FINAL REPORT

on

Feasibility Study

for

The Installation Project of

INTELSAT Standard A Earth Station

in ZIMBABWE

MARCH, 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Zimbabwe, the Government of Japan decided to conduct a feasibility study on the Project to Install an INTELSAT Standard A Earth Station in Zimbabwe, as a part of its technical cooperation, and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA dispatched to Zimbabwe a study team headed by Mr. Hiroaki Sogabe, Special Technical Adviser for International Cooperation, International Cooperation Division, Minister's Secretariat, Ministry of Posts and Telecommunications, from November 21 to December 7, 1982, to carry out a field survey.

After the field survey and relevant consultations with officials concerned of Zimbabwe, further studies were made and the present report has been prepared.

I hope that this report will contribute to the improvement of the international telecommunications in Zimbabwe as well as to the promotion of friendly relations between Japan and Zimbabwe.

I wish to express my deep appreciation to the Government of the Republic of Zimbabwe and the officials concerned for their cooperation extended to the team.

March 1983

Keisuke Arita

President
Japan International Cooperation Agency

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SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

ZIMBABWE has been striving for social and economic development since becoming an independent nation in April 1980. Especially, the development of international telecommunications is indispensable to the growth of her trade with other nations. The government has determined that she can no longer rely on the Republic of South Africa for means of international telecommunication.

Since becoming independent, ZIMBABWE had sought for ways to develop its own international communication facilities. In 1980 the government adopted a plan to install satellite communication earth stations and has been requesting financial aid from other countries. The government has also conducted technical studies and is receiving consultation from INTELSAT. Prime Minister Mugabe visited Japan in May 1981. He was interested in technical cooperation with Japan.

The Japanese government sent a preliminary study team to ZIMBABWE for fifteen days starting from September 26, 1982 as requested by ZIMBABWE. This request can be considered as part of their effort to develop international telecommunication. The study team has worked with the government of ZIMBABWE to

(1) define the scope of work for a feasibility study, prepare a summary record and establish the details and scope of the plan and survey items.

(2) conduct a preparatory study of three proposed sites for satellite communication earth stations.

Afterwards, the Japanese government sent a feasibility study group for eighteen days starting from November 21, 1982 for plans to install INTELSAT standard A earth stations in ZIMBABWE.

The group conducted a field survey of the following four items in accordance with the scope of work and the summary record made earlier:

(1) Satellite Earth Station installation project for A.O.R. (Atlantic Ocean Region)

(2) Satellite Earth Station installation project for I.O.R. (Indian Ocean Region)

(3) Trunk Exchange installation project in Bulawayo and Harare

(4) Economic evaluation of each project.

A site was selected for earth stations of sub projects (1) and (2) in such a way that three stations can be installed on the same site. Detailed computation results of radio frequency interferences which are an important factor in the site selection are summarized in a progress report of the field survey. Note that the selected earth station site was approved by the Minister of Information, Post and Telecommunication (M.I.P.T.).

1. Conclusion

The installation project of INTELSAT standard A Earth Station for A.O.R. is given the highest priority. Such station is a very significant facility for ZIMBABWE if she is to gain economic advantage and to be independent of others in the communication field. It is desirable to have the projects completed by the end of 1984 and to start the operation at the same time.

The net profit computed based on the I.R.R. law is expected to be very high and estimated to be 21.62%. One of reasons is that it is expected to redouble international traffic with the introduction of satellite communication system.

The installation project of INTELSAT standard A Earth Station for I.O.R., by the end of 1988 is desirable. For the country, transmission via satellite can be considered to be the only means of overseas telecommunication. So it needs not only satellite communication earth stations for the Atlantic ocean region but also for the Indian ocean region. The latter is to be installed when the following conditions are met:

(1) The growth of the traffic is sufficient to install a second earth station.

(2) Expenditures are to be distributed over a long period.

(3) The country will gain the experience of operating a satellite communication earth station in two years.

Based on the above conditions, it is appropriate to recommend that the implementation of a second station be started in the middle of 1987 and completed by the end of 1988.

It is suggested that the schedule shown in Table 2 be applied to the project to install earth stations.

The plan to introduce trunk telephone exchanges in Bulawayo and Harare is described in this report with the installation, operation and maintenance costs being emphasized.

Many of ZIMBABWE's telecommunication facilities have to be modernized. The installation of trunk telephone exchanges in major cities should be given one of the highest priority. At present communications among the cities are blocked by a bottle-neck in the exchange systems. The project will install new digital switches in the capital city of Harare and the second city of Bulawayo which will eliminate the state of bottleneck mentioned above. These new digital switches will also greatly improve the overseas and long distance telephone functions. Since a new exchange installed in Guweru in 1984 has the capabilities of servicing interterritorial and international calls, the quality and connectability of the long distance traffic will be considerably improved at the time the above digital switches are completed.

Therefore, the above three subprojects technically match each other and are reported on the Survey as a combination of the following two:

(1) The plan to install earth stations for A.O.R. and I.O.R. is technically and economically appropriate.

(2) The above plan and the plan to install trunk telephone exchanges in Bulawayo and Harare are technically and economically appropriate.

An economic and financial evaluation which is described in Chapter 8 "Financial and Economic Analysis" in detail indicates that each project is feasible. That is, the net profits are estimated to be 20.60% and 22.53% for the case of (1) and (2) respectively. Table 1 shows installation cost separately with every sub-project, and indicate I.R.R. according to combination of the project.

Table 1. Estimated Cost and I.R.R.*

(Unit Conversion: Z$1 = ¥250.-)

Sub-Project		COST		I.R.R. (%)
		Foreign currency portion	Local currency portion	
Earth Station installation project	for A.O.R.	¥ 2,512,000,000.- (Z$ 10,048,000.-)	Z$ 1,760,000.-	21.62
	for I.O.R.	¥ 2,751,600,000.- (Z$ 12,006,400.-)	Z$ 840,000.-	-
	for A.O.R. + I.O.R.	¥ 5,263,600,000.- (Z$ 22,054,400.-)	Z$ 3,000,000.-	20.60
Toll Exchange installation project	for HARARE	¥ 922,000,000.- (Z$ 3,688,000.-)	-	-
	for BULAWAYO	¥ 368,000,000.- (Z$ 1,472,000.-)	-	-
Total Project		-	-	22.53

Note: *I.R.R.: Internal (financial) Rate of Return.

2. Summary

2.1 INTELSAT Standard A earth station installation project

Satellite communications recently plays an extremely important part in economic and cultural development. The INTELSAT satellite communication system in particular provids world-wide communication services of high quality.

ZIMBABWE has investigated an earth station plan and obtained plan INTELSAT consultation since 1980. The progress is mentioned in the preface of this chapter. Then the Japanese Government carried out the study for viability of investment in response to the ZIMBABWE's request.

Figure 1 shows the coverage of INTELSAT satellite. This country can access both satellites of the Atlantic Ocean Region and Indian Ocean Region in extremely good conditions. The study report made the configuration scale, installation schedule, personnel, and its training plan of the A.O.R. earth station having larger traffic than I.O.R. This is referred to phase 1, and its completion was designated by the end of 1984. The I.O.R. earth station was designated as phase 2 project, and its completion at the end of 1988.

The outline of the phase 1 project consists of plans about a set of INTELSAT standard A earth station facilities, approach microwave link, site capable of providing 3 antennas in the future, station building capable of being extended for future requirement, and providing power facility. And, that includes an international TV transmission facility, which can be connected to the ZBC Harare studio. The approach microwave link has interface with existing MUX terminal station in Harare gateway office. The transmission path to newly-established Gweru international telephone exchange uses the existing microwave link.

The site of the earth station was selected at Mazowe. It is some 40 km apart north of Harare.

The following conditions were considered in the selection of the site.

(1) It is possible to make a layout of 3 antennas (3 stations).

(2) Radio frequency interference will be considered on the safe side. Refer to the note.

(3) It is to be accessible to both satellites of AOR and IOR.

(4) Approach microwave transmission path is to be obtained easily.

(5) Personnel is easily available.

Note: Detailed data in relation to radio frequency interference analysis was made on the basis of the data of prestudy, and presented as a progress report on the time of field survey of F/S. That was put to practical use as a basic data of determining the site, and ought to be put to practical use as one of basic data for obtaining the approval of INTELSAT.

Furthermore, in consideration of being accessible to the INTELSAT VI satellite, it is ready to have a wide-range antenna, transmitter, and receiver when the frequency band is expanded to 580 MHz (500 MHz, at present).

The outline of the phase 2 project is basically the same facility as that of phase 1.

That is, it is a standard A station being accessible to the I.O.R. and has a layout which a directivity of its antenna can be changed with that of the antenna for A.O.R. respectively. It is desirable to consider the method of operation as a counter-measure for failure after the completion of the I.O.R. facility, because the international telecommunications of ZIMBABWE depends only upon satellite communications.

Installation expenses was calculated on assuption of the time of completion at the end of 1988. Then, the study team investigated viability of installation timing of the I.O.R. earth station at the same time of phase 1. Traffic carrying capacity was estimated to counterbalance the scale of INTELSAT standard B earth station, and therefore the installation time was shifted by 4 years from phase 1. Three aspects are considered, that is, investigating elemets of the installation timing are

(1) The traffic carring capacity is counterbalance to the scale of standard A earth station.

(2) About two years operation is experienced for the satellite communication.

(3) The time of investment is not concentrated.

The configuration of satellite communication circuits is shown in figure 2. Direct destination countries in the phase 1 are 11 countries; U.K., U.S.A., France, West Germany, Greece, Belgium, Italy, Malawi, Nigeria, Lesotho and Swaziland and those in the phase 2 is planned to be 8 countries of Australia, Japan, Hong Kong, Pakistan, U.A.E., Kenya and Tanzania.

2.2 Toll exchange facility introduction plan

A field survey was carried out along with a sub-project for feasibility study, after it was confirmed by the minutes in the preliminaly study that there is a plan to install exchanges at Bulawayo and Harere similar to an international exchange intended to be installed at Gweru. Study team carried out a study to install a trunk switch at Bulawayo and a trunk & junction tandem switch at Harare.

This report evaluates the viability of the toll exchange introduction plan by the field survey. It also advises that the exchange in Harere is to have a design capable of adding international switching function at a time not specified.

The time of introduction is intended to be in 1985 for Bulawayo and in 1986 for Harare. Both will be digital exchanges, with flexibility of shifting a digital communication network which is a trend in the world.

Installed capacity based on estimated traffic demand at the time of 1990, is estimated to have 2,100 trunks for exchanging and 2 operator's positions in Bulawayo, and in Harare to have 6,300 trunks for exchanging and 20 operator's positions.

Training is planned to be carried out for technical operators for 6 months with and for 2 months on site, and for telephone operators for 2 weeks. Since maintenance support is also essential, an engineer each station should remain on site for a year.

A communication system generally functions with tandem connections of satellite transmission subsystem, switching subsystem, domestic transmission line, subscriber line, terminal equipment, and so on. Priority of improvement study is decided

according to which subsystem create a bottleneck. In ZIMBABWE, the satellite communication subsystem was having the greatest priority. The switching subsystem also has high priority, and therefore it is essential to improve Harare's exchange with the largest international traffic, which is estimated at 20% having increasing over the preceding year in the traffic estimate in the chapter 3, and to establish a project capable of good coordination.

2.3 Earth station installation time schedule and expenses

Mentioned above, this project consists of subproject of phase 1 and 2, and the term of works of phase 1 is very urgent. That is, as shown in table 2, its time schedule is dependent validation of the contract with a supplier early July, 1983, on 18 months for the term of works, and the completion at the end of 1984. Thus, ZIMBABWE grades this project to a national one. Phase 2 is intended to be designed on the basis of experience in operation for about 2 years, and its term of works is the validation of the contract in the middle of 1987 and the completion at the end of 1988.

The implementation of a general earth station project requires the procedure shwon in the chart 6.1 of chapter 6. The working schedule in section 3 of chapter 6 explains more breakdown of the procedure.

The cost of construction is specified in the specification made by P.T.C. (ZIMBABWE Post and Telecommunication Public Corporation). The report estimates the cost 10% higher in the installation of standard A earth station than those normally introduced to developing countries. This means to take into consideration that the shortage of funds does not occur because of requirements of specification, because prices rise by the grade-up of antenna tracking and ESC functions (Engineering Service Circuit function) and so on.

The cost of construction of phase 1 estimated in turn-key base is 2,952 million yen (2,512 million yen in foreign currency portion, 440 million yen = 1,76o thousand Z$ in local currency portion).

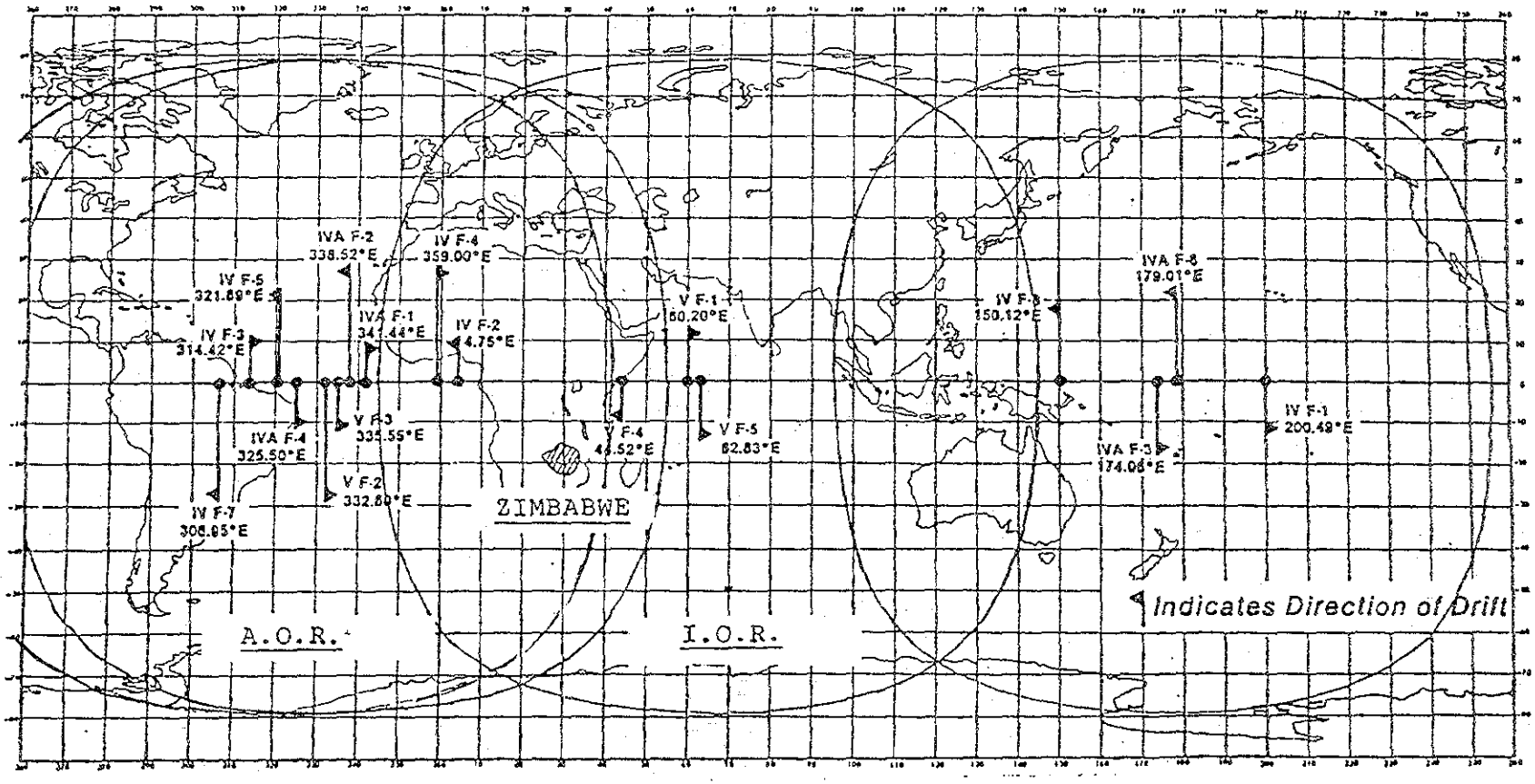
The estimate of phase 2 is 2,961,600 thousand yen (2,751,600 thousand yen in foreign currency portion, 10,000 thousand yen = 840 thousand Z$ in local currency portion.) The price of phase 2 takes inflation factors of for 4 years into consideration. (Inflation factor expects 10% rise in a year rate in personnel expenses and 7% rise in a year rate in product prices.) Round number of installation cost calculated are shown in table 7-1 and table 7-2. It then, is desirable to use consultants for about 4 months during the term of works of phase 1.

