社会開発協力部報告書

No. [illegible]

# THE ARAB REPUBLIC OF EGYPT

# FEASIBILITY STUDY REPORT

# ON

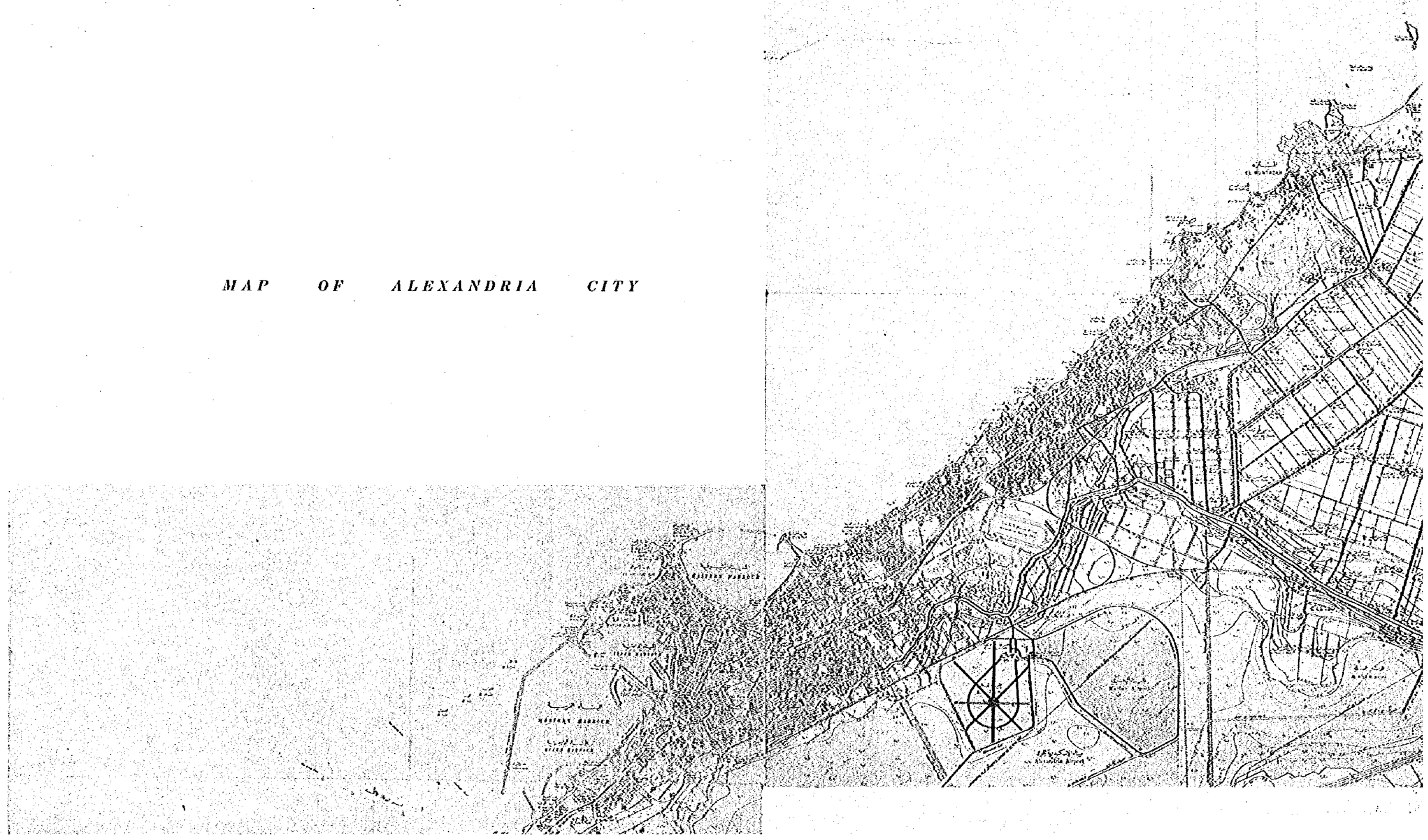
# ALEXANDRIA PCM MICROWAVE NETWORK CONSTRUCTION PROJECT



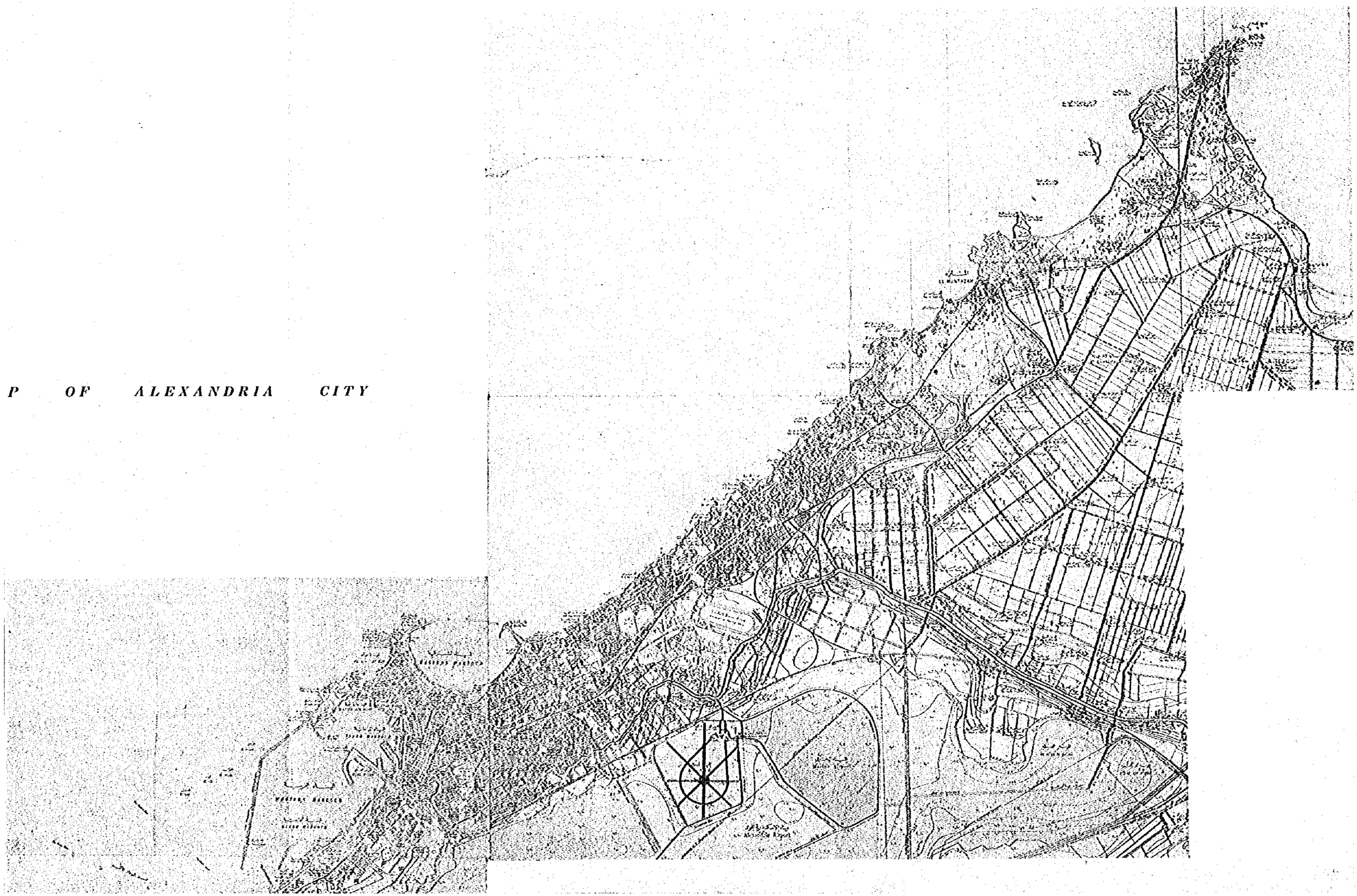
AUGUST 1981

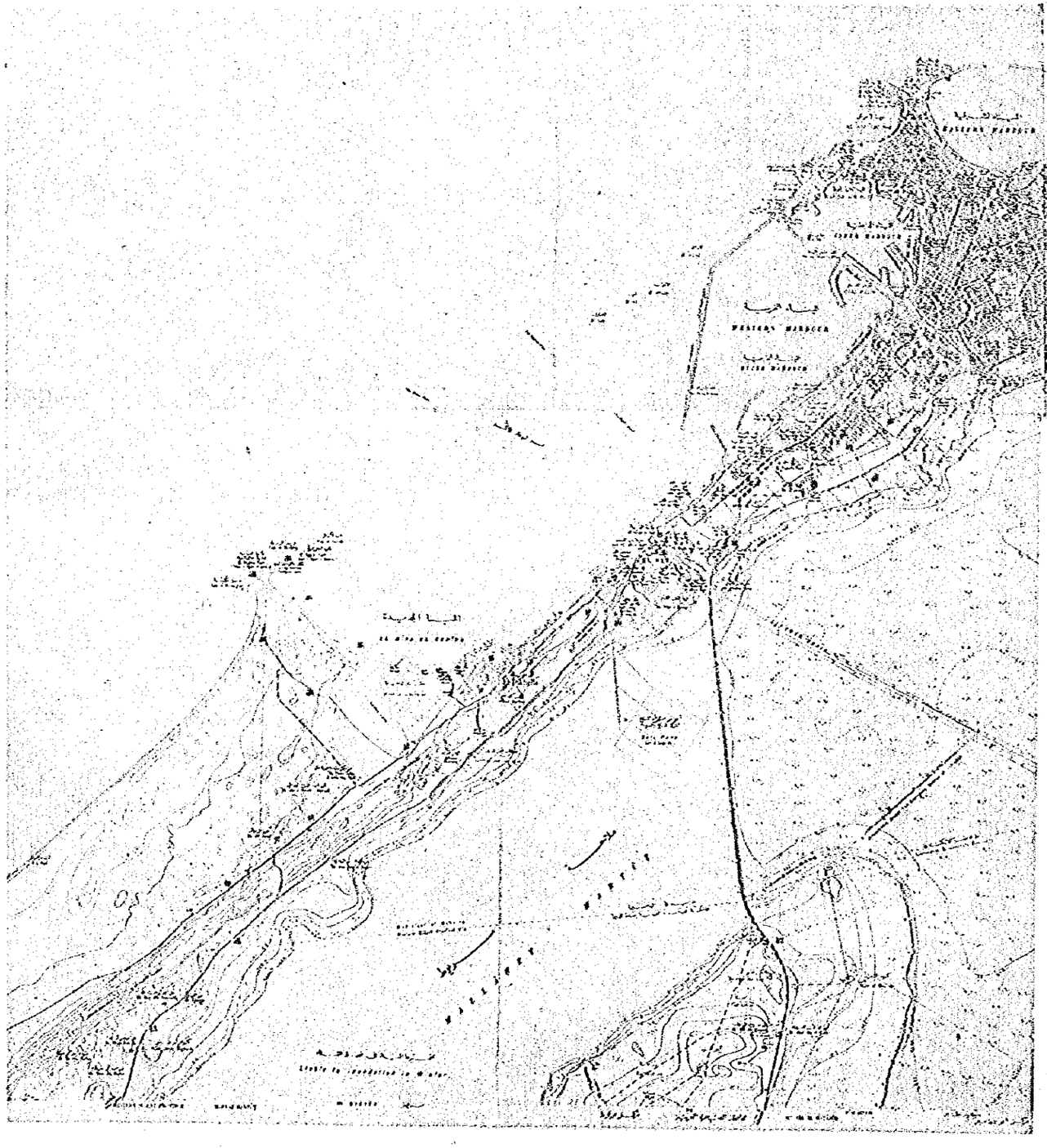
JAPAN INTERNATIONAL COOPERATION AGENCY

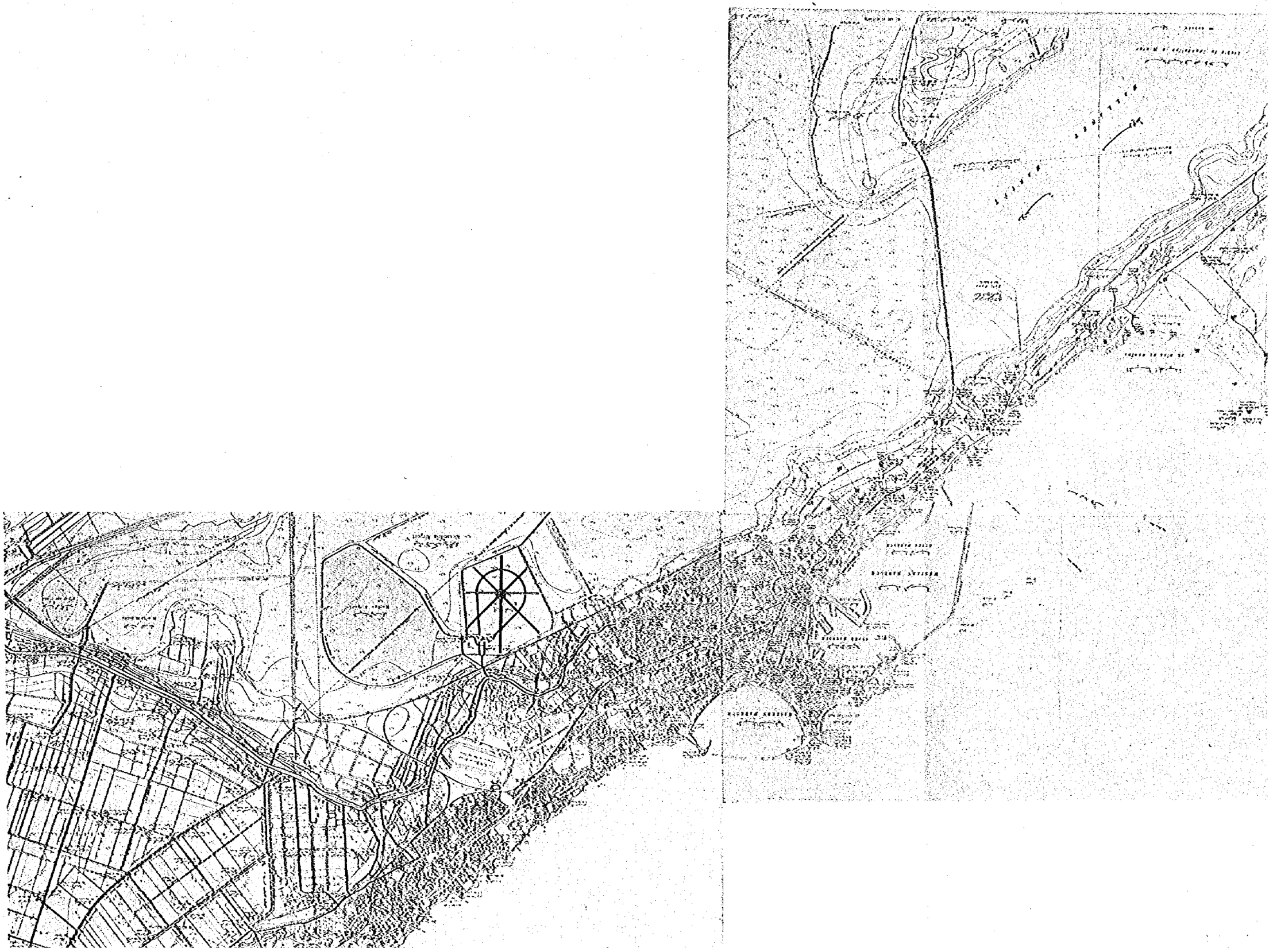
*MAP OF ALEXANDRIA CITY*



*P OF ALEXANDRIA CITY*







# PREFACE

In response to a request of the Government of Arab Republic of Egypt, the Japanese Government decided to conduct a feasibility study on PCM Microwave Network Construction Project and entrusted the survey to the Japan International Cooperation Agency (J.I.C.A.).

