XIII. Preliminary design of commercial port berths

XIII. Preliminary Design of Commercial Port Berths

XIII-1 Design conditions

(1) Tide level

H.W.L. ±1.00 m

L.W.L. ±0.00 m

In the absence of tide records at the construction site, the tide level at Lagos Bar was taken for reference.

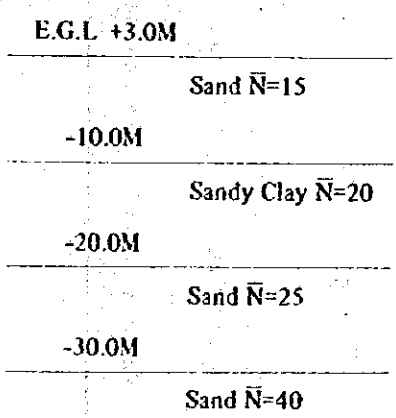
(2) Earthquake

Not to be taken into consideration as there are no precedents.

(3) Soil condition

To examine the soil condition of the project area, borings were conducted at 5 points (to refer Report on the New Ocean Terminal Project, Lagos (Phase - II) - Subsoil Investigation - March, 1979), but no borings were conducted on the sea and in the swampy area located about 400 m inland from the coastline. Although it would be difficult to assume the detaild soil condition of the vast development area from the results of only five borings, the average soil condition shown in Fig. XIII-1 can be applied for preliminary design. It was also assumed that the bearing layer of the piles of structures would be obtainable at -30 m.

Fig. XIII-1 Stratum of Subsoil



(4) Design conditions of berths

Design conditions of berths are shown in Table XIII-1.

The crown height was determined in consideration of the size of objective vessels, tide and structural type of berths.

Table . XIII-1 Design Conditions of Berths

	General Cargo Berth	Container Berth	Bulk Cargo Berth	Petroleum Berth	Small Crafts Berth
Design Conditions					
Crown Height (m)	+3.0	+3.0	+3.0	+4.0	+2.0
Surcharge (t/m^2)	2.0	1.0	2.0	–	0.5
Design Depth (m)	-10	-13	-14	-10	-3.5
Design Length (m)	185	300	300	185	
Size of Vessels (D.W.T)	15,000	50,000 GT	60,000	15,000	280G.T
Berthing Speed of Vessels (m/sec)	0.15	0.15	0.15	0.15	0.20
Cargo Handling Facilities					
Type	Mobile Crane	Container Crane	Pneumatic Unloader	Loading Arms	–
Capacity (t/hr)	–	–	400	1000	–
Lifting Load (t)	Maximum Lifting Load 20	Net Lifting Load 30.5	–	–	–

XIII-2 Structural types

As the structural type of berths, the open-type, steel sheet pile type, gravity type, steel sheet pile type with relieving platform, detached pier or dolphin is conceivable.

In determining the structural type, it is generally required to examine the characteristics of each structural type, natural conditions of site including the soil condition and water level, conditions of use such as type of vessels, cargoes to be handled, conditions of construction work, work period and cost. In this case, the natural conditions obtained from the surveys so far conducted, conditions of use according to the scale and layout of the commercial port facilities and the existing mooring facilities of Nigeria were taken into consideration and the following structural types were considered adequate for the berths, and preliminary design was made accordingly.

Break bulk berths	
General cargo berth	Open-type (use of steel pipe pile)
Container berth	- do -
Grain berth	- do -
Petroleum berth	Dolphin
Small craft berth	Steel sheet pile type

While the design has been made with steel pipe piles, use of concrete piles is also conceivable so that comparative designs will be required hereafter. Further, it will also be necessary to modify the design as required when more detailed conditions are provided through the surveys to be conducted in future.

Standard crosssections of the berths are shown in Figs. XIII-2 through XIII-6 respectively.