2.4 Economic evaluation

In Chapter 8, the project is evaluated mainly from the financial point of view. Moreover, for the Project of Installation of Satellite Communication Earth Station, sub-projects of phase 1 and phase 2 are set, and the cost of installation is calculated for each sub-project. In the evaluation, both the costs of installation are added up, and I.R.R. is found. As a result, I.R.R. is 20.60%. I.R.R. of AOR only (phase 1 only) is 21.62%, and the investment of phase 2 is judged very much feasible. As stated in Section 2-1, Project of Installation of Earth Station, this project can be evaluated that its priority is ranked very high from the technical and economical point of view, and also it is a project economically ensuring a high rate of return of profit and a great feasibility.

This report evaluates as a total project in which earth station project mentioned above and the toll exchange project are included. As a result of the evaluation, the total project is considered highly feasible and I.R.R. is estimated 22.53%.

Figure. 1 TYPICAL COMMUNICATION COVERAGE for each REGION and LOCATION of SATELLITES in ORBIT



AS OF DECEMBER 3 1982

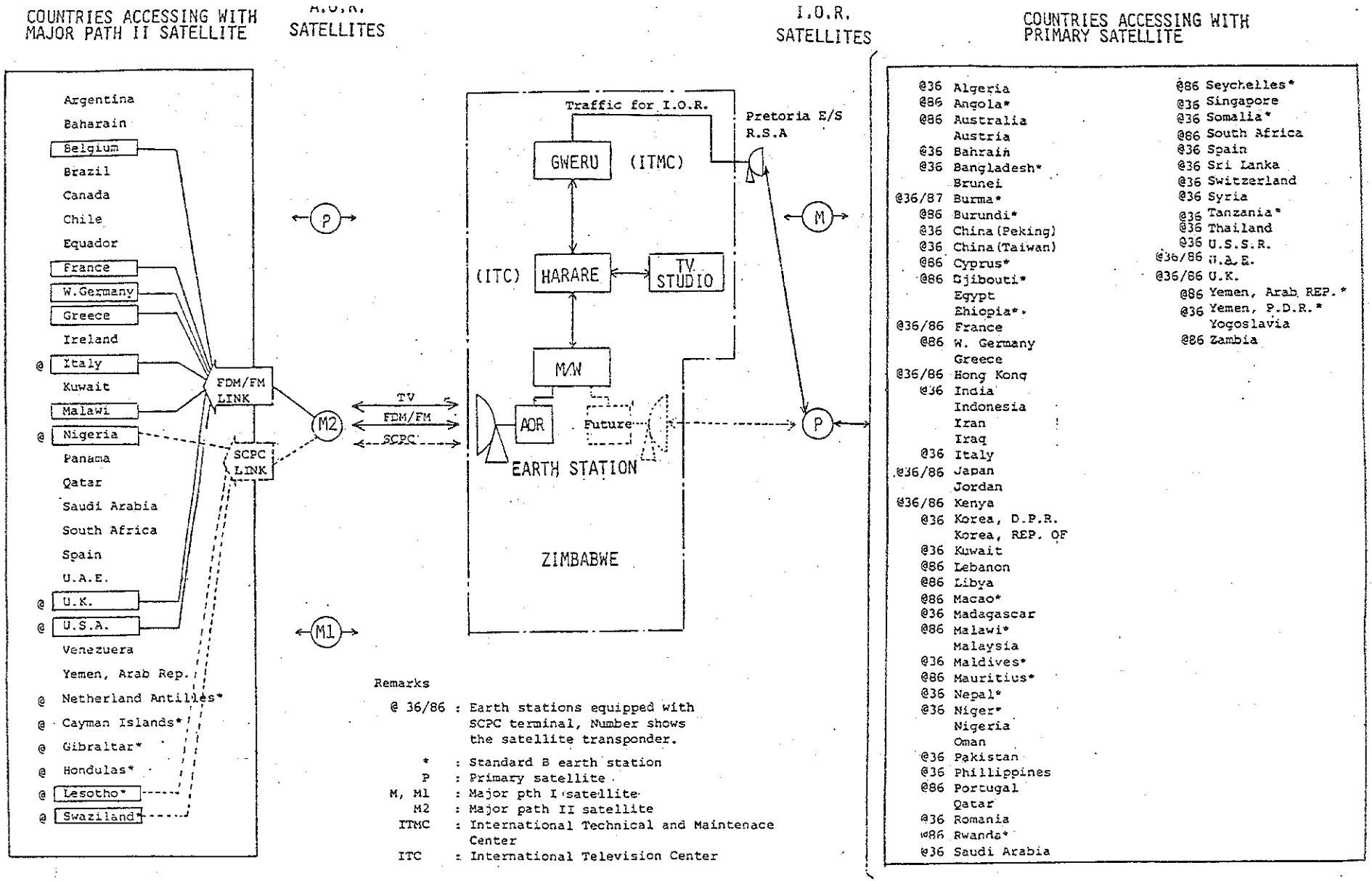
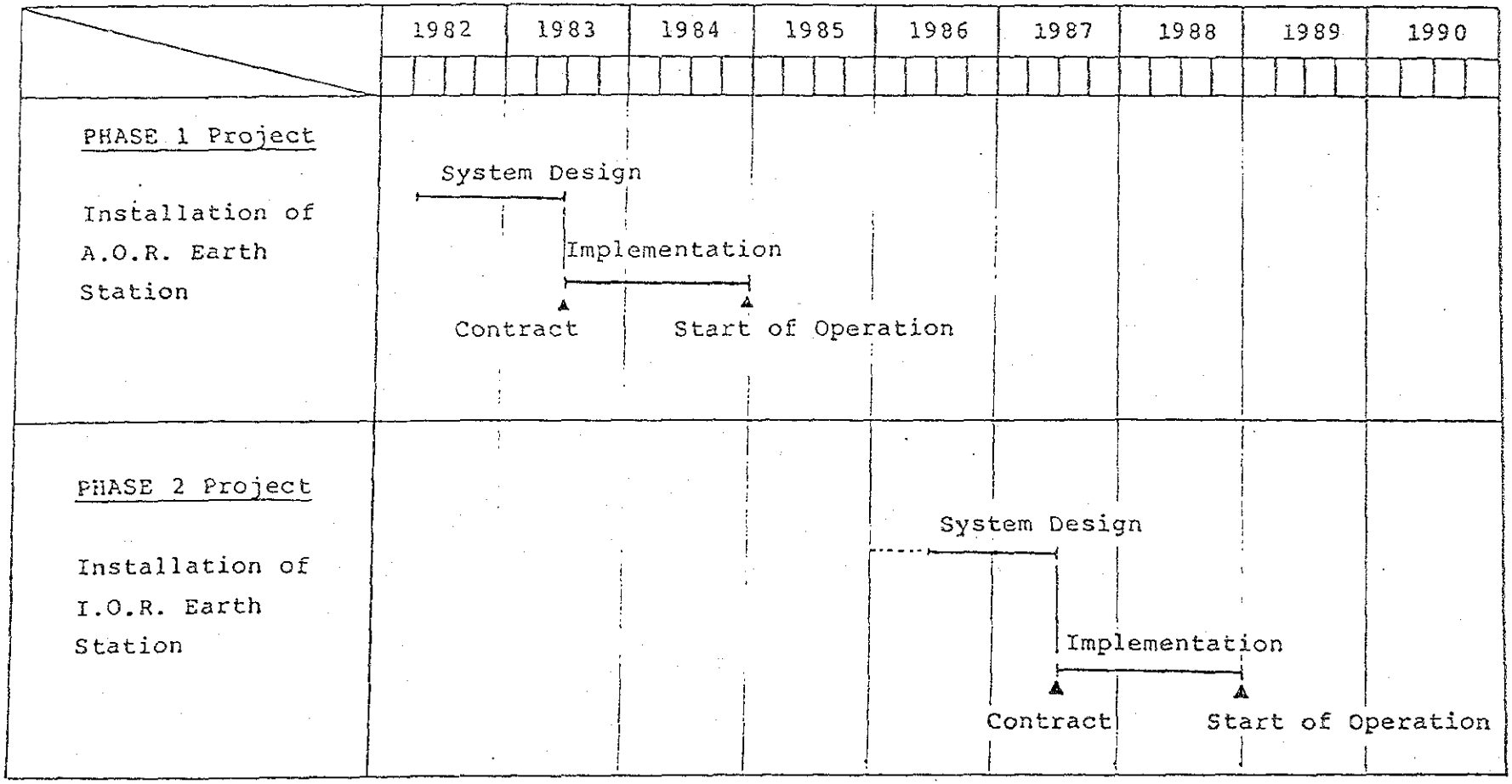


Figure 2 CONFIGURATION OF ZIMBABWEAN SATELLITE COMMUNICATIONS NETWORK
(PHASE 1)

Table 2 Proposed Implementation Schedule



Legend

A.O.R. : Atlantic Ocean Region

I.O.R. : Indian Ocean Region

CHAPTER 1

Introduction

Chapter 1. Introduction

This report aims to verify the viability of an INTELSAT standard A earth station installation project in Zimbabwe (for the Atlantic Ocean Region = A.O.R. and Indian Ocean Region = I.O.R.) and plans relating to the latest model degital exchange system scheduled for large cities of Bulawayo and Harare.

These projects will be considered as national projects of the country implying improvement of international communication and foreign trade. That is to say, a bottleneck in the operation of communication exists that all international communication except for that to the adjacent countries goes by way of Republic of South Africa (hereinafter referred to as R.S.A.). It is very necessary to change from the present situation.

This report explains an outline of the plan that will allow for the installation of the satellite communication earth stations according to the separate schedules of phase 1 and 2 and improve international telecommunication, and, for the purpose of improvement of domestic communication in close relation to that above mentioned, introduces toll switches in principal cities, and then gives an economic and financial evaluation of the projects.

Figure 2 is one of configuration of satellite communication network in ZIMBABWE, which shows the names of destination stations of INTELSAT satellite used. It shows the configuration of phase 1, and when the facilities showed in the dotted lines are completed and the network via R.S.A. shifts to facilities of the country, phase 2 project will be complete.

The project investigates also about executing the projects of abovementioned both phases at the same time, where, since the traffic for I.O.R. is little and it allows an INTELSAT

standard B earth station to be used, the time of their completion is assumed as that of phase 2, at the end of 1988, which by then the traffic requires the standard A earth station. The earth station in phase 1 is planned to have a scale of total 4 systems of transmitters, and of total 11 destination stations; U.S.A., UK, and other 6 receiving ones, and 3 for SCPC (for small capacity circuits). And that in phase 2 is planned to have a scale of 4 transmitters and 8 receiving chains, although coordination with respective correspondent country hereafter is required partly. The scale of both earth stations has no large difference on calculation of expenditure, that is, phase 1 is estimated at 2,952 million yen or 11.808 million Z$ and phase 2, at 2,961 million yen or 11.847 million Z$. These are total sums including building expenses of station building etc., training expense, maintenance aid costs, etc. other than cost of the construction of main facility. Further, in phase 2, an inflation factor for 4 years is considered.

It is the feature of this project that, since the earth station with the same scale as phase 1 is installed in phase 2, but increasing in operation and maintenance costs of phase 2 is little, very efficient operation is possible. The I.R.R. of only phase 1 is definitely estimated at 20.60%, and that of phase 1 and 2 at 21.62%.

Then, the subprojects introducing toll exchanges to Bulawayo and Harare estimate the total cost of construction on the basis of that the scale of the former is a trunk exchange having 2,100 trunks and that of the latter a trunk & junction tandem exchange having 6,300 trunks. The expense of the former is estimated at 368 million yen or 1.472 million Z$, that of the latter at 922 million yen or 3.688 million Z$, and the total expense at a little under, 1,300 million yen or 5.2 million Z$, where the cost of air-conditioning facility, etc. are not included, and each project is estimated on a turn key basis.

Economic and financial evaluation is carried out on the basis of telephone revenue, because the great majority of increase in revenue results from completion of the project. The completion of the earth station results to an expansion of international transmission path, and gives good effect to Telex. However, since rearrangement of Telex exchange and terminal equipment is not included in the project, and information of their expansion plan has not been obtained, increase in revenue by telephone was adopted. Our financial evaluation will be concluded to be proper.

CHAPTER 2

Outline of Project

Chapter 2. Outline of Project

2.1 Purpose of Project

The purpose of this project is that ZIMBABWE installs INTELSAT standard A earth station and improves rapidly the international communication traffic and at the same time, gets rid of the present situation of the international communication depending on that of the Republic of South Africa. Moreover, this purpose includes the sub-project to introduce the toll exchange to Bulawayo and Harare.

2.2 Project as the Object of Feasibility Study

In this report, the feasibility of the following sub-projects is carried out.

1) Installation of INTELSAT Standard A Earth Station for Atlantic Ocean region

2) Installation of INTELSAT Standard A Earth Station for Indian Ocean region

3) Installation of Trunk Exchange in Bulawayo

4) Installation of Trunk & Tandem Exchange in Harare

2.3 Effect on Nation and Economic Activities

If this project is realized, Zimbabwe can achieve independents of international communication desired since its independence in 1980. At the same time, both domestic and international communications can be rapidly improved. Thereby, it is expected that the economic activities can be activated and the trade balance, be improved.