The J.I.C.A. sent to Egypt, a survey team headed by Mr. Yoshihiro Yokoyama, Special Assistnat to Director, Technical Investigation Division, Ministry of Posts and Telecommunications from March 24 to April 9, 1981.

The team had series of discussions and exchanged views with the official concerned of the Government of Egypt and carried out a field survey in Alexandria.

After the team returned to Japan, further studies were made and the present report has been prepared.

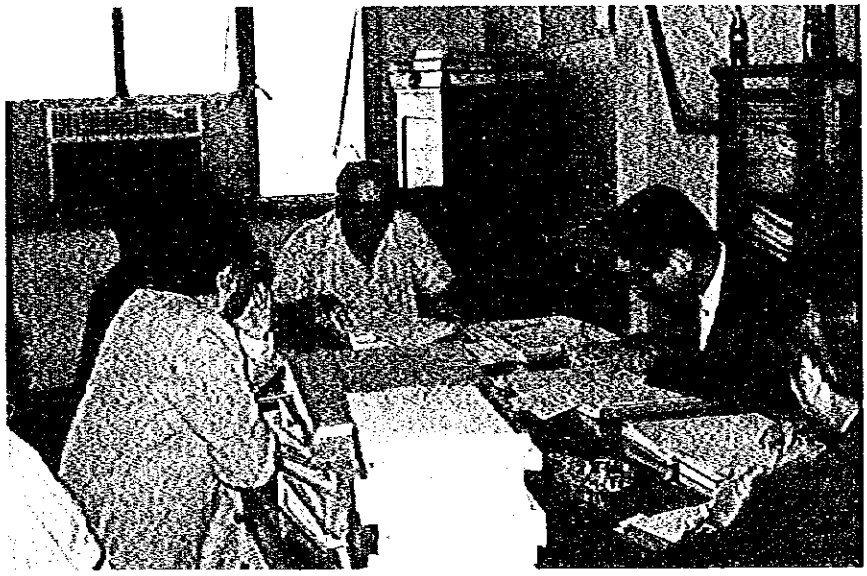
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Egypt for their close cooperation extended to the team.

