REPORT ON THE SURVEY FOR THE DEVELOPMENT PROJECT OF THE URBAN TRANSPORTATION SYSTEM IN THE GREATER CAIRO REGION, THE UNITED ARAB REPUBLIC

DECEMBER 1966

OVERSEAS TECHNICAL
COOPERATION AGENCY
GOVERNMENT OF JAPAN

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PREFACE

In response to the request of the Government of the United Arab Republic, the Government of Japan entrusted the Overseas Technical Cooperation Agency (OTCA) to conduct a survey for the development of public transportation system in the Greater Cairo Region. The OTCA, fully realizing the significance of the mission assigned to it, despatched a Survey Mission comprising eight experts headed by Mr. Yoshikazu Hirose, Director of Planning Dept., Tokyo Expressway Public Corporation, to the United Arab Republic for a period of about one and half months from the end of April till the beginning of June 1966. Since its return to Japan, the Mission has directed its efforts to the compilation and analysis of data and materials collected during the field survey, and the results are hereby submitted to the Government of the United Arab Republic as the "Report on the Survey for the Development Project of the Urban Transportation System in the Greater Cairo Region, The United Arab Republic".

It is my sincere hope that this report, which is an outcome of the joint endeavours of the peoples of the United Arab Republic and Japan, will prove to be useful for the future development of the United Arab Republic, particularly for the progress of the urban transportation system in the Greater Cairo Region, and will also serve to promote close technical and economic ties as well as friendly relations existing between both countries.

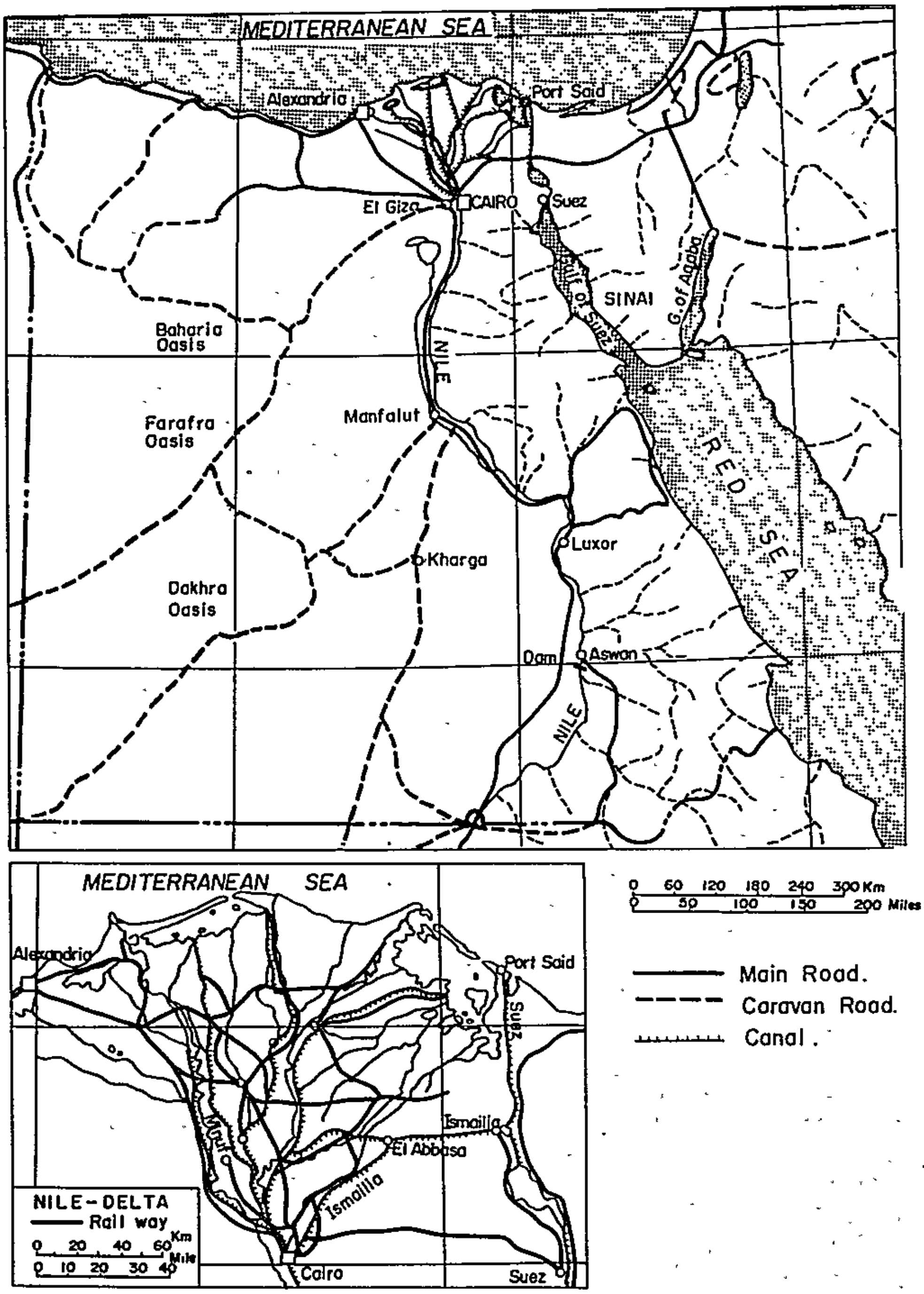
On behalf of the OTCA, I wish to take this opportunity to express my heartiest gratitude to various agencies of the Government of the United Arab Republic, the Greater Cairo Planning Commission and other competent authorities for their unlimited cooperation and assistance extended to the Mission, without which the smooth and efficient execution of the survey would not have been possible.

December 1966

S. Shibusawa

Shinichi Shibusawa

Director General
Overseas Technical
Cooperation Agency



MEDITERRANEAN SEA
Alexandria
Port Said
El Giza
CAIRO
Suez
SINAI
Gulf of Suez
G. of Aqaba
Baharia Oasis
Farafra Oasis
Dakhra Oasis
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NILE
Manfalut
RED SEA
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Aswan
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Main Road.
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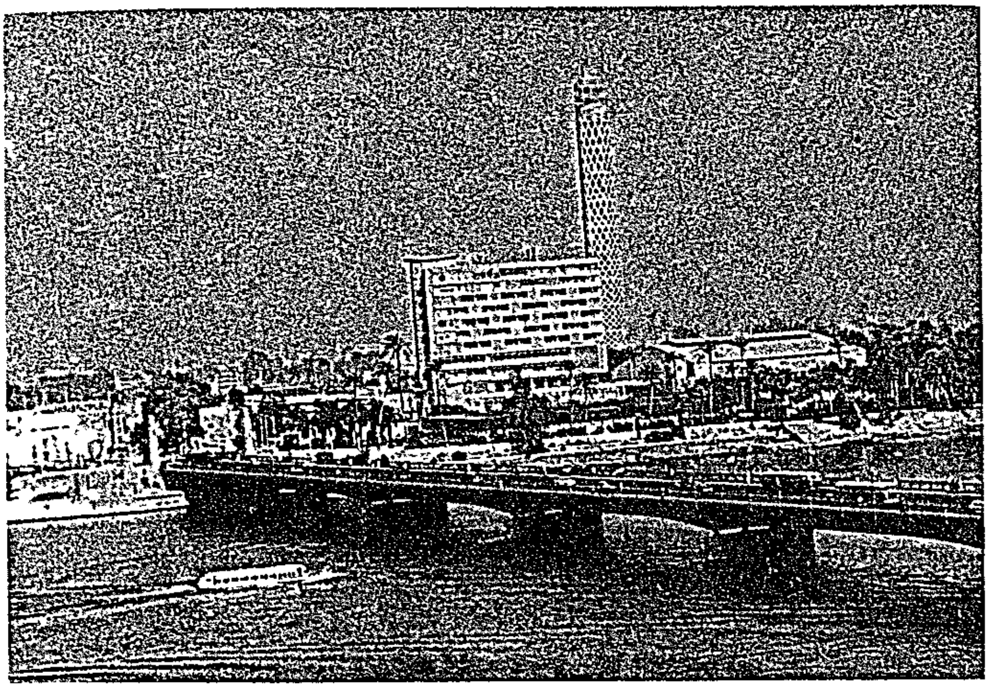
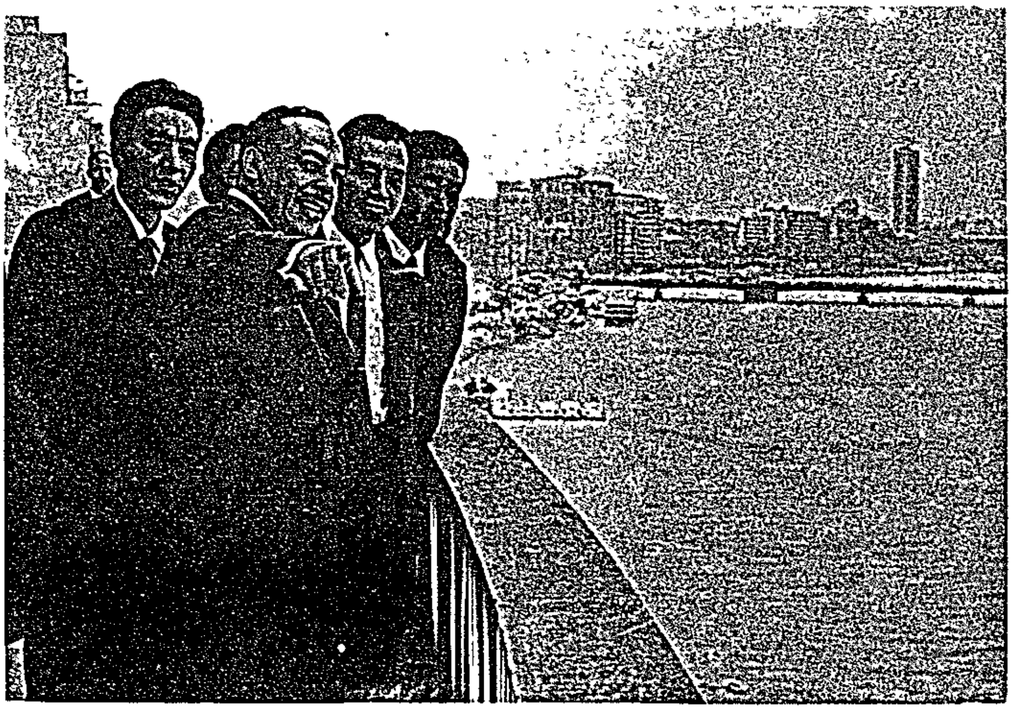


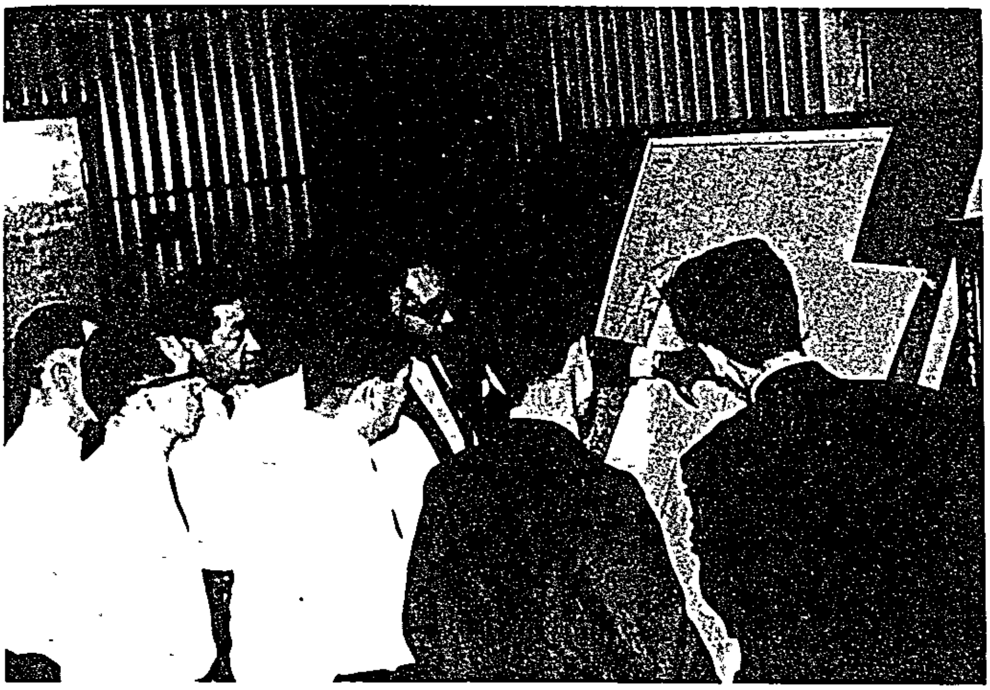
Cairo Tower, Tahrir Bridge and
Nile Bus

Interview with Eng. M. Younes,
Deputy Prime Minister, at the
Ministry of Transport

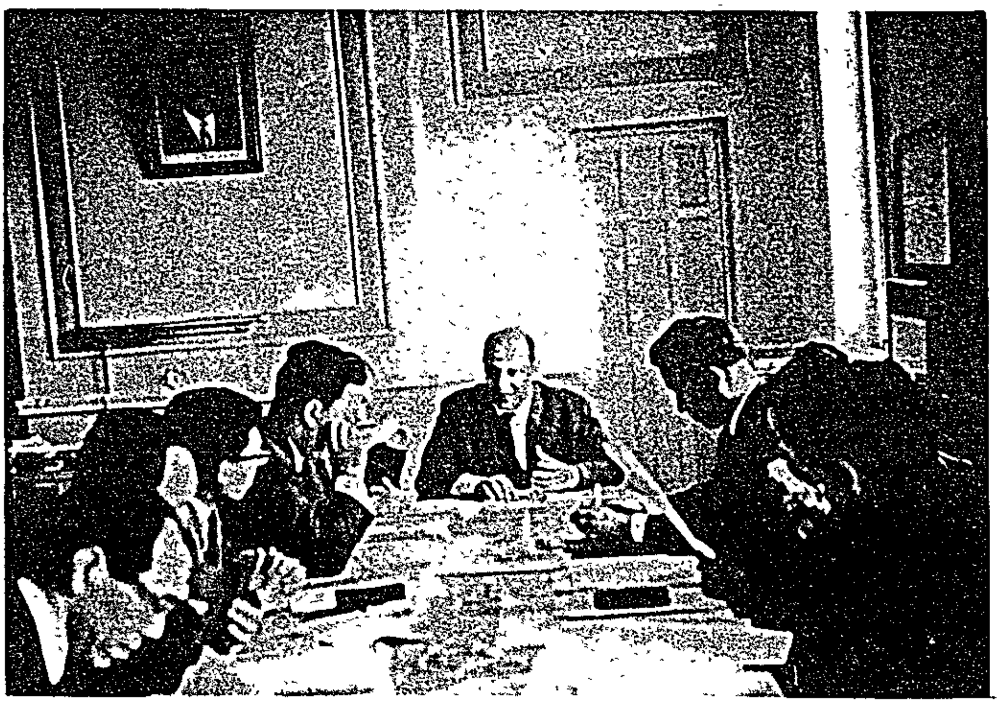
Interview with Dr. M.A.K. Hatem,
Deputy Prime Minister



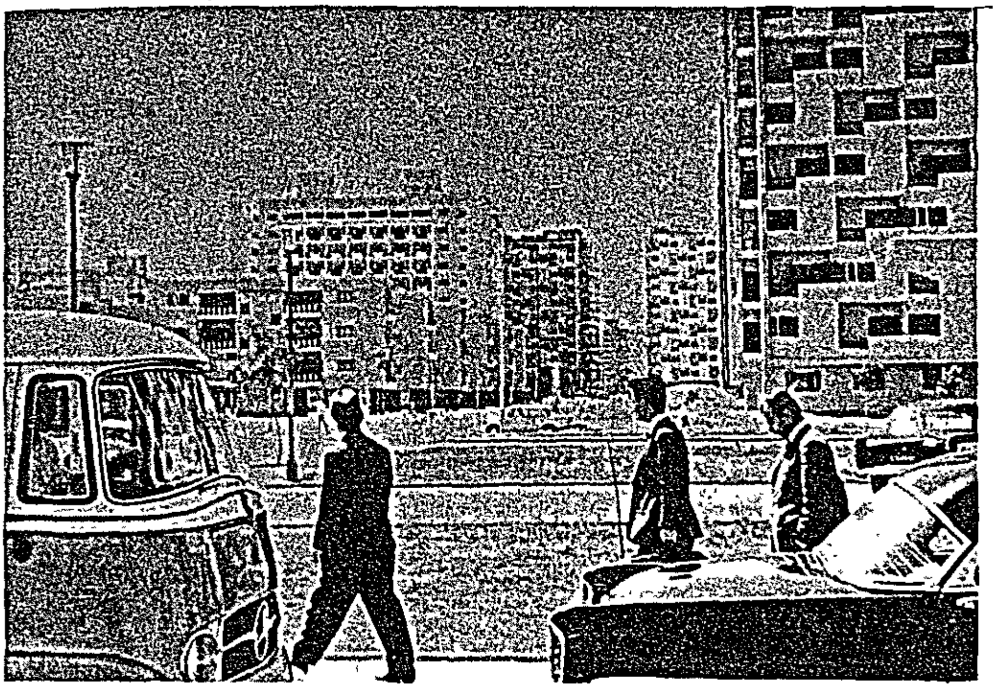
Explanation given by Dr. M.A.K.
Hatem on the City of Cairo



Discussion at the Greater Cairo Planning Commission

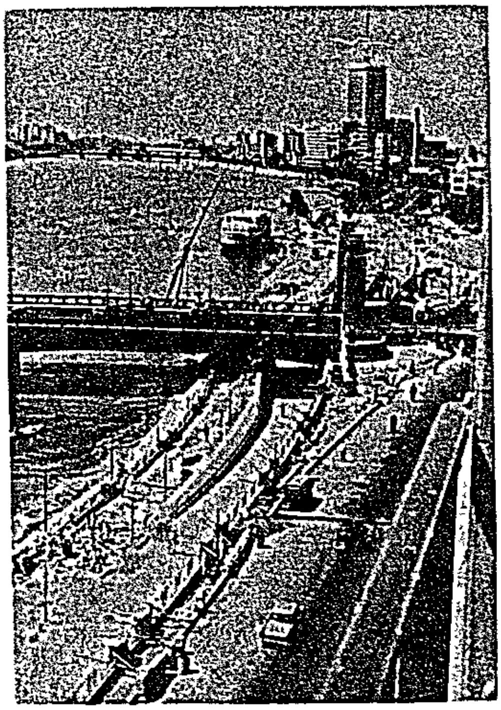


Discussion at the Ministry of Transport

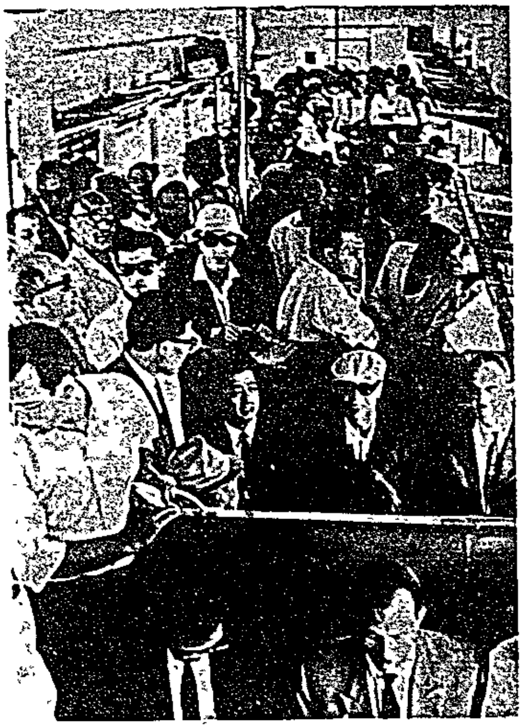


Apartment houses in Nasr City

Metro line



Sub-way construction work under Tahrir Bridge



Morning rush hour in the Egyptian National Railway

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INTRODUCTION

1. Background of investigations

Owing to the remarkable progress of the recent industrial development of the United Arab Republic, there has been a trend of extreme population convergence in cities. The population of Cairo in 1965 was 4 million as against 3.35 million in 1960, indicating a growth rate as high as 4% per annum The development of public transportation means in Cairo and its vicinity in recent years has not been sufficient to cope with this sharp population increase; thus the traffic in the city centre is subjected to severe congestion at present particularly during rush hours. Buses, tramcars and trolley buses are already overloaded and the number of traffic accidents is increasing.

With the view to relieving the pressure of the present traffic congestion, the Government of the United Arab Republic has given high priority to the development of public transportation system in its Second Five Year Plan. Measures have been taken by the Government to modernize the City of Cairo through the establishment of the Greater Cairo Planning Commission (under jurisdiction of the Ministry of Housing and Public Utilities) which has contemplated to construct, according to the preliminary reports submitted by British and French experts, an underground railway network linking the city centre and the suburban areas. This project envisages the construction of an underground railway system with four radial routes originating from the Central Railway Station and extending over a total 28 km distance.

In the meantime, H. E. Dr. Abdel Kader Hatem, Deputy Prime Minister for Culture, visited Japan and inspected underground railway construction work in Tokyo. Dr. Hatem's high evaluation of Japan's technical standards has led to his request, at a later date, that Japan undertake surveys as well as preparation of a feasibility report for Cairo's underground railway project.

On the occasion of the visit of the Japanese delegation headed by H. E. Mr. S. Kawashima, Vice President of the Liberal Democratic Party of Japan, representatives of both the United Arab Republic and Japan reached in February 1966 the agreement that Japan would render technical assistance to the United Arab Republic through despatching a survey mission at an earliest date for the planning of urban transportation system of the Greater Cairo Region inclusive of arterial roads and underground railways.

2. Scope of survey work

The purpose of the present survey was to carry out investigations on the present transportation problems facing Cairo City and to prepare a feasibility report for the development of urban transportation system in the Greater Cairo Region to be submitted to the Government of the United Arab Republic.

The scope of survey work is as outlined below:

(1) Planning of public transportation system

To estimate the future traffic demand and define the most appropriate shares of surface roads and underground railways, with consideration to the existing data, the proposed industrial development plan and the city planning.

(2) Planning of arterial streets network

To prepare a development plan for the network of arterial streets, with item (1) above taken into consideration.

(3) Planning of underground railways

To prepare a construction plan for an underground railway network, with item (1) above taken into consideration, including preliminary design. Items involved in the preliminary design are as follows:

Alignment of an underground railway network
Construction plan
Transportation plan
Construction standards
Typical standards of structures including stations
Construction method
Track structure and facilities for ventilation & drainage
Electrical facilities
Rolling stock and car shed
Construction costs and economic considerations

Field surveys and planning work relative to the above items were carried out laboriously by each member of the Mission during the 40-day stay in the United Arab Republic and in the subsequent several months after the Mission's return to Japan. It is to be mentioned that Dr. Y. Yasoshima and his assistants, Faculity of Engineering, Tokyo University, contributed largely to the preparation of the present report through making an estimate of future traffic demand required for the planning of urban transportation system in the Greater Cairo Region.

After completion of the field surveys the Mission submitted on June 5, 1966 a Preliminary Report of Japanese Survey Mission for the Urban Transportation to the Government of the United Arab Republic.

3. Formation of the Survey Mission

The formation of the Survey Mission was as follows:

Name & Occupation	Assignment
Mr. Yoshikazu Hirose, Director of Planning Dept., Tokyo Expressway Public Corporation	Leader
Dr. Yoshinosuke Yasoshima, Professor, Faculty of Engineering, Tokyo University	Deputy Leader, General city transportation
Mr. Seiya Nakajima, Director of Construction Dept., Teitō Rapid Transit Authority	Deputy Leader, Design & construction technique of underground railway
Mr. Shotaro Saito, Engineer, City Bureau, Ministry of Construction	Member, City planning
Mr. Hiroshi Mochizuki, Chief of Rolling Stock Sec., Rolling Stock Dept., Teito Rapid Transit Authority	Member, Rolling stock & workshop of underground railway

Name & Occupation	Assignment
Mr. Torao Susaki, Engineer, Electric Dept., Teito Rapid Transit Authority	Member, Signalling & electricity of underground railway
Mr. Yoshihiro Matsumura, Deputy Chief of Urban Transport Sec., Secretariat to the Minister, Ministry of Transport	Member, Planning of city transportation
Mr. Hiroshi Kimura, Assistant Secretary, Development Survey Div., Overseas Technical Cooperation Agency	Member, Liaison

The Mission arrived in the United Arab Republic on April 28, 1966 and carried out the field investigations for about 40 days.

The itinerary of the Mission is given in Appendix I.

CHAPTER I SUMMARY AND CONCLUSION

I-1 Premises to studies and planning

In conducting studies and research on the urban transportation system of Cairo, the Mission intended to make full use of various data made available by the Government of the United Arab Republic (hereinafter referred to as "the U.A.R.") and furthermore used the results of the field observations made by the Mission as well as the opinions and investigation results provided by U.A.R. experts. Data concerning the estimate of the future population and the increase of motor cars were considered to be subject to certain modifications, but were utilized without making such modifications.

The scope of work required of the Mission was limited to the preparation of construction plans for arterial streets and rapid transit railways, and therefore does not cover studies pertaining to the future development of the Greater Cairo Region (hereinafter referred to as "the Region") or the land use plan. However, plans relating to transportation cannot be worked out without an estimate of land use whose trend will obviously be affected by the extent and the course of the future development of the Region. It follows, therefore, that those two factors must be borne in mind if the task assigned to the Mission was to be carried out scrupulously. Accordingly, the Mission hoped to carry out its work on the basis of official opinions, if any, of the U.A.R. Government with respect to the above two factors, which were, unfortunately, unavailable.

As a consequence, the Mission made, though cognizant of its faultiness, an estimate of the future land use in the Region which was necessary in mapping out the required transportation plans. Although the estimate itself has a little significance, it may be mentioned that from the observations made in the Region, efforts were exerted to reach as reasonable an estimate as possible.

When proposing a construction plan, it is necessary in most cases to specify the target completion time. Such a target time is often given prior to the commencement of necessary investigations. For the proposed construction plan, however, no such target time assignment was made. The Mission therefore made studies and reviews on various facts and factors relevant to the plan, and reached the conclusion that 1980, or 15 years hence, should be set as the target year. This 15-year period has been preferred to others in order to provide ample time for the preparation of various plans and the completion of first stage construction. In underground railway construction, a preparatory period of 2 - 3 years is required before commencement of construction for a final decision on the plan, detailed designing and programmes for raising necessary funds. Furthermore, the completion of first stage construction is estimated to take a period of 3 to 5 years following commencment of construction. If, for example, the target year is set 10 years hence, it is the time when the first stage construction will have been completed, which would make the preparation of the Master Plan quite meaningless. If, again, the target year is set 20 to 25 years from now, many unpredictable factors may become involved, which would reduce the practicability of the plan. Thus, the 15-year period is proposed to avoid the two extremes.

1-2 Estimate of the future development of the Region

An important fact to take into consideration in estimating the future development of the Region is the rapid population convergence in cities, which, as in many other countries, is expected to continue in the U.A.R. The estimated upward trend of population growth is not anticipated to decline in the future. The Region is situated on the Nile Delta occupying an important area of the country; and although the U.A.R.'s industrial areas are now scattered in the country, e.g., in the south of Cairo and in Aswan district, her industrialization is expected to make a northward expansion in the future, namely, towards the north of Cairo in the direction of the Mediterranean Sea. The Mission accordingly estimates that industrialization in the Region will be most expeditious in the north where substantially great potential changes in land use will be effected in areas which are in comparatively close proximity to the city centre but are not yet urbanized.

The Mission understands that a concept is held by certain quarters that envisages the establishment of satellite towns to the east of Cairo in the direction of Suez as well as towards the west of the city near Giza district. These may be considered as a possible pattern for the future development of the Region. On the assumption that this idea is materialized after the target time set for the completion of the proposed underground railway route, the Mission incorporated it in the Master Plan to an extent, but excluded it from the plan drawn up for the period ending with the target time.

With respect to the population distribution within the Region, study had to be made of the over-populated districts in the central part of Cairo. It is beyond doubt that measures should be taken for relief of the existing high population density and also for the creation of a more hygenic and sound environment in these districts. This, it appears, is not too difficult. Even more serious than this high population density is the magnitude of the population flow into Cairo. This calls for counterbalancing capital investments for the construction of houses, which cannot be considered to be easily achieved.

Accordingly, Mission considers that there will not be any further rise in population density and a rapid decline in density is practically an impossibility, and predicts that the decline will be very sluggish even with continuous effort. Additionally, the Mission predicts that the construction of houses will contribute greatly to expediting the development of new city areas through the efforts by the government.

1-3 Proposals concerning transportation in the Region

Below is a summary of proposals which will be explained in detail in relevant chapters and sections of this report.

1-3-1 Plan for arterial streets

Although an excellent network of streets is found in some sections of Cairo, the dense surface traffic has come to an extent where smooth flow of vehicles in the central and other districts of the city is threatened. The Mission therefore proposes the following:

(1) Planning for a network of arterial streets with the entire city area being considered an integrated system of all peripheral and radial streets, thereby ensuring smooth traffic. This calls for widening and new construction of streets in certain sections;

(2) Provision for two-level crossings at important intersections in the city center, thereby alleviating dense traffic; and

(3) Construction of systematic urban expressways after the target time.

1-3-2 Plan for underground railway

Construction of an underground railway network with an extension of 62.6 km in the Region is proposed. Although this distance is far insufficient to meet the estimated demand of the Region whose population is expected to reach 9 million, it is considered most expedient in view of the amount of underground railway construction that can be achieved for the first time in the U.A.R. within the 15-year period.

Construction of the north-south route running through Shubra district is recommended for initiation as the first stage construction. As for detailed studies relative to the technical feasibility and other factors, explanations will be given later in this report.

In the Region, industrial areas are found to the north and south of the Central Business District (hereinafter referred to as "CBD"). Heavy demand for commuter transportation and resultant congestion arises from Old Cairo and the New Town lying between these areas. Since it is expected that 80% of the Region's future population will be residing on the right bank of the Nile, the construction of an artery for mass transportation running north to south on the right bank, is a matter of utmost urgency for alleviation of traffic congestion. And for this fact, the underground railway is most suitable because of its large transportation capacity. Hence, the early commencement of construction of the north-south line is recommended.

The plan for arterial streets mentioned above should naturally be put into execution in pace with the construction of the underground railway.

1-3-3 Other transportation means

(1) Surface railways

It is evident that the future development of the Region will be accompanied by a huge volume of freight transport. Functions required of freight transport can be fulfilled only with a large freight yard and a large scale freight depot in the railway transport, and with large warehouses and truck terminals in the road transport. Plans to meet these requirements should therefore be drawn up now.

(2) Buses

Buses as mass transportation means will not have less value even if they are connected with the underground railway. Bus services connected with underground railway services will become necessary. An important work for the bus service is a re-alignment of routes to eliminate uneconomical operation to give relief to surface traffic congestion.

(3) The Metro

The Metro offers transportation in Cairo and has unique characteristics with functions midway between the bus and the surface railway or between the surface railway and the underground railway. The Metro is expected to play a considerably important part in future transportation of the city and should therefore serve as a secondary transportation means supplementing bus and underground railway services. It should be preserved and improved in those areas where transportation demand cannot be met by buses only and is not heavy enough to necessitate an underground railway.

In selecting its network, therefore, suburban areas should be given more importance than the central district.

In addition to the points mentioned above, the Nile bus service should be studied.

CHAPTER II GENERAL DESCRIPTION OF THE REGION

2-1 Area and population

The Greater Cairo Region referred to in this report embodies the City of Cairo and parts of three adjoining counties, i.e., Giza, Embaba and Shubra-el-Kheima, covers an area of 206,000 acres (about 803 km^2) and is inhabited by 5,231,000 people (1965).

As shown in Fig. 2-1, the Region is divided into 8 areas, namely 5 areas of the City of Cairo (North, East, Central, South and West Cairo) and 3 areas surrounding the City (Giza City and part of Giza County, Embaba County and Shubra-el-Kheima County).

For the statistical purposes of collecting and compiling necessary data, however, the Region is subdivided into 28 districts.

2-2 Movement and expansion of population

The development of Cairo, the capital city of the United Arab Republic, has been most remarkable in recent years and is characterized by the extreme convergence of population. As is often the case with other countries, U.A.R.'s general trend towards industrialization has necessarily led to the urbanization of new industrial zones and to population convergence in the City of Cairo which is noted to be more intensive than in other major cities of the country, as Alexandria and Port-Said.

One of the effects of the sharp population growth that the U.A.R. has had to cope with recently is found in the ratio of population convergence in Cairo to the nation's total population. The population of Cairo is 5 million against the nation's total population of less than 30 million. Such an extraordinarily high population convergence in a capital city is unparalleled in history except in London in those days when Britain's colonies spread all over the world.

The cultivated lands in the U.A.R. are rather limited due to irrigation problems despite her sharp population growth, and this has led to the inevitable consequence that her sharp population increase must be absorbed by secondary and tertiary industries, — hence the increasing concentration in cities of workers. Thus, it is considered quite a natural tendency for Cairo and other major cities to absorb the whole of the increased population. As for Cairo, its population increase is expected to be quite large, and the es-mate reached by the U.A.R. Government in this connection is not in the least exaggerated.

Another outstanding feature of Cairo's population is the extreme density observed in some of the city's central districts where the number of inhabit-ants exceeds 1,000 per ha. This is much higher than the density normally considered desirable. Although this high population density should be under-stood in relation to the city's historical background, measures should be tak-en to gradually reduce the present density.

Construction of houses to meet the population convergence in many cities is not in all cases carried out smoothly, and this is a phenomenon common to many countries of the world. A housing problem is not a matter that can be easily solved. In the case of Cairo, as in many other cities of the world, many years of persistent effort will be required to settle the existing housing problem and to achieve a desired decline in the population density.

Table 2-1

Changes in the Population of the UAR, the Greater Cairo Region and the City of Cairo

Year	U A R		G C R				C A I R O			
	Population	% Annual increase	Population	% to U A R		% Annual increase	Population	% to G C R		% Annual increase
				Actual	Trend			Actual	Trend	
1882	6,712,000		520,137	7.7			350,316	60.5		
1897	9,669,000	2.9	812,226	8.4		3.7	534,648	65.8		3.4
1907	11,190,000	1.6	976,512	8.7		2.0	683,279	70.0		2.8
1917	12,718,000	1.4	1,063,405	8.4	8.5	0.9	748,241	70.0	79.5	1.0
1927	14,178,000	1.1	1,433,972	10.1	10.0	3.5	1,078,349	74.2	79.0	4.4
1937	15,921,000	1.3	1,769,903	11.6	11.6	2.4	1,345,379	76.1	78.5	2.5
1947	18,967,000	1.8	2,602,986	13.8	13.7	4.7	2,075,096	79.8	78.0	5.4
1960	25,984,000	2.8	4,331,876	16.7	16.5	5.1	3,348,779	78.2	77.5	4.7
1965	29,500,000	2.8	5,231,000	17.8	17.8	4.2	4,028,500	77.1	77.0	4.2
1970										
SERIES I	31,678,000	1.5	6,018,000			3.2	4,603,000			2.8
SERIES II	33,082,000	2.3	6,285,000		19.0	4.0	4,794,000		76.5	3.8
SERIES III	34,495,000	3.6	6,554,000			5.0	5,013,000			4.8
1975										
I	33,830,000	1.4	6,968,000			3.1	5,295,000			2.8
II	36,795,000	2.2	7,579,000		20.6	4.0	5,760,000		76.0	3.8
III	39,741,000	3.2	8,186,000			4.8	6,221,000			4.7
1980										
I	36,237,000	1.4	8,044,000			3.0	6,073,000			2.8
II	40,962,000	2.2	9,093,000		22.2	4.0	6,865,000		75.5	3.8
III	45,687,000	3.2	10,142,000			4.8	7,657,000			4.6
1985										
I	38,792,000	1.4	9,310,000			3.0	6,982,000		75.0	2.8
II	45,662,000	2.2	10,958,000		24.0	4.0	8,218,000		78.0	3.8
III	52,533,000	3.2	12,607,000			4.8	9,455,000			4.8

Table 2-2

Changes in the Population of the Greater Cairo Region, 1947 - 1965

District	Population 1947	Density 1947	Annual change 1947	Population 1960	Density 1960	Annual change 1960	Population 1965	Density 1965	Area in Acres
North Cairo									
El Sahel	97.692	67	16.1 %	303.602	207	3.6 %	356.500	227	1467.54
Rod-el-Farag	165.871	260	4.6 %	265.139	415	3.2 %	306.700	480	639.09
Shoubra	157.076	91	6.8 %	296.008	171	3.4 %	347.300	200	1727.91
T o t a l	420.909	110	8.1 %	864.749	223	3.4 %	1.010.500	262	3834.54
East Cairo									
El Mataria	48.422	3	17.9 %	160.820	10	3.4 %	188.100	12	16071.93
El Zeitoum	45.895	49	9.2 %	100.374	101	3.6 %	118.700	120	994.14
Heliopolis	81.513	11	4.2 %	124.774	16	3.- %	143.400	19	7645.41
El Waili	146.503	38	8.2 %	307.173	78	10.1 %	471.300	121	3905.75
Total	311.244	11	9.4 %	693.141	24	6.6 %	921.500	32	28617.23
Central Cairo									
El Zaher	60.777	135	5.- %	99.617	222	3.4 %	116.400	260	449.73
Bab-el-Shaaria	132.824	510	1.2 %	153.131	588	1.4 %	164.400	630	260.37
El Moski	35.963	252	0.6 %	38.469	271	3.6 %	45.100	317	142.02
El Gamalia	107.692	95	2.5 %	141.724	125	4.4 %	172.500	153	1136.16
El Darb-el-Ahmar	122.080	184	1.4 %	148.606	265	3.6 %	174.600	263	66[illegible].76
El Khalifa	114.715	56	3.2 %	161.958	79	4.- %	194.000	98	2035.62
Total	574.051	123	2.3 %	743.505	160	3.2 %	867.000	185	4686.66
South Cairo									
Masr-el-Kadima	100.904	42	7.7 %	212.233	88	3.4 %	249.200	104	2414.34
El Maadi	42.944	8	7.3 %	83.000	14	3.4 %	96.900	16	5941.17
Helwan	24.028	16	22.4 %	94.385	63	3.6 %	110.400	73	1514.88
Total	167.876	17	10.2 %	389.618	39	3.4 %	456.500	47	9870.39
West Cairo									
Boulac	193.541	302	0.3 %	202.023	315	3.6 %	237.400	370	639.09
El Azbakia	62.354	155	0.3 %	64.032	159	3.6 %	75.200	187	402.39
Kasr-el-Nil	31.268	22	1.3 %	43.094	30	3.8 %	51.200	36	1420.20
Abdine	100.740	250	-0.5 %	94.969	234	3.4 %	110.600	275	402.39
El Sayeda Zeinab	187.875	227	2.8 %	253.648	307	3.6 %	298.600	360	828.45
Total	575.788	157	1.1 %	657.766	168	3.6 %	773.000	210	3692.52
Giza I				145.332	118	4.2 %	176.000	128	1230.84
	99.316	32	11.6 %						
Giza II				105.202	56	4.2 %	127.000	67	1893.60
Giza County	174.355	4	0.4 %	167.226	4	4.- %	201.000	5	40168.00
Embaba				136.429		4.2 %	165.000		
	264.118	3			4.60			5.50	98561.90
Embaba County				316.617			379.000		
El Ahram				11.684	2	4.- %	14.000	2.2	6390.90
Total	537.789	4	5.8 %	882.490	5.90	4.- %	1.062.000	6.8	148245.24
Shoubra-el-Kheima	41.395	6	11.2%	100.607	13	2.8 %	115.000	15	7007.32

Table 2-3

Population Distribution by Profession (Persons 15 years and more), 1960

District	Total	Agricul-ture & Mining	%	Profes-sionals	%	White Collared	%	Sales	%	Industrial & Trans-portation	%	Servi-ces	%	Others	%	None	%
North Cairo																	
El Sahel	166396	867	0.5	8919	5.4	9428	5.7	9075	5.4	34237	20.7	11944	7.4	3253	1.9	88673	53.-
Rod-el-Farag	149914	305	0.2	9208	6.2	8572	5.7	10852	7.2	27392	18.2	9406	6.3	3087	2.-	81092	54.2
Shoubra	165387	1111	0.7	6012	3.7	7763	4.7	11488	7.-	35665	21.6	13189	8.-	3424	2.1	86735	52.2
East Cairo																	
El Mataria	84859	5488	6.5	2584	3.-	2910	3.5	4628	5.4	15053	17.8	6663	7.9	2193	2.6	45340	53.3
El Zeitoum	55521	429	0.8	3308	5.9	3126	5.6	2827	5.1	8983	16.2	5928	10.7	1358	2.4	29562	53.3
Heliopolis	71339	318	0.4	10760	15.1	4914	6.9	2950	4.1	4527	6.4	10639	14.9	1090	1.5	36141	50.7
El Waili	172731	1513	0.9	9896	5.7	8929	5.8	8980	5.8	29938	17.3	15810	9.2	4131	2.4	93534	52.9
Central Cairo																	
Bab-el-Shaaria	85032	86	0.1	2331	2.7	3193	3.8	7211	8.5	19839	23.3	6487	8.-	1830	2.1	44055	51.5
El Moski	20487	114	0.5	708	3.5	1070	5.3	2377	11.6	3777	18.5	1760	8.6	328	1.6	10353	50.4
El Gammalia	78489	359	0.5	1402	1.8	2348	3.-	8633	11.-	18175	23.2	5563	7.1	1101	1.5	40908	52.-
El Darb-el-Ahmar	82580	137	0.2	2968	3.6	3466	4.2	7638	9.2	17578	21.2	5900	7.2	1386	1.7	43507	52.7
El Khalifa	61317	445	0.5	2982	3.2	3255	3.6	5390	5.9	22709	25.-	7250	8.-	2315	2.6	46971	51.2
El Zaher	58288	78	0.1	5466	9.3	4519	7.8	3324	5.7	6238	10.7	8187	14.-	1223	2.1	29253	50.3
South Cairo																	
Misr-el-Kadima	118690	619	0.5	7788	6.6	4685	4.-	7600	6.4	21950	18.5	10242	8.7	2103	1.8	63703	53.5
El Maadi	48270	4846	10.1	1972	4.1	1300	2.7	2631	5.5	9230	19.2	4996	10.4	899	1.8	22396	46.2
Helwan	52997	2032	3.9	2366	4.5	1827	3.5	1635	3.1	13247	25.2	2999	5.7	1159	2.2	27232	51.9
West Cairo																	
Boulac	113009	227	0.2	4230	3.8	2975	2.7	10372	9.1	27174	23.8	1694	1.5	2169	1.9	58937	57.-
El Azbakia	35384	198	0.5	2469	6.9	2217	6.3	3274	9.2	5485	15.6	3975	11.3	746	2.1	17020	48.1
Kasr-el-Nil	23171	167	0.7	3037	13.1	956	4.2	921	4.-	1327	5.7	5545	24.-	281	1.2	9937	47.1
Abdine	51242	122	0.2	3934	7.7	3504	6.9	2972	5.8	8026	15.7	5629	11.-	973	1.9	26082	50.8
El Saida Zeinab	144896	447	0.3	9656	6.7	9687	6.7	8658	6.-	23424	16.2	13019	9.1	3107	2.1	76898	52.9
El Giza																	
Giza I	83129	1136	1.3	6631	8.-	4443	5.3	4750	5.7	10893	13.1	9290	9.9	1768	2.1	45398	54.6
Giza II	59190	784	1.3	7572	15.4	2920	4.9	2827	4.8	4079	6.9	8752	14.7	784	1.3	30482	50.7
El Ahram	6225	311	5.-	132	2.1	171	2.7	279	4.5	863	13.8	907	14.5	47	0.8	3497	56.6
Giza Country	94929	16140	18.-	851	0.9	1472	1.5	5979	6.3	12553	13.2	5722	6.-	1057	1.1	51155	53.-
Embaba																	
Embaba City	73165	824	1.1	2227	3.-	3490	4.8	3689	5.-	15812	21.7	5887	8.-	1615	2.2	39627	54.2
Embaba County	182158	52920	29.1	807	0.4	1259	0.7	7004	3.8	16740	9.2	5126	2.8	1627	0.9	96675	53.1
El Kalubia																	
Shoubra-el-Kheima	55868	2984	5.4	434	0.8	982	1.8	2066	3.7	17996	32.2	2569	4.6	706	1.3	28122	50.2

Table 2-4

Population Distribution by Level of Education (Persons 10 years and more)

District	Illiterate	%	Below Average	%	Intermedaite Education	%	College & Graduate degree	%	Total	%
El Sahel	91989	45.5	81965	40.1	24370	12.-	4943	2.4	203267	100.-
Rod-el-Farag	81739	45.-	71538	29.-	26412	14.3	5017	2.7	184706	100.-
Shoubra	105926	52.5	73283	36.5	19388	9.5	3356	1.7	201753	100.-
El Mataria	58682	54.5	37764	36.3	8344	7.9	1160	1.6	105950	100.-
El Zeitoum	30687	43.5	26955	39.-	9260	14.1	2333	3.3	69285	100.-
Heliopolis	36600	28.-	36751	38.7	22377	23.4	9455	9.9	95183	100.-
El Walli	99177	47.-	79418	37.4	26637	12.5	6484	3.1	211716	100.-
El Zaher	22970	30.8	33681	45.3	14183	19.1	3578	4.8	74412	100.-
Bab-el-Shaaria	59618	56.8	35790	34.1	8407	8.1	1041	1.-	105856	100.-
El Moski	12829	47.2	11350	41.5	2748	10.-	357	1.3	27284	100.-
El Gamalia	58345	58.-	33310	33.-	5212	8.7	526	0.5	97393	100.-
El Darb-el-Ahmar	53199	52.-	38892	38.-	9910	9.6	1472	0.4	103483	100.-
El Khalifa	61168	55.2	40324	36.4	9139	8.3	1356	0.1	111967	100.-
Masr-el-Kadima	73962	50.-	49786	34.3	17758	12.1	5639	3.6	147145	100.-
El Maadi	32921	56.-	19452	33.1	4634	7.9	1764	3.-	58771	100.-
Helwan	33279	51.9	23075	36.-	6763	10.2	1223	1.9	64340	100.-
Boulac	84017	60.5	46509	33.5	7710	5.5	744	0.5	138980	100.-
El Azbakia	18679	40.-	20860	42.5	6809	14.1	1650	3.5	48028	100.-
Kasr-el-Nil	10789	31.-	12797	36.-	6606	19.-	4943	14.-	35135	100.-
Abdine	26096	37.-	30429	43.-	11153	15.7	3023	4.3	70701	100.-
El Saida Zeinab	75988	42.5	70447	39.-	27370	15.3	5789	3.-	179604	100.-
Giza, I	44024	43.-	37814	36.7	16183	16.-	5277	4.3	103298	100.-
Giza, II	30054	40.-	25495	32.5	14148	18.2	7221	9.3	76918	100.-
Giza, County	84692	74.-	25418	23.-	2988	2.6	415	0.4	113513	100.-
Embaba	45916	51.-	36102	40.-	7823	8.7	940	0.3	90781	100.-
Embaba County	176800	79.-	38412	16.5	2784	3.6	213	0.9	218209	100.-
El Ahram	4692	60.-	2638	27.5	513	7.4	121	5.1	7964	100.-
Shoubra-el-Kheima	43861	65.-	21416	31.5	1973	2.9	110	0.6	67160	100.-

2-3 Land use

Cairo is a city built on the alluvial soil along the Nile, with almost unexploited desert areas extending in the east and west. Land use is therefore limited to the low-lying lands along the Nile.

A policy is being adopted to reserve all the existing cultivated lands and no urbanization is being carried out in those cultivated areas that are within easy access and close proximity of the central district of Cairo. Further, despite their proximity to the city centre, desert areas on the outskirts of the city are left unexploited due to deficient transportation facilities. Expansion of a city in area normally takes the form of outward development in all directions from the city centre to suburban and outlying areas. In this respect, Cairo presents a picture quite different from those of other cities.

With regard to the urbanization of lands now under cultivation, it is not justifiable to expect immediate execution since these lands are the fruits of many years of elaborate work and efforts by the Egyptian people. Exploitation of desert areas, however, should not be too difficult if proper arrangements are made for water supply and transportation, and once exploited, the benefits of accessibility to the City of Cairo will be great enough to more than make up for any other disadvantages in these areas.

From the viewpoint of effective land use, therefore, the policy currently adopted by the U.A.R. Government for the urbanization of desert areas is quite commendable. Construction of houses and other buildings are now being carried out in Heliopolis, Nasr City and Mokkatam Hill district. The Mission paid particular attention to the extablishment of a new district for government offices in Nasr City. It has been noted that construction of new government buildings is under way in Nasr City. Establishment of such a new office district presents a contrast to the prevailing concentration of government offices in the central districts of many cities, but will provide an example of a dual-centred city which would alleviate the problem of excessive office building concentration within a limited district and of resultant inconvenience caused by difficult accessibility.

2-4 Characteristics of each district

Table 2-4 indicates that districts within the Region can be classified into 3 groups by standard of education and ratio of college and graduate degrees. Districts with a higher "cultural level" of inhabitants, where the ratio of illiteracy is lowest and that of college and graduate degrees highest, are: Heliopolis, Kasr-el-Nil and Giza II, followed by 9 districts of Rod-el-Farage, El-Sahel, El-Zeitoun, El-Waili, El-Zaher, Nasr-el-Kadima, El-Azbakia, Abdine and Giza I. Districts that may be called "Downtown", with the highest ratio of illiteracy and the lowest ratio of college and graduate degrees, are the 7 districts of Bab-el-Sharia, El-Gamalia, El-Khalifa, Boulac, Giza County, Embaba County and Shubra-el-Kheima County.

On the right bank of the Nile, more working population are found in Shubra and Khalifa in the north and in Saida Zeinab and Waili in the south than in other districts, with CBD located in between. This north-south distribution of working population also applies to the left bank of the Nile where workers are found in greater numbers in Embaba in the north and el-Giza in the south, with Dokki located between the two districts.

CHAPTER III PRESENT STATUS OF TRANSPORTATION IN THE REGION

3-1 Introduction

Following is a summary of the facts that drew the Mission's attention during the course of its investigations on transportation in the Region.

As is the case with many other cities, Cairo depends predominantly on different forms of surface transportation which are supplemented, to an extent, by railway service and by the Nile bus service, though to a far less degree.

Surface transportation consists of two categories: the individual traffic by means of footpasses, handcarts, cattle-driven carriages or private motor cars, and the public transportation means such as taxis, buses, tramcars or the Metro.

The slow moving handcarts and cattle-driven carriages, though their traffic volume is extremely small, are greatly impeding the smooth traffic of motor cars, and their passage is prohibited on certain sections of roads in Cairo. Though it does not appear practicable at the present stage to totally prohibit the use of these slow moving vehicles due to the small number of motor cars registered in Cairo, it will become inevitable in the future to place increasingly severe restrictions on their use.

3-2 Number of motor cars

The total number of motor cars registered in the Region, as disclosed by the survey carried out in March 1966 (See Table 3-1), is 93,821. Overall ownership is 1 car to slightly over 55 persons including motorcycles, or 1 car to 65 persons excluding them. Compared with the ownership of 1 car to 10 persons in 1965 in 23 wards of Tokyo, the figures given above are not considered particularly great as an absolute quantity. (See Fig. 3-1)

Passenger cars account for as much as 72% of all the cars registered, indicating similarity to the trends in advanced countries. With trucks, however, it is hoped that their present low number may not become an obstacle to future industrial development.

Table 3-2 shows the transition of both population and number of cars in Cairo. A prominent characteristic of surface transportation in Cairo is that while the volume of traffic linking Cairo and its hinterland or other cities of the country is exceedingly small, the highest traffic density is observed in and around CBD.

Table 3 - 1

Number of Cars Registered in Cairo
And Adjacent Governorates
March 1966

Kind	Cairo	Giza	Kaliubia	Total
Passenger cars x	59,047	8,213	439	67,699
Taxi Cabs	5,095	824	185	6,104
Public Busses	1,540	132	63	1,735
Private Busses	521	41	33	595
Tourist Busses	229	1	-	230
School Busses	369	11	-	380
Trucks	1,140	775	285	2,200
Trailers	912	33	35	980
Tractors	36	25	30	91
Motor-Cycles	11,842	1,487	478	13,807
Total	80,731	11,542	1,548	93,821

Horse and donkey drawn carriages 40,000

x Includes Government Cars

Table 3 - 2

Population and Number of Cars
in Cairo

Year	Population (Unit: 1,000)	Growth rate	No. of Cars	Growth rate
1960	3,348	1.00	57,000	1.00
1965	4,028	1.20 (1.00)	73,000	1.28 (1.00)
1980	6,500	1.94 (1.61)	137,000	2.40 (1.88)

3-3 General description of roads

Roads in Cairo are in good condition with sufficient width except for certain sections running through North, Central and South Cairo. In older sections of the city, however, alignment of roads is not satisfactory in many areas.

From the viewpoint of civil engineering work, roads in Cairo are lacking side-ditches that are found constructed along extremely limited distances. This is ascribable to the small rainfall throughout the year.

The newly constructed peripheral transport road, and the arterial road now under construction in Nasr City as part of the planned establishment of new city areas, are excellent with roadway of ample width.

3-4 Traffic volume of motor cars

A traffic volume survey conducted in December 1965 revealed that a 24-hour traffic volume exceeding 5,000 cars was registered on two road transport routes of Cairo. One of them is the route linking Ramses St., Tahrir St. and El-Giza St., and the other 26th July St. A maximum traffic volume of 71,594 cars was registered at a point on the Ramses St. near the Central Railway Station.

It is noted that streets with a volume of more than 2,000 cars constitute arterial streets for motoring traffic in the city area. These streets are:

Shubra St., El-Khalifa — El-Mamoun St., Eigish St., Nile St. (Giza), El-Azhar St., Nile Cornish St., El-Ahram St., and Cairo University St. (See Fig. 3-2)

3-5 Traffic accident

According to 1965 statistics, 1,161 cases of traffic accidents occurred within the city area, with 155 persons killed in the accidents. These figures are quite small when compared with Tokyo where 139,629 accidents occurred and 1,167 were killed according to data collected in 1961.

3-6 Buses

As indicated in Table 3-3, buses that are in good condition and in service is 1,089, constituting 56% of the total of 1,945 buses. The rate of operation, therefore, is not considered satisfactory. In the Region, a basic number of 980 buses are placed in daily service covering 125 routes.

An analysis of the bus operation in the Region is summarized below.

Item 1 - The total distance covered by 125 routes serving the Region is 1,490 km, average extension covered by one route being 12 km. 3 routes, linking Helwan and the city centre, extend over a distance of more than 30 km, and 5 other routes extend over a distance exceeding 20 km.

Item 2 - The average number of passengers carried by one vehicle per day is less than 1,000 on 18 routes, the number of buses serving these routes being about 110.

Item 3 - 15 routes are found subjected to more than 15 minutes frequency peaks.

Item 4 - The average distance between bus stops is found to be less than 339 m on 33 routes.

These items represent inefficiency of operation. Route numbers of each of the above items are as given below.

Item 1 - 153, 333, 431, 432, 444, 555, 566 and 777

Item 2 - 41, 41', 43', 45, 107', 149, 152, 335, 401, 444, 500 500', 555, 666, 777, 999, 13 and 14.

Item 3 - 15, 16, 41, 43, 45, 63, 72, 152', 334, 335, 401, 441, 441', 444 and 14.

Item 4 - 6, 7, 9, 9', 10, 11, 12, 27, 32, 45, 54, 54', 68, 72, 82', 84, 85, 87, 88, 89, 93, 95, 95', 98, 134, 143, 146, 173', 176, 405, 777, 999 and 14.

Routes with higher efficiency are given below.

Item 1 - The average number of passengers carried by one vehicle exceeds 2,000 per day on 30 routes. On route No. 12, 107, 137 and 106, number of passengers carried are more than 2,500.

Item 2 - The average distance between bus stops exceeds 500 m on 31 routes.

Item 3 - The average distance between bus stops ranges between 400 m and 500 m on 62 routes.

Number of routes of tramcars and trolley-buses are 22 and 9 respectively.

Table 3-3

Number of Buses and their Condition, February 1966

Make of Car	IN FIELD: in good condition	IN FIELD: under repair	IN FIELD: Waiting for repair	IN FIELD: Junk	IN FIELD: Total	IN STORAGE: in good condition New	IN STORAGE: in good condition Renewed	IN STORAGE: Waiting for repair	IN STORAGE: Junk	IN STORAGE: Total	Training Center	TOTAL: in good condition	TOTAL: under repair	TOTAL: Waiting for repair	TOTAL: Junk	TOTAL: Total
Nasr	826	176	9	10	1021	-	-	39	5	44	24	850	176	48	15	1089
Chausson	99	50	10	-	159	-	-	24	61	85	1	100	50	34	61	245
Mercedes	145	33	49	59	286	-	-	39	39	78	25	170	33	88	98	389
Microbus	19	3	10	-	32	-	-	-	-	-	-	19	3	10	-	32
Bedford	-	-	3	52	55	-	-	41	11	52	3	3	-	44	63	110
Ickaros	-	-	-	-	-	-	-	5	15	20	4	4	-	5	15	24
Sckoda	-	-	-	-	-	-	-	5	11	16	-	-	-	5	11	16
Pirlet	-	-	-	6	6	-	-	-	6	6	-	-	-	-	12	12
Dodge	-	-	-	-	-	-	-	3	8	11	-	-	-	3	8	11
Pigaut	-	-	-	-	-	-	-	-	9	9	-	-	-	-	9	9
Studebaker	-	-	-	-	-	-	-	-	2	2	-	-	-	-	2	2
Chevrolet	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1
Newplan	-	-	-	-	-	-	-	1	3	4	-	-	-	1	3	4
Ford	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	1
Total	1089	262	81	127	1559	-	-	157	172	329	57	1146	262	238	299	1945

NUMBER OF CARS & TRAILER

	28th February 1966			28th February 1965		
	Licenced	Not licenced	Total	Licenced	Not licenced	Total
Cars	1357	588	1945	1548	425	1973
Trailers	32	51	83	48	35	83

3-7 Estimate of crossing traffic volume

The Greater Cairo Region extends over an area of 206,000 acres of which 145,000 acres is occupied by the Counties: Giza, Embaba and Shubra-el-Kheima. Assuming that about 90% of the area covered by these three counties is either cultivated land or desert area, and by deducting it from the overall area of the Region, the city area is calculated to be:

$$75,000 \text{ acres} \fallingdotseq 303 \text{ km}^2.$$

Furthermore, on the assumption that about 4% of the city area is occupied by arterial roads with roadway widths of 16 m or more, the distance of arterial roads in the city area may be calculated as follows:

$$303 \text{ km}^2 \times 0.04 = 12.1 \text{ km}^2$$

$$12.1 \text{ km}^2 \div 16 \text{ m} \fallingdotseq 750 \text{ km}.$$

The extension of bus routes in the Region, which involves considerable multiple operations on same routes, totals 1,490 km. It is inferred that about half of this distance, or about 750 km, is actually covered by the arterial roads.

The total number of motor cars registered in the Region is approximately 80,000 excluding motorcylcles.

Assuming that 70% of this number is in constant operation, an estimate of 56,000 cars actually on the roads in the Region can be calculated:

$$80,000 \text{ cars} \times 0.7 = 56,000 \text{ cars}.$$

On the assumption that each of the 56,000 cars makes an average of 6 trips a day, each trip covering about 8 km, the total daily distance covered by motor cars and the total number of cars that run on arterial roads may be calculated as follows:

$$56,000 \times 6 \times 8 = 2,688,000 \text{ km}$$

$$2,688,000 \div 750 \fallingdotseq 3,600 \text{ cars}.$$

The above calculation indicates that the daily traffic volume of motor cars would be about 3,600 provided that the flow of motoring traffic is even at all points of the total 750 km arterial road distance.

It may be added, for reference, that the crossing traffic volume in 23 wards of Tokyo was about 21,000 cars in 1965.

CHAPTER IV THE PROPOSAL ON THE TRANSPORTATION PLAN OF THE REGION

4-1 Introduction

In offering the proposal for the transport plan of the Region, it is quite necessary to estimate the future traffic demand in the Region. The roles to be played by various transportation means in the future can be explained by referring to such an estimate. The plan for the arterial streets will be treated in a separate chapter.

4-2 Estimate of future traffic demand

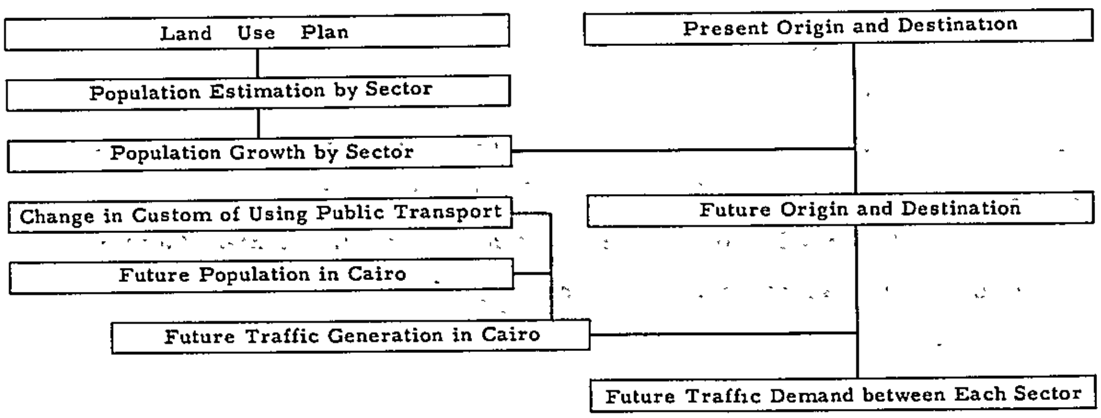
4-2-1 The procedure in obtaining the estimate

It is quite reasonable that the future traffic demand in the Region be divided into two parts: the number of passengers transported by mass transportation means and the flow of vehicles which form the major part of surface transportation. The former part is described below.

It is especially in the case of commuter transportation that mass transportation facilities play a big role. Fortunately, in the course of survey, the Mission was provided with an O. D. diagram showing the passenger flow by the public transportation means in the Region at the time of the rush hour in the morning. Based on this deagram, the future O. D. and future traffic generation was calculated according to the method to be introduced later.

Future traffic demand, estimated according to the flow chart shown below, will be described later in detail by item.

FLOW CHART



4-2-2 The prospect of land use

The Mission while in Cairo was offered much information about the intent of competent authorities in Cairo in regard to the plans for land use. The information was relevant to the development of Heliopolis, the construction of new cities such as Nasr City and Mokkatam, the acquisition of the farm land west of Giza and north of Cairo, and the redevelopment of the city centre and densely populated areas. Fig. 4-1 shows the plan of land use, based on all available information.

At this point, it should be remembered that Fig. 4-1 has not yet been approved by the U.A.R. Government, but merely represents an estimate of the Mission.

The excessive concentration of population in the residential quarters of Old Cairo is highly undesirable in any sense from the viewpoint of functions of the city as well as transportation planning. It is true, however, that the alleviation of this problem will not be accomplished in a short time, due to the exceedingly high rate of population growth, and especially due to the rapid tendency of the population to concentrate in Cairo City. As of 1965, the excessive concentration of more than 630 persons/acre (1,565 persons/ha.) is already shown at Bab-el-Sharia. The redevelopment plan for the city centre is now under consideration as a counterplan against it. Although buildings in the central district are relatively low-storied compared with those in the residential quarters in the suburbs, and shows possibilities of utilizing such a counterplan, it will need the extremely large investments to construct the high-storied apartment houses in the central district. From the viewpoint of efficient investment, close linking of the city centre and suburbs through an arrangement of suburban residential areas, the promotion of construction of new cities and the expansion of transportation is more recommendable than reckless following or promotion of the tendency of the present population concentration into city.

With regard to the construction plan of new cities such as El-Ahram and Suez City, the stable foundation of desert is advantageous. As it is expected that a large scale artificial population inducement will lead to enormous difficulties as in the case of satellite towns in England, a sufficiently powerful plan and guidance are needed in order to cope with such difficulties.

It is assumed, as already mentioned, that the construction of these new cities will not be completed before the target time.

Sufficient deliberation must be given to the fulfilment of sepatate functions by each town such as administration, education, tourism, bed-town, etc. Particulartly, the arrangement of sound residenteal environments is highly important. In these new towns, it is recommended that industries be established which will not disturb the quiet of residential environments, but will give sufficient employment of resident requiring comparatively small quantities of raw materials such as in the precision industry, photo industry, various repair shops, service industries, etc.

An enormous amount of investments is needed for irrigation facilities in reclamation of desert into arable land. Therefore, the existing farms west of the Nile in the north of Embaba is quite valuable. As the dynamic sprawl of metropolises in the world is expected in Cairo, in spite of Cairo Authotities's intent to keep a check on conversion of farm lands into residential districts, appropriate measures and guidance are required to prevent its penetration into farm lands completely. It is desirable that necessary measures be taken for appropriate control and guidance.

4-2-3 Estimate of future population

In treating the population problem of a city, careful attention must be paid to the exceedingly high rate of social growth compated with the natural growth of population, the difference in rate of population growth by district, and the large number of densely populated areas. The future population of the Region was estimated with such facts taken into consideration. As for the division of areas, administrative system of the Region was adopted, ignoring the development of satellite towns and the urban sprawl into farm lands. The Greater Cairo Region Authorities have made three different series of estimates for the entire Region based on the birth-rate. (See Table 2-1) Series II was adopted as the basis of calculation, as it is supposed to be the most moderate one among them. The population of the Region estimated by Series II is 9,093,000 in 1980. Its annual rate of population growth gained from this figure is 4%, which is higher compared with 2% growth rate of the U.A.R. as a whole and 3.8% of Cairo City. This clearly indicates the rapid concentration of population in the vicinity of Cairo City.

The population data of three years — 1960 and 1965 was obtained for administrative districts. A linear regressive equation by the least square method was obtained from these data and was extrapolated to 1970 and 1980 as shown in Fig. 4-2. In general, the coefficient of correlation is approximately 1.0 which is considered an appropriate estimate value with a few exceptions. The districts which do not lineally fit are El-Azbekia, Abdine and Giza County. The former two districts are the built-up areas where the population has been increasing recently.

Even if the coefficient of correlation is approximately 1.0 in one district, the value esitmated by extrapolation cannot be accepted unconditionally. As explained in Chapter II, there are several areas which are extremely heavily populated, and even in these areas the population is increasing steadily. However, it is considered that such an increase will continue at the same rate. Therefore, a method to check the upper limit of population was adopted, with the land use in each area taken into consideration. The figure gained from the value estimated by the regression was checked by surveying the land use in each area on the basis of the land use plan shown separately and by estimating the upper limit of population density in each area. The upper limit of population is expressed by "d_o" and is shown in the remarks column of Table 4-1. Attention must be paid to the fact that this "d_o" indicates the upper limit and not the most appropriate value. In other words, when the density obtained by the regression method is smaller than "d_o" it shall be the density of the district.

The upper limits of population are based on the present distribution.

Table 4-1 Upper Limit of Population Density by Land Use

Residential District with High Population Density	1,000 ~ 1,600 Person/ha
Residential District with Medium Population Density	800 Person/ha
Residential District with Low Population Density	150 Person/ha
Industrial Area	150 Person/ha
Cultivated Area and Green Zone	50 Person/ha
Desert Area and Cemetery Zone	0 Person/ha

The upper limit of 1,600 persons/ha is fixed, using the present density of 1,565/ha in Bab-el-Sharia as reference. Since this density is excessively high, the Mission hopes that efforts will be directed towards decreasing it as much as possible. It is to be understood that the adoption of this high density here is to give allowance to the transportation plan.

"d_o" 50 was fixed taking into consideration the policy of the Greater Cairo Region Authorities — the preservation of farm land in the north and west and control of urbanization.

Treated independently are the areas where the new town development plan is under way, such as Heliopolis and Nasr City.

The estimated population of each area in 1980, based on the above, is shown in Table 4-2. The total population of the Region in 1980, in the existing areas and towns to be developed, is estimated as follows:

	28 districts	8,768,300
	Nasr City	300,000
		9,068,300
and	Mokkatam	300,000
	El-Ahram	300,000
	Suez City	300,000

The above estimate might rise considerably, according to the progress of the development of the new towns.

