KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

MASTER PLAN STUDY
ON
THE WATER MANAGEMENT SYSTEM AND MONITORING PROGRAM
IN
THE CHAO PHRAYA RIVER BASIN

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JUNE 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND

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FINAL REPORT

ANNEX-4 MONITORING/COMMUNICATION AND DATA MANAGEMENT SYSTEM

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ANNEX-4 MONITORING/COMMUNICATION AND DATA MANAGEMENT SYSTEM

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CHAPTER 1 CURRENT MONITORING/COMMUNICATION SYSTEM

1.1 Monitoring Items

Much volume of data are continuously monitored for water management in the Chao Phraya basin by O & M and Hydrology Divisions. Monitoring items are as follows:

- Daily Rainfall

  The number of observation station is about 700 in the basin. Rainfall data for the present water management computer model are collected from total 296 observatories; 212 stations of RID and 84 stations of the Department of Meteorology.

- Daily Water Level and Stream Flow/Discharge

  Water level and flow along the rivers are observed by Hydrology Division. Observation at regulators is carried out by O & M Division. Numbers of rainfall and flow gauging stations monitored by project offices are shown in Appendix-4.1.

- Cropping data

  Cropping data on the weekly basis are monitored in irrigation area such as kinds of crops grown and crop-wise growing acreages, harvested and damaged acreages by floods and drought and puddling acreages of paddy fields.

- Gate Opening

  Gate opening at regulators are also monitored when water level is monitored.

- Daily Water Release from Bhumipol and Sirikit Dams

  Water releases are observed by EGAT. RID receives the data from head office of EGAT by telephone.

1.2 Present Monitoring System

The present monitoring system for water management is carried out as follows:

- RID Head Office

O & M Division	Monitored data collection, processing and arrangement, water allocation, and instructions.
Communication Division	Transfer of data/information and instructions for water management via existing facilities.
Data Processing Division ...	Operation of water management computer model.

- Regional Office

  Block-wide collection, arrangement and transfer of data and instructions for gate operation.

- Project Office

  Monitored data collection and data arrangement of the project, and transfer them to the RID Head Office and instructions to gate operator for operation of gates.

- Water Master

  Measurement, transfer of the data, and operation of gates.

- Zoneman

  Measurement, monitoring of fields and cropping conditions, and reporting.

1.3 Data Collection by Communication System

Data collection/distribution from/to water management staff is carried out by using the present telecommunication equipment as shown in Appendix-4.1.

1.3.1 HF/SSB Radio

HF/SSB radio is mostly used for long-distance between Head Office and Regional Offices. Among five frequency bands RID has in Thailand, four bands are applied in the basin.

Transmission performance of the current HF/SSB radio suffer much from noise and confusion.

70 to 80% of all telecommunication occupancy is by HF/SSB radio and 20 to 30% of all message communicated is concerned with water management.

Reading and writing procedures at each station are repeated by operator along communication steps to RID Head Office. Operator works in two shifts except during flood season.

1.3.2 VHF/FM Radio

VHF/FM radio is used for short-range communication, and RID has four frequency bands available in the delta. Almost half of the equipment and devides for VHF are of fixed station or mobile type and the rests are of handy type.

Recently, VHF radio system has become very popular instead of the time-worned private wire telephone in the study area, and it is quite essential to ensure a powerful and good quality communication system so as to avoid expected future jamming and confusion.

1.3.3 Private Wire Telephone

Most of the project offices provide this system as main media of their communication within their territory. Private wire telephone is magnetic switchboard type and wire is bare. In case of long-distance call more than 20 to 30 km, some stations are needed to relay the message to the project office in the current performance because of difficult direct talk over the telephone.

Present telephone system has an advantage of low transmission losses, but has some disadvantages, such as much noise and unstable transmission performance depending on weather condition. This telephone system was installed more than twenty years ago.

1.3.4 Portable Wireless Telephone

About 70% of the project offices are provided with VHF radio station, and a half of them are equipped with handy talking units for daily communication within the territory. Output power of the unit is one to five watt.

1.3.5 Motorcycle and Boat

Motorcycles are used by zonemen to visit and supervise the field and report to the water master. Most of them are private ones. Some boats are used in the canal to monitor the field in the Lower Delta, however, use of boats for monitoring is decreasing due to current development of road networks.

1.3.6 Others

TOT public telephones are installed in some offices, however, they are not used for transmission of water management data.

Current communication network by RID and current monitoring conditions in project area are shown in Appendix-4.1.

1.4 Data Processing and Distribution

1.4.1 Data Processing

The collected data are arranged on the daily or weekly basis and some data are stored in the computer files. The data of water level and discharge, however, are arranged in the another forms to be compiled into daily report/monthly report.

Systematic data processing has been in difficulty due to absence of effective method of utilizing the collected data.

1.4.2 Data Distribution

The processed and arranged data are distributed by the aforesaid RID communication system or mail on the weekly basis. And, those data and information for irrigation water supply at the reservoirs are transferred to the EGAT Head Office via TOT telephone system.

1.5 Communication System of Other Agencies

1.5.1 PTD

PTD takes charge of post and telecommunication in the country and issues radio communication license. It is necessary to submit radio network plan to PTD so as to secure radio frequency for water management activities if so required. PTD assigns radio frequency considering the current situation of communication system.

1.5.2 TOT

TOT has subscriber's telephone network by microwave radio and telephone cable covering the whole country. Data transmission circuit and leased telephone circuit be rent to government and private offices. Communication circuit is constructed on the basis of CCITT. Trunk line has high communication quality. In case of cable line, however, reliability is not enough because of inundation in flood season. TOT has some plans to extend the communication network. Most of RID's project offices do not subscribe TOT telephone at present because of insufficient networks.

1.5.3 EGAT

Multiplex radio system by microwave is used for communication of power distribution and transmission information. This system had been constructed by EGAT.

Hydrological data such as water level and discharge are transmitted by voice communication from hydropower stations at Bbumipol and Sirikit Dams to the EGAT Head Office in Bangkok. Electrical data are collected by telemeter system. Microwave radio of 900 MHZ band is currently used under good communication conditions. Communication between RID Head Office and EGAT is done by subscriber's telephone.

1.5.4 CAT

CAT has a satellite communication circuit. The channels of this circuit are rent to private companies and public agencies. CAT also serves land mobile radiotelephone.

CHAPTER 2 BASIC CONCEPT FOR IMPROVEMENT

The improvement plan for the monitoring and communication system is formulated in taking into account the existing system and problems to be solved in five alternative levels.

2.1 Observation Items and Method

In addition to the present items, water quality, groundwater and field moisture conditions shall be regularly observed in the Delta. And, automatic recording device shall be provided at several important stations, although present visual measuring shall be kept in general. Basic concept of them are shown in Table 2-1.

2.2 Data Collection/Distribution Method

Data collection system shall be made in the better use of communication system, considering the following two aspects of data transmission for water management.

- Data transmission for routine works of water allocation
- Data transmission for overall water management activities, such as basin water resources management, annual schedule of reservoir release, maintenance of water use facilities and organizational administration.

Some data for routine works have to be collected rapidly and precisely so as that RID Head Office adjust water allocations to project areas by the monitored data. In case of a large number of monitoring sites and data transmission, automatic data collection system with telemeter equipment at major key regulator is useful.

Monitored data by telemeter system shall also be transmitted to neighboring project offices for preparation of water operation. In this case, transmission may be by voice communication because of small amount of data and a few transmission partners.

Information for overall water management shall be directly transmitted from RID Head Office or Regional Office to subject regulators, and their communication may be done by talking method as same as before. However, transfer of such data by facsimile shall be applied at some places so as to facilitate recording of operation and control information. The recorded data are to be referred for the next water allocation.

Basic concept of data collection/distribution method are shown in Table 2-2.

Improvement plans of the following communication system are considered:

- Trunk line (RID Head Office --- Regionl Offices)
- Local circuit (Regional Offices --- Project Offices)
- Field circuit (Within project area)

Basic plan of improved communication system is shown in Figure 2-1.

2.3 Data Processing Method

Data processing for water allocation plan are carried out by the following approaches:

- Judgment by experience

  Data processing will be done by experimental judgment without some systematic process, in view of past facts.

- Data processing by calculation charts or forms

  In addition to experimental judgment, some compiled forms or technical charts will be utilized, if necessary. These charts and forms will be made based on past experience and past records.

- Data processing by computer program model

  Some routine works will be processed by computer program model. But, it is difficult to make program model which reflects the given irrigation/drainage situations.

Under the present situations, these approaches will be executed in line with improvement plan of monitoring/communication and data management facilities, step by step.

Basic concept of data processing and management level are shown in Table 2-3.

2.4 Monitoring/Verification Method

A suitable system for reasonable indication and recording of the collected data to meet the requirements at each level shall be prepared for appropriate understanding of water flow situations. Proper judgment for successful water allocation be able to be made by this improved system such as introduction of display panel. Improvement plan is shown in Table 2-4.

CHAPTER 3 IMPROVEMENT PLAN OF TRUNK LINE

3.1 Basic Concept for Improvement

The present HF/SSB radio being used as a trunk line fails to keep clear communication because of poor quality with much noise, fading and sometimes jamming. Trunk line shall have to be provided with the following functions:

- Transmission of many communication volume.
- Transmission of analog and digital data for telephone, facsimile and telemeter.
- Long distance communication.

Considering the above functions, it is a matter of urgency to change from the existing system to the stable one. Multiplex radio system is proposed to cope with future volume and communication quality.

The following alternatives can be considered as an improved trunk line with multiplex radio system.

i) Use of TOT telephone line or CAT satellites.
ii) Establishment of trunk line by RID.

In the above systems, the trunk line leased from CAT satellites have disadvantage of higher rent in comparison with that of TOT in case of short distance. Advantages and disadvantages of the two alternative systems have therefore been studied.

3.2 Alternative Study

3.2.1 Trunk Line leased from TOT

Communication lines are leased from TOT. Trunk line composed of TOT line is described in Figure 3-1. In this trunk line, communication lines between RID Head Office and Branch Offices are consisted of the two sections; trunk route and local line as shown in Figure 3-1. Under

the present situation, trunk routes are composed of multiplex radio relay system by microwave, and local lines are made by communication cable.

Taking account of system configuration of the trunk line, following two alternatives are examined.

i) Trunk Line based on Trunk Route by TOT and Local Line by RID

In case that trunk routes are leased from TOT and local lines between TOT offices and RID offices are constructed by RID, local lines will be consisted of low capacity multiplex radio link.

ii) Trunk Line and Local Line of TOT

In this case, both of trunk route and local line are of TOT, therefore, local lines are constructed and managed by TOT.

3.2.2 Establishment of Trunk Line by RID

(1) System configuration

In this case, all communication networks of trunk line are constructed by RID. Communication networks between all RID regional offices consist of four routes; north east, southwest, northeast routes as shown in Figure 3-2. Among these routes, north route covers Chao Phraya River basin.

This route, therefore, is considered as an alternative plan, taking account of the number of covering regional offices, distance of local line and location of relay stations. Planned route is illustrated in Figure 3-3.

(2) Number of channels

Trunk line shall be provided with communication functions for

telephone, facsimile and telemeter. Number of channels necessitated are estimated as shown in Figure 3-4.

3.2.3 Alternative Study

In case trunk line by RID shall be constructed, operated and maintained by RID, RID has to prepare the initial construction cost and operation/maintenance cost. However this has advantages of easy expansion of communication system and quick trouble management, in comparison with the case of the trunk line by TOT.

On the other hand, in case that trunk line by TOT is constructed and managed by TOT, RID has to pay the rental charge of TOT line, however, it requires neither high initial construction cost nor operation/maintenance cost.

Cost estimation for comparison has been made in the following manners:

- Communication system between RID Head Office and Regional 3 Offices are compared.

- Lifetime of communication facilities as 5% per annum.

Comparison of estimated cost is shown in Table 3-1 and Appendix-4.3.

3.2.4 Proposed Trunk Line

According to the cost comparison, line by TOT has economical advantage. Composition of line by RID as a main system and one by TOT as a supporting system is better for trunk line, taking account of some advantages by RID's line. In Table 3-1, annual depreciation cost will be different in way of initial investment. Establishment of trunk line by TOT, however, shall be proposed, considering the higher initial investment cost by RID.

CHAPTER 4 IMPROVEMENT PLAN OF LOCAL CIRCUIT

4.1 Basic Concept for Improvement

Local circuit is desirably equipped with multiplex radio system. This system, however, is not economical in taking account of future communication volume and frequency. Therefore, improvement plan shall be conducted under the following conditions:

- Local circuit is stable for data transmission, facsimile and telephone call.
- Construction and operation/maintenance cost are economical.
- Capacity of local circuit is flexible for future communication traffic.

Communication system is planned based on the data collection/distribution method by management level.

4.1.1 Level-1

(1) Improvement of VHF/FM radio system

Current transfer of data/information is carried out by radio operators in their reading and writing in fixed form. This communication method is unsuitable for quick and proper transmission of water management activities. VHF/FM radio system, therefore, shall be improved for quick contact and smooth coordination among neighboring project offices. Management staff will be able to communicate directly each other by voice communication as same as present.

4.1.2 Level-2

Duplex communication system shall be improved at whole management offices for smooth voice communication among management staff.

- Improvement of private wire telephone.
- Introduction of star type network system with duplex communication.
- Utilization of communication network of TOT and installation of PABX (private automatic branch exchange).

Levels-3 and 4 are the same improvement plan as the Level-2, from viewpoint of smooth voice communication for management activities.

4.2 Introduction of Star Type Network System

Star type network system is proposed as a local circuit, which is consisted of central station and some substations. The following two alternatives are considered for this system.

- Multi-Direction Multiplex System
- Rural Radiotelephone System

Alternative study are as follows:

4.2.1 Multi-Direction Multiplex System

Capacity of central station and substations are 36 to 48 channels and 3 to 6 channels, respectively. This system has disadvantages of higher construction cost of facilities, due to system configuration is complicated for many channels as compared with the other alternative system.

4.2.2 Rural Radiophone System

Capacity of central and substations are 8 to 10 channels and 1 to 2 channels, respectively. This system has the following advantages in taking account of future telecommunication system in the basin.

- This system is applied for a little volume of communication traffic area.
- Expansion of capacity in substation is easy.
- Facilities cost is economical.

As a result of alternative study, rural radiophone system is proposed as a star type network system of local circuit.

4.3 Improvement Plan of VHF/FM Radio System (Level-1)

For direct communication among project offices, new radio equipment such as transceiver and controller shall be introduced at all project offices. Replaced radio transceiver, at the same time, will be given to water master office for improvement of field circuit. System configuration is shown in Figures 4-1 and 4-2.

Some facilities in the existing radio system such as antenna and tower may be utilized by taking into account of the current capability of the equipment.

VHF/FM radio system shall be introduced at major regulators where proper radio system has not been provided yet. Water level and discharge data at the regulators shall be transmitted by voice communication through the introduced system for the time being.

Considering the above conditions, improvement plan of VHF/FM radio system is proposed as follows:

Radio Station	Number of Station		
	At Project Office	At Major Regulator	Total
New installation*1	8	14	22
Replacement of radio equipment and antenna*2	3	-	3
Replacement of radio equipment*3	16	-	16
Total	27	14	41

Notes: *1 -- All radio facilities such as transceiver, controller, antenna and tower shall be introduced.
*2 -- Radio equipment and antenna shall be replaced. Tower is only available.
*3 -- Radio equipment shall be replaced. Tower and antenna are available.
Radio station by project office is shown in Table 4-1 and Figure 4-3.

4.4 Improvement Plan of Private Wire Telephone (Level-2)

Improvement of about 15 km between Regional Office No.7 and project offices of Chao Phraya Dam, Borommathat and Phonlathep is propsoed. Preliminary designs of each system are as follows:

- Line loss is lower than 20dB.
- Paired cable is used for communication line. Cable conductor is more than 0.9 mm. Suspension wire is attached for construction.
- Existing ploes are used as many as possible. Span is 62.5 m.
- Capacity of channels at project office is from three to five.

4.5 Introduction of Rural Radio Telephone (Level-2)

Local circuit is mostly consisted of rural radiotelephone and leased private circuit from TOT. Alternative plans are considered as follows:

Case (A) (Figure 4-4)

Project offices with TOT subscriber's telephone in the present TOT network shall establish leased private circuit. Rural radiotelephone shall be installed at the other offices of no TOT telephone in the Delta.

Case (B) (Figure 4-5)

Rural radiotelephone system be installed at all project offices in the Delta. Leased private circuit from TOT is not planned.

Case (C) (Figure 4-6)

Leased private circuit is planned at some project offices where are located around Bangkok and close by TOT's main stations. Rural radiotelephone be installed at the others in the delta.

Taking account of development and reliability of TOT network, Case (C) is recommendable as a rural radiotelephone system.

Rural radiophone system shall be applied except in some areas equipped with improved private wire telephone and TOT telephone. Number of main and sub-stations to employ this system are five and fifteen in the delta, respectively.

Eight project offices with TOT telephone are selected in the lower Delta as shown in Figure 4-6. Leased private circuit from TOT will be easily constructed at those project offices. TOT subscriber's telephone had been already introduced except at Bang Ban and Klong Phriew project offices. The above two project offices are located close by the main station of TOT and construction of TOT circuit will be easy.

Provided that main station is located in the project office, junction circuit shall be introduced for communication between that Office and Regional Offices or RID Head Office. Junction circuit is composed of small capacity multiplex radio link or TOT leased private circuit. Project Offices selected as a main station are as follows:

Project Office	Junction Circuit
Samchuk	Low capacity multiplex radio
Bang Ban	Leased private circuit from TOT
Klong Phriew	-do-

Main stations will be changed from the above mentioned Bang Ban and Klong Phriew project offices to the Chao Chet-Bang Yihon and Pasak Tai project offices, provided that it is difficult for those project offices to lease private circuit from TOT at the time when rural radiophone is introduced. And, junction circuit shall be also changed to small capacity multiplex radio link.

Preliminary designs of rural radiotelephone system are as follows:

- Frequency band: 400 MHZ band (PTD assigns frequency band)
- Antenna: 20 - 30 M
- S/N ratio: more than 45

System configuration is shown in Figure 4-7.

4-6 Installation of PABX (Level-2)

PABX (Private Automatic Branch Exchange) shall be introduced in whole project offices to make automatic telephone.

After improvement of local circuit, replaced thirteen HF/SSB radio facilities shall be utilized for emergency state.

Improvement plan by project office is shown in Tables 4-3 and 4-4 and Appendix-4.4.

CHAPTER 5 IMPROVEMENT PLAN OF FIELD CIRCUIT

5.1 Basic Concept for Improvement

Communication network within project area shall be composed of:

- Private wire telephone.
- VHF/FM radio system.

Communication between project office and water master office shall be mainly done by improved VHF/FM radio facilities and that between water master and zoneman shall be made by improved private wire telephone and newly introduced portable wireless telephone.

The above system shall be improved at management level-2, so as to transfer data/information for management activities smoothly.

TOT subscriber will be expected to extend one office after another, dependent on development of TOT network. Introduction plan of TOT network is not considered in this study.

5.2 Improvement Plan of Private Wire Telephone (Level-2)

Rehabilitation of all deteriorated communication portions is in financial difficulties. Some key portions, therefore, will be given priority for improvement, at where have to be improved shall be selected in accordance with communication frequency expressed by the line length and the number of telephone set along the communication line.

Open wire installed as communication line suffers much from noise at present. This open wire should be replaced by cable line for reduction of induction noise and crosstalk even though line loss is much

more and communication distance is shorter than those of open wire. Line loss of cable and wire is shown in Appendix-4.5. In case of cable line, communication distance is limited to some extent. The following alternative way are considered to cope with shorter communication distance.

(i) Cable line is only installed in communication area available. VHF/FM radio system shall be introduced at where remain not installed.

(ii) Cable line is extended as much as possible, without VHF/FM radio system. Data/information is conveyed by operators located on communication line through their reading and writing, if communication distance is too long for direct telephone talk.

(iii) Repeator station in place of operator is installed for long distance communication. Data/information is transferred without operator.

Considering the above alternative plan, repeator station is apt to suffer from thunder and construction cost is high. Case(i) is finally applied in taking account of availability of the present wire telephone network and VHF/FM radio system in the basin.

Improvement plan of private wire telephone are as follows:

Items	Unit	Region 7	8	9	Total
Replacement of telephone line	km	763	617	33	1,413
Replacement of telephone set *1	Unit	232	171	8	411
Installation of telephone set (1) *2	"	108	74	12	194
Installation of telephone set (2) *3	"	300	220	20	540

Notes: *1 -- Replacement from the present old one to new one.
*2 -- New introduction at water master and other branch offices.
*3 -- Installation and replacement inside project office.

Details are shown in Table 5-1.

5.3 Improvement Plan of VHF/FM Radio System (Level-2)

Introduction of VHF/FM radio is more economical than improvement of private wire telephone to cover the monitoring area. However, provided that all communication will be done by VHF/FM radio, the following problems will be caused within project area:

- Service area covered by one radio equipment is limited in communication distance of 10 to 15 km. Many radio equipments, therefore, will have to be provided for whole monitoring area.

- And, many frequency bands will be required to avoid interference among them. If number of frequency bands available is limited in the covering area, communication system become rather complicated.

- VHF/FM radio system is made by press-to-talk method, which is not smooth as compared with private wire telephone.

Under the present situations, number of radio stations has to be limited to some extent because current frequency bands available by RID is limited in number.

In the improvement plan, therefore, radio facilities shall be introduced in project and water master offices. This radio will be used as a fixed station. In addition to the above radio facilities, portable wireless telephone shall be given for communication between water master and zoneman.

5.3.1 VHF/FM Radio for Fixed Station

Fixed station shall be installed in water master office and project office, and the number of station to be improved are as follows:

Region	Number of Station		
	Existing	New Introduction	Total
Region No.7	11	49	60
Region No.8	11	29	40
Region No.9	1	3	4
Total	23	81	104

Some project offices have already been furnished with radio equipment, and some of them are available for field circuit communication system. Therefore, number of fixed station is estimated under the following conditions:

- New radio equipment shall be equipped in project office under an improvement plan of local circuit.

- After installation of new radio equipment in project office, replaced radio transceiver shall be given to water master office for communication with water master.

Number of fixed station to be improved are finally estimated as below:

Region	Number of Station	
	New Installation	Remove to Other Office
Region 7	22	11
Region 8	12	9
Region 9	2	1
Total	36	21

Details are shown in Table 5.2 and Appendix-4.5.

5.3.2 VHF/FM Portable Wireless Telephone

Portable wireless telephone shall be introduced for communication between water master and zoneman.

Considering the extent of monitoring area by zoneman and limited communication distance by portable wireless telephone, the number of telephone sets is estimated under the following conditions:

- If private wire telephone system is already in the monitoring area under the management office, three sets are given to project office and each water master office, respectively.

- Otherwise, five sets are given.

As a result of the study, the number of wireless telephone set is estimated as follows:

Region	Number of Telephone
Region 7	231
Region 8	151
Region 9	19
Total	401

Details are shown in Table 5.2 and Appendix-4.5.

Relation between the number of telephone and project area are shown in Table 5.3. The number of coverage area is from 0.2 to 3.4 zonemen a wireless telephone and average is 1.2 zonemen. One portable wireless telephone will be able to cover the extent of average 3,500 ha.

5.3.3 VHF/FM Mobile Station

VHF/FM mobile radio shall be equipped with the existing vehicle as a supplemental communication facilities within project area. One set is given to each project office. Number of station is as follows:

Region	Number of Station
Region 7	15
Region 8	11
Region 9	1
Total	27

Details are shown in Table 5.2.

CHAPTER 6 IMPROVEMENT PLAN OF MONITORING SYSTEM

6.1 Water Level at Regulator Station

6.1.1 Outline

Most of water level observation are currently measured with staff gauge. In the improvement plan, regulator stations are selected by management level in taking account of canal capacity and required accuracy of observed data. In this selection, the following observation methods are considered.

- Staff gauge and visual measurement
- Automatic gauge and visual measurement
- Automatic gauge with telemeter

6.1.2 Improvement Plan by Management Level

Number of regulator stations in the Delta to be monitored is as follows:

Level	Regulator and Canal to be Monitored	Number of Station
1	Major regulator in Chao Phraya, Suphan, Noi river and Chainat-Pasak, Raphiphatana canal.	32
2	In addition to the regulator of Level-1, regulator in the main canal, of which capacity is 10.0 cu.m/s.	128
3	All regulators along canal, except FTO. (farm turn-out)	1,507
4	All regulator and FTO.	7,872

Note: Details are shown in Appendix-4.6.

Observation method will be improved at some important points selected in the above stations. Water level at remaining stations is measured by the same method as present.