August, 1981

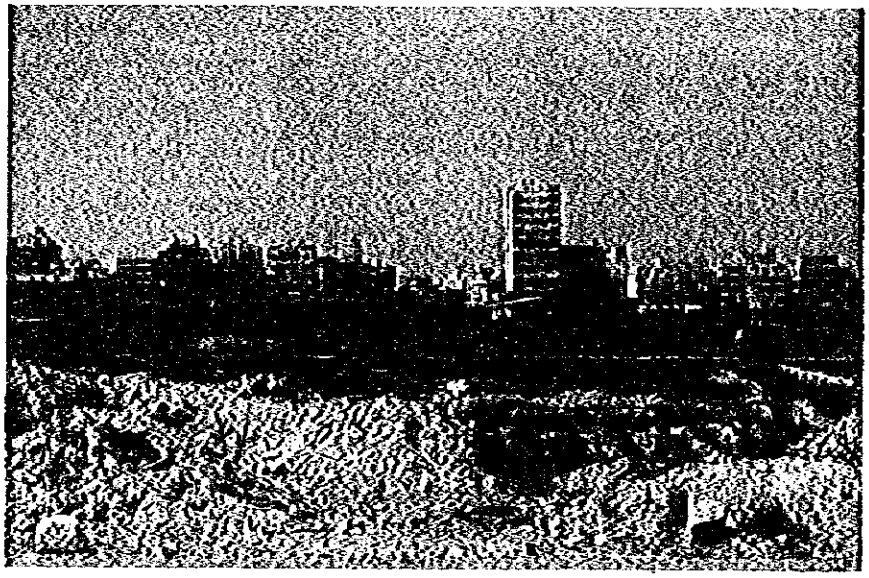
Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agnecy



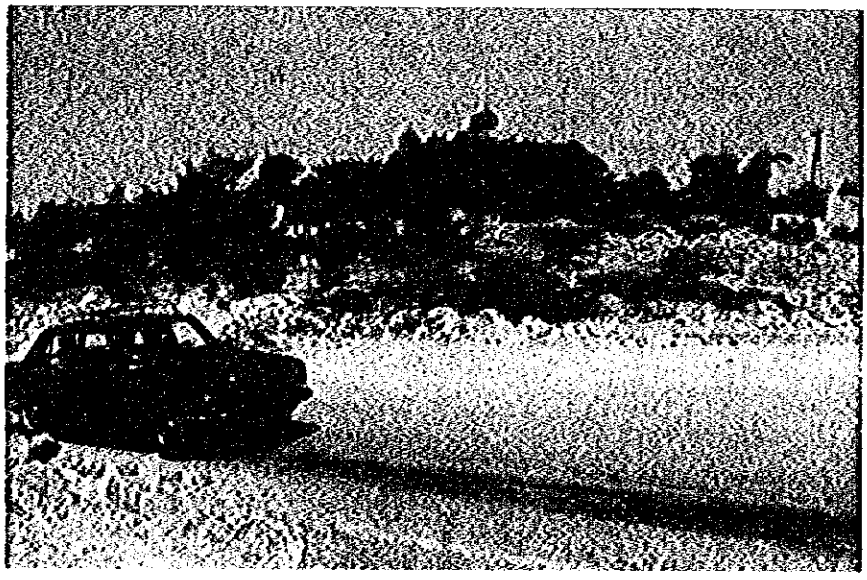
Mr. Yokoyama, Leader of Japanese Team, is signing on the meeting minutes for the final draft report on feasibility Study at the ARENTO Central office in Cairo

Mr. Nasr Eldin Hamdy, Uader Secretary of State Main Lines Seetor of ARENTO, shakes hand with Mr. Yokoyama after signing of the meeting minutes



Moharam Bey Station

El Max Station



Agami Station

Pictures show view of scheduled sites

## Contents

# SUMMARY AND RECOMMENDATIONS

SUMMARY

This project is to construct the junction network that connects the telephone exchanges in Alexandria district by PCM digital microwave system.

This junction network by PCM digital microwave system in Alexandria district, along with its counterpart in Cairo district, will perform a significant role in telecommunication services of Egypt.

The Arab Republic of Egypt National Telecommunication Organization (hereinafter referred to as ARENTO) expects Japanese cooperation in the implementation of this project. In this connection, the Japan International Cooperation Agency dispatched a feasibility study team to Alexandria for 27 days from March 24, 1981 to April 19, 1981. Earlier, in July 1980, a preliminary study team was dispatched.

The feasibility study, this time, was carried out mainly to investigate the telephone demand in Alexandria, the projected PCM microwave system route, the existing exchange building status, and the business management situation of ARENTO.

The analysis of data collected in the investigation shows that this project is fully feasible technically on condition that the microwave system route proposed in the preliminary study report be partly modified, is fully feasible from the economic viewpoint also.

Part I describes the objective, guideline, scope and background of the survey, as well as the survey team organization and the survey itinerary.

Part II presents detailed explanations of the technical feasibility study.

Section 1 deals with the method of telephone demand forecast and the demand fulfillment plan. These are outlined below.

(1) Method of Telephone Demand Forecast

By the commonly used method, i.e., by the study of correlation between GDP per capita and telephone demand density, the forecasted demand as of 1989 has been obtained.

(2) Telephone Demand Fulfillment Plan

The demand fulfillment rate as of 1989 is estimated, from the past data, to be 80% of the forecasted demand. The necessary number of channels for realizing such demand fulfillment rate is to be calculated.

Section 2 contains the traffic forecast. That is to say, by multiplying the estimated calling rate to the fulfilled segment of demand out of the demand forecast mentioned above, the originating call traffic of each exchange and the traffic distribution between exchanges have been estimated.

By such means, the necessary number of channels as of 1989 has been calculated. The number of channels thus calculated is the number of telephone circuits only. For telex and telegraph circuits, the trunk lines of the existing local network are to be utilized.

Section 3 pertains to the composition, performances, installation, as well as operation and maintenance, of the PCM digital microwave network. The training plan for personnel to be in charge of the network operation and maintenance and the estimated cost of network construction are also described. Items concerned are summarized below.

| | | |
|---|---|---|
| (1) | Route plan: | Refer to Figure II-4. |
| (2) | Frequency plan: | To conform to CCIR Rec. 387-3. Slot frequency plan of 11 GHz band (10.7 - 11.7 GHz) is to be used. Refer to Figure II-5. |
| (3) | PCM digital hierarchy: | Japan or North America Standard whose primary group is of 1544 Kbit/s. |
| (4) | Transmission capacity: | 100 Mbit/s (1440 ch) or 90 Mbit/s (1344 ch). |
| (5) | Number of RF channels: | Refer to Figure II-6.<br>Max. 9 + 1 for Auto - Moharam Bey section<br>Min. 1 + 1 for Sidi Bishr - Abu Qir section |
| (6) | Antennas and towers: | Refer to Figure II-7.<br>New towers:<br>92 m at Moharam Bey<br>60 m at Sidi Bishr<br>50 m at Agami and El Max<br>40 m at Ibrahimya<br>7 m at Manshia |
| (7) | Transmission quality: | To satisfy the objectives given in ANNEX to CCIR Report 378-2. |

(8) Power supply: Necessary AC power will be supplied by ARENTO and necessary DC power is to be supplied by Contractor.

(9) Installation and Testing:

Installation work is to be carried out by the Contractor on turn-key basis. Testing comprises in-factory test and field test.

(10) Training:

Training consists of in-factory training and on-the-job training. Each is to be administered for approximately two months.

(11) Operation and Maintenance:

For operation and maintenance, the respective systems are to be organized so that the required services can be provided systematically. Both operation and maintenance are to keep the system in normal working status.

(12) Implementation Schedule

Work schedule is to be so arranged that the system can be put into service in approximately 24 months after the date of tender closing. All work stages are to be mutually coordinated according to such work schedule.

(13) Employment of Consultant:

Consultant is to be employed in order to have work progress for project implementation managed as required in accordance with the preceding paragraph (12).

(14) Cost estimate is based on up-to-date data collected.

Section 4 describes the composition and performances of the conventional FDM/FM analog microwave network. The requirements with regard to installation, operation, maintenance and personnel training are pursuant to those in the case of PCM system in the preceding Section 3. The project cost estimate appears in Table II-13.