Fig. XIII-2 Typical Section of General Cargo Wharf

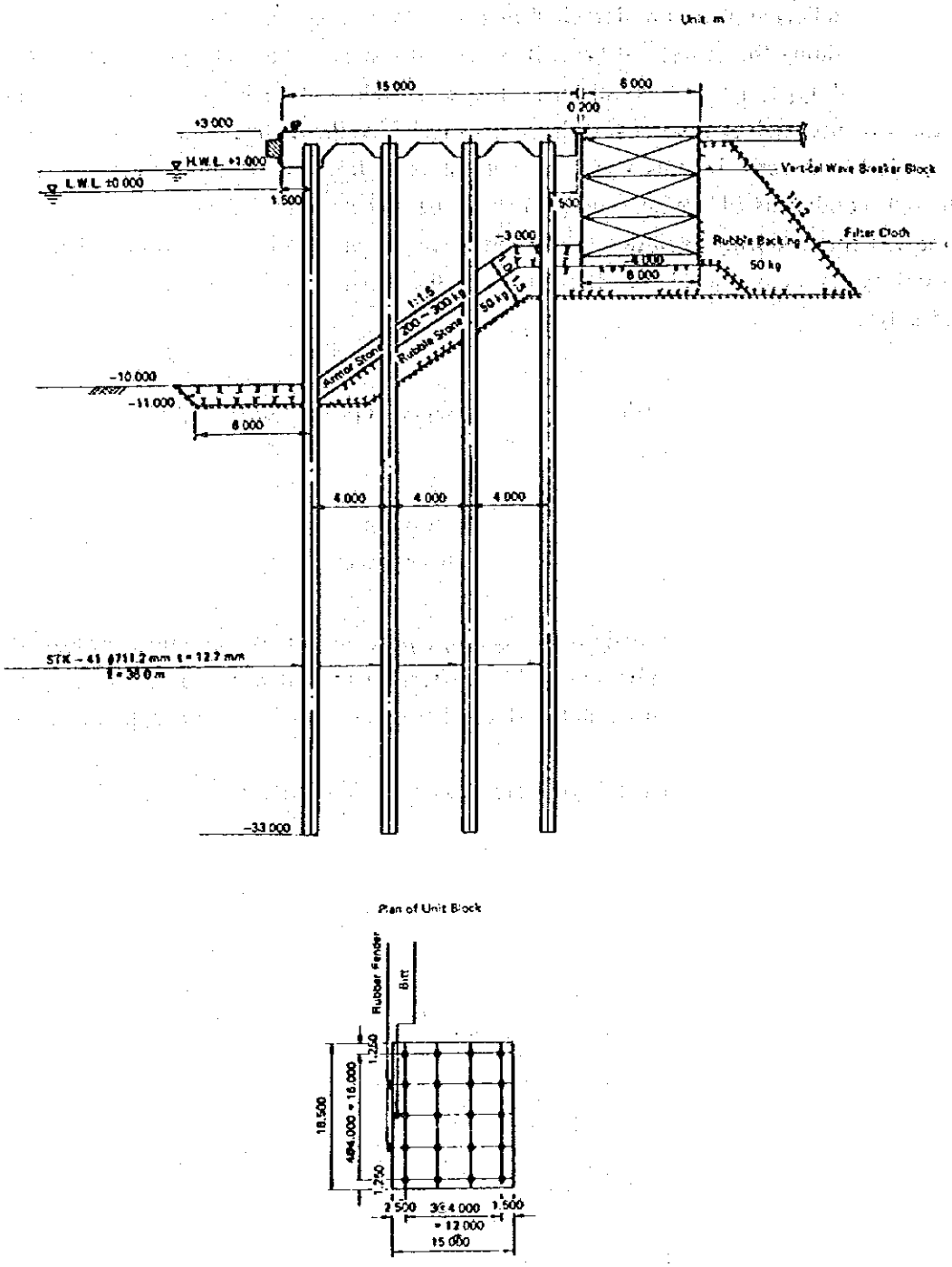


Fig. XIII-3 Typical Section of Container Wharf

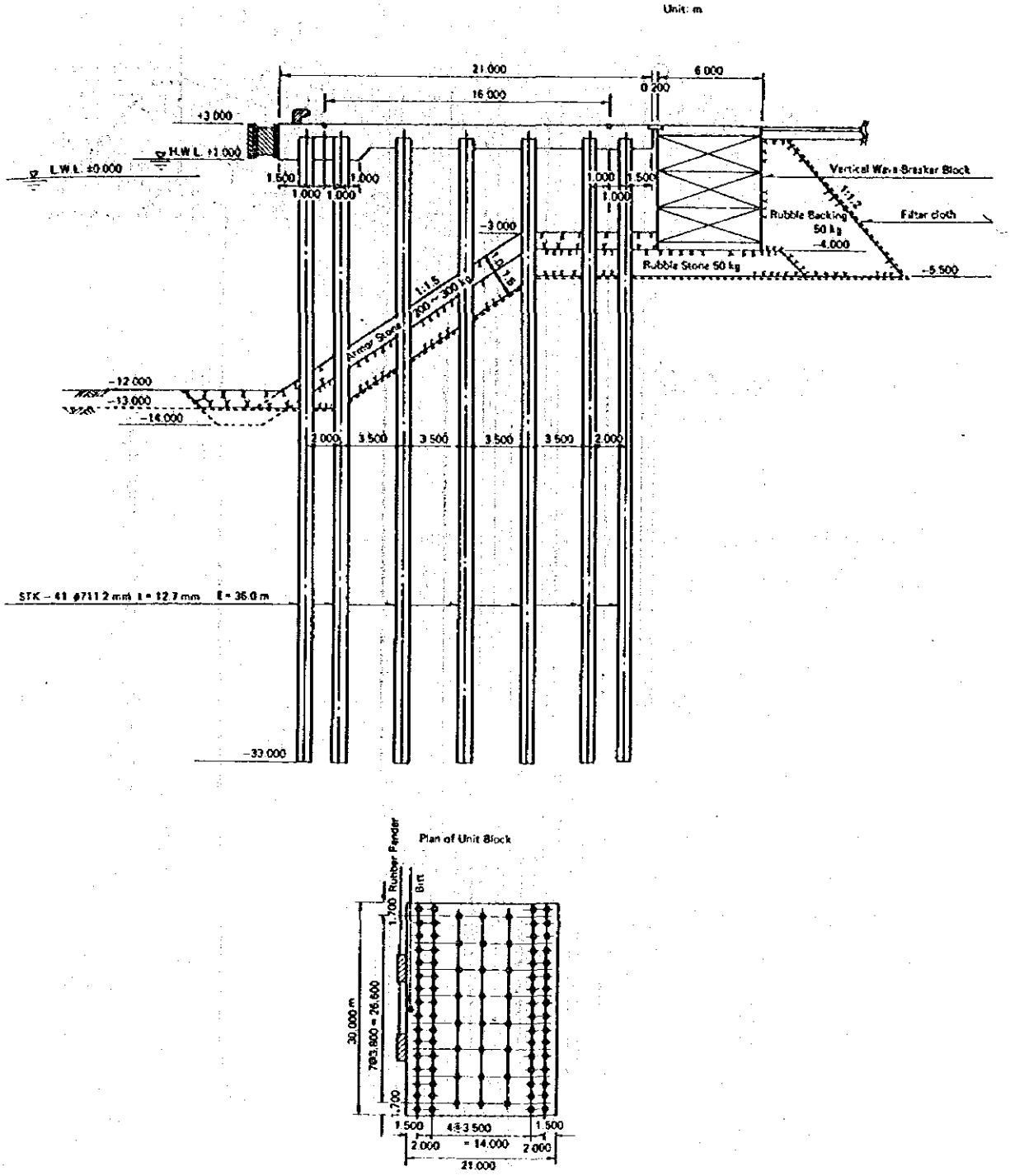


Fig. XIII-4 Typical Section of Bulk Cargo Wharf

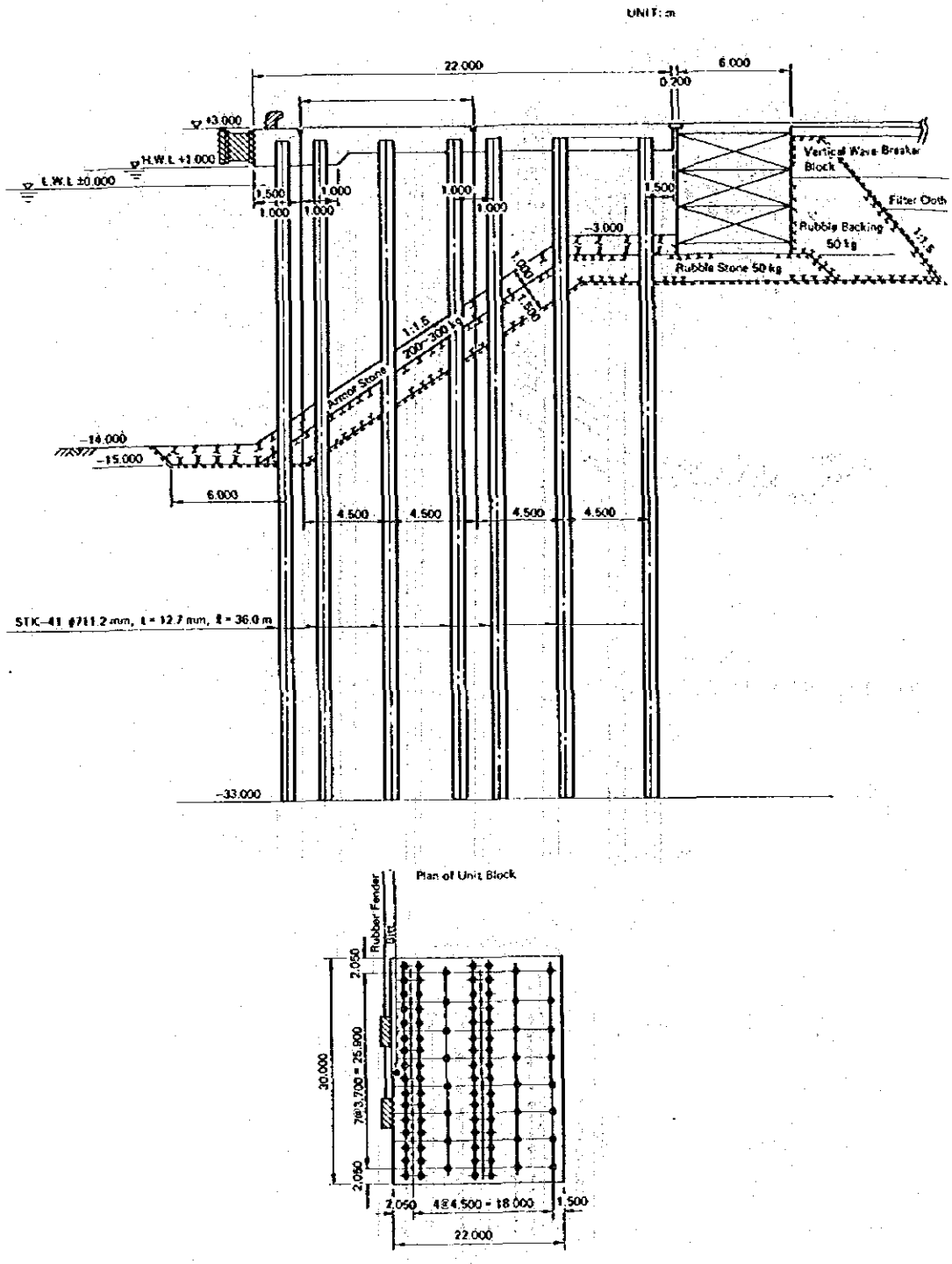


Fig. XIII-5(a) Plan of Petroleum Wharf

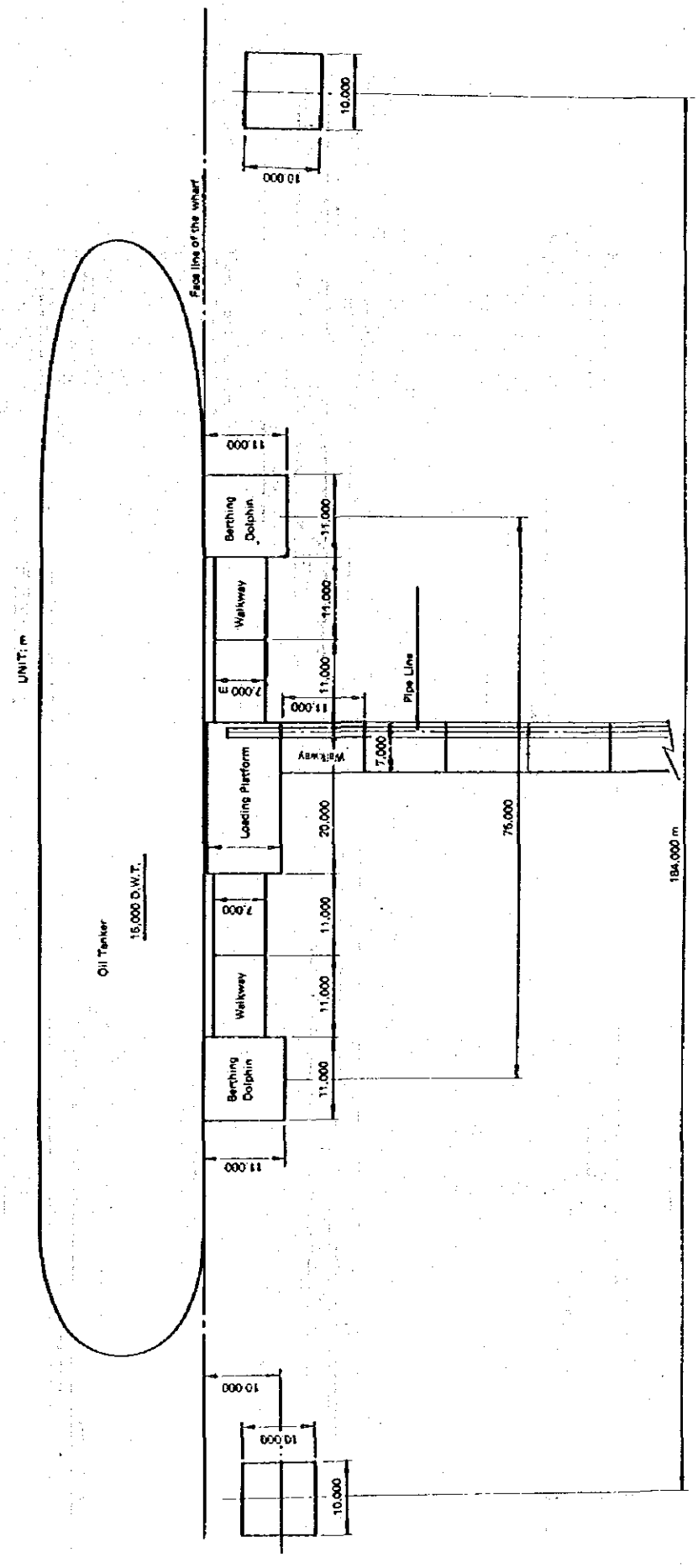


Fig. XIII-5(b) Typical Section of Loading Platform

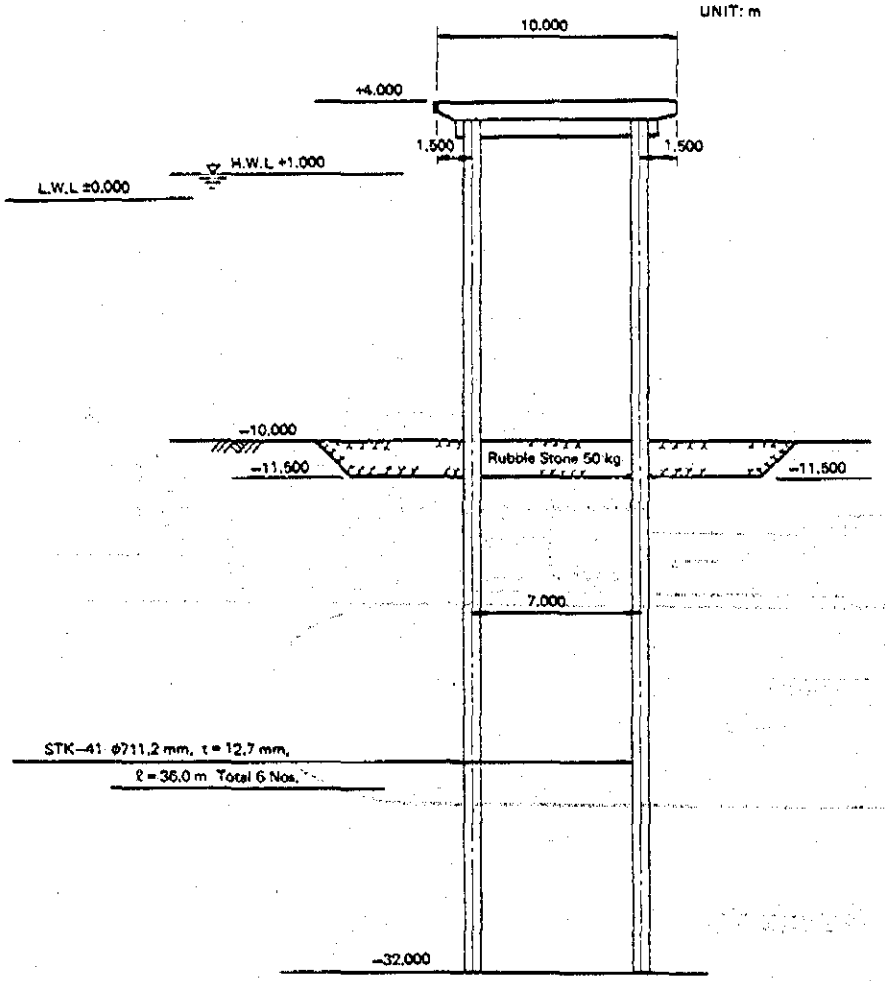


Fig. XIII-5(c) Typical Section of Berthing Dolphin

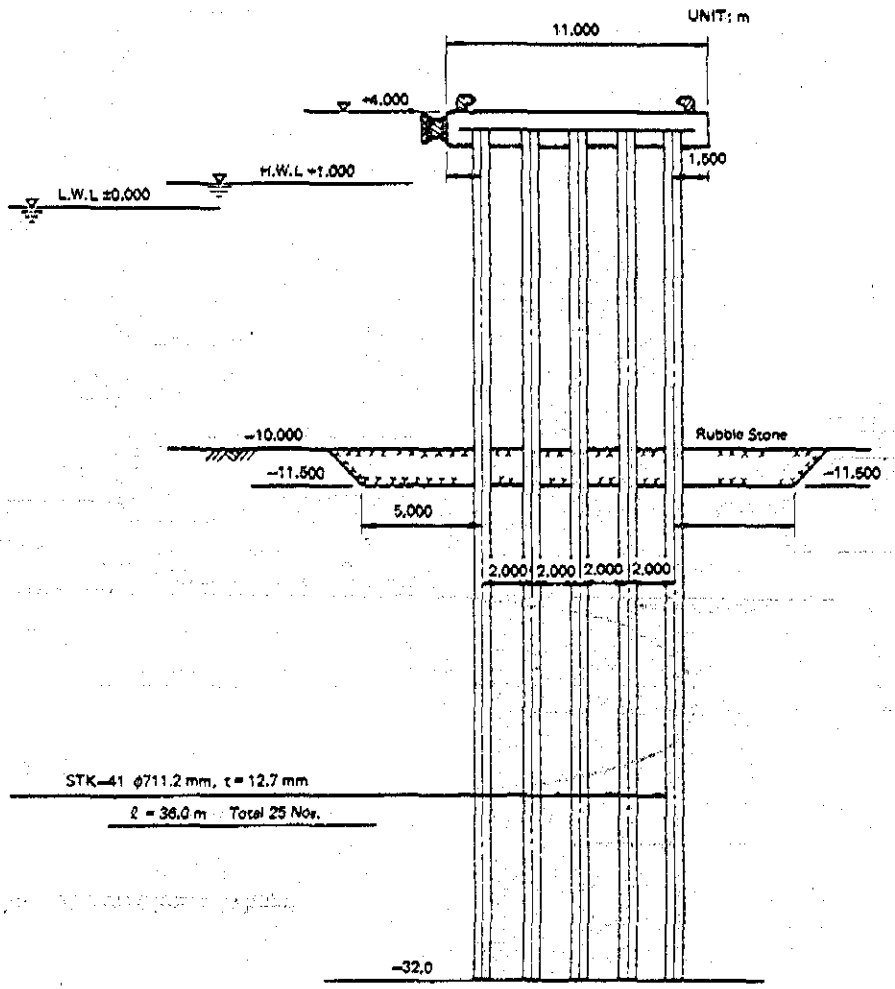


Fig. XIII-5(d) Typical Section of Mooring Dolphin

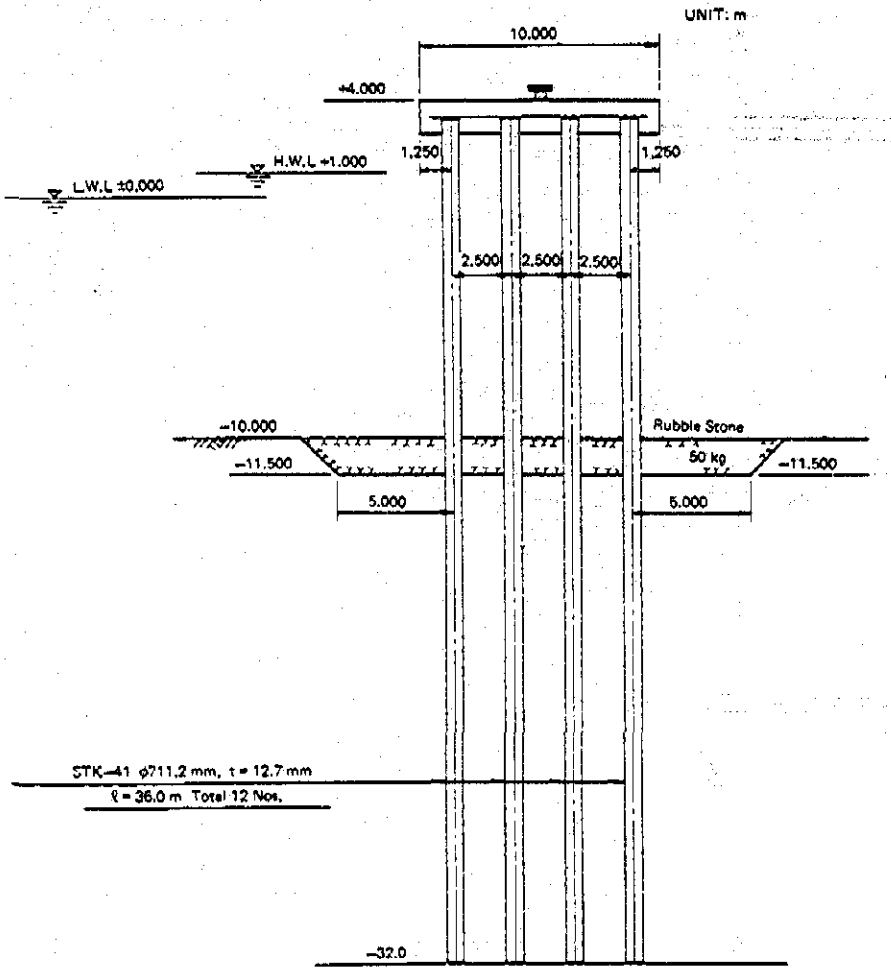


Fig. XIII-5(e) Typical Section of Walkway

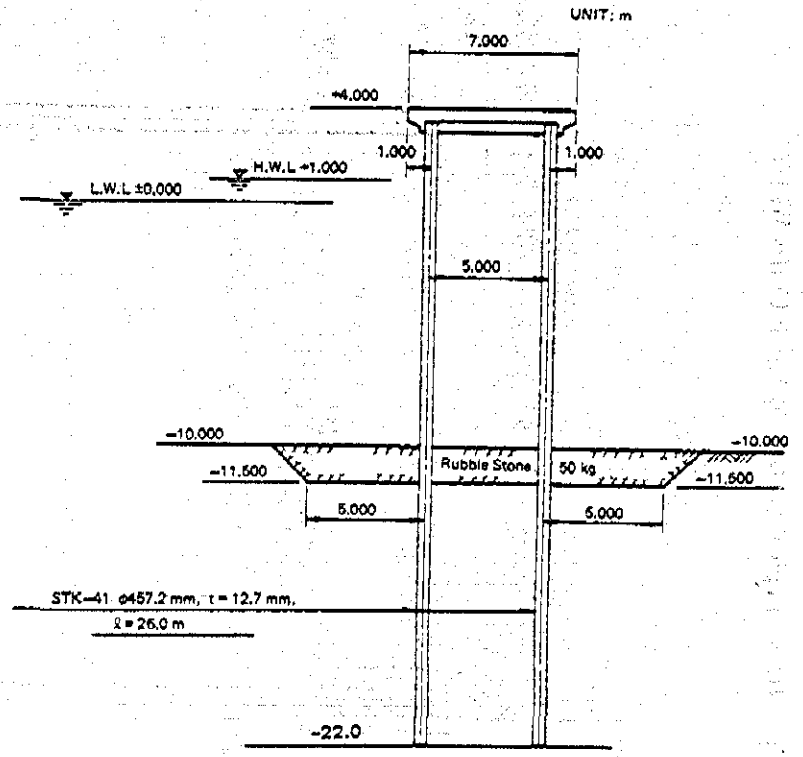
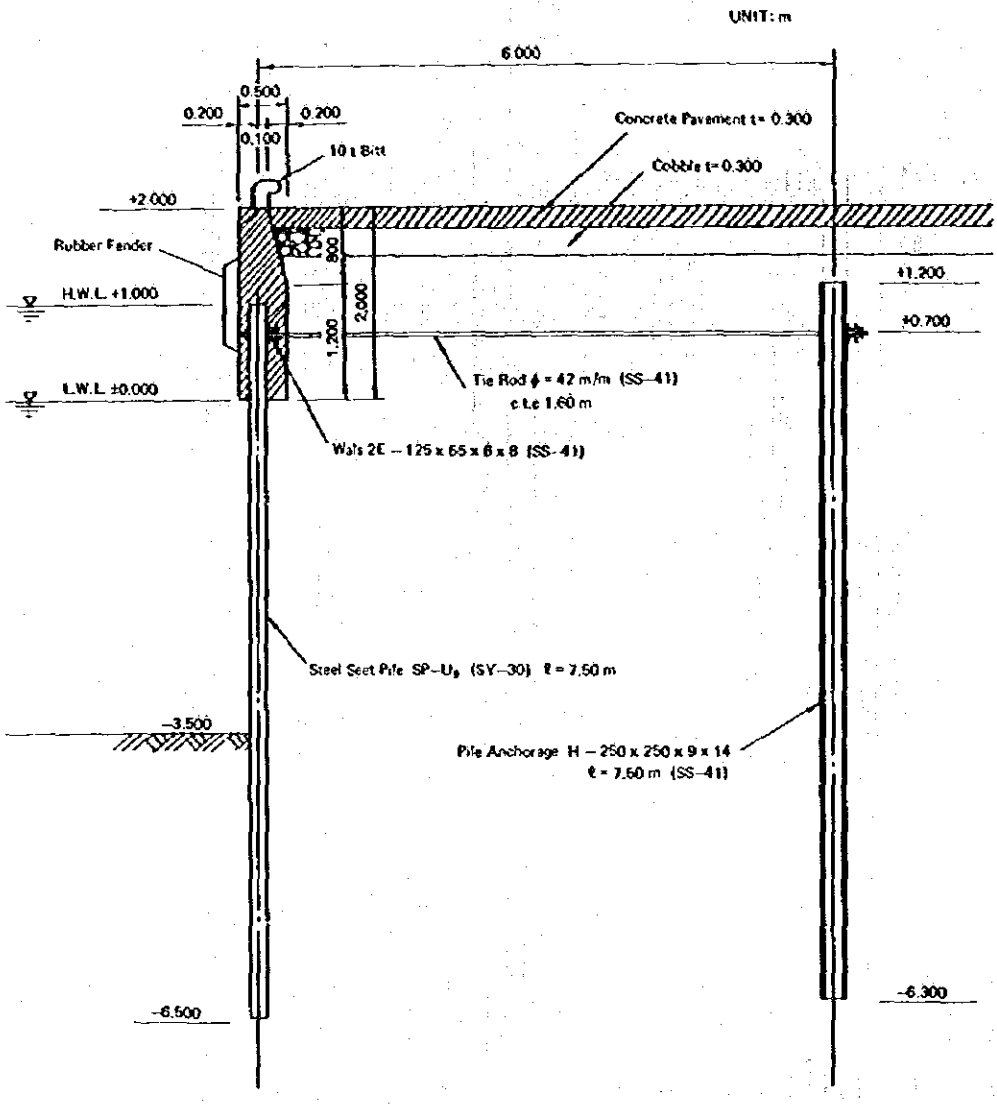


Fig. XIII-6 Typical Section of Small Crafts Wharf



XIV. Approximate cost of construction of principal port facilities

XIV. Approximate Cost of Construction of Principal Port Facilities

XIV-1 Method and scheme of execution of works

XIV-1-1 Scheme of general temporary works

(1) Temporary access roads

For access to the project site, three routes are considered: first route along the coast to connect with the Ikoyi or Victoria Island; second route (planned main access route to the New Ocean Terminal) running north to south across the Lagos Lagoon from the vicinity of Ejirin to the site; and third route consisting water and land route using wharfs provided on the south of the Lagos Lagoon for ferries or barges.

These routes are intended mainly for transport of machines, materials and workers, and the origin will be Lagos.

When the distance of 50 Km to Lagos is taken into consideration, the road is little concerned with the regular transport of workers for commutings but mainly with the transport of machines and materials. Thus, among the three routes above-mentioned the third route is most effective.

For transport of stones from quarry to the northern side of the Lagos Laggon, the existing road is assumed to be available for about 25 Km and a new supplementary road of 5 Km or so is to be constructed, and some volume of stones will be transported through the third route on the southern side of the Lagos Lagoon.

The second route which necessitates a bridge across the Lagos Lagoon is prepared according to the arterial road construction plan and will not be available during the greater part of the construction period of the project.

(2) Temporary wharfs

Near Itokin, the wharfs designed for shipment of stones and a facility for workers to get on and off are constructed. On the opposite bank, on the south of the Lagos Lagoon, there are constructed wharfs designed for unloading stones, machines and materials and facility for workers. For loading of machines and materials on the Lagos side, it is assumed that the existing facilities are usable. The stones can also be transported by trucks on barges across the Lagos Lagoon. In such a case the facilities are, of course, different.

Once temporary rubble mound breakwaters are provided and dredging becomes practicable at the project site, a wharf will be constructed at the place of dredging.

(3) Temporary rubble mound breakwaters

Rubble mound breakwaters will be constructed temporarily to permit commencement of dredging from the sea and provide a basin or shelter for construction craft.

Rubble is directly dumps into water by dump trucks.

(4) Construction yards

At a certain place of the site there will be provided yards for construction office, warehouse and repair shop, for mixing of concrete and concrete products and for steel pipe piles.

The housing for workers will be constructed separately from such plant yards.

XIV-1-2 Breakwaters

(1) Quantity of materials

Table XIV-1 shows the approximate quantities of materials necessary for the construction of breakwaters.

Table XIV-1 Quantity of Materials for Breakwaters

	Type	Length	Materials	Quantity
I. First Stage West Breakwater	Rubble Mound Breakwater	185m	Stone	19,000 m^3
	Composit Breakwater	2715m	Stone Caisson Concrete	442,000 m^3 181 Pieces 113,000 m^3
East Breakwater	Rubble Mound Breakwater	220m	Stone	23,000 m^3
	Composit Breakwater	1330m	Stone Caisson Concrete	182,000 m^3 88 Pieces 56,000 m^3
II. Final Stage West Breakwater	Composit Breakawter	700m	Stone Caisson Concrete	156,000 m^3 47 Pieces 29,000 m^3

(2) Method of construction

a) Transportation and dumping of rubbles

Temporary loading wharfs are to be planned near Itokin, north of Lagos Lagoon, and a road for transportation of rubbles is expected to be provided from the quarry to the wharfs (about 30 Km).

The rubbles quarried out are transported by large sized dump trucks to the wharfs. The rubbles for the composite breakwaters are loaded at the wharfs on rock carriers of the 500 m^3 class. The rock carrier is pushed by a 1,500 HP class pusher boat through the Lagos Lagoon to the open sea, and finally to the dumping point, about 100 Km away, where dumping is carried out by opening the bottom door. However, stones to be used for the rubble mound breakwaters are transported by dump trucks and placed in by a crane to form a prescribed section.

b) Mound of the composite breakwater

Those rubbles dumped by the rock carrier are to be arranged by a small floating crane and by divers to form a prescribed section.

c) Caisson

Caissons are fabricated on the leveled sandy ground at an appropriate site. Upon completion, the caissons are launched into water pocket dredged in front of the caissons with a cutter suction dredger. Then the caissons are towed by a boat to the setting site.

XIV-1-3 Dredging and reclamation

(1) Dredging volume

Table XIV-2 shows approximate dredging volume calculated based on the planned layout and scale of the channels and basins.

Table XIV-2 Approximate Volume of Dredging

(Unit: million m^3)

	First Stage	Final Stage	TOTAL
Commercial Port	28	58*	86
Industrial Port	–	19	19
TOTAL	28	77	105

* This figure contains the amount of soil equivalent to an area of 300 m in width with a depth of 10 m, required for the commercial port using the east channel.

(2) Method of dredging

Dredging is to be carried out by two 8,000 HP class and one 2,000 HP calss cutter suction dredgers. The dredged material is to be used mainly for raising low-lying areas. During the first stage of the project (target year: 1990), dredged material is to be used for raising of the ground level of the commercial port area and its vicinity. Disposal planning of the dredged material by the time of the final target year of 2000 is to be determined after detailed study of topographic conditions of the project site and its environs.

Initial dredging shall be started at a point of shoreline protected by temporary rubble mound breakwaters. Dredging is then to proceed along the front slope of the mooring facilities so that piling may commence soon.

XIV-1-4 Mooring facilities

According to the progress of dredging, pilling is to be carried out by pile driving barges starting with the section near the harbour entrance, excluding the wharfs near the shoreline. After calmness in the vicinity has been secured by breakwaters, the front slope of the grain and petroleum berths are to be dredged and mooring facilities of these berths are to be constructed.

Small craft berths are to be constructed by land-based machinery.

XIV-2 Work schedule of port facilities

At this stage of study it is not possible to prepare a definite work schedule. However, Table XIV-3 has been prepared to provide a concept for estimate of construction costs. This is for the first stage (target 1990) allowing seven years for the entire work schedule.

