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No. 7

STUDY REPORT

ON

THE SURABAYA-BANJARMASIN SUBMARINE CABLE PROJECT IN THE REPUBLIC OF INDONESIA

(VOLUME [illegible])

AUGUST, 1986

JAPAN INTERNATIONAL COOPERATION AGENCY

STUDY REPORT

ON

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IN

THE REPUBLIC OF INDONESIA

(VOLUME I)

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JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Indonesia, the Japanese Government decided to conduct a study on the Surabaya-Banjarmasin Submarine Cable Project and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA sent to Indonesia a study team headed by Mr. Akio Mizukoshi, Special Advisor, Ministry of Posts and Telecommunications, from December 23, 1985 to March 20, 1986.

The team exchanged views with the officials concerned of the Government of Indonesia and conducted a series of field surveys. 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 Indonesia for their close cooperation extended to the team.

August, 1986

Keisuke Arita
President
Japan International Cooperation Agency

C O N T E N T S

SUMMARY AND RECOMMENDATION

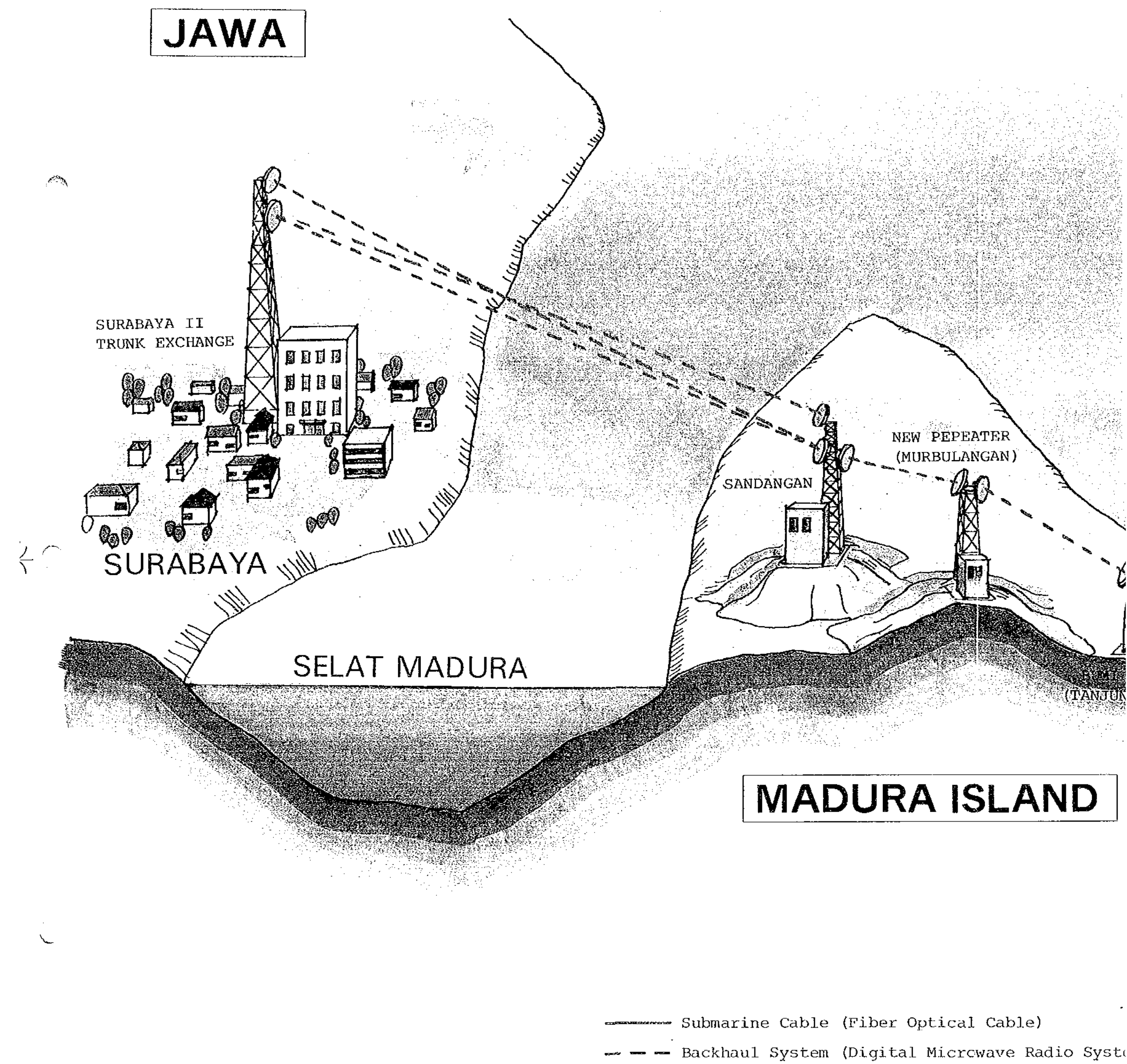
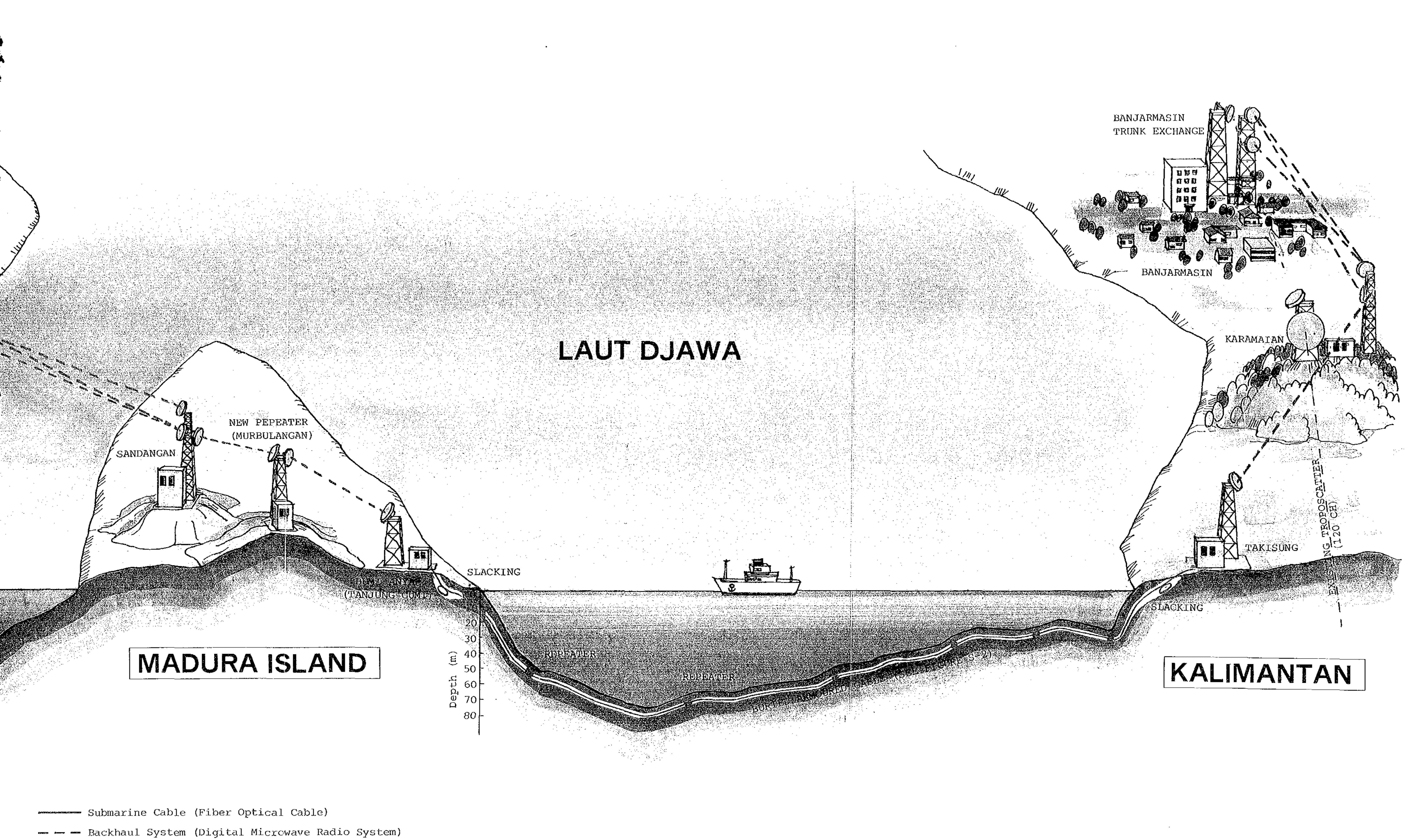
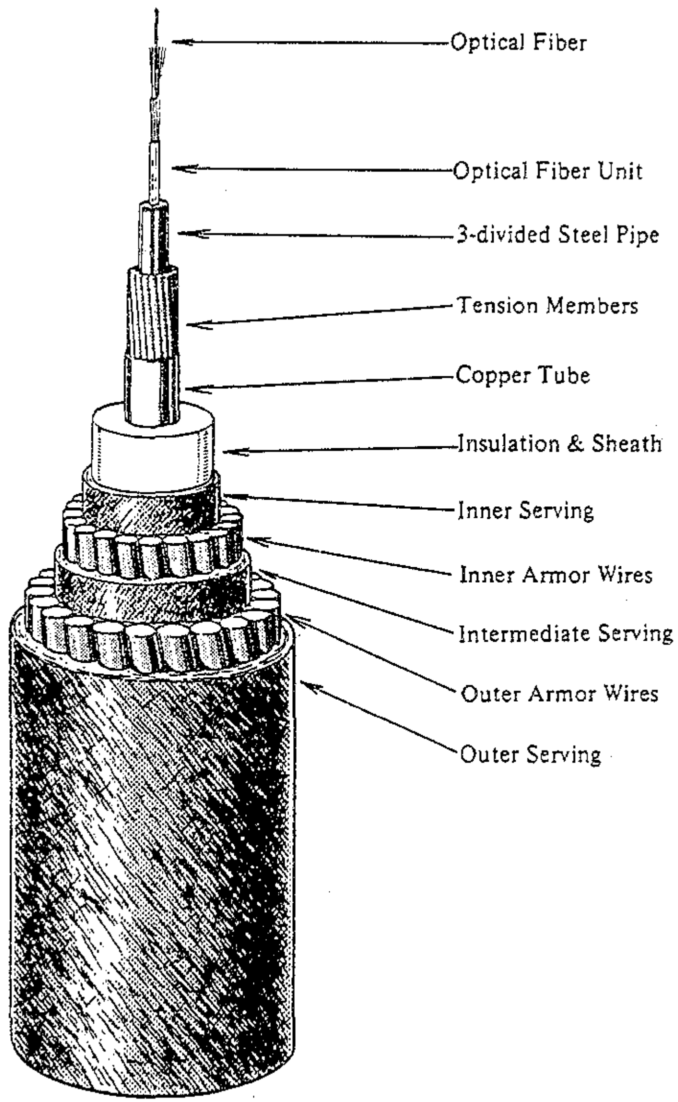


Figure S-1 GENERAL OF SURAB



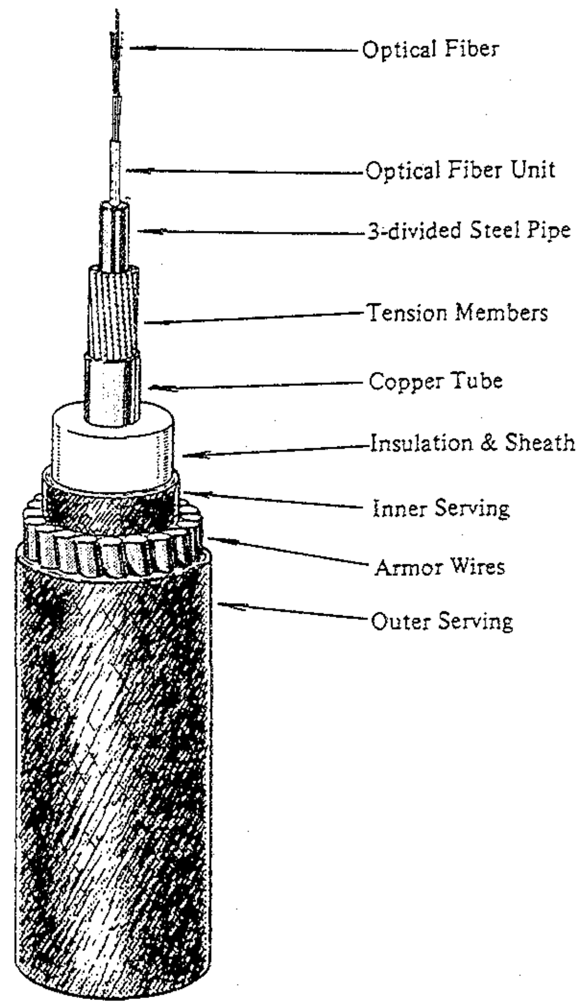
re S-1 GENERAL OF SURABAYA-BANJARMASIN SUBMARINE CABLE SYSTEM ("JAKA" SYSTEM)

Ⓐ COASTAL PART



Double Armored Cable (Type DA Cable)

Ⓑ SHALLOW SEA PART



Single Armored Cable (Type SA Cable)

Figure S-2 SUBMARINE CABLE STRUCTURE

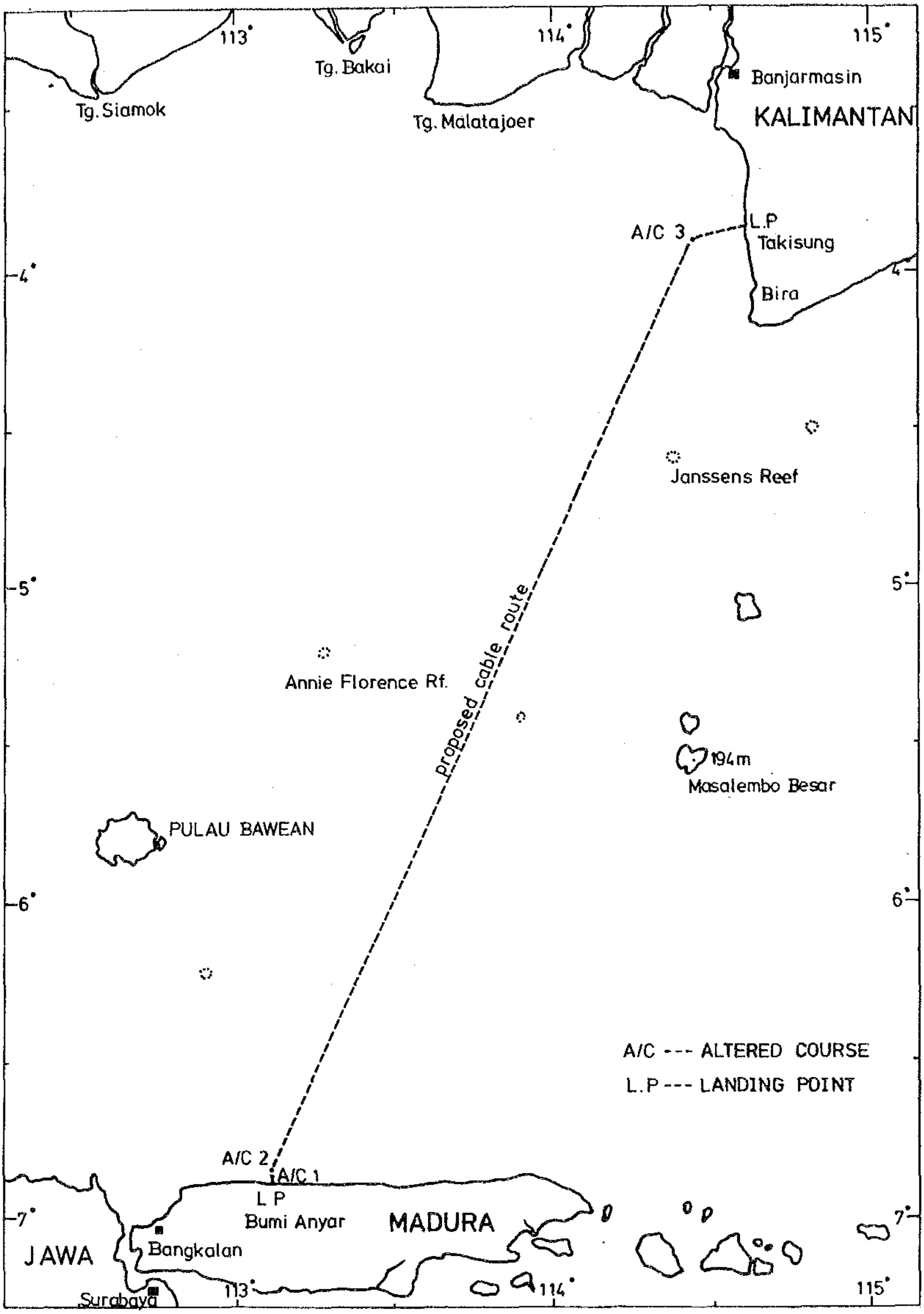


Figure S-3 PROPOSED CABLE ROUTE

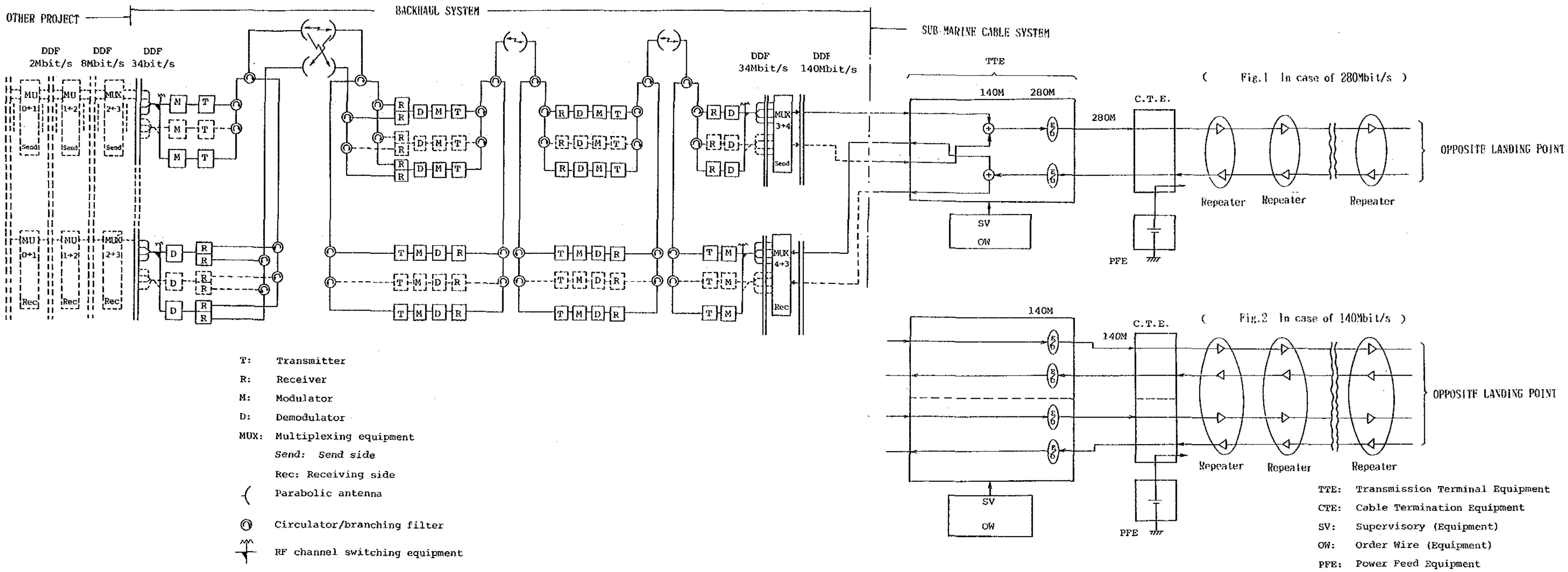


Figure S-4 CONSTRUCTION OF SURABAYA-BANJARMASIN SUBMARINE CABBLE SYSTEM

SUMMARY AND RECOMMENDATION

S-1. Objective of Study

Objective of this study is to prove into technical and economical/financial feasibilities of Surabaya-Banjarmasin submarine cable project.

S-2. Outline of Study

This study consists of field surveys in Indonesia (primary survey: mainly land section survey, secondary survey: sea section survey), as well as collection and analysis of data and information in Japan and Indonesia.

S-3. Demand Forecast and Circuit Requirements

S-3.1 Demand Forecast

The immediate coverage area of this submarine cable network is Kalimantan area only. However, when the submarine cable network planned becomes connected to Sulawesi island, Halmahera island, Maluku island, and Irian Jaya island via Balikpapan-Palu submarine cable system by REPELITA-V, the traffic between these islands and Jawa island is to be routed through Surabaya-Banjarmasin submarine cable system. Thus, for these islands, the telephone demand study is made up to the year 2014, i.e., for the economic life of the submarine cable system (25 years after the coming into operation).

For demand forecast, the same method as in JICA Report of October 1985, "Fundamental Study on Rural Telecommunication Network in the Republic of Indonesia," is adopted.

Results of telephone demand forecast up to the year 2015 are as under.

Table S-1 Telephone Demand Forecasts

(Unit: 1,000)

Year	1990	1995	2000	2005	2010	2015	(2014)
Jawa	1,396	2,132	3,015	3,931	4,884	5,867	5,664
Sumatera	374	539	728	907	1,079	1,243	1,212
Kalimantan	85	118	156	190	224	257	250
Sulawesi	115	174	241	307	373	439	426
Others	400	580	758	918	1,048	1,157	1,141
Total	2,370	3,543	4,898	6,253	7,608	8,963	8,693

Based on the demand fulfillment ratio of 85% as per above, the number of subscribers (line units:LU) by years is forecasted as under.

Table S-2 Subscriber Demand Fulfillment Forecasts

(Unit: 1,000)

Year	1990	1995	2000	2005	2010	2015	(2014)
Jawa	1,187	1,812	2,563	3,341	4,151	4,987	4,814
Sumatera	318	458	619	771	917	1,057	1,030
Kalimantan	72	100	133	162	190	218	213
Sulawesi	98	148	205	261	317	373	362
Others	340	493	644	780	891	983	970
Total	2,015	3,011	4,164	5,315	6,466	7,618	6,489

S-3.2 Traffic Forecasts

Traffic to be carried by the submarine cable system is estimated by the following formula.

TF = LU x TD (TER/SAT) x CR x TD x R(I/O)

where, LU : Number of Fulfilled Subscribers shown in Table S-2

TD(TER/SAT) : Traffic Distribution Ratio of terrestrial Network versus Satellite Network

CR : Average Subscriber Calling Rate (52.24×10^{-3} Erlang)

TD : Toll Traffic Ratio (16%)

R(I/O) : Traffic Ratio of within/without Island

In case of estimation of toll traffic, the technical policies for future telecommunication development, i,e., traffic distribution policy between terrestrial network and satellite network, long-term development plan for toll transmission network, basic concept on traffic routing, must be taken into account. At present, JICA "Telecommunication Long-term Plan Study Team" is studying on these policies. Thus, this study is based on the assumptions mentioned in Volume II of the Report. Resultly, traffic to be carried by the planned submarine cable system is estimated as under.

Table S-3 Traffic Estimates for SURABAYA-BANJARMASIN Submarine Cable

(Unit : Erlang)

Year	1990	1995	2000	2005	2010	2015	(2014)
Kalimantan	150	251	363	496	583	748	648
Sulawesi	-	-	-	293	521	866	818
Others	-	260	727	644	768	1,100	1,085
Total	150	511	1,090	1,433	1,872	2,714	2,551

S-3.3 Circuit Requirements

The submarine cable system planned, this time, is used for telex service, leased circuits, new service circuits and TV Transmission in case of emergency also, besides carrying telephone traffic. With this fact duly considered, circuit requirements can be estimated as under.