The summary description of the items concerned follows:

| | | |
|---|---|---|
| (1) | Route plan: | Same as for the digital network. |
| (2) | Frequency plan: | To conform to CCIR Rec. 387-3. Normal frequency plan of 11 GHz band (10.7 - 11.7 GHz) is to be used, in principle. Slot frequency plan will be used for some portions of the network so as to avoid interferences. Refer to Figure II-10. |
| (3) | FDM hierarchy: | To abide by relevant CCITT Recommendations. |
| (4) | Transmission capacity: | 1200 ch/RF ch |
| (5) | Number of RF channels: | Refer to Figure II-11. Max. 10 + 1 for Auto-Moharam Bey section Min. 1 + 1 for Sidi Bishr-Abu Qir section |

| | | |
|---|---|---|
| (6) | Antennas and towers: | Refer to Figure II-12.<br>An additional antenna is required at each station in the following radio sections:<br>Auto - Moharam Bey<br>Moharam Bey - Ibrahimya<br>Moharam Bey - Glym<br>The tower to mount such additional antenna is accordingly required to have greater rigidity. |
| (7) | Transmission quality: | Hourly mean noise: To satisfy CCITT Rec. G123.<br>Outage due to fading: To satisfy CCIR Rec. 395. |
| (8) | Power supply: | Necessary AC power will be supplied by ARENTO while necessary DC power is to be supplied by Contractor. |

Described in Section 5 are the basic requirements for 10 exchange, both existing and newly planned in Alexandria City, which this Project covers. Those requirements pertain to:

(1) Room or floor space where to install the microwave communication equipment required by this Project;

(2) Tower to mount the parabolic antenna for microwave communication planned by this Project.

Exchanges to have the microwave communication equipment installed in the eixsting exchange buildings number four. They are Sidi Bishr, Sidi Gaber, Manshia and Auto. Exchanges to have annexes newly built or to have new exchange builings constructed at separate sites, where to install the cmmunication equipment, are three. They are Ibrahimya, Abu Qir and Glym. The non-existing, i.e., newly planned exchanges to have the communication equipment installed in the newly built exchange buildings are three. They are Moharam Bey, El Max and Agami.

Exchanges to have parabolic antenna mounted on the existing tower or the tower under construction (as of the time of field survey) number four. They are Abu Qir, Sidi Gaber, Auto and Glym. Exchanges to have the self-support ground tower newly erected are four. They are Sidi Bishr, Moharam Bey, El Max and Agami. Manshia Exchange is to have the roof-top tower newly erected. Ibrahimya Exchange is to have the roof-top tower newly erected on the scheduled annexe building.

Ibrahimya is the exchange which is built at the very small site so that, for the construction of annexe building, the limited land space must be utilized to the maximum. Not only for the construction of annexe building but also for the erection of new roof-top tower, special circumspection is required.

It is up to ARENTO to arrange the room or floor space, where to install the microwave communication equipment and associated facilities (power supply and air-conditioning facilities), in the existing and/or newly planned exchange building. Construction of tower foundation is also up to ARENTO.

All exchanges concerned are to have the switching equipment newly installed or increased or replaced by another project. For accommodation of such switching equipment and associated facilities in the exchange buildings, concrete plans could not be known at the time of field survey. However, this switching equipment accommodation is considered to have intimately to do with the accommodation of microwave communication equipment and associated facilities in the exchange buildings by this Project.

The proposal for exchange buildings relating to this Project is based on the fact-finding judgment at the time of field survey. Therefore, when formulating the working program for this Project, it is important to make full consideration of relationships with construction works by other project.

Part III presents detail explanations of the economic and financial project evaluation.

In case the PCM digital microwave network is introduced in the local transmission system of Alexandria, the internal rate of return of the Project can be estimated at 10.05%. This estimate reflects the expectancy for the favorable cost performance in the case of PCM digital microwave transmission system, i.e., lower construction cost combined with higher operation efficiency, compared with the FDM/FM transmission system.

Such economic advantage is taken into full account in the financial evaluation of the Project. The result is the internal rate of return quoted above. In case where the FDM/FM microwave network is adopted in place of the PCM microwave network, the internal rate of return of the Project is estimated at 7.76%.

The economic data used in this analysis are on the assumption that the basic costs and benefits be evaluated by:

(1) The management capability of ARENTO;
(2) The existing telephone tariff system;
(3) The correlation between forecasted telephone traffic demand and projected number of circuits in the light of the Five-Year National Development Plan.

In the financial evaluation of the Project, it is taken for granted that the existing telephone tariff rates, the structure of which is based on metering of local calls (without free calls), toll calls and international calls are conservative. This signifies that the current call charge of 3 piasters (100 piasters to one Egyptian pound) per call is to be reviewed and raised to, but not exceeding, the level that prevails in many other countries.

The proposed local call tariff rate raises, to begin near future are twofold:

(1) From 3 piasters to 4 piasters per call;
(2) From 3 piasters to 5 piasters per call.

Assume that the data with regard to the traffic demand forecast in Alexandria district would hold true over a long term even after the proposed telephone tariff markup. Then, with the PCM digital microwave system adopted, the internal rate of return is estimated at 14.40% in case of 4 piasters per call and 18.22% in case of 5 piasters per call, respectively.

To improve the earning power of this project and thereby make this project more profitable, it is desirable that the existing tariff system be reconsidered and reorganized. It can also be said that ARENTO, by taking full advantage of the subsidy from the the treasury so as to promote the project implementation as desired, can make this project much more feasible.

Assume that the foreign currency loan to finance the procurement of equipments and materials required for project implementation be available at the interest rate of 3.5% per annum and with the grace period of 10 years. Then, the net profit to net worth ratio of ARENTO will be 85%. Meanwhile, the foreign currency loan mentioned above fills 91% of the total project cost. Thus, from the angle of ARENTO's procurement fund, this project can be evaluated as being feasible.

Completion of a total local network relating to this Project in Alexandria will create a new system function. Such new system function can absorb the telephone traffic demand that increases as the service grade improves. At the same time, the new system function goes a long way toward enhancing the economic productivity of Egypt through speedy and accurate information exchange not only in the local call area but also in the widely spread trunk call territories.

RECOMMENDATIONS

For the implementation of this project, the following recommendations are made:

(1) Radio System to be Adopted

The 11 GHz band PCM digital microwave system (24 CH base) should be adopted. This system is superior to the 11 GHz band FDM/FM analog system in these respects:

1) Pulse regeneration repeating is performed so that the frequency distortion in proportion to the number of repeating as in the analog system seldom occurs. Hence high quality of system performance.

2) Because of a high degree of immunity from radio interference, the formation of a number of PCM radio routes from one station is possible.

3) When RF channel is full-mounted, the number of antennas can be reduced by half. Hence, the tower erection cost can be reduced.

4) The cost of carrier terminal equipment is low, therefore, project cost is low priced.

(2) Modification of Path Route of Previously Proposed PCM Microwave Network

The route map for microwave network proposed in the preliminary study report is to be partly modified as undermentioned. This modification is for transmission performance improvement and for elimination/suppression of reflected wave in over-the-sea radio propagation. The modification is from economic consideration also, such as utilizing as many existing towers as possible.

(3) Operation and Maintenance

For the purpose of effective, as well as economic, operation and maintenance of PCM digital microwave system, it is recommended to make Moharam Bey Station an attended station while making the remaining nine the unattended station to receive itinerant maintenance from the attended Moharam Bey Station.

At Moharam Bey station as the attended station, the efficient organizations for operation and maintenance services, respectively, must be established.

(4) Radio, Carrier Equipment Accommodation at Ibrahimya Exchange

The existing Ibrahimya station building leaves no floor space for accommodation of radio and carrier equipments. Therefore, the building (including tower) as shown in ANNEX 5, for instance, must be completed before the time the equipment installation begins.

# PART I

# INTRODUCTION

# PART I Introduction

## 1. Objective of Study

The objective of this study is to probe into technical and economic feasibilities of the Project to establish PCM digital microwave network in the Alexandria Zone of Egypt.

## 2. Methodology of Study

The Scope of Work and the Inception Report were submitted to ARENTO on March 26, 1981.

The Scope of Work was signed by and between ARENTO and Japanese Feasibility Study Team on March 28, 1981. The Methodology of Study was determined according to the Method of Approach in the Inception Report which was based on the Scope of Work. To repeat:

### 2-1 Collection of Data and Information

Collected data on the Telecommunication Development Plan were referred to in the network plan formulation.

### 2-2 Telecommunication Demand and Traffic Forecast

Based on collected data pertaining to telecommunication demand and traffic, forecast was made with regard to the number of circuits required between exchanges.

