using the calculated water stage (H_0) and the measured water stage (Q_0), so that

$$Q_0 = AH^2 + BH + C$$

the discharge can be obtained by the least square method according to the model formula.

7-3 Camaligan point

The same method is taken as in the Ombao Point.

$$H_c = H_0 + b$$

Where H_c: Camaligan Point Water Stage (m)

H_0: Ombao Point Water Stage in respect to Travelling Time (m)

7-4 Sipocot Point

The tank model method is taken. The average rainfall is the arithmetic mean of Napolidan rainfall (R_1) and Sipocot rainfall (R_2).

$$R = \frac{R_1 + R_2}{2}$$

8. Verification of the Flood Forecasting Model

8-1 Storm Surge at Barongay Point

(1) Meteorological data during typhoons

Data on wind velocity and atmospheric pressure during disastrous typhoons at Daet point are recorded.

(2) Tide level deviation

The deviation is inferred from the astronomical tide at Legaspi Port and the daily water stage at Barongay point. Fig.5-15-shows the relationship among wind velocity, atmospheric pressure and the tide deviation. The relationship can be recognized to a certain extent. Since the data compared are collected on a daily basis, a quantitative analysis is not done. Thereafter, with the establishment of a telemetering station at Barongay point, data can be obtained on a hourly basis, and detailed examination of data accumulated on an hourly basis will become necessary.

Fig5-14-1 WIND VELOCITY, ATMOSPHERIC PRESSURE AND WATER STAGE

Barongay (1)

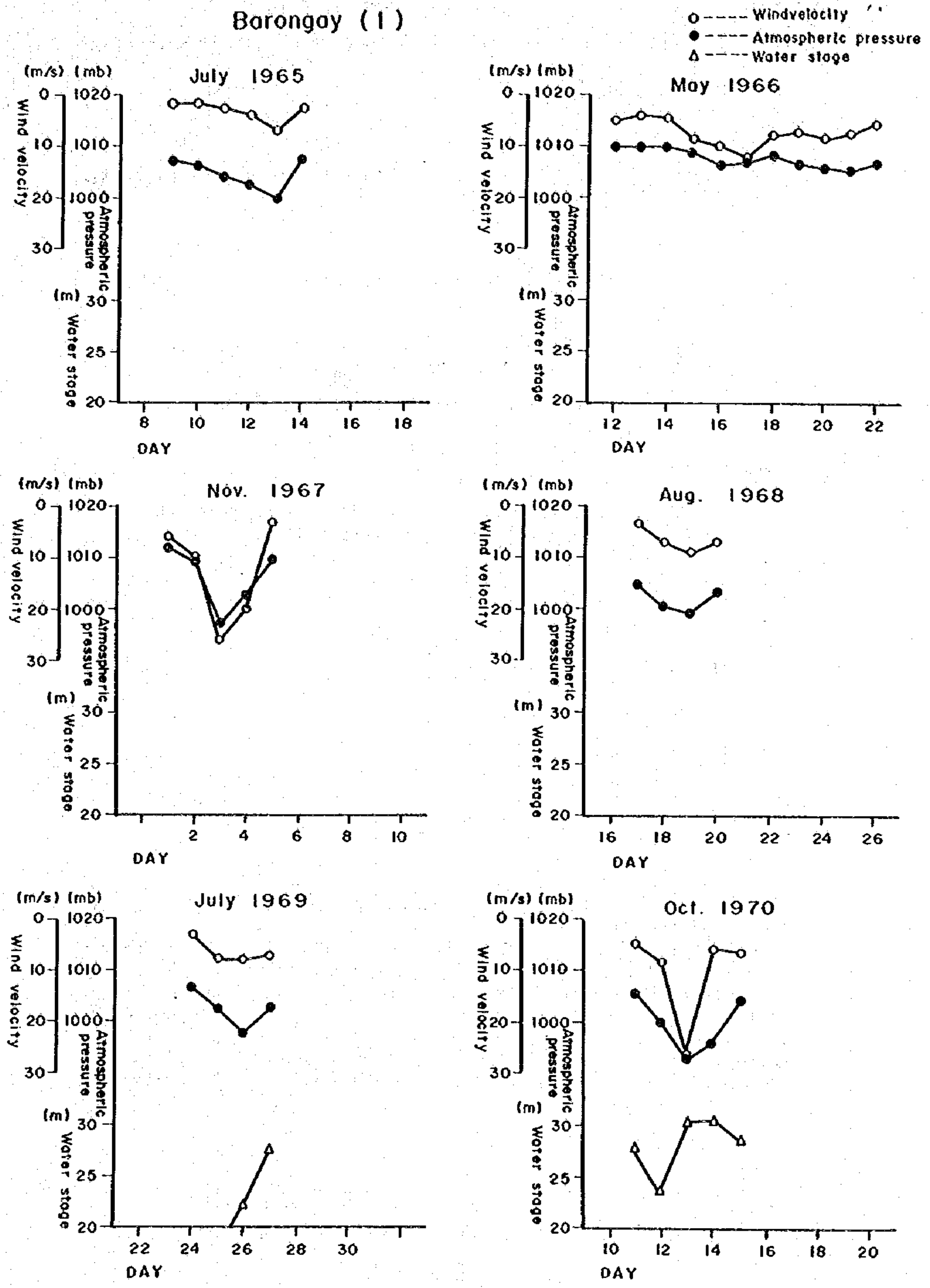


Fig.5-14-2 WIND VELOCITY, ATMOSPHERIC PRESSURE AND WATER STAGE
Borongay (2)

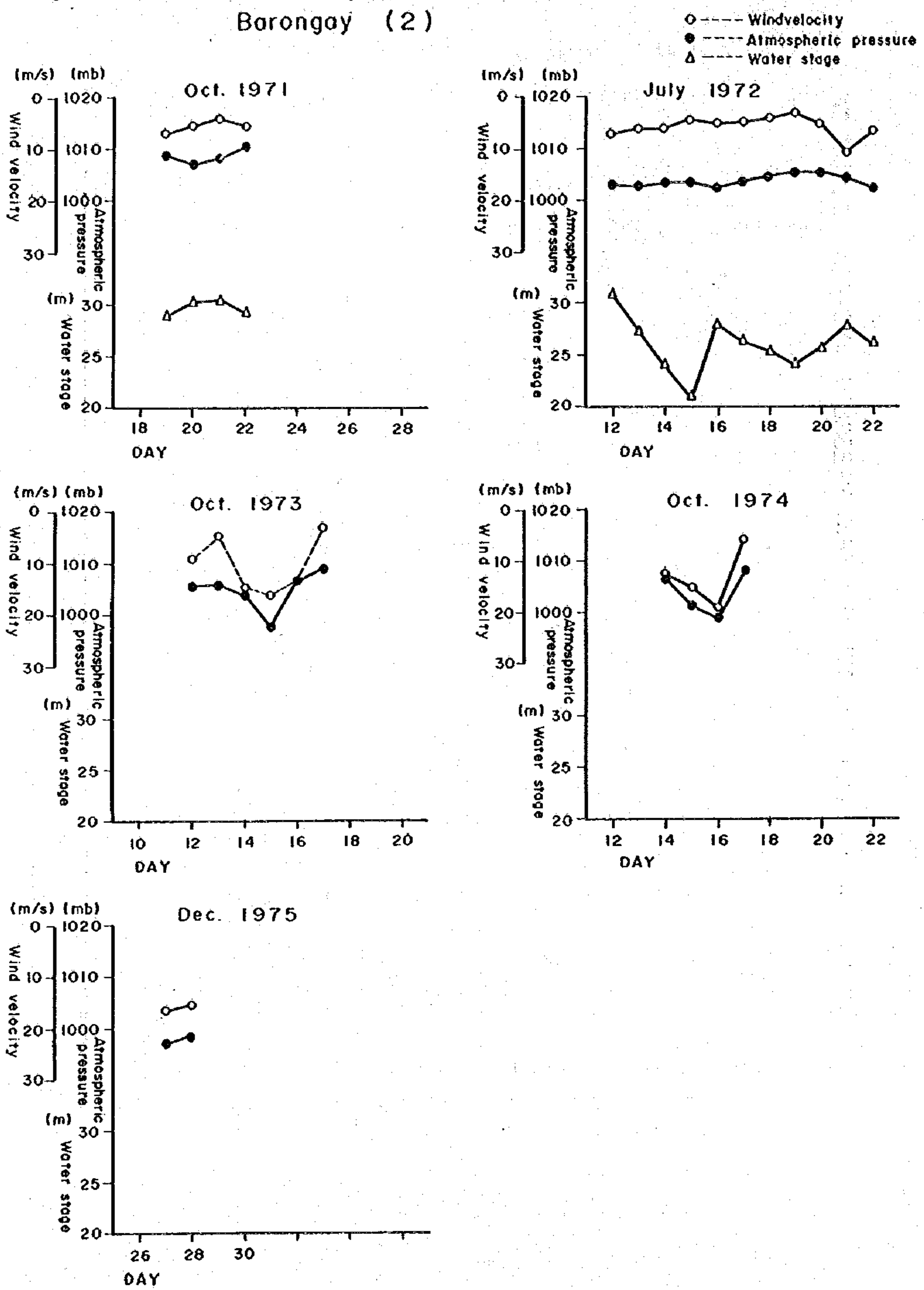
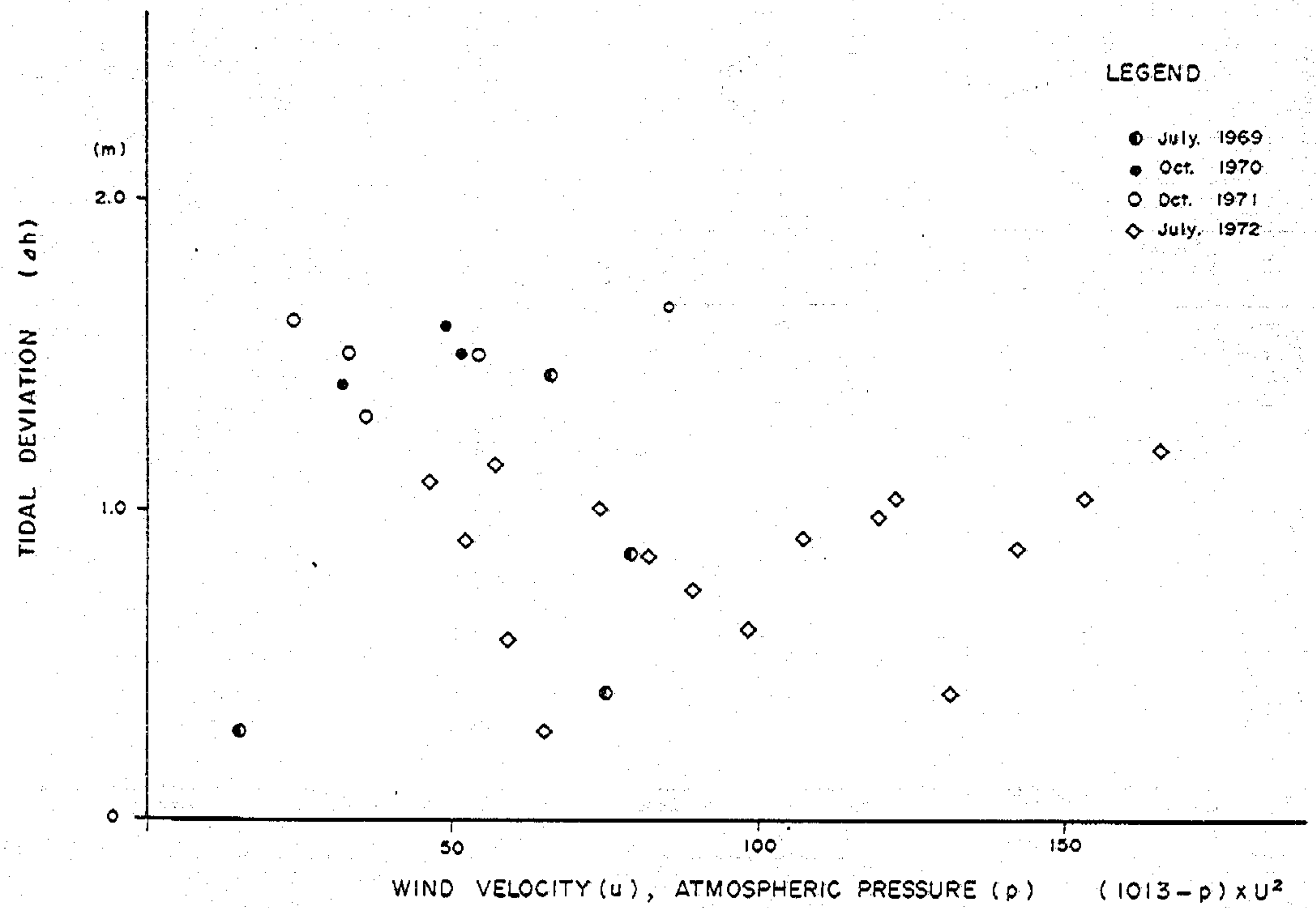


Fig. 5-15 WIND VELOCITY, ATMOSPHERIC PRESSURE AND TIDAL DEVIATION



8-2 Verification of the Flood Forecasting Method at Each Point

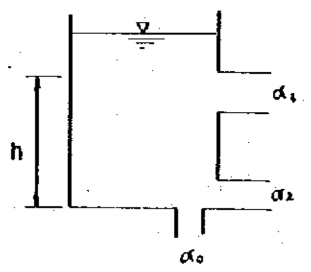
The method used at each flood forecasting point is shown in the following table.

Flood Forecasting Point	Flood Forecasting Method
Bato	Combination of tank model and fall of water level of the lake.
Ombao	Formula indicating relationship with the Bato water level.
Camaligan	Formula indicating relationship with the Ombao water level.
Sipocot	Tank model.

The flood forecasting method at each point is shown below.

(1) Bato

Outflow model



$\alpha_0 = 0.6$

$\alpha_1 = 0.05$

$\alpha_2 = 0.085$

$h = 20$ mm

Model of water reduction in the lake water level.

$\Delta H = 0.035H - 0.151$

ΔH: Amount of reduction in lake water level (m)

H: Lake (water) level (m)

(2) Ombao

$H_2 = 1.22\ H_1 - 3.8$ correlation coefficient = 0.970

H_2: Water level at Ombao (m)

H_1: Water level at Bato on the previous day (m)

(3) Camaligan

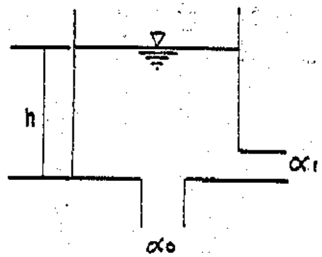
$H_2 = 0.596\ H_1 + 0.1$ correlation coefficient = 0.828

H_2: Water level at Camaligan (m)

H_1: Water level at Ombao on the previous day (m)

(4) Sipocot point

Outflow model



$\alpha_0 = 0.01$

$\alpha_1 = 0.025$

Fig 5-16 CORRELATION AMONG WATER LEVELS AT BATO, OMBAO AND CAMALIGAN

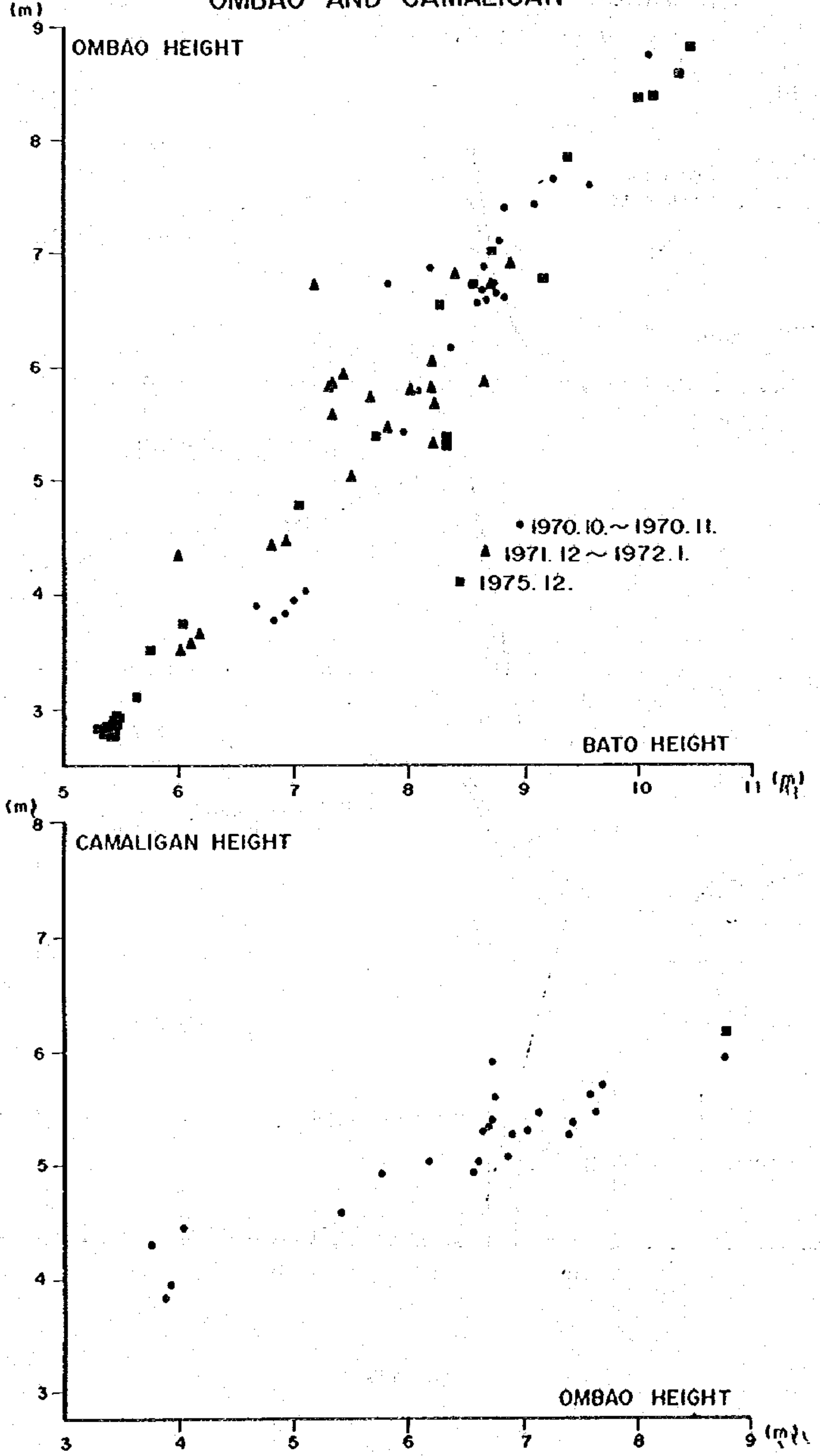


Fig. 5-17 OBSERVED AND CALCULATED WATER GAGE HEIGHT
BICOL RIVER BASIN (1)
Oct. 1970

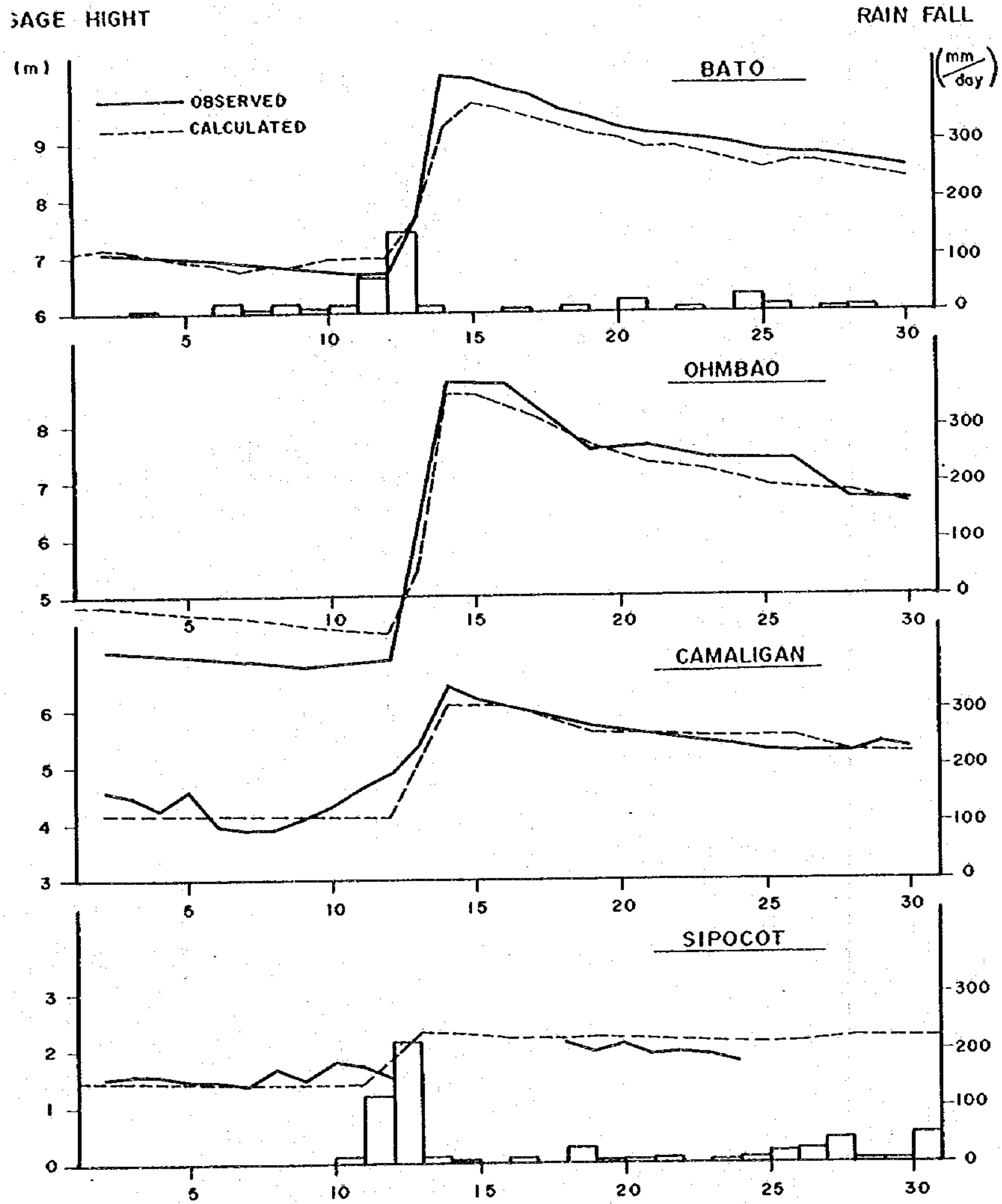
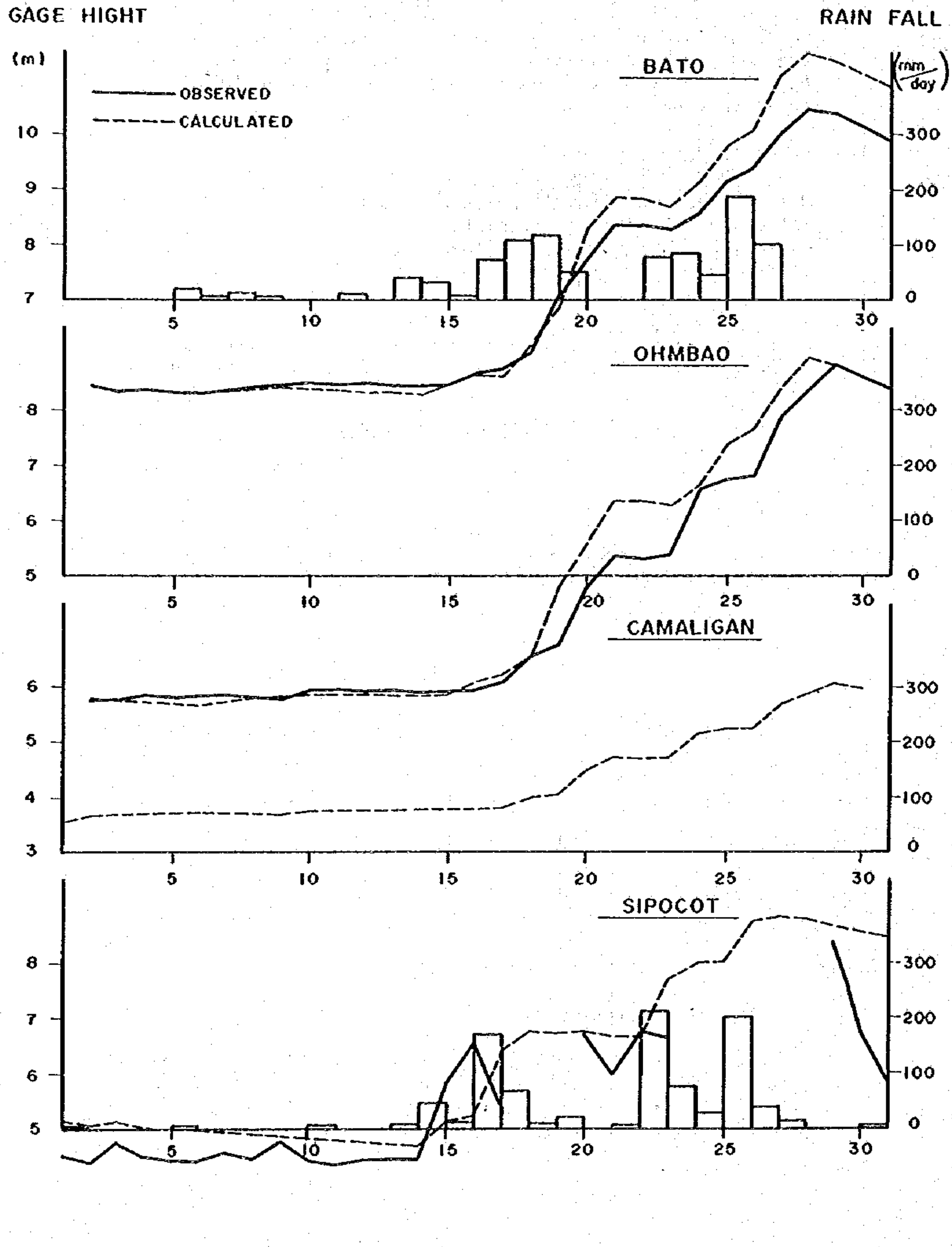


Fig. 5-18 OBSERVED AND CALCULATED WATER GAGE HEIGHT
BICOL RIVER BASIN (2)
Dec. 1975



§-3. The cagayan River

1. Hydrograph and Hyetograph

1-1 Existing hydrological stations

As shown in Fig.5-19, the major hydrological and rainfall gaging stations are distributed in the entire region of the Cagayan basin. The rainfall gaging stations began observations from a relatively early period.

1-2 Rainfall data

Data concerning rainfall which seemed to have caused floods in the Cagayan Region in the past ten years are recorded. These Hyetographs are included in Appendix.

1-3 Water stage data

Water stage data in the Cagayan River during floods in the past are recorded. These hydrographs are included in Appendix.

Table 5-6 shows the highest water stage every year.

2. Travelling Time

The rate of movement of flood waters was calculated from the average rate of flow of water, and the estimated travelling time of flood waters through sections of the river is shown in the table below.

Flood Water Travelling Time

Section of River	Distance	Slope	Rate of Flood water Movement	Flood Water Travelling Time
Dalibubun-Tumauini	90 km	1/1,000	5.4 m/s	5 hr
Tumauini-Tuguegarao	50	1/3,500	3.4	4
Tuguegarao-Aparri	110	1/6,500	2.0	15

3. Tributaries on which the Forecast is to apply

3-1 Division of the region

The target area of the Cagayan Basin is divided into 4 blocks taking into considerations the area extending from the lower part of the river to the estuary (Aparri). The blocks are shown in the following figure.