Table S-4 Circuit Requirements Estimate

(Unit : No. of circuits)

Year	1990	1995	2000	2005	2010	2015	(2014)
Total Circuit Requirements	230	760	1,600	2,110	2,780	3,840	(3,770)
Spare Circuit for TV	140 MB x1	140 MB x1	140 MB x1	64 MB x1	64 MB x1	-	-

S-4. Condition of Jawa Sea

S-4.1 Submarine Cable Route and Seabed Condition on Route

Bumi Anyar, Madura Island and Takisung, Kalimantan Island were selected for the landing points to connect Surabaya with Banjarmasin. As the results of ocean survey, the cable route between both landing points was selected as shown in Fig. S-3. The cable length is 381.5

km. the deepest point on the route is located about 95 km away from the L.P at Bumi Anyar. The water depth is 77 m. From Bumi Anyar to the deepest point, the seabed is covered with mainly mud, and is quite smooth. By contrast, from the deepest point to Takisung, the ratio of sand in the bottom material becomes higher, and the seabed has many undulations. Through the whole route, the seabed is covered with soft sediments. However, there are some places, where the thickness of sedimentary layer is extremely thin, at the Takisung side beyond the deepest point.

S-4.2 Fishing Activities

In the Indonesian Waters, the trawl fishery is completely prohibited, and the fishing activities more than 30 n.m away from the coast is also completely prohibited. The fishing activities are recognized coastal area of both landing points and also in the ocean in the along the cable route during the ocean survey. Accordingly, there is a fear to damage the submarine cable by these activities. It is neceesary to consider a counterplan of cable protection against these fishing activities.

S-4.3 Mine Non-swept Area

There are some non-swept area for mines which were installed during the World War II at the coastal area of the landing point in Madura Island. The magnetic survey for mines was carried out in the necessary area for the cable laying at Bumi Anyar. According to the result of survey, a relatively large magnetic anomaly, 26 gauss cm^2, was observed at a point, which was located 1,200 m away from the lanidng point and 87 m eastward from the route. The anomalous object was estimated to bury at 0.6 - 0.8 m below the seabed. This value is equivalent to mine's anomaly, comparing with the Japanese standard, 25 - 300 gauss cm^2. Therefore, it is recommended to confirm this anomalous object before the cable laying.

S-5. Inastallation Master Plan

S-5.1 Submarine Cable System Design Period and Investment Plan

S-5.1.1 Design Period

History of submarine cable system construction began with international long distance cable installation striding over sea channel several thousand meters deep. Therefore, the general concept is that when the forecasted circuit requirements are up to 25 years after coming into operation of the system as previously stated, the submarine cable section is to be constructed with capacity to meet demand for the whole period from initial stage until 25 years after. This concept is used, in principle, in this study also.

However, when the submarine cable system constitutes a part of national transmission system, installation sea is shallow and installation distance is as long as in the present case, careful study is required as to which, to lay the cable with initial capacity to meet demand 25 years after or to lay the cable with smaller capacity initially and lay additional cable, at the time the circuit requirements have increased, is preferable in terms of cost.

S-5.1.2 Investment Planning

PERUMTEL intends to realize 2 x 140 Mbit/s system (original plan) for the projected Surabaya-Banjarmasin submarine cable system.

The comparative study is made in initial investment ratios, assuming that 1 x 280 Mbit/s system (alternative plan) is the sole technically feasible alternative plan.

For initial investment ratios, when the initial investment ratio of 1x140 Mbit/s system is set at 100, initial investment ratios of 2x140 Mbit/s system (original plan) and 1x280 Mbit/s system (alternative plan) become 113 (13% up) and 106.5 (6.5% up), respectively.

In the projected submarine cable system, service revenue remains definite so that alternative plan where cost level is low is judged to be a preferable plan.

S-5.2 Adoption of Digital System

In this submarine cable system, digital system is to be adopted on full scale. This is to comply with the guideline of Year 2000 Indonesian Telecommunications Improvement Plan issued by PERUMTEL.

S-5.3 Cable System Selection

For the present submarine cable system plan, decision is made to adopt 1 x 280 Mbit/s optical fiber cable system, as an alternative plan to 2 x 140 Mbit/s original plan. This system selection is the result of comparison between coaxial cable system and optical fiber cable system and among three optical fiber cable systems, i.e., 2 x 140 Mbit/s, 1 x 280 Mbit/s and 1 x 140 Mbit/s systems.

S-5.4 Backhaul System Selection

For connection route (backhaul system) from submarine cable landing point to toll exchanges, 6 or 5 GHz 140 Mbit/s digital microwave radio system is to be adopted in conformity with submarine cable system.

S-6. System Outline

S-6.1 Overall System Configuration

Figure S-1 presents schematic diagram of submarine cable network planned this time. As seen in the illustration, this network is composed of overland backhaul system and undersea submarine cable system.

S-6.2 Optical Fiber Submarine Cable

Optical fiber submarine cable system is composed of optical fiber cable, submersible repeaters, and terminal equipment installed in terminal station at cable landing point. See Figure S-1.

Figure S-2 shows the structure of optical fiber cable. Figure S-3 illustrated the proposed cable route between Surabaya and Banjarmasin, and the distance between both landing points is 381.5 km. The cable length is 387.2 km with the necessary cable slack of 1.5 percent (%). Further, assuming that the cable length from the respective landing points to the landing station is 500 m, the overall cable length is 388.2 km.
Submarine cable laying is basically by cable burial. In the coastal area where sea depth is shallow, double armored cable is suitable for protection against possible hazards. In the water area deeper than 10 m, it is recommendable to bury single armoured cable. However, taking account of the safety against mines, or allied dangerous properties, jet burying of cable or non-buried double armoured cable is recommendable in danger area and non-swept area off Bumi Anyar. Meanwhile, the cable loop on land near the terminal station as shown in Figure S-1 is usually provided. It is an extra cable length for maintenance use.

S-6.3 Backhaul System

Microwave radio route is planned as under. See Figure S-1.

Surabaya side: Surabaya II toll exchange (existing) - Sandangan repeater station (existing) - Murbulangan repeater station (to be newly established) - Bumi Anyar transmission terminal (to be newly established at cable landing point)

Banjarmasin side: Banjarmasin toll exchange (existing) - Karamaian repeater station (existing) - Takisung transmission terminal (to be newly established at cable landing point)

In the microwave radio route design, existing facilities are to be utilized as much as possible. Existing over-the-horizon microwave system is of 1975 origin except additional multiplex terminal equipment installed in 1984. Since the most of over-the-horizon microwave system is already 11 years old. If it is to be utilized in the currently planned system, it must maintain its performance and quality for about 30 years until 2014. This fact is duly considered in the overall system planning.

S-6.4 Other Facilities

S-6.4.1 Power Supply Facilities

At Bumi Anyar transmission terminal (Surabaya side), Takisung transmission terminal (Banjarmasin side) and Murbulangan intermediate repeater station in Madura island, all to be newly established, commercial power supply is not available so that provision of engine generator is required.

At two cable landing points, power supply to submarine repeaters is necessary. The engine generator system to be installed is of large capacity. 30 kVA triple diesel engine generators (two working units for alternate operation and one standby unit) are to be provided.

At Murbulangan intermediate repeater station, power consumption is small. Therefore, 10 kVA triple diesel engine generator is to be provided.
At Surabaya, Karamaian and Banjarmasin stations, provision of rectifiers and batteries is necessary.

S-6.4.2 Buildings and Sites

Required site areas for stations to be newly constructed and building floor spaces are as under.
Maintenance office spare are not included.

	Building	Site	Access Road
Bumi Anyar	129 m^2($25m^2$)	1200 m^2	Not necessary
Murbulangan	24 m^2 ($9m^2$)	300 m^2	Land leveling for about 50 m is necessary.
Takisung	129 m^2($25m^2$)	1200 m^2	Not necessary

( ) shows the areas necessary for Engine Generators and Batteries

S-7. Project Implementation Program

S-7.1 Implementation Policy

Surabaya-Banjarmasin submarine cable network project consists of sea section and overland section. Either section alone is without raison d'etre so that the whole system is to be constructed on turn key basis.

Furthermore, for the purposes of economical system design, optimum work progress management and impartial settlement of problems involved, employment of consultant is recommended, because this submarine cable project is the first experience for PERUMTEL.

S-7.2 Project Cost Estimate

Cost of locally produced materials and equipments which can be used in project implementation, local manpower cost, and building construction and land procurement cost, etc., are estimated in Rupiah currency.

Estimated project costs by original plan (for installation of two pairs of 140 Mbit/s cable) and by alternative plan (for installation of single pair of 280 Mbit/s cable) to meet forecasted demand 25 years after commencement of services are as under.

Table S-5 Initial Cost Estimates

(Unit: x 10^6)

Item	Original Plan (2 x 140 Mbit/s)		Alternative Plan (1 x 280 Mbit/s)	
	Foreign Currency	Local Currency	Foreign Currency	Local Currency
Materials, Equipment cost	¥ 4,400	Rp. -	¥ 4,200	Rp. -
Work cost	2,520	2,837	2,350	2,837
Consultant fee	220	475	220	475
Total	(400) 7,140	3,312	(400) 6,770	3,312

(Parenthesized is the cost for system expansion of Micro-wave Radio System in the year 2000.)

S-7.3 Implementation Time Schedule

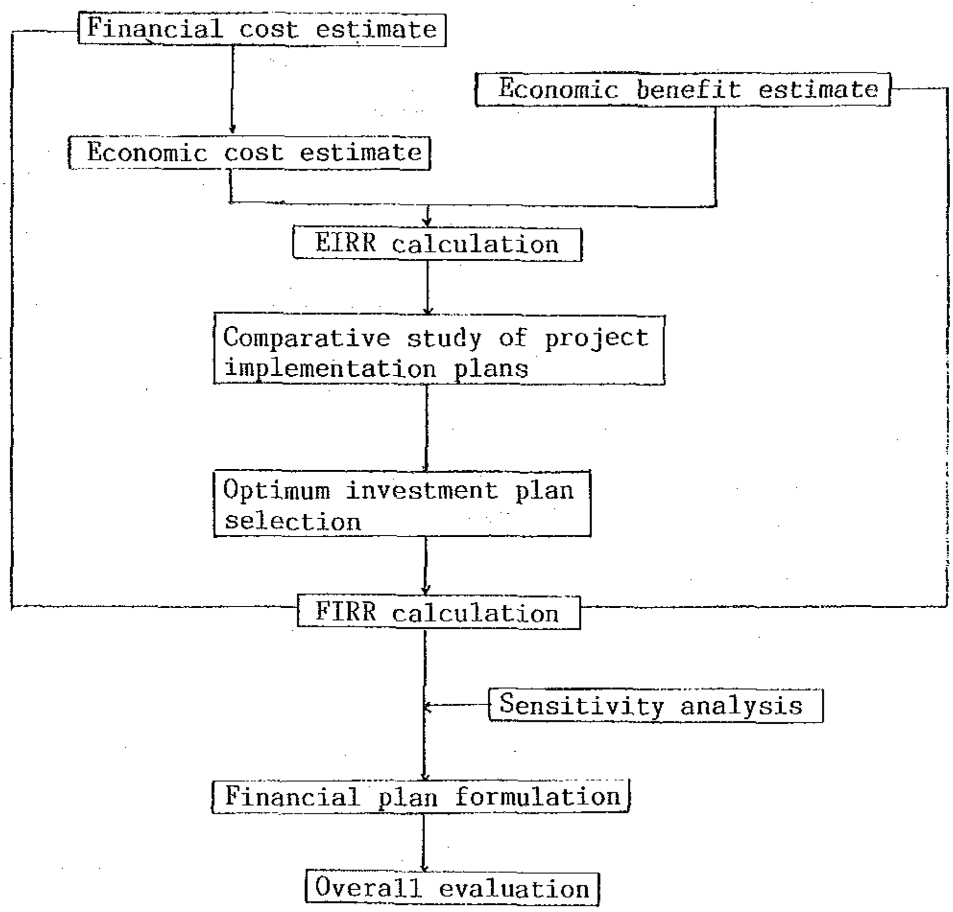
Table S-6 presents project implementation time schedule.

S-8. Economic, Financial Evaluations

Indices whereby to calculate the projected submarine cable system investment scale and service management plan derive from the undermentioned two analysis results.

(1) Economic Internal Rate of Return (EIRR)
(2) Financial Internal Rate of Return (FIRR)

Procedural requirements for both analyses are as under.



Analyses were made for original plan (2 x 140 Mbit/s) and alternative plan (1 x 280 Mbit/s), as stated in the preceding section.
Results obtained follow:

	Original Plan (2 x 140Mbit/s)	Alternative Plan (1 x 280Mbit/s)
EIRR	18.0 %	18.9 %
FIRR	* %	17.1 %
Initial cost	¥7,140 x 10^6	¥6,770 x 10^6
	Rp 3,312 x 10^6	Rp 3,312 x 10^6

* not calculated because of no meaningness

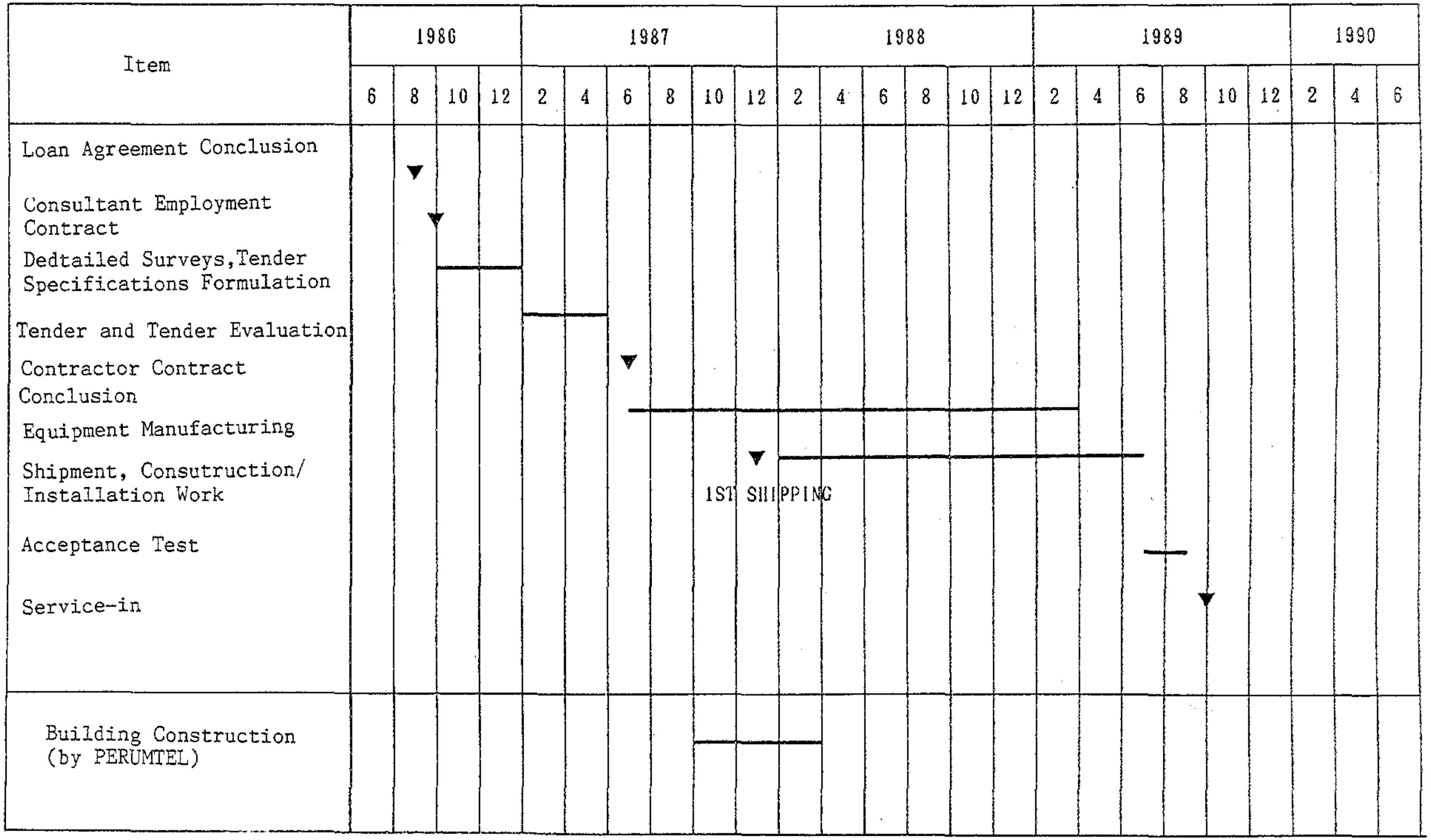
Figures quoted above indicate that both plans break even by a broad margin.

S-9. Recommendations

Both original plan (2 x 140 Mbit/s) and alternative plan (1 x 280 Mbit/s) are to install the same number of channels. Nevertheless, initial cost in alternative plan (1 x 280 Mbit/s) is lower than in original plan (2 x 140 Mbit/s). For its good profitability, adoption of the alternative plan (1 x 280 Mbit/s) is recommended.

Hence the recommendation for project implementation at the earliest possible opportunity.

Table S-6 Project Implementation Time Schedule



CHAPTER 1 INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of Study

As an integral part of national development five-year plan of the Government of the Republic of Indonesia, Kalimantan area development and readjustment plan is in progress. With this, telecommunication needs between Kalimantan and Jawa islands is increasing rapidly. Over-the-horizon microwave telecommunication system (capacity: 120 CH) that connects the two islands can no longer meet such increasing telecommunication demand satisfactorily.

However, a launching failure in the communication satellite may lead to simultaneous interruption for the TV broadcasting to those areas lacking terrestrial TV transmission link to/from Jakarta or any other district TV broadcasting center as experienced in 1985.

To minimize confusion caused by such failure, a stable TV transmission media other than the domestic satellite is pulling up momentum among island inhabitants.

To remedy the situation, on one hand, while, on the other, to introduce new systems which can meet the growth of telecommunications demand between Kalimantan and Jawa islands from now forward and which can also cater for expected new services, such as data transmission, video communication and facsimile service, in addition to TV transmission, the Government of Indonesia planned Surabaya-Banjarmasin submarine cable installation under REPELITA-IV and requested the Government of Japan to carry out feasibility study for that plan.

In response to the request, the Government of Japan dispatched a preliminary study team organized by The Japan International Cooperation Agency (JICA) to Indonesia in February 1985. Prior to the departure to Indonesia, the preliminary study team made desk study in Japan of the objective sea area. The finding was that the scheduled submarine cable landing point at Surabaya side (north coast area of Madura island) is not completely cleared of mines laid during World War II. Therefore, the preliminary study team, besides discussing the Scope of Work contents for the main study, collected information to ensure safety of ocean survey, including the progress of mine sweeping.

After the return to Japan of the preliminary study team, negotiations were continued between the Government of Japan and the Government of Indonesia concerning the still pending mine sweeping at the scheduled submarine cable landing point on Surabaya side. Negotiations resulted in the Scope of Work in Novermber 1985 came to an agreement.

On December 23, 1985, the Government of Japan dispatched the main study team organized by JICA to Indonesia. Based on the previously concluded Scope of Work, the main study team carried out Surabaya-Banjarmasin submarine cable system field surveys in two series. The first made in December 1985 and January 1986 was mainly to confirm submarine cable landing points on both sides and to survey backhaul system, i.e., connection system from landed end of submarine cable to overland telecommunication network on each side. The second made in February and March 1986 mainly consisted of ocean survey.

Then followed interim report making and discussion, and draft final report making and discussion. Through those discussions, final report was formulated wherein social, economic and technical implementation feasibilities of Surabaya-Banjarmasin submarine cable project plan were examined.

1.2 Objective and Outline of Study

1.2.1 Objective

Objective of this study is to prove into feasibility of Surabaya-Banjarmasin submarine cable project featuring system life to continue until the year 2014. Following are also included in the objective:

1) To select optimum route for Surabaya-Banjarmasin submarine cable system.

2) To select optimum system for the said submarine cable.

1.2.2 Outline

1) Objective Area

Objective area of this study comprises the area located between Surabaya and Banjarmasin related to the projected submarine cable system.

2) Outline

Study consists of field surveys in Indonesia and collection of data and information in Japan and Indonesia, as well as analysis of such data and information. Field survey practices are twofold, i.e., first series surveys and second series surveys.

Outline of study follows:

(1) To collect and analyze necessary data and information.

(2) To select submarine cable landing points.

(3) To conduct ocean survey including magnetic survey in mine afflicted sea area around Madura island.

(4) To carry out traffic forecast for Surabaya-Banjarmasin section up to year 2014 as final project year and to calculate circuit requirements.

(5) To make basic design of submarine cable system.

(6) To make basic design of backhaul system.

(7) To estimate project cost.

(8) To make economic and financial analyses pertaining to project implementation.

(9) To formulate project implementation plan.

1.3 Study Team Organization and Survey Itinerary

1.3.1 Study Team Organization

1) Preliminary Study

Preliminary study team organization is in Table 1-1.

2) First Series Field Surveys

First series field survey team organization is in Table 1-2.

3) Second Series Field Surveys

Second series field survey team organization is in Table 1-3.

1.3.2 Survey Itinerary

1) Preliminary Study Itinerary

As in Table 1-4.

2) First Series Field Surveys Itinerary

As in Table 1-5.

3) Second Series Field Surveys Itinerary

As in Table 1-6.

1.4 Indonesian Government Organizations Concerned and Members

Parties from whom the study request to Japan, this time, originated and who assume responsibilities for project implementation are Direktorat Jendral Pos dan Telekomunikasi, commonly known as POSTEL, and Perusahaan Umum Telekomunikasi or PERUMTEL for short. Personnel of these two organizations who were concerned with the aforementioned study series and other organization with its member concerned are listed in Table 1-7.