## 2-3 Recommendation of Technical Standards for Telecommunication Facilities to be Provided

The technical standards to be recommended were formulated by means of taking into account of the up-to-date techniques concerned, CCITT and CCIR recommendations, and ARENTO's telecommunication development plan.

## 2-4 Expected Telecommunication Services, Revenues and Expenditures

Study was made in the aspect of the expected telecomunication services, as well as revenues and expenditures, after the completion of PCM digital microwave network in the Alexandria Zone. The study results were utilized in the economic and financial analyses of the Project.

## 2-5 Existing Tariff System

The existing tariff system was studied for the purpose of estimating the expected revenues from the new network system project.

## 2-6 Microwave Network Route Plan in Alexandria

The microwave network route plan for the Alexandria Zone was prepared, based on the forecasted traffic demand.

## 2-7 Microwave System Design

Although the Project, this time, is to establish PCM digital microwave system, comparison between PCM digital microwave system and FDM/FM analog microwave system was made in this feasibility study.

The microwave system design includes:

(1) Frequency assignment.

(2) Decision of minimum antenna height in consideration of possible changes in atmospheric condition.

(3) Estimation of system performance, e.g., Bit Error Rate for PCM digital microwave system and signal to overall noise ratio for FDM/FM analog microwave system.

2-8 Microwave Station Construction Plan and Design

Investigation was made with regard to floor space and power supply system availabilities in the existing exchanges.

Possibilities of tower erection atop the existing exchange buildings and of additional antenna mounting on the existing towers were examined, based on detailed data obtained.

2-9 Implementation Schedule

The project implementation schedule was formulated, covering the whole period from closing of tender up to completion of acceptance test.

2-10 Operation and Maintenance

Study was made on operation and maintenance of the microwave system provided. Necessary recommendations on personnel training, as well as system operation and maintenance, were provided.

## 2-11 Cost Estimate

Cost estimate was made for PCM digital microwave system and for DFM/FM analog microwave system.

The total cost includes individual costs of spares training, installation, as well as in-station and overall system tests, and transportation, by the following assumptions:

| | | |
|---|---|---|
| (1) | Servie-in of new system: | Approx. 24 months after closing of tender |
| (2) | System life: | 15 years |
| (3) | Provisioning period: | 1989 (5 years after service-in) |
| (4) | Costof building Construction/modification: | Not included |
| (5) | Type of contract: | On turn-key basis |
| (6) | Other cost items: | Training fee, Consultant service fee |

## 2-12 Economic and Financial Analyses

Economic and financial analyses were made, using data on:

- Project cost estimate as per the preceding paragraph
- Annual operation and maintenance cost
- Expected revenue calculated basing on traffic forecast and telecommunication tariff system
- Others.

## 3. Scope of Study

Scope of study includes:

(1) Field survey

- investigate telephone demand
- prepare telephone network plan
- investigate site and radio path condition of the microwave link
- investigate conditions of buildings and towers
- collect data and information on economic and finacial analyses

(2) Report

Preparation of final report on feasibility of the PCM digital microwave network in Alexandria

## 4. Background of Study

The City of Alexandria forms the multi-exchange zone, and a mesh-form network with approximately 5,100 circuits is established, interconnecting the existing seven exchanges.

These exchanges are interconnected by the underground cable system for the most part. By reason of cable aging and difficulty of cable system maintenance due to incompletness or absence of plant records, on the average, 28% of circuits are in trouble and 48% of circuits are out of standard.

In order to redress such situation rapidly and thereby contribute to the municipal development of Alexandria, ARENTO intends to improve the telecommunication system in the City of Alexandria as part of the 1980-1984 five-year plan, and has arranged with the Japan International Cooperation Agency (JICA) to make necessary studies for that purpose.

In response, JICA dispatched a preliminary study team in July 1980. Subsequently, by a further probe into the ARENTO request, JICA found that ARENTO was desirous of introducing the PCM digital microwave network for improvement of the interconnections between exchanges in the City of Alexandria and was expecting the Japanese cooperation in realizing the plan.

Then, JICA dispatched the feasibility study team with respect to the introduction of PCM digital microwave network in the City of Alexandria. The study team carried out the necessary field survey for a period from March 24, 1981 to April 19, 1981, and has studied the feasibility and prepared this report in Japan.

5. Organization of The Study Team and Responsibility Areas of Team Members

The study team was composed of seven (7) members. Their names and responsibility areas are listed below.

| Name (Symbol) | In Charge of | Affiliated to |
|---|---|---|
| Yoshihiro Yokoyama | Member of Advisory Committee | Specialist. Technical Investigation Division, Radio Regulatory Bureau, Ministry of Posts and Telecommunications. |
| Seiichiro Kamimura (A) | Team Leader Radio Engineering | Manager, Technical Dept., The Nippon Telecommunications Consulting Co., Ltd. |
| Haruo Ishizuka (B) | Radio Engineering | Chief Engineer International Operation Division, The Nippon Telecommunications Consulting Co., Ltd. |
| Takashi Suenaga (C) | Network Planning | Senior Engineer, International Operation Division, The Nippon Telecommunications Consulting Co., Ltd. |
| Koichi Tamura (D) | Building & Tower | Architect, Planning Division, The Nippon SOGO Architectures and Engineerings. |
| Takeshi Komiya (E) | Economic & Financial Analysis | Economist, International Operation Division, The Nippon Telecommunications Consulting Co., Ltd. |
| Toshio Nakamura | Coordinator | Social Development Cooperation Department, Japan International Cooperation Agency. |

## 6. Itinerary of Study

The itinerary of study at Cairo and Alexandria appears in Table I-1.

Note: Symbol of Member in Table I-1 shows Symbol of members in parenthesis.

TABLE I-1 ITINERARY OF FEASIBILITY STUDY IN CAIRO AND ALEXANDRIA

| Date | Day | Member | Activity | Place |
|---|---|---|---|---|
| 1981 | | | | |
| Mar. 24 | Tue | A - E | Leaving from Tokyo | |
| | | Advisory Committee | | |
| " 25 | Wed | " | Arriving at Cairo | |
| " 26 | Thu | " | Meeting (Discussion on SOW and Inception Report) | ARENTO/OPERA |
| " 27 | Fri | " | Data collection | |
| " 28 | Sat | " | Signing of SOW and preparation for field survey | ARENTO/OPERA |
| " 29 | Sun | " | Preparation for field survey | |
| " 30 | Mon | " | Moving from Cairo to Alexandria | |
| " 31 | Tue | " | Meeting (Explanation of field survey) | ARENTO/Alex. (Auto Exch.) |
| | | A & B | Quick observation | Manshia, Ibrahimya, Sidi Gaber, Glym, Sidi Bishr, Abu Qir |
| | | C & D | Quick observation | El Max, Bianqi, Hanoville, Auto. |
| | | E | Data collection (organization, revenue and expenditure in Alexandria area) | |
| Apr. 1 | Wed | A,B,C & D | Discussion on Moharam Bey (M/B) site | Manshia |
| | | | Quick observation | Manshia, Ibrahimya, Sidi Gaber, Glym, M/B sites accompanied by ARENTO Civil Eng. |
| | | E | Data collection (organization, revenue and expenditure in Alexandria area) | ARENTO/Alex. (Manshia) |
| Apr. 2 | Thu | A | Site and radio path survey | Manshia |
| | | B | - do - | Bianqi |
| | | A | - do - | Auto |
| | | B | - do - | El Max |

| Date | Day | Member | Activity | Place |
|---|---|---|---|---|
| Apr. 2 | Thu | B | Site and radio path survey | Hanoville |
| | | C & D | Quick observation | Sidi Bishr, Abu Qir |
| | | E | Data collection (organization, revenue and expenditure in Alexandria area) | ARENTO/Alex. (Manshia) |
| Apr. 3 | Fri | A,B,C & D | Review of survey results and collected data and information | |
| | | E | Moving from Alexandria to Cairo together with Advisory Committee | |
| Apr. 4 | Sat | A & D | Site and radio path survey | Manshia |
| | | B & C | - do - | Agami |
| | | A & D | - do - | Auto |
| | | B & C | - do - | El Max |
| | | E | Meeting (reporting the progress) | ARENTO/OPERA |
| | | | Meeting (explanation of the investigation purpose to ARENTO) | ARENTO/RAMSIS |
| Apr. 5 | Sun | A & C | Site and radio path survey | Ibrahimya, M/B |
| | | B & D | - do - | Ibrahimya |
| | | A & C | - do - | M/B |
| | | B & D | - do - | Sidi Gaber |
| | | A & C | - do - | M/B |
| | | B & D | - do - | Glym |
| | | E | Meeting (discussion for data collection of statistics) | ARENTO/STATISTIC Office, Cairo |
| Apr. 6 | Mon | A,B,C & D | Site and radio path survey (Field survey was interrupted due to bad weather) | Sidi Bishr |
| | | | Review of survey results | |
| | | E | Data collection (5-year plan) | ARENTO/RAMSIS |
| Apr. 7 | Tue | A,B,C & D | Site and radio path survey | Sidi Bishr, Abu Qir |
| | | A & C | - do - | Sidi Bishr, M/B |
| | | B & D | - do - | Sidi Bishr |
| | | E | Data collection (Financial data) | ARENTO/RAMSIS |
| Apr. 8 | Wed | A & C | Site and radio path survey | Auto, M/B |
| | | B & D | - do - | Auto |
| | | A & C | - do - | M/B |
| | | B & D | - do - | Glym |