Table XIV-3 Work Schedule (First Stage)

Item	Quantity	1 yr / 12 mth	2 / 24	3 / 36	4 / 48	5 / 60	6 / 72	7 / 84
Preparation	Sum							
Temporary Work*	Sum							
Breakwaters	4,450 m							
Dredging & Reclamation	28,000,000 m^3							
Mooring Facilities & Related Land Facilities	15 Berth							
Others**	Sum							

* Temporary Work includes mainly construction of temporary roads, temporary wharfs, temporary breakwaters, temporary buildings and yards.

** Others include utilities, navigation aids, port service boats, power station and site clearance.

XIV-3 Rough estimates of construction cost of port facilities

XIV-3-1 Conditions of the cost estimates

1) The exchange rate is to be ₦ 1 = ¥300.
2) These estimates are based on unit prices in the year 1978.
3) Since there are no major construction firms in Nigeria for the time being foreign contractors must be employed.
4) All the materials for construction are assumed to be imported except timbers, stones, aggregates which can be produced locally.
5) The foreign currency component is calculated tentatively according to the characteristics of works.
6) The construction cost at the final stage has been estimated on the assumption that the industrial port will be constructed at this stage.
7) As for the industrial port, construction cost has been estimated on the basis of the type of structures shown in Table XIV-4.
8) The construction cost does not include cost of land purchase, compensation, and consultant fees.

XIV-3-2 Rough estimates of construction cost

Table XIV-5 shows the roughly estimated construction cost of commercial and industrial port facilities calculated on the basis of the above principles.

Table XIV-4 Types of Mooring Facilities in Industrial Port

Mooring Facilities	Type of Structures
Iron and Steel Berth	
Iron Ore Berth	Detached Pier
Coal Berth	Detached Pier
Limestone Berth	Detached Pier
Steel Product Berth	Open-type Wharf
Oil Berth	
Crude Oil Berth	Dolphin
Refined Oil Berth	Dolphin
Oil Chemicals Berth	
Oil Chemical Materials	Open-type Wharf
Oil Chemicals	Open-type Wharf
Shipbuilding Berth	Open-type Wharf
Bulk Cargo Berth	Open-type Wharf

(1) Commercial Port

Table XIV-5 Rough Estimates of Construction Cost

Unit: million ₦

Item	Quantity			Total (Master Plan)			First Stage			Final Stage		
	Total	First	Final	Total	F/C[1]	L/C	Total	F/C	L/C	Total	F/C	L/C
I. Preliminary and Temporary Work[2]	Sum	Sum	Sum	55.5	39.0	16.5	32.2	22.3	9.9	23.3	16.7	6.6
II. Breakwaters and Shore Protection Facilities												
1. Breakwaters	5,150m	4,450m	700m	111.8	89.4	22.4	94.3	75.4	18.9	17.5	14.0	3.5
2. Shore Protection Facilities	2,000m	2,000m	–	10.1	8.1	2.0	10.1	8.1	2.0	–	–	–
III. Mooring Facilities and Related Facilities[3]												
1. General Cargo Berth	33B	6B	27B	175.0	132.8	42.2	31.8	24.0	7.8	143.2	108.8	34.4
2. Container Berth	27	6	21	746.9	605.0	141.9	166.0	134.5	31.5	580.9	470.5	110.4
3. Bulk Cargo Berth	1	1	–	35.7	28.2	7.5	35.7	28.2	7.5	–	–	–
4. Petroleum Berth	3	2	1	34.5	26.9	7.6	23.0	17.9	5.1	11.5	9.0	2.5
5. Small Crafts Berth	1,100m	300m	800m	2.5	2.1	0.4	0.7	0.6	0.1	1.8	1.5	0.3
IV. Dredging and Reclamation	86,000 $\times 10^3 m^3$	28,000 $\times 10^3 m^3$	58,000 $\times 10^3 m^3$	165.6	129.1	36.5	53.9	42.0	11.9	111.7	87.1	24.6
V. Administration Office and Related Buildings	Sum	Sum	Sum	8.2	6.5	1.7	6.8	5.4	1.4	1.4	1.1	0.3
VI. Utilities												
1. Water Supply	Sum	Sum	Sum	16.3	13.0	3.3	10.9	8.7	2.2	5.4	4.3	1.1
2. Sewage and Drainage	Sum	Sum	Sum	11.0	6.6	4.4	3.0	1.8	1.2	8.0	4.8	3.2
3. Electricity Supply	Sum	Sum	Sum	9.0	8.1	0.9	3.0	2.7	0.3	6.0	5.4	0.6
4. Road and Green Belt for Port Service Area	Sum	Sum	Sum	8.3	5.0	3.3	2.0	1.2	0.8	6.3	3.8	2.5
5. Communications System	Sum	Sum	Sum	3.0	2.7	0.3	1.0	0.9	0.1	2.0	1.8	0.2
VII. Navigation Aids				4.0	3.5	0.5	2.5	2.2	0.3	1.5	1.3	0.2
VIII. Port Service Boats				9.6	9.6	–	5.3	5.3	–	4.3	4.3	–
IX. Power Station	400MW	100MW	300MW	88.0	72.0	16.0	22.0	18.0	4.0	66.0	54.0	12.0
Total				1,495.0	1,187.6	307.4	504.2	399.2	105.0	990.8	788.4	202.4
X. Physical Contingency[4]												
Grand Total				1,495.0	1,187.6	307.4	504.2	399.2	105.0	990.8	788.4	202.4

Note: 1 F/C and L/C are foreign and local currencies respectively.
2 Temporary work includes mainly construction of temporary roads, temporary wharfs, temporary breakwaters, temporary buildings and yards.
3 Related Facilities include cargo handling equipment, transit sheds, warehouses, roads, parking areas, green belts and open storage yards which relate to respective berths.
4 Physical contingency is not added.

(2) Industrial Port

Unit: million ₦

Item	Quantity	Cost
I. Preliminary and Temporary Work	Sum	11.5*
II. Mooring Facilities		
1. Iron and Steel Berth		
a. Iron Ore Berth	2 berth	30.9
b. Coal Berth	1 berth	13.2
c. Limestone Berth	1 berth	6.8
d. Steel Product Berth	9 berth	29.1
2. Oil Berth		
a. Crude Oil Berth	2 berth	5.3
b. Refined Oil Berth	1 berth	2.0
3. Chemicals Berth		
a. Chemical Materials	1 berth	3.2
b. Chemicals	5 berth	16.1
4. Shipbuilding Berth	3 berth	9.7
5. Bulk Cargo Berth	1 berth	11.3
III. Dredging & Reclamation	$19{,}000 \times 10^3$ m^3	36.6
Total		175.7

* The cost of preparation and temporary work is only for the mooring facilities and dredging of industrial port.

XV. Rough estimates of Total construction cost of the New Ocean Terminal

XV. Rough Estimates of Total Construction Cost of the New Ocean Terminal

For reference, the cost of construction of the New City, arterial transportation facilities, commercial port and industrial port is represented in Table XV-1.

However, these estimates are not of the same order of accuracy due to the difference in the method of calculation as mentioned before in each chapter, and they are not to be taken integrally. Nevertheless, the table has been prepared in order to give a general view.

Thus, for the conditions of the estimate, reference should be made to those provided for the respective chapters.

Table XV-1 Total Construction Cost of the New Ocean Terminal

Unit: million ₦

Facilities	Total (Master Plan)	First Stage 1990	Final Stage 2000
New City[1]	650	25	625
Arterial Transportation Facilities[2]	356	24[3]	332
Commercial Port[4]	1,495	504	991
Industrial Port	176	–	176
Total	2,677	553	2,124

Note: [1] For the urban facilities, only the infrastructures and architectures for public services are taken into account, and the intermediate values of estimates ranging over a certain width are indicated respectively.

[2] This construction cost includes the costs inside and outside the area of development as shown below.

	First Stage* Million ₦	Final Stage Million ₦
Inside the area of development	15	167
Outside the area of development	9	165

* Railway facilities are not included.

[3] Roads in the First Stage are planned as two-lane.

[4] The construction cost for roads in port area is included in the arterial transportation facilities.

XVI. Development benefits of the New Ocean Terminal

XVI. Development Benefits of the New Ocean Terminal

The objective of the Phase-II Report for the development of the New Ocean Terminal is to formulate it's Master Plan for the year 2000. Before the step of executing the project itself, there are many steps of studies. The next step after the master plan formulation is the so-called feasibility study. A certain part of the project included in the master plan is taken up and investigated as to whether it is feasible technically, economically and financially. Accordingly, the quantitative investigation of the economic effects is ordinarily undertaken at the feasibility study level. In general, in order to make an economic evaluation of a project in any significant accuracy to see quantitatively from the point of view of cost and benefit whether the project gives any economic benefits to the country, the particular of the project must have been examined in an accuracy warranting economic evaluation. So at the master plan level, a strict analysis of the economic effects is generally not carried out. This results from the master plan taking a broad perspective to investigate such basic items as giving the project a character, establishing long term objectives, selecting a location and setting the overall scale of the project, etc.

However, it is desirable, even in the stage of master plan, to see macroscopically whether implementation of gives any benefits to the national economy. Thus, those development benefits which can be evaluated quantitatively will be picked up to be examined after the qualitative investigation.

XVI-1 Development benefits of the New Ocean Terminal

Table XVI-1 classifies the development benefits on the New Ocean Terminal.

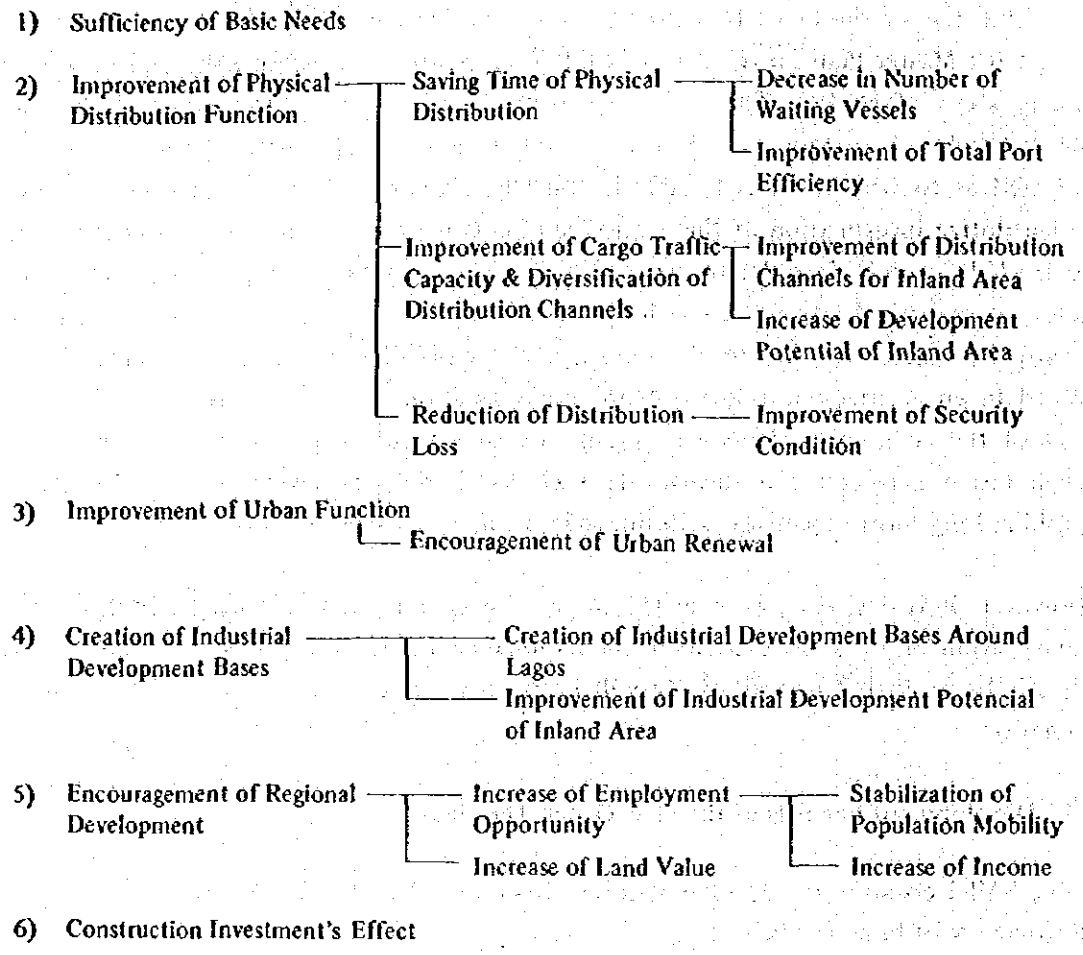
(1) Sufficiency of basic needs

In might not be sure if it is proper to take this up as development benefit, but it was the most important driving force in the conception of the project. To wit, it was considered indispensable to enlarge the port for the future economic development and the level-up of the citizens' living standards. If the present Lagos Port had no room for proper expansion, by all means, an appropriate nearby site should be selected and a new port constructed. Or the site of a different port of a several hundred kilometers distance would be expanded and it would become necessary to transport a large quantity of cargo from there to the Lagos district. If these measures were not taken, it is certain that ships would be left standing in and outside of the Port of Lagos, inviting the stagnation of the national economy. Also, the inefficient transportation structure would hurt the overall efficiency of the economy through the raising prices of commodities.

In a case like the Lagos Metropolitan Area where the demand is expected to grow sharply, it is generally more economical to build a new port within the area than to rely on another port further outside of the area.

There are especially many technical difficulties in improving the existing Nigerian ports for modern container ships and their like. Moreover, in the case of a river port, maintenance dredging is generally expensive. Thus, the construction of the New Ocean Terminal facing the Atlantic

Table XV-1 Development Benefits of the New Ocean Terminal



Ocean is something to meet a real basic national need for Nigerian economic and social development.

(2) Improvement of the physical distribution function

The largest effect of the improvement of the distribution function is the saving of physical distribution time. As the New Ocean Terminal is developed and takes over a part of cargoes from the present Lagos port, the result will be an extreme improvement of the functioning of the present Lagos port. In this way, the number of waiting ships can be reduced and the berth conditions can return to a proper level of use from over utilization of berths at the present Port of Lagos. As a result, the port's efficiency as a whole will be raised, and physical distribution time will be saved. Thus, Nigeria who has a great deal of highly timesensitive cargo traffic, can get an extremely high value added.

As already stated, the major development purpose of the New Ocean Terminal is to increase the cargo traffic capacity. If the New Ocean Terminal is not developed, it is clear that the Port of Lagos, which at present has its hands full of cargo, will not be able to handle Nigeria's future

cargo traffic and much less have its hands free to handle goods designated for other countries. On this point, the New Ocean Terminal will be able to become a cargo distribution terminal for the so-called land-locked countries of Chad, Niger, etc. This might also be said to be linked with the raising of Nigeria's international position in Africa. Also, the construction of the New Ocean Terminal will bring about a diversification of the distribution channels, and expand the channels for cargo traffic to and from the inland area, resulting in contributing to the advancement of the presently lagging inland area. This effect can contribute to effective utilization of the land of Nigeria and will become a basis for balanced national development.

The increase in distribution capacity and the saving of time are linked to the reduction of distribution loss. Generally, cargo damage occurs depending on the time the cargo sits in the hold of a ship or in port zone, and the pilferage increases when the port zone is crowded with cargo as a result of shortage in facilities. As the distribution function is improved, losses caused by poor distribution system can be kept to a minimum. This can be the factor which is also helpful in increasing international confidence of Nigeria.

(3) Improvement of urban function

The present Port of Lagos is Nigeria's largest trade port. It is a part and parcel of Lagos city and is situated in the heart of the city. Thus, its activities have an extremely strong impact on the city's urban functions and the space occupied by the Port and related enterprises is very important land. Since the level of activity in the current Port of Lagos and related enterprises may be maintained at a suitable level by the development of the New Ocean Terminal, the re-development of the area surrounding the Port will be possible. The results will have the same effect as giving birth to a valuable new urban space.

(4) Creation of industrial development bases

The New Ocean Terminal is planned as a project with combined commercial and industrial port functions. As already stated in Chapter 3, when the port reaches a certain stage in its growth, it will come to play an important role as a nucleus for industrial development. First of all, the development of the New Ocean Terminal is planned in order to contribute to the improvement of distribution function of the present Port of Lagos. Thus, in the first period the commercial port function will be developed, but, once these kinds of port function are ready for use, the land around the port becomes extremely attractive to the location of industries. For this reason, it is the fundamental intent of our Master Plan that it be planned ahead of time so that future industrial developments, especially that of coastal industry sites are smoothly brought into being. Speaking on that point, through the development of the New Ocean Terminal, Nigeria can realize the fully equipped seaboard industrial base for the first time. This will give the immeasurable benefits to Nigeria's economic development. Moreover, the effects of the New Ocean Terminal's industrial development are not limited to the immediately surrounding area, and reach far into the interior of the country by contributing in a major way toward the moving of commodities. More specifically, the New Ocean Terminal and the interior of the country will be linked by rail and road, and the New Ocean Terminal will come to supply the inland industries with needed goods and offer the smooth exporting of processed goods manufactured in the inland area. In this way the development benefit of the industrial base of the New Ocean Terminal will extend to the interior as well.

(5) Encouragement of regional development

The site planned for the construction of the New Ocean Terminal is a spacious one on the coast of a 50 km distance from Lagos city. Excluding spotted farm lands the land has been left almost entirely in its undeveloped state, and the transportation conditions are not good. The inhabitants make a living half by fishing and half by farming, and the income level is not so high. In this kind of area, the development of the New Ocean Terminal will result in a radical increase of work opportunities, a larger population coming to stay, and an increase of the inhabitants income. At present, a large population has come into Lagos city from the inland farms looking for work. This has had a grave effect on the overcrowding within Lagos city and is causing ill effects of overcrowding. It will come to be requested more and more in the future to draw this man power to places separated from Lagos city. The development of the New Ocean Terminal, in responding to the kind of problem, contributes greatly toward the improvement of the welfare of the regional inhabitants.

Also, the enrichment of the social capital such as roads and urban facilities is contemplated as a natural effect of the development of the New Ocean Terminal. And it will improve the regional living standard and convenience enormously.

Consequently, as the land which has hitherto had very little utility value transforms to the land of high utility value, it brings major economic effect to the regional economy. At the same time, creation of land of high utility value is expected to increase the "wealth of the nation" itself. This will call for the establishment of still more enterprises, and the regional economy as a whole will experience significant development.

(6) The construction investment's effects

The various effects discussed in the above are the effects which are the outcome of the comprehensive activities of the New Ocean Terminal. These effects have the nature of long-term and continuous.

Another economic effect that can be thought of is the direct effect brought by the construction investment. The construction of the New Ocean Terminal requires investment over the long-term and of a large scale. Moreover the New Ocean Terminal has various types of construction works such as a port, industrial base, urban facilities and so forth. For this reason, the construction of the entire New Ocean Terminal, by itself, will create many employment opportunities, together with the procurement of the construction materials, and will bring a wide spreading of economic benefits to all over the country.

XVI-2 Evaluation of the selected benefits

(1) Value Added with Industrial Production

There is a high possibility of the industries such as those described in Chapter V being located in the New Ocean Terminal in the future.