Here, again it must be repeated that the above statement is merely based on an estimate. (See Fig. 4-3 ~ 4-6)

Table 4-2 Land Use Plan and Estimated Population by District

		Land Use Plan						Present population density	Population density obtained by linear regression		Modified popula-tion Density	Estimated population (198)	Remarks
		a	b	c	d	e	f	Persons/ha				Persons	
	North Cairo												
11	El-Sahel	25	65			10		600	988	O		585,800	d_o = 970
12	Rod-el-Farag	80				10		1,184	1,631		1,600	413,800	Upper limit
13	Shoubra	30	65			15		498	725		1,000	699,300	d_o = 1023
	East Cairo												
21	El-Materia		10	20	70			29			109	708,900	d_o (= 145) x 75%
22	El-Zeitoun		100					295	450		600	241,400	d_o (= 800) x 75%
23	Heliopolis			100				46			129	400,000	Housing policy considered
24	El-Waili		100					292			725	1,145,000	Same density as in Shoubra
	Central Cairo												
01	Bab-el-Shaaria	50	50					1,565	1,800		1,600	168,000	Upper limit
02	El-Moski	100						791	875		1,200	68,400	d_o (= 1600) x 75%
03	El-Gammalia	70					30	372	473	O		217,800	d_o = 1120
04	El-Darb-el-Ahram	75					25	651	785	O		210,500	d_o = 1200
05	El-Khalifa	20				10	70	236	308	O		253,200	d_o = 325
06	El-Zaher	40	60					639	889	O		161,800	d_o = 1120
	South Cairo												
31	Misr-el-Kadima		70				30	255	385	O		375,600	d_o = 560
32	El-Maadi			30	20	20	30	40	59	O		142,700	d_o = 85
33	Helwan		10	20		40	30	180	307	O		187,900	d_o = 175
	West Cairo												
41	Boulak	90		10				916	997	O		258,100	d_o = 1455
42	El-Azbakia	100						461	494		668	108,800	Trend from '60 to '65 traced; Correlation coefficient not favourable.
43	Kasr-el-Nil			60	40			88	115	O		66,000	d_o = 110
44	Abdine	70	30					690	675		968	167,600	Trend from '60 to '65 traced; Correlation coefficient not favourable.
45	El-Sayeda Zeinab	50	30	20				891	1,138	O		381,100	d_o = 1070
	El-Giza												
51	Giza I		50		50			353	554		} 500	249,000	d_o = 150 } Government policy considered
52	Giza II			100				166	250			383,000	d_o = 150
53	El-Ahram			100				50	71	O		20,600	Substantial increase possible by Government policy
54	Giza County				100			12	13	O		205,200	d_o = 50
	Embaba												
61	Embaba City		30	30	30	10		} 50	} 64	O		232,400	d_o = 285
62	Embaba County				100					O		535,900	d_o = 50 Cultivated area to be preserved
71	Shoubra-el-Kheima		30		60	10		41	63	O		180,500	d_o = 285
												Σ 8,768,300	

Note: a - Residential district with high population density
b - Residential district with medium population density
c - Residential district with low population density

4-2-4 Present origins and destinations

In preparing a master plan for an urban transportation development project, it is essential to possess accurate information on the present traffic status, i.e., origins and destinations of different forms of traffic, volumes of such traffic, and the traffic density by time periods. It is also necessary to estimate, based on such information, the future changes in traffic flow. If, as a result of such an estimate, it is foreseeable that future traffic flow will undergo changes undesirable for smooth and systematic operation of the functions of a city, administrative measures should be taken to prevent the predicted adverse effects.

Since a policy has already been formulated by the Cairo City Authorities for future population and land use, the proposed underground railway network should be reviewed in relation to the state of Cairo as envisaged in that policy. This review will enable the Mission to examine the congruity of the Mission's proposal on the future aspect of the city with that envisaged by the Cairo City Authorities. Thus, any proposal to eliminate discrepancies that may be found between the two views can be made.

In an effort to understand the present traffic flow in Cairo, the Mission studied various data made available by the Cairo City Authorities. Particularly valuable of these data were the results of the origin and destination (O.D.) survey conducted by the Ministry of Transport in 1966 which are integrated in the following two diagrams:

1. Ministry of Transport;
   Movement of Passengers Using Public Transport
   Between Sectors of Greater Cairo
2. Ministry of Transport;
   Movement of Passengers Using Public Transport
   Between Sectors of Greater Cairo
   from 7:00 A.M. to 8:00 A.M.

Although the information provided during the Mission's stay in Cairo on the above two diagrams contained certain ambiguous points, they were clarified later by the Cairo City Authorities. The Mission was therefore correctly informed as to what methods were employed in the O.D. survey, how the Region was divided into sectors, and what sampling ratio was adopted.

The following is a summary of the O.D. survey conducted by the Ministry of Transport.

Observation was made to discover the origins and destinations of passengers using public transportation, and to obtain the number of passengers moving per day and per peak hour (among the 14 sectors into which the Region was divided). The division of the Region into sectors was arranged considering the following (current administrative division not taken into account):

1. Area of a sector: In districts where the high population density or concentrated trip ends were found, the area of a sector was made as amall as possible. On the other hand, extensive areas were made to cover sectors in the outskirt areas.

2. Characteristics of a sector: Maximum character congeniality grouping was attempted in each sector. Efforts were made to separate residential, commercial and industrial districts to prevent the inclusion of more than one district in one sector.

3. The natural obstacle (The Nile) and railway lines were adopted as demarcation lines for sectors.

4. Demarcation lines were drawn so as not to run on the centre lines of streets.

In actually conducting the O.D. survey, between sectors, a questionnaire method was employed. State-operated and private enterprises with more than 500 employees were selected for the sampling, and the number of effective replies was approximately 200 thousand.

At the origin and the destination of each trip were located stations of public transportation.

According to existing data, the total number of passengers moving in the entire Region is caluculated to be about 2.5 million per day. If one person makes an average of one round trip per day, it means that about 1.25 million persons are moving during a 24-hour period. Half of this number are moving within the peak periods.

The sampling number of passengers obtained was about 175 thousand for a 24-hour period and about 95 thousand for peak hours. This indicates that the sampling ratio was approximately 1 to 9. Judging from the magnitude of the population, this ratio may be considered reasonable.

From the O.D. diagram for a 24-hour period provided by the Ministry of Transport, O.D. survey table (Fig. 4-3) was prepared. This survey table is indispensable for estimating future origins and destinations. However, since the character of the passenger movement between sectors is not clearly indicated in this survey table, desire line chart was prepared on the basis of the O.D. survey table. Fig. 4-7 represents the 24-hour traffic. The thickness of lines on this chart is in proportion to the traffic volume between sectors linked by such lines.

Characteristics of daily traffic shown in Fig. 4-7 are as given below:

1. The heaviest traffic generation is observed in Sector 1. This is considered quite natural because of the fact that this sector is CBD or the centre of urban activities and thus attracts traffic, and that it embodies major terminals such as the Central Railway Station and Ramses Square.

2. The movement of passengers between Sectors 1 and 2 is conspicuously higher than between other sectors. Sector 2 has an extremely high population density and extends lengthwise, which results in a large number of passengers using public transportation means such as surface tramways and buses. Nearly all these passengers travel to Sector 1.

3. Though not shown in the chart, a large number of passengers move within Sector 2. A high rate of intra-sector passenger movement is also observed in Sector 13. Such movements are considered attributable to the high population density and the lengthwise demarcation of these sectors which cause movement within the sector to be more via public transportation than by footpass.

4. The passenger movement between sectors is the heaviest between Sector 1 - 2, followed by Sectors 1 - 13, 1 - 8, 1 - 5 and 1 - 3. These movements consist chiefly of flow into Sector 1, which indicates commuter transportation to CBD. Such movements are also shown in the desire line chart for peak-hours.

5. There is a substantial passenger movement between the two sectors to the south of Cairo and the central part of the city (i.e., Sector 8 - 11 & 10 - 13), particularly during peak hours. This indicates a considerably large number of passengers commuting to the two sectors and forms one

of the factors for the preparation of the Master Plan described later.

6. Sector 7 may be cited as having extremely low passenger movement. The limited traffic movement in this sector can be explained by the fact that it embodies the site for the proposed construction of a new city, i.e., Nasr City, and that the population settled in it presently is exceedingly small. However, construction is now under way to develop this district into a second business centre embodying a district for government offices. By the establishment of such a business centre, which is anticipated to have heavy traffic generation, Sector 7 will play an important part in the transportation development project of Cairo. In this sense, Sector 7 may be considered as an important factor which justifies necessity of the routes proposed in this report's Master Plan.

7. The smallest traffic generation is found, next to Sector 7, in Sector 14. In this sector, which is an island, foreign missions and various institutions including sports clubs, tennis clubs and polo grounds are found. The chart indicates that an extremely limited number of passengers using public transportation means have origins and destinations there. The chart indicates clearly, however, that two arterial streets, i.e., 26th July St. and Tahrir St., run through this island connecting Sector 13 to Sectors 1 and 2, with big traffic movement on each of the streets.

Characteristics of the pattern of the 24-hour passenger movement have been outlined in the above 6 items.

With regard to the pattern of peak hour movement, it is conceivable, by comparing the two O.D. deagrams, that a close similarity in overall tendency exists between the two patterns. However, it is to be noted that there is a considerable passenger movement between Sectors 8 and 11, and between Sectors 10 and 13. The passenger movement in the peak hour period between Sectors 1 and 2, though heaviest as that in the 24-hour period, is relatively smaller than the movement between other sectors. Except for this minor discrepancy, no large differences are found between the two patterns. Since this tendency is expected to be constant, it is possible to determine the future pattern of peak hour movement based on the estimate of the future origins and destinations of the 24-hour passenger movement to which the former will be proportionate. On the basis of this assumption,

Table 4-3

Movement of Passengers Using Public Transport between Sectors of Greater Cairo

(1 9 6 5)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	3476	19550	6657	2594	7460	2793	195	7709	3552	455	455	1595	11176	590	71733
2		14902	3008	2758	4522	1345	563	2903	2082	107	291	605	5613	364	73515
3			1522	2305	3626	910	333	966	600	33	104	111	992	130	22819
4				2341	1677	1821	231	569	334	34	60	84	612	47	17808
5					2923	1262	532	3394	1563	61	111	239	2491	200	32984
6						1021	178	439	218	24	43	93	586	57	11811
7							7	306	206	2	0	56	376	10	3002
8								2238	3312	91	5066	1329	3897	304	34761
9									1752	180	208	706	1792	92	18349
10										342	151	13	2207	6	4048
11											1746	21	180	4	10186
12												111	1672	95	6841
13													8414	705	49127
14														39	2682
														ΣT = 360148	

origins and destinations of 24-hour passenger movement are estinated, for the target year.

4-2-5 Future origins and destinations

The future traffic demand can be estinated by various methods employed in transportation planning. The estimate of future traffic, when considered as a process of continous work, can be divided into the following three stages:

1. Process for estimating the traffic generation
2. " " " " " distribution
3. " " " " " assignment

Since the main object of this study is to determine the future traffic volume of entire Cairo, the traffic assignment is excluded from the explanation given below.

The estimate of traffic generation is intended for study of future changes in "the traffic generation in each sector" described in the preceding section. The term "traffic generation" indicates the total number of passenger inflow and outflow in one sector. There are two methods adopted for estimating traffic generation: 1) the method in which the traffic to be generated by a single facility is calculated on the basis of the extent of land use and is multiplied by the total number of facilities; and 2) the method which utilizes economic indices as exogenenous variables. Although the former *method is effective for small sectors,* it was not adopted due to the unavailability of necessary data. The latter method was therefore employed, and, since the resident population was the only available deta that could be incorporated into the model as an economic index, the following model was formulated.

The estimated population in individual administrative district (given in the section dealing with the estimate of the future population), was redistributed among sectors demarcated for the O. D. survey. Then, the pattern and the rate of population growth in each sector, from the present to the target time, were estimated.

Table 4-4

Growth Ratio by OD Sector

Sector No.	Population (1965) (Unit: 10 Thousand)	Estimated population (1980) (Unit: 10 Thousand)	Growth rate
1	36.3	49.4	1.36
2	119.8	158.2	1.32
3	46.8	90.4	1.94
4	37.3	111.5	3.40
5	57.1	89.9	1.57
6	8.6	24.0	2.79
7	15.2	35.6	2.34
8	24.1	30.5	1.27
9	33.5	42.9	1.28
10	9.7	14.3	1.47
11	11.0	18.8	1.70
12	12.5	15.8	1.27
13	106.2	162.6	1.53
14	2.6	3.3	1.29
Total	520.6	876.8	1.68

Table 4-4, showing the growth rate in each sector, indicates that the rate will be low — ranging between 130 - 150% in the built up areas of the central part of the city, but far higher ranging from 200 to 300% in the north-eastern part of the city. A population growth by 70% for entire Cairo is expected by the target time, but no uniformity can be seen in the growth rates of individual sectors due to their versatile characteristics. The future traffic generation is the present traffic generation in one sector multiplied by the rate of population growth in that sector. In actuality, however, it will be heavier because of the anticipated elevation in living standards and the resultant increase in journey habits. The increase in journey habits, though different among individuals, may be expressed by an assumptive average value. The explanations given above lead to the following equation:

$$Ti' = a\, bi\, Ti$$

where

Ti' : Future traffic generation in Sector i

Ti : Present traffic generation in Sector i

a : Increase rate of journey habits

bi : Rate of population growth in Sector i.

In the actual calculation, the value of "a" was not fixed due to the unavailability of data on income and living standards. However, since this value is applicable to entire Cairo, it can be omitted in envisaging the pattern of future traffic of the city. The future traffic generation in each sector was therefore calculated by the application of the following equation:

$Ti'' = bi\ Ti.$

The future traffic generation thus obtained should be distributed between sectors in order to estimate the traffic distribution. Methods widely employed for estimating the traffic distribution are the gravity model method and the present pattern method. The calculation of the traffic distribution between sectors by the former method is by the application of the following equation in which the traffic between sectors is assumed to be dependent on the attraction force of the traffic generation in each sector:

$$Tij = Ti\ Tj\ \frac{K}{(Dij)}\ n$$

where

Tij : Traffic distribution between Sectors i and j

Ti, Tj : Traffic generation in Sectors i and j respectively

Dij : Distance or time-distance between Sectors i and j

k, n : Parameter.

According to the latter method, the pattern of traffic distribution between sectors, shown in the present O. D. diagram, is directly projected for the future. Compared with the gravity model method, it is simpler and can make use of the characteristics of the present O. D. diagram.

As a result of studies made for the selection of the method, the present pattern method was adopted for the preparation of the future O. D. diagram of Cairo for the reasons given below.

1. Availability of the present O. D. diagram
2. Difficulty to measure the time-distance between sectors, and
3. Difficulty in applying the homogeneous gravity model due to the diversified characteristics of Cairo.

The drawback of the present pattern method is that the sources of traffic generation which are not existent at present cannot be projected satisfactorily. Modifications must be made, when a future traffic pattern has been prepared, in order to reach as close to the actual future pattern as possible.

The preparation of the future O. D. diagram by means of the present pattern method was performed in the following order.

i	j	k	n	Total
Tii	Tij	Tik	Tin	Ti
	Tjj	Tjk	Tjn	Tj
		Tkk	Tkn	Tk
			Tnn	Tn
				$2\Sigma T$

The present traffic movement of individual zone pairs (i. e., movement between two sectors) was entered in their respective columns of the O. D. survey table, and the future traffic generation of each sector was entered in the total column. The total value of the movements of zone pairs does not naturally agree to the value of future traffic generation given on the extreme right, hence the necessity for achieving conformity between the two values by convergence. The convergence calculation was performed by the Fratar method which is considered to be very effective for rapid convergence. Computer instructions were given for the performance of a maximum of 10 repetitions, but 5 repetitions were sufficient to obtain an almost perfect convergence. Results of this calculation are given in Table 4-6. Although the overall tendency shown in the chart was almost identical to that of the present traffic movement, several characteristics, as given below, were discovered by a detailed examination.

1. The heaviest movement is seen between Sectors 1 and 2 as in the case of the present traffic movement. Although the rate of its future growth is not very large, the traffic between these two sectors has already reached the limit, necessitating the provision for new means of transportation without which the future trend of increasing traffic demand cannot be met, nor the balance of demand and supply of traffic

maintained. This is one of the reasons why the construction of the north-south line must be expedited.

2. The highest growth rate is seen in the traffic ending in Sectors 4, 6 and 13. Considerable changes are especially evident in the volume of movement itself in Sectors 4 and 6 where a large population is expected to settle.

3. In the future, the movement between Sectors 10, 11 and the city centre will increase. This increase will be heaviest during peak hours, and during off-peak hours, intrasector movement will be predominant in these two sectors.

4. For reasons already mentioned, the present pattern method gives an extremely small traffic volume in Sector 7. However, since this sector is expected to develop into a second city centre with a population of 300 thousand, modifications should be effected from the administrative viewpoint.

5. As a whole, the traffic movement is more centripetal than otherwise and flows into Sector 1 as in the case of the present traffic movement. It is expected, therefore, that the future underground railway network will consist chiefly of radial routes.

In preparing the future O. D. diagram, which is based on the present traffic pattern, no consideration was paid to the expected rise in traffic movement in those prospective city areas which presently have very low populations but are predicted to have substantial permanent populations and become sources of heavy traffic generation. The future O. D. diagram should therefore be modified with due consideration to the traffic generation expected to arise in the future. Sector 7 embodies the site for Nasr City, the new city area now under construction, and although its population is no more than 150 thousand at present, it is expected to reach 356 thousand by the time of the completion of the new city project. Further, Nasr City is not expected to become a mere residential district but to eventually perform 30% of the administrative functions of Cairo. This means that agencies and organs belonging to or affiliated with government offices will move into the new city. It is therefore anticipated that Nasr City will play an important role as the second

CBD of Cairo. It is further anticipated that a considerably heavy traffic demand for commuter transportation, business trips, etc. will arise between the existing CBD and Nasr City. The existing transportation means linking the two districts are insufficient and cannot be expected to meet the future increase in demand, hence the necessity for the proposed underground railway.

In order to estimate the actual traffic volume for the future, the population and the traffic generation in each sector, at present and in future, were correlated. The results given in Fig. 4-8 indicate that there exist fairly prominent correlations between these two factors. The figure also indicates, by arrows, the changes that will take place between the present time (1965) and the target year (1980) which are generally found to follow similar tendencies. A point worthy of notice is that the growth rate of the traffic generation surpasses that of the population by a large margin in Sectors 1, 6, 8. This may be explained by the fact that Sectors 1 and 8 are located in or near the central part of the city, providing interchanges between many public transportation means, and by the prediction for Sector 6 that Heliopolis will be even more closely tied with the city centre. As is evident on the graph, Sector 7 has poor compatibility (reasons already given). In view of the expected population increase in Nasr City and its characteristics as a second city centre, the rate of traffic generation in this sector was raised to the mean value of all sectors and was incorporated in the future O. D. diagram (Table 4-6). As for its distribution, a gravity model was considered between Sector 7 and other sectors, and arrangements were made, from the administrative viewpoint, to reflect the closer relations expected between this sector and Sector 1 where the CBD is located.

The future O. D. diagram thus prepared presents the same pattern as shown in Fig. 4-9. It is possible to notice at a glance that the network of underground railway routes and arterial streets proposed by the Mission are, when reviewed in relation to Fig. 4-9, in good conformity with the desired lines of the future traffic movement. It may therefore be said in conclusion that the proposed networks are provided with necessary and sufficient conditions and factors required in meeting the future demand for passenger transportation in Cairo.

Table 4-5

Movement of Passengers Using Public Transport between Sectors of Greater Cairo

(1 9 8 0)

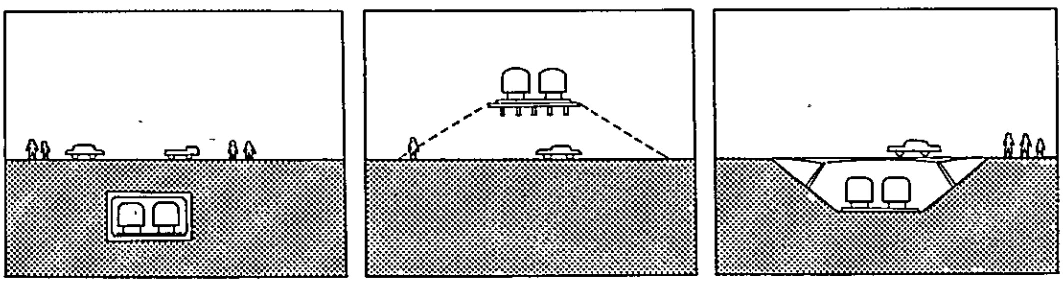
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	4682	23890	11830	6820	11820	6820	420	10250	4600	640	750	1980	15830	800	105810
2		18620	5100	7100	6420	2990	1060	3480	2600	140	460	730	8120	570	99820
3			3220	7980	7000	2700	960	1670	1000	60	260	180	1970	250	47390
4				1230	4910	8130	950	1520	870	90	210	210	1810	130	64810
5					5080	3390	1330	5160	2230	100	210	390	4080	290	57500
6						4170	690	1050	500	60	140	200	1610	150	36780
7							30	650	430	0	0	110	830	30	7720
8								2980	4300	130	7550	1660	5740	420	49540
9									2200	240	360	980	2570	130	25670
10										500	260	10	3310	10	6030
11											3150	40	330	0	16870
12												130	2340	120	9210
13													14060	1040	77700
14														50	3960
														£ZT = 608810	

4-3 Facilities required for public transportation in Cairo

4-3-1 Underground railway facilities

An underground railway, for which construction would entail a huge amount of capital investment, offers a safe transportation facility at a high speed and at close headway. Selection of its route should therefore be made to meet the demand of large numbers of passengers.

The underground railway has two different types of operation. In one case, it is constructed by methods entirely different from those applied to ordinary interurban railways. In another case, it takes the form of partial underground operation as in ordinary urban railway. In the former, there will be no obstructions whatsoever on the route such as grade crossings, etc. The underground railway is generally constructed beneath the ground surface, but for the purpose of saving costs, certain sections of the route may be constructed competely on the surface level or semi-underground by the open-cut method if no difficulties are involved in such construction.



However, whatever method is adopted, there should be no grade crossings on the route of an underground railway.

4-3-2 Facilities for the Metro

For efficient operation and better maintenance of the Metro, efforts are being made towards improving its route and placing new cars in service. The Metro plays an important role in surface transportation in Cairo. A point to be highly evaluated about the Metro is that separate tracks are provided for most of its route and where the Metro train runs on streets, tracks are provided along the centre line of the road.

These features not only show that the Metro is of a considerably higher level than an ordinary tramway but that they will become valuable in the future.

By putting in service new cars with riding comfort and equipped with highly efficient acceleration and deceleration devices, the Metro can be converted into a rapid transit surface railway which, though not capable of comparison with an underground railway, may be considered as substantially high-class.

The Metro in the future is envisaged as an important surface transport means in Cairo, but it is not expected to be a big capacity transport system as is expected of an underground railway. In order that the functions of the future Metro may be properly protected, the following measures are proposed: elimination of all such drawbacks that are seen to be causing confusion in the tramway traffic at present, prohibition of pedestrians walking into the tracks, prohibition of track-crossing by pedestrians and motor cars except at intersections where traffic signals are installed, limitation in the number of such intersections (distance between intersections should be 200 m or more), and provisions for two-level crossings at extremely congested points on the street.

It is suggested that the Metro be transformed, by taking these meassures, into a highly efficient mass transportation system that will share the future transportation load in Cairo.

Attention should be directed, however, to the fact that the operation of the Metro creates obstructions to other forms of transportation. These obstructions are not so aggravating as those caused by a tramway, but are much worse than those of an underground railway. It is therefore recommended that the Metro's route be so arranged as to avoid running through sparsely populated residential districts where motor cars can serve as the major means of surface transportation.

4-3-3 Bus facilities

Surveys are now being carried out in Cairo to estimate the future increase of passenger cars. Considering the trend towards more motorization which is expected to prevail in Egypt, figures predicted by such surveys will be far below the actual number of cars. It may be worth mentioning, however, that the increase of motor cars in any country of the world has always been correlated with the national income. It is not expected, therefore, that a phenomenal uprise in the number of motor cars will be realised in the U.A.R. in the near future. Consequently, if effective and full use is desired with the limited number of motor vehicles, it will become more necessary to increase buses that can serve as mass transportation means rather than depend on private cars. It must be remembered, however, that a limit naturally be set to the number of buses to be added since it is quite evident that buses crowding roads during peak periods can result in a paralysis of surface traffic. The underground railway or the Metro would, then, have their routes established passing through those points likely to be over-congested by buses during these peak periods.

In areas where traffic is not so great as to necessitate underground or Metro services, a network of bus routes should be established to meet the demand for public transportation with adequate interchanges being provided to link these bus routes with the underground and Metro stations for efficient public transportation.

4-3-4 The interurban railway

The primary role of an interurban railway is to ensure passenger and freight transport between cities. In larger cities, however, functions fulfilled by interurban railways in the past have not been so simple.

Long before "urban railways" in the strict sense of the word such as elevated railway and underground railway came into existence, the interurban railway had its terminal established in the centre of the city and its routes extended radially towards suburban areas. With the outward expansion of the city, the interurban railway came to serve the purpose of carrying commuters from suburban areas to the city centre. Today, interurban railways serving large cities of the world operate, more or less, as described above.

With further development of the city, the increased demand for commuter transportation makes it difficult to service both interurban and commuter transports on the same interurban railway route. As a result, it becomes impossible to find a sufficient margin of time during rush hours that would allow for keeping up the interurban transportation service. Difficulties in maintaining interurban transportation, which generally takes the form of freight train service between cities, gradually increases as the operation of freeight trains during periods of commuter's train service tends to become more and more dangerous.

For the reasons given above, the interurban railway again becomes separated from the urban railway.

In the case of Cairo, however, it may be advisable, for economic reasons, for the interurban railways to continue to chiefly serve commuters until some future date.

The operation of an interurban railway demands, if efficient and fully satisfactory service is desired, such facilities as station buildings, station fronts and bus terminals adjacent to them, as well as conveniently designed freight depots, car sheds, and streets extending from the depots. It must be added that an extensive area of land will have to be secured to accommodate all these facilities.

CHAPTER V REVIEW ON THE PLAN FOR ARTERIAL STREETS IN CAIRO

5-1 Premises to the planning

In the previous chapter, an estimate was made on the future population and land use, and the state of the planned Greater Cairo Region was envisaged. The population of 1980 will be as follows:

Greater Cairo Region	about 9 million
Cairo City	about 7 million

This is 1.7 times the present population. This population will not only be distributed in the existing city areas of about 300 km^2, but also will be absorbed, to a considerable extent, in new city areas to be developed.

The following industries can be enumerated as becoming the core of production activities:

1. Large-scale industries whose nucleus are the heavy chemical industries,
2. Small and medium sized industries and enterprises for the production and circulation of consumer goods for the populous.

The promotion and rearing of these industries are very important. Along with the plans for re-location and re-arrangement of the railway freight depot and freight yard, the arrangement of circulation machinery must be planned to fulfil this purpose. To execute such a plan, the central wholesale market must be so located as not to obstruct urbanization. The access to the Central Wholesale Market must be systematically arranged. As already mentioned, the development of new city areas must be positively promoted, because the arrangement of existing city areas is not enough to cope with the increasing population of the city. The new city areas must be divided into two categories with different characters — those to be developed as an extension of the existing city areas such as Heliopolis, Nasr City, Mokkatam Hill, etc. and the so-called new towns which are a little farther out, such as Suez City and El-Ahram, etc. As the latter can be regarded, in character, as independent cities from Cairo, it is desirable that within such cities the activities of production and consumption be guided and planned so that they will grow self-supporting and self-sufficient like the New Towns in

England. Therefore, intra-city roads should not necessarily be constructed on a standard required of urban arterial streets.

As the former is considered the extension of present Cairo, it is natural for it to be included in the arterial street plan of the Region. Very important areas will be Heliopolis where the development is progressing considerably now, and Nasr City as the second city centre which will have close connection with the existing CBD with the establishment of many government offices. Mokkatam Hill is omitted here from the new arterial street plan because the concrete plan for it has not been made yet, not to speak of its physical plan. However, at the stage the development of Mokkatam Hill has progressed and the sites of new city areas have been concretely decided, it may be included in the network of the proposed arterial street plan. At that stage, the extension of the radial road leading to Mokkatam Hill and of the peripheral road leading to Heliopolis and Nasr City can be especially expected. A concrete plan has been made to make Nasr City the second center of Cairo or governmental quarters in the future and its construction is now under way, and its main streets are included into the arterial street network.

In any case, the main purpose of the arterial street plan proposed herewith, is to solve the many problems to be confronted if the network of arterial streets is related with the construction scheme of the new rapid transit urban railway (underground raiway) and to realize the rationalization of the surface transport system of Cairo City. Therefore, although the network of the arterial streets covers the whole of Cairo City, it is planned specifically with particular emphasis on the central section of the city.

Urban expressways (in principle, the roads exclusively for motor cars with the limited entrances and exits without level crossings) will not be treated here, since the number of cars is small as compared to the scale of the city and its future increase is not estimated to be very large, though the trend for more motorization is naturally expected to prevail in the U.A.R. Actually, it is when confusion in surface transport arises in spite of the opening of several routes of underground railways, that the network of urban expressways is needed. Until that time, there will be little necessity for it to be realized.

Nevertheless, it does not mean that plans for expressways are not needed at all; efforts must be made to provide for at least 40 metre wide roads to streets which are planned for inclusion in the urban expressway network. Thus, the arterial street plan should be prepared from the long-range prospect, lest the mistake made in more advanced countries be repeated.

In any event, various policies as follows should be established now: (1) promotion of widening and arrangement of the necessary routes; (2) promotion of the improvement of intersections including the provision for two-level crossings; (3) re-organization of bus terminals, and (4) removal of surface tramcars as a result of the opening of underground railways, and replacement by buses.

Based on the above-mentioned premise, more concrete plans for main route roads will be discussed below.

5-2 Concrete plan for the arterial street network

Types of the street networks can be classified into the following four categories:

1. radial and peripheral type
2. grid type
3. diagonal type
4. combination of 1., 2. & 3.

Although there are merits and demerits to each type, many examples of the radial and peripheral type are found in spontaneously grown cities. The roads in Cairo City, though incomplete, can be classified in this category. For transport system, this type is reasonable as compared to other types. Especially, considering that the proposed arterial street network is a system which will cover the whole city, the radial and peripheral system can be regarded as the best. The following points can be cited in support of the above-mentioned system: (1) the radial roads will link the CBD directly with every part of Cairo through by-passes, (2) the peripheral roads will connect the neighbouring areas. It is expected that such a system will not conflict with the intention of the Cairo City Authorities.

The relationship between the railway stations such as those of underground railway and inter-urban railways and the arterial street network is very important. Namely, a systematic and efficient transfer system should be established for passengers between railways and buses or taxis and for goods between railways and trucks.

When Cairo City is viewed with such factors borne in mind, the existing roads can be included into the proposed network to some extent, and there are a number of routes envisaged in the plan for arterial street network but not in existence at present. For instance, the route to the city centre from the left bank of the Nile as a radial route and the route to cross Shubra, from west to east, as a belt-line route may be cited. The following are the routes definitely selected, including newly established and widened roads.

5-2-1 Main peripheral routes

The first inner peripheral route:

Midan Ramses - Midan Ataba - Midan Tahrir - Remses St. - Midan Ramses

The second inner peripheral route:

Midan Ramses - As Shariyya - Bur Said St. - Ahri Sharikh - Approach to Tahrir-Bridge - Nile Cornish St. - Tramway street in the north-west direction of Ramses St. - Midan Ramses

Outer peripheral route:

Sh. Rod Al Farais - Al Muhammadi - Shari Al Amir Kebir Karkomas - Midan Salah - Addin - Al Khalifa - Al Giza Bridge - Shari Al Sudan - Imbaba - Rod al Farais

5-2-2 Main radial routes

* via Giza for Alexandria

  " for Wasta

* Ramses St. Tahrir St., El Giza St., etc.
* 26 July St. - Jubar el Kaid St.
* Ramses St. for Suez
* from Ramses St. via airport for Suez
* Route along the north-south line of underground railway:

  Shubra St., Imed ab din St.

* from Nile Cornish St. to Helwan

With these major routes, secondary arterial streets and planned arterial streets of Helipolis and Nasr City taken into consideration, Fig. 5-1 is obtained.

5-2-3 Other routes

As the east-west route will become important as a result of the opening of the underground railway, the construction of the routes between Shubra and Waili and between El-Khriyya and Ad-Darb-el-Ahmar must be commenced at the earliest possible date.

It goes without saying that the north-south line of underground railway is urgently needed. Since the cut-and-cover method will be utilized in the construction of the underground railway route which runs through Shubra St., the removal of the surface tramway and the widening and arrangement of roads can be carried out concurrently. Most intersections of arterial streets are level-crossings, and improper alignment or defective signalling systems must be remedied. Two-level crossings must be provided at the intersections where the traffic is heavy and the rate of turning to either side is low. For instance, a two-level crossing is recommended to be provided at the El-Tawfikkya intersection where 26 July St. and Ramses St. intersect.

In case the volume of traffic surpasses the capacity of the road, the arterial street plan must be set up with some flexibility by planning a parallel street of the same kind or a street of by-pass nature, not depending on the widening of the road only.

CHAPTER VI UNDERGROUND RAILWAY NETWORK OF CAIRO

6-1 Establishment of an underground railway network

The establishment of an underground railway network has been a problem encountered by all cities that have underground railway facilities at present. One can deduce from the experience of these cities that underground railways have been constructed to meet the following two purposes:

1. Alleviation of surface traffic, and as a
2. Solution to the problem of commuter transportation

Since the advent of the underground railway, the alleviation of surface traffic has been the major purpose of its construction. In many cities of the world where congestion of roads was created by heavy traffic of vehicles and pedestrians, endeavours were made to relieve this dense traffic. As a consequence, the construction of two-level crossings was considered, but a solution was brought about by the underground railway. In the United States, however, the elevated railway preceded the underground railway. Routes of an underground railway network which were established to ease the surface traffic ran beneath all the arterial roads in the central part of the city, and considerations were made to linking main points in the city area.

It may be said that in all the cities of the world, where the underground railway service is available today, the network was established in much the same way, and its extension followed the similar patterns, at least during the early stages of its development.

With development, the city areas tend to expand outwardly, resulting in an increase in the number of commuters travelling to their offices in the limited area of the city from the suburban areas. Hence, the necessity for consideration of a network effective for the transportation of commuters, which meets the second purpose of underground railway construction mentioned in the beginning of this chapter.

The route established by New York City which transports a large number of passengers directly to the city centre from the comparatively sparsely populated suburban areas also meets this second purpose.

As is already clear, an underground railway during the early days of its development was not necessarily constructed to meet both of these purposes; the commuter transportation service came to be required of it sometime after its establishment. In Tokyo, too, the network was planned to alleviate surface traffic and the alignement followed the route of the horse tramway and the surface tramway, and its construction started at a point neat one of Tokyo's largest entertainment quarters. Most routes in present day Tokyo, however, are found to have been selected for the primary purpose of surface traffic alleviation, secondly for commuter transportation service. It is anticipated that the alignment of the future network will be along a similar pattern. This is quite applicable to Cairo where extreme traffic density is observed on a number of streets and a solution is being sought in the establishment of an underground railway network. It goes without saying that the network in Cairo should be so planned as to be able to prvide transportation for commuters in the future.

Although it is imperative for any city that has surface traffic problems now, to take measures for their immediate solution, planning must also be made with a look to the future, not depending upon capital investments that merely meets immediate needs. In view of the expansion expected in Cairo' residential destricts, as well as for the clear indication that construction of houses in such districts will be progressively carried out in the future, the underground railway network of Cairo should be planned to cover the whole of these districts.

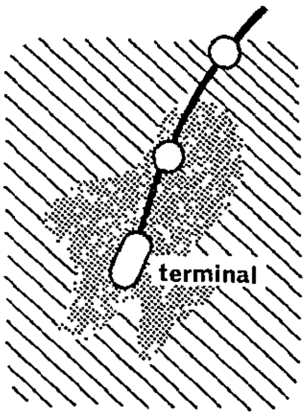
6-2 Matters to be borne in mind in network planning

Although many alternative plans could be proposed for the network of an underground railway, the final decision on its alignment must be made to ensure its full functions and that no managerial or administrative difficulties occur after it is constructed and put into operation. From such a standpoint, the following may merit serious attention as both principal and common matters to be observed in constructing an underground railway.

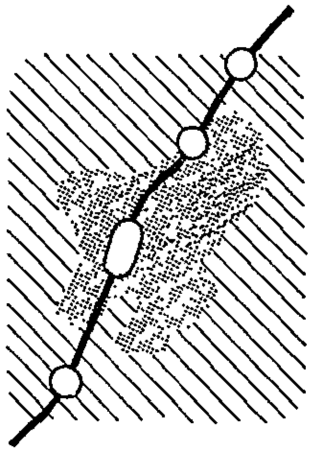
6-2-1 Necessity of serving the city centre

The route should run through the city center, from one side to the other, with no terminal station built within the bounds of the central district. It is fundamentally desirable for any underground railway to be operated so as to meet its purpose of rapid transit mass transportation. This can be materialized through operation at close headway of trains consisting of a substantial number of cars that constantly carry a sufficient number of passengers. In other words, high car load factor is desired of all underground railways.

Generally, the number of passengers increases as the trains near the city centre where the headway between trains becomes closer with shuttle service. The shuttle service at the terminal station situated in the central district of the city creates great operational difficulties, and the smooth operation of such a shuttle service inevitably calls for a larger station than is normally necessary. If such difficulties are to be avoided, the terminal station should not be located within the central district of the city.



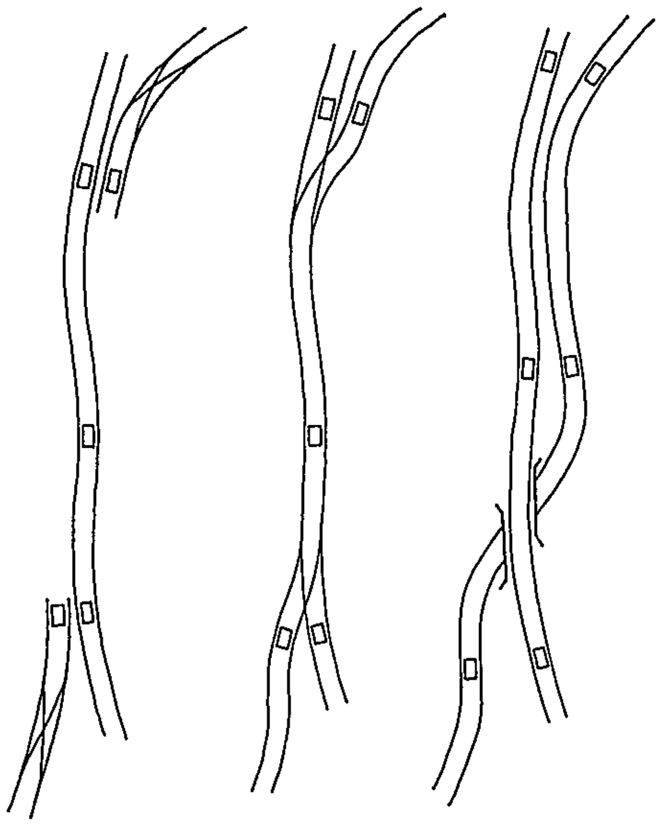
UNDESIRABLE



DESIRABLE

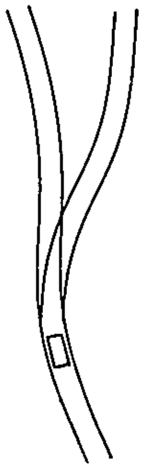
6-2-2 Necessity for simplified operation systems, with no junction stations in the central district

It is preferable to adhere to the principle of maintaining one operation system on one route, with all trains in service from the same starting and terminal stations or between two intermediate station on that route. No junction stations should be constructed in the central part of the city.



In order to maintain the high-speed operation desired of the underground railway, the policy of operating one system on one route is commendable, particularly because a multiple operation system serving on a single route causes longer headways to one of such systems, resulting in an overall decline of eificiency.

Also for reasons given above, the construction of a junction station connecting two separate routes is not advisable.



At the junction station of this nature, a heavy traffic of passengers will change from one line to the other, which only adds to the overloding of trains during rush hours and therefore is not recommended from the viewpoint of satisfactory transportation. The junction station is thus undesirable for an underground railway. However, if unavoidable, its construction should be carried out by taking precautionary measures in the operation schedule and in the anticipated flow of passengers changing from one line to the other.

The Master Plan for Tokyo's underground network once envisaged the construction of branch lines, but efforts have been made during the past 10 years to avoid constructing them for the reasons stated above. Today, not a single branch line is found in Tokyo.

6-2-3 Desirability of establishing one route over a maximum permissible distance, 10 km at least

One of the drawbacks of a route with short distance is that it causes the turn-back operation at the terminal to take a higher percentage of time in the overall time required for train operation. Another drawback of such short-distance route is that it requires the establishment, near the line, of such facilities as car sheds and workshops despite the small number of trains serving it. Furthermore, inefficiency is expected of these facilities due to their small size. For these reasons, it is advisable that an underground railway route cover as long a distance as economically possible. About 10 km would be the minimum distance considered desirable. It must be naturally understood, however, that the decision on the distance of a route is largely affected by such factors as the scale and the structure of the city.

6-2-4 Selection of a route with consideration to the location of car sheds and workshops

Due to the fact that an underground railway should be constructed in the built-up area, difficulties are often encountered in acquiring required land. Difficulties arise, not from the main underground line that can be laid beneath the streets, but from the construction of such facilities as car sheds and workshops which should be connected to the main line. A comparatively wide area of land is required to accomodate these facilities, and in many cases private land has to be purchased. Although these facilities are not related to direct services for passengers, they are indispensable for the satisfactory operation of an underground railway. Due consideration should therefore be paid to their location during the planning stage.

In Tokyo where the acquistion of land is extraordinarily difficult, a 3.2 km branch line was constructed from one of the main lines merely for the purpose of securing land necessary for accomodating the car shed. This car shed is located about 8 km from the city centre.

6-2-5 Necessity for partial underground operation of suburban railways

Commuters travelling by a suburban railway which has its terminal away from the city centre are compelled to change to other transportation means or to walk in order to get to the central district. In view of the undesirability of interchange at such a terminal station that entails difficulty and inconvenience for passengers, it is recommended that the suburban railway be extended, by underground operation, to the city centre where it may be linked to the extensions of other suburban railways. Such underground extensions to the city centre of existing suburban railways will have the same capacity and functions as those of ordinary suburban railways and not those of underground railways. These extensions are considered quite necessary for better passenger service and for easing the confusion at interchange points.

In Tokyo which has a history of 50 years of urban railway construction, terminals of many suburban railways have been located at points away from the city centre. Construction of underground railways in present-day Tokyo has therefore been carried out, in many cases, considering alignment which was arranged so as to allow for the underground operation of suburban railways to the city centre. Intensive congestion is seen nowadays during rush hours at terminal stations of those suburban lines that have not yet made direct approaches to the city centre, and this is considered one of the most acute transportation problems of Tokyo. (See Fig. 6-1)

It has been considered somewhat natural for urban transportation passengers to transfer from suburban railways to underground railways or vice versa during rush hours. Underground railways in London and Paris are constructed within a distance of about 5 km from the city centre, which made it necessary for a substantial number of passengers to change from suburban railways to underground railways if they wished to commute from suburban areas to the central district of the city.

Such has also been the case with Tokyo where an identical pattern of passenger interchange between suburban railways and underground railways has survived for about 30 years. As the population increased, however, abolition of interchange stations which not only threatened traffic safety but also caused operational inefficiency came to be one of the city's major transportation problems. This led to the planning, in or about 1955, of Tokyo's new underground network which envisaged through service between underground railways and suburban railways to assure easier access to the city centre.

In addition to these five points (6-2-1 to 6-2-5 above) on which, from the experience gained in Tokyo, the Mission wishes to place particular emphasis, there are other fundamental factors to be considered in designing an underground network as: compatibility with the basic policy adopted for city planning, desirability of serving the central business district by as many routes as possible, necessity of covering the city area with an adequate network density, and the technical feasibility of construction.

6-3 Process for the formation of an underground railway network in Cairo

6-3-1 Formation of districts from the traffic viewpoint

Major traffic arteries in the present-day Cairo may be expressed by the Model shown in Fig. 6-2.

In the central part of the city is located District A, the business centre, which is surrounded by District B, the densely populated area. District A may be considered the commercial and business centre rather than a business centre in the strict sense of the word. District B may also be considered as a commercial-industrial-residential district with a high population density. District B is surrounded by three districts, i.e., District C, D and E. District C is the industrial zone as represented by

Helwan in the south, and District D is the city area represented by Heliopolis which extends in the north-east, and District E is smaller in area than these two districts and is represented by Giza district. There exists a markedly large volume of traffic between the central part of the city (District A and B) and the surrounding three districts.

By predicting the future population of the city from its present population distribution and taking into account the policies adopted for constructing houses, it may be expected that the future state of Cairo will be as shown in Fig. 6-3.

Fig. 6-3 indicates that each of the districts mentioned above will preserve its present functional characteristics though there may be some minor changes in the boader lines. It also indicates that there will be three additional districts, i.e., District F, G and I, each presenting an independent and prominent feature on the model.

District F is an industrial zone represented by Shubra. Shubra of today should be considered, with its high population density, as a part of District B. District F envisaged in Fig. 6-3, however, is located to the north of the present-day Shubra and is included in the Greater Cairo Region, where the construction of power-houses and a number of plants has already commenced. This district, occupying the northern tip of the Region, is conveniently located for industrialization because of its comparatively close proximity to Alexandria and Suez.

District G, represented by Nasr City, is the district to which efforts for the overall development of Cairo are specially directed. Construction in this district of houses and offices is already underway and it is anticipated that it will develop into a residential district embodying, as Government policies indicate, a didtrict for government offices. Construction of government offices within a certain district is accompanied by offices of those private concerns which are affiliated to the Government. This implies that the construction now going on in Nasr City will lead to the creation of a second business centre.

The overall development policy for the City of Cairo aims, among other objectives, at the establishment of a second business centre in District G separated from the existing one. Although a sceptical view may arise concerning the future development of such a dual centred city, successful development of the second business centre is expected, as envisaged by the U.A.R. Government, through the progressive efforts and economic power of the Government.

Finally, there is District H which covers the Mokattam Hill area. This district will be exploited as Cairo's residential district when the construction of houses has been completed in other residential areas that have been designated by the Government.

Exploitation of District H can be expected to commence in the area which is located north of Cairo in the direction of Qalyub because of its proximity to the city centre and of its convenience in making use of existing transport facilities. It is beyond doubt that this area would be considered most favourable for urbanization than any other areas in District H, were it not for the fact that it is under cultivation. It is quite likely that an area of this kind, if found in other countries, would be subjugated to dsorderly urban sprawl; in Egypt, however, the acquisition of arable lands has historically been a major task of her people, and it is quite problable that the Government policy to avoid converting arable lands into residential districts will be strictly adhered to in the future.

From Fig. 6-3 which contains estimated features of each of 8 districts and from Fig. 4-3 which shows assumed population distribution, it can be inferred, based on the estimate of future O. D., that traffic arteries in the future will present such a picture as shown in Fig. 6-4.

Routes of traffic flow, a, b and c, shown in Fig. 6-4 are limited to representative ones with large traffic. These are:

a) Flow between the city centre and Shubra district which is most important with the heaviest traffic,

b) Flow between the city centre and Heliopolis, where the traffic, already great at present, is expected to become even greater, and

c) Flow between Heliopolis and Shubra district which can be readily assumed for geological reasons. Traffic volume on this flow route is quite small at present, but is expected to become very large along with the anticipated development of District F, D and G.

It is imperative to provide a highly efficient means of public transportation to these arteries, and the underground railway network is urged to be established as planned in the following section in view of the present traffic volume and of the traffic arteries envisaged above.

6-4 Description of alternative plans for the network

Description is briefly given below for each of alternative plans for the network. (See Fig. 6-5 – 6-10)

Plan A (See Fig. 6-5)

While the proposed underground railway must be focussed upon alleviation of the present surface traffic congestion as well as upon transport of commuters travelling to the city centre from their homes in suburban areas, the expansion of these suburban areas is to be considered quite natural if the population is expected to continue to cnverge in Cairo; hence the necessity of extending interurban railways to the city centre.

Plan A envisages, above all, the extension to the city centre of all the existing interurban railways serving Cairo inclusive of Materiya line, Alexandria line, Helwan line and Aswan line, and the proposed construction of a new line linking Heliopolis and Dokki.

As already mentioned, however, urbanization of areas now under cultivation is a remote possibility, and unless solution is brought to this problem, Plan A cnnnot be considered practicable.

Plan B (See Fig. 6-6)

In foretelling the expansion of the Region after the target time set for its establishment, one may entertain the prospect that the Region will extend farther eastwards than Heliopolis and westwards beyond Giza, with satellite towns surrounding it. If such a prospect should come to reality, there must be a highly efficient means of transportation connecting these satellite towns and Cairo.

Rapid transit railways including underground railways are naturally conceived of as a means of such transportation and are incorportated in Plan A.

The almost rectilinear alignment connecting Heliopolis and Giza serves to provide for the possible further extension of the line eastwards and westwards.

In regard to underground operation for a direct approach to the city centre by interurban railways, those sections of the lines serving Qalyub district and El-Mangal district, both located outside the Region, are precluded.

It may be added that due to the heavy demand for transportation existing in Heliopolis and Shubra, a loop-like route linking these two districts is provided, instead of independent routes for each district in order to maintain a better and a more efficient operation schedule. However, since satellite towns are not considered to be established before the target year, Plan B has not much significance.

Plan C (See Fig. 6-7)

Plan C, prepared from the same standpoint as that for Plan B, is intended to offset the disadvantages of Plan B.

In Plan B. the proposed route is planned to lie generally towards the south in Giza and Dokki districts after making an east to west crossing of the Nile, which creates an extremely weak service in Dokki.

Plan C is meant to revise this point by northing the route on the left bank of the Nile.

Plan D (See Fig. 6-8)

Plan D, which is identical in purport as Plans B and C, was prepared with condideration to the construction priority.

In Plan D, construction of that section of the route which runs through the Mokattam Hill area is proposed to be put into execution only after completion of the rest of the route. This is to save the great loss that may be incurred by construction before this area has been developed into a residential district.

A study of routes envisaged by Plan C to serve the central part of the city makes it evident that the line serving the west bank of the Nile runs a little too close to the northern part of Dokki district, which makes the Tahrir Bridge vicinity weakly serviced. As a remedy to this drawback, Plan D proposes for the route extending as far as Heliopolis to corss the Nile near the Tahrir Bridge. By this proposal, however, the proposed Heliopolis - Giza line will be forced to make a large detour around Dokki district.

Plan E (See Fig. 6-9)

In Plan E, no consideration is paid to the development of the Region beyond the target time set for its establishment. In other words, the underground railway network is proposed only for the Region with no attention paid to the possible necessity of linking Cairo and its satellite towns. Consequently, extension of the route as far as the suburban areas of Giza becomes unnecessary in this plan.

The network proposed in Plan E is therefore smaller in scale.

Plan F (See Fig. 6-10)

Plan F is common to Plan E in that it pays no particular attention to the future development of the Region after the target time, but it proposes to provide an additional route to meet with the heavy demand for public transportaion in areas already over-populated. This route, as shown in the drawing, is proposed to start from Ismailia Canal in the north and run southwards passing by Old Cairo. This will serve as a substitute of the line which is utilized exclusively for transporting commuters at present.

It is concluded that among the six alternative plans presented above, only two, i.e., Plans E and F, propose a network to meet the transportation demand expected to arise with the development of, and by the target time set for, the Region. Since the provision of an additional route proposed in Plan F can be meterialized at any desired time in the future, Plan E is considered most adequate for the proposed underground railway.

A detailed description of Plan E will be given in the following section.

6-5 Proposed Master Plan

Plan E presented above is proposed as the Master Plan for which detailed description will be given in the following pages. It may be noted that this Master Plan is slightly different from that proposed i. the

Preliminary Report. This is due to the fact that more importance was attached to the route of underground railway in the urban transportation of Cairo as a result ot a detailed review and that a number of route were additionally provided. (See Fig. 6-11)

6-5-1 Network Proposed in the Master Plan (15 Year Construction Programme of Underground Railways)

(1) Alignment of Lines A, B & C

Line A: North Shubra - Shubra - Central business district - Central Railway Station - El-Malik - Giza - Central business district - Nasr City - East Heliopolis

1st stage construction : Shubra - Malik	:	10.0
Others	:	23.3
Total	:	33.3 km

Line B: El-Marg - Central Railway Station - Central business district - El-Malik - Helwan

Untilization and improvement of existing lines	:	30.3
New construction below ground level	:	8.4
" " above " "	:	3.5
Total	:	40.2 km

Line C: Dokki - Central business district - Mokattam - East Heliopolis

New construction		:	19.1
Total of A, B, & C :	Existing lines	:	30.3
	New lines	:	62.6
	Total	:	92.9 km

(2) Description of Lines A, B & C

Line A: The route connecting Shubra and the central business district is to ease the dense surface traffic which has reached a state of saturation between these two points. This route will also meet the demand for public transportation service expected to arise with the future development of northern Shubra. Central business district - Heliopolis route is to alleviate the existing dense surface traffic and to cope with the development now going on in both Heliopolis and Nasr City. This route will become important in the future when large-scale meetings such as an international athletic meeting are held in Nasr City. Location of the terminal station in East Heliopolis may be determined in accordance with the extent of development in that area, and the route may be extended by degrees and put in operation as demand arises. Work is being carried out in areas to the east of Nasr City to transform the desert into a residential district, and acquisition of land in these areas is comparatively easy. In such areas, the construction does not necessarily depend upon tunnelling beneath the surface from the beginning; instead, it is commendable to keep the level of the line beneath the surface by constructing the tunnel by the open-cut method, with two-level crossings provided for surface traffic. A substantial savings in cost could be achieved by this method.

The loop-like route connecting CBD and Giza would not only absorb the heavy demand for transportation existing between these two points, but also serve for the transportation of commuters to the central part of Cairo. Construction of this loop line involves cross-river engineering work at two points which is expected to be accompanied by considerable difficulties and should not therefore be put into execution until a fair prospect of its success has been made. It would be advisable to start with the construction of the Shubra - El-Malik route and the El-Malik - Heliopolis route separately and put these routes into operation first. This would provide sufficient experience and confidence for the cross-river construction with which the designed loop line will be completed.

Line B: At present, both the Materiya line and the Helwan line play a large part in commuter transportation to and from Cairo. At Bab-el-Louk station, the starting point of the Helwan line, a severe congestion of passengers is observed, especially during rush hours. Similar congestion during rush hours is observed at the Central Railway Station which is the starting point of the Materiya line.

Line B is intended to provide a through transportation service by connecting these two suburban lines by an underground operation, thereby to realize smoother operation at closer headway which would give relief, to an extent, to the present congestion of passenger traffic.

The proposed through service has such advantages as:

1. Alleviation of congestion at terminal stations of the existing two lines,
2. Saving of loss that has hitherto been suffered on account of the turn-back operation at terminal stations of both lines, and
3. Elevation of overall operation efficiency.

Construction of Line B, though justified and made essential by these benefits, does not necessarily have to be put into execution in the immediate future. It can be carried out either upon completion of or parallel with the construction of Line A.

It is to be added that the designs of structures and the method of execution for the through service should be so planned as not to create any obstructions to the operation of the existing lines.

The current operation of the Materiya line by dieselized cars should be electrified as far as El-Marg by the time the through operation is put into practice. For this purpose the system adopted by the Helwan line is recommended, i.e., adoption of an overhead wiring system of 1,500 V. The overhead wiring system, if adopted for an underground operation, leads inevitably to a larger tunnel section which incurs some increase in cost. However, if the proposed through service is to be realized at all, unification of standards pertaining to construction gauge and other elements should be achieved for the whole extension of the two lines.

El-Marg is the terminal of the existing commuter transport lines by dieselized cars, which already covers a maximum distance suitable for commuter transportation to and from Cairo. It is therefore recommended that it remains as the terminal station of the electrified Materiya line for the future. As for the Helwan line, extension as far as Tobbin is recommended to meet the demand for transportation service by many commuters who work in the industrial area beyond Helwan.

Line C: This line connects, firstly, the city centre and Dokki district where the public surface transportation is rather limited, and secondly the city centre and the Mokattam Hill district.

Dokki district embodies a middle- and high-class residential district where the ratio of ownership of private motor cars is higher than in any other districts in Cairo and its vicinity. However, it is not to be expected that every commuter from this district can travel to the city centre by car or bus, hence the necessity of constructing this route.

The Mokattam Hill district, though barely exploited at present, is located short distance from the city centre and there is a fair prospect that it will be developed, at some future date, into a suburban residential district, accommodating many commuters who would be working in the second business centre which is expected to be established in Heliopolis district. The route connecting the Mokattam Hill district and the city centre is therefore proposed for extension in the Heliopolis direction.

In constructing the underground line in the Mokattam Hill district, which covers a hilly desert area, efforts should be made, for the sake of saving costs, to limit to the minimum the tunnelling beneath the surface through the combined use of cutting and banking methods.

Between the city centre and the Mokattam Hill district is a cemetery zone whose removal is nearly prohibitive for religious reasons. However, its partial rémoval, which will naturally be confined to the minimum, must be considered as an unavoidable consequence for the desired development of Cairo.

Designing and construction of the line passing through this section of the route calls for prior and prudent arrangements with the proprietors.

It is not considered possible that the construction of Line C, which should be carried with an eye to the extent of development in the Mokattam Hill district, can be started before Line A or B.

6-5-2 Metro line

As already mentioned, the Metro should continue to serve in the future as a mass transportation means of a nature halfway between underground railways and buses. The proposed main route, as shown separately, provides for the prospective increase of traffic volume between northern Shubra and Heliopolis as well as for the direct connection between Mokattam and Nasr City, and runs along the arterial road linking Heliopolis and the city centre.

The future Metro should be provided with its own tracks, and appropriate measures should be taken against the free track-crossing by pedestrians and motor cars.

6-5-3 Interurban railway

The route of the Aswan line starting from the Central Railway Station makes a big detour around the central part of the city, thus entails a considable loss of operation time. A plan to re-locate the terminal station in the vicinity of Giza sometime in the future when the development of the underground railway network has made substantial progress is being considered, thus passengers going to the City will take the underground railway from the new terminal.

As for freight transportation, the volume to be handled is expected to increase largely on account of the population growth in the Region. A proposal is made to establish a new central freight depot where all the freight trains leaving and arriving in Cairo will be handled. The proposed depot may be situated, not necessarily in the central part of the city, but at a point adjoining one of the arterial streets. Northern Shubra may be considered suitable for such a new dept.

A point never to be overlooked in connection with the operation of freight trains is the acquisition of an extensive area of land to be used as a freight yard. A freight yard does not have to be located adjacent to the freight depot, but in the case of Cairo, all the trains arriving from major cities of the country such as Port-Said, Alexandria and Aswan must be handled, and to attain this, the freight yard should be located in northern Shubra.

CHAPTER VII PLAN FOR CONSTRUCTION OF NORTH-SOUTH LINE

7-1 Outline of north-south line

7-1-1 Significance of the construction beginning with the north-south line

Description has already been covered on the underground railway network in the previous chapter. The problem of where construction should start from among routes given in the Master Plan is discussed here. For the above-mentioned routes, the section where surface traffic is pressing, is the distance between Shubra and the city centre.
If the construction work is started from the north-south route to link Shubra with the central district, the following merits can be enumerated:

1. It will relieve the above-mentioned current heavy surface traffic.
2. The construction work is comparatively easy because of the broadness of the road of the section. It is advisable to avoid, as much as possible, constructing first the section where construction work is expected to be difficult, because it is the start of the work on the undergound railway in Cairo.

   For such reasons, the commencement of construction at the Shubra-city center section is highly recommended.
3. It is easy to acquire land for the car sheds and the workshops in the north. The car sheds and the workshops are necessary for any short distance. Therefore, such facilities are required for the line to be established first.

This line is named the north-south line and such problems as planning, designing and execution of work will be concretely treated below.

7-1-2 Location of stations

In locating the stations, it is advisable to determine the rough average distance between the stations beforehand and to locate the stations at main points on the route and to revise their location, lest any strain should be caused to the alignment.

Accordingly, the distance between stations on the north-south line shall be 0.6 - 1.0 km tentatively. This distance may be extended if high speed operation is required. But, being different from an underground railway in a suburb where such an extension is justified, the distance between stations on the north-south line, which runs through the built up areas with many passengers, should be set as mentioned above.

The station at Shubra must be established as near the present intersection and bus terminal as possible.

At the Central Railway Station, the station should be set up near Ramses Street because of the environment. Although it might be a little far from the Central Railway Station, it will not be so inconvenient if a passageway is built. There are many such cases in other countries' underground railways.

At El-Malik and El-Salek, consideration must be given to the future extension of the line towards Giza and to the establishment of a station on the straight line section. Five intermediate stations each must be constructed in the north and south of the Central Railway Station. However, the location of two of these stations must be selected, taking into consideration the possibility of establishing underground railway lines crossing the north-south line.

Fig. 7-1 shows the location of the stations and the Table 7-1 shows the distance between the stations based on the above-mentioned policy.

Table 7-1 Distance between Stations

No. of Station	Distance (km)
1 (Shubra)	0.80
2	0.85
3	0.80
4	0.60
5	0.70
6	0.75
7 (Central Station)	1.00
8	0.85
9	0.50
10	0.90
11	0.75
12	1.30
13 (El-Malk-El-Salek)	
Total	9.80

7-1-3 Transportation volume

As already mentioned, one of the purposes of the establishment of the north-south line is to alleviate the pressing surface traffic. At present, the Shubra Street beneath which the north-south line is expected to run, is already overcrowded and especially, at peak hours, public mass transport facilities such as buses, tramcars, and trolley buses are filled to the limit. The volume of passengers carried by these vehicles has come to be enormous. Such a tendency will become more intense hereafter on account of the factors such as population growth and increase of travelling habits.

According to the provisional calculation, the volume of transportation at Shubra in the direction of the city centre will be about 36,000 - 37,000 per peak hour in 1980, which is two times that of 1963. In order to deal with such a huge transportation it is quite natural that the existing facilities are not enough and the introduction of new mass transportation facilities must be projected. The underground railway is sure to play an important role to meet such demands.

An estimate is given below on the transportation demand expected to arise when the proposed route has been opened. As sufficiently effective data for prediction are lacking, a simple calculation was made based specifically on the experience in Japan. These estimates might not be believable as they are, because of the non-existence of back data to check them, but they can be used as a tentative criterion.

The above estimate was reached by the following method. By setting the area of influence sphere of a station which was arranged to extend from the location of that station, the population in that area was calculated. Traffice generation expected to arise from the population thus calculated was estimated from the travelling habits.

The spheres were graded first and second according to its power to attract passengers. The first sphere was designated as the area inside the parallel lines at an interval of 500 meters on both sides of the route. The second sphere covered the area within 500 meters outside that parallel line. At terminal stations, the first sphere covered the area within 500 meters in the extending direction of the route, and the second sphere included areas within one km from the station.

Table 7-2 shows the calculation of the population inside the influence sphere of the station both at present time and for 1980.

Table 7-2

Population of Influence Sphere of Each Station

Station No.	1st Influence Sphere		2nd Influence Sphere	
	1965 (Unit: Thousand)	1980 (Unit: Thousand)	1965 (Unit: Thousand)	1980 (Unit: Thousand)
1	15.3	25.1	33.2	54.4
2	49.5	82.3	44.6	74.2
3	49.5	82.3	49.6	82.4
4	49.8	78.3	60.2	89.7
5	54.7	84.5	54.7	84.5
6	61.1	94.4	57.2	85.8
7	47.2	66.0	74.9	96.3
8	75.8	92.4	114.9	120.4
9	46.6	65.4	59.3	74.2
10	58.2	76.1	55.7	71.3
11	73.6	93.9	69.5	88.9
12	91.4	116.8	58.8	78.3
13	29.3	44.3	59.3	86.6
Total	702.0	1,001.8	789.9	1,087.0

The population of the first station sphere will increase by 43 % from 702,000 to 1,002,000 and that of the second sphere will increase by 23 % from 79,000 to 108,700. As the population in the second sphere is not so closely connected with the station, compared with the first station, it is presumed that 50 % of the second sphere is in the influence sphere of station. If so, the total population in the influenced spheres will be 1,097, 000 at present and 1,545,000 in 1980. The rate of increase is about 41 %. Next is the problem of changes in travelling habits. The population of the Region was, in 1960, 4,332,000 and the number of passengers carried per day by various vehicles - buses, trolley buses, tramcars, the the National Railway (Helwan line, Materiya line), and the Metro was 1,910,000. The vehicle usage frequency per passenger per day was 0.441. It was 0.528 in 1964 and 0.650 in 1965. This usage as calculated on the basis of the tendency of travelling habits will be 0.876 in 1980. This figure is considered reasonable when compared with those of foreign countries.

The number of passengers per day at present in the entire influence sphere of the stations is:

1,097,000 persons x 0.650 = 712,000 persons

The figure is almost equal to the number of the passengers carried by the mass transportation facilities on the roads on the proposed line.

According to the same calculation method, the figure in 1980 will be as follows:

1,545,000 persons x 0.876 = 1,351,000 persons

If 1970 is anticipated as the opening of the north-south line, the expected number of passengers, then, will be 925,000.

The operation schedule for the first stage is estimated to employ trains of 3-car unit at five minutes headway. The capacity of one car is 127 on an average and if the car load factor is 200 %, the approximate number of the passengers travelling in both directions per hour at peak time will be as follows:

127 passengers x 3 cars x 60 minutes/5 minutes x 200 % x 2
= 18,288 persons

The average concentration rate of commuters in a big city during rush hours is 30 %. But the rate set for the proposed line is 20 %, due to its nature that it has to bear the transportation in city area. Thus, the volume of transported passengers per day will be:

18,288 persons/0.20 = 91,440 persons

This figure, when compared with the total flowing population in the sphere of stations at that time, gives a ratio of 9.9% as indicated below.

91,440 persons/925,000 persons = 9.9%

Namely, at the time of the opening of the north-south line, 9.9% of the surface traffic will be absorbed by the underground railway. Although it is imagined that the rate of absorption might be influenced by the fare and the standard of service of the underground railways as compared with those of other competitive transport means, it is reviewed here only from the viewpoint of transporting ability. (See Fig. 7-2)

If the fare policy and other policies are established satisfactorily and the capacity is utilized fully by passengers in 1980, the following results will be obtained: six car trains at 2 minutes headway will be in service by the operation schedule at the last stage. The volume of transportation per peak hour at that time will be as shown below:

127 persons x 6 cars x 60 minutes/2 minutes x 200 % x 2

=91,440 persons

In case the concentration rate during the rush hours is 20 %, also, the volume of transportation per day will be:

91,440 persons/0.20 = 457,200 persons

The flowing population of the influence sphere of station at this time is 1,351,000, hence,

457,200 persons/1,351,000 persons = 33.8 %

Namely, 33.8 % of the population will utilize the north-south line of underground railway in 1980. In this case, the number of passengers using the existing public surface transport means would be about 850,000. The number of passengers, at the time of the opening of the north-south line, would be 820,000 with only a small decrease. This indicates that the underground railway will absorb the increased number of passengers caused by population growth and changes in travelling habits. By the opening of the underground railway, the surface tramcars will be withdrawn and the passengers utilizing them will have to use the underground railway or buses. Furthermore, as several tramcar lines will be removed, it will be necessary to establish bus routes to replace them. Meanwhile, the withdrawal of the surface tramcars will result in an increase of road space. Considering these conditions, the above-mentioned estimate can be regarded as a good approximate. What has been stated so far is based on the premise that the concentration rate during the rush hour is 20 %, that the car load factor is 200 % and that the volume of passengers transported in each direction is the same. Although these values are not necessarily precise, their authenticity can be relied on to a considerable extent in view of the good references and experiences in Japan.