Technically, the following effects are expected.

1) The satellite communication technology makes it possible to train able technicians through operation of the satellite communication because it includes the newest electronic technology.

2) Introduction of the digital electronic exchange causes spread of the digital technique and serves for structure of the digital network in the future.

2.4 Outline of Installation

2.4.1 Schedule

The proposed schedule of installation is as given in table 2 (page 14 of summary).

2.4.2 General

Civil works to be included in "THE INSTALLATION PROJECT OF INTELSAT STANDARD A STATION, ZIMBABWE" consist of building construction works, civil engineering works and relevant works necessary for the completion of the sattelite telecommunications earth station at Mazowe, a north of Harare. A steel antenna tower for a microwave link system to be installed at the station site is also included.

Based on the P.T.C.'s plan and the study of the existing facilities, civil works required to install a relay station at Iron Cap, located at the intermediate point between Harare and Mazowe, and a terminal station at Harare Centre Exchange Building necessary for installing a microwave link system between the earth station and Harare Centre Exchange Building are to be excluded from the scope of works for the project. Civil works for New Switching System are also to be excluded by the same reasons.

Notes:

1. A microwave relay station building and a steel antenna tower at Iron Cap have been planned to be installed by the installation project of microwave network between Harare and Kariba by P.T.C. separately. It has been planned to utilize the station building and the tower for the microwave link system necessary for this project.

2. At Harare Centre Exchange Building existing vacant space/rooms and building facilities will be able to be utilized for housing the microwave link system for this project. A existing steel antenna tower will also be utilized for mounting antenna.

3. Spaces/Rooms and building facilities for housing New Switching System:

   i) At Harare Centre Exchange Building the spaces/rooms will be produced by the partial renewal of the existing switching system.

   ii) At Bulawayo Centre Exchange Building existing vacant space will be utilized.

   Necessary building facilities as air-conditioning system and power supply system will be planned and installed by P.T.C. separately when the plan of new switching system take concrete shape.

CHAPTER 3

Traffic Forecasts

Chapter 3. Traffic Forecasts

3.1 Overview

According to the data collected by the PTC for the past five years, the international communication traffic of Zimbabwe has been growing steadily as shown in Table 3.1 (1) given below.

Table 3.1 (1) Traffic data of the past five years.

YEAR			1977/1978	1978/1979	1979/1980	1980/1981	1981/1982
OG+IC	TEL	CALLS	97,678	127,242	186,184	245,239	280,774
		MINS	838,020	1,151,842	1,529,517	1,969,753	2,320,701
	TLX	CALLS	111,048	125,358	207,544	639,892	817,322
		MINS	333,146	376,082	646,462	1,847,129	2,367,485

The future growth rate in international traffic is expected to increase due to the PTC's policy to improve various traffic control facilities and completion of the present projects. International telephone traffic at the time the sub-projects to build earth stations are finished in 1984/1985 is as shown in the following table. The busy hour calls will increase by 31.32 ERL (3,523,500 minutes per year). When the sub-project to build exchanges is completed in 1986/1987, the traffic will increase by 73.84 ERL (8,307,000 minutes per year). In the year of 2,000, both the sub-projects are expected to result in an increase of 203.70 ERL (22,916,250 minutes per year).

Table 3.1 (3) and (4) show the traffic transition of no effective action performed and traffic transition of completly performed all of this project.

Table 3.1 (2) Summary of traffic growth data resulted in by subprojects

YEAR	BASE DATA			ES SUBPROJECT			ES+SW SUBPROJECT		
	B.H.E	G.R	MINS X000	B.H.E	G.R	MINS X000	B.H.E	G.R.	MINS X000
1984/85	46.96	20%	5,283	78.28	100%	8,806			
1985/86	54.01	15%	6,076	93.93	20%	10,567	102.48	30%	11,529
1986/87	60.49	12%	6,805	108.02	15%	12,152	122.60	20%	13,792
2000/01	171.02	7%	19,239	316.39	7%	35,593	374,72	7%	42,156

The total busy hour calls of the traffic at the Indian ocean regions which consist of nine destinations and 48 lines will be 13.08 ERL in 1984/85. It will further increase to 26.50 ERL (2,981,250 minutes per year) in 1988/89 when the number of transmission lines is increased to 69. Thus, it is expected to exceed the number of busy hour calls 26.60 ERL (2,320,701 minutes per year) in 1981/82.

The above forecasts are derived using the E500 series recommended by the CCITT based on data obtained during the field survey. The growth rate of the present traffic up to the year of 2,000 is calculated with a recurrence formula.

$$Yt = A + Bt + Ct^2 \quad \ldots\ldots\ldots\ldots (1)$$

where

Yt is the traffic after t time interval and
A, B and C are constants the values of which are dependent on the route observed.

The growth rate found with the above recurrence formula is used to forecast the growth rate and BHE in the year of 2,000. The forecasting is done by taking into consideration the following factors:

a. The effects of the improvement policy planned by the PTC.

b. The effects of the improvement policies implemented as cooperation and aid from other countries.

c. The effects of the completion of the present project to build standard A earth stations.

Note that since the PTC's data does not include incoming calls during the period 1977/78 to 1979/80, a value obtained by doubling the number of outgoing calls is used.

The BHE's for the international telephone and telex traffic are computed by applying the computation method suggested by the CCITT. They are found with the following formula:

$$A(BHE) = Mdh/60e \quad \ldots\ldots\ldots\ldots \quad (2)$$

where

A: BHE (Busy hour traffic in Erlangs)

M: Monthly paid minutes

d: Day to month ratio

h: Busy hour to day ratio

e: Effective factor

An intermediate value of "0.0384" suggested by the CCITT is taken for the day to month ratio (d). The value "0.1" is substituted for the busy hour to day ratio (h) due to the fact that the traffic consists of communications by the Atlantic ocean regions and interterritorial countries.

3.2 International Traffic Forecasts

A BHE is computed by substituting 0.6 for (e) in Formula 2 given above and using the paid minutes data for 1981/82. The traffic thereafter is forecasted by applying the annual growth rate to each destination. The increase resulted in by the E/S subproject in 1984/85 is assumed to be 80% whereas the growth yielded by the exchange subproject in 1985/86 is

taken as 10%. The BHE's and numbers of transmission lines for each destination are forecasted up to the year of 2,000. The data is given in Table 3.2 (1) and (2) "International Telephone Traffic Forecasts (1) and (2)". The growth rates resulting from the subprojects up to the year of 2,000 and the increases in total BHE for all destinations are shown in Table 3.2 (3) "International Telephone Traffic Forecasts Estimated Each Subproject (Traffic Growth)", and "International Telephone Traffic Forecast Estimated Each Subproject (paid minutes)" is shown in Table 3.2 (4).

3.2.1 Processing of Calls via the Republic of South Africa (via Exchange Connections)

All calls connected via an exchange in the Republic of South Africa are expected to be connected via England, the U.S.A and Italy after the earth station for the Atlantic ocean regions is completed in 1984/85. The traffic via the Republic of South Africa will then be split and added to each traffic going to the three destinations.

3.2.2 Traffic to New Destinations

The direct traffic to new destinations is derived from the number of transmission lines planned by the PTC using the Erlangs B table. Note that the traffic for Holland, France and Belgium is subtracted from that for England whereas the traffic to Brazil, Canada and Japan is subtracted from that for the U.S.A.

3.2.3 Growth Rates

According to the data given by the CCITT in the past, the traffic growth is greatly affected by the use of high quality transmission media, removal of bottlenecks in the switching network, improvement in operations, etc. Such improvements are needed to accomodate traffic increases caused by the rising demand for services.

According to the PTC's plan, semiautomatic operations are started in January 1983 for destination countries the U.S.A., Italy and Australia. The plan also includes installation of a new INTS in Gweru. An increase in traffic due to these improvements is expected in addition to the traffic increases resulting from the present subprojects. The annual growth rate during the decade 1990/91 to 2000/01 is assumed to be of the same value (7%) as the domestic rate.

This traffic growth is forecasted by assuming that future bottlenecks in telephone waters are eliminated by installing new local switches such as unit #5 and #6 according to the plan.

3.3 Traffic Forecasts for Indian Ocean Regions

Destination countries in the Indian ocean regions are Australia, Kenya, Tanzania, Pakistan, New Zealand (via Australia), the UAE, India, Honkong and Japan. These destinations are countries to receive direct services. They have a relatively high traffic volume among those in the Indian ocean regions. As described in Section 3.2.1, the traffic connected via the Republic of South Africa is split into three. The forecasting is thus done by considering the fact that this traffic is originally for countries in the Indian ocean regions.

As a result, the following forecasts are obtained. The total BHE for the traffic for the Indian ocean region which include nine destinations is 13.08 ERL (1,471,500 minutes per year) in 1984/85 and 26.50 ERL (2,981,250 minutes per year) in 1988/89. The numbe of transmission lines is expected to be 48 and 69 respectively.

The international telephone traffic forecasts for the A.O.R. and I.O.R. subprojects are shown in Tables 3.3 (1) and (2). Table 3.3 (3) shows a comparative estimation list of the I.O.R. traffic and leased transmission lines.

3.4 Interterritorial Telephone Traffic Forecasts

The same method of estimation and parameters as those for the international telephone traffic forecasts described in Section 3.2 are used. The PTC plans to convert transmission media such as open wires, the HF and the UHF into the PANAFTEL network of the ITU in order to improve the interterritorial communications. This plan is to be completed in 1984/85 and the annual growth rate is estimated as the same as the international telephone traffic.

Note that since the traffic to the RSA at present uses high quality microwave lines and the connection system is subscriber trunk dialing, its growth rate is forecasted differently from the interterritorial traffic. The interterritorial telephone traffic forecasts are shown in Table 3.4 (1). The estimation of the traffic resulting from the switch subprojects is shown in Table 3.4 (2) and (3) "Interterritorial Telephone Traffic Forecast Estimated Switch Subprojects".

3.5 International Telex Traffic Forecast

The international telex traffic forecast is derived from the computation of the bearer circuit via the satellite transmission lines. Like the telephone traffic, the computation is done by using Formula 2 given in Paragraph 3.2 with a value of 0.15 substituted for the busy hour to day ratio (h) and a value of 0.8 for the effective factor (e). The same growth rate as the PTC's plan is used. The recurrence formula given as Formula 1 in Paragraph 3.1 yields a growth rate of 15% in 1991/92 and 9% in 2000/01. However, the rate after 1991/92 is taken as less than 7% due to the stagnant phenomenon in the telex traffic growth that occurs recently as indicated by the world trend. International Telex forecast is shown in table 3.5.

TABLE 3.1.(3) INTERNATIONAL TELEPHONE TRAFFIC GROWTH (NO EFFECTIVE ACTION PERFORMED)

Means Busy Hour Traffic in Erlangs(all routes)

TABLE 3.1.(4) INTERNATIONAL TELEPHONE TRAFFIC GROWTH
(IF BE PERFORMED ALL OF SUB-PROJECTS)