| Date | Day | Member | Activity | Place |
|---|---|---|---|---|
| Apr. 8 | Wed | E | Data collection (Financial data) | ARENTO/RAMSIS |
| Apr. 9 | Thu | A,B & D | Site survey | Manshia |
| | | A & B | System design (Explanation of method of system design of PCM microwave system to ARENTO counterpart) | ARENTO/Alex. (Auto) |
| | | C | Explanation of network planning to ARENTO counterpart | ARENTO/Alex. (Auto) |
| | | D | Review of collected data/information | ARENTO/Alex. (Auto) |
| | | E | Data collection (Financial data) | ARENTO/OPERA |
| | | | Meeting (report to Mr. Mohamed Ismail) | ARENTO/RAMSIS |
| Apr. 10 | Fri | A,B,C & D | Review of survey results | |
| | | | Data collection | |
| Apr. 11 | Sat | A,B,C & D | Meeting (Explanation of progress of study) | ARENTO/Alex. (Auto) |
| | | E | Data collection (organization data) | ARENTO/RAMSIS |
| Apr. 12 | Sun | A,B,C & D | Moving from Alexandria to Cairo | ARENTO/RAMSIS |
| | | E | Meeting (procedure to enter the Central Agency for Public Mobilization and Statistics) | |
| | | | Data collection | Central Agency for Public Mobilization and Statistics |
| Apr. 13 | Mon | A,B,C,D & E | Meeting (reporting the progress of the study) | ARENTO/OPERA |
| Apr. 14 | Tue | A,B,C,D & E | Preparation of the Progress Report | |
| Apr. 15 | Wed | A,B,C,D & E | - do - | |
| Apr. 16 | Thu | A,B,C,D & E | Meeting (Submission of the Progress Report) | ARENTO/OPERA |
| Apr. 17 | Fri | A,B,C,D & E | Collection of Data | |
| Apr. 18 | Sat | A,B,C,D & E | Reporting with Embassy and JICA | |
| | | | Leave from Cairo | |
| Apr. 19 | Sun | A,B,C,D & E | Arrived at Narita | |

# PART II
# TECHNICAL FEASIBILITY STUDY

# PART II Technical Feasibility Study

## 1. Telephone Demand Forecast

This SECTION deals with the telephone demand forecast by years for each telephone exchange. The purpose is to forecast the required number of radio channels for local radio trunk circuits.

### 1-1 Method of Telephone Demand Forecast

For the Alexandria Zone telephone demand forecast, the 20-year plan for telecommunications network expansion (Master Plan) prepared and presented in 1978 by Continental Telephone Company of the U.S. will be referred to where necessary. The method of demand forecast employed by Continental Telephone Company is the one accepted by CCITT as being eligible. It uses the correlation between "Telephone Demand Density" and "Gross Domestic Product (GDP) per Capita" and, as such, is a simple, practical method as commonly recognized. Its basic philosophy consists of the following assumptions:

(1) The national GDP of Egypt, considered by the past records, will maintain the annual growth by 5.5%. The Alexandria Zone GDP accounts for 16.2% of the national GDP.

(2) The population growth in Egypt up to 1980 was by 2% annually. From now on, the annual growth rate will be moderated to 1.5%. This is because of the downtrend that prevails in the urban areas. Meanwhile, the Alexandria Zone population is assumed to occupy 6.35% of the national total.

(3) In view of the above 1) and 2), the annual growth of GDP per capita in Alexandria Zone will be by 4%.

(4) The demand in each target year can be obtained by the following formula from the correlation between GDP per capita and telephone density per 100 inhabitants. That is:

$$\log Y = -3.619 + 1.459 \log X$$

where

Y: Telephone density per 100 inhabitants

X: GDP per capita in US Dollar (1975 Constant Price)

(5) The demand allocation among exchange areas is by the past record of waiting applicants and the size of area.

Table II-1 lists the past actuals of GDP (1972 - 1978) for the whole country and Alexandria Zone and their growth forecasts obtained by time series.
Fig. II-1 illustrates the correlation between the telephone density and GDP per capita as of 1979. The indication is made in the comparison between the world trend and the trend among Middle East countries.
Fig. II-2 graphically presents the past telephone demand growths for the whole country and Alexandria Zone and the growth forecasts for the future.
The comparison between the past records and the future estimates justifies that the demand forecast made by Continental Telephone Company be applied to the present Project.

## 1-2 Demand Forecast for Each Exchange

Table II-2 shows the demand forecasts of each exchange in Alexandria Zone. The allocation of gross demand in Alexandria Zone to each exchange in the zone is made, based on the distribution factor used by Continental Telephone Company.

## 1-3 Demand Fulfillment Plan

The Alexandria Zone telephone exchanges scheduled to be newly established or expanded by 1984 are listed in Table II-3. The number of telephones to be newly installed by 1984 is 201,000 units. This figure accounts for nearly 80% of the forecasted demand as of 1984.
The new exchange establishment plan and the existing exchange expansion plan beyond 1984 remain undecided. However, from the past records, the assumption is made that up to 80% of forecasted demand will be fulfilled. (Refer to Fig. II-3 wherein the dotted line indicates the 80% fulfillment level.) Therefore, the new trunk circuits will be established in the number to meet the traffic commensurate with 80% of demand as of 1989.
To meet the traffic increase resulting from the demand growth after 1989, it is recommended to consider a different system for local junction circuit (e.g., the glass fiber cable system). Reasons for the recommendation are as follows:

(1) By means of system route duplication, interruption of local junction circuit at the time of system malfunctioning or natural disaster can be avoided.

(2) By reason of the increase of high rise buildings, both the new establishment and the extension of radio local junction circuits have become technically difficult.

## 2. Traffic Forecast and Number of Channels to be Established

### 2-1 Traffic Forecast

#### 2-1-1 Originating and Terminating Calling Rate Estimates

When estimated from the average number of busy hour calls given in data (July-December, 1980) by the Traffic Department of ARENTO Alexandria, the originating and terminating calling rates, classified by call categories, are as follows:

| Call Category | Originating Calling Rate (Erl.) | Terminating Calling Rate (Erl.) |
|---|---|---|
| Local calls | 0.006 | 0.06 |
| Special calls | 0.003 | - |
| Toll calls (automatic, manual) | 0.004 | 0.008 |
| Total | 0.0067 | 0.068 |

The method of calling rate estimation as per above is explained in the ANNEX-1

#### 2-1-2 Calculation of Local Junction Traffic

Suppose that the total originating calls of Exchange in the target year of estimate is Ty(i). Then, Ty(i) can be obtained by the following formula:

$$Ty(i) = OCR \times Ly(i)$$

where

OCR : Originating calling rate. Here, OCR is set at 0.067.

Ly(i): Number of subscribers of Exchange i in the year y. Here, the demand at each exchange is used on the assumption that the demand is fulfilled 80%.

The traffic between exchanges is estimated by the following formula:

$$Ty(i \rightarrow j) = Ty(i) \times \frac{Ly(j)}{\sum_{n} Ly(i)}$$

where

Ty(i → j): Junction traffic from Exchange i to Exchange j in the year y

Table II-4 presents the total originating call estimates of each exchange in the years of 1989, 1994 and 1999. The traffic between exchanges in the year 1989 is shown in Table II-5.

## 2-2 Number of Channels to Be Established

The number of channels to be established in this Project is listed in Table II-6. The number of channels calculation is based on the traffic between exchanges as of 1989 as per Table II-5. The calculation criteria follow:

(1) To calculate the number of channels by Erlang B Formula with loss rate 1/100

(2) To make 80% of the number of circuits calculated as per above the number of channels to be established, based on the principle of fulfilling 80% of demand.

For purpose of reference, the number of circuits required as shown in ARENTO's five-year plan (1980 - 1984) is given in Table II-7.

## 2-3 Traffic Routing

From the locational relationships of all exchanges, decision has been made to make Moharam Bey the control center and Auto the sub-control center of the digital microwave network.
The motivation for choosing Auto as the sub-control center is, besides the geographic consideration, that, even if Moharam Bey comes into trouble, the whole system will not be crippled as long as Auto remains in normal operation, or, more precisely, the normal operation will be maintained at least among the exchanges that belong to Auto.