Improvement plans by management level are considered as follows:

Level-1: Water level is basically observed by staff gauge because monitored stations are a few and high accuracy of monitored data is not required in this level. Therefore, rehabilitation of 20 percent of existing staff gauges are planned at regulator sites along the canal of which capacity is more than 1.0 m^3/s.

Level-2: In this level, water flow up to main canal will have to be monitored. Then, amounts of water releases at major regulators and water supply into main canal are precisely measured to grasp water flow situations. Automatic water level gauges, therefore, are installed at up and down sites of major regulators and first regulator in main canal of which capacity is more than 10.0 m^3/s.

Level-3: In this level, water flow up to FTO will have to be monitored. Besides amounts of water releases and water supply of the above Level-2, estimation of water consumption in main canal is required to grasp amount of water supply into lateral canal. Automatic gauges, therefore, are installed at first and last regulators in main canal. Observed data by present staff gauge are also used for the above estimation and water allocation plan. And, telemeter equipment are introduced at major regulator sites of the above Level-1, because quick response for water allocation plan up to FTO and accuracy of monitored data at those points are required to some extent.

Level-4: In this level, water flow up to at on-farm will have to be monitored. Based on the same concepts as the above levels, each amount of water release, supply and consumption is estimated in all canals. Then, automatic gauges are installed at first and last regulators in canal of capacity more than 1.0 m^3/s. Telemeter equipment is also installed at first regulator in main canals so as to grasp water flow conditions, in addition to the Level-3.

6.1.3 Telemeter Station

Telemeter system is introduced at some important sites in Levels-3 and 4. Considering a large number of monitoring sites and data transmission, automatic data observation/collection system with telemeter equipment at key regulator is proposed. Types of telemeter station are considered as follows:

Type	Observation Items and Gauging Station
1	Water level gauging station with telemeter equipment is installed at side of river or canal.
2	Water level gauging stations with telemeter equipment are installed at up/down side of regulator.
3	Water level and rainfall gauging stations with telemeter equipment are installed at side of river or canal.
4	Water level and rainfall gauging stations with telemeter equipment are installed at side of regulator.

Note: Schematic diagram is shown in Figure 6-1 and Appendix-4.6.

6.1.4 Improvement Plan

Observation stations are selected by project area, taking account of canal capacity and the above-mentioned concepts for improvement. Most of the selected points are located at the existing stations and are operated by O/M Division. The water level gauged are transmitted by improved communication facilities from the observation site to the project office. Collected data are compiled and transmitted to the Head Office and Regional Offices for the water management purpose.

Details of the number of gauging stations are shown in Table 6-1. Telemeter stations are shown in Tables 6-2 and 6-3. 41 and 85 telemeter stations are proposed in Levels-3 and 4, as shown in Figures 6-2 and 6-3, respectively. Details in delta is shown in Figure 6-4 and Table 6-4.

6.2 Water Level in River System

6.2.1 Basic Concept

In addition to the regulator sites, water level in river system is observed for forecasting side flow and monitoring water flow situations. Observation/data transmission methods will be improved at some selected stations, as well as the regulator sites. Most of selected points are located at the existing stations and are gauged by Hydrology Division. The existing stations are available for improvement plan.

6.2.2 Observation/Data Collection Method

Observation and data collection method are improved, taking account of the availability of existing gauging stations and water management purpose by level.

The following alternative types are considered:

Type-1: Existing observation device is available. But, communication facilities such as HF/SSB or VHF/FM radio is provided for quick data transmission. Therefore, station house beside the existing gauge and radio facilities are constructed in this type.

Type-2: Automatic water level gauge is installed to grasp precise water flow situation at that point. Data collection is done by the same method as the present or by using improved communication facilities at near office for weekly water allocation plan. Therefore, gauging station is newly constructed in this type.

Type-3: In addition to the automatic water level gauge of Type-2, automatic rainfall gauge is also installed at same site for forecast of basin runoff. Data collection is the same as the Type-2. Therefore, both of automatic water level and rainfall gauges are installed in this type.

Type-4: Automatic water level gauge is installed to grasp precise water flow condition at that point. Radio facilities are also provided for quick data transmission at required time. Data/information is communicated by voice such as the Type-1. Therefore, automatic water level gauge and station house with radio facilities are newly constructed in this type.

Type-5: In addition to the Type-4, automatic rainfall gauge is also installed at same site. Data/information of water level/rainfall and water flow condition in surrounding area are transmitted by voice. Therefore, automatic water level/rainfall gauges and station house with radio facilities are newly constructed in this type.

Type-T(1): Automatic water level gauge with telemeter is installed. Data is automatically collected for various water management purposes. Gauging station with telemeter and house are newly constructed.

Type-T(3): In addition to the above T(1), automatic rainfall gauge is also installed at same site. Automatic gauges and house with telemeter are newly constructed. T(1) and T(3) are the same types as described in 6.1.

6.2.3 Improvement Plan

Gauging stations are selected in view of the following conditions:

- Hydrology data in the upper basin are mainly used for estimation of amount of inflows into reservoirs. Observed data are not needed for weekly water allocation plan. And, quick data collection system are not required, considering time lag of basin runoff.

- In the middle basin, hydrology data are used for forecasting of side flows between the both reservoirs and Nakhon Sawan. Even though there is about 1-week lag from the time of water releases from reservoirs to the time of arrival at Nakhon Sawan, it is desirable for water allocation planning to collect the observed data/information as quickly as possible. Quick data collection makes forecasting of side flow easy.

- In the lower basin, hydrology data are useful for understanding of water flow situation. Quick data collection are required to plan water allocation and instruct gate operation.

Based on the above conditions, observation type and gauging station are selected by levels, taking account of the availability of existing network. In case of high target, many observed data and quick transmission are required in the respective sub-basins. Most of selected stations are located near the existing one. But, as for the Sakae Krang and Pasak river basins, new gauging stations are proposed. Selected stations by levels are shown in Figure 6-5. Number of observation station selected are shown in Table 6-5.

6.3 Rainfall Station

6.3.1 Outline

Rainfall data is used for calculation of effective rainfall, basin areal rainfall and run-off discharge in sub-basins. Some rainfall data are observed together with water level in the regulator or river sides. In the improvement plan, therefore, new gauging stations are proposed in addition to the previous plan.

6.3.2 Improvement Plan

Rainfall is basically observed by the same method as the present, and collected by the improved communication system in the upper and middle basins. In the lower basin, present observation network is well developed and most of the existing gauges are available for water management. Observed data are collected by improved radio facilities. In Levels-3 and 4, collected data are processed in project offices to make water distribution plan within project area.

The following improvement plan are considered by management level.

Level-1: Existing reserving rain gauges are used. But, 10 percent of the existing gauges are rehabilitated in project area.

Level-2: Automatic rainfall gauges are introduced in project area to grasp rainfall pattern. One set is installed in one project area.

Level-3: Automatic rainfall gauges are introduced under the same concept as the Level-2.

Level-4: Same as the Level-3. But, one set is installed in one section area under the project.

The number of stations are shown in Table 6-6.

6.4 Field Moisture Condition

6.4.1 Outline

Field moisture condition is one of important factors for on-farm management. Moisture conditions are basically estimated by zone. But, present method is apt to make some errors because of personal judgment by zoneman. In the improvement plan, therefore, some devices are introduced to help zoneman measure it. But, observation is done by visual measurement.

6.4.2 Improvement Plan

Submergence depth in paddy field is measured in some fields along canal. Precise management requires to increase in opportunity for patrol and to provide an adequate appraisal method for tolerable depth by growing stage. For the purpose of that, patrol/communication vehicles are provided in project area. Regarding the appraisal method, it is desirable to make guidelines through management activities in the proposed model projects.

In case of upland crops, soil moisture conditions are currently judged from their appearance. Present water supply for upland crops is involved in that of paddy field. Measurement of soil moisture condition will be necessary for effective use of limited water resources in future.

In the improvement plan, therefore, soil moisture meter is installed in selected fields in Levels-3 and 4. Relation between moisture content and crops will be desirably studied in model projects.

Plans are considered as follows:

Level-1: Measurement is done by the same method as the present.

Level-2: Basically same as the Level-1. But, measurement is expected to be higher accuracy than the Level-1.

Level-3: In case of paddy field, the same method as the above is applied. Soil moisture meter is installed in conservation irrigation area.

Level-4: Same as the Level-3. Moisture meter is installed on a section basis in project area.

Number of meter necessitated is shown in Table 6-7.

6.5 Water Quality

6.5.1 Outline

Water quality problem is getting more important every year, from viewpoints of agriculture in urbanization in the lower delta. Therefore, water quality meter is introduced to monitor water quality in creeks, canals and rivers.

6.5.2 Improvement Plan

Water qualities are measured in river system and in canals or creeks, which are executed by Hydrology Division and O/M Division, respectively. Two types of water quality meter are considered in improvement plan. One is portable type for any time and place. The other is fixed type for continuous observation at fixed station.

Three stations of fixed type are installed in river system, as below:

New Station	River System	Existing near Station	Number of automatic water quality meter by management level Level-1	Level-2	Level-3	Level-4	Remarks
W.18	Chao	C.29	-	-	1	1	
W.19	Phraya	C.4	-	-	1	1	
W.21	Tha Chin		-	-	1	1	
	Total		-	-	3	3	

Improvement plan in canals or creeks are considered by project area, as follows:

Level-1: Same as the present condition.

Level-2: Portable type is introduced in conservation irrigation area.

Level-3: Both of portable and fixed types are introduced in conservation area.

Level-4: Same as the Level-3. Portable one is introduced on a section basis.

Stations of fixed type will be selected in canals, considering observation network including portable types in project area. The number of quality meter introduced by project area is shown in Table 6-8.

6.6 Groundwater

6.6.1 Outline

Irrigation water supply is consisted of surface flow from regulator and groundwater including return flow from upper basin. At present, availability of groundwater is considered based on past experience.

Water supply from groundwater is important factor in dry season. Continuous observation and analysis are required for examination on availability of groundwater.

6.6.2 Improvement Plan

Groundwater level observation is currently performed in the project area in the upper delta. The present observation network is basically used in Levels-1, 2 and 3. In Level-4, groundwater level gauges are new introduced in all project area in the delta, as shown in Appendix-4.5.

6.7. Monitoring Facilities in Office

6.7.1 Vehicle

One of difficulties in water operation is owing to lack of vehicle for patrol and communication in project area. In the improvement plan, motorcycles and patrol cars are provided for monitoring on a section and project basis, as shown in Table 6-9.

6.7.2 Monitoring and Verification Facilities

Monitoring and verification facilities are introduced for better understanding water flow conditions. Display panel and video system are considered in the improvement plan, from viewpoints of management manner by proposed levels. In Level-4, some facilities will be introduced in project office, because many performance for management activities will be required at on-farm level. Improvement plan is shown in Table 6-10.

6.7.3 Operation Room

Operation room is improved for smooth management activities in Levels-3 and 4. Floor area is estimated in taking account of the size of introduced equipment and space for required management activities. Required area is shown in Table 6-11.

CHAPTER 7 IMPROVEMENT PLAN OF MONITORING/COMMUNICATION SYSTEM IN THE UPPER AND MIDDLE BASINS

7.1 Improvement Plan of Communication System

7.1.1 Basic Concept

The same leased circuit from TOT as the Delta is proposed as a trunk line between Head Office and Regional Offices. The number of channels required in these lines is shown in Figure 3-4.

Improvement of HF/SSB or VHF/FM radio facilities and introduction of rural radiotelephone system are proposed as a local circuit. Improvement of wire telephone is not planned in local circuit, because higher construction cost is required for improvement of long distance communication among offices in widespread coverage area with undulated land.

As a field circuit, improvement of RID wire telephone and VHF/FM radio facilities are proposed.

Relation between management levels and the above improvement plan is the same as in the delta.

7.1.2 Improvement Plan of Communication System

- HF/SSB and VHF/FM radio

  Replacement of old facilities and introduction of new one are planned in Level-1, as a basic communication facilities. The number of HF/SSB and VHF/FM radio stations to be improved are 20 and 53, respectively.

- Rural radiotelephone

  Rural radiotelephone system are introduced at regional offices and some project offices. Main stations are located in the regional offices and sub-stations are selected under the

condition that communication distance between main and sub-station is shorter than 50 km. Number of station selected is as follows:

Region Area	Main Station	No. of Sub-Station
Region 1	Regional Office No.1	6
Region 2	Regional Office No.2	3
Region 3	Regional Office No.3	3
	Pichit Project	2
	(Regional Office No.7)	(1)
Total	4 Stations	15

Note: ( ) is Nakhon Sawan Project Office which is sub-station under the main station in the Regional Office No.7.

- Low capacity multiplex radio

  Low capacity multiplex radio facilities are introduced at Regional 3 and Pichit project offices, because of many communication volume between those offices.

- Private automatic branch exchange

  Private automatic branch exchange (PABX) is introduced at the project office.

Improvement plan is summarized in Table 7.1.

7.2 Improvement Plan of Monitoring System

7.2.1 Hydrology Observation

Introduction plan of observation facilities is formulated based on the same concepts as in the delta. The number of stations is estimated by regional area, taking account of irrigation area.

7.2.2 Monitoring Facilities in Offices

Display panel, telemeter equipment and operation room are subject to improvement of monitoring facilities in management offices. Improvement plan is formulated based on the same concepts as in the delta. But, priority is given to the Regional 3 Office in Level-3, since this office has to distribute irrigation water under water releases from reservoirs as well as in the Delta. In the improvement plan in Level-4, it is considered that number of operation room to be constructed is assumed at about half of existing one.

7.2.3 Vehicle

Motorcycle and patrol car are provided for irrigation area. Required number of vehicle is estimated based on irrigation area and number of offices.

Improvement plan is summarized in Table 8-2.

CHAPTER 8 COST ESTIMATE

Improvement plan has been formulated by management level. Construction of equipment/facilities is also proposed by improvement system and construction cost is estimated based on the unit cost of equipment, materials and other necessary items on the basis of preliminary design. Construction cost is consisted of purchase of equipment/facilities, installation, construction and engineering services for detailed design, supervision and physical contingency. Maintenance cost for spare parts, other miscellaneous expenses and rental fee of TOT is also estimated by level. Maintenance cost is assumed at 2% of introduced equipment.

8.1 Monitoring System

Proposed equipment and facilities is shown in Tables 8-1 and 8-2.

8.1.1 Construction Cost

The cost for each level is as follows:

(i) Lower Basin

(Unit: Million Baht)

Items	Level-1	Level-2	Level-3	Level-4
1. Construction of facilities	18	79	288	656
2. Engineering services	3	15	57	131
3. Contingency	2	9	34	78
Total	23	103	379	865

Note: Engineering services is 20% of direct cost 1
Contingency is about 10% of cost (1 to 2)

(ii) Upper and Middle Basin

(Unit: Million Baht)

Items	Level-1	Level-2	Level-3	Level-4
1. Construction of facilities	6	35	62	241
2. Engineering services	1	7	12	48
3. Contingency	1	4	7	28
Total	8	46	81	317

8.1.2 Maintenance Cost

Annual maintenance cost of lower basin is estimated at the amount of 1.3, 4.0 and 9.2 million Baht in Levels-2 to 4.

8.2 Communication System

Proposed equipment and facilities is shown in Tables 8-3 and 8-4.

8.2.1 Construction Cost

The cost for each level is as follows:

(i) Lower Basin

(Unit: Million Baht)

Items	Level-1	Level-2	Level-3	Level-4
1. Construction of facilities	18	368	368	368
2. Engineering services	3	73	73	73
3. Contingency	2	44	44	44
Total	23	485	485	485

(ii) Upper and Middle Basin

(Unit: Million Baht)

Items	Level-1	Level-2	Level-3	Level-4
1. Construction of facilities	25	238	238	238
2. Engineering services	5	47	47	47
3. Contingency	3	28	28	28
Total	33	313	313	313

8.2.2 Maintenance

Rental fee of TOT line is involved in maintenance cost after the construction. Annual maintenance cost of lower basin is estimated at 0.3, 9.2, 10.0 and 12.0 million Baht in Levels-1 to 4.

CHAPTER 9 CURRENT DATA MANAGEMENT SYSTEM

Effective utilization of information depends much on timely data collection, prompt and smooth data transfer, proper data compilation/processing and easy-retrievable data custody. From the above points of view, a series of site surveys and questionnaire surveys have been made. The current data management system for water management has been found as follows.

9.1. Data Collection and Data Transfer

Data for water management are categorized into four, as follows:

(1) Farming data (farming stage and acreage by each crop, etc.)
(2) Hydraulic/hydrological data (water table, flow rainfall, water quality, underground water level, etc.)
(3) Water operation records (gate operation, instruction from upper-ordinate office, etc.)
(4) Construction/Repair/Rehabilitation records (canal, regulator, etc.)

Data of the above categories (1), (2), and (3) are collected by zonemen and water masters, while (4) is occasionally recorded by Project/Regional/Head Offices.

Farming activities are reported from Project Offices to the Head Office weekly in two different forms. One is for Agricultural Irrigation Office in the O & M Division, and another is for Water Operation Center in the same Division. Data to be informed in the two forms are compiled to serve for each of them, however, most of their contents are overlapped. Project Offices fill up preliminary data sheets before reckoning into the two forms to avoid mis-calculation and conflict between the two. At the end of each season, Project Offices are required to report seasonal summary.

Most of Sectional Offices (Water Master's Offices) under Project Offices conduct seasonal or annual survey in advance to know planned cropping area before it starts. This is used as acreage indices in the season. Zonemen's survey is made usually once a couple of days, and zonemen enumerate acreage and report to Sectional Office by one day before reporting to the Head Office.

Data items (2) at key sites are reported regularly once a day, from Project Offices to Regional Office concerned. Regional Offices transfer the reported data to the Head Office and file the data for occasional reference. Operational instructions are filed in Offices concerned, except in the Head Office. Operational activities are recorded and filed in the Project Offices/Sectional Offices. Media for data transfer varies by conditions such as radio, postal service.

Difficulties in data collection were surveyed by the Study Team. Out of thus answered difficulties, "insufficient knowledge of staff concerned" has been aware by the Head Office, consequently O & M Division and Training Division are cooperatively working to improve educational/training programs for the staffs-in-charge.

9.2 Data Compilation and Data Processing

Data collected in field are primarily compiled in Sectional/Project Offices, and transferred to the senior offices. Little processings are made before the Head Office receives the data because of some difficulties in processings of complex data and in securing capable manpower for the processing in the offices when computerized data processing system was introduced for water management. Therefore, data compilation by computer programs and data processing has been centralized in the Head Office since installation of a computer (Model IBM 1130) for water management. The computer application programs for water management had been well designed and developed at the time being.

These computer programs were improved when the IBM 1130 was replaced by VAX 11/750, however, current development in data processing technologies has come to require more efficient data processing system to ease burdens of offices/staff-in-charge. Water allocation from reservoirs to the farm needs to be scheduled precisely, and therefore it is urgent to answer the requirements for efficient data processing and prompt operational instructions in response to field conditions.

9.3 Data Custody and Data Retrieval

Through the site surveys and the questionnaire surveys, it has been found that Offices concerned have several difficulties in data custody and data retrieval. In short, difficulties are in (1) indexing/filing data and (2) data storage space. Satisfactory solution for the above (1) and (2) will extend availability of data not only to the Sections/Divisions concerned but also to other Sections/Divisions.

9.4 Other Aspects of Data Management in RID

RID has respectable history in implementation of numerous important works, therefore each Section/Division/Office has accumulated their knowledge/experience supported by enormous volume of data. These data are kept in various ways and places. Drawings of structures are usually stored in RID warehouse in Pakred. Weekly farming activities from Project Offices are kept both in Project Offices and the Head Office. Operation records of structures are kept in Sectional/Project/Regional Offices. Project information are filed in Regional Office and the Head Office.

These suggest necessity of well-designed information inventory system. RID have also exerted to improve environment of data retrieval. Some Divisions have their own computerized systems, such as personnel data base system of Personnel Division, SSIP project information system of Small-Scale Project Construction Division and O & M Division. Moreover, hydrological data base system and newly-built dam safety data

base system have been set-up by Divisions concerned oriented by IEC specialists. Utilization of convenient data processing technologies are longed by Project Offices, in accordance with the questionnaire survey.

The questionnaire survey indicates that data needed by a Division is not always data kept/handled by the Division. Share of convenient use and even enjoyment of integrated information are, therefore, inevitable choice for a great step to future functions of RID.

CHAPTER 10 DATA MANAGEMENT SYSTEM IMPROVEMENT

10.1 General Concepts

10.1.1 Necessary Preparatory Works

Well managed data system, systematic complex of data, can offer reliable materials not only for water management but also for project planning, rural improvement, operation and maintenance, and so forth. For improvement of the present data management system to be with the above functions, following preparatory works are listed.

- Unification of data management system and data code system.
- Improvement of data communication system.
- Improvement of data processing system and data storage system.
- Improvement of public information service system.
- Examination of practical operation system.

10.1.2 Conception of Data Management System

Data management system does not necessarily mean computerization of data management but rationalization of information flow, data assortment, data custody and system administration.

10.1.3 Information Flow

Improvement of communication system as aforementioned directly contributes to better information flow. However, improvement of water management system and data management system may fail unless a consensus among Sections/Divisions on improvement of information flow is obtained.

A configuration of a proposed concept, Information Bus Line (IBL) or common data communication line, is shown in Figure 10-1.

Significant merits of this concept are:

i) Concurrent utilization of information even at remote offices.
ii) Elimination of duplication/conflict of data.
iii) Promptness of information.
iv) Availability of data as common property.

Radio, RID and TOT telephone, or postal service are used for information communication at present. Until computerized information system is equipped, inquiry and transfer of information shall utilize the present system. For unautomated offices, immediate upper-ordinate offices shall act the part of their subordinate offices for the time being.

Even if automated facilities are not equipped, above items ii) and iv)will benefit RID. Automated Information Bus Line (IBL), especially in case of computerization, needs on-line or off-line communication link. Though this concept might be realized even without computerized facilities, however, if any automated facilities are available, it is surely helpful for implementation of the services.

10.1.4 Data Assortment

Information to be utilized by unspecified users need to be indexed with well-examined criteria for assortment. For the sake, the following are indispensable.

i) Categorization of requirement from users to save procedure for retrieval from intricacy.

ii) Clarification of relation between data to make assortment/identification systematic and compact.

iii) Unification of indexing system for the same data category to save coding from confusion and complication.

iv) Simplification of indexing criteria to eliminate misindexing.

This methodology can usefully be applied to any kind of assortment, even to non-automated one. However, when this method is applied to computer data assortment, its convenience fully empowers information retrieval.

Some kinds of indexing system may be observed in every office, such as O & M Division's flow gauging station code system, Hydrology Division's hydrological gauging station code system, etc. Therefore, if these existing indexing system are improved by applying the above items i) - iv), RID's practical performance can be impressively advanced.

10.1.5 Data Custody

Amount of data in RID increases year by year, consequently, data assortment and custody are becoming enormous volume of work. Furthermore, stock of data in offices is in danger of loss and damage. Cooperation among Divisions is indispensable for rational and economical data/information management. Management of data as common properties may require well-examined data storage/management system. If data are stored/managed as shown in Figure 10-1, burden of management will not concentrate upon a specific part of the system.

In this concept, each system shall manage its own data, and if occasional necessity of other systems' information arises, the system can access other data storages through the Information Bus Line (IBL). Inquiry with this procedure will less bother the inquired office than with the present procedure. In other words, the whole RID data storage consists of each partial storage and it works as a virtual storage as if each system owns the whole RID data storage.

This method also has some other important merits. The first merit is adaptability for offices not equipped yet with computers, because this office-wise data management will not change the present data management system drastically. The second is easy duplication of stored data (from hard disk to magnetic tape, for instance). This offers security of data against data destruction.

10.1.6 System Administration

In the above mentioned decentralized system organization, each system office shall take responsibility of data management concerning the office as same as present. However, the central system shall be responsible for administration of the whole system. Therefore, the central system shall regulate system operation, and lead subordinate systems to follow the regulations. The central system shall be informed of condition of subordinate systems, especially of accidental mishaps on IBL and data storages. In case of mishaps on IBL, the central system shall secure substitutional media, and shall inform affected offices. Efficiency and security of the whole system shall be supervised by the central and sub-systems in accordance with well-examined guidelines.

10.2 Systems Formulation

10.2.1 Hardware Formulation

In order to relieve data custody/retrieval/processing from intricacy and superannuation, personal computers (personal-use-oriented computer) and computer network technology shall be introduced to the new data management system. Offices to be equipped with computer are the Head Office, Regional Offices, Hydrological Regional Offices and Project Offices. The computers are required to have capability of operation under multi-programmable OS (Operating System).

Moreover, for efficiency of computer network system, key stations shall have computers with higher processing capacity to manage sub-ordinate system. In other words, key nodes shall consist at least of one engineering work station (EWS). In this system, EWS can not only be terminal node but also be middle-ordinate host system. This releases the main host computer from heavy occupation of its time resource by management of all sub-ordinate nodes.