Industrial production requires investments and is costly. In the other hand, once the productive activities are started, there is created a value added with such activities. In the case of the New Ocean Terminal, such value added is obtainable only when there are industrial infrastructures including port facilities created by construction of the New Ocean Terminal, and it may be considered as an economic benefit to the country as a whole. However, this value added is not obtainable with only development of the industries included in the calculation of the New Ocean Terminal construction cost shown in Chapter XV but with the investment to plant construction required for industrial production included. Therefore, in the case of measuring the benefit to the development of infrastructures (except plant construction) of the New Ocean Terminal in use of the value added by industrial production, it is required to apportion the total value added according to the plant construction and the expense for development of the infrastructures of the New Ocean Terminal (that is, construction cost described in Chapter XV or ₦2,677 million) which are required for creation of the value added. That is,

$$\text{Amount of value added with industrial production by construction of the New Ocean Terminal} \fallingdotseq \frac{\text{Total amount of value added} \times \text{the New Ocean Terminal construction cost}}{\text{Total construction cost including plant construction cost}}$$

The value added from the industrial production is of a concept of flow. It is produced from the production every year so that it will be estimated at a rather low value for the sake of calculation of the benefit, and a total of the values produced every year in 20 years of from 1990 to 2010 will be used. Here, it is not conceivable that all plants will be operated fully from the outset of 1990. Thus, assuming that the plants will come to full operation in 2010 as shown in Fig. XVI-1 and that the degree of operation will increase linearly during the period, the total amount will be calculated.

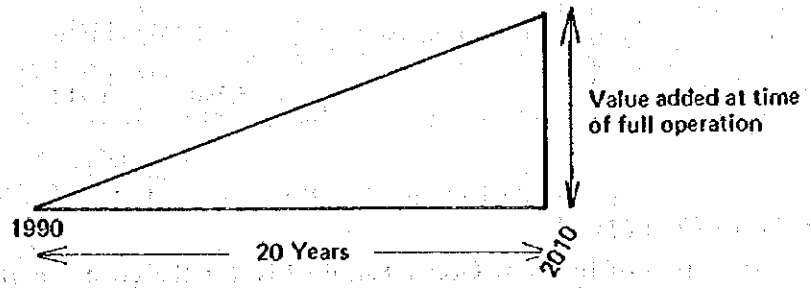


Fig. XVI-1 Degree of Plant Operation

Here, the prices used in the calculation are those fixed as of 1978.

In Table XVI-2 are shown the outputs, amounts of value added and plant construction costs of the industries which are prospected to be located in the New Ocean Terminal.

The amounts of value added shown in Table XVI-2 are calculated from the statistics of a number of enterprises in Japan and are applicable to Nigeria, if the fundamental productive structure is not different, although there may be more or less error.

As shown, the total amount of the values added of the plants located in New Ocean Terminal is estimated at 1,712 million dollars/year (₦1,070 million/year) (in 1978 price).

Thus, the amount of value added pertaining to construction of the New Ocean Terminal is calculated as

1,712 x 4283/13763 = 533 million dollars or ₦333 million

333 x 20 (years) x 1/2 = ₦3,330 million

Table XVI-2 Amounts of Value Added and Plant Construction Cost of the Industries

(1978 Price
Unit: million dollars)

Type of Industries	Production Scale	Value of Products	Value Added	Investment
Iron and Steel	Crude Steel 6 Million tons/year	2,006	469 (23.4)	3,750
Petroleum Refining	400,000 barrels/day	2,577	407 (15.8)	2,400
Petrochemicals	400,000 tons/year (Ethylene Basis)	1,355	160 (11.8)	2,000
Chemical Fertilizer	500,000 tons/year	111	27 (24.6)	80
Automobile Assembly	200,000 vehicles/year (Two Shift)	809	197 (24.4)	180
Shipbuilding and Repair	200,000 tons/year	198	76 (38.5)	200
Flour Mill and Food Processing	500,000 tons/year	319	78 (24.4)	65
Edible Oil	250,000 tons/year	114	22 (19.1)	35
Power Station	One Million KW	–	–	450
Sub Total		7,489	1,436	9,160
Other Related Industries		801	276 (34.5)	320
Public Space Including Roads and Railways, etc.				
Total		8,290	1,712	9,480

(2) Increasing Value of Use of Land

The site of construction of the New Ocean Terminal is, for the greater part, of vacant land and is, therefore, badly conditioned as an infrastructure for productive and urban activities. However, once the New Ocean Terminal is developed, the land will be regenerated into an area having a very high value of use as industrial, housing, commercial and distribution land. It can be

said that change of part of the national land from a state of little value of use can be said into land having a high value of use provides a great economic effect for the country.

The probelm is how to measure the value of the land around the New Ocean Terminal after development. For the industrial land, its value of the land use could be included in the value added with industrial production which reflect the value of land as an industrial site. But, for the remaining land, such substitute index is hardly usable. Thus, here, such value is represented by the price of land after development of the New Ocean Terminal. Under the system of liberalistic economy, the land has a price or value which the purchaser (or lessee) has recognized in the land, and thus the land value is substituted by the so-called "willingness to pay."

Now, according to the following assumptions, the increasing value of use of the land will be calculated.

1) The land as it is presently is scarcely usable for productive and other activities so that its price is assumed to be zero.

2) The mean price of the land around the New Ocean Terminal after development is considered to be of the level of price of the industrial land around Ikeja, Lagos City.

3) The land of which calculation is made covers the whole area of peripheral land including the land for expansion in the future except the public land which is not the object of sale (or lease) and the industrial land of which the benefit has been calculated in the form of the added value of industrial production.

The foregoing assumptions 2) and 3) are made for the sake of consideration that the benefit will be given rather conservatively. That is, for the assumption 2), when the New Ocean Terminal is completed actually, the peripheral land will be functionally excellent over the land around Ikeja as it is presently and will have a value equal to that of the land around Apapa which is higher in price than that in Ikeja. For the assumption 3), it is considered that the land in the outer periphery of the objective land of calculation will have the price increased considerably.

In Nigeria, land dealings have been prohibited since enforcement of the Land Use Decree in April 1978 so that in almost all cases, land supply is made by lease. As the result, exact land prices are hardly obtainable. But, in consideration of the sales before 1978 or the level of rents around Ikeja, it is assumed that the land is of a value of ₦ 10 per square meter in 1978 price.

The objective area according to assumption 3) is

Port area	270 hectares (wharfs, commercial land, etc.);
Urban area	1,570 hectares (housing and commercial land);
and	
Others	5,660 hectares (peripheral land for development);
Total	7,500 hectares.

Thus, the benefit from increasing value of use of land created by construction of the New Ocean Terminal is calculated as

$7{,}500 \times 10^4\ m^2 \times ₦10\ m^2 = ₦750$ million (in 1978 price).

(3) Comparison with Construction Cost and Benefit of the the New Ocean Terminal

Table XVI-3 shows the benefit in terms of land price rise and value added with industrial production against the cost of construction of the New Ocean Terminal.

Seeing macrospically, the benefit accruing from construction of the New Ocean Terminal surpasses the cost of construction greatly, as shown in Table XVI-3.

Of course, the cost and benefit are comprised of a number of items in addition to those taken up here depending on the way of taking the scope respectively, as stated initially. But, it is impossible to examine all of the items quantitatively for such large project of 20 years ahead. Thus, rather than minute analysis in disregard of the accuracy of estimation, prospecting from a macroscopic point of view as discussed here will be adapted for determining the feasibility of the project as a whole from a comprehensive standpoint.

Table XVI-3 Construction Cost and Benefit of the New Ocean Terminal

(Unit: million ₦)

Cost		Benefit	
New Ocean Terminal Construction Cost		Value Added with Industrial Production	3,330
		Land Price Rise	750
	2,677		4,080

XVII. Items for further survey

XVII Items for Further Survey

In a large scale project, such as the New Ocean Terminal, the master plan may be divided into several stages so that staged construction may occur as the port requirements grow.

In the case of the New Ocean Terminal, prior to each construction stage a short term (approximately 5 years) feasibility study is conducted so the scale of development can be studied in detail. The feasibility study is conducted to determine if the plan should actually be implemented, presupposing the final aim of the development shown in the master plan.

In order to implement the present project, it is necessary to conduct such a feasibility study following the Master Plan study described in this report. Those items for a feasibility study of a port and harbour project are given below.

a) Study of basic project policy

The position of the project in the national and department plans, and the project priority, must be confirmed. It is also necessary to study the principles and scope of development for forming a substitute plan, and to determine the required survey works.

b) Demand forecast and determination of scale

After determining the hinterland and establishing its socio-economic frame, the volume of cargoes to be handled, the number of ships using the port and the volume of land transportation must be forecast. From these, the number of berths can be determined and the types and scale of water and land facilities proposed.

c) Technical study

After the demand forecast and the determination of the scale, there will be a series of technical studies for the selection of the construction site, the layout planning, the general design of facilities and the computation of the construction cost.

d) Analysis of development effects

When computed, the construction cost will be regarded as an economic cost. At the same time, development effects including benefits resulting from the execution of the project will be computed and the time and the method of execution of the project will be clarified by B/C analysis etc.

e) Financial analysis

The financial cost will be clarified by such methods as the computation of the construction cost. Then, the fees will be determined and the three financial tables (statement of profit and loss, fund raising table and balance sheet) will be prepared.

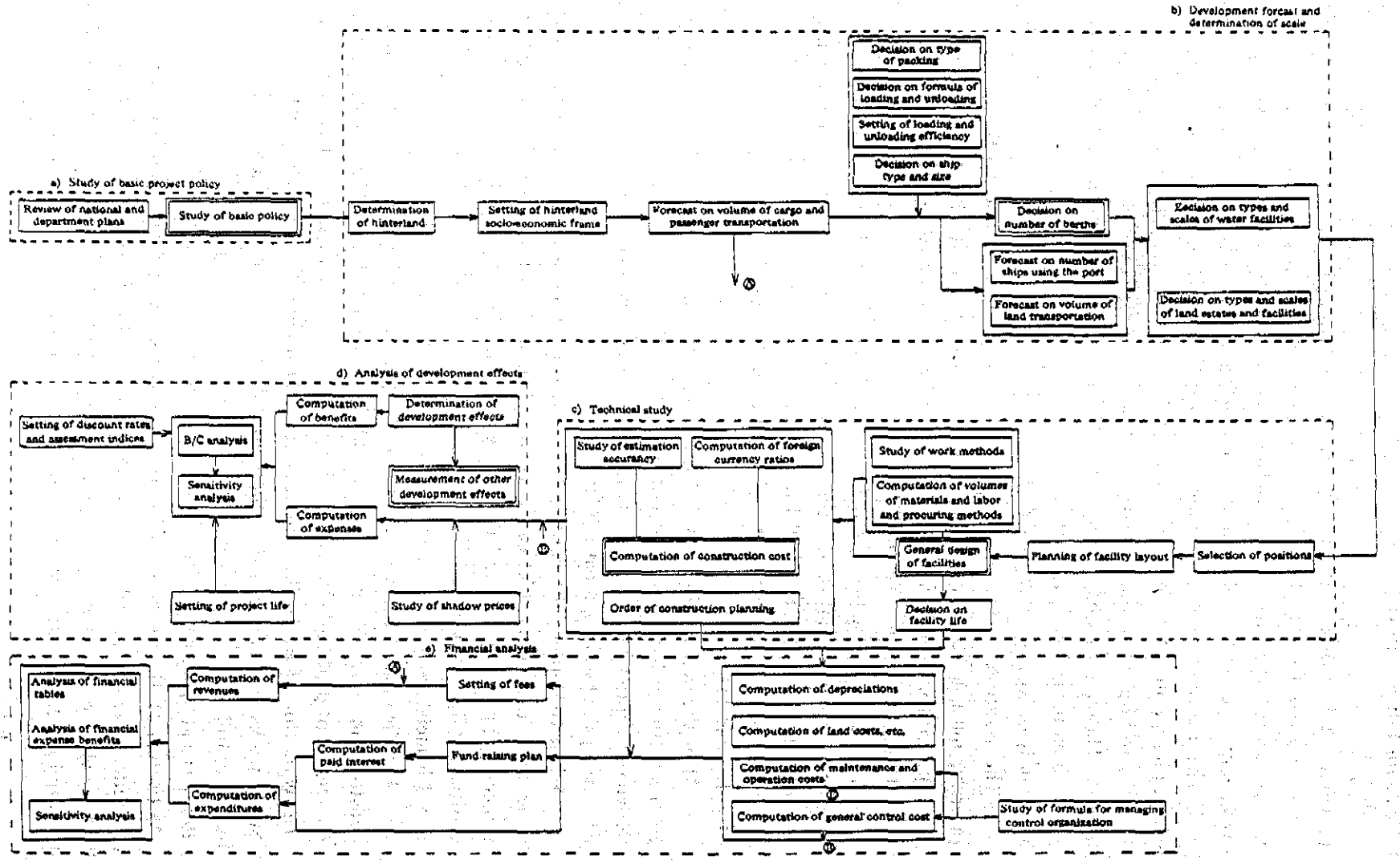
The work flow chart for the above objectives of study is shown in Fig. XVII.

Study works were completed at the master plan stage and to be done in the future may be determined as follows:

Items a) and b) were completed at the master plan stage.

As to item c), the selection of the construction site and the planning of the layout of basic port facilities were completed at the master plan stage but the planning of the layout of related facilities, such as cargo handling equipment, storage facilities and utilities, the general design of facilities and the computation of the construction cost require a more detailed study.

Fig. XVII-1 Flow Chart for Planning Work



Particularly, the general design of facilities and the computation of the construction cost must be sufficient to be used for d) analysis of development effects and e) financial analysis. It is, therefore, necessary for the investigation of natural conditions (which will provide basic data for design and computation) to be conducted in greater detail.

Specifically, it is desirable for the investigation of natural conditions to be conducted as follows:

1) Detailed geological surveys at the construction sites of mooring facilities and breakwaters
2) Detailed topographical survey for the construction area
3) Survey on the routes for the construction of trunk roads as well as temporary roads
4) Survey on groundwater in the construction area

As to items d) and e), study at the master plan stage was made only of those development effects which could be quantitatively determined, to see macroeconomically if the New Ocean Terminal Project could benefit the national economy. So, these items must be exhaustively studied at the future stage of the feasibility study.

A large-scale development project, such as the New Ocean Terminal Project, must be planned not as a simple harbour facility construction project but as a regional development project centered around harbour development and covering the whole province of Lagos or covering many provinces. It is, therefore, necessary for related facilities (transport network plan etc.) to be studied and planned in coordination to the project at either the master plan stage or the feasibility study stage. This is not merely concerned with the planning of functional facilities but, of course, includes surveys on social effects and effects on natural environments.

The following are the principal items of survey and planning deemed necessary in connection with this investigation:

1) Construction of principal transport network facilities:
   Roads, railways and inland water transport
2) Water development (fresh water and industrial water):
   Lake surface water, groundwater and river water must be surveyed and planned.
3) City development plan
4) Survey and planning of coastal industrial sites:
   The regular feasibility study of factories to be constructed must be made when carrying out an industrial port project.
5) Survey on social effects and effects on natural environments and improvement proposals:
   There is every prospect at the master plan stage and the F/S stage that this project will have favorable social and economic effects but, if some unfavorable social effects also are found, ways must be devised to improve them. Effects resulting from the change of natural conditions require adequate advance assessment.
   Particularly in constructing industrial plants, pollution control must be planned and practised using the latest techniques.

If the above-mentioned investigation and planning related to this project are skilfully executed by the respective agencies of the concerned governments, maintaining project-wide conformity, and the overall propriety of the New Ocean Terminal Project is proved and confirmed as the result, the project will take a step toward its realization.

Appendices

Appendices

1. Review of the Forcast of General Cargo Traffic through the Commercial Port

This chapter is prepared, based on the summary of discussions between the Japanese Study Team and the Nigerian Ports Authority dated August 6, 1979.

The result of the review is as follows.

1. The character of the New Ocean Terminal is positioned as an expansion of the commercial port functions of the Port of Lagos. Therefore, for prospecting the scale of the New Ocean Terminal, it is required to forecast the future traffic demand of the so-called commercial port cargo (or, here, general cargo according to NPA statistics).

2. Traffic demand of the general cargo usually has a close relationship with GDP which represents the level of economic activities of the country so that the handling volume of general cargo in the future is estimated macroscopically from correlationship with GDP.

3. This method of estimation is suitable for estimation over a long term from a macroscopic point of view and is particularly applicable to the countries of liberalistic economy and of which stable economic growth is expectable continuously.

4. Methodologically, the MIT method of cargo estimation is of the so-called summing-up system, which estimates the future traffic demand of each of the major cargos handled currently and totals them.

The advantage of this method is in that the future traffic volume of each kind of cargoes can be forcasted in accordance with the characteristics of traffic demand respectively. But, it is shortcoming in that as it estimates individually, relationship with the economic activities of the country as a whole or adjustment of the cargo estimations with one another is hardly obtainable, that it is rather confined in microscopic phenomena and is apt to miss a long ranging macroscopic viewpoint and that it is limited to estimation of the major cargos handled currently and is thus hardly responsive to generation of an entirely new type of cargo.

Therefore, the MIT method is suitable for estimation over a relatively short period during which the economic structure will undergo little change rather than for use in prospecting the cargo of the country as a whole in 2000.

5. Now, in estimation through correlationship with GDP, it is an important problem how to set the future value of GDP which has correlationship with the general cargo. In Phase-I Study, this value was set at an income level which is close to the target value shown in the Third National Development Plan of Nigeria.

Thus, upon the annual mean growth rate of GDP in 1976-2000 excludig the mining sector set at 9.8% (this rate is equal to the annual mean growth rate in 1971–1977), GDP in 2000 excluding mining at ₦95,183.6 million, grand GDP at ₦105,754.5 million (share of the mining sector at 40% currently and 10% in 2000) and population in 2000 at about 150 million (increas-

ing at 2.5% in annual average from 1975), there was set a level of per capita GDP at about N705 in 2000. (In the Third National Development plan, it is set at about N700 in 2000).

6. As the result, the volume of general cargo in 2000 was estimated at about 56,000 thousand tons.

7. However, when the subsequent circumstantial changes, delay in realization of the Third plan and recent prospects of Nigerian economy by various authorities, etc. are taken into consideration, it seems to be difficult to have the per capital income increased up to N 700 in 2000. Thus, at the present time, it seems to be reasonable to postpone the time of achievement of the target of per capita GDP of N700 for 10 years and consider a level of GDP of about N500 per capita for the year of 2000.

8. The population in 2000 is estimated at about 150 million so that GDP in the year 2000 is about N75,000 million. Then, GDP excluding mining at such time becomes N67,500 million (share of the mining sector being 10%). This level means that GDP excluding mining will show a growth of about 8.2% average a year in 1976–2000.

9. Now, modifying the formula of estimation used in the Phase-I Report by the new data of general cargo volume (furnished by NPA)

$$Yi = 0.83Xi - 1577.31$$

$r = 0.93$

Yi ; 1000 tons

Xi ; million N

The data used are as shown in Table 1.

10. Applying the value of N67,500 million (GDP excluding mining in 2000) to the foregoing formula, the volume of general cargo in 2000 is about 54,500 thousand tons which is in consequence identical with the value estimated in Phase I. Conversely, this shows that the level of 56,000 thousand tons for the volume of general cargo represents a reasonable value considering from the relationship of the new data of cargo volume versus prospect of the future level by recent trend of the Nigerian economy.