Table 1-1 Preliminary Study Organization Member List

Name	Duty in Charge	Affiliation
Akio MIZUKOSHI	Leader	Special Advisor for International Cooperation, Ministry of Posts & Telecommunications
Sadao HIGUMA	Survey Leader/ Microwave System	Deputy Director, International Cooperation Department, Kokusai Denshin Denwa Co., Ltd. (KDD)
Ryoji HOSHINA	Cable System	Staff, System Engineering Division, Submarine Cable Engineering Department, KDD
Akira IKEUCHI	Ocean Survey	Staff, Marine Engineering Division, Submarine Cable Construction Department, KDD
Kouichiro So	Coordinator	Social Development Cooperation Department, Japan International Cooperation Agency (JICA)

Table 1-2 First Series field Survey Team Member List

Name	Duty in Charge	Affiliation
Akio MIZUKOSHI	Leader	Special Advisor for International Cooperation, Ministry of Posts & Telecommunications
Sadao HIGUMA	Survey Leader	Deputy Director, International Cooperation Department, Kokusai Denshin Denwa Co., Ltd. (KDD)
Ryoji HOSHINA	Submarine Cable System	Staff, System Engineering Division, Submarine Cable Engineering Departmnet, KDD
Kazuo ICHIHARA	Coordinator	Social Development Cooperation Department, Japan International Cooperation Agency (JICA)
Ryushi SUENAGA	Assistant Survey Leader, Network Planning	Assistant Manager, C&C System Development Office, Telecommunications Division, The Nippon Telecommunication Consulting Co., Ltd. (NTC)
Susumu YAMAGATA	Radio Link Planning	Senior Engineer, Overseas Engineering Department, Telecommunications Division, NTC
Shigeaki KUBO	Sea Bottom Survey Leader	Manager, Planning Department, Sanyo Hydrographic Survey Co.,Ltd.
Hiroshi GUNJI	Radio Link Survey	Engineer, Overseas Engineering Department, Telecommunications Division, NTC
Masaaki UEDA	Economic/Financial Analysis	Economist, Overseas Engineering Department, Telecommunications Division, NTC

Table 1-3 Second Series Field Survey Team Member List

Name	Duty in Charge	Affiliation
Akio MIZUKOSHI	Leader	Special Advisor for International Cooperation, Ministry of Posts & Telecommunications
Sadao HIGUMA	Survey Leader	Deputy Director, International Cooperation Department, Kokusai Denshin Denwa Co., Ltd. (KDD)
Ryoji HOSHINA	Submarine Cable System	Staff, System Engineering Division, Submarine Cable Engineering Department, KDD
Akira IKEUCHI	Ocean Survey	Staff, Marine Engineering Division, Submarine Cable Construction Department, KDD
Kazuo ICHIHARA	Coordinator	Social Development Cooperation Department, Japan International Cooperation Agency (JICA)
Ryushi SUENAGA	Assistant Survey Leader, Network Planning	Assistant Manager, C&C System Development Office, Telecommunications Division, The Nippon Telecommunication Consulting Co., Ltd. (NTC)
Haruo ISHIZUKA	Radio Link Planning	Senior Engineer, Overseas Engineering Department, Telecommunications Division, NTC
Masaaki UEDA	Economic/Financial Analysis	Economist, Overseas Engineering Department, Telecommunications Division, NTC
Shigeaki KUBO	Sea Bottom Survey Leader	Manager, Planning Department, Sanyo Hydrographic Survey Co., Ltd. (SHS)

(Sea Bottom Surveyors)

Name of Surveyor	Belong to	In Charge of Survey	Speciality
Shoji SUGAI	SHS	Seabed analysis	Hydrographer
Takeji OTSUKA	SHS	Oceanograph analysis Planning of sounding	Oceanographer
Yasuhiko ARAI	SHS	Positioning	Hydrographer
Hisayoshi SUZUKI	SHS	Subbottom analysis	Geologist
Toshio AGU	SHS	Magnetic survey	Geophisicist
Hachiro FURUSAWA	SHS	Positioning	Hydrographer
Yasuyuki YOSHIHARA	SHS	"	"
Kenzo MIYAGAWA	SHS	Sounding	"
Hiroshi IKENAGA	SHS	"	"
Toshio SHIDO	SHS	Seismic profiling	"
Teruaki ASANO	SHS	"	"
Akira OTANI	SHS	Seabed scanning	"
Yasushi NAKAJIMA	SHS	"	"
Tsuyoshi NAKAYAMA	SHS	Magnetic survey	"
Hidemi DEGUCHI	SHS	"	"
Ikuro HAYASHI	SHS	"	"
Hiroshi NAGAOKA	SHS	"	"
Kenji HARADA	SHS	"	"

Table 1-4 Preliminary Study Team Ininerary

Date		Place visited, Service Item
1985:		
Feb.	18	Tokyo to Jakarta
	19	Visits to POSTEL/PERUMTEL, Japanese Embassy
	20	Visits to POSTEL/PERUMTEL
	21	Jakarta to Surabaya
		Visits to Surabaya Exchange, 4th Maritime Region
	22	Visit to 4th Maritime region
		Surabaya to Madura
		Visit to Bangkalan Exchange
	23	Surabaya to Banjarmasin
		Visit to Banjarbaru Exchange
	24	Banjarbaru to Takisung
		Visit to Karamaian Station
	25	Banjarmasin to Jakarta
	26	Visits to POSTEL/PERUMTEL
		Visit to PERTAMINA
	27	Minute making
	28	Minute signing
		Visit to JICA/Japanese Embassy
Mar.	1	Jakarta to Tokyo

Table 1-5 First Series Field Survey Itinerary

Date	Itinerary	
1985		
DEC.23	Tokyo - Jakarta	
24	Visit to POSTEL, Japanese Embassy, and JICA Jakarta	
25	Data Collection (National Holiday)	
26	(Jakarta to Bandung)	
27	Meeting with PERUMTEL	
28	Meeting with PERUMTEL	
29	(Bandung to Jakarta)	
30	Meeting with POSTEL Minutes of Meetings signed on.	
31	Data Collection	
1986		
JAN. 1	Data Collection	
2	Preparation for Site Survey	
3	(Jakarta to Surabaya) Meeting with WITEL and general survey	
4	Meeting with 4th Maritime Region	
5	Survey (BUMI ANYAR, SANDANGAN, TELAGA BIRU, BANGKALAN)	
6	(Surabaya - Banjarmasin) Meeting with WITEL and Municipal Office	
7	Survey (TAKISUNG and KARAMAIAN)	
8	(Banjarmasin - Jakarta)	
9	Meeting with POSTEL	(Jakarta to Surabaya)
10	Data Collection	Survey (BANGKARAN)
11	ditto	Survey (Bumi Anyar)
12	ditto	Data Arrangement
13	Data Analysis	Survey (SANDANGAN)
14	ditto	Survey (GRESIK)
15	ditto	(Surabaya to Jakarta)
16	Data Analysis	
17	ditto	
18	Preparation of Survey Report	
19	(Jakarta to Bandung)	
20	Meeting with PERUMTEL (Bandung to Jakarta)	
21	Preparation of Meeting Materials	
22	Meeting with POSTEL	
23	Data Arrangement	
24	Visit to Japanese Embassy and JICA Jakarta	
25	Leave Jakarta	
26	Arrival in Tokyo	

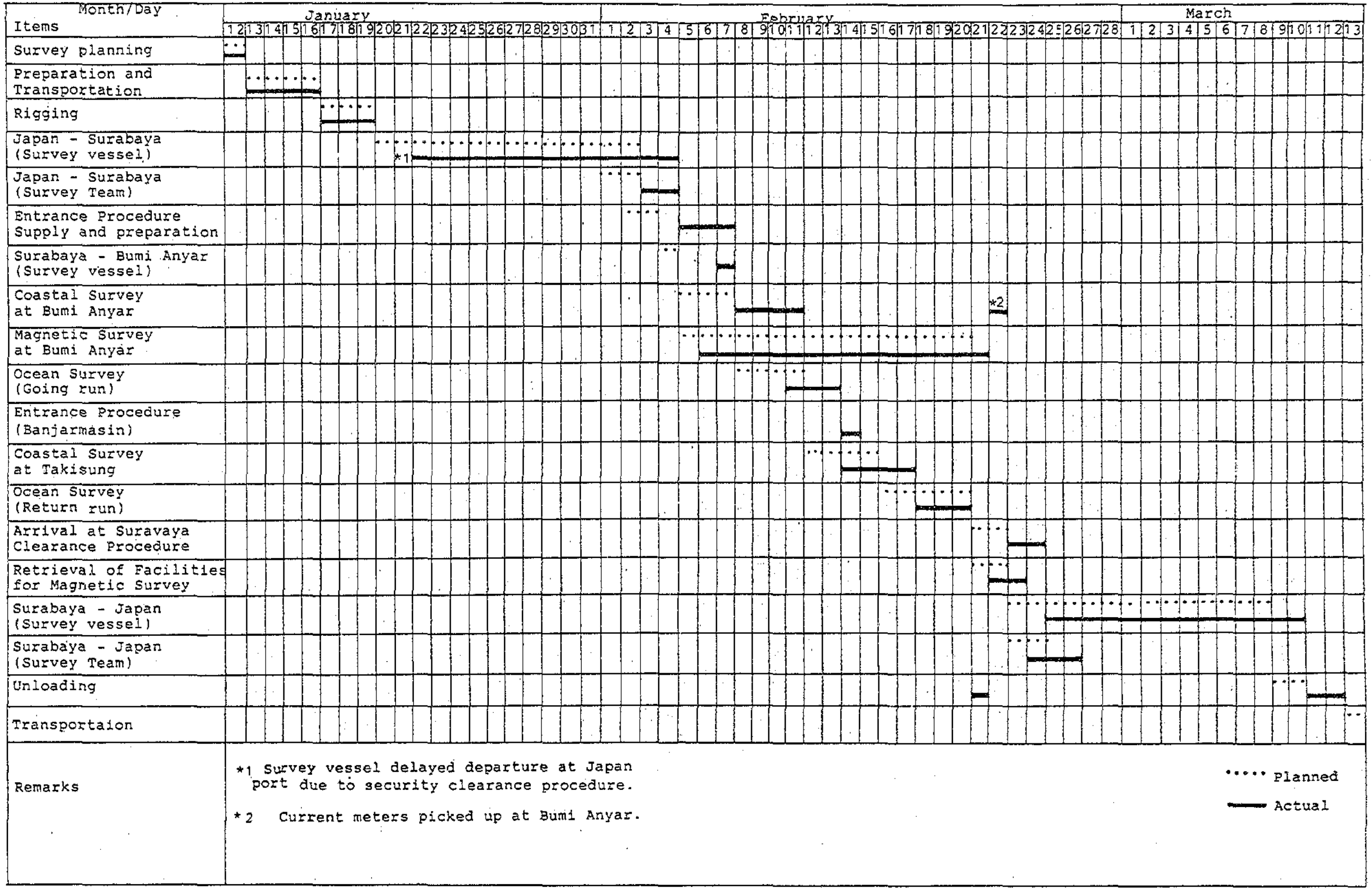


Table I-6 Field Survey Schedule

Table 1-7 Indonesian Government Members

(1) POSTEL

Ir. Rollin	Deputy Director General
Mr. R.I. Soemardi Bc.T.T	Director Planning Division
Ir. Koesmarihati Sugondo	Chief of Planning & Programming Section
Mr. Soedarpo Bc.T.T	Chief of Telecommunication Planning Section
Mr. Soehansono Bc.T.T	Operation Telephone
Mr. Rai Sardjana Bc.T.T	
Mr. Musnaldy	(Counterparts)

(2) PERUMTEL

Mr. Saleh Gunawan	Sub-Director of Development Program
Mr. Saleh Effendi	Chief of Binprotratel
Ir. Tjahyono Djatmiko	Binprotratel
Mr. Jajat Suprijatna Bc.T.T	"
Ir. Fx. Asnarto	"
Mr. Sugeng Winarto	"
Mr. Usman Azoroni	"
Mr. Sedhono Hadi	Binprosentel
Mr. H.P. Panjaitan Bc.T.T	Binprosentel
Mr. Azwar Mohamad Bc.T.Tx	WITEL 9
Mr. Pangaso	"
Mr. Agus	WITEL 7
Mr. Sugito	"

(3) DINAS Hidro-Oseangrafi INI-AL

Let.Kol.Lant Drs M.P. Silaban
Mr. P.S. Sitorus
Mr. Amunaris

CHAPTER 2 GENERAL

CHAPTER 2 GENERAL

2.1 Overview of Indonesia

2.1.1 General Features

With regard to telecommunications business in Indonesia, in-depth analysis is made in JICA report of August 1985 entitled "Fundamental Study on Rural Telecommunications Network in the Republic of Indonesia." Key points of the report are summarized below.

1) National territories of the Republic of Indonesia extend about 5,000 km from east to west and about 1,800 km from north to south. The whole territories are composed of an estimated 13,700 islands, large and small. Population numbers approximately 150 million (as of 1980). The country is the world-largest archipelagoic country.

2) The distribution of population is extremely unbalanced. Up to 62% of total population inhabit Jawa island that occupies only 6.9% of total area of national territories.

3) Population density (per km^2) is 77 in national average. The density in Jawa island stands at 691 in striking contrast to 12 in Kalimantan and 2.5 in Irian Jaya.

4) Resident population in about 13,000 islands is less than 1,000 in total.

5) The most part of population are of Malay descent. Many other tribes also inhabit the country. They use their respective languages and live under their respective life environments. Although Indonesian language is used as national language, about 25 other languages are also used.

6) As one of basic characteristics of multi-island country, one area and one tribe differ from another in life traditions including the sense of value and type of culture.

7) Urbanization rate for the whole country is 22.4% (as of 1980). Jawa island alone embraces about 70% of urban population.

8) Urban population growth rate for the whole country is 5.4% and rural population growth rate 1.7% (as of 1980). This fact reflects intense gravitation of population from rural to urban areas, especially to Jawa island. To cope with the situation, the Government is proceeding ahead with transmigration from Jawa island to Sumatera and Kalimantan.

9) Income gap among employees is conspicuous according to areas and industries.

10) Social insurance system is not fully developed so that mutual aid institution remains strongly established in local communities.

11) These days, elementary education is being rapidly promoted. Hence the downgrade of illiteracy rate among younger generations. However, there is no much to expect from higher education. It still remains to be far from the source of stable supply of capable persons who will perform key roles in national development from now forward.

12) Administrative organization is composed of 27 Provinces (Propinsi) and special districts as top grade autonomies plus 246 Prefectures (Kabupaten) and 54 Municipalities (Kotamadya) as second grade autonomies. All Kabupaten and Kotamadya are subdivided to 3,420 Countries (Kecamatan) which, in turn, break down to 64,680 Towns and Villages (Desa).

13) In densely populated Jawa island alone, Kabupaten and Kotamadya number as many as 106 whereas the total outside Jawa island is 194. In the number of Kecamatan, 1,548 in Jawa island alone are at almost the same level as 1,872 outside Jawa island. In the number of Desa, the ratio between Jawa island and elsewhere is about 1:2, the former representing 22,144 and the latter 42,536.

2.1.2 Socio-Economic Status Quo

1) Fundamental characteristic of Indonesian economy can be found in the fact that an essentially agricultural developing country embracing a large population has been promoting economic development, using oil export earnings as main financial support.

2) Average annual growth rate of GDP in real term during the period from 1972 to 1982 is 7.8%, and nominal GDP per capita as of 1981 amounts to US$ 560. Thus, in the World Bank classification, Indonesia has joined the group of "medium" income countries.

3) The industrial structure of Indonesia consists of agriculture (24.5% in the 1981 nominal GDP share), mining (24.2%), manufacturing (11.7%) and services (15%). The share of agriculture has been diminishing. The share of mining is quite large due to oil production. The mining sector had only 12.3% share in 1973 but went up to 24.2% in 1981. The share of manufacturing has been rapidly increasing. The manufacturing sector together with the services sector is predicted to be the leading sector in the Indonesian economy.

4) Greater progress of manufacturing from now on depends upon whether the strengthening of capital goods division and the upgrading of domestic enterprises can be successfully attained, or not.

5) In the balance of international payments, surplus balances of external trade account and capital account and deficit balance of service account continue. Now that the outlook of oil export earning is not as bright as it once was, Indonesian economy can keep itself safe only by soliciting official financial assistance from external sources or by stimulating export of non-oil industrial products and agricultural products.

   Due to the accumulation of official debts from external sources, debt service ratio continues to be aggravated.

2.1.3 Socio-Economic Status Quo of Kalimantan

The submarine cable system project, this time, is intimately related to socio-economic development of Kalimantan. Therefore, socio-economic status quo of Kalimantan is described below.

Kalimantan is the biggest island in the national territories of Indonesia. It is about 540000 km^2 large and occupies about 28% of the whole national territories. Population density is extremely low, being 12 per km^2.

Kalimantan is rich in natural resources. Crude oil, natural gas, coal and lumber are main products. Wooded lands in Kalimantan account for 38% of the whole in Indonesia. Lumber export occupies the majority out of the country's total. More than 100 large scale lumber miles, equal to 60% out of the total in the country, exist in Kalimantan.

Under PELITA-IV, 1984-1988, the Government of Indonesia is carrying out mining and manufacturing industry and forestry development in Kalimantan, along with Jawa to Kalimantan transmigration. Especially noteworthy is the plan to establish urea fertilizer factories (annual production: 570,000 tons x 2). Priority is given to improvement and expansion of power supply facilities, transportation facilities, water service facilities and telecommunications facilities as infrastructures to support industrial development.

Large scale mining and manufacturing industry and forestry scheduled to be developed are to supply products to world markets so that, for quantity of production, shipment time, destination and pricing, instructions are sent one after another from the central control organ or constant minute consultations are made with that organ. In other words, telecommunication circuits to/from Jawa island where the central control organs of government and private enterprises exist will have vitally to do with Kalimantan economic activities from now forward.

In the administrative structure, Kalimantan is divided into four Propinsi. They are

- Kalimantan Barat
- Kalimantan Tengah
- Kalimantan Selatan
- Kalimantan Timur

In the economic interflows with other islands, Kalimantan Barat generally maintains connections with Central Jawa and Sumatera while others are connected to Jawa through Kalimantan Selatan. This is mainly due to transportation route and communication route.

2.2 Telecommunications Service Status Quo

2.2.1 Indonesia National Network

1) Telephone Facilities

As of the end of March 1984, telephone facilities in Indonesia consist of about 670,000 line units. Breakdown: About 580,000 line units at 170 automatic exchanges and about 89,000 line units at 509 manual exchanges.

More than 85% of existing telephone facilities are concentrated in urban areas.

Table 2-1 presents Propinsi by Propinsi telephone diffusion rates and automatic service ratios as of 1983. In the national total as of 1983, telephone diffusion rate is 0.33/100 persons and automatic service ratio is 86.6%.

2) Domestic Terrestrial Transmission Facilities

Terrestrial transmission facilities in Indonesia mainly consist of analog system microwave radio system.
According to "Year 2000 Indonesia Telecommunications Plan"those analog system facilities will be replaced with digital system facilities by the year 2000.
Decision has already been made for introducing digital equipment in PELITA-IV and after.

Figure 2-1 presents summary introduction of existing and planned domestic terrestrial transmission systems by PELITA-IV.

3) Domestic Satellite Communication System

Figure 2-2 shows earth station locations for domestic satellite communication system now in operation.

4) Non-Voice Communication Services

(1) Telex Service

At present, Telex subscribers are accommodated in local Gentex exchanges. Telex exchange in all parts of the country respectively belong to Medan, Jakarta, Surabaya and Ujung Pandang tandem exchange areas.

Table 2-1 Telephone Diffusion Ratio and Automatic Service Rate (1983)

	Propinsi	Diffusion (100 Persons)	Automatic (%)
11	D.I. Aceh	0.31	72.3
12	Sumatera Utara	0.48	90.1
13	Sumatera Barat	0.24	70.6
14	Riau	0.26	68.0
15	Jambi	0.21	67.4
16	Sumatera Selatan	0.20	74.8
17	Bengkulu	0.09	80.6
18	Lampung	0.17	48.5
31	Dki Jakarta	2.6	100.0
32	Jawa Barat	0.17	81.9
33	Jawa Tengah	0.16	75.3
34	D.I. Yogyakarta	0.22	87.4
35	Jawa Timur	0.25	86.5
51	Bali	0.36	74.7
52	Nusa Tenggara Barat	0.17	62.0
53	Nusa Tenggara Timur	0.09	39.2
54	Timor Timur	–	100.0
61	Kalimantan Barat	0.11	48.1
62	Kalimantan Tengah	0.20	33.3
63	Kalimantan Selatan	0.24	66.1
64	Kalimantan Timur	0.36	89.6
71	Sulawesi Utara	0.25	60.4
72	Sulawesi Tengah	0.17	29.5
73	Sulawesi Selatan	0.21	73.4
74	Sulawesi Tenggara	0.12	62.5
81	Maluku	0.29	80.7
82	Irian Jaya	0.48	75.5
	Indonesia	0.33	86.6

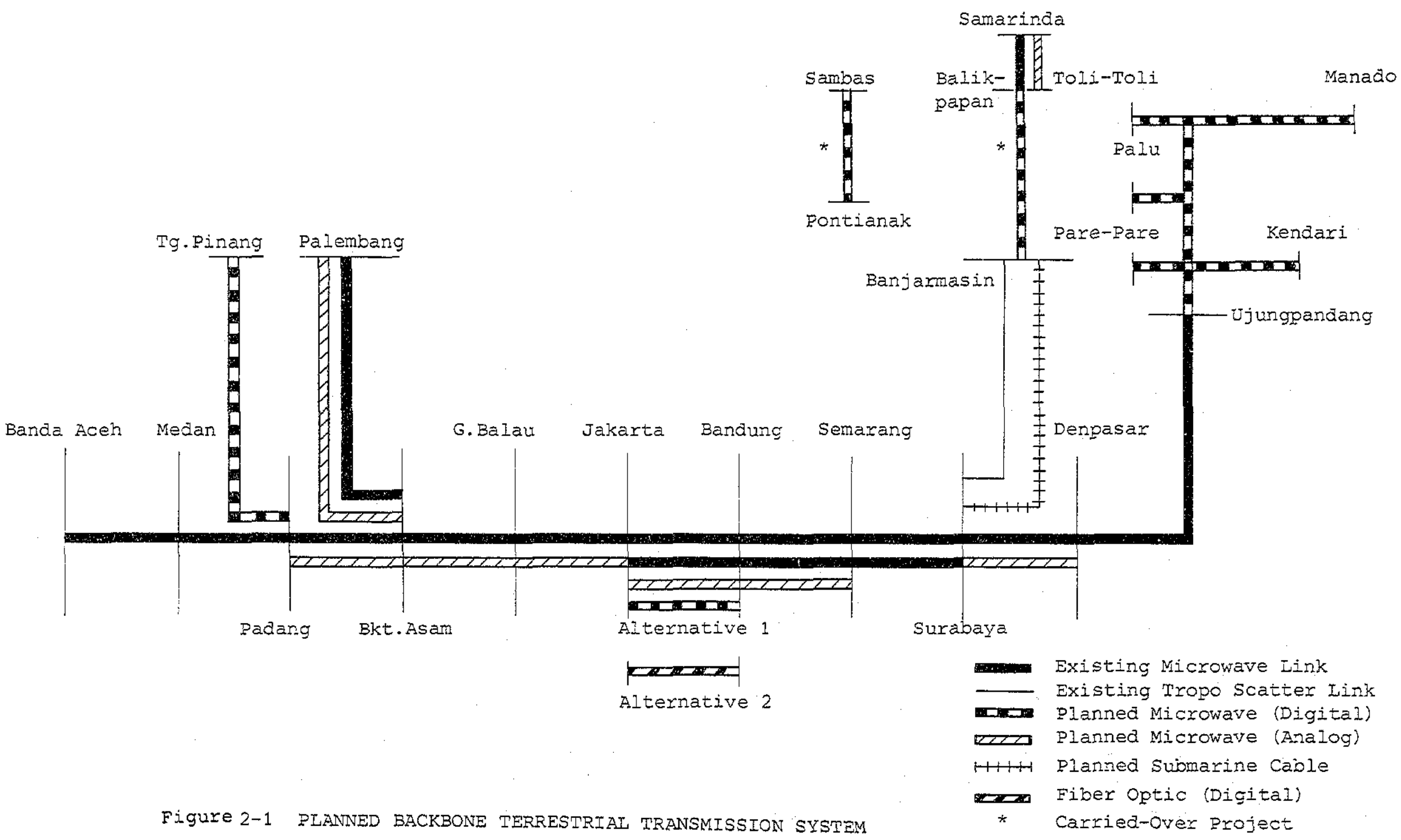


Figure 2-1 PLANNED BACKBONE TERRESTRIAL TRANSMISSION SYSTEM

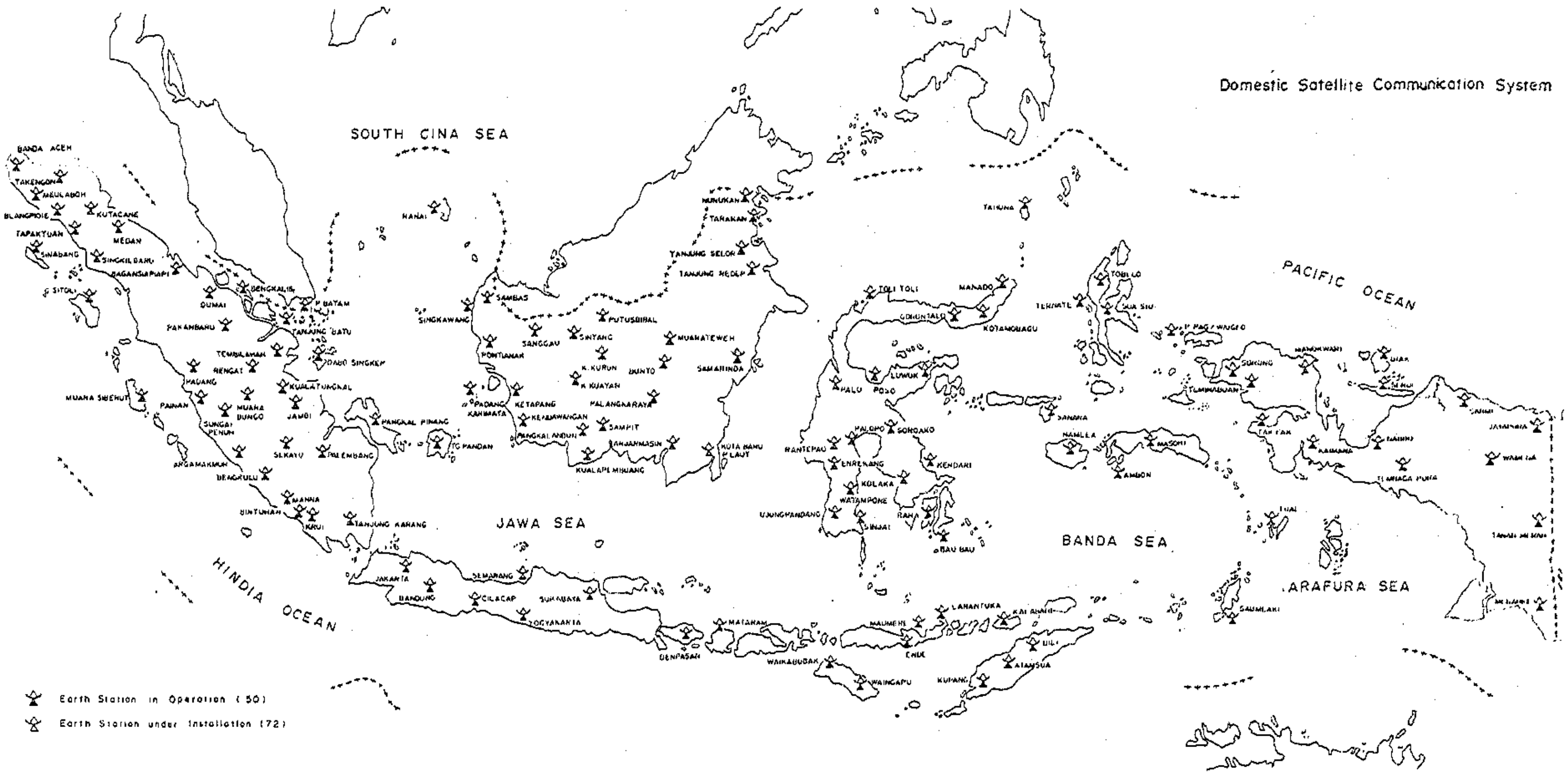


Fig. 2-2 Domestic Satellite Communication System

Table 2-2 shows area numbers and service areas for Gentex tandem exchanges in the country.