Computer communication shall utilize the improved telecommunication system, especially private/TOT wire telephone. Proper transmission rate

on wire telephone in Thailand may be 1,200 bps (bits per second), unless rapid qualitative improvement of telephone line enable 2,400 bps or more density of phase modulation. However, among on-line connected nodes (such as terminals in one office) can enjoy high density communication of 4,800 or 9,600 bps or higher.

As one of advantages of the said network system, data stored in remote offices are concurrently available in any member office, as if all data in the network system are stored in each office. DBMS (data-base management system) and computer communication softwares for the said integrated personal computer system shall be selected from high performance softwares in market in order to realize smooth introduction/operation even in local offices. Basic configuration of the system is shown in Figure 10-2.

In addition to the above, equipped facsimile system gives high convenience for data drawn, such as weather chart.

For transition period before installation of computer system, voice communication by use of radio/wire telephone and postal service shall stand proxy for data communication system.

10.2.2 Software Formulation

Operation of the system shall be under control of a management committee which consists of representatives of Divisions concerned, such as Data Processing Division, O & M Division, Hydrology Division, Project Planning Division, etc. Management system shall be designed to have a hierarchic structure to correspond to levels of management, namely, the Head Office level, Regional Office level, Project Office level and Sectional (Water Master's) Office level. Computer and peripherals shall be installed at the Head Office, Regional Offices and Project Offices. Their roles are presented as shown in Table 10-1. For field data collection by zonemen under water master, some unified data formats shall be employed. Introduction of unified data formats provides convenience for systematic field data collection and computer data input. Data can easily be reclassified or recalculated for various requirements if the formats are properly designed.

10.3 Plan of Installation

Plan of installation can be chosen from Level-1 to Level-4, in accordance with degree of necessity. Each level may be adjusted at the time of implementation plan. At any level, installation and introduction of equipment must not disturb daily work on water management, therefore, step-by-step implementation need be undertaken as below.

The first step consists of establishment of the system operation committee, exchange of data inventory among offices, data indexing, design of data/survey forms and inquiry forms, scheduling of installation, plan of computer application softwares, etc. This step is indispensable for any level of the plan of installation. Though hardwares are not equipped yet, exchange of data inventory and unified data/survey forms will highly enhance data efficiency in RID.

The second step does installation of equipment, installatin of basic computer software (such as operating system), design of computer application softwares, etc. Hardware installation may be started from offices of higher management level, such as Head Office and Regional Offices. However, due to imbalance of hardware/software installation, system efficiency is not so high in comparison with financial investment. Nevertheless, this step is a key step for the system formulation. Because in this step, design of computer application softwares, test operation and actual daily operation are the most important parts of the step.

The third step, which is the step during actual operation, is step of expansion of the second step, staff training and operation and maintenance of the system. In this step, completion of hardware/software installation fully empowers data/water management system. Each sub-system functions as a part of the integrated data-base network terminal and a local water management center. Data inquiry/retrieval can be carried out with lightening speed throughout the basin.

10.4 Equipment Plan and Implementation Cost

Improvement plan of facilities in offices concerned is summarized as shown in Tables 10-2 and 10-3. Improvement plan by project is shown in Table 10-4.

Construction cost of lower basin is as follows:

(Unit: Million Baht)

Item	Level-1	Level-2	Level-3	Level-4
1. Construction/Installation	14(-)	36(2)	77(4)	151(11)
2. Design and S/V*)	3(-)	7(1)	15(1)	30(2)
3. Contingency	2(-)	4(-)	9(1)	18(1)
Total	19(-)	47(3)	101(6)	199(14)

*) ...Cost for Design and supervision is 20% of 1, Contingency is 10% of (1+2).

( )...for Upper and Middle Basin.

Table 2-1 IMPROVEMENT PLAN OF OBSERVATION METHOD

Observation Items	Level-1	Level-2	Level-3	Level-4
Rainfall	Reserving gauge	Automatic gauge	Automatic gauge, Telemeter	Automatic gauge, Telemeter
Water level				
River	Staff gauge with radio	Automatic gauge with radio	Automatic gauge, Telemeter	Automatic gauge, Telemeter
Main canal	Staff gauge	Automatic gauge	Automatic gauge, Telemeter	Automatic gauge, Telemeter
Lateral canal	Staff gauge	Staff gauge	Staff gauge	Staff gauge, Automatic gauge
Water flow				
River	Portable meter	Portable meter	Automatic, Telemeter	Automatic, Telemeter
Main canal	Portable meter	Portable meter	Portable meter	Automatic, Telemeter
Lateral canal	Portable meter	Portable meter	Portable meter	Portable meter
Water quality				
River	Test by sampling	Portable meter	Fixed automatic gauge	Fixed automatic gauge
Main canal	Test by sampling	Portable meter	Fiexd automatic gauge	Fixed automatic gauge
Lateral canal	Test by sampling	Portable meter	Portable meter	Portable meter
Ground water	Manual observation	Manual observation	Manual observation	Automatic gauge
Field moisture condition				
Paddy field	Visual judgement	Manual measurement	Manual measurement	Manual measurement
Up-land crop	Visual judgement	Visual judgement	Soil moisture meter	Soil moisture meter

Table 2-2 IMPROVEMENT PLAN OF DATA COLLECTION/DISTRIBUTION METHOD

Level	Justification	Main improvement plan
Level-0	Use of current communication facilities	No improvement
Level-1	Smooth voice communication among Region, Project offices and main regulator stations	VHF/FM radio system at region, project and main regulator stations
Level-2	Smooth voice communication among whole management offices including water master and zoneman	In addition to the improvement of level-1 - Private wire telephone - Portable wireless telephone - Rural radiotelephone
Level-3	Voice communication system until at FTO level Automatic data collection at major regulator stations by telemeter system	In addition to the improvement of level-2 - Introduction of telemeter system at major regulator site. - Facsimile
Level-4	Same voice communication system as the level-3 Automatic data collection at main gauging station by telemeter until at main canal system	In addition to the improvement of level-3 - Introduction of telemeter system at main station

Table 2-3 BASIC CONCEPT OF DATA PROCESSING METHOD

Level	Head office	Regional and Project office	Improvement
Level-0	Current condition	Current condition	No improvement
Level-1	Caluculation of water distribution to major regulators - Caluculation of macro water demand	Compilation of cropping area, intake water discharge, growing stages and other conditions by irrigation service area of the major regulator	Development of computer programs - Water distribution calculation - Macro water demand caluculation - Preparation of compilation chart
Level-2	Caluculation of water distribution to major regulator - Caluculation of macro water demand - Forecasting of side flow - Forecastion of dam inflow	Caluculation of water distribution of allocated water from Head office to main canal system by using calculation chart	Development of computer programs in addition to the level-1 - Hydrology analysis - Preparation of calculation chart
Level-3	Caluculation of water distribution to major regulator, based on the water demand reported from Regional and Project offices and forecasted side flow and dam inflow	Caluculation of water demand by irrigation area - Micro water demand calculation by irrigation area Caluculation of water distribution of allocated water to FTO level	Development of computer programs in addition to the level-2 - Micro water demand caluculation - Caluculation of side flow and dam inflow - Water delivery by main canal
Level-4	Same data processing as the level-3	Calculation of water demand until on-farm level Calculation of water distribution of allocated water until on-farm level	Development of computer programs until at on-farm with same concept as the level-3

Table 2-4 BASIC CONCEPT OF MONITORING/VERIFICATION METHOD

Level	Head office	Regional office	Project office	Improvement
Level-0	Current condition	Current condition	Current condition	- No improvement
Level-1	Display panel - Manual input - data by voice commu--nication	Monitoring each other with voice communication by improved communication system at major regulators		- Introduction of Display panel of basin level (use of introduced panel)
Level-2	—ditto —	Display panel - Manual input - Data by voice	Monitoring by voice communication along main canal	- Introduction of Display panel by river systems at Regional offices
Level-3	Display panel of basin level - Automatic input - Data by telemeter	—ditto —	Monitoring by voice communication until at FTO level	- Introduction of Display panel at Head office - Improvement of operating room at Head and Regional offices
Level-4	Same display panel as the level-3 Video system	Display panel by river system - Automatic input - Data by telemeter Video system	Display panel by canal system at main offices - Automatic input - Data by telemeter	- Introduction of Display panel at main offices - Improvement of operating room at main offices - Video system

Table 3-1 COMPARISON OF ALTERNATIVE SYSTEM

(Unit ; 1000 Baht)

Alternatrive Plan	Construction Cost	Depreciation Cost	Rental Cost	Maintenance Cost	Total Cost
(1) Line by RID	105,000	9,258	-	1,912	11,170
(2) Line by RID and TOT	93,000	7,438	1,614	1,362	10,414
(3) Line by TOT	-	-	3,600	-	3,600

Note ; - Detail of construction cost of alternatives (1) and (2) is refered to Table 3-2 and APPENDIX 4.3.

- Rental cost of TOT line is refered to Table 3-2 and APPENDIX 4.3.

Table 3-2 BREAKDOWN OF CONSTRUCTION AND ANNUAL COST (2)

(continued)

(unit: 1,000 Yen)

(2) Annual Cost

- Depreciation 560,000 x 0.08024		44,930 (7,438,000 Baht)
- Maintenance		8,170 (1,362,000 Baht)
° Equipments 262,600 x 0.02	5,250	
° Tower* 76,800 x 0.3 x 0.18097 x 0.7	2,920	
- Rental charge		9,680 (1,614,000 Baht)

3. Rental Charge from TOT

Rental charge per channel is as follows.

(1) Trunk Route

Case (A)	more than five years	170 Baht/km/year
Case (B)	less than five years	340 Baht/km/year

In this study, Case (A) is applied.

(2) Branch Route

Branch route is between TOT Office and RID's Office. Rental charge is from 1,000 to 3,000 Baht/month on the communication distance basis.

Table 4-1 IMPROVEMENT PLAN OF VHF/FM RADIO SYSTEM IN LOCAL CIRCUI (LEVEL-1)

Number of VHF/FM Radio Station

Project Name	Project*1 (New)	Project*2 (Existing Tower)	Project*3 (Existing Antenna)	Main Regulator
Regin 7				
Chao Phraya Dam	–	–	–	–
Phonlathep	–	1	–	–
Thabote	–	1	–	–
Samchook	–	–	1	–
Don Chedi	–	–	1	–
Pho Phraya	–	–	1	–
Boromathat	1	–	–	–
Chanasutr	–	–	1	–
Yang Manee	–	–	1	–
Pakhai	1	–	–	–
Bang Ban	1	–	–	–
Chaochet Bang Yihon	1	–	–	–
Phraya Banlu	–	–	1	–
Phra Pimon	–	1	–	–
Phasi Charoen	–	–	1	–
Kra Sieo	–	–	1	–
Main Regulator	–	–	–	9
Sub - total	4	3	8	9
Region 8, 9				
Manorom	–	–	1	–
Chong Khae	–	–	1	–
Khoke Kathiem	1	–	–	–
Reong Rang	1	–	–	–
Maharaj	–	–	1	–
Pasak Tai	1	–	–	–
Raugsit Nua	–	–	1	–
Nakhon Luang	–	–	1	–
Rangsit Tai	1	–	–	–
Klong Darn	–	–	1	–
Klong Priew	–	–	1	–
Phra Ong Chaiya Nuchit	–	–	1	–
Main Regulator	–	–	–	5
Sub - total	4	–	8	5
Total	8	3	16	14

Note ; *1 = All radio facilities be introduced
*2 = Radio equipment and antenna be replaced. Tower is available
*3 = Radio equiment be replaced. Tower and antenna is available.
Antenna Type is four Element Coliner Antenna.
Antenna Tower is 20m. Coaxial cable and commector is 40m or 45m.

Table 4-2 MAJOR REGULATOR TO BE INTRODUCED VHF/FM RADIO SYSTEM (LEVEL-1)

Regulator Station	Number of VHF/FM equipment	VHF/FM Antenna type	Coaxial cable and connector	Antenna Tower
Pho Koi Regulator	1	4EL.C	35m	20m
Latchado "	1	4EL.C	35m	20m
Bang Yihon "	1	4EL.C	35m	20m
Phra Sri Sao. "	1	4EL.C	35m	20m
Phra Sri Sril "	1	4EL.C	35m	20m
Ayutthaya	1	4EL.C	35m	20m
Chao Chet Regulator	1	4EL.C	35m	20m
Phraya Banlu "	1	4EL.C	35m	20m
Phra Pimon "	1	4EL.C	35m	20m
Chimphli "	1	4EL.C	35m	20m
Menorial Bridge	1	4EL.C	35m	20m
Bang Plaked Regulator	1	4EL.C	35m	20m
Klong Rangsit "	1	4EL.C	35m	20m
Klong 13 Tail "	1	4EL.C	35m	20m

Note : 4EL.C indicates four Element Coliner Antenna

Table 4-3 IMPROVEMENT PLAN OF LOCAL CIRCUIT (LEVEL-2)

Name of Project	Type *1 of Local Circuit	To Station	
		Name	Distance (km)
Region 7			
Chao Phraya Dam	P.W.	Region 7	1.5
Phonlathep	- do -	- do -	18.2
Thabote	R.R.	- do -	21
Samchook	- do - *2	- do -	42
Don Chedi	- do -	Samchook	19
Pho Phraya	- do -	- do -	30
Boromathat	P.W.	Region 7	4.2
Chanasutr	R.R.	- do -	28
Yang Mance	- do -	Samchook	35
Phakhai	- do -	Bang Ban	20
Bang Ban	TOT	Head office	
Chaochet Bang Yihon	R.R.	Bang Ban	26
Phraya Banlu	TOT	Head office	
Phra Pimon	- do -	- do -	
Phasi Charoen	- do -	- do -	
Kra Sieo	R.R.	Samchook	46
Region 8			
Manorom	R.R.	Region 7	21
Chong Kae	- do -	- do -	25
Koke Kathiem	P.W.	Region 8	0.6
Roeng Rang	R.R.	Klong priew	25
Maharaj	- do -	Region 8	18
Pasak Tai	- do -	Klong Priew	18
Rangsit Nua	- do -	Bang Ban	26
Nakhon Luang	- do -	- do -	23
Rangsit Tai	TOT	Head office	
Klong Dan	- do -	- do -	
Klong Priew	- do -	Region 8	
Phra Ong Chaiyanichit	- do -	Head office	

Note : *1 Type of Local Circuit are as follows
P.W. = Private wire telephone system
R.R. = Rural radio system
TOT = TOT leased private circuit

*2 = Low capacity multiplex radio system shall be introduced.

Table 4-4 IMPROVEMENT PLAN OF LOCAL CIRCUIT BY PROJECT OFFICE (1)

Project Name	Rural Radiotelephone			PABX 5/50 ch.	Cable Installation (km)	Low Capacty Multilex Radio Link	Antenna Tower
	Base Station (1)	Base Station (2)	Sub. Station				
Region 7	-	1	-	-	-	1	-
Chao Phraya Dam	-	-	-	-	1.5	-	-
Phonlathep	-	-	-	1	14.0	-	-
Thabote	-	-	1	1	-	-	-
Samchook	-	1	-	1	-	1	1 (30m)
Don Chedi	-	-	1	1	-	-	-
Pho Phraya	-	-	1	1	-	-	-
Boromathat	-	-	-	1	4.2	-	-
Chanasutr	-	-	1	1	-	-	-
Yang Manee	-	-	1	1	-	-	-
Pakhai	-	-	1	1	-	-	-
Bang Ban	-	1	-	1	-	-	-
Chaochet Bang Yihon	-	-	1	1	-	-	-
Phraya Banlu	-	-	-	1	-	-	-
Phra Pimon	-	-	-	1	-	-	-
Phasi Charoen	-	-	-	1	-	-	-
Kra Sieo	-	-	1	1	-	-	-
Sub-total	-	3	8	15	19.7	2	1 (30m)

Table 4-4 IMPROVEMENT PLAN OF LOCAL CIRCUIT BY PROJECT OFFICE (2)

Project Name	Rural Radiotelephone			PABX 5/50 ch.	Cable Installation (km)	Low Capacty Multilex Radio Link	Antenna Tower
	Base Station (1)	Base Station (2)	Sub. Station				
Region 8, 9	1	–	–	–	–	–	–
Manorom	–	–	1	1	–	–	–
Chong Khae	–	–	1	1	–	–	–
Khoke Kathiem	–	–	–	–	0.6	–	–
Reong Rang	–	–	1	1	–	–	–
Maharaj	–	–	1	1	–	–	–
Pasak Tai	–	–	1	1	–	–	1 (20m)
Rangsit Nua	–	–	1	1	–	–	–
Nakhon Luang	–	–	1	1	–	–	–
Rangsit Tai	–	–	–	1	–	–	–
Klong Darn	–	–	–	1	–	–	–
Klong Priew	1	–	–	1	–	–	–
Phra Ong Chaiya Nuchit	–	–	–	1	–	–	–
Sub-total	2	–	7	11	0.6	–	1 (20m)
Total	2	3	15	26	20.3	2	1 (20m) 1 (30m)

Table 5-1 IMPROVEMENT PLAN OF PRIVATE WIRE TELEPHONE SYSTEM (1)

Project Name	RID Private Wire Telephone System							VHF Radio System					TOT Telephone	
	Existing			Improvement				Number of New Station					Number of Existing	New Installation
	Line Length (km) (A)	Number of Telephone (B)	(A)/(B)	Line Length (km) (C)	Number of Telephone (D)	(C)/(D)	(C)/(A)*1 (%)	Number of Existing	Base Station	Land Mobil	Portable Wireless	Total		
Chao Phraya Dam									-	-	3	3	1	-
Phonlethep	62	11	5.6	38	9	4.2	61	1	1	1	9	12	-	-
Thabote	104	34	3.1	70	27	2.6	67	1	2	1	9	13	-	-
Samchook	119	22	5.4	70	15	4.7	59	1	4	1	18	24	-	-
Don Chedi	55	25	2.2	50	25	2.0	91	1	1	1	9	12	-	-
Pho Phraya	156	27	5.8	89	22	4.0	57	1	4	1	19	25	-	-
Boromathat	145	22	6.6	79	20	4.0	54	1	4	1	22	28	1	-
Chanasutr	193	57	3.4	86	33	2.6	45	1	6	1	30	38	1	-
Yang Manee	158	39	4.1	76	29	2.6	48	1	2	1	14	18	-	-
Pakhai	75	19	3.9	53	18	2.9	71	-	3	1	9	13	-	-
Bang Ban	75	12	6.1	0	0	-	0	-	1	1	15	17	1	-
Chaochet Bang Yihon	152	26	5.8	52	18	2.9	34	-	3	1	14	18	1	-
Phraya Banlu	148	17	8.7	75	10	7.5	51	1	4	1	19	25	1	-
Phra Pimon	57	9	6.3	25	6	4.2	44	-	2	1	11	14	1	-
Phasi Charoen	0	0	-	0	0	-	-	1	2	1	15	19	3	-
Kra Sieo	42	13	3.2	0	0	-	0	1	1	1	15	18	-	-
Main Regulator	-	-	-	-	-	-	-	-	9	-	-	9	-	-
Sub - total	1,541	333	4.6	763	232	3.3	49.3	11	49	15	231	306	9	-

Note *1 : Percent of improvement length

Table 5-1 IMPROVEMENT PLAN OF PRIVATE WIRE TELEPHONE SYSTEM (2)

Project Name	RID Private Wire Telephone System							VHF Radio Sustem					TOT Telephone	
	Existing			Improvement				Number of New Station					Number of Existing	New Installation
	Line Length (km) (A)	Number of Telephone (B)	(A) / (B)	Line Length (km) (C)	Number of Telephone (D)	(C) / (D)	(C) /(A) *1 (%)	Number of Existing	Base Station	Land Mobil	Portable Wireless	Total		
Manorom	140	34	4.1	83	29	2.9	59	1	2	1	12	16	1	-
Chong Khae	118	14	8.4	58	11	5.3	49	1	1	1	9	12	1	-
Khoke Kathiem	148	33	4.5	78	31	2.5	53	1	2	1	9	13	3	-
Roeng Rang	78	13	6.0	36	10	3.6	46	1	1	1	11	14	-	-
Maharaj	228	51	4.8	118	35	3.4	52	1	5	1	28	35	1	-
Pasak Tai	68	12	5.7	42	11	3.8	62	1	1	1	9	12	1	-
Rangsit Nua	77	21	3.7	40	14	2.9	52	1	2	1	12	16	1	-
Nakhon Luang	100	21	4.8	60	15	4.0	60	1	2	1	12	16	1	-
Rangsit Tai	106	14	7.6	58	5	11.6	55	1	4	1	20	26	1	-
Klong Darn	0	0	-	0	0	-	-	1	3	1	20	25	4	-
Klong Priew	70	12	5.8	44	10	4.4	63	1	1	1	9	12	1	-
Main Regulator	-	-	-	-	-	-	-	-	5	-	-	5	-	-
Sub - total	1,133	225	5.0	617	171	3.6	54.4	11	29	11	151	202	15	
Phra Ong Chaiyanichit	65	12	5.4	33	8	4.1	50.8	1	3	1	19	24	1	
Sub - total	65	12	5.4	33	8	4.1	50.8	1	3	1	19	24	1	
Total	2,739	570	4.8	1,413	411	3.4	51.6	23	81	27	401	532	25	

Note *1 : Percent of improvement length

Table 5-2 IMPROVEMENT PLAN OF FIELD CIRCUIT (1)

Project Name	Wire Communication System		VHF /FM Base Station		VHF /FM Mobil Station	
	Cable length (km)	Number of Telephone set	Number of New Station	Number of Removal	Number of Land Mobil	Number of Portable Wireless telephone
Region 7						
Chao Phraya Dam	-	-	-	-	-	3
Phonlathep	38	33	-	1	1	9
Thabote	70	55	1	1	1	9
Samchook	70	45	3	1	1	18
Don Chedi	50	49	-	1	1	9
Pho Phraya	89	58	3	1	1	19
Boromathat	79	50	3	1	1	22
Chanasutr	86	73	5	1	1	30
Yang Manee	76	57	1	1	1	14
Pakhai	53	46	1	-	1	9
Bang Ban	-	20	-	-	1	15
Chachet Bang Yihon	52	42	1	-	1	14
Phraya Banlu	75	42	3	1	1	19
Phra Pimon	25	30	-	-	1	11
Phasi Charoen	-	20	1	1	1	15
Kra Sieo	-	20	-	1	1	15
Sub - total	763	640	22	11	15	231

Table 5-2 IMPROVEMENT PLAN OF FIELD CIRCUIT (2)

Project Name	Wire Communication System		VHF /FM Base Station		VHF /FM Mobil Station	
	Cable length (km)	Number of Telephone set	Number of New Station	Number of Removal	Number of Land Mobil	Number of Portable Wireless telephone
Region 8 ,9						
Manorom	83	57	1	1	1	12
Chong Kae	58	35	-	1	1	9
Koke Kathiem	78	59	2	-	1	9
Reong Rang	36	34	-	1	1	11
Maharaj	118	69	3	1	1	28
Pasak Tai	42	35	-	-	1	9
Rangist Nue	40	42	1	1	1	12
Nakhon Luang	60	43	1	1	1	12
Rangsit Tai	58	37	2	1	1	20
Klong Darn	-	20	2	1	1	20
Klong Priew	44	34	-	1	1	9
Phra Ong Chaiya Nuchit	33	40	2	1	1	19
Sub - total	650	505	14	10	12	170
Total	1,413	1,145	36	21	27	401

Table 5-3 IMPROVEMENT PLAN OF PORTABLE WIRELESS TELEPHONE (1)

Project Name	Number of Water-Master	Number of Zone-man (A)	Project Area (rai) (B)	Number of Portable Wireless Telephone (C)	(A)/(C)	(B)/(C)
Region 7						
Chao Phraya Dam	0	-	0	3		
Phonlathep	2	8	103,000	9	0.9	11,400
Thabote	2	16	218,500	9	1.8	24,300
Samchook	4	19	372,000	18	1.1	20,600
Don Chedi	2	12	162,500	9	1.3	18,100
Pho Phraya	4	36	416,000	19	1.9	21,900
Boromathat	4	30	405,000	22	1.4	18,400
Chanasutr	7	41	527,000	30	1.4	17,600
Yang Manee	3	18	233,500	14	1.3	16,700
Pakhai	2	13	206,000	9	1.4	22,900
Bang Ban	2	8	160,000	15	0.5	10,700
Chachet Bang Yihon	3	9	438,000	14	0.6	31,300
Phraya Banlu	4	9	476,500	19	0.5	25,100
Phra Pimon	2	2	285,500	11	0.2	26,000
Phasi Charoen	2	6	350,000	15	0.4	23,300
Kra Sieo	2	8	(130,000)*1	15	0.5	(8,700)
Total	45	227	4,353,500*2	231	1.0	18,800(3,010ha)