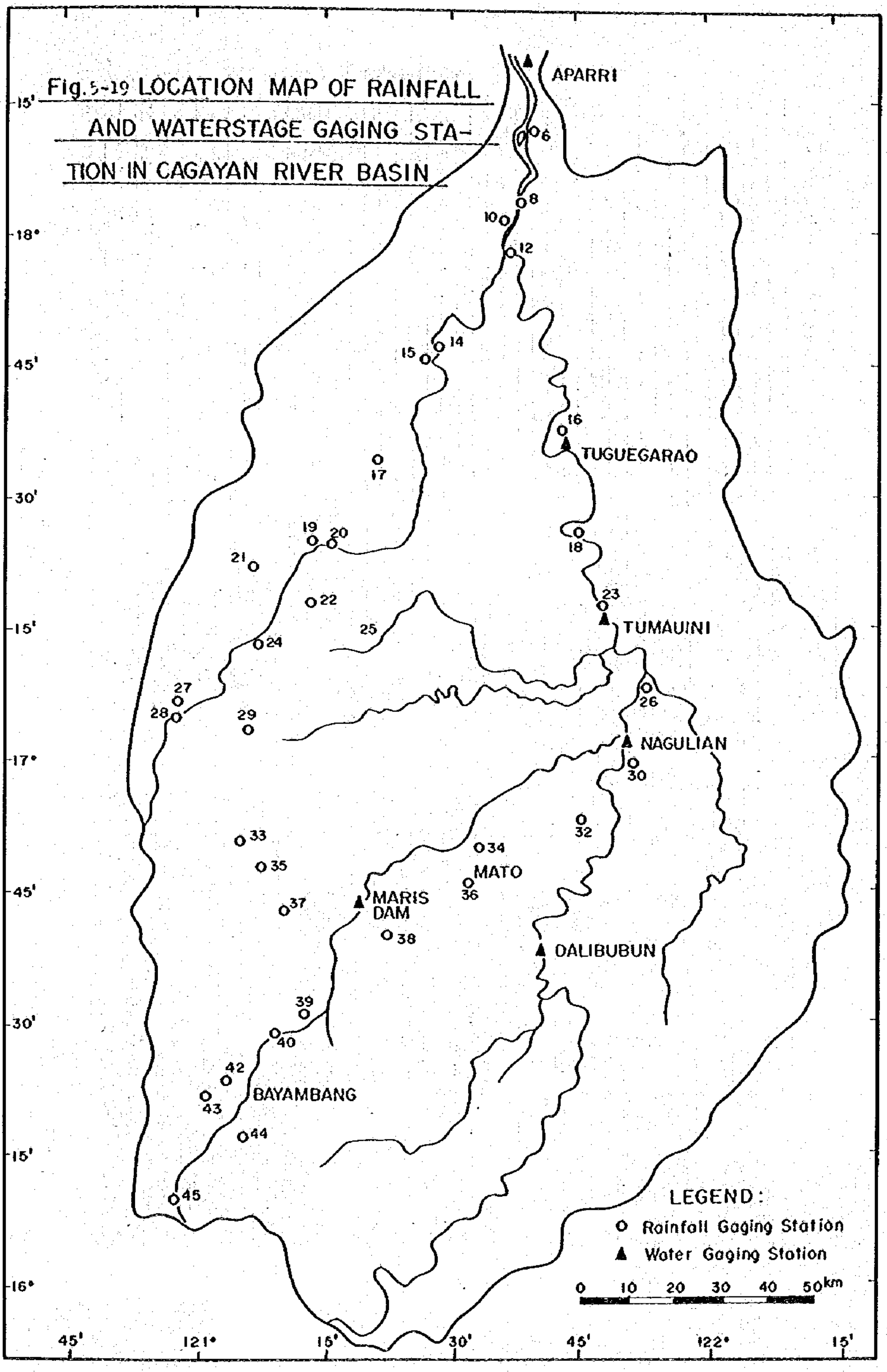


Fig.5-19 LOCATION MAP OF RAINFALL AND WATERSTAGE GAGING STATION IN CAGAYAN RIVER BASIN

Table 5-5 Location of Rainfall Gaging Station

Cagayan River Basin

No.	Name of Stations	Location: Latitude	Location: Longitude	Location: Elevation	Type of Ins	Date Established	Managed by	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
1	Sanchez Miro, Cagayan	18°34'00"	121°13'00"		RG/OG	May, 1976	HM											
2	Baggo,Pamplona,Cagayan	18°27'40"	121°21'00"	5	OG	1973	CM											
3	Balleageros,Cagayan	18°24'36"	121°30'42"		RG/OG	May, 1976	HM											
4	Apparri,Cagayan	18°22'00"	121°38'00"	4	RG/OG	1902-39, 1947	MGSD								O	X	O	O
5	Mataguisi,Pudtol,Kalinga-Apayao	18°13'00"	121°22'00"		OG	1971	CM											
6	Lal-lo,Cagayan	18°12'00"	121°39'40"	7	OG	1973	CM								O	O	O	O
7	Baliwanan,Kabuyao,Kalinga-Apayao	18°08'10"	121°08'00"	320	OG	1969	CM											
8	Gattaran,Cagayan	18°03'42"	121°38'24"	10	RG/OG	May, 1976	HM				O	O	O	O	O	O	O	O
9	Kabugao,Kabugao,Kalinga-Apayao	18°01'30"	121°11'00"	120	OG	1948	CM											
10	Aggunetan,Lasam,Cagayan	18°01'30"	121°37'10"	10	OG	1947	CM											
11	Mt.Polis Pass,Banawe,Ifugao	17°58'00"	121°01'30"	1900	OG	1963	CM											
12	Nassiping,Alcala,Cagayan	17°58'00"	121°37'40"	10	OG	1948-71	CM	Δ	O	O	Δ	Δ	Δ			X	X	X
13	Lenneng,Kabugao,Kalinga-Apayao	17°55'20"	121°12'40"	231	OG	1969	CM											
14	Piat,Cagayan	17°47'36"	121°28'36"	40	RG/OG	May, 1976	HM											O
15	Cagumifan,Tauo,Cagayan	17°45'50"	121°27'30"	35	OG	1947	CM	O	O	O	O	O	O	O	O	O	O	X
16	Tuguegarao,Cagayan	17°37'00"	121°44'00"	24	RG/OG	1903-39;1947	MGSD	O	O	O	O	O	O	O	O	O	O	O
17	Pinukpuk,Kalinga-Apayao	17°34'40"	121°22'00"	120	OG	1971	CM					O	O	O	O	O	O	O
18	Cabagan,Isabela	17°25'42"	121°45'48"	20	RG/OG	May, 1976	HM										O	
19	Tomiangan,Tabuk,Kalinga-Apayao	17°25'00"	121°14'00"		OG	1974	CM								O	O	O	
20	Maneng,Tabuk,Kalinga-Apayao	17°24'40"	121°16'00"	360	OG	1947	CM	O		O	O	O	O	O		O	O	O
21	Latauan,Lubuagan,Kalinga-Apayao	17°22'00"	121°07'00"	740	OG	1963	CM			O	X	O	O	O	X	X	X	X
22	Guilguila,Tarudan,Kalinga-Apayao	17°18'00"	121°14'10"	500	OG	1963	CM	O	X	O	O	O	O	O	O	O	O	X
23	Tumauini, Isabela	17°16'42"	121°48'12"		RG/OG	May, 1976	HM											O
24	Basao,Tinglayan,Kalinga-Apayao	17°13'30"	121°07'20"	800	OG	1963	CM											
25	Calanasan,Bayog,Kalinga-Apayao	17°13'30"	121°19'00"		OG	1968-70	CM											
26	Ilagan, Isabela	17°08'00"	121°53'10"	40	OG	1925-39;1949	CM	O	O	O	O	O	O	O	O	O	O	O
27	Banga-an,Sagada,Mt.Province	17°07'00"	120°58'00"		OG	1963 | 1960	CM	O	X	O	O	O	X	X	O	O	X	O
28	Bontoc,Mt.Province	17°05'00"	120°58'00"		OG	1950	CM	X	O	O	O	O	O	O	O	O	X	X
29	Barling,Mt. Province	17°03'30"	121°06'20"		OG	1963	CM	X	X	O	O	O	X	O	O	O	X	O
30	Reina Mercedes, Isabela	16°59'30"	121°51'00"		RG/OG	May, 1976	HM											O
31	Bauko, Mt. Province	16°57'00"	121°52'00"		OG	1963	CM			O	O	O	O	O	O	O	O	O
32	Munurgan,Canayan,Isabela	16°53'00"	121°45'00"		RG/OG	Dec. 1974	HM-NIA											
33	Mamulditan,Lagawe,Ifugao	16°51'10"	121°05'10"	900	OG	1969	CM			O	X	O	X	O	O	O	X	
34	Sinamar,San Mateo,Isabela	16°50'00"	121°33'00"		RG/OG	Dec. 1974	HM-NIA										O	
35	Lagawe,Lagawe,Ifugao	16°48'00"	121°07'20"	470	OG	1970	CM			O		O		O	O	O	O	O
36	Raniag,Ramon,Isabela	16°46'00"	121°32'00"		RG/OG	Dec. 1974	HM-NIA										O	
37	Mayom,Lamut,Ifugao	16°43'20"	121°10'20"	320	OG	1971	CM						O	O	O	O	X	O
38	Magat(Ref.Proj),Diadi,N.V.	16°40'00"	121°22'00"	243	OG	Jan. 1966	CM		O	O	O	O	O	X				
39	Solano,Nueva Viscaya	16°31'10"	121°11'50"	225	OG	1967	CM		O	O	O	O	O	O	O	O	O	
40	Balbalan,Saleseg,Kalinga-Apayao	16°31'00"	121°50'00"		OG	1948	CM											
41	Bayombong,Nueva Viscaya	16°29'00"	121°09'00"	270	RG/OG	March, 1976	HM											O
42	Barat,Bambang,Nueva Viscaya	16°23'20"	121°03'20"	310	OG	1969	CM			O	O	O	O	O	O	O	O	O
43	Salinas(Ref.Proj.),Bampang,N.V.	16°22'30"	121°01'00"	610	OG	Jan. 1968	CM											
44	Dupat,Nueva,Viscaya	16°17'10"	121°05'20"	364	OG	1968	CM			O	O	O	O	O	O	O	O	O
45	Consuelo,Sta.Fe,Nueva,Viscaya	16°10'00"	120°57'00"	550	OG	1948	CM	O	O	O	O	O	O	O	O	O	O	O

Legend

O: Collected data

X: No data

Table 5-6 Maximum Water Gage Height

Cagayan River Basin

Unit: (m)
( ) Discharge(m^3/s)

Station / Year	DARIBUBUN (PANGAL)		MARIS DAM		TUMUINI (NAGULIAN)		TUGUEGARAO		APARRI	
1966	Nov.22	(7735) 15.55							Nov.14	0.92
67	Nov.4	(7848) 17.50							June28	0.94
68	Nov.30	(4258) 9.75			Nov.30	(2838) 7.7	Dec.1	17.50	July26	1.08
69	Nov.24	(1302) 6.00			Nov.26	(2182) 6.78	Nov.27	18.03	Nov.28	1.15
70	Sep.12	(7503) 12.50			Oct.14	(7899) 13.83	Oct.16	21.95	Aug.10	1.99
71	Nov.16	(4511) 10.00			Oct.12	(9692) 15.90	Dec.2	20.97	Mar.22	1.77
72	Nov.7	(2233) 7.25			Nov.7	(1879) 6.84	July19	18.37	Jan.14	7.21
73	Oct.15	(5032) 10.75					Nov.22	15.20	(June	)
74	June11	(4511) 16.00								
75										
76										

3-2 Flood forecasting point

The following flood forecasting points are selected from the target area and the sub-divisions:

Dalibubun

Maris Dam

Tumauini

Tuguegarao

4. Telemetering Stations

The location of the telemetering station for flood forecasting are selected as shown in the following table. In the future it will become necessary to set up stations at both the lower part of the Cagayan River and the Chico Basin. Dalibubun Station is located at the Pangal Station where B.P.W. had used for hydrological observations in the past.

Cagayna River Basin: List of Gaging Station

No.	Station	Location of Station	River Basin	Remarks
1	Dalibubun	Make use of Pangal Station(belonging to B.P.W.). Left Bank	Cagayan R.	Newly constructed Rainfall, water level
2	Maris Dam	Make use of existing hydrological station downstream from Maris Dam. Right Bank	Magat R.	"
3	Tumauini	Within Tumauini Town. Right Bank.	Cagayan R.	"
4	Tuguegarao	Bandon Bridge. Right Bank	Cagayan R.	"

5. Storm Surge Model

In the Cagayan River basin, storm surge probably can be neglected, therfore no study is made.

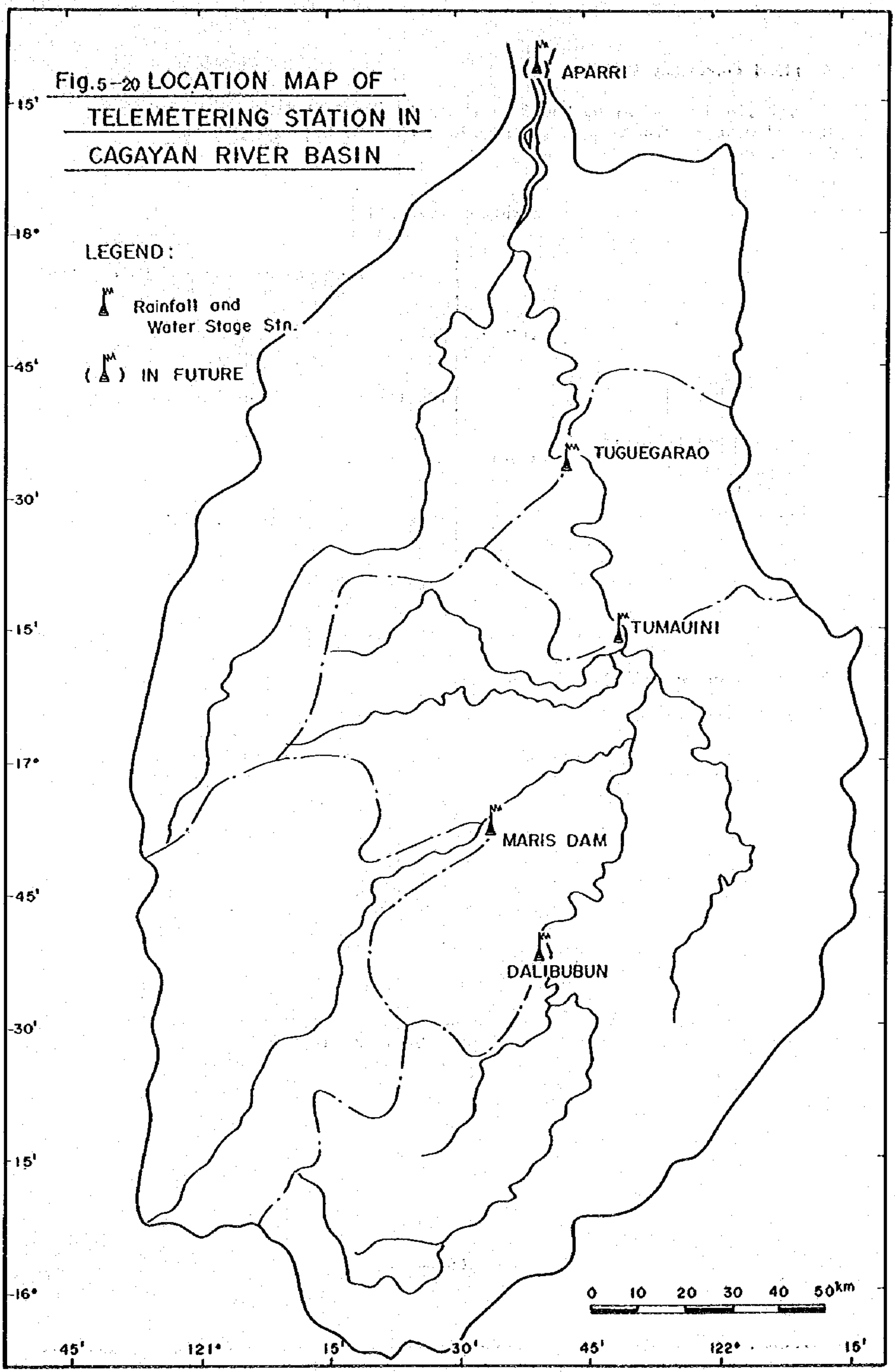


Fig.5-20 LOCATION MAP OF TELEMETERING STATION IN CAGAYAN RIVER BASIN
LEGEND:
Rainfall and Water Stage Stn.
( ) IN FUTURE
APARRI
TUGUEGARAO
TUMAUINI
MARIS DAM
DALIBUBUN
0 10 20 30 40 50km
15'
18°
45'
30'
15'
17°
45'
30'
15'
16°
45'
121°
15'
30'
45'
122°
15'

6. Flood Forecasting Model

The Flood Forecasting Model as shown in the following figure was drafted with considerations to the Flood Forecasting Point in the Cagayan Region

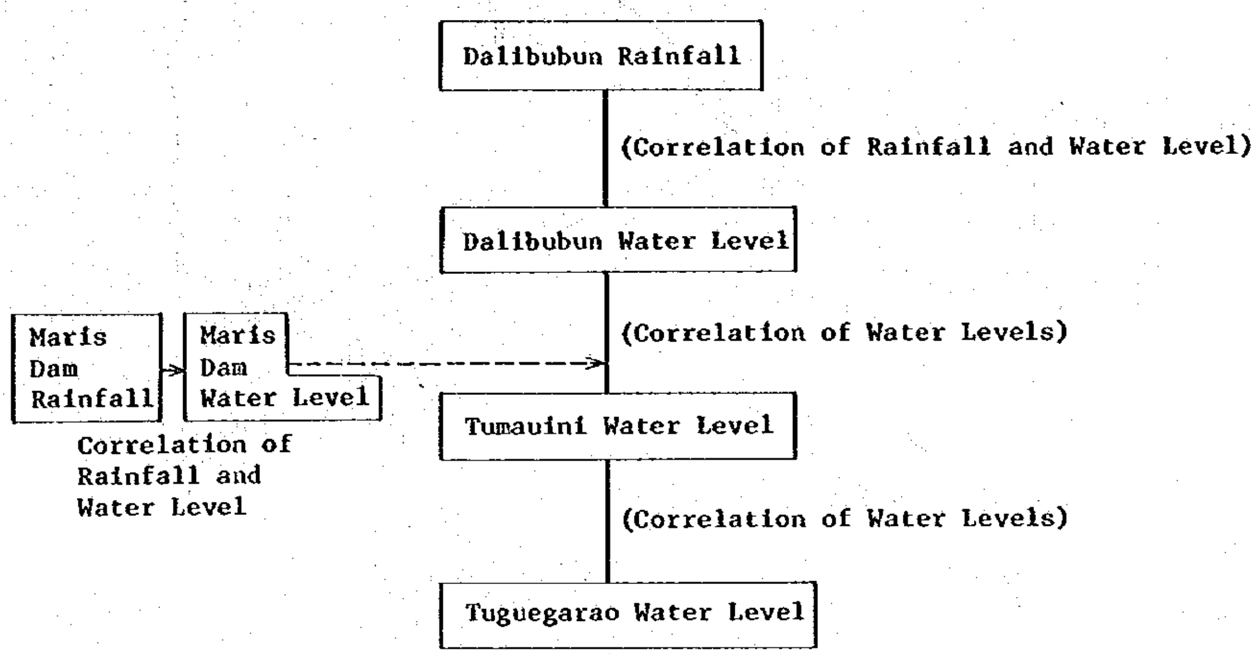
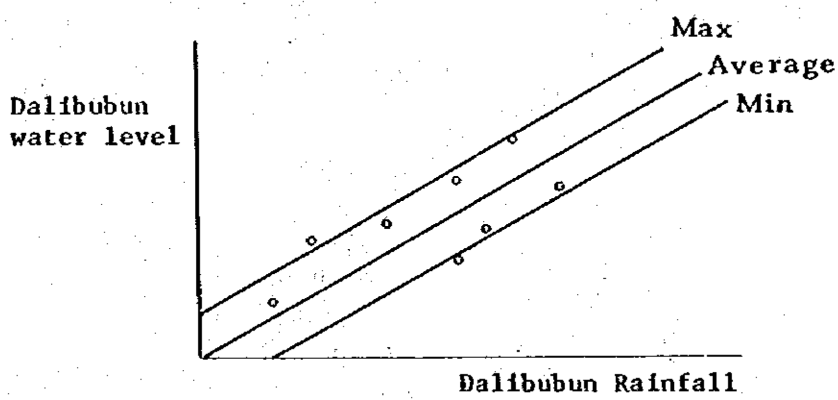


Fig. Flood Forecasting Model

7. Flood Forecasting Method

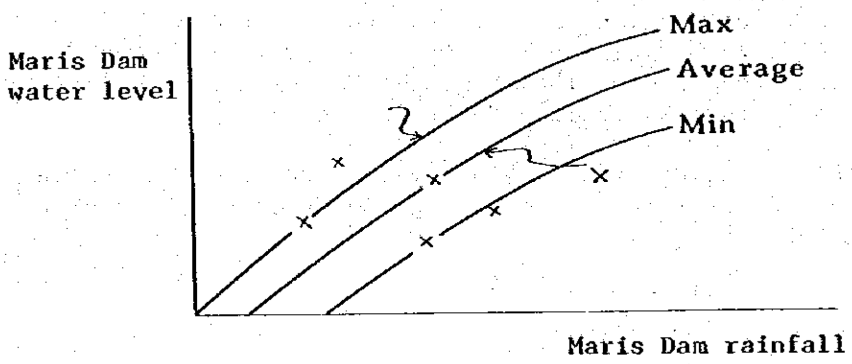
7-1 Dalibubun Point'

Forecast on the basis of correlation between rainfall and water level at Dalibubun Point.



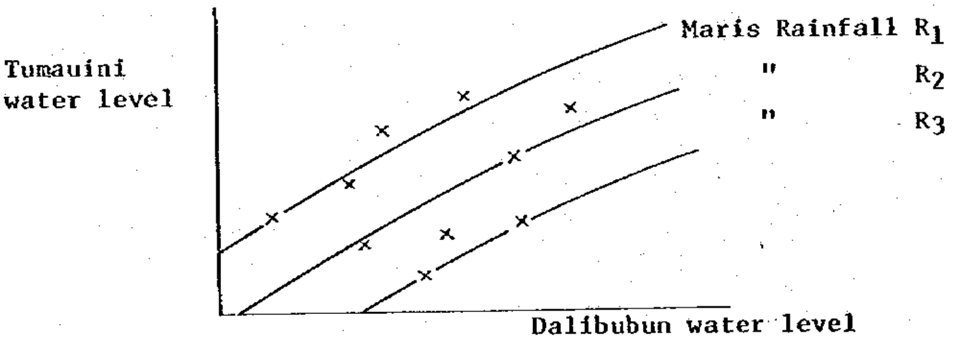
7-2 Maris Dam Point

Forecasting based on correlation between rainfall and water level at Maris Dam Point.



7-3 Tumuini Point

Forecasting of the water level at Tumauini Point is based on the Correlation Figure of the water levels at Dalibubun Point with respect to the travelling time. In cases when the water levels are scattered, the rainfall at Maris Dam is used as a parameter.



7-4 Tuguegarao Point

The forecasting method is the same as for Tumuini Point. The water level is forecasted with the use of a correlation figure, showing the water levels at Tumauini Point and Tuguegarao Point with respect to the following time.

8. Verification of the Flood Forecasting Model

(1) The relationship between rainfall and the water level at Pangal is shown in Fig. 5-21.

For estimation of the Pangal water level, the tank model method is being studied.

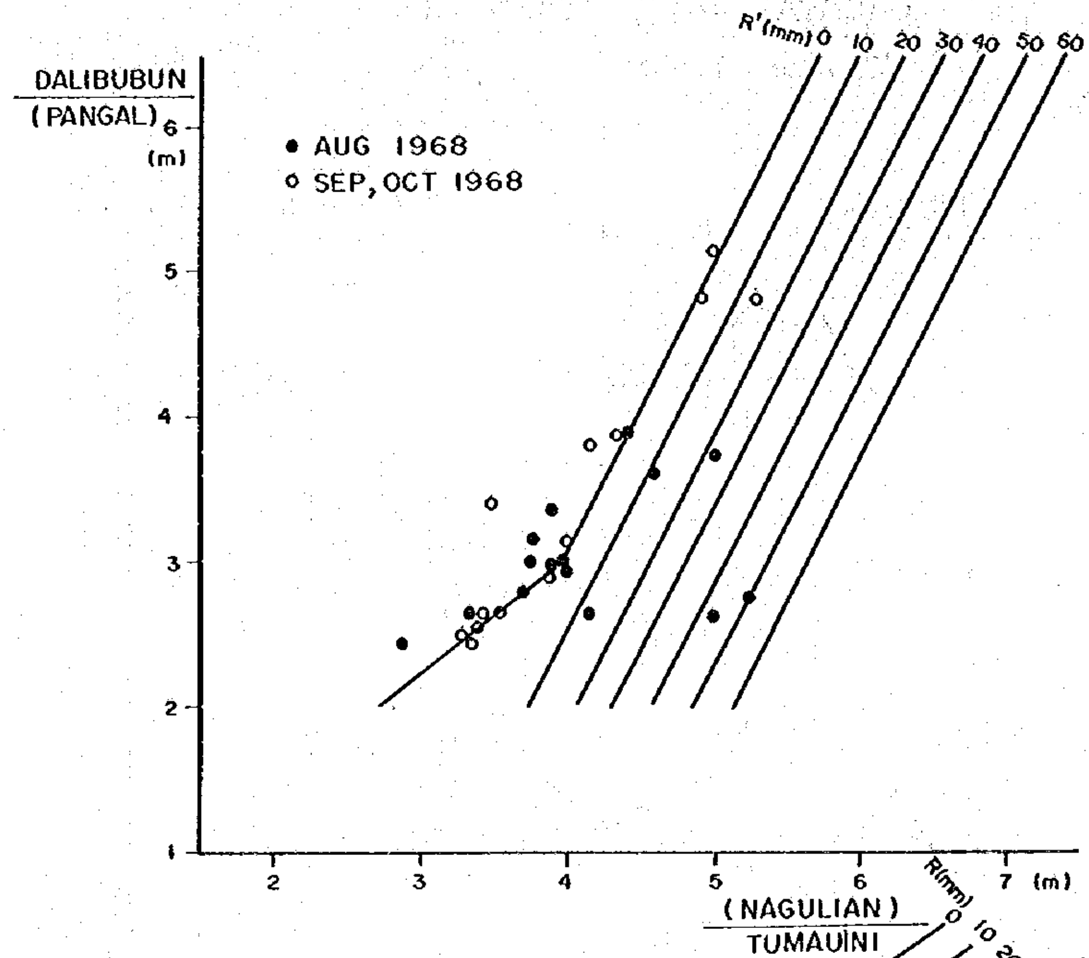
Constants are $\alpha_1 = 0.2$, $\alpha_2 = 0.0$.

Original amount stored is 50 mm.

(2) With travelling time as one day, the relationship between Pangal water level and Tamauini water level is shown in Fig.5-21. There is no information about the Tamauini water level, therefore the Nagurian information is presented.

(3) With travelling time as one day, the relationship between the Tamauini water level and Tuguegarao water level is shown in Fig.5-21.

Fig.5—21 CORRELATION AMONG GAGE HEIGHTS AT DALIBUBUN TUMAUINI AND TUGUEGARAO



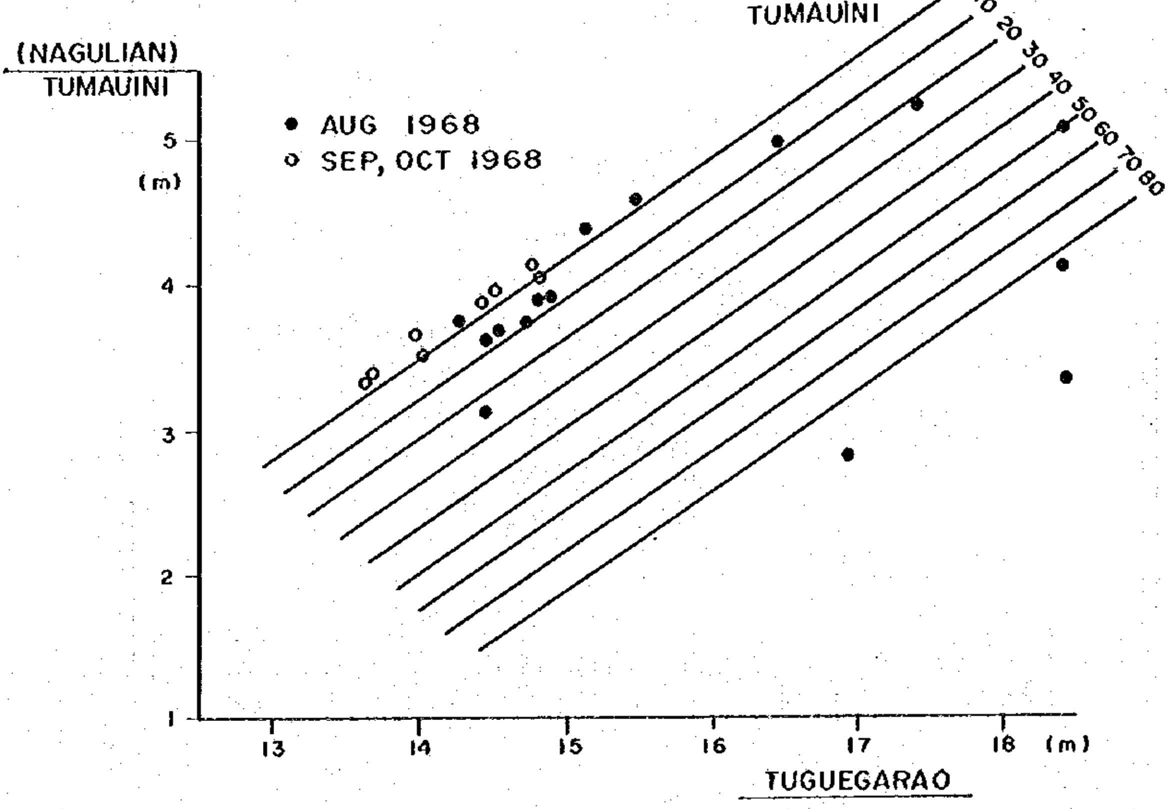
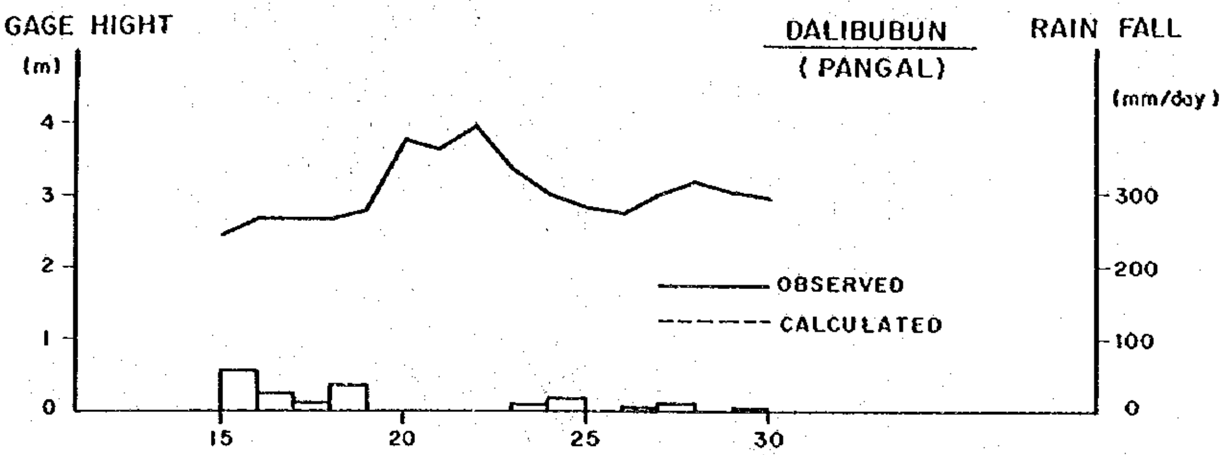
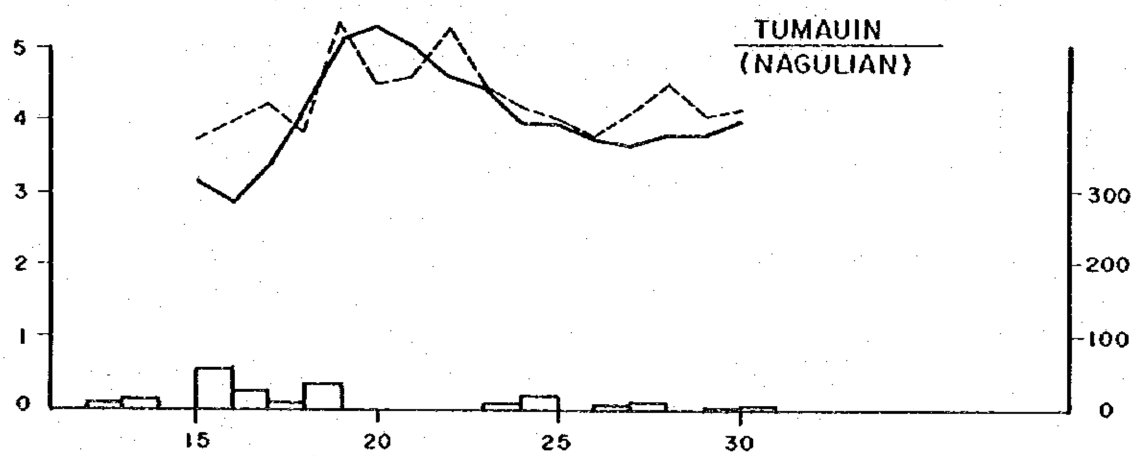