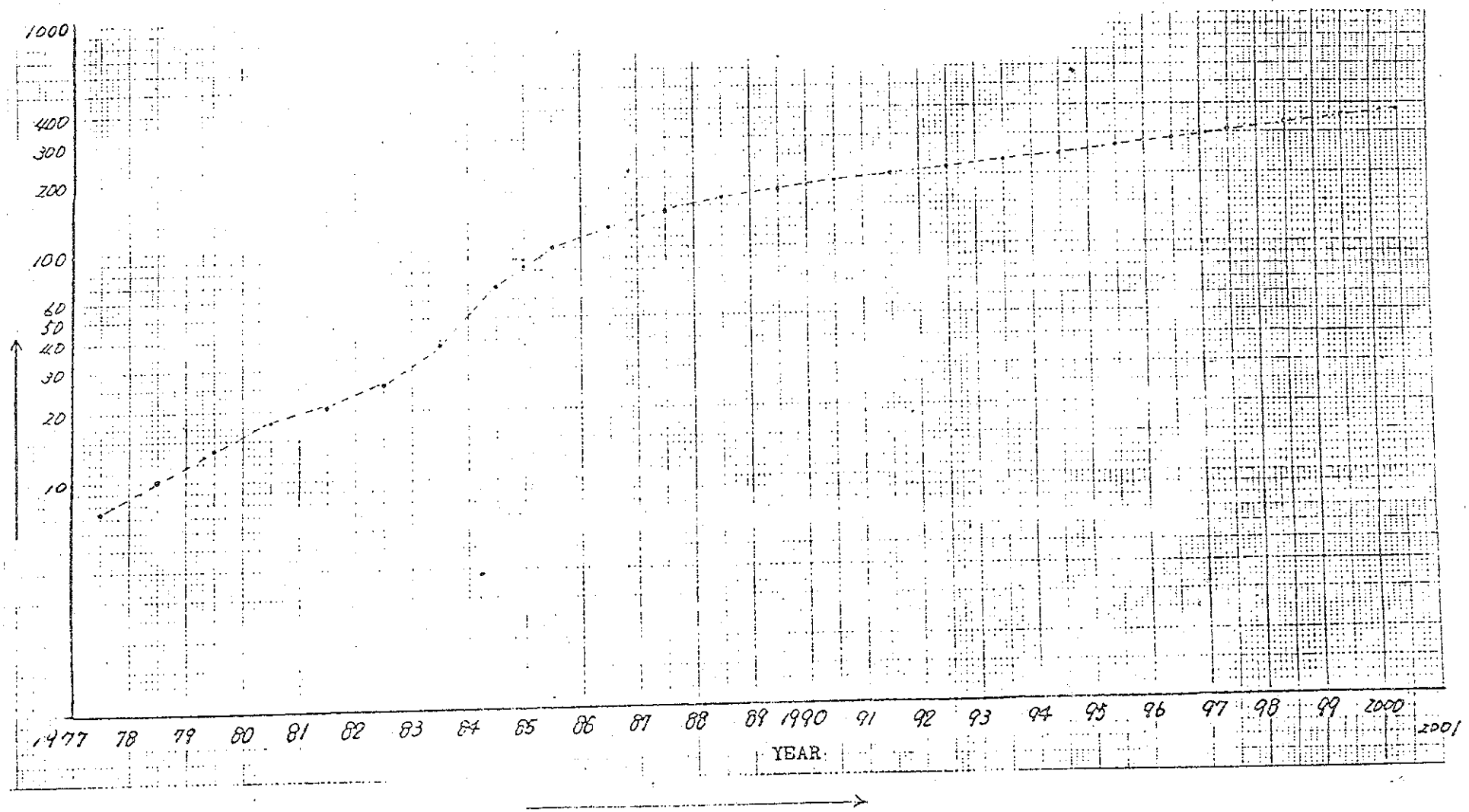


Table 3.2(1)INTERNATIONAL TELEPHONE TRAFFIC FORECAST

DESTINATION	BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		19
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(% & ERL
UNITED KINGDOM			(19%)		(50%)		(100%)		(30%)		(20%)		(15%)
	11.83E	12	13.85E	20	20.55E	31	41.66E	55	54.16E	68	64.98E	80	74.73
U. S. A.			(50%)		(50%)		( )		( )				
	3.34E	6	5.01E	10	7.50E	15	13.88E	23	18.05E	28	21.20E	32	24.40
SWITZERLAND			(50%)		(50%)		( )		( )				
	0.55E	1	0.82E	4	1.23E	4	2.46E	8	3.69E	9	4.42E	10	5.08
GREECE			(19%)		(50%)		( )		( )				
	0.34E	1	0.40E	3	0.60E	4	1.20E	5	1.80E	6	2.16E	7	2.48
ITALY			(19%)		(50%)		( )		( )				
	0.53E	4	0.79E	4	1.18E	4	2.60E	8	3.36E	9	4.04E	10	4.64
WEST GERMANY			(19%)		(50%)		( )		( )				
	0.62E	1	0.73E	4	1.09E	4	2.18E	8	2.83E	8	3.39E	9	3.89
NETHERLANDS					(300%)		(190%)		( )				
		-	0.15E	1	0.45E	2	1.30E	4	1.69E	6	2.03E	7	2.33
FRANCE		-		-		-	1.90E	5	2.47E	6	2.96E	8	3.40
BRAZIL		-		-		-		-		-	0.45E	2	0.51
BELGIUM		-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33
CANADA		-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33
SUB-TOTAL	17.21E	25	21.75E	45	32.60E	63	69.78E	124	91.42E	152	109.69E	179	126.12
JAPAN		-		-		-	(100%) 1.30E	4	(30%) 1.69E	6	(20%) 2.03E	7	(15%) 2.33
KENYA	0.76E	3	(19%) 0.90E	4	(50%) 1.35E	5	(100%) 2.70E	9	(30%) 3.51E	9	4.21E	10	4.84
AUSTRALIA	1.00E	1	(50%) 1.50E	5	(50%) 2.25E	7	(100%) 4.50E	12	5.85E	12	6.69E	14	7.69
R.S.A.	1.65E	(6)	(19%) 1.96E	(6)	(50%) 2.94E	(7)	WILL BE TRANSFERRED TO OTHER MAJOR ROUT						
MALAWI	(5.60E)	(+12) (4)	(19%) (6.55E)	(+12) (4)	(50%) (7.80E)	(15)	WILL BE TRANSFERRED TO PANAFTEL NETWORK						
SUB-TOTAL	3.41E	8	4.36E	13	6.54E	19	8.50E	25	11.05E	27	12.93E	31	14.76
TOTAL	20.62E	29	26.11E	55	39.14E	81	78.28E	149	102.48E	179	122.62E	210	140.98

Table 3.2(1) INTERNATIONAL TELEPHONE TRAFFIC FORECAST

BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995/96		1996/97	
G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
11.83E	12	(19%) 13.85E	20	(50%) 20.55E	31	(100%) 41.66E	55	(30%) 54.16E	68	(20%) 64.98E	80	(15%) 74.73E	91	(15%) 85.92E	102	(10%) 94.51E	111	(7%) 101.13E	119	(7%) 108.20E	127	(7%) 115.76E	134	(7%) 123.87E	143	(7%) 132.53E	152	(7%) 141.84E	161	(7%) 151.76E	172
3.34E	6	(50%) 5.01E	10	(50%) 7.50E	15	( ) 13.88E	23	( ) 18.05E	28	21.20E	32	24.40E	35	28.04E	39	30.84E	43	33.01E	45	35.31E	48	37.77E	50	40.40E	53	43.24E	56	46.25E	60	49.49E	63
0.55E	1	(50%) 0.82E	4	(50%) 1.23E	4	( ) 2.46E	8	( ) 3.69E	9	4.42E	10	5.08E	11	5.84E	12	6.42E	13	6.86E	14	7.34E	14	7.85E	15	8.39E	16	8.97E	17	9.59E	17	10.26E	18
0.34E	1	(19%) 0.40E	3	(50%) 0.60E	4	( ) 1.20E	5	( ) 1.80E	6	2.16E	7	2.48E	7	2.85E	8	3.13E	9	3.34E	9	3.57E	9	3.81E	10	4.07E	10	4.35E	10	4.64E	11	4.97E	11
0.53E	4	(19%) 0.79E	4	(50%) 1.18E	4	( ) 2.60E	8	( ) 3.36E	9	4.04E	10	4.64E	11	5.34E	12	5.87E	12	6.27E	14	6.71E	14	7.17E	14	7.67E	15	8.20E	16	8.76E	16	9.38E	17
0.62E	1	(19%) 0.73E	4	(50%) 1.09E	4	( ) 2.18E	8	( ) 2.83E	8	3.39E	9	3.89E	10	4.47E	11	4.91E	11	5.25E	12	5.61E	12	6.00E	13	6.42E	13	6.86E	14	7.33E	14	7.85E	15
	-	0.15E	1	(300%) 0.45E	2	(190%) 1.30E	4	( ) 1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11
	-		-		-	1.90E	5	2.47E	6	2.96E	8	3.40E	9	3.91E	10	4.30E	10	4.61E	11	4.93E	11	5.27E	12	5.64E	12	6.04E	13	6.41E	13	6.85E	14
	-		-		-		-		-	0.45E	2	0.51E	4	0.60E	4	0.65E	4	0.70E	4	0.75E	4	0.80E	4	0.86E	5	0.91E	5	0.97E	5	1.04E	5
	-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11
	-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11
17.21E	25	21.75E	45	32.60E	63	69.78E	124	91.42E	152	109.69E	179	126.12E	202	145.01E	222	159.48E	237	170.62E	255	182.53E	266	195.26E	279	208.90E	297	223.49E	313	239.02E	327	255.76E	343
	-		-		-	(100%) 1.30E	4	(30%) 1.69E	6	(20%) 2.03E	7	(15%) 2.33E	8	(15%) 2.68E	8	(10%) 2.95E	8	(7%) 3.15E	9	(7%) 3.37E	9	(7%) 3.61E	9	(7%) 3.86E	10	(7%) 4.13E	10	(7%) 4.41E	10	(7%) 4.72E	11
0.76E	3	(19%) 0.90E	4	(50%) 1.35E	5	(100%) 2.70E	9	(30%) 3.51E	9	4.21E	10	4.84E	11	5.56E	12	6.11E	13	6.53E	13	6.98E	14	7.46E	15	7.98E	15	8.53E	16	9.11E	17	9.75E	18
1.00E	1	(50%) 1.50E	5	(50%) 2.25E	7	(100%) 4.50E	12	5.85E	12	6.69E	14	7.69E	15	8.84E	16	9.72E	18	10.40E	18	11.12E	19	11.90E	20	12.73E	21	13.62E	22	14.56E	24	15.58E	25
1.65E	(6)	(19%) 1.96E	(6)	(50%) 2.94E	(7)	WILL BE TRANSFERRED TO OTHER MAJOR ROUTES																									
(5.60E)	(+12) (4)	(19%) (6.55E)	(+12) (4)	(50%) (7.80E)	(15)	WILL BE TRANSFERRED TO PANAFTEL NETWORK																									
3.41E	8	4.36E	13	6.54E	19	8.50E	25	11.05E	27	12.93E	31	14.76E	33	17.08E	36	18.78E	39	20.08E	40	21.47E	42	22.97E	44	24.57E	46	26.28E	48	28.05E	51	30.05E	54
20.62E	29	26.11E	55	39.14E	81	78.28E	149	102.48E	179	122.62E	210	140.98E	235	162.09E	258	178.26E	276	190.70E	295	204.00E	308	218.23E	329	233.47E	343	249.77E	361	267.20E	378	285.90E	402

ECAST

986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/20001	
)	CCTS	G.R(%) & ERL (15%)	CCTS	G.R(%) & ERL (15%)	CCTS	G.R(%) & ERL (10%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS
E	80	74.73E	91	85.92E	102	94.51E	111	101.13E	119	108.20E	127	115.76E	134	123.87E	143	132.53E	152	141.84E	161	151.76E	172	162.40E	183	173.76E	193	185.90E	207	198.87E	220
E	32	24.40E	35	28.04E	39	30.84E	43	33.01E	45	35.31E	48	37.77E	50	40.40E	53	43.24E	56	46.25E	60	49.49E	63	52.96E	67	56.65E	71	60.62E	75	64.87E	80
E	10	5.08E	11	5.84E	12	6.42E	13	6.86E	14	7.34E	14	7.85E	15	8.39E	16	8.97E	17	9.59E	17	10.26E	18	10.98E	19	11.74E	20	12.57E	21	13.45E	22
E	7	2.48E	7	2.85E	8	3.13E	9	3.34E	9	3.57E	9	3.81E	10	4.07E	10	4.35E	10	4.64E	11	4.97E	11	5.32E	12	5.68E	12	6.08E	13	6.51E	14
E	10	4.64E	11	5.34E	12	5.87E	12	6.27E	14	6.71E	14	7.17E	14	7.67E	15	8.20E	16	8.76E	16	9.38E	17	10.04E	18	10.73E	19	11.48E	20	12.29E	21
E	9	3.89E	10	4.47E	11	4.91E	11	5.25E	12	5.61E	12	6.00E	13	6.42E	13	6.86E	14	7.33E	14	7.85E	15	8.40E	16	8.98E	17	9.61E	17	10.29E	18
E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11	5.06E	12	5.41E	12	5.79E	12	6.20E	13
E	8	3.40E	9	3.91E	10	4.30E	10	4.61E	11	4.93E	11	5.27E	12	5.64E	12	6.04E	13	6.41E	13	6.85E	14	7.34E	14	7.91E	15	8.46E	16	9.06E	17
E	2	0.51E	4	0.60E	4	0.65E	4	0.70E	4	0.75E	4	0.80E	4	0.86E	5	0.91E	5	0.97E	5	1.04E	5	1.12E	5	1.20E	5	1.28E	5	1.37E	6
E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11	5.06E	12	5.41E	12	5.79E	12	6.20E	13
E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11	5.06E	12	5.41E	12	5.79E	12	6.20E	13
E	179	126.12E	202	145.01E	222	159.48E	237	170.62E	255	182.53E	266	195.26E	279	208.90E	297	223.49E	313	239.02E	327	255.76E	348	273.74E	370	292.88E	388	313.37E	410	335.31E	437
		(15%)		(15%)		(10%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)	
E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9	3.86E	10	4.13E	10	4.41E	10	4.72E	11	5.06E	12	5.41E	12	5.79E	12	6.20E	13
E	10	4.84E	11	5.56E	12	6.11E	13	6.53E	13	6.98E	14	7.46E	15	7.98E	15	8.53E	16	9.11E	17	9.75E	18	10.44E	19	11.16E	19	11.94E	20	12.78E	21
E	14	7.69E	15	8.84E	16	9.72E	18	10.40E	18	11.12E	19	11.90E	20	12.73E	21	13.62E	22	14.56E	24	15.58E	25	16.68E	26	17.84E	28	19.09E	29	20.43E	31
THER MAJOR ROUTES																													
NAFTEL NETWORK																													
E	31	14.76E	33	17.08E	36	18.78E	39	20.08E	40	21.47E	42	22.97E	44	24.57E	46	26.28E	48	28.05E	51	30.05E	54	32.18E	57	34.41E	59	36.82E	61	39.41E	65
E	210	140.98E	235	162.09E	258	178.26E	276	190.70E	295	204.00E	308	218.23E	329	233.47E	343	249.77E	361	267.20E	378	285.90E	402	305.92E	427	327.31E	447	350.22E	471	374.72E	502

Table 3.2.(2) INTERNATIONAL TELEPHONE TRAFFIC FORECAST
ESTIMATED EACH SUB-PROJECT (TRAFFIC GROWTH)

YEAR	NO EFFECTIVE ACTION PERFORMED (NATURAL GROWTH)		AFTER COMPLETION OF I.N.T.S. IN GUELÙ		IN CASE OF INTRODUCTED SATTELITE EARTH STATION		IN CASE OF INTRODUCTED TRUNK & JUNCTION SW	
1977/78	7.54e							
1978/79	10.23e	37.3%						
1979/80	13.60e	32.9%						
1980/81	17.50e	28.6%						
1981/82	20.60e	17.7%						
1982/83	24.53e	19.1%	26.11e	26%				
1983/84	28.48e	16.1%	39.14e	50%				
1984/85	32.53e	14.4%	46.96e	20%	78.28e	100%	78.28e	100%
1985/86	36.86e	13.1%	54.01e	15%	93.93e	20%	102.48e	30%
1986/87	41.30e	12.1%	60.49e	12%	108.02e	15%	122.60e	20%
1987/88	45.91e	11.1%	67.14e	11%	124.23e	15%	140.98e	15%
1988/89	50.69e	10.4%	73.86e	10%	136.65e	10%	162.09e	15%
1989/90	55.63e	9.7%	81.25e	10%	150.31e	10%	178.26e	10%
1990/91	60.74e	9.1%	86.93e	7%	160.84e	7%	190.70e	7%
1991/92	66.03e	8.7%	93.02e	7%	172.09e	7%	204.00e	7%
1992/93	71.47e	8.2%	99.53e	7%	184.14e	7%	218.23e	7%
1993/94	"	:	106.50e	7%	197.03e	7%	233.47e	7%
1994/95	82.86e	:	113.95e	7%	210.82e	7%	249.77e	7%
1995/96	88.81e	7.1%	121.93e	7%	225.58e	7%	267.20e	7%
1996/97	"	:	130.47e	7%	241.37e	7%	285.90e	7%
1997/98	"	:	139.60e	7%	258.27e	7%	305.92e	7%
1998/99	"	:	149.37e	7%	276.35e	7%	327.31e	7%
99/2000	114.27e	:	159.83e	7%	295.69e	7%	350.22e	7%
2000/01	121.06e	5.9%	171.02e	7%	316.39e	7%	374.73e	7%

Table 3.2.(3) INTERNATIONAL TELEPHONE TRAFFIC FORECAST
ESTIMATED EACH SUB-PROJECT (PAID MINUTES)

YEAR	NET INCREASE SAT E/S PROJECT		NET INCREASE SW PROJECT		NET INCREASE SAT E/S + SW PROJECT	
	TRAFFIC IN ERLANG	PAID MINUTES PER ANNUM	TRAFFIC IN ERLANG	PAID MINUTES PER ANNUM	TRAFFIC IN ERLANG	TOTAL PAID MINUTES PER ANNUM
1979/80						
1980/81						
1981/82						
1982/83						
1983/84						
1984/85	31.32e	3523500			31.32e	3523500
1985/86	39.92e	4491000	8.55e	961875	48.47e	5452875
1986/87	47.53e	5347125	14.58e	1640250	62.11e	6987375
1987/88	57.09e	6422625	16.75e	1884375	73.84e	8307000
1988/89	62.79e	7063825	25.44e	2862000	88.23e	9925875
1989/90	69.06e	7769250	27.95e	3144375	97.01e	10913625
1990/91	73.91e	8314875	29.86e	3359250	103.77e	11674125
1991/92	79.09e	8895375	31.91e	3589875	110.98e	12485250
1992/93	85.61e	9518625	34.09e	3835125	118.70e	13353750
1993/94	90.53e	10184625	36.44e	4099500	126.97e	14284124
1994/95	96.87e	10897875	38.95e	4381875	135.82e	15279750
1995/96	103.65e	11660625	41.62e	4682250	145.27e	16342874
1996/97	110.90e	12476250	44.53e	5009625	155.43e	17485874
1997/98	118.67e	13350374	47.65e	5360625	166.32e	18711000
1998/99	126.98e	14285250	50.96e	5733000	177.94e	20018250
99/2000	135.86e	15284250	54.63e	6134625	190.39e	21418874
2000/01	145.37e	16354124	58.33e	6562125	203.70e	22916250

