IX. Concept for the scale and layout of urban facilities

IX. Concept for the Scale and Layout of Urban Facilities

The New Ocean Terminal, which is intended not only as a commercial port but also a basis for the industrial development, necessitates a large migratory movement of workers into the development area. New inhabitants will not only include the planned employees and their families, but also people to be engaged in the service industries, such as retailing, financial businessess, and public services.

It is important to systematically provide housing and urban facilities to meet the increase in employees. And the significance of developing a new city is not limited to merely providing urban services and a favorable environment for the new inhabitants.

Serious considerations must be given also to the substantial economy of planned capital investment in infrastructures, which would avoid costly slum clearances or improvement of roads to sprawling residential areas in future, and develop agricultural industry in this region with new routes to the Lagos market.

The objective of this chapter is to plan urban facilities indispensable for an orderly development of the New Ocean Terminal. This proposal covers the scale and location of the New City, and the basic concept for the layout of its various facilities.

IX-1 Scale of the New City

IX-1-1 Employment, population and households

The planned number of employees in relating to the commercial port is 20,000, 30,000 to the manufacturing industries; 50,000 in total. Based on these figures, the population scale of the New City in the year 2000 is estimated as follows:

First, the total number of employees is estimated based on the employment structure by industry. Generally, the employment structure of a city greatly depends upon its major industries, functional role in a regional economy, and upon the stage of its urban growth. In the case of a development like this, the employment structure mainly comprises transport, communication and manufacturing industries. Then the tertiary industries increase gradually to support smoothly operating economic and social activities. The scale of the tertiary industries is generally determined by the scale of hinterlands. This project site is positioned within a 50 km zone from Lagos City, and is only about 20 km from Epe, the present center of this region. Therefore, the hinterland is limited to the peripheral area of the project site, and the future growth of the tertiary industries is surmised to be relatively small.

In this context the New City is supposed to develop as a specialized city in the planned businesses and industries, and the employment structure is estimated as follows, relcting to data in Nigeria and the experience in Japan as shown on Table IX-1.

Table IX-1 Sectorial Distribution of Employment

	Planned Employees in 2000 No. thousands	Planned Employees in 2000 %	Lagos State 1975 * %	Nigeria 1975 ** %	Japan 1975 *** %
Agriculture, Mining & Quarrying	0	0	3.2	64.4	13.3
Manufacturing and Processing	(30)	(36)	12.5	16.8	25.8
Construction and Building	8	10	8.3	0.9	9.1
Distribution				12.2	24.8
Electricity, Gas and Water	17	20	47.8	0.1	6.9
Transport and Communications	(20)	(24)	5.7	0.6	
Services	8	10	22.5	5.0	20.1
Total	(50) 83	(60) 100	100.0	100.0	100.0

Source: * Regional Plan for Lagos State, Existing Conditions 1977
** 3rd National Development Plan 1975–80 Vol. 1.
*** Prime Minister's Office, Government of Japan
Note: ( ) Shows planned figures for the New Ocean Terminal.

The proportion of the employees for the planned businesses and industries (transport and manufacturing) to the total employees in the New City is assumed to be 60% (50,000 people). This proportion is far higher than the Nigerian average of 17.4% (1975). And 40% of the total employees are set for the service industries such as retailing. As a result of above assumption, the total number of employees estimated is 83,000.

The population can be estimated based on the number of employees, using the labour force participation ratio.

The age structure of Nigerian population is a typical pyramid type with younger generations at its base, and this trend will remain unchanged in the near future. Therefore, the working age group will remain in the 50s percent as shown in Table IX-2, and the labour force participation ratio will fluctuate between 30% and 40%. On the other hand, with the high economic growth in Lagos State and its vast employment opportunities with continuing inflow of a young labour force will keep the labour force participation ratio high in the 40s percent.

As a continuous economic growth of this community is expected, it can be assumed that a relatively high labour force participation ratio of 40% to 45% will continue for a long time. By dividing the total number of employees by the ratio, the population is forecast as follow.

Low population forecast: 83,000/0.45 = 184,000 (persons)

High population forecast: 83,000/0.40 = 208,000 (persons)

The planned final population of 200,000 close to the high forecast is employed for this study.

Table IX-2 Demographic Characteristics

	Lagos States		Nigeria		Japan
	1963	1975	1963	1975	1975 ***
Population (1,000 person)	1,444* (665)**	3,500*	55,670**		111,288
Population Ratio of 15 Years Old & Over (%)	(63.6)**	–	57.0**	–	75.4
Labour Force Participation Ratio (%)	46.4*	41.0*	32.9*	38.6*	47.4

Source: * Regional Plan for Lagos State, Existing Conditions 1977.
** Annual Abstract of Statistics 1974.
*** Prime Minister's Office, Government of Japan.
Note: ( ) shows Lagos Division only.

Since sufficient data on households are not available, the planned value of FESTAC Town (Black Art Festival Town), a figure of 5 persons per household is employed for the 40,000 estimate of the total number of households.

IX-1-2 Urban facilities

The entire land demand is estimated by the general method using a gross zone overall population density.

In relation to the gross residential density which is an important portion of the gross zone overall population density, the average in present Lagos City shows a considerably high density of 262 persons/ha; however, the densities in the slum areas of the urban centre and of Ikeja show a higher density of over 1,200 persons/ha. In many other areas, the density is from 300 to 800 persons/ha, and a density of less than 150 persons/ha can be seen only in the high-class residential areas of Ikoi and Victoria island.

The population densities of other cities are not available. But, judging from comparison made with Lagos City by the number of residents per room in Table IX-3, they are surmised to be about 50% of that of Lagos City, which is a relatively appropriate density. In comparison with 3.8 persons per room of Lagos City, other cities show 50% to 70% of that of Lagos City. Since this only shows one phase of urbanization scale, there must also be a difference in housing densities, thus warranting the above mentioned estimate on population density.

Table IX-3 Housing Conditions in Selected Nigerian Towns in the year 1971

Town	% of Households occupying one room	Average No. of persons per room	% of Houses with tap water	% of Houses with flush Toilet	% of Houses with electricity
Lagos	72.5	3.8	71.7	43.5	93.2
Port Harcourt	51.5	2.4	75.0	18.6	81.4
Benin	48.0	2.2	24.9	4.0	59.3
Warri	59.9	2.6	62.4	10.9	89.7
Kaduna	63.9	2.1	40.3	14.1	53.3
Kano	69.1	2.4	26.1	1.8	69.1
Ilorin	23.9	1.6	30.7	10.4	28.4
Ibadan	47.3	2.1	33.4	25.2	56.1

Source: 3rd National Development Plan 1975–80 Vol. I.

On the other hand, according to past experiences in developing new towns in various countries, in large-scale development based on the mixed arrangement of detached houses and apartment houses, it has been proven that a gross zone overall population density of 40 to 130 persons/ha allows a favorable living environment. To be specific, the gross residential density is from 50 to 350 persons/ha, as shown in Table IX-4 to 6, and the proportion of housing lots to the total urban area is from 70 to 30%. For instance, FESTAC Town, developed in the suburbs of Lagos City, is planned with a gross zone overall population density of 68 persons/ha.

Table IX-4 Gross Residential Density by Type of Housing

Housing type		No. of houses/ha	*No. of Residents/ha
Detached House (1–2F)		14–25	56–100
Attached House (2F)		43–54	172–216
Apartment	(3–4F)	54–76	216–304
House	(6–10F)	69–85	276–340

Source: Theory and design for residential environment by S. Tabata and K. Ikeda Kashimashuppankai
Note: *Estimated on the assumption of 4 residents/house

Table IX-5 Distribution of Land Use by Type of Housing: New Town

Unit: percent

Housing Type		Residential	Commerce, office and public facilities	Open space	Transport facilities
Detached house	(1–2F)	60–75	4–7	4–10	17–22
Attached house	(2F)	45–55	11–14	13–16	23–25
Apartment house	(3–4F)	40–50	12–15	15–19	24–27
	(6–9F)	35–45	14–16	17–21	26–28
	(10–12F)	30–40	15–17	19–22	28–30

Source: Theory and design for residential environment by S. Tabata and K. Ikeda Kashimashuppankai

Table IX-6 Land Use Characteristics in Selected New Towns

		Harlow N.T. U.K.	Cumber-nauld N.T. U.K.	Don Mils I.P. USA	Sharps Town I.P. USA	Senri N.T. Japan	Senboku N.T. Japan
Population	(1,000 person)	90	70	–	–	150	188
Planned Area	(ha)	2,588	(752) 1,680	850	1,600	1,160	1,520
Gross Zone Overall Population Density	(person/ha)	35	(60)	–	–	130	120
Distribution of Land Use							
Residential Area	(%)	24	31	33	46	44	44
Commerce and Office	(%)	3	3	3	6	4	6
Public Facilities	(%)	5	7	6	8	6	6
Industry	(%)	5	18	18	16		–
Roads	(%)		8	18	17	22	22
Open Space	(%)	63	31	22	7	24	22
Others	(%)		2	–	–	–	–
Total	(%)	100	100	100	100	100	100

Note: ( ) indicates newly planned urban areas.

Based on the above facts, this New City is planned with an overall population density of 70 persons/ha assuring a favorable environment at low cost with a medium density development of mixed dwelling types. The land use of urban area is as shown in Table IX-7, and the total area is to be 2,900 ha. The net residential density is 140 persons/ha, and the gross residential density is about 100 persons/ha.

Table IX-7 Planned Land Use for the New City in the year 2000

Residential Area	1,450	(50%)
Commerce and Office	120	(4%)
Public Facilities	170	(6%)
Roads	580	(20%)
Open Space	580	(20%)
Total	2,900	(100%)

The result of a study about essential urban facilities is shown in Table IX-8. These facilities are estimated mainly based on residentail districts. A residential district is a primary school district covering an area of 70 to 90 ha where through traffic is eliminated, and forming a small community with a population of 7,000 to 9,000.

To finalize the project, however, a further study must be made at an appropriate stage of planning on the scale of various facilities based on the Nigerian situation such as the age structure, income level and life style etc.

Table IX-8 Required Urban Facilities in the year 2000

Functions	Number of facilities (unit)		Area per unit (ha)	Total area (ha)
PUBLIC SERVICE				
Administrative Centre: a city office, police station, fire station, taxation office, post office, etc.	(26)	1	6	6
Administrative Sub-centre: branches of a city office, police & fire station and post office	(4~6)	6	1	6
Education Centre: a college, teacher training centre, library	(26)	1	12	12
Secondary schools	(2)	13	4	52
Primary schools	(1)	26	2	52
Nursery schools	(0.5)	52	0.5	26
A central hospital, health centre, etc.	(26)	1		10.4
Clinics	(2)	13	0.2	2.6
A children house, home for aged and rehabilitation centre	(26)	1		3
Total Public Facilities	–		–	170
COMMERCE AND BUSINESS				
Central district for commerce, business, amusement and service industries	(26)	1	94	94
Daily goods' shops and restaurants	(1)	26	1	26
Total Commerce and Business	–		–	120
OPEN SPACE				
A central park, Sports ground and golf field	(26)	1	140	140
District parks	(4~6)	6	4	24
Neighborhood parks	(1)	26	2	52
Play lots	(0.25)	104	0.5	52
Other open space	–		–	312
Total Open Space	–		–	580
INFRASTRUCTURE	(Unit)		(Total)	
Water supply	130 ℓ/day·person		26,000 m^3/day	
Sewerage	130 ℓ/day·person		26,000 m^3/day	
Electric power generating capacity	0.2 KW/person		40,000 KW	
Telephone connections	1 set/5 peson		40,000 sets	

Remark: Areas of facilities are shown as net areas.
Note: ( ) shows the service area of a facility in number of residential districts. This new city consists of 26 residential districts. And each one has 7,000~9,000 population.

IX-2 Location of the New City

IX-2-1 Discussion on alternative plans

For selecting the site of the New City, alternative plans are discussed in relation to the three important elements mentioned below:

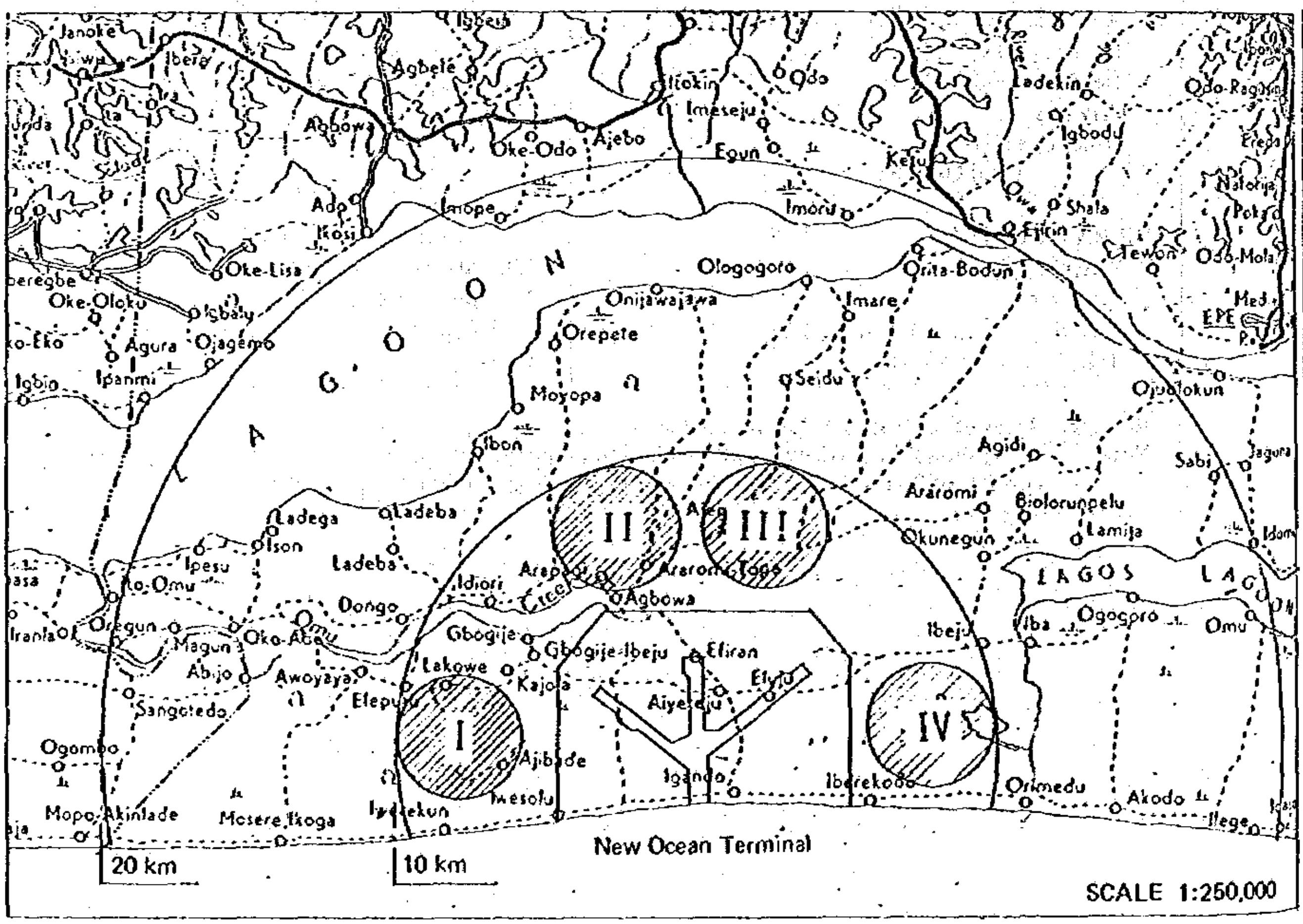
The first element is the layout pattern or distribution pattern of the New City. Two major patterns of concentration and dispersal are discussed as alternatives.

The second element is the boundary of the New Ocean Terminal in relation to commuting distances from the proposed New City Sites.

When the commuting distance is short, compact urban activities can be attained. But, in general, there occurs a trade-off between capital cost of a site and the commuting distance. Since the cpital cost, such as land price around working areas is often high, it is not always advantageous for a residential district to be located within a short distance of the working place.

In the case of the area around the New Ocean Terminal, it can be said that there are no special restrictive conditions as to capital cost. Because the land price can be considered negligibly cheep from the present land use; natural forests except a few burnt fields. In reference to the construction cost, subsoil conditions are good in the consolidated dunes as well as topographical condition in the spacious flat areas.

Fig. IX-1 Four Alternatives for the Site of the New City



Therefore, only one boundary alternative is set at 10 km by straight line out from the centre of the New Ocean Terminal, imposing little hardship on cummuters.

The third important element is location. The boundary of the New Ocean Terminal is divided into four sections from the south to north axis of the channel and the east to west axis of the creek. The four sections are discussed as the alternatives shown in Fig. IX-1. The alternative dispersal patterns have a major town in one of the sections and minor towns in the others.

Thus, the alternative plans to be evaluated are the two layout patterns, one boundary plan and four locational plans; totaling 8 alternatives by multiplying them.

IX-2-2 Selection of the site

The site selection of the New City is made through a preset evaluation system. The system has two hierarchical phases: evaluation aspect (upper) and ealuation items (lower). The three evaluation aspects are: "utilization of the site"–to measure the usefulness of the land itself; "economy of the site"--to measure the cost required to obtain the usefulness; and "effect on environment." The respective aspects consist of more concrete evaluation items selected through an objective and in-depth research as shown in Table IX-9, together with respective evaluation points.

Table IX-9 Evaluation of Alternatives

Evaluation View Points	Weight	Concentration Pattern				Dispersal Pattern			
		I	II	III	IV	I	II	III	IV
UTILIZATION OF THE SITE	(3.33)								
*Freedom from Floods	0.833	O	O	O	X	O	O	O	X
Freedom from Air Pollution	0.832	O	O	X	X	O	O	X	X
Accessibility to the Sea or Lagoon	0.555	O	O	X	O	O	O	X	O
Variety of Urban Services	0.555	O	O	O	O	X	X	X	X
Convenience for Commuters	0.555	X	O	O	X	O	O	O	O
ECONOMY OF THE SITE	(3.34)								
Construction Cost of Infrastructure	3.34	O	O	O	O	X	X	X	X
EFFECT ON ENVIRONMENT	(3.33)								
Adaptability to Existing Community	0.833	X	X	X	X	O	O	O	O
Conservation of Nature	0.832	O	O	O	O	X	X	X	X
Future Prosperity of This Region	1.665	O	O	O	O	X	X	X	X

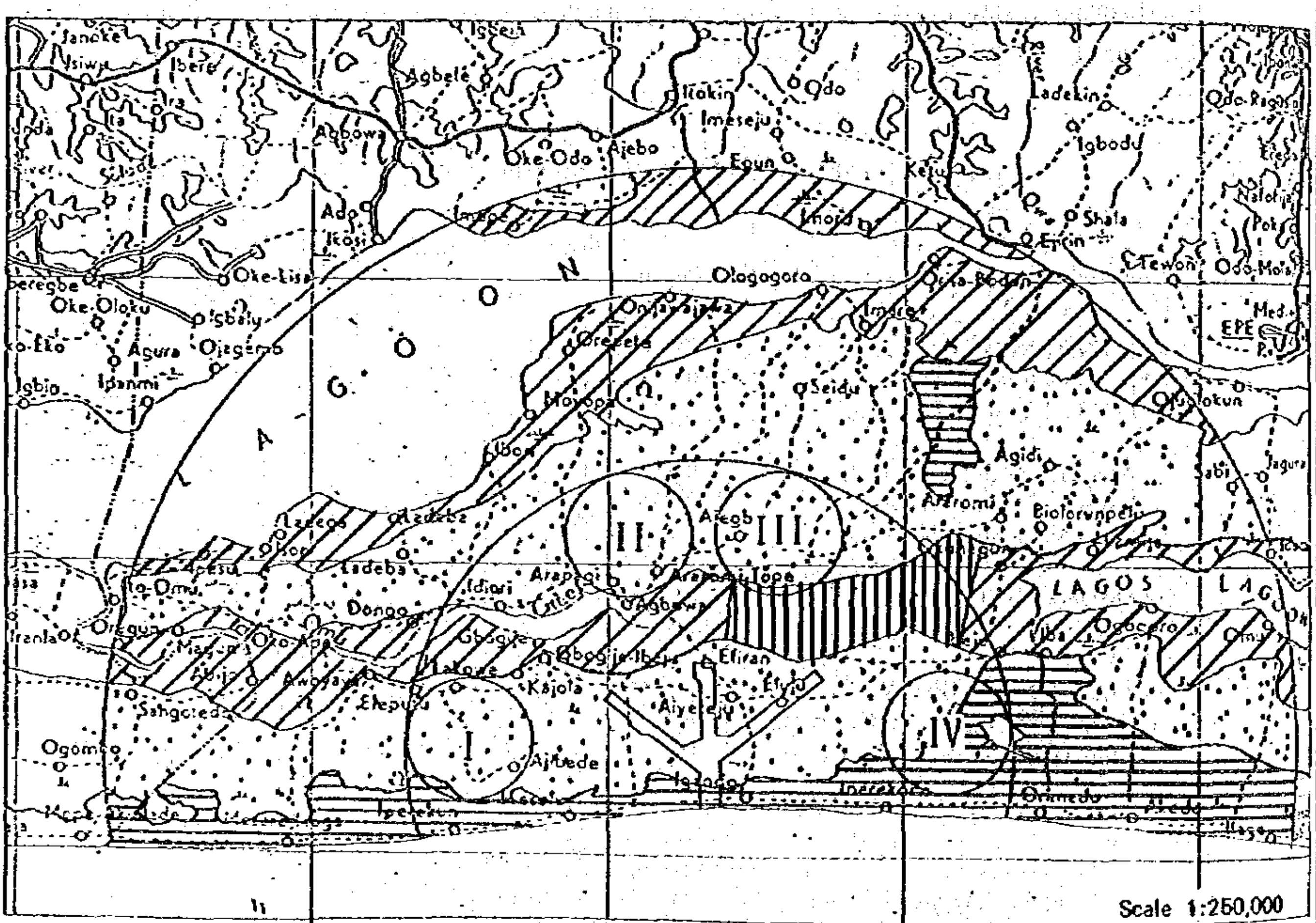
Notes: O shows good, X shows bad or problematic.
Remarks: * Damages from the wind and earthquake are excluded because of the geological and topological similality in the area. Noise from industrial area and water pollution are also excluded because of the distance and the planned treatment plant, respectively.

For the "utilization of the site" aspect, subject concerning safety, health, amenities and conveniences are discussed. First "freedom from floods" item is chosen as the element for safety and health, since this area is flat and has much rainfall in rainy season. Judging from the drainage conditions, as shown in Fig. IX-2, most of the alternative plan IV area is a water logged area, and is less desirable to the other alternatives.

"Freedom from air pollution" is also vitally important, since iron and steel and petroleum industries are planned in the New Ocen Treminal and despite sufficient countermeasures taken against the sources of pollution. The prevailing wind direction throughout a year is southwest, therefore alternative plans III and IV in the east half of the New Ocean Terminal are unsatisfactory.

As for amenity, amenities for the residential environment, such as parks, are not considered since it can be kept at a certain level by planning; here the amenity of natural environment around the New City is evaluated by the "accessibility to the sea or lagoon." Though there is not much difference, alternative III which is not close to the sea or lagoon, is considered inadequate.

Fig. IX-2 Land Formations, Topography and Drainage Conditions



Dry land on consolidated dunes

Low river valleys on consolidated dunes

Water logged areas on alluvial deposits and consolidated dunes

Flood plains

Source: Regional Plan for Lagos State, Existing Conditions 1977

And the "variety of urban services," such as areas for shopping and amusement is also important and the superiority of the concentration pattern which enables taking an advantage of scale merit is obvious.

As for convenience, "convenience for commuters" to evaluate the consolidation of the New City with the New Ocean Terminal is a very important item. All the disperal plans are supposed to provide sufficient conveniences, but alternative plans I and IV of the concentration pattern are inferior, since some sections to the New Ocean Terminal inevitably require long distance commuting by a detour around the channels.

In the aspect of "economy of the site," "construction cost of infrastructure," for such facilities as water supply, sewerage and roads, is considered. Costs for disaster countermeasures are not evaluated in the element of "economy of the site" but as an element of "safety". So this item substantially relates to layout patterns, and the dispersal pattern which elongates the road length, etc. is inferior.

The aspect of "effect on environment" focuses on the adaptability of this developmet to the existing community and environment, namely the items of "adaptability to existing community", "conservation of nature" and "future prosperity of this region."

The "adaptability to existing community" is considered in the view of developing local or town centres in the existing communities and providing urban services for its environs. But there is no community large enough to be developed as a local centre in this area as shown in Fig. IX-3. Therefore the developing centres in existing communities cannot be considered as the element of "Adaptability to existing community." Although Epe may play the role of a regional centre, it is too far from the development area to become the daily life centre of this area. Therefore, the evaluation is made relating to the provision of daily urban services such as water and electricity supply and commodity services. In this case, the dispersal pattern, which allows approaches to many communities, is superior.

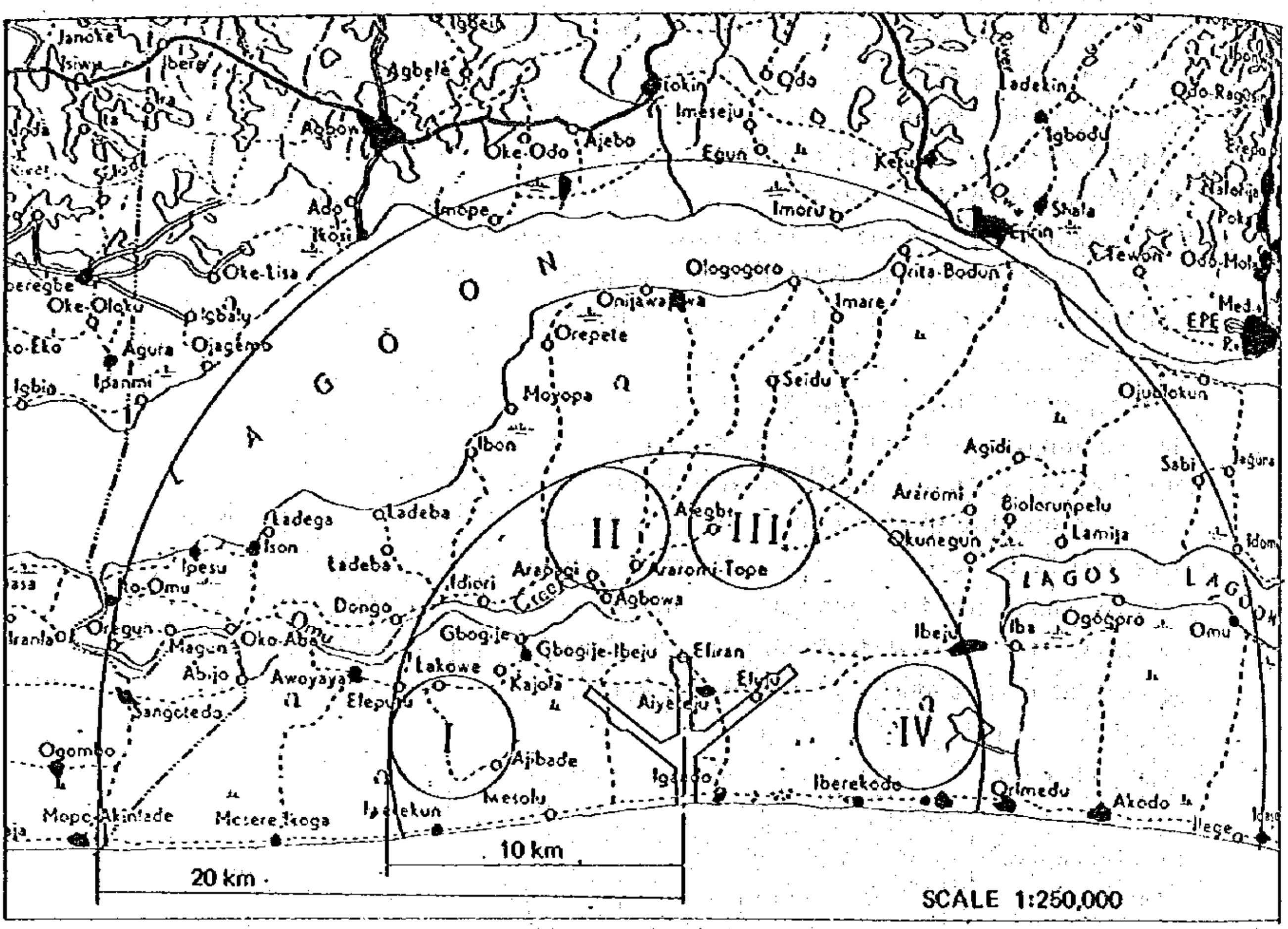
As regard to the "conservation of nature," it is generally known that an urban development changes the ecosystem in and around the developed area. The concentration pattern is superior since it allows for compact development in the same scale and its effect on environment is minimal.