Note : *1 = Irrigable area
*2 = Except Kra Sieo Project

Table 5-3 IMPROVEMENT PLAN OF PORTABLE WIRELESS TELEPHONE (2)

Project Name	Number of Water-Master	Number of Zone-man (A)	Project Area (rai) (B)	Number of Portable Wireless Telephone (C)	(A) / (C)	(B) / (C)
Region 8,9						
Manorom	3	27	264,000	12	2.3	22,000
Chong Kae	2	18	292,500	9	2.0	32,500
Koke Kathiem	2	16	246,000	9	1.8	27,300
Reong Rang	2	11	194,000	11	1.0	17,600
Maharaj	6	48	503,000	28	1.7	18,000
Pasak Tai	2	17	272,000	9	1.9	30,200
Rangist Nue	3	41	462,500	12	3.4	38,500
Nakhon Luang	3	26	302,000	12	2.2	25,200
Rangsit Tai	5	9	578,000	20	0.5	28,900
Klong Darn	3	5	569,000	20	0.3	28,450
Klong Priew	2	13	176,000	9	1.4	19,600
Phra Ong Chaiya Nuchit	4	16	510,000	19	0.8	26,800
Sub - total	37	247	4,369,800	170	1.5	25,700 (4,110 ha)
Total	82	474	8,723,300	401	1.2	21,800 (3,480 ha)

Table 6-1 NUMBER OF GAUGING STATION BY PROJECT OFFICE (1)

Project	Level-1 Reha. Gauge	Level-2 Aut Gauge	Level-3 Aut	Level-3 Telemeter (1)	(2)	(3)	(4)	Level-4 Aut	Level-4 Telemeter (1)	(2)	(3)	(4)
Phonlathep	9	6	8	1	1	-	-	12	1	3	-	-
Borommathat	20	8	12	-	-	-	1	18	-	3	-	1
Sam Chuk	16	6	12	-	-	-	1	16	-	3	-	1
Don Chedi	24	4	4	-	-	-	-	12	-	-	-	-
Thabote	8	6	8	-	-	-	1	10	-	2	-	1
Pho Phraya	11	12	16	-	2	-	1	20	-	6	-	1
Chanasutr	33	4	8	-	-	-	1	40	-	2	-	1
Yangmanee	20	6	12	-	-	-	1	20	-	2	-	1
Phak Hai	3	6	4	-	1	-	2	6	-	1	-	2
Bang Ban	5	-	6	-	-	-	-	14	-	-	-	-
Chao Ched-Bang Yihon	9	4	-	-	1	-	-	-	-	1	-	-
Phraya Ban Lu	6	2	-	-	1	-	1	-	-	1	-	1
Phra Pimon	3	6	-	-	1	-	2	-	-	1	-	2
Phasi Charoen	4	-	4	-	-	-	-	4	-	-	-	-
Region-7	171	70	94	1	7	-	11	172	1	25	-	11
Manorom-Khao Kaeo	23	-	-	-	-	-	1	28	-	-	-	1
Chong Kae	16	6	8	-	-	-	1	20	-	2	-	1
Maharaj	28	4	10	1	-	-	-	26	1	3	-	-
Khok Kathiem	14	2	8	-	-	-	1	18	-	2	-	1
Roeng Rang	7	2	6	-	-	-	1	10	-	2	-	1
Pasak Tai	12	2	4	2	1	-	1	16	2	1	-	1
Nakhon Luang	10	2	6	-	-	-	-	18	-	-	-	-
Rangsit Nua	5	-	2	1	-	-	1	4	1	-	-	1
Rangsit Tai	5	2	2	-	-	-	1	4	-	-	-	1
Khlong Dan	2	2	2	-	-	-	1	6	-	-	-	1
Region-8	122	22	48	4	1	-	8	150	4	10	-	8
Phra-Ong Chaiya-nuchit	6	-	2	-	-	-	-	6	-	-	-	-
Total	299	92	144	5	8	-	19	328	5	35	-	19

Note Aut ; Automatic water level gauge.
Reha ; Rehabilitation of existing staff gauge.

Table 6-1 NUMBER OF GAUGING STATION BY PROJECT OFFICE (2)

Facilities	Level-1 Reha. Gauge	Level-2 Aut Gauge	Level-3 Telemeter Aut	(1)	(2)	(3)	(4)	Level-4 Telemeter Aut	(1)	(2)	(3)	(4)
Chao Phraya Dam	-	-	-	-	-	-	1	-	-	-	-	1
Nare Suan Dam	-	2	-	-	-	-	1	-	-	-	-	1
Vajiralongkorn Dam	-	2	2	-	-	-	-	-	-	1	-	-
Diversion canal from Mae klong(1)	1	1	-	1	-	-	-	-	1	-	-	-
〃 (2)	1	1	-	1	-	-	-	-	1	-	-	-
Mae Yom Weir	-	1	1	-	-	-	-	-	1	-	-	-
Kiu Lom Dam	-	1	1	-	-	-	-	-	1	-	-	-
Total	2	8	4	2	-	-	2	-	4	1	-	2
Total of Station by Project	299	92	144	5	8	-	19	328	5	35	-	19
Grand Total	301	100	148	7	8	-	21	328	9	36	-	21

Note ; Water level gauge at dam is installed at up and down sites of dam.

Table 6-2 TELEMETER STATION BY MANAGEMENT LEVEL (1)

Station Number	Station	Management Office	Observation Type (1)	(2)	(3)	(4)
Level-3						
W-1	Nakhon Sawan(C.2)	Hy.Div.	1	-	-	-
W-2	Manorom Re.	Manorom Pr.	-	-	-	1
W-3	Makamthao-Uthong Re.	Phonlathep Pr.	1	-	-	-
W-4	Phonlathep Re.	〃	-	1	-	-
W-5	Maharaj Re.	Maharaj Pr.	-	1	-	-
W-6	Borommathat Re.	Borommathat Pr.	1	-	-	-
W-7	Chao Phraya Dam	Chao Phraya Dam Pr	-	-	-	1
W-8	Chong Kae Re.	Chong Kae Pr.	-	-	-	1
W-9	Thabote Re.	Thabote Pr.	-	-	-	1
W-10	Chanasutr Re.	Chanasutr Pr.	-	-	-	1
W-11	Koke Kathiem Re.	Koke Kathiem Pr.	-	-	-	1
W-12	Yangmanee Re.	Yangmanee Pr.	-	-	-	1
W-13	Sam Chuk Re.	Sam Chuk Pr.	-	-	-	1
W-14	Phokoi Re.	Pho Phraya Pr.	-	1	-	-
W-15	Pakhai-Chaochet Re.	Pak Hai Pr.	-	1	-	-
W-16	Pakhai Re.	〃	-	-	-	1
W-17	Bang Yihon Re.	Pho Phraya Pr.	-	1	-	-
W-18	Pho Phraya Re.	〃	-	-	-	1
W-19	Roeng Rang Re.	Roeng Rang Pr.	-	-	-	1
W-20	Rama VI	Pasak Tai Pr.	-	-	-	1
W-21	Phra Narai Re.	〃	1	-	-	-
W-22	Phra Sri Sao Waphak Re.	〃	-	1	-	-
W-23	Phra Sri Sril Re.	〃	1	-	-	-
W-24	Ayutthaya(S.5)	Hy.Div.	1	-	-	-
W-25	Chaochet Re.	Pak Hai Pr.	-	-	-	1
W-26	Phraya Ban Lu Re.	Phraya Ban Lu Pr.	-	1	-	-
W-27	Singhanat Re.	Chao Chet-Bang Yihon	-	-	-	1
W-28	Phra Phimon Re.	Phra Phimon Pr.	-	1	-	-
W-29	Bang Buanthong Re.	Phraya Ban Lu Pr.	-	-	-	1
W-30	Maha Sawat Re.	Phra Phimon Pr.	-	-	-	1
W-31	Chimphli Re.	〃	-	1	-	-
W-32	Memorial Bridge(C.4)	Hy.Div.	1	-	-	-
W-33	2E-Canal Re.	Rangsit Nua Pr.	-	-	-	1
W-34	Klong Rangsit Canal	Rangsit Tai Pr.	1	-	-	-

Table 6-2 TELEMETER STATION BY MANAGEMENT LEVEL (2)

Station Number	Station	Management Office	Observation Type (1)	(2)	(3)	(4)
Level-3						
W-35	Klong 13 Tail Re.	Rangsit Tai Pr.	-	-	-	1
W-36	Khlong Dan Re.	Khlong Dan Pr.	-	-	-	1
W-37	Ang Thong(C.7A)	Hy.Div.	1	-	-	-
W-38	Kaing Koi	-	1	-	-	-
W-39	Diversion from Mae Klong	(1)	1	-	-	-
W-40	〃	(2)	1	-	-	-
W-41	Naresuan Dam	Regional 3 off.	-	-	-	1
	Total		12	9	-	20
Level-4 (in addition to the level-3)						
W-42	Vajiralongkorn Dam	Regional 10 off.	-	1	-	-
W-43	Mae Yom Weir		-	1	-	-
W-44	Kiu Lom Dam	Regional 2 off.	-	1	-	-
W-45	Ping River (P.12)	Hy.Div.	-	-	1	-
W-46	〃 (P.7)	〃	-	-	1	-
W-47	Yom River (Y.3A)	〃	-	-	1	-
W-48	〃 (Y.17)	〃	-	-	1	-
W-49	Nan River(N.12A)	〃	-	-	1	-
W-50	〃 (N.7)	〃	-	-	1	-
W-51	〃 (N.10A)	〃	1	-	-	-
W-52	Sakaekrang River	-	-	-	1	-
W-53	Chao Phraya River(C.3)	Hy.Div.	1	-	-	-
W-54	〃 (C.29)	〃	1	-	-	-
W-55	Lop Buri River(L.2A)	〃	1	-	-	-
W-56	Pasak River	-	-	-	1	-
W-57	Sri Nakarindra Dam	Regional 10 off.	1	-	-	-
W-58	Kao Laem Dam	〃	1	-	-	-
Total of Station W-1 to W-41 of level-3			12	9	-	20
	Sub-total		18	12	8	20
Number of telemeter station in main canal system			-	27	-	-
	Total		18	39	8	20

Table 6-3 NUMBER OF TELEMETER STATION IN MAIN CANAL SYSTEM

Project Name	Type(1)	Type(2)	Type(3)	Type(4)	Remarks
Phonlathep	-	2	-	-	
Borommathat	-	3	-	-	
Sam Chuk	-	3	-	-	
Don Chedi	-	-	-	-	
Thabote	-	2	-	-	
Pho Phraya	-	4	-	-	
Chanasutr	-	2	-	-	
Yangmanee	-	2	-	-	
Phak Hai	-	-	-	-	
Bang Ban	-	-	-	-	
Chao Chet-Bang Yihon	-	-	-	-	
Phraya Ban Lu	-	-	-	-	
Phra Pimon	-	-	-	-	
Phasi Charoen	-	-	-	-	
(Region-7)	(-)	(18)	(-)	(-)	
Manorom-Khao Kaeo	-	-	-	-	
Chong Kae	-	2	-	-	
Maharaj	-	3	-	-	
Khok Kathiem	-	2	-	-	
Roeng Rang	-	2	-	-	
Pasak Tai	-	-	-	-	
Nakhon Luang	-	-	-	-	
Rangsit Nua	-	-	-	-	
Rangsit Tai	-	-	-	-	
Khlong Dan	-	-	-	-	
(Region-8)	(-)	(9)	(-)	(-)	
Phra-Ong Chaiyanuchit	-	-	-	-	
Total	-	27	-	-	

Table 6-4 TELEMETER STATION IN THE DELTA (LEVEL-3) (1)

Code No.	Station	Transmission Data		Location (Project)		Transmission		Remarks
		Water level	Discharge	Management office	Project Name	Method	To station	
W - 1	Nakhon Sawan	1	1	Province office	Nakhon Sawan	VHF (New)	Nakhon Sawan	
W - 2	Monorom Regulator	2	1	Project office	Manorom	VHF (Existing)		
W - 3	Makamthao Regulator	2	1	- do -	Phonlathep	VHF (New)		
W - 4	Phonlathep Regulator	2	1	- do -	Phonlathep	Wire		
W - 5	Maharaj Regulator	2	1	Water Master (I) office	Maharaj	VHF (New)		
W - 6	Borommathat Regulator	2	1	Project office	Borommathat	Wire	Region 7	Region 7
W - 7	Chao Phraya Dam	2	1	- do -	Chao Phraya Dam	Wire		
W - 8	Chong Kae Regulator	2	1	- do -	Chong Kae	VHF (Existing)		
W - 9	Thabote Regulator	2	1	- do -	Thabote	VHF (Existing)		
W - 10	Chanasutr Regulator	2	1	- do -	Chanasutr	VHF (Existing)		
W - 11	Koke Kathiem Regulator	2	1	- do -	Koke Kathiem	Wire	Region 8	
W - 12	Yang Manee Regulator	2	1	- do -	Yang Manee	VHF (Existing)		
W - 13	Samchook Regulator	2	1	- do -	Samchook	VHF (Existing)		
W - 14	Pho Koi Regulator	2	1	Branch office	Phophaya	VHF (New)		
W - 15	Latchado Regulator	2	1	Water Master (II) office	Pakhai	Wire	Phophaya Project	
W - 16	Pakhai Regulator	2	1	Project office	Pakhai	VHF (New)		
W - 17	Bang Yihon Regulator	2	1	Branch office	Phophaya	VHF (New)		
W - 18	Phophaya Regulator	2	1	- do -	Phophaya	VHF (Existing)		Repeater station
W - 19	Reong Rang Regulator	2	1	- do -	Reong Rang	VHF (Existing)		
W - 20	Rama VI Dam	2	1	- do -	Pasak Tai	VHF (Existing)		Repeater station
W - 21	Phranarai Regulator	2	1	- do -	Pasak Tai	" "	Pasak Tai	
W - 22	Phrasri saowaphak Regulator	2	1	Water Master(II) office	Pasak Tai	VHF (New)	Project	
W - 23	Phrasri sril Regulator	1	1	Water Master(II) office	Pasak Tai			
W - 24	Ayutthaya	1	-			VHF (New)		
W - 25	Chaochet Regulator	2	1	Gate tender office	Pakhai	VHF (New)		
W - 26	Phraya Banlu Regulator	2	1	Water Master(III) office	Chao chet	VHF (New)	Chao chet Project	Repeater station
W - 27	Lumtonglang Regulator	2	1	Project office	Chao chet	VHF (New)		
W - 28	Phra Pimon Regulator	2	1	Branch office	Phra Pimon	VHF (New)		
W - 29	Bang Bua Tong Regulator	2	1	- do -	Phraya Banlu	VHF (New)	Head office	
W - 30	Maha Sawat Regulator	2	1	- do -	Phra Pimon	VHF (New)		
W - 31	Chimphli Regulator	2	1	Water Master(II) office	Phra Pimon	VHF (New)		
W - 32	Menorial Bridge	1	-			VHF (New)		

Table 6-4 TELEMETER STATION IN THE DELTA (LEVEL-3) (2)

Code No.	Station	Transmission Data		Location (Project)		Transmission		Remarks
		Water Level	Discharge	Management office	Project Name	Method	To station	
W - 33	Bang Plaked Regulator	2	1		Rangsit Nue	VHF (New)		Region 9
W - 34	Klong Rangsit	2	1		Rangsit Nue	VHF (New)	Klong 13 Tail	
W - 35	Klong 13 Tail Regulator	2	1	Water Master(III) office	Rangsit Tai	VHF (New)		Repeation station
W - 36	Klong Dan Regulator	2	1	Project Office	Klong Dan	VHF (New)		

Table 6-5 OBSERVATION STATION IN RIVER SYSTEM BY LEVEL

Telemeter Station number	River system	Existing near station	Observation/Data collection type Level-1	Level-2	Level-3	Level-4	Remarks
-	Ping	P. 1	-	-	-	2	
-	〃	P. 19	-	-	2	2	
W. 45	〃	P. 12	-	1	4	T(3)	
W. 46	〃	P. 7	1	5	5	T(3)	
-	Wang	W. 16	-	-	-	2	
-	〃	W. 1A	-	-	2	3	
-	〃	W. 4A	-	1	1	4	
-	Yom	Y. 20	-	-	-	3	
W. 47	〃	Y. 3A	1	1	5	T(3)	
W. 48	〃	Y. 17	-	1	5	T(3)	
-	Nam	N. 35	-	-	2	3	
W. 49	〃	N. 12A	-	1	4	T(3)	
W. 50	〃	N. 7	1	5	5	T(3)	
W. 51	〃	N. 10A	-	1	4	T(1)	
W. 52	Sakae Krang	-	-	4	5	T(3)	New
W. 1	Chao	C. 2	1	1	T(3)	T(3)	
W. 33	Phraya	C. 3	-	2	4	T(1)	
W. 37	〃	C. 7A	-	1	T(1)	T(1)	
W. 54	〃	C. 29	1	1	4	T(1)	
W. 32	〃	C. 4	1	1	T(1)	T(1)	
-	〃	-	-	-	-	1	Bang Soi Nung
-	Suphan	-	-	-	-	1	Sam Phran
W. 55	Lop Buri	L. 2A	-	-	1	T(1)	
W. 38	Pasak	S. 9	1	5	T(1)	T(1)	
W. 24	〃	S. 5	-	-	T(1)	T(1)	
W. 56	〃	-	-	-	5	T(3)	New
W. 57	Mae Klong	-	-	-	2	T(1)	
W. 58	〃	K. 13	-	-	2	T(1)	
	Total		7	15	23	28	

Note T(1) ; Telemeter type(1), T(3) ; Telemeter type(3)

Table 6-6 NUMBER OF RAINFALL OBSERVATION STATION BY LEVEL

Project name	Number of reporting stations	Management Level and Type											
		Level-1			Level-2			Level-3			Level-4		
		1	2	3	1	2	3	1	2	3	1	2	3
Phonlathep	9	1	-	-	-	1	-	-	1	-	-	2	-
Borommathat	7	1	-	-	-	1	-	-	1	1	-	4	1
Sam Chuk	15	2	-	-	-	1	-	-	1	1	-	4	1
Don Chedi	3	-	-	-	-	1	-	-	1	-	-	2	-
Thabote	10	1	-	-	-	1	-	-	1	1	-	2	1
Pho Phraya	9	1	-	-	-	1	-	-	1	1	-	4	1
Chanasutr	8	1	-	-	-	1	-	-	1	1	-	7	1
Yangmance	12	1	-	-	-	1	-	-	1	1	-	3	1
Phak Hai	3	-	-	-	-	1	-	-	1	2	-	2	2
Bang Ban	1	-	-	-	-	1	-	-	1	-	-	2	-
Chao Ched-Bang Yihon	7	1	-	-	-	1	-	-	1	1	-	3	1
Phraya Ban Lu	10	1	-	-	-	1	-	-	1	-	-	5	-
Phra Pimon	7	1	-	-	-	1	-	-	1	2	-	2	2
Phasi Charoen	4	-	-	-	-	1	-	-	1	-	-	2	-
Region-7		11	-	-	-	14	-	-	14	11	-	44	11
Manorom-Khao Kaeo	12	1	-	-	-	1	-	-	1	1	-	3	1
Chong Kae	11	1	-	-	-	1	-	-	1	1	-	2	1
MaharaJ	18	1	-	-	-	1	-	-	1	-	-	6	-
Khok Kathiem	12	1	-	-	-	1	-	-	1	1	-	2	1
Roeng Rang	15	1	-	-	-	1	-	-	1	1	-	2	1
Pasak Tai	5	1	-	-	-	1	-	-	1	1	-	2	1
Nakhon Luang	13	1	-	-	-	1	-	-	1	-	-	3	-
Rangsit Nua	15	1	-	-	-	1	-	-	1	1	-	3	1
Rangsit Tai	12	1	-	-	-	1	-	-	1	1	-	5	1
Khlong Dan	8	1	-	-	-	1	-	-	1	1	-	3	1
Region-8		10	-	-	-	10	-	-	10	8	-	31	8
Phra Ong Chaiya-nuchit	10	1	-	-	-	1	-	-	1	-	-	4	-
Total		22	-	-	-	25	-	-	25	19	-	79	19

Note : Type 1 ; Reserving rain gauge.
〃 2 ; Automatic rainfall gauge.
〃 3 ; Automatic rainfall gauge with telemeter.

Table 6-7 NUMBER OF SOIL MOISTURE OBSERVATION STATION BY LEVEL

Project	Irrigable area(ha)	Number of Section	Number of Zoneman	Number of Meter Level 1	2	3	4
Phonlathep	15,400	2	8	-	-	-	-
Borommathat	58,400	4	30	-	-	-	-
Sam Chuk	48,800	4	19	-	-	-	-
Don Chedi	23,100	2	12	-	-	-	-
Thabote	28,700	2	16	-	-	-	-
Pho Phraya	59,200	4	36	-	-	-	-
Chanasutr	75,900	7	41	-	-	-	-
Yangmanee	37,300	3	18	-	-	-	-
Phak Hai	33,000	2	13	-	-	-	-
Bang Bang	23,100	2	8	-	-	-	-
Chao Ched-Bang Yihon	65,000	3	9	-	-	3	6
Phraya Ban Lu	70,000	5	9	-	-	5	10
Phra Pimon	41,800	2	2	-	-	2	4
Phasi Charoen	32,000	2	6	-	-	2	4
(Region-7)						(12)	(24)
Manorom-Khao Kaeo	37,800	3	27	-	-	-	-
Chong Kae	46,800	2	18	-	-	-	-
Maharaj	76,200	6	48	-	-	-	-
Khok Kathiem	35,200	2	16	-	-	-	-
Roeng Rang	29,300	2	11	-	-	-	-
Pasak Tai	38,500	2	17	-	-	2	4
Nakhon Luang	42,700	3	26	-	-	3	6
Rangsit Nua	72,600	3	41	-	-	3	6
Rangsit Tai	92,500	5	9	-	-	5	10
Khlong Dan	84,500	3	5	-	-	5	6
(Region-8)						(16)	(32)
Phra-Ong Chaiya-nuchit	81,600	4	16	-	-	4	8
Total				-	-	32	64

Table 6-8 NUMBER OF WATER QUALITY OBSERVATION STATION BY LEVEL

Project	Irrigable area(ha)	Number of Water Quality Meter							
		Level-1		Level-2		Level-3		Level-4	
		P	F	P	F	P	F	P	F
Phonlathep	15,400	-	-	-	-	-	-	-	-
Borommathat	58,400	-	-	-	-	-	-	-	-
Sam Chuk	48,800	-	-	-	-	-	-	-	-
Don Chedi	23,100	-	-	-	-	-	-	-	-
Thabote	28,700	-	-	-	-	-	-	-	-
Pho Phraya	59,200	-	-	-	-	-	-	-	-
Chanasutr	75,900	-	-	-	-	-	-	-	-
Yangmanee	37,300	-	-	-	-	-	-	-	-
Phak Hai	33,000	-	-	-	-	-	-	-	-
Bang Ban	23,100	-	-	-	-	-	-	-	-
Chao Ched-Bang Yihon	65,000	-	-	1	-	1	-	3	1
Phraya Ban Lu	70,000	-	-	1	-	1	1	5	1
Phra Pimon	41,800	-	-	1	-	1	1	2	2
Phasi Charoen	32,000	-	-	1	-	1	1	2	2
Reginal 7 off. (Region-7)		- (-)	- (-)	- (4)	- (-)	2 (6)	- (3)	4 (16)	- (6)
Manorom-Khao Kaeo	37,800	-	-	-	-	-	-	-	-
Chong Kae	46,800	-	-	-	-	-	-	-	-
Maharaj	76,200	-	-	-	-	-	-	-	-
Khok Kathiem	35,200	-	-	-	-	-	-	-	-
Roeng Rang	29,300	-	-	-	-	-	-	-	-
Pasak Tai	38,500	-	-	-	-	-	-	-	-
Nakhon Luang	42,700	-	-	-	-	-	-	-	-
Rangsit Nua	72,600	-	-	1	-	1	-	3	1
Rangsit Tai	92,500	-	-	1	-	1	1	5	1
Khlong Dan	84,500	-	-	1	-	1	1	3	2
Reginal 8 off. (Region-8)		- (-)	- (-)	- (3)	- (-)	2 (5)	- (2)	4 (15)	- (4)
Phra Ong Chaiya-nuchit	81,600	-	-	1	-	1	1	4	2
Total		-	-	8	-	12	6	35	12

Note P; Portable type, F; Fixed type automatic meter.