Table 2-2 Gentex Network Service Areas

Tandem Exchange	Area No.	Service Area
Jakarta	2 & 4	Jakarta, Jawa Barat Jawa Tengah, D.I. Yogyakarata Jambi, Sumatera Selatan Bengkulu, Lampung
Surabaya	3	Jawa Timur, Bali Nusa Tenggara Barat, Timor Timur Nusa Tenggara Timur Kalimantan Barat, Kalimantan Tengah Kalimantan Selatan, Kalimantan Timur
Medan	5	D.I. Aceh, Sumatera Utala Sumatera Barat, Riau
Ujung Pandang	7	Sulawesi, Maluku, Irian Jaya

Domestic Telex traffic growth rate is about 30% in annual average. Annual average growth rate per subscriber can be estimated at 2.5%.

International Telex traffic registers growth by 30% in annual average in the case of domestic telex traffic. Annual average growth rate per subscriber can be estimated at 4%.

(2) Telegram Service

Telegraph terminals of telegram offices in major cities of the country are accommodated in local Gentex exchanges. Thus, on Gentex network, message sending/receiving between telegram offices by automatic connection system is possible.

Communication to/from telegram offices without access to terrestrial transmission system and without satellite communication facilities is by Morse codes mainly via HF circuits.

Domestic telegram growth rate during 1973 through 1983 is about 8% in annual average. International telegrams are on the decrease annually, the number handled in 1983 being not more than 22% or thereabouts of the number handled in 1973.

(3) Leased Circuit Service

Leased circuit service is to cater for circuit demand among big users. Table 2-3 presents service behaviors by years.

Table 2-3 Leased Circuit Service Trends

Year	No. of Circuits
1973	63
1974	76
1975	105
1976	124
1977	150
1978	172
1979	202
1980	385
1981	444
(1982)	(126)

Source: Statistical Yearbook of Common Carrier Telecommunications, ITU

In case of 1982, counted of January to March

2.2.2 Telecommunications Service Status Quo of Kalimantan

According to 1980 statistics, the population of Kalimantan numbers about 6,300,000. Of this total, 20% is the population in urban areas, such as Banjarmasin and Pontianak. The status quo of telecommunications services in Kalimantan is summarized below.

1) Telephone Facilities

As of 1983, about 24,000 telephones - automatic and manual telephones combined - are installed in Kalimantan. Diffusion rate or density is 0.23 per population of 100 which is lower than the national average of 0.33. For Propinsi by Propinsi diffusion rates and automatic service ratios, refer to the earlier shown

Table 2-1. Figure 2-3 presents main telephone exchange locations in Kalimantan.

2) Terrestrial Transmission Facilities

Existing and planned terrestrial transmission system in Kalimantan by REPELITA-IV are introduced in the previously shown Figure 2-1.

Surabaya-Banjarmasin over-the-horizon microwave link (tropo-scatter system) to be used as part of the projected submarine cable system was in service since December 1975 with 60 channel capacity but it was expanded to 120 channel capacity in March 1984. This microwave link already lacks capacity to carry Kalimantan-Jawa telephone and telex traffic.

For Banjarmasin-Balikpapan digital microwave system to serve north of Banjarmasin, construction plan is now underway. Pontianak-Sambas transmission system is also planned as digital microwave link. Therefore, when the projected submarine cable system is completed by digital optical fiber cable system, the most part of toll transmission network in Kalimantan becomes digital network.

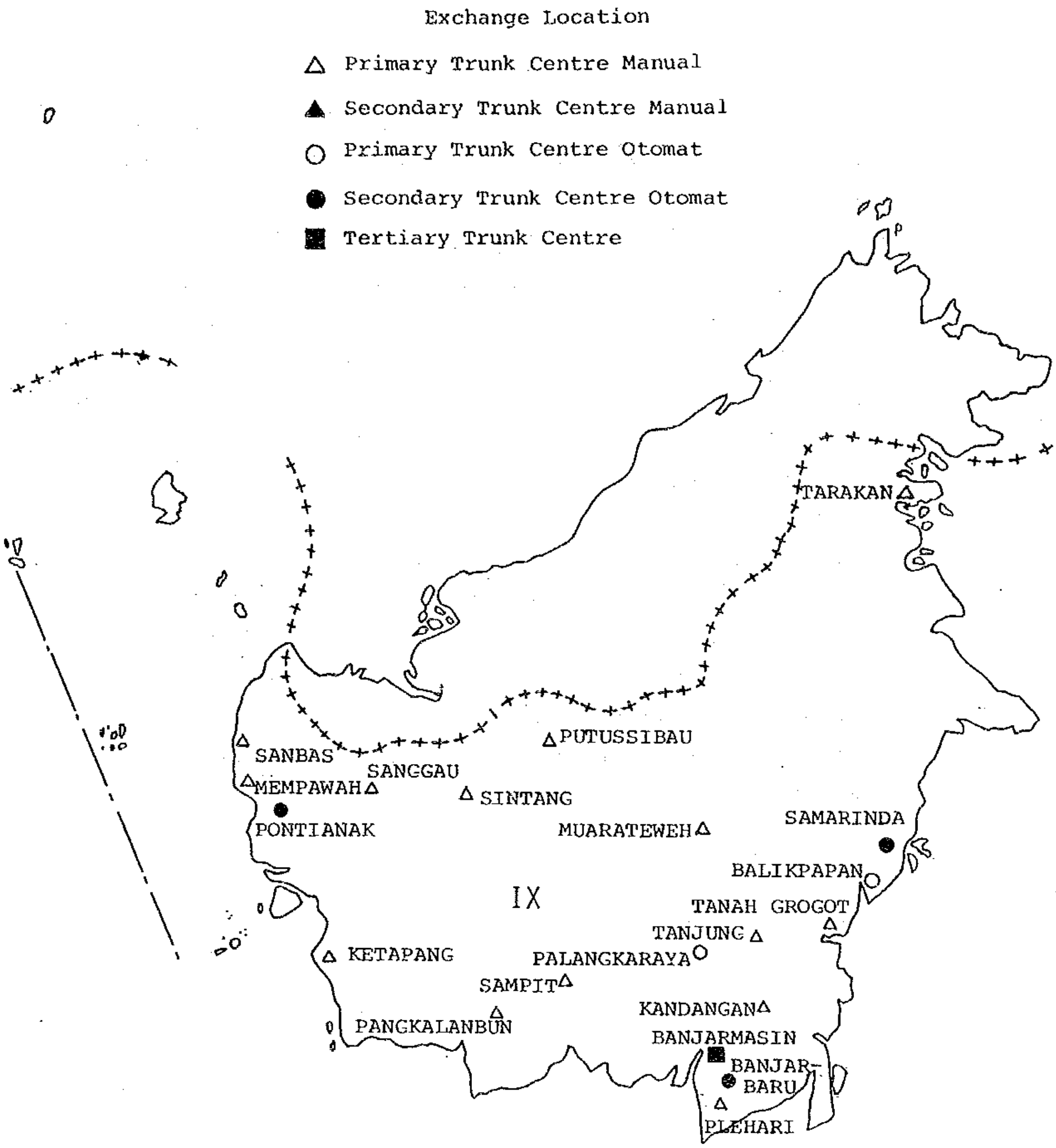
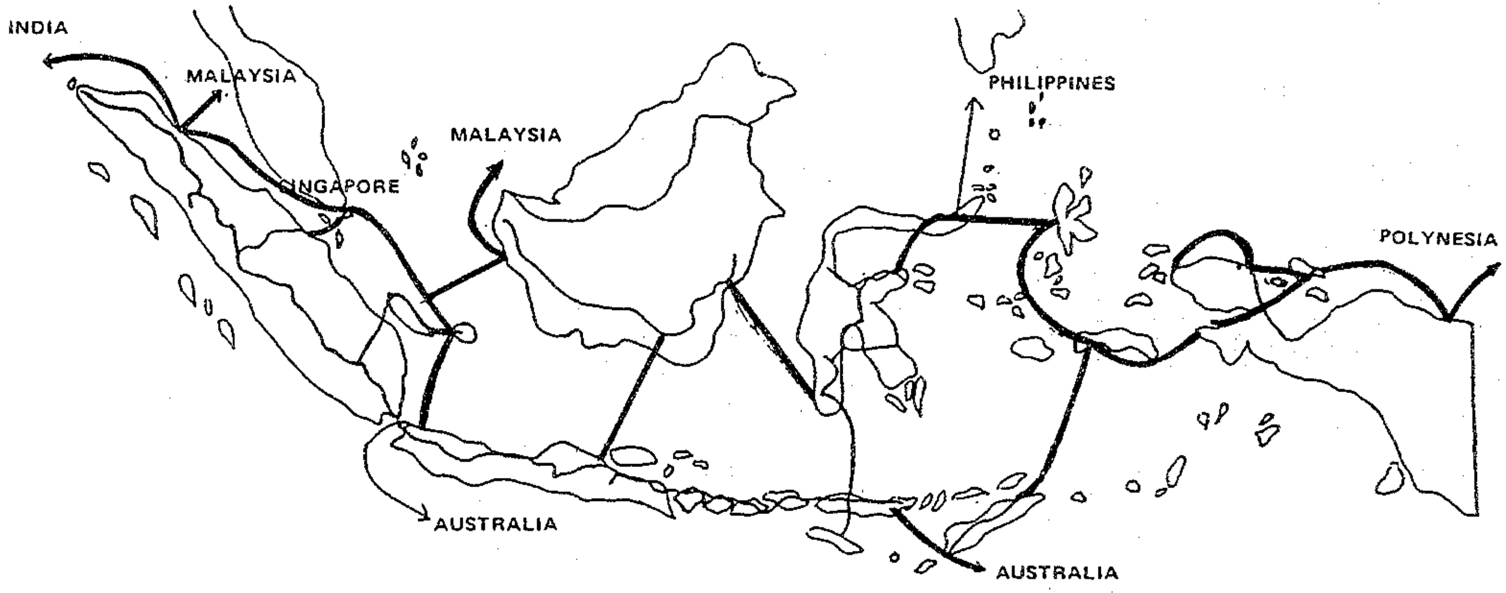


Figure 2-3 Main Telephone Exchanges at Kalimantan



Microwave

Submarine Cable

Figure 2-4 Terrestrial Transmission in the Year 2000

3) Domestic Satellite System Utilization

In Kalimantan, domestic satellite communication system is utilized through 25 earth stations to provide transmission routes to/from remote towns where terrestrial transmission route is not available and where traffic volume is small. Furthermore, the satellite system is utilized for TV signal transmission to Pontianak, Banjarmasin and Balikpapan also.

It is PERUMTEL's poicy to establish both satellite and terrestrial links between important communication centers and these two links functions to back up each other in case of emergency.

4) Gentex and Telegram Services

In Kalimantan, Gentex systems are installed as under.

Propinsi	No. of System	Capacity
Kalimantan Selatan	1	180 CH
Kalimantan Timur	2	500 CH

In Kalimantan, there are limits to telephone diffusion and transmission system capacity expansion so that the degree of dependence on Gentex and telegram services is high. Inhabitants expect much from telegram facilities expansion.

5) TV Transmission

TV broadcasting is not under the control of PERUMTEL. It comes under the jurisdiction of Radio, TV and Cinema Censorship Office of the Ministry of Information. At present, the state managed TVRI is the sole authorized TV service organization.

In Kalimantan, TV set ownerships numbered about 9,000 in 1976. In 1983, the number increased broadly to about 300,000. Thus, in TV diffusion rate, Kalimantan even exceeds Jawa, holding the highest rate in the country. As of 1983, the diffusion rate in Kalimantan stands at 41 sets per 1,000 inhabitants against 36 sets per 1,000 inhabitants in Jawa.

2.3 Telecommunications Service Outlook

According to JICA report of October 1985 entitled "Study on Rural Telecommunications Network Improvement Plan of the Republic of Indonesia," telephone demand as of the year 2000 in the whole of Indonesia will reach about 5 million. PERUMTEL in its "Year 2000 Plan" reports that telecommunications network will become fully digitalized in the year 2000.

PERUMTEL report expects 133,000 telephone subscribers in Kalimantan in the year 2000. The projected Surabaya-Banjarmasin submarine cable system is scheduled to carry more than 1000 Erlang telephone traffic.

Futhermore, the Surabaya-Banjarmasin submarine cable system is identified to constitute and integral part of Jawa-Kalimantan-Sulawesi-Halmahera-Maluku-Irian Jaya backbone telecommunications network in the year 2000. See Figure 2-4. This expected backbone network is to carry traffic of new services, such as data communication, facsimile service and video transmission, besides telephone and telex traffic.

For TV services also, which include the expected new education TV service in addition to the existing state-managed TVRI service, the prospective backbone network will be utilized as transmission media.

2.4 Project Implementing Entities

Implementing entities for Surabaya-Kalimantan submarine cable system project are DITJEN POSTEL of the Ministry of Posts, Communication and Tourism and PERUMTEL.

Figure 2-5 presents the organizational chart of the Ministry of Posts, Communication and Tourism, with its substructure concerned with the projected submarine cable system construction.

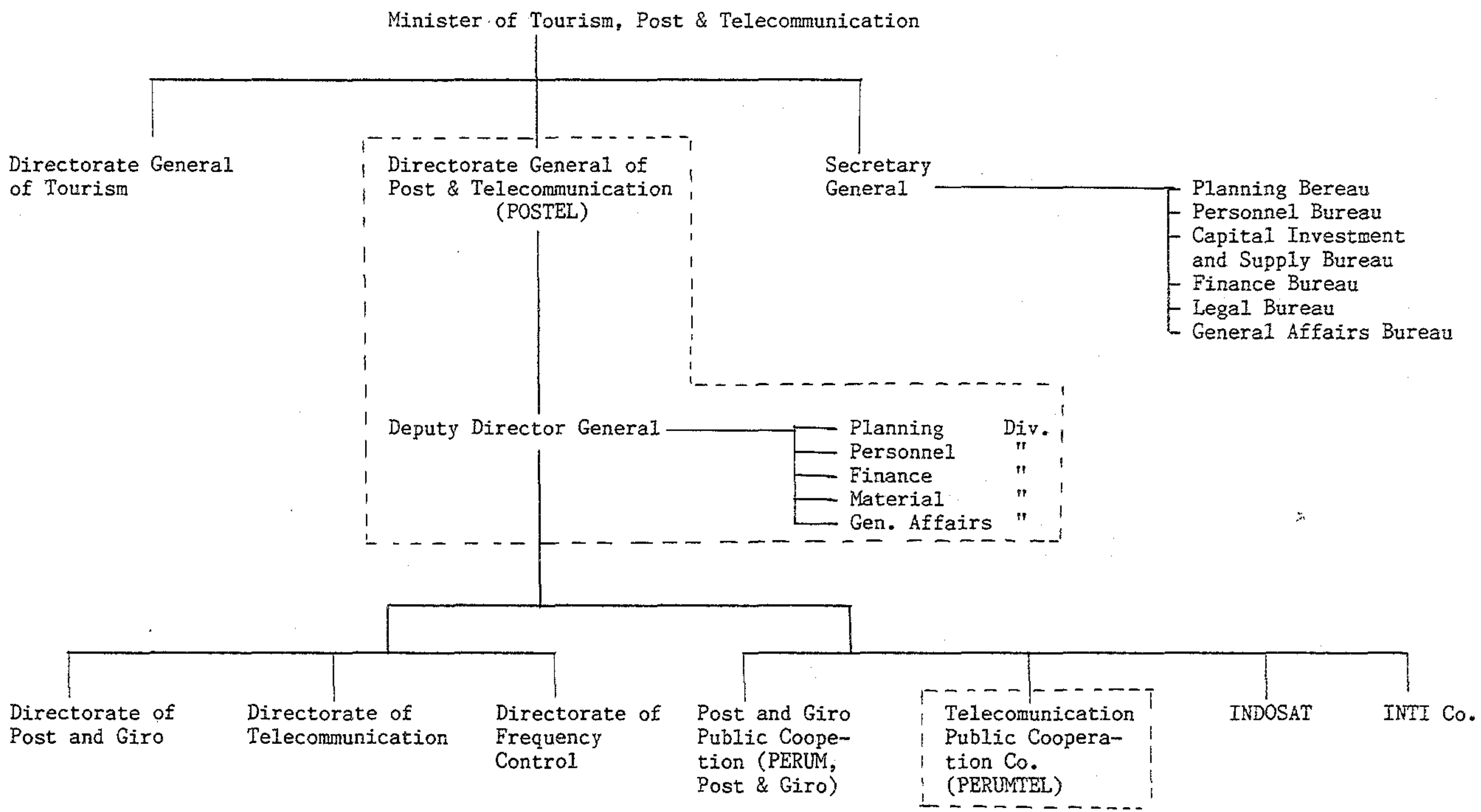


Figure 2-4 Organization of Ministry of Tourism, Post and Telecommunications

CHAPTER 3 DEMAND FORECAST AND CIRCUIT REQUIREMENTS

CHAPTER 3 DEMAND FORECAST AND CIRCUIT REQUIREMENTS

3.1 Demand Forecast

The projected Surabaya-Banjarmasin submarine cable system is to become an integral part of Jawa-Kalimantan-Sulawesi-Halmahera-Maluku-Irian Jaya-Timor backbone telecommunications network after the year 2000 as stated in the preceding chapter. In-depth demand forecast in the areas concerned is made below.

Demand forecast for all Indonesia until year 2000 has already been made in JICA report of October 1985, "Fundamental Study on Rural Telecommunications Network in the Republic of Indonesia (hereafter referred to as "JICA Report"). Since this demand forecast is approved by the organizations concerned in Indonesia, the forecast methodology used in that report is employed in this study also.

3.1.1 Forecast Years and Forecast Formula

1) Forecast Years

Economic life of submarine cable system is generally considered to be 25 years. Thus, for every five years after 1989 as service-in year, demand forecast is made up to 2014.

2) Forecast Formula

The same forecast formula as in the aforementioned JICA Report is used. That is to say, demand forecast for the whole of Indonesia is made by

$$\log (MLA_t + NA_t + W_t + S_t)$$

$$= - 1.819 - 0.408 \log SF_t + 0.384 \log \frac{GDP_t}{POP_t}$$

$$+ 0.590 \log \frac{ML_{t-1}}{MPS_t} + \log (MPS_t - ML_{t-1})$$

.... (1)

where

log	:	Natural logarithmic operator
ML_t	:	Number of main lines in the year t (x 10^6)
ML_{t-1}	:	Number of main lines in the year t-1 (x 10^{-6})
MLA_t	:	$ML_t - ML_{t-1}$ (x 10^6)
NA_t	:	Number of new subscriber applicants in the year t (x 10^6)
W_t	:	Number of waiting subscribers in the year t (x 10^6)
SF_t	:	Mean subscription fare in real term per main line in the year t (in US$ as of 1975)
GDP_t	:	GDP in the year t (x 10^6; in US$ as of 1975)
POP_t	:	Population in the year t (x 10^6)
MPS_t	:	Demand potential population in the year t = POP_t x 0.7 (x 10^6)
S_t	:	Latent demand in the year t (x 10^6)

In the aforementioned JICA Report, demand forecast until 2000 is made by substituting the past recorded data and forecasted GDP and population for each forecast year in Formula (1). Figures used in JICA Report forecast are reproduced in Volume II to this report.

3.1.2 National Demand Forecast

Demand forecast results for all Indonesia up to the year 2000 available in JICA Report are shown below.

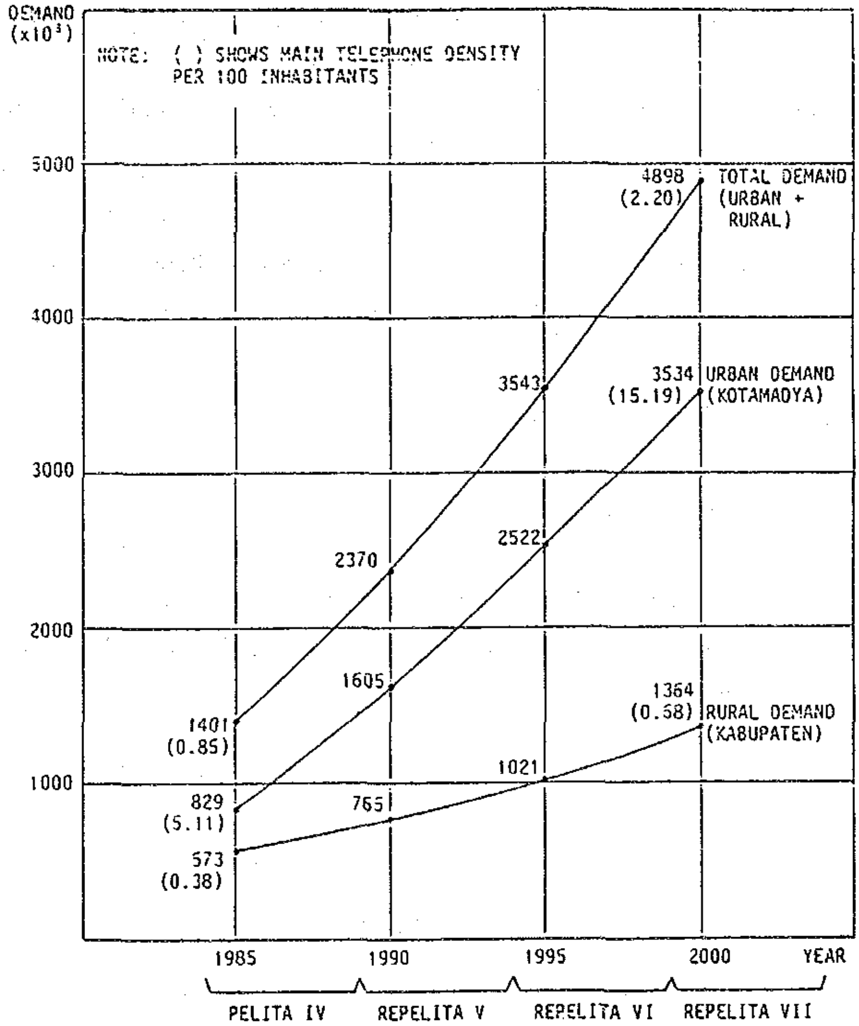


Figure 3-1 Telephone Demand Forecast for All Indonesia

Demand growth after 2000 is considered to be an extension of the above forecast unless specific factors develop, such as drastic deterioration of population growth or sharp growth of GDP in the years after 2000.