7-1-4 Operation schedule

Although description will be given on the Rolling Stock later, the following are the major points:

length of car	18 m
capacity	127 persons

It is recommended that a reserved operation schedule be maintained during the early days of underground railway operation until the residents along the route get accustomed to the underground railway services and the smooth management is attained. Although this may result in a shortage of transportation capacity, the operation of 3-car trains at 5-minute headway is proposed at least for the early stage. Assuming that the car load factor is 200 %, number of passengers carried per hour is calculated to be 9, 144. That is, the operation schedule at the time of the opening of the underground railway, can be determined as follows: 5 minutes headway during rush hours and 10 minutes during slow hours. 24-hour service can be provided but it is not recommended, since sometime for maintenance should be set aside. Peak hours occur twice a day-morning and evening, and the operation hours can be adjusted easily depending on actual situations. At least 42 cars are required to ensure the operation schedule mentioned above, and a total stock of about 50 cars is recommended to be maintained.

The schedule speed is 25 km/h, and the end-to-end time required will be 24 minutes.

The total distance covered by trains in service will be 2, 760 km per day and the number of the trains required will be discussed later.

7-1-5 Relationship between the underground railway and the streets

The relationship between the underground railway and the streets is established on the method of tunnel construction. In the case of the proposed north-south line, the tunnel will be constructed by the cut-and-cover method for which detailed description will be given later.

A principle to be noted in connection with the cut-and-cover method is that the route must run beneath the streets, because the tunnel should be constructed by digging the ground from the surface where necessary open area is available. This method requires that the structures, constructed under the street, be so located as to be about 2 m away from the building line because such civil and erecting work as excavation of ground and driving of supporters occupies a strip of land about 1 m wide along each side of the structure under construction.

The tunnel, however, cannot always be constructed beneath the street due to restrictions on alignment. Arrangements should therefore be made, as occasion demands, so that the tunnel may be constructed to run beneath such public open areas as parks, squares, etc. .

In cases where the tunnel must run beneath buildings, one of the following measures should be taken:

i) Leave the building as it is and run the tunnel through by a method other than the cut-and-cover method,

ii) Purchase the land required, demolish the building, and run the tunnel through by the open-cut method, or

iii) Demolish the building, run the tunnel through by the open-cut method, and re-construct the building after completion of tunnel construction.

In case of measure i), studies should be made prior to construction as to whether the land required has conditions that would allow tunneling without demolishing the buildings, e.g., absence of underground structures attached to the building, sufficient strength of building foundation, etc. . This method is practicable if the distance to be covered is short.

Construction by measures ii) or iii) does not involve may engineering difficulties provided that settlement with the owner of the building can be achieved. If, however, the demolition should entail shuch compesations as may be required for reconstruction at a different site, demolition of high-storied permanent buildings is not economically recommendable. These two measures are therefore applicable and desirable only when demolition is confined to brick or reinforced concrete buildings of 4 - 5 stories high.

At any rate, all of these 3 measures incur an increase in overall construction cost. It is therefore recommended that efforts be exerted to see that the route would run beneath the street as much as possible and that tunnelling beneath building foundations be done only in unavoidable cases.

The level of the line should be as near the surface as possible for more savings in cost. It should, however, have a certain depth from the surface because of various underground pipes and cables as well as for topographical conditions. It is proposed that a 3 m depth of earthfill be maintained between the ground surface and the tunnel roof, with the provision that it may be made deeper than 3 m depending upon the alignment and the condition of the underground pipes and cables in each individual section of the route.

7-1-6 Alignment

Detailed description on alignment will be given later. In the following sub-sections, general explanations will be given on major points relating to the alignment.

(1) Curvature

As in the case of ordinary surface railways, the curves of an underground railway should not be too sharp since the small radius of curvature causes undesirable restriction of speed. In the case of the proposed underground railway, however, severe curves are inevitable since the tunnel runs beneath the streets as it will be constructed by the cut-and-cover method.

In Tokyo, experience has shown that the small radius of curvature is one of the causes of greater noise, more risks in derailing, and extreme difficulties in track maintenance. It can be readily gathered that similar disadvantages have been undergone by underground railways in many other cities of the world because of small radius. Taking this fact into account, it is proposed that the minumum radius of curvature of the proposed route, precluding specific sections and points, be 160 m which is already adopted in Tokyo.

The turn out curve behind frog cannot be expected to have a large radius due to its geometric design and of its being located within station premises where space is limited and severe curving is unavoidable. The minimum radius of 100 m is recommended for such a case. For side-tracks at car sheds, the same minimum radius of 100 m is also recommended.

A transition curve must be provided at both ends of a curved section and at the intermediate section of compound curves where the cant and slack are to be provided.

The above-mentioned minimum radius of 160 m, to be applied in the greater portion of the proposed route, creates severer curves when compared with ordinary surface railways, but it must be remembered that an underground railway route cannot make a 90° turn beneath intersections in the built-up area.

(2) Grade

A limit is to be set on the grade of an underground railway just as in the case of ordinary surface railways, though a steeper grade is permissible with the underground railway since trains in operation are generally higher in efficiency and tractive force, and are equipped with better controlling devices. It must be remembered, too, that the level of the line should be as near the surface as possible for as much saving as possible.

For these considerations, the maximum grade of 35 ‰ or less is adopted in Tokyo, and is recommended for the general sections of the proposed route. Within the station premises, particularly near the platform where it is essential to ensure the stopping at the pre-designed stop-lines and the starting with an ample reserve of tractive force, the maximum grade of 10 ‰ is to be observed.

For side-tracks laid in car sheds and workshops, the grade should preferably be level, but if this is not possible, it should be kept below 3.5 ‰ so as to prevent derailing.

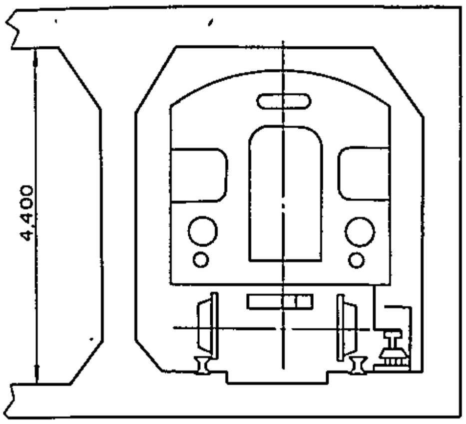
A vertical curve similar to that of ordinary surface railways is to be provided at the changing points of gradient.

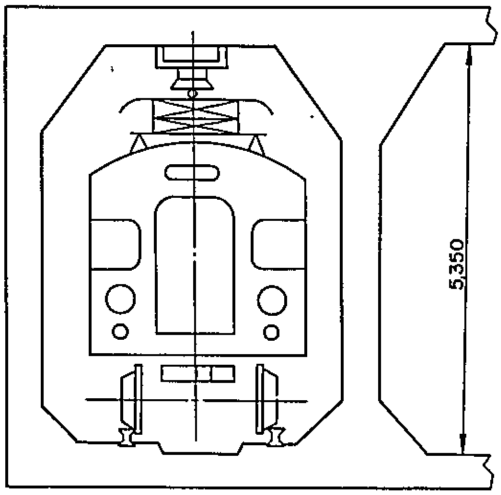
7-1-7 Construction gauge and rolling stock gauge

Both the construction gauge and the rolling stock gauge should be predetermined in the designing stage. In the case of an underground railway, the smaller the construction gauge is, the more the saving in cost becomes, and the bigger the rolling stock gauge is, the more passenger capacity is possible. In cities like London and Paris, comparatively small gauges are adopted. However, since an underground railway requires a huge amount of capital investment, it is desirable to construct it with bigger designed gauges which allow for greater transportation capacity.

Another factor affecting cost is the current collecting method. The prevailing adoption of the third rail system by ordinary underground railways is advantageous in that it allows for larger rolling stock size against smaller tunnel section.

However, in the case of an existing suburban railway proposed to make a direct approach to the city centre by underground operation, the current collecting method would be the overhead wiring system provided that such a system is currently adopted for its surface operation and cannot be shifted to another system.





As for the proposed north-south line, the third rail system is recommended inasmuch as the direct connection by existing suburban railways is not expected even if future extension of the underground line in both directions is taken into account.

Proposed gauges for the north-south line, according to the experience gained in Tokyo, are as shown in the following table.

	Construction gauge	Rolling stock gauge
Height	4.75 m	4.00 m
Width	3.30 m	2.90 m

It goes without saying that both the construction gauge and the rolling stock gauge should be calculated with more accuracy and precision, for which detailed description will be given later.

Details of the construction gauge and the rolling stock gauge are as shown in Fig. 7-3. in which both the overhead system and the third rail system are depicted.

The overhead wiring system should be revised in accordance with the construction gauge and the rolling stock gauge presently adopted by the Egyptian National Railways. A point worthy of attention here is that the tunnel gauge should be set outside the construction gauge. This is necessary for securing the space within the running tunnel through which wires, cables and pipes are to be laid. As shown by solid lines in the drawing, these wires and cables run through the tunnel and cannot make any detours.

7-1-8 General descriptions of stations

Three standard types of stations are presented in Fig. 7-4 – 7-6. Type I represents important stations where passengers get on and off in substantial numbers. A mezzanine should be constructed at such stations to deal with the flow of passengers as well as to install various railway and station facilities, inclusive of the ventilator room. Type II represents stations of less importance than Type I where a fairly large number of passengers get on or off. At both ends of the island-platform should be constructed the mezzanine which leads to the stairways and to the surface entrances. Passengers getting on or off at the island-platform can communicate to and from the entrances set on the street. Since no mezzanine is constructed on the central section of this type of station, it is possilbe that an underground passageway or another underground railway route be constructed to traverse this section if necessity arises in the future. Type III is the simplest of the three types, with two side platforms constructed to face each other and tracks laid between them. Passengers have a direct access to the entrance set on one side of the street. An underground passageway that crosses the tracks beneath the line level and connects both platforms must be built at this type of station.

7-1-9 Plan and profile of route

The plan of the proposed route is shown in Fig. 7-1.

Station No. 1 is the terminal in Shubra district and Station No. 13 represents the terminal in the south. Location of these two stations has been selected taking into account the future extension of the line in both directions and the location of car sheds. Station No. 7 is the Central Railway Station. These three stations are to be constructed as in Type I design because of their relative importance and because of the large number of passengers anticipated.

Stations No. 8 and 9, which are to provide interchange to other transportation means, should be constructed as in Type II design, while the rest of the stations should be built as in Type III design.

The profile of the route is as shown in Fig. 7-7.

Taking into account underground cables and pipes, the tunnel is designed to run as near the ground surface as possible. It will, however, be constructed at a deeper depth in the vicinity of Station No. 7. This is because Station No. 7 should be constructed as in Type I design due to its importance and also because of possible construction of a new line in the future that will cross the proposed route in its vicinity. Tunnels for two important stations, No. 1 and No. 13, are also designed to run deeper from the surface to provide for the future extension of the line and for the construction of car sheds.

As is clear in Fig. 7-7, the maximum grade is 5 ‰ and the minimum radius of curvature is designed to be 160 m. The figure also indicates the type of tunnel for each individual section, viz., the station type are those tunnel sections within station premises, the double track type are rigid-framed square type tunnels with centre posts. The crossover type is also tunnel of rigid-frame square type structure, but without centre posts on account of the crossover installed to the tracks. The approach to the station covers those tunnel sections where necessary arrangements are made for connecting two different sections.

7-2 Tunnel structure types

7-2-1 Determination of tunnel structure for general tunnel sections

The tunnel structure can be generally considered under two categories according to the depth of its construction from the ground surface.

A tunnel constructed comparatively near the surface, when compared to that at a deeper depth, not only incurs less capital investment and operating expenditures but also provides easier interchange to other transportation means and ensures better ventilation and quicker refuge.

Judging from the characteristics of the present demand for transportation in Cairo, it is advisable that underground facilities be constructed so as to allow passengers to reach the platform within the shortest time possible from the surface entrances and that stations are spaced rather closely.

The tunnel structure that allows construction near the surface should therefore be considered for Cairo.

Since the underground railway in Cairo should be laid near the ground surface, the tunnel structure should be decided according to that principle.

As will be described at length later, the method of execution is the cut-and-cover method and the tunnel structure compatible with it is recommended.

Tunnel sections can be grouped into three major kinds, i.e., Square Type, Arch Type and Round Type, of which the Square Type section is most frequently adopted for construction at a level near the surface. The Square Type tunnel, whose cross section is similar to that of the rolling stock and is therefore economical, is advantageous in that it creates no loss in excavation and ensures safer execution and easier drainage and ventilation.

The Square Type, Double-Track Tunnel is therefore proposed as the most economical structure, though it is inferior in appearance to the Arch Type tunnel.

Stations will not necessarily be provided with mezzanies over their entire length. This fact will depend upon the number of passengers and the need for interchange to other lines.

Most auxiliary facilities will be constructed underground with the exception of car sheds and substations which should preferably be built on ground level.

7-2-2 Standards regarding tunnel structure

(1) Construction materials

When constructing an underground railway tunnel by the cut-and-cover method, materials required for construction must be carried through mud-fall preventors driven substantial depth beneath the ground surface. The tunnel should be constructed from bottom to top. The tunnel structure is subject to changes in construction conditions along the route. It is preferable, therefore, that materials able to meet such changes be used. In addition, the tunnel must, because it is an underground structure, have the minumum cross section which would allow for savings in cost.

For these reasons, for general sections of the proposed route, it is adequate to construct the tunnel with reinforced concrete which has been greatly improved in quality in recent years. In principle, the tunnel should have water-proof layer on its outer surface.

(2) Design load

In designing an underground railway tunnel, various loads should be taken into consideration including the soil pressure with the effects of underground water, the surface load, and the load of buildings. If the route traverses private lands due to alignment, additional and adequate foundations should be designed to resist the load of existing buildings or the design load of structures to be built on such lands.

(3) Effects of earthquakes

Earthquakes can present various problems in structure design. From the past experience, however, no particular considerations were generally paid to such problems in designing the tunnels in Tokyo except when they have had to be constructed partially above the ground surface or when the earth-fill was extremely small in thickness. In such exceptional cases, careful attention should be paid to undergound structures.

In the case of Cairo, the investigations of the Mission show that no particular consideration will be required.

(4) Principal standards for construction and design. (See Table 7-3)

(a) Track gauge

As in the case of existing railways, the track gauge is designed to be 1,435 mm.

(b) Electric system

The electric system of the proposed north-south route is recommended to be the third rail system, D.C. 750 V. The current is to be collected from the third rail by means of the collector shoe attached to the lower part of both sides of the car.

(c) Construction gauge, rolling stock gauge, tunnel cross section, and length of rolling stock. (See Fig. 7-3)

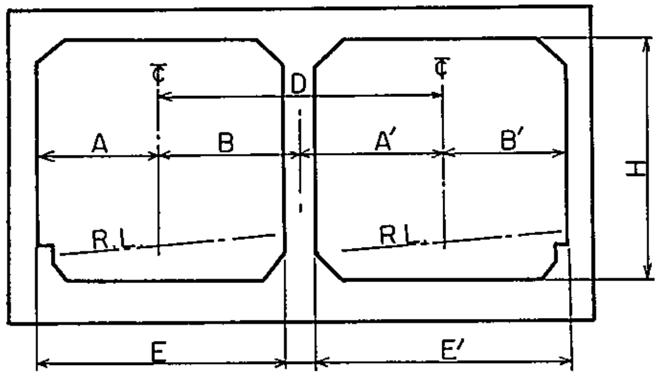
Decision on standards of the rolling stock inclusive of its structure, dimensions, speed, etc., leads to the determination of such factors as rolling stock gauge, construction gauge, minimum radius of curvature, maximum grade, cant and slack, and transition curve.

With the rolling stock gauge having been determined according to the structure and dimensions of the rolling stock as shown in a separate drawing, the construction gauge was designed so as to leave, outside the rolling stock gauge, a clearance of 200 mm in width on both sides and 300 mm in height in consideration of various factors.

Judging from the transport capacity, the structure of the truck and the minimum radius of curvature, the appropriate length of a rolling stock would be less than 20 m. For the proposed north-south route, an 18 m length is recommended.

(d) Widening of tunnel cross sections in curved sections

The cross section of the tunnel must be designed so as to be wider in curved sections according to the minimum radius. The widening of the tunnel cross section should be based on the following equations.



The Center of The Curvature is on The Left

$$A = \frac{\text{Construction gauge (width)}}{2} + \text{(Clearance to the side wall)} + \alpha$$

$$B = \frac{\text{Construction gauge (width)}}{2} + \text{(Clearance to the center post)} + \frac{\text{Center post width}}{2} + \beta$$

$$A' = \frac{\text{Construction gauge (width)}}{2} + \text{(Clearance to the center post)} + \frac{\text{Center post width}}{2} + \alpha$$

$$B' = \frac{\text{Construction gauge (width)}}{2} + \text{(Clearance to the side wall)} + \beta$$

$$H = \text{Construction gauge (height)} + \text{(Clearance to the tunnel ceiling)} + h$$

Where α = Total internal increase

β = Total external increase

h = Increase in height due to cant.

α and β above are, as shown by the two equations below, the sum of "Increase in width of construction gauge due to curve ($W = \frac{2,000}{R}$ mm)" and "Increase in width of the rolling stock gauge due to cant and slack:"

$$\alpha = W + q_c + s$$

$$\beta = W - q_e.$$

To be precise, α, β and h are determined by the application of the

Table 7-3 Summary of Design Standards

Item		Underground Railway only	Through Service with Suburban Railways	Remarks
Rolling Stock Gauge (width x height)		$2.8^m \times 3.5^m$	$2.9^m \times 4.0^m$	Refer to the separate drawing
Construction Gauge (width x height)		$3.2^m \times 3.8^m$	$3.30^m \times 4.75^m$	Refer to the separate drawing
Minimum Radius of Curvature	Main Line	160^m	Same as left	
	Turn out curve	150^m	"	Radius of curvature of No. 8 turn out to be considered
	Line along platform	500^m	"	Minimum: 300 m
	Side track	85^m	"	Radius of curvature of No. 6 turn out to be considered
Transition Curve		When the radius of curvature is below 800^m: $L = 0.07\frac{V^3}{R}$ where V: speed (Km/h), R: radius of curvature (m)	"	Calculation based on Crandall's formula. No transition curve to be provided along platform. Refer to the separate table for the value of V against R.
Distance between Transition Curves Extending in Opposite Directions		More than 15 m	"	No straight line to be provided, if impossible.
Cant		$C = 10\frac{V^2}{R}$ C: cant (mm) V: speed (Km/h) R: radius (M)	"	No cant is to be provided along the platform if the radius of curvature exceeds 800 m. If the radius is less than 800 m, a cant of 10 mm is provided. Where no transition curve is provided, the cant is to be reduced gradually over an extension whose length is 300 times the cant or more.
Maximum grade	Main Line	33 ‰	"	
	Line in Station Premises	10 ‰	"	
	Side Track	45 ‰	"	
Minimum Grade of Underground Line		2 ‰	"	Not necessarily applicable to tracks along platforms.
Minimum Grade of Vertical Curve		2.000 m in case of gradient exceeding 10 ‰	"	Standard: 3000 m, In case of side track only: 1.500 m
Extension of Construction Gauge in Curved Sections		When the radius of curvature is below 800 m: $W = \frac{20,000}{R}$	"	W: Increase in width on both sides (mm) R: Radius of curvature (m)
Slack		When the radius of curvature is below 600 m: $S = \frac{4,500}{R} - 5$	"	S: Increase towards the centre of curve (mm) R: Radius of curvature
Dimensions of Sleeper (width x thickness x length)		Ordinary Use: $230^{mm} \times 150^{mm} \times 2440^{mm}$ 3rd Rail Use: $230^{mm} \times 150^{mm} \times 2740^{mm}$	"	
Height from Roadbed Bottom to Rail		Above ground level: 510^{mm} Beneath " ": Concrete roadbed - 500^{mm}; Ballast roadbed - 700^{mm}	"	
Minimum Centre-to-Centre Distance of Tracks		Above ground level: 3.500^m Beneath " ": 4.050^m	"	The standard centre-to-centre distance of tracks laid on the ground level regardless of their being curved lines or straight lines, is 3,500 m with the exception of specific sections.
Track Gauge		1435 mm	"	
Electric System		Third Rail System (750 V, D.C.)	Overhead Wiring System (1500 V, D.C.)	

following equations:

$$q_c = H_1 \sin \theta - (1 - \cos \theta)\ b$$

$$q_e = H_2 \sin \theta + (1 - \cos \theta)\ (b + G)$$

$$h = H_3 \sec \theta + \{(G + b) - (b - H_3 \tan \theta)\} \sin \theta$$

(e) Minimum radius of curvature

The minumum radius of 160 m, which is designed for the proposed route precluding specific sections, is recommended only in unavoidable causes where the route must make detours around existing buildings.

In the station premises, however, the minimum radius is designed to be 500 m in order to avert the danger in boarding and alighting which may be caused by an excessive opening between the platform and the train.

(f) Grade

The maximum grade is designed to be 35 ‰ for general sections of the route and 10 ‰ within station premises. The minimum grade required for draining the tunnel, including the disposal of leaking water, is designed to be 2 ‰.

(g) Minimum radius of vertical curve

Where a change in grade exceeds 10 ‰, the minimum radius of vertical curve should be 2,000 m.

(h) Cant

Where the design speed is V (KM/H) and the radius of curvature is R (m), the cant shall be as expressed in the equation below:

$$C = 10 \frac{V^2}{R} \text{ (mm)}.$$

No cant should be provided to the track along the platform if the radius of curvature exceeds 800 m. However, where the radius is less than 800 m, cant of about 7 mm, not exceeding 10 mm, may be provided.

The cant provided to the outer rail of one of the reverse curves should be reduced while elevating the inner rail, so that the connection with the other curved section may be made with the same gradient. (See Fig. 7-8)

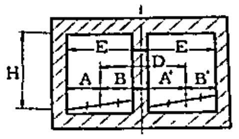
(i) Slack

Where the radius of curvature, R (m), does not exceed 600 m, the slack should be as expressed in the equation below:

$$S = \frac{4,500}{R} - 5 \text{ (mm)}.$$

Values of all the above-mentioned items have been calculated for each individual curved section on the proposed route and are tabulated in Table 7-4.

Table 7-4 Details of Design Standards

Item / Radius R (m)	Speed V (Km/h)	Cant $C=10\frac{V^2}{R}$ (mm)	Length of Transition Curve $L=0.07\frac{V^3}{R}$ (m)	Extension of Construction gauge due to Curves $W=\frac{20000}{R}$ (mm)	Internal Deviation due to Cant q_c (mm)	Slack $S=\frac{4500}{R}-5$ (mm)	Increase in Height due to Cant h (mm)	Total Internal Increase of Curved Sections $\alpha=w+q_c+s$ (mm)	External Deviation Due to Cant q_e (mm)	Total External Increase of Curved Sections $\beta=w-q_e$	(Unit: mm)  A = 1600 + 300 + α, B = 1600 + 200 + 225 + β, A' = 1600 + 200 + 225 + α, B' = 1600 + 300 + β, H = 3800 + 100 + h A	B	A'	B'	D	E	H
120	35	115	36	167	266	25	125	458	87	80	2360	2105	2485	1980	4590	4465	4030
130	40	145	34	160	334	25	154	519	113	47	2420	2075	2545	1950	4620	4495	4060
160	42	110	33	125	255	21	121	401	83	42	2300	2065	2425	1940	4490	4365	4040
170	44	114	35	118	264	"	125	403	86	32	"	"	"	"	"	"	"
180	46	118	38	111	273	19	129	403	90	21	"	"	"	"	"	"	"
190	48	121	41	105	280	"	131	404	92	13	"	"	"	"	"	"	"
200	50	125	44	100	289	17	136	406	95	5	"	"	"	"	"	"	"
210	51	124	44	95	287	"	135	399	95	0	"	"	"	"	"	"	"
220	52	123	45	91	284	15	134	390	94	"	"	"	"	"	"	"	"
230	53	122	45	87	282	"	133	384	93	"	"	"	"	"	"	"	"
240	54	122	46	83	282	13	133	378	93	"	"	"	"	"	"	"	"
250	55	121	47	80	280	"	132	373	92	"	"	"	"	"	"	"	"
260	56	121	47	77	280	"	132	370	92	"	"	"	"	"	"	"	"
270	57	120	48	74	278	11	131	363	91	"	"	"	"	"	"	"	"
280	58	120	49	77	278	"	131	360	91	"	"	"	"	"	"	"	"
290	59	120	50	69	278	"	131	358	91	"	"	"	"	"	"	"	
300	60	120	50	67	278	9	131	354	91	"	2250	2025	2375	1900	4400	4275	4030
350	65	121	55	57	280	7	132	344	92	"	"	"		"	"	"	"
400	"	106	48	50	246	"	117	303	80	"	"	"	"	"	"	"	
450	"	94	43	44	218	5	105	267	70	"	"	"	"	"	"	"	"
500	"	85	39	40	197	3	96	240	63	"	"	"	"	"	"	"	"
550	"	87	35	36	179	"	88	218	57	"	"	"	"	"	"	"	"
600	"	70	32	33	163	"	80	199	51		21( )	2025	2225	1900	4250	4125	4000
650	"	65	30	31	151		75	182	47	"	"	"	"	"	"	"	"
700	"	60	28	29	140		69	169	43	"	"	"	"	"	"	"	"
750	"	56	26	27	131		66	158	40	"	"	"	"	"	"	"	
800	"	53	24	25	124		61	149	38	"	"	"	"	"	"	"	"
850	"	50								"	"	"	"	"	"	"	
900	"	47			110		55	110	34	"	"	"	"	"	"	"	"
950	"	44								"	"	"	"	"	"	"	"
1000	"	42			98		49	98	30	"	2000	2025	2125	1900	4150	4025	3950
1100	"	38			89		45	89	27	"	"	"	"	"	"	"	"
1200	"	35			82		41	82	25	"	"	"	"	"	"	"	"
1500	"	28			66		34	66	19	"	"	"	"	"	"	"	"
2000	"	21			49		26	49	14	"	"	"	"	"	"	"	"
Straight Line Section	"	0	0	0	0	0	0	0	0	0	1900	2025	2025	1900	4050	3925	3900
Remarks	* In cases where R = 120 or R = 130, the cant (c) is expressed by the equation: $C = 11.3\frac{V^2}{R}$.																

(5) Station facilities

Underground railway stations can be classified into 3 types, i.e., a 3-floor type, a 2-floor type with a mezzanine partly provided and a 2-floor type without a mezzanine.

Platforms can be classified into two fundamental types, i.e., the side-platform and the island-platform. The design and construction in the former are easier and more economical because of simpler alignment and structure. However, it has its own demerits, e.g., the necessity for an underground passageway or mezzanines to connect the platforms constructed on both sides of the track.

The latter platform has characteristics quite contrary to those of the former, and the selection between the two types should be made with due consideration to the location of the station, interchange facility to other transportation means, and other factors.

Considering the estimated number of passengers using each proposed station based on their present travelling habits and the population within the area to be covered by each station, it is recommended for economic reasons that stations some distance from the city center be provided with side-platforms with a width exceeding 3 m and that main stations within the central district of the city be provided with island-platforms with a width exceeding 6 m.

In the following sub-sections, typical standards for different station facilities will be given. (See Fig. 7-4 - 7-6)

(a) Platform

1) Length

When determining the length of a platform, it is the common practice to provide an allowance of a certain length to the maximum length of the train to meet the technical requirements arising from train operation, and to secure space for the announcing room, the signal cabin and the train dispatcher's office, if such facilities are required.

If the operation of 6-car trains is desired ultimately, the platform should have a length of about 120 m as expressed in the equation below, provided that one car is 18 m long.

$6 \times 18 \text{ m} + 10 \doteqdot 120 \text{ m}.$

2) Width

The width of a platform should be determined with consideration to the anticipated increase of passengers.

On the assumption that passengers are distributed evenly at each door of the train, the width can be calculated by the equation given below. However, in order to obtain the width that meets the actual situation, the value obtained by this calculation should be modified according to the location of stairways on the platform, the flow of passengers, and other factors.

$$B = B_1 + B_2 + B_3 + B_c$$

Where

B = Required width of the platform

B_1 = Width required for boarding

B_2 = Width required for the flow of boarding passengers

B_3 = Width required for the flow of alighting passengers

B_c = Width constant conforming to the type of platform

Explanations are given below on each of the above factors.

$$B_1 = \sqrt{\frac{2}{\pi} \cdot \frac{Pa}{N.m.\rho_1}}$$

where

Pa = Number of passengers boarding one train

N = Number of cars in train

m = Number of doors on one side of the train

ρ_1 = Density of boarding passengers (about 4 persons/m^2)

$$B_2 = \frac{1}{\rho_1 v_1} \cdot \frac{Pa'}{T}$$

where

ρ_1 = Density of passengers on the platform (Free footpass limited to 1.25 persons/m^2)

v_1 = Walking speed (Free footpass limited to 1.1 m/sec)

T = Headway (sec)

Pa' = Number of boarding passengers in each flow direction

$$B_3 = \frac{1}{\rho_1 \ell} \cdot \left(\frac{Pb}{N}\right)$$

where

ℓ = Length of the train

Pb = Number of passengers getting off one train

B_c = Width of posts, benches, announcing room, etc. on the platform

(b) Stairway

1) Width

On the assumption that the boarding and alighting passengers are distributed evenly along the entire length of the train, the required width of the stairway can be calculated by the application of the following equation:

$$S = (B_2 + B_3) \cdot \frac{\rho_1 v_1}{\rho_2 v_2}$$

where

B_2, B_3, ρ_1 v_1 = Values applied in the calucation of the width of the platform.

ρ_2 = Passenger density on the stirway (persons/m^2)

v_2 = Speed of passenger flow on the stairway (m/sec)

The above equation is applicable when the stairway is constructed on one end of the platform. If, however, it is constructed over the central part of the platform, the value of both S and B is doubled.

2) Minimum width

The minimum width of a stairway can be calculated by the equation below:

$$S = \frac{1}{\rho_2 v_2} \cdot \frac{P}{T} (1 + \alpha)$$

where

T = Headway (sec)

P = Number of boarding and alighting passengers

α = Rate of allowance

3) Dimensions of stairway

Considering laws and regulations pertaining to building construction and the special necessity for constructing a stairway within a limited space, its dimensions should preferably be based on the standards given below.

a) The length of the riser and the tread should be 165 mm and 330 mm respectively.

b) If the height of the stairway exceeds 3 m, a pace with a length of 1. 2 m or more should be provided.

c) The width of the stairway should include the required effective width, the width of handrails, and the thickness of the interior finish. A side-ditch of about 50 mm wide should be provided along each side of the stairway.

d) The height of the cross section should be determined in proportion to that of the adjoining passageways and of the mezzanine. In case stairways lead to entrances, a height of 2. 5 m should be provided vertically between the tread face and the stairway ceiling.

(c) Entrances

1) Minimum width

The minimum width allowing two persons to walk side by side is 1. 2 - 1. 4 m. For practical purposes, however, 1. 5 m is recommended.

2) Entrances set on a side walk

The width of an entrance set on a sidewalk should be determined so as not to excessively occupy the effective width of the sidewalk.

If the entrance is to be set on four corners of an intersection, care should be taken so as not to hinder the visibility on the street.

3) Passageways connected with buildings

Passageways connected with underground structures of main buildings in the station vicinity afford much covenience to passengers and at once serve to alleviate surface traffic.

It is therefore advisable that if main buildings expected to be renovated or constructed are in the vicinity of an underground railway station, plans should be drawn up in advance so that a connection between such buildings and the station may be materialized in the future. The station most stuitable for such connection is the 2-floor type with the island-platform.

(d) Booking Office

The booking office should have a depth of 2. 5 m with windows 1. 5 m in width. The number of windows should be determined according to the scale of the station.

One window would be required at stations with less than 8,000 boarding passengers, two windows at stations with 8,000 - 16,000 boarding passengers, and three at stations with boarding passengers exceeding 16,000. 1 -3 supplementary windows should be installed at all stations regardless of their scale.

(e) Fare adjustment offices

At stations with more than 17,000 alighting passengers, a fare adjustment office should be installed at the ticket collecting gate. A fare adjustment office should also be installed at terminal stations, central stations and interchange stations even if the number of passengers getting off at these stations may reach no more than 10,000.

The fare adjustment office should have a width of 1.25 - 1.70 m and a length of 1.55 - 3.55 m.

(f) Annoucing room

At stations where the number of daily boarding passengers exceeds 10,000, announcing facilities should be installed to ensure smooth flow of passengers. Such facilities are usually accomodated in an announcing room measuring approximately 3.0 m x 1.7 m.

(g) Other station facilities

In addition to the above, such station facilities as the station office, the waiting room, the rest room, the council room for station staff as well as the store house should be provided in order to ensure smooth and reliable passenger service. The space required for these facilities may be determined based on the standards given below.

1. Station office .... (10 m^2 (for station officer))
(5 m^2/ person
2. Waiting room .... 1.5 m^2/person
3. Rest room .... 2.8 m^2/person
4. Council room .... 0.8 m^2/person
5. Washroom .... Lavatory and urinal, one each
6. Store house .... (30 M^2 (at stations with station office))
(6 m^2 (at other stations))
7. Hot water service room ... 4 m^2

(h) Signalling facilities

1) Signal cabin

The signal cabin to be constructed within the premises of a station with a crossover should have a space of about 40 m^2.

2) Compressor cabin

The compressor cabin, measuring 4 m x 8 m x 3 m (height), produces compressed air which is requred to drive the interlocking device.

(i) Electrical facilities

1) Electricity room

The electricity room receives current from its substation through the high voltage distribution line and supplies power for signalling, lighting and pumping through switches after reducing the voltage by transformers.

The space required for the electricity room (A) is expressed in the following equation:

$$A = 3.3 \sqrt{K}$$

where

K = constant x area illuminated.

The interrelation between the constant and the illuminated area is classified by the scale of the station as shown below.

Class	Illuminated area (m^2)	Constant (KVA/m^2)
A	More than 4,000	0.0180
B	3,000	0.0160
C	~ 4,000	0.0145
D	Less than 3,000	0.0130

2) Terminal board room

The terminal board room with a space of about 9 m^2 should be installed next to the electricity room.

3) Battery room

Storage batteries for signalling and lighting which can supply the minimum power required for maintenance in case of service interruption are installed in the battery room which should generally have a space of about 10 m^2, or about 20 m^2 if necessary.

(j) Lavatories for passengers

Intallation of lavatories may not be justified since they would be constructed as underground structures. With the development of the city, however, the underground lavatories will become one of the essential facili-cilities of the underground railway service.

(k) Fire extinguishing facilities

1) Fire plugs

Fire plugs should be installed at intervals of 50 m along the entire extension of the platform, the mezzanine and the passageway. This interval of 50 m is determined by the length of the hoses which is 25 m. The water discharge capacity of one fire plug is 140 lit. /min.

2) Water tank

In case one tank is to be installed at a station, it should have a 20 m^3 capacity which enables 6 fire plugs to simultaneously discharge water for 20 continuous minutes. If two tanks are to be provided, the capacity of each tank should be 6 m^3 so that 2 fire plugs can discharge water simultaneously for 20 continuous minutes.

7-2-3 Type of structure of interchange station and junction station

(1) Interchange station connected to the Central Railway Station

It is necessary for an interchange station to be constructed at a point which would allow westward extension from the Central Railway Station of the existing National Railway and the Metro by underground operation. An underground passageway should therefore be constructed between the Central Railway Station and this interchange station (which will be built as a two-floor type station). The Metro line and the National Railway are envisaged to run across the proposed north-south route beneath and above this station respectively. It is proposed that the interchange between these three lines be provided by underground passageways constructed at this station which will be developed into a composite station in the future.

This station may be constructed at the pre-designed intersection of the three lines parallel with the construction of the proposed north-south line; otherwise, it may be so built as to allow for necessary renovation in the future so that no loss in construction may be entailed.

(2) Junction station connected to the car shed line

The layout of the tracks at the proposed junction station should be so designed that trains can go into the shed after passengers have got off and leave the shed so that passengers may get on. A crossover should therefore be provided near the northern end of the platform so that the connection with the car shed may be made. (See Fig. 7-9)

Furthermore, considering the possible northward extension of the line, which will run beneath the canal, the station should be constructed at a substantial depth with a mezzanine and side-platforms.

7-2-4 Drainage, ventilation and tunnel washing

(1) Drainage facilities

Pumping rooms should be installed in the lower sections of the longitudinal slope of the route in order to dispose of waste water from stations and tunnel leakage, but there will be no necessity for disposing of water from rainfall.

The longitudinal slope should therefore be designed to allow for the establishment of pumping rooms at intervals of about 2 km.

Although the scale of a pumping room naturally depends on the amount of water to be disposed of, it should generally be designed to cover a 2 km distance, with the capacity of 2 m^3/min. and a cesspool that can store water for 30 continuous minutes.

A total of 3 pumps comprising 2 pumps of 5" caliber (with a motor of 10HP) in constant use and 1 pump for stand-by purpose should be installed in the pumping room. The space required for their installation should also be secured.

(2) Ventilation facilities

Although no intensive discomfort is felt in Cairo in places which are sheltered from direct sunlight, the temperature and the humidity in the tunnel rise, accompanied by discomfort, in proportion to the increase of passengers and to the decrease of train headway.

Ventilation may be provided by two different means, i.e., natural ventilation by the running of trains at a high speed, and forced ventilation by means of ventilators.

For natural ventilation, which is more economical in the general sections of the tunnel, 2 holes measuring about 2.0 x 1.3 m should be provided on the side wall or the tunnel ceiling at intervals of about 1,000 m. The hot and humid air flows through these holes to the gridcovered openings set at corners on the sidewalk or in open areas.

Within the station premises where long stoppage of trains incurs higher rises in temperature despite the short length of the tunnel, ventilating openings should be installed in larger numbers than in the general tunnel sections. It often occurs, however, that the scale and topographical conditions of a station make it impossible to install as many openings as desired. It is therefore recommended that forced ventilation facilities be installed at stations.

Forced ventilation is performed by two different methods: drawing air in at stations and drawing it off in general tunnel sections, and performance of both suction and discharging within the station premises. Selection between the two methods should be made with consideration to the distance between stations and various conditions that affect the location of the stations.

(3) Tunnel washing facilities

A water pipe should be laid in the tunnel with cocks provided at regular intervals so that the tunnel sections may be kept clean and dust-free by periodical washings. (See Fig. 7-10)

7-2-5 Tracks

(1) Characteristics of underground railway tracks

The tracks of an underground railway should meet various requirements arising from tunnel structure, rail conditions and train operation.

(a) Rigid structure is needed due to difficulty in maintenance. (Difficulty caused by rapid train operation at close headway during service hours)

(b) Least damage to the rail is required because of the long service hours per day and the consequent short hours of operation suspension during which the maintenance work must be done.

(c) Antiseptic and anti-corrosive structure is required for better drainage.

(d) Structure and materials should be suitable for noise and vibration absorption.

(e) Roadbed should be designed so that the tunnel section area is reduced to the minimum.

(f) Construction should be performed so as to meet the requirements arising from comparatively sharp curves and grades.

It is considered necessary for the tunnels of the proposed underground railway of Cairo to be frequently washed. It is therefore desirable that the structure of the tracks be such as will make the tunnel washing easy.

(2) Track structure (See Fig. 7-11)

As already mentioned in the foregoing sections, the concrete roadbed is recommended for general sections of the route in view of the characteristics of an underground railway.

It is appropriate, however, to adopt the ballast roadbed in those specific sections where the residents above the route must be protected from the noise and vibration of the running trains since the route transverses private land and the earthfill is less than 4 m thick.

The number of joints in the rail should be minimized and constant elasticity of the track must be maintained if it is desired to attain rigid track structure, alleviation of track maintenance, prevention of noise caused by the friction between the rail and the wheel, and better riding comfort.

In the case of the concrete roadbed, the elasticity of the track can be sought only in the fastening device of the rail. The rail fastening device has made remarkable progress in recent years and is quite capable of meeting such requirements. The latest fastening device provides vertical as well as lateral elasticity, thereby adding to the life of the track. It is therefore proposed that the direct elastic fastening method be adopted for the general sections of the route, whereby the rail may be laid directly on the concrete roadbed without sleepers. In this system, the material that comes in contact with the rail is of rubber. The rail, therefore, is completely insulated from other structures.

The lateral pressure of the rail is sustained, through the shoulder of the rubber tie plate and the rail clip, by the anchor bolt. The anchor bolt is insulated with 100 M Ω of resistance.

Group	I	II	III	IV
Curvature	Straight line & R > 800 M	800 M R > 600 M	600 M R > 200 M	200 M R > 150 M
Axle Load (t)	15	15	15	15
Wheel Load (t)	8.63 (constant)		9.75 (upper limit)	
Lateral Wheel Pressure (t)	not considered	3.75 (constant)	6.00 (upper limit)	
Plate Vertical Spring Constant (t/cm)	50 + 10 - 5		—	—
Clip Lateral Spring Constant (t/cm)	6 + 2 - 2		—	—
Top Lateral Spring Constant (t/cm)	less than 4 mm			

For economic reasons, the route is classified into four groups according to the radius of curvature as shown in the following table which indicates design specifications and capacities for each group.

In the general sections of the route, the long rail, 50 kg per meter in weight, should be used. In curved sections, the hard-top rail with excellent anti-abrasive property should be used. It is recommended that frogs of managese steel be used and that the joints in the rail be connected by the thermit welding so that the track may consist of as long rails as possible.

(3) Specifications for track designing

(a) General

1) The rail should be 50 kg in weight and 25 m in length. Ordinary rails should be laid in sections where the radius exceeds 450 m, and hard-top rails should be used in sections where the radius is less than 450 m and at points where frogs are installed.

2) Anti-creepers

In the ballast roadbed, 4 stop piles for sleepers should be installed for each 25 m on one side in sections with an up grade of more than 25 ‰ and in braking distances.

12 anti-creepers should be installed for each 25 m on one side in sections with a down grade exceeding 25 ‰, in braking distances as well as along the 50 m distance in both directions from the point where the frog is installed.

The braking distance mentioned here is the 200 m distance in the running direction of the train from the points of the train's approach to the station, plus the length of the platform.

(3) Tunnel sections

1) Joint of rails

Where the radius does not exceed 450 m, the joints should be connected by the ordinary method, and in sections where the radius exceeds 450 m, they should be welded.

2) Fastening of rails

The direct elastic fastening method should be employed in sections where the roadbed is of concrete without sleepers, and the tie plate method should be adopted in ballast roadbed sections.

3) Types of roadbeds

The concrete roadbed should be adopted except in special cases (e.g. traversing of private lands) where consideration must be given to the prevention of noise and vibration and the ballast roadbed is required.

4) Arrangement of sleepers

On the concrete roadbed at turnout points, 45 sleepers should be laid for each 25 m at intervals of 565 mm, and on the ballast roadbed, 47 sleepers should be laid for each 25 m at intervals of 450 mm.

5) Chock

22 chocks should be provided for each 25 m on one side of the concrete roadbed where the radius is less than 450 m. Installation of chocks outside the tunnel must be based on a different standard.

7-3 Method of tunnel construction

The cut-and-cover method is recommended for the tunnel construction with modifications to be effected to meet diversified characteristics and geological conditions of individual construction sites.

7-3-1 Method generally adopted

Methods adopted for the construction of underground railway tunnels are generally considered under two categories. According to one of the methods, the tunnel is constructed at a prescribed depth beneath the surface by excavating the soil vertically from the ground surface. The other method is to make a horizontal excavation beneath the surface without regard to the surface conditions.

The route of the proposed north-south line, particularly that of the 10 km extension from Ismailia Canal as far southwards as the vicinity of El-Malik Station of the Helwan line, has been designed to run relatively near the surface as already explained in the sections dealing with tunnel structure. The former method is therefore recommended for general sections of the route.

Judging from the results of geological surveys conducted along the proposed route, which were made available to the Mission, the greater portion of the soil consists of layers of fine sand containing clay soils except for the surface soil.

As for underground water, its level is expected to be stabilized and maintained at the dry season level as a natural consequence of the anticipated stabilization of the water level of the Nile. It is expected that the Nile's water level will, when the High Dam is completed, maintain the low water level of about +16. 5 m throughout the year.

Drainage of underground water during construction does not seem to present many difficulties except at the southern end of the route which is close to the Nile, but the definite conclusion in this respect should await the results of further detailed geological surveys.

At any rate, it is considered possible to adopt the open-cut method which is a typical method employed in the construction of underground railway tunnels. However, other methods including the caisson method will have to be applied for cross-river construction involved in the crossing of the Ismailia Canal in the north and the Nile River in the south.

The open-cut method is advantageous in that it is technically easier, incure less cost than other methods, and ensures the completion of work within a shorter period. (See Fig. 7-12)

The excavation should commence with the driving of steel piles such as I-beams and H-beams at regular intervals on both sides of the tunnel to prevent mud fall. Sheet piles must also be driven continually in the soil if demanded by the geological conditions. In cases where I-beams or H-beams are employed, sheet piles should be horizontally inserted between such beams to prevent mud fall. To resist the lateral pressure of soil, driving of steel piles such as H-beams should be arranged.

In cases where surface traffic should be maintained at the construction site, surface planking work should precede excavation in order to resist the surface load.

If a large excavation width is required, e. g. for stations, intermediate piles should be employed so as to facilitate the planking work and prevent mud fall.

As the excavation proceeds, measures should be taken to prevent sinking of these intermediate piles so that their bearing power against the surface load may be maintained.

Various mains that are exposed in the course of excavation should usually be suspended or supported in their original positions with proper protection.

When excavation reaches the designed depth, the foundation upon which to construct the tunnel should be formed. The tunnel should normally be protected by waterproof layers coated on the outer surface of the tunnel.

As the tunnel construction proceeds by means of consecutive construction of unit tunnel sections of about 20 m, the space between the tunnel roof and the ground surface should be refilled while restoring various mains to their original positions and shapes.

When the refilling work comes close to the ground surface, surface planking must be removed and the surface should be paved temporarily after the roadbed is arranged so as not to cause any obstructions to traffic.

The tunnel construction is complete when the roadbed is finally paved after extracting piles such as I-beams, H-beams and sheet piles.

Explanations are given below on major works required for tunnel construction.

(1) Pile driving

In order to prevent mud fall during tunnel construction, sheathing piles such as I-beams (300 x 150 x 10 mm) and H-beams (300 x 300 x 11 x 12 mm) are generally employed.

If the excavation is carried out close to building foundations and in areas with satisfactory soil condition, piles with smaller sections or pieces of used rails should be utilized. If the soil is soft and underground water is found in a large quantity, sheet piles should be used.

Mud fall preventors not only resist soil pressure but also support the load imposed by surface traffic. In employing the cut-and-cover method, therefore, the driving depth of piles should be determined by careful examination.

Since the positions on which piles are driven serve to secure the correct and prescribed location of the tunnel, due consideration should be paid to the equipment and the method employed in pile driving.

In cases where a large excavation width is required, e.g. for stations, intermediate piles should be used to support the surface beams and to maintain the rigidity of mud fall preventors. As the bearing power of these intermediate piles decline with excavation, it is necessary to connect them and prevent their sinking.

Equipment used for pile driving are: electric drop hammer, diesel hammer and vibrating pile-driver. What particular equipment should be used is a matter determined by the soil condition and the extent of consideration to be paid to the wayside buildings.

In cases where hard layers make pile driving difficult, or where old and decrepit buildings are found near the excavation site to which the vibration is dangerous, or where the noise of pile driving is prohibitive, piles are erected into holes bored by means of earth drills or earth augers. In such cases, the holes into which piles have been erected should be filled with lean-mix mortar to prevent mud fall during excavation.

(2) Surface planking

Surface planking is required to maintain normal surface traffic in those construction areas where the roadway width is too small to cut off traffic.

An example of the planking work is given below.

Heads of piles or sheet piles are fastened together with channel steels to form abutments, on which crossbeams (normally I-beams with 600 mm height or H-beams) capable of supporting the surface load are spanned across the street at 2 meter intervals. Steel plates measuring 2 m x (0.75 - 1.0) m are then placed on these crossbeams.

If the surface tramway tracks should be supported, concrete planks are to be spanned as a means of electrical insulation.

If there are by-passes, it is feasible to achieve a saving in cost by enforcing a limit to the surface traffic load in the construction area.

(3) Excavation

If excavation is to be carried out beneath streets with heavy traffic or in the city area where buildings are constructed close together, prudent study on the method of excavation should be made in advance. This study would avoid adverse effects that may be caused by the loosening of the ground, i. e., settlement of the surface road, damage to various underground installations, and harm to buildings near the construction site.

It is therefore necessary to make various studies prior to the construction, including: soil survey, investigation of building foundations and structures, etc. Also, it is imperative to make studies, at least on the following points, in order to ensure safe execution of work.

(a) Calculation of soil pressure, water pressure, and strength of each member of the mud fall preventor

The examination of mud fall preventors should be made not only for the final, but for each stage of excavation. Furthermore, safety should be assured for concrete placing stages and pile extracting stages.

(b) Load imposed by buildings in the neighbourhood of the site, influence of structure on and beneath the ground level

(c) Method of leakage disposal, and safety measures against heaving

(d) Safety of facing

The facing comes in two kinds, i.e., the temporary work to be performed while the excavation is in progress, and the semi-permanent work for covering the connection between two unit construction sections. The latter is left untouched for a comparatively long time.

(e) Influence of the settlement of ground due to consolidation and contraction, and measures to be taken against it

(f) Measures to be taken against damages from storms and floods.

Excavation should commence only after studying the above-mentioned points (a - f) and determining the order and method of work. Although higher efficiency can be gained from use of mechanical power, often in excavation work, manual power must be employed due to limited working space resulting from the driving of piles and the existence of underground mains.

Excavated soil is usually shovelled up to the ground surface where skips are to be installed at intervals of 20 m-- the length of a unit excavation section. The skips should be installed to as not to impede surface traffic.

(4) Tunnel body

Concrete placing should be performed as soon as possible upon completion of excavation when mudfall prevention is most unstable. In the case of a reinforced concrete structure, construction speed is largely affected by the setting of reinforcing bars and form. It is therefore essential to secure a sufficient number of labourers in view of the progress of the excavation work.

The tunnel body is usually constructed from bottom to top when the soil has been excavated to the required depth. The ground condition at this time is subject to the longest period of instability. If, therefore, the soil condition is not rigid enough, or old buildings are found in the neighbourhood, consideration must be given to the possible necessity of excavating to the depth of the top slab first, and excavating further downwards after constructing the top slab.

As for the method of supplying concrete in the city area, it would be most appropriate to have a concrete-mixing plant established some distance from the construction site, and provide the ready-mixed concrete to each working section. The location of the concrete-mixing plant should be selected with consideration to the distance between the plant and the construction site, difficulty in transporting the mixing materials, and other factors.

The most representative of the waterproofing work are the membrane type and the surface coating type. The former type covers the outer surface of the tunnel with a waterproof layer made up mainly of asphalt which is painted on anti-corrosive material. The latter type coats the tunnel's outer surface with mortar mixed with waterproof material which is either liquid or powder.

(5) Refilling work and restoration of surface road

The refilling work should be started when the tunnel is completed.

In order to restore surface traffic in a short period, the refilling work is usually carried out beneath the planked surface by filling the gap with soil. In this case, it is absolutely necessary that the refilled soil be thoroughly tamped.

In areas where many underground mains are found, the refilling work should be performed concurrently with the restoration of such mains and the extracting of mud fall preventors. This makes it difficult to utilize mechanical power and often leads to future settlement of surface ground. The temporary paving work is therefore to be completed as quickly as possible in such areas so that the final paving work may be done after a lapse of time in which the refilled soil should have settled sufficiently.

If the temporary paving work is conducted in conformity to the specifications set for the final paving work, with materials of good quality used for the roadbed and the subsoil, it will be possible to complete the final paving work in a shorter period and at less cost since the roadbed and subsoil arrangement can be omitted.

7-3-2 Method of construction work in each district

(1) Shubra Street

The widening of Shubra St. is now in progress and its three km section in the north has already been widened. A part of Shubra St. in the southern district is also under construction and its completion must be stepped up. Needless to say, in undertaking this work it is most important to execute the temporary work, including excavation, in the safest and most economical way to save construction costs. The width needed for the construction of underground railway tunnels with double tracks is usually 10 m.

If the tunnel is made beneath the present tramway track, it will lessen the obstacles for public traffic and construction will be executed with comarative ease since there will be hardly any mains beneath the track.

The tramway service in the 2.5 km section in the northern part, judging from its present transportation capacity, may be replaced by buses. The construction work, after withdrawal of tramways, will be carried out faster and more economically.

Due to the soil condition in this section, it is sufficient to adopt the open-cut method by pile driving and construction may be carried out, in principle, without surface planking except for sections which occupy large parts of roadways such as intersections and station sites, and curved roadways.

In the 2 km section in the southern part, the execution of work with surface planking is inevitable in order to preserve tramway service.

For sections which are close to high storied buildings, deliberation must be given to the adoption of a method for erecting mud fall preventors in holes bored by drills or augers as introduced below.

(2) City centre (Imad El-Din St.)

From Imad El-Din St. starts the central part of Cairo after passing Ramses St. Here, in spite of 20 m wide road, there is the tendency for traffic conges tion; and high storied buildings are constructed on both sides of the street. Measures which will permit vehicles to turn into other streets, as much as possible, must be taken during the construction.

Surface traffic of the main street must be maintained as much as possible even during construction.

Accordingly, the "cut-and cover" method must be adopted in this case.

The demolition of buildings along the route is not necessary because of the 20 m wide road, but in the area where high storied buildings are found, pile driving is necessary so as not to cause vibration.

Thus, drilling to the prescribed depth must be made by the earth drills or earth augers. H-beams and I-beams must be erected with the necessary driving depth so as to give supporting power against the surface load.

While drilling, the bentonite solution must be filled in the hole to prevent earthfall. After completion of pile driving, lean-mix mortar must be poured to replace the bentonite solution. This is to prevent earthfall due to the loosening at drilled holes during excavation.

Cement milk and chemical solution should be poured prior to reinforcing the ground lest the neighbouring buildings settle disproportionately due to the pumping of the surrounding sand together with underground water. At the same time, consideration should be given so as not to loosen building foundations.

(3) Area where the level of underground water is high -- Southern section of the proposed line

In the area leading to El-Malik, parallel to the Helwan line, which is comparatively close to the Nile in the southern portion of the proposed line, it seems that the level of underground water is high and thus water gush is heavy.

Excavation in this area, if carried out without taking appropriate measures, will be accompanied by water gush, quick sand and boiling phenomena, since the soil consists chiefly of fine sand; thus the safety of construction cannot be assured.

In this district, excavation must proceed after the lowering of the underground water level is achieved through forced drainage by the well point method. In so doing, work can be carried out safely and easily and efficiency will be elevated. The draining method must be suitable to the nature of the soil, thus the method to be adopted must be determined on the basis of the data obtained from a detailed survey of the soil.

In planning the well point method, the main problems to be studied and solved are as follows.

(a) In order to carry out efficient drainage, the required soil test must include surveys of the underground water level and the layers of the soil by boring and gathering undisturbed soil samples.

The type and capacity of well point method must be studied. Particularly, the permeability test must be conducted at the site to obtain the coefficient of permeability of the sandy soil.

(b) The capacity of the pump and the number of well points to be established must be based on the amount of seepage and rainfall. The interval between well points is usually 1.0 - 1.5 m for clay layers and 1.5 - 2.0 m for sand layers.

For silt layers, the desired results may be obtained by first setting up sand pile and establishing the well point in the pile.

(c) A water collection of 20 - 40 lit./min. per well point is appropriate.

(d) Although the length of the riser pipe is usually 8 m, the effective depth against the lowering of water level should be designed to be 6 m.

Accordingly, the method to install them in two or three stages

(e) The pore water pressure must be measured by a piezo meter to determine the effect of the well point method.

(4) Narrow roads south of El-Nasriya Street

In the section starting southwards from El-Nasriya St. to El-Barani St., there are exceedingly narrow roads.

There are, too, a group of houses which obstruct the construction of the tunnel on the El-Abisaifain St., but many of them are so dilapidated that destroying them is advisable. Demolition of these houses should be done keeping pace with the road plan or from the standpoint of its own.

These buildings can be re-constructed on the original sites, if necessary, after the completion of the tunnels.

In case of work in which buildings are destroyed, the open-cut method is advantageous.

(5) Main station premises and vicinity

In the neighbourhood of the main station, the line will pass beneath high-storied concrete buildings and a group of congested rails. Although the conditions of the foundation of the station are not clear, it does not appear difficult to let the proposed line pass beneath the buildings through the underground support method, thus keeping the buildings as they are. The following is the method for underground supports.

(a) Set up rows of concrete supporters by digging through the deep foundation method.

(b) Span the main steel girders, using these supporters as piers.

(c) Span steel cross beams over these main girders.

This steel cross beam should be installed by trench digging beneath the foundation of the building. The building will be directly supported by steel cross beams.

(d) Drive earth fall preventors along both outer lines of the tunnel.

(e) Forced drainage by well point method should be employed prior to the digging so as not to loosen the ground unnecessarily.

The foundation of the buildings close to the dug portion should be reinforced by grouting to prevent settlement of the buildings.

(f) Main excavation work will begin after the completion of underground support.

In order not to loosen the surrounding ground, the steel mud fall preventors must be set firmly at the appropriate time.

Upon completion of excavation to the required depth, the construction of the tunnel should begin immediately.

(g) The work will be finished while buildings are supported by underground supports which will remain as permanent structures after completion of the tunnel.

The construction of the tunnel running beneath congested rails should be finished by the open-cut method following the support of the surface tracks. The following is the order.

(a) The first temporary support should be built beneath the track. For this purpose, the abutment, in the beginning, should be constructed to support each track by rail beams, etc.

For this, foundation piles are necessary. The steel beams must be spanned over them, provisionally, so as to support the track.

(b) The second temporary support should be performed following the first temporary support of the track and the removal of roadbed, by driving permanent supporting steel piles and mud fall preventors which will serve to support the tracks.

(c) Upon completion of the above temporary supports of tracks, excavation must proceed in the open-cut method to complete the tunnel. Necessary measures must be taken so that the loosening of the surrounding ground will not occur.

(d) After completion of the tunnel, the restoring of tracks will begin. The surface should be constructed with good quality material by gradually removing the underground supports and restoring the original shape. As mentioned above, in executing the traversing work beneath the tracks, appropriate measures at proper times must be taken in order to minimize loosening and settling of the surrounding ground and to secure the safety of the busy operation of trains.

7-3-3 Soil profile and underground water

The outline of the nature of soils in Cairo resembles that of the

Delta zone of the Nile, except for the southern hills and their influenced areas.

The subsoil condition along the north-south line shows clay or different graded sand composition to a considerable depth from the surface. (See Fig. 7-13).

The level of underground water, as estimated from the data so far provided and the survey of several construction sites in the city, is supposedly 2.5 - 4.5 m beneath the surface in the vicinity of the main line. Closer study must be made from the detailed survey, but it is believed that the level is comparatively low in the city centre, while it becomes gradually higher as the route nears the Nile in the north and south of the city. It is also believed that there is a large quantity of gushing water in districts closer to the Nile.

The clear fact that the level of underground water is greatly influenced by the water level of the Nile is shown in Fig. 7 - 14.

Now that the flooding of the Nile no longer occurs due to the construction of the High Dam with the water level stabilized, the underground water level is not liable to drastic changes and will go below that of the dry season.

7-4 Execution of construction work

For Cairo City, as proposed already, the north-south line should begin before any other lines.

From exactly what district the north-south line should start depends on actual situation of transportation means of the in-city, the schedule of construction work, the difficulty of construction and problems of management after the opening of underground railway. As a result of various surveys, it is quite clear that, due to the following, the construction should start from Shubra District which is an important source of traffic demand.

1. The start of construction of the north-south line at all sections simultaneously will be accompanied by many difficult problems. Thus the construction of the line will be in two stages.

At the same time, the indispensable facilities of the underground railway -- car shed and workshops, should be set up north of Shubra because of site suitability.

2. Shubra district is under easier construction conditions than others because of its comparatively wide roads, favourable circumstances along the route, etc.

3. The easy execution of the work is advantageous from the viewpoint of overall construction period. Meanwhile, the construction data obtained from the work in this district will become important reference for the execution of work in the city centre and other districts.

From the above-mentioned viewpoints, it is advisable to start from the northern district of Shubra; and the 5 km section in which the Central Railway Station is located should be constructed during the first construction stage.

Following the first stage construction, or overlapping it, the second stage construction must be started, to pass through the central district of the city on to the southern districts to connect with the El-Malik and the El-Salek Stations to establish a connection with Helwan.

This part, an extension of about 10 km of the north-south line, should be completed as soon as possible.

Next comes the problem of the construction period. The first construction stage will be completed smoothly, in the period of 2.5 years, if construction is started with thorough arrangements and various preparations. As there are many problems to be solved, such as removal of obstructing houses, and facilities for connection with the Helwan line after the second stage construction, a sufficient preparatory period is necessary to cope with these problems.

7-5 Rolling stock

7-5-1 Principle of design and general description

The fundamentals of rolling stock for an underground railway are that designing should be carried out considering the characteristics of an underground railway.

Attention should be given to the following points.

(1) On the north-south line to be opened for the first stage, distances between stations are rather short and rolling stock on this route must permit high acceleration and deceleration to shorten operating time with high schedule speed, namely to reduce headway but there is no need to set the maximum speed very high.

In order to secure high acceleration and deceleration, the rolling stock must be of electric drive because the adhesion weight of the train must be large.

A full electric-drive train is advantageous because the function of a train does not change according to the number of cars coupled and the number of cars for a train can be increased according to the increase in transportation demand.

Trains equipped with total wheel motors are quite suitable for the application of electric brakes.

(2) Because underground railway trains always run through dark tunnels, high safety is essential to ease passenger uneasiness and confusion in case of an accident. A fire in a tunnel especially causes great damage; therefore, rolling stock must be of the highly non-combustible construction. Also, in order to check rear-end collisions or other accidents, close attention should be paid to protective devices.

(3) The sectional area of the tunnels of underground railways must be as small as possible since it greatly influences the construction cost of the tunnels; meanwhile, the sectional area of rolling stock must be as large as possible to make its transportation capacity larger.

Therefore, rolling stock must be as large as possible to make the most economical and effective use of the sectional areas of tunnels.

(4) In order that passengers may not suffer from particular unpleasantness and uneasiness while going through tunnels, due attention must be paid to lighting, ventilation, sound absorption and comfort in the trains.

(5) Maintenance should be simplified by employing devices and instruments of high reliability as well as consumables of long life. Thorough attention must be paid to dust proofing machines and instruments

so that no trouble occurs during operation at places where the dust is especially dry.

In view of the abovementioned points, the general outline of the rolling stock to be adopted for this project is designed as follows.

(6) Main elements

Type of Car : All metallic double-axle bogie electric passenger car

Track Gauge : 1,435mm

Electric System : DC 750V, 3rd rail system

Capacity : Control electric motor car - - - 124 (54 seats, 70 standing)

Trailer car - - - - - - 132 (58 seats, 74 s tanding)

Tare : Control electric motor car - - - - 34,5 t

Trailer car - - - - - - - - - - - - - 34 t

Acceleration : 4.0km/H/S

Deceleration : 4.0km/H/S (5.0km/H/S in case of an emergency)

Max. Speed : 60km/H

Max. Dimensions : Length - - - - - 18,000mm

Width - - - - - 2,790mm

Height - - - - - 3,495mm

Truck -

Coupling Device : Tight lock coupler

Main Motor : DC series-wound, w/interpole, weak field control w/shunt

Control System : Ultra-multistage acceleration and deceleration by load pattern control system, with dynamic brake

Current Collector : Third rail shoe

Low-voltage Stand-by Power Source : Motor-generator, Alkaline battery

Door Operating Equipment : Diffierential pressure operating door engine

Lighting Equipment	:	AC fluorescent lamp
Ventilating Device	:	AC blower
Safety Device	:	FS automatic train stop system, inductive radio emergency telephone, w/ emergency signalling system

6-5-2 Car body

Car bodies should be of solid construction and high refractoriness, comfortable even at high speed and light weight for easy maintenance.

(1) Main Measurements

Outside Measurements:

Length (between couplers) - - - - - - - - - - - - - - 18,000mm

Length (between side plates) - - - - - - - - - - - - 17,500mm

Width (" ") - - - - - - - - - - - - 2,790mm

Height (above the surface of rail) - - - - - - - - 3,495mm

Distance between central points of truck - - - - - 12,000mm

Fixed wheel base - - - - - - - - - - - - - - - - - 2,300mm

Height of coupler (for idlers) - - - - - - - - - - 720mm

Inside Measurements of Passenger Car:

Width - 2,630mm

Height (from the floor to the ceiling) - - - - - - - 2,260mm

Width of entrance - - - - - - - - - - - - - - - - - - - 1,300mm

Height of entrance - - - - - - - - - - - - - - - - - - 1,810mm

(2) Underframe

Underframe should be of ordinary bent steel plates, to be assembled by welding. It should be of solid construction and of light weight.

(3) Steel body

Each member of the framework should be of ordinary bent steel plates. Roof should be made of ordinary steel plates, and side plates should be of steel.

Assembly of frames and fitting of the roof and side plates should be carried out by welding to provide high rigidity against bending and torsion. The inner surface of the roof and side plates should be entirely coated with the sound and heat insulating material.

The space between the roof and the ceiling should be used as the air duct for the ventilating device, and inlets for the air duct should be installed on both sides of the roof.

(4) Ceiling and lining

To minimize weight, the ceiling board and lining should be anticorrosion light alloy plates.

(5) Floor

The floor of the rolling stock for the underground railway should be, of course, constructed for high safety against fire and other accidents, and also for insulation of noise. The structure of the floor is shown in Fig. 7-15.

Keystone plates of weather-resistance high-stress steel plates should be fitted by welding directly and firmly to the upper surface of the underframe. Over the keystone plates, a highly sound-proof flooring compound should be applied completely, and then, a floor board of incombustibility be spread.

(6) Passageways

Passageways over the couplers should be equipped with overall hoods so that passengers can pass through in safety at any time.

The overall hoods should be of such a construction that passage through it will not be interfered even by a stagger caused by deflection upon passage through a curved section or a crossover. Hoods must be of incombustible material.

(7) Windows and doors

Side windows of passenger cars should be as wide as possible, and shall be vertical 2-leaf type.

The upper leaf should be of the slide-down system, and the lower one, of the slide-up system. The opening space for the lower leaf should be about 100 mm in order to avoid danger in the tunnel.

A car should be equipped with 3 doors with a width of 1, 300 mm on each side so that substantial numbers of passengers can pass through during short stops.

Double-leaf sliding doors should be opened and closed by a door engine and double-door mechanism.

(8) Crew's compartment

The crew's compartment should be provided with all the machines and instruments necessary for operation; its habitability should be taken into consideration so that the crew can easily carry on operation without fatigue.

The compartment should have the same width as the full width of the car and be separated from the passenger room by a fixed partition wall, with a door installed at its center for passage to the passenger quarter. At both sides of the crew's compartment, sliding doors shall be installed for the crew's use.

It is necessary to install an emergency door at the centre of the end plank through which passengers can leave in case of an emergency.

(9) Interior facilities (See Fig 7-16)

Seats:

In view of the characteristics of rapid transit urban railway, long seats shall be employed, in order to increase standing capacity and to shorten the boarding and alighting time through a smooth flow of passengers.

Hand Straps, Luggage Racks:

Because of the high acceleration and deceleration of the rolling stock, and for the convenience of standing passengers, hand straps should be fixed over the seats, with grip bars fixed to the luggage racks that are installed along both sides of the car except passenger doors.

Fluorescent Lamps:

40W AC fluorescent lamps shall be installed along both sides on the ceiling, to provide passengers with an average illumination of 300 lx. for reading books with no fatigue.

Furthermore, of necessity is the installation of incandescent lamps in the car, with a cell as the power source, as a stand-by facility in case of service interruption.

Blower:

The rolling stock running through tunnels should be provided with not only natural ventilation through windows but also a forced ventilating device for drawing fresh outside air into the car.

For this purpose, six 40 cm pres surized axial-flow blowers should be installed along the centre of the ceiling so that the air may be induced from outside the roof through ventilating intakes above the ceiling, and then blown downwards for ventilation of the car.