In the "future prosperity of this region" item, the area for future expansion need not be covered because sufficient space around is available. Therefore the possibility of further social and economic growth in this region is evaluated.

In the case of a medium-scale city with a population of 200,000, sophisticated goods transportation, financial and insurance businesses, etc provide various functions by accumulation, which is indicated in terms of scale merit in the "variety of urban services." Those functions contribute toward energetic urban activities and provide a base for economic growth of a region. Obviously urban development depends not only on the centralization of various business functions but heavily on the national economic trend and policies. As a whole, the concentration alternative is superior.

Judging from the above evaluations, it can be concluded that the concentration alternative is superior in the light of layout pattern, and that plan II is superior in the light of location. Therefore, the New City was planned for a lot in the northwest section of the New Ocean Terminal.

Fig. IX-3 Distribution of Existing Built up Areas



Built up Areas. O Isolated Compounds

For reference, the calculated comprehensive points for the respective alternatives are shown in Table IX-10.

As for evaluating the respective alternatives, the respective items are weighed to give 10 points for the best evaluated and 0 point for the least desirable as a total points of the items. For the purpose of weighting, there are various methods such as the delphi or paired comparison techniques. But in this case, an approximate evaluation is carried out by the following subjective weighting method.

As understood in the above description of the evaluation system, the nature of problems to be evaluated in the respective aspects differ greatly. Therefore, even in a government, those in charge of finance will emphasize the importance of "economy of the site" and those in charge of environment will put on emphasis on the aspect of "effect on environment." Thus, different values are given by those who have differing viewpoints. Here, however, the planner assumes that the respective aspects have equivalent weights. Similarly, the items in a aspect are assumed to be equivalent. Sub-items covering similar contents are regarded as one item.

Table IX-10 Comprehensive Evaluation of Alternatives

Layout Patterns	Concentration				Dispersal			
Locations	I	II	III	IV	I	II	III	IV
Comprehensive points	8.612	9.167	7.780	6.947	3.608	3.608	2.221	1.943

IX-3 Concept for the layout of urban facilities

The layout of urban facilities is planned, as shown in Fig. IX-4, based on the scale and location of the New City discussed in Sections 1 and 2. The planning is also guided by the following principles.

(1) Site of the New City

The area in which the New City can be located is surrounded by Lagos Lagoon, Omu Creek and the main access road extending toward the north. And it is to be located almost in the centre of the area for the following reasons.

a) Proximity to the New Ocean Terminal for convenient commuting.
b) Sufficient space for future extension toward the north and west.
c) The water-fronts of the lagoon and the creek are to be planned as recreation areas.

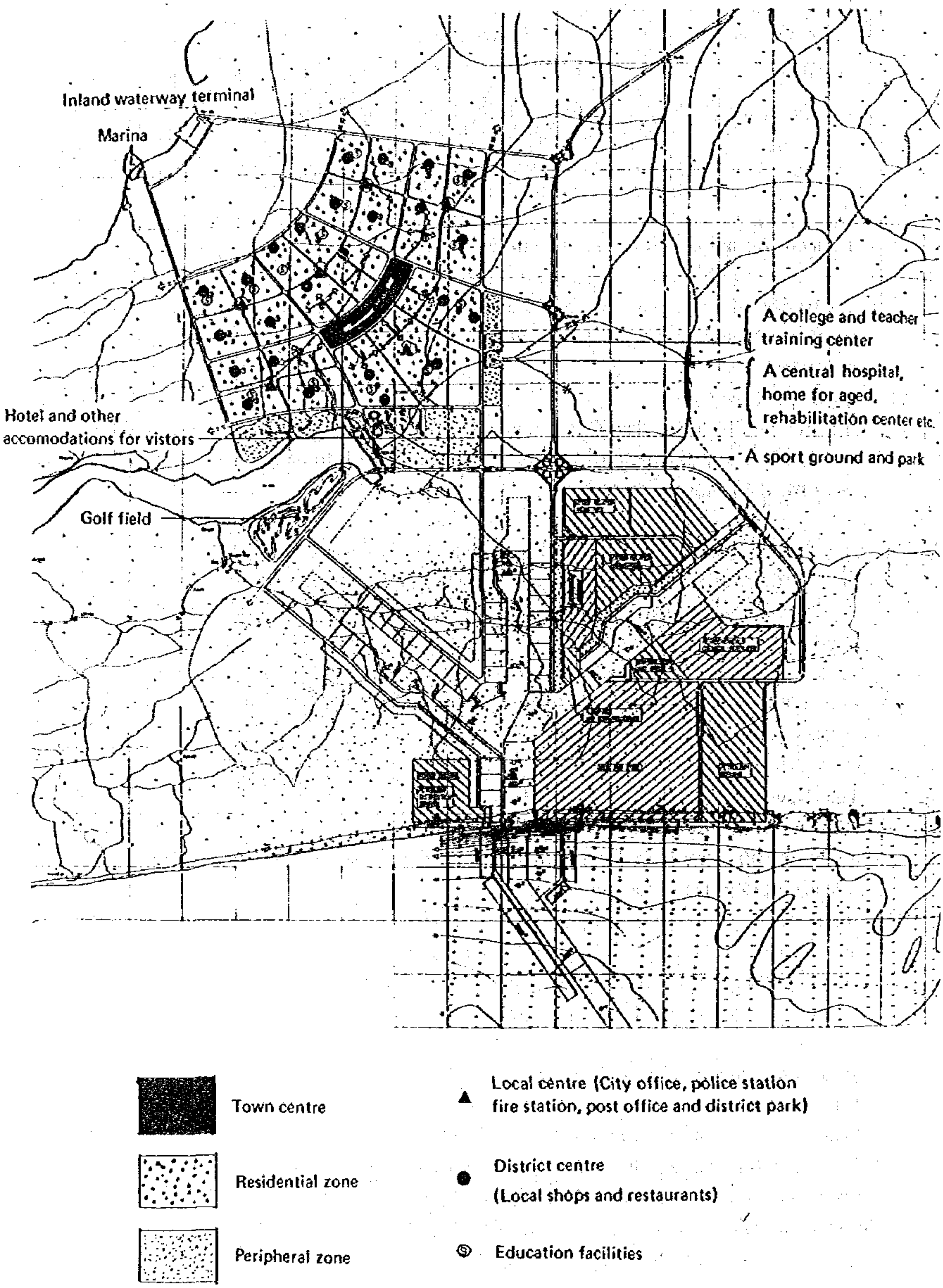
(2) Physical framework of the New City

The frame is formed by the urban arterial roads. Some are to open out like a fan toward the New Ocean Terminal, and others are to extend from west to north to induce future development toward the west and north.

(3) Centralized development of the New City

The New City is to be integrated as one town centre, to take the advantage of the centralization as mentioned in the previous section. And, within walking distance from the town centre (about 500 m), a high density area is planned and a low density area and sufficient open space are arranged in the outer area.

Fig. IX-4   Conceptual Plan of the New City



IX-3-1 Land use

The areas according to land use are shown in Table IX-7 and the layout in Fig. IX-4, based on the principles mentioned above and characteristics of the development area. Since the area is flat with few restrictive conditions for planning, the planning principles are clearly visible in the plan.

As for the general structure, the town center is situated at the centre of the area and the residential zone is arranged around it. On the peripheral zone, large open spaces, college and other facilities are arranged. It is intended to arrange the major portion of urban activities, such as businesses and communication, at the town centre, and provide the less dense activities and calmer environment in a zone apart from the town centre. Thus the city can be harmoniously connected with the natural open spaces remaining outside the development area.

Described below are the respective zones. the facilities arranged in the zones are as shown in Table IX-11.

Table IX-11 Distribution of Urban Facilities in the year 2000

Functions	Area per zone (ha)				
	Town centre	Residential zone			Peripheral zone
		4–6 Districts	2 Districts	Each District	
PUBLIC SERVICE					
Administrative Centre: city office, police station, fire station, taxation office, post office etc.	6				
Administrative Sub-Centre: branch city offices, police & fire station and post office		6			
Education Centre: a college, teacher training centre, library	2				10
Secondary schools			52		
Primary schools				52	
Nursery schools				26	
A central hospital, health center, etc.	1				9.4
Clinics			2.6		
A children house, home for aged and rehabilitation centre					3
COMMERCE AND BUSINESS					
Central district for commerce, business, amusement and service industries	94				
Daily goods'shops and restaurants				26	
OPEN SPACE					
A central park, sports ground and gold field					140
District parks		24			
Neighbourhood parks				52	
Play lots/areas				52	
Other open areas	27			130	155
Urban Facilities Total (870 ha)	130	30	54.6	338	317.4

Remark: Areas of facilities are shown in terms of net areas.

(1) Town centre

The town centre is the field of the activities in which shopping, amusement and public service facilities are collectively arranged, and is the symbolic centre of the New City. It also presents plazas and pedestrian decks for festivals or other events. Considering the characteristics of the development area which is flat with little topographic variation, the centrality of he town cnetre is to be visually expressed by high rise buildings.

(2) Residential zone

The residential zone consists of 26 residential districts, each having 7,000 to 9,000 people, or 6 sections surrounded by urban arterial roads. The zone is also divided in a different way into three subzones with difference in population density and building type, as shown in Fig. IX-5. To meet various demands of new inhabitants, the subzone convenient for shopping in the proximity to the town centre is highly dense, but the peripheral subzone is low dense to provide a calm environment. The area along the fan-shaped urban arterial roads close to the New Ocean Terminal is convenient for commuters, and planned for highly dense multi-storied apartment housess. This visually reveals the physical framework of the city opening toward the New Ocean Terminal. As a result, 80,000 people will inhabit an area within 500 m (about 8 minutes on foot) from the town centre and 130,000 people within 1 km (about 15 minutes); thus 65% of the population can easily have the town centre for their daily life.

In each residential district, facilities (schools, local shops, children's parks, etc.) indispensable for daily life are planned.

(3) Peripheral zone

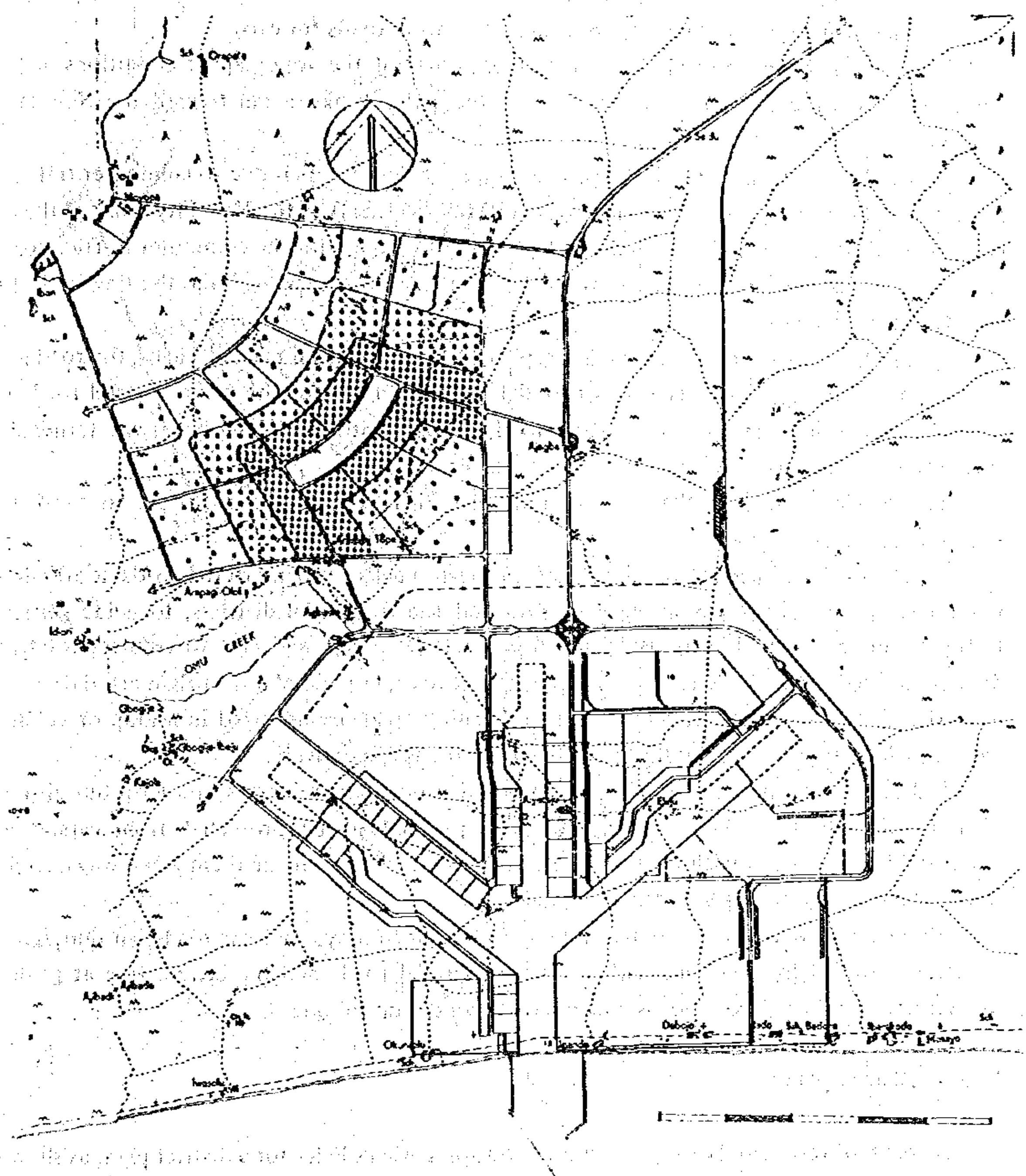
The water-fronts of Lagos Lagoon and Omu Creek are used for recreation. The types of recreation, however, vary widely.

The water-front of Omu Creek is used for daily recreation and includes an athletic park, golf field and boating, and serves the function as a buffer greenbelt for the New Ocean Terminal. Lodgings for visitors are also planned at the water-front. The water-front of Lagos Lagoon is used as a base of yachting and fishing for weeknd recreation, and as an inland waterway terminal for high speed ferryboats, hovercraft and barges.

Facilities such as a college, hospital and rehabilitation centre require a calm environment. So they are arranged in east peripheral zone which is calm as well as convenient.

The importance of green tracts and natural open spaces in an urban society is often pointed out, and in a town like the New City, conservation and utilization planning for the water front shoud not be neglected simply because of economic reasons.

Fig. IX-5 Planned Residential Density of the New City



Zone	Gross residential density persons/ha.	Housing type	Remarks
High density zone	150	apartment house	within 600 m from the town centre
Medium density zone	100	attached house court house	within 1 km from the town centre
Low density zone	70	detached house	

IV-3-2 Transportation network

People living in the New City generally move by cars or on foot. Mainly for the purpose of safety, pedestrian ways should be laid out separately from roads for cars.

The arterial road network is in a grid pattern, but the topographic conditions and the characteristics, as described below, transform the pattern like a fan toward the New Ocean Terminal.

It is well known that the traffic generated during peak hours is due to commuter traffic. As described in Section 2, 60% of the employees (50,000 workers) of the New City work at the New Ocean Terminal. It is a serious problem of planning to cope with the commuter traffic. For this reason, four urban arterial roads are connected to the main access road and the ring road of the New Ocean Terminal.

As the Lagos State Government has a plan to build a coastal road to Lagos, the road at the northwest end of the New City is considered to become a part of the future coastal road. Two arterial roads, extending up to the coastal road, connect with the inland waterway terminal for future traffic demands.

To provide services for the residential districts, the urban arterial roads are arranged at 1.5 km to 2 km intervals.

Local distribution roads are connected to the respective urban arterial roads at 500 m to 1 km intervals. The roads are arranged to surround the residential districts, to guide generated traffic in the residential districts to the urban arterial roads, and also to connect residential districts to each other. They can be arranged, if necessary, in parallel to an urban arterial road.

The access roads within the respective dwelling areas are arranged in a loop or cul-de-sac pattern, which are connected with the distribution roads respectively.

Pedestrain way network is planned to connect not only sub-areas in a loop but also each district with the town centre. They are also planned to be protected from cars, and as comfortable green ways with trees, squares, benches, etc. So, we name them green ways. And the width of green ways varies between 10 m and 30 m.

There are two types of intersections between green ways and car roads, an underground pedestrain way at intersections with the urban arterial roads and the intersection at grade for distribution roads and access roads which have small traffic volume.

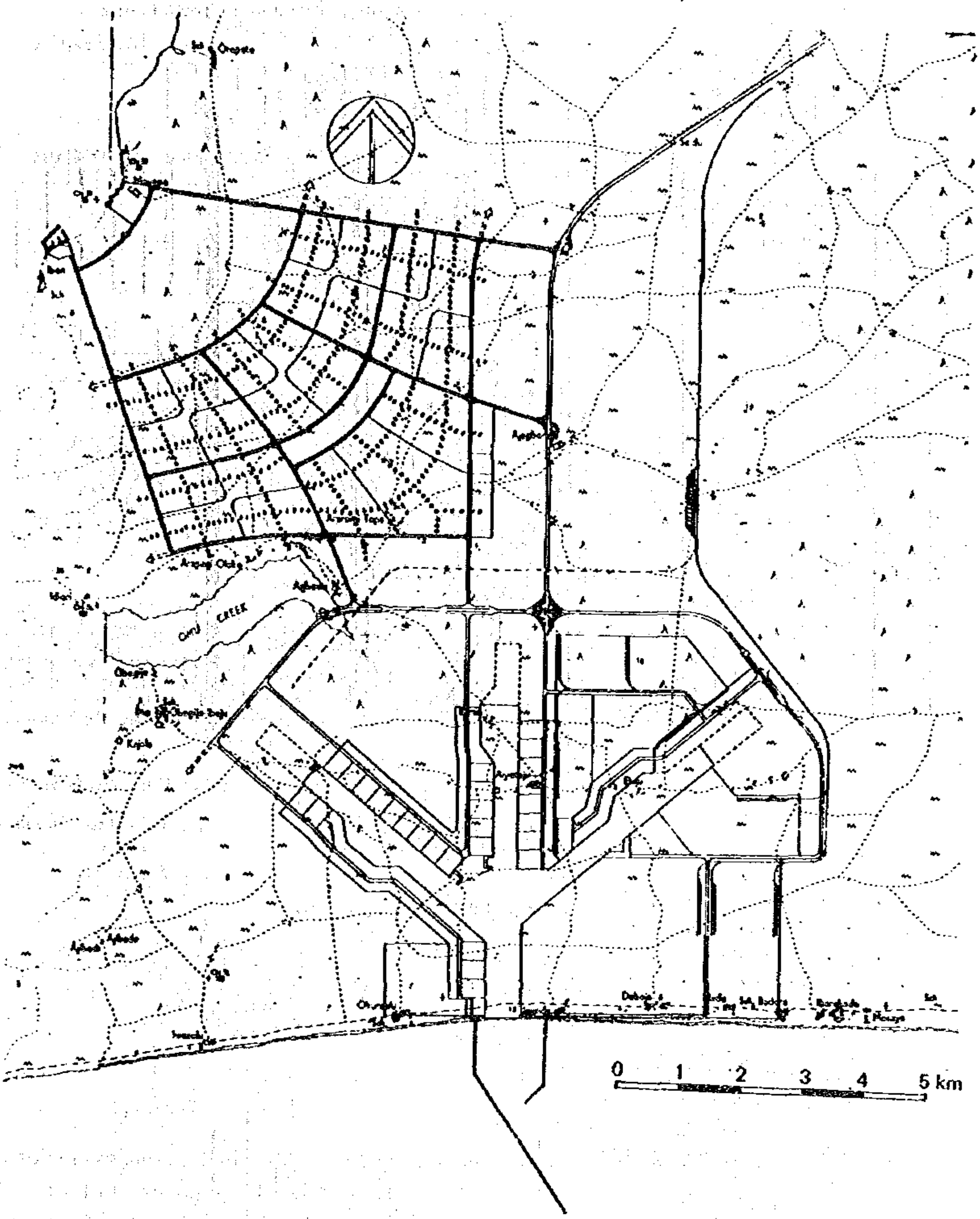
IV-3-3 District plan

A standard residential district is studied to form basic policies for a district plan, as shown in Fig. IX-7.

A standard residential district consists of a rectangle of approximately 800 m × 1 km (80 ha area), with approximately 8,000 population and 1,600 dwelling units.

To attain variation and order of space, a neighbourhood of about 50 dwelling units is set as the minimum unit of local community comprised with harmonious types of building and with a semi-public space, as shown in Fig. IX-8. In this way, each residential district is planned comprehensively as a combination of the neighbourhoods.

Fig. IX-6 Road Network of the New City



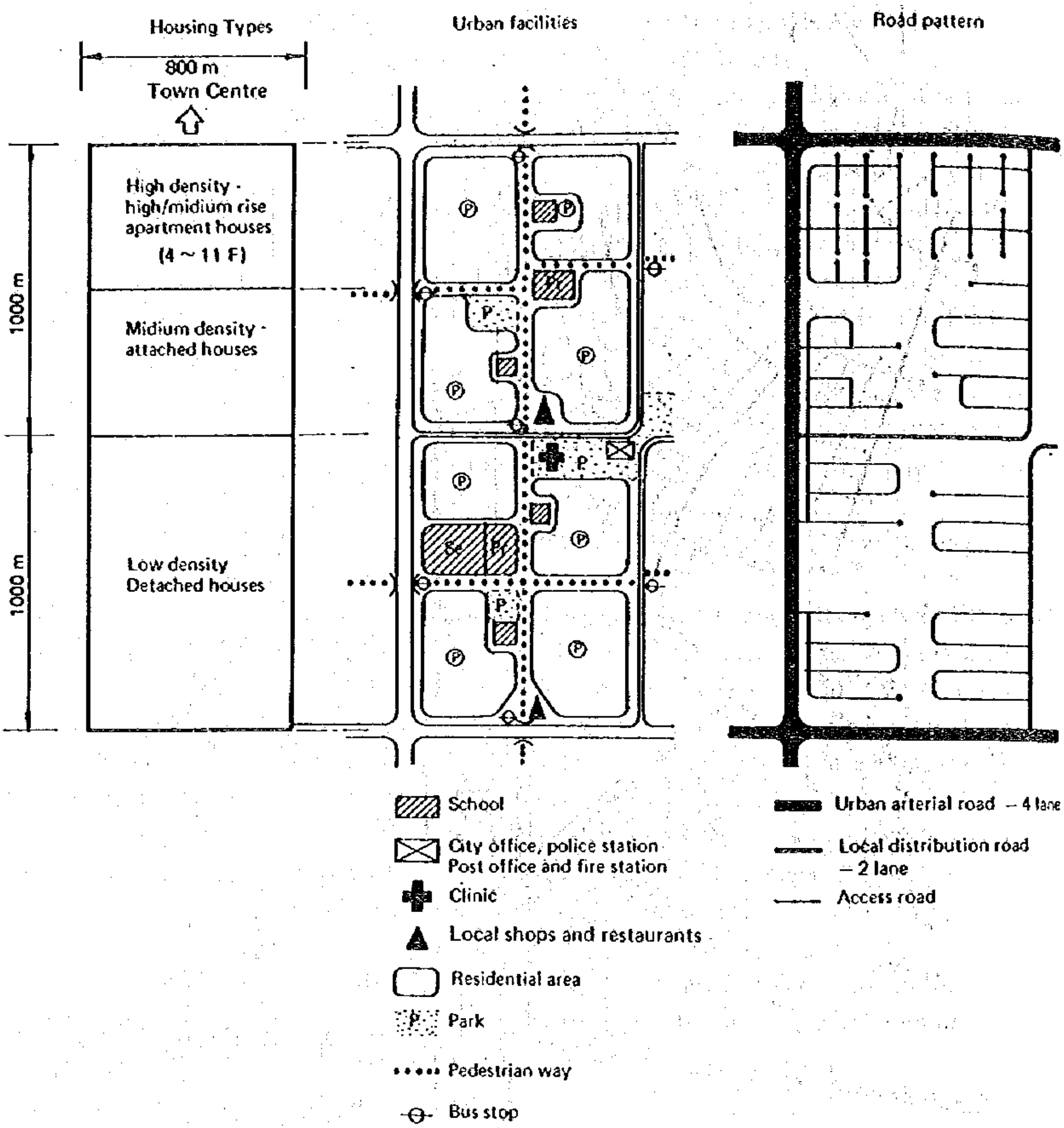
Urban arterial road – 4 lane

Lacal distribution road – 2 lane

Major pedestrian way width 10m – 30m

Fig. IX-7 A Model Plan of Residential District

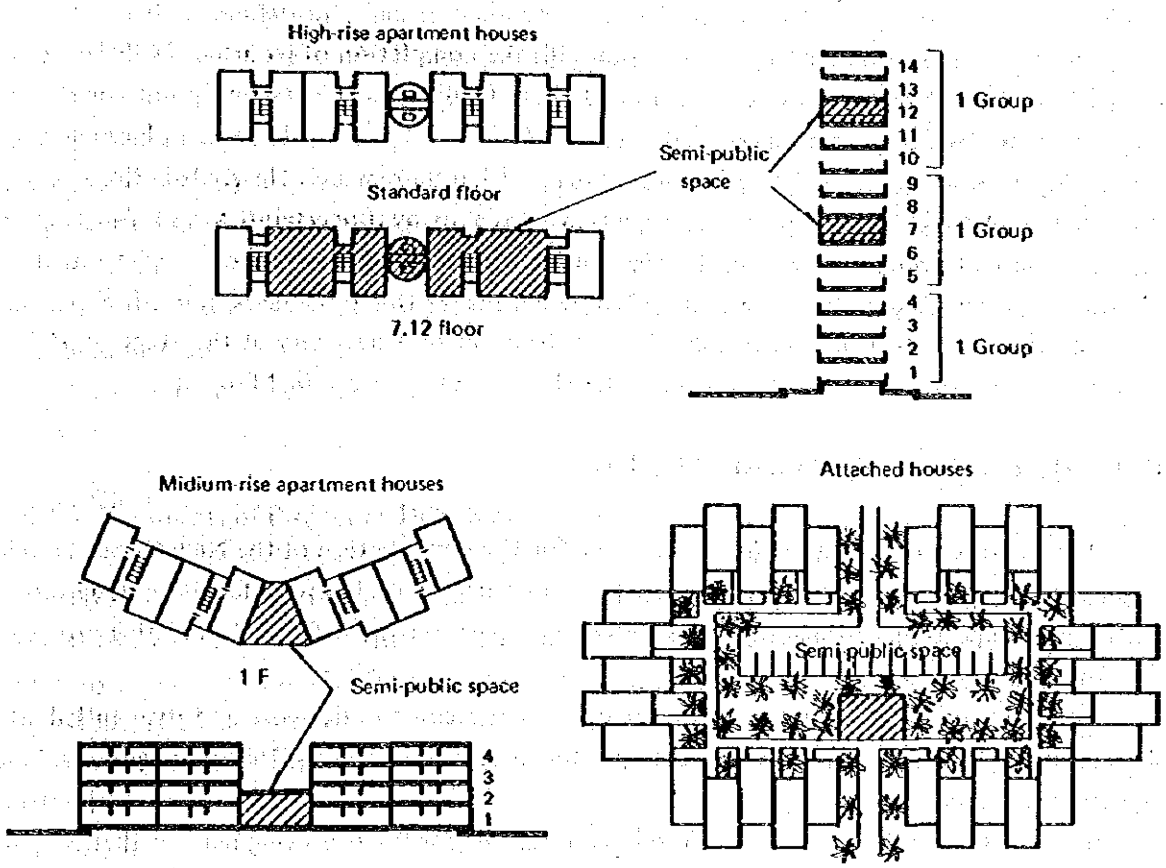
– Two residential districts adjacent to the Town Centre –

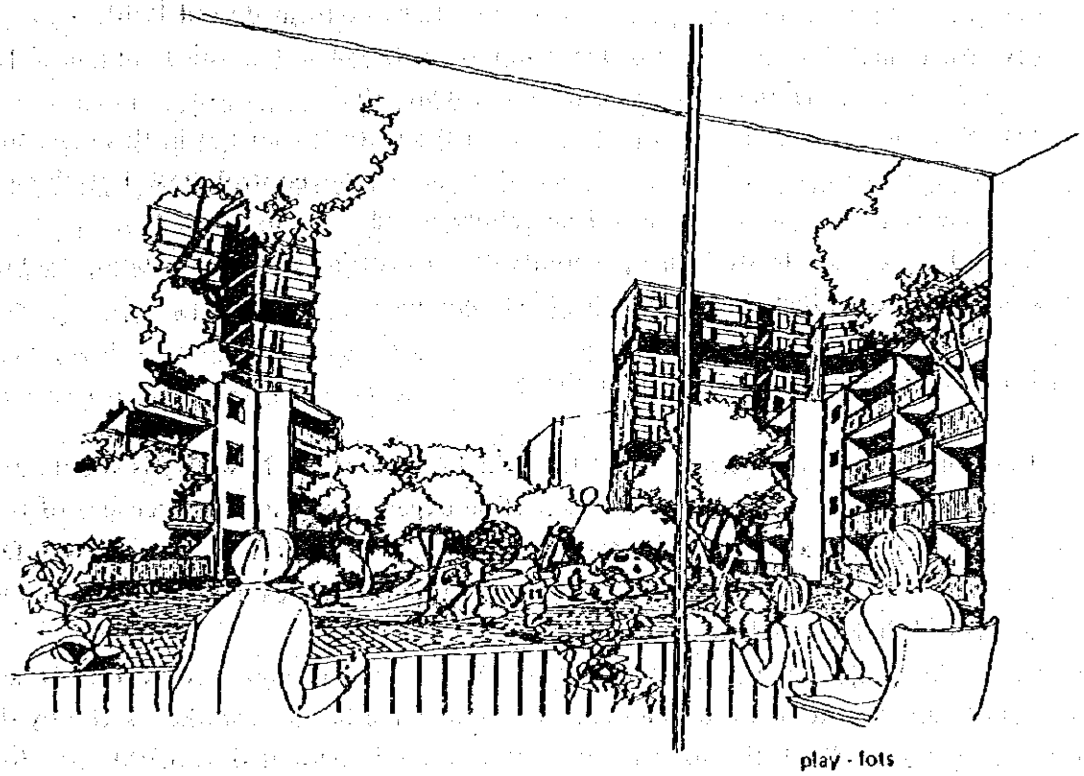


Those facilities indispensable for daily life, such as shops, are arranged along the major green ways. Since neighbourhoods are provided with sub-green ways, the residents can be free from traffic to enjoy their daily life. For instance, shops, schools and bus stops are provided within a 500 m area (8 minutes on foot), children's parks within a 250 m area (4 minutes), and clinics and police boxes within an 1 km area (15 minutes).