Table 3-1 presents demand forecast results up to 2015 obtained by application of the same forecast formula.

Table 3-1 All Indonesia Demand Forecast Up to 2015

(Unit: 1,000)

	1990	1995	2000	2005	2010	2015 (2014)
Rural demand	765	1,021	1,364	1,707	2,050	2,393 (2,324)
Urban demand	1,605	2,522	3,534	4,546	5,558	6,570 (6,368)
Total demand	2,370	3,543	4,898	6,253	7,608	8,963 (8,692)

3.1.3 Propinsi by Propinsi Demand Distribution

1) Rural Demand Distribution

In the aforementioned JICA Report, rural demand out of national demand forecast as of 2000 as shown in Table 3-1 is distributed by islands as under.

Jawa	820×10^3
Sumatera	304×10^3
Kalimantan	68×10^3
Sulawesi	78×10^3
Others	94×10^3
Total	1,364

Here, the assumption is made that until 2014, demand arises by the same distribution ratio. Table 3-2 shows rural demand forecast after 2000.

Table 3-2 Rural Demand Forecast by Islands

(Unit: 1,000)

	1990	1995	2000	2005	2010	2015	(2014)
Jawa	460	614	820	1,026	1,232	1,439	(1,397)
Sumatera	169	226	304	380	457	533	(518)
Kalimantan	40	52	68	85	102	119	(116)
Sulawesi	43	58	78	98	117	137	(133)
Others	53	71	94	118	142	165	(160)
Total	765	1,021	1,364	1,707	2,050	2,393	(2,324)

2) Urban demand Distribution

Urban demand distribution is according to urban population ratios by islands. Urban population ratios by islands as shown in Statistical Yearbook of Indonesia (1980) appears in table 3-3.

Table 3-3 Urban Population Ratios by Islands (1980)

	Urban population Ratio	Population Gravitation to Urban Area Ratio
Jawa	54.4%	2.3%
Sumatera	13.6	1.0
Kalimantan	3.1	0.5
Sulawesi	4.4	1.8
Others	24.5	0.3
(All Indonesia)	(100.0)	(5.9)

In Kalimantan, population inflow to such cities as Pontianak, Planga Raya, Banjarmasin, Balikpapan and Samarinda by the Government's transmigration policy preponderates. Growth ratio of such population inflow against urban population of Kalimantan reaches 15.6% (on national basis: 0.5% growth).

When the assumption is that urban population ratios by islands as shown in Table 3-3 remain unchanged in the coming years also and, on this basis, urban population in each island grows, urban population ratios up to the year 2015 are considered to vary as under.

Table 3-4 Urban Population Ratio Variation Forecast (%)

	1980	1985	1990	1995	2000	2005	2010	2015	(2014)
Jawa	54.4	56.4	58.3	60.2	62.1	63.9	65.7	67.4	67.0
Sumatera	13.6	13.2	12.8	12.4	12.0	11.6	11.2	10.8	10.9
Kalimantan	3.1	3.0	2.8	2.6	2.5	2.3	2.2	2.1	2.1
Sulawesi	4.4	4.4	4.5	4.6	4.6	4.6	4.6	4.6	4.6
Others	24.5	23.0	21.6	20.2	18.8	17.6	16.2	15.1	15.4
All Indonesia	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

When urban demand out of all Indonesia demand forecast as in table 3-1 is distributed by islands according to Table 3-4, results as in Table 3-5 are obtained.

Table 3-5 Urban Demand Distribution by Islands

(Unit: 1,000)

	1990	1995	2000	2005	2010	2015	(2014)
Jawa	936	1,518	2,195	2,905	3,652	4,428	4,267
Sumatera	205	313	424	527	622	710	694
Kalimantan	45	66	88	105	122	138	134
Sulawesi	72	116	163	209	256	302	293
Others	347	509	664	800	906	992	981
Total	1,605	2,522	3,534	4,546	5,558	6,570	6,369

Table 3-2 and Table 3-5 produce the following total demand of whole Indonesia up to the year 2015.

Table 3-6 Whole Indonesia demand Forecast

(Unit: 1,000)

	1990	1995	2000	2005	2010	2015	(2014)
Jawa	1,396	2,132	3,015	3,931	4,884	5,867	5,664
Sumatera	374	539	728	907	1,079	1,243	1,212
Kalimantan	85	118	156	190	224	257	250
Sulawesi	115	174	241	307	373	439	426
Others	400	580	758	918	1,048	1,157	1,141
Total	2,370	3,543	4,898	6,253	7,608	8,963	8,963

3.1.4 Demand forecast for Objective Area

The projected Surabaya-Banjarmasin submarine cable system will be concerned to Sulawesi, Halmahera, Maluku and Irian Jaya in the near future when these islands are connected by other submarine cable systems. This time, Kalimantan, Sulawesi and "Others" are taken up as demand forecast areas concerned with the Project. About 60% of "Others" is to be estimated to be of Halmahera, Maluku and Irian Jaya.

3.2 Demand Fulfillment Ratio

Demand forecasts in the preceding paragraphs are calculations wherein latent demand is taken into account to more than 10%. Therefore, actual demand fulfillments that can be expected are to the extent of 90% at a maximum. Furthermore, considering that demand does not exactly take shape as expected, i.e., as previously calculated, so that construction/installation plan cannot fully follow suit, maximum demand fulfillments may probably be 85% or thereabouts even though all other requirements are satisfied. Thus, in this study, demand fulfillment ratio is set at 85%. Shown in Table 3-7 are the expected demand fulfillments in the objective area.

Table 3-7 Expected Demand Fulfillments

(Unit : 1,000)

	1990	1995	2000	2005	2010	2015	(2014)
Kalimantan	73	100	133	162	190	218	212
Sulawesi	98	148	205	261	317	373	362
Others (x60%)	204	296	387	469	535	590	582

3.3 Traffic Forecast

In order to forecast the traffic, the following assumptions were made to this study. The detailed estimation is cleared in Volume-II.

3.3.1 Subscriber Originating, Terminating Calling Rate

Based on traffic measurements at existing automatic and manual exchanges, the aforementioned JICA Report calculates automatic exchange subscriber originating and terminating calling rates as under.

Local:	33.98×10^{-3} Erl.	(Real originating calling rate: 14.16×10^{-3})
SLDD:	16.78×10^{-3} Erl.	(Real originating calling rate: 6.99×10^{-3})
Total:	50.76×10^{-3} Erl.	(21.15×10^{-3})

With the above value plus busy hour concentration rate, as well as coefficient wherein connection time, signal selection time, incomplete call, etc., are allowed for, local and toll originating and terminating calling rates as of 2000 are estimated as under.

Local originating and terminating calling rate:

34.94×10^{-3} Erl.

Toll originating and terminating calling rate:

17.30×10^{-3} Erl.

Total 52.24×10^{-3} Erl.

The foregoing forecast does not involve any specific factor subject to major change in the years up to 2015. Therefore, in this study, the above local and toll originating and terminating calling rates are used up to 2015.

3.3.2 Traffic Distribution

For traffic distribution also, the methodology used in the aforementioned JICA Report is employed up to 2015. This is because the methodology also does not involve factors subject to major change until 2015.

3.3.3 Traffic Flow in Kalimantan

As stated in Chapter 2, Kalimantan is composed of four Propinsi. Out of them, Kalimantan Barat is closely related to Sumatera not only geographically but economically also. Thus, in Kalimantan Barat, the most part of existing traffic flow is to Sumatera and Jawa.

This trend will continue in the future also. However, when Pontianak-Palembang submarine cable system (see figure 3-2: Estimated Traffic flow 2000-2015) is constructed, Kalimantan Barat traffic flow will no longer be through Surabaya-Kalimantan submarine cable system projected this time.

Traffic in three other Propinsi (Kalimantan Timur, Kalimantan Tengah and Kalimantan Selatan) will concentrate at Banjarmasin Tertiary Trunk Center wherefrom to flow to Jawa via Surabaya-Banjarmasin submarine cable system.

The number of line units now installed at telephone exchanges in Kalimantan Barat and telephone exchanges in three other Propinsi is as under. (See Figure 3-2.)

(Unit: Number of line units)

	Automatic Exchanges	Manual Exchanges	Total
Kalimantan Barat	2,900	2,110	5,010
Other Propinsi	15,200	3,670	18,870
Total			23,880

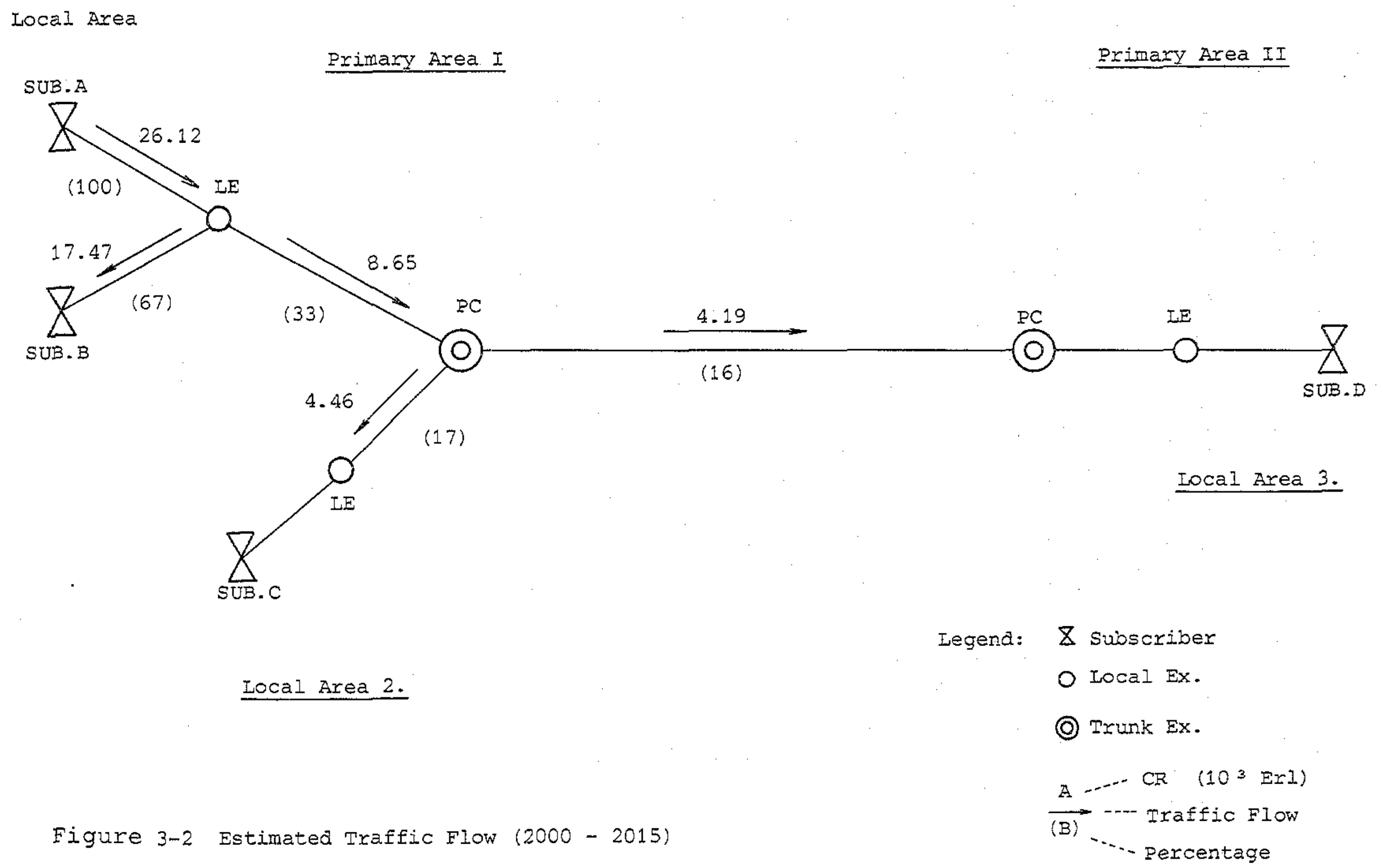


Figure 3-2 Estimated Traffic Flow (2000 - 2015)

The ratio in terms of line units installed is about 1:4. This fact makes it safe to assume that 80% of outgoing and incoming traffic from/to Kalimantan will be through the projected Surabaya-Kalimantan submarine cable system.

3.3.4 Traffic Distribution between Terrestrial Transmission Network and Satellite Communication Network

In the areas where terrestrial transmission network is not yet developed, transmission system utilizing communication satellite is advantageous. On the other hand, terrestrial transmission network holds advantage in that it can establish large capacity transmission system. The philosophy whereby to distribute traffic between terrestrial transmission network and satellite communication network, this time, is as under.

(1) To use terrestrial transmission network preferentially in the areas where terrestrial transmission network is fully developed. However, for alternative route, to establish satellite route where to transmit 10% of traffic.

(2) To distribute 20%, 40%, 60% or 80% of traffic to satellite communication network, depending upon terrestial transmission network capacity, in the areas where terrestrial transmission network exists but its capacity is deficient.

(3) To distribute 100% of traffic to satellite communication network in the areas where terrestrial transmission network establishment is difficult.

3.3.5 Other Conditions

A. Eastern Microwave System now operates as analog system and its capacity is 9960 CH. Additional establishment of digital microwave system on the same route is technically infeasible, considering that a long distance section (approx. 170 km) exists on the route. Therefore, traffic to be transmitted on this route is to be limited to about 800 Erlang.

B. Kalimantan-Sulawesi submarine cable system, Sulawesi-Halmahera-Maluku submarine cable system and Halmahera-Irian Jaya submarine cable system are to be established by 1995 so that outgoing and incoming traffic between those islands and Jawa can be transmitted via submarine cable system projected, this time.

C. Jawa-Irian Jaya submarine cable system completion is expected by 2005. Therefore, traffic distribution after 2005 is to be 50% to Jawa-Irian Jaya route and the remaining 50% to Kalimantan route included in the current project.

3.4 Traffic Estimate for Current Project

By the foregoing Paragraph 3.3.1 through Paragraph 3.3.5 preconditions, traffic to be covered by this project can be estimated as under.

Table 3-8 Surabaya-Banjarmasin Submarine Cable Traffic

(Unit: Erlang)

	1990	1995	2000	2005	2010	2015	(2014)
Kalimantan	150	251	363	496	583	748	648
Sulawesi				293	521	866	818
Others (60%)		260	727	644	768	1,100	1,085
Total	150	511	1,090	1,433	1,872	2,714	2,511

3.4.1 Telephone Circuits

For telephone circuit requirements, calculation is made on the assumption that circuit efficiency is 90% at a maximum based on Table 3-8 traffic estimates. Calculation results appear in Table 3-9.

3.4.2 Telex, Leased Circuits, and New Service Circuits

A. Telex Circuit

Telex circuits handle telegram service also as Gentex. Utility is high while telephone density remains low and the number of terminals also will increase. At present, in Kalimantan Selatan and Kalimantan Timur, 680 Gentex terminals are installed. This figure corresponds to about 4.5% of 15,200 automatic telephone line units.

For Telex circuits, demand is estimated at 5% of telephone circuits in the future also.

B. Leased Circuits, New Service Circuits

In Kalimantan, many state managed enterprises, mostly mining and manufacturing enterprises, exist. Production of export goods is also brisk. Therefore, demand for data transmission circuits, etc., can be expected from now forward.

Depending upon transmission speed to be adopted, data circuit requirements also vary. This time, 5% equivalent of telephone circuits is estimated for data circuit requirements.

3.4.3 TV Transmission

In this submarine cable system project, TV transmission philosophy is as under.

(1) Main TV transmission media is PALAPA communication satellite. In view, however, of the total communication failure including TV transmission that took place in 1985 in relation to PARAPA-B launching, and in order that such trouble will never take place again, alternative route for TV transmission to be established in terrestrial transmission system.

(2) Therefore, in the submarine cable system projected, this time, also, channel capacity for TV transmission (for emergency use) be considered. That is to say, submarine cable system branching point as backhaul system be located at 34 Mbit/s interface. Hence no consideration to install TV CODEC.

Table 3-9 shows channel capacity which the projected submarine cable system can alocate for TV transmission. According to this capacity allocation plan, channel up to 40 Mbit/s can be used for TV transmission until 2000.

3.4.4 Circuit requirements by Years

Total circuit requirements for telephone service (Paragraph 3.4.1) and Telex/leased circuit/new services (Paragraph 3.4.2) appear in Table 3-9. Total circuit requirements to cover a loss (20% is assumed) due to digital group switching are also shown in this table.

Table 3-9 Circuit Requirements by Service by Years

(Unit: No. of Circuit)

Circuit Category	1990	1995	2000	2005	2010	2015	(2014)
Telephone Circuits	170	570	1,210	1,600	2,100	3,000	2,850
Telex, Leased Circuits	20	60	120	160	210	300	290
(Sub-Total)	190	630	1,330	1,760	2,310	3,300	3,140
Total with Group Switching Loss	230	760	1,600	2,110	2,780	3,840	3,770
Spare Circuit for TV	140Mbit/s x1	140Mbit/s x1	140Mbit/s x1	64Mbit/s x1	64Mbit/s x1	-	-

CHAPTER 4 CONDITIONS OF OCEAN

CHAPTER 4 CONDITIONS OF OCEAN

4.1 General Oceanography in the Jawa Sea

The ocean where a submarine cable is being planned between Bumi Anyar, Madura Island and Takisung, Kalimantan Island belongs to the Jawa Sea. And the planned cable route crosses the Jawa Sea in the N-S direction at the eastern side.

The Jawa Sea is spreading between Kalimantan Island and Jawa Island. It is bound on the west by Sumatera and on the east by deep sea which extends from the Makassar Strait.

The region of this area is affected by the monsoon. In the period of the NW monsoon from November to March, Westerly to Northwesterly wind dominates in this area. In the SE monsoon from May to September, Southeasterly wind dominates in this area.

The currents in the Jawa Sea are controlled by the monsoon winds. The current direction on the sea surface reverses two times in a year. In transition of the monsoon, current flow varies in various directions.

The currents on the sea surface set in a predominantly ESE to E direction with it's velocity about 1.0 to 1.5 knots in the NW monsoon and WNW wards going with velocity 0.8 knots in the SE monsoon. The current mean velocity is about 0.8 knots on the sea surface in transition to/from the monsoon.

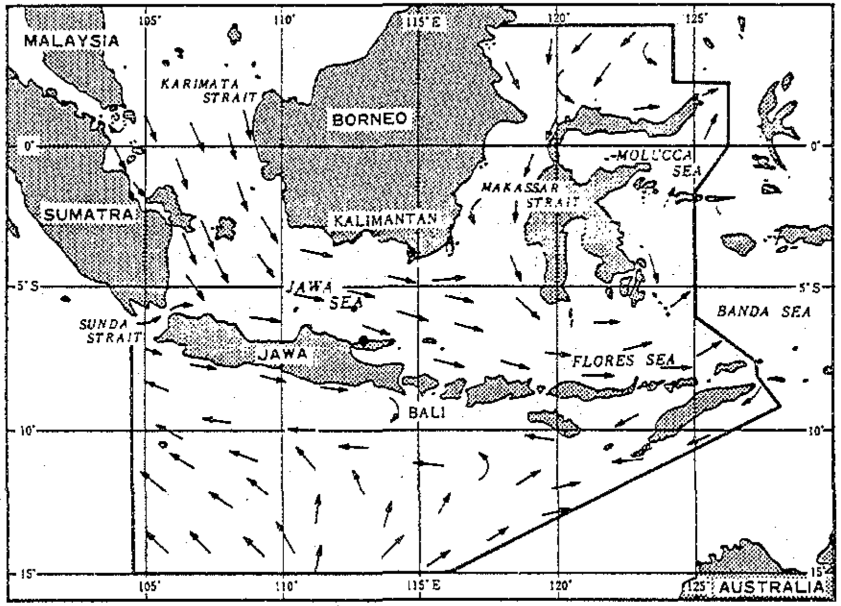
Tidal streams in this area have a marked diurnal inequality. The sea water comes from the Pacific Ocean throughout the year. The water comes from the Pacific Ocean Via the South China Sea in NW monsoon and through the Flores Sea in SE monsoon (Figure 4-1).

The Jawa Sea belongs to the so-called continental shelf and water depth is less than 100 m. Several islands are scattered. The seabed is almost flat except near the eastern edge of the Jawa Sea. The deepest area in the Jawa Sea is located in the middle between Bawean Island and Kangean Island, where is 80-100 m in water depth.

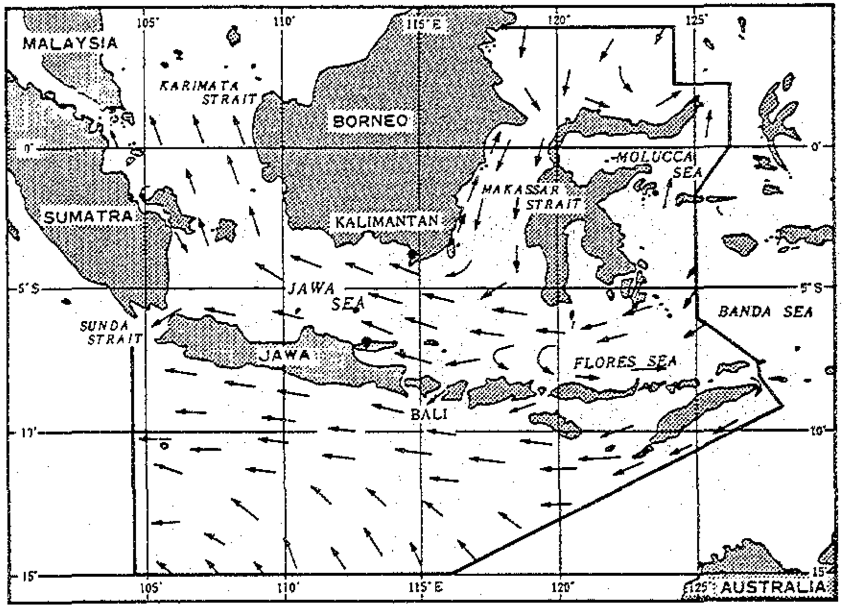
The basements of the Jawa Sea are low-grade metasedimentary rocks and granitic rocks, which are covered with the sediments and sedimentary rocks on the data of oil exploration wells (W. Hamilton, 1979).

The uppermost sediments which belong to pleistocene age have complicated structures, namely "Cut-and-Fill Features" (K.O. Emery et.al.,1972). Those structures were formed by the erosion and sedimentation caused by the glacial eustasy during Pleistocene age. It is famous that the Paleo-River System is hidden under the sea in the Sunda Shelf and the Jawa Sea. Figure 4-2 roughly indicates this Paleo-River System, which was prepared by K.O. Emery et.al. (1972) based on the maps of Moloengraaff (1921) and Kuenen (1950).