(10) Outside facilities

A direction indicator of fluorescent illumination should be installed at the upper side of the front of the car for the convenience of passengers.

A head lamp and a marker lamp for each side should be installed at the lower part of the front of the car.

A side lamp should be installed at the upper centre on each side of the car indicating the opening and closing of doors.

7-5-3 Truck (See Fig. 7-17)

For more comfort and the reduction of noise, the improvement of vibration absorption, the driving system and the braking device are the most important factor.

The truck must be a double-axle bogie car of solid construction that assures stable operation with safety and comfort even at high speeds, regardless if the car is full or empty.

(1) Main elements:

Track Gauge -		1,435mm
Wheelbase -		2,300mm
Wheel (solid rolled steel wheel) - - - - - - - - - -		860mmø
Main Bearing (spherical roller bearing) - - - - - -		120mmø
Driving Device - - -	Parallel flexible drive system	
Brake Device - - -	Truck rigging type	
Center Plate Load -	without load	10,00kg
	at full load	17,700kg

(2) Truck frame & swing bolster

The truck frame should consist of a side beam and a lateral beam, chiefly made of high tensile steel and of welded construction.

The axle box should be so installed to the truck frame that it would not create rubbing of any section as the axle guard, etc. It must be constructed with a proper buffer for the thrust bearing load.

(3) Swing device & spring rigging

The swing device should consist of upper and lower swing bolsters and a suspension link, with fine characteristics for vibration and swing.

For load supporting, a centre plate supporting system is suitable.

Spring rigging should consist of bolster springs and axle springs, each spring equipped with a coil spring; also, an oil damper is used for maintaining excellent vibration characteristics.

(4) Driving device

The parallel flexible drive system should be adopted, with a highspeed motor installed directly at the truck frame, parallel to the axle, for drive by means of flexible joints and large and small gears.

This system has long been confirmed by actual records of application in the underground railways of Tokyo.

The main motor is installed on the axle spring, namely the weight of the motor is placed on the axle spring. Thus, shock given by the wheel axle to the rails and vibration of the car body can be reduced. Motor trouble caused by vibration can be remarkably lessened, making maintenance much easier.

(5) Brake device

Dynamic braking and air damping should be jointly used, and of these two, the former is usually applied.

Air damping should be employed to ensure stoppage at the fixed point after deceleration, and as an emergency brake.

As for the air damping system, 4 brake cylinders per truck should be installed for perfect performance.

The brake shoe should be of synthetic resin to reduce adverse influence from shoe dust on the electric system.

(6) Current collector

2 units of current collector supporting beams, which are electri-

cally insulated, should be installed between axle boxes fixed outside the side beam of the truck. The supporting beams should be equipped with collecting shoes and fuses.

7-5-4 Main motors (See Fig. 7-18 & 7-19)

To be adopted as main motors are small-type light-weight high-speed motors, 4 motors per car. 2 units should be connected in a permanent series for the 3rd rail voltage 750 V.

The efficiency of the train can be raised remarkably by the application of high acceleration of large gear ratio, dynamic braking available at high-speed operation, high-speed performance by wide-range weak field control system and train formation by all electric motor cars.

(1) Main elements:

Electric System - - - - DC 750 V, 3rd Rail System

Train Formation - - - - Full electric-drive cars, 6-car unit at maximum

Maximum Operating Speed - - - 60K/H

Acceleration - - - - 4.0K/H/S (constant up to 200% of the capacity)

Deceleration - - - - Normal deceleration by dynamic-pneumatic brake - - - 4.0K/H/S (constant up to 200% of the capacity)

- - - - Emergency deceleration by pneumatic brake - - - 5.0K/H/S (constant up to 200% of the capacity)

Wheel Diameter - - - - 860 mm

Motor Mounting System - - - - Truck-mounted

Drive System - - - - Parallel flexible drive system

Flexible Joint - - - Double internal-external type

Reduction gear - - Single-stage reduction

(2) Type & ratings:

System - - - - - - - - DC series-wound, w/interpole, shunt field control system

Type - - - - - - - - -	Truck-mounted, round-frame, semi-closed, self-ventilation type
One-hour Ratings - - -	75kW, 375 V, 280A, 1500 r.p.m. (100% F)
Minimum Field Ratio - -	50%
Gear Ratio - - - - - - - -	121 : 19 = 6.37

7-5-5 Control system (See Fig. 7-20 - 7-22)

The control device is of the multiple unit control system with the ability to control, at the driver's stand, secure and smooth operation of electric trains with 75kW main motors and 6-car units, maximum.

The vernier control system should be adopted to secure high acceleration and deceleration as well as to improve riding comfort by making the best use of the adhesion.

A constant acceleration starter and an automatic interlocking device for electro-pneumatic brakes to be operated with the same brake handle should be installed to keep a specified acceleration regardless of passenger load and also to make smooth joint use of the electro-pneumatic brakes.

Relays in the control device should be protected with a cover to prevent trouble caused by dust.

System - - - - - - -	Electrically drawn cam shaft, vernier ultra-multi-stage type
Control Capacity - -	75kW main motor - - - - 4 units
No. of Stages - - -	Power running - - - 68 stages (series 31 stages, parallel 31 stages, weak field 6 stages)
	Brake - - - - - - - - - - 61 stages
Main Circuit - - - -	Series & parallel, weak field control system

7-5-6 Pneumatic brake system (See Fig. 7-23)

The electromagnetic self-lap, straight pneumatic brake system is to be applied for trains of maximum 6-car units for safe, reliable and smooth braking.

As for the brake system for normal use, one brake handle should be employed for smooth handling of both dynamic and pneumatic brakes. In other words, the electro-pneumatic brake should operate according to the angle of the handle of the brake valve, as the dynamic braking force is exhausted. The braking system should be automatically shifted to pneumatic damping of the same force.

Emergency braking should be only by the automatic pneumatic damping system.

Furthermore, emergency braking should be conducted, other than the operation of the brake valve, by the breaking of the brake pipe or the hose of the coupler, handling of the conductor's valve, or the deadman device of the main controller.

Acceleration and maximum deceleration should be kept constant at all times by the device to comply with load, regardless of fluctuation of passenger load.

In order to secure higher safety, the brake system should be equipped with an automatic train control system which will stop a train by interlocking with signalling devices on the ground.

System : Electromagnetic, self-lap, straight pneumatic brake

Deceleration : Normal use --- 4.0K/H/S

Emergency use --- 5.0K/H/S

Device Adjustable to Load : Detecting system by deflection of swing bolster spring

Safety Device : Conductor's valve, deadman device

7-5-7 Low-voltage power source

The AC motor-generator and battery should be applied for the low-voltage power source.

The motor-generator should be the power source for the AC load to blowers and fluorescent lamps. It will also be the power source for the DC load to the control system, brake system and door-closing signal after rectified by the rectifier.

Though it is desirable that voltage at the power source be AC 200 V and DC 100 V and frequency be 50 c/s, the application of a suitable voltage according to the purpose of load is necessary.

The battery should be used as the emergency power source for stand-by lamps during service interruption of the 3rd rail, automatic train stop system, announcing device or emergency telephone.

Appropriate is an alkaline battery with a capacity of more than 40 AH.

7-5-8 Automatic train stop system

The application of the automatic train stop system is indispensable in order to secure higher safety in the underground railway operation. The automatic train stop system should continuously receive induced current on the car, through the receiver from KC track circuit used for the ground signal device, and also receive the signal input selected and amplified by the receiving unit.

In case a train goes into a stop signal section by error, the emergency brake should automatically operate at once to stop the train.

7-5-9 Emergency telephone, announcing device

The emergency telephone is necessary for quick communication in an accident and also for prevention of spread of the accident.

With the telephone, mutual communication should be carried on between the crew on a running train and the train dispatcher's office through induction between the emergency telephone line on the side wall in tunnels and the antenna on the train. Thus, an accident and its location can be reported without delay to the train dispatcher's office. Also, in an emergency, service interruption for the 3rd rail is possible through the dispatch of the emergency signal.

Beside the abovementioned emergency telephone, trains should be equipped with personal telephones for communication among crew members, loud speakers for announcing to the passengers, and an emergency alarm device inside the cars through which passengers may inform the crew of an emergency.

7-6 Car inspection shop and workshop (See Fig. 7-24)

7-6-1 Outline of plan

It is recommended that the car shed and workshops necessary for inspection and repair of rolling stock be established in Shubra district since that district is suitable for meeting the demand of daily transportation and provides an extensive site for car shed.

Storage tracks and installations for inspecting and repairing cars should be installed with capacity for 50 cars at the first stage, and 200 cars for the final stage (6-car 2-minute headway operation).

A car inspection shop and a workshop should be established at the site.

(1) Area of the Site : about 74,200 m^2

(2) Capacity for Cars : about 50 cars for the first stage

Length of cars - - - - - 18 m

Length of trains - - - - 54 m

about 200 cars for the final stage

Length of trains - - - - 108 m

(3) Car Inspection & Repair Schedule

Classification of Inspection	Inspection Recurrence	Section
a. Daily Inspection	everyday	Inspection Section
b. Monthly Inspection	every month	"
c. Minor Repair		"
d. Annual Inspection	every year	Workshops
e. 3-year Inspection	every 3 years	"
f. Overhauling, Temporary Repair		"

7-6-2 Equipment at car inspection shop

The car inspection office should be in charge of the dispatch of cars and inspection for daily operation.

An outline of equipment for the section is as follows:

(1) Strorage Track:

Capacity --- the first stage --- 6 cars x 15 tracks

the final stage --- 6 cars x 34 tracks

Extension of Track --- the first stage --- 5,740 m

the final stage --- 11,200 m

(2) Inspection & Repair Equipment:

(a) Daily Inspection Section:

the first stage --- 3 cars x 3 tracks, 1134 m^2

the final stage --- 6 cars x 3 tracks, 2268 m^2

(b) Monthly Inspection Section:

the first stage --- 3 cars x 2 tracks, 819 m^2

the final stage --- 6 cars x 2 tracks, 1638 m^2

(c) Minor Repair Section:

the first stage --- 1 car x 1 track, 360 m^2

the final stage --- 2 cars x 1 track, 720 m^2

(d) Wheel Shop: 1 track, 504 m^2

(3) Car Washing Equipment:

(a) Car Washing Stand --- the first stage, 6 cars x 1 track

the final stage, 6 cars x 2 tracks

(b) Car Washer ------ 1 unit

(4) Office, etc.:

(a) Office (including locker room and dining hall)

(b) Air compressor room

(c) Storehouse

(5) Main Machinery:

The car shed should be equipped with machines necessary for daily inspection and repair work such as tire milling machine, welder, drilling machine, grinder, lifting jacks, over-head crane (3-ton), air compressors, etc. .

7-6-3 Workshop equipment

Workshops should be in charge of annual inspection, 3-year inspection and overhauling (including temporary repairs).

Outline of the equipment necessary for workshops is as follows:

(1) Inspection & repair work

As a standard, the number of days required for inspection should be 10 days for the annual inspection, 16 days for the 3-year inspection including painting and 25 days for overhauling.

2 cars at one time should be led into the workshops for the annual or 3-year inspections.

(2) Equipment for inspection & repair:

(a) Inspection Shop - - - 2 cars x 1 track, 378 m^2

(b) Dismantling & Assembling Shop - - -
2 cars x 3 tracks, 1584 m^2

(c) Bogie Shop - - - - - 480 m^2

(d) Wheel Shop - - - - - 480 m^2

(e) Motor Shop - - - - - 468 m^2

(f) Brake & Electric Parts Shop - - - at the first stage, to be substituted by a section of bogie & motor shops; at the final stage, 792 m^2

(g) Body Repair Shop - - - at the first stage - - -
1 car x 2 tracks, 288 m^2
at the final stage - - -
1 car x 4 tracks, 576 m^2

(h) Paint Shop - - - - - - - at the first stage - - -
1 car x 1 track, 144 m^2
at the final stage - - -
1 car x 2 tracks, 288 m^2

(i) Repair Shop - - - - - - at the first stage - - -
1 car x 1 track, 144 m^2
at the final stage - - -
1 car x 4 tracks, 576 m^2

(j) Machine Shop - - - - - 156 m^2

(k) Smith Shop - - - - - - 150 m^2

(3) Office, etc.

(a) Office (including locker room and dining hall)

(b) Storehouse

(c) Boiler room

(d) Air compressor room

(4) Main Machinery

To be installed inside workshops are over-head cranes, traverser, automatic bogie washer, tire milling machine, tire lathe, axle press, boring & turning mill, tire heater, tire clamping machine, tire remover, wheel center lathe, snap ring cutter, shaping machine, drilling machine, grinder, rotary tester, brake valve tester, high power - high voltage relay tester, dielectric tester, ultrasonic tester, etc. .

7-7 Electric power, signal and communication

7-7-1 Electric systems

(1) The 3rd rail

(a) Construction of the 3rd rail

The 3rd rail should be laid along either side of the track; along the side near the wall in sections of straight line and of the curve radius of more than 200 m; along the outer rail in sections of curve radius of less than 200 m in the tunnel; and along the side opposite the platform at stations.

Rails should be welded and in case the unit length of welded rails is more than 800 m, an expansion joint should be employed to absorb the expansion of the rail.

Structure of the 3rd rail is shown in Fig. 7-25. Sections of the 3rd rail should be connected with jumper cables.

(b) Specifications of the 3rd rail

Type - - - - - Type 1.

Weight - - - - 50 kg/m.

Material - - - low-carbon steel.

(c) Specifications of jumper cable for the 3rd rail

Kind - - - - - Synthetic rubber reinforced cable

Size of cable - 500 sq. mm.

No. of cable - 2 - 3.

(2) Return rail bond

Track rails are to be welded as much as possible; however, in case rails cannot be connected by welding, Compress bonds and Welding bonds shall be used.

Size of Bonds:

Compress bond - - - 115 sq. mm.

Welding bond - - - - 110 sq. mm.

(3) Electric power transmission line

Power transmission lines should be laid between substations. In the tunnel, the cables should be installed in the ceramic trough set at the lower part of the side wall.

Specifications of Cables:

Kind of cable - - - - Tape Armoured Sl. Cable

Size of cable - - - - 60 sq. mm. or 100 sq. mm.

Working voltage - - 22 kV

(4) Distribution line

For power distribution at the switch house of each station, 6.6 kV 3-pahse power distribution cables should be laid along the total extension inside the tunnel.

The cables are to be installed in the ceramic trough set at the lower part of the side wall.

Specifications of Cables:

Kind of cable - - - - Butyl Rubber Insulated High-tension Cable

Size of cable - - - - 30 sq. mm., 3 cores

Working voltage - - 6.6 kV

No. of cable - - - - #2

(5) Low tension power lines

(a) 200 V, 3-phase, 3-wire power cables should be laid for drainage pumps in the tunnel and for tunnel lighting. The cable installation is shown in Fig. 7-26.

Lighting lamps should be of single phase and 200 V, installed zigzag at every 15 - 20 m.

(b) Low voltage aerial cable of single phase, 100 V and double wires should be installed as the power source for signaling. Installation is shown in Fig. 7-26.

(6) Feeder & return line

(a) Feeder

Feeder should be laid between the bus bar and the 3rd rail.

No. of circuit - - - - - 4 circuits

No. of lines - - - - - - 2/circuit

Kind of cable - - - - - - Synthetic Rubber Reinforced Cable

Size of cable - - - - - - 500 sq. mm.

(b) Return line

Negative feeder should be laid between the negative bus bar and impedance bond in the tunnel.

No. of circuit - - - - - 2 circuits

No. of line - - - - - - 3/circuit

Kind of cable - - - - - Single Core V.I.R.

Size of calbe - - - - - 500 sq. mm

(7) Switch house

A switch house should be installed for lighting and power equipment at each station so that the power will be transformed from 3-phase 6.6kV down to 200/100V 3-phase 3-wire. Standard connection diagram is shown in Fig. 7-27. Standard layout is shown in Fig. 7-28.

(8) Drainage pumps

A drainage pump room should be installed at the lowest level section between stations for tunnel drainage, miscellaneous drainage and water leakage. (See Fig. 7-29 — 7-31)

Specifications of Drainage Pump:

Kind of pump - - - - - - Vertical Borehole Type

Pumping-up level - - - 21 m (varies depending on place)

Motor horsepower - - - 15 HP (varies depending on pumping-up level)

Caliber - - - - - - - - - 130 mm

No. of pumps - - - - - 2 - 3

(9) Ventilation fan

(a) Ventilators should be installed at main stations for forced draught.

Kind of ventilator:

Type - - - - - - - - - Multiblade type

Wind pressure - - - - 100 mmAq

Motor horsepower - - 37 kW - 75 kW

Airflow - - - - - - - - 800 - 1,400 m^3/min.

No. of Unit - - - - - 2 - 3

(b) Ceiling fans should be installed on the ceiling of the platform at main stations.

(10) Lighting of stations

All the stations should be equipped with fluorescent lighting fixtures which should be designed for each station according to the standards; 200 lx. for 1st-class stations and 150 lx. for 2nd-class stations.

Wiring should be 3-phase and 3-wire at 200/100 V and also single-phase and 2-wire at 200/100V; and power is to be supplied to load.

In case of interruption of AC power, the emergency lamp (FL 20W) should be lit by a cell. Illumination for such should be designed to be about 2 - 5 lx.

7-7-2 Automatic signal & interlocking plant

The signalling system was designed on the basis of 3-minute headway and 6-car unit train.

The automatic signal should be a 3 position colour light signal system, and the control system should be a full overlap control system.

The automatic train stop system should be employed for higher safety, since it is easy to shift it to the automatic train control system is the future.

Refer to Fig. 7-32 & 7-33 for way-side signal installation, and Fig. 7-36 for design of signal aspect.

Interlocking plant should be of electro-pneumatic relay interlocking, to be installed at terminal stations and stations for head-end operation.

(1) Specifications of automatic signal

Kind of signal - - - - - 3 position color light automatic signal

Signal aspect - - - - - G (command proceed)

Y (command caution)

R (command stop)

Block control - - - - - Full-overlap control system

Connection - - - - - - - - - - According to Fig. 7-34 & 35

Automatic train stop system - FS system

(can be shifted to automatic train control system in the future)

(2) Specifications of interlocking plant

Kind of interlocking plant - - - - - Electro-pneumatic relay interlocking plant

System of interlocking machine - - Route lever type

Kind of switch machine - - - - - - Electro-pneumatic switch machine

(3) Compressed air plant

Air compressor - - - - To be installed at stations equipped with interlocking plants

Type - - - Air Comp. - - - air cooled, vertical type, 3 cylinders, 2 stages.

Capacity - - - - - - - - $1.2\ m^3/min.$

Max. allowable pressure - - - $7\ kg/cm^2$

Normal pressure - - - $4\ kg/cm^2$

One plant for normal service and another for stand-by service are to be installed at a station.

7-7-3 Train dispatcher's office

Train dispatcher's office should be installed at the mezzanine of Station No. 7.

The office is to be equipped with a device for indication of train positions and indications of train numbers for the entire route, as well as an inductive radio system, an emergency calling system and a dispatcher telephone to be described later.

The traffic on the entire route is indicated at the train dispatcher's office and instructions for operation are conveyed direct to the train crew through an inductive radio system, in order to enable smooth operation.

In case of an accident, quick and correct instructions should be given to the train crew and the station staff through the inductive radio system and the dispatcher telephone. This will prevent spread of the accident and restore traffic with maximum efficiency.

Refer to Fig. 7-40 for traffic display.

7-7-4 Telephne & communication

(1) Communication cable

(a) Telephone cable - - - - - To be laid; one for each side of the tunnel

Kind of cable - - - - - - - Corrosion resisting lead covered telephone cable

Number of cables - - - - 2

Core diameter - - - - - - 0. 9 mm

Number of pairs - - - - - 50 p.

(b) Telephone aerial line

To be laid; one circuit for each side of the tunnel and center post (Refer to Fig. 7-26)

Kind of wire - - - - - - - Copper wire

Size of line - - - - - - - - 2. 6 mm

Number of circuits - - - 3

Emergency telephone - - - - 2
Safety service telephone - - 1

(2) Telephone

(a) Railway telephone

1) Automatic telephone - - - To be employed for communication between stations and offices, for traffic business in general

2) Specifications of automatic telephone

Voltage - - - - - - - - - DC 48 V

Capacity - - - - - - - - - 200 circuits

Type - - - - - - - - - - - Cross-bar system

(b) Dispatcher telephone

WE dispatcher telephone

(c) Emergency telephone

Train crew can connect their portable telephone with the emergency telephone cable in the tunnel and communicate with the train dispatcher's office.

In an accident, train crew should push the emergency calling push button, inform the train dispatcher's office of the accident, and give the power control centre an emergency indication calling to stop the power transmission to the section of the accident.

(d) Inductive radio system

performance:

1. Radio commuincation between trains and the train dispatcher's office.
2. Indication of accident and request for service interruption from train or station to the train dispatcher's office and the power control office.

The abovementioned communication must be carried out by wireless telephone, in combination with a wire telephone.

Frequency allocation:

Train ⟶ Dispatcher's office

135 kc (to be modulated by 487.5 c/s) ⟶ for emergency

155 kc ⟶ for talking

Dispatcher's office ⟶ Train

185 kc ⟶ for talking

(duplex telephone system)

Transmission line:

Emergency telephone cable & communication cable.

Transmission system:

Electromagnetic induction between antenna coil of train and emergency telephone cable.

Modulation ⟶ Frequency modulation.

The system is shown in Fig. 7-41

(e) Telephone for arrangements on entering and leaving car shed

Magneto telephone for communication between car shed and signal cabin.

(f) Telephone for making arrangements between workshops or between maintenance offices.

7-7-5 Design of power supply

Substations are to be constructed at stations No. 1, 4, 7, 10 and 13.

Electric power for the use of the Cairo Underground Railway should be supplied, by 3-phase AC at 22kV, from North SS to No. 1 St. SS, and from South SS to No. 13 St. SS.

As for power for trolley 3-phase alternating current at 22kV to be supplied from the Underground Railway SS should be transformed into DC 750 V and fed to the 3rd rail.

As for power for lighting and other uses, the power transformed into 3-phase AC 6.6kV at No. 1 St. SS and No. 13 St. SS should be distributed to switch houses at every station where the voltage is to be stepped down.

The power should be supplied to load.

(1) Outline of power supply system for trolleys

Power for trolleys, DC 750 V, should be supplied through the 3rd rail. Considering trolley voltage drops, operation in case of trouble of machines and instrument and maintenance and safety in an accident, it is advisable to install substations at every 2 ~ 2.5km.

In view of conditions of location, substations must be arranged as shown in Fig. 7-42.

The number of transformers was decided by calculation of power for trolleys, based on the unit capacity of transformers, 1500kW, to be installed at substations.

The feeding system should be in parallel with neighboring substations and 4-circuit feeders should be installed for each direction of up and down tracks from the substations. Exclusive feeders should be installed in the workshops.

(2) Power supply system for lighting & other uses

Power for lighting and other uses should be transformed into 3-phase AC 6.6kV at No. 1 St. SS and No. 13 St. SS and distributed to the whole system. The capacity of transformers was decided according to power calculations.

As for the 6.6kV distribution line for the whole system, 2 circuits, one for the up track and the other for the down track, should be installed for power distribution to switch houses at stations. Also to be installed are

2 circuits by direction for No. 13 St. SS, another 2 circuits by direction for No. 1 St. SS, and a power distribution system for the use of the car shed.

(3) Outline of transmission & receiving system

No. 1 St. SS and No. 13 St. SS shall receive 3-phase 22kV AC from Cairo City substations through one circuit. Power should be transmitted from No. 1 St. SS to No. 4 St. SS, and from No. 13 St. SS to No. 7 and No. 10 St. SSs, respectively.

Furthermore, a one-circuit transmission line is to be installed between No. 4 and No. 7 St. SSs to provide mutual stand-by facility in case of an accident over the whole route. Fig. 7-42 shows the outline of the system.

7-7-6 Design of substations

(1) No. 1 station SS

A 2-storied reinforced concrete building to be installed at a site adjacent to the car inspection office.

(a) Receiving system

To receive 3-phase 22kV AC through one circuit from the North SS, and transmit to No. 4 St. SS.

(b) Transformer installation

To be equipped with 2 sets of 750V 1500kW silicon rectifier.

(c) Feeder line

2 circuits for train operation and another for workshops should be installed at the outset. 2 circuits for train operation should be added in the future.

(d) Distant monitoring & controlling system

To be installed as an unattended substation controlled constantly by No. 7 Station SS.

(e) Transformers for lighting & other uses

Single-phase 1000kVA - - - 3 units

Primary - - - - - - - 22kV

Secondary - - - - - - 6.6kV

To be of delta connection.

(f) Power distribution system

3-phase AC 6.6kV - - - - -2 circuits

To be distributed through 2 circuits to the switch house at each station.

Refer to Fig. 7-42 for details.

(2) No. 4 Station SS should be installed in the neighborhood of Station No. 4

(a) Transmitting & receiving system

3-phase 22kV AC should be received through one circuit from No. 1 Station SS, and transmitted to No. 7 Station SS.

(b) Transformer installation

To be equipped with 2 units of 750V, 1500kW silicon rectifier.

(c) Feeder line

4 circuits should be installed for feeding through 2 circuits in each direction.

(d) Distant monitoring & controlling system

To be installed as an unattended substation constantly controlled by No. 7 Station SS.

(3) No. 7 Station SS should be installed in the neighborhood of Station No. 7.

(a) Receiving system

To receive 3-phase 22kV AC through one circuit from No. 4 St. SS, and another circuit from No. 10 St. SS.

(b) Distant monitoring & controlling system

To be equipped with controllers for distant monitoring & controlling systems at other substations.

(c) Transformer installation

To be equipped with 2 units of 750V, 1500kW silicon rectifier.

(d) Feeder line

4 circuits should be installed for feeding in both directions.

(4) No. 10 Station SS should be installed in the neighborhood of Station No. 10

(a) Transmitting & receiving system

3-phase 22kV AC should be received through one circuit from No. 13 Station SS, and transmitted to No. 7 Station SS.

(b) Transformer installation

To be equipped with 2 units of 750V, 1500kW silicon rectifier.

(c) Feeder line

4 circuits should be installed for feeding in both directions.

(d) Distant monitoring & controlling system

To be installed as an unattended substation constantly controlled by No. 7 Station SS.

(5) No. 13 Station SS should be a 2-storied reinforced concrete building in the neighborhood of Station No. 13.

(a) Receiving system

3-phase 22kV AC should be received through one circuit from the South SS, and transmitted to No. 10 St. SS.

(b) Transformer installation

To be equipped with 2 units of 750V, 1500kW silicon rectifier.

(c) Feeder line

2 circuits should be installed at the outset.

(d) Distant monitoring & controlling system

To be installed as an unattended substation constantly controlled by No. 7 Station SS.

(e) Transformers for lighting & other uses

Single-phase 1000kVA - - - 3 units

Primary - - - - - - - 22kV

Secondary - - - - - - 6.6kV

To be of delta connection.

(f) Power distribution system

3-phase 6.6kV AC - - - - - 2 circuits

To be used as a mutual stand-by facility with 2 circuits from the switch house of Station No. 12.

7-7-7 Required Power for Trolleys

The total capacity of transformers at substations, as shown in the table below, was calculated so that the maximum output per hour at the substation will be about 70% of the total capacity, on the basis of 6-car trains at 3-minute head-way with a unit capacity 1500kW, including stand-by machines.

The maximum output per hour at substation is as follows:

Feeder section of a substation - - - - - - - - - - - ℓ km

Each substation feeds power parallel with neighbouring substations, taking over half of the distance to those stations for feeding.

Load power, Wkw, in case of a 6-car train at 2. 5-minute head-way and load power per 1 km, can be calculated by the following equation:

$$W = \frac{2 \times 60 \times w \times c}{H}$$

c : No. of cars per train - - - - - - - - - 6-car unit

H : head-way - - - - - - - - - - - - - - 3 minutes

w : power consumption ratio - - - - - - 3Kwh/car - km

$$W = \frac{2 \times 60 \times 3 \times 6}{3} = 720\text{kw/km}$$

Load power of substation - - - - - - - - - - - - - W ℓ kw

W ℓ kw = ℓ km x Wkw/km

Substation / Classification	No. 1 St. SS	No. 4 St. SS	No. 7 St. SS	No. 10 St. SS	No. 13 St. SS
Feeding distance of each substation km	1.45	2.47	2.19	2.64	1.47
Load of each substation kW (A)	1044	1778	1576	1900	1058
Installed Capacity kW (B)	1500 x 1	1500 x 2	1500 x 2	1500 x 2	1500 x 1
Ratio % (A/B)	70	59	53	63	70

7-8 Construction cost and estimated accounts

7-8-1 Construction cost

Based on the data offered, the results of the field survey and also the records of construction work in Tokyo, the construction costs of the north-south line with the extension of 10.2km are estimated according to the following conditions.

1. The scope of construction should comply with the recommendations made in this report, and necessary costs should be added according to the operation plan at each stage of reinforcing transportation capacity.

2. The estimates are based on present-day prices, without considering fluctuation of prices due to a delay in beginning construction.

3. No particular consideration is given to expenses for importing construction materials.

4. For the purpose of purchase, lease or transfer of land, buildings, etc., which are deterrent to construction, 5% of the total cost should be summed.

5. The estimate includes such construction as civil engineering, truck work, building construction and interior work, electric system, car sheds and workshops, and also purchase of rolling stock and miscellaneous expenses.

Table 7-5 Construction Cost Items

Total Extension - - - 10.2km

Item	Amount Unit: $ million	Percentage %	Remarks
1. Civil Engineering Work	39.8	49.8	Tunnels, Stations
2. Buildings	2.4	3.0	Stations, Substations, Car sheds, Offices
3. Track Work	1.8	2.3	Tracks & accessories, Sleepers, Roadbeds, Turnouts
4. Electrical Engineering Work	4.9	6.1	Communication, Protective & power equipment
5. Rolling Stock	16.5	20.6	Passenger cars
6. Machines & Instruments	0.2	0.2	Machinery and equipment for substations, communication systems, workshops, drainage & ventilating systems

Item	Amount Unit: $ million	Percentage %	Remarks
7. Land	4.0	5.0	Sites for car sheds, substations, offices
8. Surveying & Supervision	8.0	10.0	Personnel expenses and other expenditures for design, survey & supervision
9. Contingencies	2.4	3.0	
TOTAL	80.0	100.0	

The following are details of important items in the construction cost.

1. Civil engineering works

Tunnel construction cost : $27,600,000

Extension - - - - - - - - - - 8,440m

Average excavating width - - about 10 m

Average earthfill - - - - - - 7.1m

Soil to be excavated - - - - about 1,123,000m^3

Station construction cost : $12,200,000

No. of stations - - - - - - - 13

Length of station - - - - - - 150m

Soil to be excavated - - - - - about 437,000m^3

To be inclusive of platforms, entrances (42), etc.

. Building construction

Station interior work : $1,600,000

Building construction (substations, car sheds and offices): $ 800,000

Track work

Main Line : Extension - - - - - 10.2km, double-track

Car Shed Line : Extension - - - - - 9km, single-track

Electrical engineering work

Substations : $1,700,000

Lighting devices : $1,800,000

Signalling system : $1,000,000

Communication system : $ 400,000

The capacity of substations should be 18,000kW for operation of 6-car trains at 2-minute headway.

5. Rolling stock

About 198 cars would be required for operation of 6-car trains at 2-minute headway for the final stage, on conditions that the operation distance is 10km, the schedule speed 26km/h and the time required for shuttle service at terminals 6 minutes. However, the operation should be initiated with about 50 cars.

7-8-2 Estimated accounts

(1) Estimation of accounts was made according to the following conditions.

(a) Modification of facilities in scale by changes in operation plan should be limited to the extension of car shed line, the capacity of substations and the number of rolling stock.

(b) Estimation was made on the assumption that commodity prices and wages would not fluctuate.

(c) Depreciation was estimated in compliance with the standards of durable years set by the U.A.R. Government.

(d) The number of employees, personnel expenses, miscellaneous expenses, energy charge and etc. are based upon statistical data collected in Tokyo, and reasonable minimum amounts were estimated.

(e) The rate of 5.5% per annum, which is in compliance with a standard of the World Bank, is applied in computing the interest for the total amount.

(f) It is considered that the loans will be unredeemed for the first five years and then to be refunded equally for the next 25 years in compliance with a standard of the World Bank.

(g) Utilization efficiency of passenger cars and income were estimated on the assumption that the average travelling distance per capita is 3 km.

(h) Fare was estimated to be 5 milliemes (4. 31 cents) per kilometer per capita.

(i) After one year of operation with 6-car trains at 2-minute headway, the income is estimated to increase by 2% compared with that of the first year, and the expenses by 1%.

There are different systems such as flat rate system, district rate system, and distance scale rate system. The flat rate system is recommended since it is the simplest of all, and only a comparatively short extension of the service distance is expected in Cairo.

In this system, passengers will be requested only to have their tickets punched at wickets where ticket collectors are not required, besides the issuance of tickets and the installation and operation of automatic ticket issuing machine will be easier. Therefore, operating expenses can be remarkably saved.

(2) Depreciation fund : Refer to Table 7-6

(3) Summary table : Table 7-7

(4) Estimation of both construction costs and accounts was made based on the present conversion rate of L. E. 0.43 to US$ 1.00.

Table 7-6 Depreciation Fund (6-car unit, 2-minute headway)

Item	Basic Amount	Straight line depreciation system of the Japanese Government			Straight line depreciation system of the U.A.R. Government		
		Durable Year	Ratio	Amount Redeemable	Durable Year	Ratio	Amount Redeemable
	Unit: $ Million			Unit: $ Thousand			Unit: $ Thousand
1. Tunnels	39.0	60	0.017	663	-	-	-
2. Stations	0.8	32	0.032	26	10-20	0.066	5.3
3. Buildings	2.4	30-55	0.024	58	40	0.019	46
4. Track	1.8	8-70	0.041	74	20	0.050	90
5. Power Transmission Equipment	3.5	5-40	0.052	182	20	0.050	175
6. Signalling Equipment	1.4	30	0.034	48	20	0.050	70
7. Rolling Stock	16.5	15	0.066	1089	35	0.031	512
8. Workshop Equipment	0.2	19	0.052	10	10	0.100	20
Total			0.027	2150		0.012	966

Table 7-7 Summary Table

Operation Plan		6-car unit, 2-minute headway	6-car unit, 5-minute headway	5-car unit, 5-minute headway	4-car unit, 5-minute headway	3-car unit, 5-minute headway
Extension of Car Shed Line		single track 9.0 km	" 4.1 km	" 3.5 km	" 2.9 km	" 2.3 km
Capacity of Substations		18,000kW	7,500kW	6,000kW	4,500kW	4,500kW
No. of Rolling Stock		198 cars	84 cars	70 cars	56 cars	42 cars
Additional Construction Costs	Track	million $ 0.3	million $ 0.1	million $ 0.1	million $ 0.1	million $ 0.1
	Substations	" 0.2	" 0.1	" 0.1	" 0.1	" 0.1
	Rolling Stock	" 16.5	" 7.0	" 5.8	" 4.7	" 3.5
	Sub Total	" 17.0	" 7.2	" 6.0	" 4.8	" 3.6
	Amount Added	" 13.3	" 3.6	" 2.4	" 1.2	" 0
Total Construction Costs		" 80.0	" 70.2	" 69.0	" 67.8	" 66.6
Additional Depreciation Fund	Track	" 0.015	" 0.005	" 0.005	" 0.005	" 0.005
	Substations	" 0.010	" 0.005	" 0.005	" 0.005	" 0.005
	Rolling Stock	" 0.512	" 0.217	" 0.180	" 0.145	" 0.109
	Sub Total	" 0.537	" 0.227	" 0.190	" 0.155	" 0.119
	Amount Added	" 0.42	" 0.11	" 0.07	" 0.04	" 0

Operation Plan		6-car unit, 2-minute headway	6-car unit, 5-minute headway	5-car unit, 5-minute headway	4-car unit, 5-minute headway	3-car unit, 5-minute headway
Total Depreciation Fund		Million $ 0.97	million $ 0.66	million $ 0.62	million $ 0.58	million $ 0.55
No. of Employees		1,323	719	647	577	511
Annual Total Distance Travelled		Thousand Kilometer 12,790	" 8,410	" 7,010	" 5,610	" 4,200
Personnel Expenses		Million $ 1.36	" 0.74	" 0.67	" 0.59	" 0.53
Miscellaneous Expenses		" 0.87	" 0.53	" 0.46	" 0.39	" 0.33
Interest		" 4.40	" 3.86	" 3.79	" 3.73	" 3.66
Amount to be refunded		" 3.20	" 2.81	" 2.76	" 2.34	" 2.66
Total Expenditures		" 10.80	" 8.60	" 8.30	" 7.63	" 7.73
Total Passengers per annum		in thousand 184,000	" 73,700	" 61,300	" 48,900	" 36,900
Average Cost per capita		cent 5.87	cent 11.7	cent 13.5	cent 14.6	cent 21.0
Cost per capita per kilometer		" 1.96	" 3.89	" 4.51	" 4.86	" 6.98
Excluding the Amount to be Refunded	Total Expenditures	million $ 7.60	" 5.79	" 5.54	" 5.29	" 5.07
	Average Cost per capita	cent 4.13	cent 7.86	cent 9.04	cent 10.82	cent 13.74
	Cost per capita per kilometer	" 1.38	" 2.62	" 3.01	" 3.61	" 4.58

Appendix I

Itinerary of the Japanese Survey Mission

Appendix II

List of Data Provided by U. A. R. Authorities

Appendix I — Itinerary of the Japanese Survey Mission

-- April 27 ~ June 7, 1966 --

Date & Day	Time	Description
Apr 27 (Wed)	13:00	Departure of the 8-member Survey Mission headed by Mr. Y. Hirose from Haneda International Airport for Cairo by JAL 451
Apr 28 (Thu)	3:30	Arrival at Cairo Airport; received by Mr. M. Ohno, Secretary of the Japanese Embassy, Eng. Mohsen Idris, Director of the Planning Dept., Greater Cairo Planning Commission, and his staff incl. Eng. Aly Zein El Abdine, Deputy Director, Mr. Saad Helmi, Dr. Nohad Toulan, Mr. Mohammed Niazi Ibrahim and others. Accomodation at Semiramis Hotel.
	11:00	Visit to Ambassador Kakitsubo at the Japanese Embassy.
	11:30	Visit to the Ministry of Housing and Public Utilities; inspected the office reserved for the Mission.
	12:00	Interview with H. E. Dr. Mohamed Ezet Salama, Minister for Housing and Public Utilities.
	12:30	Interview with H. E. Eng. Mohamoud Abd el Salam, Minister for Transport.
Apr 29 (Fri)	10:00	Guided tour by the staff of the Greater Cairo Planning Commission (hereinafter referred to as "the Commission") for inspection of newly built apartment houses, plants and Ismailia Canal district.

Date & Day	Time	Description
	18:00	Reception held by Ambassador Kakitsubo at Nile Hilton Hotel in celebration of the birthday of the Emperor of Japan.
Apr 30 (Sat)	10:00	Meeting with the U.A.R. staff at the Commission's office; explanations given on data requested by the Mission and on the general scope of work desired of the Mission.
May 1 (Sun)	10:00	Meeting with the U.A.R staff at the Commission's Office; explanations given on data provided and on the histroical background of the establishment of the Commission.
May 2 (Mon)	9:00	Meeting with the U.A.R. staff at the Commission's office.
	15:00	Interview with Mr. Salah Galal, Editor of Science Dept. Al Ahram Newspaper.
	21:30	Dinner party held by H. E. Dr. M. E. Salama, Minister for Housing and Public Utilities at Shooting Club.
May 3 (Tue)	9:00	Meeting and discussion with the U.A.R. staff on the data provided.
	17:00	Guided tour by the Commission's staff for inspection of Cairo City and suburban areas.
May 4 (Wed)	10:00	Visit to the Ministry of Transport; interview with H. E. Eng. M. A. Salam, Minister for Transport, Eng. Soliman Abd el Hay, Under-Secretary of State for Transport, and Eng. Mahmoud Ghoneim, General Manager of the Egyptian Railway Authority; discussion on data provided by the Ministry of

Date & Day	Time	Description
		Transport.
May 5 (Thu)	10:00	Interview with H. E. Eng. Mahmoud Younes, Deputy Prime Minister for Transport and Communication.
	11:00	Discussion with the U.A.R staff on the survey schedule.
May 6 (Wed)		(Holiday)
May 7 (Thu)	7:00	Inspection of the Helwan line from Bab-el-Luk station.
	9:30	Discussion with the U.A.R staff on data provided.
May 8 (Sun)	9:30	Discussion with the U.A.R. staff at the the Commission's office; submission of a list of additional data required by the Mission
	19:00	Interview with the Japanese correspondents in Cairo at Semiramis Hotel.
May 9 (Mon)	7:00	Inspection of the Metro line between Cairo and Heliopolis.
	9:30	Visit to Heliopolis Company for Housing and Development, discussion with the Company's staff and inspection of workshops of the Metro; discussion held with - Eng. Mohamed Abdel Hamid Aboul Atta, Chairman Eng. Aly Gamal el Dine Hassanein, General manager Eng. Abdel Moneim Seif, Director of Transport Eng. Selim Kamel, Director of Development.

Date & Day	Time	Description
	10:30	Visit to Nasr City; discussion with the following staff of Nasr City Co. - Eng. Araf Ali Mahdy, Chairman Eng. Gamal eldin Fahim, General Director Eng. Mohamed Khair el din Ragab, Director of Projects
	14:40	Inspection of the Materiya line from Pont Limon station.
May 10 (Tue)	9:30	Discussion with the following U.A.R staff at the Ministry of Transport - Eng. Soliman Abdel Hay, Under-Secretary of State Eng. Ahmad Aboul Naga, Director of Planning
	12:00	Discussion with the U.A.R. staff at the Commission's office
May 11 (Wed)	8:00	Inspection of the National Railway (Cairo - Benha - Minuf).
	12:00	Return to Cairo.
May 12 (Thu)	9:30	Discussion with the U.A.R. staff at the Commission's office on the survey schedule and the contents of the Preliminary Report.
	11:30 ~ 17:30	Inspection of intersections and the proposed route of the underground railway (Mission grouped into two for the inspection).
May 13 (Fri)		(Holiday)
May 14 (Sat)	9:30	Discussion with the U.A.R. staff at the Ministry of Transport on data provided.
May 15 (Sun)	9:30	Discussion with the U.A.R staff at the

Date & Day	Time	Description
		Commission's office (a group of members engaged in field survey in Cairo).
	18:00	Discussion by the Mission's members at the working office of Semiramis Hotel for preparation of a list of additional data required.
May 16 (Mon)	9:30	Discussion with the U.A.R staff at the Commission's office (a group of members engaged in the inspection of the Helwan line and intersections in Cairo).
	14:00	Discussion resumed at the Commission's office.
May 17 (Tue)	7:30	Departure from the Central Railway Station for inspection of Aswan High Dam.
	22:30	Arrival at Aswan.
May 18 (Wed)	8:30	Inspection of Aswan High Dam; explanations on High Dam given by Mr. Ibrahim Zaki Kenawi, Deputy Minister of the High Dam, High Dam Authority.
	12:30	Inspection of Aswan Dam power plant.
	19:00	Inspection of Kima fertilizer plant.
May 19 (Thu)	6:00	Departure from Aswan for Luxor.
	10:00	Arrival at Luxor; visit to Valley of King, Karnak Shrine and others.
	23:00	Departure from Luxor for Cairo.
May 20 (Fri)	9:30	Arrival at Cairo.
	18:00	Discussion by the Mission's members at the working office on the contents of the

Date & Day	Time	Description
		Preliminary Report and the survey schedule.
May 21 (Sat)	7:00	Inspection of traffic congestion in Cairo during rush hours.
	11:00	Interview with H. E. Dr. Mohamed Abdel Kader Hatem, Deputy Prime Minister for Culture.
	19:00	Film show at the Cultural Centre of the Japanese Embassy, attended by H. E. Dr. M. A. K. Hatem and many other government officials of the U.A.R. Titles of films shown - 1. Underground railway construction in Ginza, the businest section in Tokyo. 2. Edobashi interchange over the river. 3. Flexible pier construction in Akasakamitsuke.
May 22 (Sun)	7:00	Inspection of Shubra and Ataba districts.
	10:00	Interview with Dr. Aly Sabri, Professor of Cairo University.
	19:00	Tea party held by H. E. Dr. M. A. K. Hatem on Nile Steamer "ISIS."
May 23 (Mon)	7:00	Inspection of traffic congestion in Cairo during rush hours.
	9:30	Discussion with U.A.R. staff at the Commission's office.
May 24 (Tue)	7:00	Inspection of the Metro's workshop in Heliopolis.

Date & Day	Time	Description
May 25 (Wed)	7:00	Departure for Ismailia and Port-Said.
	9:00	Arrival at Ismailia, visit to Mr. Ahmed Mashour, President of Suez Canal Authority; inspection of the Research Institute of the Authority.
	12:00	Arrival at Port-Said, inspection of the port for an hour.
May 26 (Thu)	9:00	Interview with H. E. Mr. Farid Toulan, Governor of Port-Said.
	10:00	A bouquet of flowers laid at the Monument of Unknown Soldiers.
	14:00	Inspection of "Suez-Maru" of Mizuno-Gumi Co., engaged in dredging work at Suez Canal.
	16:00	Arrival at Suez.
	17:00	Departure from Suez for Cairo via Desert Road.
	19:00	Arrival at Cairo.
May 27 (Fri)	9:00	Discussion by the Mission's members at the working room on the proposed route of underground railways.
	19:00	Discussion at the same room on immediate actions for traffic problems in Cairo.
May 28 (Sat)	10:30	Interview by Mr. Hirose, Leader of the Mission with H. E. Dr. M. E. Salama, Minister for Housing and Public Utilities.
	18:00	Discussion by the Mission's members at the working room on the contents of the Preliminary Report.

Date & Day	Time	Description
May 29 (Sun)	9:30	Visit by a group of members to the Ministry of Transport and the National Railway Authority.
	10:30	Conference between Mr. Y. Hirose and Eng. M. Idris, Director of Planning Department of the Commission.
May 30 (Mon)	-	Drafting of the Preliminary Report by each member.
May 31 (Tue)	15:30	Departure form Cairo for Alexandria by car.
	18:30	Arrival at Alexandria.
Jun 1 (Wed)	11:00	Interview with H. E. Mr. Mohamed Mahmoud Abd El Sood, Deputy Minister for Housing and Public Utilities, at Alexandria Governorate.
	11:30	Visit to Montaza Palace.
	18:30	Departure from Alexandria for Cairo via Desert Road.
	21:30	Arrival at Cairo.
Jun 2 (Thu)	12:00	Conference between Mr. Y. Hirose, other members of the Mission and H.E. Dr. M.E. Salama, Minister for Housing and Public Utilities.
	20:00	Press interview with Japanese correspondents in Cairo.
Jun 3 (Fri)	10:00	Visit to the Japanese Embassy.
	19:00	Cocktail party held by Mr. Y. Hirose at Semiramis Hotel with attendance of the staff of the Commission and the Japanese Embassy.

Date & Day	Time	Description
Jun 4 (Sat)	9:30	Conference between Mr. Y. Hirose and H. E. Dr. M. E. Salama on the Memorandum to be signed by both parties.
	19:30	Dinner party held by Ambassador Kakitsubo at the Japanese Embassy.
Jun 5 (Sun)	10:30	Visit by Mr. Y. Hirose to the Japanese Embassy.
	12:00	Conference between Mr. Y. Hirose and Eng. M. Idris of the Commission on the Memorandum; submission of the Preliminary Report to the Commission.
Jun 6 (Mon)	10:00	Departure from Cairo of Dr. Y. Yasoshima, Mr. S. Nakajima, Mr. H. Mochizuki and Mr. T. Susaki for Rome by AZ 493. Memorandum signed by Mr. Y. Hirose and Eng. M. Idris of the Commission.
Jun 7 (Tue)	8:45	Interview with H. E. Dr. M. E. Salama, Minister for Housing and Public Utilities to offer greetings before departure from Cairo.
	10:30	Interview with H. E. Dr. M. A. K. Hatem, Deputy Prime Minister for Culture to offer greetings before departure from Cairo.
	12:30	Press interview with the U. A. R. journalists.
	16:30	Departure from Cairo of Mr. Y. Hirose, Mr. S. Saito, Mr. Y. Matsumura and Mr. H. Kimura for Beiruth by ME 303.

Appendix II

List of Data Provided by U.A.R. Authorities

Code No.	Description
1001001	Changes in the population of the UAR, the Greater Cairo Region and the City of Cairo
101002	Changes in the population of Greater CairoRegion, 1947 - 1965
101003	Population distribution by level of education
101004	Population distrubution by age, 1960
101005	Population estimates by age by sex, the City of Cairo, 1965
101006	Population distribution by profession, 1960
101007	Distribution of persons working in industry
101008	Development of capital invested and number of labourers working in the new industries in Greater Cario Region, 1963 - 1962
101009	Quotation from the building code
101010	National per capita income, labourers daily wages and working hours
101011	Number of cars registered in Cairo and adjacent governorates, March 1966
101012	Accidents reported to police, Cairo, 1965
101013	Meteorological data of the Greater Cairo Region, 1947 & 1960
101014	House construction in Greater Cairo Region
102001	Map of Egypt
102002	Map of Cairo, 1/25,000
102003	Map of Cairo, 1/5,000
102004	Map showing districts and boundaries of the Greater Cario Region

Code No.	Description
102005	Map showing plan of land use of Cairo, 1966
102006	Map showing main routes, Cairo, 1966
102007	Alignement of ducts
102008	Map showing location of check points of subsoil water level and boring, Cairo
102009	Subsoil water level and Nile level, 1945 - 1953
102010	Subsoil water level and Nile level, 1956 - 1957
102011	Subsol water level and Nile level, 1963
102012	Borings at different parts of Cairo city
102013	Graph showing number of cars in Cario in different years with projections
102014	Map showing major intersections that are currently under consideration for possible improvement
102015	Location of A. C. substation, Cairo, 1966
102016	Location of telephone exchanges, Greater Cairo Region
102017	Trav. cross section in Rameses St. beside main telephone exchange
102018	Topographical map of Cairo, 1/25,000
102019	Proposed road network of Cairo
102020	Proposed realignment of Ramses Square
102021	Plan of major bus terminals
102022	One-way streets, parking and no parking area
102023	Map showing proposed road widening of Cairo, 1/1,000
102024	Cross section of main streets
102025	Cross section of Ismalia canal, 1/250
102060	Cross section of bridges crossing the Nile.

Code No.	Description
103027	Pure water pipes (date of construction and diameter of pipe line) 1/15,000
102028	Map showing water pipe of Cairo
102029	Map showing drainage pipe line of Cairo 1/500
102030	Drainage pipes, 1/12,000
102031	Drainage pipes, 1/5,000
102032	Telephone cable, 1/5,000
102033	Longitudinal profile of drainage pipe
202001	Movement of passengers using public transport between sectors of Greater Cairo
202002	Movement of passengers using public transport between sectors of Greater Cairo from 7 a.m. to 8 a.m.
202003	Map of daily traffic for 24 hours for lines and streets of general transport, December 1965
202004	Map of traffic at hour of maximum in the single lane in the streets of lines, December 1965
202005	Patronage using intercity bus services per day inbound and outbound Cairo
202006	Traffic survey of main intersections, Cairo
211001	Annaual total number of cars since 1956 of Egyptian Railways
211002	Number of passengers
211003	Forecast of the number of passengers and number of cars of Matariya Line and Helwan Line
211004	Fare structure and receipt-expenditure of Egyptian Railways
211005	Fares on Bab-el-Louk - Helwan el Hamamat Line
211006	Fares on Kobry El-Limun - Marg - Shebin el Kanater Line

Code No.	Description
211007	Data of Egyptian Railways within 50 km from Cairo
211008	Data of Matariya Line and Helwan Line
211009	Communication system and electric facilities of Helwan Line and Matariya Line.
211010	Signalling system of Helwan Line and Matariya Line
211011	Signalling system and communication system of Egyptian Railways
211012	Train bridge in and around Cairo
211013	Geological conditions (borings)
211014	Time-table of suburban trains of Egyptian Railways
211015	Time-table of passenger trains of Egyptian Railways
211016	Cargo moving in Greater Cairo Region
212001	Structure and car gauges
212002	Plans of electric three coach train for Helwan Line
212003	Plans of suburban diesel train
212004	Details of track laying in vignole rails 42 kg.
212005	Details of track laying in vignole rails 46 kg.
212006	Track in flat bottom rail 47. Track laying of vig. rail 47 on wooden sleepers
212007	Details of track laying in vignole rails 47 kg.
212008	Track in flat bottom rails 52 kg.
212009	Track in flat bottom rails 54 kg.
212110	Schematic graph of Helwan Line
212011	Schematic graph of Matariya Line
212012	Signalling electirfication of Kobri-el-Leimoun - El Marg Line

Code No.	Description
212013	Schematic graph of signalling system of Helwan Line
212014	Longitudinal cross section of Helwan Line
212015	Longitudinal cross section of Matariya Line
212016	Railways in Greater Cairo Region
212017	Tura station remodelling
221001	Designations of Our Metro + trailer cars
221002	Designations of Metro and trailer cars
221003	Annual passengers carried by the Metro of Heliopolis
221004	Average daily passengers in the various lines, Heliopolis
221005	Working tariffs on Metro Lines
221006	Balance sheet for years 1962/1963 - 1963/1964 - 1964/1965
221007	Data of Metro and tram services
221008	Actual service carried by Metro of Heliopolis
221009	Average capacity on Metro Lines
221010	Future service on Metro Lines on the base of 65 units, 30 units for Darrasa Line
222001	Diagram showing 1 - Length of distances on each line, 2 - Stops on each line.
222002	Existing and proposed routes of Metro and rapid trams
222003	Plan and table of specifications of Metro cars
222004	Meter gauge, Metro cars, DRG. No. G-C-687A
222005	Meter gauge, Metro cars, DRG. No. G-C-944
222006	Plans of Metro cars
222007	Diagram of Metro Lines
222008	Location of sub-stations on Metro Lines

Code No.	Description
222009	Plan of new repair shop of Metro Lines at El Mazah
222010	Plan of new hungers of Metro Lines at El Mazah
222011	Cross section of new hungers of Metro Lines at El Mazah
222012	Longitudinal profile for lines of C.E.R. & H.D.C. from Pont Limoun to Roxy
222013	Profils on Traverse
222014	Span construction for our double track roadway
222015	Tie-bar entretoise
2220'6	Loading gauge of our rolling stock
222017	Schematic graph of new electric signalling of Metro Lines
231001	Average number of vehicles in service per day
231002	Number of busses and their condition, February 28th, 1966
231003	Average yearly number of passengers per day. Total of ticket and season ticket passengers.
231004	Average number of passengers per day, year 1964/65
231005	Bus, tram and trolley-bus peak hour passenger counts, year 1953 -54 & 1963
231006	Number of tram ticket passengers per day
231007	On and off passengers per hour of bus lines ending or passing Ataba & Ramsis stations, morning peak hour on the maximum load direction.
231008	Bus lines (Number of vehicles, number of passengers)
231009	Street Cars (Number of vehicles, number of passengers)
231010	Trolley bus (Number of vehicles, number of passengers)
231011	Fare structure, Tram, Trolley - busses, busses
231012	Bus lines season tickets.

Code No.	Description
231013	Tram & Trolley bus lines season tickets
231014	Receipts and expenses, Tram, trolley and bus
231015	Bus lines (Average length between stations)
231016	Street cars (Average length between stations)
231017	Trolley bus (Average length between stations)
231018	Gauge, method + voltage of electirc current, facilities of repair shop and amount of electric consumption in Cairo, Transport Authority
232001	Bus routes
232002	Trams and Trolley bus routes
232003	Location and numbers of passengers count points, year 1965
232004	Graph showing number of passengers at stations
232005	Map for substations for electircity (Tramways & trolley bus)

- Regarding the bridges which cross over the River Nile and the Al Ismailiya Canal in Greater Cairo Region:

  1) Design standards.
     a) Name
     b) Type (railway bridge or car bridge)
     c) Structure (for example, simple truss - 6 spans)
     d) Material (for example, reinforced concrete, rough iron)
     e) Total length, span length, width, number of main girders.
     f) Number, condition of foundation of abutment and piers.
     g) Level of bridge surface, mean water, river bottom.
     h) Typical geological conditions.

- Regarding the cement and steel products (Bar steel, Angle

Code No.	Description
	steel, Channel steel, I beam Sheet pile)
	1) Quality and strength.
	2) Amount of products available to civil construction works.

LIST OF FIGURES

Fig. 2—1 Administrative Districts of the Greater Cairo Region

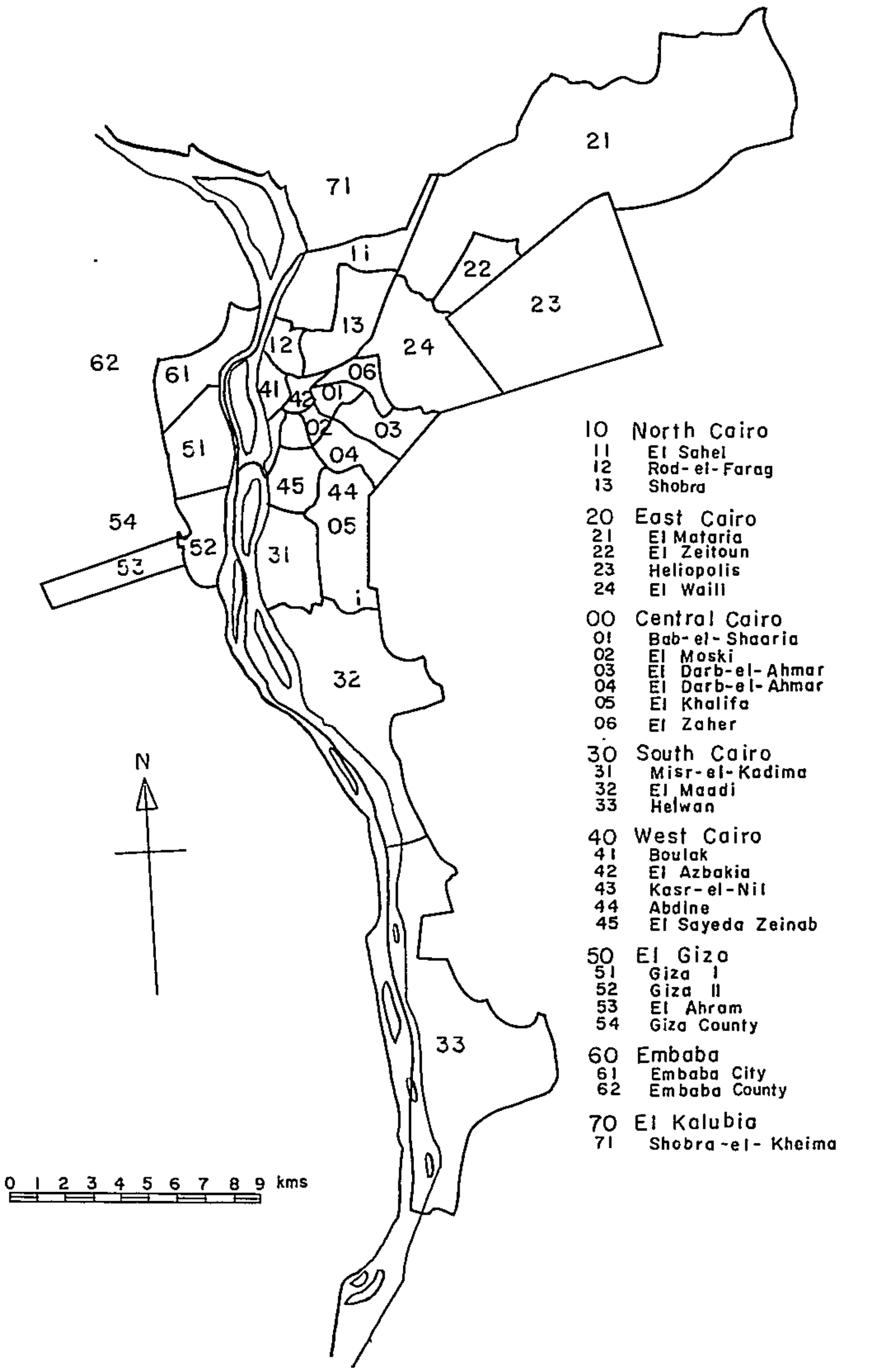


Fig. 3—1 Vehicle Registration Trends in Cairo (Forecast made by Cairo Transport Authority)

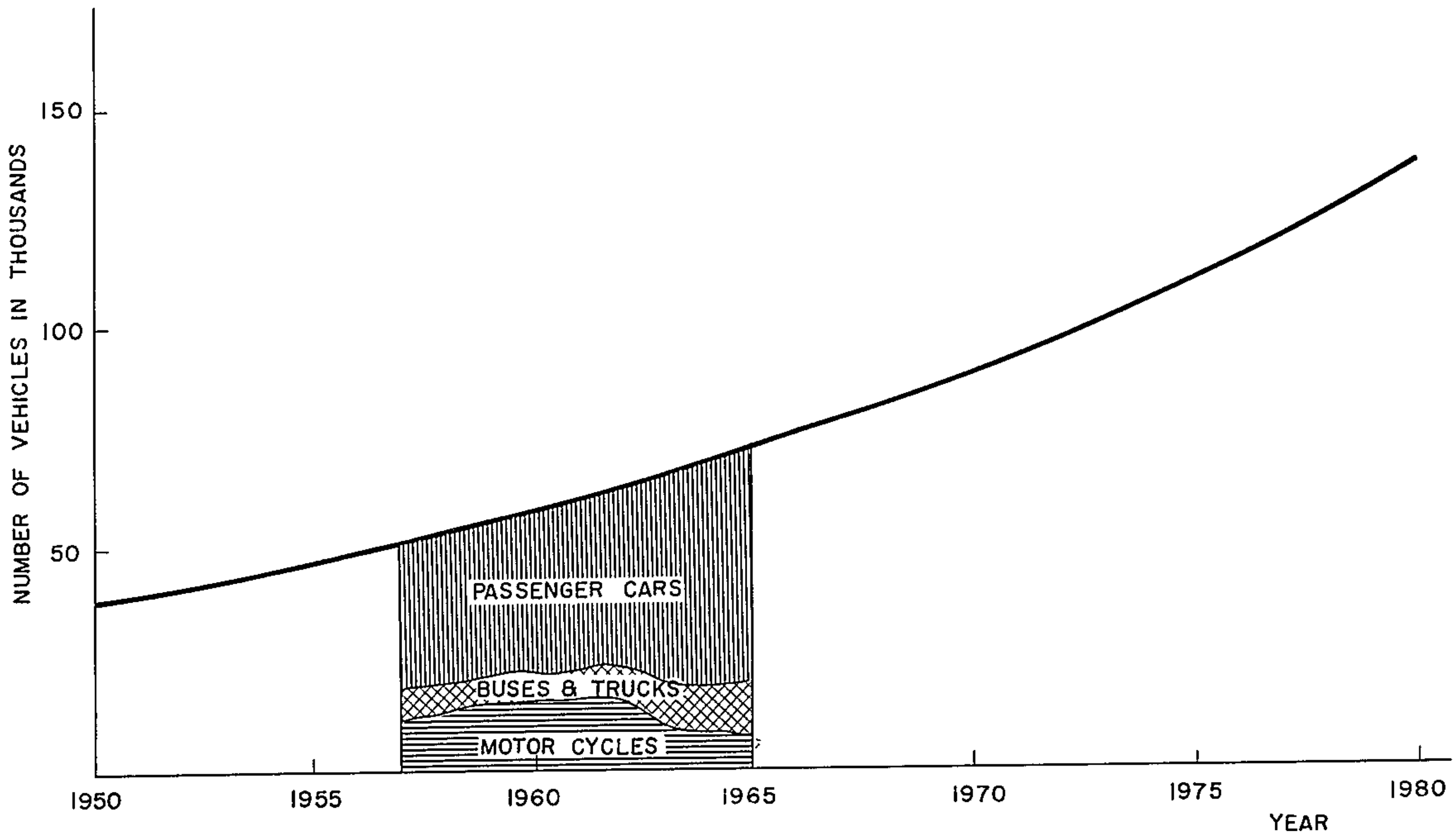


Fig. 3—2　Map of Daily Automobile Traffic for 24 hours

(December 1965)