Table 6-9 INTRODUCTION PLAN OF PATROL/COMMUNICATION VEHICLE BY LEVEL

Project	Level-1		Level-2		Level-3		Level-4	
	Motor cycle	Patrol car	Motor cycle	Patrol car	Motor cycle	Patrol car	Motor cycle	Patrol car
Head office	-	-	-	-	-	1	-	1
Regional-7 off.	-	-	-	1	-	1	-	1
regional-8 off.	-	-	-	1	-	1	-	1
Sub-total	-	-	-	2	-	3	-	3
Phonlathep	-	-	2	1	3	1	4	1
Borommathat	-	-	4	1	5	1	8	1
Sam Chuk	-	-	4	1	5	1	8	1
Don Chedi	-	-	2	1	3	1	4	1
Thabote	-	-	2	1	3	1	4	1
Pho Phraya	-	-	4	1	5	1	8	1
Chanasutr	-	-	7	1	8	1	14	1
Yangmanee	-	-	3	1	4	1	6	1
Phak Hai	-	-	2	1	3	1	4	1
Bang Ban	-	-	2	1	3	1	4	1
Chao Ched B.Y.	-	-	3	1	4	1	6	1
Phraya Ban Lu	-	-	5	1	6	1	10	1
Phra Pimon	-	-	2	1	3	1	4	1
Phasi Charoen	-	-	2	1	3	1	4	1
Sub-total			44	14	58	14	88	14
Manorom-Khao Kaeo	-	-	3	1	4	1	6	1
Chong Kae	-	-	2	1	3	1	4	1
Maharaj	-	-	6	1	7	1	12	1
Khok Kathiem	-	-	2	1	3	1	4	1
Roeng Rang	-	-	2	1	3	1	4	1
Pasak Tai	-	-	2	1	3	1	4	1
Nakhon Luang	-	-	3	1	4	1	6	1
Rangsit Nua	-	-	3	1	4	1	6	1
Rangsit Tai	-	-	5	1	6	1	10	1
Khlong Dan	-	-	3	1	4	1	6	1
Sub-total	-	-	31	10	41	10	62	10
Phra-Ong C. N.	-	-	4	1	5	1	8	1
Total	-	-	79	27	104	28	158	28

Table 6-10 MONITORING/VERIFICATION FACILITIES BY LEVEL

Project	Level-1				Level-2				Level-3				Level-4			
	(1)	(2)	(3)	R	(1)	(2)	(3)	R	(1)	(2)	(3)	R	(1)	(2)	(3)	R
Head office	1"	-	-	-	1"	-	-	-	-	1	-	1	-	1	1	1
Regional-7 off.	-	-	-	-	1	-	-	-	1	-	-	1	-	1	1	1
regional-8 off.	-	-	-	-	1	-	-	-	1	-	-	1	-	1	1	1
Sub-total	-	-	-	-	2	-	-	-	2	1	-	3	-	3	3	3
Phonlathep	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Borommathat	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Sam Chuk	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1'
Don Chedi	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Thabote	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Pho Phraya	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Chanasutr	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Yangmanee	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Phak Hai	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Bang Ban	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1'
Chao Ched B.Y.	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Phraya Ban Lu	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Phra Pimon	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Phasi Charoen	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1'
Manorom-Khao Kaeo	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Chong Kae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Maharaj	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Khok Kathiem	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	1
Roeng Rang	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Pasak Tai	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1'
Nakhon Luang	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Rangsit Nua	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Rangsit Tai	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1'
Khlong Dan	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
sub-total	-	-	-	-	-	-	-	-	-	-	-	24	7	5	-	24
Phra-Ong C. N.	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Total	-	-	-	-	2	-	-	-	2	1	-	28	7	8	3	28

Note (1) ; Introduction of display panel by manual input.
(2) ; Introduction of display panel by automatic input with telemeter.
(3) ; Introduction of video system.
R ; Improvement of operating and communication room.
1' ; Room including telemeter equipment. 1" ; Use of current panel.

Table 6-11 REQUIRED FLOOR AREA OF OPERATING ROOM

(Unit ; sq.m.)

Room	Level-2			Level-3			Level-4		
	He	Re	Pr	He	Re	Pr	He	Re	Pr
Communication equipment	-	-	-	30	-	10	50	20	10
Computer machine	-	-	-	40	-	-	50	30	10
Data processing	-	-	-	40	40	-	50	30	20
Battery	-	-	-	20	-	-	20	10	10
Maintenance	-	-	-	20	-	-	30	20	10
Spairs, Tool, Material	-	-	-	20	-	-	30	20	10
Personnel	-	-	-	150	-	-	200	100	-
Meeting	-	-	-	100	100	-	100	100	50
Conference	-	-	-	150	-	-	200	100	-
Training	-	-	-	150	150	-	200	100	50
Information service	-	-	-	-	-	-	100	50	50
Stairs, Lavatory, Corridor and others	-	-	-	280	110	-	470	220	80
Total	-	-	-	1000	400	10	1500	800	300

Note He ; RID Head office.
Re ; Reginal office.
Pr ; Project office.
Floor area of project office (Pr) in level-4 includes installation of telemeter equipment. In case of no introduction of the telemeter equipment, required floor area is estimated at 40 m^2 ; communication equipment room and meeting room are 10 m^2 and 30 m^2.

Table 7-1 IMPROVEMENT PLAN OF COMMUNICATION SYSTEM IN UPPER AND MIDDLE BASINS (1)

Name of office	HF/SSB	VHF/FM Radio		Wire Telephone		Rural Radiophone		Low Multiplex Radio Station	PABX 5/50 ch.
		New Installation	Replacement of Radio *1	Telephone set	Line Length (km)	Main Station	Sub Station		
Region 3	–	–	–	–	–	1	–	1	–
Tha Bua	–	–	1	15	10	–	1	–	1
Sukhothai	–	1	–	14	8	–	1	–	1
Nam Pat	1	1	–	–	–	–	–	–	–
Nam Rid	–	1	–	–	–	–	–	–	–
Phasuk	1	–	1	–	–	–	–	–	–
Huai Pa Daeng	–	1	–	13	7	–	–	–	–
Tak	1	–	1	45	83	–	–	–	–
Mae Sot	–	–	1	21	25	–	–	–	–
Wang Yang	–	1	–	–	–	–	–	–	–
Kamphaengphet	1	–	1	17	15	–	–	–	–
Wang Sri Sup	–	1	–	–	–	–	–	–	–
Phetchabun	–	1	–	–	–	–	–	–	–
Khao Kloi	1	–	1	–	–	–	–	–	–
Huai Lug	1	1	–	–	–	–	–	–	–
Phichit	–	–	1	11	6	1	–	1	1
Bang Rai	–	1	–	19	21	–	1	–	1
Sawankhalok	–	–	1	–	–	–	1	–	1
Nakhon Sawan	–	–	1	–	–	–	1	–	1
Naresuan Dam	–	–	1	–	–	–	1	–	1
Total	6	9	10	155	175	2	6	2	7

Note *1 ; Replacement of radio equipment except antenna and tower.

Table 7-1 IMPROVEMENT PLAN OF COMMUNICATION SYSTEM IN UPPER AND MIDDLE BASINS (2)

Name of office	HF/SSB	VHF/FM Radio		Wire Telephone		Rural Radiophone		Low Multiplex Radio Station	PABX 5/50 ch.
		New Installation	Replacement of Radio *1	Telephone set	Line Length (km)	Main Station	Sub Station		
Region 2	–	–	–	–	–	1	–	–	–
Kuw Lom	–	–	1	36	62	–	1	–	1
Mae Lao	–	1	–	39	70	–	–	–	–
Mae Sai	1	–	1	12	3	–	–	–	–
Mae Yom	1	–	1	40	71	–	–	–	–
Phayao	1	–	1	–	–	–	–	–	–
Chiang Rai	1	1	–	–	–	–	–	–	–
Mae Man	1	–	1	–	–	–	–	–	–
Mae Song	–	1	–	–	–	–	–	–	–
Huai Chang	1	1	–	–	–	–	–	–	–
Dong Mada	1	1	–	–	–	–	–	–	–
Nan Nsae	–	–	1	–	–	–	–	–	–
Mae Tam	–	1	–	–	–	–	1	–	1
Den Chai	1	–	1	–	–	–	–	–	–
Phrae	–	1	–	–	–	–	–	–	–
Phai Samun	–	–	1	–	–	–	–	–	–
Mae Pung	–	1	–	–	–	–	–	–	–
Mechanucal Branch	–	–	1	–	–	–	1	–	1
Total	8	8	9	127	206	1	3	–	3

Note *1 ; Replacement of radio equipment except antenna and tower.

Table 7-1 IMPROVEMENT PLAN OF COMMUNICATION SYSTEM IN UPPER AND MIDDLE BASINS (3)

Name of office	VHF/FM Radio			Wire Telephone		Rural Radiophone		Low Multiplex Radio Station	PABX 5/50 ch.
	HF/SSB	New Installation	Replacement of Radio *1	Telephone set	Line Length (km)	Main Station	Sub Station		
Region 1	–	–	–	–	–	1	–	–	–
Mae kuang	1	–	1	20	25	–	1	–	1
Nan Yuam	–	1	–	18	20	–	–	–	–
Mae Ngao	1	–	1	20	25	–	–	–	–
Mae Sao	–	–	1	17	15	–	–	–	–
Mae Faek	1	–	1	28	43	–	1	–	1
Nong Krating	1	–	1	–	–	–	–	–	–
Huai Muang	–	–	1	–	–	–	–	–	–
Huai Hong Krai	1	–	1	–	–	–	1	–	1
Mae Hong Son	1	1	–	12	4	–	–	–	–
Mae Tub	–	–	1	31	50	–	–	–	–
Mae Ngon	–	–	1	–	–	–	1	–	1
Chom Thong	–	–	1	–	–	–	1	–	1
Huai Pong	–	–	1	–	–	–	–	–	–
Mae San	–	1	–	–	–	–	1	–	1
Phai Doi Noi	–	–	1	–	–	–	–	–	–
Mae Jok	–	–	1	–	–	–	–	–	–
Trae Tor 1	–	–	1	–	–	–	–	–	–
Total	6	3	17	146	182	1	6	–	6

Note *1 ; Replacement of radio equipment except antenna and tower.

Table 8-1 REQUIRED MONITORING FACILITIES BY LEVEL (LOWER BASIN)

Required Facilities	Unit	Level-1	Level-2	Level-3	Level-4
Observation Facilities in project area					
Staff gauge	set	301	-	-	-
Automatic water level gauge	〃	-	100	148	328
Reserving rainfall gauge	〃	22	-	-	-
Automatic rainfall gauge	〃	-	25	25	79
Water level/Rainfall with telemeter equipment	〃	-	-	36	66
Water quality meter (portable)	〃	-	8	12	35
Water quality meter (fixed)	〃	-	-	6	12
Soil moisture meter	〃	-	-	32	64
Ground water level gauge	〃	-	-	-	50
Water flow meter (portable)	〃	-	-	25	104
Monitoring Facilities in office					
Display panel (offline)	set	-	2	2	7
Telemetering equipment	site	-	-	1	8
Operating room	〃	-	-	28	28
Monitoring Vehicle in project					
Motorcycle	set	-	79	104	158
Patrol car	〃	-	27	28	28
Maintenance car	〃	-	-	1	3
Observation Facilities in river system					
Radio facilities with housing	set	7	10	2	2
Automatic water level gauge	〃	-	1	5	3
Automatic water level/rainfall gauge	〃	-	-	-	3
Automatic water level gauge with radio facilities	〃	-	1	5	1
Automatic water level/rainfall gauge with radio facilities	〃	-	3	6	-
Water level gauge with telemeter equipment	〃	-	-	4	10
Water level/rainfall gauge with telemeter equipment	〃	-	-	1	9
Automatic water quality meter	〃	-	-	-	3

Table 8-3 REQUIRED COMMUNICATION FACILITIES BY LEVEL (LOWER BASIN)

Required Facilities	Unit	Level-1	Level-2	Level-3	Level-4
Communication Facilities of Local Circuit					
VHF/FM radio system					
-New installation	set	8	8	8	8
-Replacement of radio equip ment and antenna	〃	3	3	3	3
-Replacement of radio equipment	〃	16	16	16	16
-New installation at major regulator site	〃	14	14	14	14
Private wire telephone cable	km	-	20.3	20.3	20.3
Low capacity multiplex radio	set	-	2	2	2
Rural radiotelephone					
-Main station(1)	〃	-	2	2	2
-Main station(2)	〃	-	3	3	3
-Sub station	〃	-	15	15	15
Private automatic branch exchange	〃	-	26	26	26
Antenna tower	〃	-	1	1	1
Communication Facilities of Field Circuit					
Private wire telephone					
-Communication cable	km	-	1,413	1,413	1,413
-Telephone set	set	-	1,145	1,145	1,145
VHF/FM radio system					
-New installation	〃	-	36	36	36
-Removal	〃	-	21	21	21
-Land mobil	〃	-	27	27	27
-Portable wireless telephone	〃	-	401	401	401

Table 8-2 REQUIRED MONITORING FACILITIES BY LEVEL (UPPER AND MIDDLE BASINS)

Required Facility	Unit	Level-1	Level-2	Level-3	Level-4
Observation Facilities in project area					
Staff gauge	set	149	-	-	-
Automatic water level gauge	〃	-	49	68	164
Reserving rainfall gauge	〃	10	-	-	-
Automatic rainfall gauge	〃	-	12	12	12
Water level/Rainfall with telemeter equipment	〃	-	-	-	16
Water quality meter (portable)	〃	-	-	-	-
Water quality meter (fixed)	〃	-	-	-	-
Soil moisture meter	〃	-	-	12	24
Ground water level gauge	〃	-	-	-	12
Water flow meter (portable)	〃	-	-	12	24
Monitoring Facilities in office					
Display panel (offline)	set	-	-	1	-
Telemetering equipment	site	-	-	-	3
Operating room	〃	-	-	1	29
Monitoring Vehicle in project					
Motorcycle	unit	-	38	49	79
Patrol car	〃	-	25	25	56
Maintenance car	〃	-	-	-	3

Table 8-4 REQUIRED COMMUNICATION FACILITIES BY LEVEL (UPPER AND MIDDLE BASINS)

Required Facility	Unit	Level-1	Level-2	Level-3	Level-4
HF/SSB radio equipment	set	20	20	20	20
VHF/FM radio system					
- New installation	〃	20	20	20	20
- Replacement of radio equipment	〃	33	33	33	33
Private wire telephone					
- Communication cable	km	-	563	563	563
- Telephone set	set	-	428	428	428
Rural radiotelephone					
- Main station(1)	〃	-	3	3	3
- Main station(2)	〃	-	1	1	1
- Sub station	〃	-	15	15	15
Low capacity multiplex radio	〃	-	2	2	2
Private automatic branch exchange	〃	-	16	16	16
VHF/FM radio system in project area					
- Radio equipment	〃	-	106	106	106
- Land mobil	〃	-	53	53	53
- Portable wireless telephone	〃	-	477	477	477

Table 10-1 ROLES AT DATA MANAGEMENT LEVELS

Function	Operational Authority	Roles
Central System	Head Office	(1) Standardization/Regularization of system operation (2) Software design and supervision of software development (3) Supervision/Back-up of operation in the central system and sub-systems (4) Public information service (5) Data entry into the central storage (6) Data compilation/processing (7) Data transfer to/from subordinate systems (8) Maintenance of the central system (9) Staff training for the central and sub-systems
Sub-System	Regional Offices, Hydrological Regional Offices, Divions in Head/Regional Offices	(1) Supervision/Back-up of operation in the sub-system and subordinate terminal systems (2) Public information service for the sub-system and subordinate terminal systems (3) Data entry into the sub-system storage (4) Data compilation/processing (5) Data transfer to/from the central system and subordinate terminal systems (6) Maintenance of the sub-system (7) Staff training for the sub-system and soubordinate terminal systems
Terminal System	Project Offices	(1) Data collection at sites (2) Data entry into the terminal system (3) Data compilation/processing (4) Data tranfer to/from other systems (5) Maintenance of the terminal system

Table 10-2 REQUIRED DATA MANAGEMENT FACILITIES (LOWER BASIN)

Required Facilities	Unit	Level-1	Level-2	Level-3	Level-4
Computer system					
- Mini-computer system	set	4	10	19	41
- Mini-computer and X-Y plotter	〃	1	4	6	16
- Work station	〃	1	2	5	7
Air conditionner	〃	4	8	13	31
Steel cabinet	〃	20	32	50	101
Facsimile	〃	3	7	31	34
Video projector	〃	-	-	1	3

Table 10-3 REQUIRED DATA MANAGEMENT FACILITIES (UPPER AND MIDDLE BASINS)

Required Facilities	Unit	Level-1	Level-2	Level-3	Level-4
Computer system					
- Mini-computer system	set	-	1	2	4
- Mini-computer and X-Y plotter	〃	-	-	-	-
- Work station	〃	-	-	-	-
Air conditionner	〃	-	1	2	4
Steel cabinet	〃	-	-	12	12
Facsimile	〃	-	-	1	4
Video projector	〃	-	-	-	1

Table 10-4 REQUIRED FACILITIES BY PROJECT (1)

Project	Level-1				Level-2				Level-3				Level-4			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Head office	2	1	1	2	2	2	2	2	5	2	3	2	10	4	5	3
Reginal 7 of	1	-	-	1	2	1	-	1	1	2	1	1	2	3	1	1
Reginal 8 of	1	-	-	1	2	1	-	1	1	2	1	1	2	3	1	1
Sub-total	4	1	1	4	6	4	2	4	7	6	5	4	14	10	7	4
Phonlathep	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Borommathat	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Sam Chuk	-	-	-	-	1	-	-	1	1	-	-	1	1	1	-	1
Don Chedi	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Thabote	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Kra Sieo	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Pho Phraya	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Chanasutr	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Yangmanee	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Phak Hai	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	1
Bang Ban	-	-	-	-	-	-	-	-	1	-	-	1	1	1	-	1
Chao Ched-Bang Yihon	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Phraya B.I	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Phra Pimon	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Phasi Cha.	-	-	-	-	1	-	-	1	1	-	-	1	1	1	-	1
Manorom	-	-	-	-	-	-	-	-	1	-	-	1	1	1	-	1
Chong Kae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Maharaj	-	-	-	-	-	-	-	-	1	-	-	1	1	1	-	1
Khok Kathiem	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Roeng Rang	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Klong Priew	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Pasak Tai	-	-	-	-	1	-	-	1	1	-	-	1	1	1	-	1
Nakhon Luang	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Rangsit Nua	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Rangsit Tai	-	-	-	-	1	-	-	1	1	-	-	1	1	-	-	1
Khlong Dan	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Phra-Ong C.N	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Sub-total	-	-	-	-	4	-	-	4	12	-	-	12	27	6	-	27
Total	4	1	1	4	10	4	2	8	19	6	5	16	41	16	7	31

Table 10-4 REQUIRED FACILITIES BY PROJECT (2)

Project	Level-1			Level-2			Level-3			Level-4		
	E	F	G	E	F	G	E	F	G	E	F	G
Head office	10	1	-	10	1	-	10	2	1	10	3	1
Reginal 7 of	5	1	-	5	1	-	5	1	-	5	2	1
Reginal 8 of	5	1	-	5	1	-	5	1	-	5	2	1
Sub-total	20	3	-	20	3	-	20	4	1	20	7	3
Phonlathep	-	-	-	-	-	-	3	1	-	3	1	-
Borommayhat	-	-	-	-	-	-	3	1	-	3	1	-
Sam Chuk	-	-	-	3	1	-	3	1	-	3	1	-
Don Chedi	-	-	-	-	-	-	-	1	-	3	1	-
Thabote	-	-	-	-	-	-	-	1	-	3	1	-
Kra Sieo	-	-	-	-	-	-	-	1	-	3	1	-
Pho Phraya	-	-	-	-	-	-	-	1	-	3	1	-
Chanasutr	-	-	-	-	-	-	-	1	-	3	1	-
Yangmanee	-	-	-	-	-	-	3	1	-	3	1	-
Phak Hai	-	-	-	-	-	-	-	1	-	3	1	-
Bang Ban	-	-	-	-	-	-	3	1	-	3	1	-
Chao Ched-	-	-	-	-	-	-	-	1	-	3	1	-
-Bang Yihon												
Phraya B.L	-	-	-	-	-	-	-	1	-	3	1	-
Phra Pimon	-	-	-	-	-	-	-	1	-	3	1	-
Phasi Cha.	-	-	-	3	1	-	3	1	-	3	1	-
Manorom	-	-	-	-	-	-	3	1	-	3	1	-
Chong Kae	-	-	-	-	-	-	-	1	-	3	1	-
Maharaj	-	-	-	-	-	-	3	1	-	3	1	-
Khok Kathiem	-	-	-	-	-	-	-	1	-	3	1	-
Roeng Rang	-	-	-	-	-	-	-	1	-	3	1	-
Klong Priew	-	-	-	-	-	-	-	1	-	3	1	-
Pasak Tai	-	-	-	3	1	-	3	1	-	3	1	-
Nakhon Luang	-	-	-	-	-	-	-	1	-	3	1	-
Rangsit Nua	-	-	-	-	-	-	-	1	-	3	1	-
Rangsit Tai	-	-	-	3	1	-	3	1	-	3	1	-
Khlong Dan	-	-	-	-	-	-	-	1	-	3	1	-
Phra-Ong C.N	-	-	-	-	-	-	-	1	-	3	1	-
Sub-total	-	-	-	12	4	-	30	27	-	81	27	-
Total	20	3	-	32	7	-	50	31	1	101	34	3

Data Management Facilities

Type	Facility
A	Mini-computer system - Personal computer CPU ; 16-32 bit Memory ; 120MB or more Full ASCII character set and switchable Thai character set - Printer 132-column 24-pin wire dot matrix - Mouse - Image scanner - Floating point co-processor - 2-diskette drives - CRT display (14-inch or more) - Modem - Interface circuit boards for peripherals
B	In addition to Type-A - X-Y plotter (A3 size) - Interface circuit board
C	Computer work station - Work station - Modem - Interface and controller
D	Air conditionner
E	Steel cabinet for storage of data file
F	Facsimile
G	Video projector (100-inch)