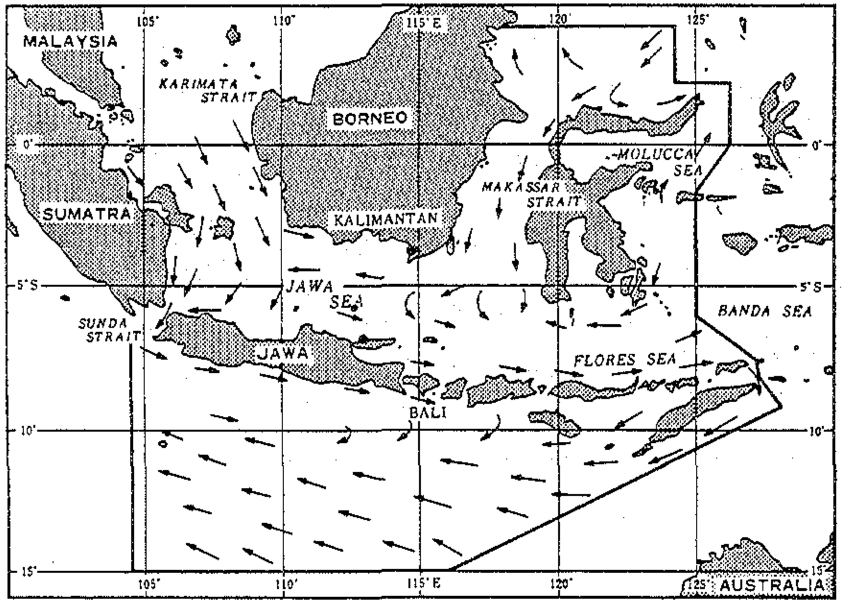
The main bottom sediments in the Jawa Sea are mud, sandy mud and muddy sand (Figure 4-2, by K.O. Emery, 1972).
Sand, gravel, rock and coral are distributed in the neighborhood of islands. A relatively broad sand areas exist off south-eastern Kalimantan Island.



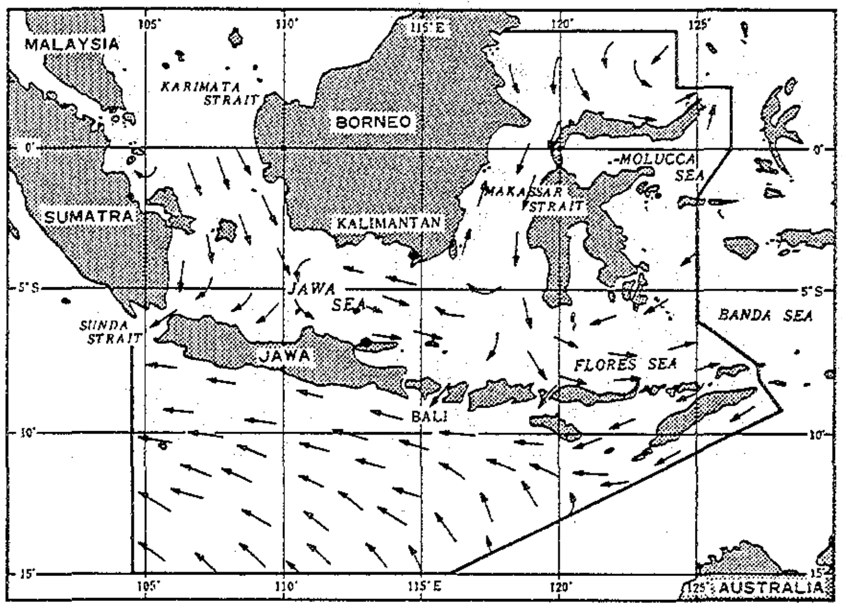
NW Monsoon (February)



SE Monsoon (August)



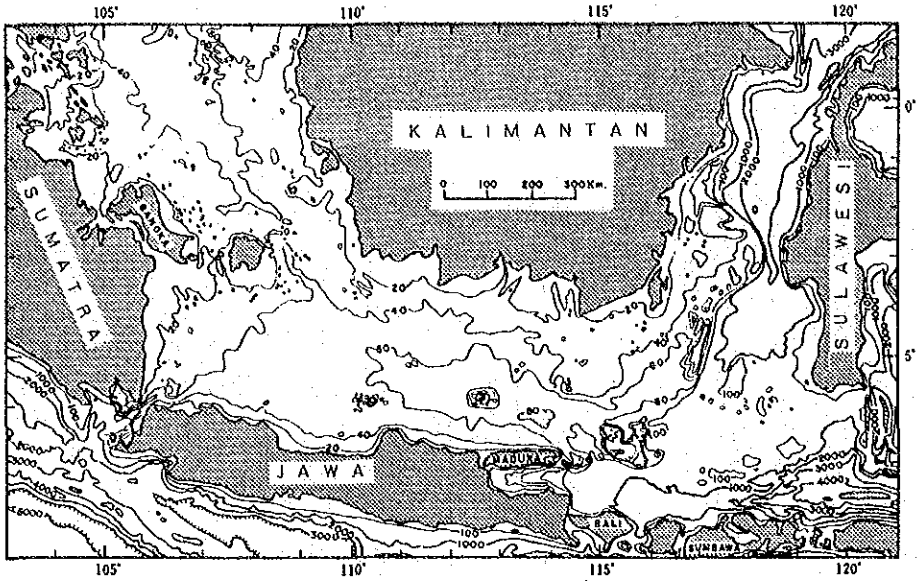
Monsoon in Transition(April)



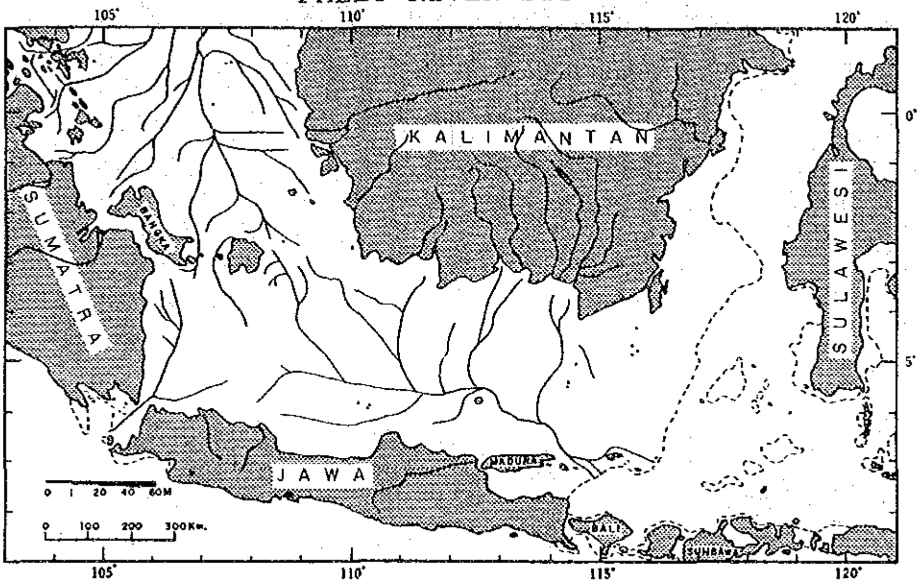
Monsoon in Transition(October)

Figure4 - 1 General Surface Currents Circulation in The Jawa Sea(British Pilot Book)

SUBMARINE TOPOGRAPHY



PALEO-RIVER SYSTEM



BOTTOM SEDIMENTS

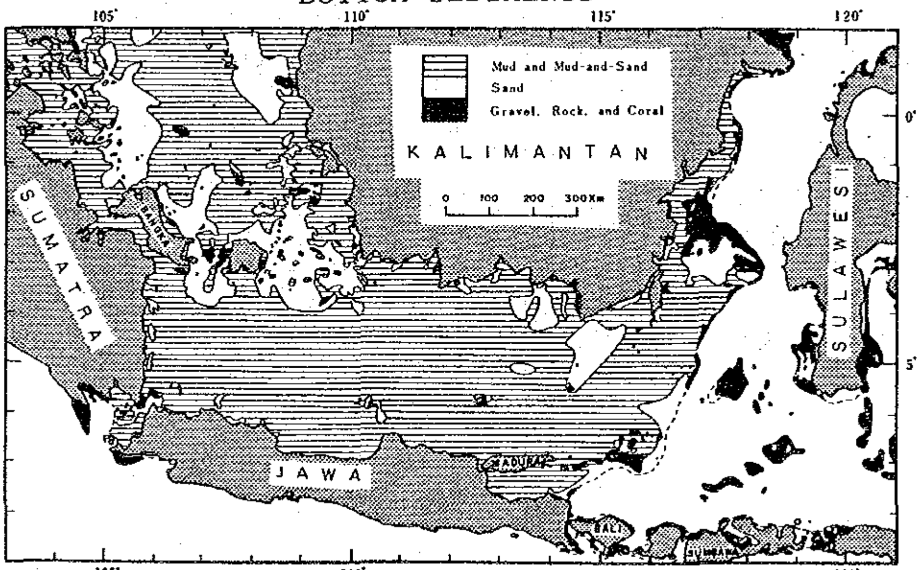


Figure 4 - 2 SUBMARINE TOPOGRAPHY, PALEO-RIVER SYSTEM and BOTTOM SEDIMENTS
(Modified from K.O.Emery et al,1972)

4.2 Fishing Activities

According to the information obtained from Japanese fishery firm in Japan, it was found that the trawl fishery has been prohibited since January 1, 1983 over the whole Indonesian waters by the order issued by the president of Indonesia in January, 1982.

Further our investigation regarding fishing activities was carried out at Surabaya in February, 1986. The survey team obtained the following latest informations from the Sea Communication, Department of Communication Indonesia in that investigation.

a. The trawl fishery has been completely prohibited in the Indonesian waters (except the fishery described in item C).

b. All kinds of fishings can operate only within 30 n.m from the coast.

c. The towing net on the middle layer can be operated less than 12 m depth below the sea surface.

On the route of our ocean survey, we have seen the floating gears made of bamboo in the ocean area 30 n.m or more away from the coast. We inquired the Sea Communication about this fact and understood that such fishing activities were against the Indonesian law or regulation.

4.3 Shipping Activities

The shipping traffic routes in the Jawa Sea are complicated with the routes among islands or the routes passing through the straits via the Jawa Sea.

Bumi Anyar and Takisung for the cable landing points are far away from the Surabaya Port and the Banjarmasin Port, respectively, which are main neighbor ports. Therefore, it is considerable that the vessels entering/sailing out at each port will not make hazards to the cable route.

The existing and planned anchoring area for both ports mentioned above do not have an effect on the route because of the same reason mentioned above.

The harbor development plan at the Surabaya Port is limited to Gresik at this stage, which is located in the northwestern neighborhood of Surabaya. That plan do not also have an effect on the route because Gresik is far from Bumi Anyar L.P. The information was obtained that a harbor construction is planned near Batakan about 25 km south of Takisung. However this plan will not make hazards to the route because it is far away from Takisung L.P.

During the Ocean Survey, our survey vessel encountered many kinds of vessel (ocean-going cargo vessels, local small boats and fishing vessels). The positions and number of those vessels are described on Vol.III Result of Ocean Survey.

4.4 Offshore Oil Activities

Petroleum exploitations are proceeding in many places in the Jawa Sea, especially in the southern part of the Jawa Sea.

The oil companies - KODECO and KERR MCGEE - are performing the petroleum exploitation in the neighborhood of the planned submarine cable route according to the map of Petroleum Activity, Indonesia, issued in August 1985 by Petroconsultants, s.a.. The contract areas are indicated in Figure 4-3 (1),(2). The planned route from Bumi Anyar landing point to the altered course No.2 via No.1 is passing through roughly on the eastern boundary line of KODECO's contract area. The other parts of the planned route are free form the petroleum activities except off Kalimantan Island at this stage.

PERTAMINA invited tenders for the petroleum exploitation in the northern part of the Jawa Sea off the southeastern Kalimantan Island. The details of this matter will be described on Vol. III Result of Ocean Survey.

The oil and gas wells which have been drilled near the planned cable route are scattered around the planned route, as showing in Figure 4-3 (1),(2). The positions of those wells existing close to the route are listed in Table 4-1 based on the letter from PERTAMINA dated April 4, 1985 and the hearing from PERTAMINA in March, 1986.

The abandoned well "JS 14A - 1" is nearest to the planned route and the distance is 1.1 n.m.. In our opinion, the laying of submarine cable along the planned route is free from the existing and abandoned wells of oil and gas, if the adequate positioning system is employed during cable construction.

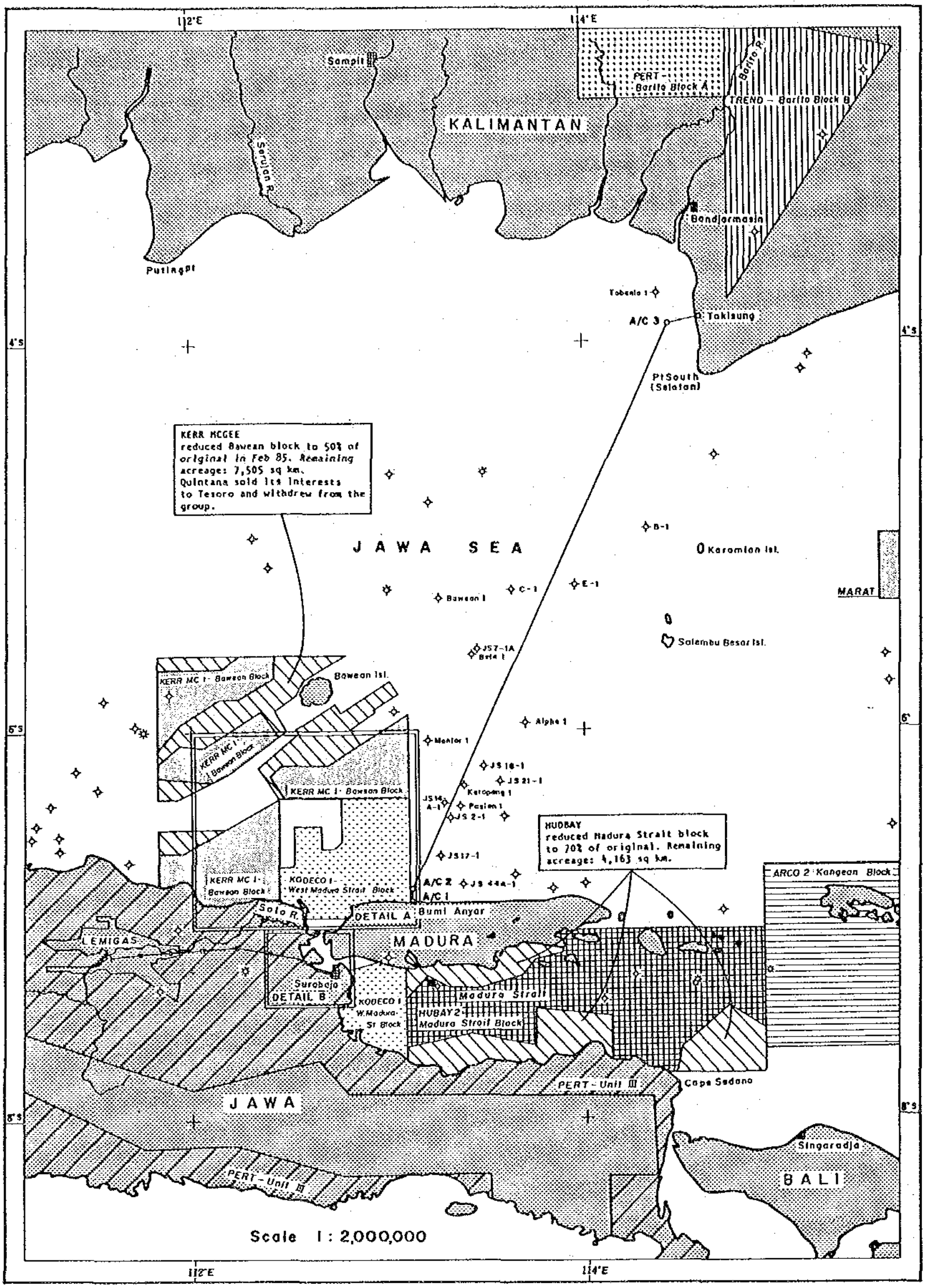
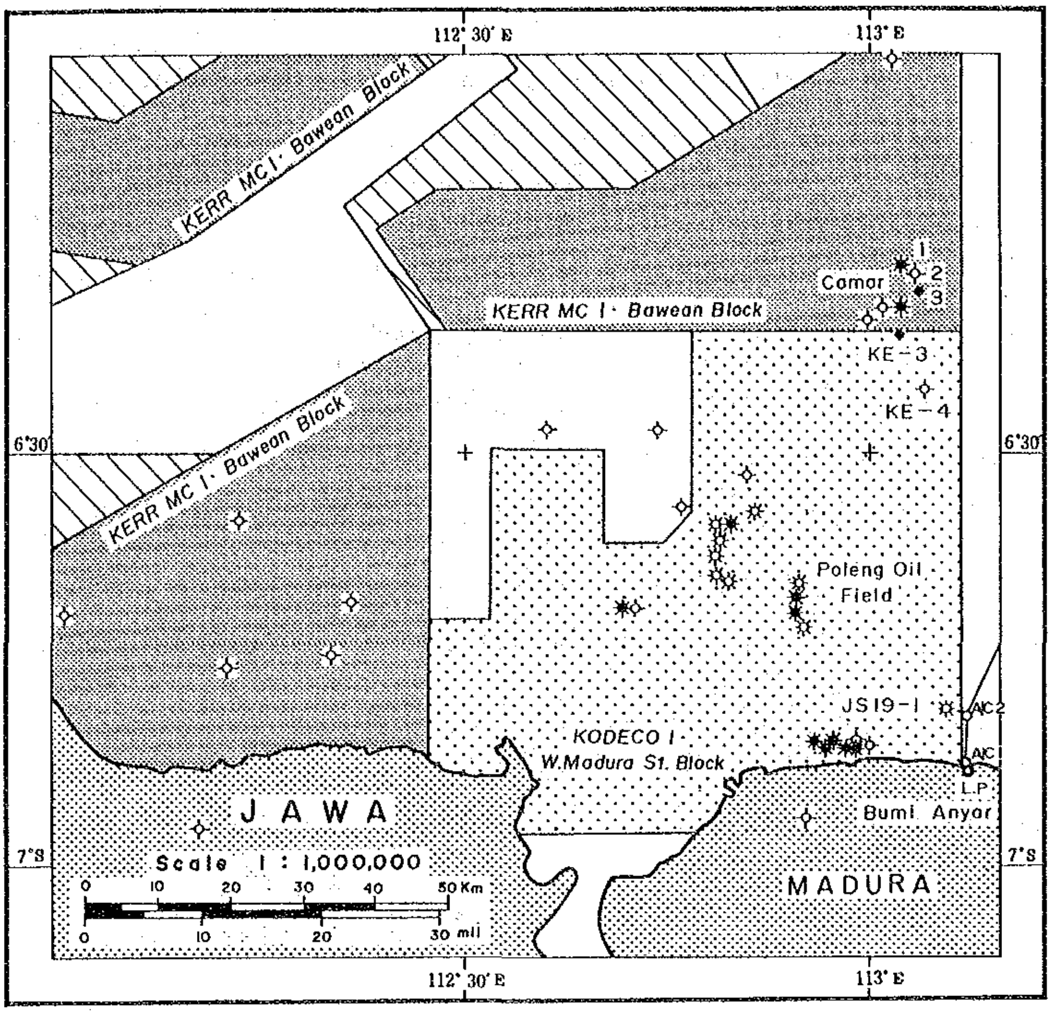


Figure 4-3(1) PETROLEUM ACTIVITIES IN EASTERN JAWA SEA

DETAIL A



DETAIL B

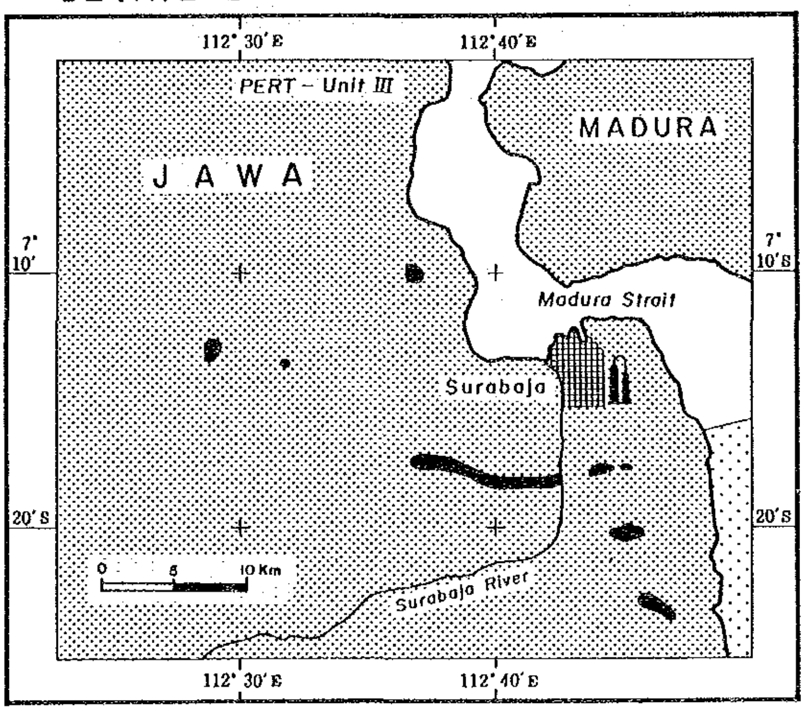


Figure 4-3(2) PETROLEUM ACTIVITIES IN EASTERN JAWA SEA

Table 4-1 List of Well Along Planned Cable Route

Name of Well	Coordinate		Distance	Name of Oil
	Latitude	Longitude	from Route	Company
Tobanio 1	$3^{o}45'11.25''$	$114^{o}22'25''$	10.1 N.M	Ashland
E - 1	$5^{o}15'08.137''$	$113^{o}57'37.806''$	7.2	Ashland
C - 1	$5^{o}16'17.84''$	$113^{o}38'26.27''$	9.8	Ashland
JS 7 - 1A	$5^{o}35'30''$	$113^{o}27'20''$	11.9	ICSI
Beta 1	$5^{o}37'08''$	$113^{o}25'46''$	12.7	Pexamin
Alpha 1	$5^{o}58'03.1''$	$113^{o}42'02.5''$	10.7	Houston Oil
Montor 1	$6^{o}02'02.50''$	$113^{o}11'55.07''$	15.0	Union Oil
JS 18 - 1	$6^{o}11'29.64$	$113^{o}29'35.82''$	5.0	ICSI
Ketapang 1	$6^{o}17'50.89''$	$113^{o}22'50.34''$	1.5	Union Oil
Pasian 1	$6^{o}24'04.449''$	$113^{o}22'30.142''$	3.8	Union Oil
JS 14A - 1	$6^{o}23'04.45''$	$113^{o}17'28.83''$	1.1	ICSI
JS 2 - 1	$6^{o}27'10''$	$113^{o}19'20''$	2.2	ICSI
JS 17 - 1*	$6^{o}39'$	$113^{o}16.5'$	4.4	ICSI
JS 44A - 1	$6^{o}47'44''$	$113^{o}23'12''$	14.3	ICSI
KE - 4	$6^{o}24'41.86''$	$113^{o}04'45.85''$	12.1	KODECO
JS 19 - 1	$6^{o}47'22''$	$113^{o}05'50''$	1.7	ICSI

* : The coordinate of this well is based on the map of "*Petroleum Activity, Indonesia*".

4.5 Cable Landing Point and Submarine Cable Route

4.5.1 Cable Landing Point

Regarding the cable landing point at Surabaya side, 4 points were considered, they are two points in island of Jawa and two points in island of Madura, on the initial stage of project study. However, on the further study of the information collected in the desk work and discussion with Indonesia government concerned, the landing point of Surabaya side was concentrated to the two points of the island of Madura. The field survey for selecting the landing point of Surabaya side was done after the completion of above mentioned study at the northern part coast line of Madura island. The result of the field survey is examined with collected information, then Bumi Anyar Beach was selected as the cable landing point of Surabaya side due to narrow width of dangerous offshore area caused by mines where the cable passes through. In advance of the main ocean survey, in January 1986, detailed field survey was carried out at this beach to select the cable pull in point (landing point) and the east side of sandy beach at Bumi Anyar was finally selected as the cable landing point of Surabaya.

Concerning the cable landing point of Banjarmasin, 3 points (Tanbanio, Takisung and Batakan) were selected on the desk study taking into consideration of the river mouth of Basrito and access road condition, etc. The field survey was done on these points and as the result of survey, Takisung was selected as the cable landing point of Banjarmasin side due to the access road washed out at Tabanio and the difficulty of construction of land line at Batakan. Also detailed field survey was carried out at Takisung beach to select the cable pull in point (landing point), then Takisung was selected as the cable landing point of Banjarmasin.