Table 3.3 (1) INTERNATIONAL TELEPHONE TRAFFIC FORECAST ON THE A.O.R. NETWORK

DESTINATION	BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93	
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
UNITED KINGDOM	11.83E	12	13.85E	20	20.55E	31	(100%) 37.50E	50	(30%) 48.75E	62	(20%) 58.50E	73	(15%) 67.28E	83	(15%) 77.37E	93	(10%) 85.10E	102	(7%) 91.06E	108	(7%) 97.43E	115	(7%) 104.24E	123
U.S.A.	3.34E	6	5.01E	10	7.50E	15	13.70E	23	17.81E	27	20.92E	31	24.07E	35	27.66E	39	30.43E	42	32.56E	45	34.83E	47	37.26E	50
SWITZERLAND	0.55E	1	0.82E	4	1.23E	4	2.46E	8	3.69E	9	4.42E	10	5.08E	11	5.84E	12	6.42E	13	6.86E	14	7.34E	14	7.85E	15
GREECE	0.34E	1	0.40E	3	0.60E	3	1.20E	5	1.80E	6	2.16E	7	2.48E	7	2.85E	8	3.13E	9	3.34E	9	3.57E	9	3.81E	10
ITALY	0.53E	4	0.79E	4	1.18E	4	2.36E	7	3.06E	8	3.67E	9	4.22E	10	4.85E	11	5.33E	12	5.70E	12	6.10E	13	6.52E	13
WEST GERMANY	0.62E	1	0.73E	4	1.09E	4	2.18E	8	2.83E	8	3.39E	9	3.89E	10	4.47E	11	4.91E	11	5.25E	12	5.61E	12	6.00E	13
NETHERLANDS		-	0.15E	1	0.45E	2	1.30E	4	1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9
FRANCE		-		-		-	1.90E	5	2.47E	6	2.96E	8	3.40E	9	3.91E	10	4.30E	10	4.61E	11	4.93E	11	5.27E	12
BRAZIL		-		-		-		-		-	0.45E	2	0.51E	4	0.60E	4	0.65E	4	0.70E	4	0.75E	4	0.80E	4
BELGIUM		-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9
CANADA		-		-		-	1.30E	4	1.69E	6	2.03E	7	2.33E	8	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9
SUB-TOTAL	17.21E	25	21.75E	45	32.60E	63	65.20E	118	85.48E	144	20.06E	170	117.92E	193	135.59E	212	149.12E	227	159.53E	242	170.67E	252	182.58E	267

DESTINATION	BASE DATA 1993/94		1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/2001	
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
UNITED KINGDOM	(7%) 111.54E	130	(7%) 119.34E	138	(7%)		(7%)		(7%) 146.25E	167	(7%)		(7%)		(7%) 179.09E	201
U.S.A.	39.86E	53	42.66E	56					52.25E	66					64.00E	79
SWITZERLAND	8.39E	16	8.97E	17					10.98E	19					13.45E	22
GREECE	4.07E	10	4.35E	10					5.32E	12					6.51E	14
ITALY	6.97E	13	7.45E	15					9.12E	17					11.17E	19
WEST GERMANY	6.42E	13	6.86E	14					8.40E	16					10.29E	18
NETHERLANDS	3.86E	10	4.13E	10					5.06E	12					6.20E	13
FRANCE	5.64E	12	6.04E	13					7.34E	14					9.06E	17
BRAZIL	0.86E	5	0.91E	5					1.12E	5					1.37E	6
BELGIUM	3.86E	10	4.13E	10					5.06E	12					6.20E	13
CANADA	3.86E	10	4.13E	10					5.06E	12					6.20E	13
SUB-TOTAL	195.33E	282	208.97E	298					255.96E	352					313.54E	415

Table 3.3 (2) INTERNATIONAL TELEPHONE TRAFFIC FORECAST ON THE I.O.R. NETWORK

DESTINATION	BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93	
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
AUSTRALIA	1.00E	1	1.50E	5	2.25E	7	(100%) 4.50E	12	(30%) 5.85E	12	(20%) 6.69E	14	(15%) 7.69E	15	(15%) 8.84E	16	(10%) 9.72E	18	(7%) 10.40E	18	(7%) 11.12E	19	(7%) 11.90E	20
KENYA	0.76E	3	0.90E	4	1.35E	5	2.70E	9	3.51E	9	4.21E	10	4.84E	11	5.56E	12	6.11E	13	6.53E	13	6.98E	14	7.46E	15
TANZANIA							1.04E	4	1.35E	5	1.62E	6	1.87E	6	2.15E	7	2.36E	7	2.54E	8	2.71E	8	2.90E	8
PAKISTAN							0.90E	4	1.17E	5	1.40E	6	1.61E	6	1.85E	6	2.03E	7	2.18E	7	2.33E	7	2.49E	7
NEW ZEALAND (AUSTRALIA)							0.47E	4	0.61E	4	0.73E	4	0.84E	4	0.96E	4	1.06E	4	1.13E	4	1.21E	4	1.29E	4
U.A.E.							0.40E	3	0.52E	4	0.62E	4	0.71E	4	0.82E	4	0.90E	4	0.96E	4	1.03E	4	1.10E	4
INDIA							1.30E	4	1.69E	6	2.03E	7	2.33E	7	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9
JAPAN							1.30E	4	1.69E	6	2.03E	7	2.33E	7	2.68E	8	2.95E	8	3.15E	9	3.37E	9	3.61E	9
HONG KONG							0.47E	4	0.61E	4	0.73E	4	0.84E	4	0.96E	4	1.06E	4	1.13E	4	1.21E	4	1.29E	4
SUB-TOTAL							13.08E	48	17.00E	55	20.06E	62	23.06E	64	26.50E	69	29.14E	73	31.17E	76	33.33E	78	35.65E	80
TOTAL							78.28E	166	102.48E	199	122.60E	232	140.98E	257	162.09E	281	178.26E	300	190.70E	318	204.00E	330	218.23E	347

DESTINATION	BASE DATA 1993/94		1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/2001	
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
AUSTRALIA	(7%) 12.73E	21	(7%) 13.62E	22	(7%)		(7%)		(7%) 16.68E	26	(7%)		(7%)		(7%) 20.43E	31
KENYA	7.98E	15	8.53E	16					10.44E	19					12.78E	21
TANZANIA	3.10E	8	3.32E	9					4.07E	10					4.98E	11
PAKISTAN	2.67E	8	2.86E	8					3.50E	9					4.29E	10
NEW ZEALAND (AUSTRALIA)	1.38E	5	1.47E	6					1.80E	6					2.20E	7
U.A.E	1.18E	4	1.27E	4					1.55E	6					1.90E	6
INDIA	3.86E	10	4.13E	10					5.06E	11					6.20E	13
JAPAN	3.86E	10	4.13E	10					5.06E	11					6.20E	13
HONG KONG	1.38E	5	1.47E	6					1.80E	6					2.20E	7
SUB-TOTAL	38.14E	86	40.80E	91					49.96E	104					61.18E	119
TOTAL	233.47E	368	249.77E	389	267.20E		285.90E		305.92E	456	327.31E		350.22E		374.72E	534

Table 3.3.(3) ESTIMATING LIST FOR THE I.O.R. SATTELITE SUB-PROJECT

YEAR	TRAFFIC ON THE I.O.R. NETWORK				LEASED SATTELITE CIRCUIT COST		
	TRAFFIC IN ERLING	TOTAL PAID MINUTES PER ANNUM	INCOME		CCTS	ZD × 1K	YEN × 1K
			ZD × 1K	YEN × 1K			
1979/80							
1980/81							
1981/82							
1982/83							
1983/84							
1984/85	13.08e	1471500	1618	404500	48	542.4	135600
1985/86	17.00e	1912500	2103	525750	55	621.5	155375
1986/87	20.06e	1256750	2482	620500	62	700.6	175150
1987/88	23.06e	2594250	2853	713250	64	723.2	180800
1988/89	26.50e	2981250	3279	819750	69	779.7	194925
1989/90	29.14e	3278250	3606	911500	73	824.9	206225
1990/91	31.17e	3506625	3857	964250	76	858.8	214700
1991/92	33.33e	3749625	4124	1031000	78	881.4	220350
1992/93	35.65e	4010625	4411	1102750	80	904.0	226000
1993/94	38.14e	4290750	4719	1179750	86	971.8	242950
1994/95	40.80e	4590000	5049	1262250	91	1028.3	257075
1995/96	40.80e	4590000	5049	1252250	91		
1996/97	40.80e	4590000	5049	1252250	91		
1997/98	49.96e	5620500	6182	1545500	104	1175.2	293800
1998/99	49.96e	5620500	6182	1545500	104		
99/2000	49.96e	5620500	6182	1545500	104		
2000/01	61.18e	6882750	7571	1892750	119	1344.7	336175

Table 3.4 (1) INTERTERRITORIAL TELEPHONE TRAFFIC FORECAST

DESTINATION	BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL
BOTSWANA	5.60E		(19%) 6.66E	12	(50%) 9.99E	17	(100%) 19.98E	30	(30%) 25.97E	37	(20%) 31.16E	43	(15%) 35.84E	48	(15%) 41.22E	54	(10%) 45.34E	59	(7%) 48.51E	62	(7%) 51.91E	66	(7%) 55.53E	70	(7%) 59.42E	74	(7%) 63.57E	79	(7%) 68.01E
LESOTHO	1.84E		( ) 2.19E	6	3.28E	9	6.57E	13	8.54E	16	12.29E	21	13.15E	22	15.13E	24	16.64E	26	17.81E	28	19.05E	29	20.39E	31	21.81E	32	23.34E	34	24.97E
MALAWI	5.33E		( ) 6.34E	12	9.51E	17	19.02E	29	24.72E	36	29.66E	41	34.11E	46	39.29E	52	43.15E	56	46.17E	60	49.40E	63	52.86E	67	56.56E	71	60.52E	75	64.75E
MOZAMBIQUE	2.12E		( ) 2.54E	6	3.78E	9	7.56E	15	9.82E	18	11.78E	20	13.55E	22	15.58E	25	17.14E	27	18.34E	28	19.62E	30	21.00E	31	22.47E	33	24.04E	35	25.71E
SWAZILAND	0.53E		( ) 0.63E	3	0.94E	5	1.89E	6	2.45E	7	2.94E	8	3.38E	9	3.88E	10	4.27E	10	4.57E	11	4.89	11	5.23E	12	5.60E	12	5.99E	13	6.40E
ZAMBIA	3.48E		( ) 4.14E	9	6.21E	13	12.42E	22	16.14E	25	19.36E	29	22.27E	33	25.61E	36	28.17E	40	30.14E	42	32.25E	44	34.51E	47	36.93E	49	39.51E	52	42.27E
R.S.A.	171.10E		(7%) 183.10E	205	(15%) 210.50E	233	(15%) 242.00E	264	(15%) 278.00E	302	(15%) 320.00E	344	(10%) 368.00E	393	(7%) 405.00E	430	(7%) 433.00E	459	(7%) 463.00E	489	(7%) 496.00E	523	530.00E	557	568.00E	595	607.00E	634	650.00E
TOTAL	190.00E		205.58E	253	243.71E	303	309.44E	379	365.67E	441	427.19E	506	490.30E	573	545.71E	631	587.71E	677	628.54E	720	673.21E	766	719.52E	815	770.79E	866	823.97E	922	882.11E

FORECAST

1987/88		1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/20001	
G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS
(15%)		(15%)		(10%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)	
35.84E	48	41.22E	54	45.34E	59	48.51E	62	51.91E	66	55,53E	70	59.42E	74	63.57E	79	68.01E	83	72.78E	88	77.88E	94	83.32E	100	89.16E	106	95.41E	113
13.15E	22	15.13E	24	16.64E	26	17.81E	28	19.05E	29	20.39E	31	21.81E	32	23.34E	34	24.97E	36	26.72E	38	28.59E	40	30.59E	42	32.73E	45	35.03E	46
34.11E	46	39.29E	52	43.15E	56	46.17E	60	49.40E	63	52.86E	67	56.56E	71	60.52E	75	64.75E	80	69.28E	85	74.14E	90	79.32E	95	84.88E	101	90.83E	107
13.55E	22	15.58E	25	17.14E	27	18.34E	28	19.62E	30	21.00E	31	22.47E	33	24.04E	35	25.71E	36	27.51E	39	29.45E	41	31.50E	43	33.71E	46	36.08E	48
3.38E	9	3.88E	10	4.27E	10	4.57E	11	4.89	11	5.23E	12	5.60E	12	5.99E	13	6.40E	13	6.85E	14	7.34E	14	7.85E	15	8.40E	16	9.00E	17
22.27E	33	25.61E	36	28.17E	40	30.14E	42	32.25E	44	34.51E	47	36.93E	49	39.51E	52	42.27E	55	45.23E	59	48.40E	62	51.78E	65	55.41E	69	59.30E	74
(10%)		(7%)		(7%)		(7%)		(7%)																			
368.00E	393	405.00E	430	433.00E	459	463.00E	489	496.00E	523	530.00E	557	568.00E	595	607.00E	634	650.00E	678	695.00E	723	744.00E	771	796.00	824	852.00E	880	912.00E	941
490.30E	573	545.71E	631	587.71E	677	628.54E	720	673.21E	766	719.52E	815	770.79E	866	823.97E	922	882.11E	981	943.37E	1046	1009.80E	1112	1080.36E	1184	1156.29E	1263	1237.65E	1346

Table 3.4.(2) INTERNATIONAL TELEPHONE TRAFFIC FORECAST
ESTIMATED SW SUB-PROJECT (EXCLUDING ROUTE TO R.S.A.)