Fig.5－22 OBSERVED AND CALCULATED WATER GAGE HEIGHT
CAGAYAN RIVER BASIN (1)
Aug. 1968





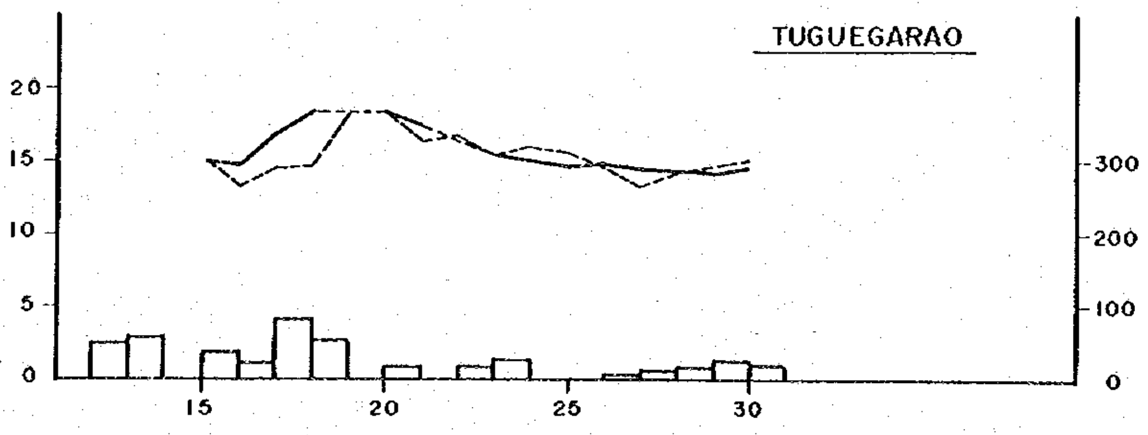
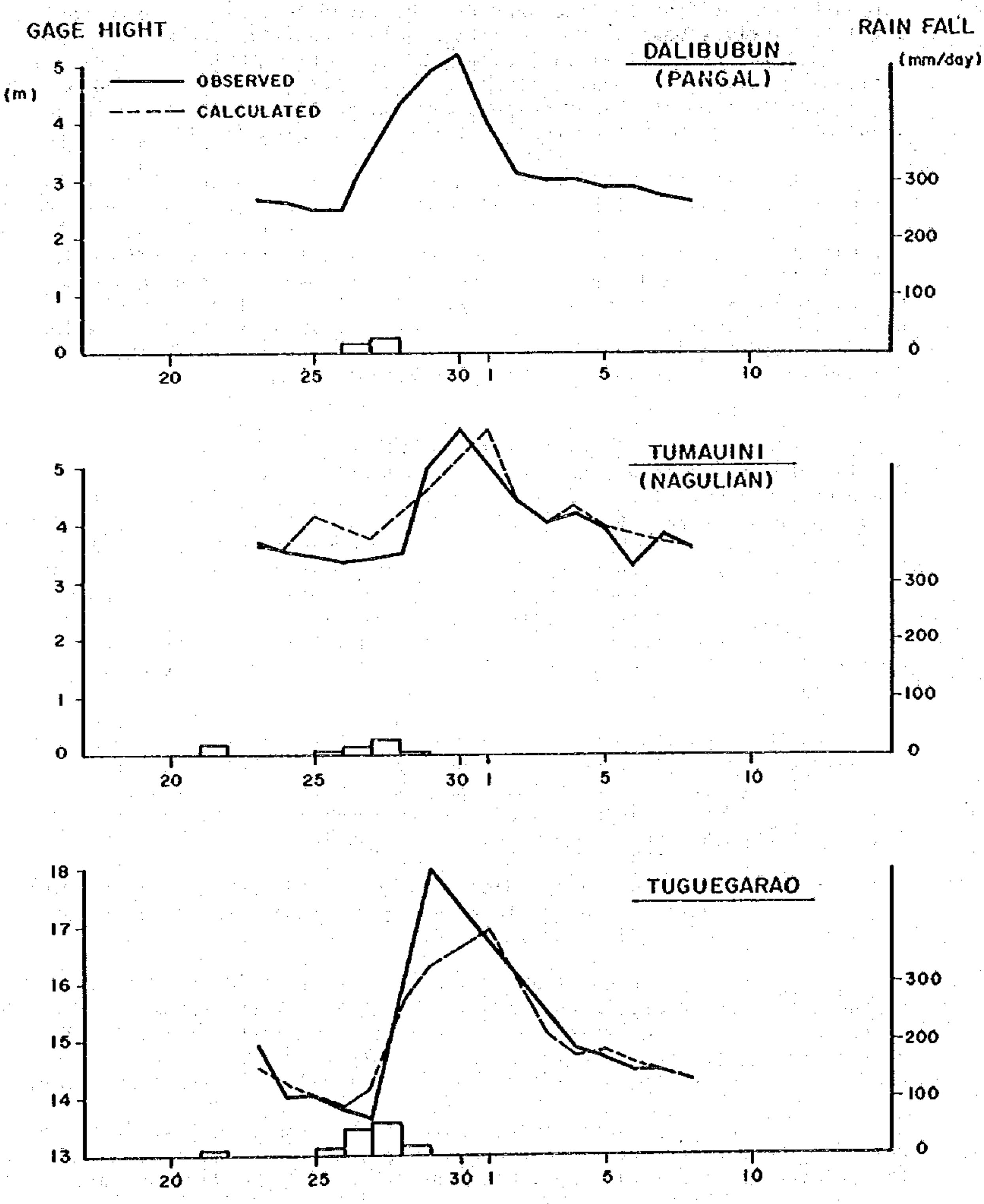


Fig. 5-23 OBSERVED AND CALCULATED WATER GAGE HEIGHT
CAGAYAN RIVER BASIN
Sept, Oct. 1968



VI. Telecommunications and Telemetery Systems

§-1. Outline

The team recommends the application of automatic transmission and communication of data for the operation of flood forecasting and warning in each river basin. Sub-centers should be established in the middle of each of the three river basins for the collection of data and the operation as well as maintenance of the system. All the data observed at the gaging stations should be transmitted automatically to the sub-center by means of the telemetry network with VHF telecommunication links.

Two transmitting and receiving stations (relay station) should be set up in the suburbs of Manila for relaying data and other infomration to and from the sub-centers. The team recommends that a multiplex telecommunication system by means of tropospheric scattering of radio wave with 400 MHz band should be set up for the transmission of data from the sub-centers to the relay stations, and another multiplex telecommunication system with 400 MHz band be set up between the relay stations, Flood Forecasting Center (F.F.C.), and Bureau of Public Works (B.P.W.) for the automatic transmission of hydrological information and other data.

These telecommunication links connecting the sub-centers with Manila form the heart of the flood forecasting and warning system and hence they are extremely important. Consequently, it is also advisale to set up a short wave telecommunication system with S.S.B. (single-side band system) as a back-up in case the telecommunication links are interrupted due to system faults or other troubles. This is because a great difficulty in flood forecasting is anticipated to result from such an interruption. For efficient maintenance work, it is also considered necessary to set up the base station and land mobiles and for each sub-center with VHF band to permit radiotelephone communication readily available.

If the downstream of the Cagayan River Basin is to be included in the target area, it is necessary to set up another telemetring stations for collecting data. In that instance, radio wave propagation tests should be conducted before they are incorporated in the Flood Forecasting and Warning System of the Cagayan River Basin.

The operation and maintenance records marked by the Pampanga Flood Forecasting and Warning System since 1973 have highlighted several pending issues to be solved or improved.

For successful expansion and improvement of the system, it is of urgent necessity to expand the maintenance staff for the telemetry system as well as to establish a firm structure whereby the staff will be able to acquire new techniques to cope with the situation created by the introduction of the multiplex troposcatter telecommunication system.

Sufficient experience on the part of the maintenance staff is necessary for the maintenance and operational control of the system, therefore, the efforts to help their experience through on-the-job training are vitally important. At the same time, systematic appropriation supported by necessary budgetary arrangement is a must for the proper management of the system.

Needless to say, a smooth and effective system operation is impossible without due coordination and cooperation among all the related organizations including those which are not directly involved in the operation of the system.

In view of the above, the success of this project is solely dependent on the earliest possible formation of a viable man-organization system through effective training of the maintenance staff and efficient coordination and cooperation of the Agencies concerned.

§-2. Examination of Proposed System.

An outline of the facilities and the systems proposed for collection of data in each river basin is shown in Fig. 6-1. The details are as follows:

1. Agno River System

PAGASA Synoptic Station in Dagupan and B.P.W. Office in Carmen Rosales have both been examined as the location of the sub-center. With consideration of the space, the number of personnel and the vehicle availability, the team recommends the sub-center be located at Agno River Control Office of B P W at Carmen Rosales.

The results of the radio propagation tests have shown that each telemetering station can be connected directly to the sub-center except for that located at Binga Dam.

The proposed telemetry network is shown in Fig. 6-2. The system set up is schematically shown in Fig. 6-3.

With respect to the Binga Dam Station, a good telemetry network can be set up if connection is made via the repeater station located at Mt. Sto Tomas.

The data collected at the sub-center can be transmitted automatically to FFC at Manila through the 400 MHz band multiplex telecommunication system. The system should be such that each telemetering station can be monitored and controlled by FFC. By incorporating the troposcatter telecommunication system, this multiplex telecommunication system makes it possible to have a communication between two spots with fairly a long distance apart aided by the relay station provided at Deliman near Manila.

It is also advisable to set up a short wave telecommunication system by using the S.S.B as a back-up against possible suspension of the multiplex telecommunication system.

The results of the investigations on the proposed locations of each telemetering stations are shown in Table 6-1.

To facilitate the maintenance work of this system, base station and land mobiles with VHF band should be provided for the sub-center.

TELECOMMUNICATION NETWORK

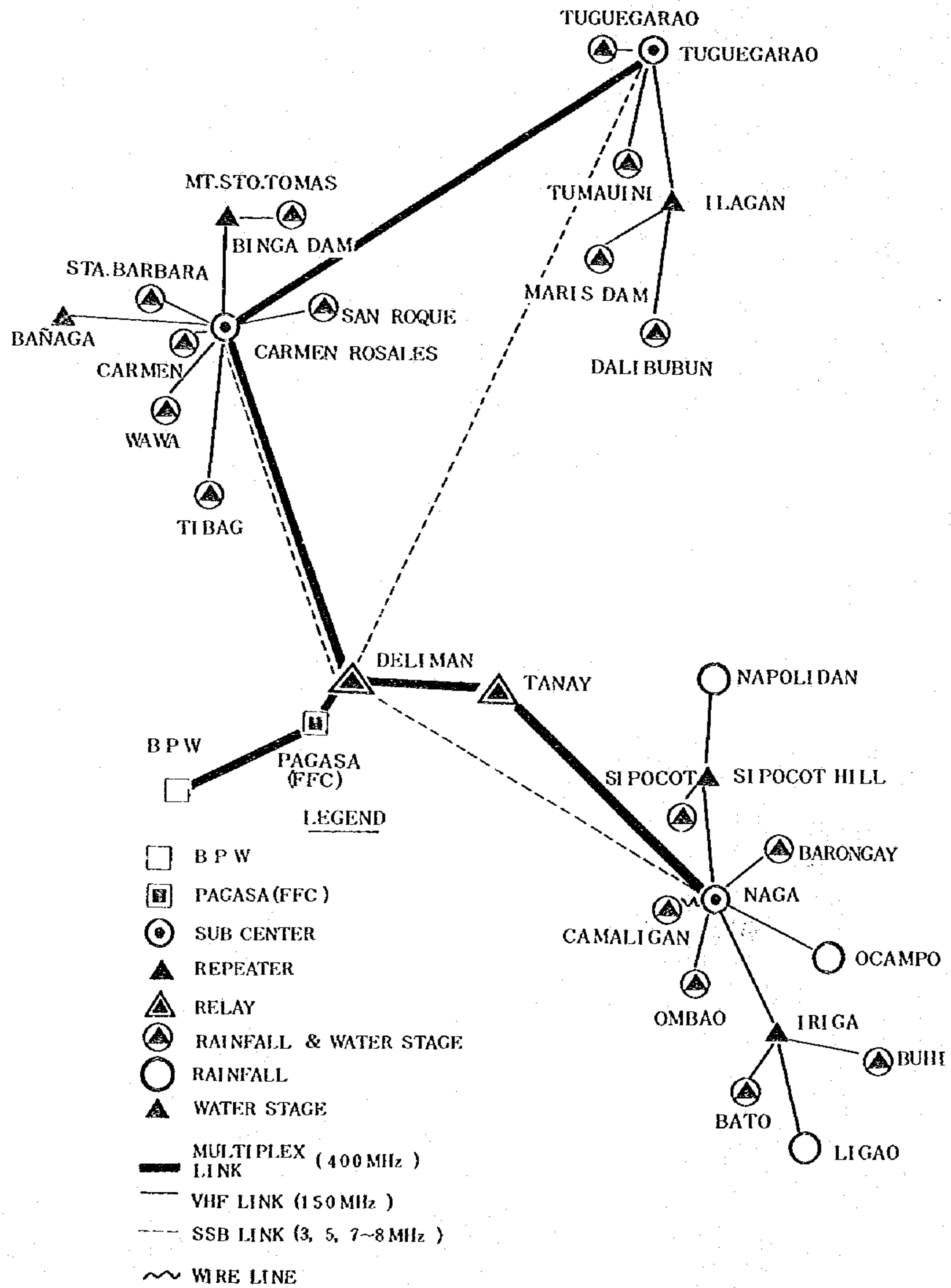


Fig. 6-2 Telemetry Network

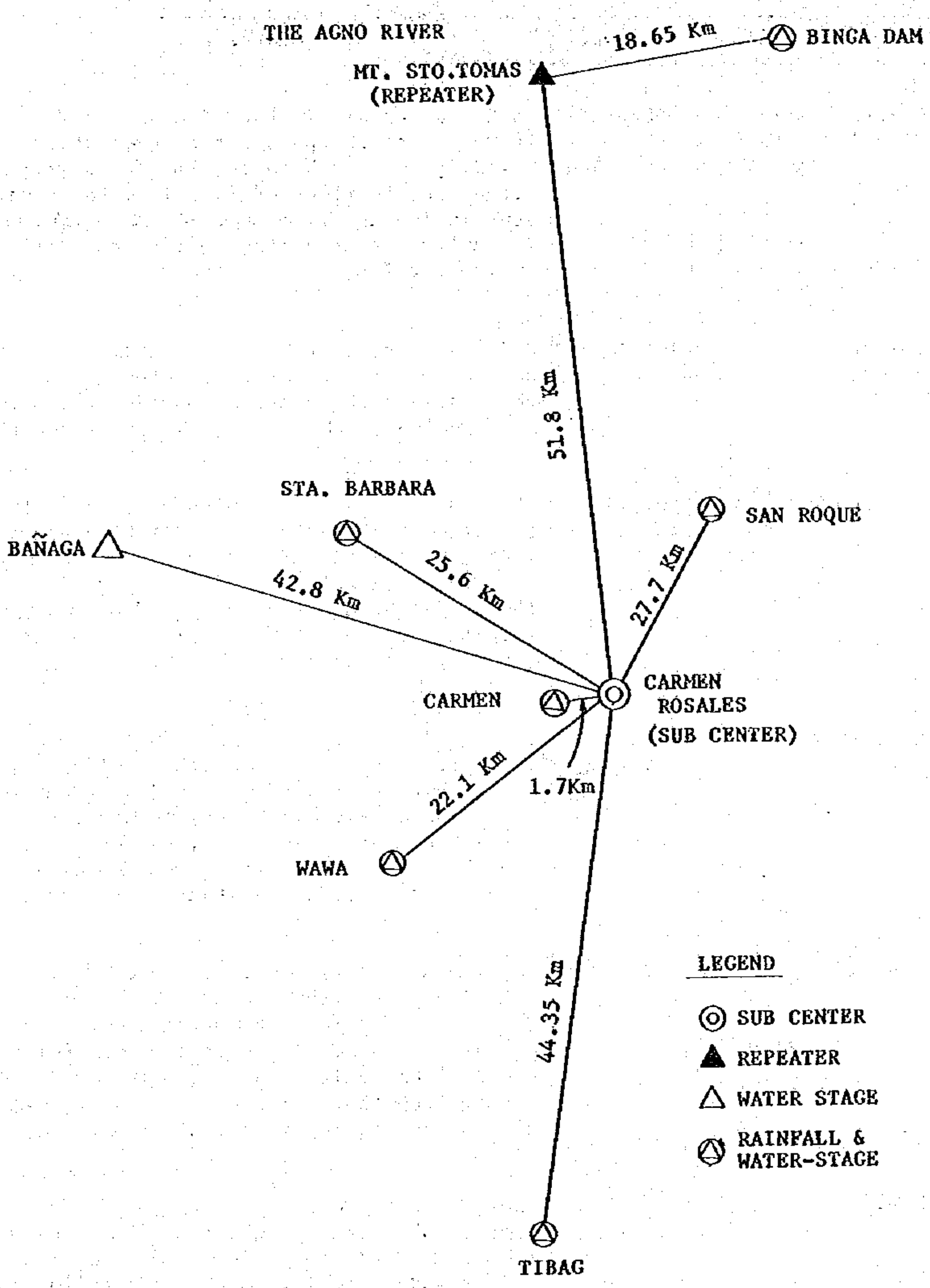


Table 6-1 Result of On-Site Investigation on the Proposed Telemetry Stations
(The Agno River Basin)

Name of Station	Type	Remarks
Carmen Rosales	Sub-center	To be set up within the site of B P W There is enough space for accommodating building and steel tower, but for safety precaution in times of flooding, the equipment including the generator set should be installed at the height equivalent to that of the 2nd floor.
Carmen	Rainfall & water stage	Being located near the sub-center, no problem may arise for radio propagation, but the telemetering station housing should be constructed on the heights of the river bank.
San Roque	Rainfall & water stage	The station housing is planned to be constructed on the existing irrigation water intake dam (4~5 m above the ground level). No problem exists for radio propagation. There will be no space-wise problem if the station housing can be constructed on the existing dam site as intended.
Sta. Barbara	Rainfall & water stage	The station housing is planned to be constructed within a site of the residence of an inhabitant located at the downstream of the Maramba Bridge. Direct connection to the sub-center is feasible, but connection via the repeater station at Sto.Tomas may also be considered if situation demands.
Bañaga	Water stage	The radio propagation test was conducted at relatively low ground area. The station housing should be constructed on an area of higher ground level. Direct connection to the sub-center is feasible, but connection via the repeater station at Sto Tomas may also be considered if situation demands.
Wawa	Rainfall & water stage	The site for the station housing is in a coconut plantation, requiring land embankment. Direct connection to the sub-center can be made offering no specific radio propagation problem.

Name of Station	Type	Remarks
Tibag	Rainfall & water stage	The station housing is to be constructed on the left bank at the downstream of Agana Bridge. No obstacle is found in the vicinity of the prospective housing site, and no radio propagation problem exists since connection is made directly to the sub-center.
Binga Dam	Rainfall & water stage	The telemetry link can be established if connection is made via the repeater station at Sto Tomas. In view of the unstable propagation of radio wave due to the topographical condition proved in the radio propagation test, the setting of the antenna poles requires special consideration and taking care.
Sto.Tomas	Repeater station	The existing radar site should be utilized.

Fig. 6-3-1 Schematic Diagram Of Monitor And Control Station

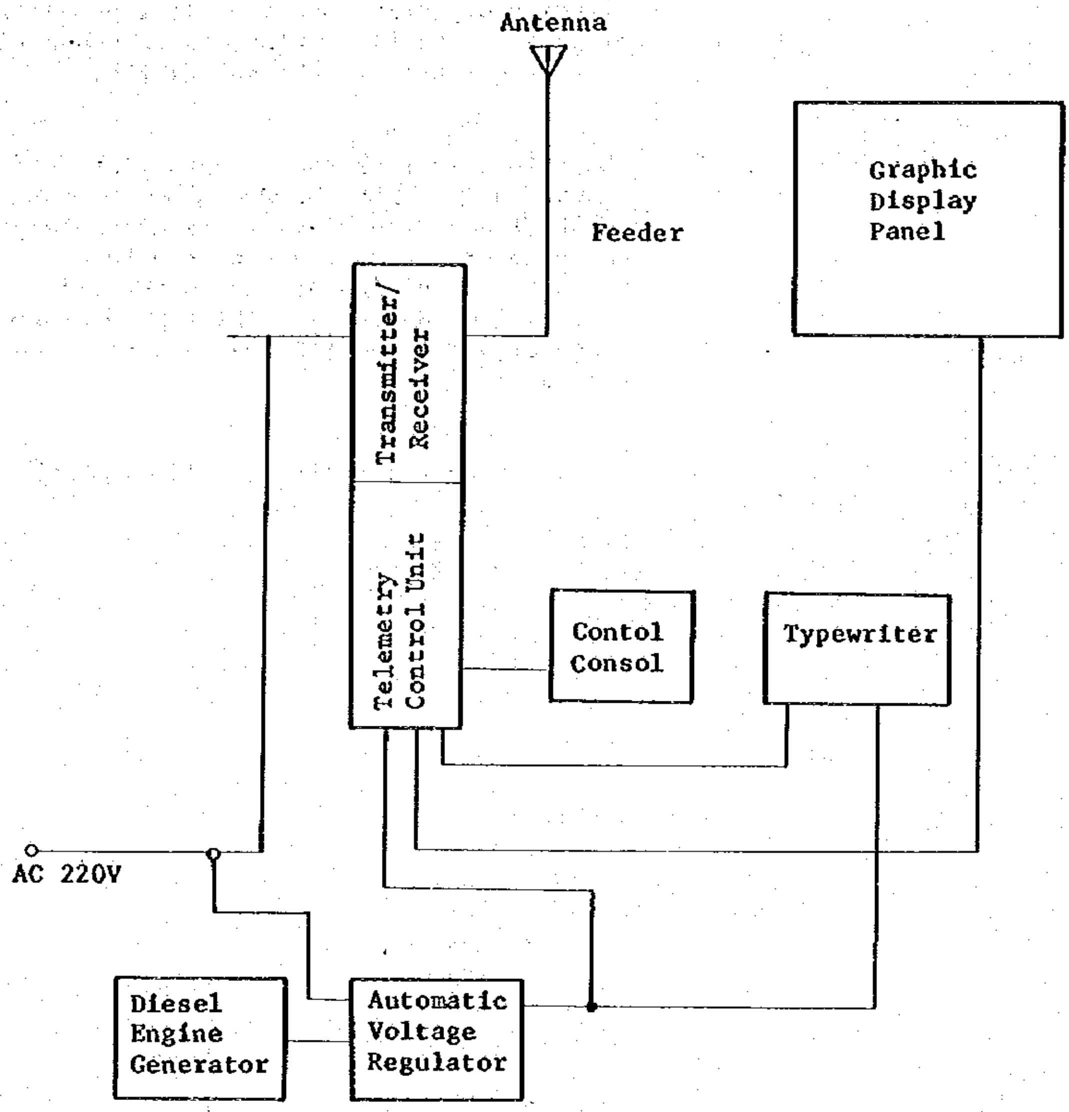


Fig. 6-3-2 Schematic Diagram Of Rainfall And Water Level Telemetering Station

(Example of Sensing Pole Type Water Stage Caging Equipment)

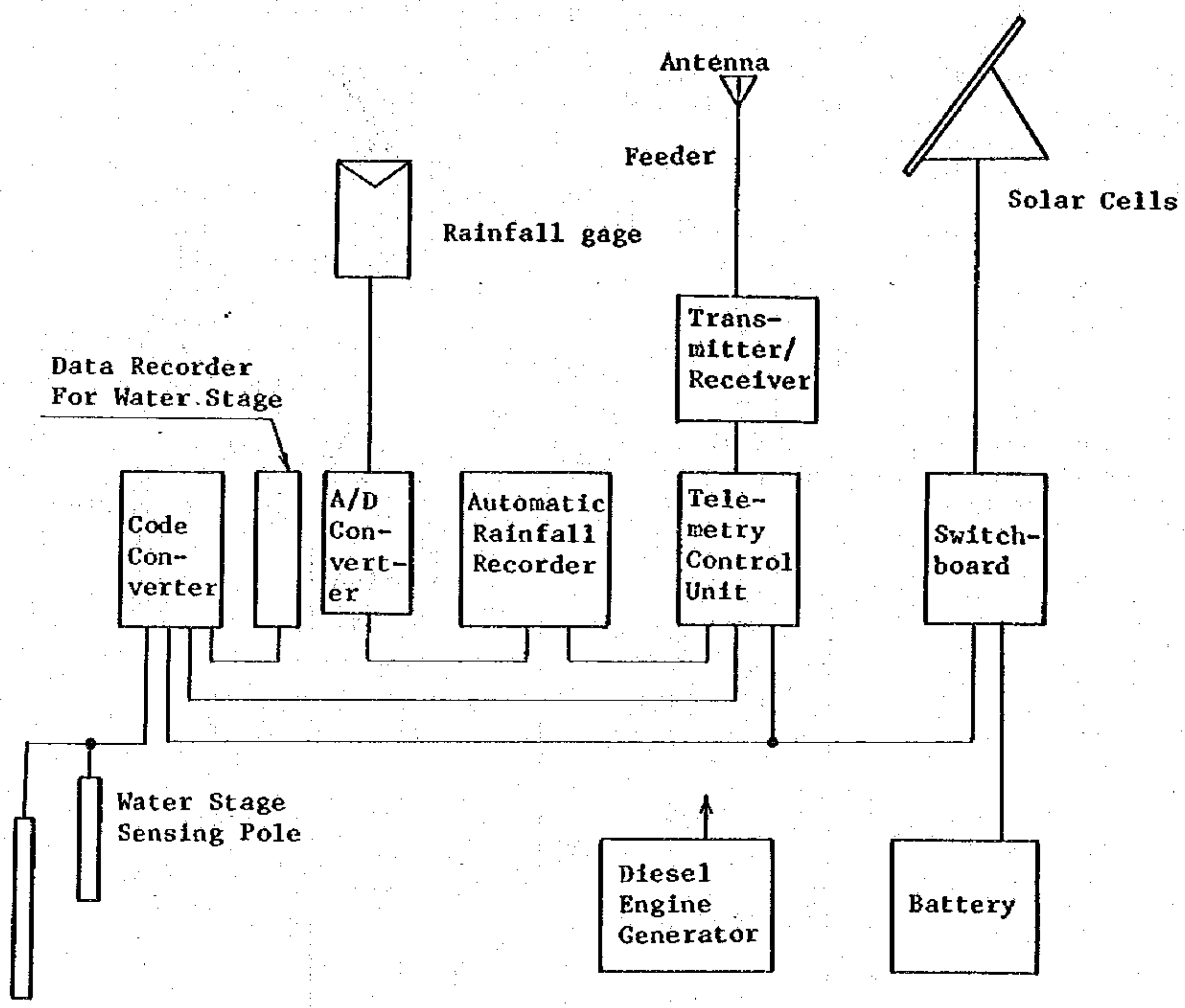
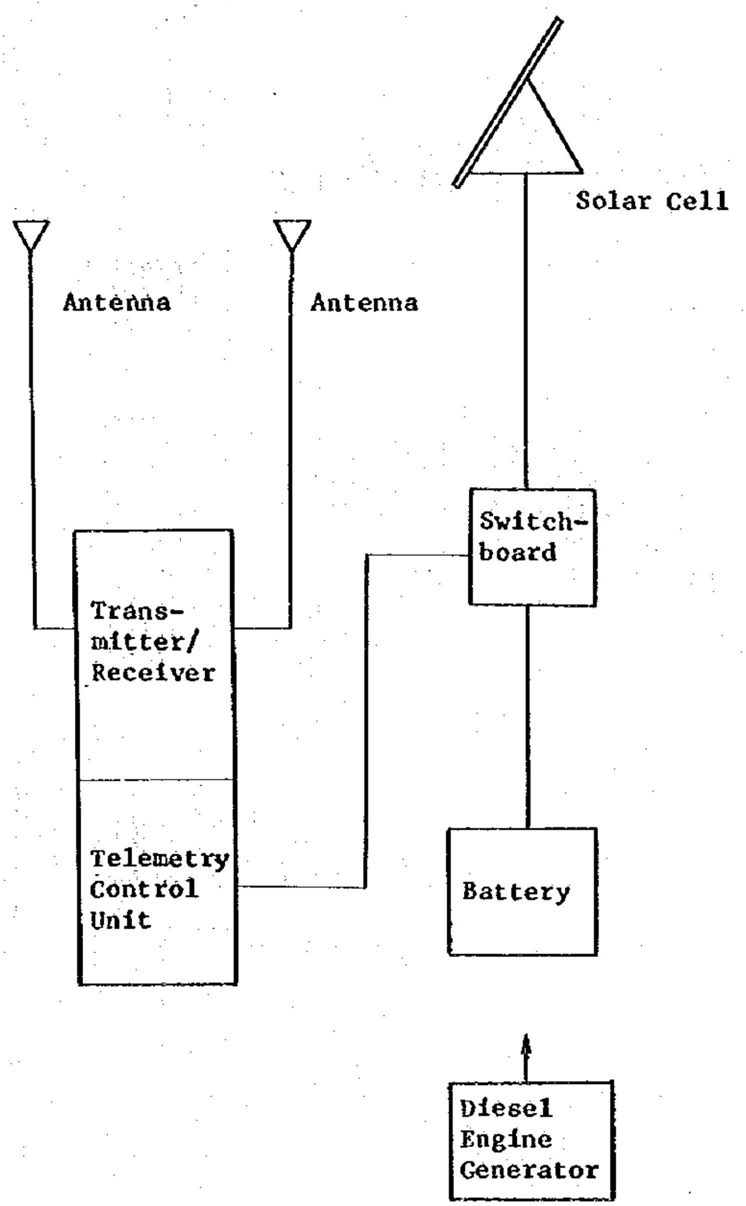


Fig. 6-3-3 Schematic diagram of repeater station



2. Bicol River System

The sub-center should be located at the Bical River Control Office, B P W in Naga.

The network of the telemetering stations should be established on the basis of the radio propagation tests as follows:

The proposed telemetry network is shown in Fig. 6-4. The system set-ups are the same as in that of the Agno River Basin.

As for the Bicol River Basin, the Ocampo, Ombao and Barongay telemetering stations can be directly connected to the sub-center, whereas the Camaligan station is to be connected through the wire line.

In the case of Sipocot River, two spots on the map, situated in high grounds some 3 km north of the town of Sipocot along the road are being considered for the site of a repeater station. According to the results of the propagation tests, it is shown that Napolidan and Sipocot stations can be connected to the telemetry network from either end of the proposed repeater stations. But in consideration of the convenience of maintenance and the topographical conditions, the spot in high ground in the vinicity of a school was selected for the location of repeater station.