On the other hand, commuting outside of the residential districts can be promptly made by car from the doors of respective houses via the access roads and distribution roads. Parks and green ways are designed so that emergency car and garbage wagon can cross them to provide efficient services.

Fig. IX-8 Semi-public Spaces by Type of Housing





play - lots

IX-4 Phased Formation of the New City

The formation of a new city will not and with the completion of its urban facilities. Rather, it should be considered that the completion of these facilities is the starting point for the New City. Perhaps, this applies to port and harbour facilities as well. However, planning a city thoroughly is more difficult than planning a port and harbour, which clearly functions at goods distribution. A city has composite activities involving many uncertainties and functions for habitation. In planning a new city, therefore, trial and error in construction – assessment – is always necessary. A phased construction plan which makes this possible is, indeed, an essential element. Here, we shall discuss mainly the construction of a new city at the stage of 1990 to achieve conformity with the harbour plan under the New Ocean Terminal Project.

IX-4-1 Quarters Necessary at Construction Phase

The provision of urban facilities necessary for the construction of the New Ocean Terminal begins with quarters for those engaged in the construction of harbour facilities. Quarters are particularly important to this project which is to be performed far from the existing urban area and for a prolonged period.

Normally, quarters are temporarily set up near the construction site and dismantled when the construction is over. In large projects, quarters are often accompanied by restaurants, hotels and grocery stores.

In the case of this project, it is considered desirable for the following reasons that the camp should be located, for some time at least, within the proposed central control area.

(1) This area is close to the site of construction to be performed until 1990.

(2) When such infrastructures of the camp as roads and water works are completed they can be used as infrastructures of the control area itself.

(3) Restaurants etc. are usually closed when the work is over but in this case, they may operate permanently since they are located in the control area. For this purpose, however, the control area must be carefully zoned.

It will be necessary to study the possibility of constructing some of the permanent quarters in the new city though they do not meet the (2) requirement.

IX-4-2 Urban Facilities Necessary at 1990 Stage

The number of workers necessary at the initial period of the New City is about 2,000. The settlement of sufficient retail businesses cannot be expected at this stage because of the many uncertainties likely to exist then about the development of the city. Yet, the success or failure of the plan to construct a new city away from the existing urban area depends largely on whether the workers and their dependents will settle there or not.

Under this project, the population scale of the new city is conceived as follows: assuming that retail businesses are induced as a policy and that retail business workers settle by the same ratio as in the year 2000, the total number of workers is estimated at 3,300: 60% (or 2,000 persons) for the proposed industries and 40% (1,300 persons) for other industries of the service type, notably the tertiary industries.

As to the population scale, it is about 7,500 people if 0.45 is to be used as the ratio of the employed: 3300 ÷ 0.45 = 7500. The number of families is 1,500: 7500 people ÷ 5 people/family = 1500.

The population of 7,500 people corresponds to one of the previously discussed habitation divisions. Necessary urban facilities are as shown in Table IX-12. These include facilities, such as a junior high school, with a service area extending over two or more habitation divisions. They may not be adequately efficient but are indispensable to the life of inhabitants. The proposed site is the habitation division closer to the harbour area than any other habitation division of the proposed new city.

Further details of the above estimated values must be studied at the stage of feasibility study.

IX-4-3 Keypoints of Project at 1990 Stage

As stated already, trial and error in construction – assessment – is, indeed, necessary for the construction of a new city. In forming the project for the 1990 stage, the following must be carefully planned as a model for the construction of new cities.

(1) Housing construction

Cutting the cost of housing construction by adopting industrialized construction and other methods.

(2) Realization of community mix

The separation and mixing of housing groups by social strata according to incomes, occupations and other factors. (In the preceding chapter, 50 homes was proposed as the unit.)

(3) Formation of social service system

A system to efficiently arrange and operate schools, hospitals and cultural facilities.

(4) Advancement of regional development

Providing civic service to people living in the environs and improving the goods distributing system by methods including the opening of markets.

(5) Study of developing methods

Cooperating with the national and provincial authorities, the Development Corporation and research institutes and allocating roles (planning, construction and control). Developing methods for all stages from planning to control.

Table IX-12 Urban Facilities in the year 1990

Functions	Number of facilities (unit)
Public Service	
Administrative Sub-centre: branches of a city office, police & fire station and post office	1
Secondary school	1
Primary school	1
Nursery schools	4
Clinic	1
Commerce and Business	
Daily good's shops and restaurants	1
Open Space	
Neighborhood park	1
Play lots	4
Infrastructure	
Water supply	1000 t/day
Sewerage	1000 t/day
Electric power generating capacity	1500 KW
Telephone connections	1500 set

IX-5 Construction cost of the New City

The New City development plan presented here is just at the initial stage. And the plan should be understood as a sort of rough sketch. Based on this planning element, the construction costs covering all the undertakings required for the New City are temporarily estimated, though there remains a problem of accuracy. To see the funds required in the public and private sectors respectively, construction cost by type of undertaking, is roughly estimated. Basically, it is assumed for simple calculations that the public sector constructs all the infrastructures, open space & recreational facilities and buildings for public services, and that the private sector constructs all housing and buildings for commerce and business.

The result of estimate is shown in Table IX-12, with the total cost at approximately ₦1,500 million, and at about ₦700 million for public sector and ₦800 million for private sector.

In this estimate, the design standard and construction unit cost are supposed as follows: The design standard is considered as a future target for the Third National Development Plan and Lagos State Government. Unit costs are set by the construction costs in Nigeria and the budget in Recurrent and Capital Estimates of the Government of the Federal Republic of Nigeria 1978-79, and are complemented by recent experiences in various countries.

Table IX-13 Construction Cost for the New City

Unit: million ₦ 1978 current price

Public Sector	
Infrastructures *	410–600
Open Space & Recreational Facilities **	10–20
Architectures for Public Services ***	110–150
Public Sector Total	530–770
Private Sector	
Housing ****	430–620
Architectures for Commerce & Business	240–360
Private Sector Total	670–980
New City Total	1,200 – 1,750

Notes. * This item includes deforestation, roads, water & electric energy supply, sewerage and storm water drainage, but excluds cut/fill because of uncertainty of the topography.

** This item includes parks, open space, a golf field, a recreational port and an inland waterway terminal.

*** This item includes facilities for administration, education, health and social welfare.

**** Housing includes telephone connections.

X. Planning of arterial transportation facilities

X. Planning of Arterial Transportation Facilities

X-1 Present traffic situation in Nigeria

X-1-1 Commodity flow

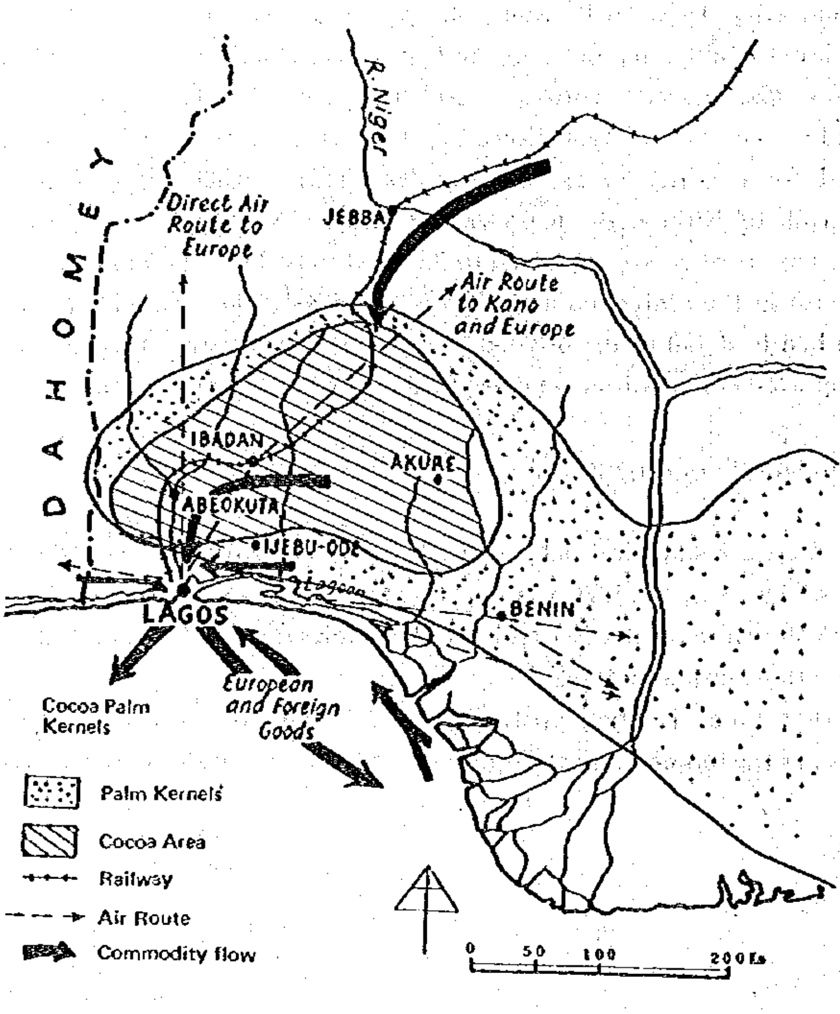
Commodity distribution around Lagos is represented by two flows consisting of south to north connecting Lagos with Kano and west to east connecting Lagos with Port Harcourt. Fig.X-1 shows commodity flows in the Lagos area. The Port of Lagos had been exporting mainly cash crops, viz. peanuts, cotton, cocoa, palm kernels, etc. produced in the north and the hinterland of the Port of Lagos. However, at present, the export of peanuts and raw cotton which accounted for majority of exports has decreased, and according to a monthly report of the Central Bank of Nigeria, the main export cash crops in 1977 were cocoa and palm kernels. In 1976, the export of cocoa amounted to 231,000 tons. These two main export items are produced in the south in the hinterland area shown in Fig.X-1. The commodity flows of imported goods are described in detail in the origin-destination study of Paragraph 6, Section 1, Chapter X. Most of the imported commodities are consumed in the Lagos metropolitan area.

X-1-2 Modal split of cargoes

Based on the statistical data of the Nigerian Ports Authority, imports and exports through the port of Lagos in 1975/76 were analyzed with reference to inland transport modes, and the results are shown in Tables X-1 and X-2. The tables show that about 95% of cargoes generated in 1976 were transported by truck.

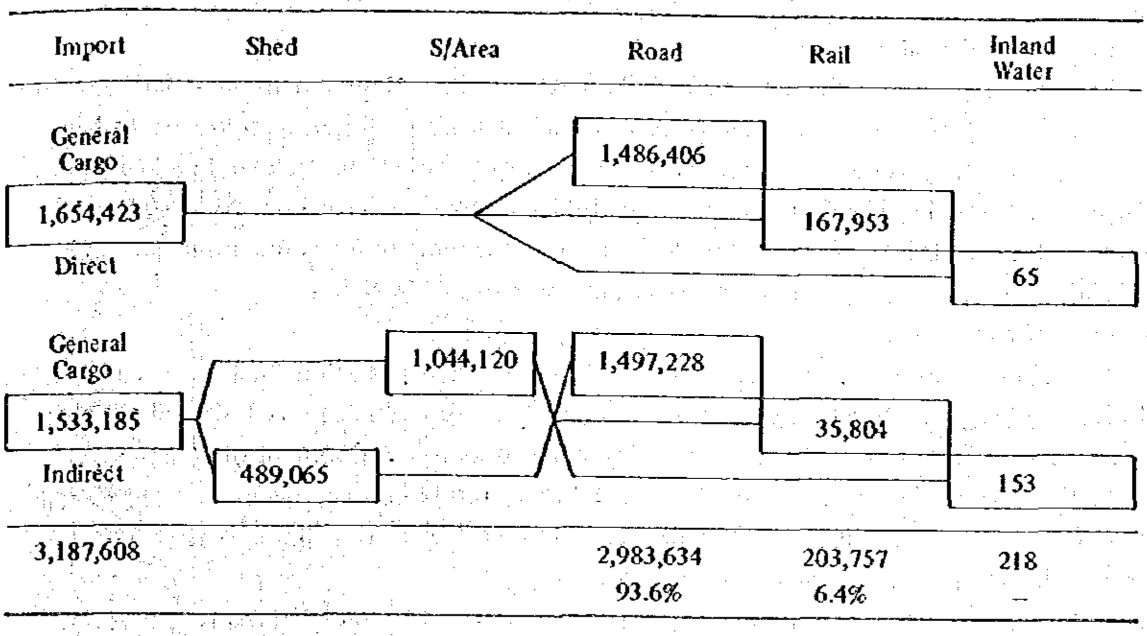
At that time, Tin Can port, planned without railway access, had not been completed. Therefore, at the moment, most cargoes generated by the port are transported by truck.

Fig. X-1 Main Commodity flow in Lagos Area.



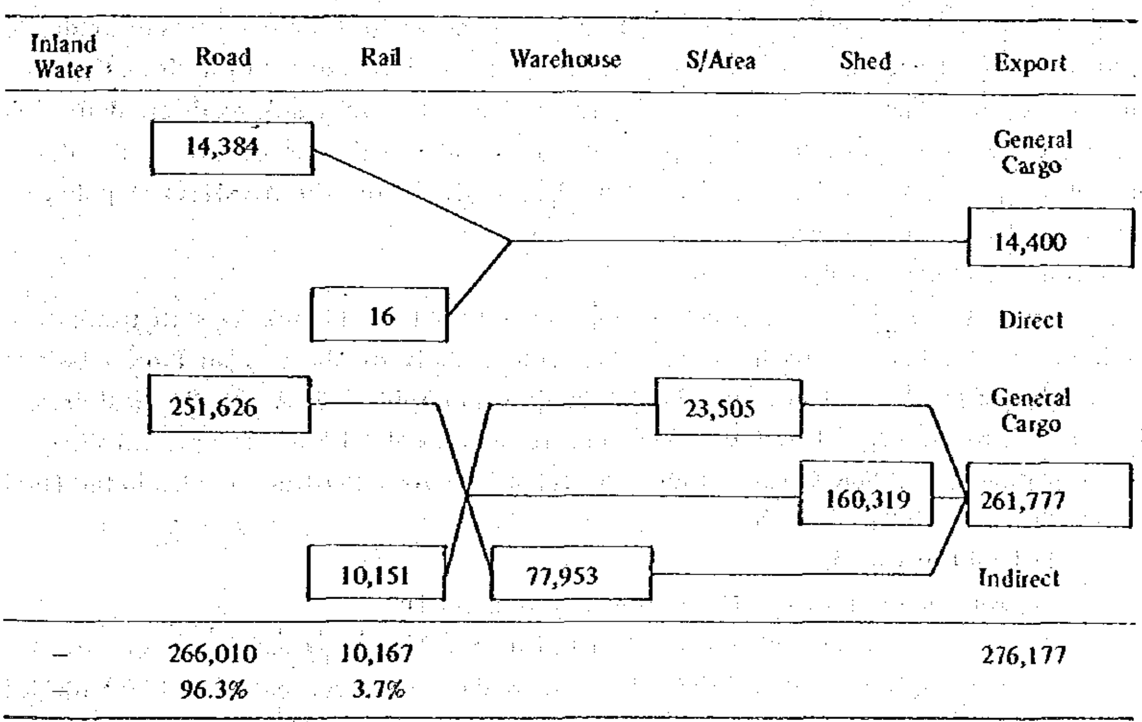
Source: International Development Centre, Japan

Table X-1 Import Tonnage Flow through the Port of Lagos Unit: ton



Source: Nigerian Ports Authority

Table X-2 Export Tonnage Flow through the Port of Lagos Unit: ton



Source: Nigerian Ports Authority

X-1-3 Present condition of roads

(1) International road network

In the conference of the Central and West African Port Mansgement Association, held in Dakar at the end of November 1978, NPA was requested by neighboring countries to have the Port of Lagos function as a transshipment base for cargoes destined to such land locked countries as Niger and Chad. Fig.X-2 shows a plan of the future international road network for the African continent. Most of the Trans-African Highway runs on the same route as the domestic trunk road A121, which is an important trunk road extending west to east in Nigeria.

(2) Domestic trunk roads

The Third Five-Year Plan stresses improvement on transportation facilities such as roads, railways and pipelines, because, there three modes of transport have played all will continue to play a very significant role in the social, political and economic development of Nigeria.

In the current Third Five-Year Plan, a total of N10.0 billion has been allocated as capital expenditure in the transport sector. Highways account for N7.05 billion that is 73% of the allocation for the transportation sector as a whole.

The road network of Nigeria comprises federal trunk roads and local roads. The former are constructed and maintained by the federal government and the latter, by state governments. In the Third Five-Year Plan, it is planned to establish 50 to 60 offices for road maintenance throughout the country, at a cost of N138.6 million.

The present road network consists of 27,000 km of federal roads and 26,000 km of state roads plus 41,000 km of local roads, a total length of 1,600 km of state roads was up-graded to federal trunk road standard in accordance with the recommendation of the Consulting Engineer, Kampsax. Federal trunk road network is shown in Fig. X-3. Federal trunk roads are defined as the roads connecting main domestic ports, main cities and neighboring countries. The design manual developed by the Federal Ministry of Works is derived from the AASHTO 'A policy on geometric design of rural highways'.

(3) Regional road network of Lagos state

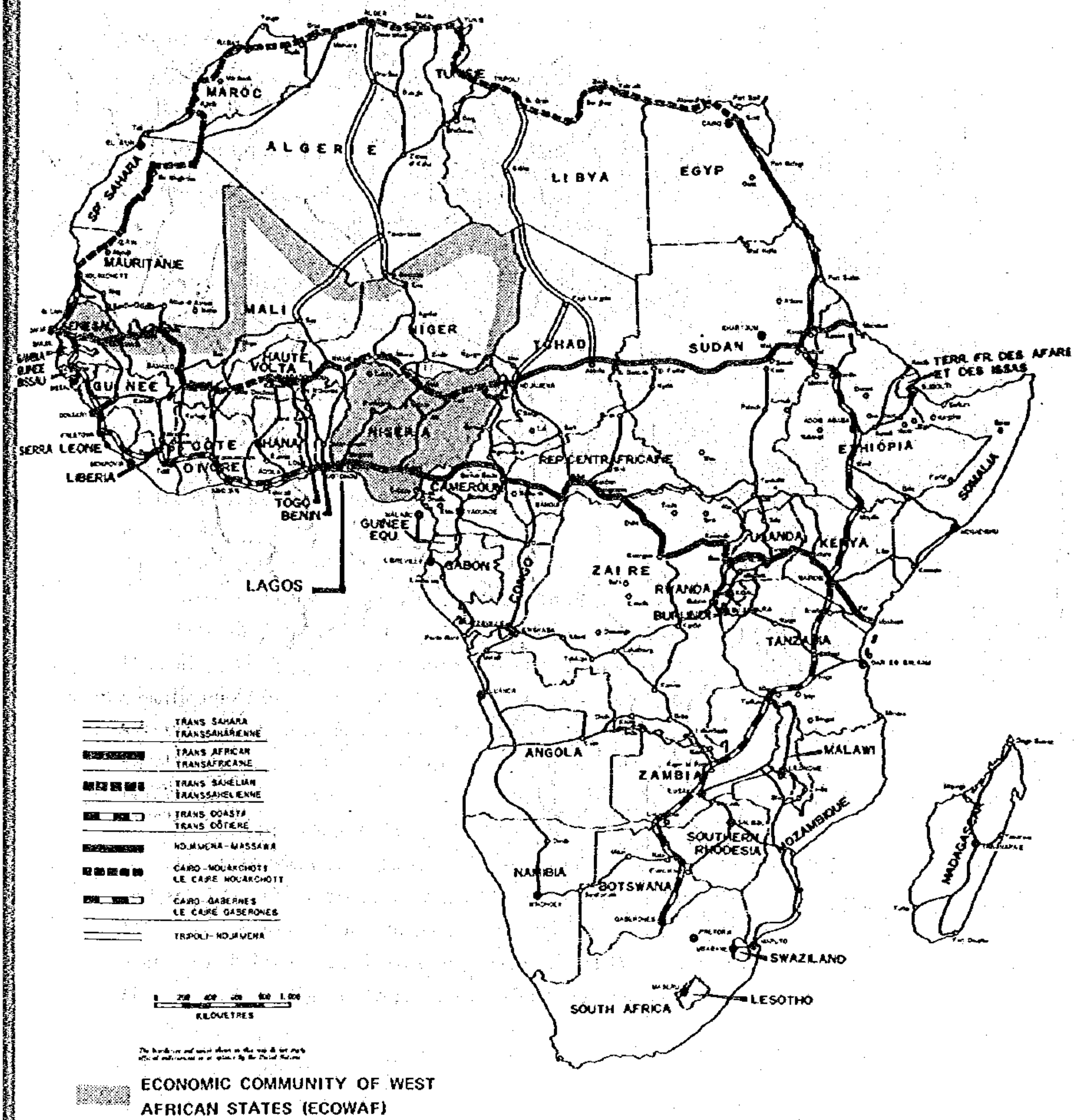
The road network of Lagos state consists of federal trunk roads (Trunk A), state trunk roads (Trunk B), and local roads. According to the inventory study of Master Plan Project Unit of Lagos State, the lengths and rates in 1975 are as shown in Table X-3. As for the road density including local roads, a road length of 1 km can serve an area of 4.1 km². The present situation of roads relating to the New Ocean Terminal Project and the road construction plan in the Third Five-Year Plan are as follows:

1) Federal trunk roads

Lagos-Ibadan Expressway (south to north trunk road):

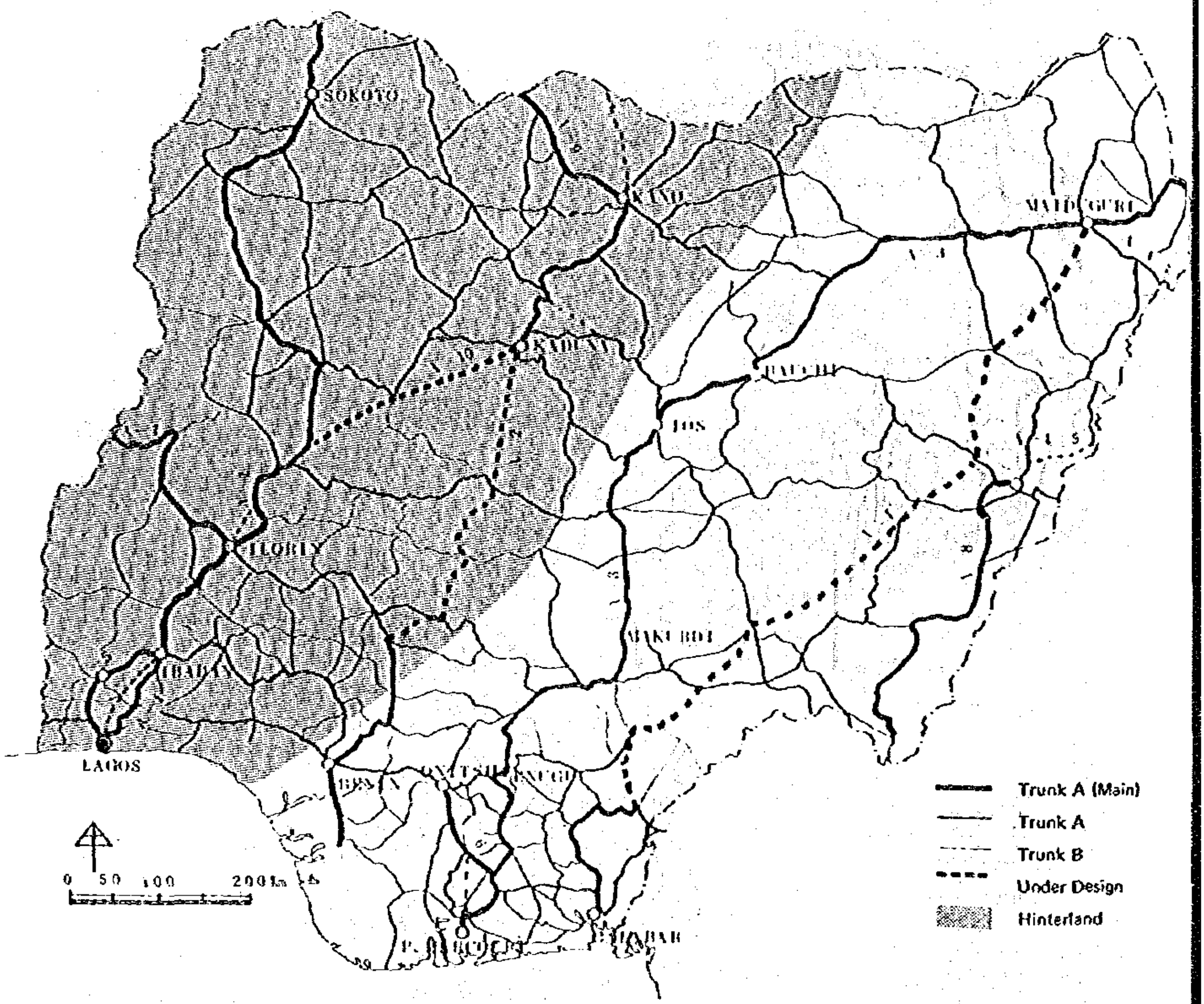
This road was constructed as the first toll road in Nigeria. It has a length of 106 km and has been operating since 1978. This road is the full access-controled 4-lane divided highway, and has been designed for a speed of 110 km per hour. At present, there is a total of 25 structures along the right of way and they are constructed with sufficient allowance for future expansion into a 6-lane highway. Initially in April, 1974, the construction cost was estimated at N81 million, but since subsoil conditions over a part of route were bad, the construction method was changed from embankment to concrete slabs plus embankment,

Fig. X-2 International Road Network



Source: Economic Commission for Africa

Fig. X-3 Trunk Road Network in the Year 1977.



Source: International Development Centre, Japan

Table X-3 Lagos State: Length of Regional Road Network

	Length (kms)	% of Total
Trunk A	140	16
Trunk B	130	15
Feader (approx.)	600	69
Total	870	100

Source: Regional Plan for Lagos State, Vol. 1 Existing Conditions, Table 2.81

increasing the cost to N170 million.

Shagamu-Benin road: (A121), east to west trunk road:

This road is a section of federal trunk road A121 with a total length of 261 km, and is being constructed as a 4-lane divided highway. As mentioned before, this road forms a part of the West-East Trans-African Highway, running from Lagos to Mombasa. Construction cost was about N96 million.

2) State trunk roads

Itokin-Ijebu Ode road: (F204), south to north trunk road:

This road is an undivided 2-lane highway with a length of 26 km improved in December, 1976. The road functions as a south to north link in this area.