YEAR	AFTER COMPLETION OF I.N.T.S. IN GUELU		IN CASE OF INTRODUCTED TRUNK & JUNCTION SW				REMARKS
	TRAFFIC IN ERLANG	GROWTH RATE	TRAFFIC IN ERLANG	GROWTH RATE	NET IN ERLANG	NET INCREASE PAID MINUTES PER ANNUM	
1979/80							
1980/81							
1981/82	18.90e						
1982/83	22.48e	19%					
1983/84	33.71e	50%					GUELU SW
1984/85	67.44e	100%					COMPLETION PANAFTEL
1985/86	80.90e	20%	87.67e	30%	6.77e	761625	
1986/87	93.03e	15%	107.19e	20%	14.16e	1593000	
1987/88	106.99e	15%	122.30e	15%	15.31e	1722375	
1988/89	117.69e	10%	140.71e	15%	23.03e	2589750	
1989/90	129.46e	10%	154.71e	10%	25.25e	2840625	
1990/91	138.54e	7%	165.54e	7%	27.00e	3037500	
1991/92	148.24e	7%	177.21e	7%	28.97e	3259125	
1992/93	158.62e	7%	189.52e	7%	30.90e	3476250	
1993/94	169.72e	7%	202.79e	7%	33.07e	3720375	
1994/95	181.37e	7%	216.97e	7%	35.60e	4005000	
1995/96	194.37e	7%	232.11e	7%	37.74e	4245750	
1996/97	207.91e	7%	248.37e	7%	40.46e	4551750	
1997/98	222.48e	7%	265.80e	7%	43.32e	4873500	
1998/99	238.10e	7%	284.36e	7%	46.26e	5204250	
99/2000	254.70e	7%	304.29e	7%	49.59e	5578875	
2000/01	272.55e	7%	325.65e	7%	53.10e	5973750	

Table 3.4.(3) INTERNATIONAL TELEPHONE TRAFFIC FORECAST
ESTIMATED SW SUB-PROJECT (ONLY TO R.S.A.)

YEAR	AFTER COMPLETION OF I.N.T.S. IN GUELU		IN CASE OF INTRODUCTED TRUNK & JUNCTION SW				REMARKS
	TRAFFIC IN ERLANG	GROWTH RATE	TRAFFIC IN ERLANG	GROWTH RATE	NET IN ERLANG	NET INCREASE PAID MINUTES PER ANNUM	
1979/80							
1980/81							
1981/82	171e						
1982/83	183e	7%					
1983/84	210e	15%					
1984/85	242e	15%					
1985/86	266e	10%	278e	15%	12e	1350000	
1986/87	292e	10%	320e	15%	28e	3150000	
1987/88	322e	10%	368e	15%	46e	5175000	
1988/89	354e	7%	405e	10%	51e	5737500	
1989/90	379e	7%	433e	7%	54e	6075000	
1990/91	405e	7%	463e	7%	58e	6525000	
1991/92	434e	7%	496e	7%	62e	6975000	
1992/93	464e	7%	530e	7%	66e	7425000	
1993/94	496e	7%	568e	7%	72e	8100000	
1994/95	531e	7%	607e	7%	76e	8550000	
1995/96	568e	7%	650e	7%	82e	9225000	
1996/97	608e	7%	695e	7%	87e	9787500	
1997/98	651e	7%	744e	7%	93e	10462500	
1998/99	696e	7%	796e	7%	100e	11250000	
99/2000	745e	7%	852e	7%	107e	12037500	
2000/01	797e	7%	912e	7%	115e	12937500	

Table 3.5 INTERNATIONAL TELEX TRAFFIC FORECAST (FIGURE WITH CIRCLE ARE IN

DESTINATION	BASE DATA 1981/82		1982/83		1983/84		1984/85		1985/86		1986/87		1
	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(& ERI
			(40%)		(50%)		(20%)		(15%)		(15%)		(15%
UNITED KINGDOM	10.19E	2 18/28	14.26E	23/28	21.39E	32	25.69E	37	29.53E	41	33.96E	2 46	39.0
R.S.A.	1.02E	1 5/63	1.42E	6/63	2.14E	7/63	2.57E	8/63	2.95E	8/63	3.39E	9/63	3.9
SWITZERLAND	5.28E	1 20	7.39E	15/20	10.80E	19/20	13.30E	1 22	15.30E	2 25	17.59E	27	20.2
ITALY	1.73E	1 6/12	2.42E	7/12	3.63E	9/12	4.35E	10/12	5.01E	11/12	5.76E	11/12	6.6
U.S.A. (I.T.T.)	1.51E	24 1 6/24	2.11E	24 7/24	3.17E	24 1 9	3.80E	26 2 10	4.37E	29 10	5.03E	32 11	5.2
U.S.A. (W.U.I.)	1.24E	5/24	1.73E	6/24	2.60E	7	3.12E	8	3.59E	9	4.13E	10	4.7
U.S.A. (R.C.A.)	1.50E	6/24	2.10E	7/24	3.15E	8	3.78E	8	4.34E	10	4.99E	11	5.7
FRANCE	0.77E	1 4	1.07E	5	1.61E	6	1.94E	7	2.23E	7	2.56E	8	2.9
KENYA	0.35E	1 3/4	0.49E	4	0.73E	4	0.88E	5	1.01E	5	1.16E	5	1.
WEST GERMANY	0.10E	1 2/4	0.14E	2/4	0.21E	3/4	0.25E	3/4	0.28E	3/4	0.33E	3/4	0.

3.5 INTERNATIONAL TELEX TRAFFIC FORECAST (FIGURE WITH CIRCLE ARE INDICATED BASED ON BEARER)

82/83		1983/84		1984/85		1985/86		1986/87		1987/88		1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98		199
	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL	CCTS	G.R(%) & ERL
		(50%)		(20%)		(15%)		(15%)		(15%)		(10%)		(10%)		(10%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)		(7%)	
									2		3							3		4							4		5		
E	23/23	21.39E	32	25.69E	37	29.53E	41	33.96E	46	39.05E	52	42.95E	56	47.95E	62	51.98E	66	55.61E	69	59.51E	74	63.67E	79	68.13E	83	72.90E	89	78.00E	94	83.47E	100	89.31
E	6/63	2.14E	7/63	2.57E	8/63	2.95E	8/63	3.39E	9/63	3.90E	10/63	4.30E	10/63	4.73E	11/63	5.20E	12/63	5.56E	12/63	5.96E	13/63	6.37E	13/63	6.82E	14/63	7.29E	14/63	7.80E	15/63	8.35E	16/63	8.94
					1		2																		2		3				
E	15/20	10.80E	19/20	13.30E	22	15.30E	25	17.59E	27	20.23E	30	22.25E	33	24.48E	35	26.93E	38	28.81E	40	30.83E	43	32.99E	45	35.30E	48	37.77E	50	40.42E	53	43.25E	56	46.27
E	7/12	3.63E	9/12	4.35E	10/12	5.01E	11/12	5.76E	11/12	6.63E	14	7.29E	15	8.02E	16	8.82E	16	9.44E	17	10.10E	18	10.81E	19	11.56E	20	12.37E	21	13.24E	22	14.17E	23	15.16
	24		24		26		29		32		35		38		40		43		46		46		49		52		54		57		60	
				1		2														2		3									
E	7/24	3.17E	9	3.80E	10	4.37E	10	5.03E	11	5.28E	12	6.36E	13	7.00E	14	7.70E	15	8.24E	16	8.81E	16	9.43E	17	10.09E	18	10.80E	19	11.55E	20	12.36E	21	13.27
E	6/24	2.60E	7	3.12E	8	3.59E	9	4.13E	10	4.75E	11	5.22E	12	5.75E	12	6.32E	13	6.76E	14	7.24E	14	7.74E	15	8.29E	16	8.87E	16	9.49E	17	10.15E	18	10.86
E	7/24	3.15E	8	3.78E	8	4.34E	10	4.99E	11	5.74E	12	6.32E	13	6.95E	14	7.65E	15	8.18E	16	8.76E	16	9.37E	17	10.02E	18	10.73E	19	11.48E	20	12.28E	21	13.1
E	5	1.61E	6	1.94E	7	2.23E	7	2.56E	8	2.95E	8	3.24E	9	3.57E	9	3.92E	10	4.20E	10	4.49E	11	4.81E	11	5.14E	11	5.50E	12	5.89E	14	6.30E	13	6.7
E	4	0.73E	4	0.88E	5	1.01E	5	1.16E	5	1.34E	5	1.47E	6	1.62E	6	1.78E	6	1.91E	7	2.04E	7	2.18E	7	2.34E	7	2.50E	7	2.67E	8	2.86E	8	3.0
E	2/4	0.21E	3/4	0.25E	3/4	0.28E	3/4	0.33E	3/4	0.38E	3/4	0.42E	3/4	0.46E	4	0.51E	4	0.54E	4	0.58E	4	0.62E	4	0.66E	4	0.71E	4	0.76E	4	0.81E	4	0.8

CATED BASED ON BEARER)

7/88	1988/89		1989/90		1990/91		1991/92		1992/93		1993/94		1994/95		1995/96		1996/97		1997/98		1998/99		1999/2000		2000/20001	
CCTS	G.R(%) & ERL (10%)	CCTS	G.R(%) & ERL (10%)	CCTS	G.R(%) & ERL (10%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS	G.R(%) & ERL (7%)	CCTS
3								3		4								4		5						5
52	42.95E	56	47.95E	62	51.98E	66	55.61E	69	59.51E	74	63.67E	79	68.13E	83	72.90E	89	78.00E	94	83.47E	100	89.31E	106	95.56E	112	102.25E	120
																										1
10/63	4.30E	10/63	4.73E	11/63	5.20E	12/63	5.56E	12/63	5.96E	13/63	6.37E	13/63	6.82E	14/63	7.29E	14/63	7.80E	15/63	8.35E	16/63	8.94E	17/63	9.56E	17/63	10.23E	18.63
														2		3										3
30	22.25E	33	24.48E	35	26.93E	38	28.81E	40	30.83E	43	32.99E	45	35.30E	48	37.77E	50	40.42E	53	43.25E	56	46.27E	60	49.51E	63	52.98E	67
																				1				2		2
14	7.29E	15	8.02E	16	8.82E	16	9.44E	17	10.10E	18	10.81E	19	11.56E	20	12.37E	21	13.24E	22	14.17E	23	15.16E	24	16.22E	26	17.36E	27
35		38		40		43		46		46		49		52		54		57		60		63		66		69
										2		3														3
12	6.36E	13	7.00E	14	7.70E	15	8.24E	16	8.81E	16	9.43E	17	10.09E	18	10.80E	19	11.55E	20	12.36E	21	13.23E	22	14.16E	23	15.15E	24
11	5.22E	12	5.75E	12	6.32E	13	6.76E	14	7.24E	14	7.74E	15	8.29E	16	8.87E	16	9.49E	17	10.15E	18	10.86E	19	11.62E	20	12.44E	21
12	6.32E	13	6.95E	14	7.65E	15	8.18E	16	8.76E	16	9.37E	17	10.02E	18	10.73E	19	11.48E	20	12.28E	21	13.14E	22	14.06E	23	15.05E	24
																										1
8	3.24E	9	3.57E	9	3.92E	10	4.20E	10	4.49E	11	4.81E	11	5.14E	11	5.50E	12	5.89E	14	6.30E	13	6.74E	14	7.22E	14	7.72E	15
																										1
5	1.47E	6	1.62E	6	1.78E	6	1.91E	7	2.04E	7	2.18E	7	2.34E	7	2.50E	7	2.67E	8	2.86E	8	3.06E	8	3.28E	9	3.51E	9
																										1
3/4	0.42E	3/4	0.46E	4	0.51E	4	0.54E	4	0.58E	4	0.62E	4	0.66E	4	0.71E	4	0.76E	4	0.81E	4	0.87E	4	0.93E	5	1.00E	5

CHAPTER 4

Planning for Satellite Communications Earth Station

Chapter 4. Planning for Satellite Communications Earth Station

4.1 Introduction

Today, satellite communications play an important role in developing a new and wide range of cultural and economic opportunities.

The INTELSAT satellite communications system is able to provide an worldwide telecommunications service of high quality through network established over the three ocean regions, i.e., Atlantic Ocean region (A.O.R.), Indian Ocean region (I.O.R.) and Pacific Ocean region (P.O.R.).

Zimbabwe has the greatest geographical advantage from the INTELSAT satellite coverage aspect, being located within coverage of both A.O.R. and I.O.R. INTELSAT communications satellites. To establish such an efficient telecommunications network for Zimbabwe, it is necessary for the project to study the feasibility of satellite communications earth station installation projects from various technical and economical points of view.

Chapter 4 shows the result of technical feasibility studies made on the both A.O.R. and I.O.R. earth station installation projects and contains details of scope of work for the two projects. Detailed schemes or methods for implementing them, and cost estimations of their implementation are contained chapter 6 & chapter 7 respectively.

4.2 Outline of Earth Station Installation Project

4.2.1 General

Zimbabwe currently provides inter-territorial telecommunication services by Zimbabwe's microwave links and land line communications system. However, inter-continental telecommunication services rely on the services and facilities provided via an administration in the Republic of South Africa. There is no provision for direct inter-continental telecommunication services existing in Zimbabwe.

The earth station installation project is intended to establish an efficient satellite communications system in Zimbabwe by introducing a worldwide INTELSAT satellite communications network system, and to provide high-quality of telecommunication services through ZIMBABWE's own telecommunication facilities.

To establish such a satellite communications system in Zimbabwe, the earth station installation project is composed of two projects, Phase 1 and Phase 2, considering the traffic demand increase.

4.2.2 Outline of the Phase 1 Project

The Phase 1 project is to implement an INTELSAT Standard A earth station facility and its associated microwave link system for interconnecting with the existing telecommunications facility.

The project is planned to be completed and start operation by the end of 1984.

The earth station is installed at Mazowe, some 40 km away from the city of Harare, and will be operated with an INTELSAT major path II satellite in the Atlantic Ocean region.

The satellite communications system to be implemented in this phase will be able to provide direct and full time message transmission services with 11 countries by both Single Channel Per Carrier (SCPC) system and Frequency Division Multiplex, Frequency Modulation (FDM/FM) system. It will also provide an international television transmission service with audio either in colour or monochrome on an occasional basis.

An international television transmission to be handled at the earth station is extended to the ZBC Harare TV studio through a new microwave link between the earth station and the Harare Center Exchange Building and the existing microwave link between the Harare Center Exchange Building and ZBC Harare TV studio.

On the other hand, all message traffic is extended from the earth station to the Gweru Center Exchange Building through a new microwave link between the earth station and the Harare Center Exchange Building and the existing microwave links between Harare and Gweru.

The project is designed to interface well with the existing telecommunications networks in Zimbabwe with the minimum project cost requirements. To this end, the scope of works for accomplishing the Phase 1 project satisfactorily must cover the followings:

(a) Implementation of an INTELSAT Standard A earth station telecommunications complex.

(b) Construction of the earth station buildings and its associated facilities.

(c) Implementation of telecommunications equipment necessary for a microwave link between the earth station and the Harare Center Exchange Building, and having one microwave repeater station at Iron Cap.

(d) Implementation of various interface telecommunications equipment at the Harare Center Exchange Building.

4.2.3 Outline of the Phase 2 Project

The Phase 2 project is to implement the second INTELSAT Standard A earth station complex at Mazowe and to expand the size of the earth station complex to establish the direct satellite communications links with the necessary countries located in the coverage of the Indian Ocean region satellite.