In the case of the Bicol River Basin, it was planned, consulting to a map, to set up a repeater station either in Ocampo or Iriga. But the results of radio wave propagation tests and the conditions of maintenance suggest the priority of establishing a repeater station on high ground in the vicinity of Iriga city, thus making it possible to form a telemetry network connecting Bato, Buhi and Ligao.

As in the case of the Agno River Basin, the 400 MHz band multiplex troposcatter telecommunication system should be applied for the automatic transmission of data to F F C

The monitoring and controlling of the telemetering stations from F F C are identical with that employed in the Agno River Basin.

The relay station for the multiplex telecommunication system should be set up at Tanay in the suburbs of Manila.

The S.S.B. short wave telecommunication system should be secured for back-up for possible interruption of the multiplex telecommunication system due to system faults or other reasons as is assumed in the Agno River Basin.

The results of the on-site investigations on the proposed telemetering stations are shown in Table 6-2.

For the satisfactory maintenance of this system, base station and land mobiles with VHF band should be set up for the sub-center as in the case of the Agno River Basin.

Fig. 6-4 Telemetry Network

The Bicol River

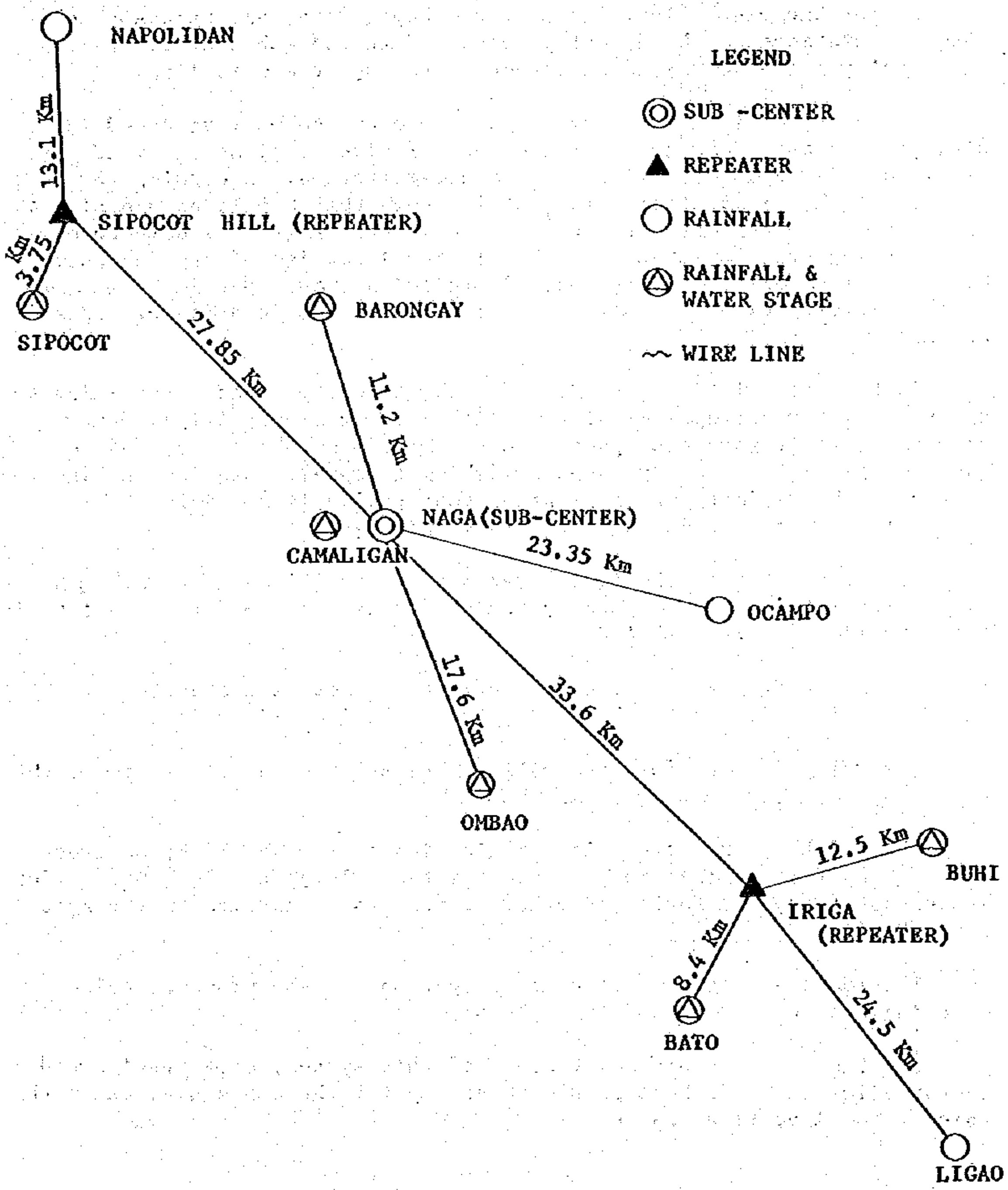


Table 6-2 Results of On-Site Investigations on the Proposed Telemetry Stations (The Bicol River Basin)

Name of Station	Type	Remarks
Naga	Sub-center	There is enough space for the station building, steel tower, and no specific problem for the telemetry network. The station building should preferably be of the 2-story construction.
Camaligan	Rainfall & water stage	Being located in the site of the B P W it is connected to the sub-center through the wire line, thus no specific problem is anticipated.
Barongay	Rainfall & Water stage	No problem exists in the housing site, topographical condition, and radio propagation. Direct connection to the sub-center is feasible.
Ocampo	Rainfall	The Iriga repeater station can cover the areas within the network, thus, it has become unnecessary for Ocampo to have a repeater station. No specific problem is anticipated in line configuration since it is possible to set up a station (for rainfall gaging only) in the vicinity of the highway as there is no need to give consideration but to perspective in the direction of Naga city.
Iriga	Repeater station	A total of four points enumerated from No. 3 to No. 6 were examined whereby No. 3 was concluded to be the best site for a repeater station. The site is in coconut plantation (private property), and is free from any fault in the vicinity. No specific problem exists concerning Naga, Buhi, Bato, and Ligao.
Buhi	Rainfall & water stage	The station housing is scheduled to be built at the waterside of the Lake Buhi. But it is recommended that a station housing should be constructed at as high a level as possible. There is no specific problem concerning radio wave propagation between the station at Buhi and that at Iriga.

Name of Station	Type	Remarks
Bato	Rainfall & water stage	Being located very close to the Iriga repeater station, no specific problem exists in the space and radio propagation.
Ligao	Rainfall	The point chosen in the basic investigation may be able to serve as a telemetering station in the network, but does not always provide a best link. It is hence desirable to transfer the location to a site closer to Ligao providing that there is no hydrographical difficulties. And, by so doing, traffic as well as maintenance conditions will be improved.
Ombao	Rainfall & water stage	There is no problem in the space, based on the topographical condition and radio propagation. Direct connection to the sub-center is feasible.
Sipocot Hill	Repeater station	Two locations were examined in the desk plan. Both of them were, as a result of the propagation tests, found to be good stations in the directional evaluations to Naga, Sipocot and Napolidan. Priority should be given to No. 2 point, namely Sipocot, if there is no problem in acquiring necessary land or other specific restrictions. No obstacle is found in the vicinity. The station is to be named as the Sipocot Hill Repeater Station.
Sipocot	Rainfall & water stage	There is no propagation problem for the network via the Sipocot Hill Repeater Station as the distance is short. The site where the construction of station housing is currently scheduled involves some difficulties in maintenance. Consideration should be given to this point.
Napolidan(1)	Rainfall	The present location of the water stage gaging equipment presents difficulties for the telemetry link. At this stage of the project, the water stage

Name of Station	Type	Remarks
Napolidan (2) (conted)		in this area has no significance. Hence, no problem may arise if the rainfall gaging station is provided at an area in the vicinity of the highway.

3. Cagayan River System

The sub-center may be built either in the BPW Region II Office or Tuguegarao Synoptic Station of PAGASA in Tuguegarao. In consideration of the space and buildings available, the BPW Region II Office is adopted.

Of the telemetry stations within the system, those located in Tumauini and Tuguegarao are directly connected to the sub-center. For Maris Dam and Dalibubun, direct connection to the sub-center is not feasible on account of the propagation difficulties, hence a repeater station is set up in Ilagan through which they are connected to the sub-center.

The telemetry network is shown in Fig. 6-5. The system setups are identical to that in the Agno River Basin.

As in the case of the Agno River Basin, the 400 MHz band multiplex troposcatter telecommunication system should be applied for the automatic transmission of data to F F C

The monitoring and controlling of the telemetering stations from F.F.C. are identical with that employed in the Agno River Basin.

Since a direct connection to the Deliman relay station through the 400 MHz band multiplex telecommunication system is not feasible, a connection will be made from the sub-center in the Cagayan River Basin to that in the Agno River Basin, and both river basins will share the same multiplex telecommunication system between Carmen and Manila.

The S.S.B. telecommunication system as in the case of the Agno River Basin will be provided to back-up the multiplex telecommunication system in a possible event of suspension due to system faults or other troubles.

The results of the on-site investigations on the proposed telemetry stations are shown in Table 6-3.

For the satisfactory maintenance of this system, base station and land mobiles with VHF band should be set-up for the sub-center as in the case of the Agno River Basin.

Fig. 6-5 Telemetry Network

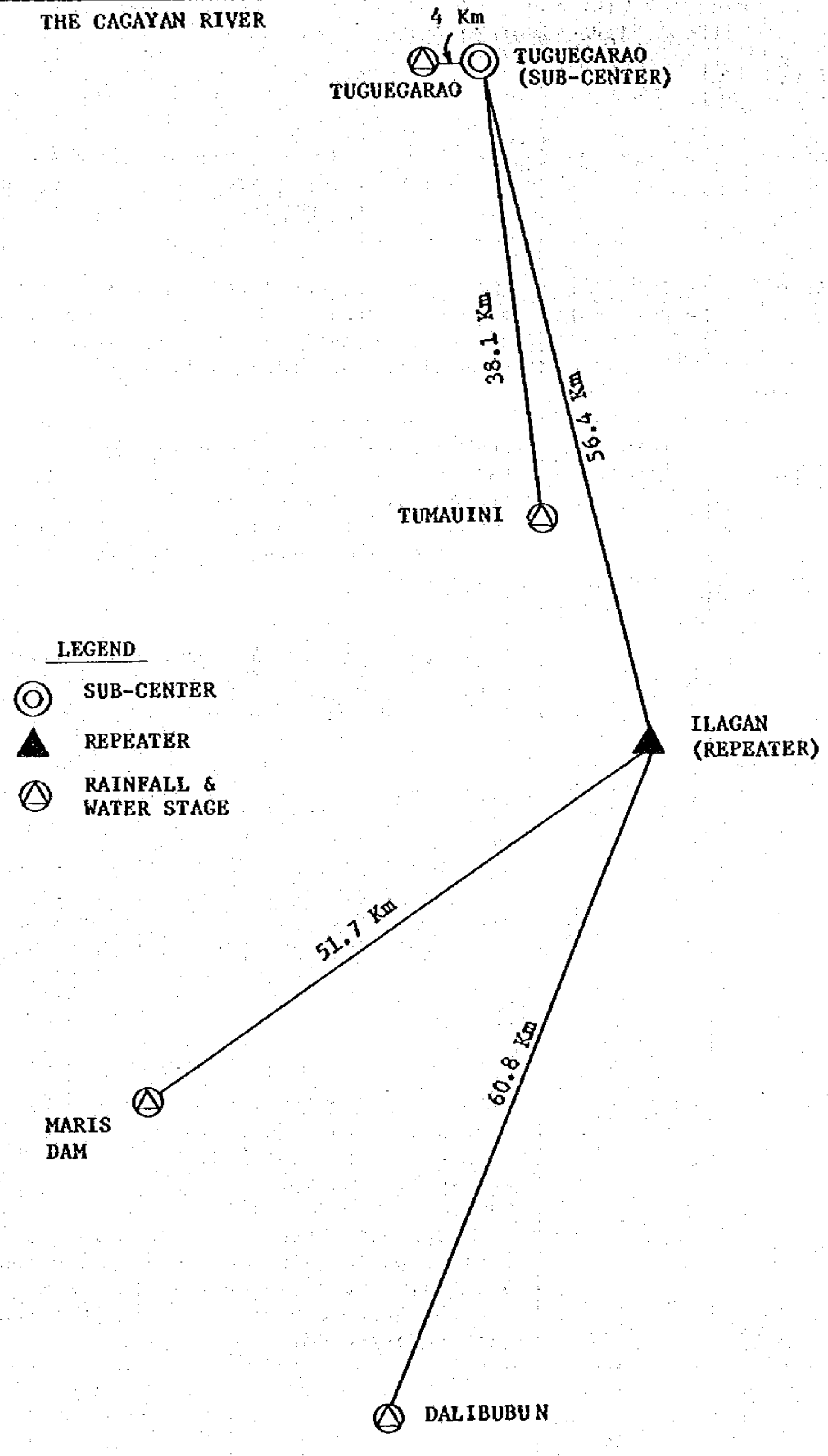


Table 6-3 Results of On-Site Investigations on the Proposed Telemetry Stations (The Cagayan River Basin)

Name of Station	Type	Remarks
Tuguegarao	Sub-center	Enough space is available for building and steel tower, and there is no specific problem for telemetry network.
Tuguegarao	Rainfall & water stage	The space for the station housing offers no problem. Direct connection to the sub-center can be made, and there is no propagation problem since the distance is short.
Tumauini	Rainfall & water stage	There is no problem relative to the space and propagation conditions. Direct connection is made to the Tuguegarao sub-center. Connection via the Ilagan repeater station is also feasible without presenting specific problem.
Ilagan	Repeater station	It is located in front of B.P.W. District Engineers office. There is no problem relative to the space and propagation condition.
Maris Dam	Rainfall & water stage	The propagation test conducted in the vicinity of the gaging station shows that the connection via the Ilagan repeater station offers no problem. For the time being, the antenna pole is constructed on the existing gaging housing, but if it is transferred to an area on the river bank in the future, better network may be obtained. The San Mateo repeater station once considered in the desk plan will become unnecessary.
Dalibubun	Rainfall & water stage	With the present location of the water stage gaging station no satisfactory telemetry network can be established. The station housing should be constructed in a farm on the river bank. No propagation problem is anticipated if connection is made via the Ilagan repeater station. The cable between the gaging site and the station housing should preferably be laid underground.

§·3. Design of Telecommunication System

Drawing up a plan of a wireless telecommunication system concerning the proposed system, the team has worked out designs on maps on the scale of 1/50,000 and 1/250,000.

Furthermore, regarding the telemetry system, the team has made corrections to the desk plan according to the results of the radio propagation tests conducted at this time. The details are as follows:

1. Telemetery System

a. Equipment and instruments used in propagation test

Item	Rating	Quantity	Remarks
Radtiotelephone	CRI-15, f.152.275 MHz	3	10W
Electric field strength meter	M-321C type, 20 230 MHz	1	
Diesel engine generator	300W AC220V DC12V	3	
Battery	12V 40AH	3	
Battery charger	100/200V 12V 10A	1	
Yagi antenna	3E provided with 10 m of pole assembly	3	
Through type wattmeter	TLP-52A 15W	2	
Terminal type wattmeter	15W	1	
Circuit tester	TL-700	3	
Transmission characteristic measuring instrument	MS-20M type	1	
S/N measuring instrument	KCD-1 type	2	
High frequency coaxial cable	5D-2V 10 m	3	
Voltage Regulator	200/100V 0 220V	1	
Tools	S-10	3	
Spares and accessories		1	

b. Method of Propagation Test.

(a) Propagation test equipments

The setup of the propagation test equipments are as shown in Fig. 6-6. Measurements were made on the following items:

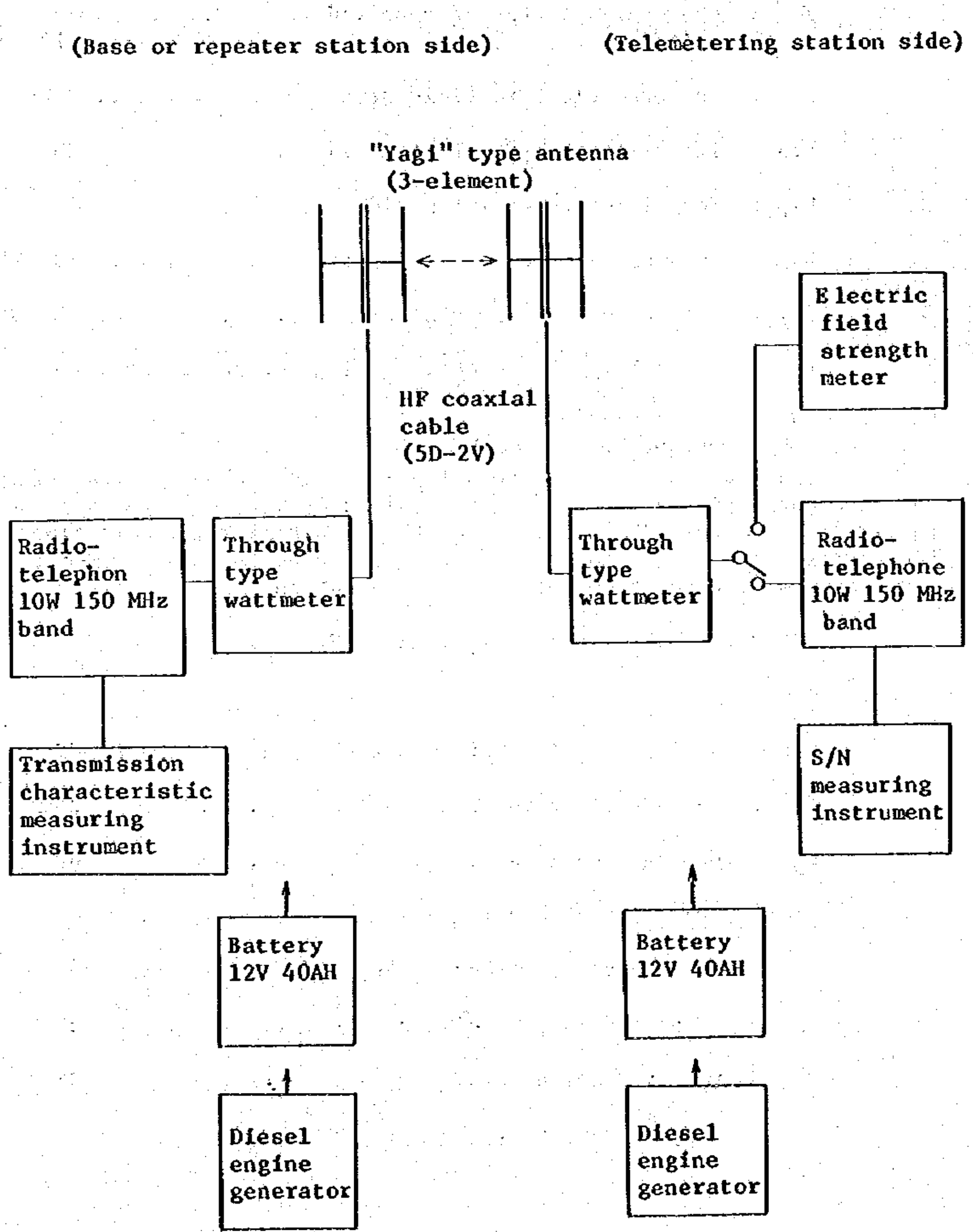
Received input power
Directivity of received wave
Relationship between antenna height and received power S/N ratio, etc.

(b) Team

Three teams were organized for the propagation tests: one team was assigned to the base (repeater) station, and two teams were assinged to the telemetering stations. One team comprised the following six persons:

Telecommunication engineer	one
Telecommunication technician	one
Driver	one
Laborer	two
Telecommunication Expert	one

Fig. 6-6 Schematic Diagram Showing Radio Wave Propagation Test Equipment



(c) Equation for propagation loss

$$L_p = X + r + L_{ft} + L_{fr} - G_{At} - G_{Ar} - P$$

where

L_p : propagation loss

X : conversion factor of received power and received voltage . . . . 113 dB

r : measured electric field strength . . . . dBμV

L_{ft} : feeder loss, transmitting side . . . . dB

L_{fr} : feeder loss, receiving side . . . . dB

G_{At} : antenna gain, transmitting side . . . . dB (GIS)

G_{Ar} : antenna gain, receiving side . . . . dB (GIS)

P : through type wattmeter reading (output power). dBm

C. Examination by experiments

(a) Examination for S/N ratio

Examination on signal to noise ratio in a channel. The team has made corrections to the design of telecommunication link based on the propagation loss (LP) obtained as the result of radio wave propagation tests. The signal to noise ratio (S/N) used in making the corrections was obtained from the following equation.

$$S/N = P_t - (L_p + L_f) + G_{At} + G_{Ar} - P_{rn} - I$$

where

S/N : signal to noise ratio in a channel . . . . . dB

P_t : antenna power in transmission . . . . dBm

L_p : propagation loss . . . . dB

L_f : transmitting and receiving feeder loss . . . dB

G_{At} : antenna gain, transmitting side . . . . dB (GIS)

G_{Ar} : antenna gain, receiving side . . . . db (GIS)

P_{rn} : received noise power . . . . dBm

* $P_{rn} = P_{rni} + P_{rne}$

where

P_{rni} : internal noise power of receiver . . dBm

P_{rne} : external noise power . . . . dBm

I : S/N improvement factor

$$* I = 10 \log(\frac{3fd^2 . B}{2fm^3}) \quad \ldots\ldots\ldots\ldots \quad dB$$

where

f_d : maximum frequency shift . . . . KHz

B : noise equivalent bandwidth of receiver "

f_m : maximum modulation frequency . . . . "

The design of telecommunication links for each river basin are shown in Table 6-4, Table, 6-5 and Table 6-6.
It is necessary to keep the signal to noise ratio (S/N ratio) at more than 30 dB at the standard condition of channel for each district.

(b) Reliability of link

The reliability of a single telecommunication link (above 95%) is justified acceptable when the antenna power P_t satisfies the criterion formula:

$$P_t > A$$

$$A(dBm) = (L_p + L_f + LF) + G_{At} + G_{Ar} - P_{th}$$

where

L_p : propagation loss . . . . dB

L_f : feeder loss . . . . dB

L_F : fading loss . . . . dB

= 0.1 (dB/km) x distance (km)

P_{th} : threshold level . . . . dBm

(a value higher than the addition of the internal noise power of a receiver (P_{rni}) and the external noise power (P_{rne}) by an amount equivalent to cf (9dB))

(c) Applicable radio frequency

It is necessary to provide the Agno River Basin with two new frequencies from VHF band; the Bicol River Basin and the Cagayan River Basin with two frequencies, too. The repeater system for each river basin is shown in Fig. 6-7, Fig. 6-8 and Fig. 6-9 respectively.

Aside from the telemetry links, another frequency from VHF band is necessary for the land mobiles. Consequently, a total of five frequencies from VHF band will be necessary.

Table 6-4 (1) AGNO SYSTEM

System Design Data Sheet

Item \ Name of Station	Unit	CARMEN ROSALES (Sub-Center) -TIBAG 44.35 Km		- WAWA 22.1 Km		- BANAGA 42.8 Km		-Sco. BABARA 25.6 Km		-Mt. Sto. TOMAS (Repeater) 51.8 Km		- CARMEN 1.7 Km	
Antenna power	dBm	+ 34.8	3 W	+ 30	1 W	+40	10 W	+ 30	1 W	+ 40	10 W	+30	1 W
Free space loss	dB	-110		-103.9		-109.7		-105.2		-111.3		- 81.7	
Additional loss	"	- 37.1		- 35.1		- 40.8		- 33.7		-29.5		- 13	
Feeder loss	"	- 2.1	AFZE-50-4 60 m		AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 3.1	AFZE-50-4 90 m	- 2.1	AFZE-50-4 60 m
Antenna gain (transmitting)	"	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 6	3-stage co-linear	+ 8	Yagi 3E
Antenna gain (receiving)	"	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear
	"												
	"												
Received power	dBm	-100.4		- 97.1		- 98.6		- 97		- 91.9		- 52.8	
Received noise power	"	-119		-119		-119		-119		-119		-119	
High frequency S/N.(C/N)	dB	18.6		21.9		20.4		22		27.1		66.2	
S/N improvement factor	"	12		12		12		12		12		12	
S/N in standard state	"	30.6		33.9		32.4		34		39.1		78.2	
Fading loss	"	- 7.4	0.1 dB/Km +3 dB	- 5.2		- 7.3		- 5.6		- 8.2		- 3.2	
S/N in each section during fading	"	23.2		28.7		25.1		28.4		30.9		75	
Total S/N	"												
Threshold level	dBm	-110		-110		-110		-110		-110		-110	
Fading margin against Threshold level	dB	9.6		12.9		11.4		13		18.1		57.2	
Margin against Threshold level during fading	"	2.2		7.7		4.1		7.4		9.9		54	
Remarks													

Table 6-4 (2) AGNO SYSTEM

Item \ Name of Station	Unit	- SAN ROQUE 27.7 Km		Mt. Sto. TOMAS (Repeater) - BINGDAM 18.65 Km	
Antenna power	dBm	+ 30	1 W	+ 34.8	3 W
Free space loss	dB	-105.9		-102.4	
Additional loss	"	- 23		- 41.1	
Feeder loss	"	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m
Antenna gain (transmitting)	"	+ 8	Yagi 3E	+ 8	Yagi 3E
Antenna gain (receiving)	"	+ 6	3-stage co-linear	+ 6	3-stage co-linear
	"				
	"				
Received power	dBm	- 87		- 96.8	
Received noise power	"	-119		-119	
High frequency S/N, (C/N)	dB	32 12		22.2 12	
S/N improvement factor	"	44		34.2	
S/N in standard state	"	- 5.8		- 4.9	
Fading loss	"	38.2		29.3	
S/N in each section during fading	"				
Total S/N	"				
Threshold level	dBm	-110		-110	
Fading margin against Threshold level	dB	23		13.2	
Margin against Threshold level during fading	"	17.2		8.3	
Remarks					

Table 6-5 (1) BICOL SYSTEM System Design Data Sheet

Item \ Name of Station	Unit	NAGA (Sub Center) - BARONGAY 11.2 Km		-CAMALIGAN (Wire system)	- OCAMPO 23.35 Km		- OMBAO 17.6 Km		- SIPOCOT HILL (Repeater) 27.85 Km		- IRIGA (Repeater) 33.6 Km	
Antenna power	dBm	+ 30	1 W		+30	1 W	+30	1 W	+ 40	10 W	+ 40	10 W
Free space loss	dB	- 98.5			-104.6		-102.5		-106.5		-108	
Additional loss	"	- 29			- 36.4		- 25.8		- 22		- 22.5	
Feeder loss	"	- 2.1	AFZE-50-4 60 m		- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 3.1	AFZE-50-4 90 m	- 3.1	AFZZE-50-4 90 m
Antenna gain (transmitting)	"	+ 8	Yagi 3E		+ 8	Yagi 3E	+ 8	Yagi 3E	+ 6	3-stage co-linear	+ 6	3-stage co-linear
Antenna gain (receiving)	"	+ 6	3-stage co-linear		+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear
Received power	dBm	-85.6			- 99.1		- 86.4		- 79.6		- 81.6	
Received noise power	"	-119			-119		-119		-119		-119	
High frequency S/N, C/N	dB	33.4			19.9		32.6		39.4		37.4	
S/N improvement factor	"	12			12		12		12		12	
S/N in standard state	"	45.4			31.9		44.6		51.4		49.4	
Fading loss	"	- 4.1	0.1 dB/Km +3 dB		- 5.3		- 4.8		- 5.8		- 6.4	
S/N in each section during fading	"	41.3			26.6		39.8		45.6		43	
Threhold level	dBm	-110			-110		-110		-110		-110	
Fading margin against threhold level	dB	24.4			10.9		23.6		30.4		28.4	
Margin against threhold level during fading	"	20.3			5.1		18.8		24.6		22	
Remarks												

Table 6-5 (2) BICOL SYSTEM System Design Data Sheet

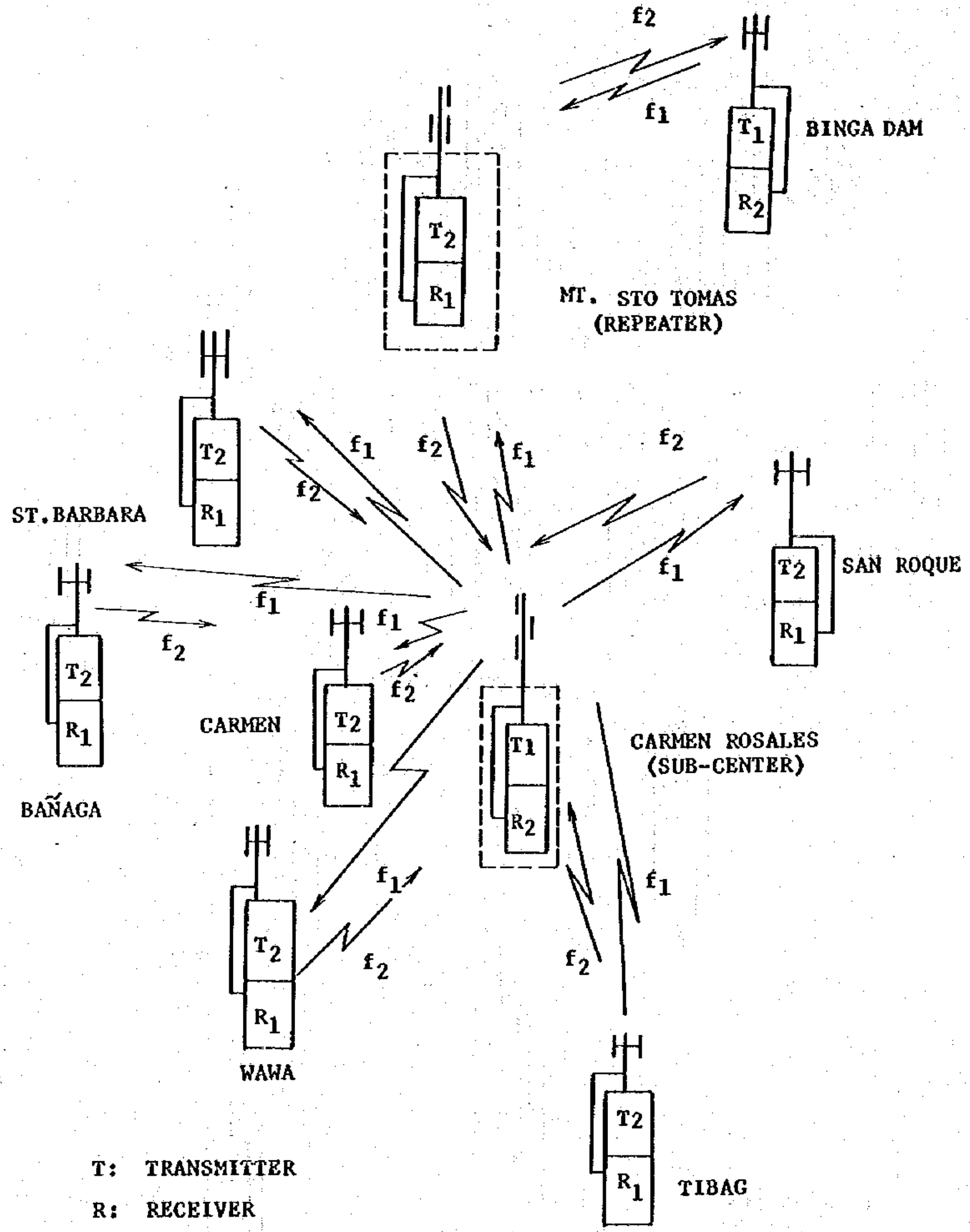
Item \ Name of Station	Unit	SIPOCOT HILL (Repeater) - SIPOCOT 3.75 Km		- NAPOLIDAN 13.1 Km		- BATO 8.4 Km		IRIGA (Repeater) - BUHI 12.5 Km		- LIGAO 24.5 Km		- OMBAO 18.5 Km	
Antenna power	dBm	+ 30	1 W	+ 34.8	3 W	+ 30	1 W	+ 34.8	3 W	+ 40	10 W	+ 30	1 W
Free space loss	dB	- 89		-100		- 91.5		- 99		-105		-100	
Additional loss	"	- 15		- 42.5		- 26.5		- 45.5		- 45.5		- 27.5	
Feeder loss	"	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m	- 2.1	AFZE-50-4 60 m
Antenna gain (transmitting)	"	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E	+ 8	Yagi 3E
Antenna gain (receiving)	"	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear	+ 6	3-stage co-linear
Received power	dBm	- 62.1		- 95.8		- 76.1		- 97.8		- 98.6		- 88.6	
Received noise power	"	-119		-119		-119		-119		-119		-119	
High frequency S/N, C/N	dB	56.9		23.2		42.9		21.2		20.4		30.4	
S/N improvement factor	"	12		12		12		12		12		12	
S/N in standard state	"	68.9		35.2		54.9		33.2		32.4		42.4	
Fading loss	"	- 3.4		- 4.3		- 3.8		- 4.3		- 5.5		- 4.9	
S/N in each section during fading	"	65.5		30.9		51.1		28.9		26.9		37.5	
Threhold level	dBm	-110		-110		-110		-110		-110		-110	
Fading margin against threhold level	dB	47.9		14.2		33.9		12.2		11.4		21.4	
Margin against threhold level during fading	"	44.5		9.9		30.1		7.9		5.9		16.5	
Remarks													