Originally, the junction network center should, at the same time, be the group center of the Alexandria area. This means that the center exchange must be provided with the trunk switching equipment having sufficient capacity, as well as the manual switching equipment.

However, in ARENTO's five-year plan to be completed in 1984, there is no concrete indication concerning the establishment of new trunk switching equipment. Therefore, the trunk circuits and special service circuits from all other exchanges will continue to be concentrated at the existing trunk exchange (Auto), so that, in the exchange hierarchy, Auto is bound to be the group center.

The trunk switching equipment at Auto is limited in the number of circuits. Hence, a new, large capacity trunk switching equipment will have to be established in the near future.

However, considering the exchange floor space and tower capacity at Auto, the new trunk switching equipment should be installed at Moharam Bey instead of Auto and, at the same time, all trunk circuits and international circuits presently terminated at Auto should be transferred to Moharam Bey.

## 2-4 Existing Cable Junction Network

Utilization of the existing cable junction is not to be considered for telephone network after completion of radio junction network.
The existing cable junction may be used for telex network or lease circuits.
And also, the existing 2 GHz - 60 CH Digital Microwave junction system which was supplied by Japanese Contractor may be used for back-up system for traffic in summer season.

## 3. PCM Digital Microwave Network Plan

### 3-1 Microwave Network Route

The presently planned microwave network will interconnect 10 exchanges in the City of Alexandria and its suburbs, placing the center of these exchanges at Moharam Bey.

The City of Alexandria is located in the 3-4 km wide oblong seaboard area facing the Mediterranean Sea. Therefore, it is difficult to establish the microwave network in the star form centering upon Moharam Bey because of microwave interference.

The route plan formulated in overall considration of the transmission capacity and network performance of the network, RF channel arrangement and the field survey results appears in Fig. II-4.

Accroding to the network route plan suggested in the Preliminary Study Report, Bianqi and Hanoville (now combined into Agami) were to be directly linked with Manshia, however, the present plan proposes that Agami is linked directly with El Max to avoid an undesirable effect caused by reflection to be encountered on the Agami - Manshia radio path and also to shorten the radio hop length to improve the radio propagation.

The Preliminary Study Report also suggests to link Sidi Bishr and Abu Qir directly with Moharam Bey, however, the present plan proposes to link Sidi Bishr with Glym and Abu Qir with Sidi Bishr to minimize the interference and radio signal fading and to enable the use of the existing tower at Abu Qir.

## 3-2 Frequency Plan

In the presently planned PCM digital microwave network, the 11 GHz band radio frequency (RF) channel arrangement, specified in CCIR Rec. 387-3, is to be used.

The channel arrangement is illustrated in Fig. II-5.

The reason why the 11 GHz band RF channel arrangement is to be used follows:

Lower frequency bands than the 11 GHz band, e.g., 4 GHz and 6 GHz (lower and upper), should be preferentially used in the long distance trunk microwave link. And the 2 GHz band is not broad enough to accomodate the required RF channels for the projected microwave network.

That is to say, 12 systems (including one standby system) are allocated to one route. Transmission capacity per system is for 192 channels (24 CH x 4 x 2), or, more precisely, two pulse rows of secondary group in PCM hierarchy after phase modulation in four phases. Transmission capacity per route is not more than 192 CH x 11 systems = 2,112 CH/route. This transmission capacity is not adequate for large capacity transmission as in this Project.

Frequency bands higher than the 11 GHz band have also begun to be used in many countries; however, the 11 GHz band is most extensively used in the short distance or urban microwave link. In other words, the adequacy of using 11 GHz band radio equipment for the urban microwave link is a proven fact. Hence, the 11 GHz band is considered to be the optimum choice for the presently planned microwave network.

The 11 GHz band allows two kinds of channel arrangements:

"Normal" i.e., RF channel arrangement and "slot" RF channel arrangement. In the digital microwave network presently planned, the slot RF channel arrangement based on CCIR Rec. 387-3 will be adopted.

The adoption of the slot RF channel arrangement makes it possible to accommodate 11 RF channels including protection RF channel, as shown in Fig. II-5. In this case, one RF channel can transmit 1,344 or 1,440 telephone channels.

## 3-3 Transmission Capacity

### 3-3-1 Number of Channel Required

Total number of channels to be transmitted between any two microwave stations which are adjacent each other is estimated from Fig. II-6 and it is given as below.

| | | |
|---|---|---|
| Agami - El Max | 1,240 | channels |
| Manshia - Auto | 4,909 | " |
| El Max - Auto | 3,037 | " |
| Auto - Moharam Bey | 11,702 | " |
| Ibrahimya - Moharam Bey | 6,704 | " |
| Sidi Gaber - Moharam Bey | 4,470 | " |
| Moharam Bey - Glym | 9,356 | " |
| Glym - Sidi Bishr | 3,423 | " |
| Sidi Bishr - Abu Qir | 631 | " |

Details of the number of channels requried are shown in ANNEX-4

### 3-3-2 Interconnection at Each Exchange

Interconnection of telephone circuits at each exchange must be carried out at the group level as high as possible to minimize the impairment of transmission quality due to interconnection and to save the equipment cost. If possible, the back to back connection of radio receiver including demodulator and transmitter including modulator is preferred.

### 3-3-3 Digital Hierarchy Selection

There are three (3) kinds of digital hierarchy standards recommended by CCITT. They are the Japan Standard of 24-channel primary group, the North American Standard also of 24-channel primary group, and the CEPT Standard of 30-channel base used in Europe.

The presently planned network can employ any one of the standards, however use of, 24-channel primary group hierarchy is assumed according to the request by ARENTO. The Japan Standard makes it possible to transmit 1,440 telephone channels per RF channel while the North American standard, 1,344 telephone channels per RF channel by use of frequency arrangement in 11 GHz band pursuant to CCIR Rec. 378-3.

### 3-3-4 Number of RF Channels

The number of required RF channels determined under the conditions presented in the preceding paragraphs 3-3-1, 3-3-2 and 3-3-3 is given in Fig. II-6.

## 3-4 Status of Radio Propagation Path, Required Antenna and Tower

### 3-4-1 Visibility

The visibility between the adjoining radio stations was examined in the field survey including mirror test, as well as the map study. And, based on the results obtained, the minimum antenna height was calculated. The path profile of each radio section is presented in Annexes 3-1 through 3-9.

The antenna height includes an allowance to cope with anticipated obstacles on the propagation path, including high riser buildings to be constructed and roof-top extensions of the existing buildings in the future.

In the City of Alexandria, so many number of high riser buildings are under construction. In view of this, when this Project is implemented, it is preferable that detailed surveys be carried out to reconfirm up-to-date conditions of the radio paths.

### 3-4-2 Antenna and Tower Required

The heights of antenna mounting and new towers have been determined in consideration of the status of each propagation path. The size of parabolic antenna has been determined so as to satisfy the required performance objective by estimating interferences of various kinds and thermal noise. Positions and sizes of antennas and requirement for new and existing towers are shown in Fig. II-7. For structural requirements for the tower, refer to para.5.

## 3-5 Composition of Microwave Link

A typical composition of PCM digital microwave link appears in Fig. II-8.

Analog telephone signals from the telephone switcing equipment are applied to through MDF (Main Distribution Frame) to the digital multiplex equipment where the signals are converted to 100Mb/s (in case of 1,440-ch capacity) serial and bipolar PCM signal according to the digital hierarchy.

This PCM signal is then applied to the microwave transmitter through the system switchover euqipment where the bipolar signal is converted to a unipolar signal and the serial pulse stream is converted into two paralled pulse streams.

These two pulse streams of PCM signal are applied to the IF or RF phase modulator and a 4-phase PCM signal is obtained.

In the receiving side the signal is processed conversely.

The system switchover equipment has a function of automatic switchover of any working RF channel which suffers from the deep fading or equipment failure to the protection RF channel and also of the protection RF channel to the previous working RF channel when such deep fading disappears or the equipment failure is cleared.

The radio transmitter/receiver is connected to the dual horn parabolic antenna via branching filter, circulator and waveguide.

The radio equipment and the carrier terminal equipment in the planned 11 GHz PCM digital microwave network can be operated and maintained by means of remote supervising and control from Moharam Bey Station, the center of the network. This means the feasibility of making Moharam Bey Station only attended while keeping all other stations unattended.

For the purpose of attaining the above objective, the supervisory and control equipment will be provided at each station. The control and display desk is required at Moharam Bey station as the network center.

It is possible to use one antenna for both transmission and receiving.

Interconnection of the radio links at each station will be made at as high digital group level as possible.

3-6 Transmission Quality

PCM digital microwave link transmission quality is defined by the bit error rate (BER) and the probability that the specified BER is exceeded.

In the Annex to CCIR Rep. 378-2, the recommended objectives for 2,500 km digital hypothetical reference circuit are given. They are:

(1) The mean BER per 10 minutes exceeds $10^{-7}$ for 5% or less of any one month.