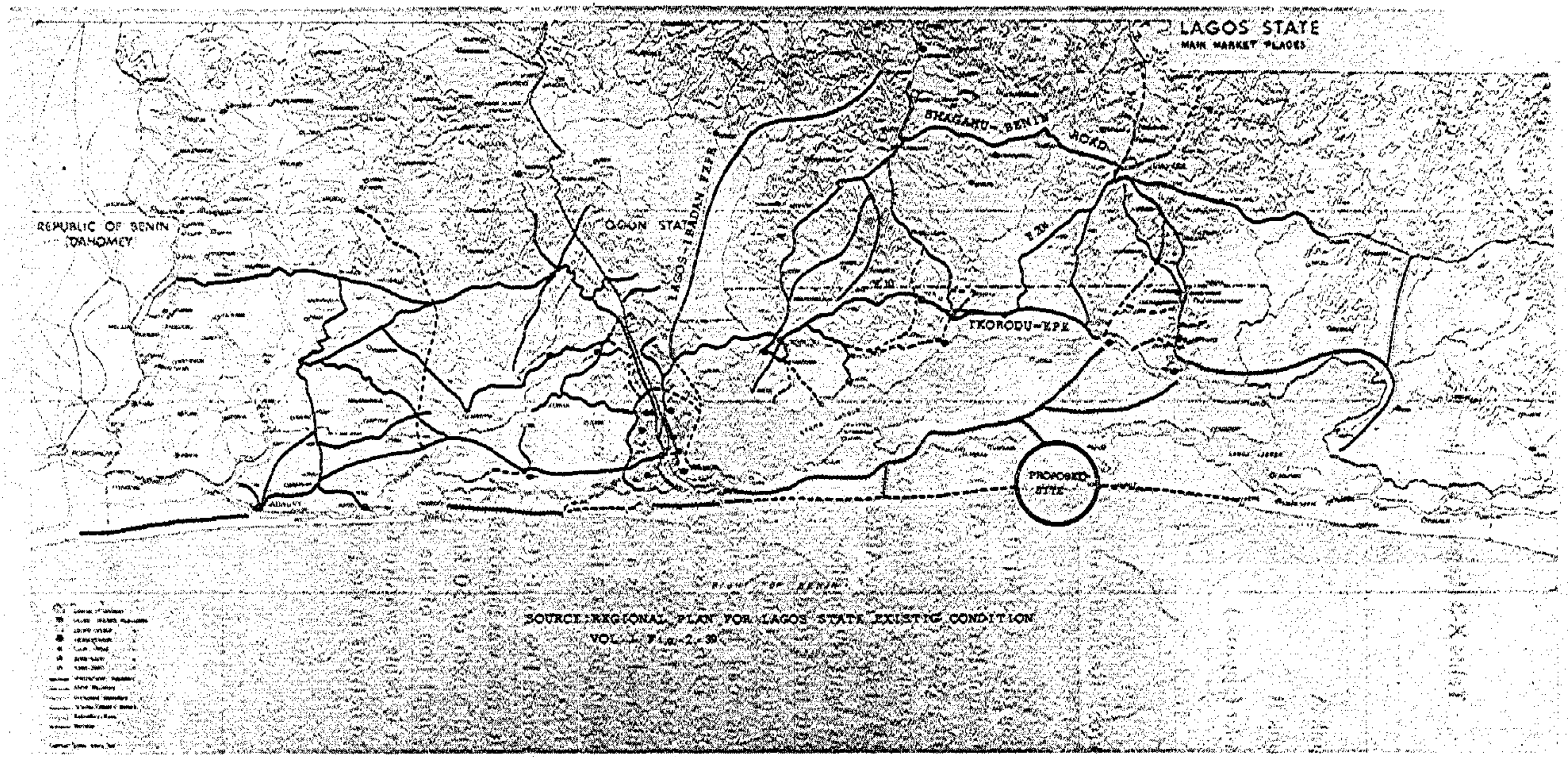
Ijeb Ode-Idi Ayvnye road: (F204), south to north trunk road

This road, too, is a section of the state trunk road F204 connecting the project area with Ibadan, and has a length of about 51 km. This section, too, is scheduled to be overlaid before long.

Ikorodu-Epe road: (F101), east to west trunk road.

This road was improved recently to an undevided 2-lane highway with a width of 7.6 m and total length of 50 km. This trunk road extends from east to west in State of Lagos. After completion of the improvement, the travel time for this section was halved. A contract is being awarded for construction of F101-1 planned as an extension of this road. The road network in the project area is shown in Fig. X-4.

Fig. X-4 Existing Road Network in Lagos State



3) Present traffic volume

Highway Department of theFederal Ministry of Works started traffic counts in 1978 on main trunk roads. However, up to December, 1978, the results of the survey were not produced in a report form. Therefore, the hourly traffic volumes and compositions of vehicle types observed by the study team are shown in Tables X-4 and X-5. As shown in Table X-5, the percentage of heavy vehicles on the Lagos-Ikorodu road is very high at 45%, and the traffic volume in terms of equivalent passenger car units is 1,600 vehicles/hour already reaching the capacity of the road. As mentioned before, the Lagos-Ibadan expressway is the first toll road in Nigeria. It has been observed that the expected diversion from the Lagos-Ikorodu road did not occur because there is a feeling of resistance against the toll charge. The traffic volume on the Ikorodu-Epe road in terms of equivalent passenger car units is about 450 vehicles/hour, and there seems to be sufficient allowance in the capacity as long as there is no large-scale development along the right of way. Therefore, it is surmised that it will function adequately as an access road between Lagos and the project site at the time of construction of the new port, and also for construction access. Fig. X-5 shows the traffic volumes counted by Kampsax in 1965.

Table X-4 Hourly Traffic Volume on Existing Road in December 1978

Unit: Vehicle

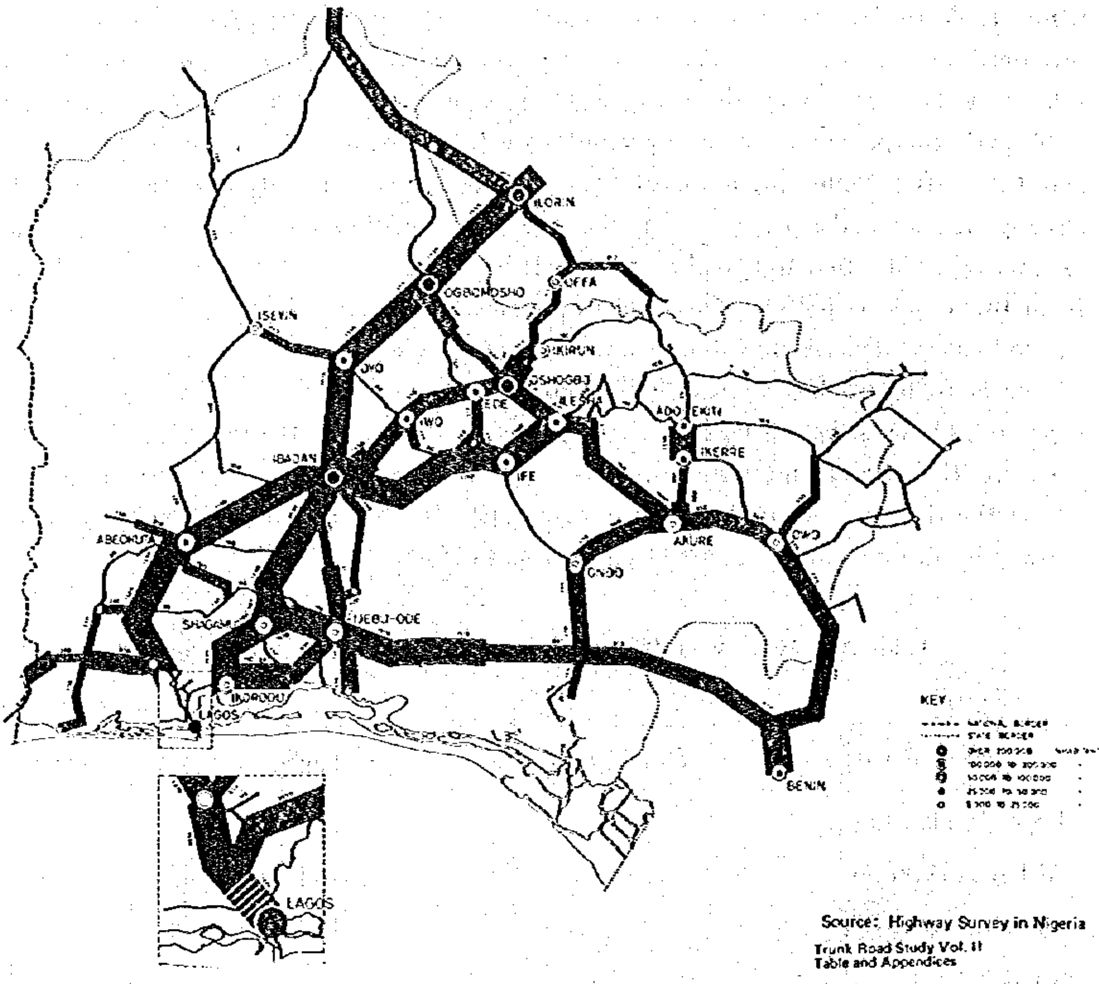
Name of Road	from Lagos	to Lagos	Total
Lagos Ibadan Expr.	160	312	472
A1 Lagos-Ikorodu	396	464	860
F101 Ikorodu-Epe	128	132	250
A121 Ijebu Ode-Ore	–	–	1,273

Table X-5 Vehicle Composition

Unit: %

Name of Road / Type of Vehicle	Lagos-Ibadan Expr.	Lagos-Ikorodu	Ikorodu-Epe
1 Car Taxi	55.1	28.4	36.8
2 Jeep	5.1	0.9	1.6
3 Van & Pickup	27.1	24.7	17.6
4 Medium Truck	–	24.2	25.6
5 Heavy Truck	0.8	3.7	1.6
6 Trailer	3.4	7.9	3.2
7 Bus	8.5	9.3	12.8
8 Motor Cycle	–	0.9	0.8
Total	100.0	100.0	100.0

Fig. X-5 Average Daily Traffic Volume in the Year 1965.



(4) Number of registered vehicles

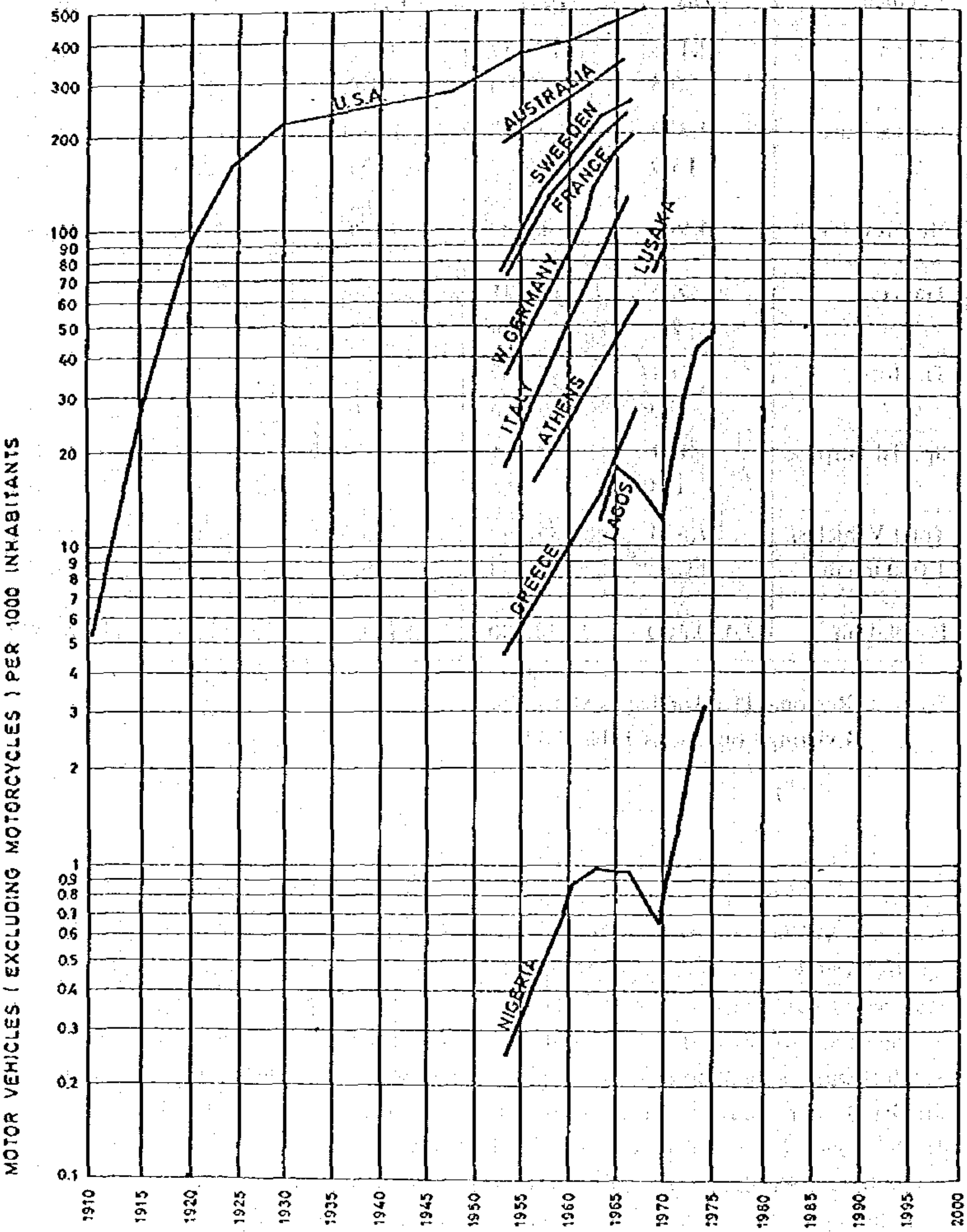
According to a publication, "General conditions of Nigeria" issued by the Nigerian Government, the registration and licencing of motor vehicles are described as follows. "All motor vehicles used in Nigeria must be registered. Motor vehicles are also required to be licenced annually at any of the motor licencing authorities in the 19 states. It is an offence to operate an unlicenced vehicle in the country." However, the national statistics of Nigeria, provide data only up to 1974, and the present correct number of registered vehicles is unknown. Furthermore, obtainable statistical figures for newly registered vehicles in the year 1974 cover only the 6 southern states, and no statistical data are available for the northern states. Up to the present, many reports have been submitted to the Nigerian Government, and the vehicle population was variously estimated in the different reports. Therefore, the vehicle population in Lagos State and those of the entire nation estimated by the Master Plan Project Unit of Lagos State Ministry of Works were used and are shown in Table X-6 and Fig. X-6. By the year 2000, the ownership level of passenger cars is estimated to be 160 vehicles/1,000 persons, and commercial vehicles taken is 18% of the number of passenger cars.

Table X-6 Number of Vehicles in Lagos State

Type of Vehicle	YEARS				
	1970	1971	1972	1973	1974
Saloon	22,153	27,557	39,021	52,699	64,618
%	80.5	72.6	69.9	70.5	69.8
Lorries Buses	4,373	8,842	14,436	19,267	24,784
%	15.9	23.3	25.9	25.8	26.8
Motorcycles	4,902	8,222	13,769	20,387	26,081
Trailers	735	1,131	1,687	2,026	2,303
%	2.7	3.0	3.0	2.7	2.5
Tractors	161	207	319	366	411
%	0.6	0.5	0.6	0.5	0.4
Special Purpose	101	211	340	409	448
%	0.4	0.6	0.6	0.6	0.5
Total Vehicles/ 1,000 inhab.	27,524 11.32	37,948 14.43	55,803 19.65	74,787 24.44	92,564 28.13
Population	2,430,600	2,630,000	2,840,000	3,060,000	3,290,000

Source: Regional Plan for Lagos State, Vol. 1
Existing Conditions Table 2.82

Fig. X-6 Car Ownership in Nigeria, Lagos and Selected Countries.



Source: Regional Plan for Lagos State Vol. 1 Existing Conditions Fig. 2.37.

Regarding the number of passenger cars produced in Nigeria, the Peugeot factory in Kaduna produces, reportedly, 100 vehicles monthly, and the Volkswagen factory in Lagos, 180 vehicles, to make the total production in Nigeria 280 vehicles now. As for heavy trucks, Layland started production in Ibadan; and Fiat in Kano, Mercedes Benz in Enugu and Steyr in Bauchi are respectively constructing motor vehicle factories. The numbers of vehicles imported in 1974 and 1975 are shown in Table X-7.

Table X-7 Number of Imported Vehicles

Year	Saloon Car	Truck and Bus	Total
1974	44,842	19,294	64,136
1975	59,277	47,755	107,052

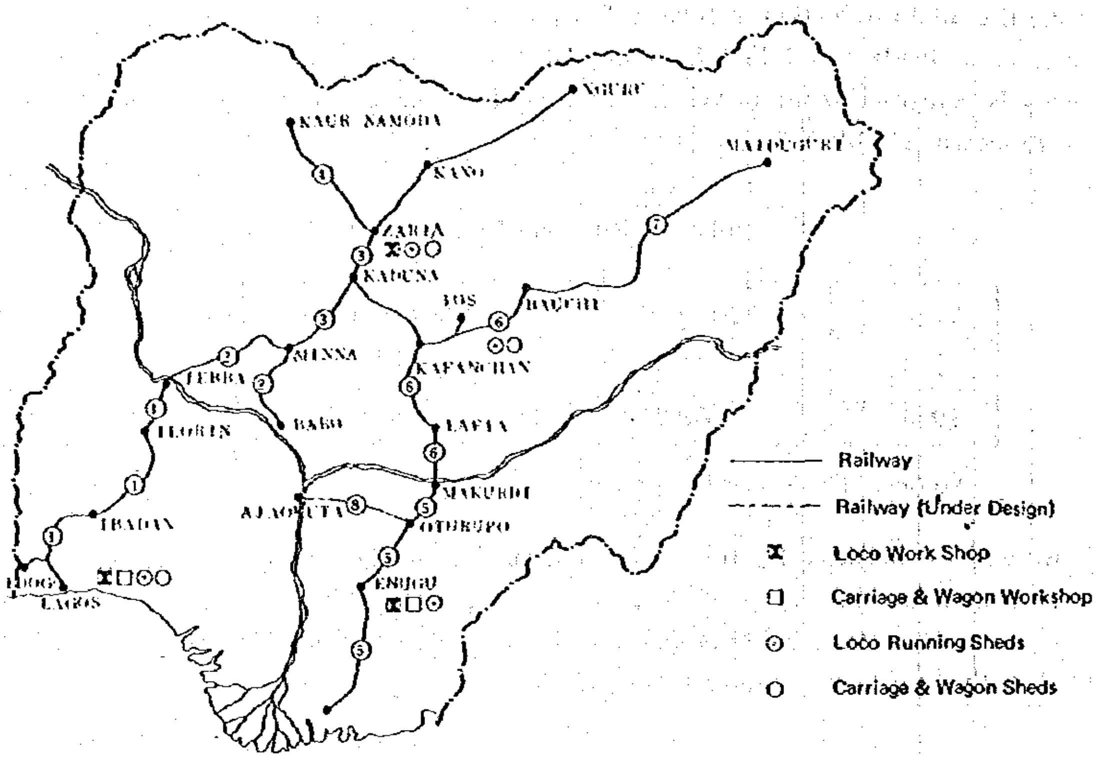
Source: The Motor Industry of Japan

By way of incentive for the above-mentioned assembly plants, the Nigerian Government decided to prohibit the import of passenger cars exceeding 2,500cc and to restrict the import of passenger cars of capacity 2,500 cc and less by means of import licencing. However, according to Table X-6, the vehicle ownership rate is increasing rapidly.

X-1-4 Present condition of railways

The present line network is 3,505 km, and all the lines consist of single track of 3'–6" gauge (1,067 mm). The railway network is composed of two south to north trunk lines connecting the Port of Lagos and Port Harcourt with the interior. The railway network and main facilities are shown in Fig. X-7. Nigerian Railways used to be operated as a department of the Government. Since 1955 it has been organized as a public corporation. However, policies and fares are decided by the federal government. Since 1955, thanks to agricultural exports such as peanuts, raw cotton and cocoa which were supported by favorable agricultural development and also to leather, the railway freight and passenger traffic kept increasing until 1963/64. However, since 1965, droughts occurred continuously in the north, and the export of agricultural products, particularly peanuts which accounted for most of the export cash crops, decreased suddenly. About the same time, the development of petroleum started along the coastal area in and around the Rivers state, and partly because of this, the drive for agricultural development was weakened. While export cargoes decreased, import cargoes began to increase due to the economic development supported by petroleum. The railways, which should be advantageous for the transport of bulk freight operated at the low speeds of 15 to 35 km/hour due to poor geometrical design standards. Furthermore, since the emphasis of national development policies was placed on the improvement of roads, comfortable long-distance buses and trucks made their appearance and led to diversion of traffic from railway to road. At present, the railway travel time of 32 hours between Lagos and Kano is very slow compared to 14 hours by vehicles. Table X-8 shows the change in railway traffic volume.

Fig. X-7 Railway Network



Source: International Development Centre, Japan

Table X-8 Line Capacity and Utilization of Existing Railway

Section	Present Capacity (train)	Utilisation	
		train	%
Lagos-Ifaw	25	16	64
Ifaw-Ibadan	12	8	67
Ibadan-Offa	14.4	6	42
Offa-Mokwa	11.6	6	52
Mokwa-Minna	11.9	6	50
Minna-Kaduna	12.0	6	50
Kaduna-Zaria	16.0	6	38
Zaria-Kano	14.0	6	43
Kano-Nguru	8.8	2.5	28

Source: A Techno-Economic Feasibility Study for Standard Gauge Preliminary Report Annexure 5.2.4

The Biafra war which started in 1967 caused considerable damage to railway facilities, and made the operation of the East line connecting Port Harcourt with the interior practically impossible.

During this period, large quantities of locomotives, wagons and passenger coaches were destroyed, and about 6,000 employees left the Railway Corporation. After the war ended in 1970, the railways were rehabilitated, but many sections remain below the previous operating levels due to the obsolescence of cars and facilities, insufficient line capacity and scarcity of skilled labour, etc.

About half of the 201 diesel locomotives of the Nigerian Railway Corporation are now not properly maintained. The proportion of diesel locomotives has been increasing since 1973, because the operating cost of diesel locomotives is about half that of steam locomotives. Several trains are operated daily on the main lines but due to the defective state of signalling and communication facilities in addition to the above-mentioned reasons, the trains have not been able to operate on schedule. Table X-9 shows the line capacities and utilization rates of the Lagos-Nguru line.

Table X-9 Trends in Goods and Passengers Traffic, 1954 to 1976

Years	Goods Traffic			Passenger Traffic		
	Tonnage (000)	Ton-Km (million)	Average Distance (Km)	Passenger (000)	Passenger-Km (millions)	Average Distance (Km)
1954–55	2,602	1,726	663	5,451	558	102
1959–60	2,803	2,000	714	7,881	573	73
1961–62	3,003	2,259	752	11,061	770	70
1967–68	1,868	1,578	845	6,916	395	57
1969–70	1,553	1,520	979	8,370	725	87
1970–71	1,604	1,571	979	8,942	978	109
1971–72	1,406	1,200	853	6,151	955	155
1972–73	1,670	1,358	813	5,819	1,024	176
1973–74	2,129	1,533	720	4,670	808	173
1974–75	1,098	n.a.	–	n.a.	771	–
1975–76	1,198	n.a.	–	5,988	1,032	–

Source: Third National Development Plan 1975–'80

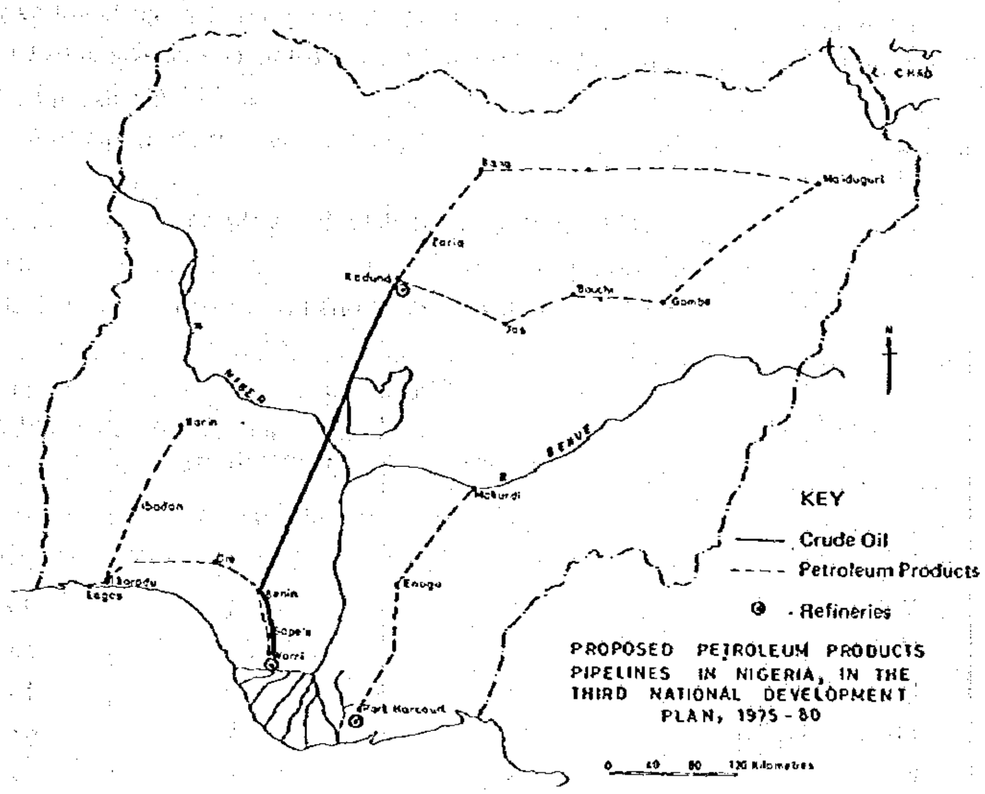
X-1-5 Pipelines

The volume of petroleum products transported from main port to the interior by road and rail in 1975 amounted to 2.9 million tons, of which 2.3 million tons were carried through the Port of Lagos. There are two oil refineries operating in Nigeria, one is the Port Harcourt refinery with a capacity of 60,000 barrels/day and the other is the Warri refinery with a capacity of 100,000 barrels/day. At the moment, the Warri refinery is reportedly operating at 60 percent capacity. In addition, a refinery with a capacity of 70,000 barrels/day is now being constructed in Kaduna, to be completed in 1981 and a further refinery for export of 300,000 barrels/day is planned.

Under the Third Five-Year Plan, in addition to the construction of these refineries pipelines are being constructed: the Warri-Benin-Ore-Ikorodu and the Lagos-Ikorodu-Ilorin line. These pipelines will transport petroleum products from the refineries in Warri to the interior, and a further pipeline known as the Warri-Benin-Kaduna line is planned initially to transport petroleum products from the Warri refinery and later to transport crude oil from Warri after completion of the Kaduna refinery.

Fig. X-8 shows the pipeline network. After completion of this network, most of the refined oil transported by road and rail will be diverted to the pipelines.

Fig. X-8 Pipeline Network



Source: A Geography of Nigerian Development Fig. 20.3.

X-1-6 Traffic survey in Lagos port

A traffic survey has not so far been made for the Port of Lagos. Therefore, the study team carried out an origin-destination survey by means of direct interview at the entrance of both Tin Can Island port and Apapa Wharf to find out the present traffic volumes, origin of incoming cargoes and destination of outgoing cargoes transported by truck. Since it was said that the traffic volume in the Port of Lagos was generally at its height on Mondays and Fridays, the survey was conducted on December 8, 1978, Friday for Tin Can Island port, and on December 11, 1978, Monday for Apapa Wharf. The survey covered five hours from 10:00 a.m. to 3:00 p.m. It is said that the traffic volume during this time zone was small, but this is no more than a guess from the length of the queue of motor vehicles. According to the survey results conducted by the study team, the number of vehicles passing the gate per hour depends on by the inspection capacity per hour of the customs at each gate and variations at different times of day were not observed.

(1) Generated traffic volume

Table X-10 shows average hourly generated traffic volumes by port. According to the results of the survey, the related vehicles other than commercial vehicles accounted for 81% for Tin Can Island port and 82% for Apapa Wharf – these are high values. Almost all the traffic was for business. The reason is surmised to be that business communication is conducted directly by use of vehicles or motor cycles because of poor telephone facilities. During the survey, the same vehicles and motor cycles were observed several times. The present cargo handling capacity per month of both the ports amount to about 500,000 tons in total. This corresponds to about 1,400 tons of cargo per hour. In other words, in the port of Lagos, 234 trucks and 1,126 related vehicles and motor cycles on business are generated per 1,000 tons of cargoes.