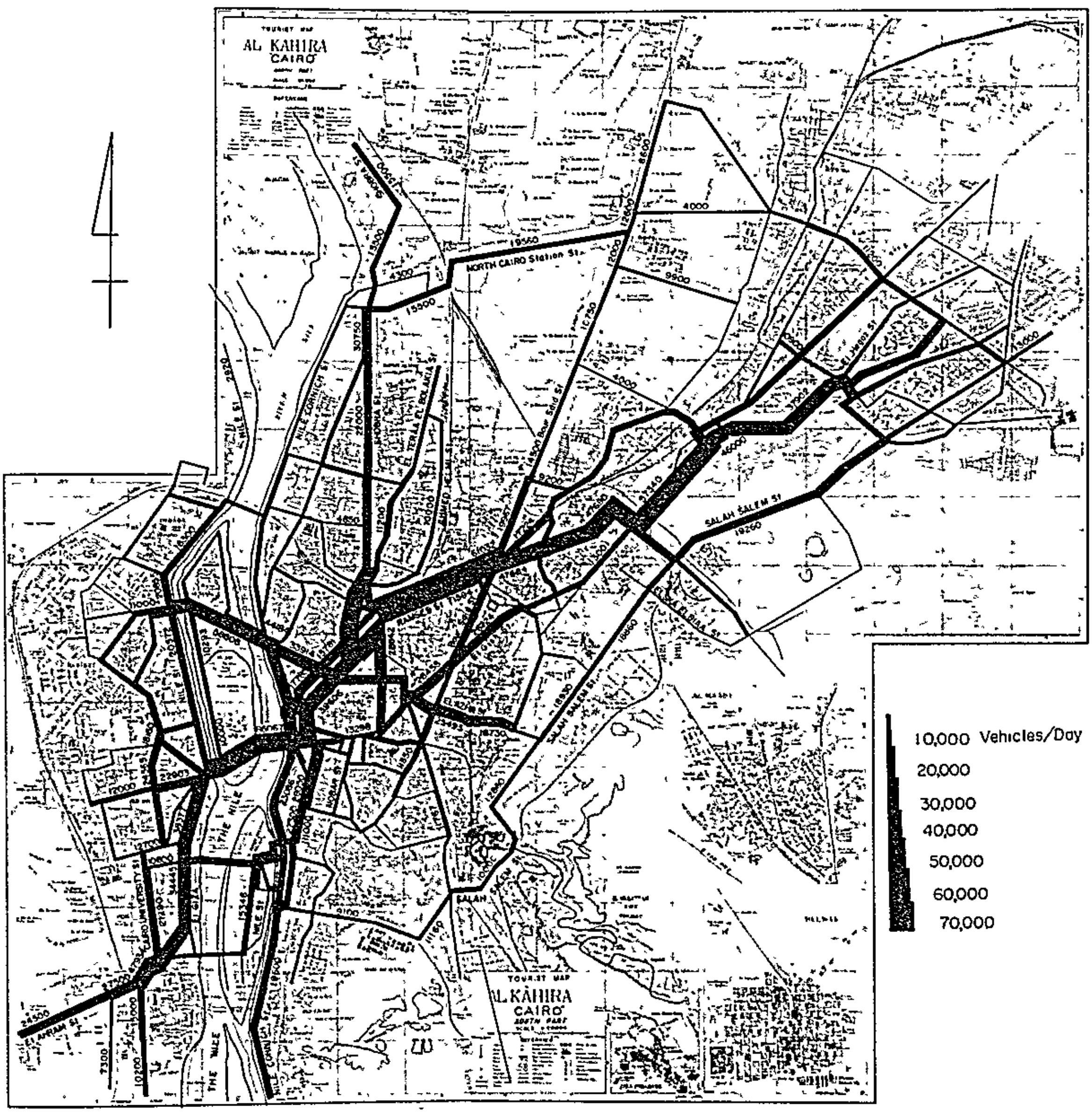


Fig. 4-1 Land Use Plan

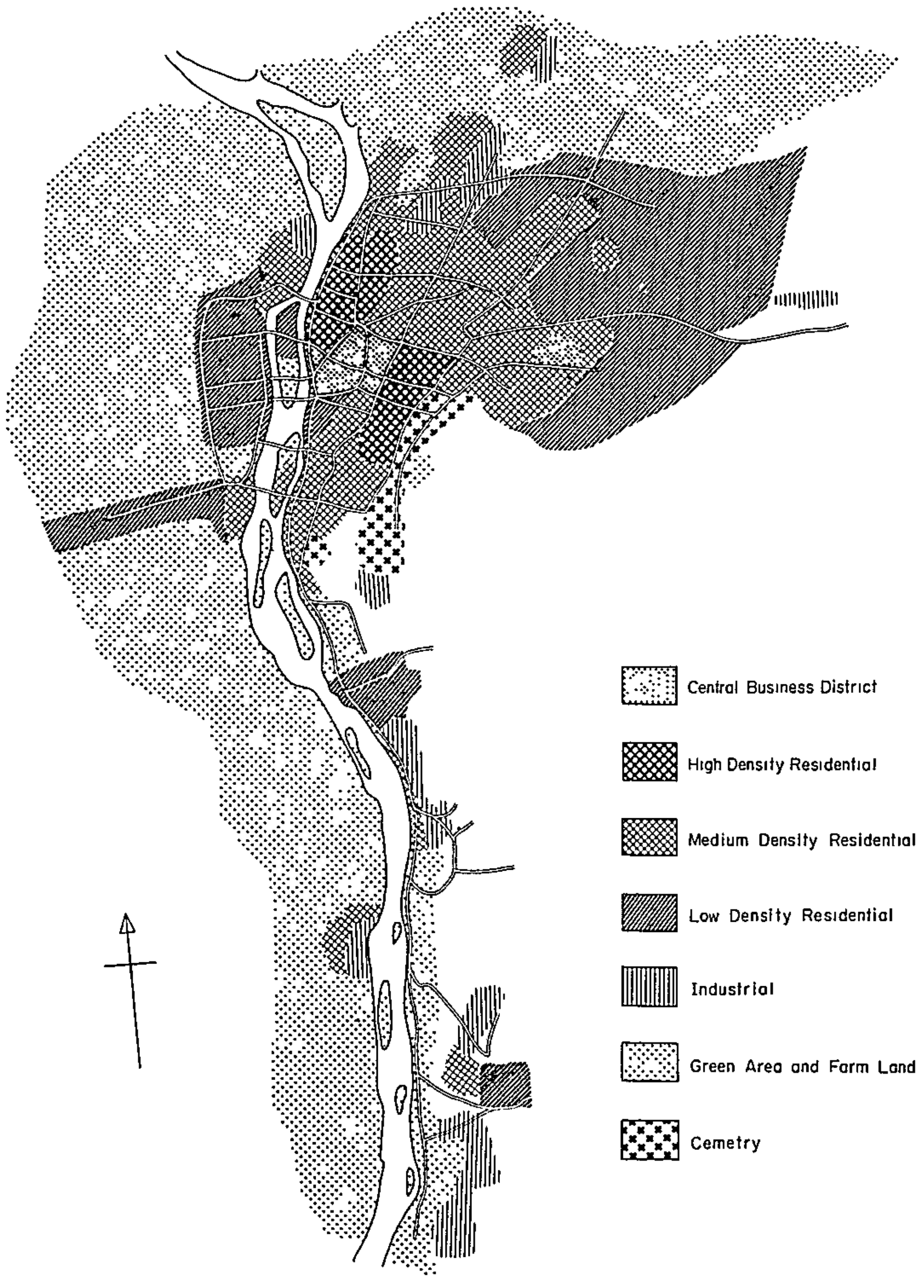
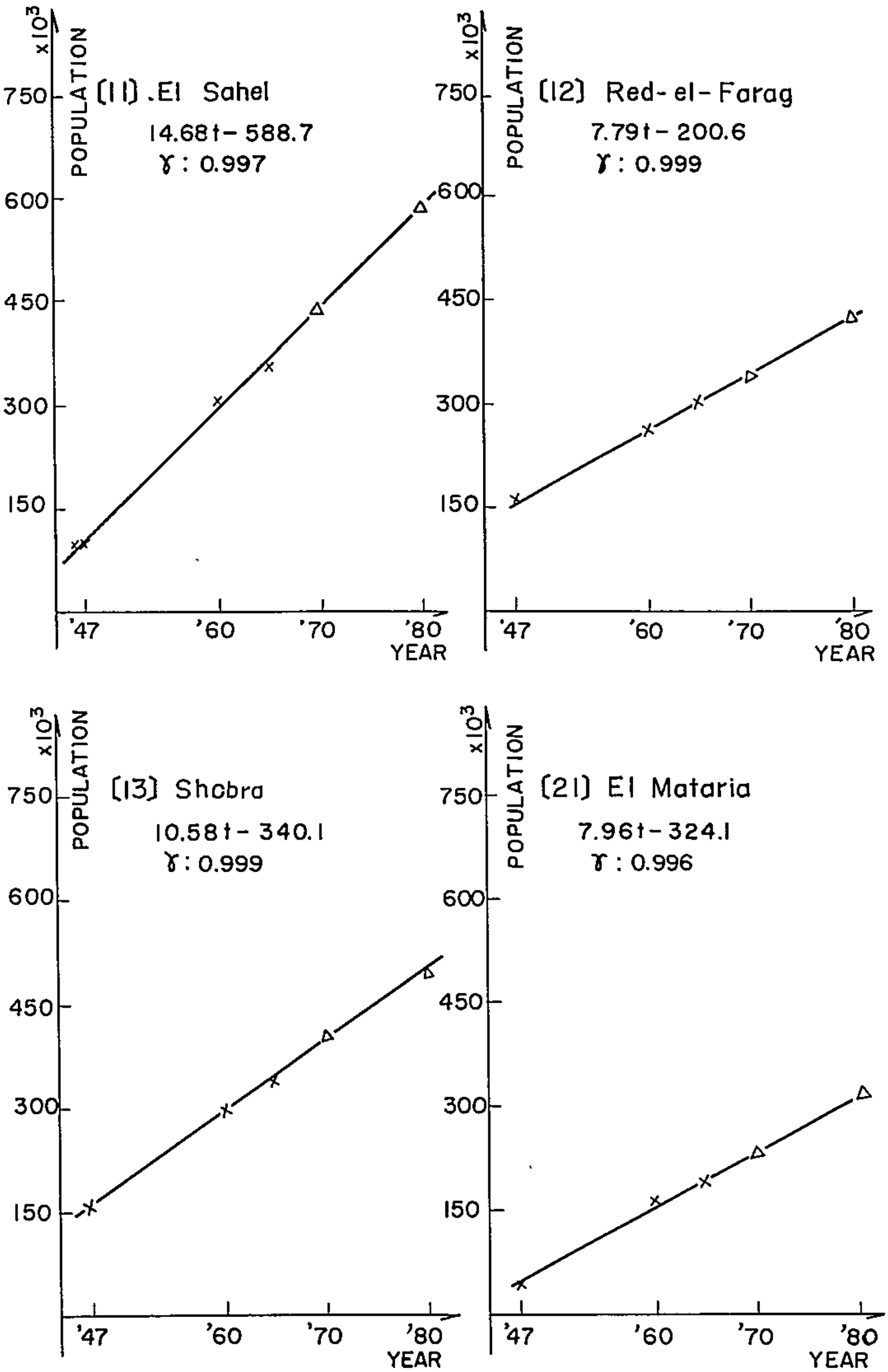
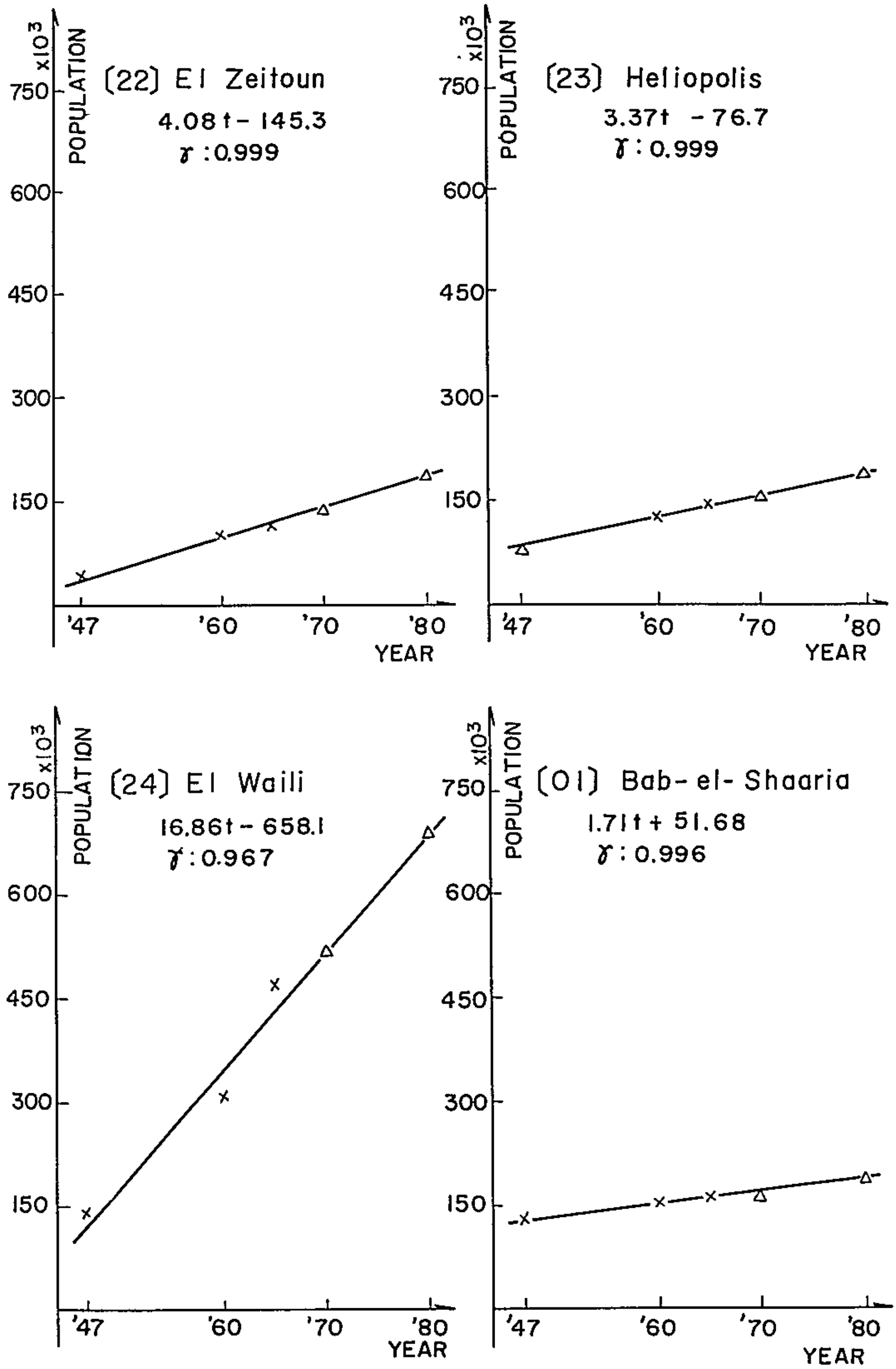


Fig. 4—2 Future Population Trends by District

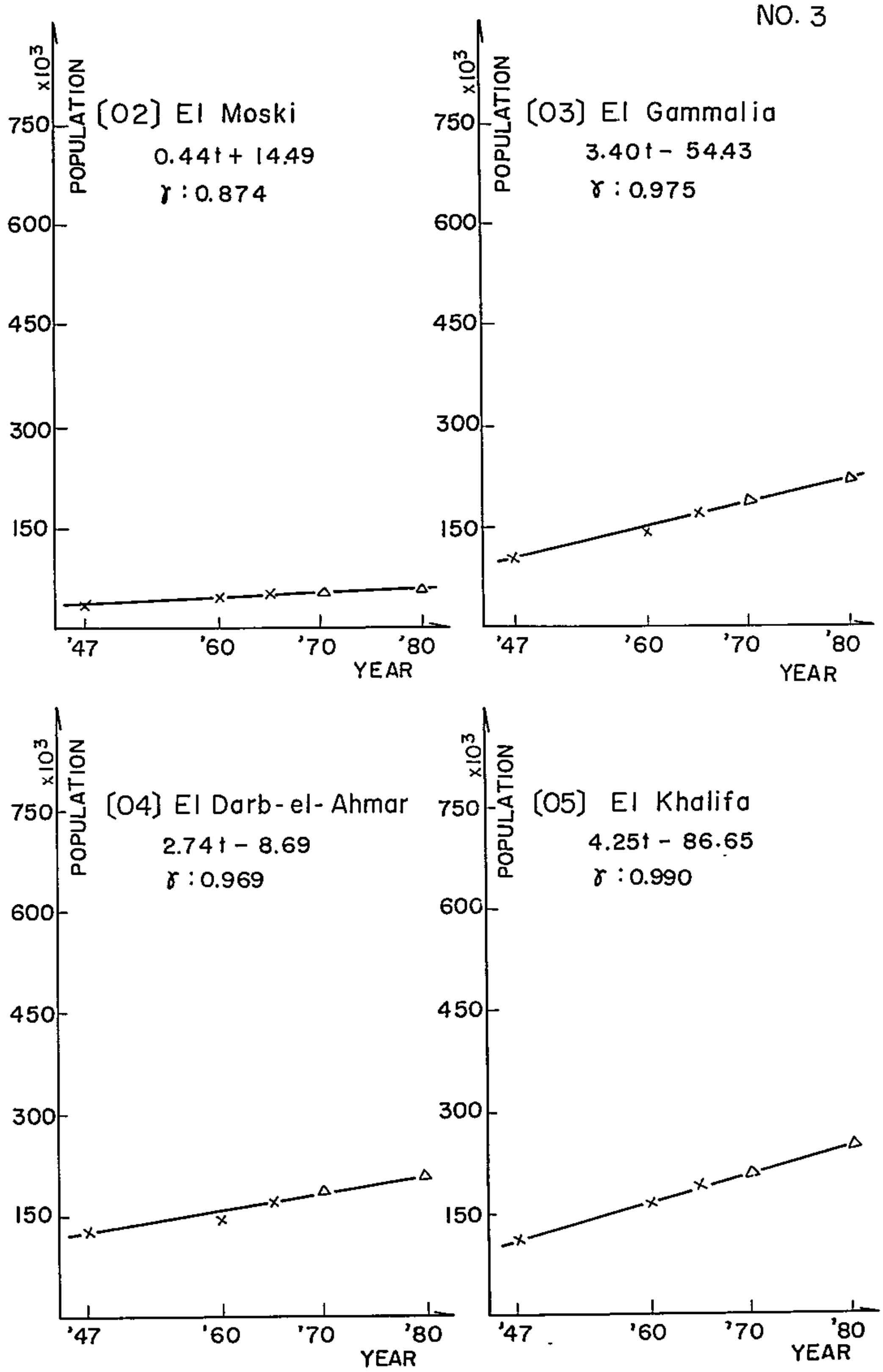
NO. 1

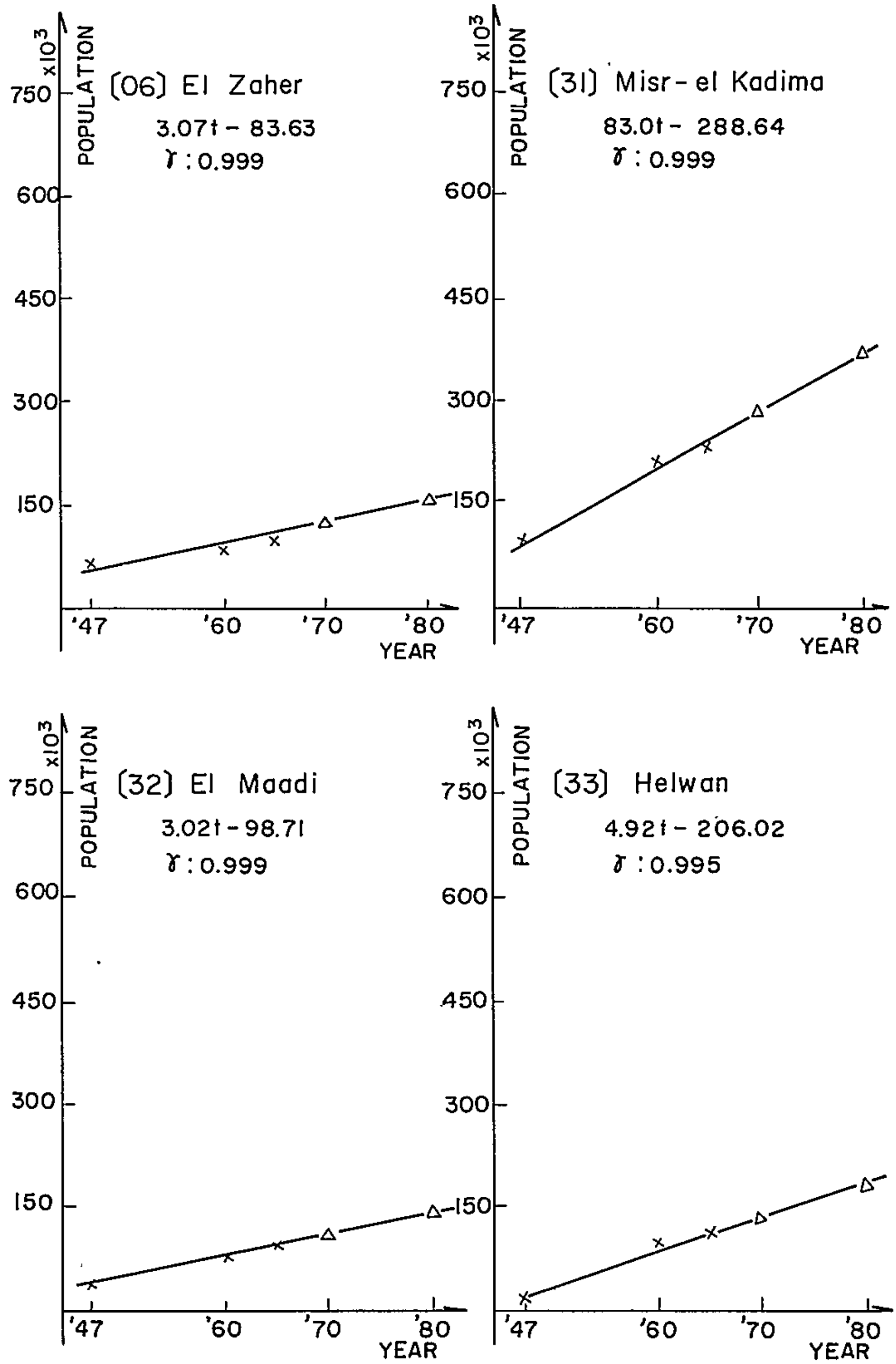


NO. 2

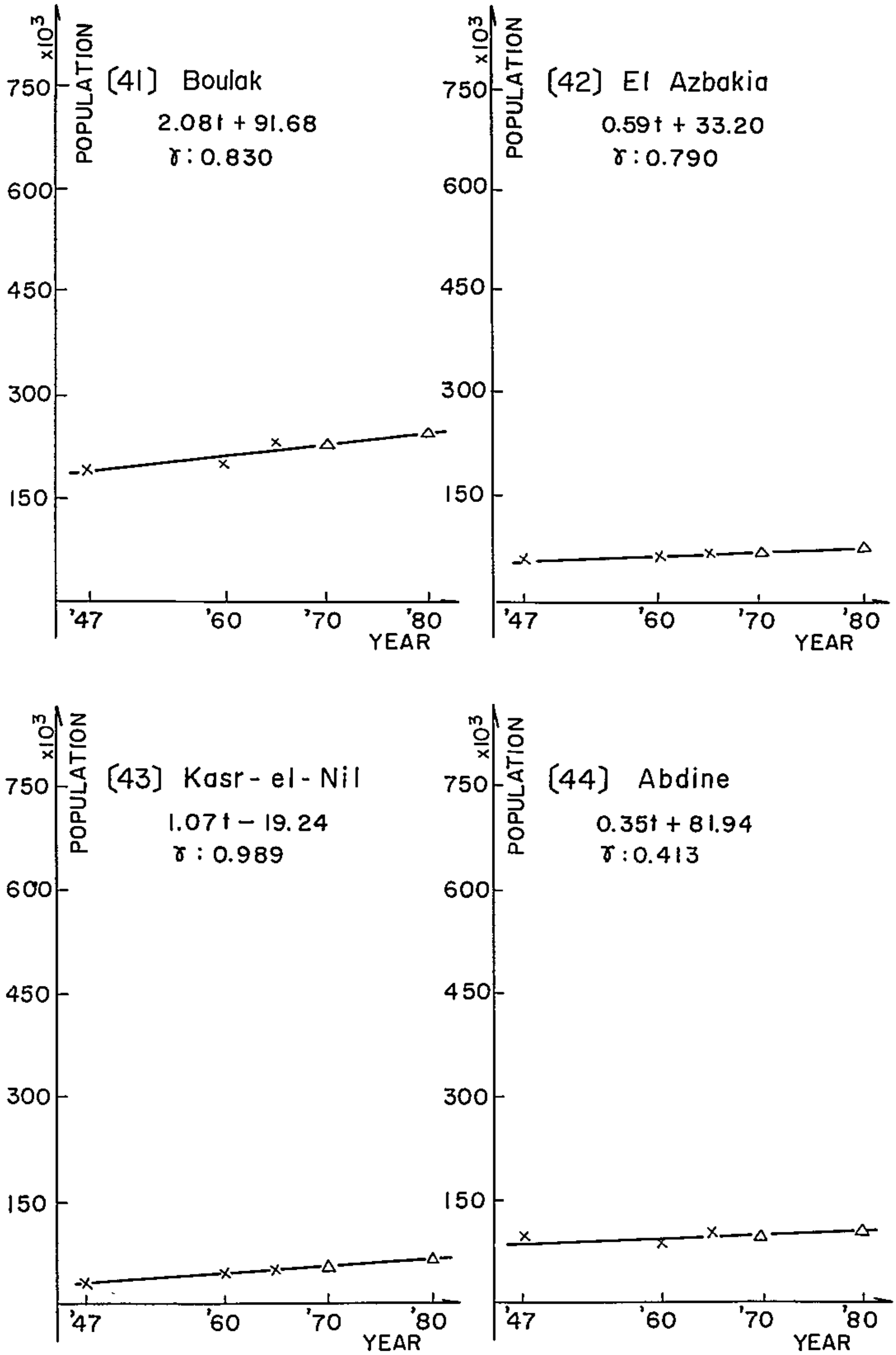


POPULATION
x10³
YEAR
(22) El Zeitoun
4.08t - 145.3
γ :0.999
(23) Heliopolis
3.37t - 76.7
γ : 0.999
(24) El Waili
16.86t - 658.1
γ : 0.967
(01) Bab-el-Shaaria
1.71t + 51.68
γ : 0.996
750
600
450
300
150
'47
'60
'70
'80

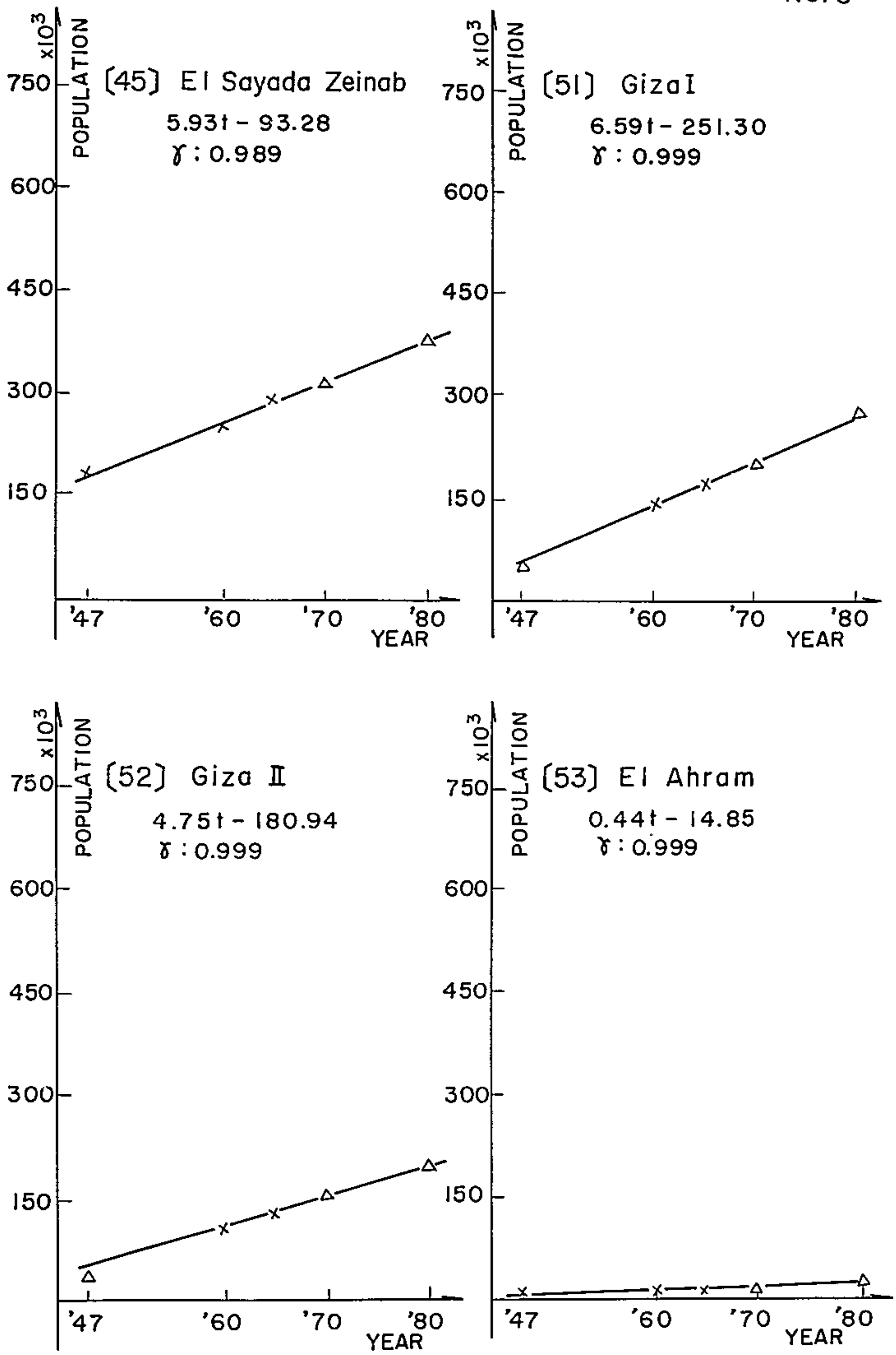

(02) El Moski
0.44t + 14.49
γ : 0.874
(03) El Gammalia
3.40t - 54.43
γ : 0.975
(04) El Darb-el-Ahmar
2.74t - 8.69
γ : 0.969
(05) El Khalifa
4.25t - 86.65
γ : 0.990
POPULATION
x10³
750
600
450
300
150
'47
'60
'70
'80
YEAR


(06) El Zaher
3.07t - 83.63
γ : 0.999
(31) Misr-el Kadima
83.0t - 288.64
γ : 0.999
(32) El Maadi
3.02t - 98.71
γ : 0.999
(33) Helwan
4.92t - 206.02
γ : 0.995
POPULATION
x10³
750
600
450
300
150
'47
'60
'70
'80
YEAR

NO. 5

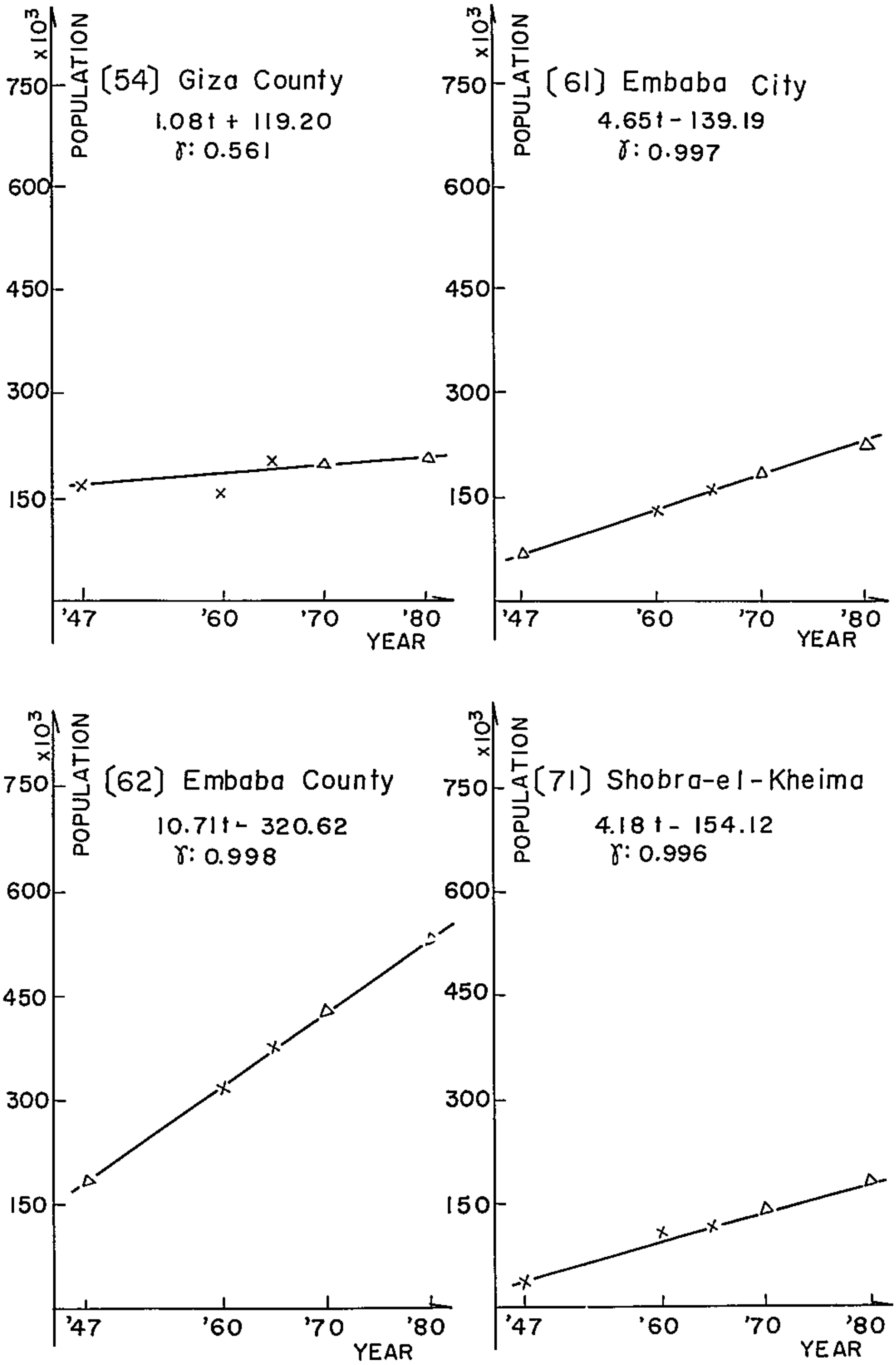

(41) Boulak
2.08t + 91.68
γ : 0.830
(42) El Azbakia
0.59t + 33.20
γ : 0.790
(43) Kasr-el-Nil
1.07t − 19.24
γ : 0.989
(44) Abdine
0.35t + 81.94
γ : 0.413
POPULATION
x10³
750
600
450
300
150
'47
'60
'70
'80
YEAR

NO. 6



(45) El Sayada Zeinab
5.93t - 93.28
γ : 0.989
(51) Giza I
6.59t - 251.30
γ : 0.999
(52) Giza II
4.75t - 180.94
γ : 0.999
(53) El Ahram
0.44t - 14.85
γ : 0.999
POPULATION
x10³
750
600
450
300
150
'47
'60
'70
'80
YEAR

NO. 7



(54) Giza County
1.08t + 119.20
γ: 0.561
(61) Embaba City
4.65t - 139.19
γ: 0.997
(62) Embaba County
10.71t - 320.62
γ: 0.998
(71) Shobra-el-Kheima
4.18t - 154.12
γ: 0.996
POPULATION
x10³
750
600
450
300
150
'47
'60
'70
'80
YEAR

Fig. 4—3 Present and Future Population Distribution

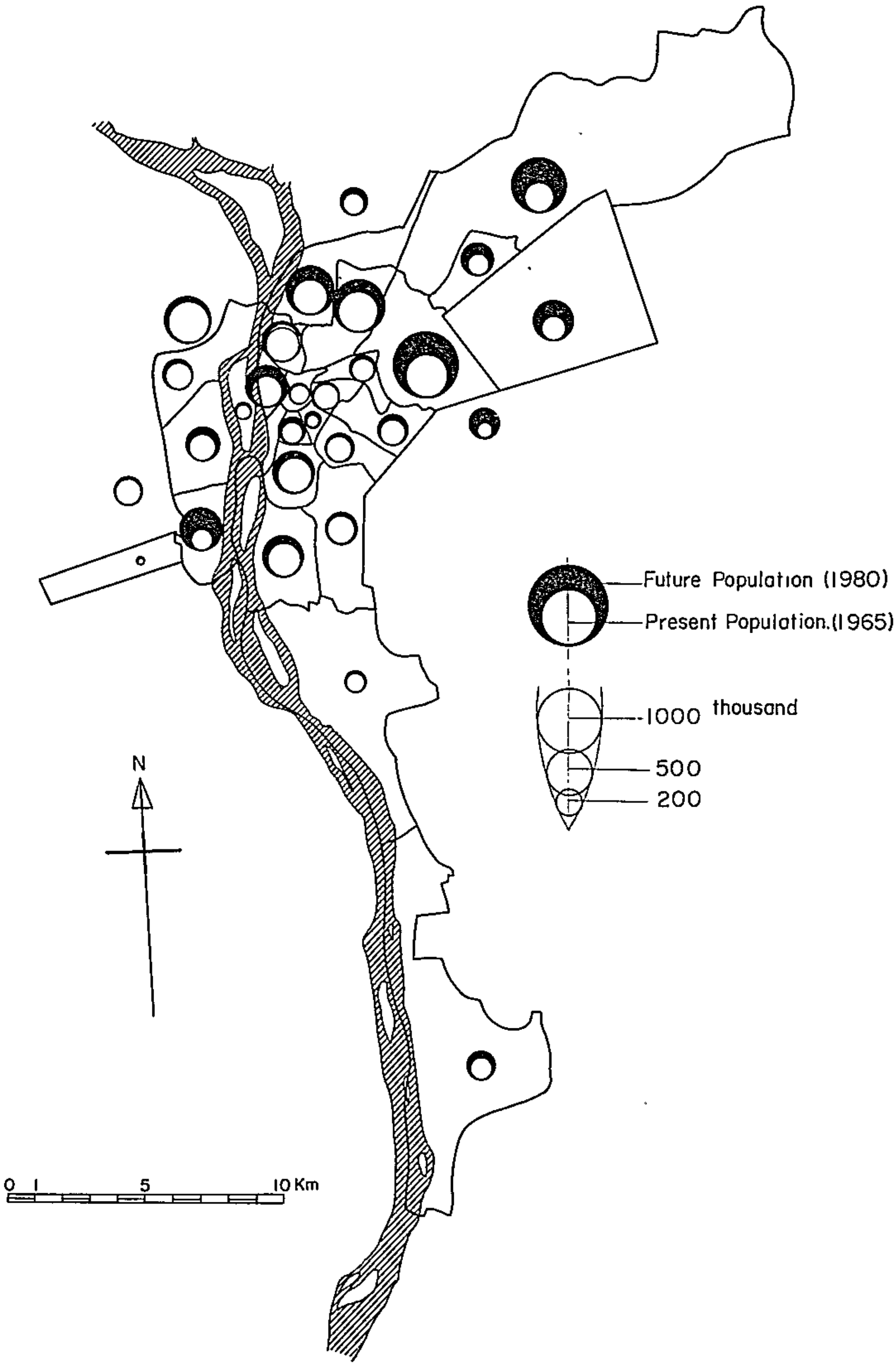


Fig. 4—4 Present Population Density

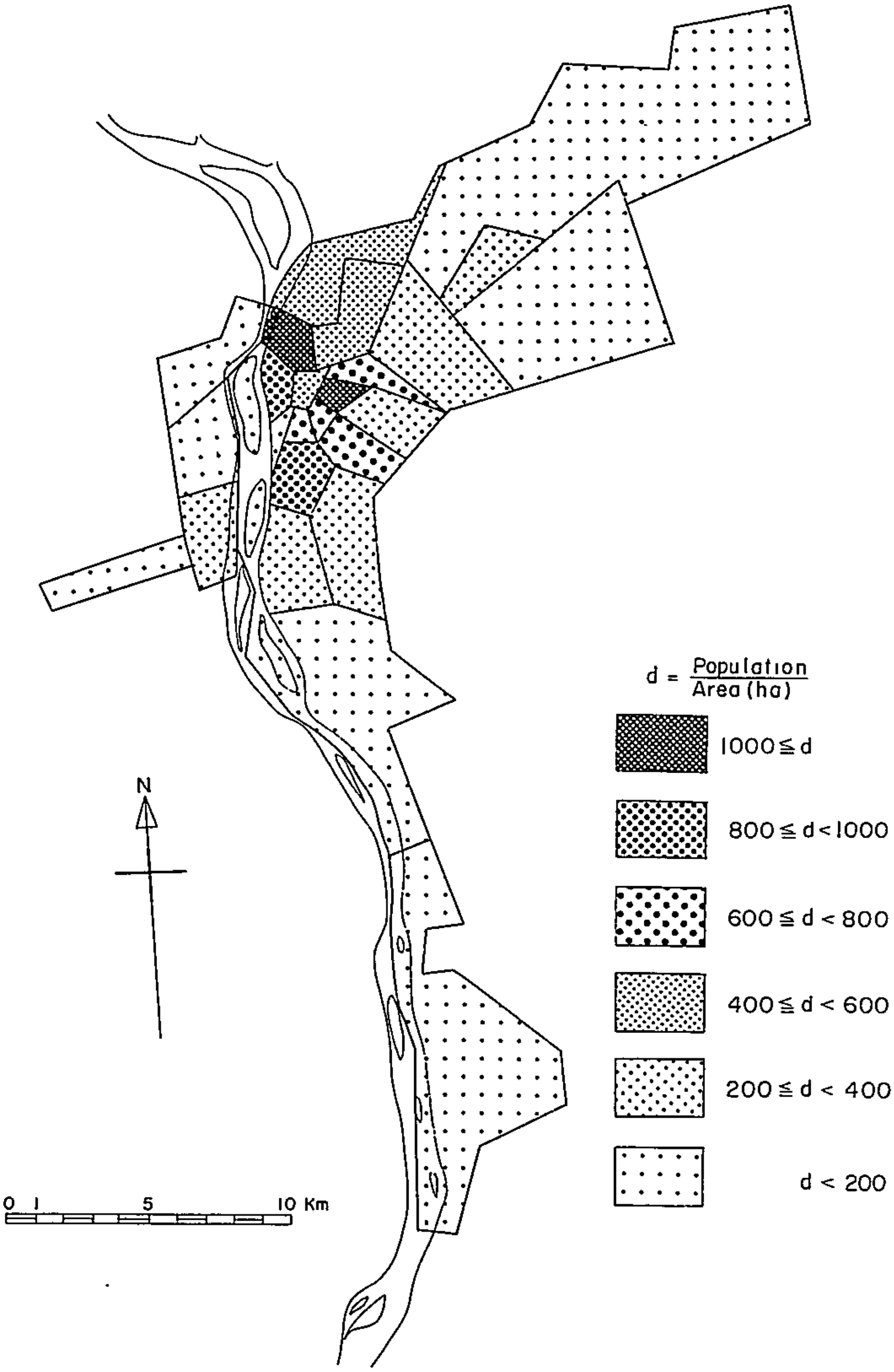


Fig. 4—5 Future Population Density

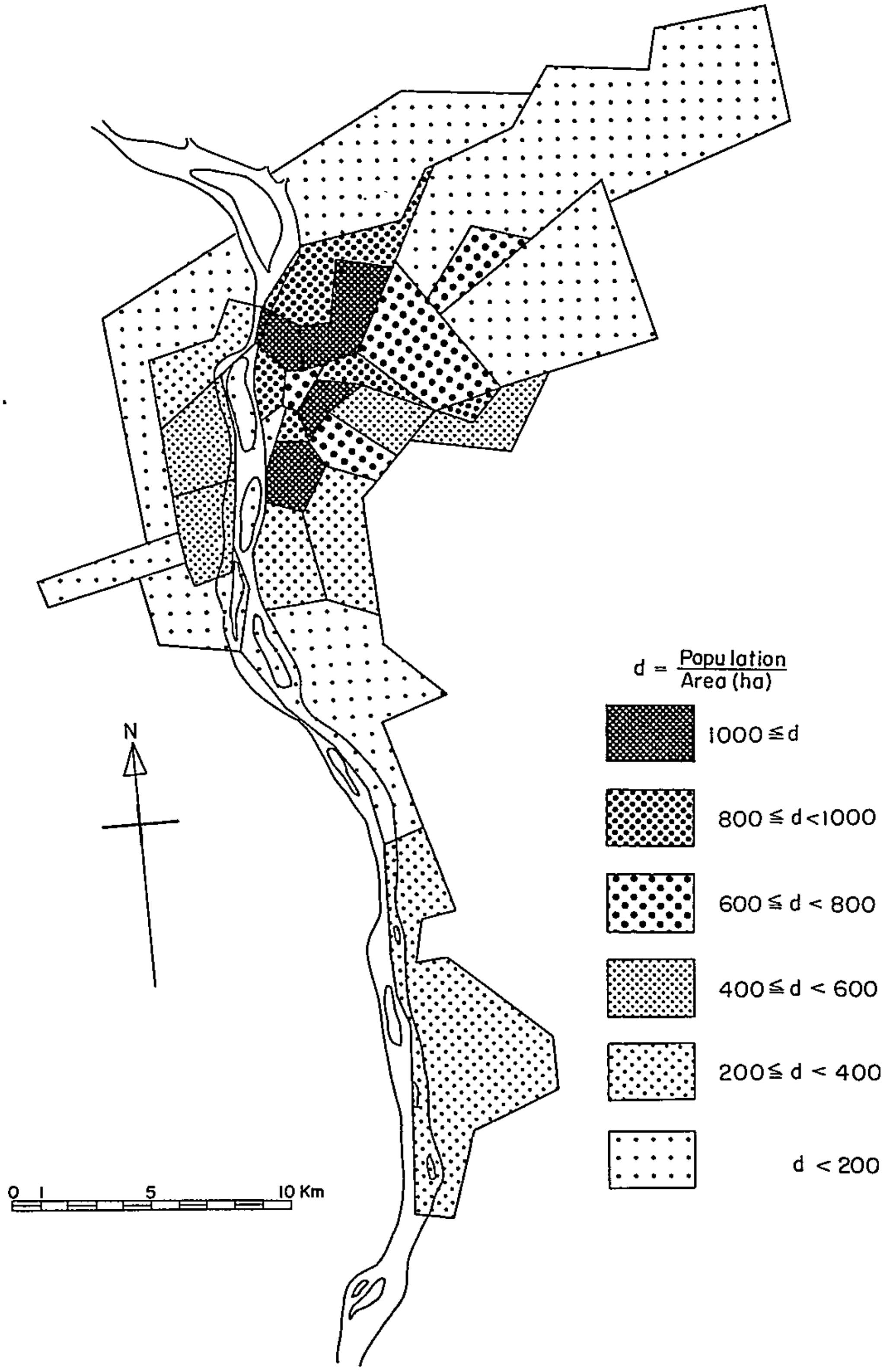


Fig. 4−6 Population Growth Ratio

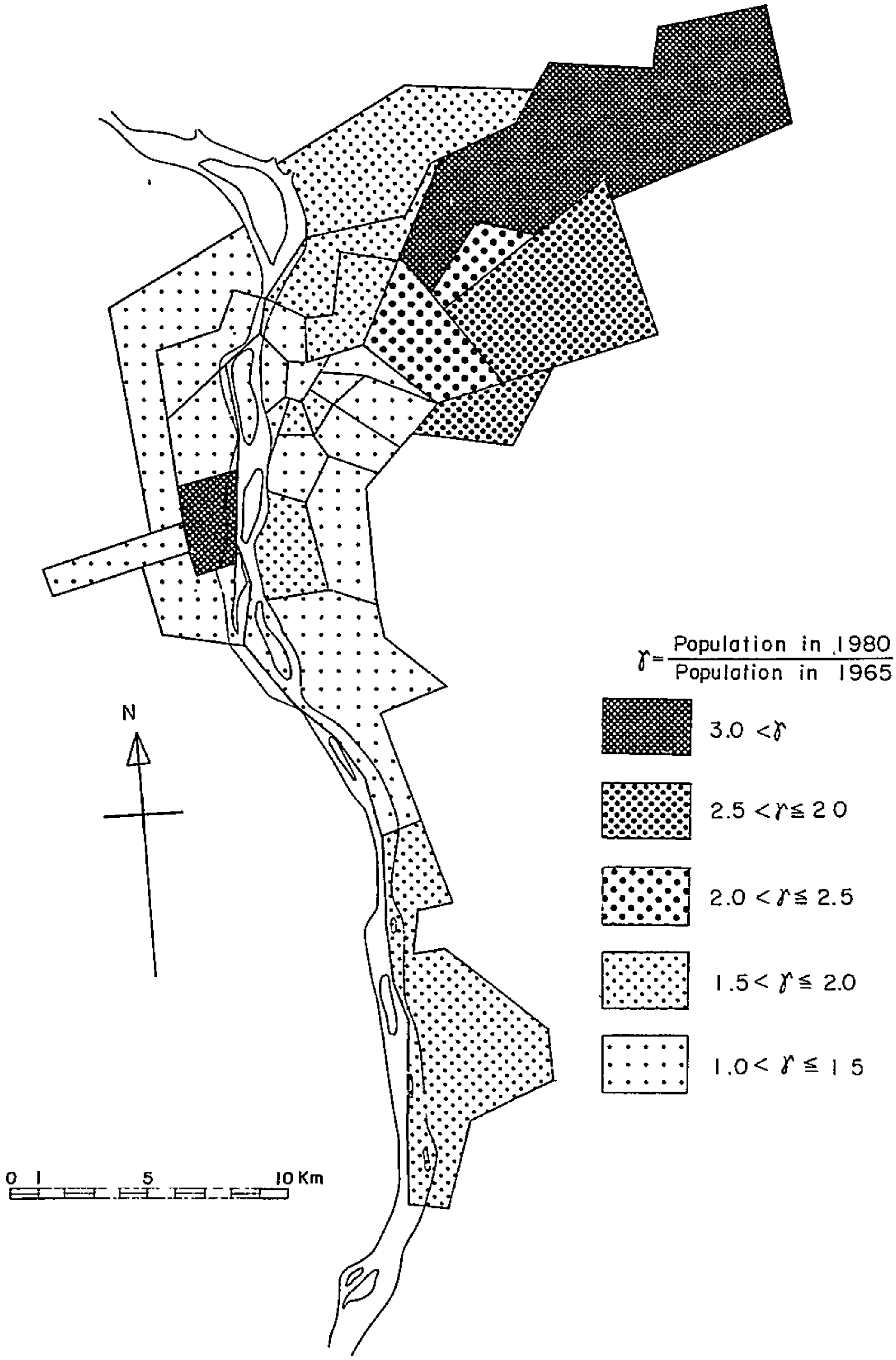


Fig. 4—7 Present Desire Line Chart

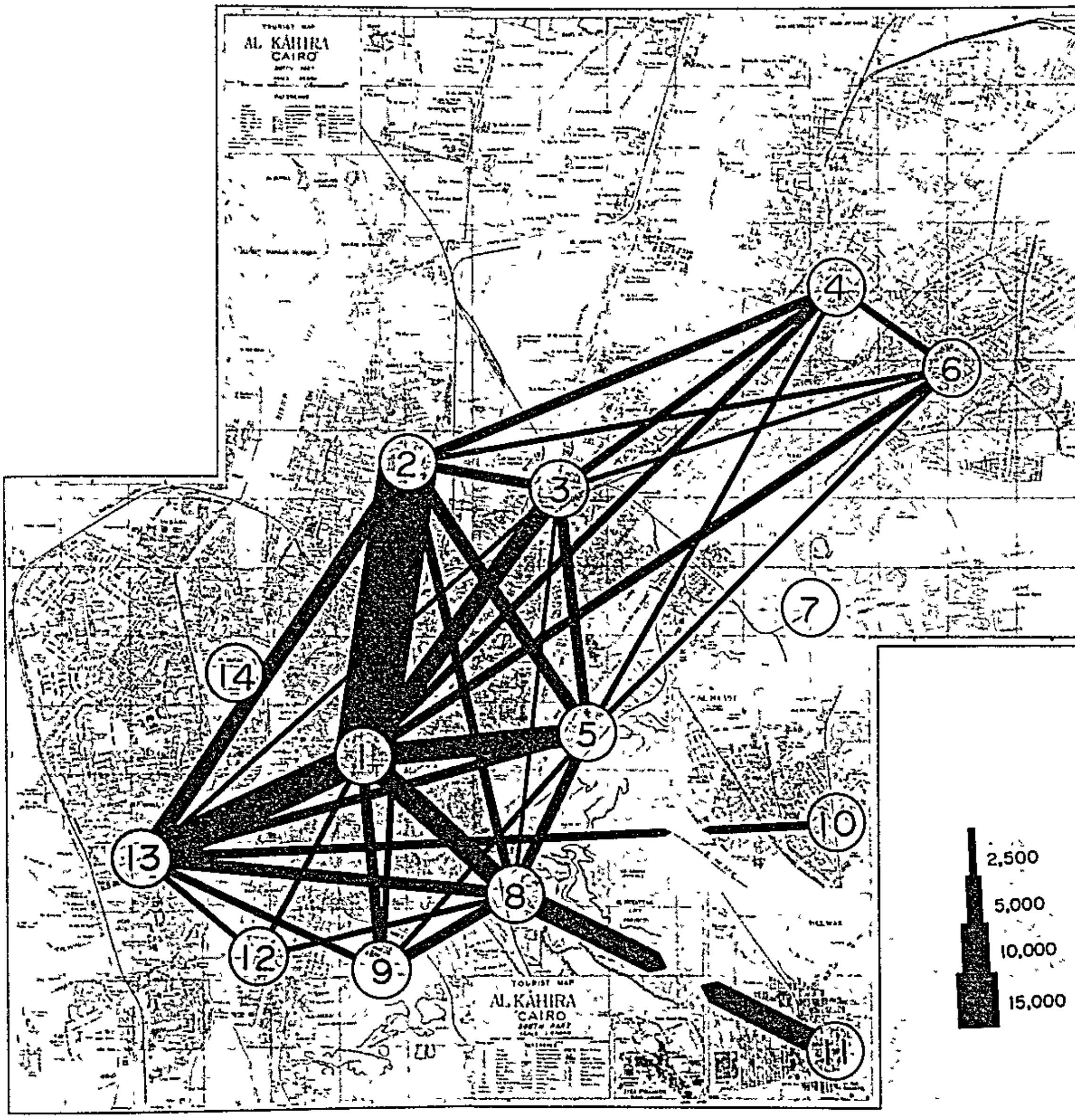


Fig. 4—8　Future Desire Line Chart

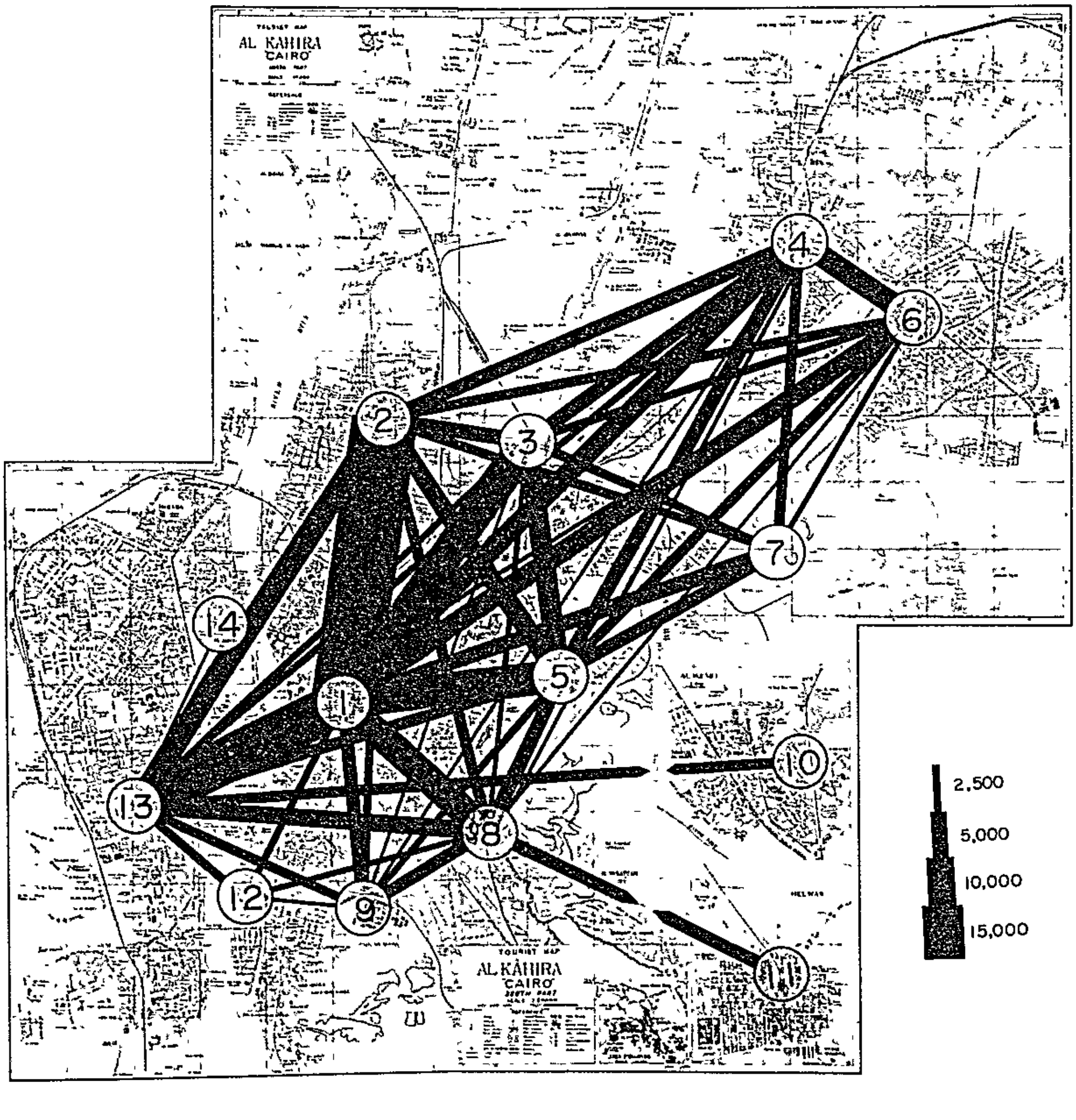


Fig. 4—9 Correlation between Population and Traffic Generation and Its Transition

