aspects of terminal operations. No report is yet available, but no oil pollution seems to have been detected.

Inflatable oil booms have been used for 3 or 4 small spills and a small skimming barge (with steel roller) is kept at hand. The four specially designed and built 2,800- BHP tugs have 1,000-gallon dispersant (BP 1011) tanks and spraying booms. One tug is always kept on standby. This equipment has been found efficient in the few spills which have occurred, without, however, bringing evidence to contradict the generally recognized inefficiency in swells and current.

I.7.3 Traffic Control

The port manager is in charge of traffic which remains small, and VHF radio communications are deemed essential between mooring master, ship, tug, shore, and doppler operators. This communication capability is doubled by walkie-talkies. The ship receives radiotelephone orders to come in; it then enters on its own radar, helped by a center line of buoys, each with light and reflector installed by Gulf. Tankers have sufficient crew members to secure two tugs at a time, one fore and one aft.

I.7.4 Air Pollution

There are neither fumes nor odors, because of floating roof construction on storage tanks. Some escaping odors could occur during loading and unloading through vapor vent valves.

I.7.5 Solid Waste

None.

I.7.6 Visual Intrusion

The tanks are hidden from the mainland by an embankment. Ships' passages are infrequent but draw the attention of visitors and tourists, who have requested observation points. No noise intrusion can be noticed.

I.7.7 Safety

No accidents have occurred. The four tugs have fire fighting equipment including a remote control hydrant on a soft tower, to be higher than the ship's deck. Foam and water systems are distributed on the sea island and terminal.

I.7.8 Land and Water Use

Bantry Bay was constructed on one-third of the 1,500 acres of agricultural land. The land was purchased by Gulf and a quarter of the acreage is being taken by the present terminal. Gulf is forbidden to build petroleum product tankage, and cannot sell Bunker C outside its own operations. There are no prospects for a dry bulk terminal, basic industry or ship repair activities in the Bay. Fresh water requirements are small.

I.7.9 Socio-Economic Aspects

Sixty people, all Irish, are employed at the terminal and on service boats. Crews on leave seem to have brought little disturbance; they enplane to other destinations as soon as possible.

Bantry is a fishing town, but little fishing is done in the Bay, mostly outside in the ocean. Little is known of what happened to the 100 islanders who moved away, or to the real estate of the area, or to the

standard of living of people who stayed on the island in the Bantry area. However, no complaints have been lodged with the local and central government or with Gulf itself.

Recreation has been practically untouched: some protests about the somewhat hidden tanks are balanced by requests from residents and visitors to have better observation points to view the "big ships."

I.8 ENVIRONMENTAL PROTECTION

I.8.1 Storage Area

All storage tanks are diked with natural earthen dikes which would contain a gradual tank leak. It is doubtful, however, whether the dikes could withstand the impact of a crude oil tidal wave in the event of a sudden accidental release of the entire contents of a tank (of similar experience in Antwerp or Holland).

The water drains from the diked area are kept closed when not in use to drain rainwater from within the dike.

The tanks are equipped with a remotely controlled "VAREC" liquid level reading system, whereby the tank's liquid content can be determined from a computerized control panel within the central control center in the land-based administration office.

All of the tanks are equipped with integral steam heating coils.

The accumulated condensate water from within the bulk storage tanks is drained into a closed drainage system which empties into the terminal's two ballast tanks.

The ballasting/deballasting, bilge pumping system is quite unique. A dock-located pumping facility provides the terminal and visiting vessels with a means of discharging contaminated water into any of two 500,000-bbl onshore ballast tanks. This same contaminated water (see statement

of plant's improvements p.I-16) is then used to ballast ships prior to their departure. Generally, after 7 to 9 hours of crude oil cargo discharge, the tankers are ready to take on ballast. The ballast tanks are filled with bay water prior to a tanker's arrival, and once the computerized filling system displays the need for taking on ballast, 80,000-100,000 tons of ballast water are transferred into the unloading vessel.