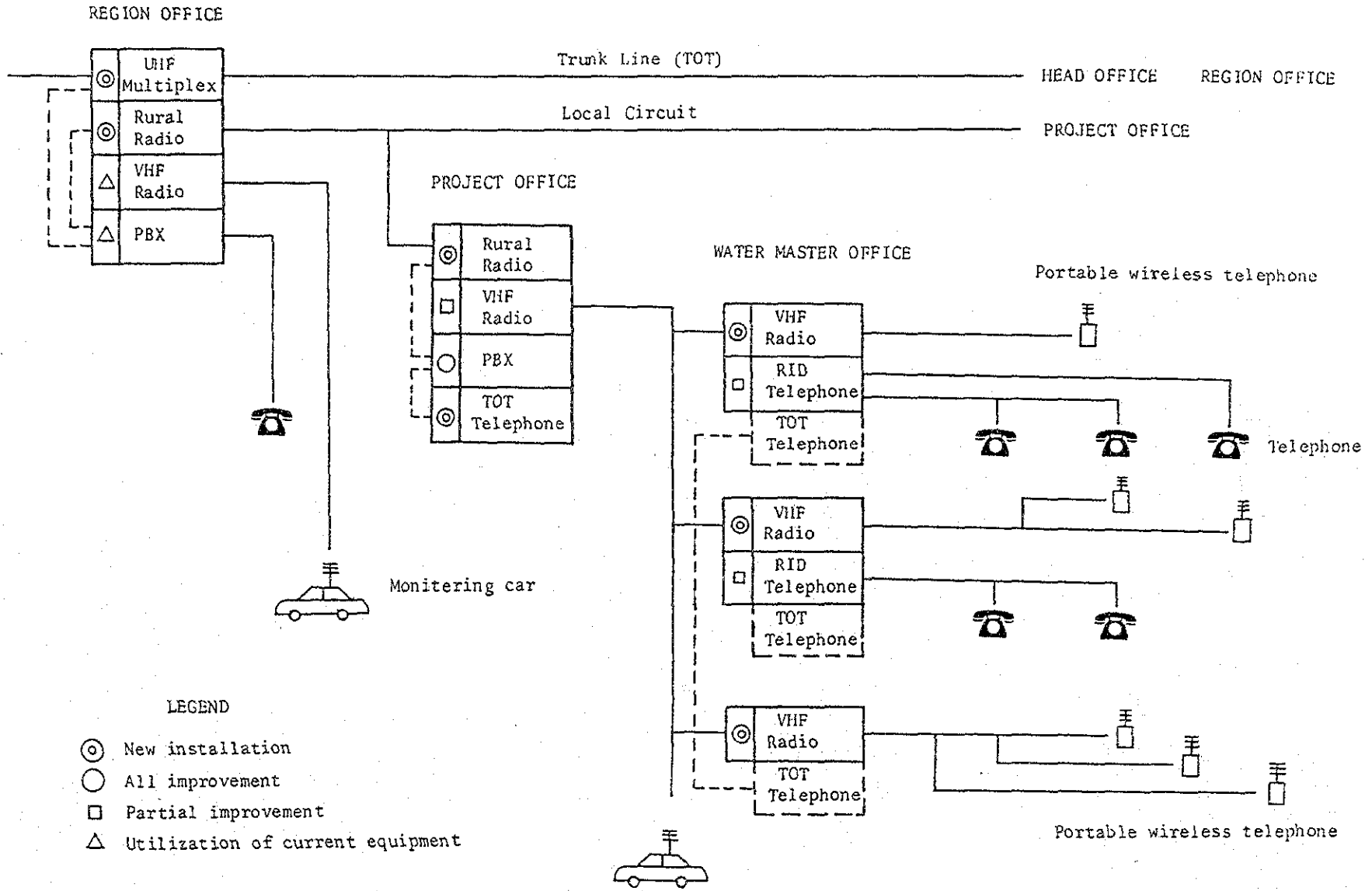
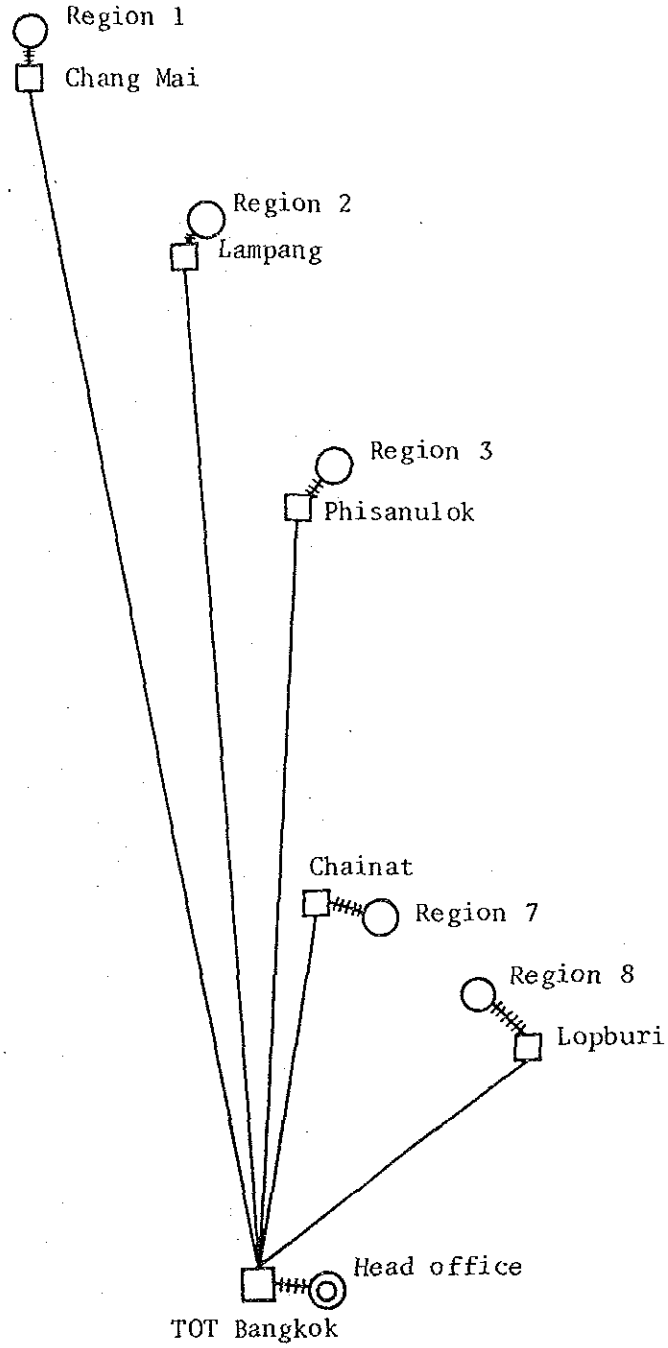


Figure 2-1 BASIC PLAN OF IMPROVED COMMUNICATION SYSTEM



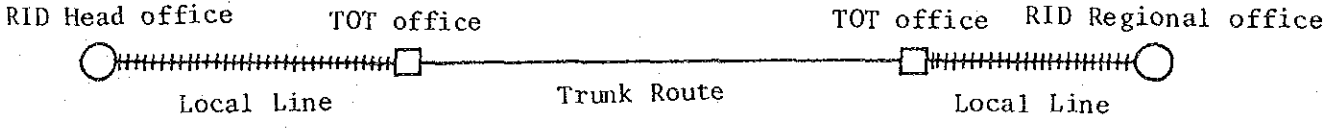


Figure 3-1 SYSTEM PLAN OF TRUNK LINE LEASED FROM TOT

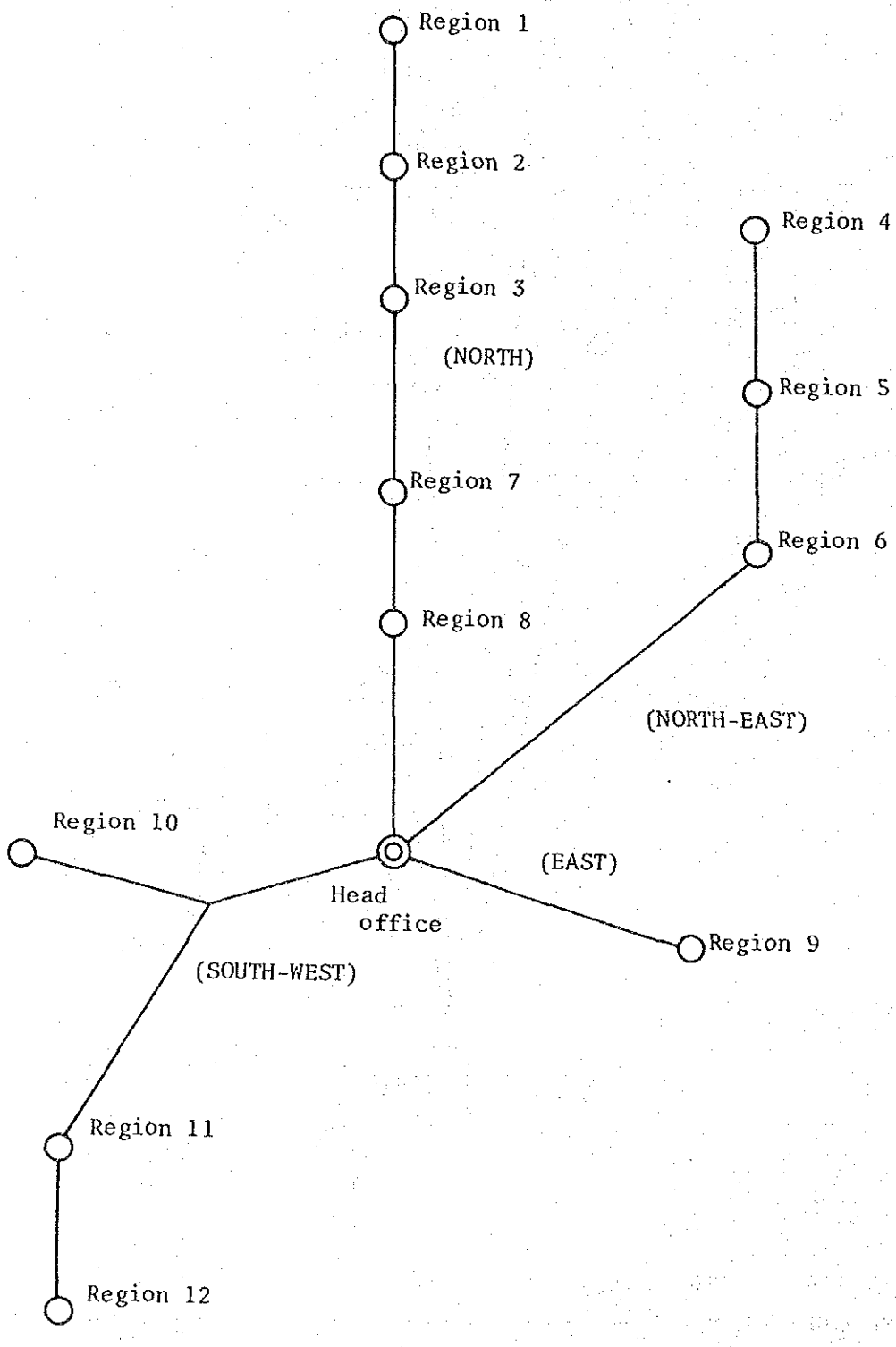


Figure 3-2 ROUTE OF PRIVATE TRUNK LINE BY RID

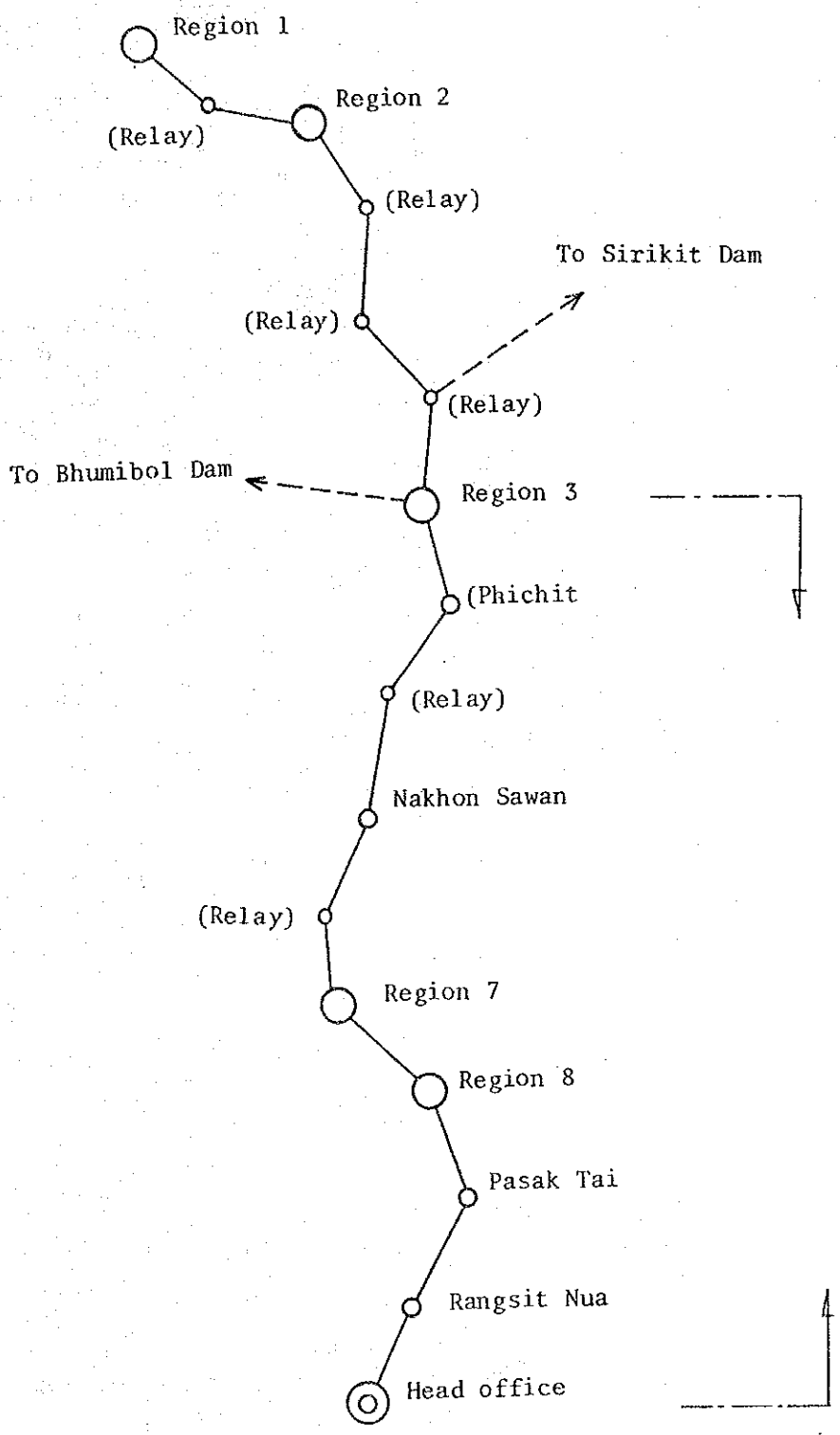


Figure 3-3 TRUNK ROUTE OF PRIVATE COMMUNICATION SYSTEM BY RID

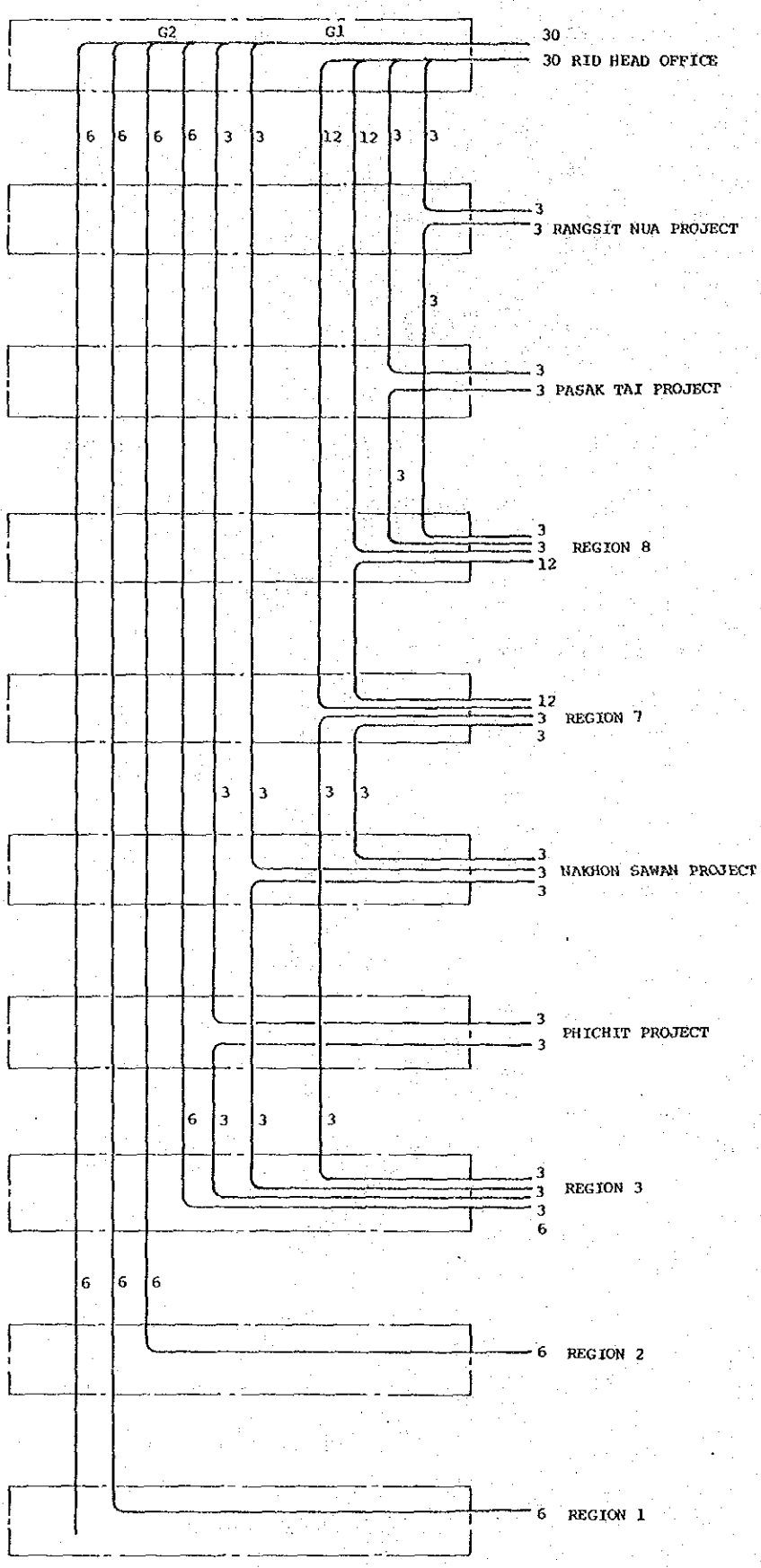


Figure 3-4 CHANNEL PLAN OF TRUNK LINE

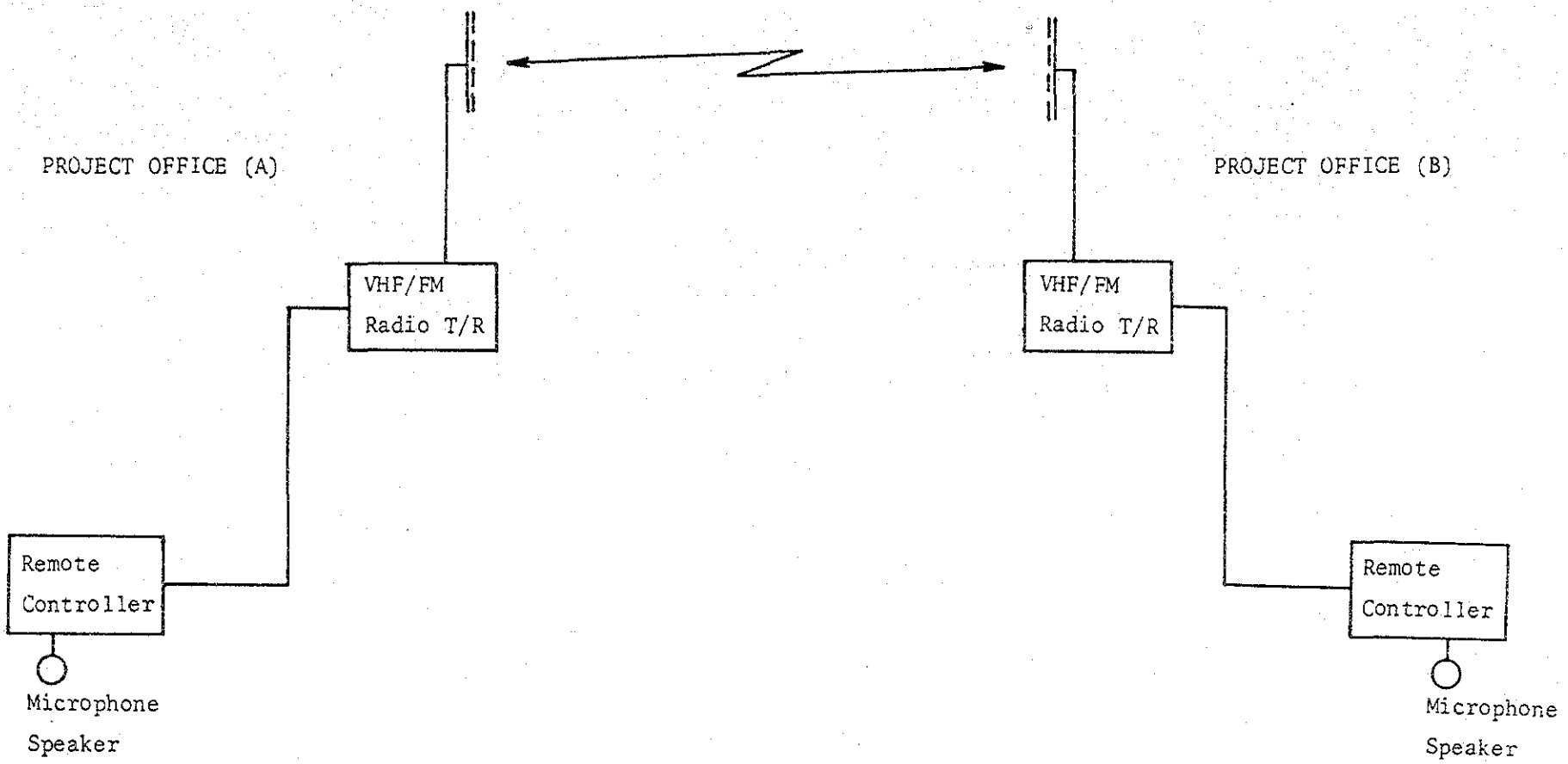


Figure 4-1 VHF/FM RADIO SYSTEM CONFIGURATION

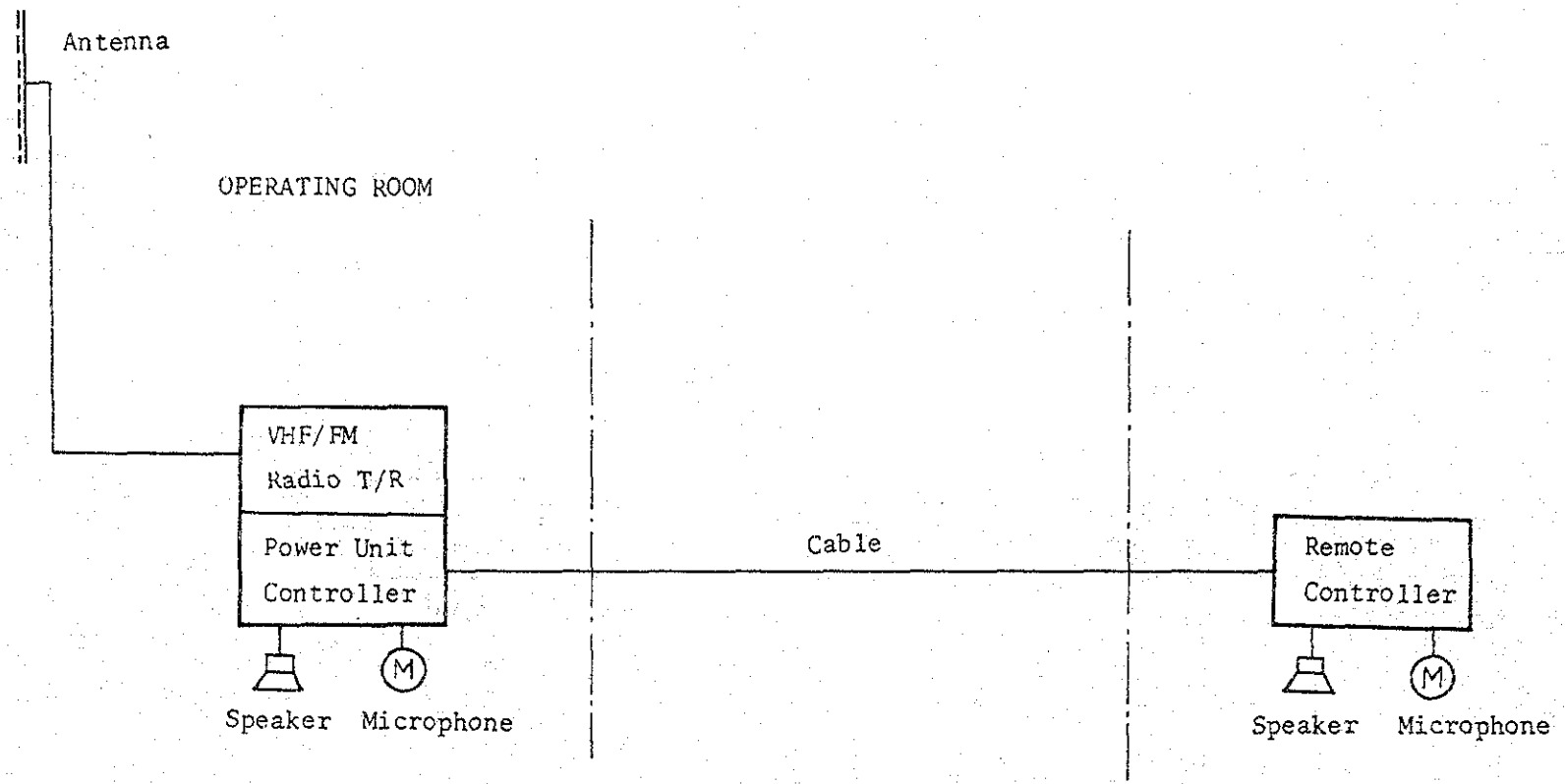


Figure 4-2 VHF/FM RADIO SYSTEM DIAGRAM OF PROJECT OFFICE

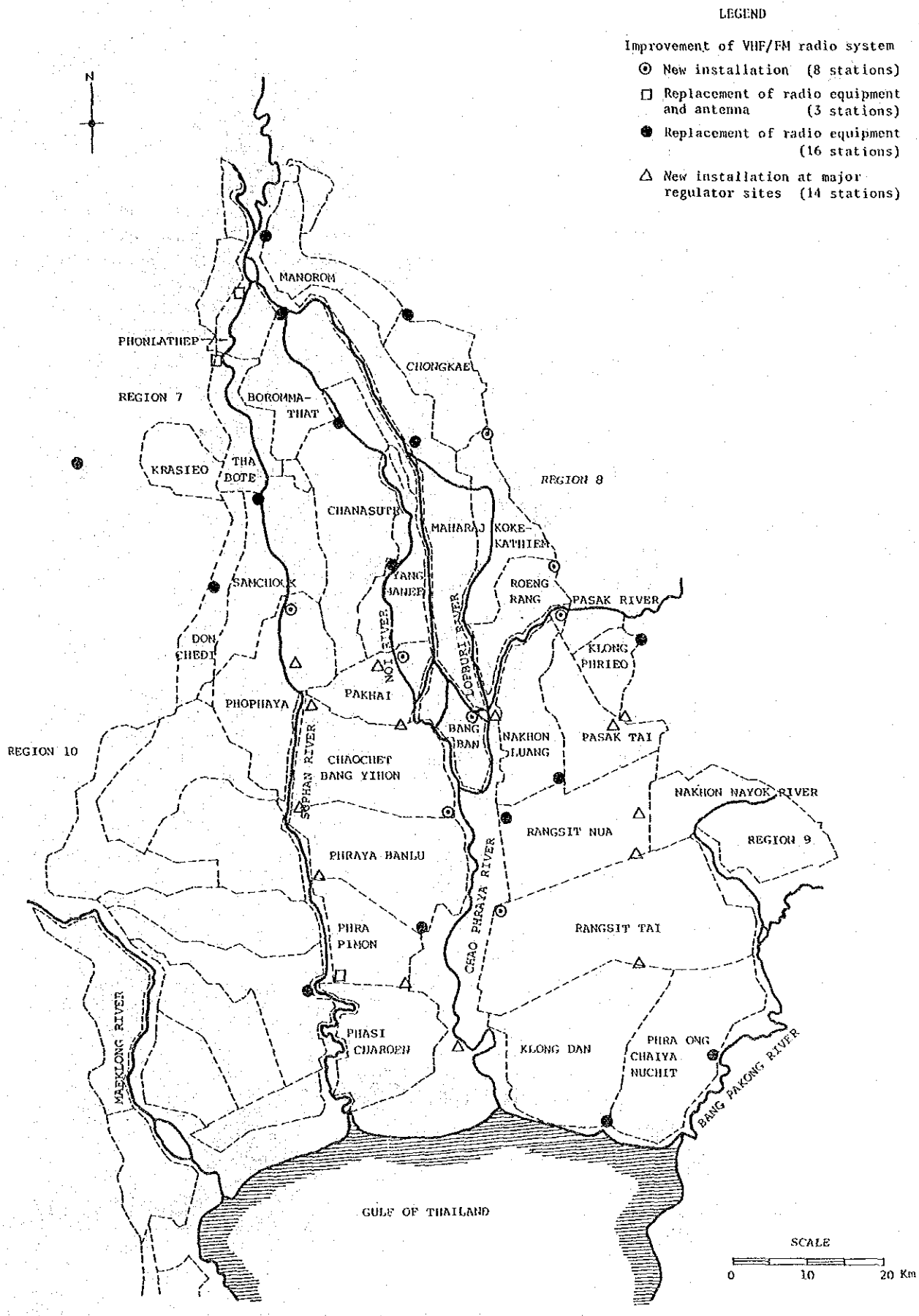


Figure 4-3 IMPROVEMENT PLAN OF COMMUNICATION FACILITIES (LEVEL-1)