11. From the result of estimation by MIT, the commeodities corresponding to the general cargo according to the NPA material are picked up and totaled as shown in Table 2. In 2000, the total of export and import is 28,253.9 thousand tons. Estimating GDP (excluding mining) in 2000 conversely from such value in use of our formula of estimation, it is given as N39,934 million in grand GDP. This value means a growth of 5.3% average a year in 23 years of from 1976–77 and is of a rather low level for the target in future. Calculating the per capital income in 2000, it is given as N266 (N39,934 million/150 million persons), improved only slightly over the present status (at about N200 per capita). (In the Third National Development plan, an income of about N700/man is prospected.)

12. The result of estimation of the general cargo is dependent on how the value of GDP is forecasted so far as the formula of correlationship of general cargo and GDP is used. Further, depending on how the level of supply by domestic production is set for the demand for the respective commodities, the volumes of export and import are also variable. But, here, by using the formula of correlationship with GDP, the level of the respective domestic industries can be included macrospically in the formula.

It is discussed that with development of the economic power, the products so far imported are substituted by the products of domestic industries so that the import will decrease for that portion of domestic production. Such a phenomenon is surely observed in some quarter. But, where the import decreases, the products are limited to those which are of the same kind and quality to the products produced domestically and are priced higher in the domestic price than the indigenous products. actually, however, it is a general trend that when the economic power of the country as a whole has been developed to such a level at which the formerly imported products are produced domestically by the import substitute industries, it accompanies improvement of the national life and transformation of the industrial structure into higher level so that there are increasing demands for raw materials, intermediate products and final products which have not so far been the objects of import, resulting in increasing volume of import cargos.

13. Cargos other than general cargo are, for the greater part, connected directly to industrial production. Thus, for the cargos generating in relation to the industries which are assumed to be located in the New Ocean Terminal, the prospected amounts of handling are estimated separately from the relationship with the scale of industrial production so that they are hardly comparable with the result of estimation by MIT.

14. For the NPA estimation, details by commodity are not known so that it is unable to take out the general cargo only for comparison. But, by using the same share of general cargo in total cargo of MIT estimation, the handling volume of general cargo (total of export and import) is presumed to be something more than 30,000 thousand tons which is not much different from the value of estimation by MIT. In either case, the difference in the prospect of economic growth of the country as a whole is reproduced in the difference of the result of estimation of the volume of general cargo.

For reference, in Fig. 1 are shown the past values of general cargo and the future values estimated by NPA, MIT and our team this time, and in Fig. 2 the relationship between GNP and cargo volume in Japan.

15. As a principle for estimation for the master plan of a large and long term project such as the New Ocean Terminal, the future values of various indexes are estimated, in many instances, rather greatly, of course, within the practicable range in a sense to set a target for the efforts of the country. The growth rate of GDP set at 8.2% average a year may seem to be still high, but when the mission of the master plan to ascertain the final scale of the project is considered, such basic attitude may be said to be proper.

16. In general, the scale of a plan or, more particularly, a long term master plan is dependent on the social condition at the time at which the plan is formulated so that it is a matter of course that the propriety of the scale at the target year is subject to discussion depending on the subsequent circumstantial change. In such a case, the time of achievement of the scale of project shown in the master plan should be reviewed by, for example, changing th target year (rearward if overrated or forward if underrated) for realization of the project.

The study of the New Ocean Terminal is in the stage of master plan, and a realizable scale in the period of 5–10 years should be determined in the stage of Feasibility Study to be made upon more detailed surveys.

Table 1 CARGO TRAFFIC (NIGERIAN PORTS) AND GROSS DOMESTIC PRODUCT

Year	Gross domestic product[1]		Gross domestic product excluding mining sector[1]		Cargo traffic[2] (general cargo)		Remarks
	Amount (N million)	Percentage increase over the previous year	Amount (N million)	Percentage increase over the previous year	Cargo traffic (thousand metric tons)	Percentage increase over the previous year	
1970–71	9,442.1	–	6,314.2	–	4,139	–	
1971–72	11,177.9	18.4	6,785.2	7.5	4,599	11.1	
1972–73	11,993.1	7.3	6,790.2	0	3,875	–18.7	
1973–74	13,135.5	9.5	7,207.9	6.2	4,264	10.1	
1974–75	14,254.3	8.5	8,394.6	16.5	4,394	3.0	
1975–76	14,448.8	1.4	9,667.5	15.2	6,157	40.1	
1976–77	16,346.2	13.1	11,084.3	14.7	8,281	34.5	

Table 2 FORECASTS OF GENERAL CARGO TRAFFIC (BY MIT)

	1975	1980	1985	1990	1995	2000
(IMPORTS)						
Consumer Goods	2,181.8	2,836.3	3,691.1	5,826.8	8,560.0	11,453.0
Motor Vehicles	386.1	487.9	589.2	927.1	1,263.2	1,484.9
Chemicals	273.9	438.2	772.1	1,243.2	1,843.7	2,443.6
Iron and Steel	1,470.0	2,000.0	993.0	1,418.0	1,903.0	2,451.0
Machinery	474.2	474.2	763.4	1,229.1	1,891.7	2,778.8
Paper and Products	202.0	315.0	409.0	533.0	695.0	902.0
Salt	129.6	164.5	188.9	215.7	245.3	277.5
Sugar	193.0	143.5	130.0	173.9	227.3	290.0
Fertilizer	207.8	426.0	1,209.0	2,104.0	3,414.0	5,197.0
IMPORTS GENERAL Cargo	5,518.4	7,285.6	8,745.7	13,670.8	20,043.2	27,277.8
(EXPORTS)						
Cocoa	193.0	220.0	254.0	322.6	381.0	450.0
Rubber	34.0	20.0	25.0	30.0	33.0	41.0
Palm Oil & Prod	65.6	172.1	227.9	252.3	258.2	223.3
Palm WERNEL	171.0	145.6	129.5	105.1	63.9	0
Other	77.4	98.8	126.0	160.8	205.0	261.8
EXPORTS GENERAL Cargo	541.0	656.5	762.4	870.8	941.1	976.1
GENERAL Cargo TOTAL	6,059.4	7,942.1	9,508.1	14,541.6	20,984.3	28,253.9

Fig. 1 Forecasts of General Cargo Traffic through Nigerian Ports

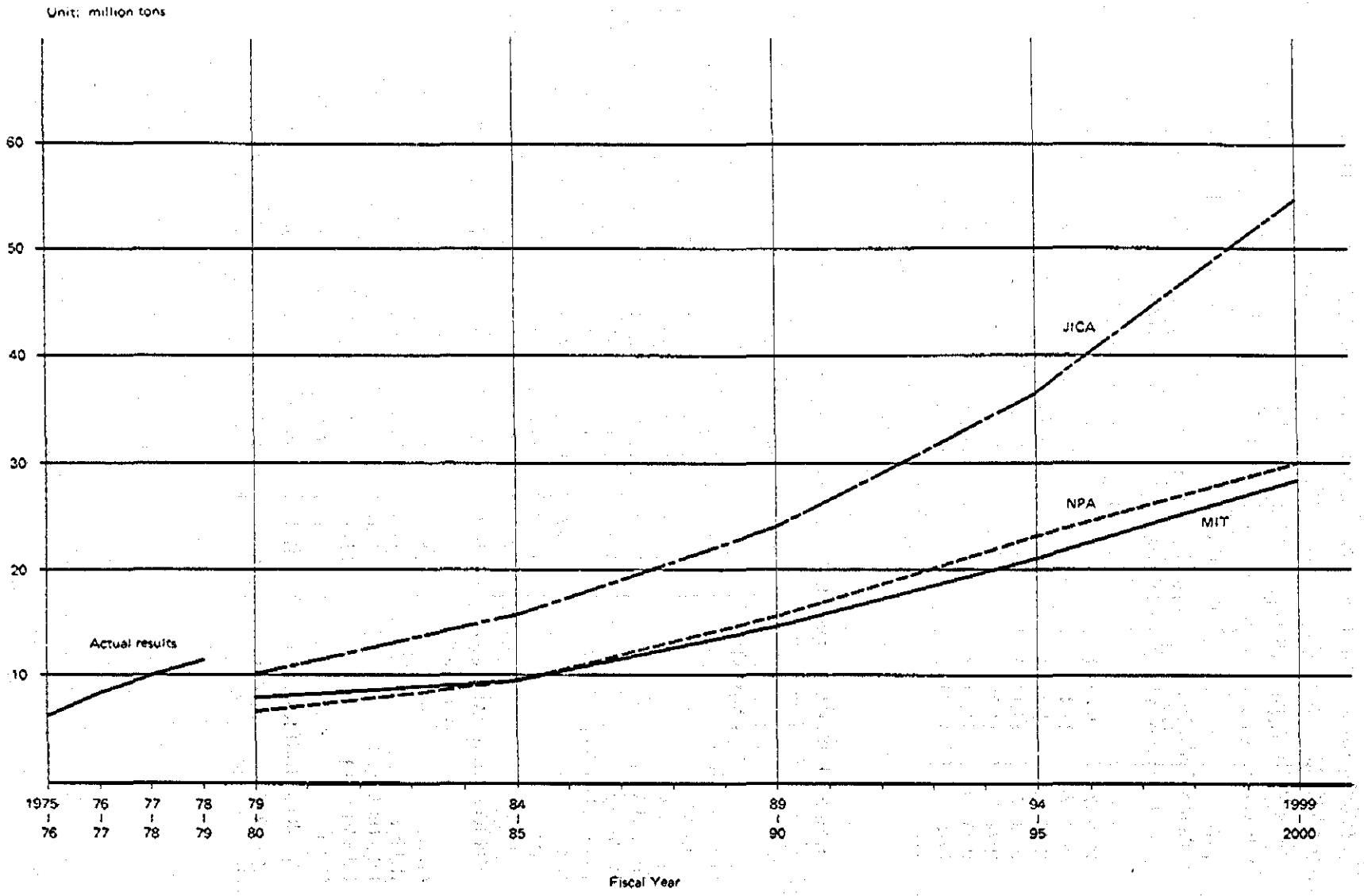
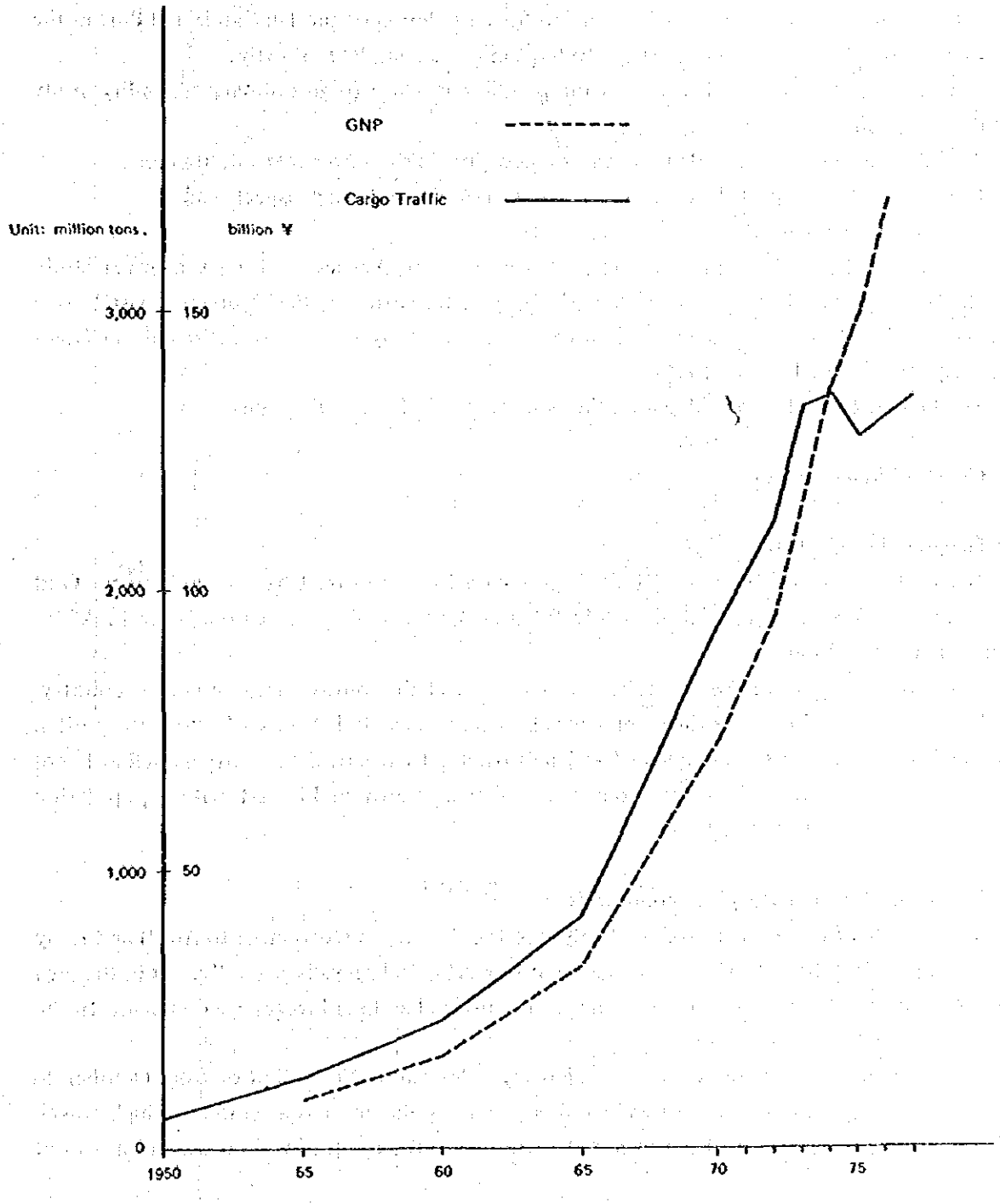


Fig. 2 Gross National Product and Total Seaborne Cargo Traffic in Japan



2. SUMMARY OF PHASE-I REPORT

1. Introduction

The Government of the Federal Republic of Nigeria is studying construction of the New Ocean Terminal as a project in the next stage to the completion of the Tin Can Island Port in the Lagos Ports Complex and the Third Apapa Extension to be completed shortly.

This study was conducted as one in the preliminary stage to an ordinary feasibility study with the following as main themes:

(1) Selection of the most suitable location of a new port in the Lagos metropolitan area;
(2) Proposal on the scale of the port development upon a long-term prospect; and
(3) Proposal on the matters to be studied hereafter.

For this purpose, the Japan International Cooporation Agency sent a six member study team headed by Mr. S. Maeda, Director of Planning Department, the Overseas Coastal Area Development Institute of Japan in order to carry out the study on the project mainly in Lagos for 35 days from 13th January 1978.

The Phase-I Report is formulated on the basis of the findings of the study.

2. General Circumstances

(1) Geographical Conditions

Nigeria (latitude 4°–14°N, longitude 3°–15°E) is located in West Africa and faces the Gulf of Guinea. It has an area of approximately 924,000 km^2 and the largest population in Africa estimated at about 80 million.

Lagos is the capital of the Republic and is located at the southwestern end of the country. It is situated at the tidal estuary of Lagos Lagoon and creek. It forms a Lagos metropolitan area and is the centre of the commercial and industrial activities of the country as well as Lagos State. The Lagos metropolitan area comprises an area shown in Fig. 2-1 with a population allegedly reached 3,500,000 in 1976.

(2) Meteorological and maritime conditions

The climate of Nigeria is classified clearly into the dry season (November to April) and rainy season (May to October). In the dry season, a strong NE wind prevails generally, but in the area near the seashore, the wind is not so strong, and daily land and sea breezes are dominant. In the rainy season, a SW wind is prevailing.

Waves along the coast of Nigeria are relatively calm during the period of from October to April. In the rainy season when the SW wind is prevailing the coast is assaulted by high waves, with the highest wave height of 3.5 m noted according to the result of wave observation for one year.