I.8.2 Vessels

Vessel design has 24 tanks in 8 compartments, of maximum size 12,000 m^3 versus 15,000 m^3 asked by conservationists. Excellent insurance rates were obtained on account of twin screw-rudders, route and performance. Cargo handling is remote controlled, but without datalogger on cargo volume, trim and stress, as Gulf could not get a level gauge reliable enough for inputs. Coating and scantling, which were then conservative, now look better and better.

Gulf had the option to add 15,000 tons of steel over shipyard design, and exercised it entirely. Stiffening under focs'le deck, skipped by the shipyard, is now done under guarantee. Ship services include ballast transfer from shuttle ship to shore tanks and then mammoth tankers. Ship waste and sewage are contained entirely as soon as the tanker enters the Bay.

I.8.3 Oil Spills

Past spill experience has not been severe. There was one 3-bbl Bunker C overfill spill when a visiting ship was transfering fuel oil within the vessel. The resulting slick was cleaned up within 1 1/2 hours.

Another spill occurred while disconnecting two unloading arms. Due to a misunderstanding, oil standing in the lines was drained onto the ship's deck. The ship's scuppers were plugged, but the vessel was down at the

stern and due to a recent rain, accumulated water was evident at the stern section. The oil slid over the standing water into the Bay. This spill occurred on 1/29/70 and Gulf was fined $300 on 3/26/71. Modifications initiated because of these accidents are: bigger vent valves on the chicksan arms, and bleeding lines on the manifolds. A small tank overflow spill seeped through fractured rock under the dike and reached the walls to everybody's surprise.

The only other spill occurred when some hydraulic oil was spilled into the Bay. This happened from the loading platform and was quickly "killed" from the platform.

No fishing is conducted in the area of the Terminal, although some fishing is conducted in the Bay itself (but mostly outside). The fish consist mainly of scallops, herring, codfish, and salmon. No fishing complaints have been experienced for the entire period of operation. Currently, Gulf is funding an Irish University student to conduct regular water quality tests in the Bay, and a small laboratory (an old construction shack) is made available within the Terminal for this purpose. The student has not published any analytical reports on his study.

All four of the Terminal's tugs can provide fire and spill clean-up protection. Each tug has three lances capable of discharging and directing 3,400 bbls of dispersal chemicals (BP 1011) onto an oil slick. Two tugs are kept on constant standby for oil spill clean-up and fire prevention service. Chemical detergent sprayers are also evident on the loading/unloading pier. The sprayers use a high water pressure to agitate and emulsify the spill. During an actual spill, one tug dispersed the chemical while its companion tug provided an agitation water jet. A 3,000 to 4,000 square foot area was cleaned up in one hour by this method. In addition, each ship has two drums of Gulf Agent 100G to fight small spills.

The Terminal maintains its own fire engine and a fire fighting team comprised of trained plant workers. The tugs can also provide hose

service when required. The storage tanks can be foam blanketed in the event of fire and two pumps are used to maintain pressure on the foam system. Water and foam distribution systems cover terminal and berth.

The Terminal also maintains 1,000 meters of inflatable oil containment boom in 50-meter lengths. The boom has a 20-inch freeboard and a 20-inch submerged skirt. A 30-cubic-meter capacity oil recovery barge is available. This operates on a paddle wheel principle by which the slick is raised from the water surface and deposited into the oil and water separation section of the recovery barge. The "TT" oil boom and skimmer are manufactured by Trygve Thune, Oslo 1, Munchsgate 5, Norway. A bubble curtain around the island was considered but found very expensive and inefficient in the sometimes strong swells.

Originally, only one side of the Terminal was fenced. This fence is being extended to fully enclose the property. As an additional security measure, the services of a private guard company are retained on a 24-hour, 7-day week basis.

Viewed from a mountain side elevation near Glengarriff directly north of Whiddy Island, the entire Terminal blends well with the natural background and lessons can be learned from the aesthetic design of the property.

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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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