Project planning will greatly rely on the P.T.C.'s policies in establishing the Phase 2 project. However, it is planned tentatively to start its operation by the end of 1988.

The earth station will operate with a Primary satellite in the Indian Ocean Region having capabilities to provide full time message transmission services with 8 countries by means of SCPC and FDM/FM communication systems. It will also provide international colour/monochrome television services on an occasional basis.

The work necessary for Phase 2 project will be smaller than that of Phase 1 and it must cover the following:

(a) Implementation of an INTELSAT Standard A earth station telecommunications complex

(b) Construction of an antenna pedestal building

4.3 Earth Station Site Selection

4.3.1 General

A number of crucial factors have to be considered when selecting the most suitable site for the satellite communications earth station. Such factors must cover all items relative to the cost of the project as well as assuring an easy operation and maintenance of the facilities.

In accordance with an agreement made on the summary record signed on 8th October 1982, the study team has completed detailed technical analysis on the subject of radio frequency interference analysis at the three proposed sites (Chishawasha, Shurugwi and Mazowe) and of earth station site selection as shown in the Draft Progress Report submitted in November 1982.

P.T.C. and the study team have made technical discussions on the Draft Progress Report during the field survey of November 23rd - December 6th, 1982, and it was mutually confirmed that the recommendation by the study team to select Mazowe site could well agree with the decision that had made by P.T.C. and approved by the Minister of Information, Posts and Telecommunications, Dr. Shamuyarira.

With those considerations, this section shows the summary of analysis made on the earth station site selection.

4.3.2 Summary of Earth Station Site Selection Study

Various conditions at the three proposed earth station sites (Chishawasha, Shurugwi and Mazowe) have been deeply studied to investigate the advantages of each as a satellite communications earth station in Zimbabwe.

Analysis covers the following key items:

(a) Visibility of various INTELSAT satellites located in A.O.R. and I.O.R. considering provisions to establish the second and third earth station facilities at the same site.

(b) Determination of the Radio Frequency Interference (RFI) coordination distances and/or their areas in accordance with the ITU Radio Regulations.

(c) Detailed RFI analysis between the earth station and the existing microwave links operating in the 6 GHz frequency band.

(d) System design considerations to establish an efficient telecommunicatios network by the satellite communications system

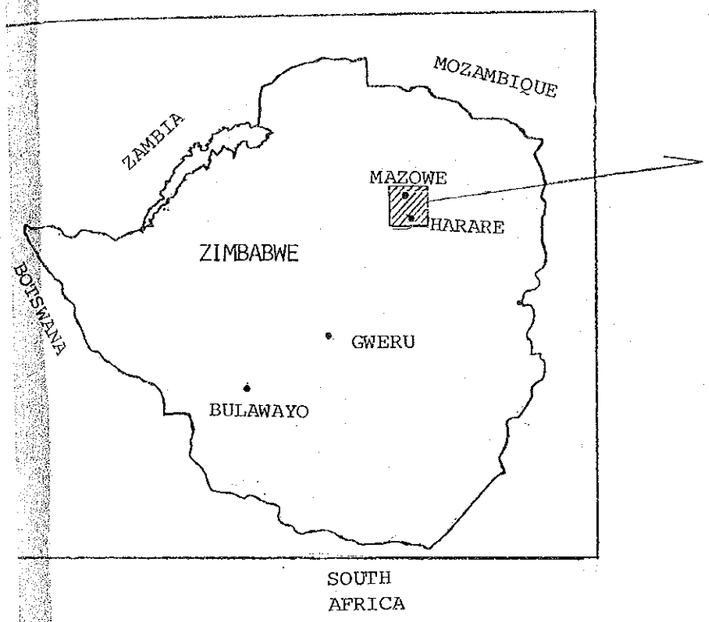
As a result of studies on these areas, it was technically determined that the most suitable site is Mazowe.

4.3.3 Geographical Site Location

Figure 4-1 shows the locations of the earth station at Mazowe, the microwave repeater station planned for Iron Cap and the Harare Center Exchange Building.

1) Earth Station at Mazowe

Zimbabwe's first satellite communications earth station is situated in a small village of Mazowe, some 40 km away from the city of Harare. The station is surrounded by hills and an orange field, thus providing a natural screening effect of radio frequency interference between the earth station and the existing terrestrial microwave links operating in the 6 GHz band.



OLD NAME	NEW NAME
SALISBURY	HARARE
MAZOE	MAZOWE

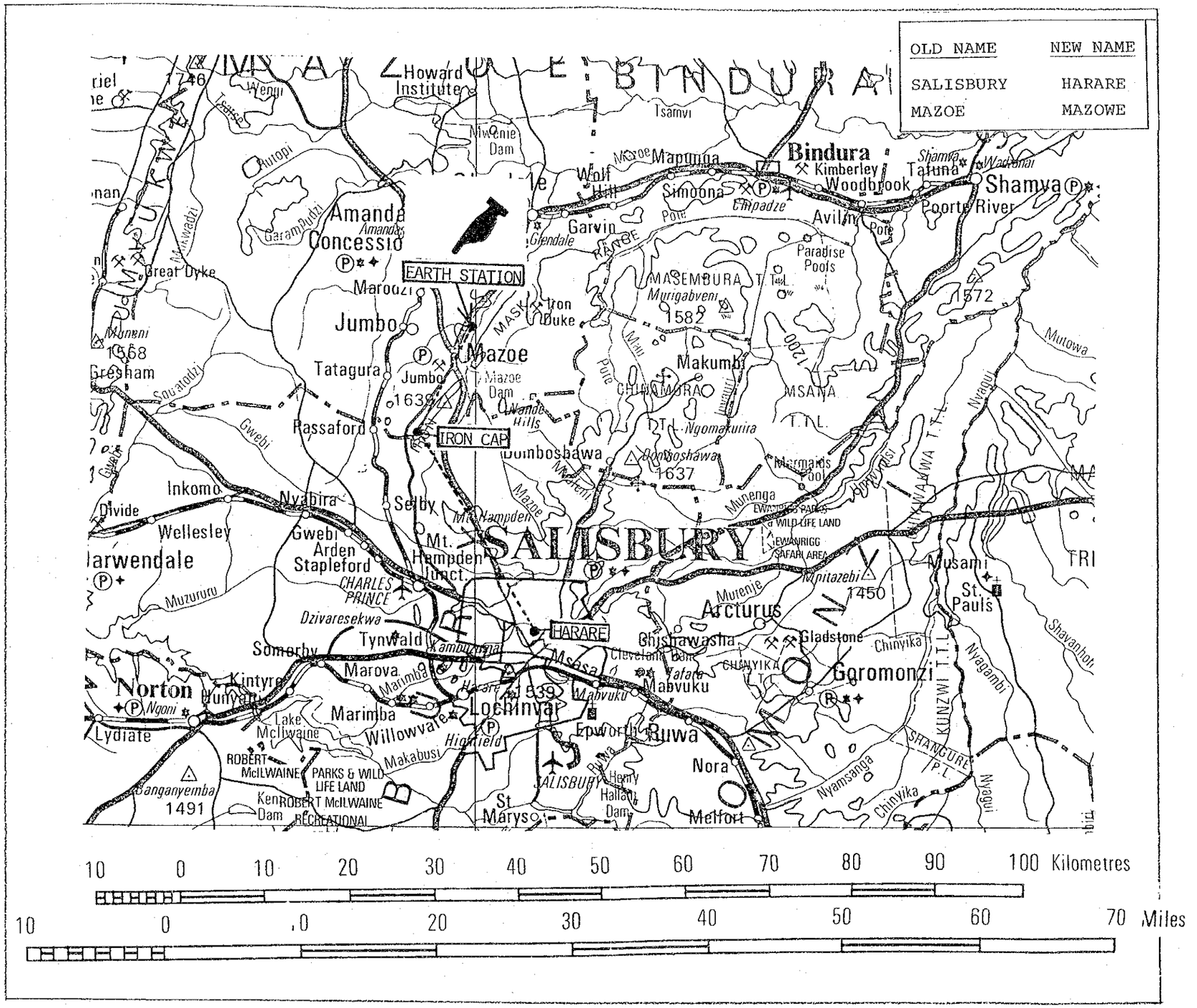


FIGURE 4-1 SITE LOCATION MAP

Geographical location of the earth station at Mazowe as taken from a map on a scale of 1/50,000:

- Longitude : 30° 59' 46" East
- Latitude : 17° 28' 26" South
- Ground Level : approx. 1,189 m (Above mean sea level)

Figure 4-2 shows the skyline profile and satellite geosynchronous arc seen from the site. From the figure, it is clearly understood that all INTELSAT satellites located at both the A.O.R. and the I.O.R. could be observed with sufficiently high elevation angles.

2) Microwave Repeater Station at Iron Cap

The microwave repeater station at Iron Cap is situated on the neck of Iron Cap Hill, some 14 km away from the earth station site at Mazowe and some 30 km from the Harare Center Exchange Building. It is also the site of the UHF repeater station.

This station will be used also for the repeater station for the terrestrial microwave link system between Harare and Kariba.

Site data are:

- Longitude : 30° 56' 18" East
- Latitude : 17° 35' 10" South
- Ground Level : 1,530 m (Above mean sea level)

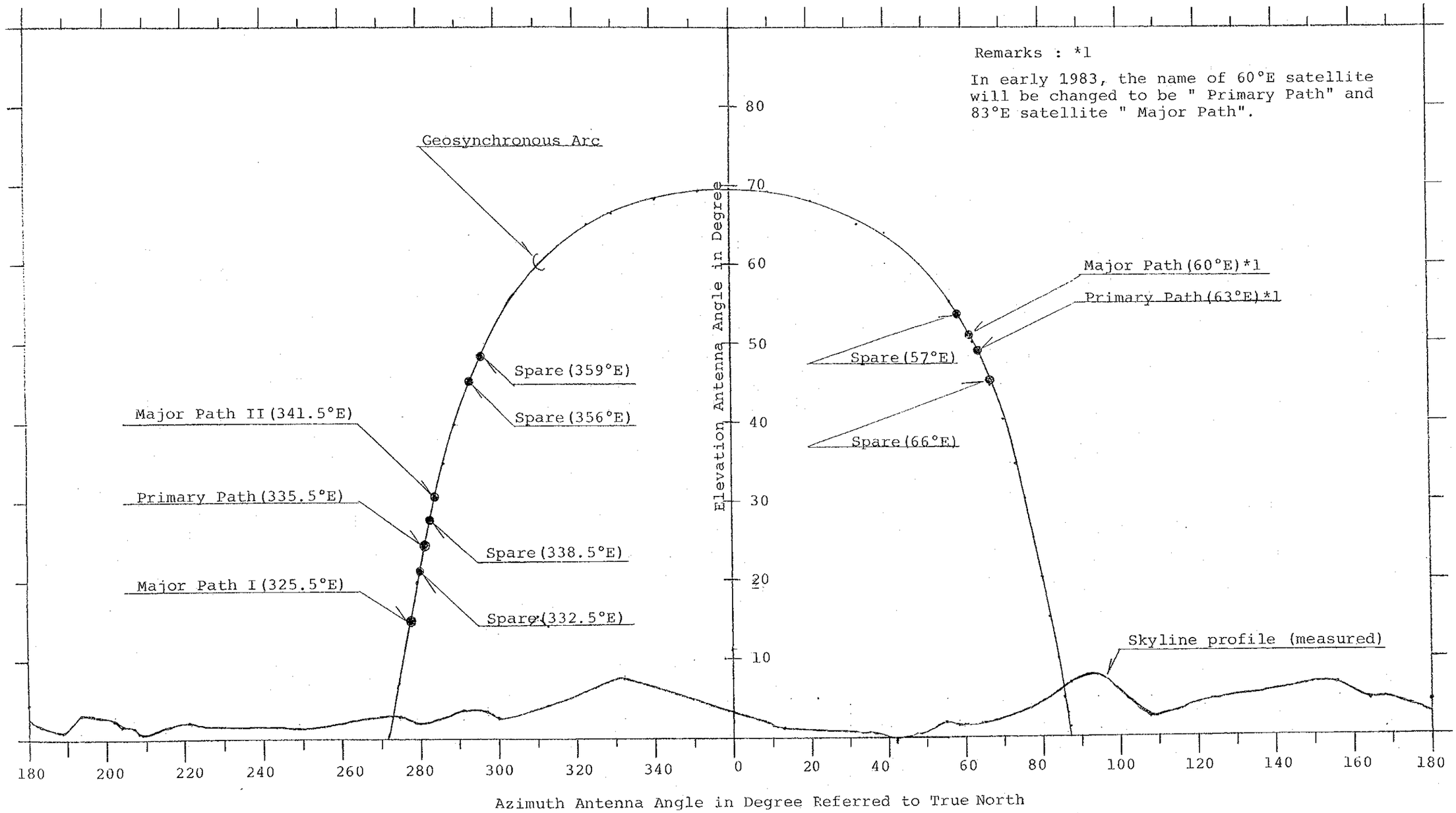
3) Harare Center Exchange Building at Harare

The Harare Center Exchange Building is located at the center of the city of Harare, capital of Zimbabwe. The earth station will be linked to this building by a microwave link system to be implemented by the Phase 1 project.

FIGURE 4-2 SKYLINE PROFILE AND SATELLITE GEOSYNCHRONOUS ARC

Proposed Site : Mazoe (final)

30° 59' 46" East Long.
17° 28' 26" South Lat.
G.L = 1,189 m (A.S.L)



Since the Harare Center Exchange Building is the center of nationl telecommunications network in Zimbabwe, the Phase 1 project will interface with the existing teLecommunications facility in this building.

Geographical location of the building is:

- Longitude : 31° 03' 04" East
- Latitude : 17° 49' 27" South
- Ground Level : 1,478 m (Above mean sea level)

4.3.4 Meteorological Data

1) Weather Conditions

Table 4-1 and Figure 4-3 show the Meteorological data measured at the city of Harare.

As the earth station site at Mazowe is situated at some 40 km away from the city of Harare, it is said that the climate of the Marowe area is not so different from that of the city of Harare.

It should be noticed that the heavy lightning will occure frequently.

2) Earthquake

There will be no felt earth tremor in this area.

TABLE 4-1 METEOROLOGICAL DATA

Figures published by Zimbabwe Department of Meteorological Services September 1982, Harare

Reporting Station : Meteorological Observatory , Harare
Location : 17 50' S - 31 01'E
Elevation : 1471 m A.S.L.