Table 6-6 CAGAYAN SYSTEM System Design Data Sheet

Item \ Name of Station	Unit	TUGUEGARAO (Sub Center) - TUGUEGARAO 4.0 Km		- TUMAUINI 38.1 Km		- ILAGAN 56.4 Km		ILAGAN (Repeater) - DALIBUBUN 60.8 Km		- MARIS DAM 51.7 Km		- TUMAUINI 18.65 Km	
Antenna power	dBm	+30	1 W	+40	10 W	+40	10W	+40	10W	+34.8	3 W	+30	1 W
Free space loss	dB	-89.5		-109		-112.5		-113		-112		-103	
Additional loss	"	-12.5		- 43		-35		- 40.3		-31.5		-19	
Feeder loss	"	-2.1	AFZE-50-4 60 m	-2.1	AFZE-50-4 60 m	-3.1	AFZE-50-4 60 m	-2.1	AFZE-50-4 60 m	-2.1	AFZE-50-4 60 m	-2.1	AFZE-50-4 60 m
Antenna gain (transmitting)	"	+8	Yagi 3E	+8	Yagi 3E	+6	3-stage co-linear	+11	Yagi 5E	+8	Yagi 3E	+8	Yagi 3E
Antenna gain (receiving)	"	+6	3-stage co-linear	+6	3-stage co-linear	+6	3-stage co-linear	+6	3-stage co-linear	+6	3-stage co-linear	+6	3-stage co-linear
	"												
	"												
Received power	dBm	-60.1		-100.1		-98.6		- 98.4		-96.8		-80.1	
Received noise power	"	-119		-119		-119		-119		-119		-119	
High frequency S/N, C/N	dB	58.9		18.9		20.3		20.6		22.22		38.9	
S/N improvement factor	"	12		12		12		12		12		12	
S/N in standard state	"	70.9		30.9		32.3		32.6		34.2		50.9	
Fading loss	"	-3.4	0.1 dB/Km +3 dB	-6.8		-8.6		-9.1		-8.2		-4.9	
S/N in each section during fading	"	67.5		24.1		23.7		23.5		26		46	
Total S/N	"												
Threshold level	dBm	-110		-110		-110		-110		-110		-110	
Fading margin against threshold level	dB	49.9		9.9		11.3		11.6		13.2		29.9	
Margin against threshold level during fading	"	46.5		3.1		2.7		2.5		5		2.5	
Remarks													

Fig. 6-7 Telemeter Trunk Network System Diagram

THE AGNO RIVER



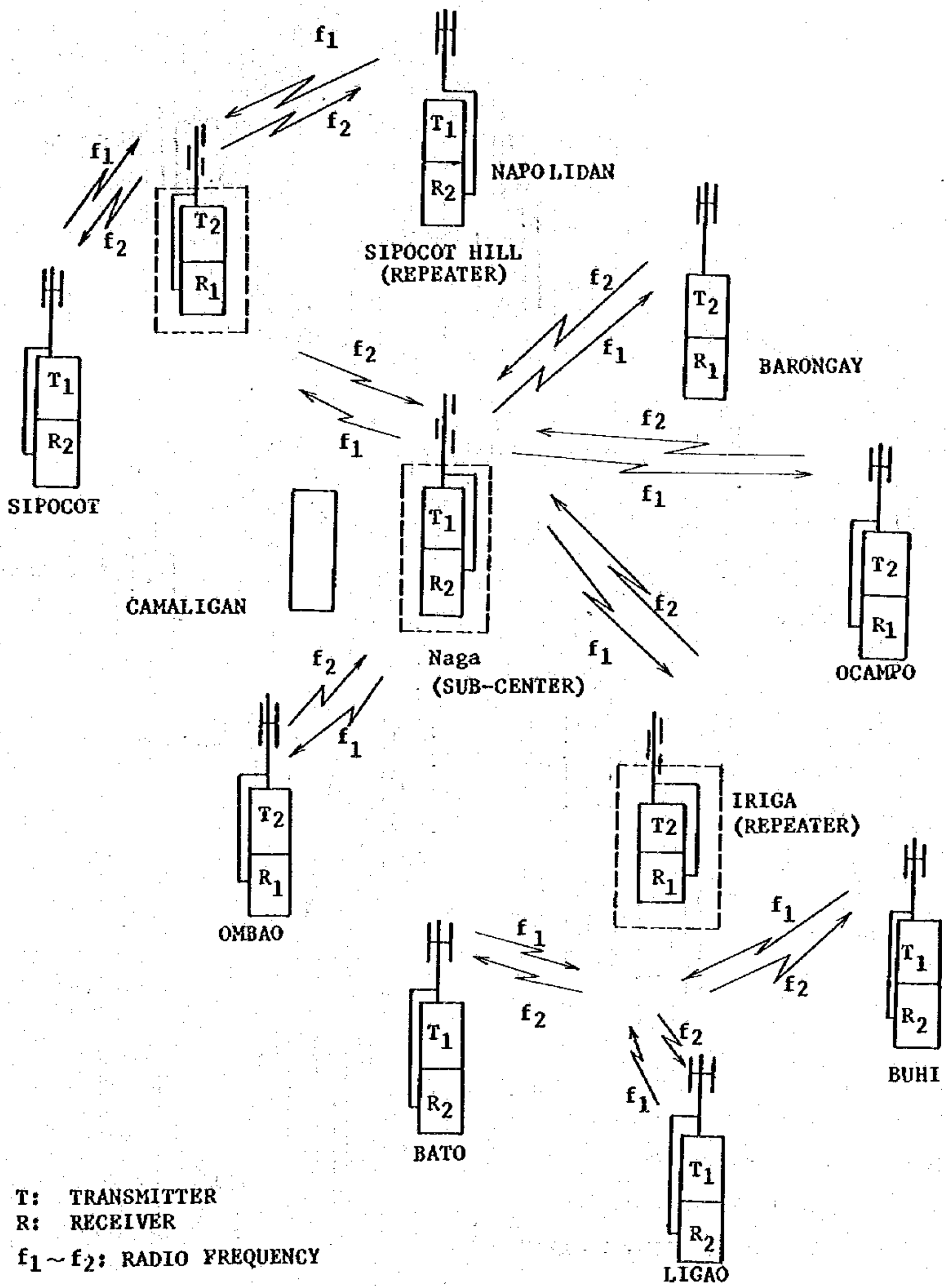
T: TRANSMITTER

R: RECEIVER

f1～f2: RADIO FREQUENCY

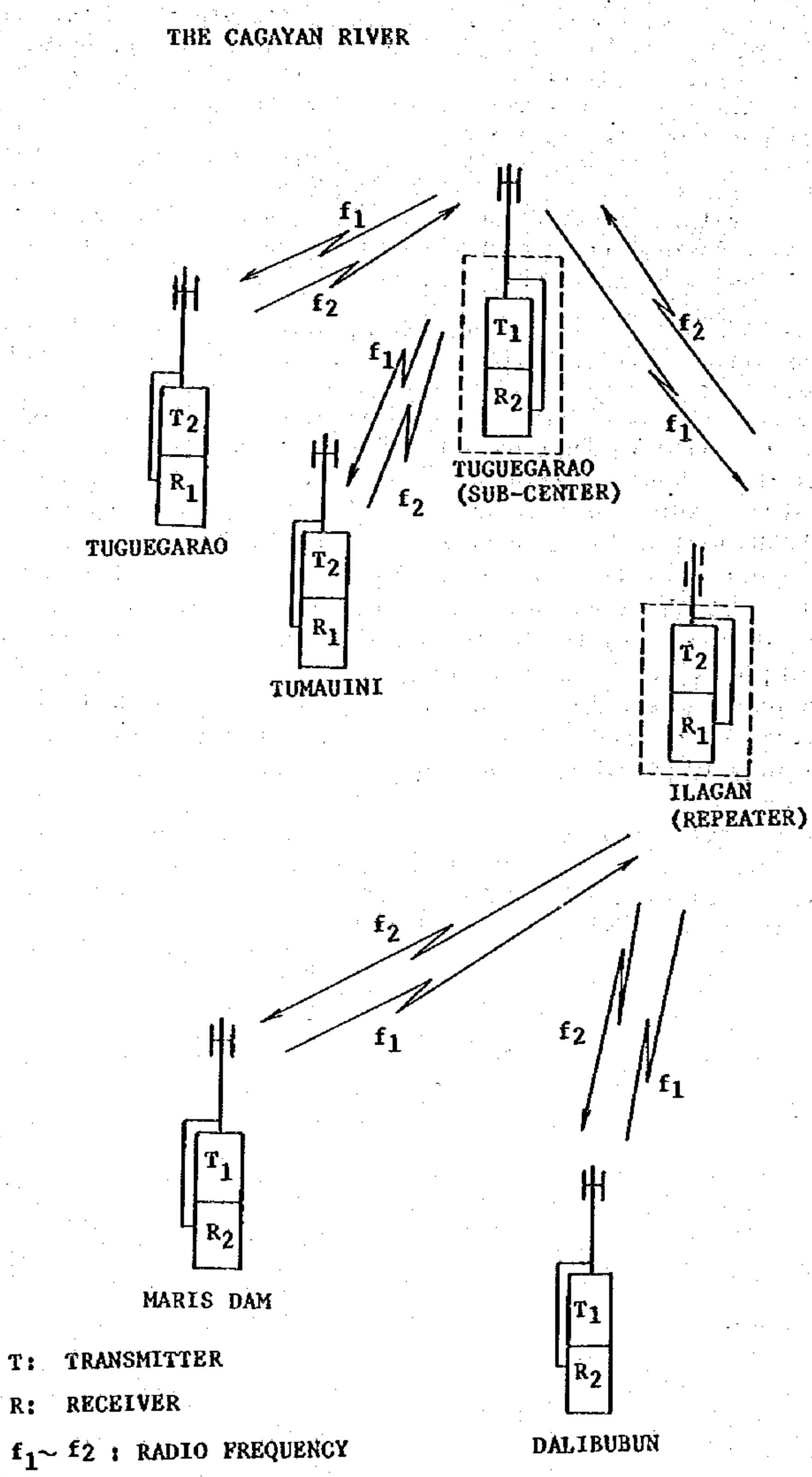
Fig. 6-8 Telemeter Trunk Network System Diagram

THE BICOL RIVER



T: TRANSMITTER
R: RECEIVER
$f_1 \sim f_2$: RADIO FREQUENCY

Fig. 6-9 Telemeter Trunk Network System Diagram



2. Multiplex Telecommunication Network

The 400 MHz band multiplex telecommunication links which connect each sub-center with F F C and B P W in Manila via the relay stations have been examined in the desk plan, and are shown in Fig. 6-10. The system configuration is shown in Fig. 6-11, and the system design data are tabulated in Table 6-7. For the Agno River Basin, the proposed links configuration envisages a repeater station to be constructed in Deliman in the vicinity of Manila for achieving connection to F F C and B P W Direct connection of the sub-center in the Cagayan River Basin to the relay station at Deliman will be difficult, hence, the Cagayan River Basin will be connected to the Agno sub-center and share the Agno telecommunication system up to F F C and B P W

In the case of the Bicol River Basin, direct connection to the sub-center will be difficult if a relay station is located at Deliman. Therefore, it is recommended that a relay station be established at Tanay, so that the Bicol River Basin will be connected via Tanay to Deliman or PAGASA, whichever is better. It is, however, possible to change the circuit between Naga and Tanay judging from the results of the radio propagation test. This is because the map (scale: 1/50,000) in the vicinity of Tanay could not be procured in the performed surveys. In view of fairly long distance between each sub-center and the relay station, it will be necessary to employ the frequency diversity system to mitigate the fading effects. For satisfactory implementation of this system, four pairs (8 frequencies) of radio frequencies for the troposcatter system with 400 MHz band and three pairs (6 frequencies) for the short distance telecommunication in the vicinity of Manila will be required.

Being the desk plan, radio propagation tests and on-site investigation are necessary before implementing the project. In its outline the project is as follows:

River System	Section	Type	Capacity	Antenna power	Distance	Remarks
Agno River Basin	Carmen Rosales (sub-center)←→Deliman (relay station)	Troposcatter system	(CH) 12	(W) 50	(km) 163.1	Frequency diversity system
	Deliman (relay station) PAGASA (F F C)	Applicable standards	12 or 24	10	3.0	
	PAGASA (F F C) ←→ B P W	"	"	10	8.8	
Bicol River Basin	Naga (sub-center) ←→ Tanay (relay station)	Troposcatter system	6 or 12	50	222	Frequency diversity system
	Tanay (sub-center) ←→ Deliman (relay station)	Applicable standards	12 or 24	10	32	
Cagayan River Basin	Tuguegarao (sub-center) ←→ Carmen Rosales (Sub-center)	Troposcatter system	6	(kW) 1.0	224.5	Frequency diversity system

3. Back-up Telecommunication Links

Short wave telecommunication system should be established from each sub-center to F F C and B P W as a back-up in case of suspension of the multiplex telecommunication network. Fig. 6-12 shows a schematic network of these back-up telecommunication links, and Fig. 6-13 shows the system setup of the links.

The frequency ranges will be 3 MHz, 5 MHz and 7 - 8 MHz. Alternative use of these three frequency ranges will ensure a satisfactory telecommunication system throughout the year.

4. VHF Telecommunication Links

For a smooth operation and maintenance of this system, each sub-center should be provided with base and mobile stations with VHF band to permit radio-telephone communication readily be available.

Fig. 6-10 Multiplex Telecommunication Network

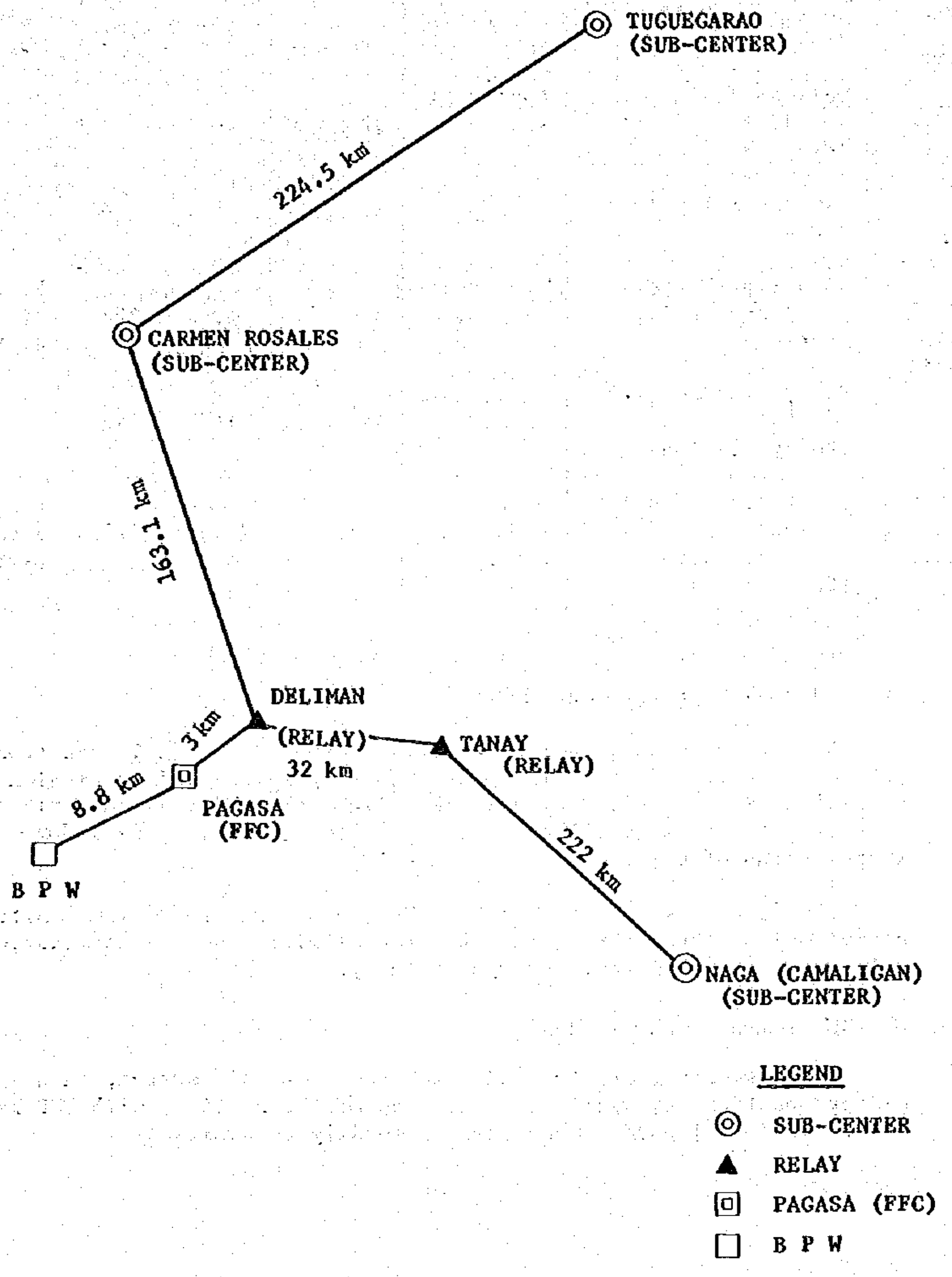


Fig. 6-11 Schematic Multiplex Telecommunication

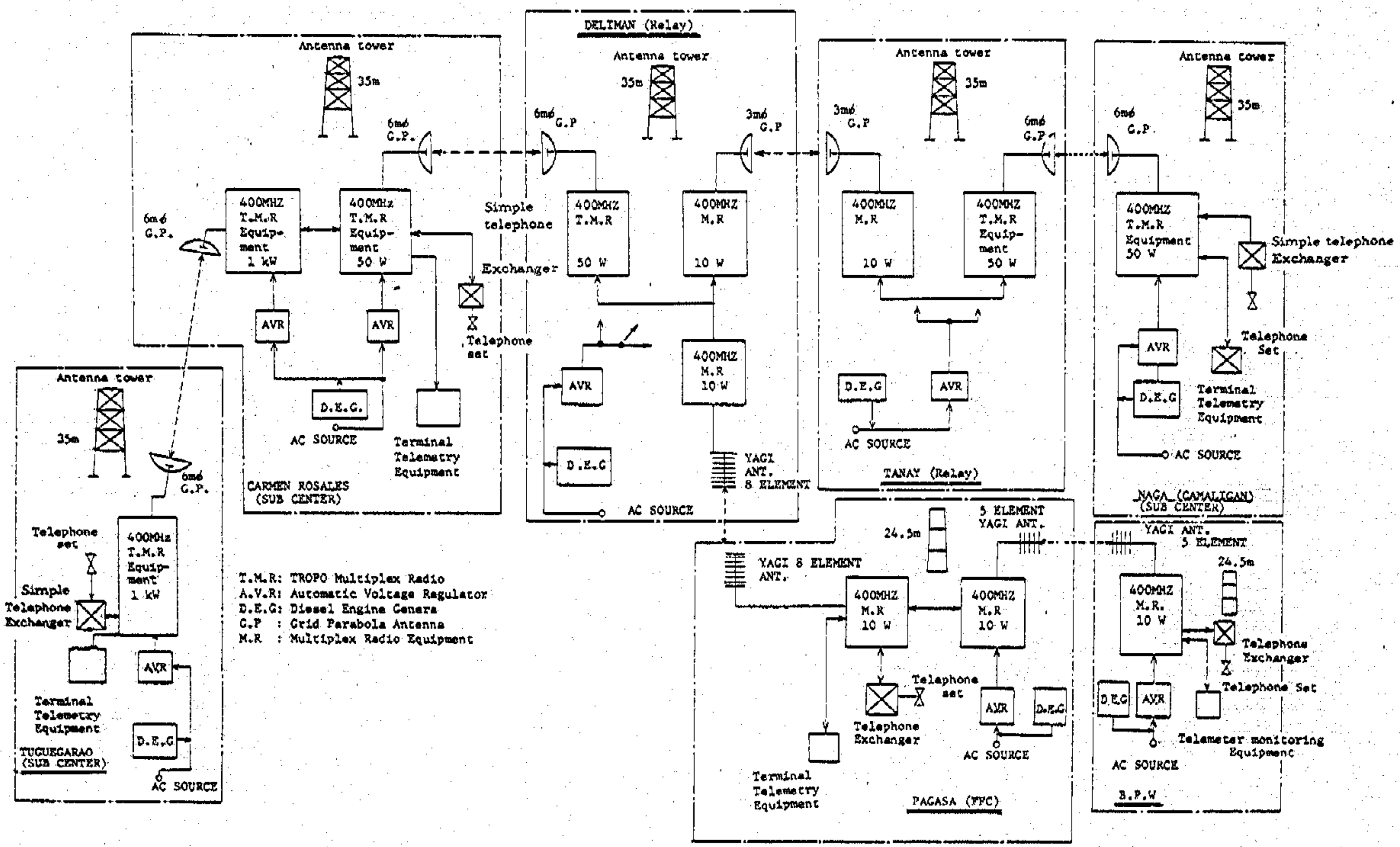


Table 6-7 Network system calculation chart (Multiplex telecommunication network)

System Design Data Sheet

Name of station / Item	Unit	Agno River Basin						Bicol River Basin				Cagayan River Basin	
		Carman Rosales (Sub Center) Daliman (Relay) (163.1 Km)		Daliman (Relay) -PAGASA(F.F.C.) (3 Km)		Pagasa (F.F.C) - B.F.W. (8.8 Km)		Naga (Sub Center) - Tanay (Relay) (222 Km)		Tanay (Relay) - Daliman (Relay) (32 Km)		Tuguegarao (Sub Center) - Carman Rosales (Sub Center) (224.5 Km)	
Antenna power	dBm	+47	50 W	+40	10 W	+40	10 W	+47	50 W	+40	10 W	+60	1 kW
Free space loss	dB	-171.2	f:400 MHz	-94	f : 400 MHz 3 Km	-103	f: 400 MHz 8.8 Km	-180.1		-114.5	f: 400 MHz 32 Km	-193.5	
Additional loss	"	+6	Experimental correction	-10	Topographic factor	-10	Topographic factor	+6	Experimental correction	+35	Topographic factor	-6	Experimental correction
Feeder loss	"	-4.2	AFZE-50-10 70+70m	-5.6	AFZE-50-7 70+70m	-5.6	AFZE-50-7 70+70m	-4.2		-5.6	AFZE-50-7 70+70m	-2.8	
Antenna gain (transmitting)	"	+25.5	6m ϕ G.P.B.R.	+11	Yagi 3E	+13	Yagi 8E	+25.5	6m ϕ G.P.B.R.	+19	3m ϕ G.P.B.R.	+25.5	6m ϕ G.P.B.R.
Antenna gain (receiving)	"	+25.5	"	+11	"	+11	"	+25.5	"	+19	"	+25.5	"
Duplex system loss	"	-3		-7	T 2dB,R 5dB	-7	T 2dB,R 5dB	-3		-7	T 2dB,R 5dB	-3	
	"												
Received power	dBm	-86.4		-54.6		-59.6		-95.3		-84.1		-94.3	
Received noise power	"			-110		-110				-110			
High frequency S/N.(C/N)	dB			55.4		50.4				25.9			
S/N improvement factor	"	+4	Frequecy diversity improvement	+8		+8		+4	Frequency diversity improvement	+8		+4	Frequency civer-sity improvement
S/N in standard state	"	51.6		63.4		58.4		+42.7		33.9		43.7	
Fading loss	"	-16		-3.6	0.2dB/Km×3+3	-4.8	0.2dB/Km×8.8 +3=4.76dB	-16		-9.4	0.2dB/Km×32 +3=9.4dB	-16	0.2dB/Km×8.8 +3=4.76dB
S/N in during fading	"	29		59.8		53.6		21		24.5		21	
Total S/N													
Threshold level	dBm	-105		-101		-101		-113		-101		-113	
Fading margin against threshold level	dB			46.4		41.4				16.9			
Margin against threshold level during fading	"	18.6		42.8		36.6		17.7		7.5		18.7	
Remarks		Troposcatter system						Troposcatter				Troposcatter	

Fig. 6-12 SHORT WAVE TELECOMMUNICATION NETWORK

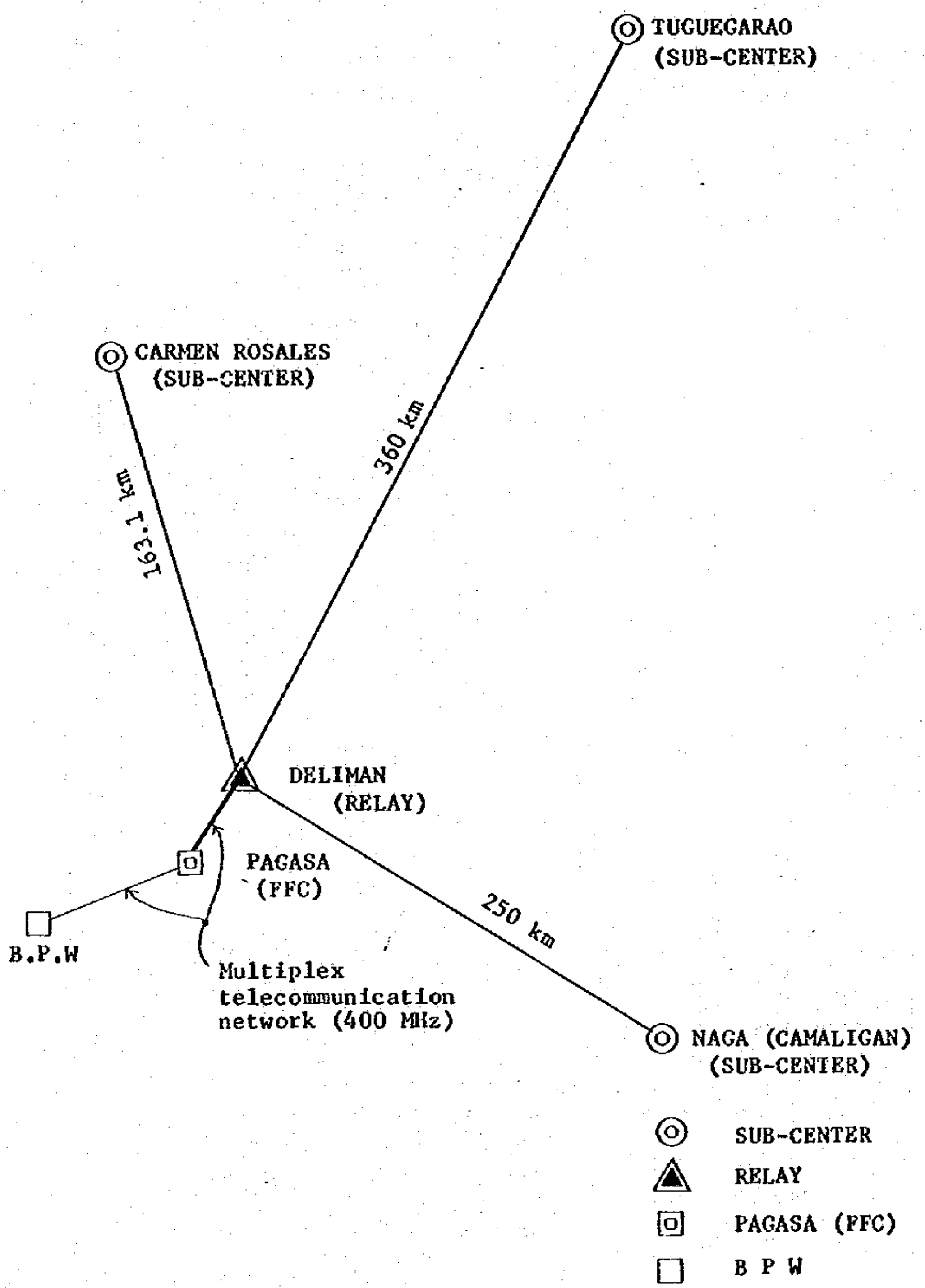
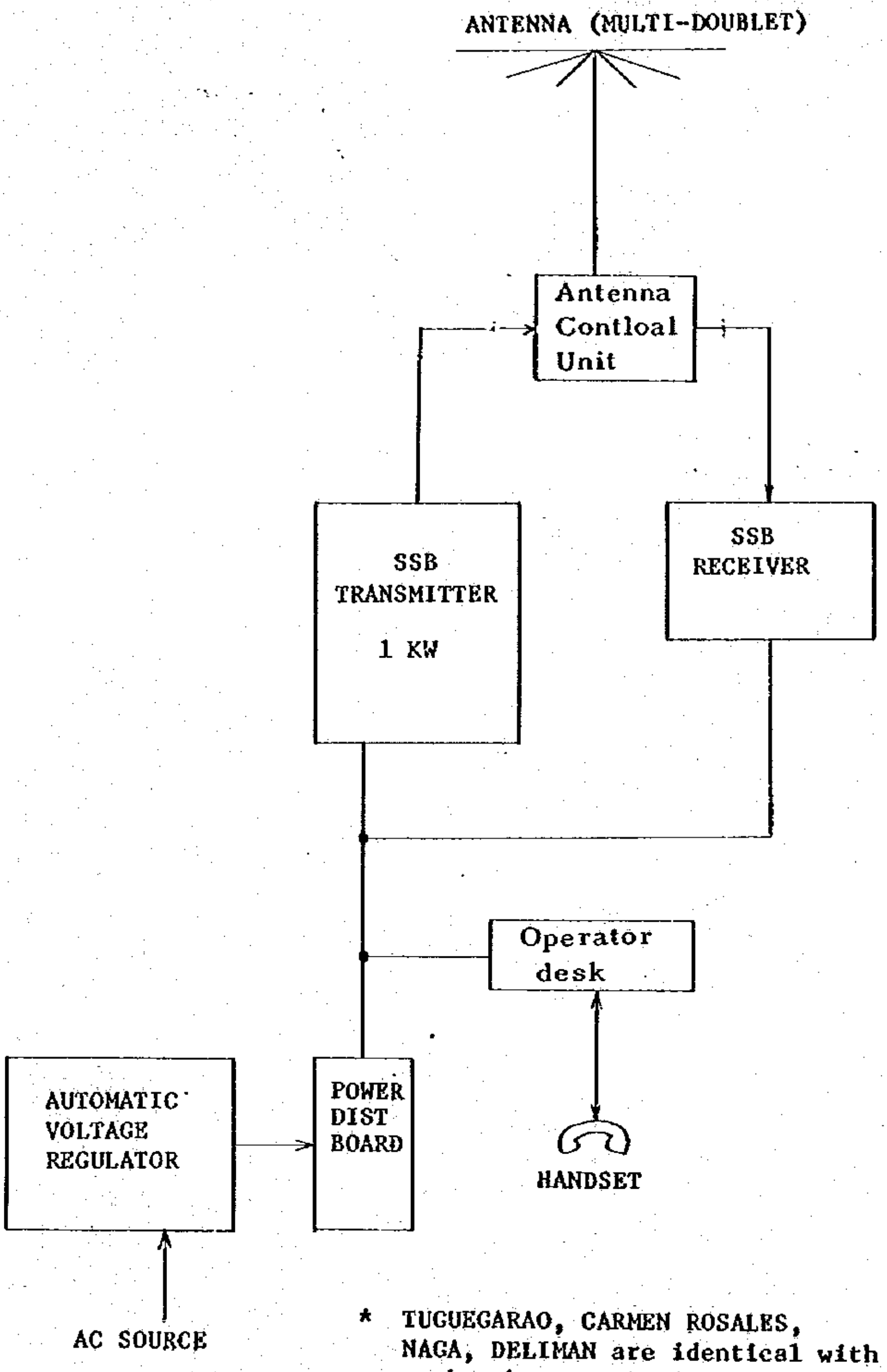


Fig. 6-13 Schematic Diagram of S,S.B Radio Station



* TUGUEGARAO, CARMEN ROSALES, NAGA, DELIMAN are identical with each other systemwise.