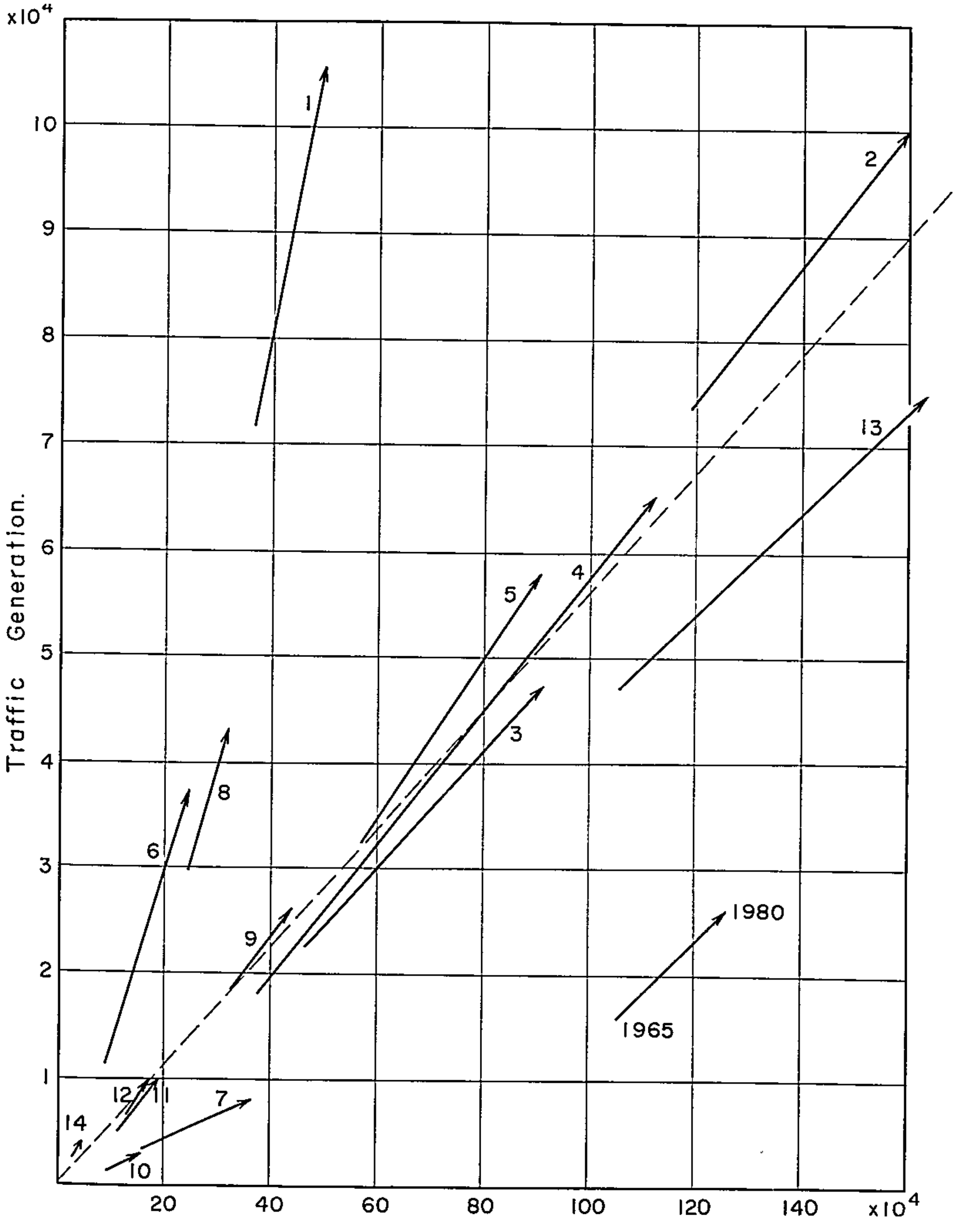


Fig. 5-1   Plan of Proposed Arterial Street Network

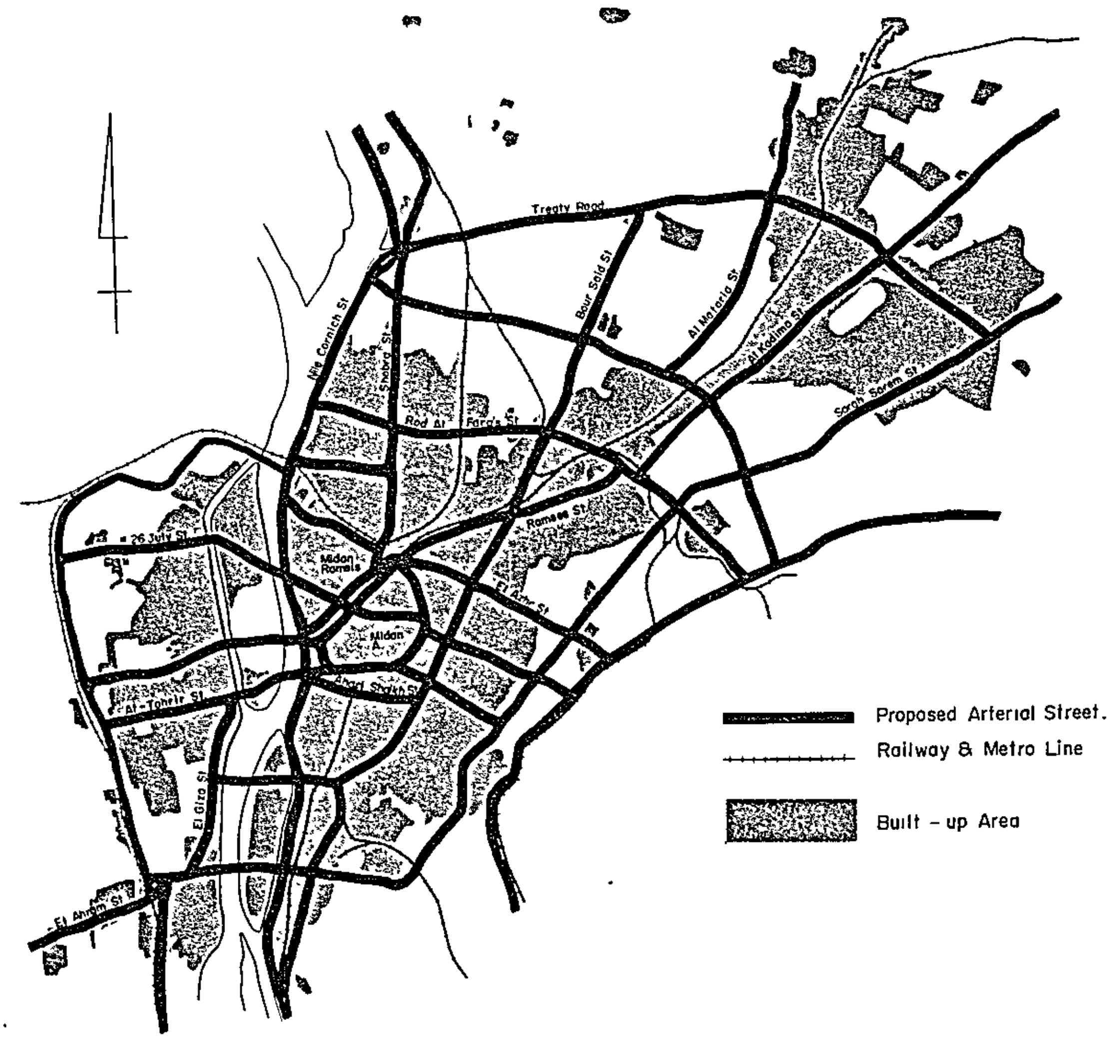


Fig. 6—1 Network of Underground Railways in Tokyo

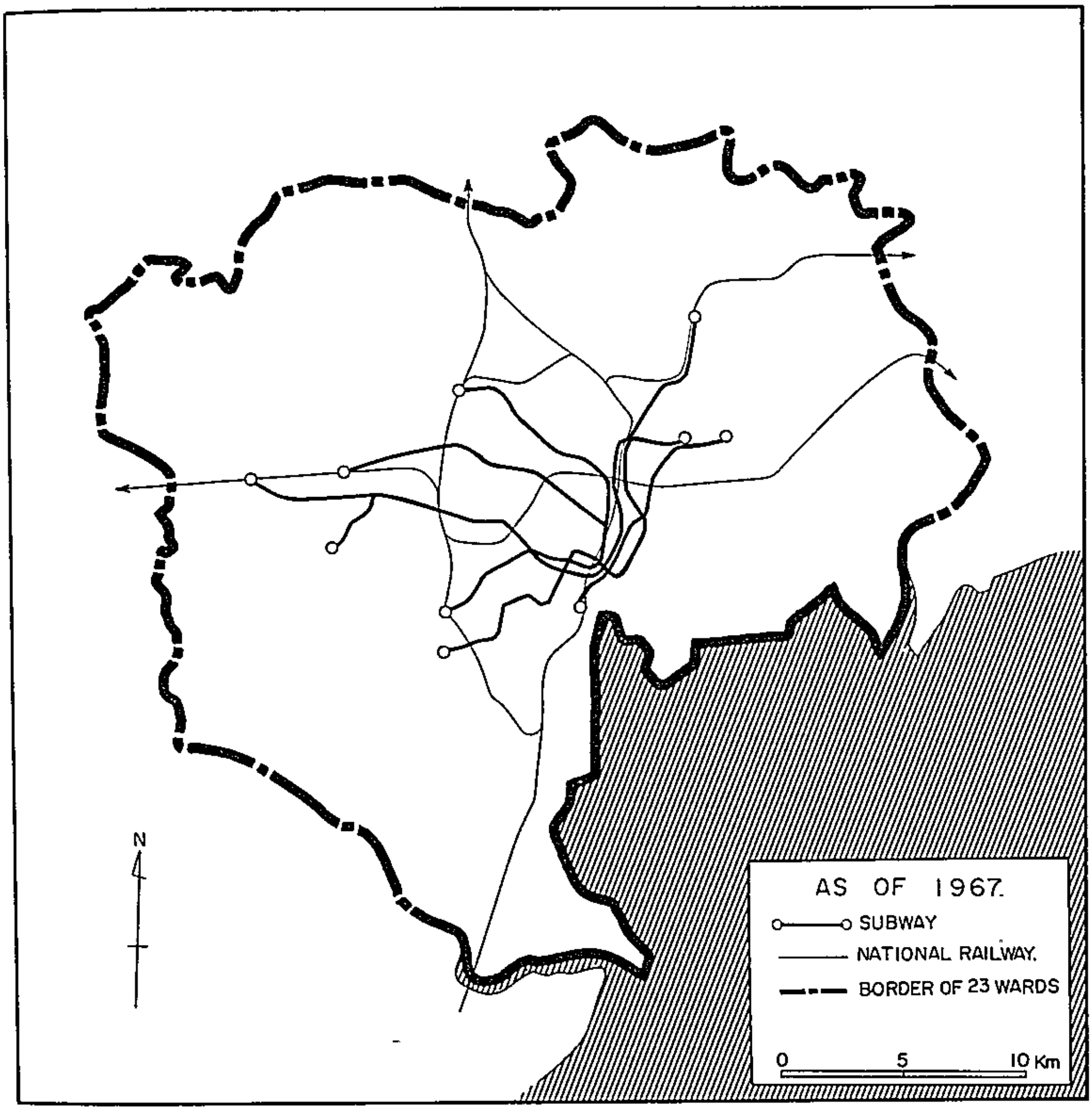


Fig. 6—2 Present Pattern of Traffic Flow

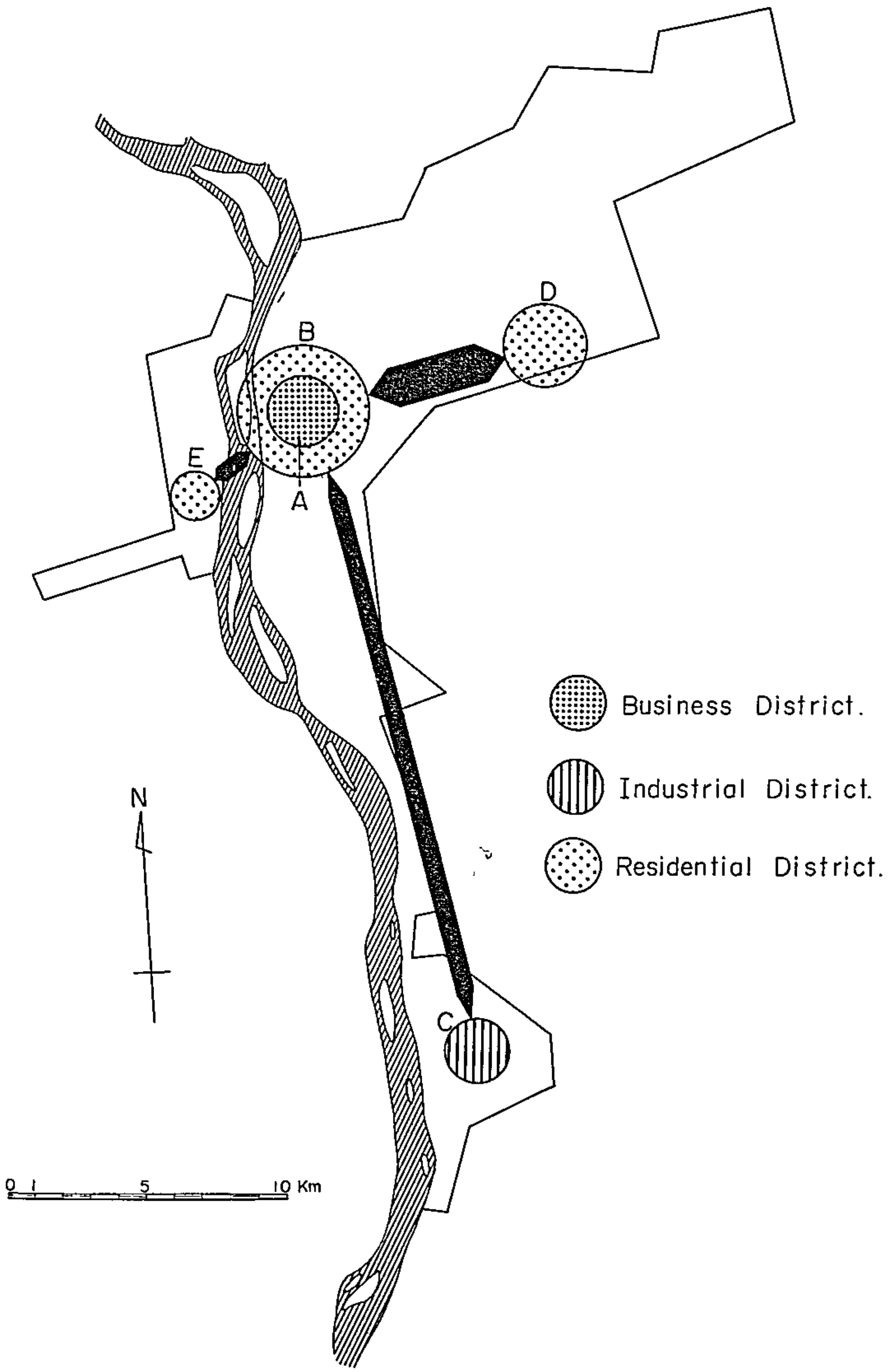


Fig. 6—3 Business and Industrial Districts in Future

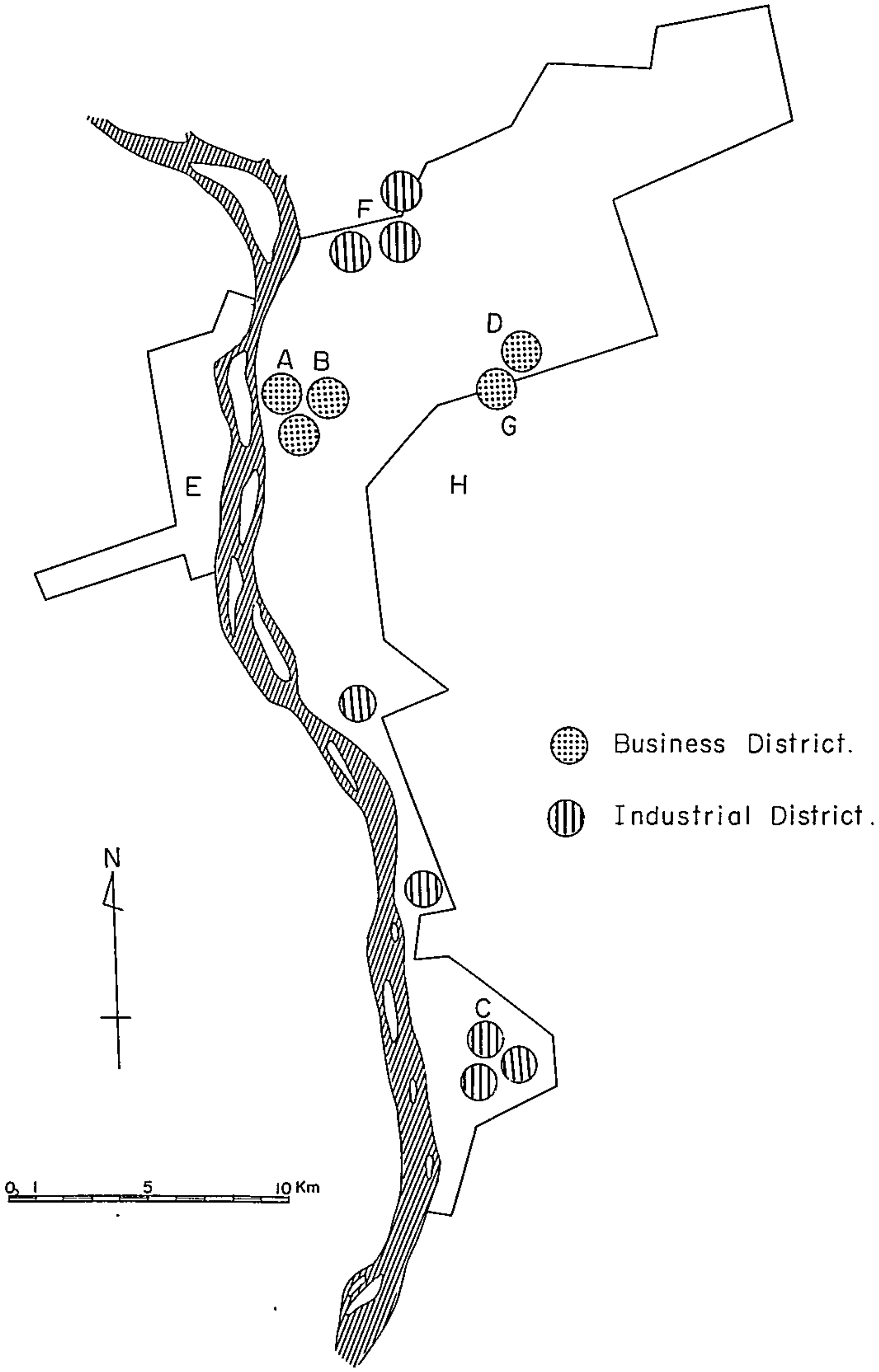


Fig. 6—4 Future Pattern of Traffic Flow

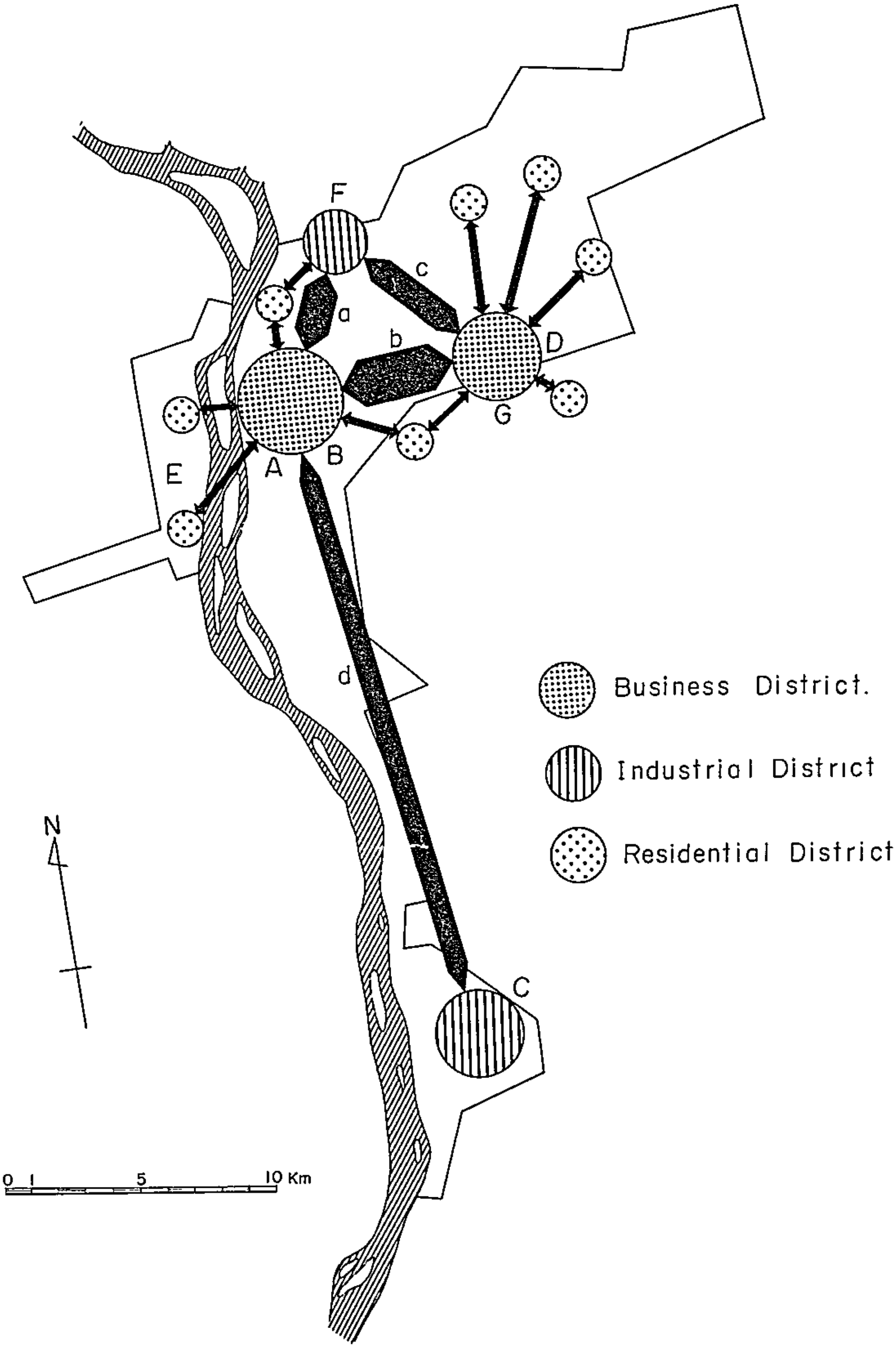


Fig. 6-5 Alternative Plans for Underground Railway Network

Plan A

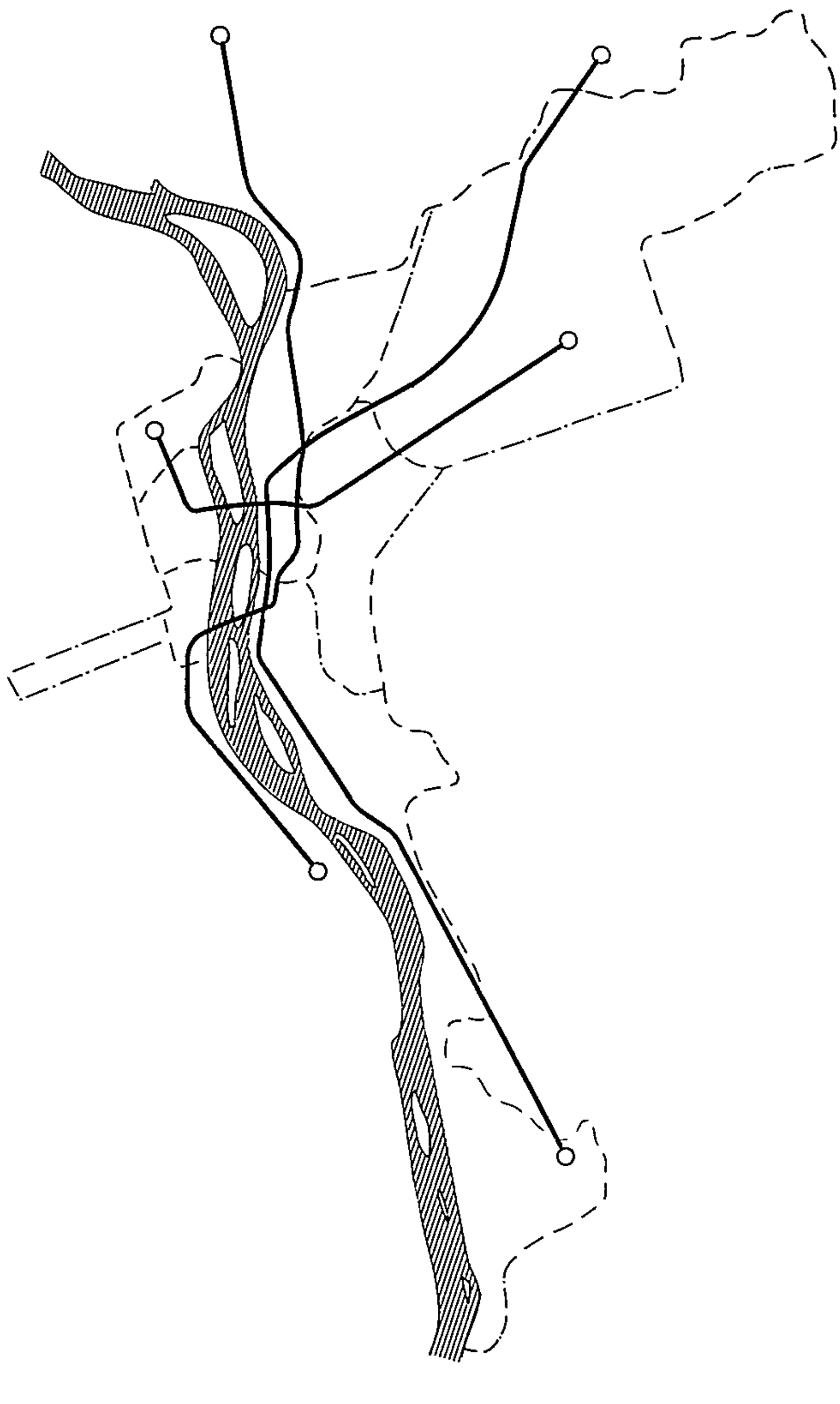


Fig. 6-6 Alternative Plans for Underground Railway Network

Plan B

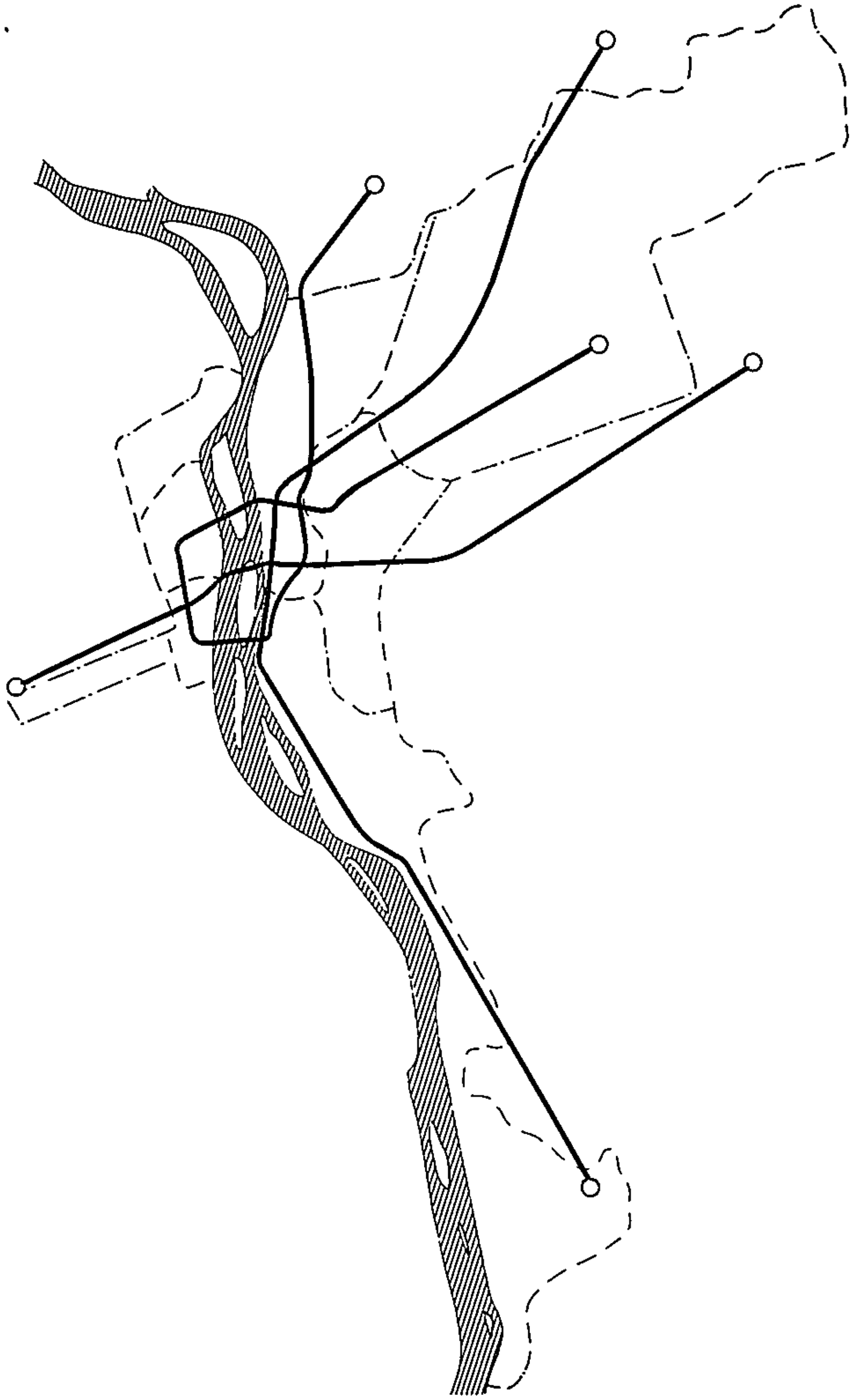


Fig. 6—7 Alternative Plans for Underground Railway Network

Plan C

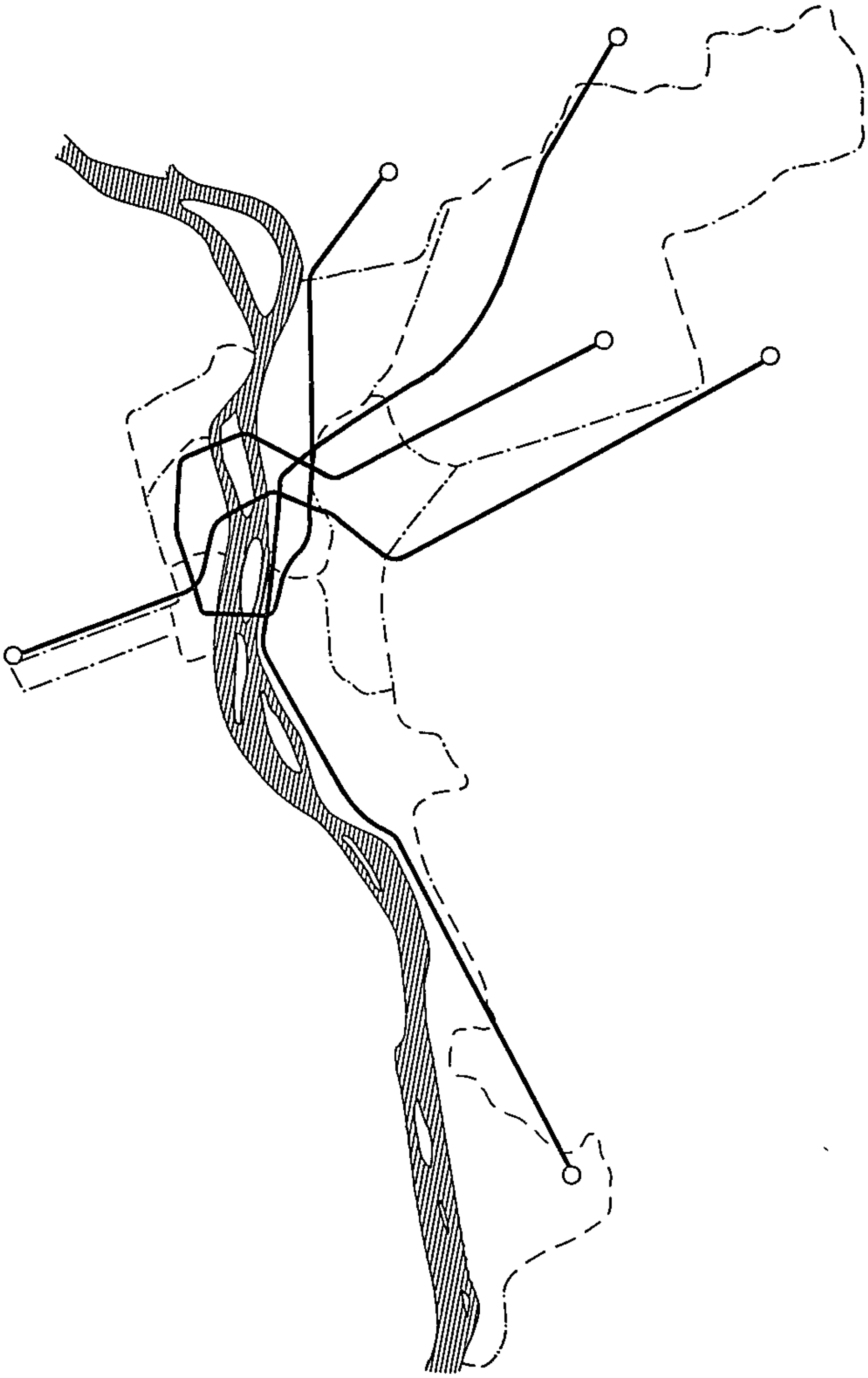


Fig. 6—8 Alternative Plans for Underground Railway Network

Plan D

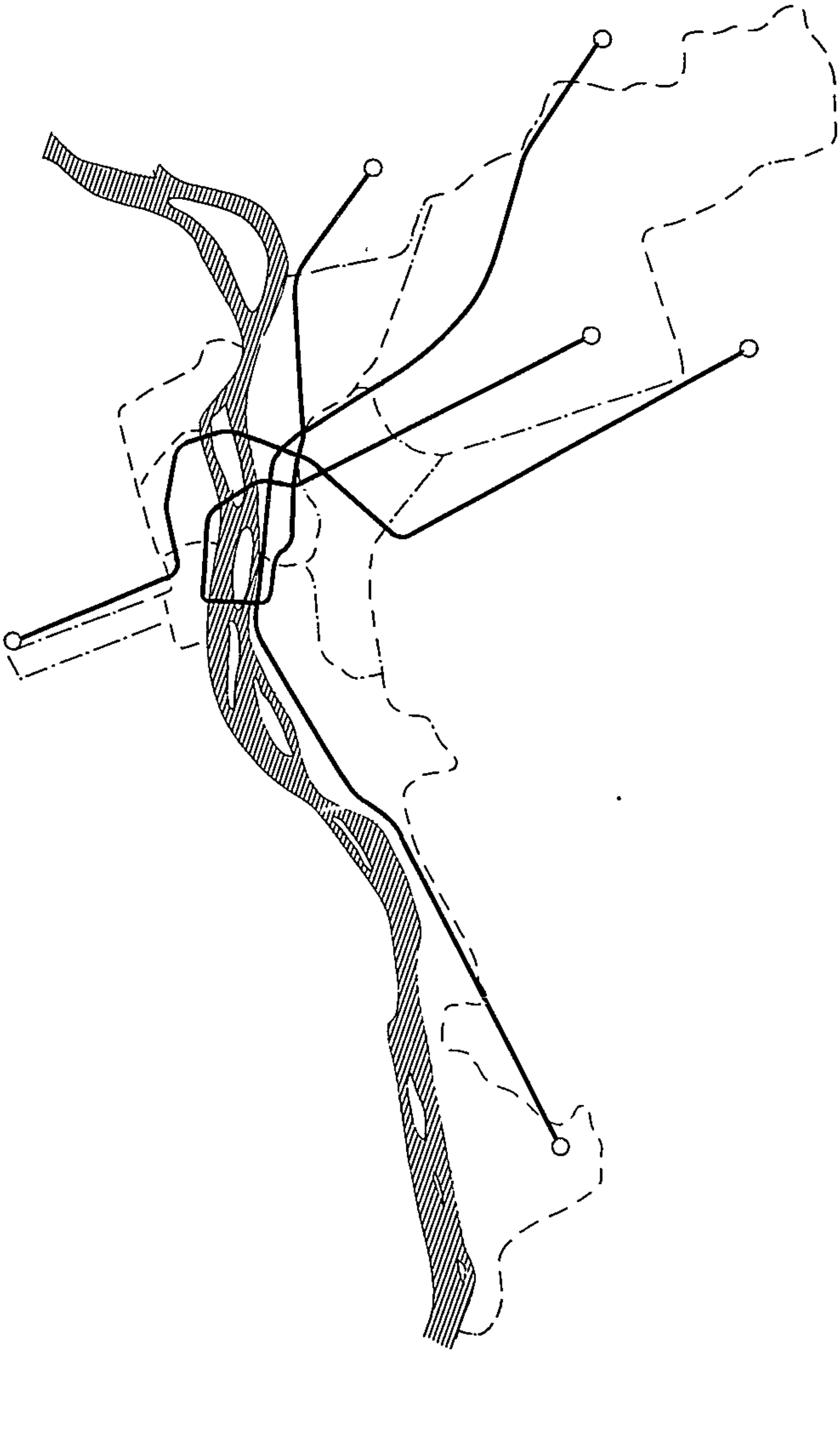


Fig. 6-9 Alternative Plans for Underground Railway Network

Plan E

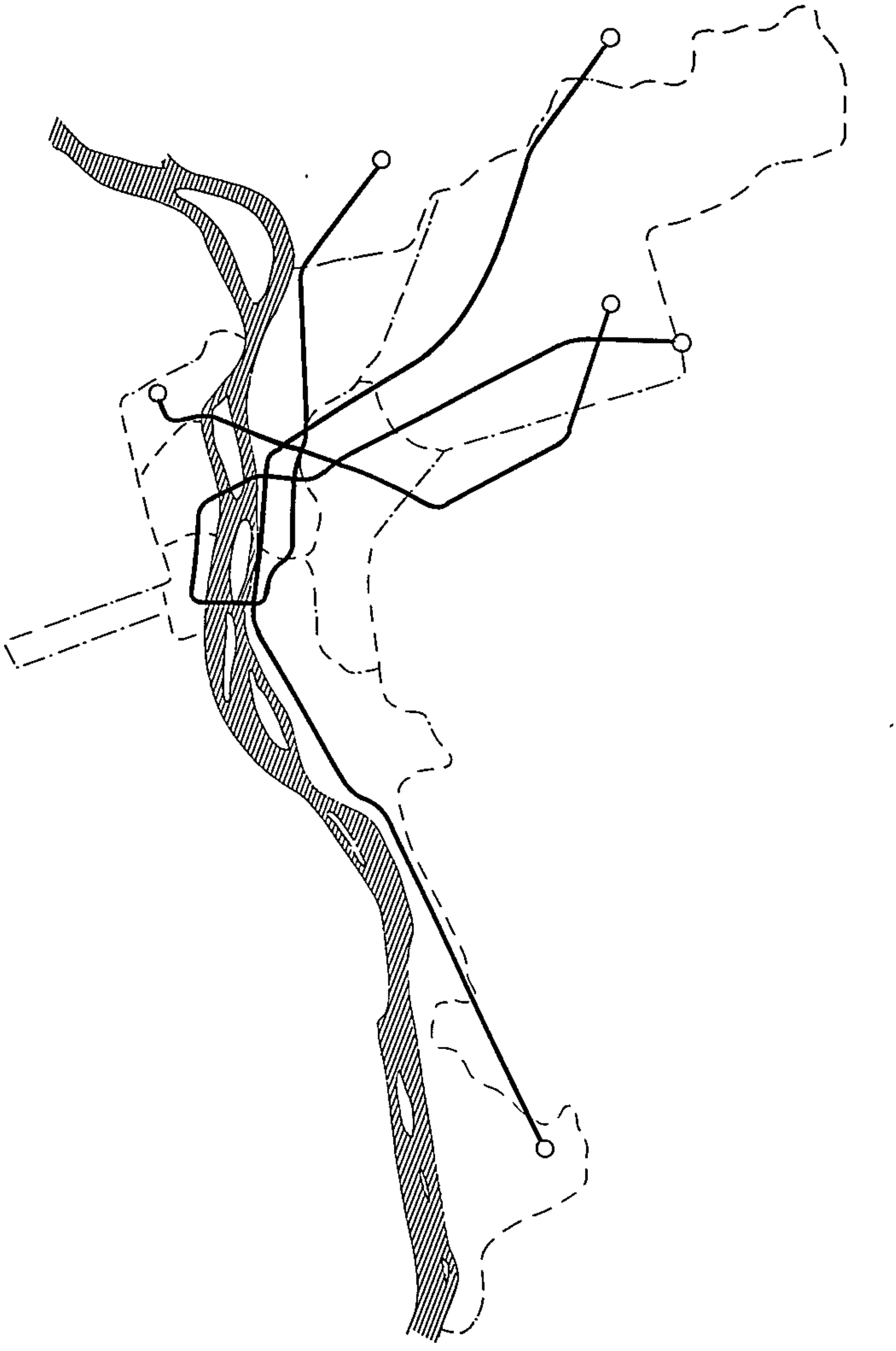


Fig. 6-10 Alternative Plans for Underground Railway Network

Plan F

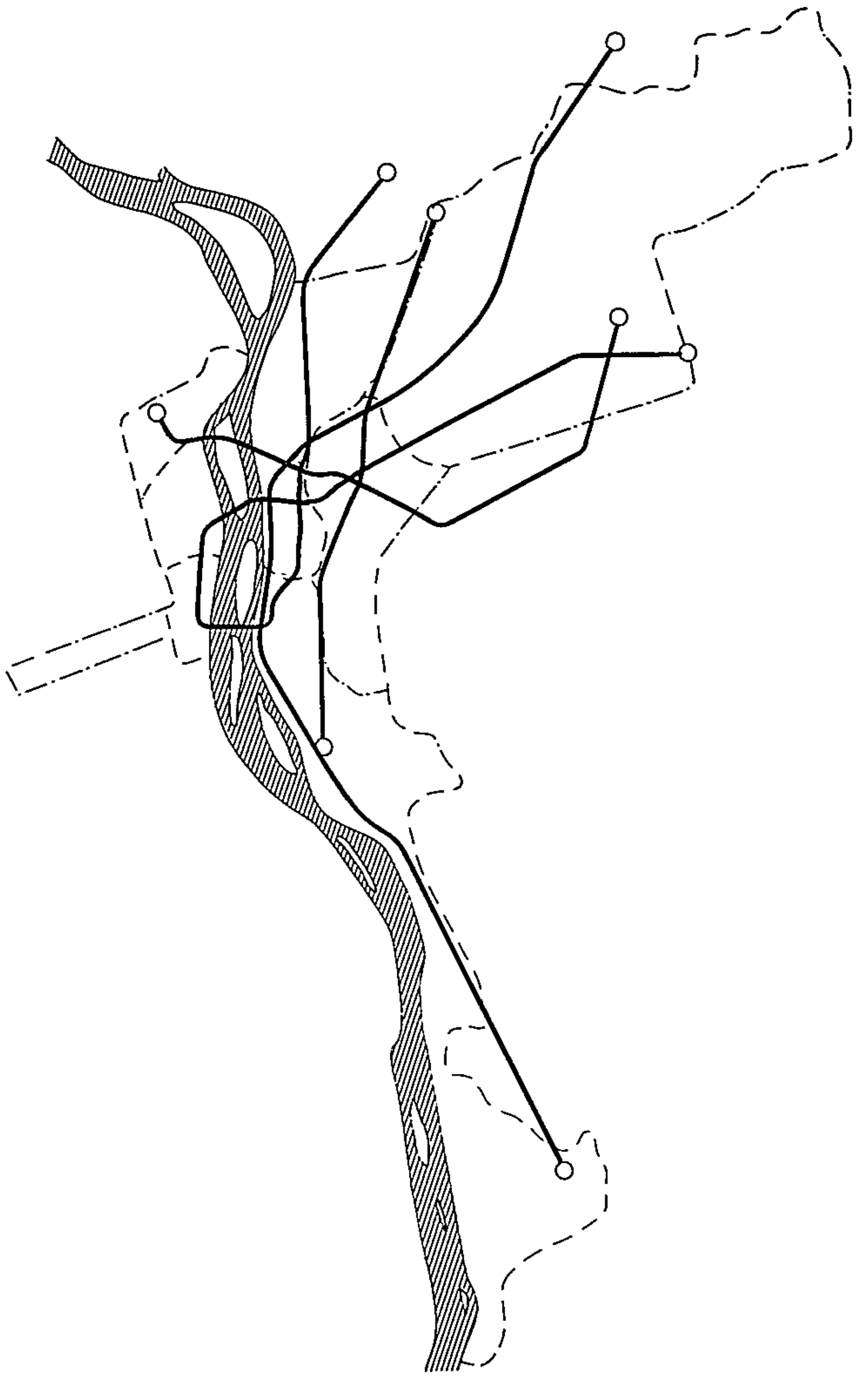


Fig. 6-11 Proposed Master Plan

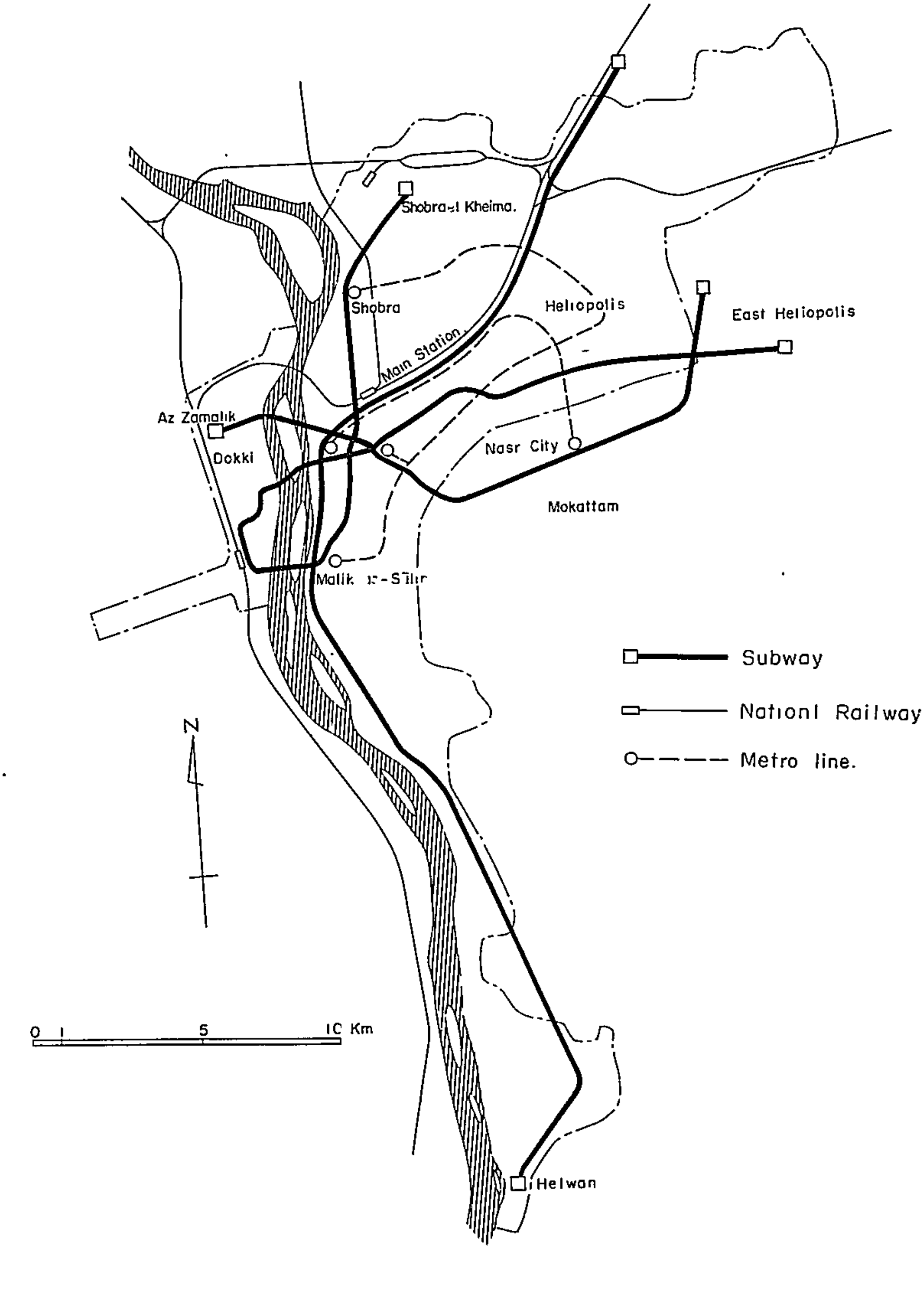


Fig. 7-1 Plan of Proposed Line

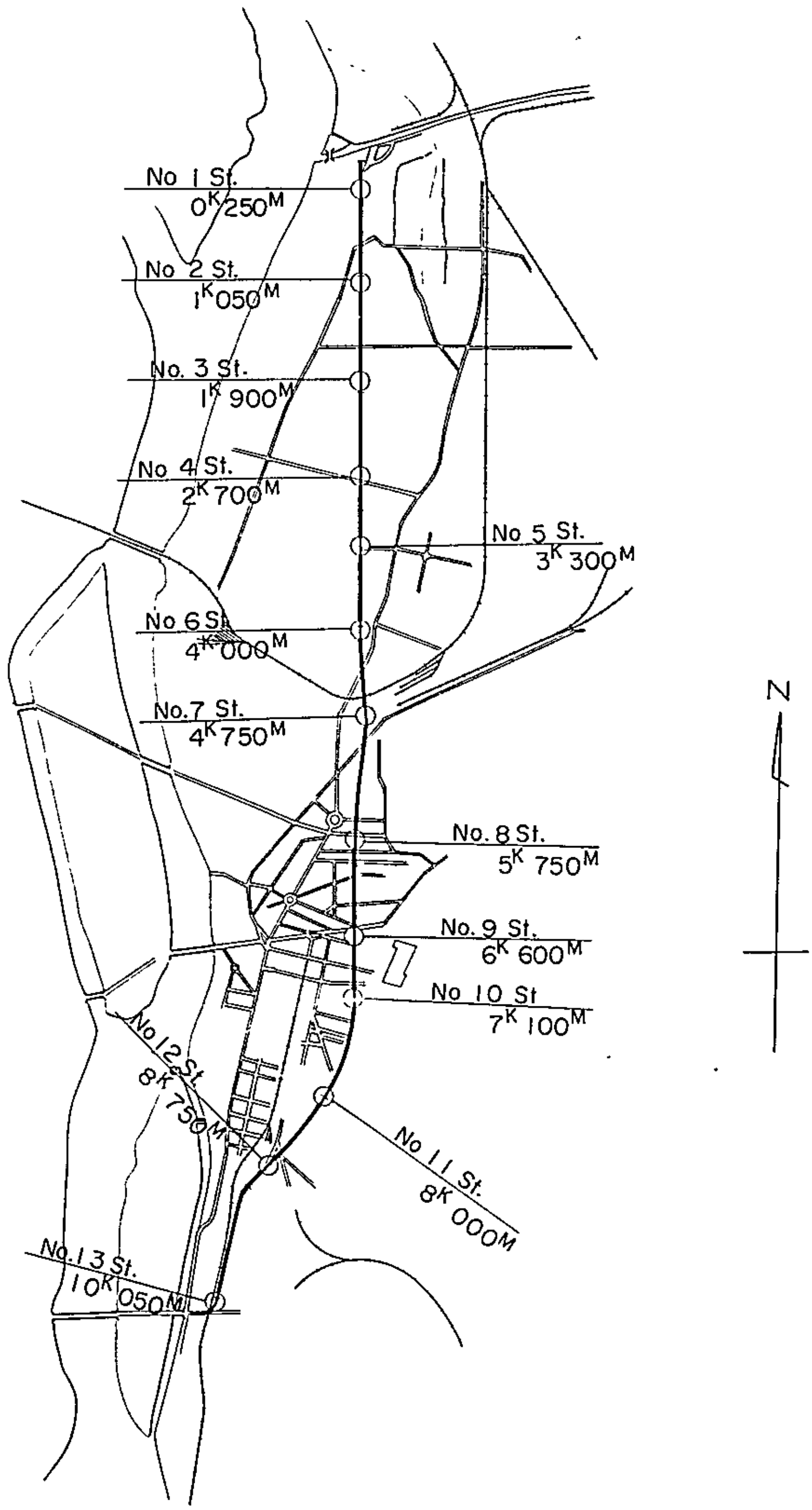


Fig. 7—2 Estimated Transportation Volume of the Proposed Line
(Based on the Population along the North-South Line)

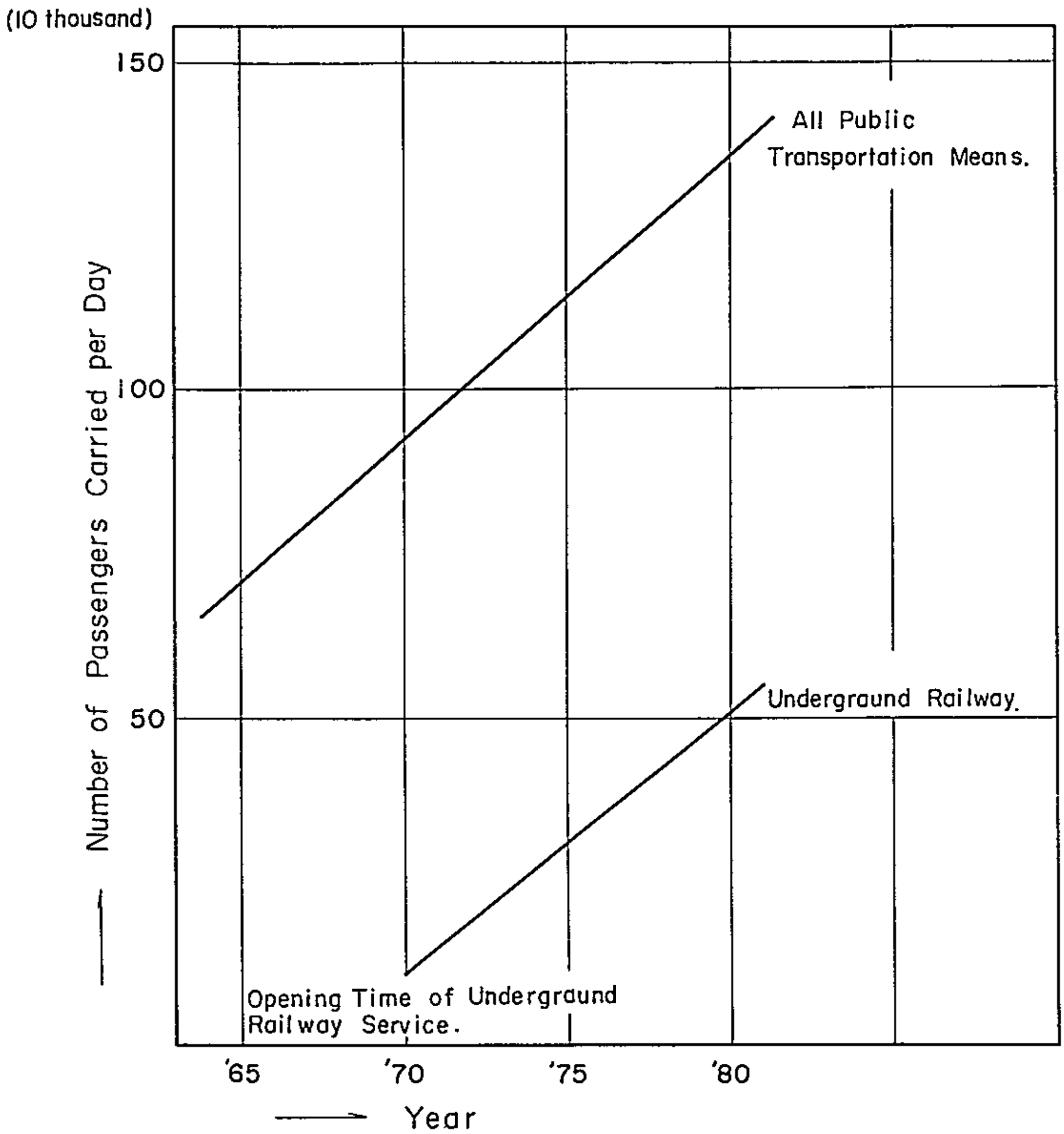
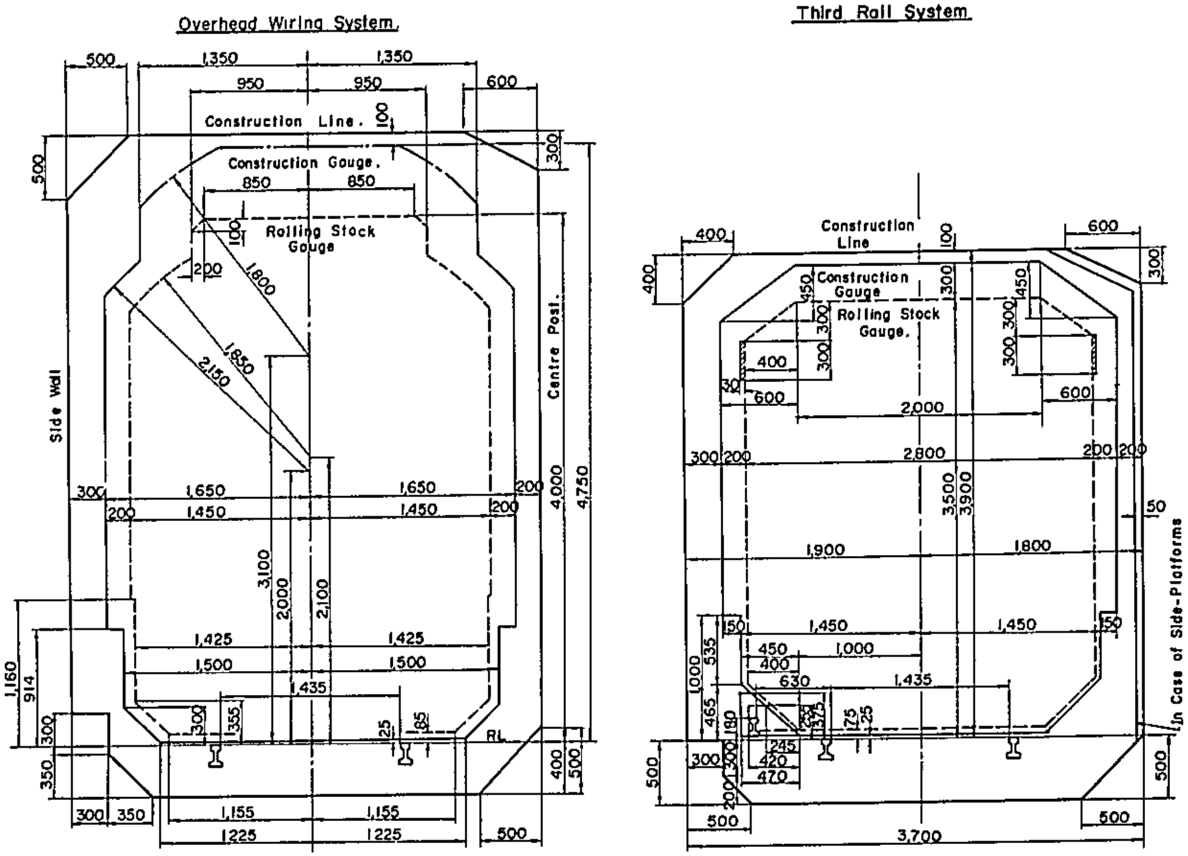


Fig. 7−3 Construction Gauge and Rolling Stock Gauge



* Note; ▨ Indicates Side Lamps

Fig. 7−4 General Plan of Station (Type I)

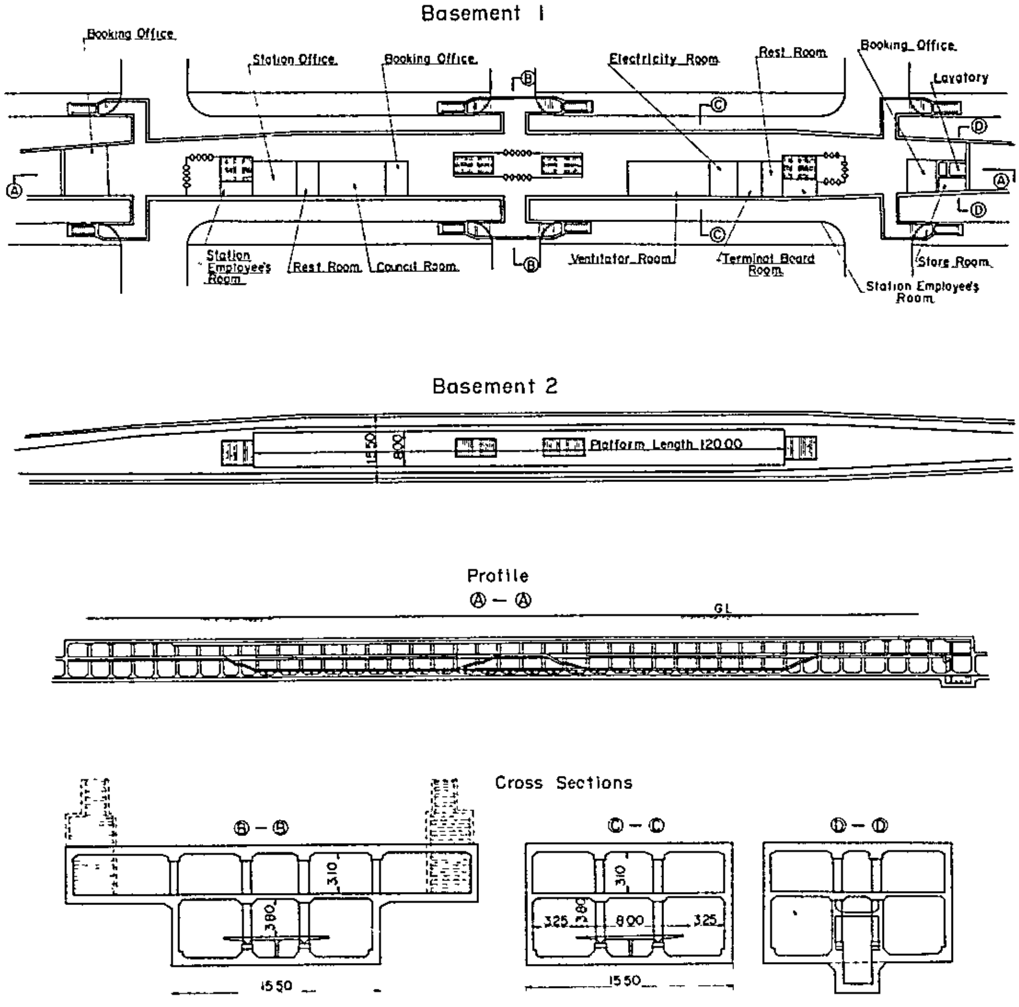
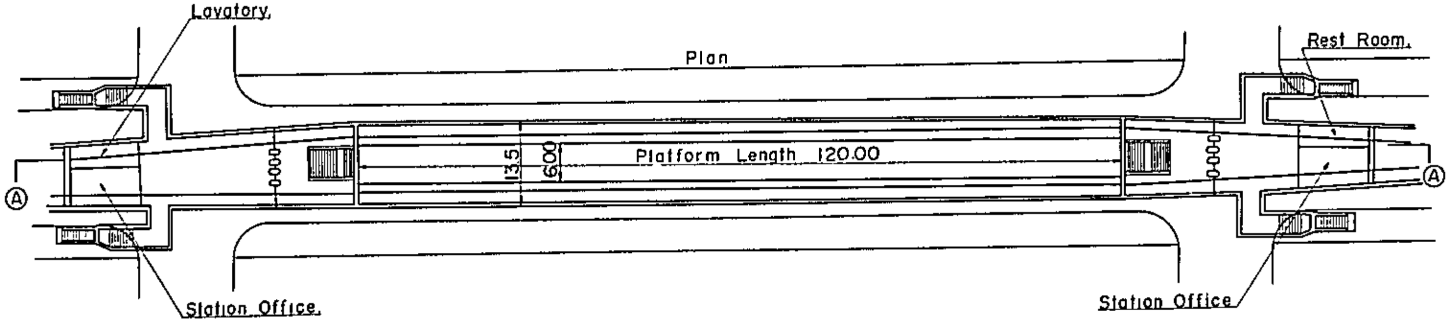
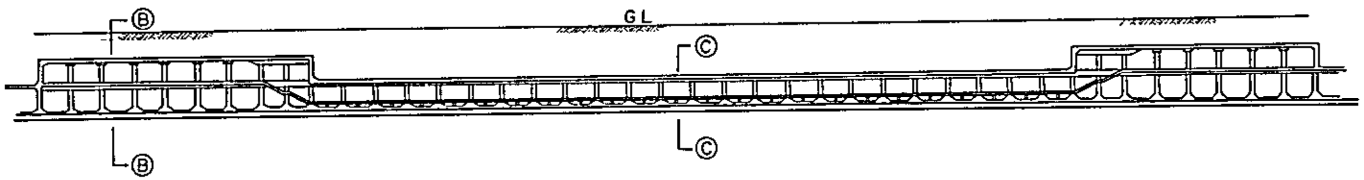


Fig. 7—5 General Plan of Station (Type II)

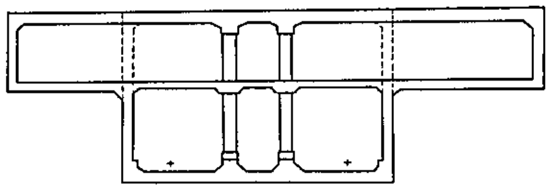


Profile
Ⓐ — Ⓐ



Cross Sections

Ⓑ - Ⓑ



Ⓒ - Ⓒ

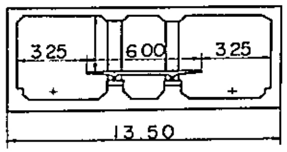


Fig. 7−6 General Plan of Station (Type III)

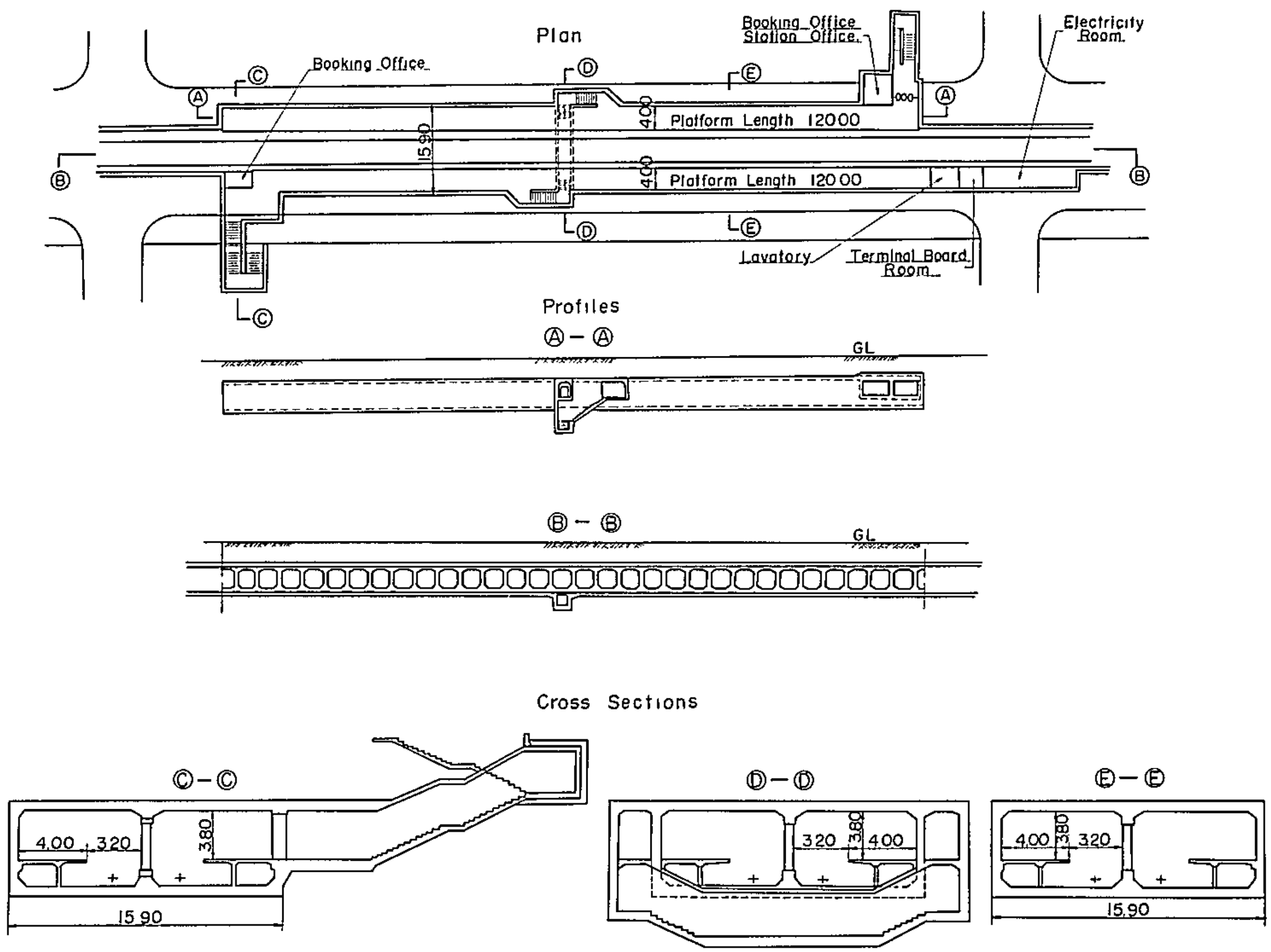
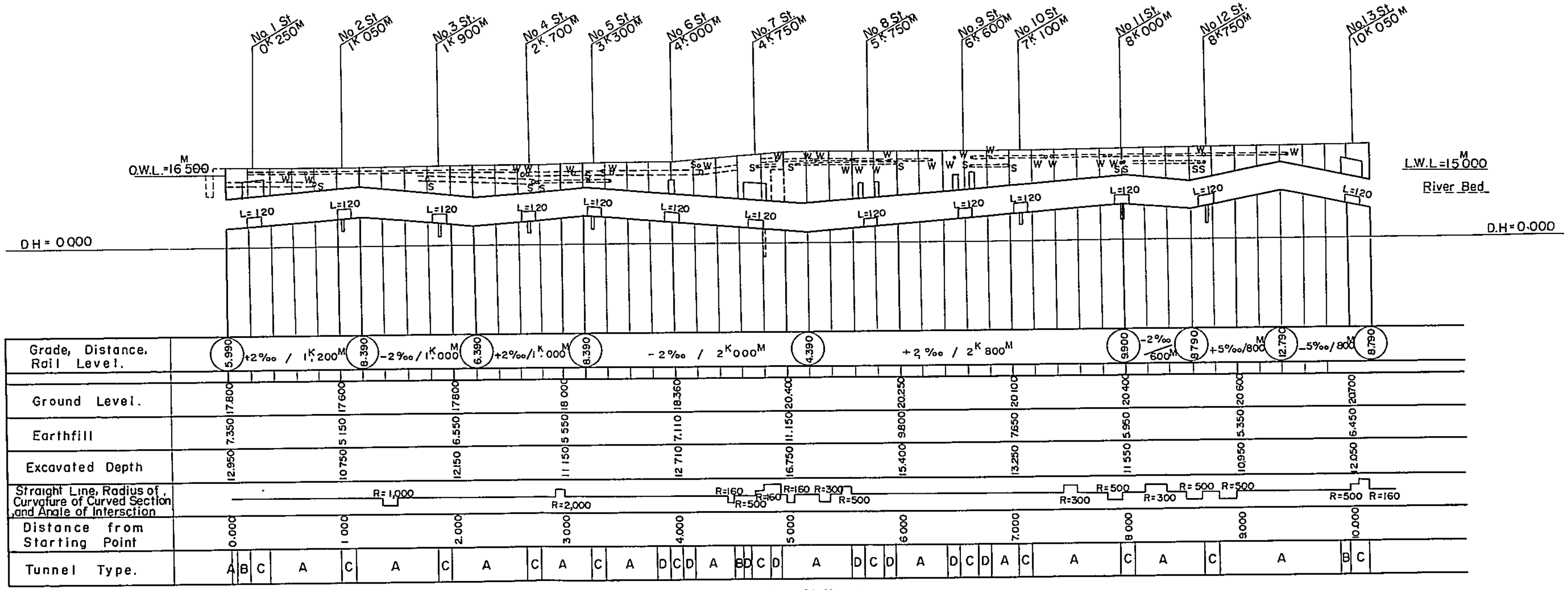


Fig. 7−7 Profile of the Proposed Route



A ; Double track type. C ; Station type.
B ; Crossover type. D ; Connection type.

Fig. 7—8 Deviation of Construction Gauge with Cant

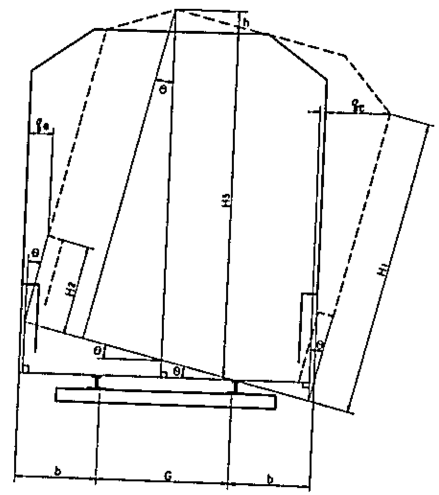


Fig. 7—9 Layout of Track to Car Shed

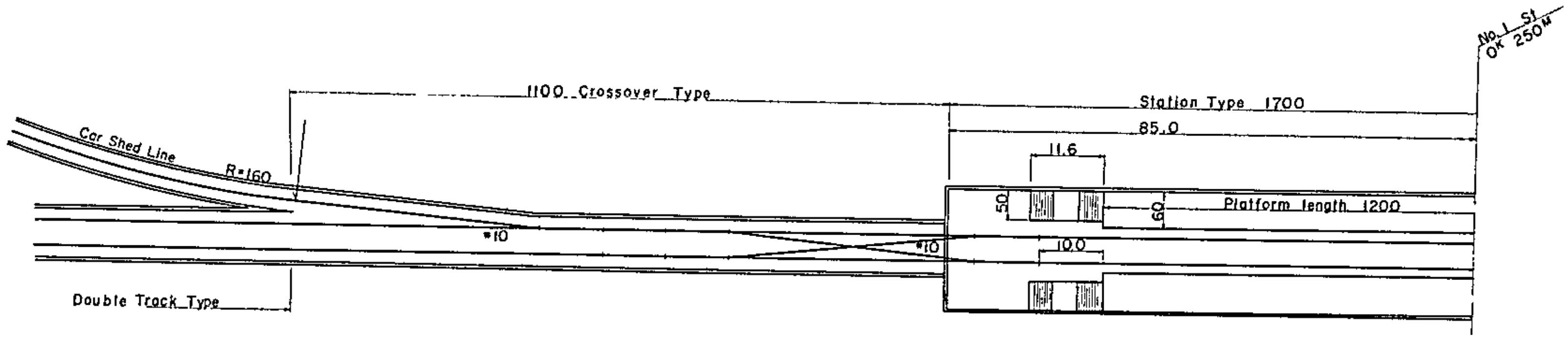


Fig. 7—10 Cross Section at Individual Points

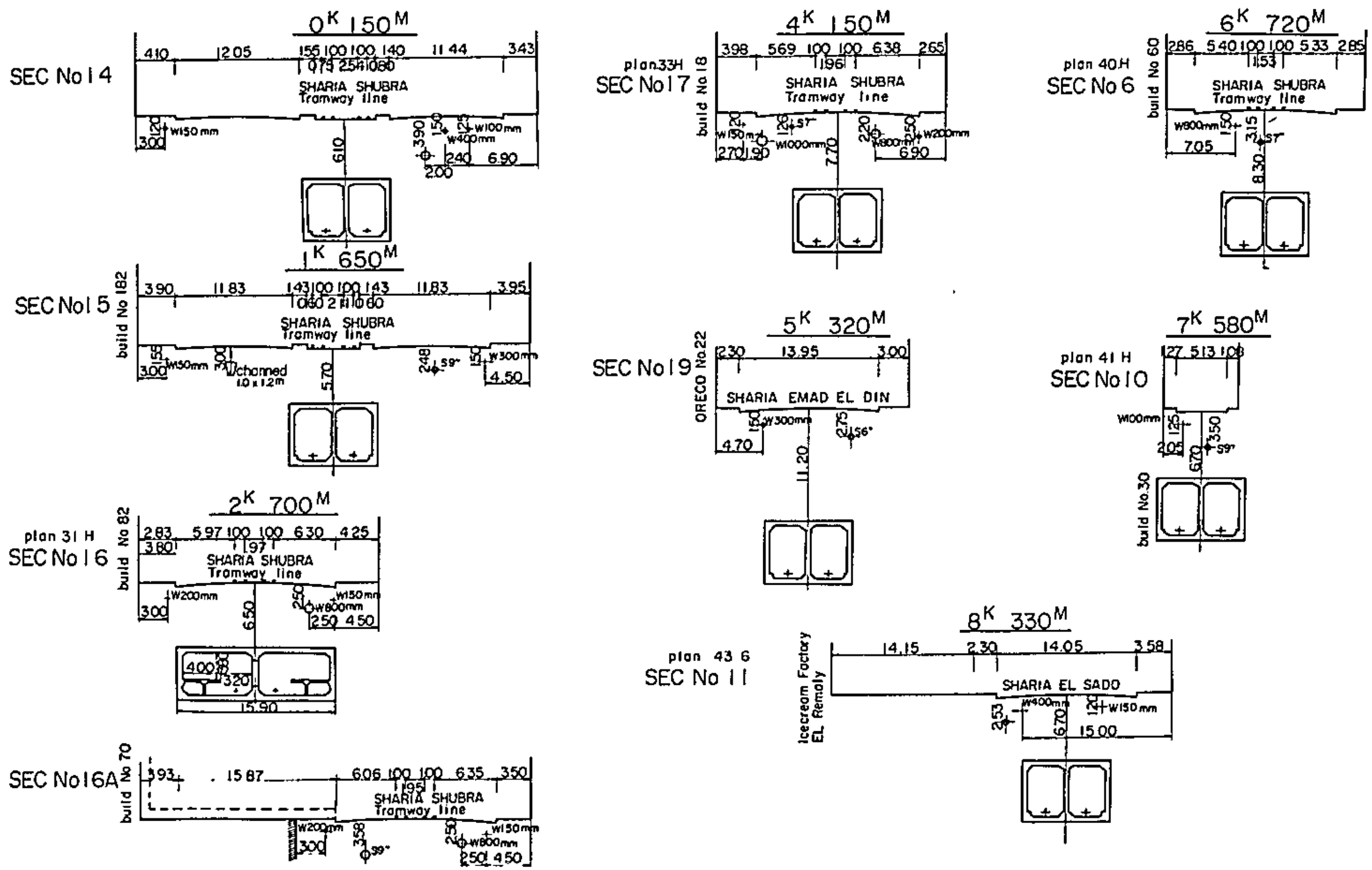
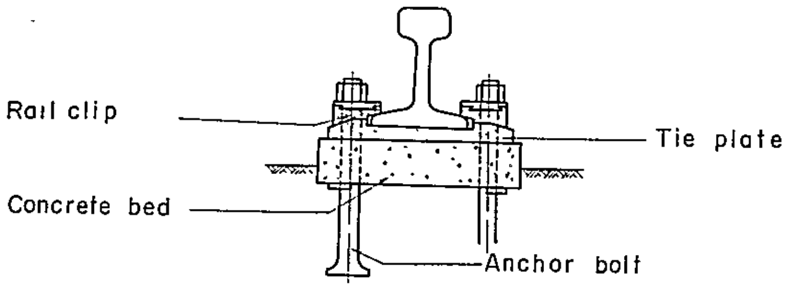


Fig. 7—11　Cross Section of Concrete Roadbed without Sleepers

Illustration of Rail Fastening.