Fig. 2-1 LAGOS METROPOLITAN AREA

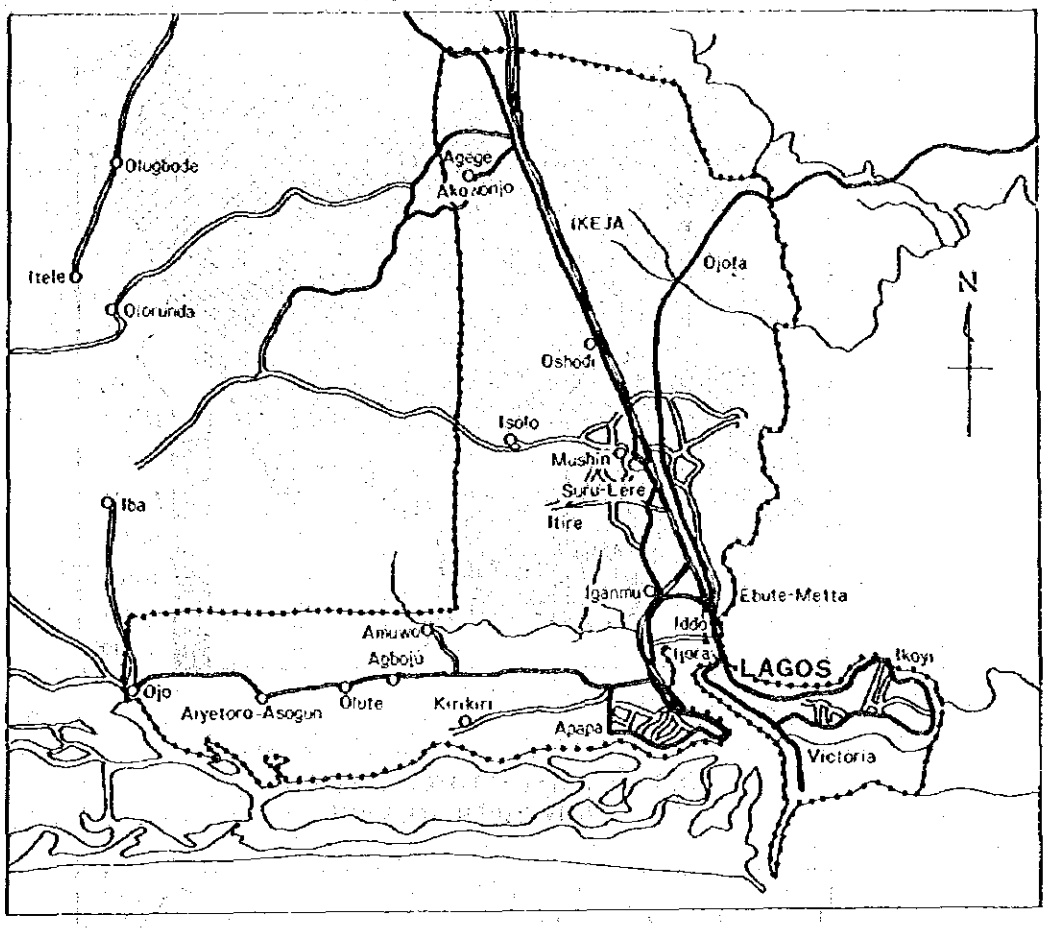


Fig. 2-2-a PRESSURE AND WINDS IN JANUARY

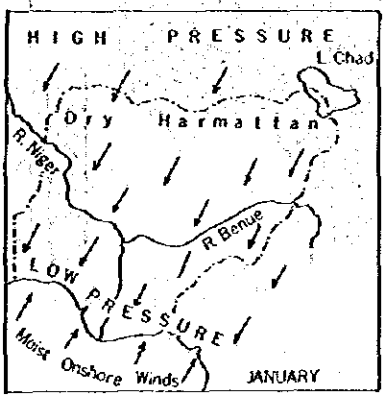


Fig. 2-2-b PRESSURE AND WINDS IN JULY

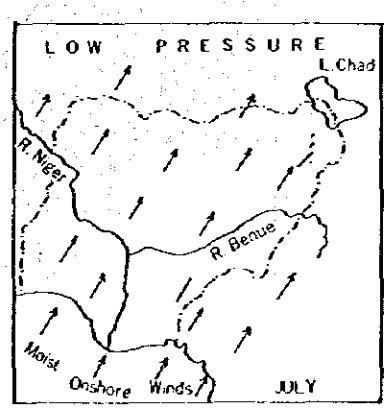


Fig. 2-3-a RAINFALL-RAINY SEASON
MAY TO OCTOBER

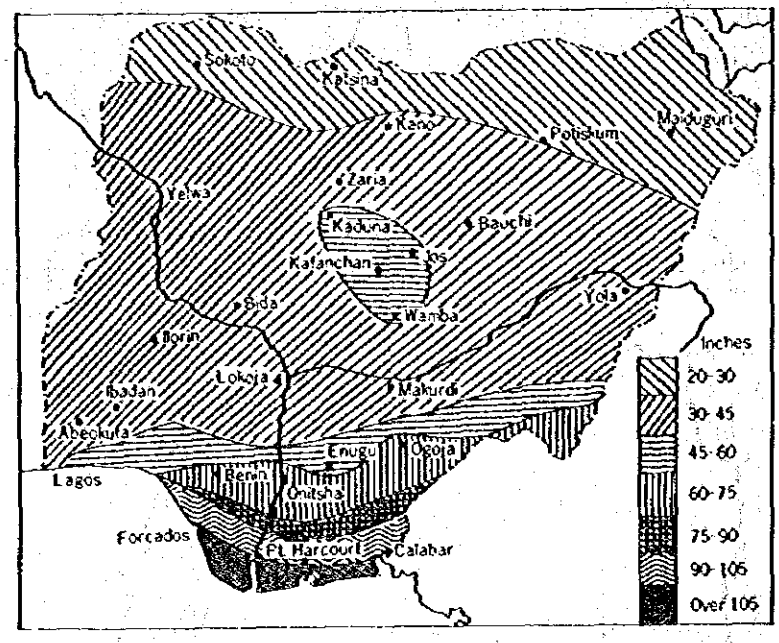
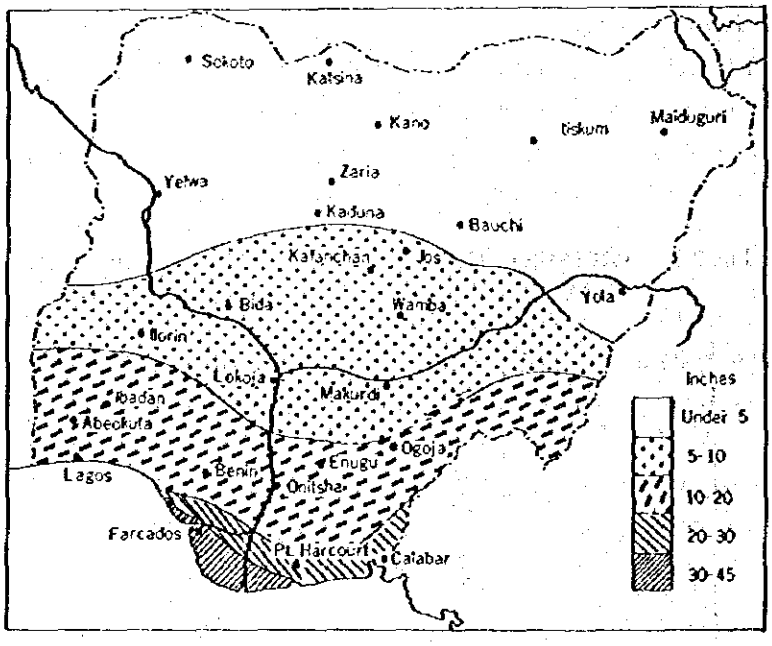


Fig. 2-3-b RAINFALL-DRY SEASON
NOVEMBER TO APRIL



(3) Economic conditions

The economy of Nigeria depending largely on the export of crude oil had been stagnant because of a slump in the export of crude oil, but in 1976, it came out of the slump in the preceding year and recorded a gross domestic production of N18,600 million. With the population assumed to be 80 million, the GDP per capita is N233 (or 388 dollars, with N0.6=1 US dollar).

Now looking the percentage distribution by sector of GDP in 1976, the mining sector including production of crude oil is at 32.2 per cent, and the agriculture, forestry, fishery and livestock sector at 28 per cent, these two sectors thus constituting a greater part. However, in the growth rate by sector in 3 years of 1974 to 1976, the manufacturing industry is the largest in growth, while the mining sector still falls short of the level of 1974.

Taking the revenue of the Federal Government, the direct taxes are the largest as the source of revenue, followed by the revenue relative to the mining industry. The former is comprised largely of the petroleum profit tax, and the latter the royalty on oil and gas. These constituting about 74 per cent of the revenue, the national treasury is dependent greatly on the revenue from oil.

Table 2-1 GROSS DOMESTIC PRODUCT AT CONSTANT 1974/75 FACTOR COST

₦ MILLION

Sector	Current estimate		
	1974-1975*	1975-1976	1976-1977
1. Agriculture, livestock, forestry and fishing	3,636.2	4,081.9	4,565.6
2. Mining and quarrying	5,859.7	4,781.3	5,261.9
3. Manufacturing and crafts	681.2	1,384.0	1,666.0
4. Electricity and water supply	56.6	65.0	81.4
5. Building and construction	837.8	759.8	896.6
6. Distribution	1,191.1	1,338.4	1,421.8
7. Transport and communication	366.8	411.0	541.9
8. General Government	901.8	883.3	1,056.2
9. Education	375.8	407.3	417.1
10. Health	132.0	115.1	185.4
11. Other services	215.3	221.7	252.3
TOTAL	14,254.3	14,448.8	16,346.2
Annual Growth Rate	8.5%	1.4%	13.1%

Source: Central Planning Office

* Federal Office of Statistics Provisional Figures adjusted by the Central Planning Office.

Looking the balance of payments, the export trade amounted to about N6,700 million in 1976, showing a considerable improvement over the preceding year. Such improvement is due to increase in the export of crude oil and elevation of the price. The proportion of oil in the total export is as high as about 94 percent. On the other hand, the import is increasing greatly in these years. In 1976, it is in a scale 3 times that in 1974. Such a rapid increase of import is causing serious congestions in the port of Lagos, etc. Now seeing the pattern of foreign trade, the West European countries and the U.S.A. are the major counterparts for both export and import, but for the import, Japan takes part in. In the trade with Japan, Nigeria is in deficit in the balance.

The industries in Nigeria are expanding rapidly in these years. But, the proportion of the industrial (manufacturing) sector in GDP is low barely at 10 per cent in 1976. Further, the manufacturing is composed largely of light industries which do not require a high level of technology such as foods, drinkings, tobacco, textile and clothing.

The development of heavy and chemical industries is a problem to be resolved hereafter, and the Federal Government is tackling the problem of industrial development actively with the revenue accruing from export of crude oil in the background.

As stated at the outset, the economy of Nigeria is dependent greatly on the export of crude oil. Thus, if the worldwide recession continues as in these days, the oil export will become slack and the high growth rate of the economy now experienced (for example, the growth rate to previous year of GDP in 1976 is 13.1 per cent in real term) will not be expected. It appears to us that the shortage of fund required for the implementation of various projects is already appreciable, and that there is an increasing trend of relying on external loans.

It has been said that on account of the shortage of the engineering skill as well as materials and machines in the construction sector and also the inflation now in progress consecutively, the progress of the Third National Development Plan (1975–1979) in which an emphasis is placed on the development of infrastructures, particularly of the transport sector, will be delayed considerably and some of the projects will be carried over into the next plan period.

It was told that in the next five-year plan, an emphasis would be put on agriculture and industry. For the development of these sectors, a well balanced development of social overhead capital is inevitable. Judging from the present situation of railways, ports and harbours as well as roads, there seems to be a need to give priority to continued investments in these sub-sectors of infrastructure.

(4) Transportation network

Among the various means of transportation, the road transportation is playing the most important role. The construction of Class A roads is under the jurisdiction of the Federal Ministry of Works, while the other roads are under the jurisdiction of the competent State Governments. The construction of the Lagos Ring Road which will display effects in resolution of the traffic congestion in the Lagos Island and in its vicinity, and that of expressways from Lagos to the peripheral cities are being carried on energetically by the hand of the Federal Government.

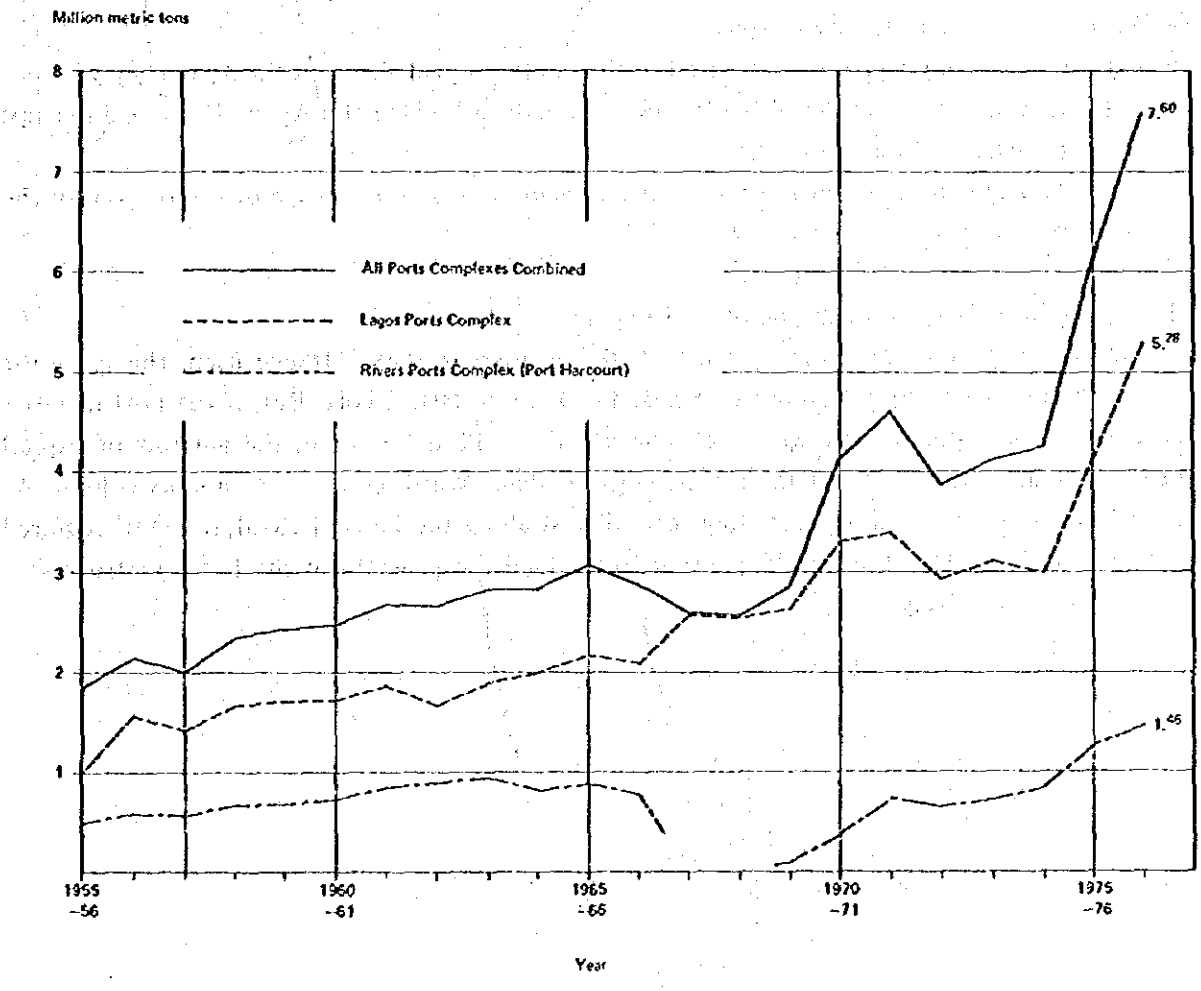
The railways under the jurisdiction of the Nigerian National Railways were originally built for the purpose of transporting the agricultural products in the northern part of the country to the ports then under the jurisdiction of the Railways for export. Consequently, the present railways are extremely shortcoming as a countrywide network. There is also no plan of constructing a new line except some section.

The ports in Nigeria are under the jurisdiction of the Nigerian Ports Authority established under the federal law. The Ports Authority administers all of the ports, channels, navigational aids and pilotage in Nigeria. Each port is managed by a Port Manager who is responsible for daily operations of the port (or port area).

The major ports of Nigeria are the ports of Lagos and Port Harcourt, the former handling 70 per cent, and the latter 19 per cent shown in Fig. 2-4, of the total general cargo traffic of the whole country. In general, the ports of Nigeria are river ports except the crude oil terminals for large tankers, and the port of Lagos is also located at the tidal estuary of the Lagos Lagoon. For this reason, it is difficult to improve or expand these ports to permit the entry of large container ships or bulk carriers.

The inland wafer transport mainly on the Niger and Benue Rivers is playing only a very limited role because of the development of the road transport network on one hand and instability of the waterways on the other. The coastal shipping is also playing a limited role to the extent of transporting refined oil from the ports in the Delta to the port of Lagos.

Fig. 2-4 General Cargo Handled from 1955-56 to 1976-77



3. Present situation and problems of the Lagos Ports Complex

(1) Outlines of main facilities

The main facilities of the port of Lagos, shown in Fig. 3-1 are the Apapa Quay (water depth, 8.23 m; and quay length, 2,393 m) existing from the olden days and the modern Tin Can Island Port (design water depth, 13.5 m; and quay length, 2,500 m) completed in October 1977. In addition, the Third Apapa Extension Project (tentative water depth, 11.5 m; quay length, 1,500 m; and container/roro wharf, 6 berths) will be completed shortly. The basin in the port allows anchorage of about 25 vessels.

The entrance channels has shortly been dredged to a width of 250 m and a depth of 11 m except part near the Tin Can Island Port. Upon such widening, it is apprehended that the volume of maintenance dredging will increase greatly.

(2) Problems of the port of Lagos

Because of sharply increasing import cargoes, chronic port congestions have prevailed. It has been said that the waiting time of tramp vessels has been reduced greatly with the Tin Can Island Port placed in service. But, at the time of our survey, any appreciable degree of dissolution of the congestion was not observed.

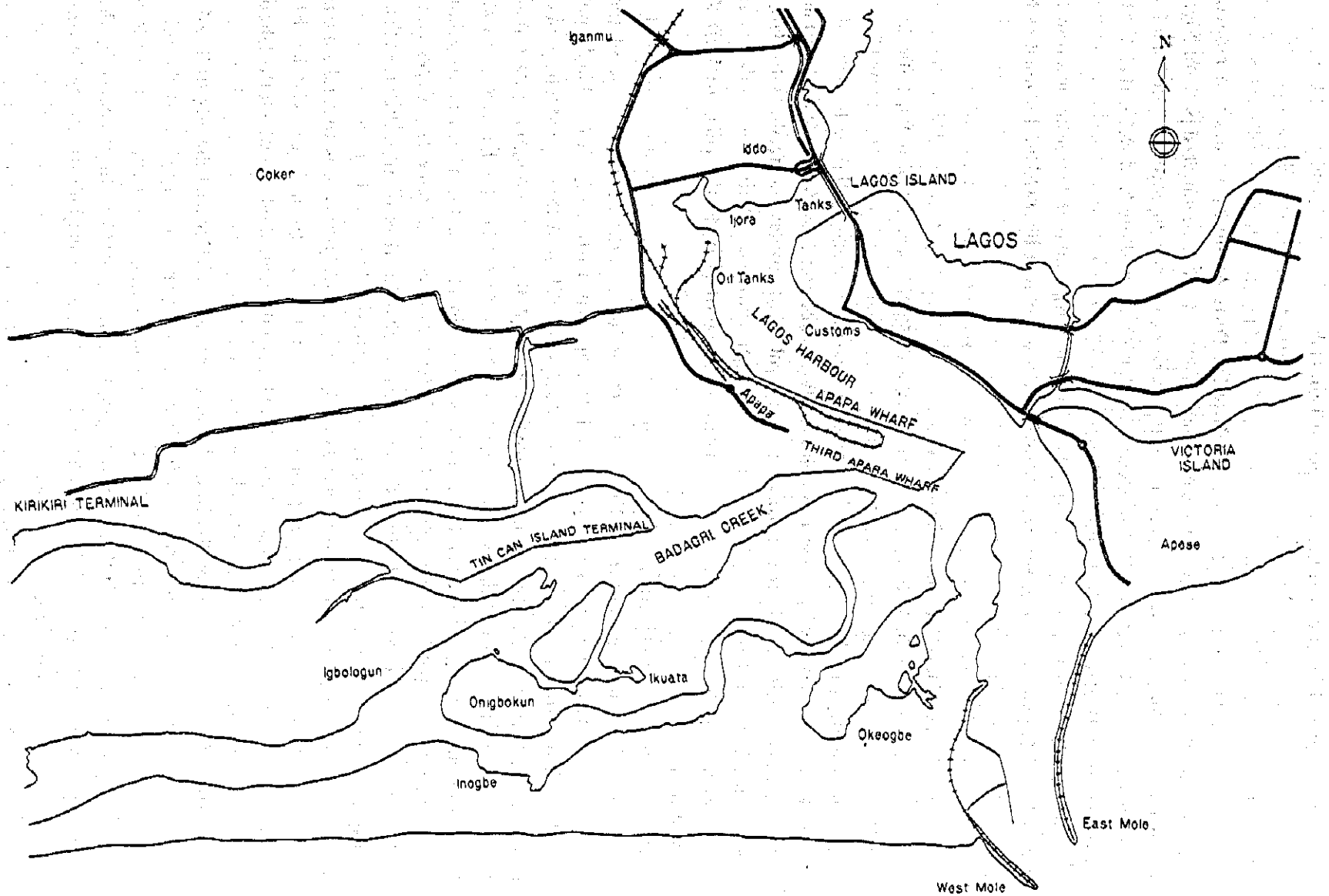
The congestion in the port of Lagos seems to be accelerated by the increasing volume of cargoes as well as the following reasons.

a) Cargoes staying for a long period of time in the transit sheds on the Apapa Quay,
b) A number of cargo waiting lorries staying disorderly in the Apapa Quay to interrupt the cargo handling operations,
c) Traffic congestion in the Lagos City precluding smooth carriage of cargoes out of the port.

(3) Feasibility of expansion of the port of Lagos

When the port of Lagos is expanded with the present port entrance used, the space for expansion is nowhere found except that near the Tin Can Island Port. But, if the port facilities are planned for large vessels with a channel depth of 11 m or more, the amount of capital dredging of the channel and of the maintenance dredging will become an enormous volume. As the urbanization of Lagos is proceeding toward west along the Badagri Road, it will be required that the adjustment of the port expansion to the land use program of the Lagos metropolitan area be made intensively.