TEMPERATURE

Maximum mean temperature	: 25.3	°C
Minimum mean temperature	: 12.2	°C
Yearly minimum temperature	: 18.8	°C
Absolute mininimum temperature	: - 1	°C
Absolute maximum temperature	: 35	°C
Maximum sol air tempertature	: 60	°C
Diurnal variation approximately	: 15	°C

RAINFALL

Total average annual rainfall	: 820	mm
Number days with rainfall exceeding 1 mm	: 70	days
Greatest amount of rainfall in 24 hours	: 160	mm/hr
Average maximum rainfall	: 157	mm/hr
Highest rainfall rate ever recorded	: 368	mm/hr

HUMIDITY

Range	: 20% to 100%	

HAIL

Approximately 1 day of hail per year is recorded, with 0.5% chance of hail greater than 10 mm diameter and 0.0005% chance of hail greater than 35 mm diameter.

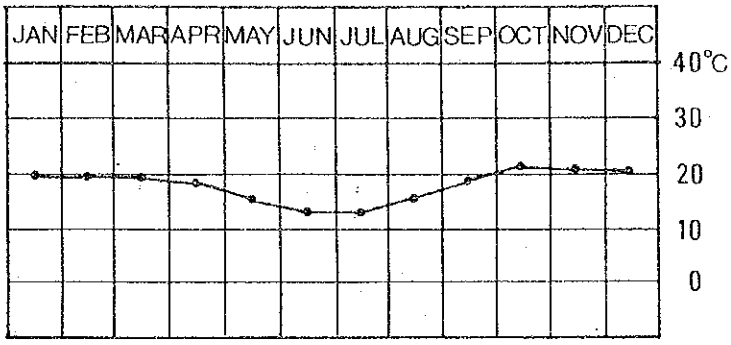
WIND

Mean wind velocity	: 6.3	knots
Maximum wind velocity	: 30	knots
Maximum gust velocity	: 80	knots

FIGURE 4-3 METEOROLOGICAL DATA

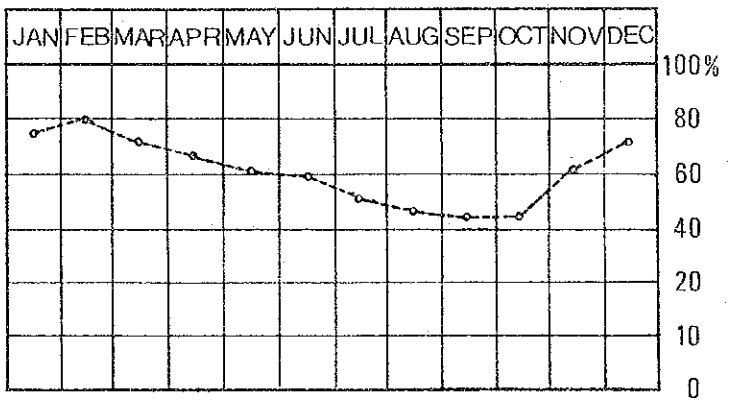
MONTHLY TEMPERATURE

Average of daily mean

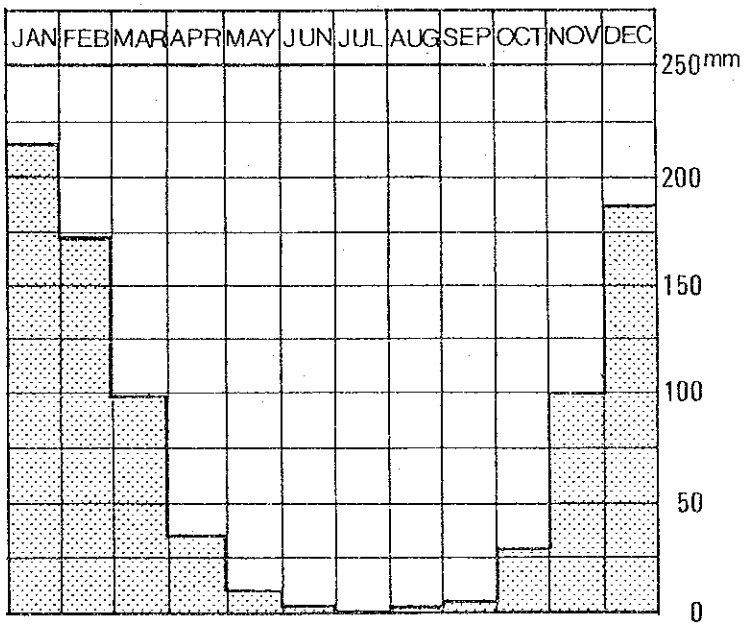


MONTHLY RELATIVE HUMIDITY

Average of daily mean



PRECIPITATION



Average from 1931 to 1960

4.4 Site Layout Plan at Proposed Earth Station Site

4.4.1 Location and Land Feature

1) Location:

The proposed site is located some 0.5 km apart north-northwest from the road, to Bindura from Harare via Mazowe, at the point of nearly 3 km run after diverging point to Mvurwi at Mazowe area as shown in Figure 4-4.

2) Area and Elevation:

According to the P.T.C.'s plan land area for the site will be approximately 15 acres (60,700 square metres).

It is supposed in this report that the site is a square land of 240 m by 250 m (60,000 sq.m.).

A map drawn on a scale of 1 to 50,000 indicates that the elevation of the site is about 3,900 feet (1,189 m) above mean sea level (A.S.L.).

The land slopes down from northwest to southeast direction and the maximum difference of elevation with in the site is estimated to be a little less than 50 feet (15 m) by contour lines shown on the map. The half of this figure could be expected for the area to be surrounded by security fences by the phase I project.

No land surveying had been made by the time when the Survey Team finished its field survey. A land surveying is scheduled to be made before land procurement.

3) Present conditions:

The proposed site and surrounding area seems a arable land, but now it looks like a grazing land covered with grasses and scattered with shrubs.

4.4.2 Site Layout Plan

A site layout plan showing the locations of buildings, antennae and other constructions is made as shown on Figure 4-5. The site layout planning was carried out for the purpose of the feasibility study by setting up the conditions as follows:

1) Basic Conditions

(1) Numbers of antennae are scheduled to be three (3), however, the site layout should be most proper when two (2) antennae, one for A.O.R. and another for I.O.R., would have been be provided.

(2) Each of three antennae should be located reciprocally to operate to A.O.R. and/or I.O.R. INTELSAT satellites without blocking any of the radiowave propagation paths of the other antennae.

Propagation path for approach microwave link also should not cross any of propagation paths mentioned above.

No building and obstructive constructions should be located within the radiowave propagation paths to A.O.R. as the antenna operational elevation angles is very low.

(3) Main building will house three (3) sections consisting of telecommunications (mainly consisting of control room), power section and administration section. Each section should be able to be extended, by connecting a new floor continuously to existing floors.

2) Condition Set Up for Cost Estimate

The plan of civil works for phase 1 -- installation project of A.O.R earth station only -- should be made in connection with the extent and content of telecommunications systems required for phase 1 project,

however, considering the economical efficiency including Phase 2 project -- installation project of I.O.R. earth station -- extent of civil works of phase 1 project is to include some works corresponding to Phase 2 project of telecommunications systems.

3) Other Considerations

(1) To give a symbolic or peculiar design feature to the station one of the cardinal lines of the main building is set to the direction to the INTELSAT's satellite located at 341.5°E, Major path II A.O.R. satellite.

(2) Layout is so designed that the visitors to the station could look at the front face of A.O.R. antenna as they approach to the main gate from the public access road.

(3) P.T.C.'s plan for staff accommodtion or residence has not been clearly decided. In this site layout plan a housing area is tentatively set up within the site boarders but outside of security fences of Phase 1 project.

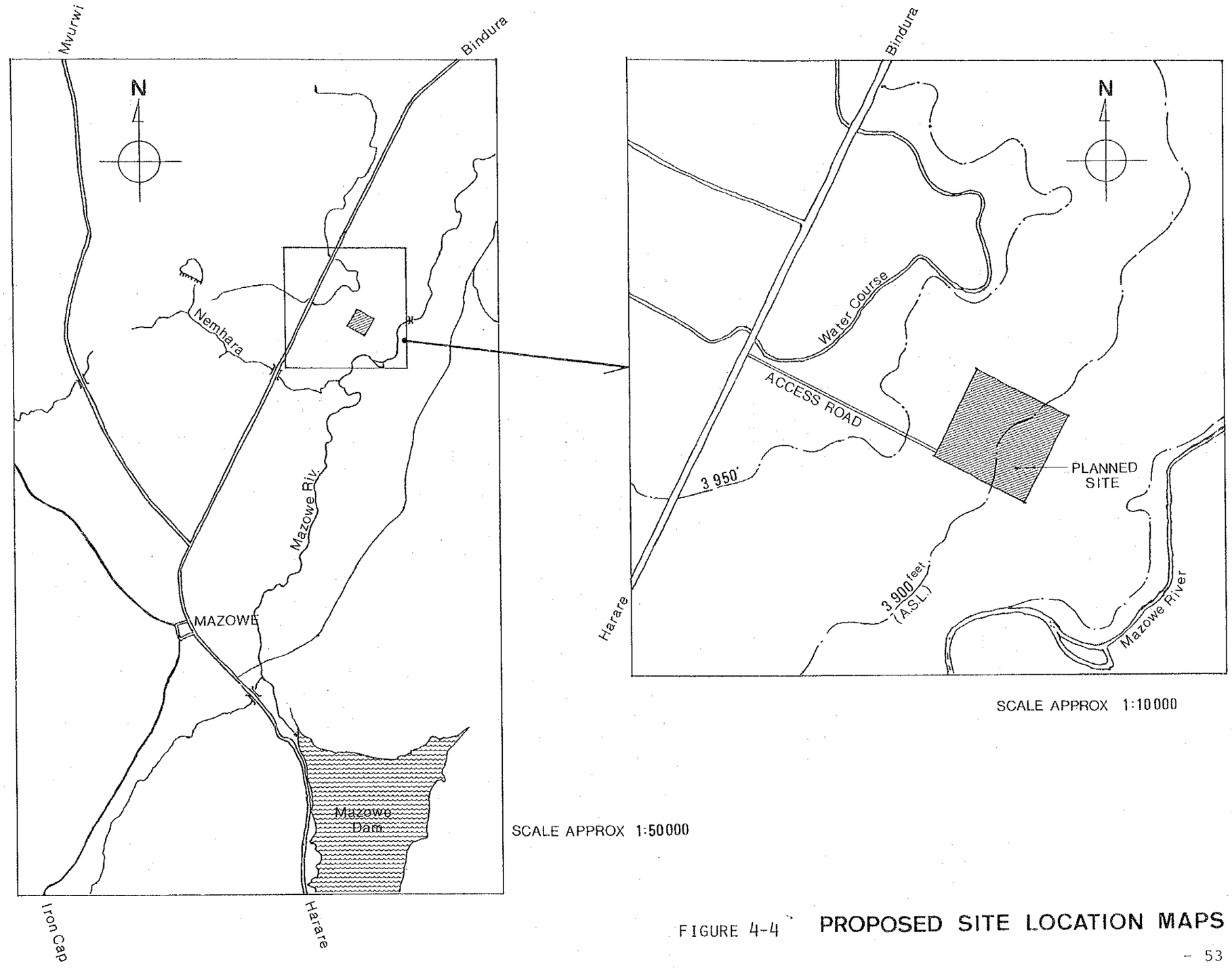


FIGURE 4-4 PROPOSED SITE LOCATION MAPS

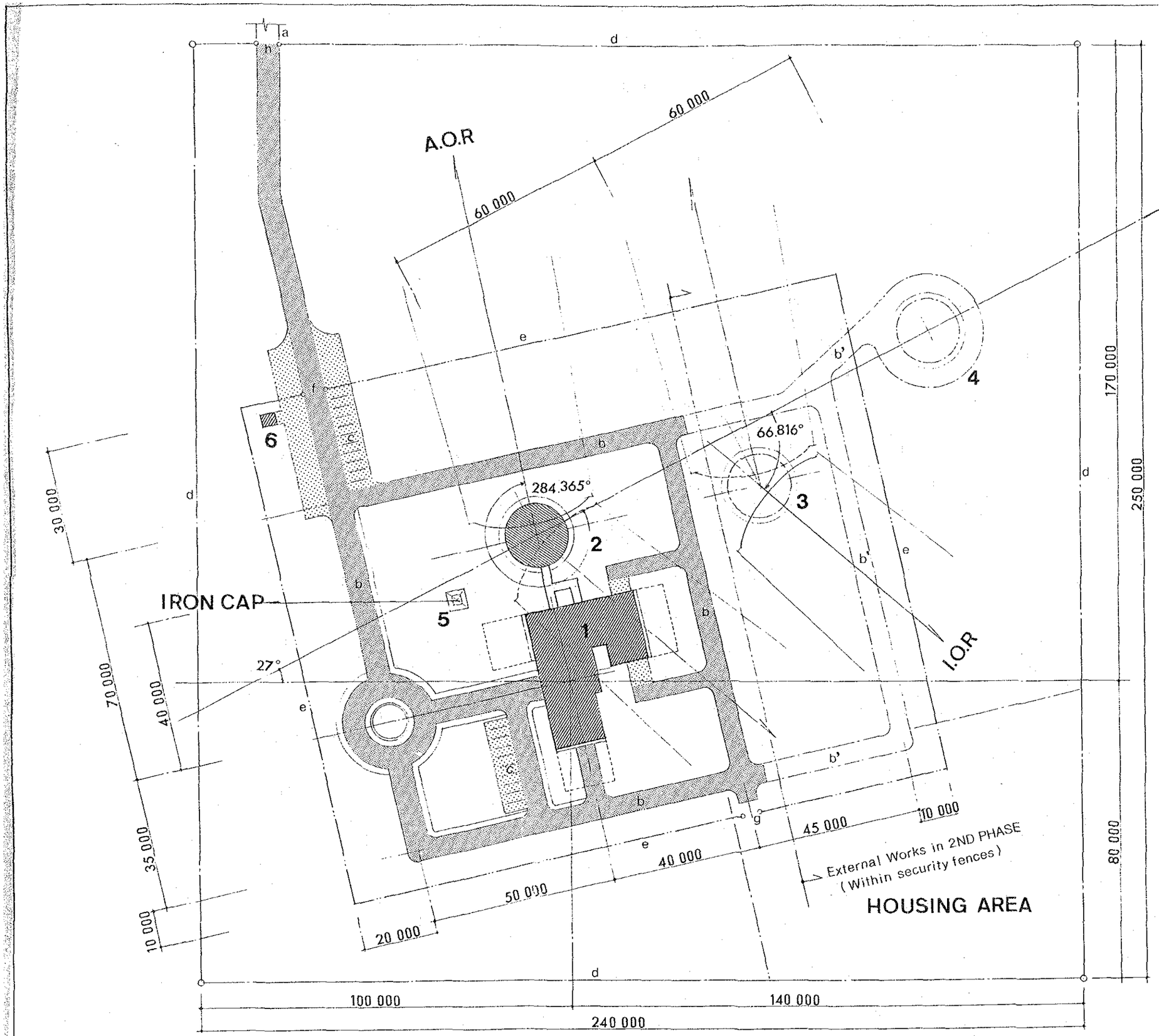


FIGURE 4-5

SITE LAYOUT PLAN	
FEB.1983	SCALE 1:1000