4.5.2 Submarine Cable Route

As to the submarine cable route connecting Bumi Anyar and Takisung, the route including two alternate was examined on the desk study. the reason of planning this route were as follows:

(1) To avoid the sunked ship which clearly marked on the chart at the offing of Bumi Anyar and also to avoid a small hill on the sea bottom at the offing of Takisung.

(2) To keep the safety of cable against waves and fishing activities for the necessity of laying cable to the deeper sea from the beach in short distance.

After planning the cable route mentioned above, the route was made a small change to add one alternate point at the Bumi Anyar side due to moving the cable pull in point slightly at the beach based on the result of field survey, etc. However, the planned cable route was hardly changed on the results of main ocean survey.
The recommended cable route is shown on Table 4-2 and Fig. 4-4. The distance between both cable landing points is 381.47 km. And details of measurement of ship's position during survey is described on vol. III Result of Ocean Survey.

Table 4-2 Position List on the Proposed Cable Route

Pos.No.	Position		Distance (km)	
L.P,A/C	Latitude(S)	Longitude(E)	Between	Cumulation
Bumi - Anyar L.P	6°-53.64'	113°-07.11'		0
			1.50	
A/C 1	6°-52.89'	113°-06.82'		1.50 (0.81nm)
			7.17	
A/C 2	6°-49.00'	113°-07.00'		8.67 (4.68nm)
			353.52	
A/C 3	3°-54.50'	114°-26.50'		362.19 (195.57nm)
			19.28	
Takisung L.P	3°-52.43'	114°-36.71		381.47 (205.98nm)

* 1 nm is equivalent to 1.852 km.

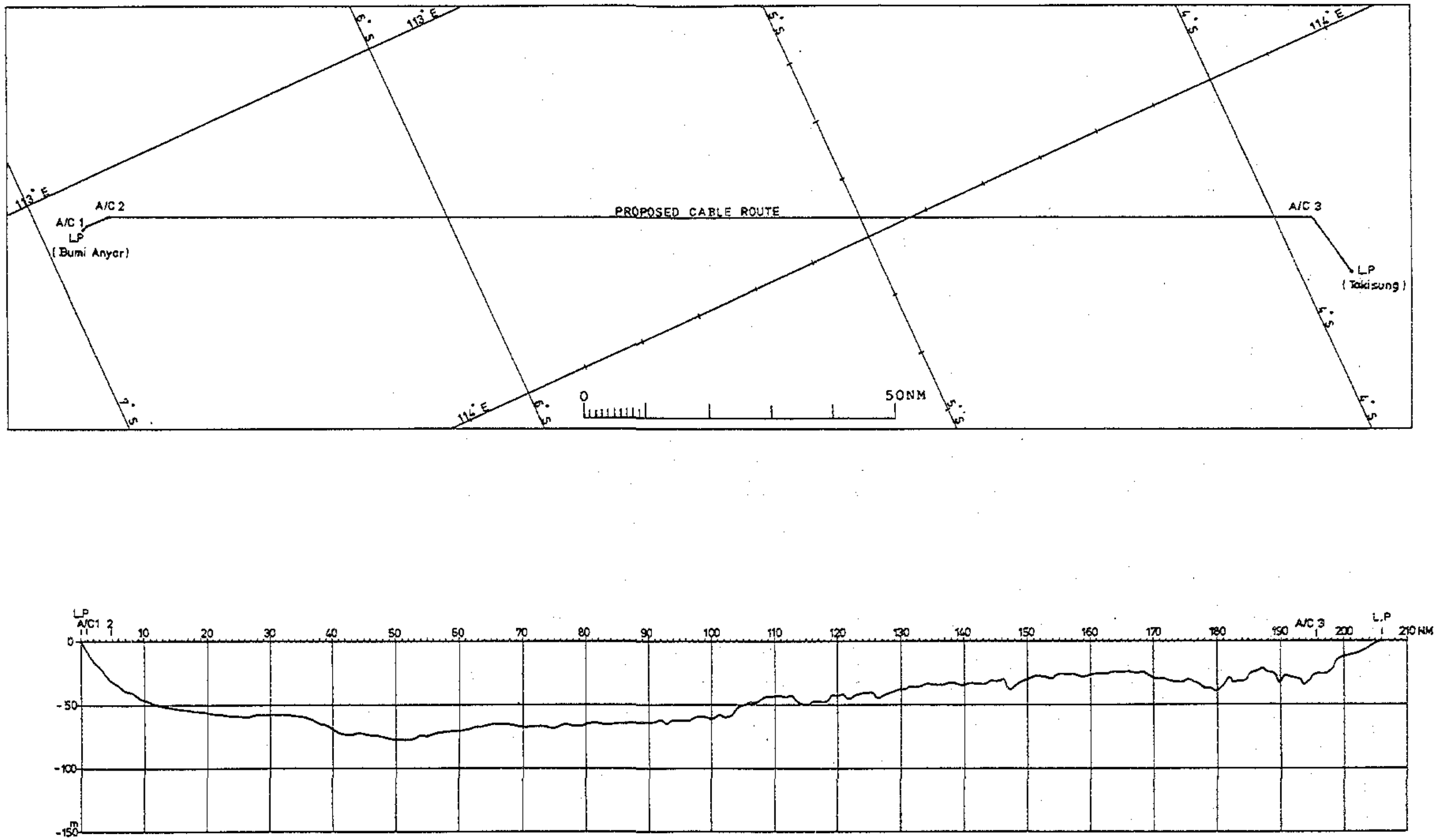


Figure 4-4 BOTTOM PROFILE ALONG THE PROPOSED CABLE ROUTE

4.6 Mine Dangerous Area

The mines were installed during the World War II. Some area beside Mudura Island have not been swept yet. The mine dangerous area is illustrated in Figure 4-5. The magnetic survey was carried out by the Team in the dangerous area concerned.

The magnetic survey was carried out by using magnetic meter towed by tug boat and/or man power in dangerous area along the cable route.

On this survey, several magnetic anomalies were found in this survey area. Most of them were very small like a fragment of steel plate, except three anomalous points which are indicated in Figure 4-6. The anomaly at No. 1 point is equivalent to mine's anomaly (quantity of magnetic charge 25 - 300 gauss cm^2) and the anomalous object is buried at 0.6 - 0.8 m beneath the sea bottom. The other two anomalies (No.2 and No.3) are smaller than mine's anomaly.

The Team recommends that the detected anomaly at No.1 point should further be confirmed whether it is a mine or not before cable construction.

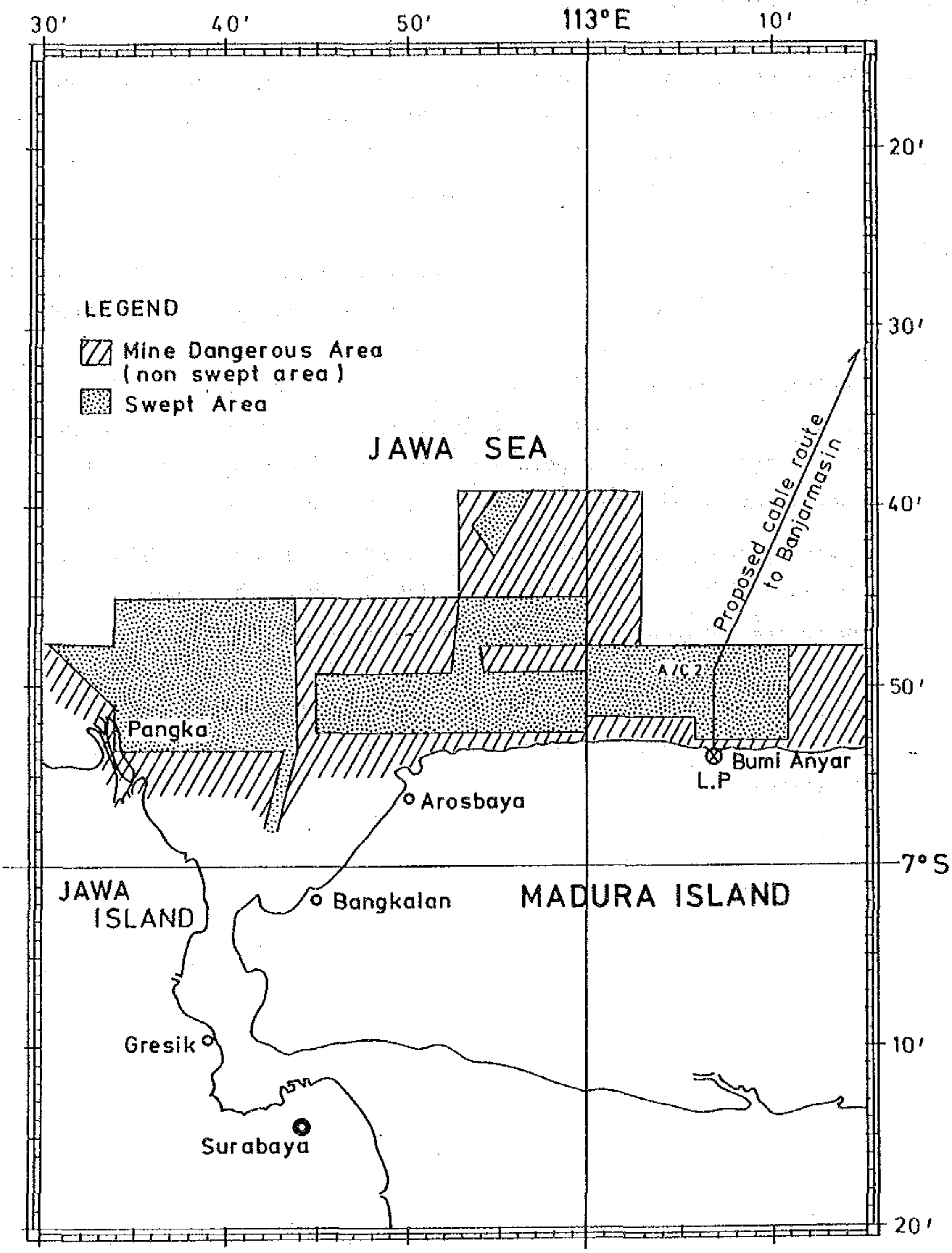
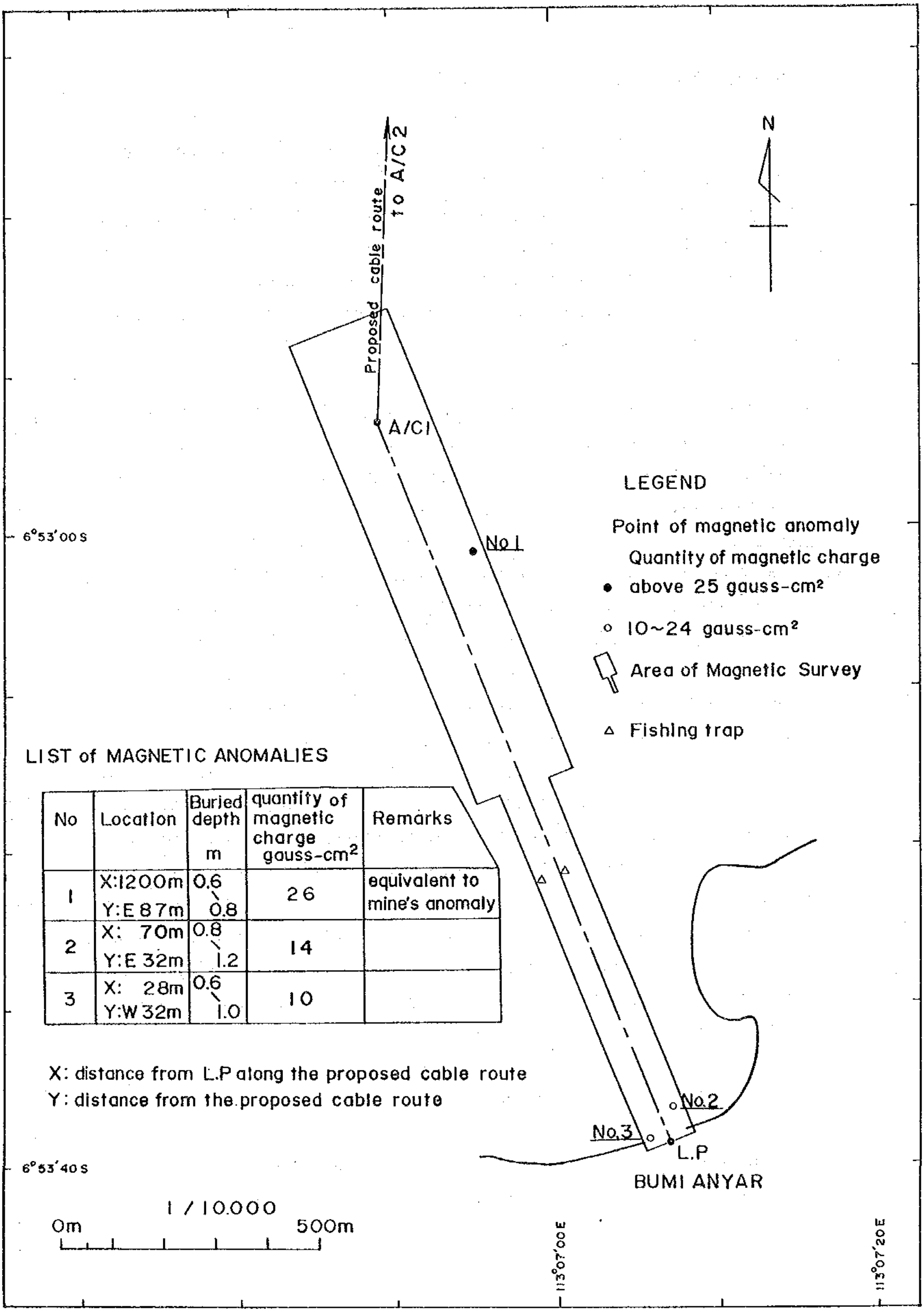


Figure 4-5 MINE DANGEROUS AREA



LIST of MAGNETIC ANOMALIES

No	Location	Buried depth m	quantity of magnetic charge gauss-cm²	Remarks
1	X:1200m Y:E 87m	0.6 ~ 0.8	26	equivalent to mine's anomaly
2	X: 70m Y:E 32m	0.8 ~ 1.2	14	
3	X: 28m Y:W 32m	0.6 ~ 1.0	10	

X: distance from L.P along the proposed cable route
Y: distance from the proposed cable route

Figure 4-6 POSITION of MAGNETIC ANOMALIES

4.7 Submarine Topography and Geology

The seabed near the shore in Bumi Anyar, Madura Island, has a down-slope to the area water depth 40 m, which is located about 15 km away from the shore line. The gradient is about 1/300 - 1/800 along the proposed cable route. From the area whose water depth is 45 m (about 19 km away from the shore line), the seabed becomes flat.
The maximum water depth (77 m) point is located about 95 km away from Madura shore line.

From the point of maximum water depth to the offing of Takisung, Kalimantan Island, the seabed has a gentle upward slope with gradual undulation, the gradient of which is about 1/4,100 on the average (Figure 4-4).

As a result of survey about the bottom samplings, seismic profilings and bottom scannings, the following bottom conditions were found.
The outcrop of old-type reef limestone is recognized on the shore in Bumi Anyar. And also sand and coral reef are recognized on the shore. Mud is mainly distributed beyond the seaward end of coral reef up to the deepest area.

From the area mentioned above to offshore Takisung, the main bottom sediments are muddy sand and mud, etc. It seems that the bottom sediments have a close relationship with the characteristic submarine topography.
In the area offshore Takisung, the bottom materials are mud, sandy mud, muddy sand and pebbly sand. On the shore in Takisung, the outcrops of low-grade metasedimentary rocks are recognized. And also sand is recognized on the shore.

The sea bottom along the proposed cable route is almost covered with soft sediments and the thickness of sediments is roughly about 1-4 m. The thickness decreases, less than 1 m, in some places, where the compact white clay layer exists beneath the sedimentary layer.

Many dimples are found on the sea bottom along the proposed cable route except the coastal area. Most of dimples is less than 50 x 50 m in size and less than 1 m in depth.
Those appear to have been eruptions by gas from the seabed.
In the area about 90 km away from the shore line of Takisung, sand Waves are found. The direction of sand wave's elongation is roughly N-S. The wavelength of sand waves are roughly 30-50 m and the waveheight is several tens cm.

4.8 Currents and Water Temperatures

Continuous current observations were carried out at both Coastal Areas for about 3 days, respectively and instantaneous observations were carried out at 11 stations in the Ocean Area. The following are results of the current observation at Coastal and Ocean Areas in NW-monsoon.
Judging from Table 4-3, current velocities at the sea surface (5 m below sea surface) are stronger than at the bottom (Coastal Area: 1 m above seabed, Ocean Area: 3 m above seabed) through the Coastal and the Ocean Area. Max. velocity at the sea surface was 1.5 knots at Bumi Anyar, 0.9 knots at Takisung and 1.3 knots in the Ocean Area, respectively. And also Max. velocity at the bottom was 0.8 knots through the Coastal and the Ocean Areas.

The current directions at the sea surface were eastward at the Coastal Area of Bumi Anyar and in the Ocean Area. At the Coastal Area of Takisung, southward and northward currents appeared with excess frequencies.

Appeared current directions at the bottom do not agree with the corresponding sea surface current direction at each station. And periodical tendencies appeared on the current direction or the variation of current velocity at each station. These are considered that the currents are affected by the tidal stream.

Table 4-3 Result of Current Observation

		Max.Velocity (knots)	Mean Velocity (knots)	Frequency of Direction
Coastal Area	Surface	1.5	0.8	E'ly (NE-SE) 100%
Bumi-Anyar (St, A-1)	Bottom	0.7	0.3	N'ly (NW-NE) 1.2% E'ly (NE-SE) 64.5% S'ly (SE-SW) 15.7% W'ly (SW-NW) 18.6%
Takisung (St.B-1)	Surface	0.9	0.5	N'ly (NW-NE) 43.2% E'ly (NE-SE) 16.3% S'ly (SE-SW) 33.5% W'ly (SW-NW) 7.0%
	Bottom	0.8	0.3	N'ly (NW-NE) 55.0% E'ly (NE-SE) 8.0% S'ly (SE-SW) 29.7% W'ly (SW-NW) 7.3%
	Surface	1.3	0.7	E'ly (NE-SE) 100%
Ocean Area (St. O-2 and O-4 to 13)	Bottom	0.5	0.3	N'ly (NW-NE) 27.3% E'ly (NE-SE) 27.3% S'ly (SE-SW) 18.2% W'ly (SW-NW) 27.2%

Water thermometries were carried out at each 5 stations at both Coastal Areas and 11 stations in Ocean Area and following were found.

Coastal

Bumi Anyar

Water temperatures were Max. 28.4°C and Min. 27.8°C at the sea surface (0.5 m below sea surface) and Max. 28.1°C and Min. 27.3°C at the bottom (1 m above seabed). The vertical variation of water temperature at each station went down with a little variation form sea surface to bottom. The range of variation between sea surface and bottom was Max. 1.1°C.

Takisung

Water temperatures were Max. 28.9°C and Min. 28.6°C at the sea surface, and Max. 28.8°C and Min. 28.6°C at the bottom. The vertical variation at each station was very small, i.e., within 0.3°C.

Ocean Area

Water temperatures were Max. 28.8°C and Min. 27.7°C at the sea surface, and Max. 28.6°C and Min. 27.0°C at the bottom. The vertical variation of water temperature at each station went down with a little variation from sea surface to bottom within 0.9°C. This maximum range appeared at Loc. 0-4 (water depth 37 m)

Judging from above-mentioned data, the normal conditions were found on the water temperature at the Coastal and Ocean Area.

4.9 Quantity and Type of Recommended Cables

4.9.1 Quantity of Recommended Cables

The distance between both landing points along the selected cable route is 381.47 km, and the cable length is 387.2 km with the necessary cable slack of 1.5 percent (%). Further, assuming that the cable length from the respective landing points to the landing station is 500 m, the overall cable length is 388.2 km. The final cable length is subject to change due to the installation plan and the system design.

4.9.2 Type of Recommended Cable

The type of cable is recommended based on the result of ocean survey as follows:

It is recommended for the land section to use the single armoured cable with direct burying in order to protect the cable from a trouble caused by human activities. Further, in case of that the cable crosses a road, a conduit should be installed under the road to protect the cable. It is recommended for the very shallow water section (less than 10 m in water depth) to use the double armoured cable with direct burying to protect the cable from a trouble caused by waves and human activities, in principle. However, it is desirable to very the double armoured cable by using water jet type burier, or not to bury it in the both of non-swept area and swept area at the coastal area of Bumi Anyar.

It is recommended for the shallow water section (more than 10 m in water depth) to bury the cable in order to protect the cable from a trouble caused by the fishing activities and the natural obstructions. Furthermore, it is recommended to employ the single armoured cable, considering to make perfection more perfect for the cable protection and to handle the cable on the cable laying.

4.10 Recommendations Concerning Submarine Cable System Installation

4.10.1 *Work at Landing Point and at Very Shallow Water Section*

The front sea area of both landing points is very shallow. So that, the approach of a cable ship to the very shallow water area is limited by the draft of the ship. Therefore, it is recommended that the cable laying works from the beach to the point where the cable ship comes in shall be done by using a flat bottom boat.
Also, the transparency of this area is very poor. Therefore it is recommended to carry out cable laying and burying work simultaneously.

4.10.2 Laying Work at Ocean Section

The transparency of the whole Jawa Sea is so poor that the cable burying after laying is impossible. It is therefore recommended to carry out cable laying and burying work simultaneously.

4.10.3 Land Mark Installation

In order to protect the cable from a trouble caused by the fishing activities and the anchoring of vessels, etc., it is recommended to install a land mark for indicating the laid cable route to fishing boats and sailing vessels.

4.10.4 Enactment of a New Law for Protection of Cable

A new law acting for the prohibition of the fishing activities and the ship's anchoring on the cable laid ground shall be enacted for the protection of cable, if possible.

CHAPTER 5 INSTALLATION MASTER PLAN

CHAPTER 5 INSTALLATION MASTER PLAN

5.1. Submarine Cable System Design Period and Investment Plan

5.1.1 Design Period

The common practice in submarine cable system construction is to forecast demand in the final year of system life and install at initial stage the number of circuits which are absolutely required.

Circumstances that necessitate such practice are as under.

In many cases, submarine cable system is a part of international communication network or laid on a very deep sea bottom or an extensive sea bed. Therefore,

(1) Construction/installation is financed jointly by all countries to utilize the system, based on an agreement among those countries, and each country gets its circuit requirement allocated. Cost of surplus circuits after allocations, if any, is to be borne by the countries where the cable landing point is located. Hence the installation of necessary minimum number of circuits.

(2) Construction/installation work is extremely difficult because the cable line generally traverse sea-channel several thousand meters deep or extends for a long distance of several thousand km. Naturally, the work requires high cost and takes much time. Hence the execution by forecasted circuit requirements as of the year of final system life.

(3) Depending upon diplomatic relations between/among participating countries, such case may arise wherein the environment to allow system expansion in the intermediate period cannot be obtained.

The projected Surabaya-Banjarmasin submarine cable system requires a large number of circuits from the initial stage as stated in CHAPTER 3. Therefore, considering that the service life of submarine cable is 25 years, the initial stage system capacity is to be designed to meet estimated demand 25 years after service-in (i.e., 2014).

5.1.2 Investment Planning

The Surabaya-Banjarmasin submarine cable system project constitutes Kalimantan-Jawa transmission system expansion plan as an integral part of all-Kalimantan communication facilities improvement plan in Kalimantan and other island concerned to be completed in 2014.
The prime requisite for economical investment plan to finance the projected submarine cable system is that the construction/ installation commensurate with long term demand forecast for communication services in the whole of Kalimantan is worthwhile to execute in a real sense from the national viewpoint of Indonesia and the financial standpoint of PERUMTEL as responsible party for project implementation.

Thus, for up-to-date facilities installation plans of various kinds which can be realized with technologies available at the present stage, full study must be made in both economic and financial aspects.

Following is a comparative study of technically possible alternative plans for 2 x 140 Mbit/s system which PERUMTEL intends to realize for the projected Surabaya-Banjarmasin submarine cable system.