VII. Design of Gaging Stations and Telecommunication Facilities

§-1. Design of Gaging Stations

1. Housing

1-1 Rainfall gaging stations

(1) Location

It is desirable that the region in question be divided into areas where rainfall over the respective areas is about equal one another and a rainfall gaging station be located in each area.

Also for flood forecasting purposes these stations should be equipped with telemetering facilities to ensure positive collection of observation data.

(2) Selection of installation sites

In selecting the installation sites for the rainfall gaging stations, a field survey must be conducted to check the following conditions.

a. Avoid narrow areas where disturbances to wind direction and wind speed are observed.

b. Avoid location where rainfall conditions are disturbed by.

c. Sites providing less disturbances to telemeter communications.

(3) Determination of installation sites

The installation sites should be determined to meet the following requirements.

a. Open site at least 10 m^2 in area with less changes in the air streams.

b. Site free from flood.

c. Site which offers ready access to gaging and where gage keepers are readily available.

Generally, buildings and big trees located adjacent to the rainfall gaging stations can affect the wind conditions which in turn will probably disturb rainfall measurements.

There is no accepted theory in regard to scope of such effects, however it is considered desirable in Japan that the station be located in an open site which is at least 600 m^2 in area or that there be a distance of four times the height of adjacent buildings or trees. However it is really in feasible to obtain sites meeting such requirements in Japan, so open sites 10 m^2 approx. have been selected.

The sites of the rainfall gaging stations to be constructed in the Agno, Bicol and Cagayan River Basins, are described in Table. Sketches of the proposed sites are as shown in Appendix.

The construction of Banban gaging station in the Agno River Basin is proposed only when an overall flood forecasting system covering the Pampanga River is completed in the future.

1-2 Water level gaging stations

(1) Location

Water level gaging stations were to be located in areas considered necessary for flood forecasting purposes.

(2) Selection of installation sites

Following factors have been considered in selecting the suitable sites for the water stage gaging stations.

a. Sites where the flow is steady and shows no significant changes in the flow conditions with changes in discharge.

b. Sites where river channel and river bed conditions are relatively steady are to be selected to secure a continued observation for uninterrupted observation records.

c. Sites with a minimum of possible hazards during observation, which provide ease of observation even during flooding.

d. Sites where gage keepers are readily available.

e. Sites having no concern of lakes and marshes and reservoirs being formed, or stationery points (or sections).

f. Sites where water will not dry up during a dray season.

g. Sites which are free from the attack of high waves, driftwood, etc. or where special protections are provided against these attacks.

h. Sites where mooring of boats or rafts is prohibited.

i. Sites where propagation of telemeter waves is good.

The installation site for each river basin has been determined considering the above factors. The sketch of proposed sites is as shown in Appendix.

No detailed survey has been conducted on the possible construction of the Aparri gaging station along the Cagayan River, however it should be constructed taking the future development of the river basin into consideration.

1-3 Selection of discharge gaging points

The following eight locations were selected for observing the discharge for flood forecasting purposes.

		Survey method
Agno river basin	Sta Barbara	Current Meter
	Wawa	"
	San Roque	Float
	Carmen	Current Meter
	Tibag	"
	Binga Dam	Obtain H-Q curve based on Binga Dam water discharge
Bicol river basin	Sipocot	Current Meter
	Camaligan	"
	Ombao	"

Discharge observation will be carried out in the vicinity of the water stage gaging station. For points where current meter is used, measurement is made from the bridge above. The float method will be used at San Roque by means of a float dropper; it may, however, be switched to a weir discharge curve (weir method) employing the existing weir for irrigation water.

Criteria for the selection of installation sites are as follows.

a. Water current is steady.

b. Rate of flow is not too rapid or too slow.

c. Variations in water channel and river bed are as little as possible.

d. Observation is possible even during dry seasons.

e. Safety in observation work.

f. The site is conveniently located.

2. Facilities

2-1 Rainfall gage

The recording rain gage is the most commonly used. There are several types of the gage according to the sensor configuration; tumbling type, tank type and weight measure type. For ready access to telemeterization, tumbling type rainfall gages were adopted.

2-2 Recording water level gages

(1) Selection of recording water stage gages

In the selection of recording water stage gages, instrumental features (analogue or digital, easiness of reading etc.), environmental conditions (waves, river bed fluctuations, etc.), processing method (necessity of manual operation), and cost (including the installation cost) are to be considered.

(2) Types of recording water stage gages

a. Suiken Model 62

Using two types of pen to ensure recording ranges of 10, 20 and 50 m with a minimum of 1 cm. Clocks are available in two types; one-month and three-month winding.

b. Suiken Model 70

Similar to Suiken Model 62, equipped with a damper that allows use of the equipment where high waves are anticipated.

c. Lead switch type (Sensing pole)

Lead switches are installed at intervals of 1 cm on the inside wall of a pipe placed vertically in water, and the movement of a magnet attached to the float within the pipe causes the lead switch to open and close to read the water stage. This water stage gage has no limitations in the recording range, allowing a minimum recording width of 1 cm. Recording is made either by pring method or cassette tape method and permits three-month measurements at time intervals of 10 minutes.

Water stage gages have thus been selected taking the instrumental features, river conditions, and water stage fluctuations, etc. into consideration.

A listing of the gaging stations in the Agno, Bicol and Cagayan River Basins for flood forecasting is shown in the following table.

List of the Gaging Station

No.	Location of station	River basin	Typf of water level gaging station	Rainfall gaging station	Measurement
1	Bañaga	Agno	well-type		
2	Sta. Barbara	"	"	1	Current meter
3	Wawa	"	"	1	"
4	Binga Dam	"	Sensing pole type	1	
5	San Roque	"	"	1	Float dropper
6	Carmen	"	"	1	Current meter
7	Tibag	"	"	1	"
8	(Banban)	"		(1)	
Sub total			well 3 pole 4	6(7)	
9	Napolidan	Bicol		1	
10	Sipocot	"	Sensing pole-type	1	Current meter
11	Barongay	"	"	1	
12	Camaligan	"	well-type	1	Current meter
13	Ocampo	"		1	
14	Ombao	"	well-type	1	Current meter
15	Bato	"	sensing pole-type	1	
16	Buhi	"	well-type	1	
17	Ligao	"		1	
Sub total			well 3 pole 3	9	
18	Dalibubun	Cagayan	well-type	1	
19	Maris Dam	"	sensing pole-type	1	
20	Tumauini	"	"	1	
21	Tuguegarao	"	"	1	
22	(Aparri)	"	(well-type)	(1)	
Sub total			well 1 (2) pole 3	4(5)	
Total			well 7(8) pole 10	19(21)	

Fig. 7—1 ARRANGEMENT OF TYPE FOR RAINFALL, WATER STAGE, DISCHAGE & HOUSING

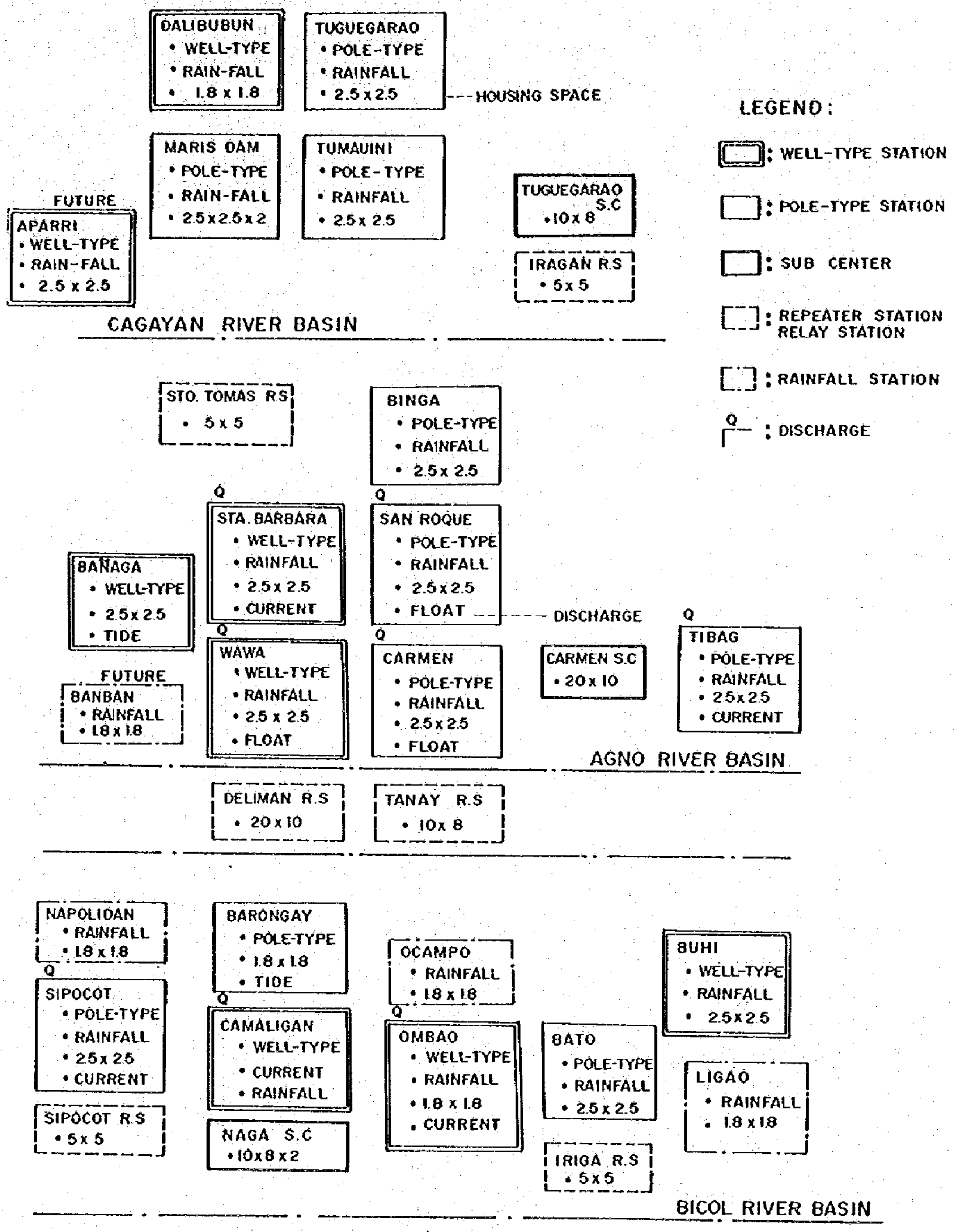
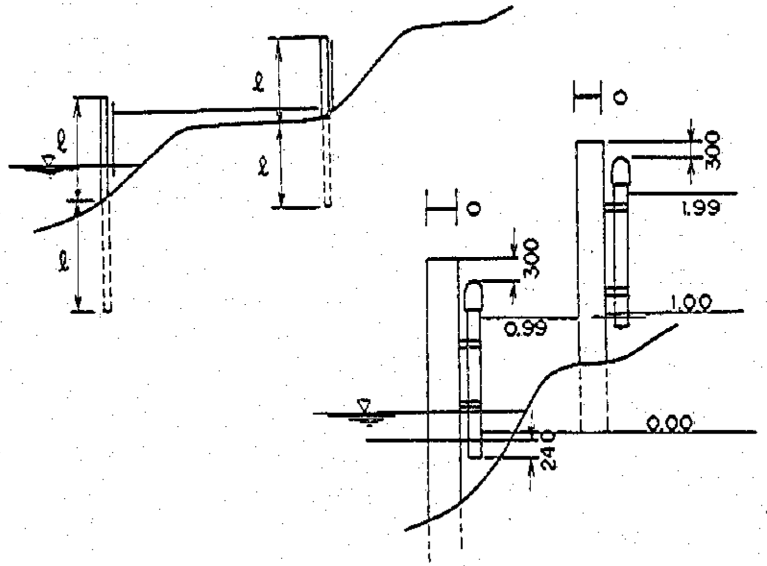


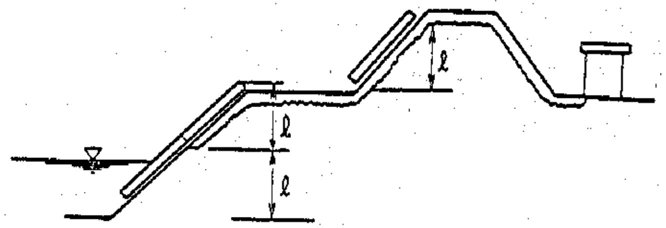
Fig 7—2 WATER STAGE STATION POLE - TYPE

UNIT : mm

TYPE A



TYPE B



TYPE C

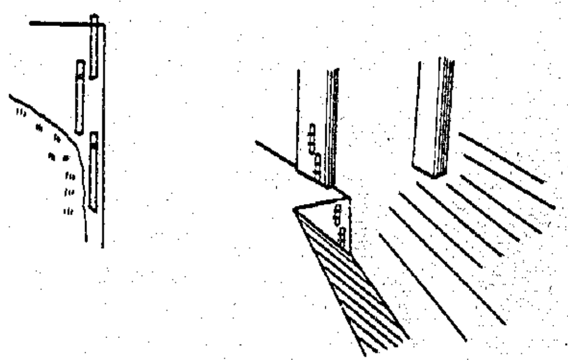


Fig. 7—3 WATER STAGE STATION WELL TYPE

UNIT ; mm

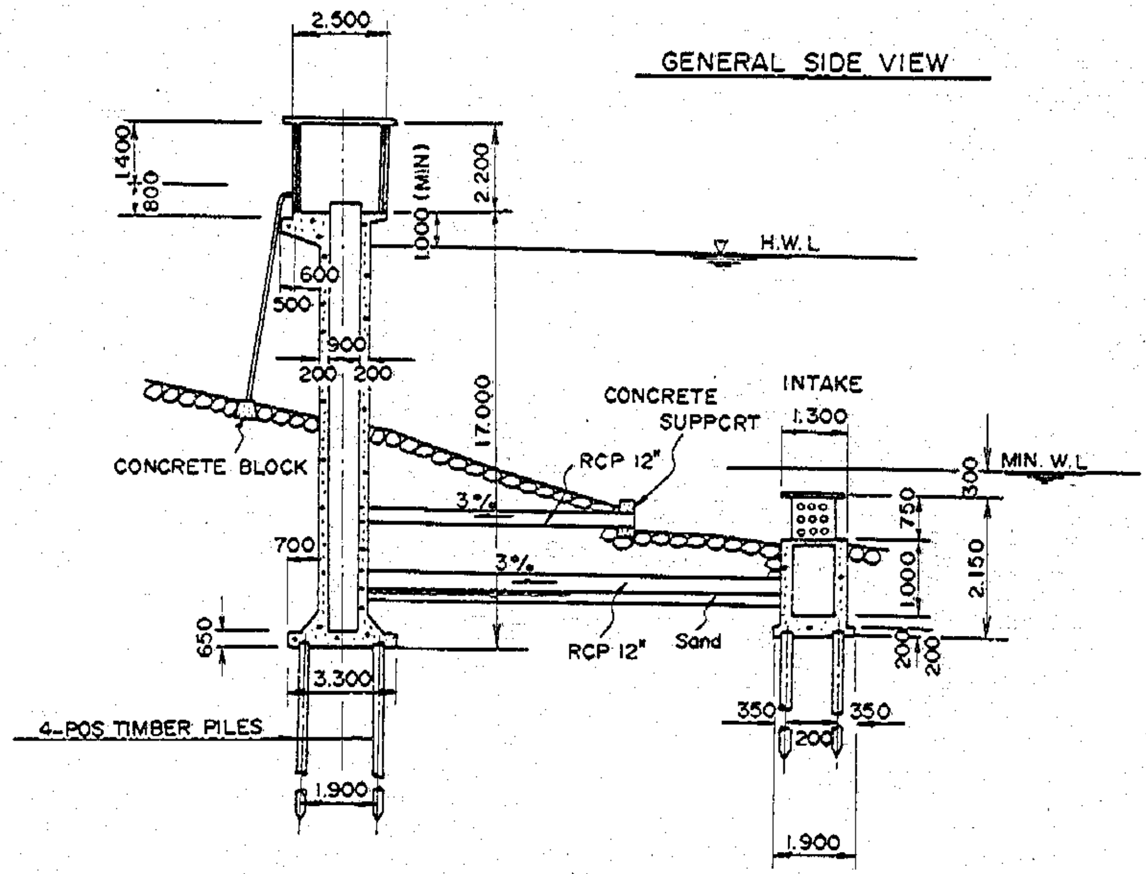


Fig 7—5 FLOATER DROPPING FACILITIES

UNIT : mm

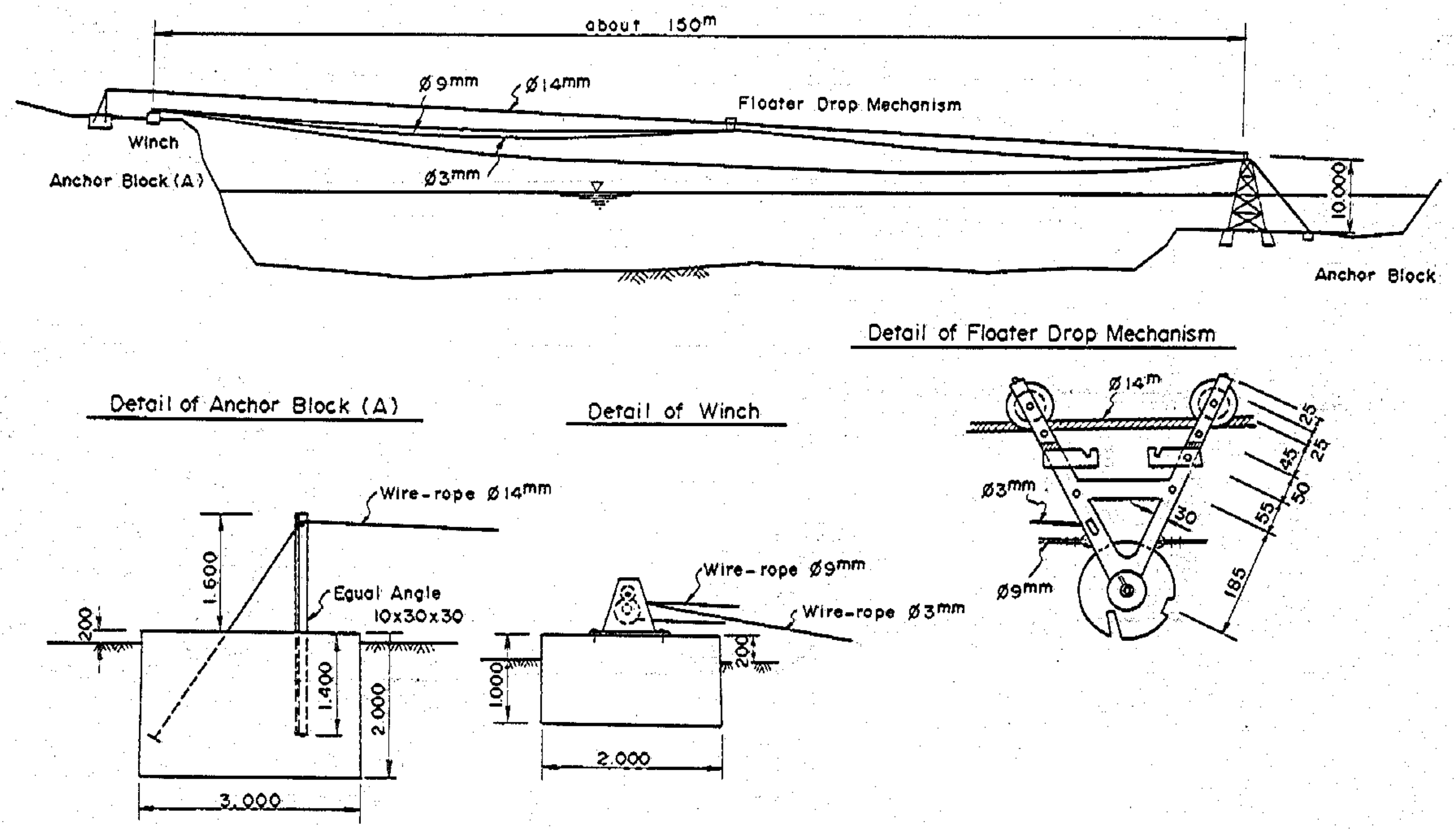


Fig 7—6 TIPPING BUCKET RAINFALL GAGE INTEGRATE TYPE

UNIT : mm

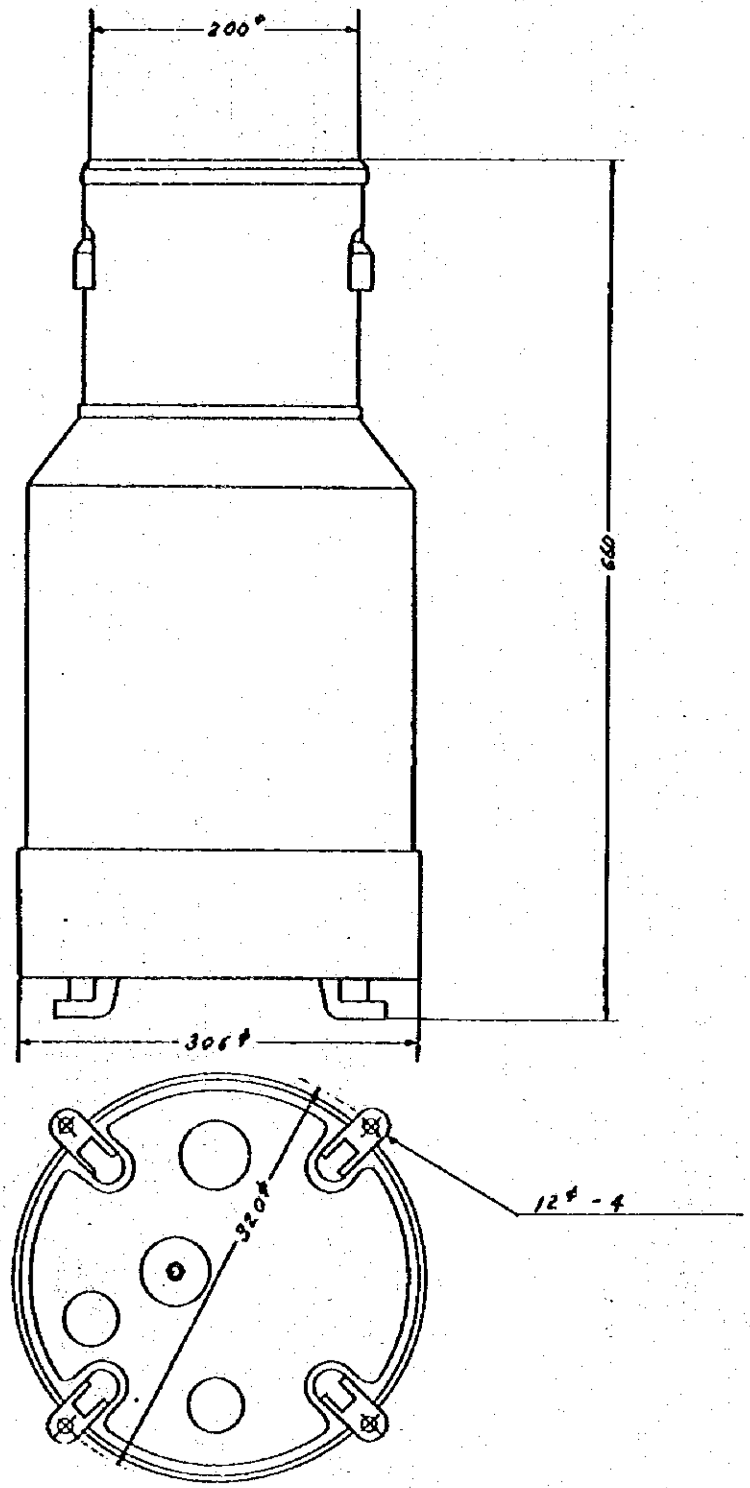
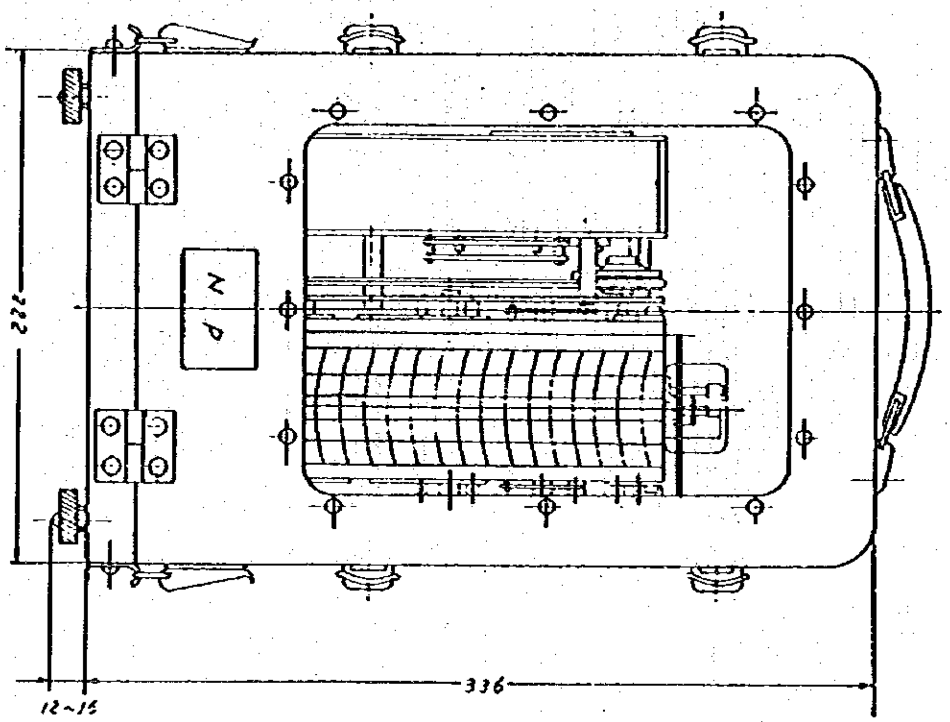