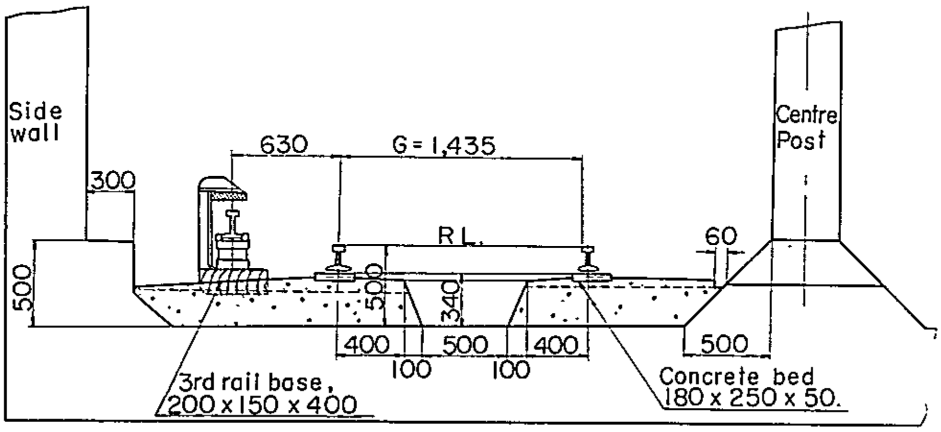


Fig. 7—12 Typical Excavation Method

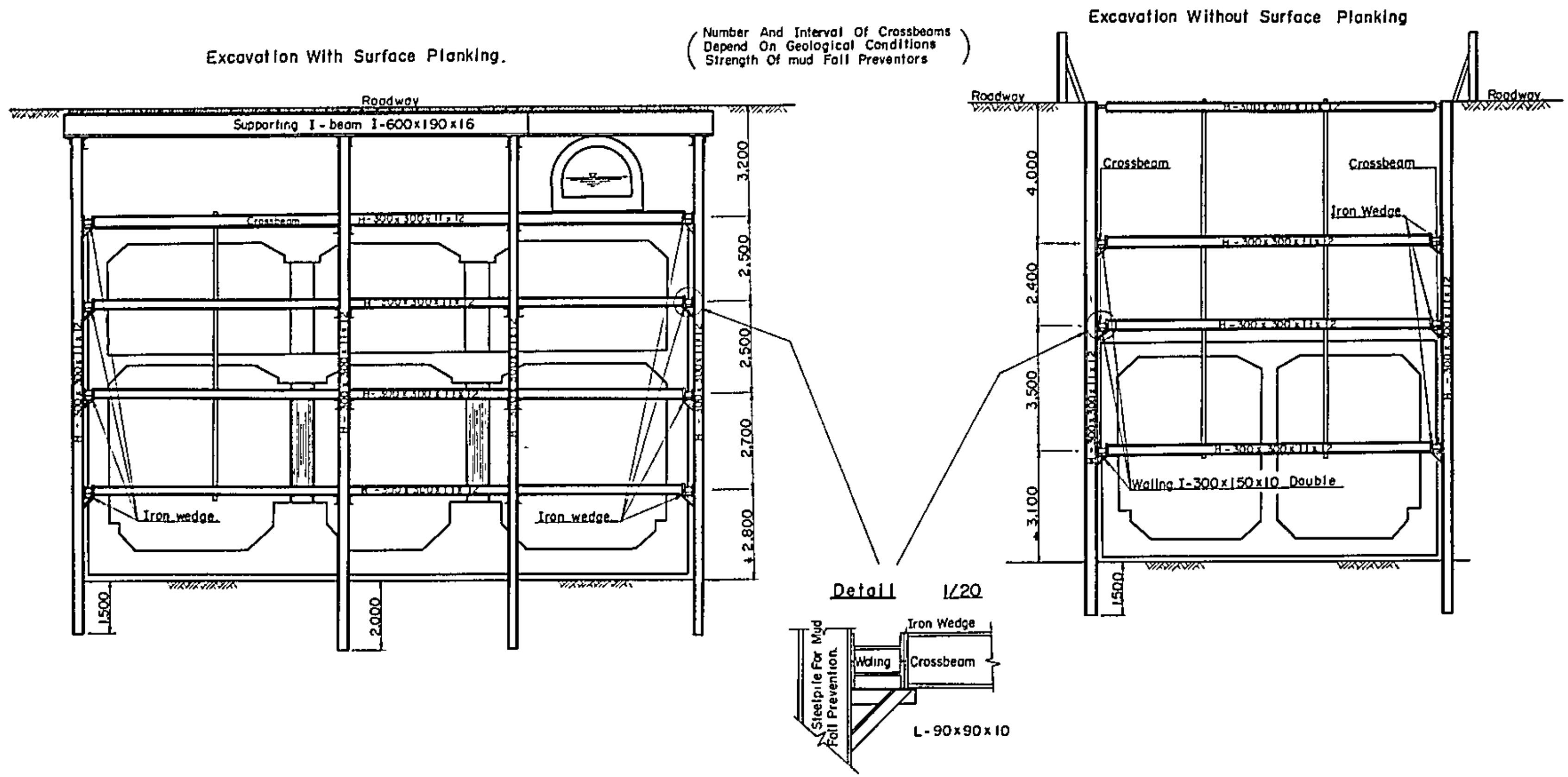


Fig. 7—13 Boring at Different Points of Cairo City

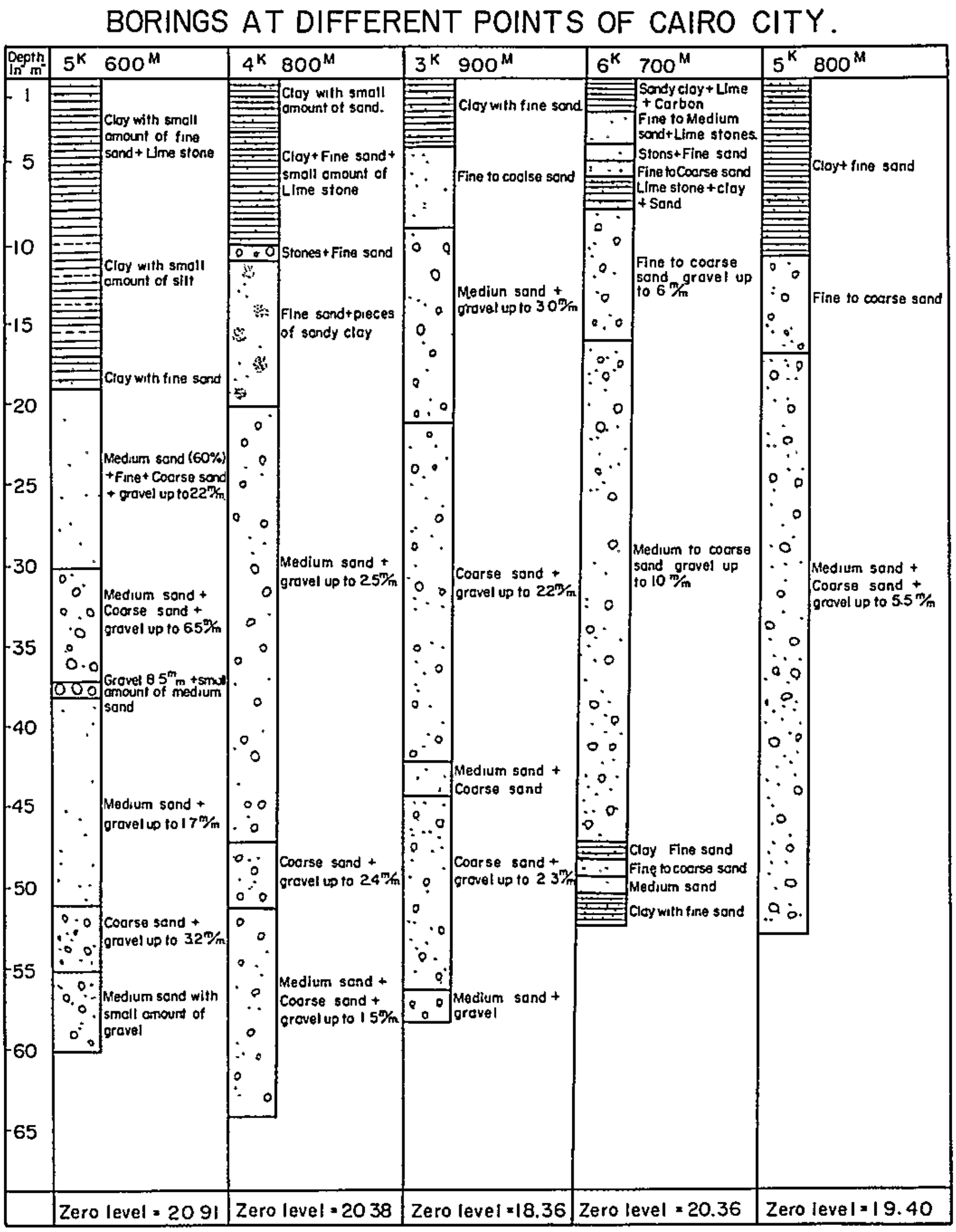
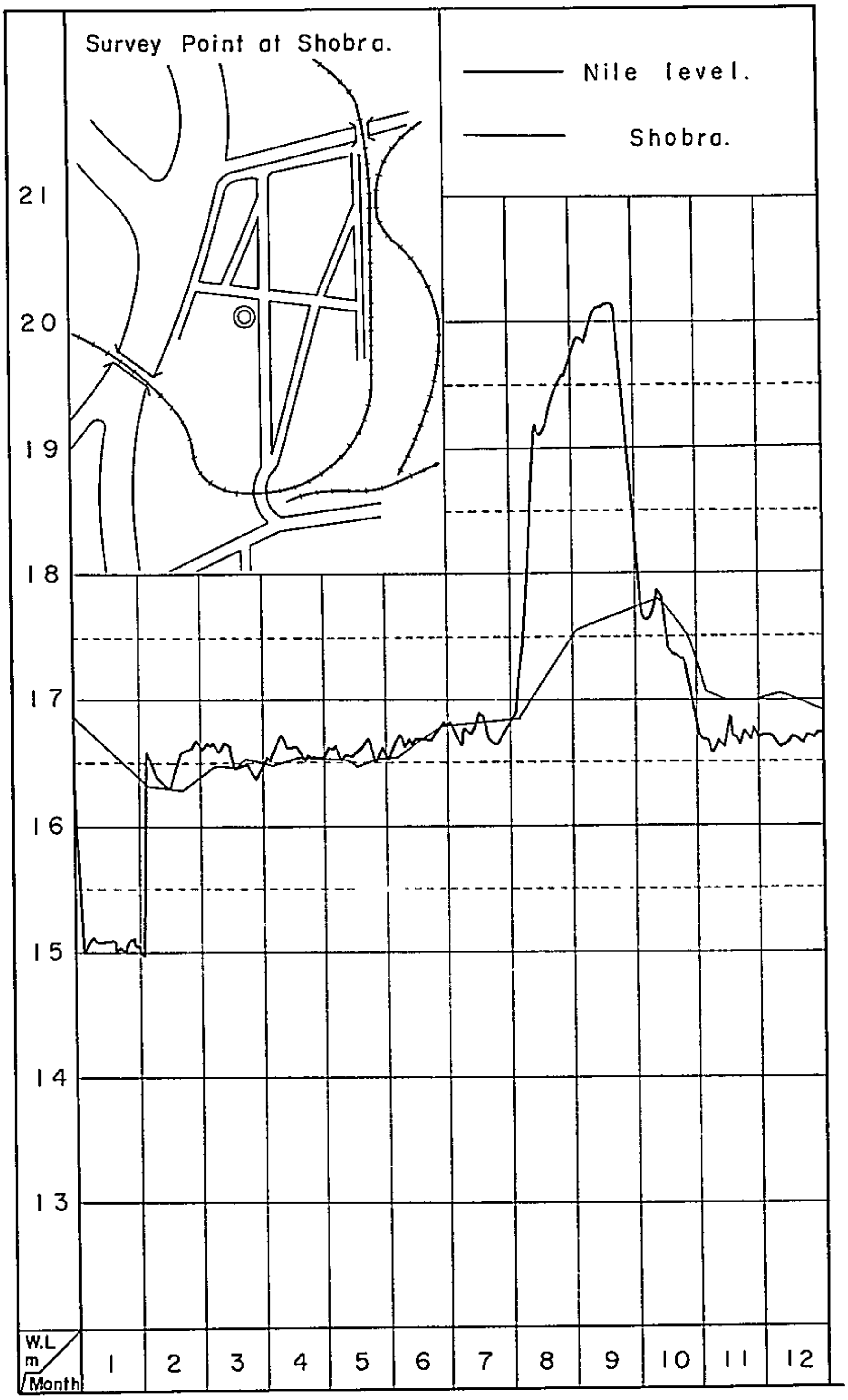


Fig. 7－14 Water Level of the Nile and Underground Water Level in Shubra District



(1963)

Fig. 7—15 Electric Car for the Underground Railway

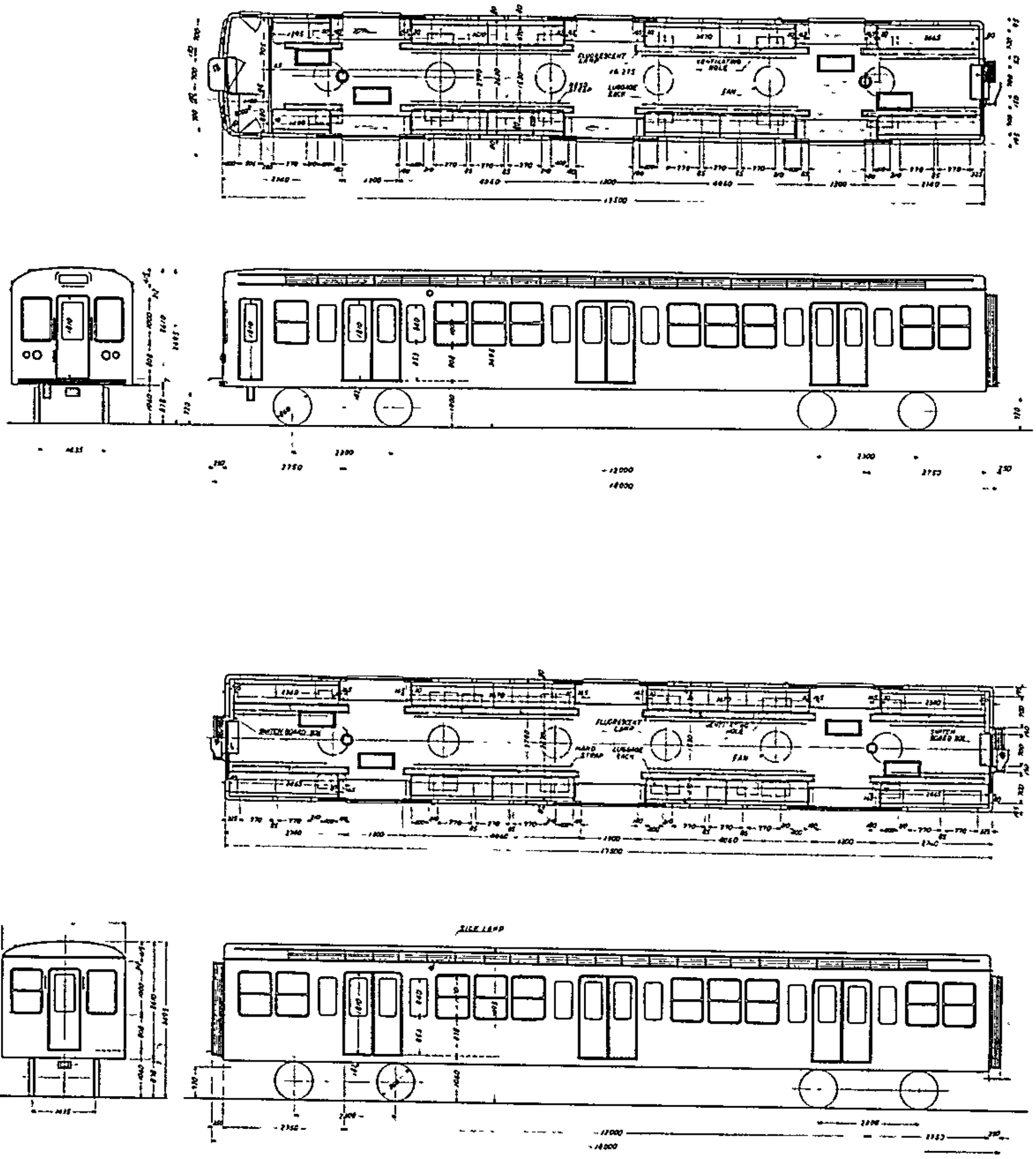


Fig. 7—16 Interior View of the Car

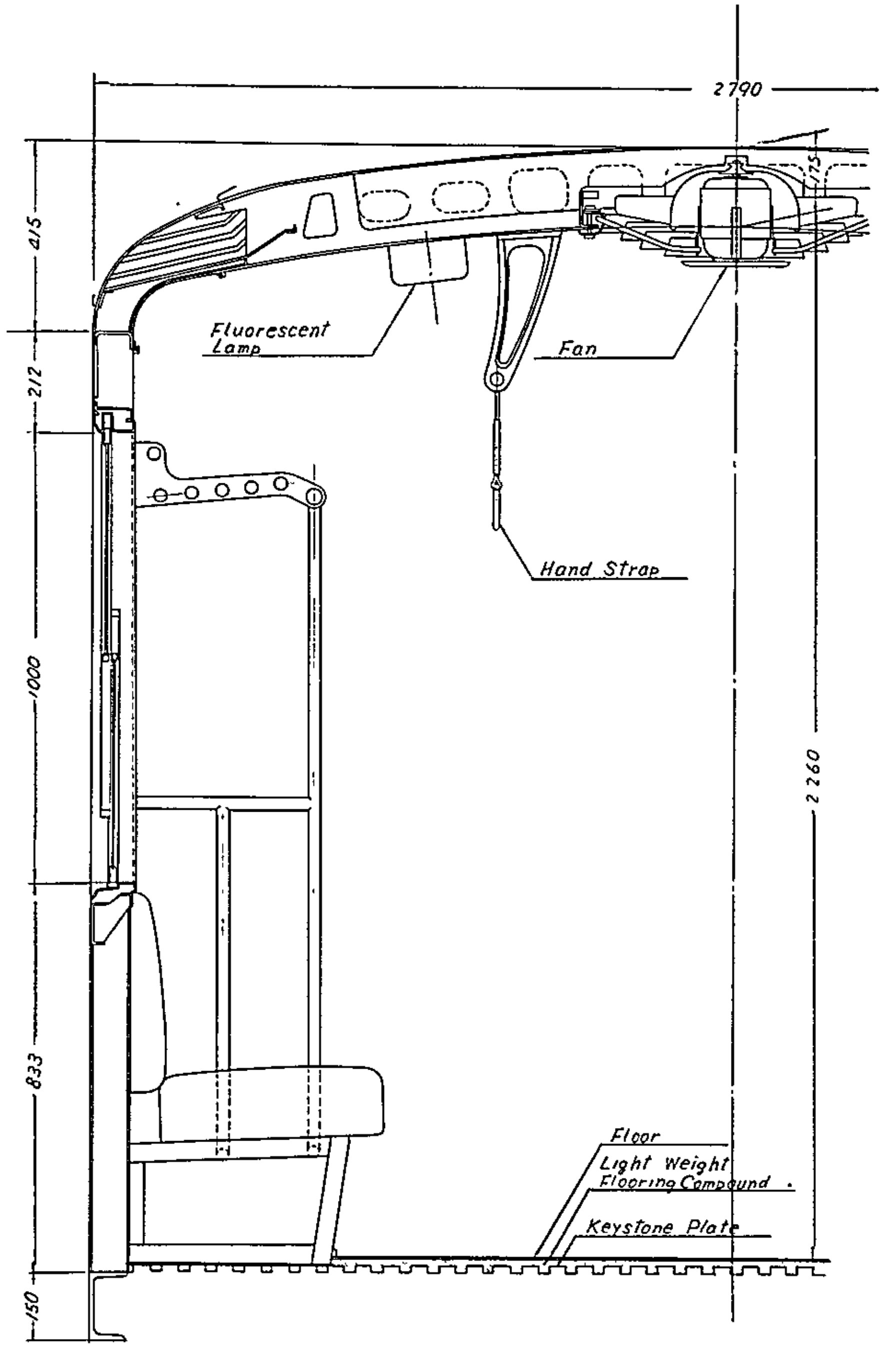


Fig. 7−17 Bogie for the Underground Railway

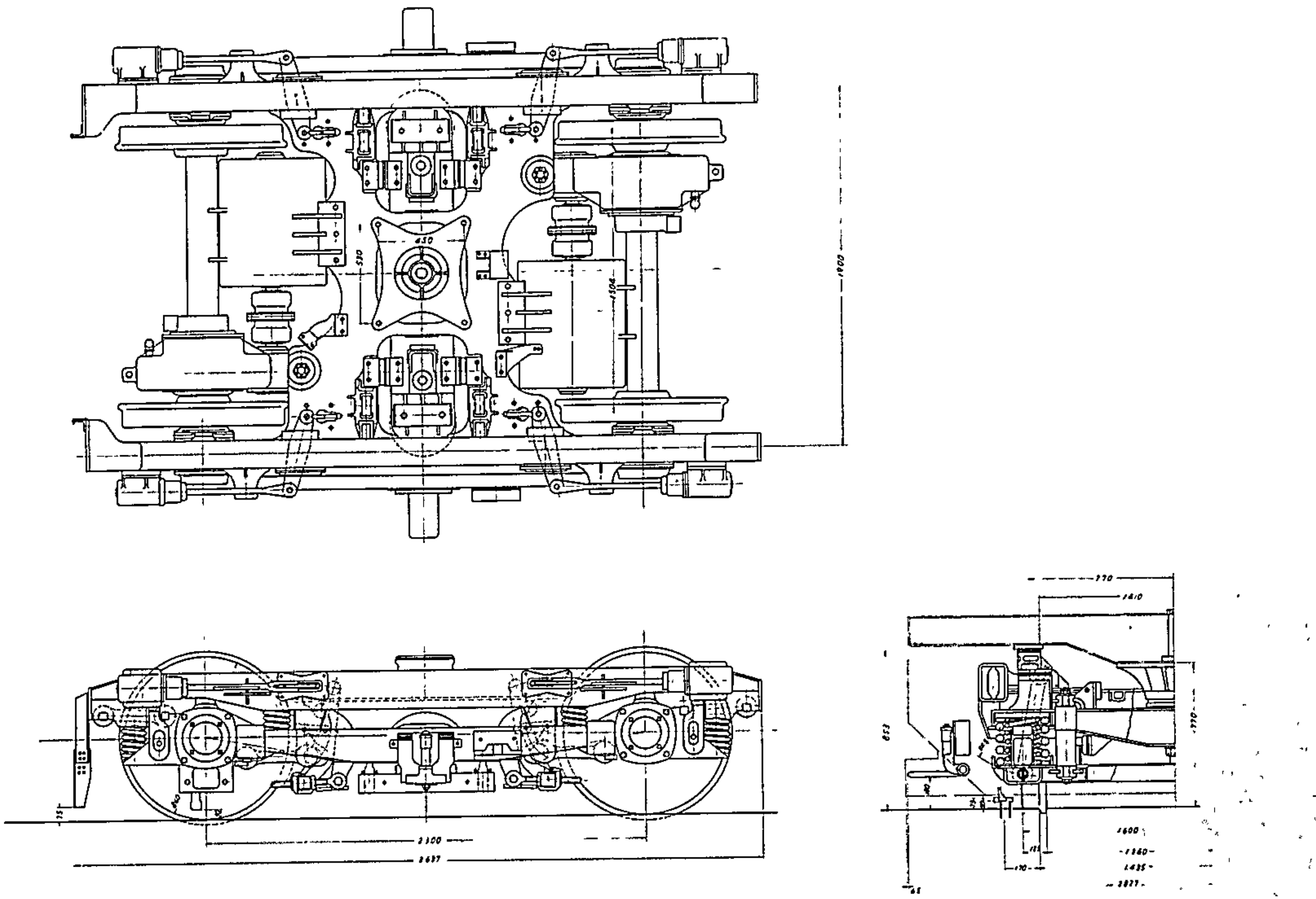


Fig. 7—18 Outline Drawing for Traction Motor

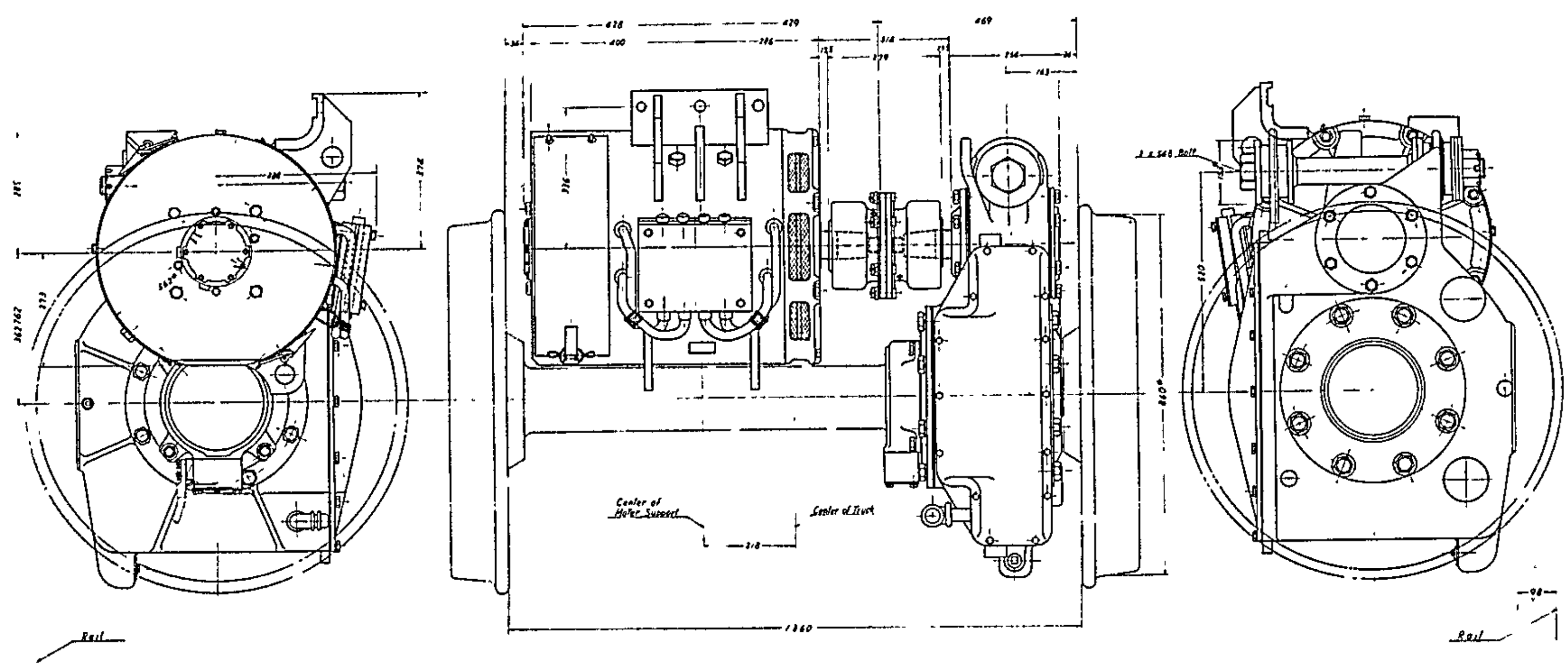


Fig. 7－19　Characteristic Curve of Traction Motor

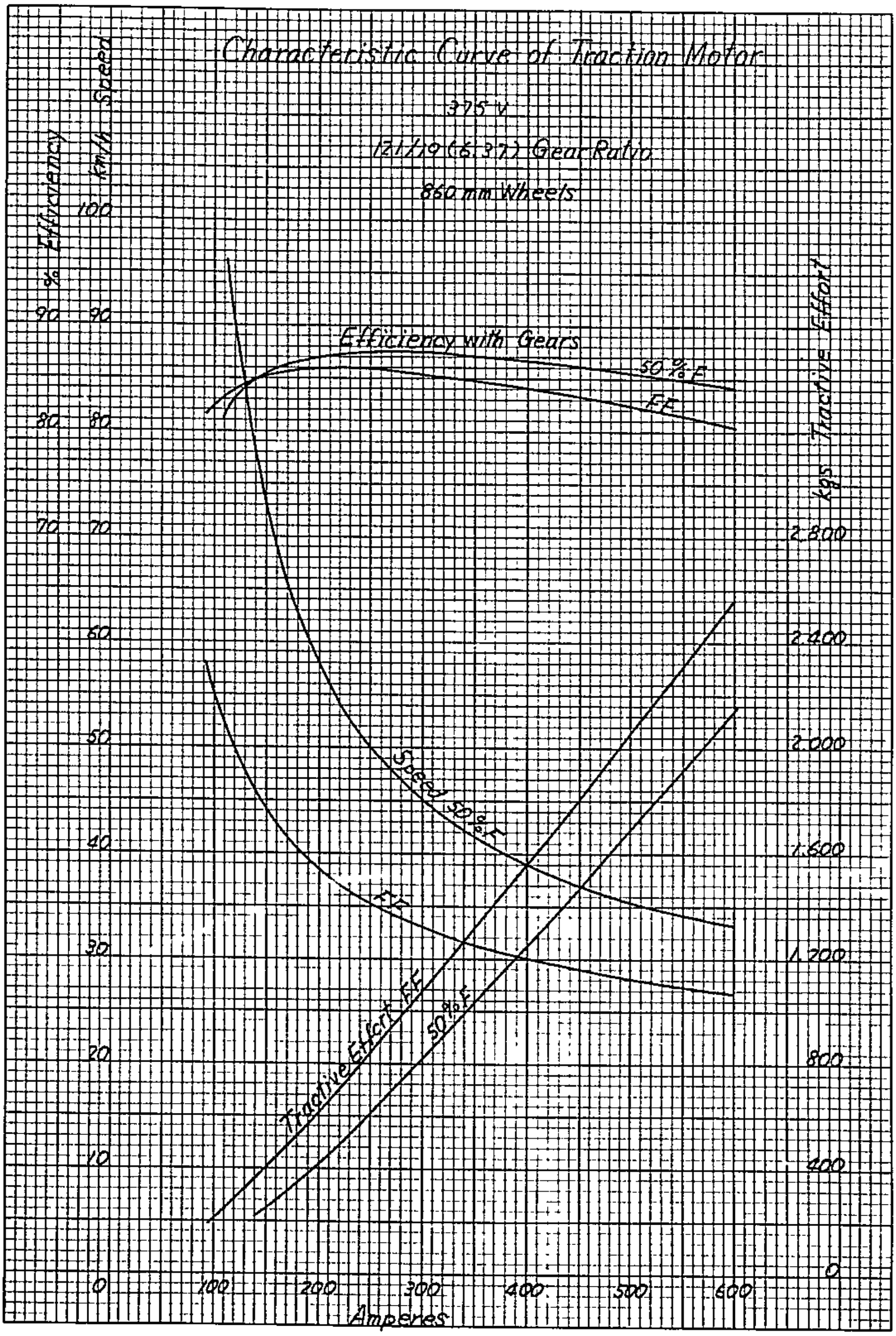
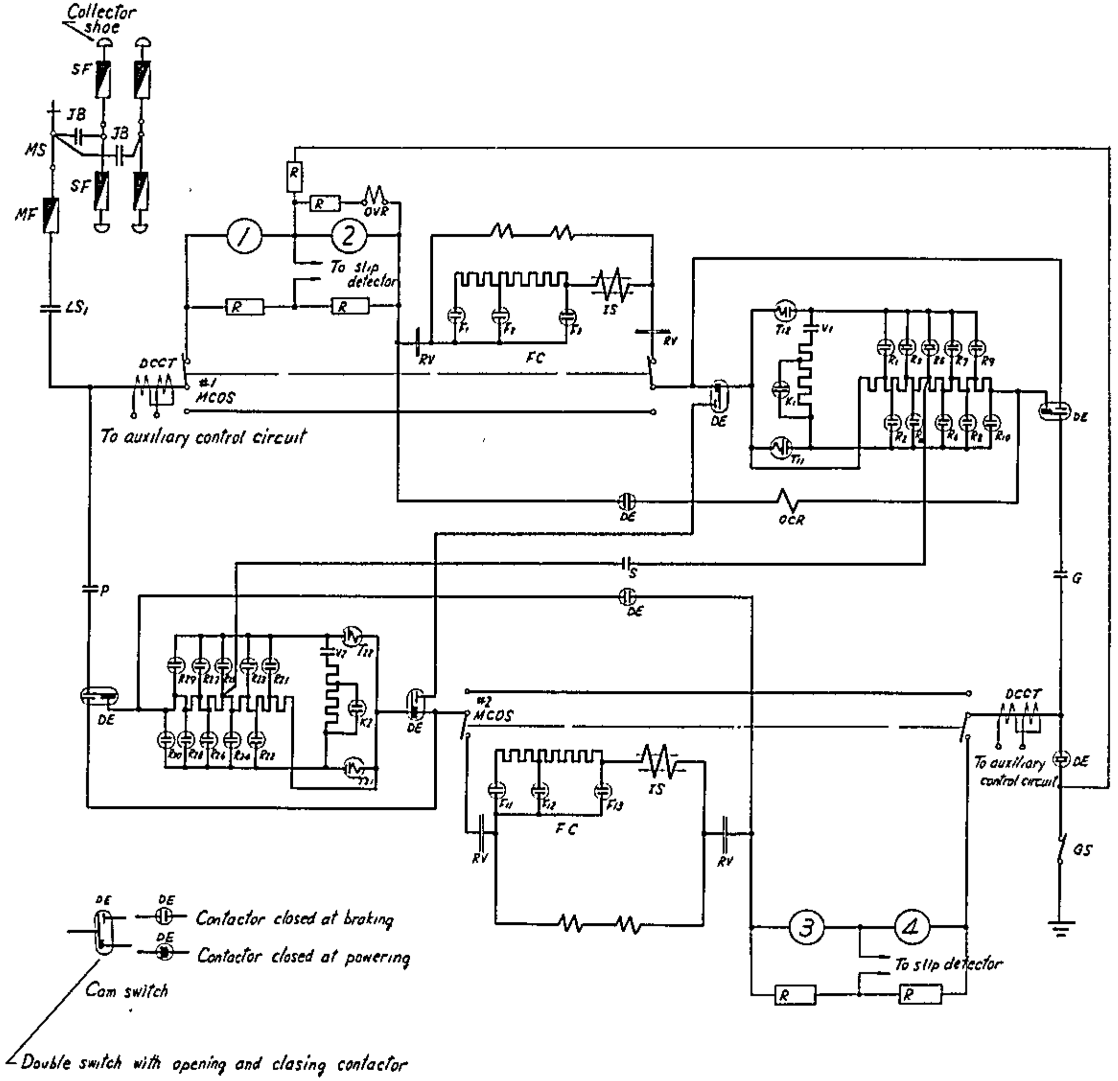


Fig. 7—20 Main Circuit Connection Diagram



The number of step

Powering	Serise connection	31	68
	Parallel connection	31	
	Weak field connection	6	
Braking	Full field connection	61	

Symbol	Name
LS1	Circuit breaker
P.G.S.V	Electro-pneumatic unit switch
T	Transfer cam switch
R	Selector 〃
K	Vernier 〃
FC	Field control cam 〃
RV	Reversing cam 〃
DE	Braking cam 〃
MCOS	Main motor cut out 〃
IS	Induction shunt
DCCT	DC current transformer
LA	Arrester
OCR	Over current relay
OVR	Over voltage 〃
MF	Main fuse
MS	Main switch
GS	Ground 〃
SF	Shoe fuse
JB	Junction box

Fig. 7—21 Notching Curves (Powering)

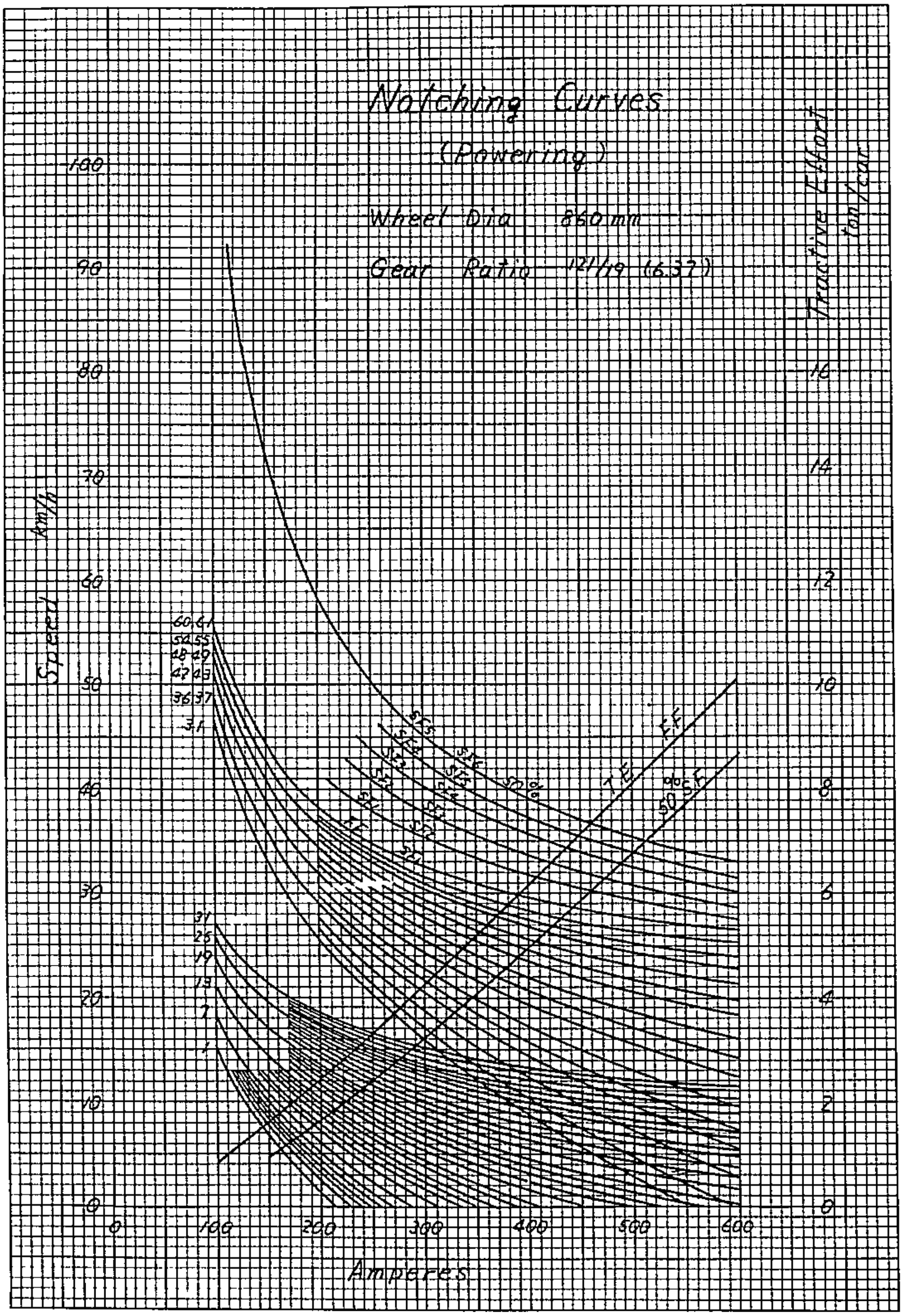


Fig. 7−22 Notching Curves (Braking)

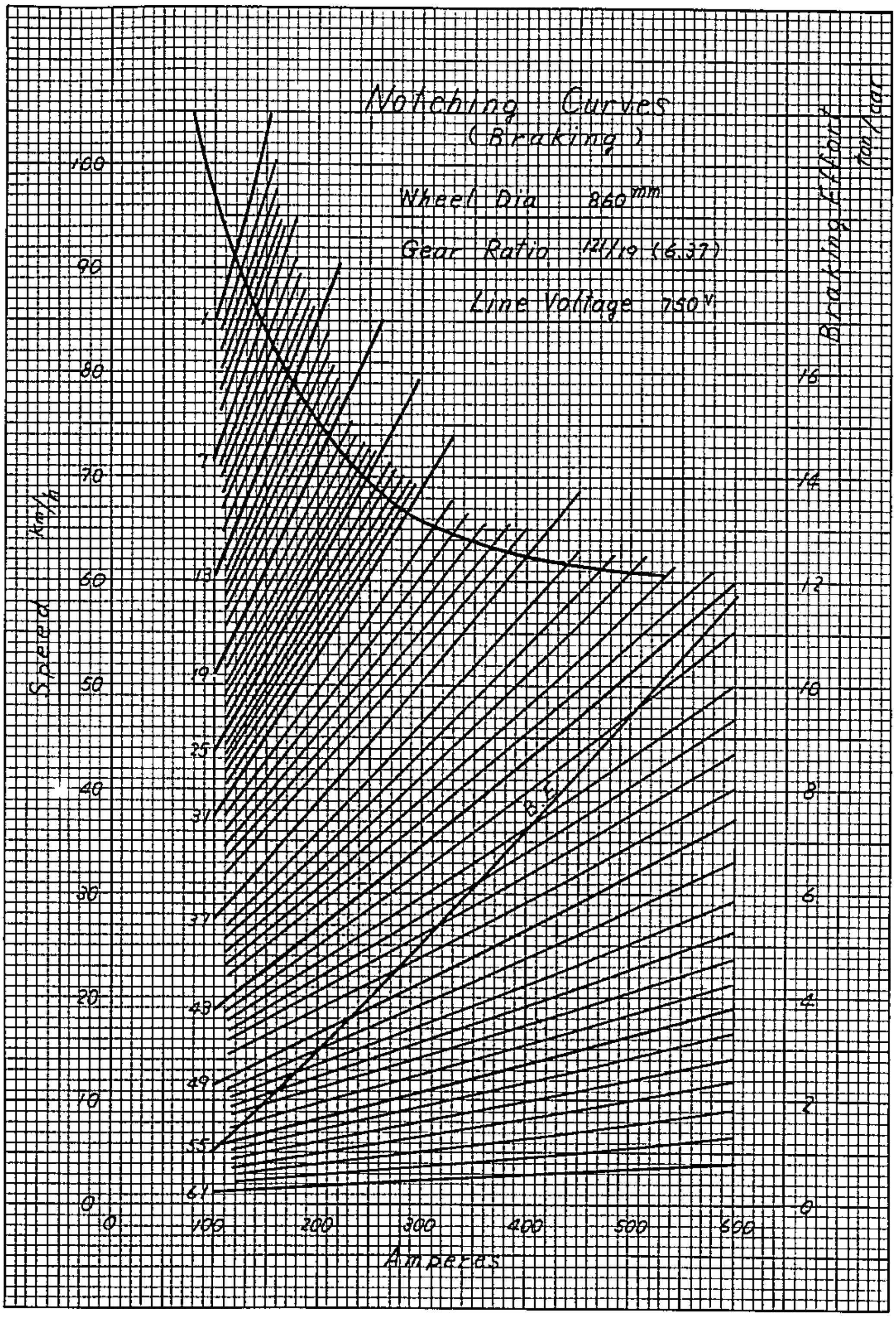
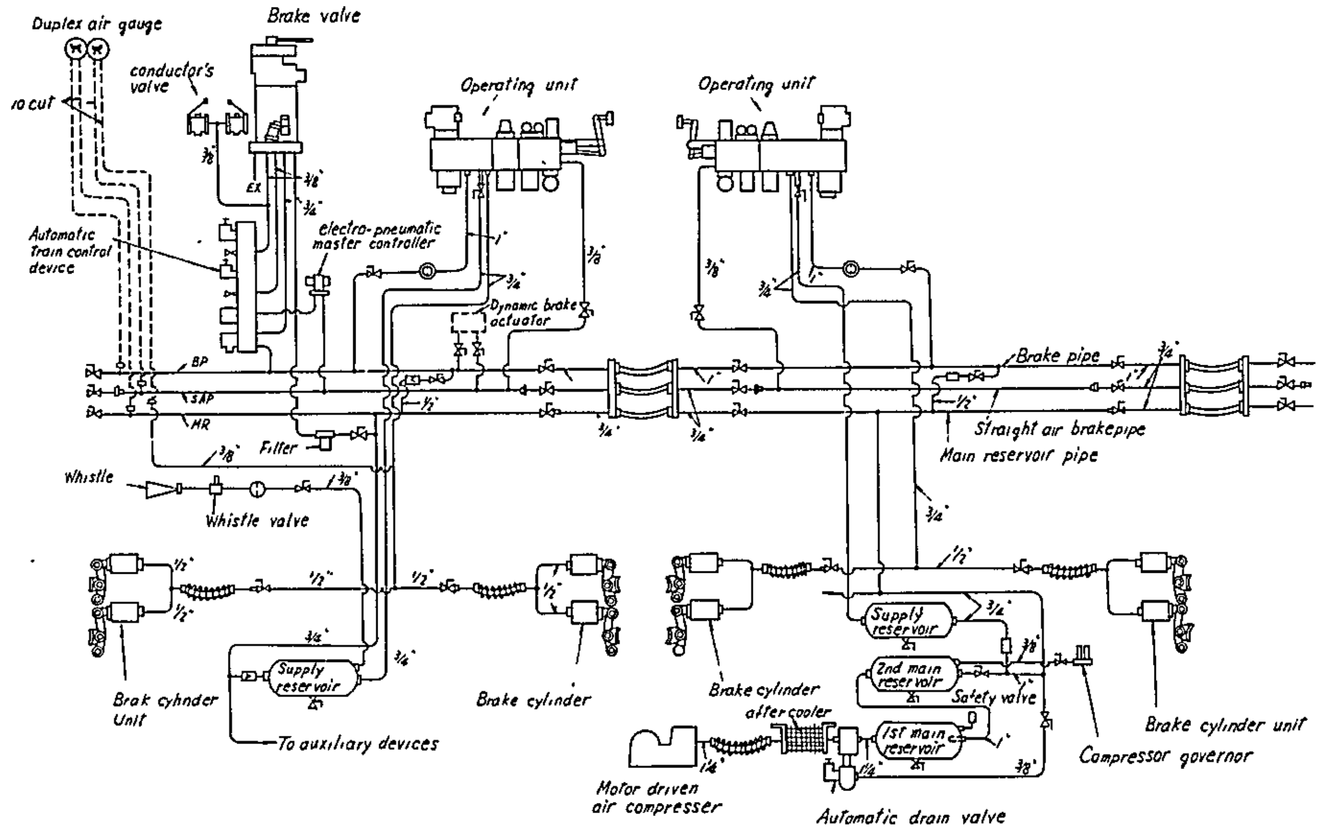
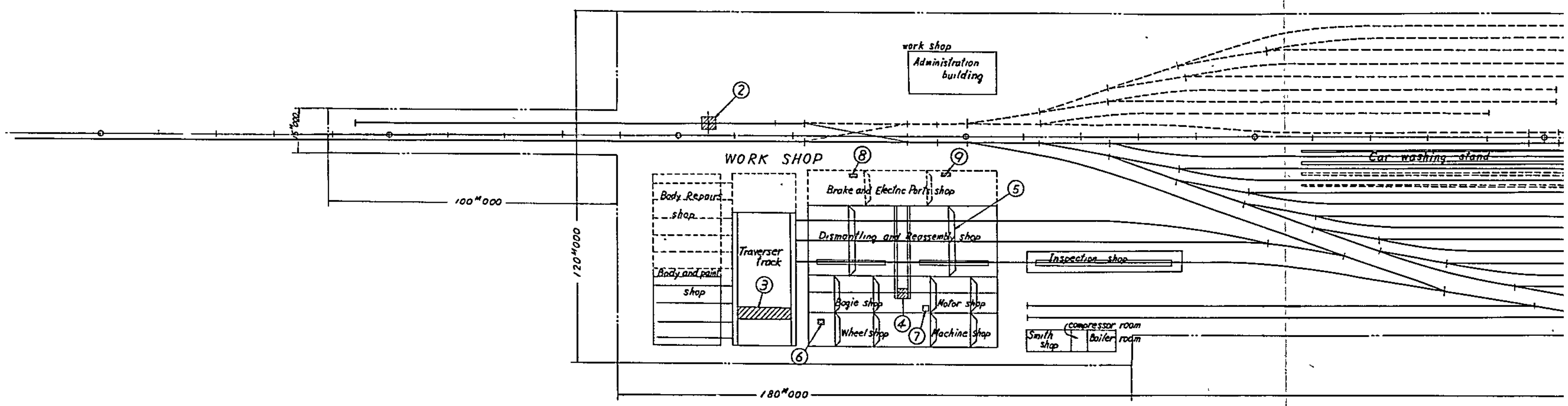


Fig. 7—23 Piping Diagram of "HSC-D" Brake Equipment



Area of the site abaut 74.200 M²

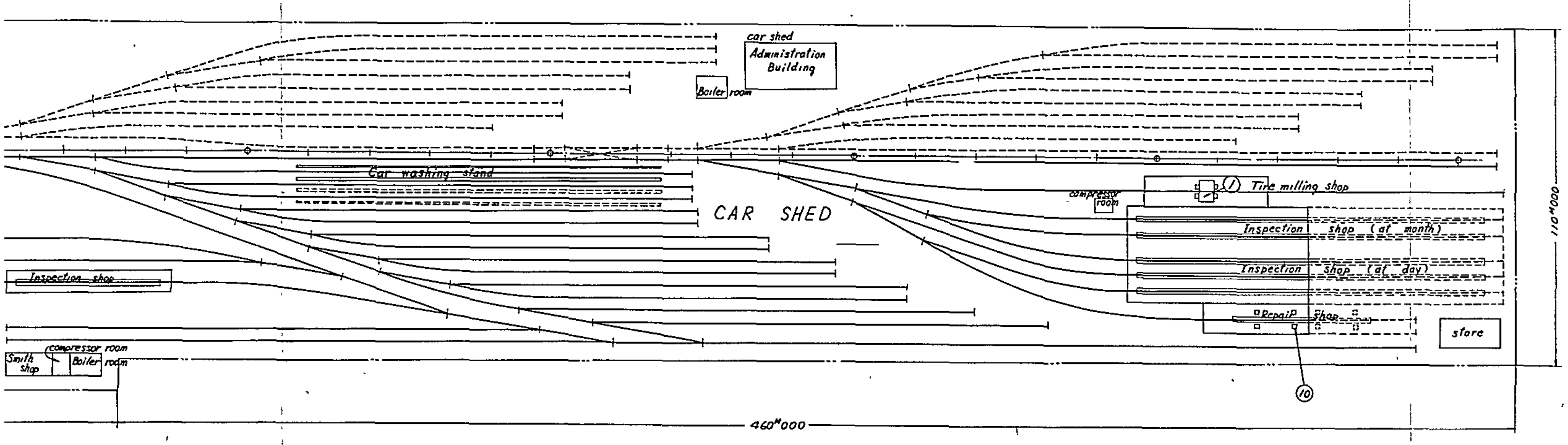
Capacity abaut 200 cars



	name	number	
1	Tire milling machine	1	
2	Automatic car washer	1	
3	Traverse	1	
4	Automatic bogie washer	1	
5	15Ton Over head Crane	2	
6	Tire lathe	1	
7	Rotary Tester	1	
8	Brake Valves Tester	1	
9	Relays Tester	1	
10	Lifting Jack	2	

Fig. 7—24 Plan of the Car Shed and Workshop for Underground Railway

Area of the site abaut 74 200 M²
Capacity abaut 200 cars (6 cars x 34 Train)



	name	number	
1	Tire milling machine	1	
2	Automatic car washer	1	
3	Traverse	1	
4	Automatic bogie washer	1	
5	15 Ton Over head Crane	2	
6	Tire lathe	1	
7	Rotary Tester	1	
8	Brake Valves Tester	1	
9	Relays Tester	1	
10	Lifting Jack	2	

Fig. 7—25 Structural Figure of 3rd Rail

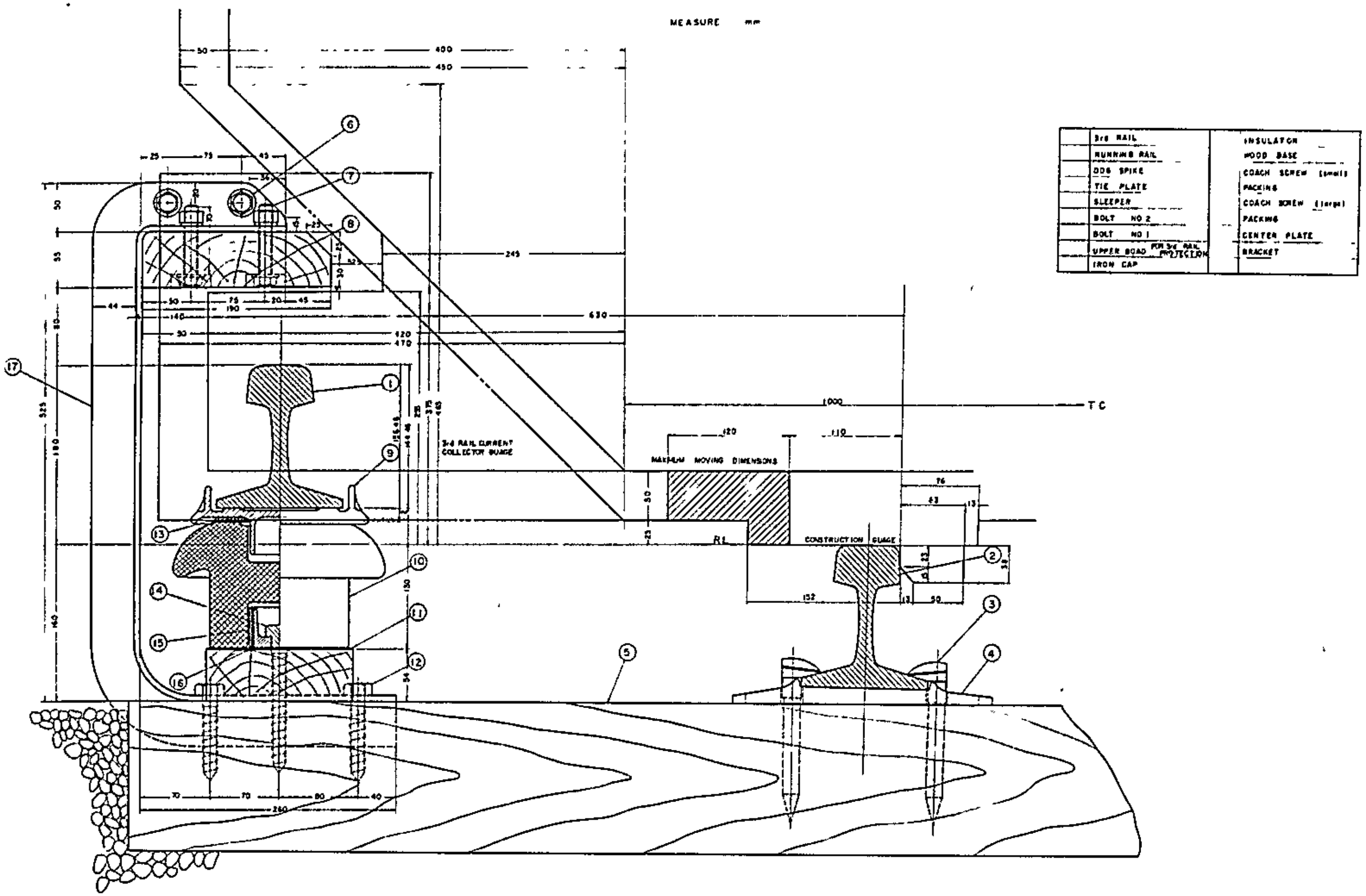


Fig. 7—26 Cable Installation

MEASURE : mm

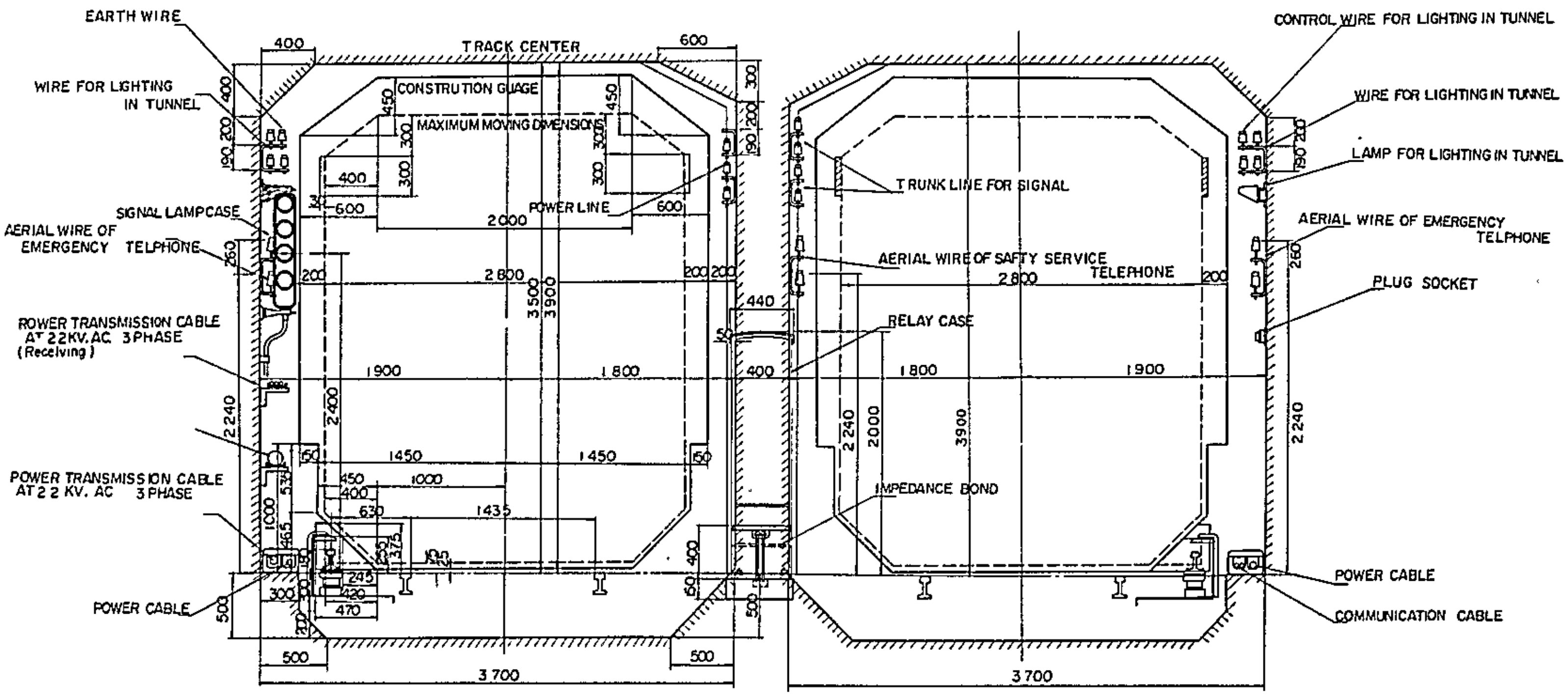


Fig. 7—27 Standard Connection Diagram of Power Distribution Circuit in Switch House

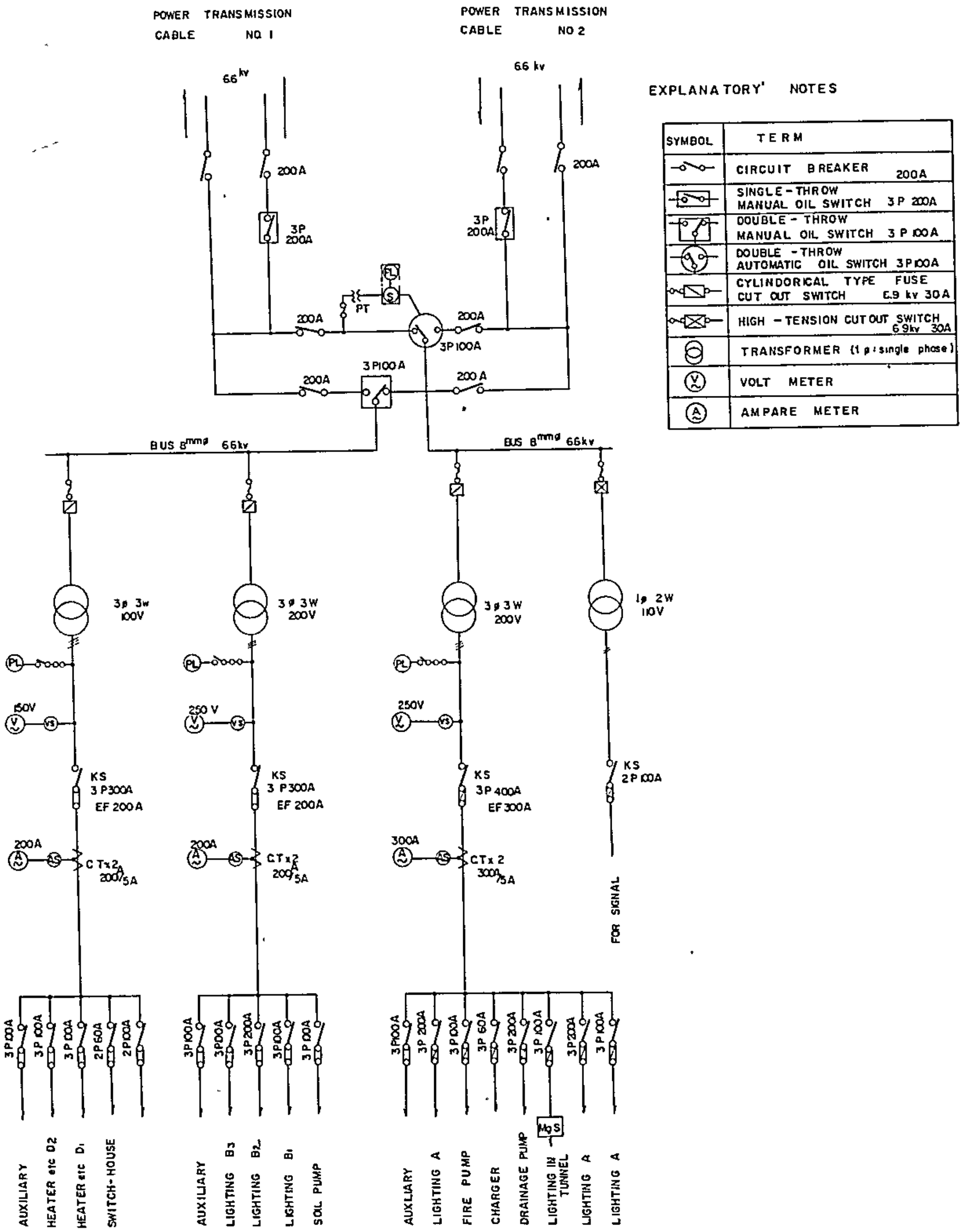


Fig. 7—28 Standard Layout of Switch House

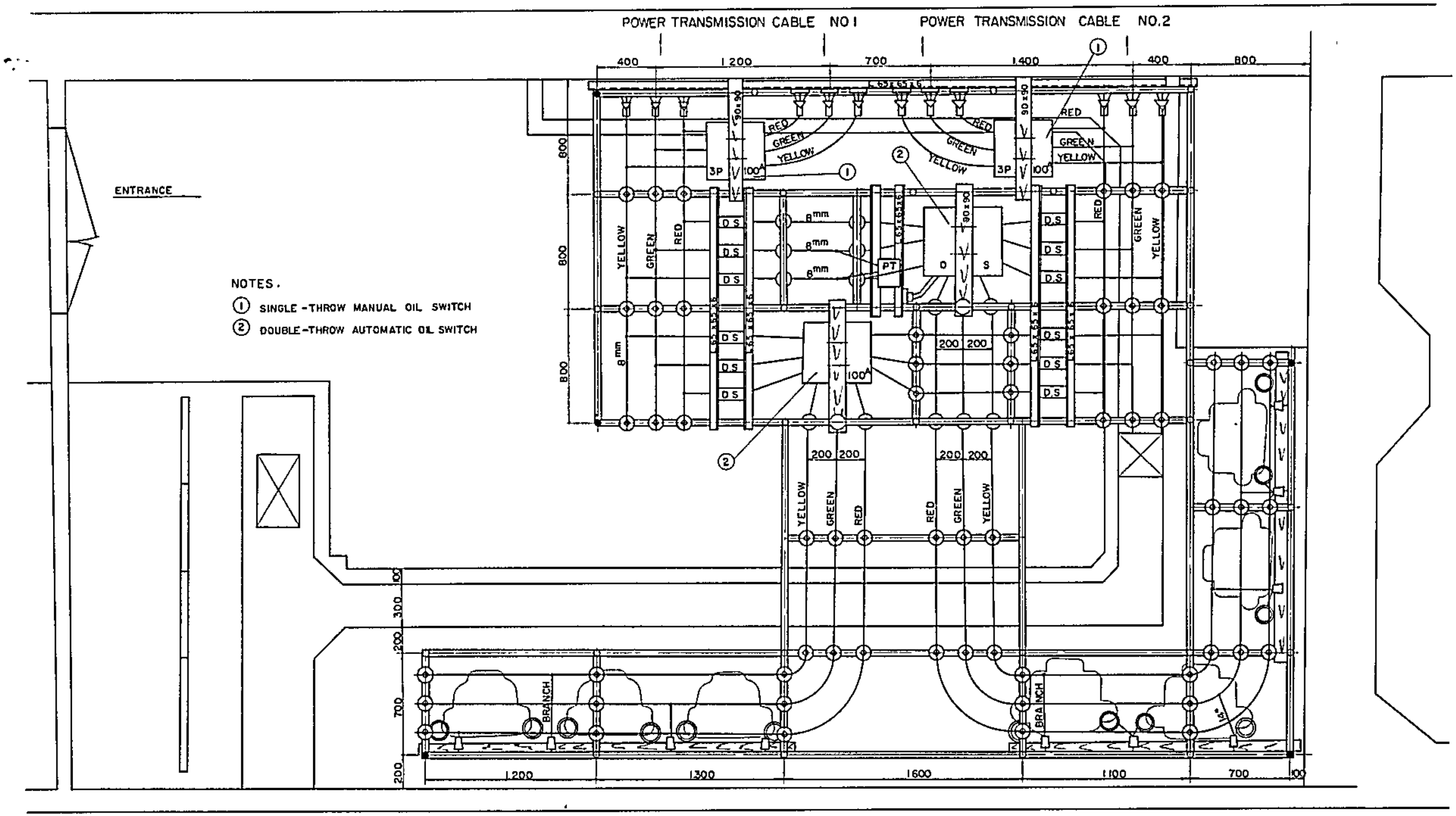
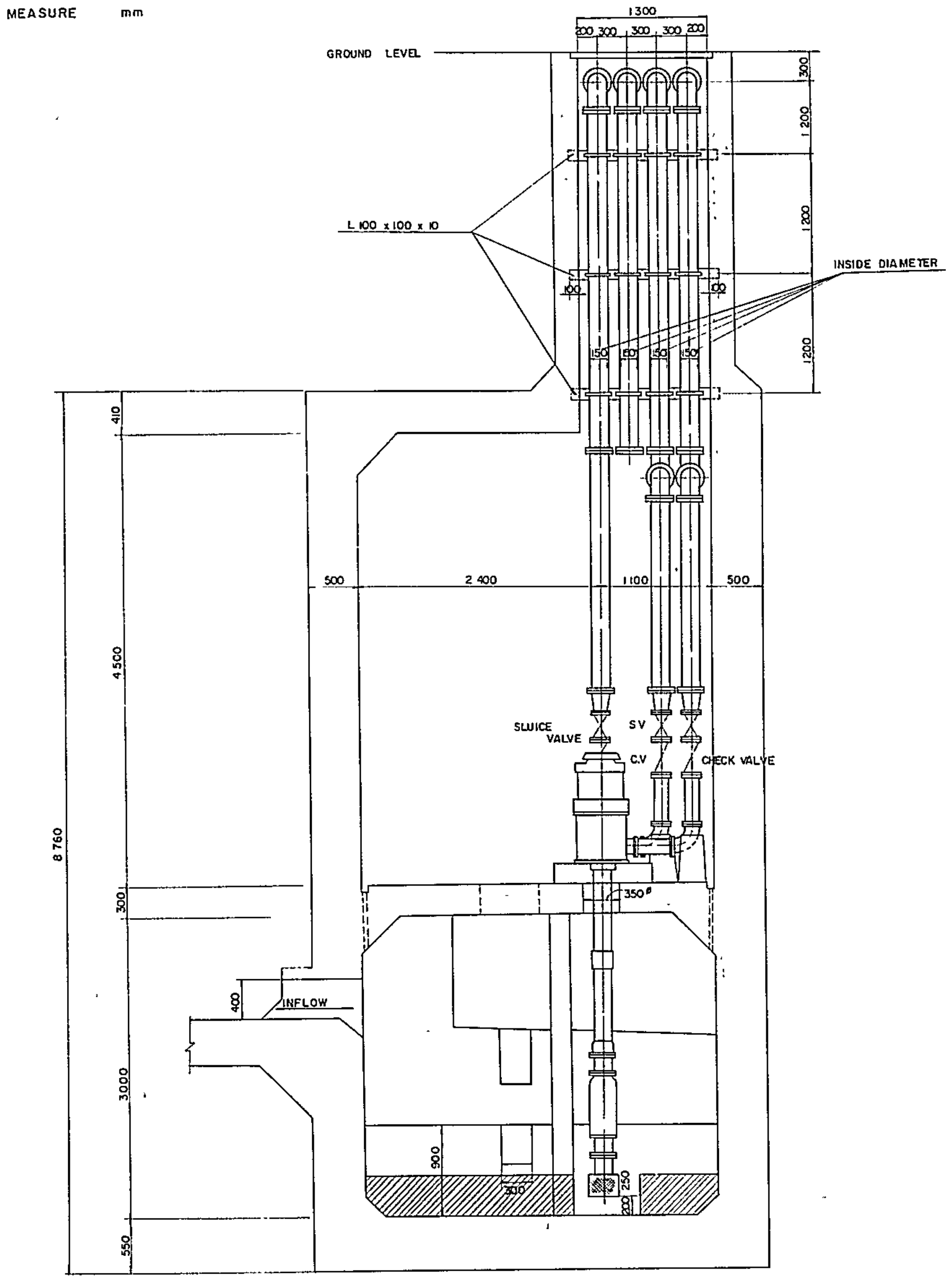
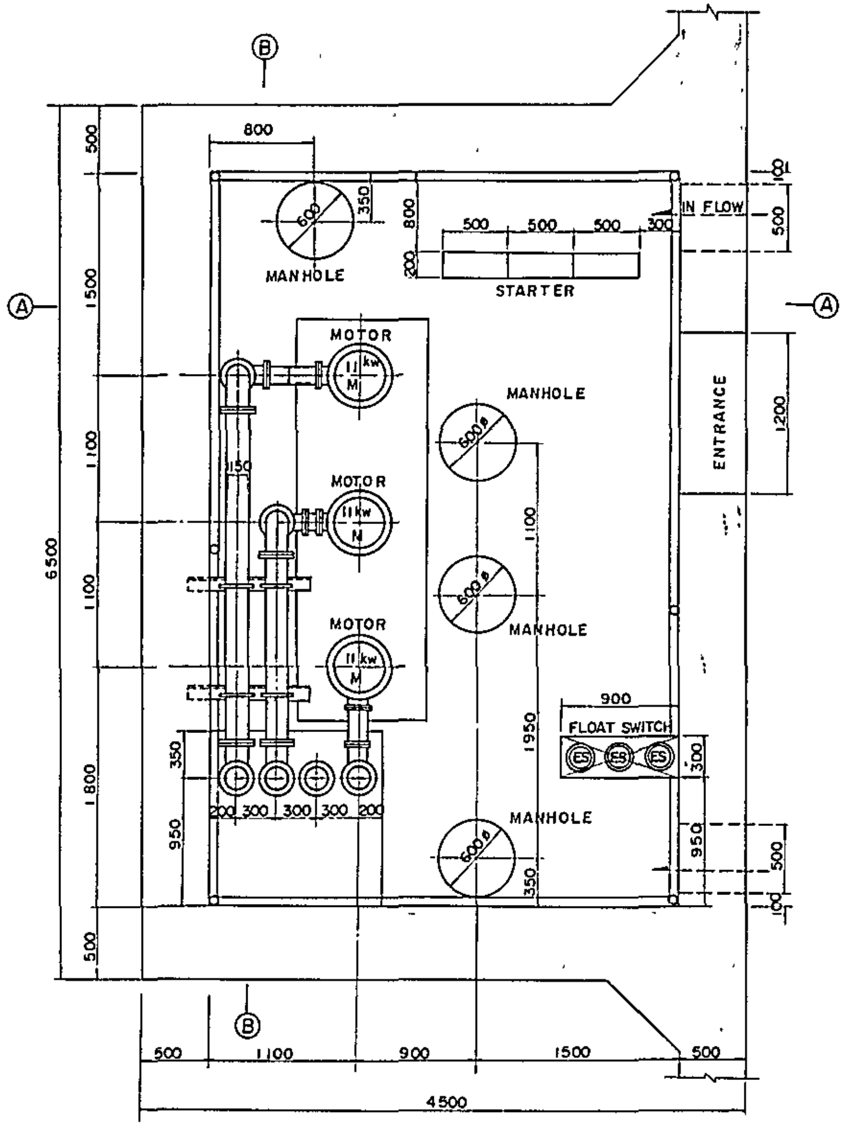