Table X-10 Generated Traffic Volume

a) Traffic count (Average hourly traffic volume).

i) Tin Can Island Port, 8th Decembre 1978 (10:00–15:00)

Type of Vehicle	Direction		Total
	in (absorption)	out (generation)	
Car, Taxi	118	125	243
Jeep	9	8	17
Van & Pickup	45	54	99
Medium Truck	29	24	53
Heavy Truck	3	10	13
Truck – Trailer	43	25	68
Bus	1	1	2
Motorcycle	127	109	236
Others	3	3	6
Total	378 Veh/hr.	359 Veh/hr.	737 Veh/hr.

ii) Apapa Quay, 11th December, 1978 (10:00--15:00)

Type of Vehicle	Direction		Total
	in (absorption)	out (generation)	
Car, Taxi	202	224	426
Jeep	17	17	34
Van & Pickup	56	56	112
Medium Truck	36	60	96
Heavy Truck	18	2	20
Truck – Trailer	23	37	60
Container Truck	10	8	18
Bus	1	1	2
Motor Cycle	208	195	403
Others	14	6	20
Total	585 Veh/hr.	606 Veh/hr.	1,191 Veh/hr.

Source: Study Team Survey

(2) Origin-destination survey

To ascertain the distribution of cargoes between the Port of Lagos and the interior, drivers of 573 trucks were interviewed directly at the entrances of both ports. The survey items were as follows:

Origin & destination
Kind of commodity carried
Tonnage carried

Table X-11 shows the results of the origin-destination study. Destinations by commodity of 332 trucks which transported main import items are shown in Table X-12.

In both tables, the percentage of trucks working in the Lagos area as the origin and destination amounted to about 85%, and almost all imported cargoes were transported to the Lagos area. The rate of loaded trucks was 87% for Tin Can Island port and 70% for Apapa Wharf, and the average loaded tonnage was 14.6 tons. The low loading rate of outgoing trucks of Apapa was due to the fact that cocoa was transported to the quay from the interior. According to the origin-destination survey for passengers conducted at the entrance to Tin Can Island port, 99% of passenger cars came from the Lagos area. The occupancy rate for passenger cars was found to be 1.96 passenger/vehicle.

Table X-11 Result of O-D Interview

Origin & Destination	Tin Can		Apapa	
	No. of Interview	Percent (%)	No. of Interview	Percent (%)
1. Lagos – Lagos	174	58.0	198	72.5
2. Lagos – Ikeja	24	8.0	30	11.0
3. Lagos – Badagry	49	16.4	7	2.6
4. Lagos – Ikorodu				
5. Lagos – Epe				
6. Lagos – Ogun			9	3.3
7. Lagos – Oyo	1	0.3		
8. Lagos – Kwara				
9. Lagos – Ondo				
10. Lagos – Bendel	3	1.0		
11. Lagos – Niger	1	0.3	1	0.3
12. Lagos – Sokoto	5	1.7	4	1.5
13. Lagos – Kaduna	17	5.7	3	1.1
14. Lagos – Kano	14	4.7	8	2.9
15. Lagos – Federal Capital Area				
16. Lagos – Borno	4	1.3		
17. Lagos – Bauchi	1	0.3		
18. Lagos – Plateau	2	0.7	3	1.1
19. Lagos – Gongola				
20. Lagos – Benue				
21. Lagos – Anambra	3	1.0	7	2.6
22. Lagos – Imo	1	0.3	3	1.1
23. Lagos – Cross River	1	0.3		
24. Lagos – Rivers				
Total	300	100.0	273	100.0

Table X-12 Distribution of Commodities from the Port of Lagos by Commodity Type

Unit: No. of truck interviewed

From Port to \ Commodity Type	1 Rice	2 Fuel	3 Iron Mate.	4 Chemi-cal	5 Milk	6 Sugar & Salt	7 Fish	8 Glasses	9 Const. Equip.	10 Parts	11 Malt	12 Cotton	13 Tomato	14 Con-tainer	15 Others	Total	Percent (%)
1. Lagos	32	25	7	14	14	3	12	9		11	6	1	8	4	39	185	55.7
2. Ikeja	14	6	11	11	1										4	47	14.2
3. Badagry	24	1	10		2			3		1		4			7	52	15.7
4. Ikorodu																	
5. Epe																	
Lagos Total	70	32	28	25	17	3	12	12	-	12	6	5	8	4	50	284	85.6
6. Ogun		1							4		3					8	2.4
7. Oyo																	
8. Kwara																	
9. Ondo																	
10. Bendel	1															1	0.3
11. Niger	1	1														2	0.6
12. Sokoto	1					4										5	1.5
13. Kaduna									7			3			1	11	3.3
14. Kano	1					5									1	7	2.1
15. Federal Capital Area																	
16. Borno																	
17. Bauchi																	
18. Plateau					1	2			1							4	1.2
19. Gongola																	
20 Benue																	
21. Anambra	4				2										1	7	2.1
22. Imo	1				2											3	0.9
23. Cross River																	
24. Rivers																	
Other Area Total	9	2	-	-	5	11	-	-	12	-	3	3	-	-	3	48	14.4
G. Total	79	34	28	25	22	14	12	12	12	12	9	8	8	4	53	332	100.0
Average Loaded Ton	16.5	16.0	22.8	8.4	11.4	24.0	7.8	10.0	12.8	11.1	18.0	15.6	13.7	25.0	10.7	(unit Ton) 14.6	

X-2 Future relative development plans

The important development plans relating to the transportation facility plan for the New Ocean Terminal project are taken from the following reports. "A Techno-Economic Feasibility Study for Standard Gauge" prepared by the Nigerian Federal Ministry of Transport and the "Lagos State Regional Plan" prepared by the Master Plan Project Unit of Lagos State Ministry of Housing Survey and Special Duties.

X-2-1 Nigerian railway standard gauge line construction plan

"A Techno-Economic Feasibility Study for Standard Gauge"

The Third Five-Year Plan includes a plan for new standard gauge lines covering 960 km of main lines from the Port of Lagos and Port Harcourt to the interior along existing metre gauge lines, and a 194 km branch line to the Ajaokuta steel mill. The budget is N790 million, accounting for about 80% of the railway development cost in the Third Five-Year Plan. Already tenders have been called, and contractors decided for several sections. However, in view of the recent fall of income from petroleum, doubts arose in the minds of the authorities regarding the plan for the new line which requires considerable expenditures. Later, based on the request of the Nigerian Government, consultants from the Indian Government conducted a feasibility study and submitted "A Techno-Economic Feasibility Study for Standard Gauge" – Preliminary Report to the Nigerian Federal Ministry of Transport. A summary of this report is as follows:

The basic concept of the standard guage line construction plan is to connect both the Port of Lagos and Port Harcourt acting as transshipment terminals with the main cities in the interior along existing lines. The hinterland of the Port of Lagos is considered to be the western half of Nigeria as an assumption made by the Japanese Study Team. They reviewed the Third Five-Year Plan and carried out an input and output analysis by region, by item, deciding the shares of railway transportation as shown in Table X-13.

The comparing standard gauge railway transport with truck transport, they concluded that railway transport is more advantageous for distances of 362 km and more over. There are two alternative plans using existing line improvement and standard gauge line construction. For the existing line improvement plan, the branch line to Ajaokuta is planned as metre gauge, and in the case of the standard gauge plan, the standard gauge is used.

As a result, even if existing lines are double-tracked, with improvements of signalling and communication facilities, the line capacity will be less than the forecasted traffic volume in the year 2000. On the other hand, it is reported that if new lines are constructed in standard gauge parallel to the existing lines, single track operation will be sufficient for all lines excluding the Lagos-Ifaw section.

The design speeds for standard gauge are 160 km/hr for passenger trains and 100 km/hr for freight trains. Thus, though it now takes 32 hours by train from Lagos to Kano, the completion of a standard gauge line will shorten it to 10 hours. Furthermore, the report proposes the construction of a new line to the planned New Capital and branch line between Ibadan and Ajaokuta after completion of the trunk lines in standard gauge. Fig. X-9 shows the planned railway network in standard gauge and implementation schedule. The proposed construction plan is as follows:

Table X-13 Forecasted Traffic by Type of Goods

(in 1000 Tons)

COMMODITY	1980			1985			1990			1995			2000		
Mode of Transport	Rail	Others	Total	Rail	Others	Total	Rail	Others	Total	Rail	Others	Total	Rail	Others	Total
1. Cement	1056	3982	5038	1584	5973	735*	2138	8064	10202	2672	10080	12752	3206	12096	15302
2. Iron & Steel	368	412	780	640	1924	2564	960	2886	3846	1200	3608	4808	1440	4330	5770
3. Coal	780	445	1225	3030	730	3760	5000	800	5800	6250	1000	7250	7500	1200	8700
4. Fertilizer	397	313	710	760	660	1420	1140	990	2130	1425	1238	2663	1710	1486	3196
5. Sugar	94	106	200	127	143	270	171	193	364	214	241	455	257	289	546
6. POL* White Oil	625	7967	8592	-	11174	11174	-	17561	12561	-	21951	21951	-	26341	26341
7. POL Black Oil	286	816	1102	515	1072	1587	721	1418	2139	901	1772	2673	1081	2126	3207
8. POL Bitumen & asphalt	52	252	304	94	286	380	132	343	475	165	429	594	198	545	713
9. Groundnut	310	804	1114	397	1029	1426	508	1317	1825	635	1646	2281	762	1075	2737
10. Gypsum	136	114	250	204	171	375	276	231	507	345	286	631	414	366	760
11. Other Goods	1321	4871	6192	1650	6247	7897	2091	7898	9989	2614	9872	12486	3137	11846	14983
Total	5425	20082	25507	9001	29409	38410	13137	41701	54838	16421	52123	68544	19705	62550	82255
Percent share of mode	21.3	78.7	100.0	23.4	76.6	100.0	24.0	76.0	100.0	24.0	76.0	100.0	24.0	76.0	100.0
Percent rate of growth of traffic Per annum LINEAR				13.2	9.3	10.1	9.2	8.4	8.6	5.0	5.0	5.0	4.0	4.0	4.0
COMPOUND				10.7	7.9	8.5	7.9	7.3	7.4	3.9	3.9	3.9	3.7	3.7	3.7

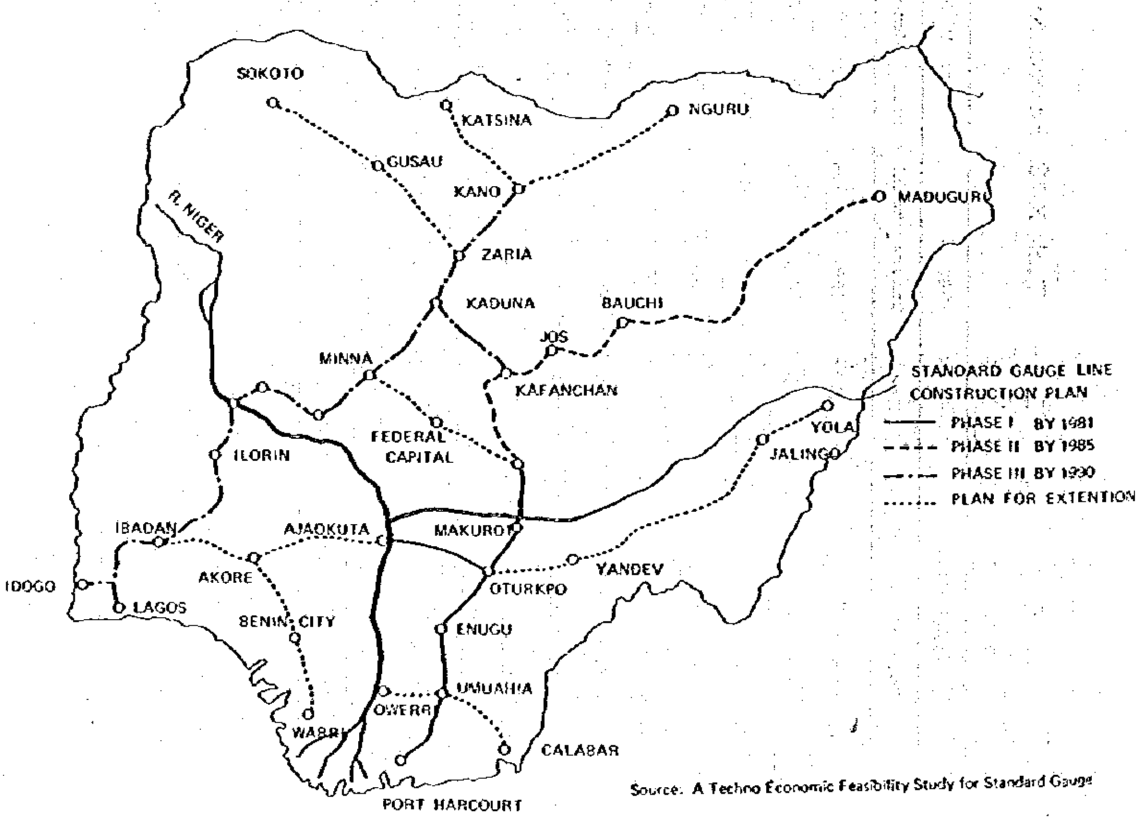
Source: A Techno-Economic Feasibility Study for Standard Gauge

Preliminary Report Annexure 4.6.5

Note: *Refined petroluem product

Phase	Opening Year	Section	Length (km)	Construction Cost (₦ million)
Phase I	1981	Port Harcourt-Lafia		
		Oturkpo-Ajaokuta	759	856
Phase II	1990	Lafia-Maiduguri	838	1,585
Phase III	1990	Lagos-Kano		
		Kaduna-Kafanchan		
		Ifaw-Idogo Branch	1,343	1,964
Phase IV	1995	Zana-Gusau-Sokoto		
		Kano-Nguru	587	486
Further the following are planned:				
		Ajaokuta-Ibadan	340	441
		Akure-Benin City-Warri	260	356
		Minna-Federal Capital-		
		Lafia	280	395

Fig. X-9 Planned Railway Network for New Standard Gauge Line



X-2-2 Lagos state regional plan

The Master Plan Project Unit of Lagos State Ministry of Housing Survey and Special Duties is now preparing the regional plan for Lagos state which is growing rapidly. The target year of the regional plan is 2000, and it is intended to integrate economic, social, environmental, and aesthetic considerations to create an environment consistent with new and improved standards of living. And it is supposed that at that time, Lagos state will be the centre of the West African Megalopolis of Ecunopolis.

The study was made using the following procedures:

1. To define the present situation with regard to the natural conditions, population, economy and environment of Lagos state.
2. To define the present problems involved in urbanization and gravitation of population to the cities.
3. To decide development policies to increase employment opportunities and to introduce population dispersal plans in relation to these policies.
4. To decide economic development and population scale in future.
5. To prepare the master plan of Lagos state with 2000 as the target year, and to decide the investment plan.

Population scale

As regards population scale, it is estimated that the population will grow from the present 3,720,000 to 12,600,000 by the year 2000 judging from an inhabitantable area of 192,186 ha in future and acceptable population densities, that the employable population will grow from 1,200,000 to 4,540,000, and that the population distribution ratio of primary, secondary and tertiary sectors of industry will be 1:30:69. In the regional plan, Lagos state is divided into 7 development areas, and the respective populations by the year 2000 are estimated to be as shown in Table X-14.

Table X-14 Population Distribution and Employment by Sector or Economic Activity in the year 2000

Unit: thousand persons

SECTOR \ D.A	LAGOS DEVELOPMENT AREA		IKORODU D.A		EPE D.A		BADAGRY D.A		AGPOWA D.A		ATLANTIC D.A. (LEKKI)		SOUTHERN D.A		TOTAL	
		(%)		(%)		(%)		(%)		(%)		(%)		(%)		(%)
PRIMARY	-		2	0.3	7	1.8	5	2.1	6	13.3	3	8.8	7	15.2	30	0.7
SECONDARY	910	29.8	286	39.2	130	32.5	30	12.8	18	40.0	3	8.8	3	6.5	1,380	30.4
TERTIARY	2,140	70.2	442	60.5	263	65.7	200	85.1	21	46.7	28	82.4	36	78.3	3,130	68.9
TOTAL EMPLOYMENT	3,050	100.0	730	100.0	400	100.0	235	100.0	45	100.0	34	100.0	46	100.0	4,540	100.0
URBAN POPULATION	3,050	100.0	2,000	99.0	1,050	95.5	600	94.5	90	72.0	90	85.0	90	55.0	12,370	98.0
RURAL POPULATION	-	-	20	1.0	50	4.5	35	5.5	35	28.0	15	15.0	75	45.0	230	2.0
TOTAL POPULATION	3,050	100.0	2,020	100.0	1,100	100.0	635	100.0	125	100.0	105	100.0	165	100.0	12,600	100.0

Source: Lagos State Regional Plan Vol. 3. Table 6.27

Land use

Factories are planned to be established in Ikorodu, Epe and Badagry, for future industrial development

X-3 Planned traffic volumes

X-3-1 Modal split

(1) Goods

The planned annual cargo handling tonnage of the year 2000 of the port and industrial complex and the sharing by mode of land transport, are described in Chapter IV. Scale and Layout of the Commercial Port Facilities and Chapter V. Concept for Industrial Development. Table X-15 shows the annual cargo tonnages by type of commodity, by port road, and the share by transport mode. Fig. X-10 shows port roads described in Section 4. Layout of Related Facilities of Chapter IV. Six port roads named, from the west, A, B, C, D, E and F are planned. All the movement generated from the New City are assumed to be transported by truck.

(2) Passengers

Usually, in the case of a city with a population of 200,000, most passengers move by vehicle. Therefore, for this project, the passengers are assumed to move by vehicle.

X-3-2 Planned traffic volumes

(1) Traffic distribution

In order to get the peak hourly traffic volume, traffic volumes are estimated in terms of business traffic (trucks and related vehicles) and commuter traffic.

In this case, the peak hours for business traffic does not coincide with the peak for commuter traffic and commuter traffic is assumed to be concentrated in morning and evening peaks of one hour duration. The business traffic in this case is defined as all the traffic except the commuter traffic. Business traffic and commuter traffic are classified as follows.

Table X-15 Generated Cargo Flow in the year 2000 by Type of Commodities and Transport Modes

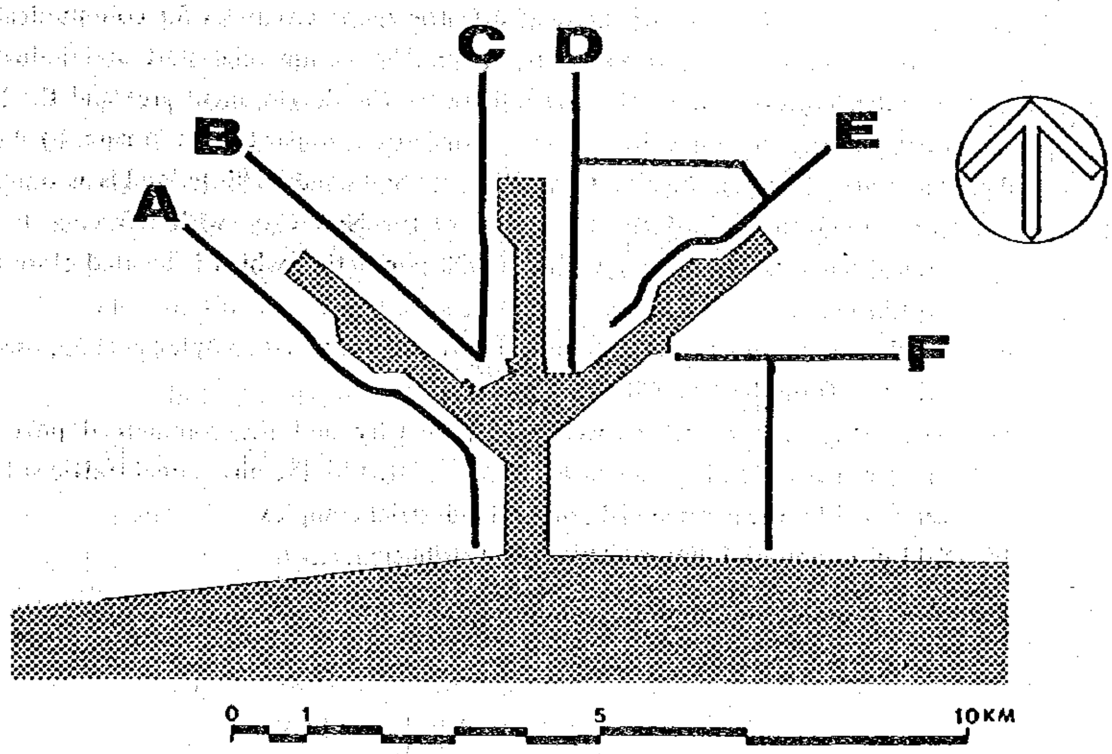
Unit: 1000 tons

Type Commodity	Nigeria & Lagos State	Community	Industrial Complex	New Ocean Port
Road A				
Container	(2,442)	← (42) ←	100%T	(2,484)
Break Bulk	(3,522)	← (82) ←	100%T	(3,604)
Grain	(1,028)	← (14) ←	100%T	(1,042)
Petroleum product distribution	(5,273)	← (127) ←	100%T	(5,400)
Road B				
Container	(4,394)	← (76) ←	100%T	(4,470)
Road C				
Container	(2,442)	← (42) ←	100%T	(2,484)
Break Bulk	(978)	← (23) ←	100%T	(1,001)
Road D				
Container	(3,909)	← (67) ←	100%T	(3,976)
Automobile Assembly	T(156) R(39)	80%T20%R	(195)	
Other Related Industries	T(405)			
Road E				
Other Related Industry	T(811) R(304)	80%T20%R	(1,520)	
Break Bulk	T(1,955)	← (46) ←	100%T	(2,001)
Flour Mill and Food Processing	T(588) R(147)	80%T20%R	(735)	
Road F				
Iron & Steel Products	T(2,760) R(920)	75%T25%R	(3,680)	
Petroleum Refining	T(5,449) R(2,335)	70%T30%R	(7,784)	
Petrochemicals	T(1,172) R(293)	80%T20%R	(1,456)	

T: 37,284 x 10^3 tons
R: 4,038 x 10^3 tons

T: Truck
R: Rail

Fig. X-10 Layout of Port Road



1) Business traffic

Traffic volumes generated by the commercial port and industrial complex

Intra-zonal traffic	: Commercial port	- New City
	Industrial complex	- New City
Inter-zonal traffic	: Commercial port	- Lagos State and its hinterland
	Industrial complex	- Lagos State and its hinterland

Generated traffic volumes of the New City

Intra-zonal traffic :	New City	- New City
	New City	- Commercial port
	New City	- Industrial complex
Inter-zonal traffic :	New City	- Lagos State and its hinterland

2) Commuter traffic

Commercial port - New City
Industrial complex - New City

These distribution patterns were established based on the following assumptions.

a) For determining the distribution patterns, all the traffic generated by the commercial port and industrial complex is assumed to go outside the commercial port and industrial complex, with no intra-zonal traffic within this zone.

b) Resulting from the origin-destination study, it is assumed that 85% of the generated traffic volume of the commercial port and industrial complex corresponds to the traffic with Lagos State including the New City, and 15%, to the traffic with the rest of the hinterland area other than Lagos State.

c) It is assumed that 50% of the related traffic such as vehicles for communication involved in the generation of traffic in the commercial port and industrial complex corresponds to the traffic between the development area and the New City, and the remaining 50% shows a distribution similar to that in para. b) above.

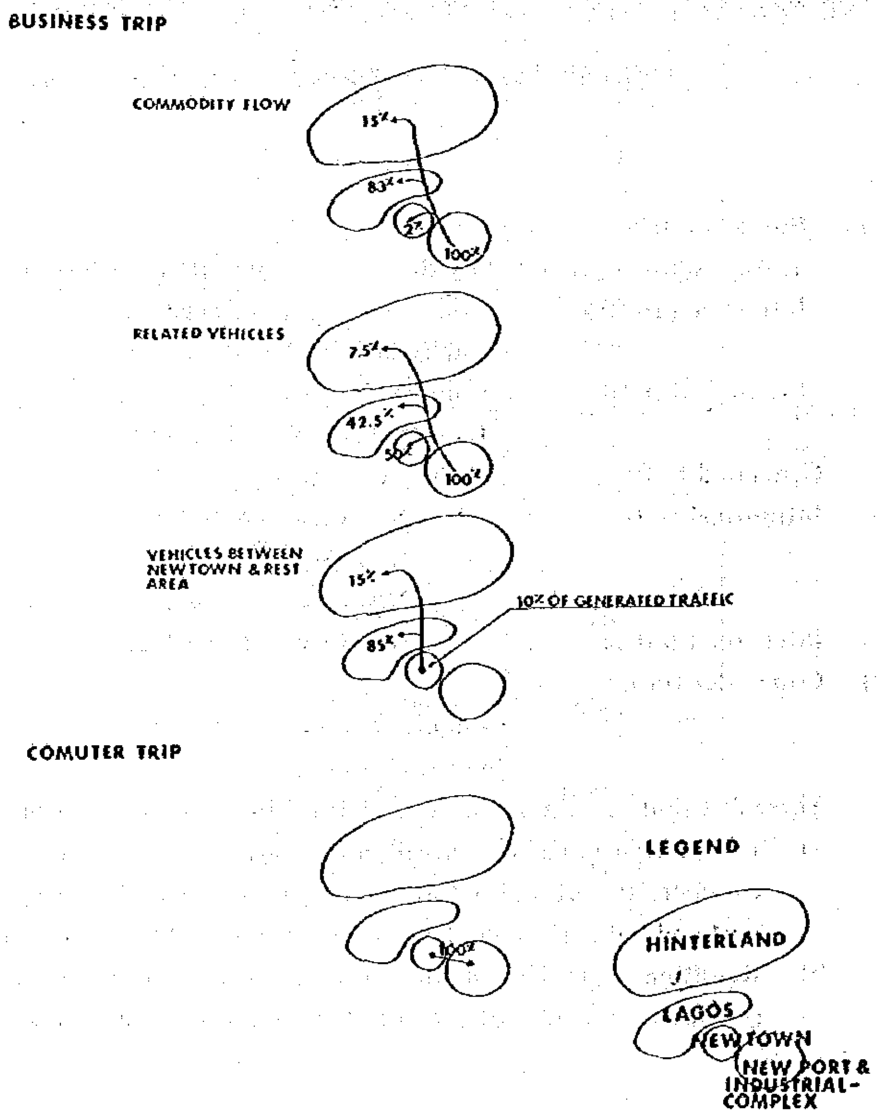
d) The traffic between the New City and Lagos State and its hinterland is assumed to correspond to 10% of the total trips of the New City, with reference to the inter-zonal rate of the city with 200,000 population which is located close to a port in Japan.

e) All the commuters to the commercial port and industrial complex are supposed to originate from the New City.

f) The intra-zonal traffic between the New City and the commercial port and industrial complex is assumed to be represented by the intra-zonal traffic volume generated by the commercial port and industrial complex.

Fig. X-11 gives a typical illustration of the distribution.

Fig. X-11 Distribution Pattern of Generated Traffic



(2) Forecast of traffic volumes

1) Business traffic volumes

a) Generated traffic volumes of the commercial port and industrial complex

The following equation is an empirical formula now used for Japanese port master plan projects. Since this formula permits a simple forecast of the traffic volumes generated by a port and industrial complex from a macroscopic viewpoint, it is used especially for long-term port plans (master plans). This equation enables estimate of the traffic volume generated during the peak hour including related vehicles other than trucks, using the annual cargo volumes planned to be handled by the port and industrial plants. This traffic volume is obtained in terms of mixed traffic comprising heavy and small vehicles.

In this equation, commuter traffic volumes are not considered.

$$\text{Planned traffic volume (vehicles/hour)} = z \times \frac{\alpha}{w} \times \frac{\beta}{12} \times \frac{\gamma}{30} \times \frac{1+\delta}{\epsilon} \times \sigma$$

where:

z : Annual cargo volume (1,000 tons)

w : Average tonnage/truck

α : Share of modal split by truck

β : Monthly variation (peak month/ordinary month)

γ : Daily variation (peak day/ordinary day)

δ : Rate of related vehicles (related vehicles/all trucks)

ϵ : Loading rate (loaded trucks/all trucks)

σ : Hourly variation (generated traffic volume of peak hour/generated traffic volume of peak day)

The annual cargo volumes by port road by type of commodities are shown in Table X-15.

w : Average tonnage/truck

For the average tonnage/truck, the figures shown in Table X-17 are used. These were decided with reference to the average tonnage by type of commodities obtained as a result of origin-destination study, as shown in Table X-12.

α : Model split by trucks

Shares of modal split by port road by type of commodities are shown in Table X-15.

β : Monthly variation γ : Daily variation

σ : Hourly variation

As for β, γ and σ, considering the survey examples in Japan and the present situation of Nigerian port traffic, it is assumed that the values will be close to those of Japan by the year 2000, and the values shown in Table X-17 are used.

δ : Rate of related vehicle

The results of traffic counts made by the study team at the entrances of Tin Can port and Apapa Wharf were analyzed, and the result is shown in Table X-16. It is said that the large number of motorcycles was generated by the poor telephone service in Lagos area. Therefore, if the telephone situation improves, the related vehicle rate shared by motorcycles will be changed in future. The related vehicle rates of 1.0 to 2.0 are close to the figures in Japan. The related vehicle rates by type of commodities as shown in Table X-17 are used.