To comparative study is made in initial investment ratios, assuming that 1 x 280 Mbit/s system is the sole technically feasible alternative plan. This is because at the present inceptive stage of study, traffic distribution between the existing domestic satellite communication system and the projected submarine cable system remains indistinct and because the degree of traffic inflow from Sulawesi cannot be correctly known.

When the initial investment ratio of 1 x 140 Mbit/s system is set at 100, initial investment ratios of 2 x 140 Mbit/s system (original plan) and 1 x 280 Mbit/s system (alternative plan) become 113 (13% up) and 106.5 (6.5% up), respectively.

In the projected submarine cable system, service revenue remains definite so that alternative plan where cost level is low is judged to be a preferable plan. For two alternative plans, in-depth analysis by comparison from economic viewpoint whereby to select optimum investment plan is made in CHAPTER 8.

Schematic Cost Comparison

Plan	Traffic Carrying Capacity	Cost Weighted	Increment Ratio
-	1 x 140 Mbit/s	100	-
Original	2 x 140 Mbit/s	113	13%
Alternative	1 x 280 Mbit/s	106.5	6.5%

5.2 Adoption of Digital System

Adoption of digital system complies with Year 2000 Indonesia Telecommunications Plan, wherein 100% attainment of network digitalization throughout the country is one of objectives. This is why digital system is to be adopted on full scale in the projected Surabaya-Banjarmasin submarine cable system.

Digital system adoption brings about these technical advantages:

1) By means of self-check function, etc., highly reliable system configuration can be realized.

2) The whole network transmission loss can be reduced so that transmission performance can be improved. Furthermore, since

surplus transmission loss can be distributed to subscriber network, exchange area expansion is possible.

3) Introduction of new services based on data processing, e.g., high speed date transmission and high speed facsimile and video transmission between computer systems, becomes possible. By means of combination of such new services, new public telecommunications services of various kinds can be realized. Those new services include conference telephone service, high speed news transmission service, air carrier/train seat and hotel room reservation service, data bank service, computer communication service, and video communication service.

4) By reasons of reliability enhancement of the whole system, as well as availability of operation program controlled self-diagnosis system and trouble-shooting system, manpower cost and supplies cost required for system operation can be curtailed. This fact makes it possible to retrench operation cast of the whole system.

5) Equipment size becomes small so that floor space required for equipment installation can be reduced.

The common practice in submarine cable installation is to install at the initial stage the number of circuits required as of the time the economic life of system terminates, in consideration of technical difficulty of installation, financial investment efficiency and so forth.

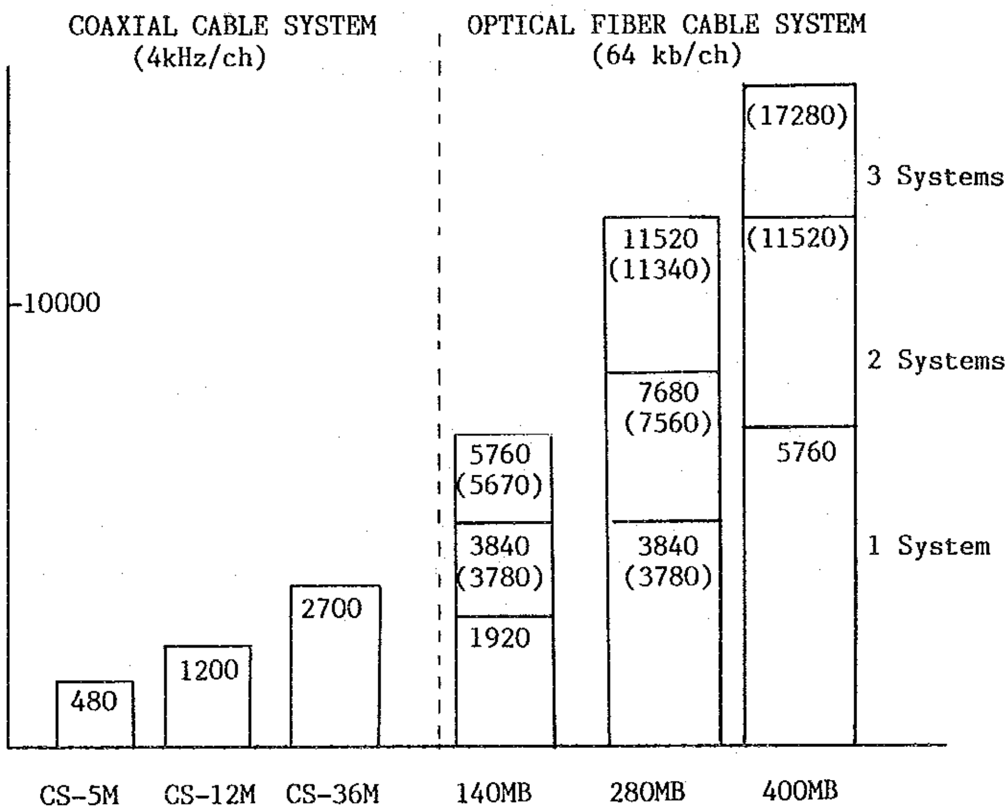
5.3 Submarine Cable System Selection

5.3.1 Optical Fiber Cable

In the past, for submarine cable system, coaxial cable was mainly used. However, in view of necessity for high speed digital transmission and large transmission channel capacity and as a result of remarkable technological advancement achieved recently, optical fiber cable has come to be used for submarine cable.

Figure 5-1 presents channel capacity and system performance relationships.

In the projected Surabaya-Banjarmasin submarine cable system also, optical fiber cable is to be adopted.



Note: Numbers in ( ) are for Non-CEPT Hierarchy.

Figure 5-1 Channel Capacity for Each System

5.3.2 System Selection

1) System Parameters

As of the present, types of submarine cable systems wherein optical fiber cable is used are threefold. They are 140 Mbit/s system, 280 Mbit/s system and 400 Mbit/s system.

Generally, 140 Mbit/s system and 280 Mbit/s system are designed for long distance, ocean traversing international route. 400 Mbit/s system is mainly designed for medium distance domestic system which requires large capacity.

Table 5-1 presents major system parameters of the three optical fiber cable systems.

2) System Study

The cable portion of the projected Surabaya-Banjarmasin submarine cable system extends about 388.2 km. This distance is relatively short for submarine cable system. Therefore, 400 Mbit/s system is applicable. However, as shown in Figure 3-9 of CHAPTER 3, circuit requirements (3,770 CH) remain short of one 400 Mbit/s system capacity (5,760 CH) even after the economic system life (up to 2014). Hence no consideration of 400 Mbit/s system, this time.

The fact that circuit requirements are 3,066 CH signifies that 2 x 140 Mbit/s system or 1 x 280 Mbit/s system is sufficient.

5.4 Backhaul System Selection

Trunk connection routes from Surabaya II toll exchange to submarine cable landing point on Madura Island (Kecamatan: Tanjungbum, Desa:

Bumi Anyar) and from Banjarmasin toll exchange to cable landing point in Kalimantan (Desa: Takisung) are called backhaul systems.

For both routes, digital microwave radio system is to be adopted from the following reasons:

1) Adoption of digital system is necessary for adapting future digitalization of whole national transmission network.

2) Use of radio system is desirous to avoid failures caused by road work, ground sinking, traffic accident, etc. to be encountered in the case of cable backhaul system and obviate additional submarine cable in a strait between Madura island and Jawa island.

For the backhaul system, use of upper 6 GHz band is preferred if no advance interference to/from the the second Jawa-Bali microwave system with associated "ring belt system" is present, however, if any harmful interference is expected, use of another frequency band such as 5GHz, 11GHz, etc. should be considered. Selection of a suitable radio frequency band for the backhaul microwave system should be finalized in detailed design.

Comparison of various radio frequency bands is given in Table 38 of Volume II.

Table 5-1 Optical Fiber Cable System Parameter

SYSTEM DESCRIPTION	140 Mbit/s	280 Mbit/s	400 Mbit/s
Line Bit-Rate (MBPS)	147.42 Mbit/s	295.6 Mbit/s	445.837 Mbit/s
Channel Capacity (64kb/ch)	1920/1890 *	3840/3780 *	5760/sub-sys.
Number of Sub-Systems		Max. 3	
Max. System Length (km)	8000 km		1000 km
Wavelength		1.3 um	
Repeater Spacing	60 km	50 km	40 km
Light Source		InGaAsP DC PBH LD	
Light Detector		Ge-APD	
Line Code	24 B1P		10 B1C
Power Feeding Current	1.6 A		1.8 A

* Non CEPT/HYBRID Hierarchy

CHAPTER 6 OUTLINE OF SYSTEM

CHAPTER 6 OUTLINE OF SYSTEM

6.1 Overall View

Overall view of the projected Surabaya-Banjarmasin submarine cable system is in Figure S-1.

The projected system consists of land section and ocean section. The land section covers backhaul system extending from Surabaya or Banjarmasin trunk exchange to submarine cable landing point. the ocean section comprises the main part of submarine cable system.

System capacity in terms of telephone circuits is 3,840 CH at a maximum (in CEPT/HYBRID hierarchy).

The backhaul system and submarine cable system interface is by 139,264 Kbit/s as recommended in CCITT Rec. G703.

The whole system constitutes a backbone telecommunication network between Jawa and Kalimantan islands. As such, it is to transmit telephone, telex, new service and TV (emergency) traffic between the two islands. In the future, Sulawesi Island, Halmahera Island, Maluku Island and Irian Jaya are to be connected to Kalimantan by another submarine cable system so that part Sulawesi telecommunication traffic is also to be carried by the submarine cable system projected this time.

6.2 Optical Fiber Submarine Cable System

Optical fiber submarine cable structure is in Figure S-2. This system is composed of the optical fiber submarine cable, submersible repeaters, and terminal equipment plus power supply equipment installed in terminal station at each cable landing point.

In the submarine cable system projected, cable installation area is divided into three sections. They are:

(1) Land section: From cable landing point to terminal station.

(2) Very shallow sea section: From cable landing point to sea area with about 10 m depth.

(3) Shallow sea section: Sea area deeper than 10 m to 100 m.

6.2.1 Cable Installation Method

(1) Land section (from terminal station to cable landing point)

To protect cable from artificial hazards, direct burying of single armored cable at both sides is recommended.

(2) Very shallow sea section (from cable landing point to sea area with 10 m depth)

To protect cable from artificial hazards and damage by waves, adoption of buried double armored cable is recommended. On beach and surfzone, the cable is to be buried as deeply as possible so as not to be moved or damaged.

(3) Shallow sea section (deeper than 10 m)

Generally, in shallow sea section, cable is protected by appropriate method from damage due to fishery activities, mainly trawl fishery, and anchor casting. Desirable cable protection method is to bury cable. Although the trawl fishery is prohibited and small-scale fishing activities are allowed to be conducted around islands, it is confirmed, in this study, that there are fishing activities by small boats which is likely to cause cable failures, if non-protection were applied.

Considering this fact, burying of single armed cable is recommendable in their area. However, considering the fact as stated in Chapter 4.5 in the very shallow and shallow sea area, it is recommendable that the cable protection method in the danger area and swept area off Bumi Anyar shall be chosen at most care such as jet buring of the cable or unburied double armored cable usage.

6.2.2 Required Cable Length

The total route distance between both landing points amounts 381.47 km. Cable slack of 1.5% would be required for laying cable along the recommended route. Therefore, the required cable length along the recommended route including both land cables length is 388.2 km. Proposed cable route is shown in Figure S-3.

6.2.3 Submarine Cable System Parameters

Submarine cable system parameters are as under.

(1) Line bit rate: 295.6 Mbit/s
(2) Channel capacity: 3,840/3,780 *
(* : By Non CEPT/HYBRID hierarchy)
(3) Wavelength: 1.3 um
(4) Repeater spacing: 50 km
(5) Mode: Single mode
(6) Light source: Laser diode
(7) Light discrimination: APD (avalanche photo diode)
(8) Cable length: 388.2 km
(9) No. of repeaters: 8
(10) Repeater monitoring system: Loopback monitoring system
(11) Current supply: 1.6 A by copper tube
(12) Electric signal interface: 139.214 Mbit/s, based on CCITT Rec. G703
(13) Mean bit error rate: Better than 1×10^{-8}

6.2.4 Cable Route Safety Check

The sea area where the projected submarine cable system is to be constructed has not been completely cleared of mines laid during World War II. Since the cable system is to traverse such sea area, this study carried out magnetic survey in the unswept area to examine whether the sea area was still polluted with mines or allied dangerous property, or not. Study finding is only one magnetic anomalous point in the limited survey area.

In consideration of possible cable route error due to shipping route error, magnetic survey error, and so forth, recommendation is made for execution of magnetic survey once again to make sure of cable route safety, prior to cable system construction work.

6.3 Digital Microwave Radio System

Digital microwave radio system as backhaul system of the projected submarine cable system is schematically introduced in Figure S-1.

6.3.1 Route Selection

Route selection for backhaul system from submarine cable landing point to Surabaya/Banjarmasin trunk exchange must be free from technical difficulty and at least possible cost.

Routes conceivable under such conditions are as under.

- Surabaya side: As in Plan A, Plan B and Plan C shown in Figure 6-1.
- Banjarmasin side: As in Plan A and Plan B shown in Figure 6-2.

In-depth description follows:

- Surabaya side:

  Plan A: Surabaya $\xrightarrow{(M/W)}$ Sandangan $\xrightarrow{(M/W)}$ Murbulangan $\xrightarrow{(M/W)}$

Bumi Anyar (cable landing point)

Note: M/W denotes microwave radio system.
Surabaya and Sandangan are existing radio stations.
Murbulangan and Bumi Anyar are existing radio stations to be newly established.

Plan B: Surabaya —(M/W)— Gresik —(M/W)— Bangkalan —(M.W)— Pudjung —(M/W)— Bumi Anyar

Note: Surabaya, Gresik and Bangkalan are existing radio stations.
Pudjung and Bumi Anyar are radio stations to be newly established.

Plan C: Same route as in Plan A. Submarine cable to connect Murbulangan and Bumi Anyar. Bumi Anyar radio station is omitted.

- Banjarmasin side:

Plan A: Takisung cable landing point —(M/W)— Karamaian —(M/W)— Banjarmasin

Note: Banjarmasin and Karamaian are existing radio stations.
Takisung radio station is to be newly established.

Plan B: Takisung —(M/W)— Banjarmasin

For both Surabaya side and Banjarmasin side, Plan A route is recommended. This is the result of in-depth technical and economic comparison of proposed routes.

Comparison results for all proposed plans appear in ANNEX-2.

6.3.2 Microwave Radio system Parameters

Microwave radio system parameters are as under.

(1) Frequency band: 6,430 - 7,110 MHz (CCIR Rec. 384-3), or 4,400 - 5,000 MHz

(2) Transmission capacity: 140 Mbit/s (equivalent to 1,920 telephone CH)

(3) No. of radio channels: 2 + 1
(2 working channels and 1 standby channel, but 1+1 initially)

(4) Repeater system: Regenerative repeater system

(5) Modulation system: 16 QAM system

(6) Baseband interface: 139.264 MB (CCITT Rec. G703)

(7) Bit error rate: To satisfy CCIR Rec. 594 standard.

(8) Supervisory and control equipment:
1) Order wire
2) Remote supervision and control
3) Automatic channel changeover

6.4 Other Equipment

6.4.1 Power Supply Equipment

At Bumi Anyar (Surabaya side) and Takisung (Banjarmasin side) cable landing points and at intermediate repeater station (Murbulangan) to be newly established on Madura island, commercial power supply is unavailable so that diesel engine generator system is to be introduced. At both cable landing points, power supply to submersible repeaters installed at sea bottom is necessary so that engine generators of large capacity (30 kVA) are required. To be used are triple diesel engine generators (two working units for alternate operation plus one standby unit).

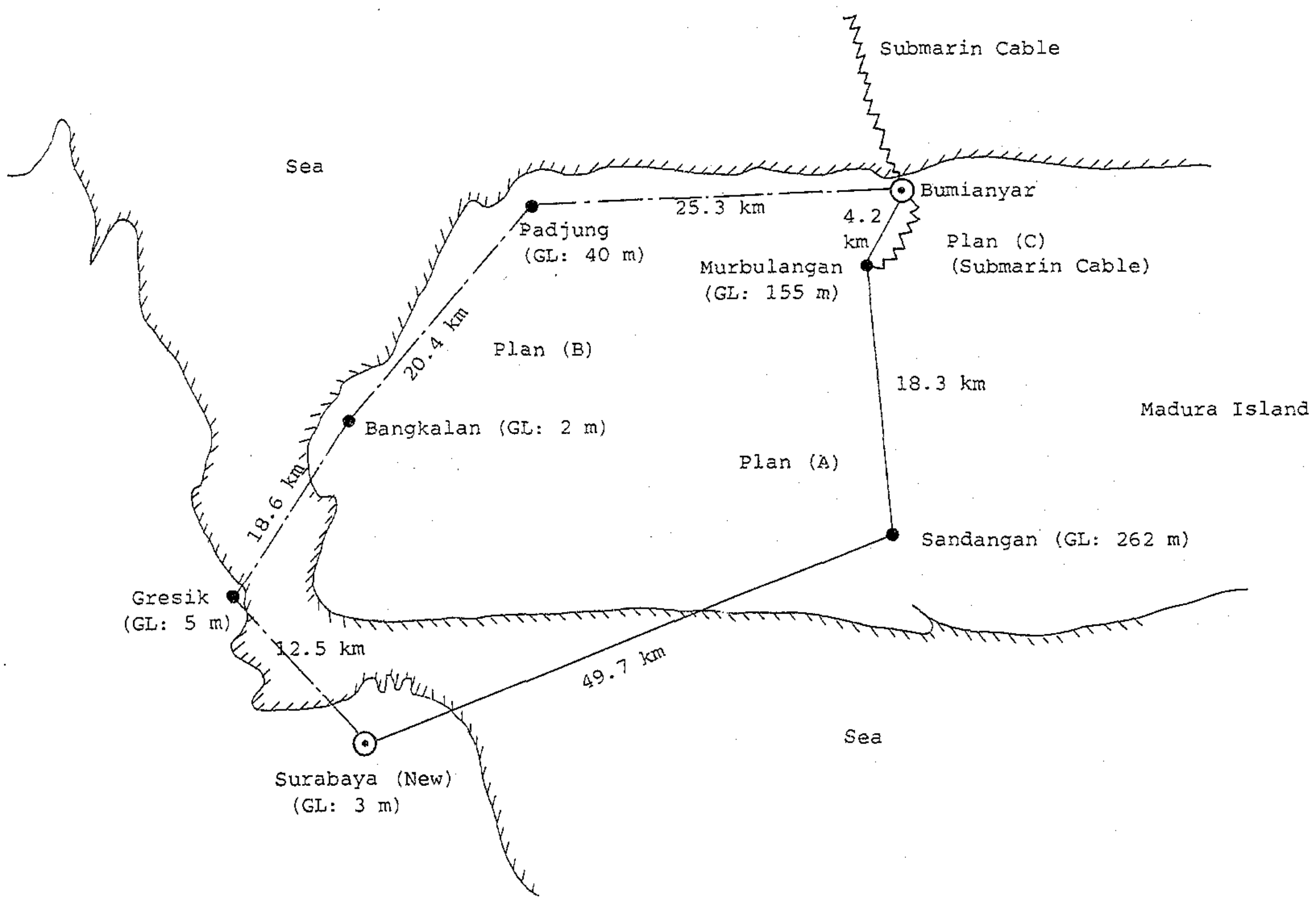


Figure 6-1 Microwave Radio Route (SurabayaSide)

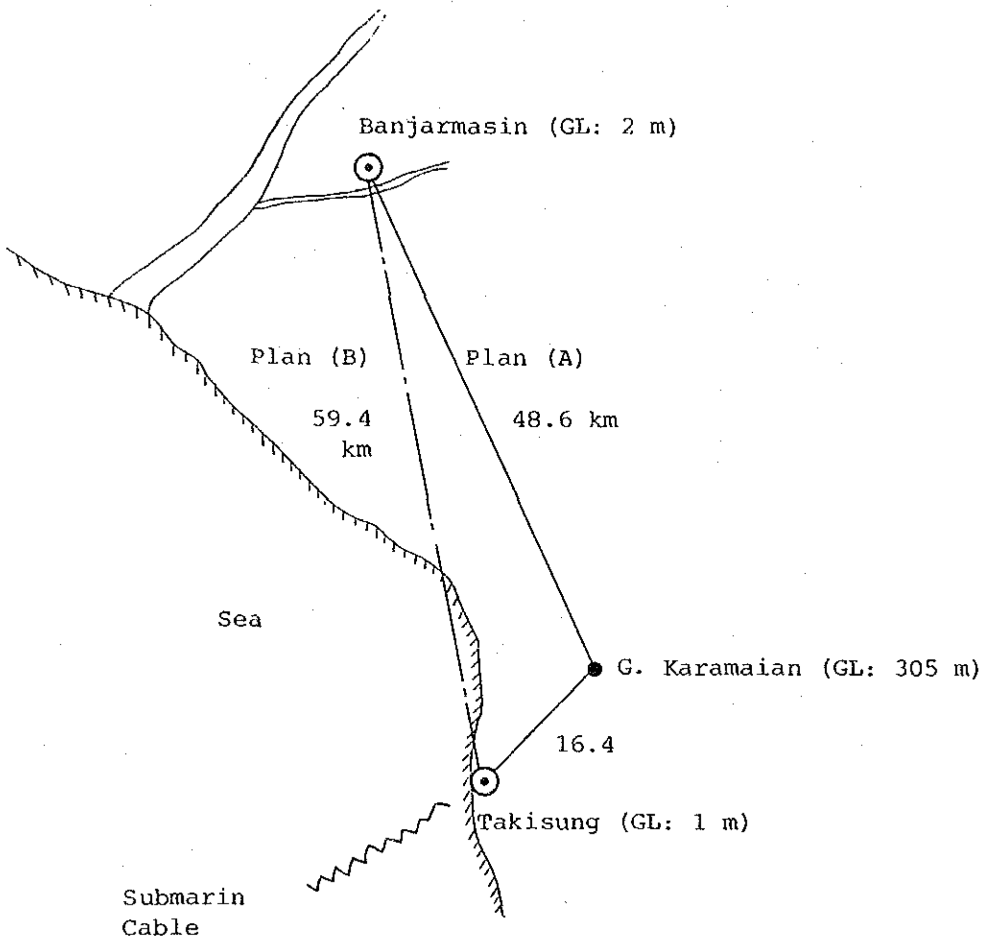


Figure 6-2 Microwave Radio Route (Banjarmasin Side)

At Murbulangan intermediate repeater station where current consumptions limited, triple engine generator of small capacity (10 kVA) are to be installed.

6.4.2 Buildings and Site Lands

For station building construction and site land procurement, PERUMTEL is to assume all responsibilities.

Locations where station are to be newly established, as well as required site land area and building floor space, are shown below. Space for office is not included in these figures.

	Station Building	Site Land	Access Road
Bumi Anyar	129 m^2 (25 m)	1200 m^2	Not necessary
Murbulangan (to be shelter type)	24 m^2 (9 m)	300 m^2	Ground leveling for about 50 m is necessary.
Takisung	129 m^2 (25 m)	1200 m^2	Not necessary

( ) shows space for Engine-generator and Batteries.

At Bumi Anyar and takisung cable landing points, buildings are to be constructed in coast area so that high floor level is essential to prevent damage due to sprays from rough seas or tidal waves. Tide fences must also be provided.

6.4.3 Ocean Earthing

Digital microwave radio system requires earthing. For submarine cable system which supplies large current to intermediate repeaters, precision earthing arrangement is especially important. For this reason, earthing system is to be provided at both cable landing points. For the purpose of cable protection, it is recommended that the earth cable is buried underground as well as land cable.

6.4.4 Slacking

At submarine cable landing points, spare cable is to be buried in station site land so that it can be used for repairs when cable faults, with in a few km from cable landing point, take place. This work is called slacking.

Station site land where spare cable is kept buried is to be without permanent structures so that buried cable can be recovered whenever necessary.