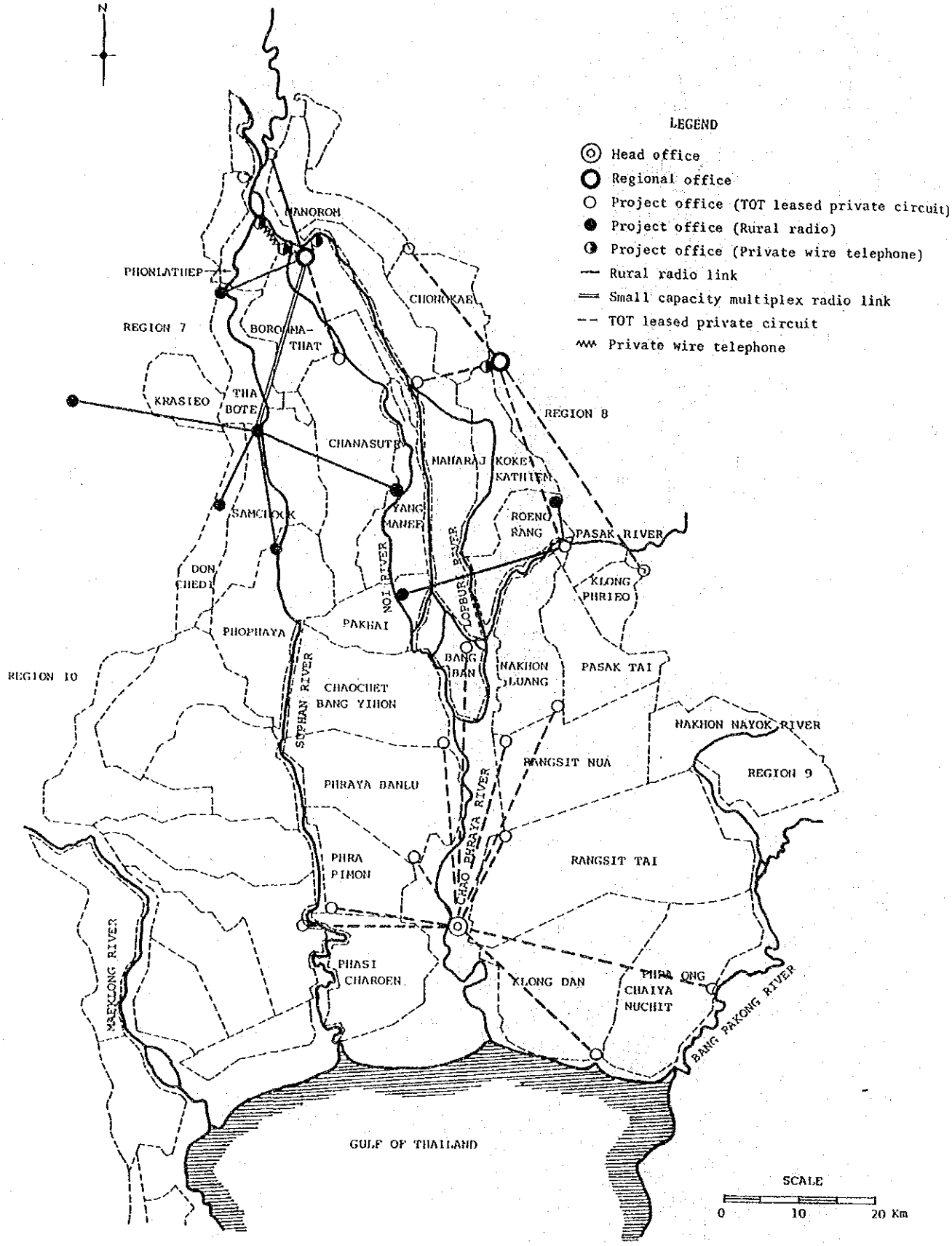


Figure 4-4 IMPROVEMENT PLAN OF LOCAL CIRCUIT (CASE (A))

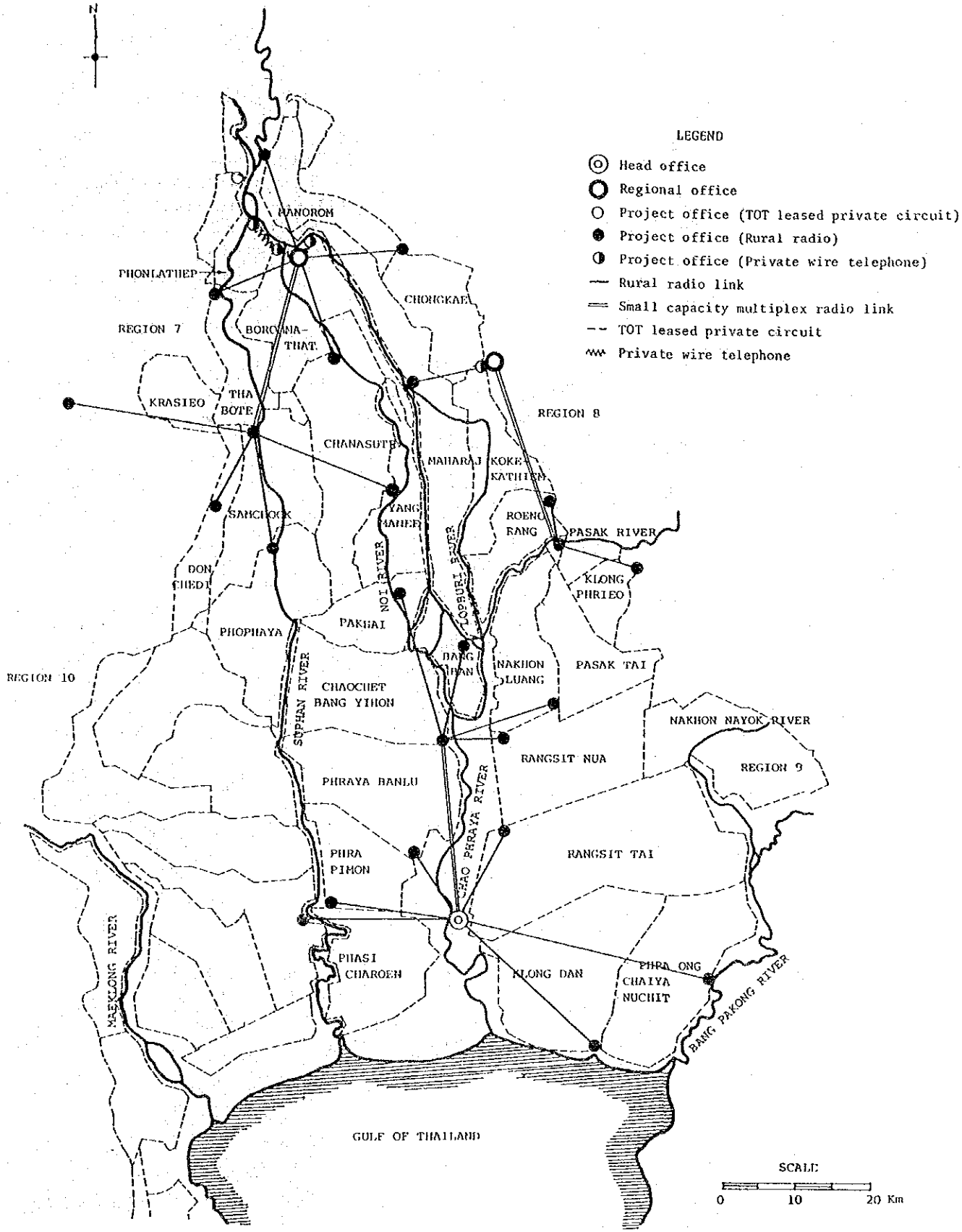


Figure 4-5 IMPROVEMENT PLAN OF LOCAL CIRCUIT (CASE (B))

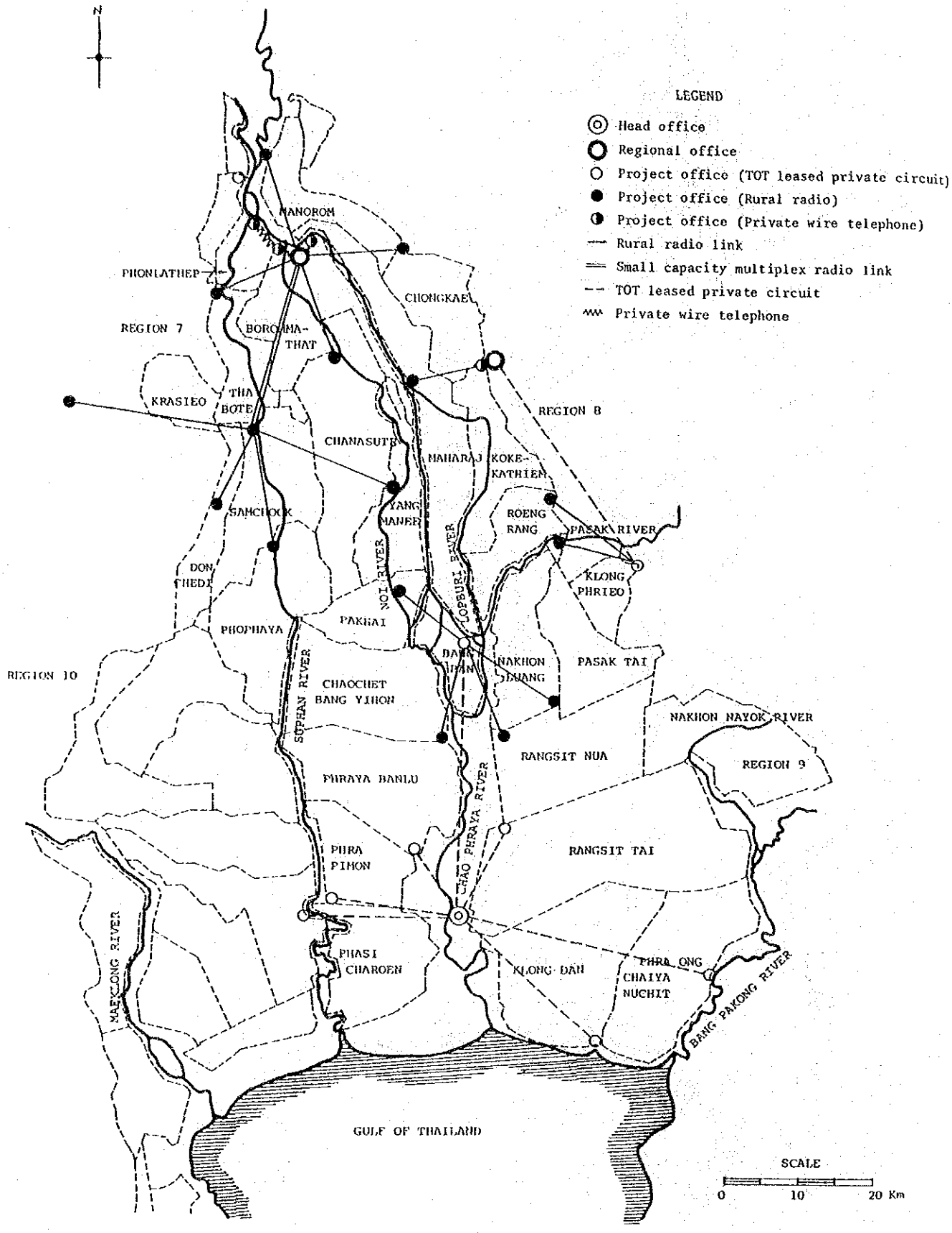


Figure 4-6 IMPROVEMENT PLAN OF LOCAL CIRCUIT (CASE (C))

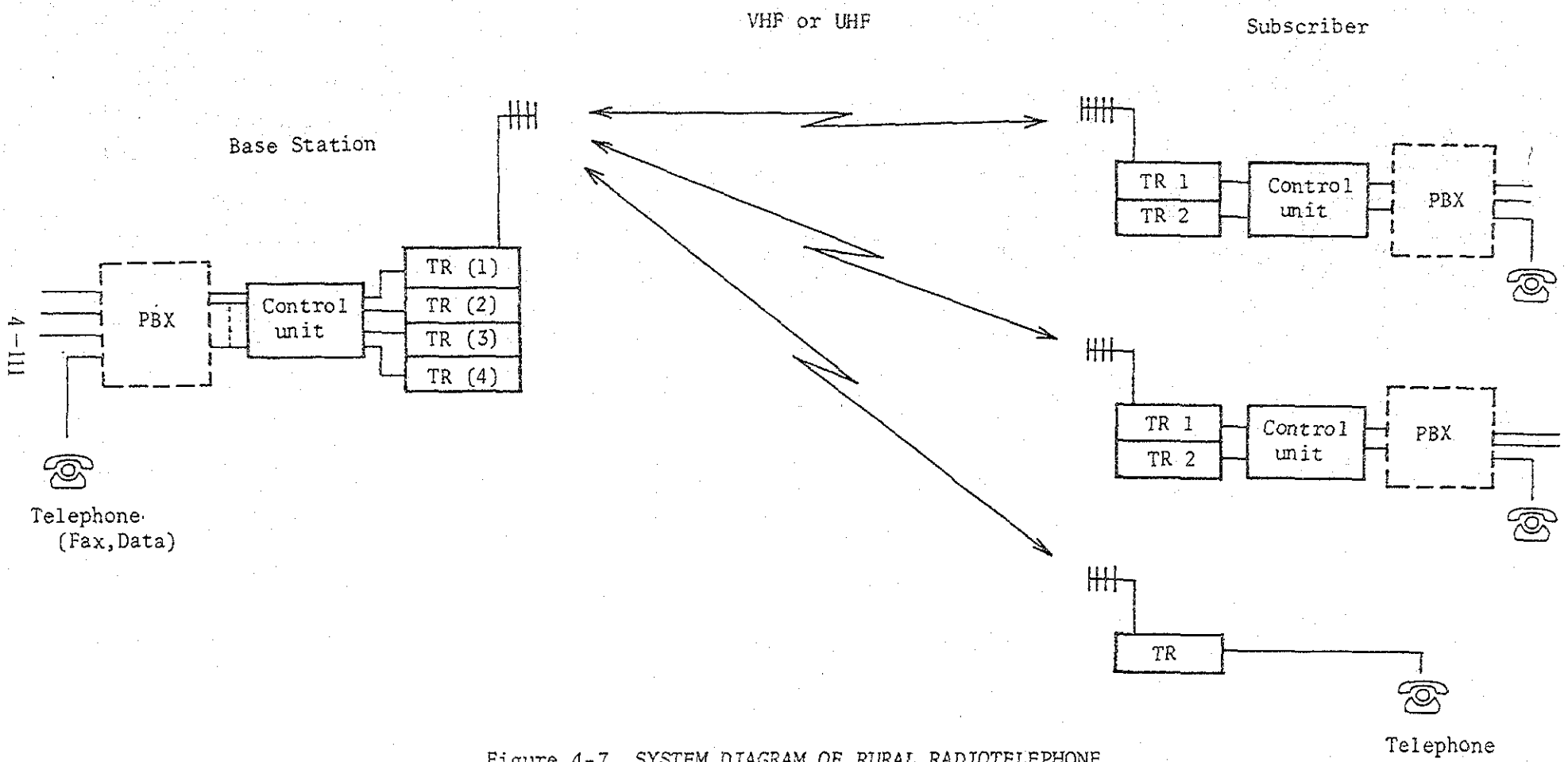
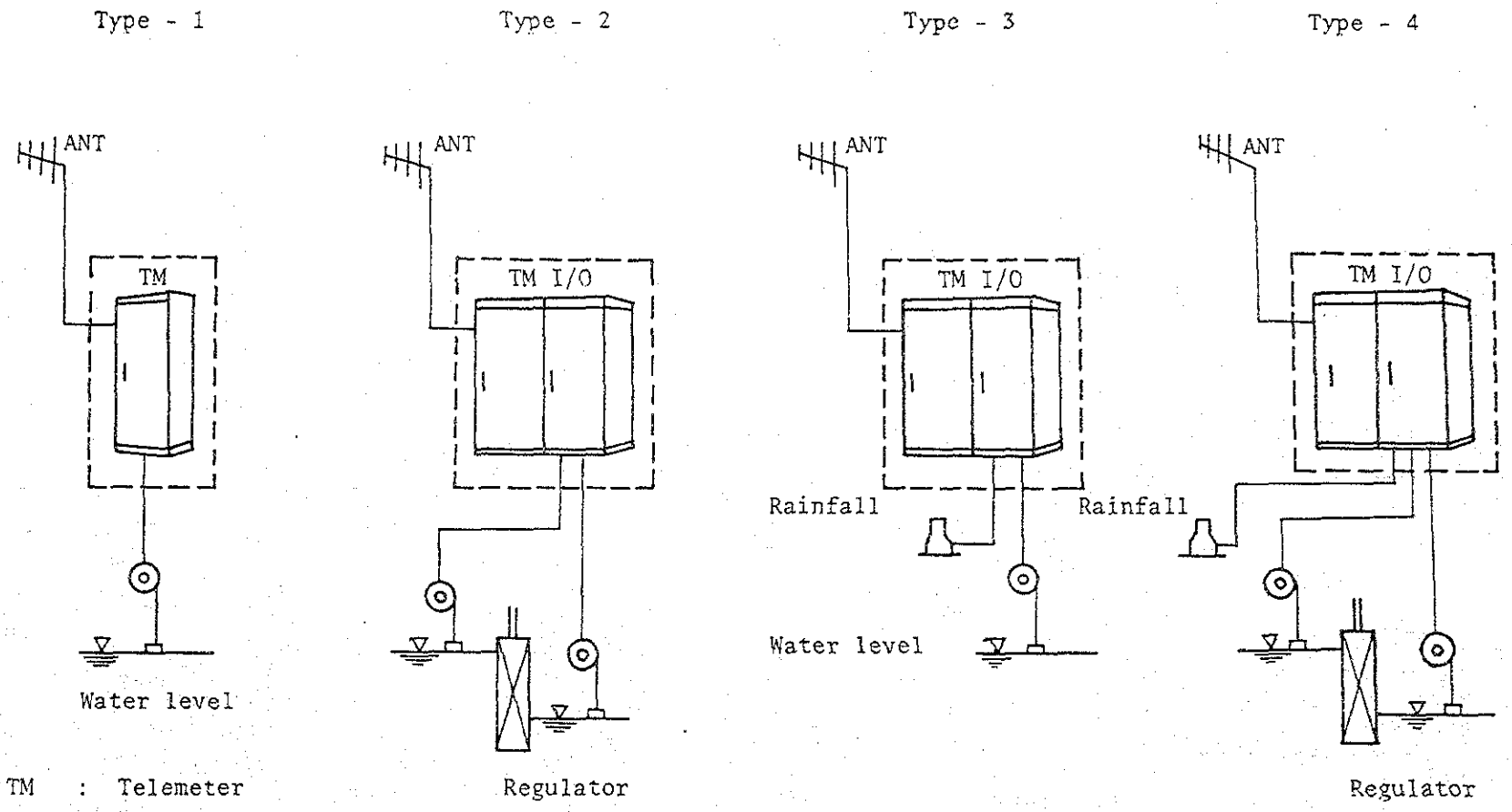


Figure 4-7 SYSTEM DIAGRAM OF RURAL RADIOTELEPHONE



TM : Telemeter
I/O : Input/Output Unit
ANT : Antenna

Figure 6-1 SCHEMATIC DIAGRAM OF TELEMETER STATION

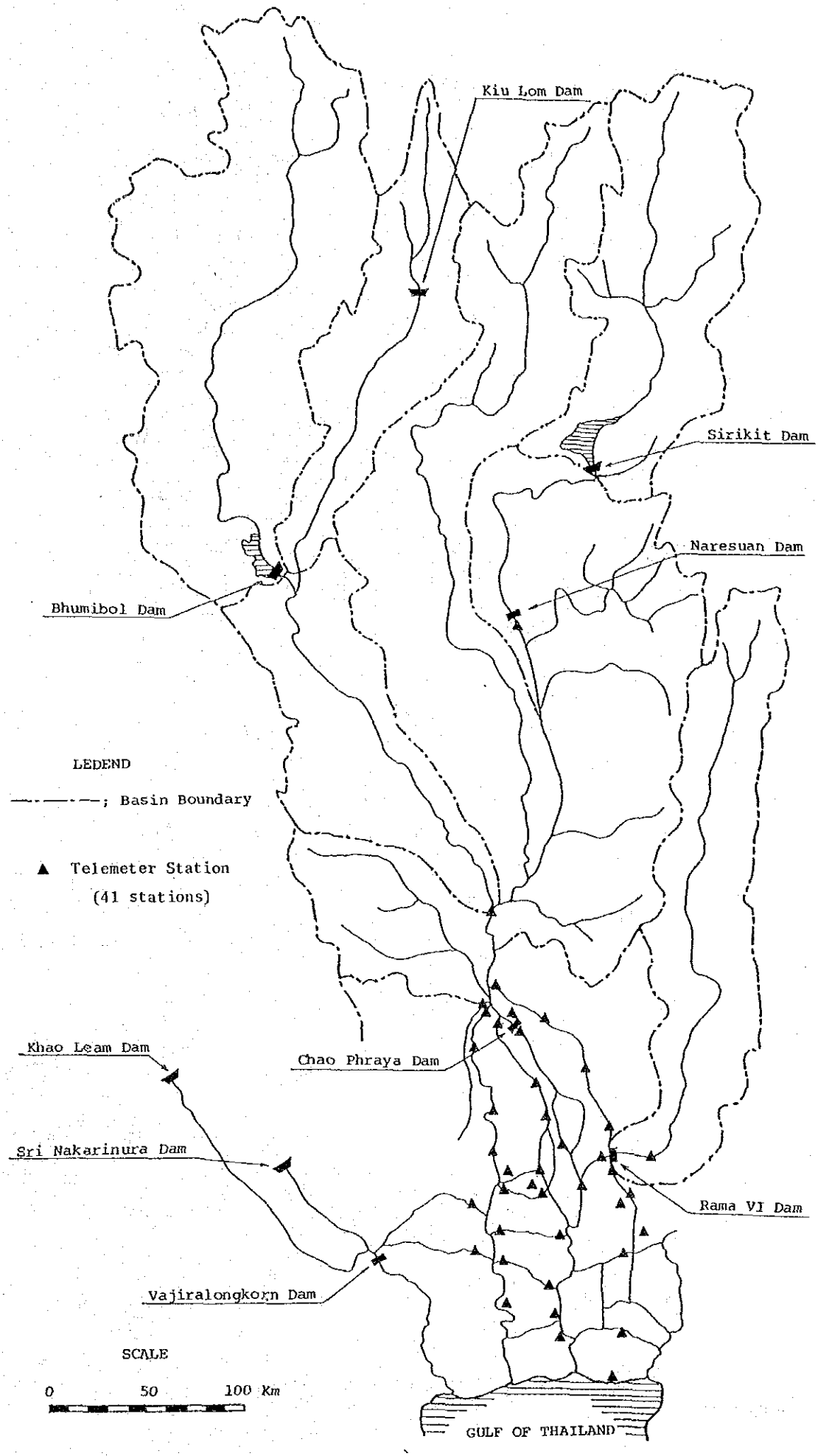


Figure 6-2 LOCATION OF TELEMETER STATION (LEVEL-3)