ϵ : Loading rate

As a result of the origin-destination survey, 50% of the trucks working in the Port of Lagos were loaded. This value is assumed to remain unchanged in future, and the loading rate of commodities other than iron and steel products is assumed to be 0.5. Regarding iron and steel products, the loading rate of trucks from steel mill in Japan is used. The values used are shown in Table X-17.

Equivalent passenger car units for heavy vehicles:

As the equivalent passenger car units for heavy vehicles, the values of Highway Manual Part I Design, Federal Ministry of Works and Housing 1973 shown in Table X-18 are used. The traffic volumes generated by the port roads in the port and industrial complex, are shown in Tables X-19, X-20 and X-21.

Table X-16 Coefficient between Trucks and Passenger Vehicles of Tin Can and Apapa Port

Port / Type of Vehicle	Apapa	Tin-Can	Total	Remarks
Trucks	250	184	434	Trucks & 1/2 Van Pickups
A: Passenger Vehicles A	941	554	1,495	Passenger Cars including Motorcycles
B: Passenger Vehicles B	538	318	856	Passenger Cars excluding Motorcycles
A/Trucks	3.7	3.0	3.4	
B/Trucks	2.2	1.7	2.0	

Table X-17 Coefficient of Traffic Forecast for Empirical Formula

	ω	α	β	γ	δ	ε	σ
1. Container	25	1.0	1.0	1.2	2.0	0.5	0.1
2. Break Bulk	10	1.0	1.0	1.2	2.0	0.5	0.1
3. Grain	16	1.0	1.0	1.2	2.0	0.5	0.1
4. Petroleum Products Distribution	16	1.0	1.0	1.5	2.0	0.5	0.1
5. Floor Mill and Food Processing	16	0.8	1.0	1.5	1.0	0.5	0.1
6. Iron & Steel Products	20	0.75	1.0	1.5	1.0	0.6	0.2
7. Petroleum Refining	16	0.7	1.0	1.5	1.0	0.5	0.2
8. Petrochemical	10	0.8	1.0	1.5	1.0	0.5	0.1
9. Automobil	5	0.8	1.0	1.5	1.0	0.5	0.1
10. Others	10	0.8	1.0	1.2	2.0	0.5	0.1

Table X-18 Equivalent Passenger Car Unit

Vehicle Type	Equivalent Passenger Car Units
Pedal Cycle. Tricycles and Motorcycles	0.5
Motor-car Station Wagon Taxi Kit-Car or Pick-up Jeep Land Rover Light Delivery Van Minibus	1
Trailer attached to above	Add 1
2-Axle Truck Class Lorry inc. Timber Lorry Truck Mammy Wagon Petrol Tanker	2
Trailer attached to above	Add 1
3 to 5 Axle Combination Tractor Trailer inc. Low Loader Petrol Tanker Bus (Excluding Municipal)	3
Municipal Bus More than 5 Axle Combination	4

Table X-19 Total Generated Traffic Volume per Peak Hour

Dock Road	Mixed Traffic	Passenger Car Units
A	1,894	2,917
B	358	597
C	399	598
D	471	743
E	664	956
F	1,713	3,329
Total	5,499	9,140

Table X-20 Intra-zonal Traffic Volume per Peak Hour

Dock Road	Mixed Traffic	Passenger Car Units
A	669	729
B	125	137
C	141	152
D	172	193
E	226	265
F	428	428
Total	1,761	1,904

Table X-21 Inter-zonal Traffic Volume per Peak Hour

Dock Road	Mixed Traffic	Passenger Car Units
A	1,225	2,188
B	233	460
C	258	446
D	299	550
E	438	691
F	1,285	2,901
Total	3,738	7,236

b) Traffic volumes between the New City, and Lagos State and its hinterland

As described in relation to the number of owned motor vehicles, the Master Plan Project Unit of Lagos State fixed the owning rates in the year 2000 as follows:

Saloon car : 160 vehicles/1,000 persons

Truck and bus : Number of saloon cars x 0.18

To obtain the total trips in the New City, the values of Lagos Metropolitan Area Transportation Study and those of a city with 200,000 population in Japan were compared and discussed, and the following values were used:

Passenger car : 6.0 trips/vehicle/day

Truck & bus : 4.5 trips/vehicle/day

Therefore, the total trips per day by type of vehicles are as follows:

Passenger car : 192,000 trips/day

Truck & bus : 25,920 trips/day

Of the above, if the inter-zonal traffic is assumed to correspond to 10%, as described in (1) Distribution of traffic volume, then

Passenger car : 19,200 trips/day

Truck & bus : 2,592 trips/day

If the peak rate is 8%, the traffic volumes at peak hour are:

Passenger car : 1,536 trips/hour
Truck & bus : 207 trips/hour

The equivalent number of passenger cars at the peak hour is 1,950 vehicle/hour.

2) Commuter traffic

The assumed numbers of commuters at the peak hours, using port road are shown in Table X-22. Commuter traffic is forecasted based on the following assumptions.

Table X-22 Number of Commuters by Port Road in Peak Hour

Unit: employee

Dock Road	Port	Industry	Total
A	5,640	100	5,740
B	2,040		2,040
C	1,560		1,560
D	1,800	6,200	8,000
E	960	6,200	7,160
F		6,700	6,700
Total	12,000	19,200	31,200

a) 50% of commuters will commute by passenger cars, and the occupancy rate per car will be 2.0 according to the result of the origin-destination survey. This corresponds to one person on one motorcycle, since the equivalent number of passenger car unit for a motorcycle is 0.5.

b) 50% of commuters will commute by bus. The average number of passengers in this case will be 40.

c) Commuter traffic is concentrated in one hour in the morning and one hour in the evening. Table X-23 shows the result of the calculation.

Table X-23 Commuter Traffic Volume in Peak Hour

Unit: vehicle

Commuter Traffic	Mixed Traffic	Passenger Car Units
A	1,507	1,651
B	536	588
C	410	450
D	2,100	2,300
E	1,880	2,060
F	1,759	1,927
Total	8,192	8,976

(3) Design traffic volumes of trunk roads

Comparing the results of X-3-1 (2) Forecast of Traffic Volumes, business traffic volume is smaller than commuter traffic volume. During the peak hour, 90% of vehicles are occupied by commuter traffic in Tokyo, and 95%, in Jakarta. Therefore, for the trunk roads in the residential area, trunk roads in the commercial port and industrial complex and port roads, the commuter traffic volumes obtained in terms of one way traffic are taken as design traffic volumes. For the main access road, the total inter-zonal traffic volume, generated by traffic from the commercial port and industrial complex, and the related vehicles (business use) between the New City, and Lagos State and its hinterland is taken as the design traffic volume.

X-3-3. Planned traffic volumes of railways

The volumes of freight handled by railways are obtained as annual volumes by district by type of commodities as shown in Table X-15. According to Section 4 in Chapter V Concept for Industrial Development, destinations by type of commodities, or the distribution of railway cargoes generated from the New Ocean Terminal is as shown in Table X-24. The values of Table X-24 can be converted as shown in Table X-25, in terms of numbers of trains by type of commodities produced from the New Ocean Terminal and the industrial zone per day, based on the following assumptions.

a) The tractive force of a locomotive is 2,000 tons.
b) If the total weight of freight cars is 1,000 tons, the total weight of freight per train is 1,000 tons.
c) If the total weight of one loaded wagon is 50 tons, the weight of its freight is 25 tons.
d) One train is made up of 40 wagon.

Table X-24 Distribution of Railway Traffic

Unit: 1,000 ton

Type of commodity / From New Ocean Terminal to	Petroleum	Iron & Steel	Others	Total
Niger, Federal Capital & Kwara States	1,353	200	–	1,553
Sokoto, Kaduna & Kano States	982	720	783	2,485
Total	2,335	920	783	4,038

Table X-25 Generated Railway Traffic (One Way)

Unit: No. of Trains

Type of commodities / From New Ocean Terminal to	Petroleum	Iron & Steel	Petro-Chemicals	Motor Vehicles	Food	Others	Total
Niger, Federal Capital & Kwara States	3.7	0.6	–	–	–	–	4.3
Sokoto, Kaduna & Kano States	2.7	2.0	1.1	0.1	0.4	0.9	7.2
Total	6.4	2.6	1.1	0.1	0.4	0.9	11.5

According to Table X-25, the number of trains departing from the New Ocean Terminal per day is 12. Therefore, in both directions, 24 trains are operated per day.

As described in Section 4 of Chapter IV, the road network plan is made, assuming that all the land transport to meet commercial port requirements is performed only by road transport, but the right of way for a railway line should be considered to allow for the introduction of a railway into the commercial port to meet the future changes of transport modes. The planned traffic volume for this purpose is supposed to be 15% of the cargo volume per day generated from the commercial port, viz. 10,500 tons. This corresponds to twenty two trains in both direction per day.

X-4 Transportation network plan

X-4-1 Scope of the project

With regard to the entire transportation network plan of Lagos State, a desirable transportation network for the New Ocean Terminal and its peripheries is proposed herein laying stress on the results of the study of the Master Plan Project Unit of Lagos State. Arterial roads are decided as follows; from Section 1 Principles for the formulation of the Master Plan of Chapter III of this report; The arterial road is to run north from the development area to reach the existing road between Epe and Ikorodu via a bridge on the channel connecting Lagos Lagoon with Lekki Lagoon.

The New City, commercial port area and industrial area are to be linked by an arterial road running through the development area."

Furthermore, in this study, the ring road connects the port roads A to F as shown before. The arterial roads of the residential area connecting the New City with the outside trunk roads and with the ring road are within the scope of the New City plan, and the crosssection and interchange plan are included in this traffic facility plan. The railway plan covers the port railway line into the industrial complex and the plan of the new line to Ibadan. The preliminary design includes a plan for the marshalling yard in the development area.

X-4-2 Layout of transportation network

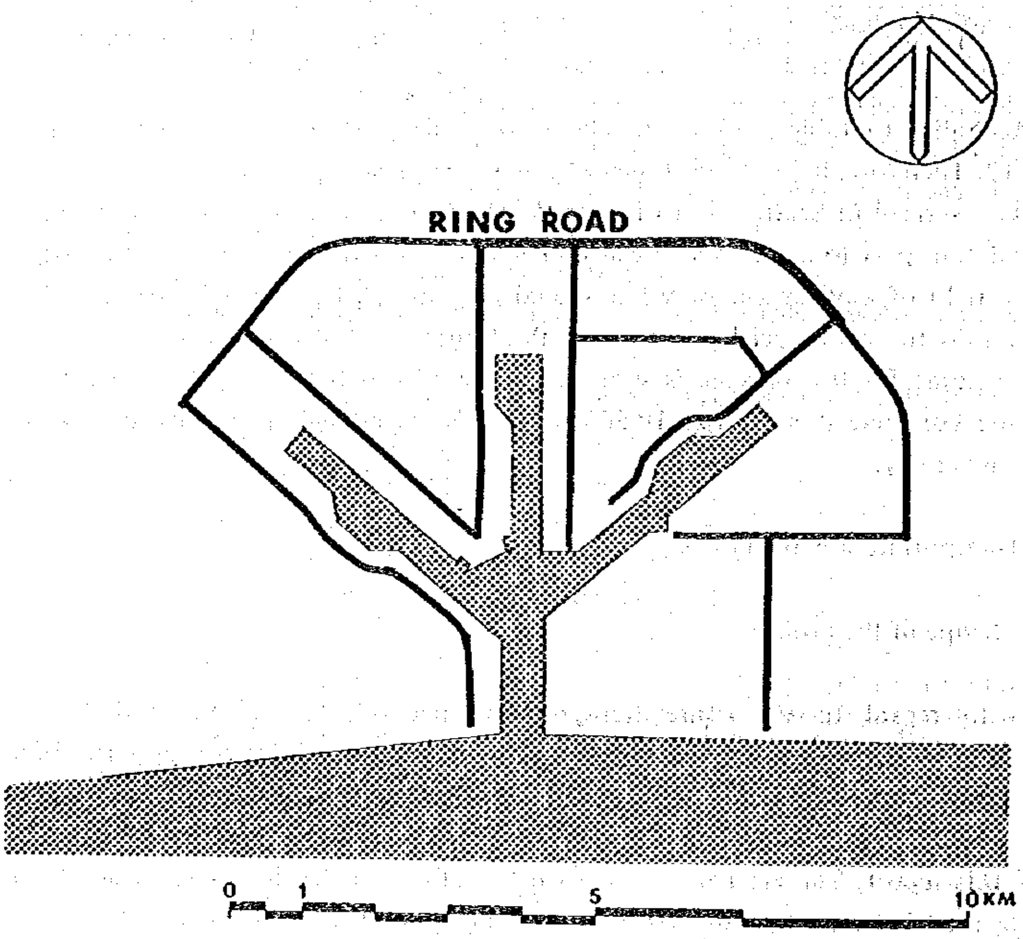
(1) Layout of trunk roads

1) Ring road (inter trunk road)

The layout of the port roads is already described in (1) Port Roads, 4-1, Chapter IV. The port roads are planned radially as shown in Fig. X-10.

A ring road as shown in Fig. X-12 is employed as a trunk road connecting the radial port roads for the following reasons.

Fig. X-12 Layout of Ring Road



a) The lengths of the port roads can be made equal.

b) The intersections between the ring road and the port roads can be made at right angles.

c) For reasons a) and b), the ring road can be arranged simply, for effective land use.

2) Main access road

Considering the business and commuter traffic volume obtained before and the location of the New City, the main access road is planned on the right side of the ring road, i.e. on the extension of port road D. As described in the scope of the project, it terminates on the Ikorodu-Epe road. Fig. X-13 shows the concept.

3) Road network concept

The entire concept of the trunk road network including the New City is shown in Fig. X-14.

(2) Layout of railways

1) Port railway

As shown in Table X-15, railway freight from the industrial complex are generated along the two port roads E and F. Therefore, the port railway is planned along the port roads E and F, with sidings planned for respective industrial plants. In Section 4 Layout of Related Facilities, Chapter IV Scale and Layout of the Commercial Port Facilities, the following layout of the port railway is proposed: "The port railway should be planned to exclusively handle cargoes relating to manufacturing industries with industrial sidings provided for the respective plants if necessary and a marshalling yard should be arranged between the joint of these sidings and the main line toward the inland. The yard should function as a freight station of the entire New Ocean Terminal." Therefore, the port railway and the terminal are planned, as shown in Fig. X-15. Regarding railway layout for the commercial port function, the right of way for the railway should be secured to cope with future changes in transport modes. In this case, the railway should be located in such a way that it does not interfere with the installation of a fly-over on trunk roads, for future commercial port functions. The basic concept of the railway layout for this purpose is indicated by dotted line in Fig. X-15.

2) Railway trunk line

The main access railway line to the north starts the marshalling yard which is located outside the intersection between the port road E close to the industrial complex and the ring road. It will lead to the north, and connect with the standard gauge new line being planned to connect Lagos metropolitan area with Kano.

3) Railway network concept

The concept of the railway network for the New Ocean Terminal is shown in Fig. X-15.

Fig. X-13 Layout of Main Access Road

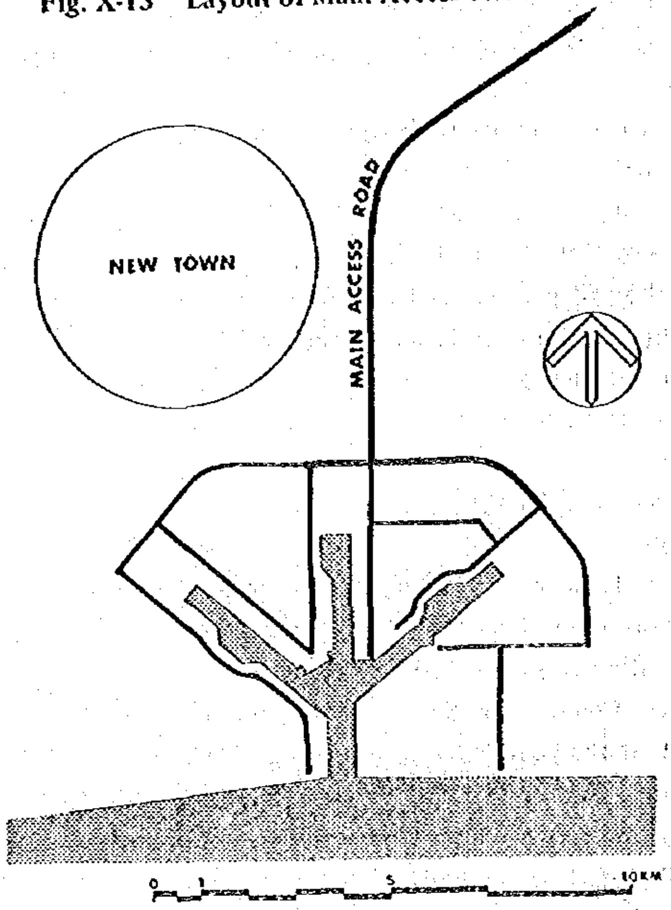


Fig. X-14 Planned Road Network

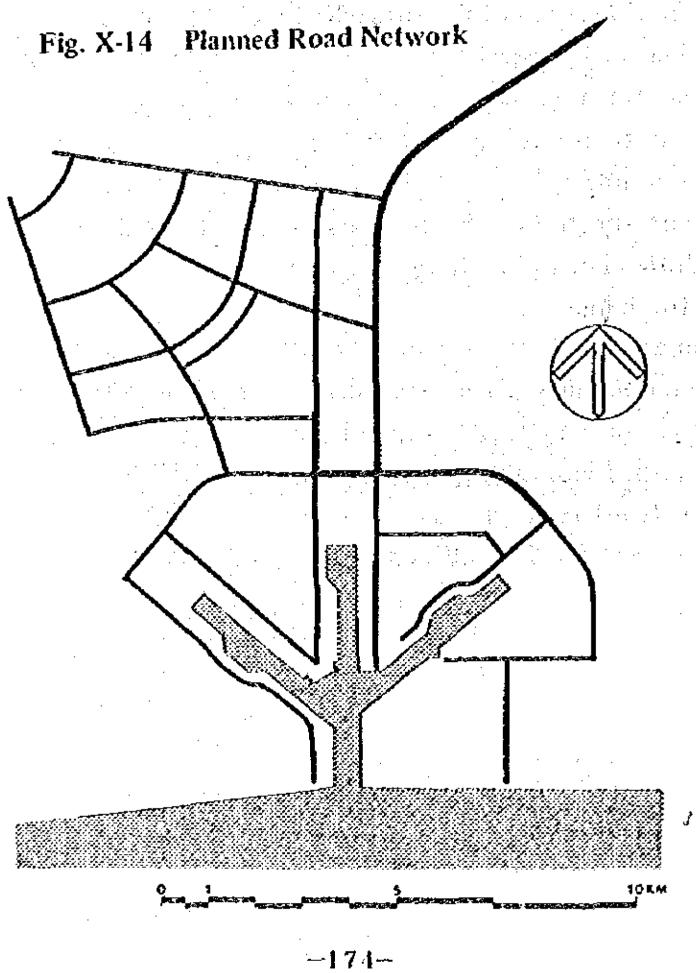
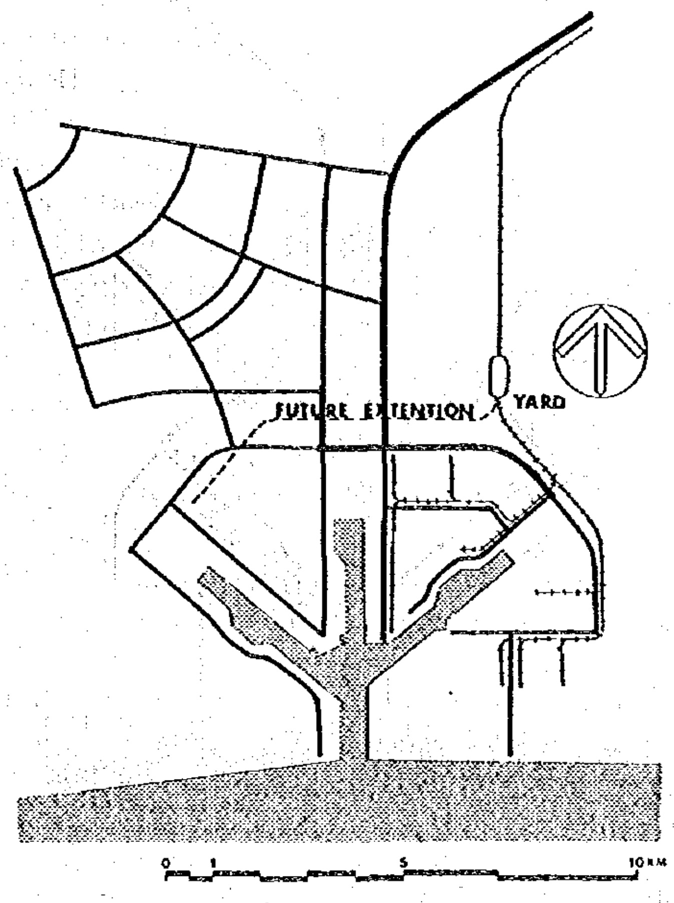


Fig X-15 Planned Transportation Network



X-4-3 Traffic assignment

(1) Roads

If, in the general concept, the business and commuter traffic are assigned to the trunk road network based on the shortest route, the assigned volumes are as shown in Figs. X-16 and X-17. These assigned volumes are in terms of equivalent passenger car units.

Fig. X-16 Traffic Assignment for Business Traffic
(Equivalent Passenger Car Unit)

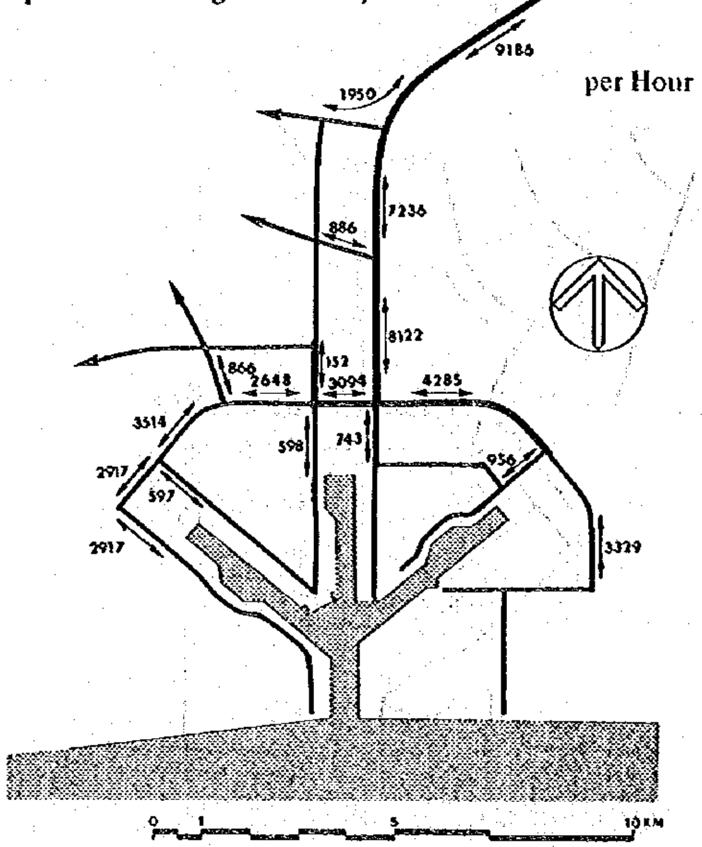
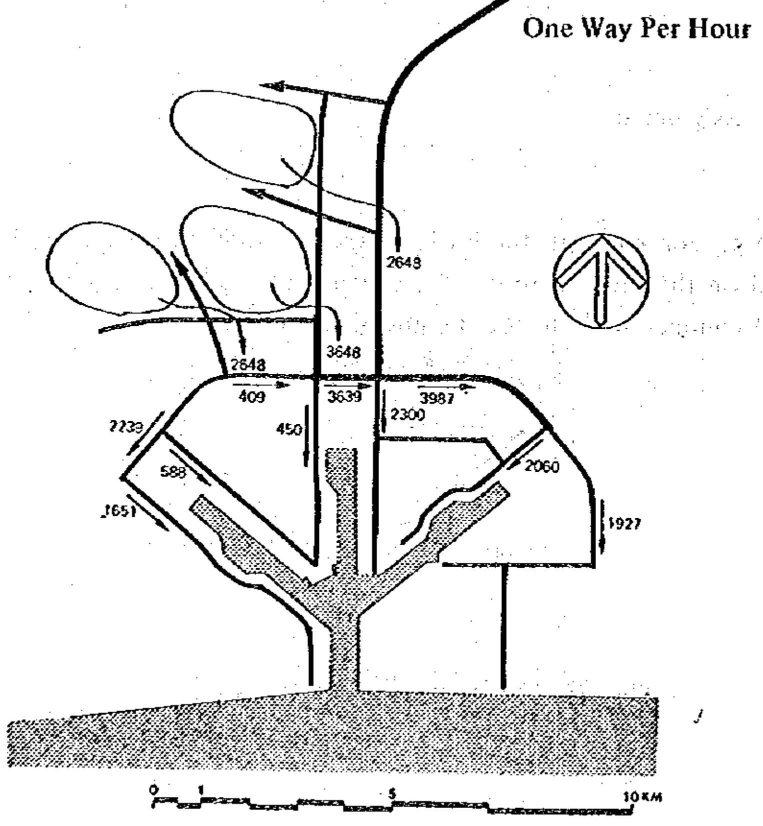


Fig. X-17 Traffic Assignment for Commuter Traffic
(Equivalent Passenger Car Unit)



X-5 Preliminary design of trunk transportation facilities

X-5-1 Preliminary design of trunk roads

(1) Design standard

Table X-26 shows the design standard.

(2) Required number of lanes

If the design traffic volume assigned to each trunk road is divided by the practical capacity per lane expressed by the equivalent number of passenger car units by road classification in the design standard of Table X-26, then the number of lanes required is obtained. For the trunk roads in the development area including the port roads, at least a four lane divided highway is envisioned. Fig. X-18 shows the number of lanes required for each trunk road.

(3) Typical crosssection

Typical crosssections of respective roads are shown in Fig. X-19.

(4) Intersection plan

The intersections on respective trunk roads are numbered as shown in Fig. X-20. Since the main access road is planned as a fully controlled access, all the intersections have to be constructed by grade separation. Therefore, considering the design traffic volumes and directions shown in Fig. X-21, Design Hourly Volumes and Interchange Types, the interchange types shown in the figure are proposed. In the case of the ring road, since partially controlled access is employed, the choice of grade separation is decided according to the design traffic volume and interchange capacity. The capacity of an at-grade intersection is different from the simple use of channelization and the installation of signals in combination with it. The final results are shown in Fig. X-21. For the interchanges (4), (5) and (9) with port roads, at-grade intersection is proposed, and for the other interchanges, diamond interchange is proposed.

(5) Alignment study of the ring road

Fig. X-22 shows the alignment of the ring road. The minimum radius curvature of the ring road is 1,000 m, and the alignment is free from any problem even if an intersection is provided in the curved portion. The total length of the ring road is 13.5 km, of which the 6-lane section constitutes 5.2 km and the 4-lane section, 8.3 km.

(6) Alignment of the main access road

Fig. X-22 shows the alignment of the main access road. The minimum radius for the main access road is 2,500 m, to secure comfortable driving speeds. The starting point is the intersection between the ring road and the port road D at the optimum river crossing site, reaching the Ikordu-Epe road with the minimum length. The main access road is planned as a 6-lane divided highway for the entire length of 18.0 km. The length of the bridge planned for crossing the Lagos Lagoon is estimated at 700 m, with 100 m each allowance for the both side approaches to the channel span of 500 m as read from a 1:50,000 scale map.