Fig. 3-1 LOCATION OF FACILITIES IN THE LAGOS PORTS COMPLEX



4. Concept and functions of the New Ocean Terminal

(1) Basic concept

The New Ocean Terminal which the Nigerian Ports Authority desires is a modern port permitting free entry and exit of large container vessels, etc. The commercial ports of Nigeria are not facing the open sea, so that it is very difficult to expand or improve them for admission of such large vessels. For this reason, it is very appropriate to plan the New Ocean Terminal as the next stage of development of the port of Lagos.

Considering that the Lagos metropolitan area is a large market of consumption in Nigeria and is the largest area of concentration of industries, the first New Ocean Terminal in Nigeria should be planned in the Lagos metropolitan area.

(2) Functions of the New Ocean Terminal

The functions which the New Ocean Terminal should have are listed specifically in the following.

(a) Functions as a modern port

Functions as a strategic point of commodity distribution provided with modern container wharfs to cope with the containerization in the regular liner routes and facilities for large grain and other bulk carriers.

Such a port can perform the functions as a transit port to the adjacent West African countries.

(b) Functions as an industrial centre

The Federal Government of Nigeria has the industrialization policy as one of the most important policies along with the agricultural development. Particularly, it is taking a policy of industrial dispersal to curb the excessive flow of population into the Lagos Metropolitan area. Considering the present condition of expanding population and urbanization of the Lagos metropolitan area, we feel that the following opinion maintained by the Lagos State Ministry of Works and Planning is correct: the industries to be located in the Lagos metropolitan area should be restricted to those of the Lagos Port dependent and large city dependent types. Nevertheless, we would like to stress the importance of industrialization in the area close to the Lagos metropolitan area. The reasons are as given below.

a) The population once flowed into a large city scarcely goes back to rural area. For this reason, in order to give an employment opportunity to the excessive labour force in this area, industrialization in an area close to the metropolis, to which the labour force can easily move, should be accelerated.

b) The construction of the New Ocean Terminal, which means the advantage of marine transportation by means of large vessels, plays a very important role as an infrastructure for the location of seaboard industries.

The industries requiring their own waterfront must be added to those chosen by the Lagos State Ministry of Works and Planning. Specifically, the following industries may be considered suitable.

- Shipbuilding and repairing yard
- Iron and steel mill
- Petroleum oil refining and petrochemical industry

- Flour mill
- Automobile assembling factory
- Fertilizer manufacturing plant

(3) The New Ocean Terminal Project as a regional development project

As stated in the foregoing, the New Ocean Terminal is planned not only as a mere commercial port but as an industrial port having a vast industrial zone. Accordingly, this project becomes one of a large scale and accompanies projects of related infrastructures such as housing, road, water supply and electricity. The project must then be understood to be a comprehensive regional development project. As a specific image, it is the construction of a coastal satellite city with the port as a nucleus.

It is required of this new city that it will realize the easy movement of population from the Lagos metropolitan area and thus serve to alleviate the present overpopulation of Lagos and, at the same time, function as a new ocean terminal serving for the present hinterland of the port of Lagos. Therefore, it should be located close to the Lagos City within the range of 50 to 60 km.

Because of such large scale, multifarious character and accompanying subprojects, it appears to us that it will be difficult for the project to be implemented by the Nigerian Ports Authority alone. Therefore, we consider that it is very important to have close consultations and maintain tight coordination with the government organizations concerned from the initial stage of the project planning.

5. Development scale of the New Ocean Terminal

(1) Traffic forcast

The general cargo traffic in the year 2000 was macroscopically forecasted using 9.8% rate of GDP growth, the average rate during the past six years. Such a macroscopic procedure forecasts the total cargo traffic in the whole country of Nigeria. And the share to be borne by the port of Lagos was assumed, upon examination of the progress of development of the other ports and the population in the projected hinterland, that the share of Lagos in 2000 would decline from the present level of about 70 per cent to 50 per cent.

One of the characteristics of this forecasting work is that a great progress of containerization is prospected with the construction of the New Ocean Terminal, and 50% as a containerizable rate of general cargoes (except cement) in 2000 was determined.

Further, for the petroleum products and wheat which were considered to be important for the port of Lagos among the special cargoes other than general cargoes forecasting was made individually upon analysis of the relationship between production and demand. The import of cement included in general cargoes was assumed to be reduced to zero in 2000 with establishment of the self-supply system.

The export cargoes of Nigeria are, if the crude oil is excluded, largely agricultural products and are not containerized presently. But, with progress in containerization of import cargoes, the containerization of export cargoes will be expedited. In this forecasting, therefore, it was assumed that about 20 per cent of the export cargoes would be containerized.

The result of forecasting of the cargo traffic through the port of Lagos is represented in Table 5-1. However, as stated in the preceding chapter, the cargo traffic due to industrial

development at the New Ocean Terminal are not included.

The total cargo traffic through the port of Lagos including the New Ocean Terminal in 2000 A.D. is about 38 million tons or 5.5 times that in 1975–76, but the general cargoes (including the containerized cargoes) increase by 7 times from the present 4 million tons to 28 million tons.

Table 5-1 FORECASTS OF THE TOTAL CARGO TRAFFIC THROUGH LAGOS PORTS COMPLEX

Unit: thousand metric tons

Year	By outward and inward	General cargo				Wheat	Petroleum oil	Others	Total throughput
		Break bulk	Containerized	Cement	Sub total				
1975-76	Outward	385	-	-	385	81	90	26	582
	Inward	2,310	241	1,140	3,687	380	2,313	70	6,450
	Total	2,701	241	1,140	4,082	461	96	96	7,042
1984-85	Outward	784	195	-	979	-	-	-	979
	Inward	4,028	2,690	1,203	7,921	664	4,400	-	12,984
	Total	4,812	2,885	1,203	8,900	664	-	-	13,964
1989-90	Outward	1,170	293	-	1,463	-	-	-	1,463
	Inward	5,907	4,550	1,380	11,837	784	6,100	-	18,721
	Total	7,077	4,843	1,380	13,300	784	6,100	-	20,184
1999-2000	Outward	2,464	616	-	3,080	-	-	-	3,080
	Inward	12,460	12,460	-	24,920	1,042	9,400	-	35,362
	Total	14,924	13,076	-	28,000	1,042	9,400	-	38,442

Notes : 1. Figures in 1975-76 show actual results.
2. Wheat includes offal.
3. Others mean dry bulk cargoes.

(2) Annual handling capacities of wharfs

For determination of the development scale of the New Ocean Terminal, there was employed a method of first calculating the cargo handling capacity of the current facilities of the port of Lagos, then estimating the required additional facilities for handling the cargoes in 2000 forecasted as above.

Generally, the annual cargo handling volume of a deep water general cargo wharf is estimated to be 150,000 to 200,000 tons per berth. In this project, a capacity of 150,000 tons per berth was assumed for the Apapa Quay, and that of 200,000 tons for the modern Tin Can Island Port and the New Ocean Terminal. For the lighter berth, the annual handling cargo volume was assumed to be 400 tons per metre of the berth.

The annual handling cargo volume of a container wharf is estimated to be 60,000 twenty foot containers in the case of the New Ocean Terminal or 50,000 containers in the case of the container wharf of Apapa where the yard is not spacious. If the container loaded rates are 100 per cent for import cargoes and 10 per cent for export cargoes and the cargo volume per container is 15 tons, the annual cargo handling capacity of a container wharf is 400,000 tons in the case of Apapa Quay or 500,000 tons in the case of the New Ocean Terminal.

The capacity of a grain wharf handling wheat, etc., is usually governed by the capacity of unloaders. For the wharf of the New Ocean Terminal designed for super-large vessels, the annual

handling capacity is set at 1,440,000 tons upon the premise that two units of unloaders having a capacity 400 tons an hour are installed per berth, and for the bulk cargo berths of the Apapa Quay and Tin Can Island Port, it is set at 50 per cent of the foregoing value or 720,000 tons.

The annual handling capacity of the oil terminal is set at about *2 million tons* per berth upon the premise that the oil products are carried to Lagos from the port of Port Harcourt and with 10,000 DWT class vessels taken as projected objectives.

Based on the foregoing annual cargo handling capacities per berth, the cargo handling capacity of the port of Lagos including the Third Apapa Wharf now under construction is calculated to be 9,420,000 tons.

(3) Development scale of the New Ocean Terminal

If the capacities of the current facilities are calculated by kind of cargo as mentioned above, and all of the shortcoming facilities are planned in the New Ocean Terminal, the required number of berths will be 73 berths. That is, up to 1999–2000, there should be developed the general cargo wharf, 50 berths; container wharf, 19 berths; wheat wharf, 1 berth; and oil wharf, 3 berths.

(4) Study on the industrial development

While the kinds and scales of the industries which are suitable to locate in the New Ocean Terminal have been described in Section 4, the required industrial land area amounts to about 17 million m^2 including the land for related industries and to 22 million m^2 if the land for public facilities such as roads and railways is included additionally.

With such a scale of industrial development, there will be formed a new city of a population of about 150,000 comprising about 20,000 persons of labour force as a basis and including their families and population in the commerce and related services.

In planning the port facilities in relation to seaboard industries, the largest ship size must first be determined. In the case of this project, with the assumption that the iron ore for the steel mill is imported from Brazil, etc., it is considered to be desirable to plan an access channel and basin allowing entry and exit of the 200,000 DWT class carriers.

In this report, only a general concept has been proposed on the industrial development. However, it is considered to be very important to formulate the master plan of the New Ocean Terminal including such industrial development.

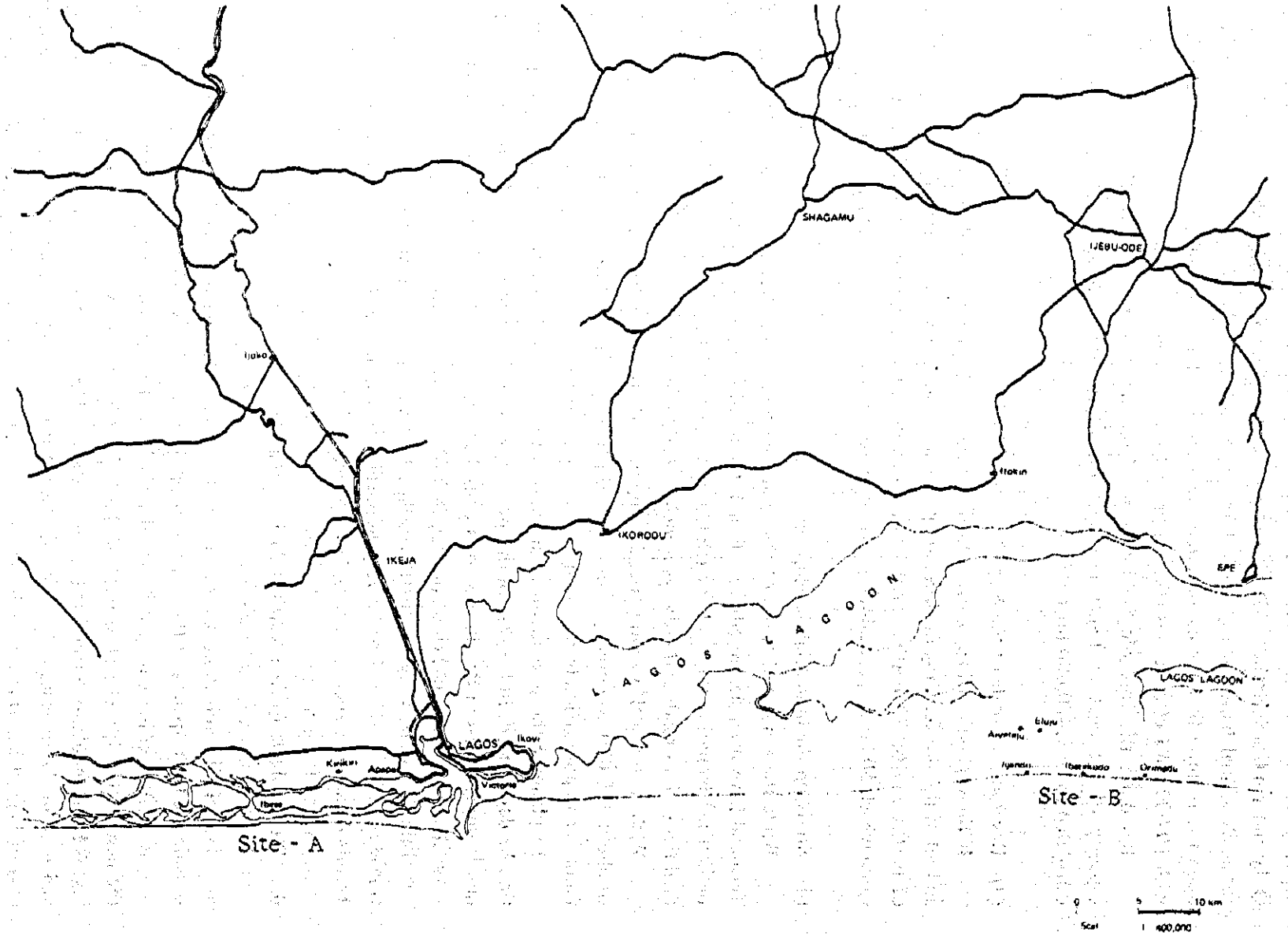
6. Proposed site for the New Ocean Terminal

The construction site of the New Ocean Terminal must be chosen from places located outside the built-up area of the Lagos metropolis and facing the open sea.

A discussion has emerged among the Nigerian officials concerned on the possible location of the new terminal; viz. east or west of the Lagos City. Here, we have chosen two places shown in Fig. 6-1 for comparative studies. The site-A is located immediately west of the urban area of Lagos and is of low and swampy land; while the site-B is a vast undeveloped area located about 50 km easy of Lagos City. It is a place having no appreciable undulation and covered with scrub.

In addition to these two sites, other two or three sites were examined. But finally, these two sites were chosen and compared with each other from the points of view of port planning and urbanization and also from the technical point of view. The result of study of listed in the table

Fig. 6-1 POSSIBLE SITES FOR THE NEW OCEAN TERMINAL



given in the following. Such study is not always based on any theoretical or quantitative analysis, but the construction of the New Ocean Terminal at the site-B may be of higher cost than the development of the site-A. We are, however, of the opinion that the development of the site-B will extremely contribute to the long-term development of the Lagos metropolitan area.

Table 6-1 RESULT OF COMPARATIVE STUDIES OF SITES-A AND B

	Advantageous points	Disadvantageous points
Site-A	1. At the initial stage of construction, the entrance of the present port of Lagos is usable, so that the initial investment is less than that of the site-B. 2. Being located closer to the Lagos Urban area, the construction cost of the access road is less than that for the site-B. 3. The related infrastructures of the Lagos metropolian area being available, the project cost will be generally smaller than that for the site-B. 4. With two port entrances provided, the port function is not suspended should one of the entrances be closed due to an accident, etc. 5. As the creek is usable as part of the channel or basin, less dredging is required.	1. Being located very close to the densely populated area of Lagos and from the fact that the urbanization is spreading westward, large scale development of this area has a possibility of causing adverse effects onto sound development of the Lagos metropolitan area. 2. Being located at the south-western end of the country, it is hardly said to be a correct policy, from the balance in the whole country, to develop a port or industrial zone. Also, contrary to the policy of the Federal Government to disperse industries. 3. Excavating the beach to the creek to open a new harbour entrance will have adverse effects upon the hydraulic characteristics of the present entrance (such as increasing amount of sediment due to decreasing tidal flush). 4. Located near the site is the source of water supply, so that infiltration of saline water due to excavation of the new harbour entrance may have adverse effects on the water resource. 5. Lengthy breakwater protecting the new entrance channel causes erosion of the seashore between the new and old entrances. Then, the resulting change in the littoral drift may cause adverse effects on the maintenance of the existing entrance channel.
Site-B	1. Being entirely undeveloped area with scarce inhabitants, large scale development is enabled without causing adverse effects onto the regional environment. 2. There is little possibility of adverse effect onto the Lagos metropolitan area. 3. Being a virgin land for development with no geographical restriction, multifarious planning is enabled. 4. Complying with the Federal Government's policy of industrial dispersal. 5. Being an undeveloped area, any change caused to the features of the seashore in the vicinity by excavation of a new harbour entrance poses no particular problem.	1. Being the construction of a new city in a virgin area, an enormous amount of fund is required. 2. The improvement of the road from Lagos to Epe are required. 3. Extra cost is required for access to railway. 4. In the absence of available water surface such as creek, dredging for construction of the port is much greater than that at the site-A.

3. DESIGN AND CONSTRUCTION OF CAISSON TYPE BREAKWATER

There are no Nigerian precedents for the caisson type breakwaters recommended in this report.

For reference, the methods of design and construction of the caisson type breakwaters are represented as follows:

1. Types of Breakwaters and Features of Caisson Breakwater

1-1 Types of Breakwaters

(1)

- Breakwater
  - Banking type breakwater
    - Rubble mound breakwater
    - Concrete block type sloping breakwater
  - Upright breakwater
    - Caisson type upright breakwater
    - Concrete block type upright breakwater
    - Cellular concrete block type upright breakwater
    - Mass concrete type upright breakwater
  - Composite breakwater
    - Caisson type composite breakwater
    - Concrete block type composite breakwater
    - Cellular concrete block type composite breakwater
    - Mass concrete type composite breakwater
  - Breakwater armored with wave dissipating concrete blocks
  - Special breakwater

(2) The banking type breakwaters are of rubble or concrete blocks deposited in a trapezoidal form and have the energy dissipated mainly by wave breaking over the slope.

(3) The upright breakwaters are of a structure of wall having a vertical front face set on the sea bottom and are intended mainly to reflect the energy of waves.

(4) The composite breakwaters are comprised of a vertical wall provided on the rubble mound. When the rubble crown is low against the wave height, they present a function closer to that of the banking type breakwaters, and when it is high, a function closer to the upright breakwaters.

(5) The breakwater armored with wave dissipating concrete blocks is comprised of an upright or composite breakwater and the wave dissipating concrete blocks installed in front of the breakwater. It has the wave energy dissipated by the concrete blocks and, at the same time, checks the permeation of waves by the upright section.

1-2 Features of Caisson Type Breakwater at Great Water Depth

The rubble mound breakwater receives a pressure of waves under the broken condition. If it is sloped sharply, it receives a very strong force of breaking wave. Therefore, for stabilization of the rubble, large concrete blocks must be used, or a gently sloped structure must be employed. Further, the run up of waves is great so that the crown height must be elevated. On the other hand, in the case of a caisson type breakwater, it is adapted to receive the waves as standing waves so that the wave pressure is reduced considerably.