(2) The mean BER per second exceeds $10^{-3}$ for 0.05% or less of any one month.

Performance of the PCM digital microwave network to be provided shall satisfy the above two objectives.

However, experience shows that when the latter of the above two objectives is satisfied, the former is easily satisfied. Hence, the study was made pertinent to the latter objective.

The equipment proposed to be used in this Project is designed to satisfy the objective of BER = $10^{-4}$ for 0.05% of worst month for 2,500 km hypothetical reference circuit. This requirement is more stringent than the objective recommended by CCIR Rep. 378-2, i.e.:

> BER = $10^{-3}$ for 0.05% of worst month for 2,500 km hypothetical reference circuit

The BER of $10^{-4}$ corresponds to C/N = 11.8 dB in case where coherent detection is employed.

PCM digital signal transmission involves basic degradation.

The basic degradation is caused by inter-symbol interference, repeater imperfection and degradation due to ambient temperature change and aging.

Since the basic degradation of 5 dB in C/N is considered as reasonable, the value of C/N allocated for degradation due to the other causes is 16.8 dB as shown in Table II-8.

According to this table, the C/N due to thermal noise is 20.6 dB. This defines the acceptable minimum of C/N by the thermal noise for the time,

$$t_r = 0.05 \times \frac{d\ (km)}{2,500} \quad (\%)$$

of any month where the fading due to rainfall or multipath fading is severe ("d" denotes the path length). This $t_r$ includes outage due to failure of communication equipment or power supply.

The maximum precipitation in the Alexandria area is approximately 200 mm per year or 60 mm per month according to the meteorological data. The fading by this degree of rainfall on the radio path can be ignored, compared with the fading due to multipath type, i.e., Rayleigh fading.

To obtain the probability of Rayleigh fading, $P_R$ the following empirical formula given in CCIR Report 338-2, Geneva, 1974, is used:

$$P_R = \left(\frac{f}{4}\right)^{1.2} \cdot Q \cdot d^{3.5}$$

where

f : frequency (GHz)

d : path length (km)

$$Q = 3.8 \times 10^{-7} \frac{\sqrt{2}}{\sqrt{h_1 + h_2}}$$

$h_1$ : Antenna height above ground (m) at Site 1

$h_2$ : Same as above at Site 2

Considering the radio meteorological condition in the Alexandria area, 4 $P_R$ instead of $P_R$ was used as the probability of Rayleigh fading in this area.

C/N = 20.6 dB occurs at the receiver input of

$$-90 \text{ dBm} + 20.6 \text{ dB} = -69.4 \text{ dBm}$$

where -90 dBm is the assumed thermal noise power of the receiver.

The receiver input in the normal state is determined by various parameters, such as transmitter output, free space loss, antenna gain and feeder system loss. The difference between the normal receiver input minus 3 dB as the maintenance margin and the previously quoted -69.4 dBm is the fading margin, M (dB).

The outage due to Rayleigh fading, $t_e$, was estimated by the following formula:

$$t_e = 4 P_R 10^{-\frac{M}{10}}$$

The estimated outage, $t_e$ for each radio section appears in Table II-9. From this table, $t_e$ for radio link can be estimated. Examples of the estimation for multisection radio links between Agami and Abu Qir, Agami and Moharam Bey, and Moharam Bey and Abu Qir are shown as tabulated below.

| Section | Length (km) | $t_e$ (%) | $t_r$ (%) |
|---|---|---|---|
| Agami - Abu Qir | 37.1 | $1.1 \times 10^{-5}$ | $7.4 \times 10^{-4}$ |
| Agami - Moharam Bey | 21.2 | $1.9 \times 10^{-6}$ | $4.2 \times 10^{-4}$ |
| Moharam Bey - Abu Qir | 16.0 | $1.4 \times 10^{-5}$ | $3.2 \times 10^{-4}$ |

## 3-7 Power Supply

ARENTO is to supply AC power which is necessary for the operation of radio equipment and carrier terminal equipment to be installed in this Project. Therefore, the DC power supply equiment must be installed by the Contractor.

AC power to be provided by ARENTO is of 380V $^{+10\%}_{-15\%}$ 50Hz$\pm$4% on 3-Phase and 4-wire.

For the DC power supply system, adoption of the full floating battery charging system is recommended.

Holding time of the batteries in case of AC failure is to be 5 hours at least, since the capacity of the batteries used for the telephone exchange is approximately 5 hours according to the information obtained in ARENTO Alexandria.

Block diagram of typical power supply appears in Fig. II-9.

Power Requirements

The required DC and AC plant capacities for each station are assumed roughly as follows:

| Station | Type of Equipment | -24V.DC Watt | AC kVA |
|---|---|---|---|
| Agami | Radio | 670 | 9.8 |
| | Mux | 1,251 | |
| El Max | Radio | 1,790 | 23.2 |
| | Mux | 3,105 | |
| Manshia | Radio | 1,530 | 24.8 |
| | Mux | 4,965 | |
| Auto | Radio | 5,410 | 69.4 |
| | Mux | 13,269 | |
| Moharam Bey | Radio | 8,460 | 89.7 |
| | Mux | 18,028 | |
| Ibrahimya | Radio | 1,790 | 28.3 |
| | Mux | 6,640 | |
| Sidi Gaber | Radio | 1,530 | 29.3 |
| | Mux | 4,546 | |

| Station | Type of Equipment | -24V.DC Watt | AC kVA |
|---|---|---|---|
| Glym | Radio | 3,590 | 69.8 |
| | Mux | 9,750 | |
| Sidi Bishr | Radio | 1,790 | 26.6 |
| | Mux | 3,575 | |
| Abu Qir | Radio | 670 | 8.5 |
| | Mux | 716 | |

Note: The above AC power is to include that for room and equipment lighting and AC outlet for test equipment, etc..

## 3-8 Technical Standards of Telecommunication and Power Supply Facilities

Technical standards of main equipments that constitute PCM digital microwave network are listed below.

### 3-8-1 11 GHz PCM Radio Transmitter and Receiver

1) Component : Fully solid state

2) Frequency band : 10.7 - 11.7 GHz

3) Transmission capacity: 100 Mb/s (1,440 telephone channels) or 90 Mb/s (1,344 telephone channels)

4) Repeating system : Pulse regenerating relay system

5) Modulation system : 4- or 8- phase PSK

6) Demodulation system : Coherent detection system

7) Transmitter output and noise figure : To be so determined as to satisfy the systems performance objectives

### 3-8-2 Antenna and Feeder System

(1) Antenna directivity, cross-polarization discrimination and gain.

Directivity, cross-polarization discrimination and gain of the parabolic antenna shall be sufficient to suppress undesired interferences and to give a suitable receiver input and a necessary fade margin. Typical figures of the antenna gain are as follows:

49.2 dB for 3.3-m parabolic antenna
43.0 dB for 1.8-m parabolic antenna
39.5 dB for 1.2-m parabolic antenna

(2) Feeder system

There are mainly two types of feeder, i.e., elliptical and circular waveguides. Typical feeder losses of these waveguides are;

0.15 dB/m for elliptical waveguide
0.02 dB/m for circular waveguide

Typical figure of the losses of the other feeder components such as polarization filter, taper waveguide, mode filter, branching filter, circulator and gas barrier waveguide is 6.1 dB in total.

### 3-8-3 Radio PCM System Switchover Equipment

This equipment shall be capable of automatic changeover to protection RF channel from any one of working RF channels on deep fading or at the time of equipment failure and vise versa upon restoration to normal condition.

### 3-8-4 Other Functions Required for PCM Digital Microwave Network

The PCM digital microwave network shall have following functions other than mentioned above.

Remote supervisory system

Since Moharam Bey station is the supervisory center from where other stations are to be remotely supervised.

Provision of engineering channel

Two engineering orderwire channels at least are to be provided, and calling shall be possbile by speaker and selective calling device.

### 3-8-5 Power Supply Equipment

(1) Rectifier

Full floating type with Silicon or Thyristor is used.

(2) Batteries

Enclosed lead acid type is used.

Capacity is sufficient for at least five hours operation of telecommunication equipent.

## 3-9 Installation and Test

### 3-9-1 Installation

For the smooth progress of telecommunication facilities installation by the Contractor, the timely completion of the following work items by ARENTO in advance is requisite:

(1) Site selection and procurement.

(2) Construction of Exchange building.

The earthing work for building, general lighting facilities, and AC power making use of communication systems are comprised in new building construction.

(3) Provisioning of radio and carrier equipment room.

In the existing exchanges, this is to consider equipment room space for installation of radio and carrier equipments.

(4) Provisioning of necessary AC power supply.

This means provisioning of power supply system up to low tension AC power distribution board.

(5) Construction of tower foundation.