Table X-26 Road Classification and Standards for the Arterial Network

Road Characteristics and Standards	Road Classification	
	Main Access Road	Ring and Port Road
Traffic Function	Long Distance Interstate Trips	Interregional Trips
Access control	Full	Full or partial
Service roads	Where Necessary	Where Necessary
Median	Included	Included
Design speed in km/h	120–100	100
Operating speed in km/h	90–70	70
Practical capacity in passenger car units per hour and lane	1,600	1,300
Number of lanes	6	4–6
Right-of-way (m) (restricted-desirable)	92	50–80
Minimum grade		
a. Through pavement	4	6
b. Ramps down	8	8
c. Ramps up	7	7
Minimum horizontal radius in metres	700	400
Lane widths (m)	3.75	3.50
Intersection type	Grade Separated	Grade Separated or at Grade with Some Channelization and High Type Control Signalization

Fig. X-18 Required Number of Lane

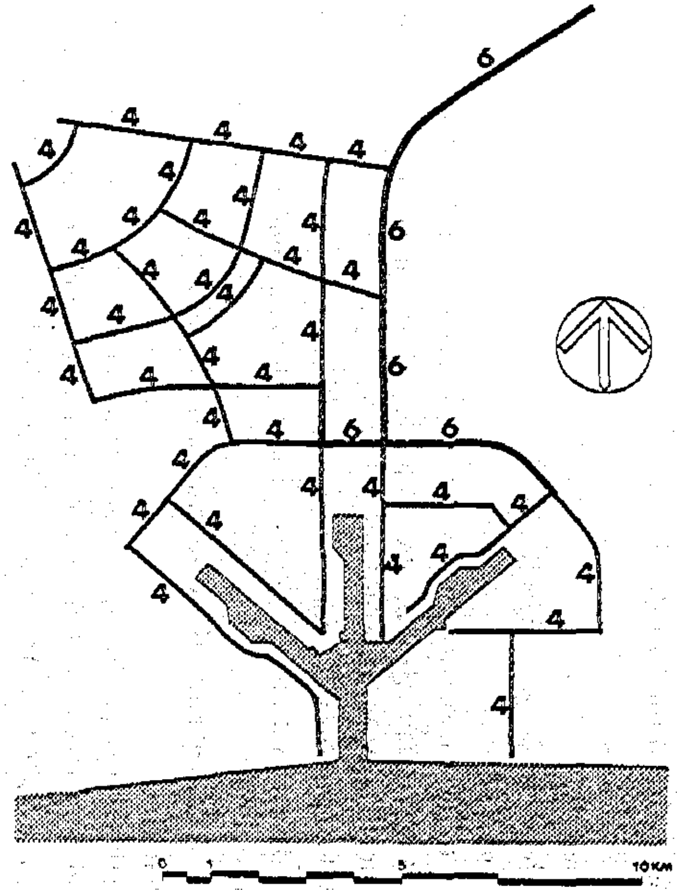
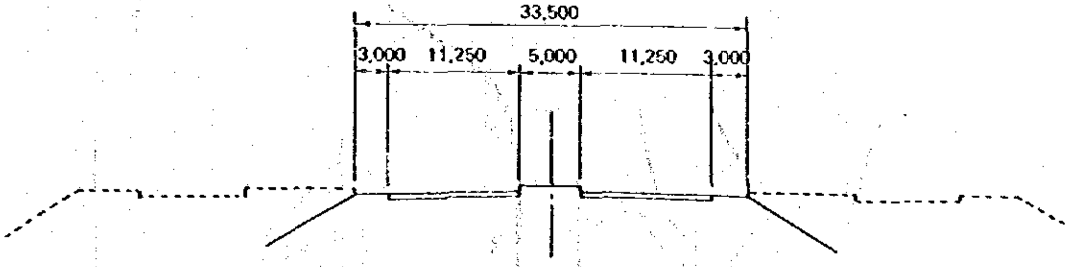


Fig. X-19 Typical Cross Section for Road

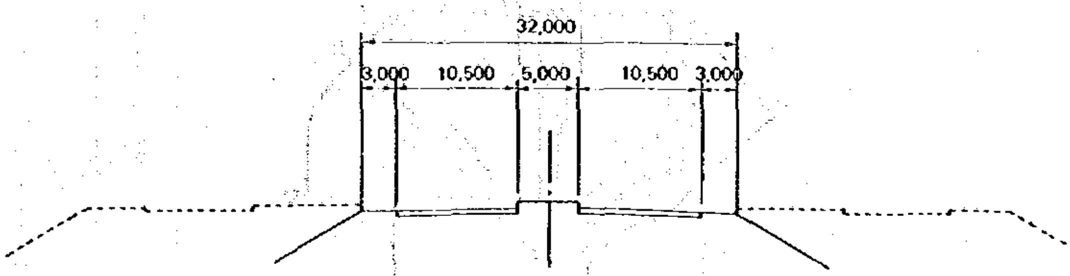
measurement: millimeter

MAIN ACCESS ROAD

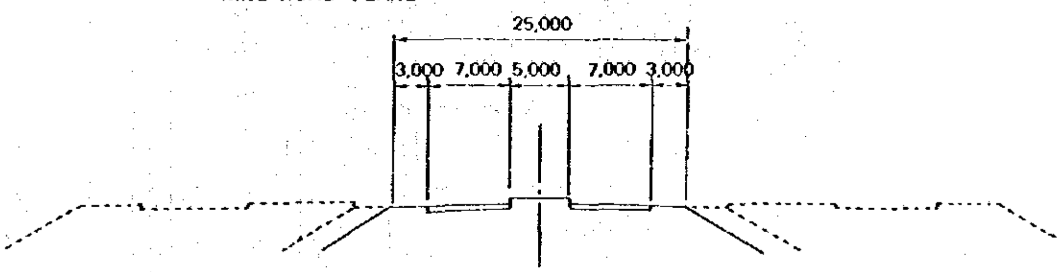


RING & PORT ROAD

RING ROAD 6-LANE



RING ROAD 4-LANE



PORT ROAD

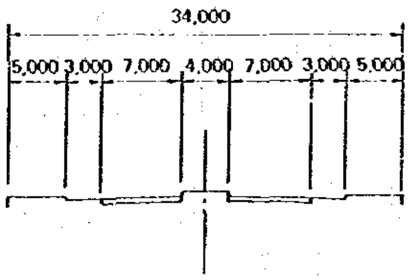


Fig. X-20 Intersection Number

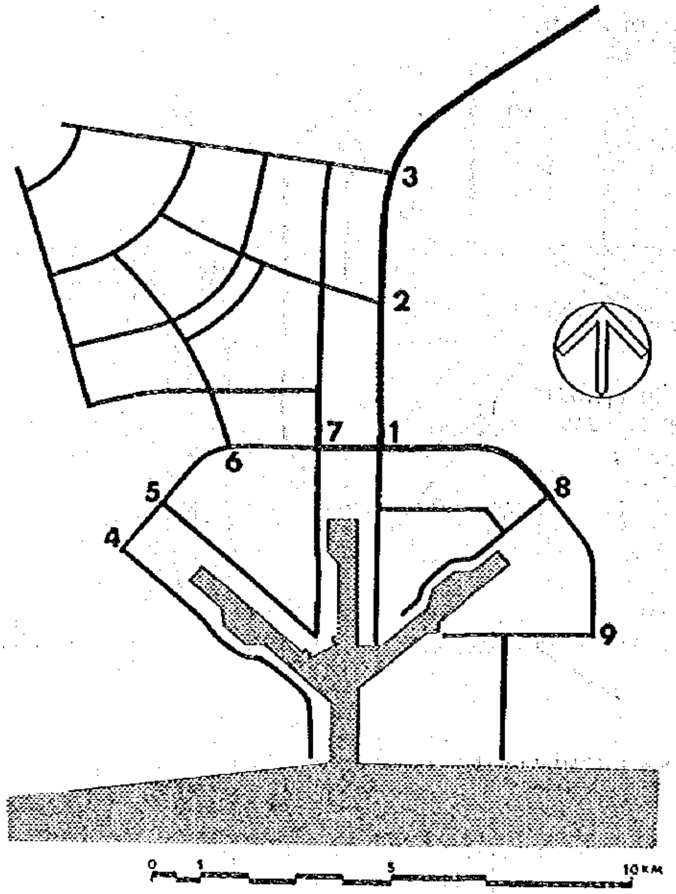
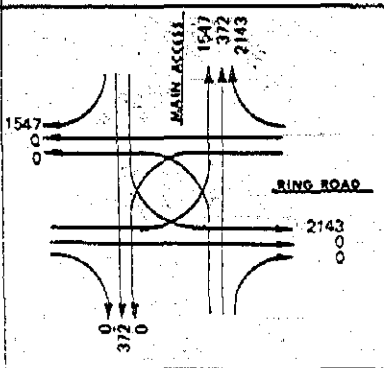
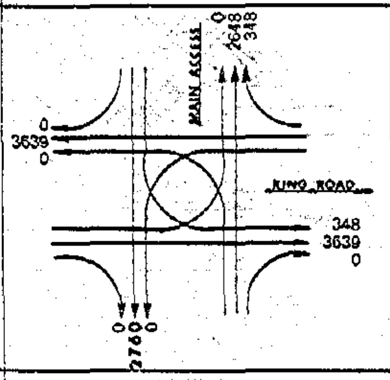
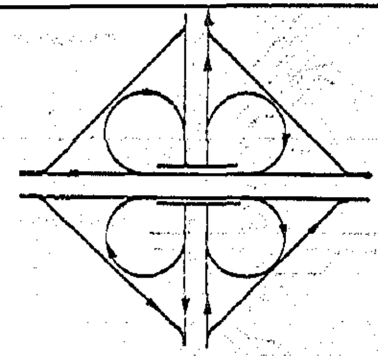
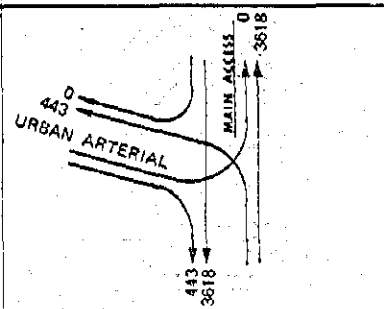
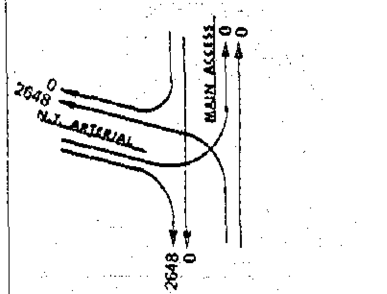
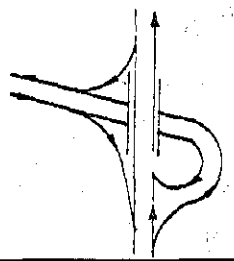
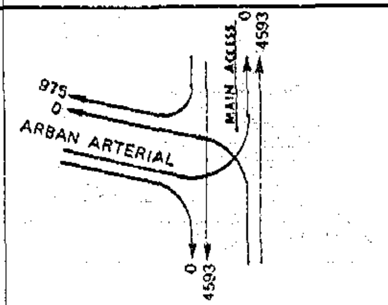
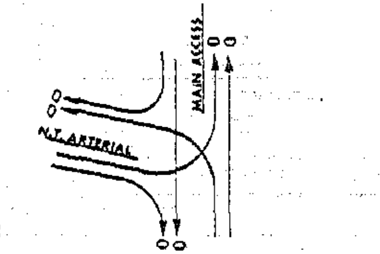
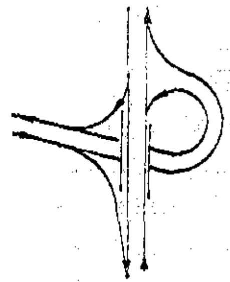


Fig. X-21 Design Hourly Volume and Interchange Type

Main Access Road

No. of Intersection	Design Hourly Traffic Volume		Interchange Type		Remarks
	Business Traffic	Comuter Traffic			
1			CLOVER LEAF		
2			TRUMPET		
3			TRUMPET		

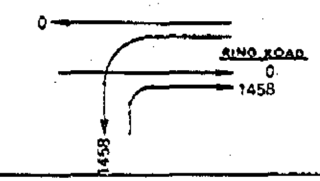
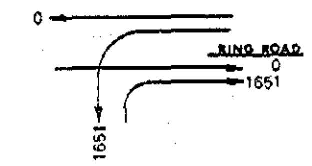
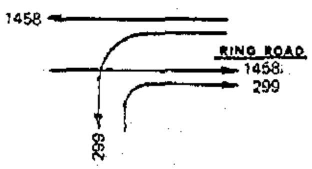
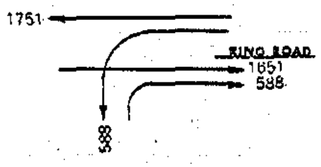
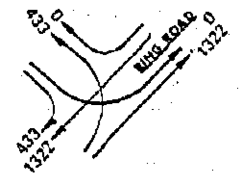
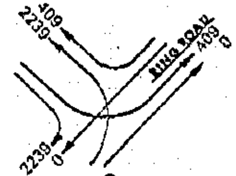
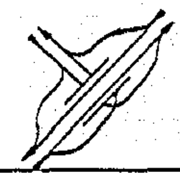
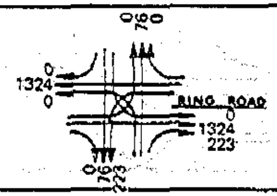
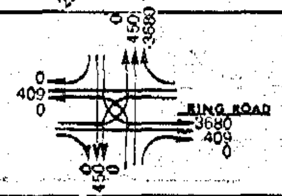
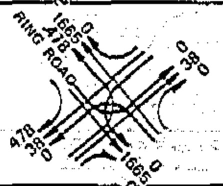
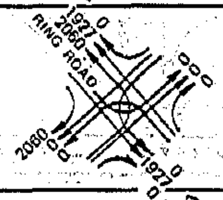
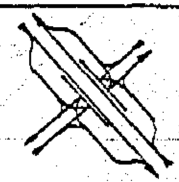
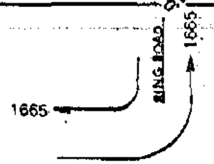
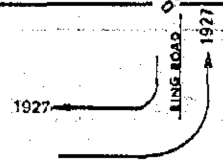
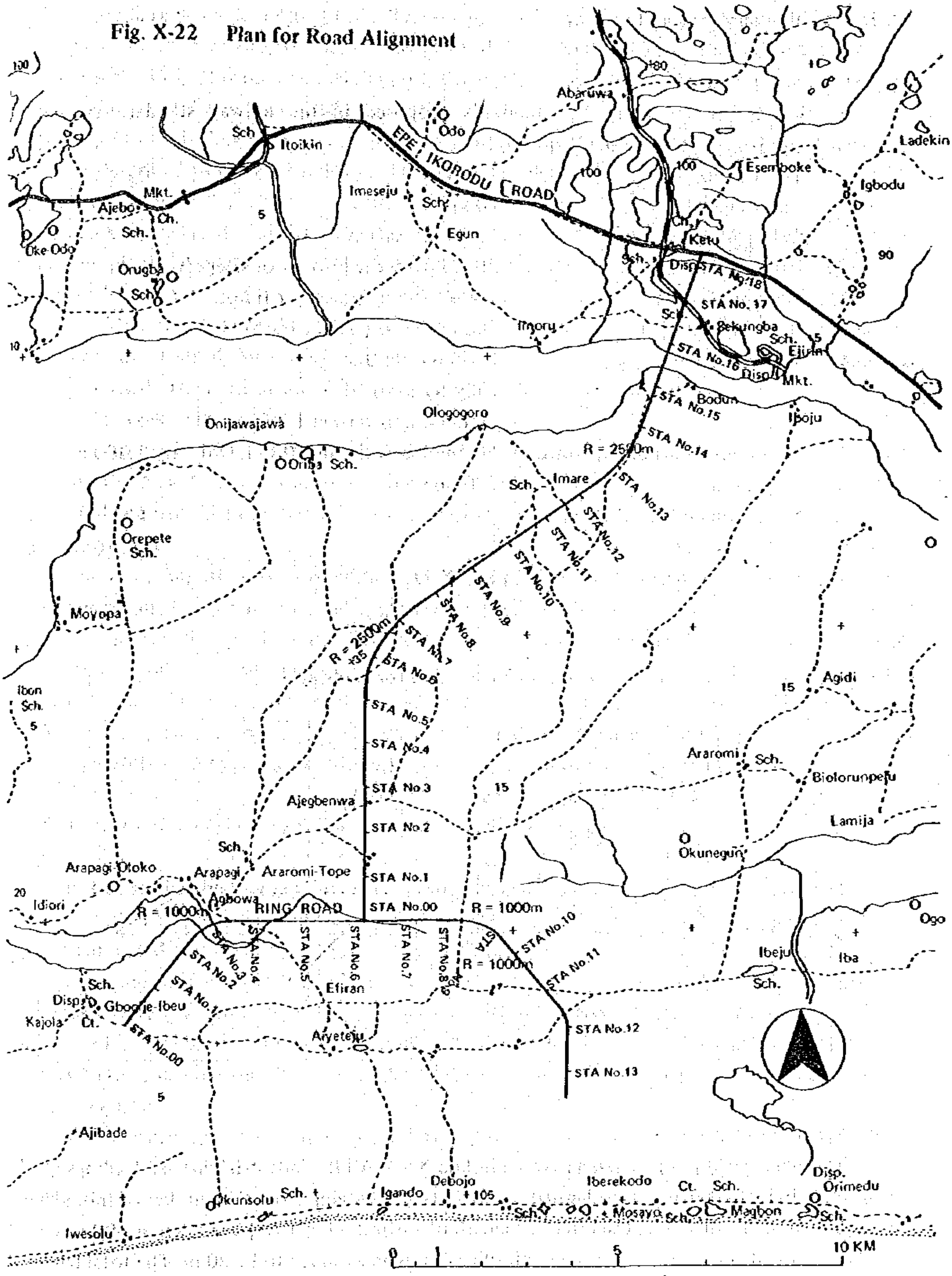
NO. OF INTERSECTION	DESIGN HOURLY TRAFFIC VOLUME		INTERSECTION TYPE	INTERCHANGE TYPE		REMARKS
	BUSINESS TRAFFIC	COMUTER TRAFFIC				
4			AT GRADE WITH CHANNELIZATION			
5			AT GRADE WITH CHANNELIZATION AND CONTOL SIGNALIZATION			
6			GRADE SEPARATED	DIAMOND		
7			GRADE SEPARATED	DIAMOND		
8			GRADE SEPARATED	DIAMOND		
9			AT GRADE WITH CHANNELIZATION			

Fig. X-22 Plan for Road Alignment



X-5-2 Preliminary design of railway

(1) Design standard

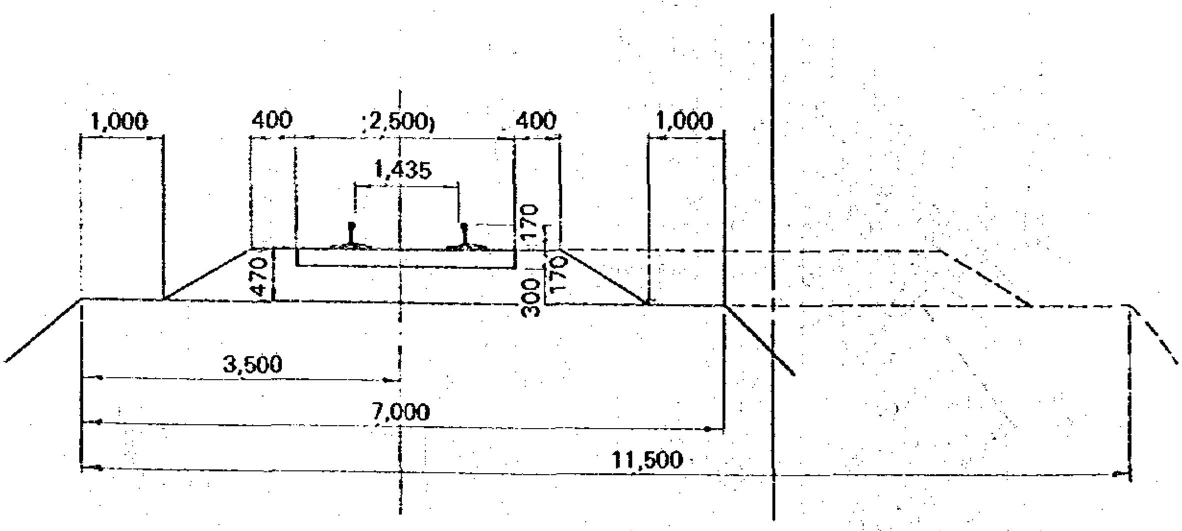
As the design standard, the standards proposed in the railway standard gauge line construction plan as shown below is employed.

1.	Track gauge	:	1.435 m
2.	Rail waight	:	60 kg/m
	Sleeper density	:	1,700 pieces/km
	Ballast thickness	:	30 cm from the bottom of sleepers
3.	Maximum speed	:	160 km/hour (passenger train), 100 km/hour (freight train)
4.	Maximum grade	:	Level terrain 0.5% Hilly terrain 1.0% Mountainous terrain 1.2%
5.	Minimum radius of curvature	:	Mountainous terrain 600 m, Ordinary 1,200 m
6.	Maximum cant	:	150 mm
7.	Maximum design axle load	:	25 tons

(2) Standard cross-section

The standard cross-section is shown in Fig. X-23.

Fig. X-23 Typical Crosssection for Railway



(3) Port railway

The port railway is planned as shown in Fig. X-24. All the industrial lines and sidings for the respective industrial plants are planned as single track, judging from the number of trains shown in Table X-24. In this case, the effective length of sorting siding in a plant is set as 800 m since it is the length of one train with the length of each wagon assumed to be 20 m. The total length of the port railway is 20 km. The freight generated from the respective plants i.e. iron and steel, petroleum refining, petrochemicals, and chemical fertilizers, is collected into one train at each plant, and are removed as a direct train. The siding length for the commercial port is 12.0 km.

As mentioned before, the railway is planned exclusively for plant the industrial complex, but as for the siding for the commercial port, the right of way for a single track should be secured for the alignment shown by dotted line.

(4) Plan of marshalling yard

As described in (3) Port railway, the wagons leaving the respective plants for iron and steel, petroleum refining and petrochemicals, and chemical fertilizers are considered to be treated as trains passing the yard, and the wagons to be treated in the marshalling yard are planned to come from the plants of related manufacturing, automobiles and foodstuffs industries. Therefore, the number of main lines for departure and arrival and the number of sorting sidings are to be designed after the scale of the those industries, transportation method, detailed destinations, etc. have been determined. Meanwhile, an interim scale of marshalling yard for about 100 wagons has been proposed. The right of way for extension to the commercial port is assumed.

(5) Main access railway

The trunk line is of single track, judging from the number of trains. The pass-by facilities between the New Ocean Terminal and the river crossing point are provided at one intermediate point, judging from the number of trains.

Alignment plan

The most important control point of this plan is the river crossing site at Lagos Lagoon. The bridge is planned as a rail-cum-road bridge. Therefore, the trunk line is planned to go northward from the marshalling yard of the New Ocean Terminal along the main access road, and after crossing the bridge, it is planned to parallel the existing road as far as Ibadan. Fig. X-25 shows the plan of alignment. The connection to the trunk line now planned in the standard gauge line construction plan for connecting the existing port of Lagos with Kano is made northeast of Ibadan, with Ibadan bypassed on the east. The total length of trunk line is 115 km.

X-6 Construction cost of trunk transportation facilities

In this study, the topographic survey, geological survey, etc. required for design of the trunk transportation facilities were not conducted. Therefore, in this master plan, the bridge and road pavement could not be designed accurately. This being the case, the unit construction cost per km or per unit as shown in Table X-27 was decided based on the scale and typical crosssections of transportation facilities already planned, and with reference to interviews with the authorities concerned made in the study of December,1978 and to the materials such as relative study reports, etc. collected simultaneously. All of these construction costs are expressed in terms of financial costs.

The construction costs of respective transportation facilities planned in X-5 Preliminary design of trunk transportation facilities are arranged by transport modes, by specification, being divided into two areas one for the Development Area and the other for outside the Development Area, in Tables X-28 and X-29.

Fig. X-24 Plan for Port Railway Alignment

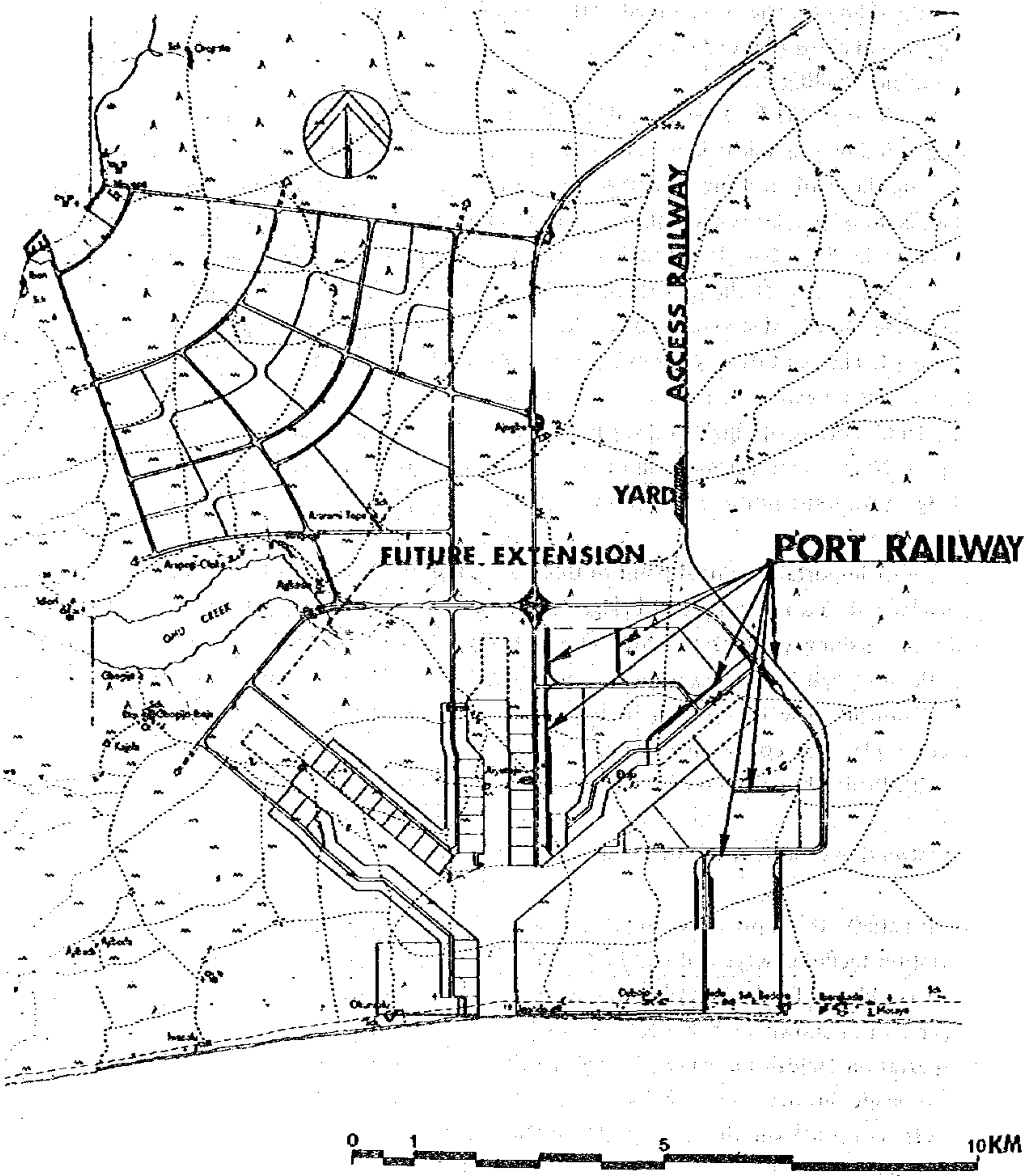


Table X-27 Construction Unit Cost for Transportation Facilities

Road	
Devided 6-lane Road	2.5 million₦/km
Devided 4-lane Road	2.0 million₦/km
Road Bridge	1,800₦/m²
Crover Type Interchange	6.0 million₦/Unit
Trumpet Type Interchange	4.0 million₦/Unit
Diamond Type Interchange	3.0 million₦/Unit
Railway	
Standard Gauge Single Track (Including Signalling, Telecommunication & Small Structures)	1.0 million₦/km
Railway Bridge	2,000₦/m²
Yard (Excluding Main Trail)	3.0 million₦/Unit
Junction (Excluding Main Trail)	1.5 million₦/Unit

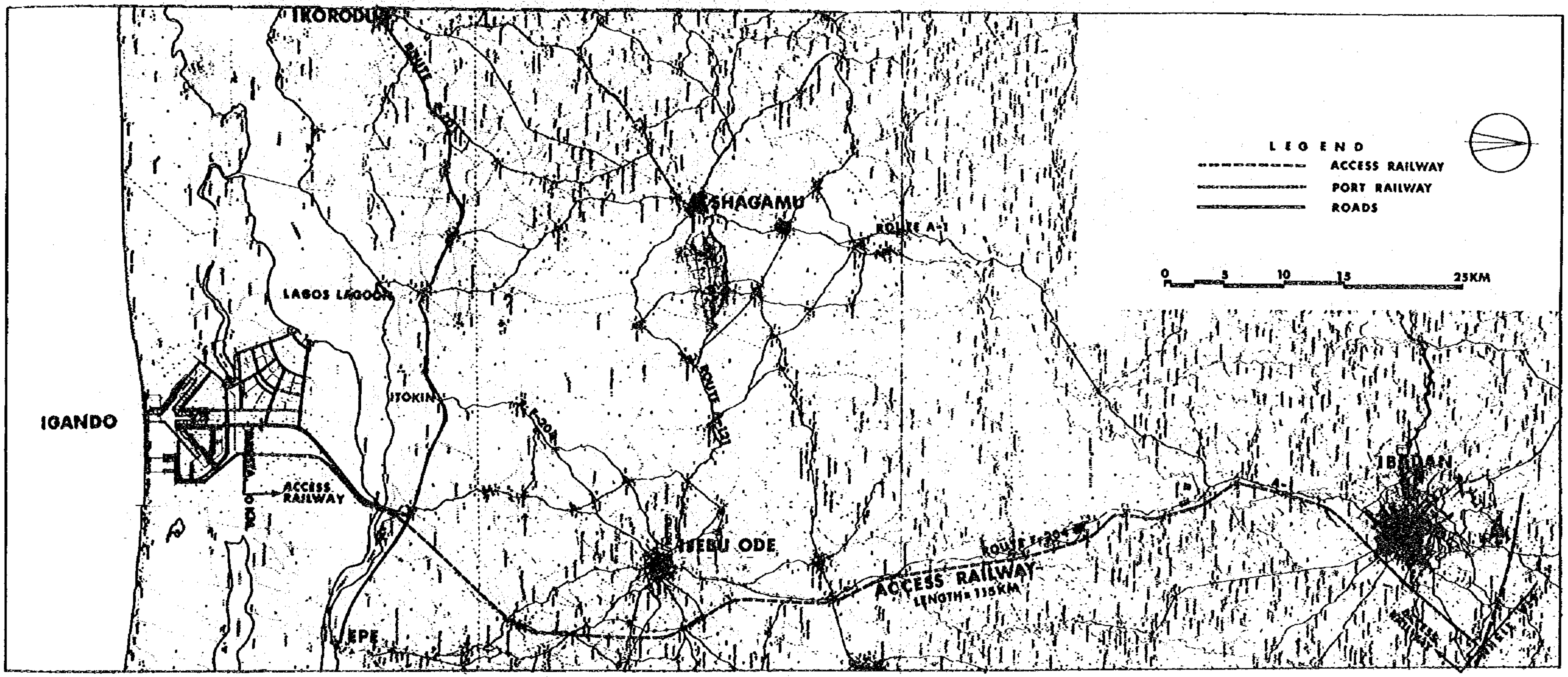
Table X-28 Construction Cost for Transportation Facilities in the Development Area

Arterial Road	Quantity		Construction Cost (million ₦)		
	Embankment Length (km)	Structure	Embankment Section	Structure	Total
Main Access Road 6-lane	12.0	Trumpet I.C. 1 Unit	30.0	4.0	34.0
Ring Road 6-lane	5.2	Crover I.C. 1 Unit	13.0	6.0	19.0
4-lane	8.3	Diamond I.C. 3 Unit	16.0	9.0	25.0
Port Road 4-lane	31.0	–	62.0	–	62.0
Urban Arterial 4-lane	46.5	–	93.0	–	93.0
				Road Total	233.0
Railway					
Port Railway	30.5	Yard 1 Unit	30.5	3.0	33.5
Main Access Railway	6.5	Junction 1 Unit	6.5	1.5	8.0
				Railway Total	41.5
			Transportation Total		274.5

Table X-29 Construction Cost for Transportation Facilities out of the Development Area

	Quantity		Construction Cost (million ₦)		
	Embankment (km)	Structure (m^2)	Embankment Section	Structure	Total
Main Access Road 6-lane	8.7	21,000	21.8	37.7	59.5
Main Access Railway	107.8	3,000	107.8	6.0	113.8
			Transportation Total		173.3

Fig. X-25 Location Map of Access Railway



XI. Concept for divisionanl development

XI. Concept for divisional development

XI-1 Principles

In general, large scale development, not to speak of harbour development, cannot be completed in a short period; in fact it takes a long period of time for completion. Consequently, the larger the scale and the longer the term of a project, the longer the period required for the investment efficiency to be gained. With this type of tendency, it is not rare in the development of a new site to spend a painfully high percentage of capital on the early stages of development while having the period with few concrete results drag on and on. It is, therefore, necessary to divide development stages to increase investment efficiency by planning the project in such a way that it will be possible to commence partial service.