Thus:

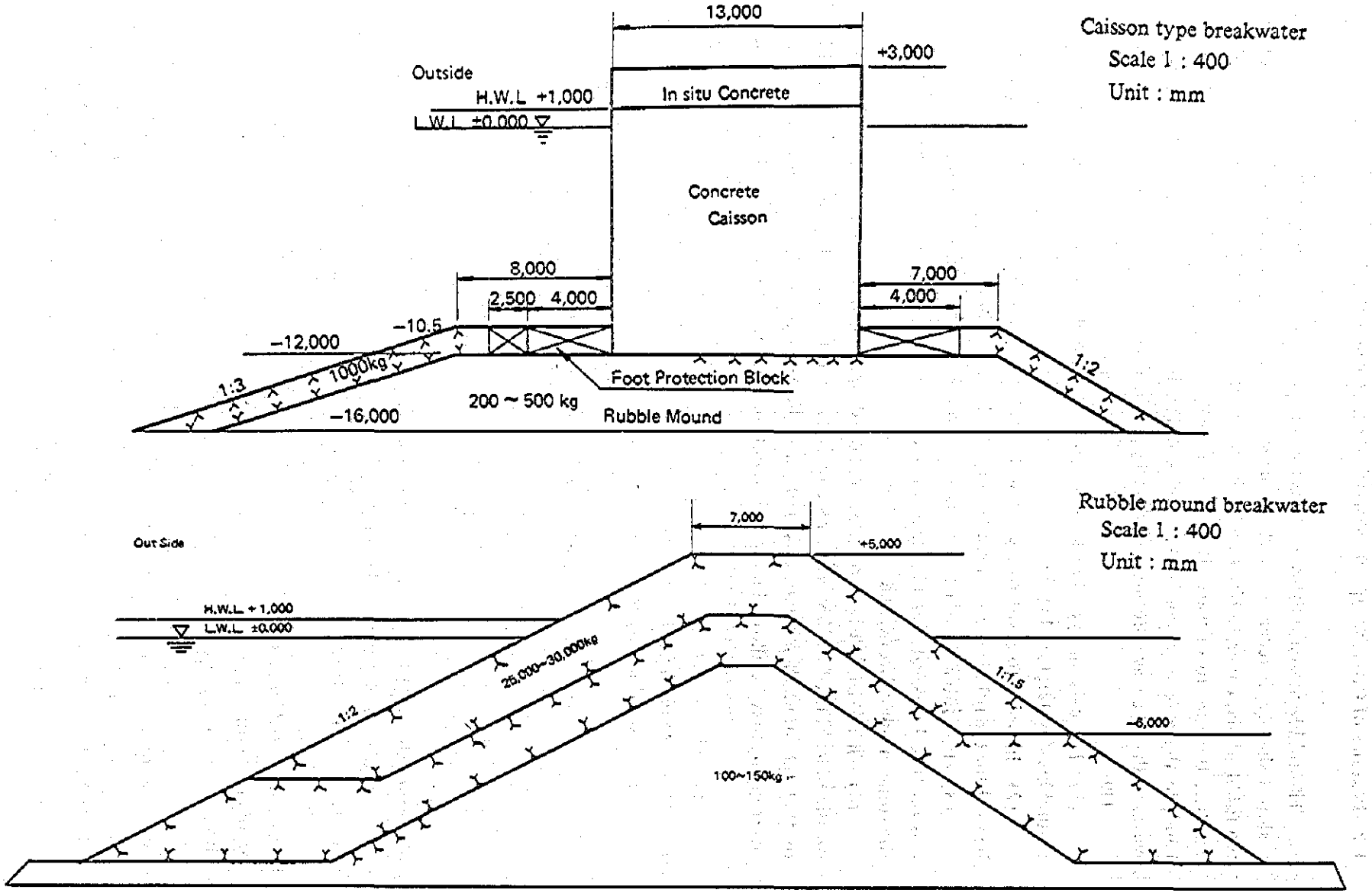
(1) The caisson type breakwater can have a smaller cross-section than that of the rubble mound breakwater; (see Fig.-1)

(2) In order to resist to a great wave pressure, the rubble with the large unit weight must be used for the rubble mound breakwater, but this has a limit;

(3) The rubble mound breakwater requires longer hours of work at the site than the caisson type breakwater and involves a risk of work lagging because of, for example, scattering of the stone in rubble work; and

(4) In the case of the rubble mound breakwater, if wave overtopping is allowed, the rubble on the inner side of the breakwater are often taken off so that the crown height must be elevated or that the strength must be increased, while in the case of the caisson type breakwater, wave overtopping may be allowed more or less but the strength of the breakwater is least affected.

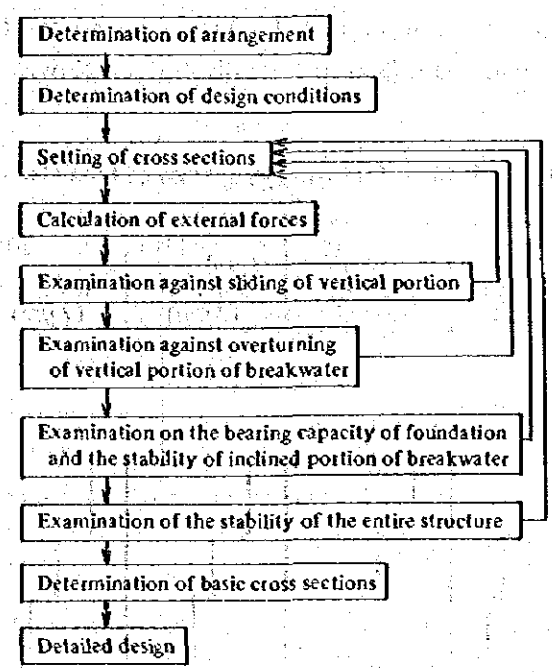
Fig.-1 Example of the crosssection of caisson type breakwater and rubble-mound breakwater at the same design conditions ($H_{1/3}$ = 6.0m, Waterdepth = −16.0m)



2. Design Procedure for Caisson Type Breakwater

Design of the caisson type breakwater is made generally according to the following sequence.

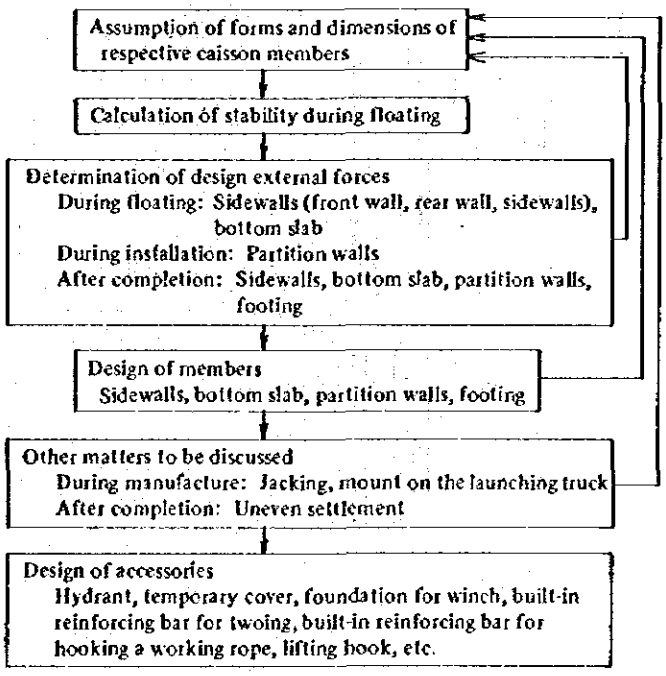
Fig.-2



3. Design Procedure for Caisson

Design of the caisson itself is made generally according to the following sequence.

Fig.-3



4. Caisson Manufacturing and Launching

4-1 Caisson Manufacturing

Caissons are manufactured generally according to the following sequence.
Caisson platform preparation – Reinforcement assembly – Form assembly – Concrete placing – Curing and rest – Form removal – Launching preparation.
Work processes of caisson manufacturing are illustrated below.

Table-1 Manufacturing Processes of One Caisson

Days / Works	5	10	15	20	25	30
	1st Stage (1.5m)	2nd Stage (3.0m)	3rd Stage (3.0m)	4th Stage (2.0m)	5th Stage (2.1m)	Miscel-laneous
Caisson platform preparation						
Reinforcement assembly						
Form assembly						
Concrete placing						
Curing and rest						
Form removal						
Launching preparation						
Overall process	30 Days					
Form constraining days	28 Days					
Scaffolding constraining days	23 Days					

4-2 Types of Caisson Yards

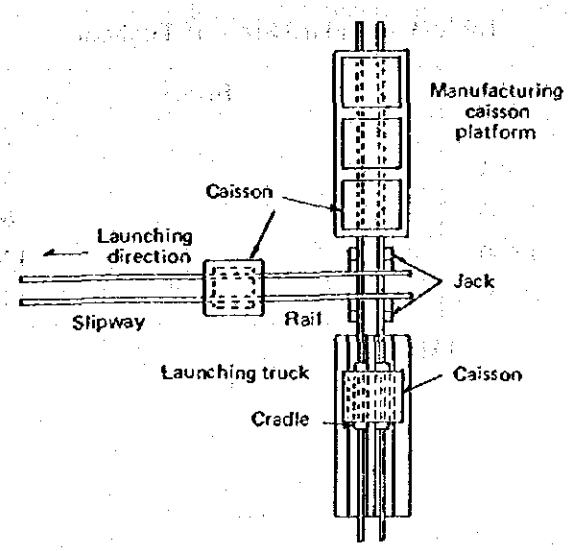
The yards required for manufacturing a caisson include the following.

Table-2 Types of Caisson Yards

Manufacturing Place	Launching Method	
On land	Slip way	(a) By sliding rail
		(b) By truck
	(c) By floating crane	
	(d) By beach excavation	
In dock	(e) By dry dock	
	(f) By floating dock	
	(g) By dolphin dock	
	(h) By mud dock	
In the Sea	(i) By waiting for the tide to come in	
	(j) By pump drainage	

What kind of yard is to be chosen is dependent on the number of caissons to be manufactured, caisson size, work period and availability of land for the yard. In the case of a large caisson, the floating dock is used often, and when a number of caissons of medium size have to be manufactured, the slipway type with trucks is used.

Fig.-4 Method by Means of Truck



4-3 Caisson Launching

Caissons take a different form of launching respectively depending on the kind of yard employed.

(1) In the case of a slipway, the caisson is allowed to slide over the slipway on trucks or sliding rails into the sea.

(2) In the case of a floating dock, the dock is allowed to sink to float the caisson.

(3) Where a crane is used, the caisson is lifted by a sea or land crane and placed in the sea.

(4) Where the caisson is manufactured on a sand beach, it is often launched by dredging the sand beneath it.

5. Breakwater Foundation Work

The mound on which a caisson is installed is prepared by first depositing rubble and then leveling the crown of rubble mound evenly so that the caisson is not subject to uneven force.

Where the ground is not good, a ground improvement work such as removal and substitution of the existing ground should be made before the rubble work is executed.

6. Towing of Caisson, and Installation

6-1 Towing

The launched caisson is once kept at the site temporarily, then it is towed to the place of installation by a tugboat. In this case, it is customary to connect the rope fixed around the caisson to the tugboat across a towing rope.

Standard sizes of tugboat are shown in Table-4.

Table-3 Standard Sizes of Tugboat

Caisson Weight	Tugboat	
Less than 400t	120PS	30t
" 700	180	40
" 1,000	450	80
" 1,600	800	120
1,600t or more	1,000	150

towing speed : 2 – 3 knot

6-2 Installation

(1) Installation is made by pouring water into the caisson towed over the foundation mound erected at the site as specified in Section 5 and sinking it in place by its own weight.

(2) In this case, the installation accuracy of the first caisson governs the result of the whole so that the installation of the first caisson should be made carefully.

(3) The second and subsequent caissons are installed successively along the face line of the breakwater by pulling with rope so that there is no clearance produced to the immediately preceding caisson.

7. Caisson Filling and Coping Works

7-1 Filling

(1) Filling should be made as soon as practicable after installation in order to provide a designed weight.

(2) For the filling material, sand is used.

(3) Upon completion of the filling, a cover concrete work is executed with precast members or in-situ concrete.

7-2 Coping

Over the caisson covered with concrete an in-situ concrete coping work is made by a floating mixing plant.

8. Miscellaneous

Where the design condition requires a wave dissipating work to be made in the front, necessary wave dissipating concrete blocks are placed in fromt of the breakwater with a floating crane used.

4. Review of the Construction Cost

The construction cost of the New Ocean Terminal was, as stated in "XIV-3-1 Conditions of the cost estimates", determined by 1) using ₦1 = ¥300 is the exchange rate and 2) using unit prices in 1978 as the basis.

It was taken for granted that the exchange rate and the unit prices would change during the next two years until the preparation of the final report (1980). Further, a very roughly estimated construction cost is usually sufficient at a master plan stage. So, no amendment was made for the change of the exchange rate and the unit prices.

But in Nigeria the exchange rate greatly changed during the two years from 1978. So, the construction cost was reviewed under the following conditions to see how far the change of the exchange rate would affect the construction cost.

Conditions of the cost estimates:

1) Exchange rate: ₦1 = ¥420

2) According to a rise in prices of materials, labour charges etc, construction cost with local and foreign-currency rose 15% and 10%, respectively.

3) Foreign currency ratios in the New City construction cost and arterial transportation facilities construction cost: 50% and 20%, respectively.

Table 1 shows the construction cost of the commercial and industrial port and Table 2 shows the total construction cost of the New Ocean Terminal in 1980.

Table 1 Rough Estimates of Construction Cost

(1) Commercial Port

Unit: million ₦

Item	Quantity			Total (Master Plan)			First Stage			Final Stage		
	Total	First	Final	Total	F/C[1]	L/C	Total	F/C	L/C	Total	F/C	L/C
I. Preliminary and Temporary Work[2]	Sum	Sum	Sum	49.6	30.6	19.0	28.9	17.5	11.4	20.7	13.1	7.6
II. Breakwaters and Shore Protection Facilities												
1. Breakwaters	5,150m	4,450m	700m	96.0	70.3	25.7	81.0	59.3	21.7	15.0	11.0	4.0
2. Shore Protection Facilities	2,000m	2,000m	–	8.7	6.4	2.3	8.7	6.4	2.3	–	–	–
III. Mooring Facilities and Related Facilities[3]												
1. General Cargo Berth	33B	6B	27B	152.9	104.3	48.6	27.8	18.8	9.0	125.1	85.5	39.6
2. Container Berth	27	6	21	638.6	475.4	163.2	141.9	105.7	36.2	496.7	369.7	127.0
3. Bulk Cargo Berth	1	1	–	30.7	22.1	8.6	30.7	22.1	8.6	–	–	–
4. Petroleum Berth	3	2	1	29.9	21.1	8.8	20.0	14.1	5.9	9.9	7.0	2.9
5. Small Crafts Berth	1,100m	300m	800m	2.0	1.6	0.4	0.5	0.4	0.1	1.5	1.2	0.3
IV. Dredging and Reclamation	86,000 x10³m³	28,000 x10³m³	58,000 x10³m³	143.4	101.4	42.0	34.37	33.0	13.7	96.7	68.4	28.3
V. Administration Office and Related Buildings	Sum	Sum	Sum	7.1	5.2	1.9	5.9	4.3	1.6	1.2	0.9	0.3
VI. Utilities												
1. Water Supply	Sum	Sum	Sum	14.0	10.2	3.8	9.3	6.8	2.5	4.7	3.4	1.3
2. Sewage and Drainage	Sum	Sum	Sum	10.2	5.1	5.1	2.8	1.4	1.4	7.4	3.7	3.7
3. Electricity Supply	Sum	Sum	Sum	7.4	6.4	1.0	2.4	2.1	0.3	5.0	4.3	0.7
4. Road and Green Belt for Port Service Area	Sum	Sum	Sum	7.8	4.0	3.8	1.9	1.0	0.9	5.9	3.0	2.9
5. Communications System	Sum	Sum	Sum	2.4	2.1	0.3	0.8	0.7	0.1	1.6	1.4	0.2
VII. Navigation Aids				3.3	2.8	0.5	2.1	1.8	0.3	1.2	1.0	0.2
VIII. Port Service Boats				7.6	7.6	–	4.2	4.2	–	3.4	3.4	–
IX. Power Station	400MW	100MW	300MW	75.1	56.7	18.4	18.8	14.2	4.6	56.3	42.5	13.8
Total				1,286.7	933.3	353.4	434.4	313.8	120.6	852.3	619.5	232.8
X. Physical Contingency[4]												
Grand Total				1,286.7	933.3	353.4	434.4	313.8	120.6	852.3	619.5	232.8

Note: 1 F/C and L/C are foreign and local currencies respectively.
2 Temporary work includes mainly construction of temporary roads, temporary wharfs, temporary breakwaters, temporary buildings and yards.
3 Related Facilities include cargo handling equipment, transit sheds, warehouses, roads, parking areas, green belts and open storage yards which relate to respective berths.
4 Physical contingency is not added.

(2) Industrial Port

Unit: million ₦

Item	Quantity	Cost
I. Preliminary and Temporary Work	Sum	10.1*
II. Mooring Facilities		
1. Iron and Steel Berth		
a. Iron Ore Berth	2 berth	26.0
b. Coal Berth	1 berth	11.1
c. Limestone Berth	1 berth	6.3
d. Steel Product Berth	9 berth	24.5
2. Oil Berth		
a. Crude Oil Berth	2 berth	4.4
b. Refined Oil Berth	1 berth	1.7
3. Chemicals Berth		
a. Chemical Materials	1 berth	2.7
b. Chemicals	5 berth	13.5
4. Shipbuilding Berth	3 berth	8.2
5. Bulk Cargo Berth	1 berth	9.5
III. Dredging & Reclamation	19,000 x 10^3 m^3	31.4
Total		149.4

* The cost of preparation and temporary work is only for the mooring facilities and dredging of industrial port.

Table 2 Total Construction Cost of the New Ocean Terminal

Unit: million ₦

Facilities	Total (Master Plan)	First Stage 1990	Final Stage 2000
New City[1]	627	24	306
Arterial Transportation Facilities[2]	383	26	357
Commercial Port[4]	1,287	435	852
Industrial Port	149	–	149
Total	2,446	485	1,961

Note: [1] For the urban facilities, only the infrastructures and architectures for public services are taken into account, and the intermediate values of estimates ranging over a certain width are indicated respectively.

[2] This construction cost includes the costs inside and outside the area of development as shown below.

	First Stage* Million ₦	Final Stage Million ₦
Inside the area of development	16	179
Outside the area of development	10	178

* Railway facilities are not included.

[3] Roads in the First Stage are planned as two-lane.

[4] The construction cost for roads in port area is included in the arterial transportation facilities.

5. Organization of Study Team

Phase II (1st Year) Study Team
(November 23, 1978 ~ December 22, 1978)

Name	Duty	Position
Susumu MAEDA	Head	General Manager, OCDI
Yukio NISHIDA	Deputy Head; Port Planning	Civil Engineer, OCDI
Tomotsuka TAKAYAMA	Coastal Engineering	Chief, Wave Laboratory Ports & Harbour Research Institute Ministry of Transport
Takao KAWAI	Structural Design and Cost Estimates	Civil Engineer, OCDI
Masayoshi TAMURA	Land Use Planning	Town Planner, OCDI
Kunio OHASHI	Transport Planning	Traffic Engineer, OCDI
Yorihiro MANO	Industrial Development Planning	Economist, OCDI

Phase II (2nd Year) Study Team
(July 24, 1979 ~ August 9, 1979)

Name	Duty	Position
Masao OHNO	Head	Executive Director, OCDI
Yukio NISHIDA	Deputy Head; Port Planning	Deputy Director, OCDI
Tomotsuka TAKAYAMA	Coastal Engineering	Chief, Wave Laboratory Ports & Harbour Research Institute Ministry of Transport
Koichi FUJIKAWA	Structural Design and Cost Estimates	Civil Engineer, OCDI
Hiroyuki NISHIJIMA	Coordinator	Technical Official (Civil Engineer) JICA

(February 3, 1980 ~ February 16, 1980)

Masao OHNO	Head	Executive Director, OCDI
Yukio NISHIDA	Deputy Head; Port Planning	Deputy Director, OCDI
Tomotsuka TAKAYAMA	Coastal Engineering	Chief, Wave Laboratory Ports & Harbour Research Institute Ministry of Transport

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