Fig 7—7 RAINFALL RECORCER

UNIT : mm



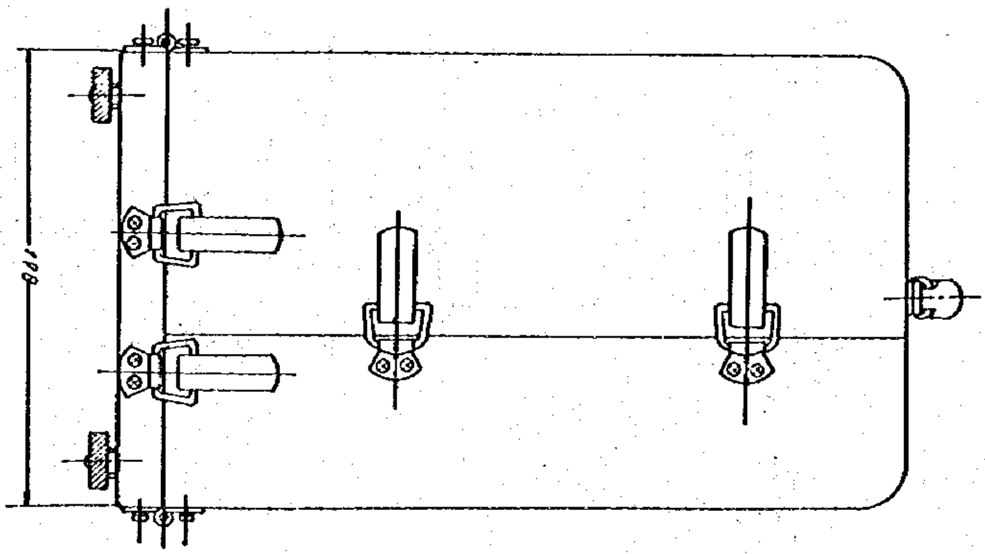
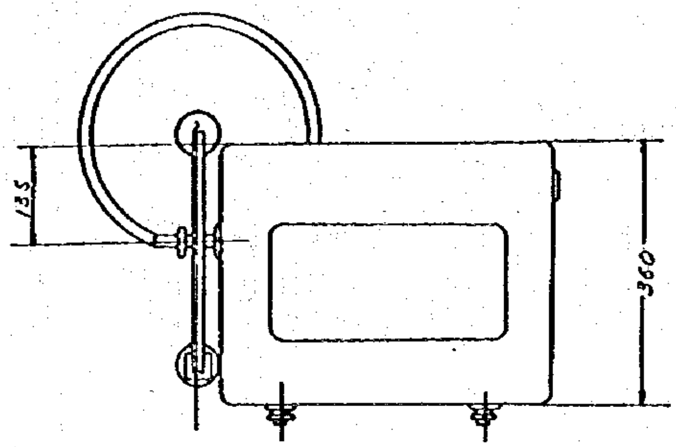


Fig 7—8 WATER LEVEL GAGE FLOAT TYPE SUIKEN 62

UNIT mm



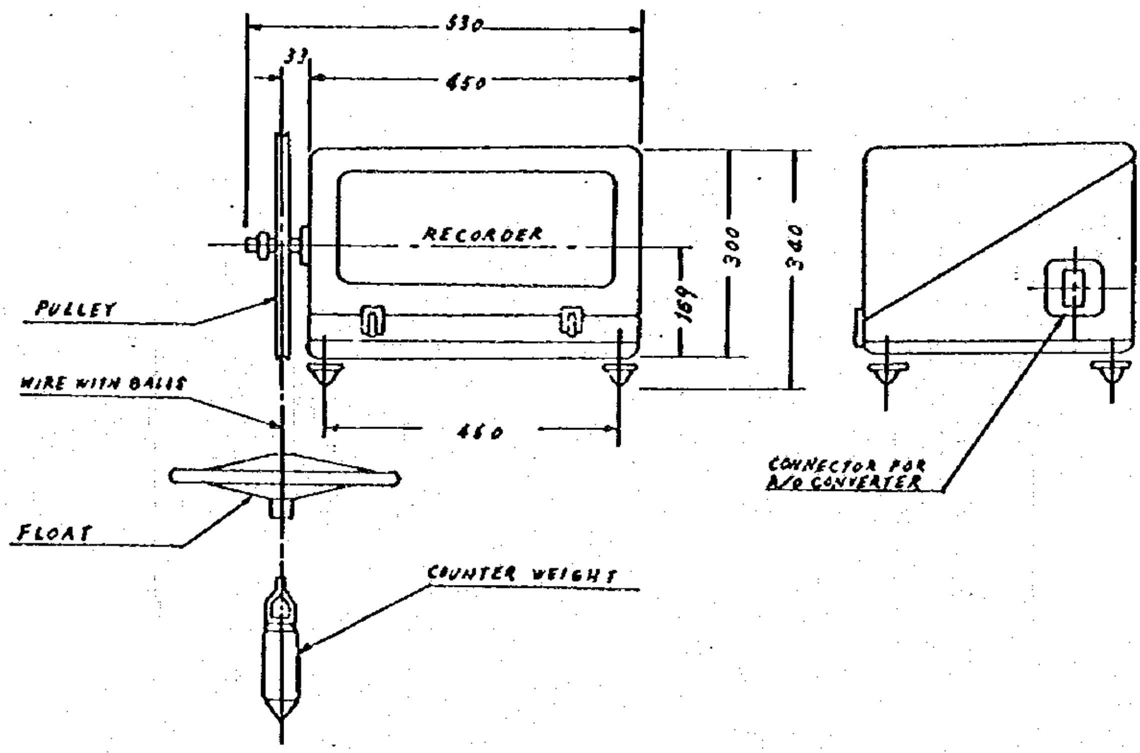


Fig-7-9 POLETYPE WATER LEVEL GAGE
GAUGEING POLE

UNIT: mm

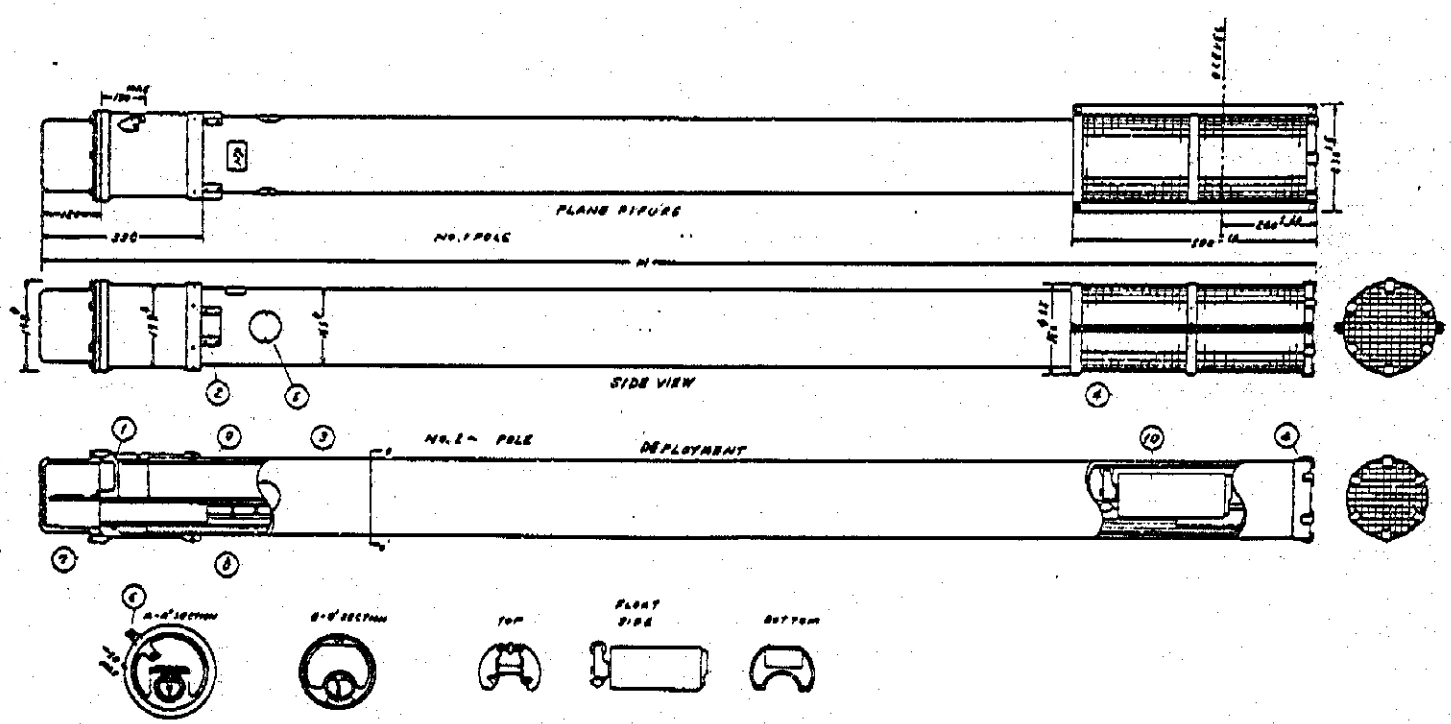
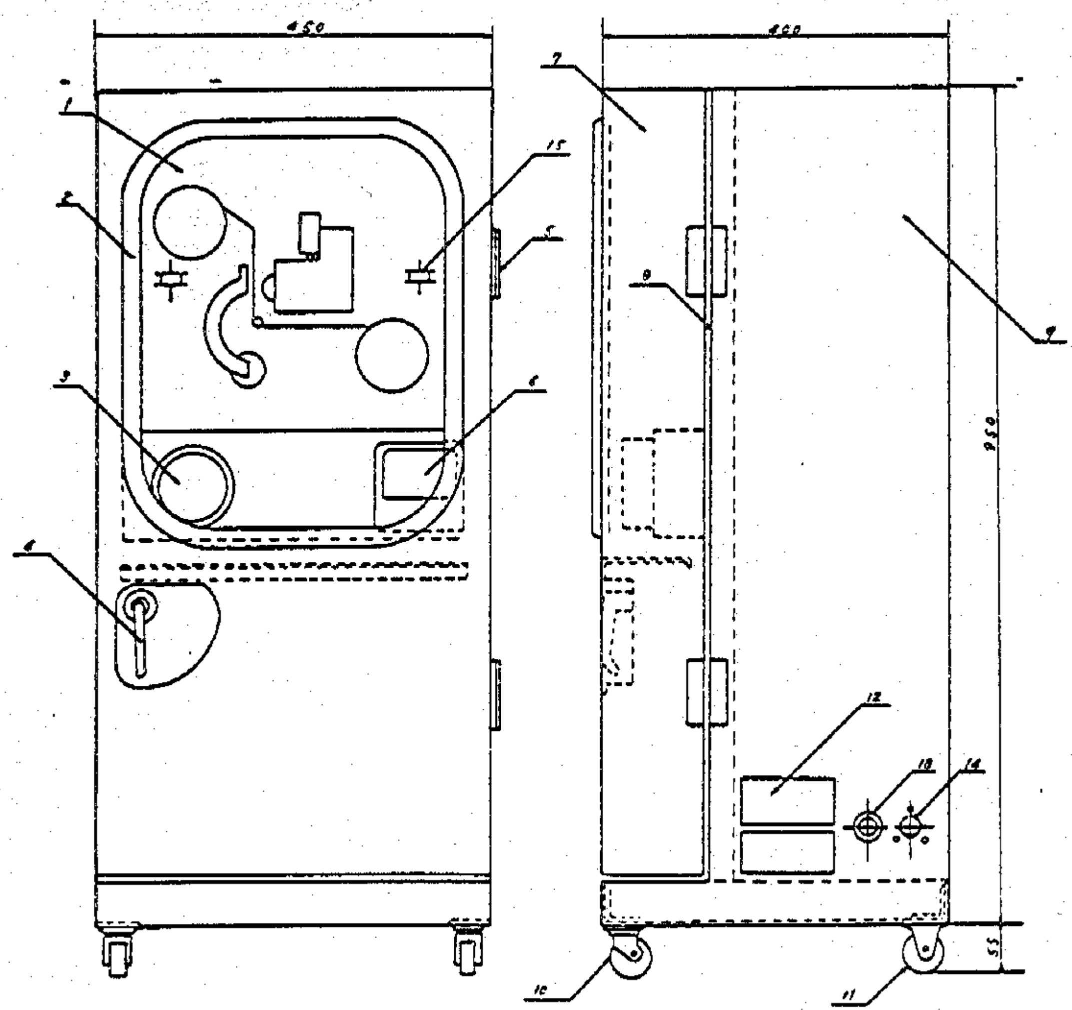


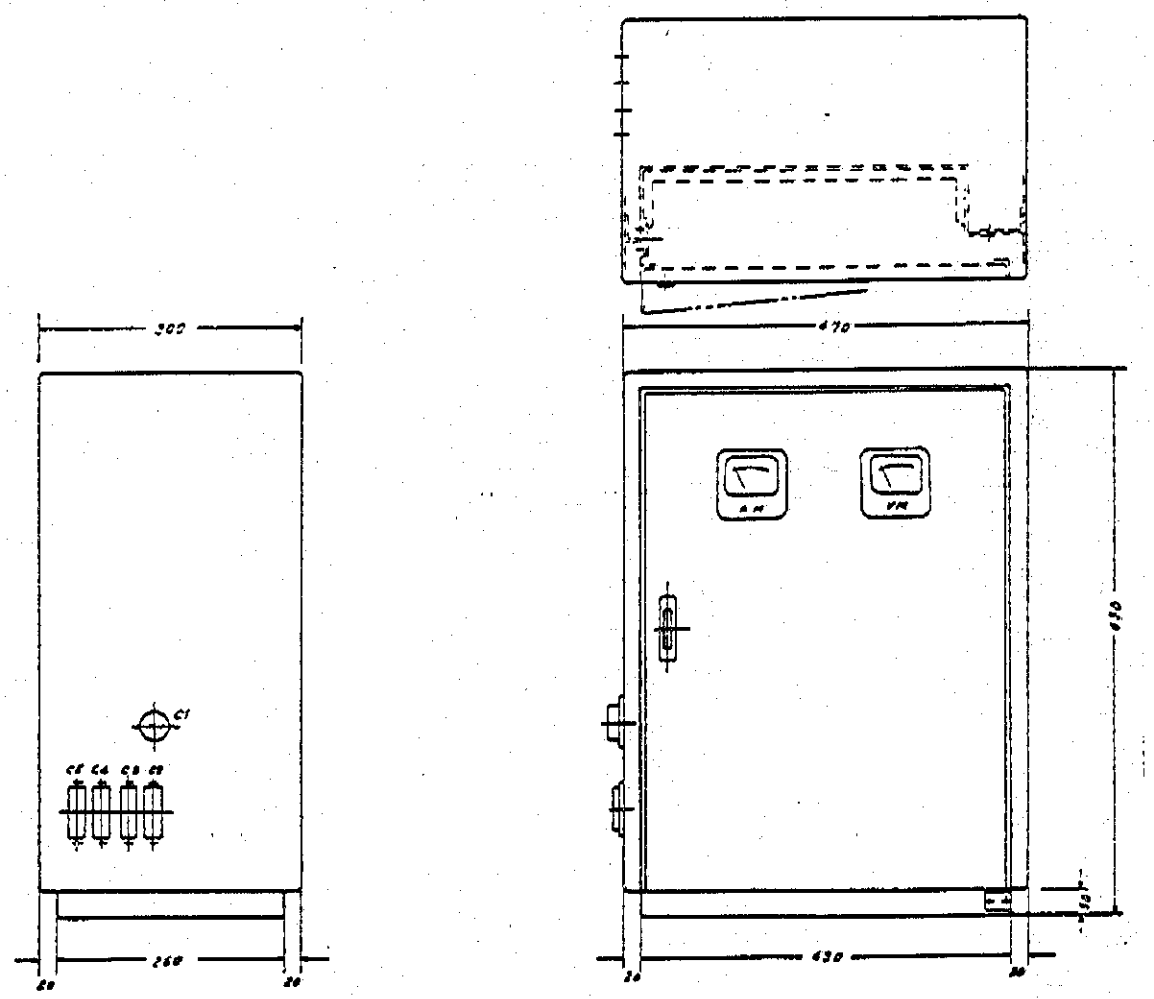
Fig-7-10 POLE TYPE WATER LEVEL GAGE DATE RECORDER

UNIT : mm



NO.	NAME
1	WINDOW GLASS
2	RUBBER SEAL
3	CLOCK
4	HANDLE
5	HINGE
6	VOLT METER
7	DOOR
8	GASKET
9	HOUSING
10	FREE WHEEL
11	WHELL
12	COVER
13	GROMMET
14	CONNECTOR
15	TYPEING RIBBON

Fig- 7 - 11 POLE TYPE WATER LEVEL GAGE
CORD CONVERTER UNIT : mm



§-2. Design of Telecommunication Facilities

1. Housing, Telepole and Tower

For station housing intended for water stage gaging (for sensing pole-type) and rainfall gaging, Type B (station with a space of 2.5 m x 2.5 m) was selected, and for station housing intended for rainfall gaging only, Type A (station with a space of 1.8 m x 1.8 m) was selected.

Each observation station is provided with a 10-meter high steel pole for antenna. The repeater station for telemetry communication is furnished with a 30-meter high triangular type tower. A 35 m high steel is installed in the sub-center in each basin and in the relay stations in Deliman and Tanay.

All the repeater stations for telemetry communication are of the same type, having a space of 5.0 m x 5.0 m.

Sub-center has the following spacings depending on the changing capacity in the individual river basins.

Agno River Basin	Carmen Sub-center	20 m x 10 m
Bicol River Basin	Naga Sub-center	10 m x 8 m x 2-story
	Two-storied due to the concern of possible flooding	
Cagayan River Basin		
	Tuguegarao Sub-center	10 m x 8 m
	Deliman	20 m x 10 m
	Tanay	10 m x 8 m

The types of pole and tower for each basin are as shown in the following chart.

Fig7—12 TYPES OF TOWER & POLE FOR ANTENNA

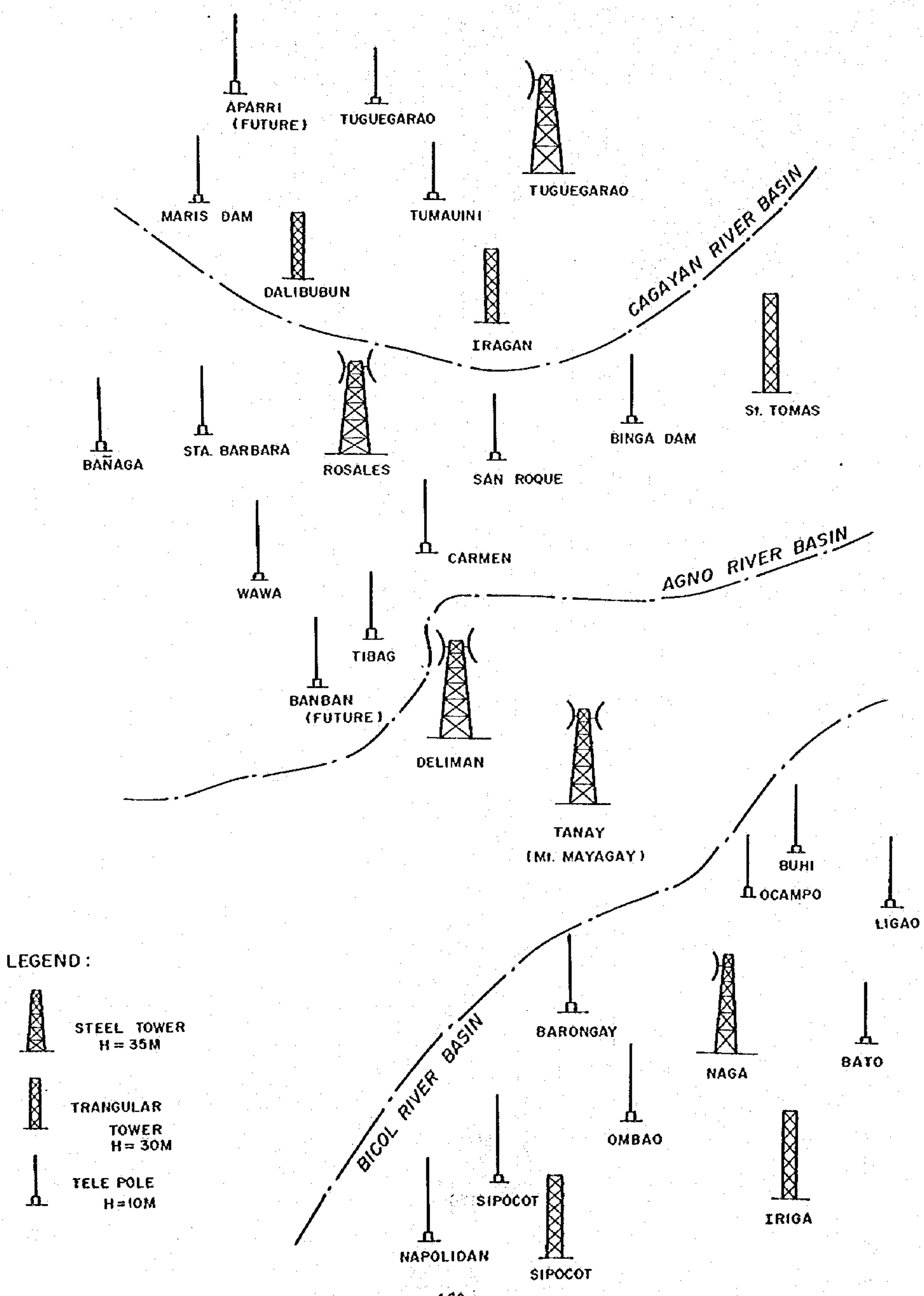


Fig7—13TELE POLE H=10M

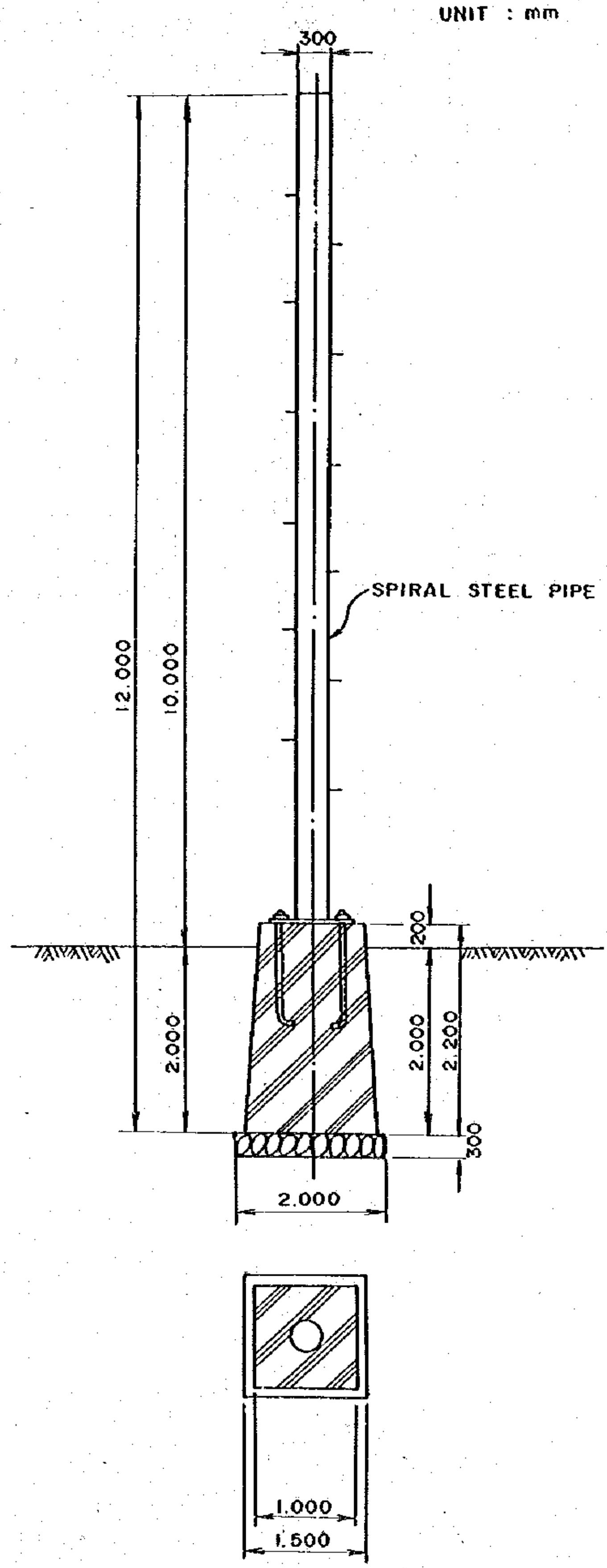


Fig. 7—14 TRIANGULAR TOWER H= 30M

UNIT : mm

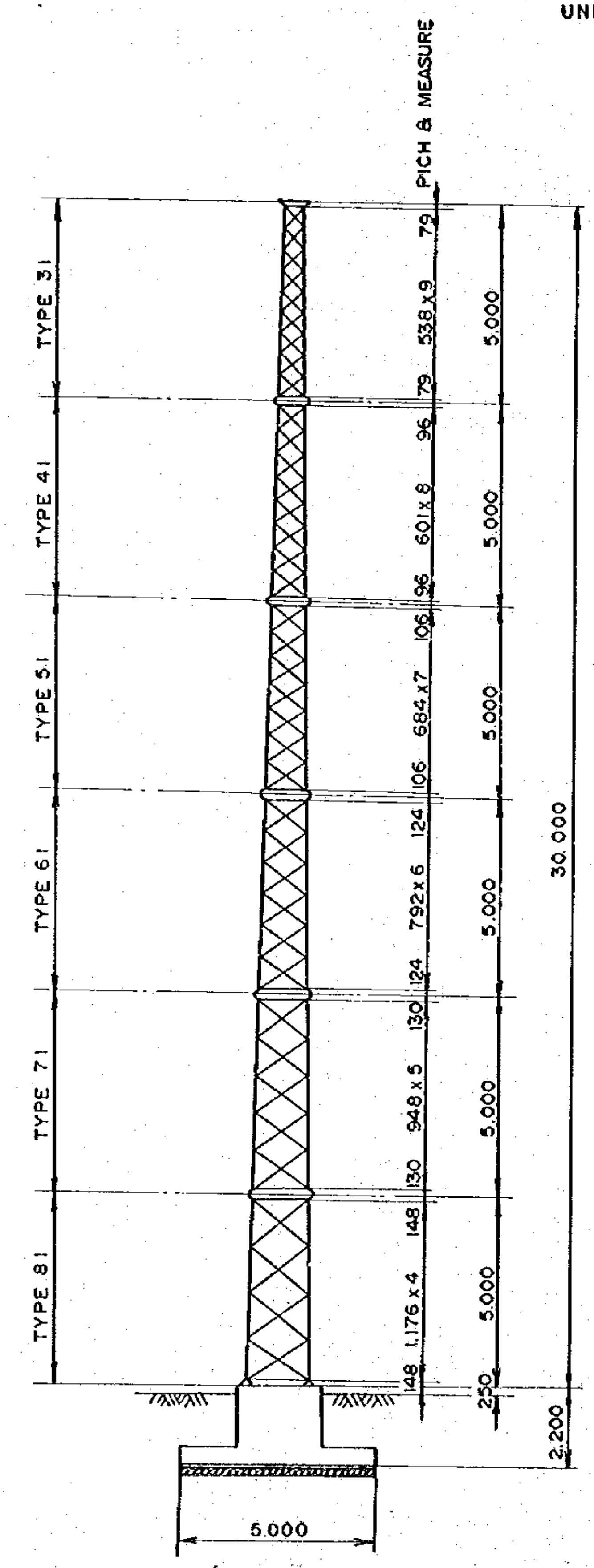


Fig7—15 STEEL TOWER FOR WIRELESS H=35M

UNIT : mm

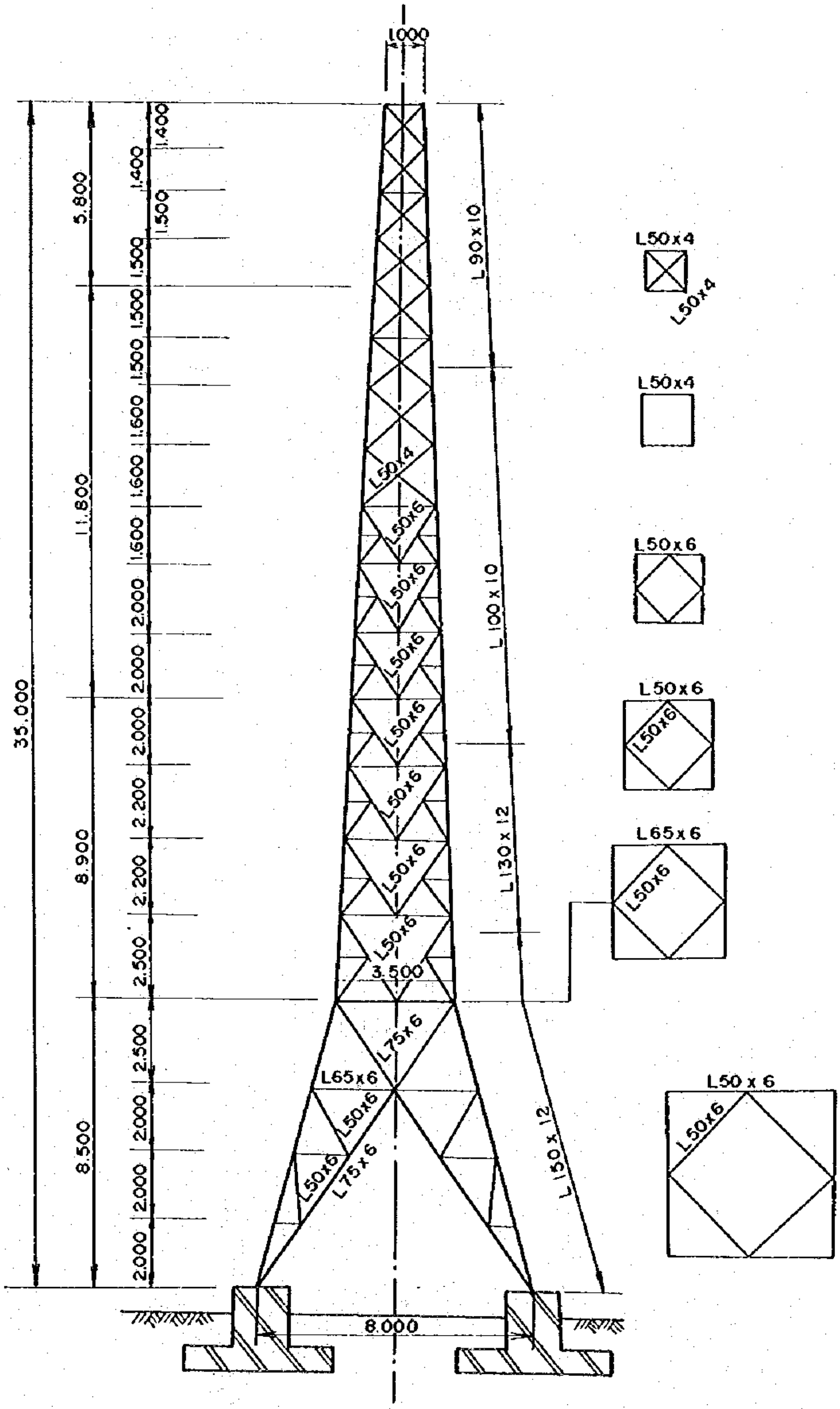


Fig. 7—4 STATION HOUSE TYPE A : 1.80m x 1.80m
TYPE B : 2.50m x 2.50m

UNIT : mm

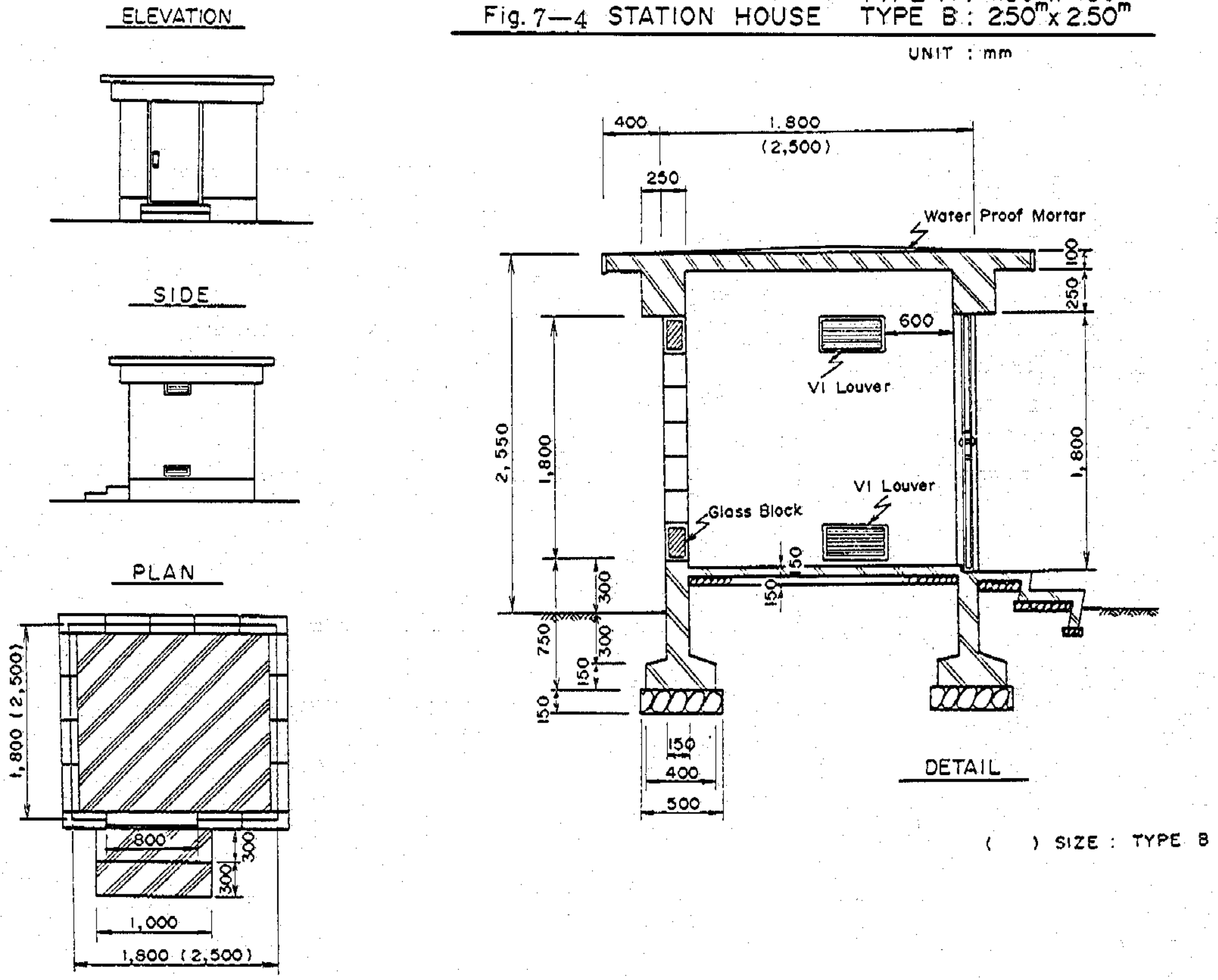
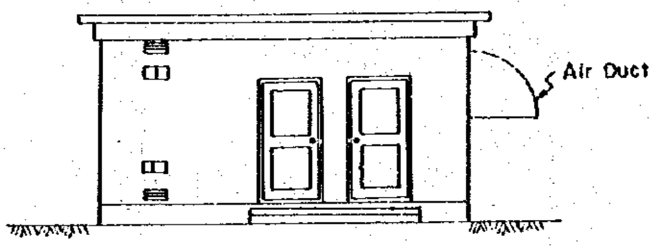