Further, if the target year is far ahead, chances of uncertainty creeping into the forecast of various components of the project will increase. Thus, if investments are made at the initial stage in such a way as to determine the final form of the project, it is possible that contingency offsets the effects of investments.

In order to cope with such uncertainty, it will be necessary to give sufficient consideration to the phases of development so that those facilities provided for the definite demand in the near future may not be detrimental to the response to changing circumstances in future.

From whatever perspective, in order to cope with conditions of this type, the preparation of a so-called the divisional development or stage construction becomes important. This is done by dividing the development plan into appropriate phases. With each new phase there should be the possibility of increasing utilization of the facilities while simultaneously making checks regarding the contents of the later phase plans.

The development of the New Ocean Terminal is one of those projects for which such divisional development is extremely important. As has been mentioned in Phase-I Report and in above Chapters, the scale of the development of the New Ocean Terminal is considerably large, and the development is planned on virgin land which is at a distance from the existing urban accumulation.

Further, compared with the certainly of future demand for commercial port facilities, the possibility of industrial location is somewhat uncertain. In addition, taking account of the present condition of the Lagos Ports Complex, it will be appropriate to divide the development into two stages (1990 and 2000) and plan to commence partial service in respect of the commercial port facilities in the year 1990.

XI-2 Development pattern in the year 1990

The development pattern of the New Ocean Terminal in the year 1990 was planned based on the following principles:

1) Emphasis is placed on the commercial port facilities for which definite demand can be expected in the year 1990;
2) Since the development scale of commercial port functions in 1990 will be relatively small it will not be attractive to large scale industrial location. Accordingly, large scale industrial location is not to be expected in the year 1990;

3) In that case, various facilities are to be positioned in such a way that future expansion may not be hindered and construction order may not be reversed;

4) In particular, breakwaters are to be constructed so as to ensure minimum calmness in the harbour to reduce the initial investment,

5) Necessary facilities are to be positioned at one place so long as it is possible to avoid unnecessary road construction, dredging, etc.

Based on above principles, the port functions are quantitatively arranged as shown in Table XI-1. The corresponding roads, urban population, and so forth are as shown in Table XI-2, and their layout is shown in Figure XI-1.

Table XI-1 Development Scale of Commercial Port Facilities at the New Ocean Terminal in the year 1990

Cargo Traffic, Dimension of Vessels and Berths	General Cargo Berths		Grain Berth	Petroleum Oil Berth	Small Craft Berths	Total
	Break Bulk	Containerized				
Cargo Traffic (1,000 ton/yr.)	1,207	3,006	964*	2,100	–	7,277
Maximum Size of Vessels (DWT)	15,000	G.T. 50,000	30,000	15,000	280GT	–
Structural Depth of Berth (m)	-10	-12(-13)	-12	-10	-3.5	–
Length of each Berth (m/Berth)	185	300	300**	185	–	–
Total Number of Berths	6	6	1	2	–	15
Total Length of Berths (m)	1,110	1,800	300	370	300	3,880
Width of each Wharf (m)	200	400	300	–	25	–

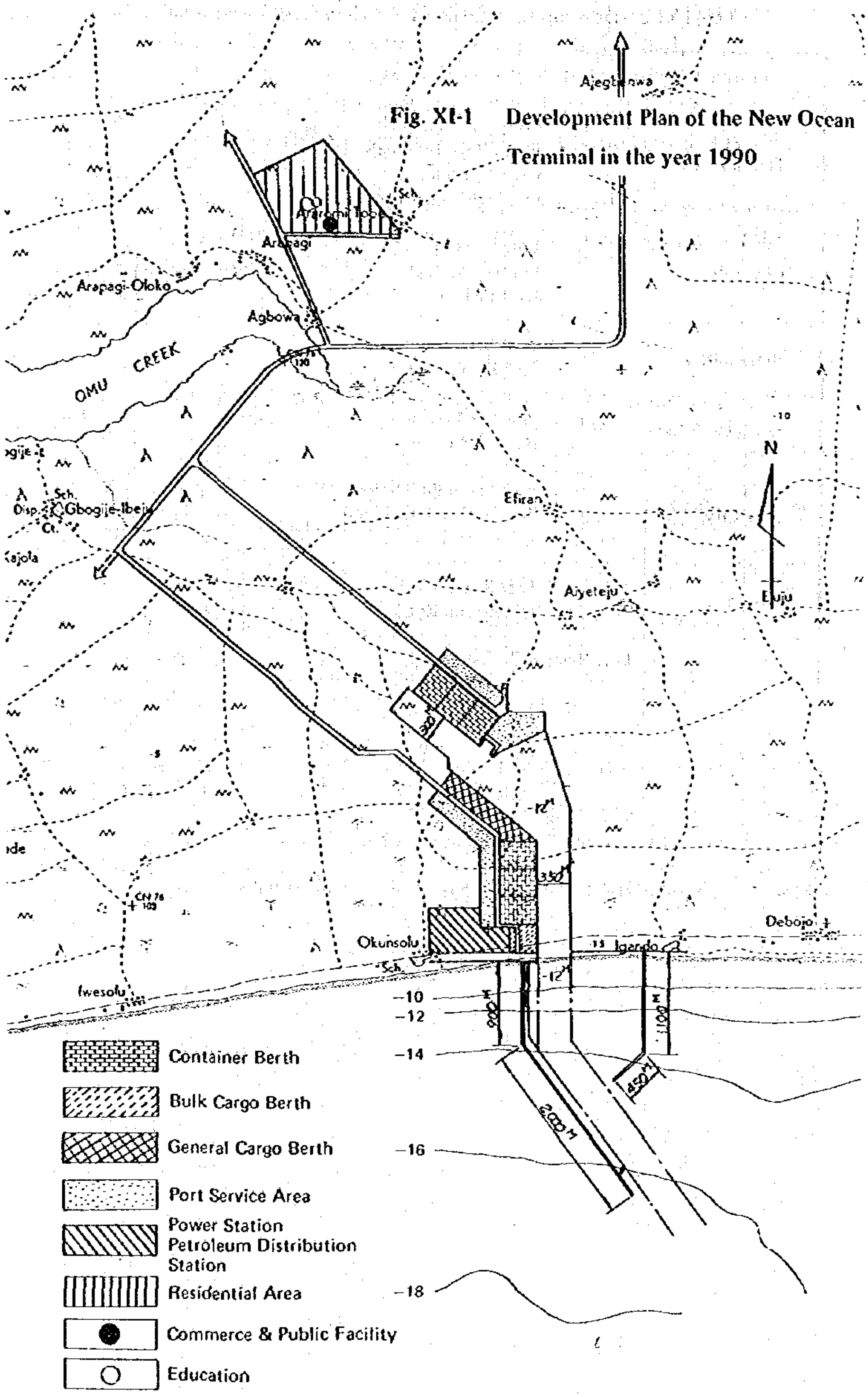
* Including 180,000 ton of cement. All imported cement is going to be replaced by domestic production in the year 2000.

** The length of the grain berth is set to meet the maximum size of vessels (60,000 DWT) in the year 2000

Table XI-2 Development Scale of the New Ocean Terminal in the year 1990

Facilities		Scale
Terminal Area	Container Terminals Break Bulk Terminals Grain Terminal Oil Distribution Terminal	72 ha 22 ha 9 ha 35 ha
Channels	Entrance Channel Central Channel West Chanel	(350 m) x (-12 m) (350 m) x (-12 m) (300 m) x (-12 m)
Breakwaters	West Breakwater East Breakwater	2,900 m 1,550 m
Small Craft Basins	Mooring Facilities Basin Area	300 m 15,000 m^2
New City	Port Labor Population Total Urban Population Urban Area	2,000 7,500 100 ha
Roads	Port Road (A) (B) Outer Link Road	2-lanes 3-lanes
Port Related Business Area		56 ha

Fig. XI-1 Development Plan of the New Ocean Terminal in the year 1990



XII. Preliminary design of breakwaters

XII. Preliminary Design of Breakwaters

XII-1 Design policy of breakwaters

Even if a rubble mound breakwater is to be constructed, it cannot be decided clearly, since sufficient data cannot be obtained as to what weight of rubblestones are available and as to whether they, even if available, can be transported to the site of the New Ocean Terminal. However, according to the result of reconnaissance of the east and west breakwaters of the Port of Lagos, stones of maximum size about 3 m^3 seem to be used. That is, a rubble of almost upto 8 tons are surmised to be able to be used for breakwater construction.

A rubble mound breakwater should be constructed with 8 ton rubble for the particular part where the rubble mound structure can bear the wave force. On the other hand, the type of a composite breakwater (a breakwater with concrete caisson placed on the rubble mound) should be selected for the part where the rubble mound structure cannot bear the wave force.

As for the structural type of breakwater, it can be also considered to use the method in which a breakwater is constructed by rubbles available locally, being covered by wave dissipating concrete blocks resistant to the design wave. However, at present, what types of forms for blocks can easily be obtained in Nigeria is not investigated, and therefore the policy as mentioned above has been tentatively adopted. In the stage of feasibility study of the project, this point, too, should be discussed in comparison.

XII-2 Design conditions

XII-2-1 Estimates of deep-water waves

The British Meteorological Agency collects wave information not only from stations for oceanographic meteorological observation but also from 500 boats regularly sailing throughout the world, and arranges waves data in the respective small divided areas along the coasts of the world. Fig. XII-1 shows the divided areas of the sea along the coasts of Africa. However, the sea along the Nigerian coast is not included in the divided areas. Therefore, the wave data in areas 28 and 34 as the nearest areas to Nigerian coast were used to estimate the deep-water waves along Nigerian coast.

With regard to the wave data of areas 28 and 34, the significant wave heights of deep-water wave to recurrence periods are estimated by applying Gunbell's extremum distribution. Then, they are shown in Fig. XII-2 by a dot-dash-line and a dotted line. According to the result, the significant wave heights of deep-water waves to a recurrence period of 50 years are 8.3 m in area 28 and 8.2 m in area 34, the value of area 28 being a little larger. As the deep-water waves of Nigerian coast, these values are surmised to be a little bit large.

In addition, for the construction of ocean terminal for petroleum shipping, the consultant, A.H. Glenn and Associate, prepared a diagram for the estimates of significant wave heights in deep sea to recurrence periods. This diagram is rewritten as a solid line in Fig. XII-2. According to it, the significant wave height of deep-water wave to recurrence period of 50 years is 6.0 m.

Furthermore, the consultant, Dames and Moore, propose 6.4 m and 11.5 m as the maximum waves in deep sea to recurrence periods of 1 year and 100 years. If they are changed into the

Fig. XII-1 Divided Areas around Africa

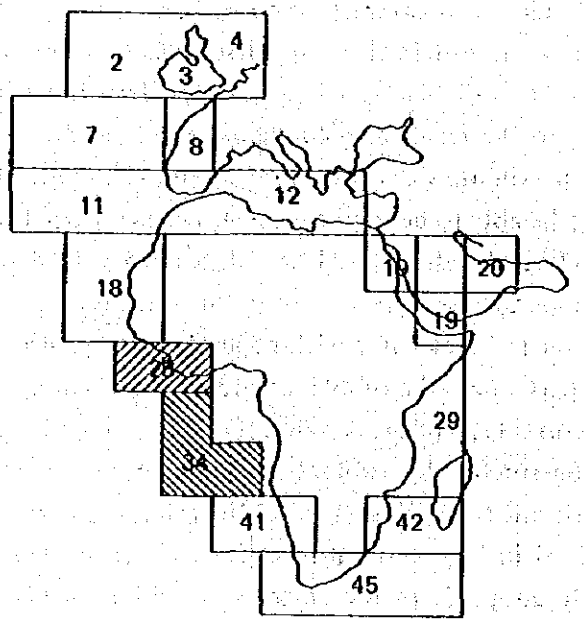
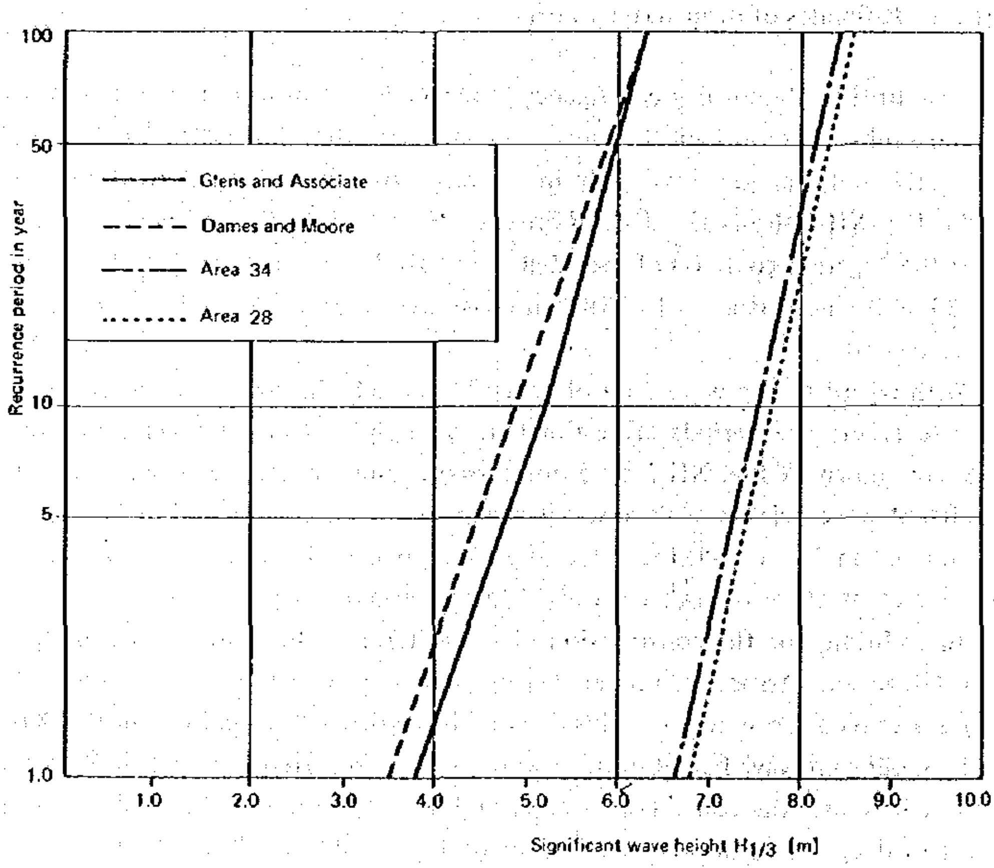


Fig. XII-2 Relation of Significant Wave Height to Recurrence Period



significant wave heights of deep-water waves, using the relation $H_{max} = 1.8\ H_{1/3}$ between maximum wave height (H_{max}) and significant wave height ($H_{1/3}$), they correspond to 3.5 m and 6.3 m respectively. They can be expressed by a broken line of Fig. XII-2. From the above, 5.9 m can be obtained as the significant wave height of 50-year expectation in deep sea.

Based on the above result, 6.0 m is employed as the significant wave height of deep-water waves to be used for designing the breakwaters of the New Ocean Terminal.

Now, it is necessary to estimate the period of the significant wave in deep sea. Regarding this, the above mentioned Dames and Moore Co. proposes $T_{1/3}$ = 12 sec, as the period of wave of 100-year expectation. Furthermore, the period of the highest wave to appear is 11 to 13 sec in Table VII-2. Judging from these, the period for significant wave with 6 m in height is supposed to be 12 sec.

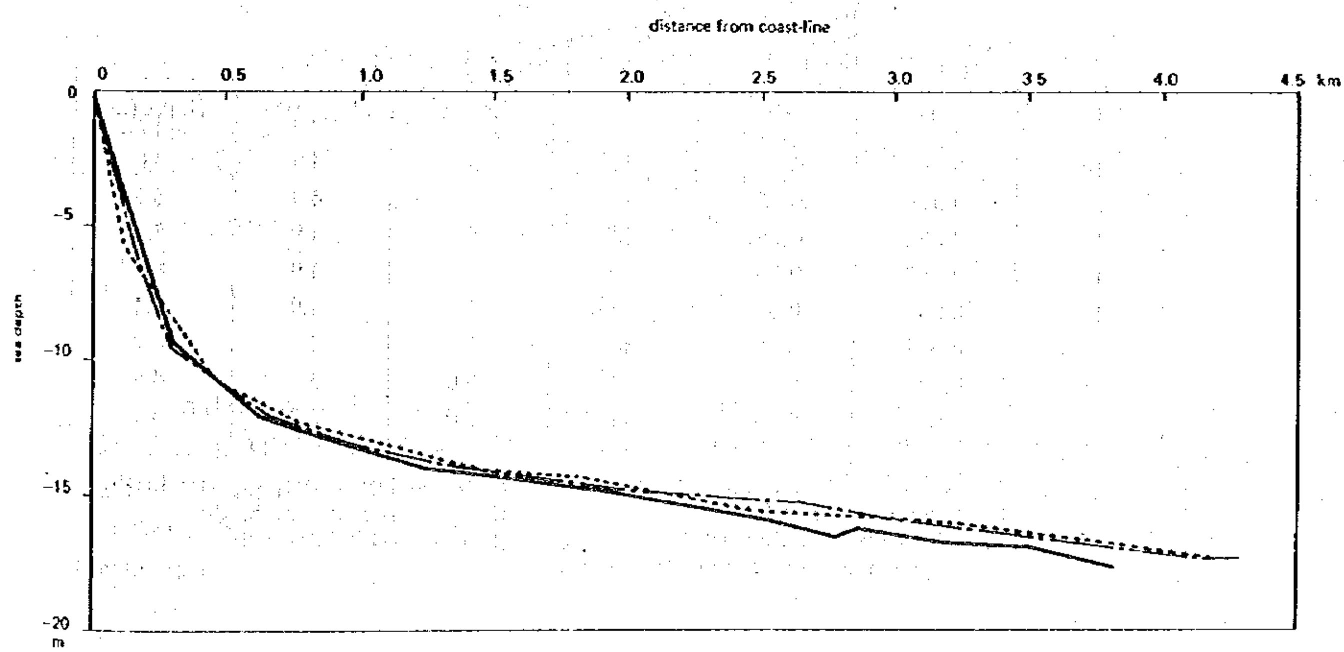
As obvious from Table VII-1, almost half the waves come from southwest, and the highest wave also approaches from southwest.

Referring to the above result, it was determind that the design wave has 6 m in significant wave height of deep-water waves, 12 sec in period and that it approaches from southwest.

XII-2-2 Calculation of design wave heights for respective water depths

Fig. XII-3 shows the bottom topography in front of the construction site of the New Ocean Terminal. This figure was drawn based on the results of sounding conducted from December 1978 to January 1979. It is clarified in the figure that the water depth becomes deeper with sea bottom slope of almost 1/40 to a water depth of 10 m, and at more than 12 m depth the bottom slope becomes suddenly gentle to about 1/1000. Since the deep-water wave height is

Fig. XII-3 Variation of Sea Depth along Three Sounding Lines around the Site of the New Ocean Terminal.



6.0 m, the average bottom slope of 1/1000 between 9 m and 18 m depths is to be used for *calculating the design wave height.*

For the calculation of design waves, the transformation of irregular waves due to breaking is calculated by using the method proposed by Mr. Goda. This calculation method is built on the basic concept that the wave height distribution of irregular waves in deep sea is in *accordance with Rayeiyh distribution,* and that waves begin to break from the larger ones corresponding to the water depth and then lower their height gradually. This calculation includes the effect due to surf beat and due to the change of average water level caused by the change of wave height.

The calculation result obtained by this method is shown in Table XII-1. Since the deep-water wave direction is southwest, the wave height decreases, being affected by refraction. The extent of decrease is expressed with refraction coefficient Kr which is a ratio of wave height to deep-water wave height. In the calculation of refraction coefficient, since waves are considered as irregular waves, the value of Kr is slightly different from that of regular waves. The directional concentration of irregular waves with directional spectrum is expressed by a parameter S_{max}. As value of S_{max} increases, the directional concentration is intensified. The waves of $S_{max} = 20$ with a little swelling are used in the calculation.

Waves with significant wave height of 4.9 m at −18 m depth are attenuated to 3.7 m in significant wave height at −6 m depth by wave breaking. The change of wave height by the breaking is particularly sudden at the maximum wave height, and the maximum wave height of 8.6 m at −18 m depth decreases to 4.9 m at −6 m depth, almost 5/9 that of −18 m depth.

Table XII-1 Variation of Significant Wave Height at Different Sea Depths

Assumption:
Ho = 6.0 m, To = 12 sec
Wave direction: SW
Sea bottom slope : 1/1000
Coeff. of wave directional concentration : Smax = 20

h (m)	h/Lo	Kr	α	Ho' (m)	$H_{1/3}$ (m)	Hmax (m)
18	0.080	0.87	24°	5.2	4.9	8.6
16	0.071	0.86	23°	5.1	4.9	8.6
14	0.062	0.86	22°	5.1	4.9	8.6
12	0.053	0.85	20°	5.1	4.9	8.6
10	0.043	0.85	18°	5.1	4.9	7.4
8	0.035	0.85	16°	5.1	4.8	6.2
6	0.027	0.84	14°	5.0	3.7	4.9
4	0.017	0.84	11°	5.0	2.7	3.7

h = sea depth
Lo = wave length in deep sea
Kr = refraction coefficient
α = predominant wave angle from south

Ho' = equivalent deep sea wave height
Ho = *significant wave height*
Hmax = max. wave height

XII-3 Crosssection design

In the layout of breakwaters as shown in Chapter VII, the east breakwater is within the sheltering area of the west breakwater, and then it is little affected by large waves. On the other hand, the west breakwater is directly attacked by waves. Therefore, in this Section, the cross section of west breakwater is preliminarily designed.

According to the basic policy of XII-1, the part where 8-ton rubblesones provide sufficient resistance is designed against waves of 4.2 m or less wave height, if the slope of rubble mound in front of a breakwater is 1:2. Judging from Table XII-1, it corresponds to the range of –6.5 m or less water depth. From that point, viz. in the portion of –6.5 m or more depth, a composite breakwater is to be built.

Fig. XII-4 shows the approximate design of breakwater at –16 m water depth. The safety factors of the breakwater against sliding and overturning are both 1.2 or more. The design height at the top of breakwater above sea level is to be +3 m, as 0.6 times or more of incident significant wave height. Foot protection blocks are placed on both sides of the composite breakwater.

Fig. XII-4 Crosssection of Composite Breakwater at –16m Depth

Scale 1:300

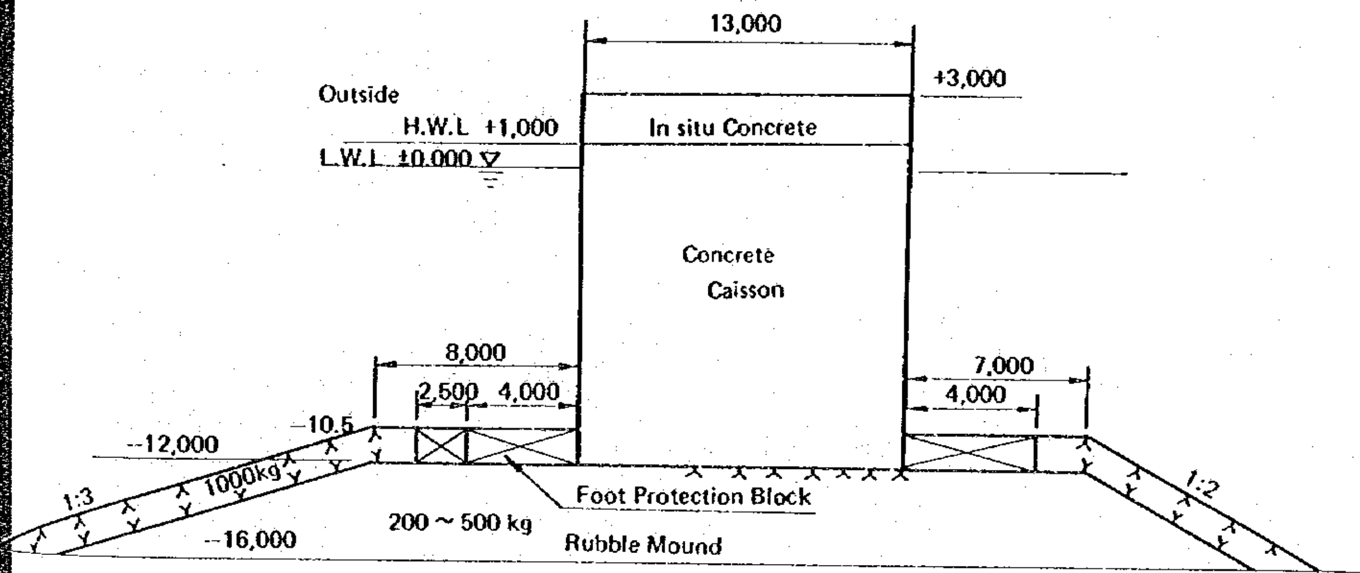


Fig. XII-5 shows the crosssection of rubble mound breakwater at –6 m depth by approximate design. The front gradient is 1:2, and the rear gradient is 1:1.5, the rear gradient being slightly sharper. The top width is 5 m, including allowance. The height at the top of breakwater above sea level is +3.0 m, as 0.6 $H_{1/3}$ or more, being adjusted to that of composite breakwater.

Fig. XII-5 Crosssection of Rubble Mound Breakwater at −6m Depth