Fig. 7—29 Standard Installation of Drainage Pump

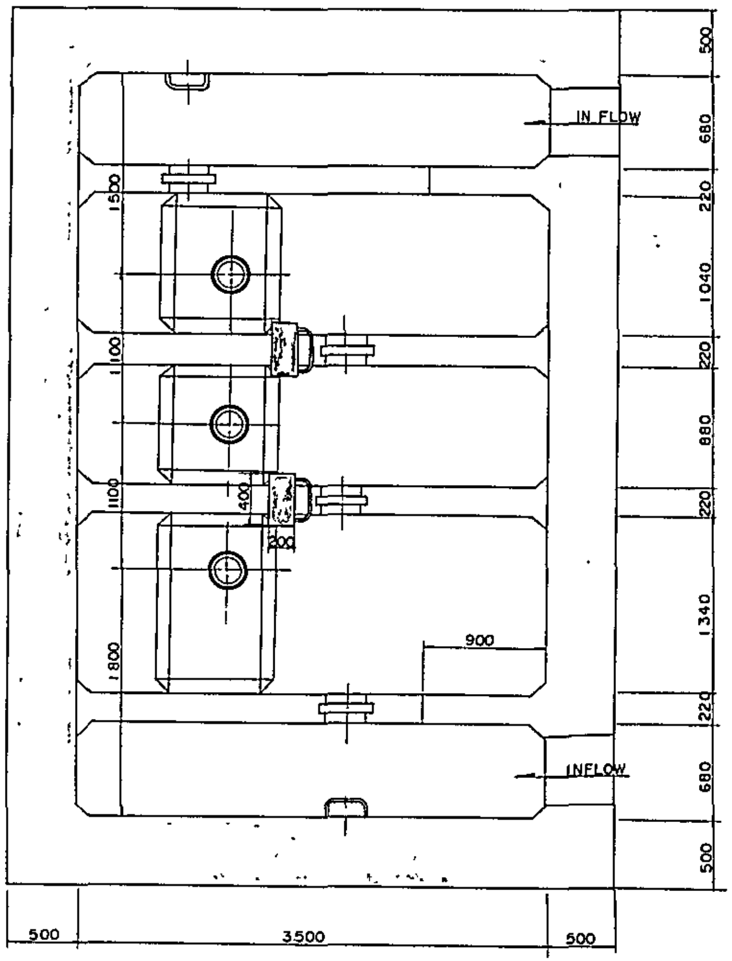


MEASURE mm

Fig. 7—30 Standard Installation of Drainage Pump

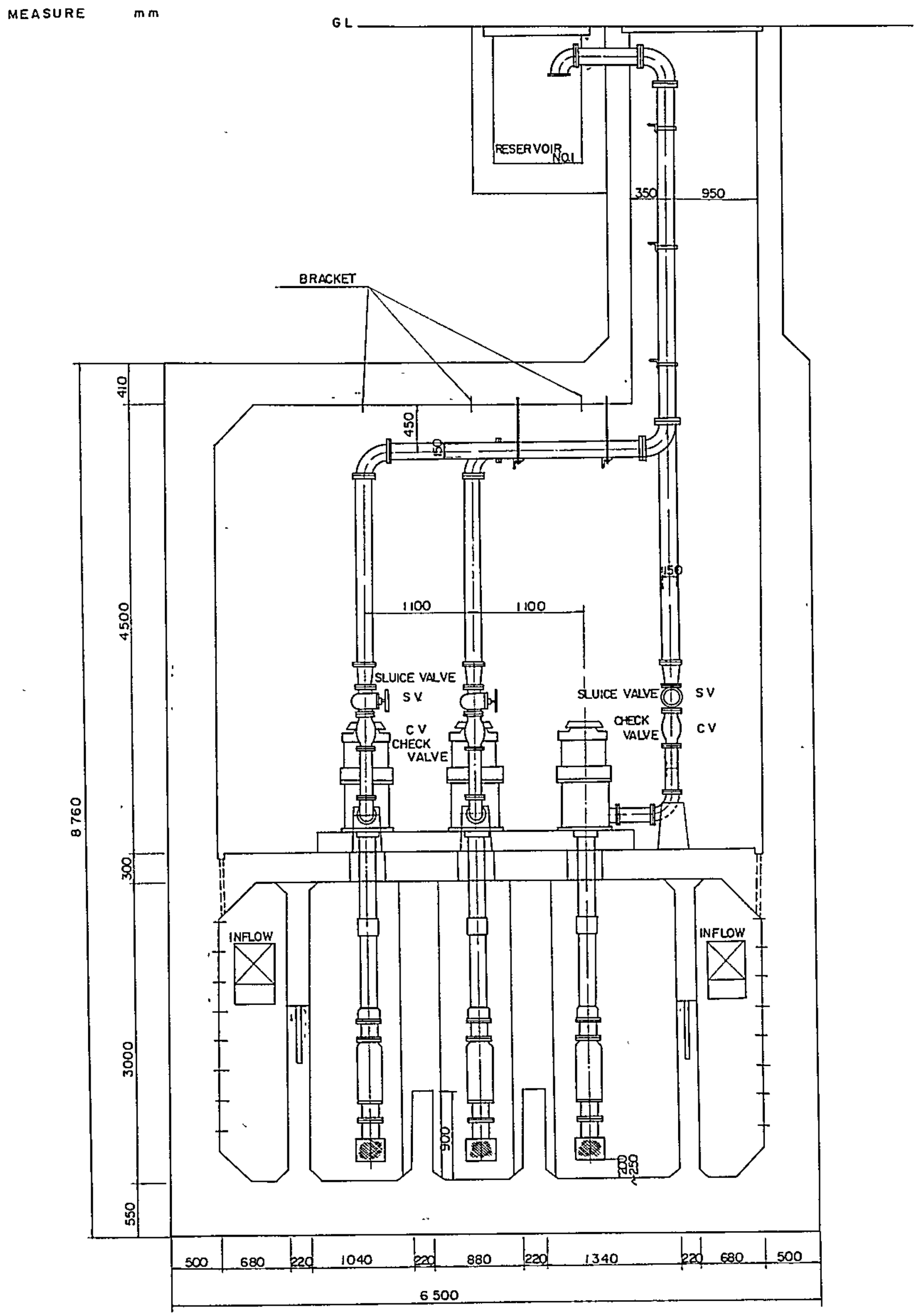


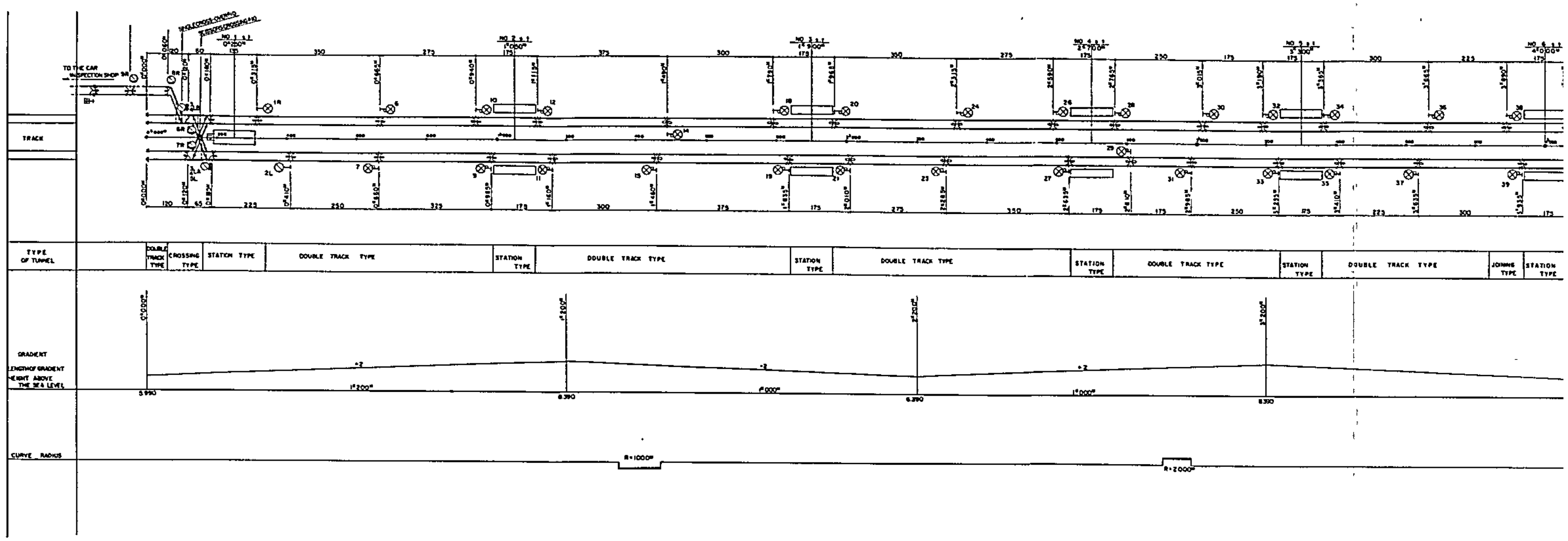
DRAINAGE PUMP INSTALLATION



RESERVOIR INSTALLATION

Fig. 7−31 Standard Installation of Drainage Pump




TO THE CAR INSPECTION SHOP
TRACK
TYPE OF TUNNEL
DOUBLE TRACK TYPE
CROSSING TYPE
STATION TYPE
JOINING TYPE
GRADIENT
LENGTH OF GRADIENT
HEIGHT ABOVE THE SEA LEVEL
CURVE RADIUS
R=1000m
R=2000m

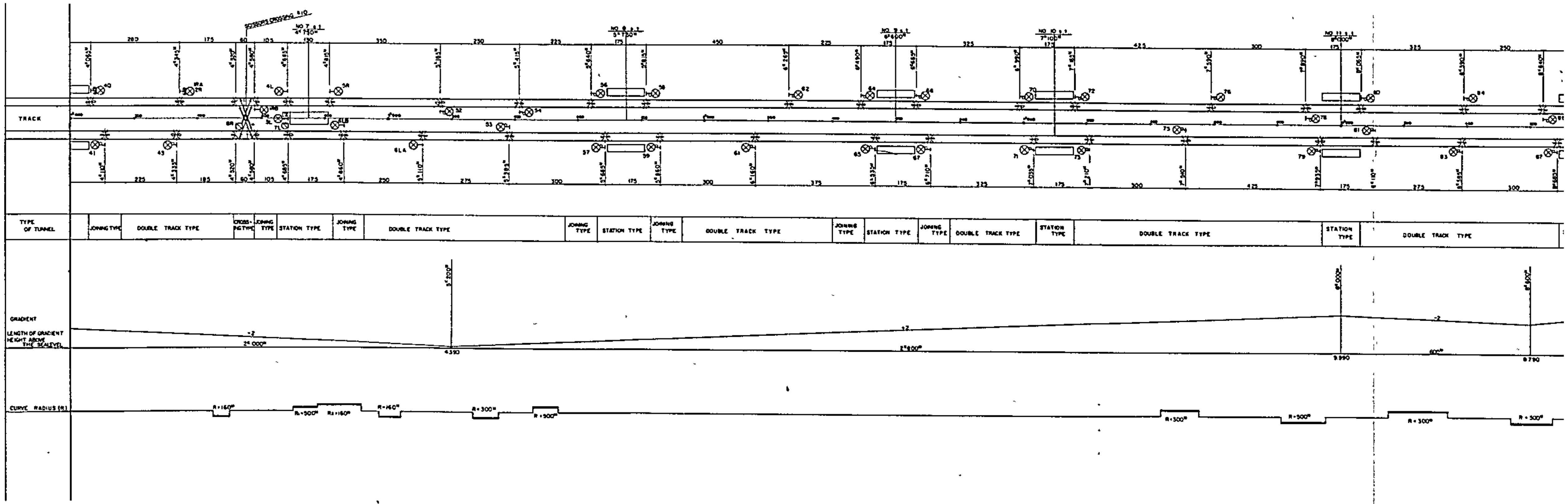

TRACK
TYPE OF TUNNEL
JOINING TYPE
DOUBLE TRACK TYPE
CROSSING TYPE
STATION TYPE
GRADIENT
LENGTH OF GRADIENT
HEIGHT ABOVE THE SEA LEVEL
CURVE RADIUS (R)

Fig. 7－32　Way-side Signal Installation

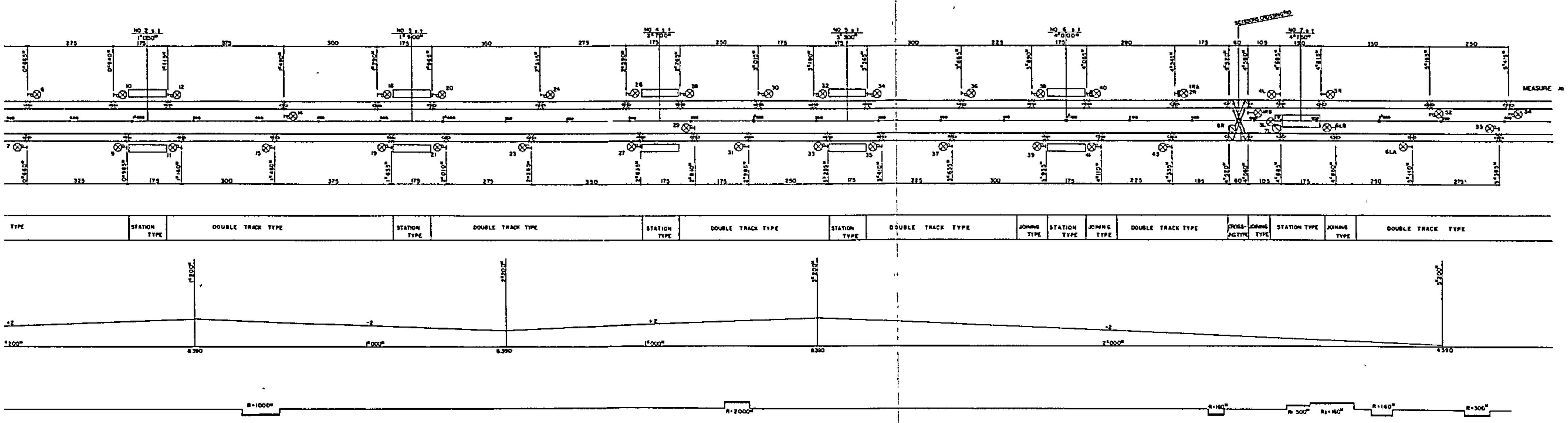


Fig. 7－33　Way-side Signal Installation

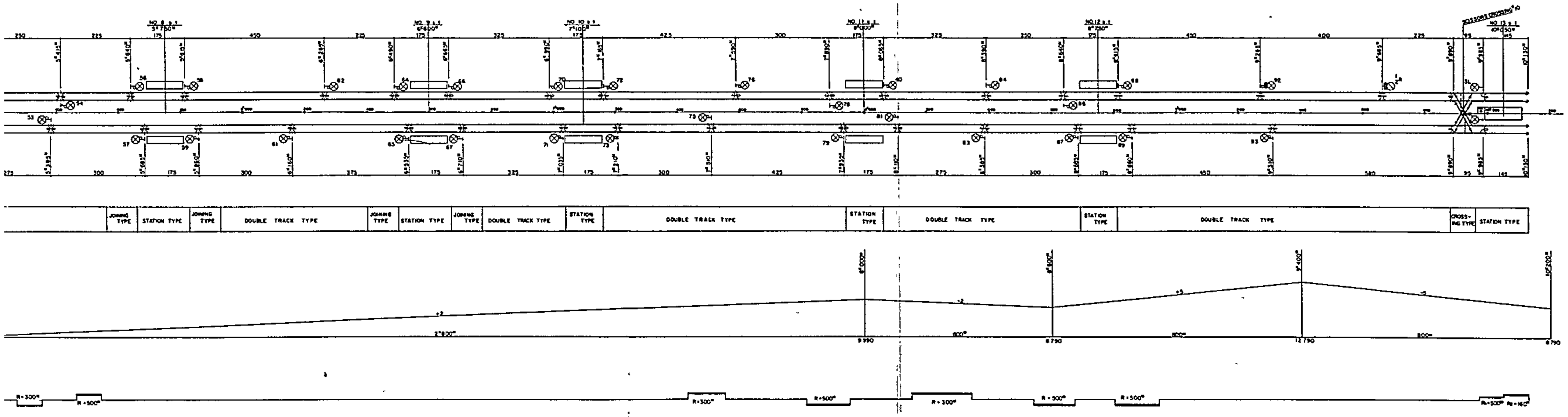
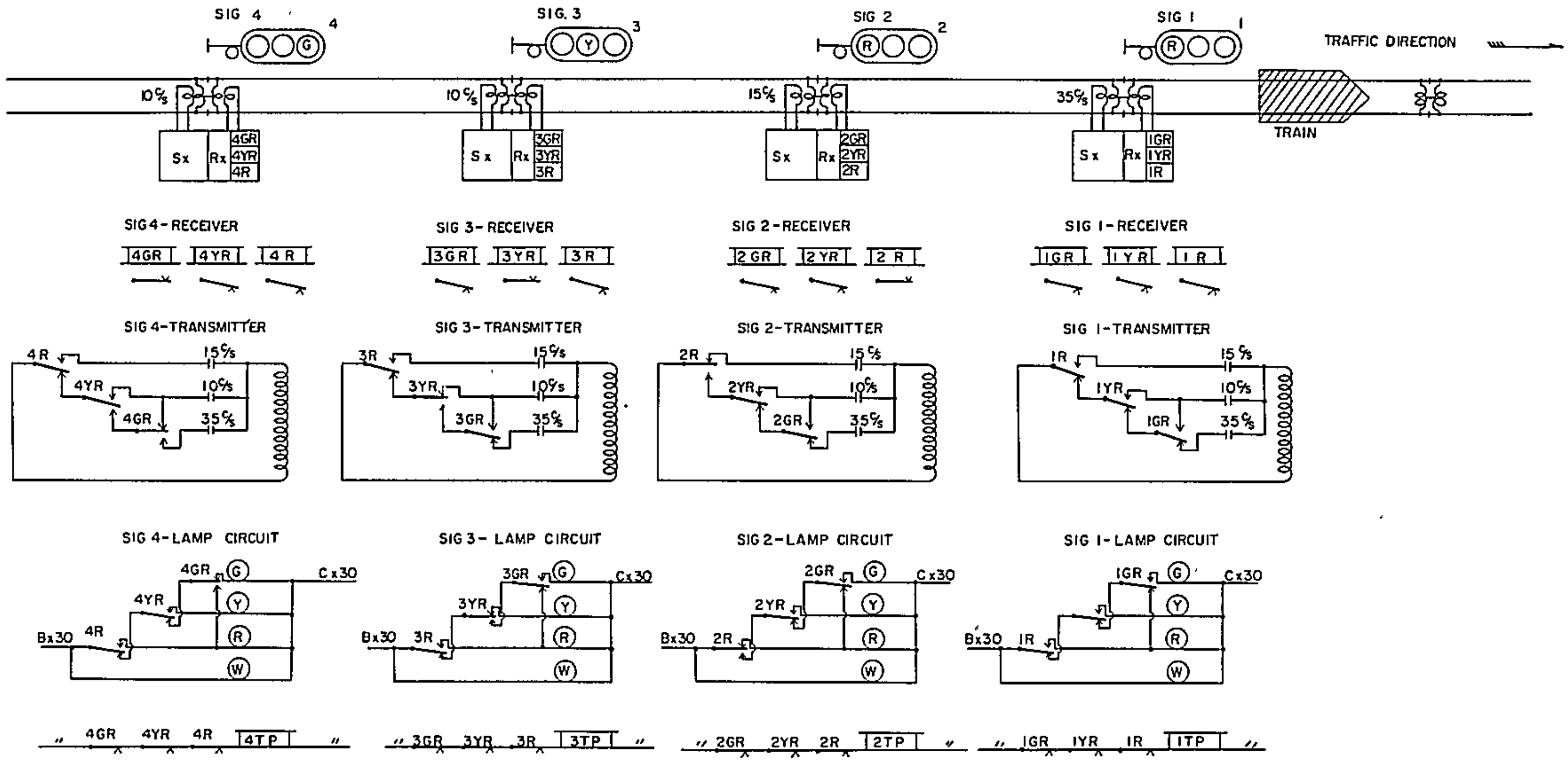


Fig. 7—34 Standard Connection Diagram of Automatic Signal Circuit



NOTES

Sx	TRANSMITTER	Ⓨ .	YELLOW LIGHT
Rx .	RECEIVER	Ⓡ .	RED LIGHT
Ⓖ .	GREEN LIGHT	Ⓦ :	WHITE LIGHT (MARKER LIGHT)

Fig. 7—35 Standard Connection Diagram of Automatic Signal Circuit

A.T.S. SYSTEM BLOCK DIAGRAM

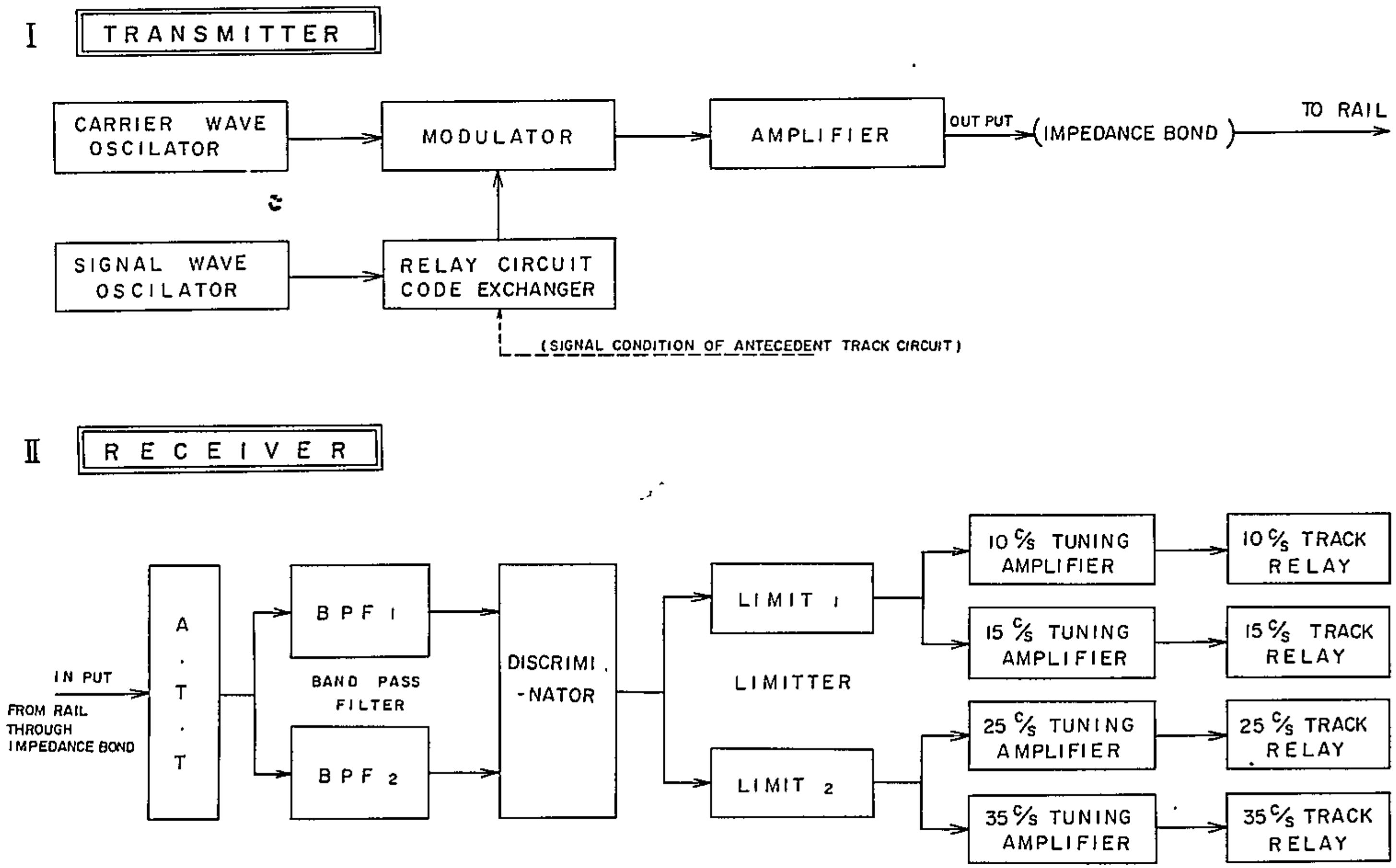


Fig. 7—36 Signal Aspect of Automatic Signal

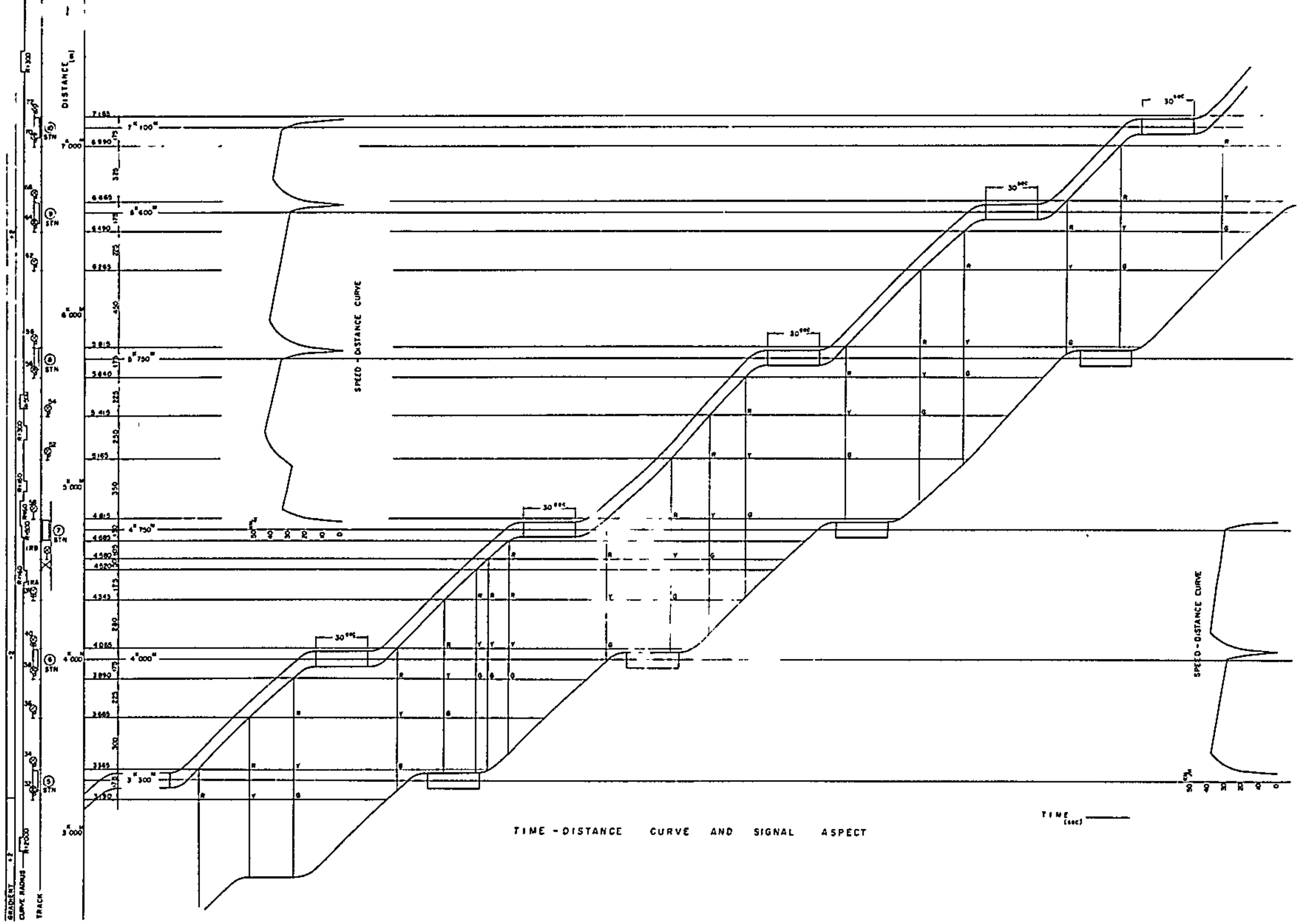
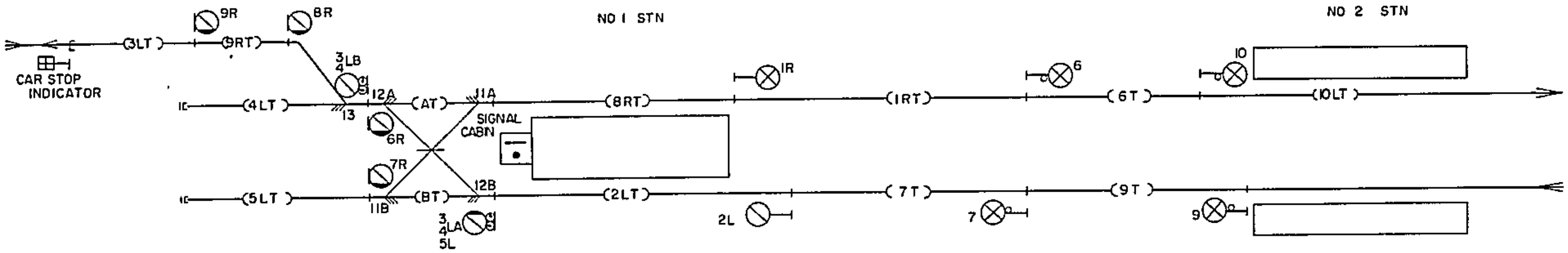


Fig. 7−37 Locking Sheet

NO 1 STATION LOCKING SHEET

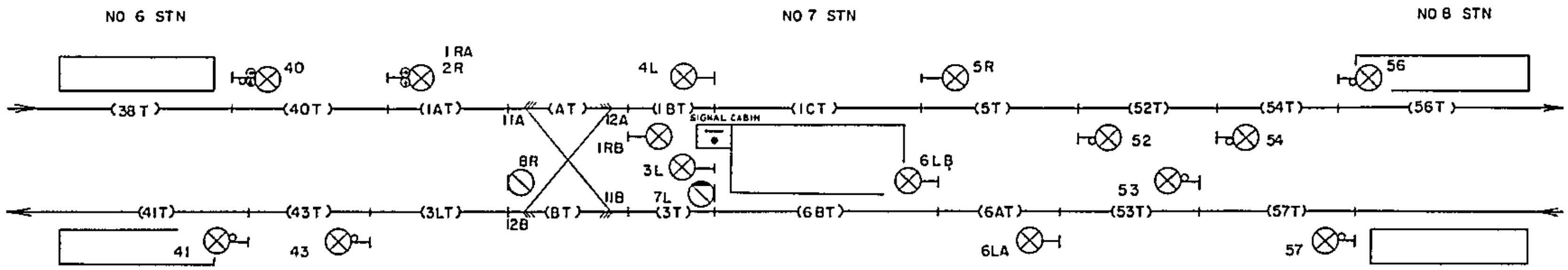


(USE : 1st CLASS ELECTROPNEUMATIC RELAY INTERLOCKING)

CASE		SIGNAL ASPECTS	ROUTE INDICATOR	SIGNAL NUMBER		MUTUAL LOCKING	SIGNAL CONTROL AND DETECTOR LOCKING	ROUTE LOCKING	APPROACH LOCKING
STARTING SIGNAL	8RT → 1RT	CAUTION(Y)		1 R			1RT, 6T		
		PROCEED(G)					1RT, SIG 6-CAUTION (Y) or PROCEED (G)		
HOME SIGNAL	7T → 2LT	CAUTION(Y)		2 L			2LT, BT need 1 sec.		
SHUNTING SIGNAL	2LT → AT		→	3L	A	⑫, 11, ⑬, 9R	BT, AT, SIG 3LB − CAUTION(Y)	(BT, AT) (4LT)	2LT (NEED 30 SEC AFTER CONTROL THE TIME RELEASE PUSH BUTTON)
〃	AT → 3LT		→		B		4LT, 9RT, 3LT		
〃	2LT → AT		→	4L	A	⑫, 11, 13	BT, AT SIG4LB − CAUTION(Y)	(BT, AT) (4LT)	
〃	AT → 4LT		↑		B		4LT		
〃	2LT → 5LT		↑	5	L	11, 12	BT, 5LT	(BT) 〃	
〃	4LT → 8RT			6	R	11, 12	AT, 8RT	(AT)	4LT (〃)
〃	5LT → 8RT			7	R	⑪, 12	BT, AT, 8RT	(BT, AT)	5LT (〃)
〃	9RT → 4LT			8	R	⑬	4LT, SIG 6R − CAUTION(Y)	(4LT)	9RT (〃)
〃	3LT → 9RT			9	R	3L	9RT, 4LT		3LT (〃)
SWITCH		(DOUBLE SWITCH)		11	N	7R	AT, BT		
					R	3L 4L, 5L, 6R			
〃		(DOUBLE SWITCH)		12	N	3L 4L	AT, BT		
					R	5L, 6R, 7R			
〃		(SINGLE SWITCH)		13	N	3L, 8R	4LT		
					R	4L			
AUTOMATIC SIGNAL		CAUTION(Y)		7			7T, 2LT		
		PROCEED(G)					7T, SIG 2L − CAUTION(Y)		

Fig. 7—38 Locking Sheet

NO 7 STATION LOCKING SHEET



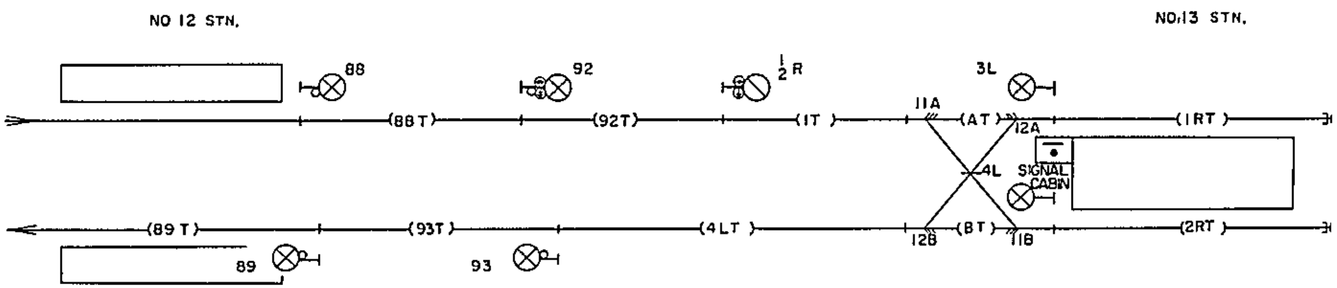
(USE. 1st CLASS ELECTRO PNEUMATIC RELAY INTERLOCKING)

CASE		SIGNAL ASPECTS	ROUTE INDICATOR	SIGNAL NAMBER		MUTUAL LOCKING	SIGNAL CONTROL AND DETECTOR LOCKING	ROUTE LOCKING	APPROACH LOCKING
NO 1 HOME SIGNAL	40T→AT	CAUTION(Y)	⇧	1R	A	11 12	1AT, AT, 1BT, 1CT	(1AT AT)	38T, 40T (NEED 30 SEC.AFTER CONTROL THE TIME RELEASE PUSH BOTTON)
		PROCEED(G)					1AT, AT, SIG 1RB-CAUTION(Y) or PROCEED(G)		
NO 2. HOME SIGNAL	AT→1CT	CAUTION(Y)			B		1BT, 1CT, 5T		
		PROCEED(G)					1BT, 1CT, SIG 5R-CAUTION(Y) or PROCEED(G)		
HOME SIGNAL	40T→6BT	CAUTION(Y)	⇨	2R		(11), 12, 6L	1AT, AT, BT, 3T, 6BT, 6AT	(1AT,AT,BT)(3T)	
STARTING SIGNAL	6BT→3LT	CAUTION(Y)		3L		11, 12, 7L	3T, BT, 3LT, 43T	(3T, BT)	6AT, 6BT (〃)
		PROCEED(G)					3T, BT, 3LT, SIG 43-CAUTION(Y) or PROCEED(G)		
〃	1CT→3LT	CAUTION(Y)		4L		11, (12), 8R, 5R	1BT, AT, BT, 3LT, 43T	(1BT,AT,BT)	1CT (〃)
		PROCEED(G)					1BT, AT, BT, 3LT, SIG 43-CAUTION(Y) or PROCEED(G)		
〃	1CT→5T	CAUTION(Y)		5R		4L	5T, 52T		
		PROCEED(G)					5T; SIG 52-CAUTION(Y) or PROCEED(G)		
NO 1 HOME SIGNAL	53T→6AT	CAUTION(Y)		6L	A	2R	6AT, 6BT		57T, 53T (〃)
		PROCEED(G)					6AT, SIG 6LB-CAUTION(Y) or PROCEED(G)		
NO 2 HOME SIGNAL	6AT→6BT	CAUTION(Y)			B		6BT, 3T, BT need 12 sec		
		PROCEED(G)					6BT, SIG 3L-CAUTION(Y) or PROCEED(G)		
SHUNTING SIGNAL	6BT→3LT			7L		11, 12, 3L	3T, BT, 3LT	(3T, BT)	6BT (〃)
	3LT→1CT			8R		11, (12), 4L	BT, AT, 1BT, 1CT	(BT, AT)	3LT (〃)
SWICH		(DOUBLE SWITCH)		11	N	2R	AT, BT		
					R	1R, 3L, 4L, 7L, 8R			
〃		(DOUBLE SWITCH)		12	N	4R, 8R	AT, BT		
					R	1R, 2R, 3L, 7L			

CASE	SIGNAL ASPECTS	ROUTE INDICATOR	SIGNAL NAMBER	MUTUAL LOCKING	SIGNAL CONTROL AND DETECTOR LOCKING	ROUTE LOCKING	APPROACH LOCKING
AUTOMATIC SIGNAL	CAUTION(Y)		40		40T, 1AT		
	PROCEED(G)	⇑			40T, SIG 1RA-CAUTION(Y) or PROCEED(G)		
		⇒			40T, SIG 2R-CAUTION(Y)		
〃			53		53T, 6AT		
					53T, SIG 6LA-CAUTION(Y) or PROCEED(G)		

Fig. 7−39　Locking Sheet

NO 13 STATION LOCKING SHEET

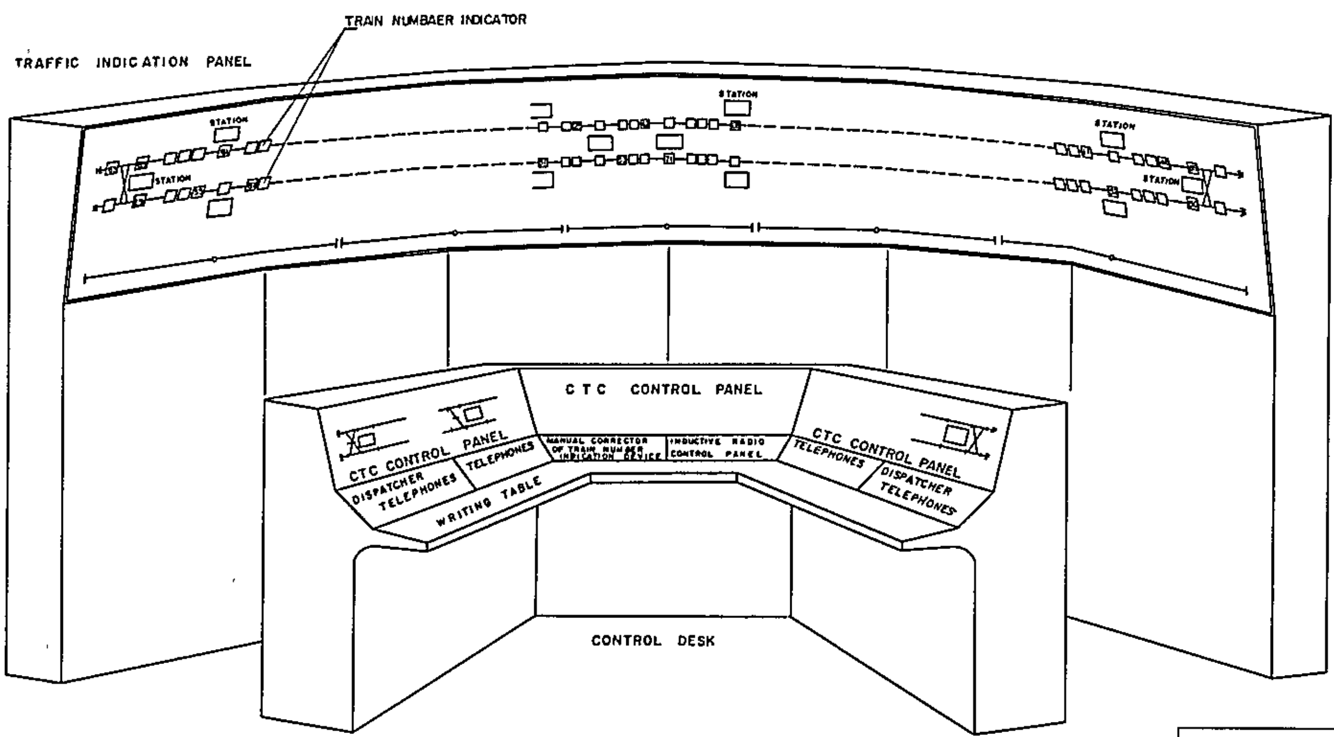


(USE . Ist CLASS ELECTROPNEUMATIC RELAY INTERLOCKING)

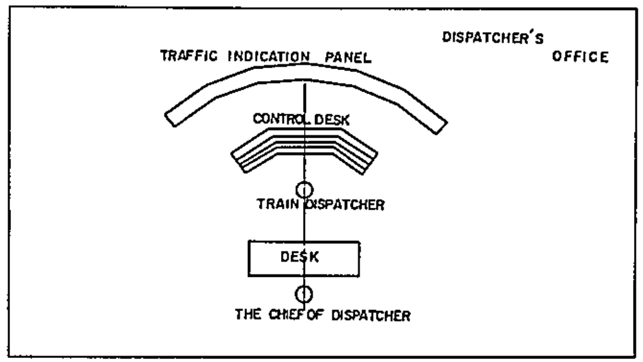
CASE		SIGNAL ASPECTS	ROUTE INDICATOR	SIGNAL NOMBER		MUTUAL LOCKING	SIGNAL CONTROL AND DETECTOR LOCKING	ROUTE LOCKING	APPROACH LOCKING
HOME SIGNAL	92T → IRT	CAUTION(Y)	(↑)	IR		11, 12	IT, AT, IRT	(IT, AT)	88T, 92T (NEED 30 SEC AFTER CONTROL THE TIME RELEASE PUSH BUTTON)
〃	92T → 2RT	CAUTION(Y)	(→)	2R		(11), 12	IT, AT, BT, 2RT	(IT, AT, BT)	
STARTING SIGNAL	IRT → 4LT	CAUTION(Y)		3L		11, (12)	AT, BT, 4LT, 93T	(AT, BT)	IRT
		PROCEED(G)					AT, BT, 4LT, SIG 93-CAUTION(Y)or PROCEED(G)		(〃)
〃	2RT → 4LT	CAUTION(Y)		4L		11, 12	BT, 4LT, 93T	(BT)	2RT
		PROCEED(G)					BT, 4LT, SIG 93-CAUTION(Y) or PROCEED (G)		(〃)
SWITCH		(DOUBLE SWITCH)		11	N	2R	AT, BT		
					R	IR, 3L, 4L			
〃		(DOUBLE SWITCH)		12	N	3L,	AT, BT		
					R	IR, 2R, 4L			
AUTOMATIC SIGNAL		CAUTION(Y)		92			92T, IT		
		PROCEED(G)	(↑)				92T, SIG IR-CAUTION(Y)		
			(→)				92T, SIG 2R-CAUTION(Y)		

Fig. 7—40 Layout of Dispatcher's Office

TRAFFIC INDICATION PANEL AND CONTROL DESK

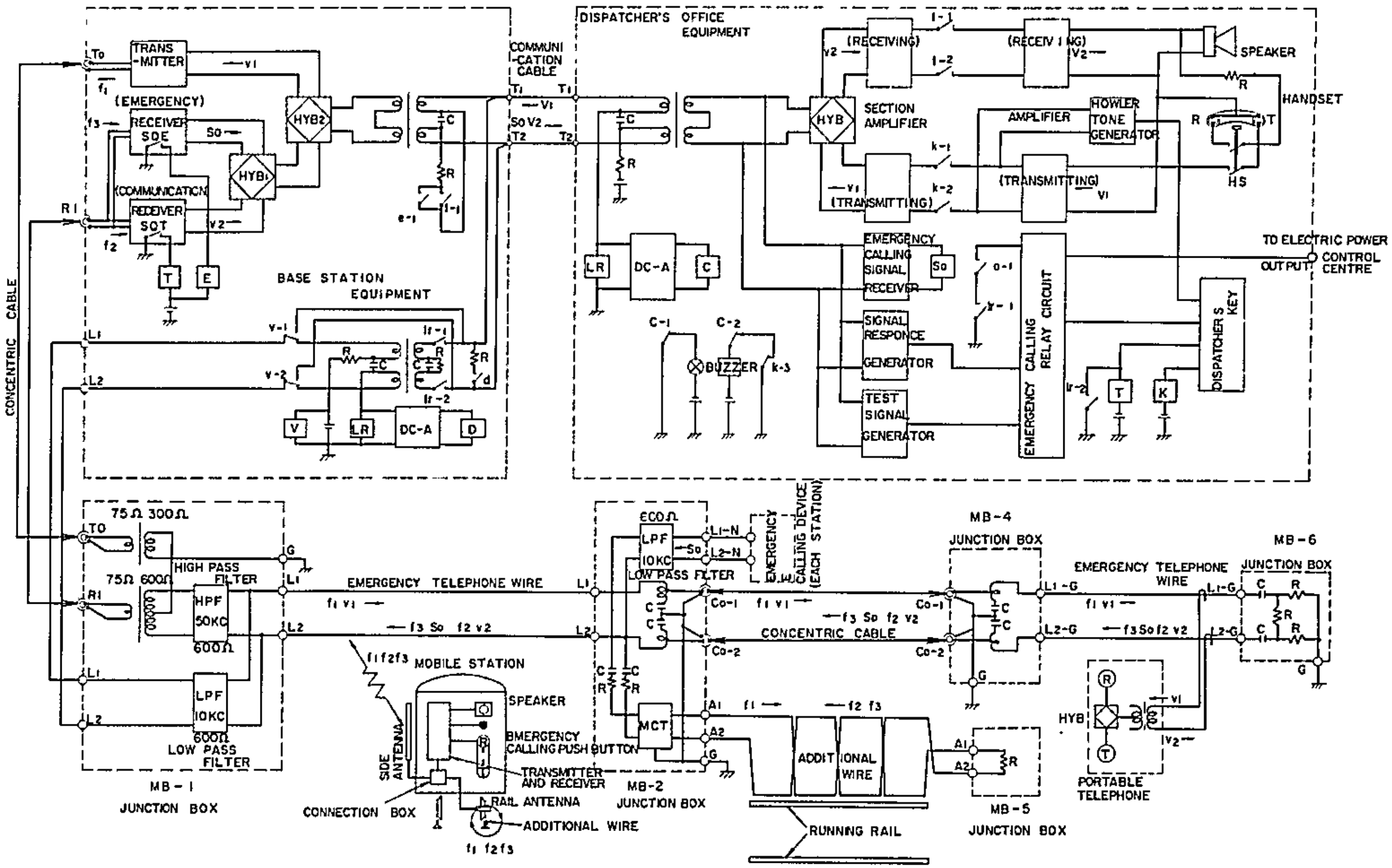


LAY OUT



* C T C ' CENTRALIZED TRAFFIC CONTROL

Fig. 7—41 Inductive Radio System

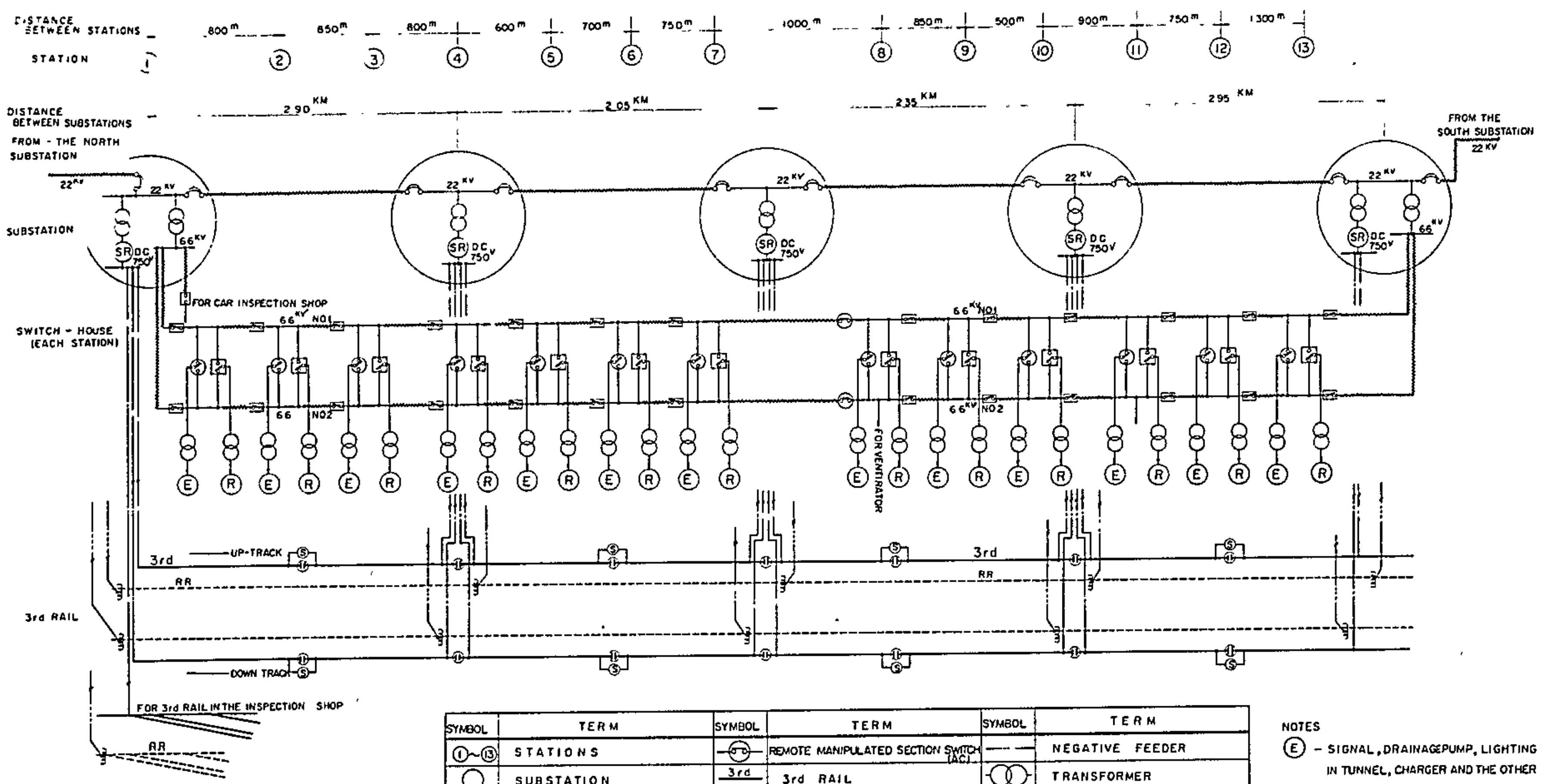


* FREQUENCY ALLOCATION

f_1	185 KC	So	4875 c/s
f_2	155 KC	v_1 v_2	300 ~ 2700 c/s
f_3	135 KC		

L R	LINE RELAY	MCT	EARTH RETURNCIRCUIT - METALIC CIRCUIT EXCHANGER
C D	CHECK CURRENT RELAY (FOR DETECTING BURN-OUT)	HYB	HYBRID NETWORK
T E	SQUELCH RELAY (BASE STATION)		

Fig. 7—42 Substation and Power Supply System



SYMBOL	TERM	SYMBOL	TERM	SYMBOL	TERM
①~⑬	STATIONS		REMOTE MANIPULATED SECTION SWITCH (AC)		NEGATIVE FEEDER
	SUBSTATION	3rd	3rd RAIL		TRANSFORMER
	22^{KV} 66^{KV} TRANSMISSION CABLE		RUNNING RAIL	SR	SILICON RECTIFIER
	SINGLE-THROW MANUAL OIL SWITCH		DEAD SECTION		HIGH-TENSION CIRCUIT BREAKER
	DOUBLE-THROW AUTOMATIC OIL SWITCH	S	REMOTE MANIPULATED SECTION SWITCH (DC)		IMPEDANCE BOND
	DOUBLE-THROW MANUAL OIL SWITCH		POSITIVE FEEDER		

NOTES

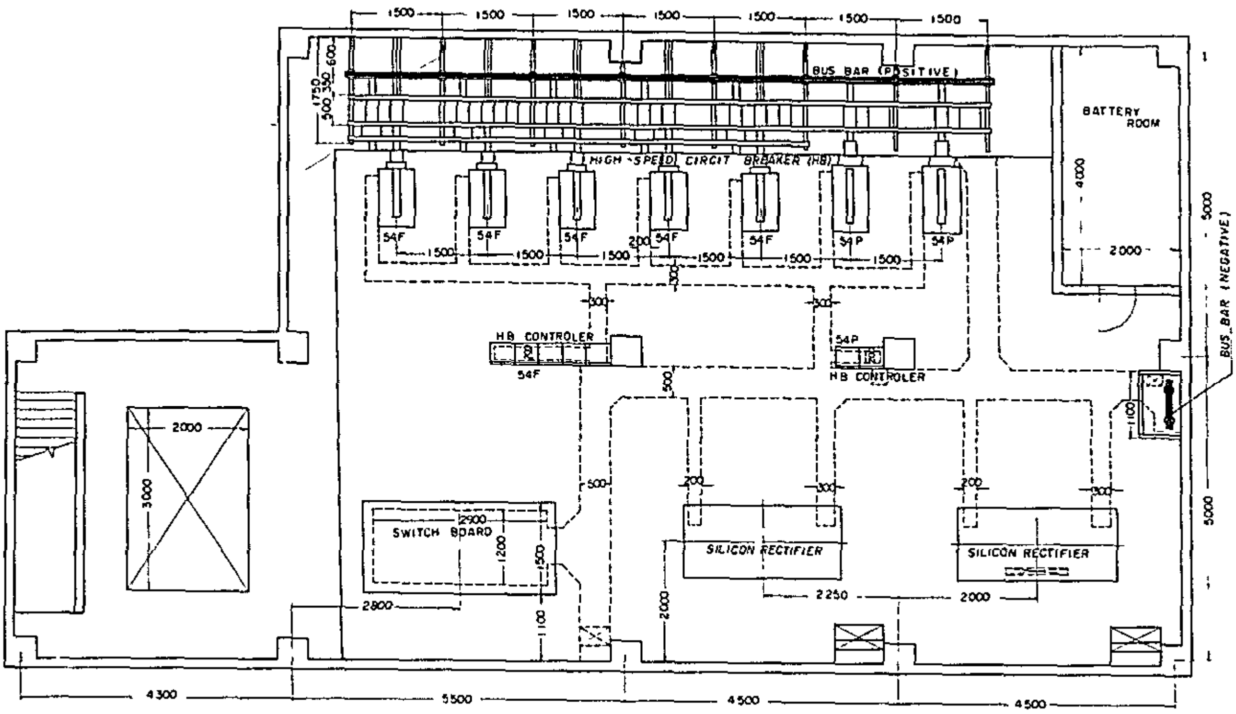
Ⓔ - SIGNAL, DRAINAGEPUMP, LIGHTING IN TUNNEL, CHARGER AND THE OTHER USE

Ⓡ - LIGHTING IN STATION, VENTILATOR, ESCARATOR AND THE OTHER USE

Fig. 7−43 Standard Layout of Substation

MEASURE mm)

LAY-OUT OF THE FIRST FLOOR



LAY-OUT OF THE GROUND FLOOR

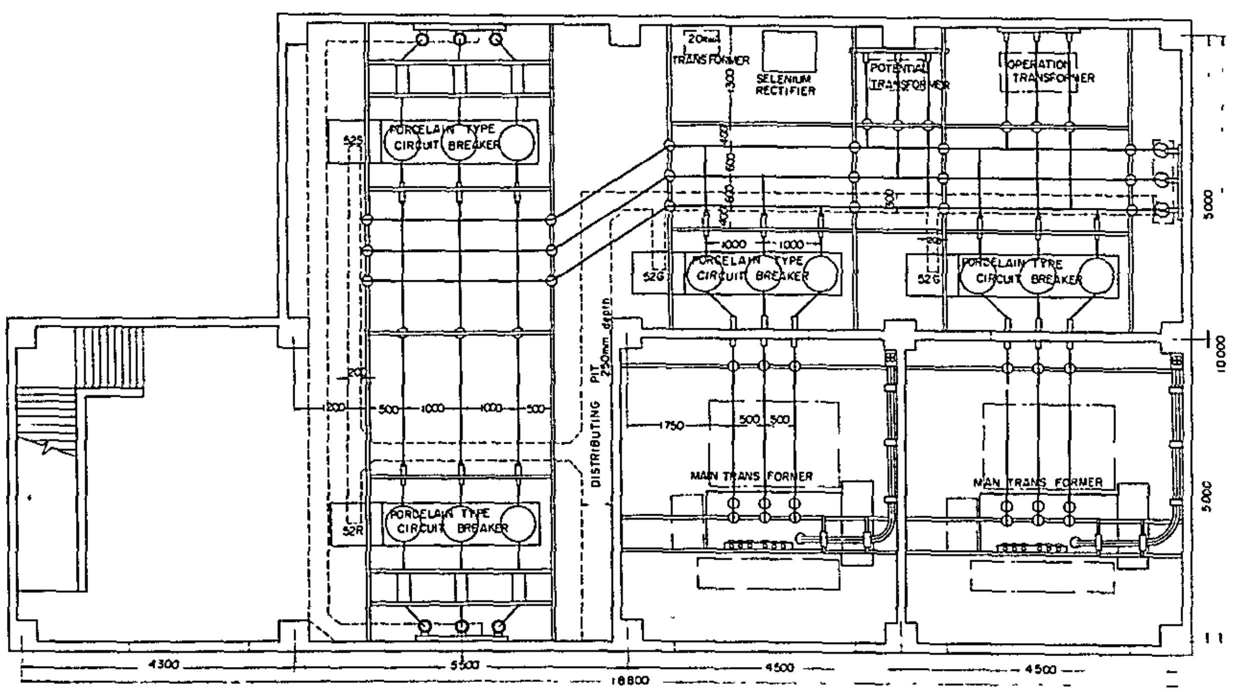
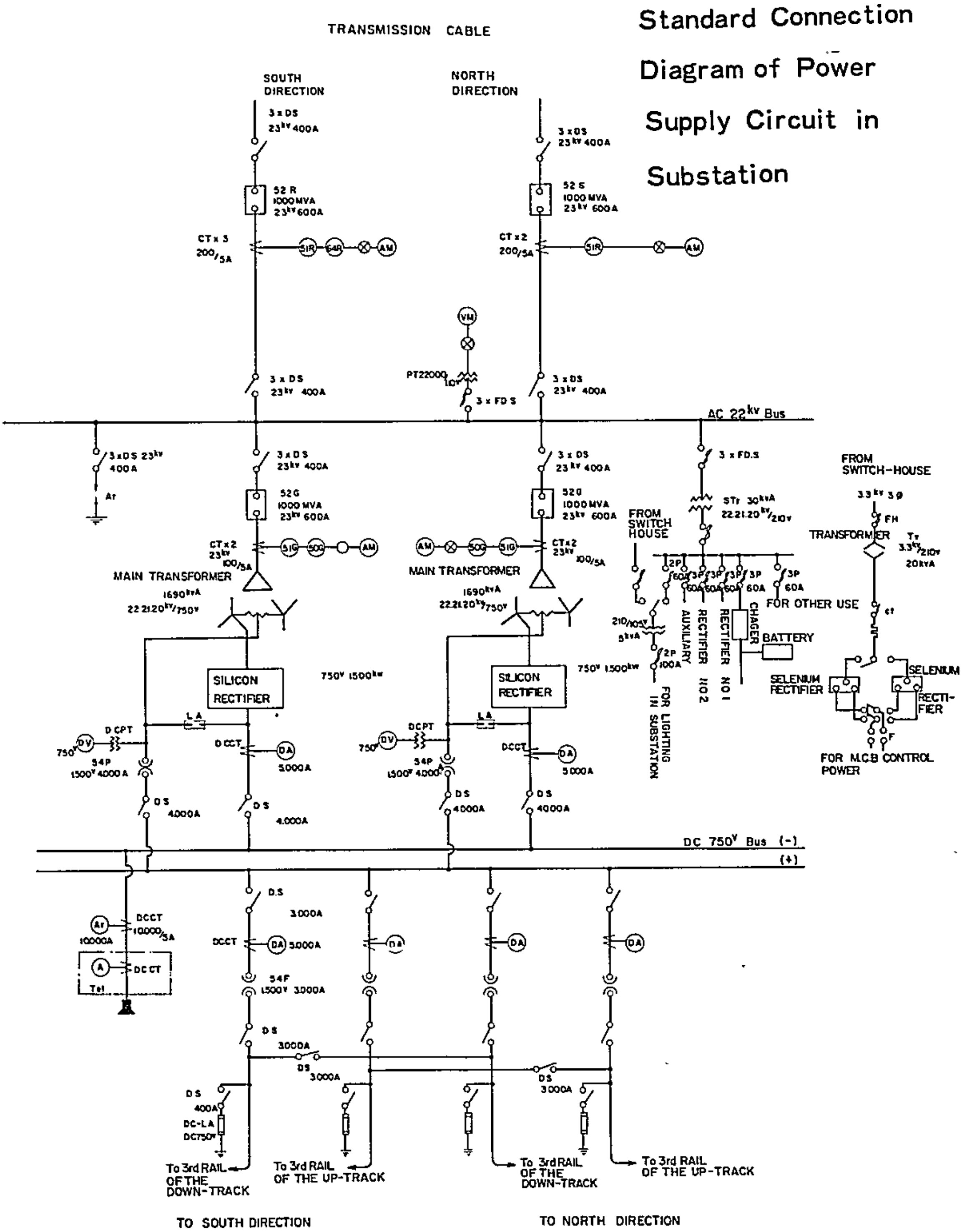


Fig. 7—44 Standard Connection Diagram of Power Supply Circuit in Substation



SYMBOL	TERM	SYMBOL	TERM
51R	OVERCURRENT RELAY		DISCONNECTING SWITCH
WHM	INTEGRATING WATTMETER		PORCELAIN TYPE CIRCUIT BREAKER
51G	OVERCURRENT RELAY		CURRENT TRANSFORMER
DV	D C VOLT METER		TRANSFORMER
DA	D C AMPARE METER		HIGH-SPEED AIR CIRCUIT BREAKER
Ar	RECORDING AMMETER		SOLUBLE DISCONNECTING SWITCH
ATel	TELEMETERING AMMETER		ARRESTER
AM	AMPARE METER		DISCHARGER
VM	VOLT METER	SIR	SILICON RECTIFIER
64R	GROUND RELAY		