Fig7--17REPEATER STATION HOUSE

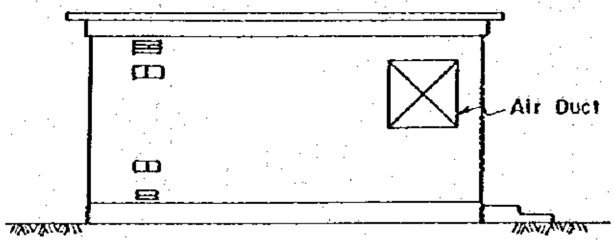
5ᵐ x 5ᵐ

UNIT : mm

ELEVATION



SIDE



PLAN

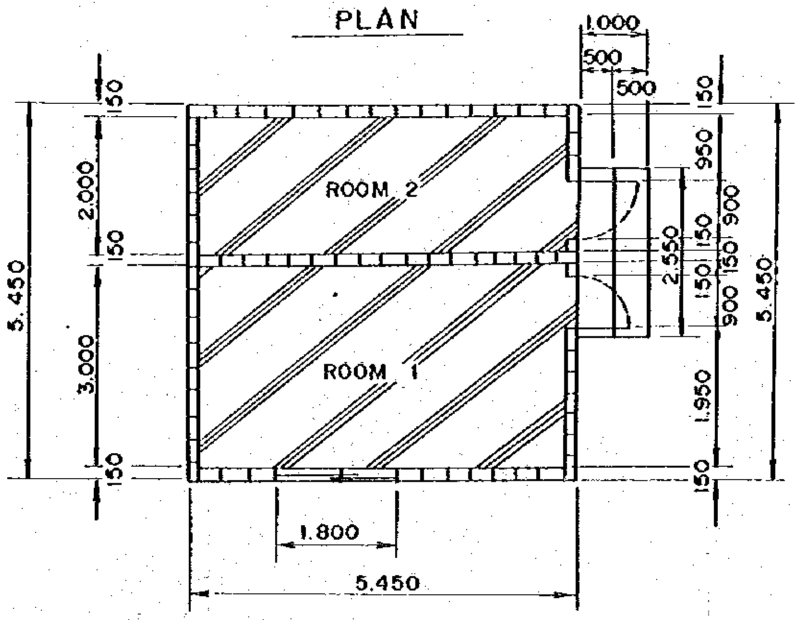
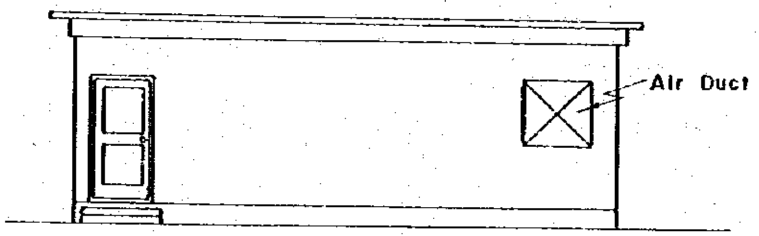


Fig.7—16 SUB CENTER HOUSE

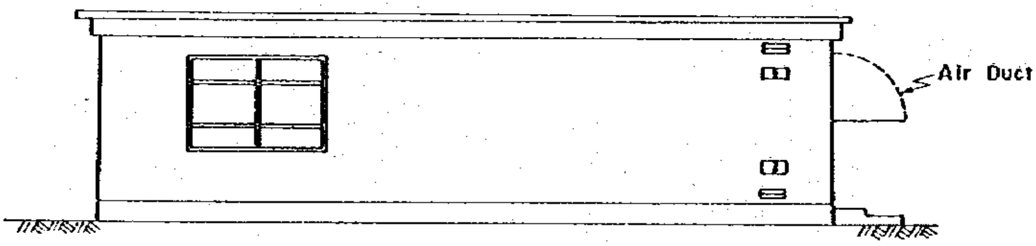
$10^M \times 8^M$

UNIT : mm

ELEVATION



SIDE



PLAN

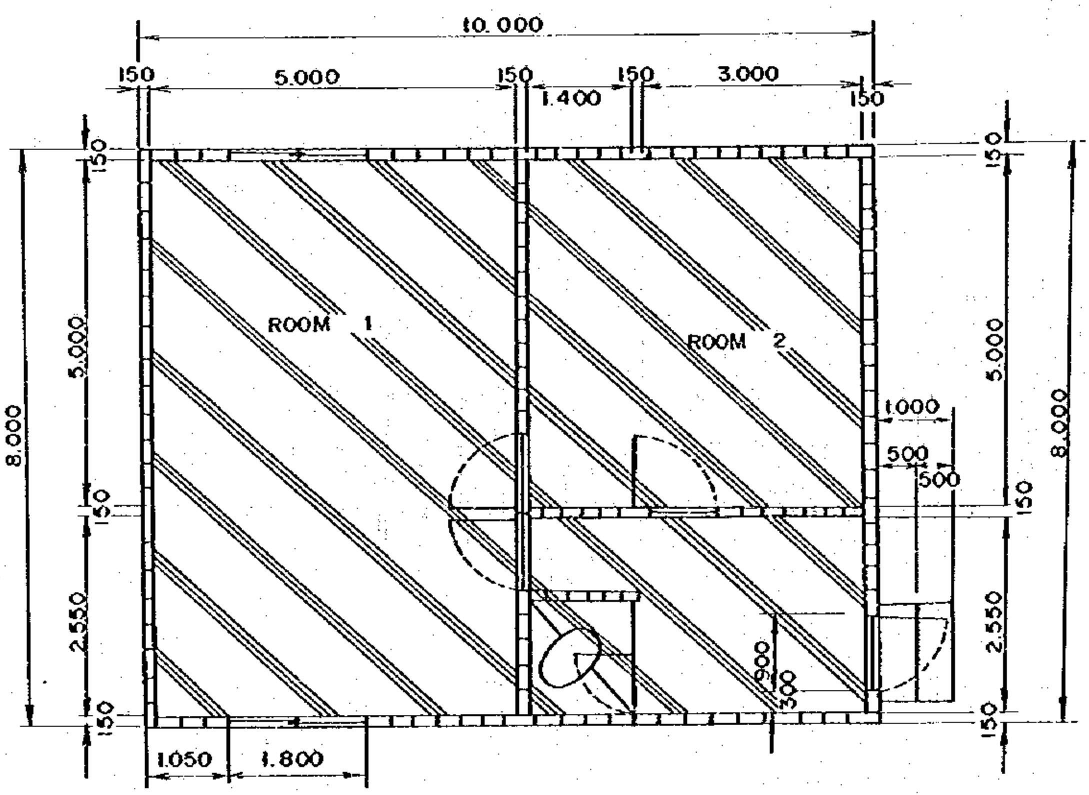
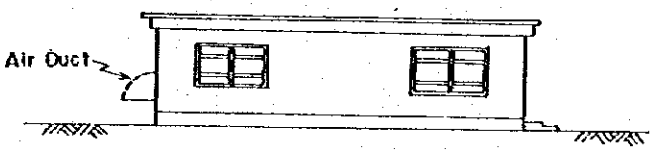


Fig7—18SUB CENTER HOUSE

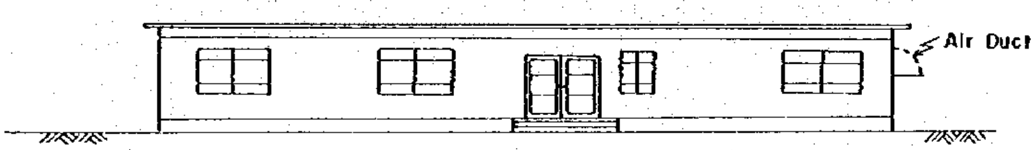
$10^M \times 20^M$

UNIT : mm

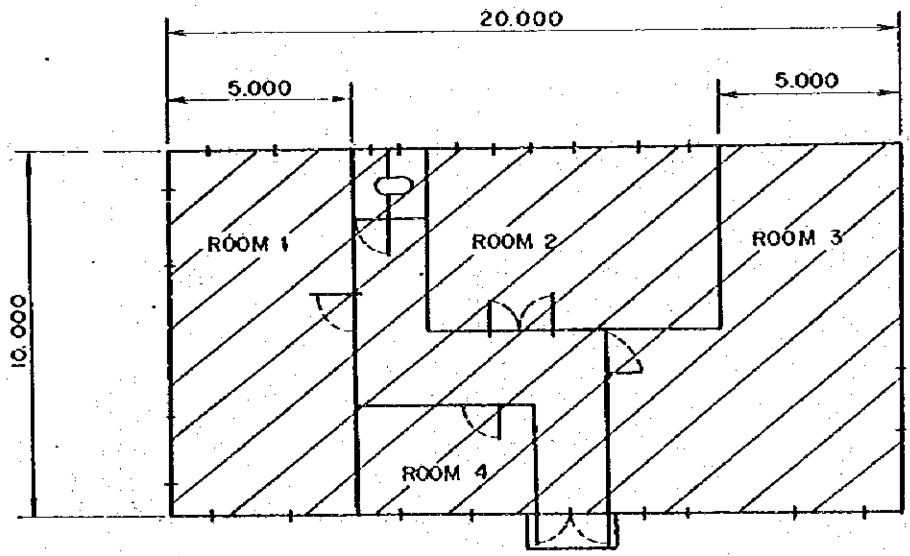
SIDE



ELEVATION



PLAN



2. System Components

(1) Telemetry Network

The equipment and instruments to be used in this system shall conform to the existing standard.

The facilities used in each river system are tabulated in Table 7-2 ~ 7-4.

The classified stations are as follows:

River Basin	Monitor & Control Station(S.C.)	Monitor-ing Station	Repeater Station	Telemeter-ing Station	Remarks
Agno River Basin	PAGASA Carmen Rosales	B.P.W.	Sto Tomas	Tibag Bañaga Sta Barbara Carmen San Roque Binga Dam Wawa	
Bicol River Basin	PAGASA Naga	B.P.W.	Sipocot Hill Iriga	Barongay Ocampo Ombao Sipocot Napolidan Bato Buhi Ligao Camaligan	
Cagayan	PAGASA Tuguegarao	(B.P.W.)	Ilagan	Tuguegarao Tumauini Dalibubun Maris	

Table 7-2 List of system components

1. Telecommunication and telemetry system

(1) Agno River Basin

Items	Application	Pagasa monitor and control station	B.P.W. monitoring station	Carmen Rosales monitor and control station	Sto. Tomas repeater station	Tibag rainfall and waterstage	Wawa Rainfall and waterstage	Bañaga waterstage	Sta Barbara rainfall and waterstage	Carmen rainfall and waterstage	San Roque rainfall and waterstage	San Roque rainfall and waterstage	Total
		Quantity	"	"	"	"	"	"	"	"	"	"	"
Telemetry control unit	For monitor control	1											1
"	"			1									1
"	For monitoring		1										1
"	For rainfall and waterstage					1	1		1	1	1	1	6
"	For waterstage							1					1
"	For repeater station				1								1
Antenna system	3-stage co-linear			1	1								2
Antenna system	Yagi 3E				1	1	1	1	1	1	1	1	8
Graphic panel	Self-contained type	1	1										2
Indicator panel	Wall-hanging type			1									1
Control console	Console type	1		1									2
Typewriter	Remington model 26	3	3	1									7
Stabilizer power unit	7.5 or 1.5 kVA	1	1	1									3
DC power unit	Battery 60AH	1	1	1									3
Diesel engine generator	2 or 7.5 kVA	1	1	1	1	1	1	1	1	1	1	1	11
Solar cell unit	12V for telemetrying station					1	1	1	1	1	1	1	7
"	12V for repeater station				1								1
Cable protector						1	1	1	1	1	1	1	7
Instruments		1	1	1									3
Sub-station stand-by equipment				1									1
Timer power unit				1									1
Spares and accessories		1	1	1	1	1	1	1	1	1	1	1	11

Table 7-3 List of system components

(2) Bicol River Basin

Item	Application \ Location	Naga monitor and control station	Sipocot repeater station	Iriga repeater station	Barongay rainfall and waterstage	Camaligan rainfall and waterstage	Ocampo rainfall	Ombao rainfall and waterstage	Bato rainfall and waterstage	Sipocot rainfall and waterstage	Napolidan rainfall	Buhi rainfall and waterstage	Ligao rainfall	Total
		Quantity	"	"	"	"	"	"	"	"	"	"	"	
Telemetry control unit	For monitor and control	1												1
"	For rainfall a.d water stage				1	1		1	1	1		1		6
"	For rainfall						1				1		1	3
"	For waterstage													–
"	For repeater station		1	1										2
Antenna system	3-stage co-linear	1	1	1										3
"	Yagi 3E				1		1	1	1	1	1	1	1	8
Indicator panel	Wall-hanging type	1												1
Control console	Console type	1												1
Typewriter	Remington model 26	1												1
Stabilizer power unit	1.5 KVA	1												1
DC power unit	Battery 60AH	1												1
Diesel engine generator	2 kVA	1	1	1	1	1		1	1	1		1		9
Solar cell power unit	12V for telemetrying stn.				1	1	1	1	1	1	1	1	1	9
"	12V for repeater station		1	1										2
Cable protector					1	1		1	1	1		1		6
Instruments		1												1
Spares and accessories		1	1	1	1	1	1	1	1	1	1	1	1	12
Sub-station stand-by equipment		1												1

Table 7-4 List of system components

(3) Cagayan River Basin

Item \ Location	Application	Tuguegarao monitor and control station	Iragan repeater station	Tuguegarao rainfall and water-stage	Tumauini rainfall and waterstage	Dalibubun rainfall and waterstage	Maris rainfall and waterstage	Total
		Quantity	"	"	"	"	"	
Telemetry control unit	For monitor and control	1						1
"	For rainfall and waterstage			1	1	1	1	4
"	For repeater station		1					1
Antenna system	3-stage co-linear		1					1
"	Yagi 3E	1		1	1	1	1	5
Indicator panel	Wall-hanging type	1						1
Control console	Console type	1						1
Typewriter	Remington model 26	1						1
Stabilizer power unit	1.5 kVA	1						1
DC power unit	Battery 60 AH	1						1
Diesel engine generator	2 kVA	1	1	1	1	1	1	6
Solar cell power unit	12V for teremetrying station			1	1	1	1	4
"	12V for repeater station		1					1
Cable protector				1	1	1	1	4
Instruments		1						1
Spares and accessories		1	1	1	1	1	1	6
Sub-station stand-by equipment		1						1

(2) Multiplex Telecommunication Network

The equipment and instruments to be used in this system shall conform to the applicable standard. For those to be used for the transhorizon communication system, special specification may be applied.

The facilities used in each river basin are tabulated in Table 7-5～7-7.

Table 7-5 List of system components

Multiplex telecommunication network

(1) Agno River Basin

Item	Application (Location)	BPW monitoring	PAGASA monitor and control station	Deliman relay station	Carmen Rosales sub-center	Total
		Quantity	"	"	"	"
400 MHz Multiplex radio equipment	10W SS-PM 24CH	1	2	1		4 sets
"	50W SS-PM 12CH Troposeater			1	1	2 "
Carrier-frequency terminal equipment	24/24 CH	1	2			3 "
"	6/6 CH				1	1 set
"	for repeater station			1		1 "
Parabolic antenna	6 mϕ with grid rack			1	1	2 sets
Yagi antenna	8E with ST 400 MHz	1	1			2 "
"	5E		1	1		2 "
Coaxial cable	(AFZE-50-10) (AFZE-50-7)	1	1	1	1	4 "
DC power unit	Alkali battery 24V 100 AH	1	1	1	1	4 "
Stand-by generator	100V 10KVA with automatic starter panel	1	1	1	1	4 "
Remote control equipment	Master station cyclic		2			2 "
"	Sub-station cyclic	1		1	1	3 "
Simple telephone exchanger	Provided with 10 telephone sets				1	1 set
Telephone exchanger	XB type 60CH with charger and battery	1	1			2 sets
Automatic voltage regulator	5 kVA	1	1	1	1	4 "
Repeater bay		1	1	1	1	4 "
Instruments		1	1	1	1	4 "
Spares and accessories		1	1	1	1	4 "

Table 7-6 List of system components

Multiple telecommunication network

(2) Bicol River Basin

Item \ Location / Application		Naga sub-center	Tanay relay station	Deliman relay statin	Total
Item	Application	Quantity	"	"	"
400 MHz Multiplex radio equipment	10W SS-PM 24CH		1	1	2 sets
"	50W SS-PM 12CH Tropo	1	1		2 "
Carrier-frequency terminal equipment	6/6CH	1			1 set
"	for repeater station		1	1	2 sets
Parabolic antenna	6 mϕ with grid rack	1	1		2 "
"	3 mϕ with grid rack		1	1	2 "
Coaxial cable assortment	(AFZE-50-10) (AFZE-50-7)	1	1	1	3 "
DC power unit	Alkali battery 24V 100AH	1	1	1	3 "
Stand-by generator	10 kVA automatic starting	1	1	1	3 "
Remote monitoring and control equipment	Sub-station cyclic	1	1	1	3 "
Simple telephone exchanger	Provided with 10 telephone sets	1			1 set
Automatic voltage regulator	5 kVA	1	1		2 sets
Repeater bay		1	1		2 "
Instruments		1	1		2 "
Spares and accessories		1	1	1	3 "

Table 7-7 List of system components

Multiplex telecommunication network

(3) Cagayan River Basin

Item	Location / Application	Carmen Rosales sub-center	Tuguegarao sub-center	Total
		Quantity	"	"
400 MHz Multiplex radio equipment	1 kW SS-PM 6CH Troposcatter	1	1	2 sets
Carrier-frequency terminal equipment	6/6 CH		1	1 set
Parabolic antenna	6 mϕ with grid rack	1	1	2 sets
Coaxial cable assortment	AFZE-50-13W	1	1	2 "
DC power unit	Alkali battery 24V 100AH		1	1 set
Stand-by generator	100V 20 kVA automatic starting		1	1 "
Remote monitor and control equipment	sub-station cyclic		1	1 "
Simple telephone exchange	Provided with 10 telephone sets		1	1 "
Automatic voltage regulator	15 kVA	1	1	2 sets
Repeater bay		1	1	2 "
Instruments		1	1	2 "
Spares and accessories		1	1	2 "

(3) Short Wave Telecommunication Network

The facilities used in each river basin are tabulated in Table

(4) Land mobiles with VHF Band for maintenance of the Table 7-9 communication Network

Table 7-8 List of system components

Short wave telecommunication network

Agno, Bicol and Cagayan River Basin respectively

Item (Name of river / Location)	Application	Agno River: Carmen Rosales (sub-center)	Agno River: Deliman (relay station)	Agno River: Total	Bicol River: Naga (sub-center)	Cagayan River: Tuguegarao (sub-center)	Total
		Quantity	"	"	Quantity	"	"
SSB transmitter	1 kW 3-wave mounting	1	1	2	1	1	4 sets
SSB receiver	all waves	1	1	2	1	1	4 "
Antenna control unit		1	1	2	.1	1	4 "
Antenna		1	1	2	1	1	4 "
Power Dist. Board		1	1	2	1	1	4 "
Automatic voltage regulator	5 kVA, 100V	1	1	2	1	1	4 "
Operator desk		1	1	2	1	1	4 "
Instruments		1	1	2	1	1	4 "
Spares and accessories	special tools included	1	1	2	1	1	4 "

Table 7-9 VHF Band Mobile Stations and Maintenance Vehicles for Telecommunication Network

Item	Application	Agno River Basin			Bicol River Basin	Cagayan River Basin		Total
	Location	Carmen Rosales (sub-center)	Dagupan (PAGASA)	Deliman (repeater station)	Naga (sub-center)	Tuguegarao (sub-center)	Tuguegarao (PAGASA)	
		Quantity	"	"	"	"	"	
Base Station								
Radiotelephony equipment	150 MHz 10W	2	1	1	1	1	1	7 sets
Antenna system		2	1	1	1	1	1	7 "
AC power unit		2	1	1	1	1	1	7 "
Spares and accessories		2				1	1	4 "
Handie-Talkie	1W	2			2	2		6 "
Mobil Station								
Radiotelephony equipment	150 MHz 1W	2			4	2		8 "
Antenna		2			4	2		8 "
Others								
Liaison vehicle	land cruiser	1			1	1		3 "
Observatory boat					1			1 set

VIII. Operation and Maintenance

§-1. Hydrological Facilities

1. Maintenance of Hydrological Observation Equipment

Maintenance of hydrological observation equipment in their best condition is a must for the satisfactory observation of floods.

For this purpose, it is recommended to keep a gage keeper at each station for once-a-day inspection and maintenance service of the equipment.

To perform periodic inspection, it is recommended to prepare an inspection manual specifying all necessary procedures for routine and emergency repairs and for replenishment of supplies, etc. Also recommended is special close check-ups before rainy seasons.

2. Discharge Survey

To obtain water stage/discharge rating curve, discharge survey will be performed at the site of station. Observation should cover practically all different conditions from low-water to high-water and an increase in number of observation means a higher accuracy of observation.

An observation party will consist of 5 to 10 persons for low-water and 10 to 15 for high-water observations. When period of high-water observation is prolonged, two to three parties may be needed. It is necessary to secure required number of observation personnel and train the personnel based on the observation manual.

3. Filing of Observation Data

Observation data, after careful examination, will be filed as basic reference materials for statistical presentations and hydrological analyses.

The basic reference materials mentioned above may have to be preserved for a long period.

§-2. Telecommunication Systems

It is important that all instruments, in particular the telemeter equipment is maintained in perfect condition and improved to suit the objectives so that the Flood Forecasting and Warning System can function smoothly. For this purpose, not only the employment of maintenance personnel and endless training to improve the techniques but also the provision of the necessary budget for maintenance and operation are important. The maintenance expenditure generally differs from year to year, but the minimum requirement will be an annual 3 to 5% of the new installation cost.

One supervising engineer, two qualified engineers, and two technicians are needed for the telemetry system and the multiplex telecommunication links at each sub-center. These personnel will be stationed permanently in each sub-center to study and carry out the routine maintenance plans, and provide repair in times of the system failures and furnish parts and supplies. In addition to the maintenance personnel for the telemetry system at the Pampanga River, FFC will call for one supervising engineer, two qualified engineers and two technicians who, in control of the whole system, will draw up and put into practice the maintenance, improvement, training, supply and instrument upkeep programs as well as to manage and run F F C and B P W monitor stations and Deliman and Tanay relay stations.
Additionally, one chief engineer is to be assigned to F F C to administer the whole system.

A systematic plan of the above will be shown in Table 8-1.

Table 8-1 Staffing Schedule

	Hydrologist			
	Chief Engineer	Supervising Engineer	Technician	
F F C	1	4		5
Agno sub-center		1	1	2
Bicol "		1	1	2
Cagayan "		1	1	2
Pampanga "				
Total	1	7	3	11

	Telecommunication Engineer					
	Chief Engineer	Supervising Engineer	Qualified Engineer	Technician		
F F C	1	1	2	2	6	11
Agno sub-center		1	2	2	5	7
Bicol "		1	2	2	5	7
Cagayan "		1	2	2	5	7
Pampanga "		1	1	3	5	5
Total	1	5	9	11	26	37

§-3. Technical Supervision

1. Despatching of Technical Supervisors

Technology and knowledge are essential to the proper operation of the systems. For this purpose it is necessary to despatch engineers as part of the technical co-operation transfer project.

In the present discussion it is considered necessary to despatch at least one hydrologist and four telecommunication engineers for the on-the-job training service for two years to assist the local engineers with the correct knowledge, and operation and maintenance procedures.

2. Training of Engineers

To ensure that the systems, after completion, will provide smooth flood forecasting operation over long periods of the time, Philippine engineers will be trained in the following manner.

1 Training of at least eight hydrologists and eleven telecommunication engineers will be conducted before the systems are put into operation.

2 Training of additional three hydrologists and fifteen telecommunication engineers will be conducted before the on-the-job training is complete.

This means that for the operation of the systems at least 11 hydrologists and 26 telecommunication engineers will be trained in the Philippines.

3. Forecasting and Warning Communication System

Flood forecasting and warning services are carried out via many different stages of work, from gaging to reporting of the information to the inhabitants and to flood defense operation. Without rapid, correct perfection of the work it will be impossible to utilize the service efficiently.

To prevent disasters, it is essential to clearly specify the communications system and the network of communications. To achieve this, following disater prevention measures should be taken into consideration and the communications systems made clear.

1 Maintenance of disaster prevention organizations

2 Education and training in disaster prevention knowledge

3 Supply and maintenance of disaster prevention commodities and materials

4. Maintenance of disaster prevention equipment and facilities

5 Designation of areas potentially liable to disaster and improvement of hazardous points

§-4. Setting up a New Organization

As an organization responsible for running the Flood Forecasting and Warning System, Flood Forecasting Center (FFC) has been in operation since 1973 to cover the Pampanga River Basin.

The organization, established as a joint project pursuant to an agreement by and between PAGASA and BPW, is characterized by:

a) There is no proper personnel within the organization, so that all activities are being performed by PAGASA and BPW officials.

b) Expenses incurred from operating the organization are borne by either of the two parties depending on the expense items.

The features, however, have turned out the following disadvantages:

a) The shortage of available staff makes the line of demarcation between job responsibilities thin, making the organization heavily dependent on the members' voluntariness for operation.

b) The shortage of budget results in poor treatment of capable engineers, which encourages the trained personnel to change the jobs for better positions in governmental agencies or private firms.

c) Instruments and materials necessary for the maintenance and operation of the organization are not adequately supplied.

The present FFC is anticipated to experience certain difficulties in handling the new system.

In addition, there is a possibility that Flood Forecasting and Warning System may be extended from the Luzon Island to other islands such as Mindanao. Should this happen, operation by FFC is expected to become further difficult.

It is beyond the scope of the survey team to discuss circumstances around the Philippine governmental establishment, however, the team would like to propose that Flood Forecasting Authority (FFA) be established to supplement the existing FFC. The new organization should have experience in flood control activities and have the capacity to supply necessary personnel.

One important point to be noted here is that FFA will be made part of the governmental organization and have its own exclusive budget as well as proper personnel.

FFA will have as its primary function to operate the Flood Forecasting and Warning System, but it should also be provided with a research division and a planning division for better forecasting accuracy and future expansion, respectively.

The new organization will offer the following benefits:

1) It facilitates new staffing and transference in of personnel

from other existing organizations.

2) The centralized organization assures operation of efficient activities.

3) Improvement of treatment for the staff is easier to attain.

4) The budget for maintenance and management of the organization is easier to obtain.

5) The research and development division and planning division serve to enhance the forecasting accuracy, to manage the system more efficiently and to facilitate expansion of flood forecasting and warning services to other river basins.

- FFA
  - FFC (in Manila)
    - Management Division
    - Hydrology Division
    - Telecommunication Division
    - Planning Division
    - Research Division
    - Training Division (Training for engineers)
  - Sub-Center
    - Management Section
    - Hydrology Section
    - Telecommunication Section

STAFFING OF F F C AND SUB-CENTERS