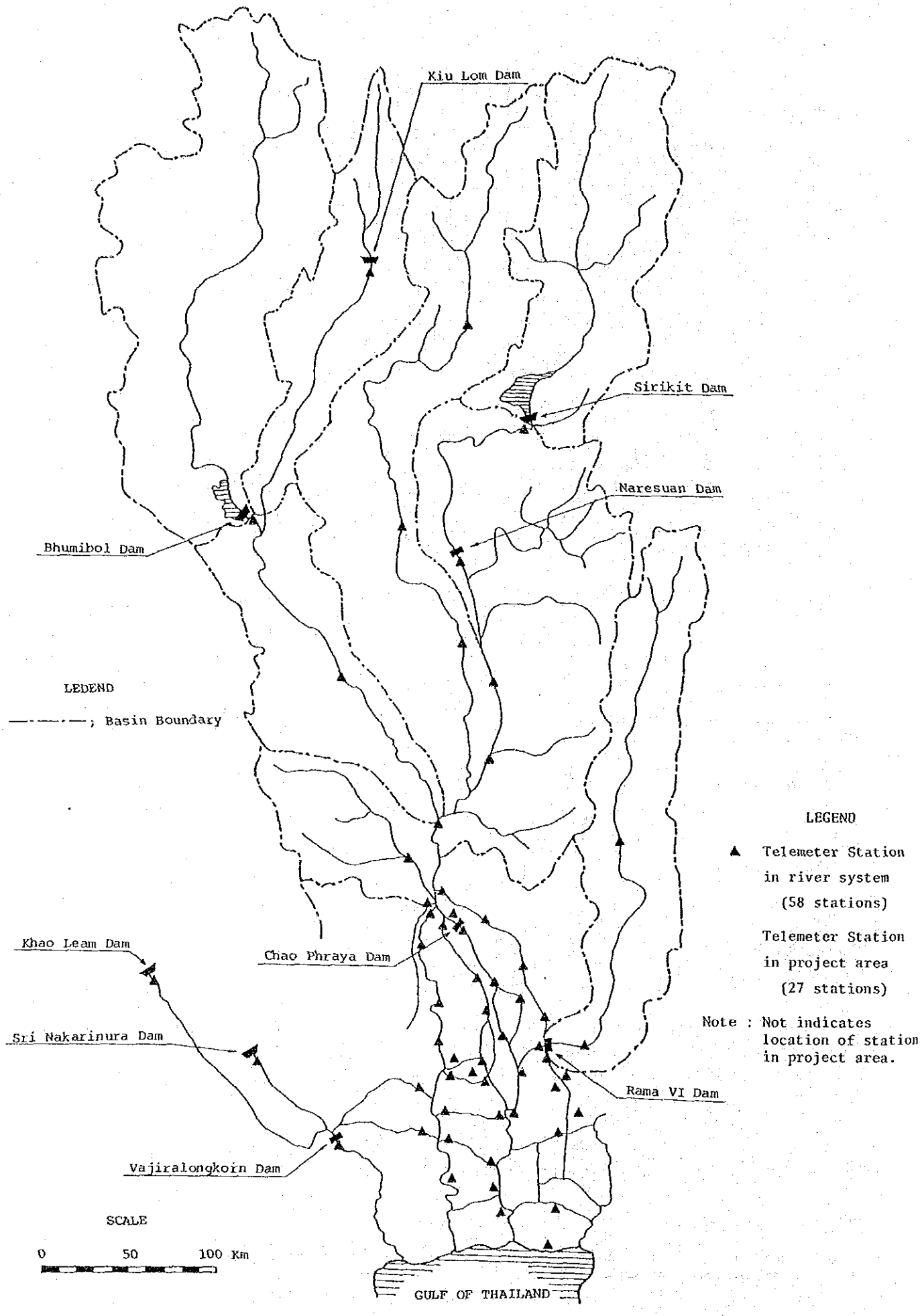


Figure 6-3 LOCATION OF TELEMETER STATION (LEVEL-4)

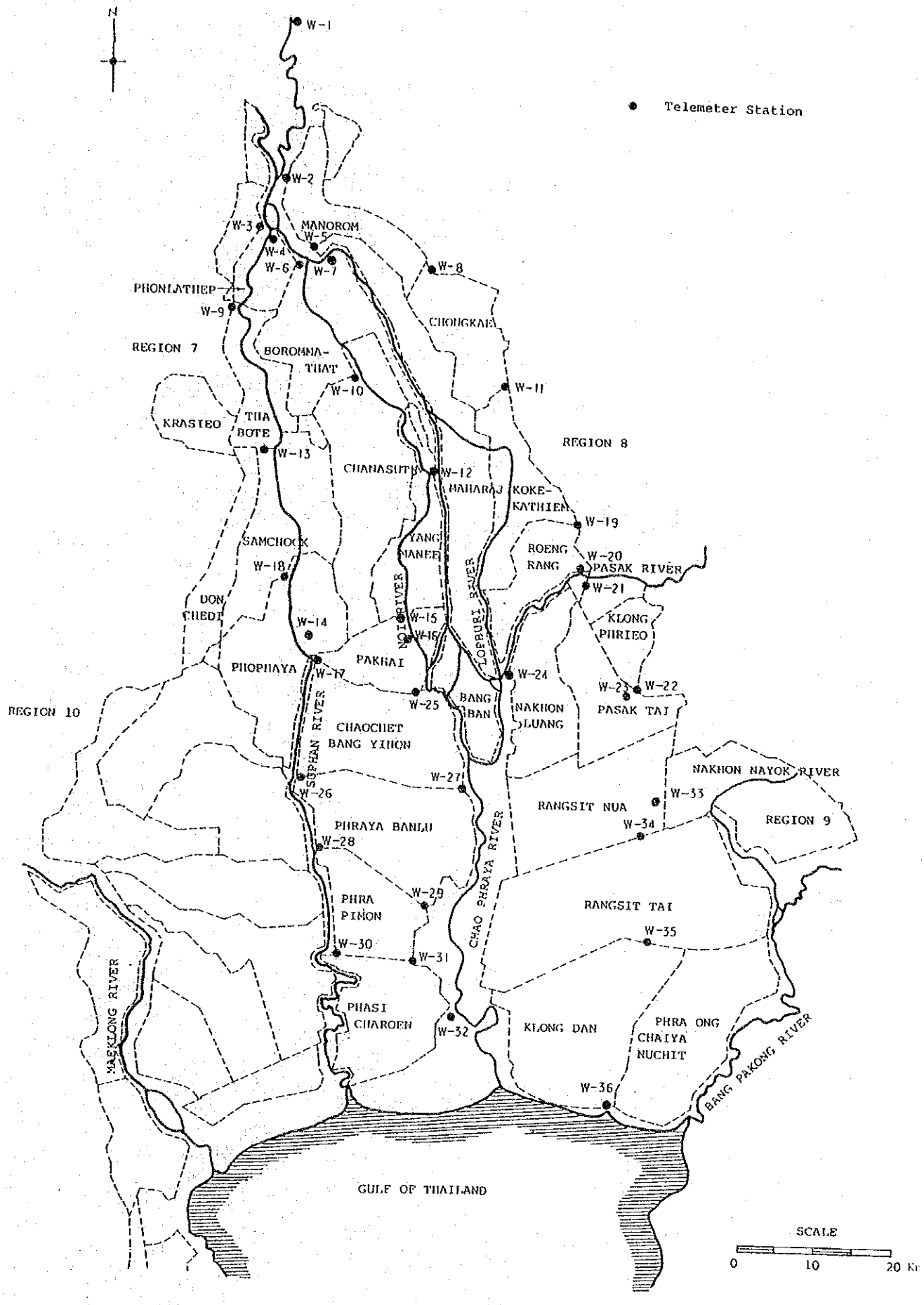


Figure 6-4 LOCATION OF TELEMETERING STATION IN THE DELTA (LEVEL-3)

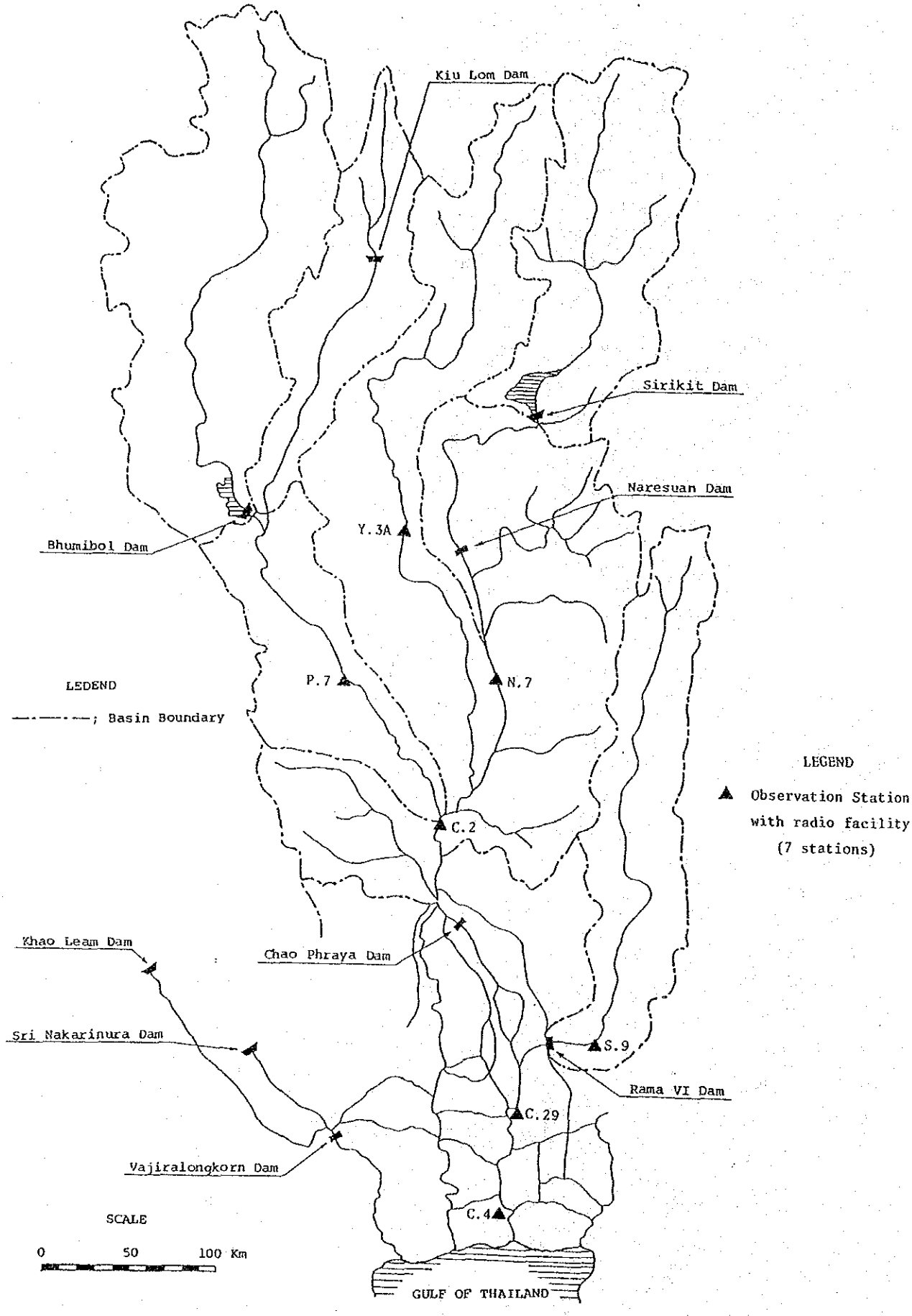


Figure 6-5 MAIN OBSERVATION STATION IN RIVER SYSTEM (LEVEL-1)

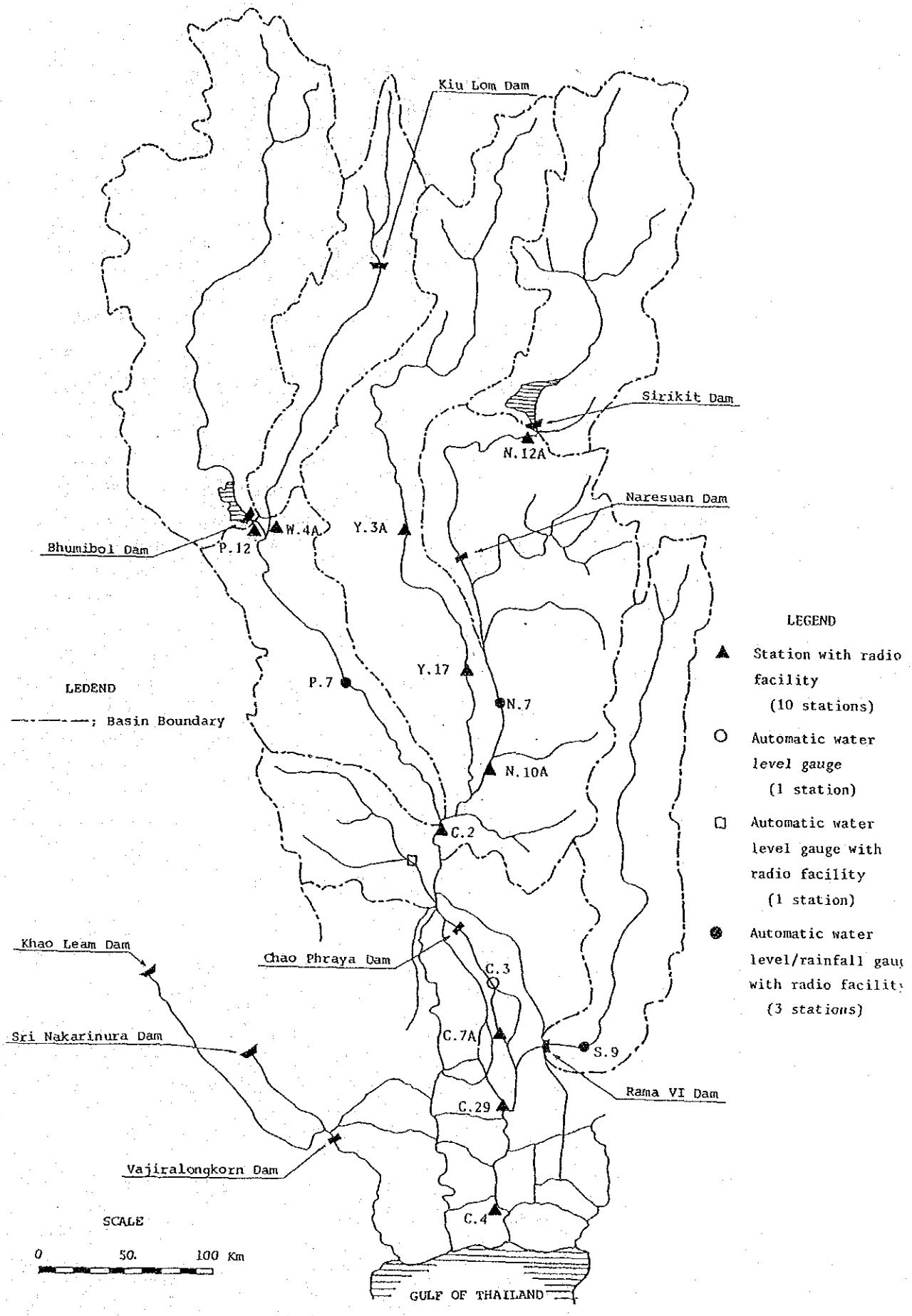


Figure 6-5 MAIN OBSERVATION STATION IN RIVER SYSTEM (LEVEL-2)

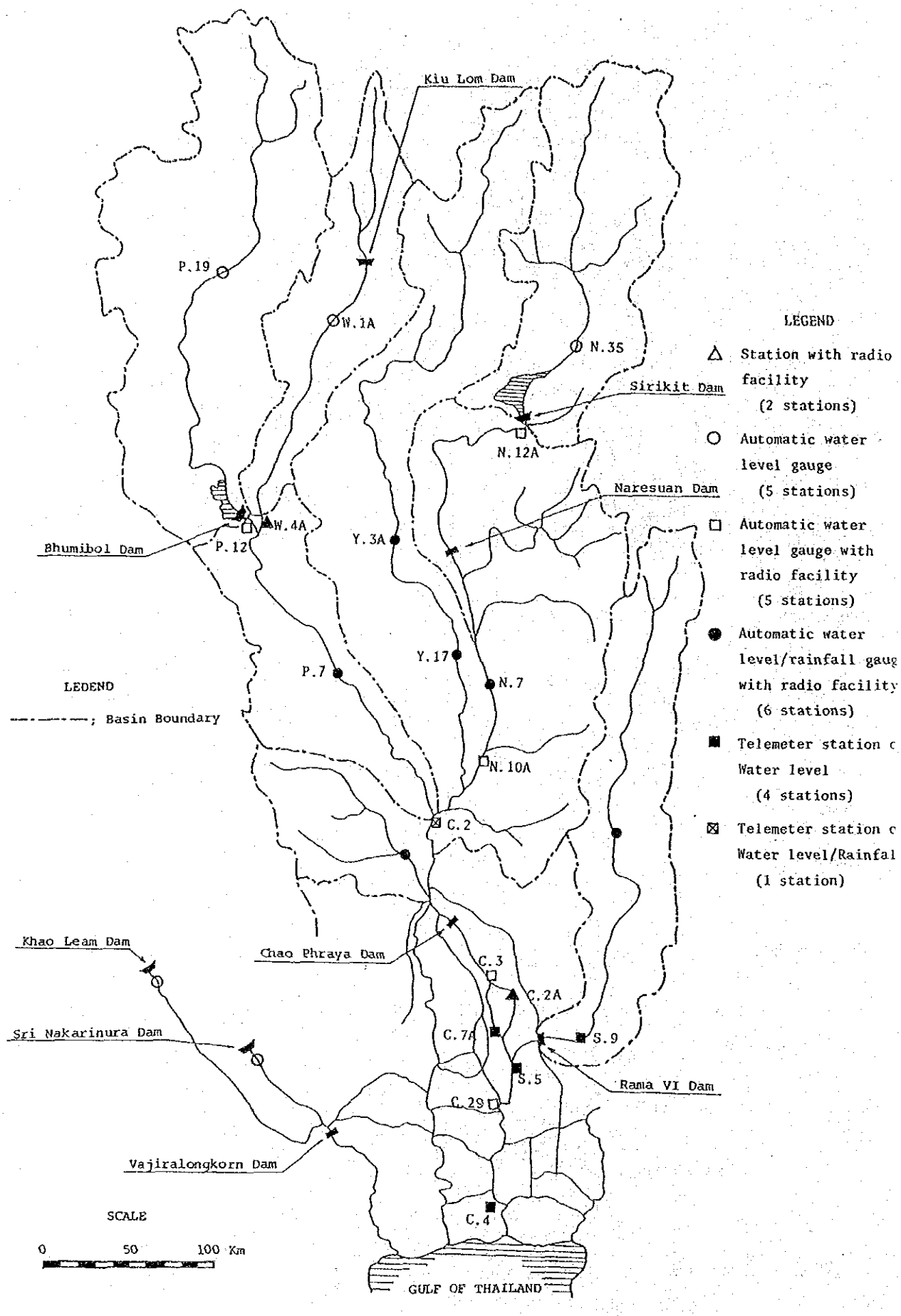


Figure 6-5 MAIN OBSERVATION STATION IN RIVER SYSTEM (LEVEL-3)

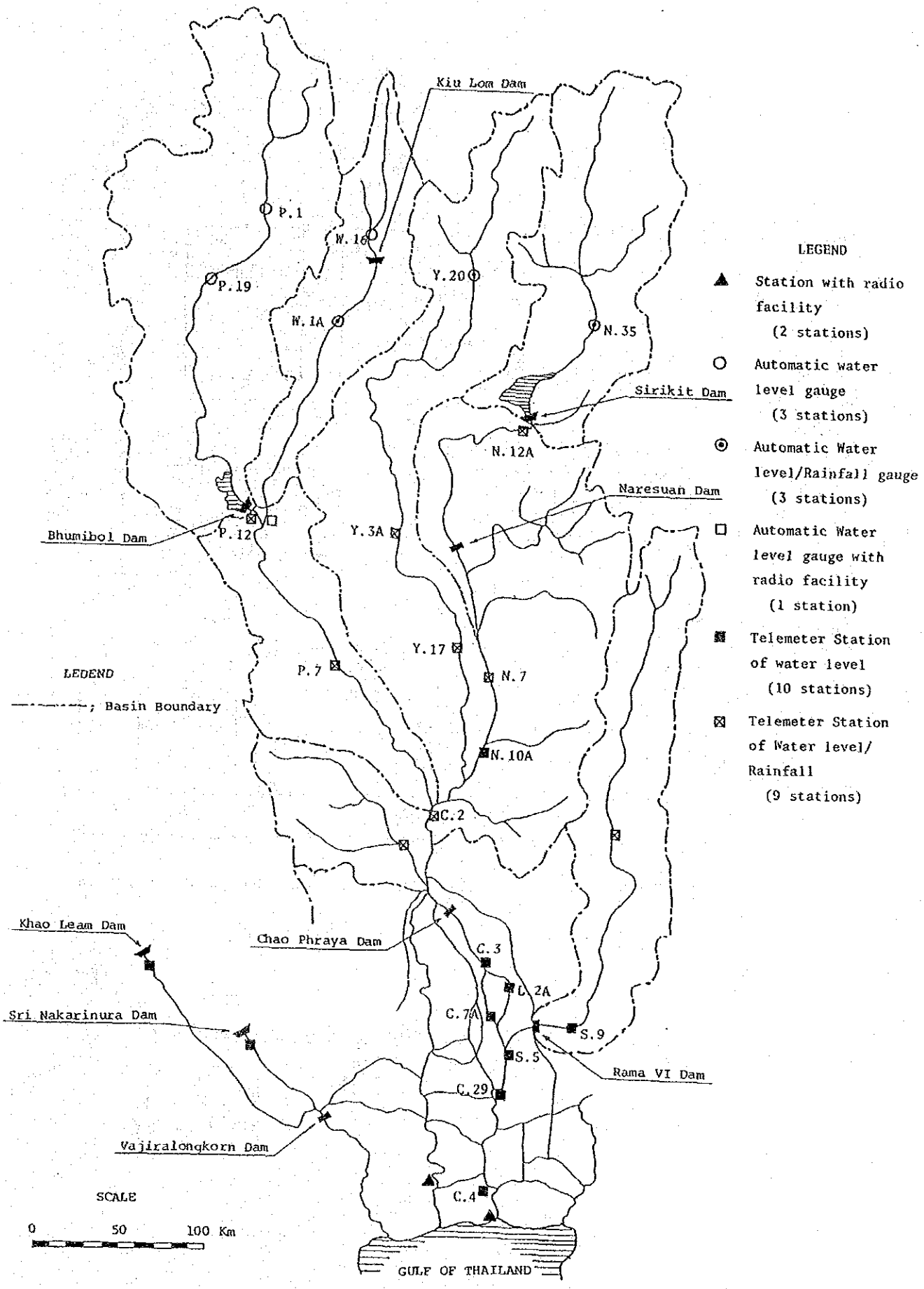
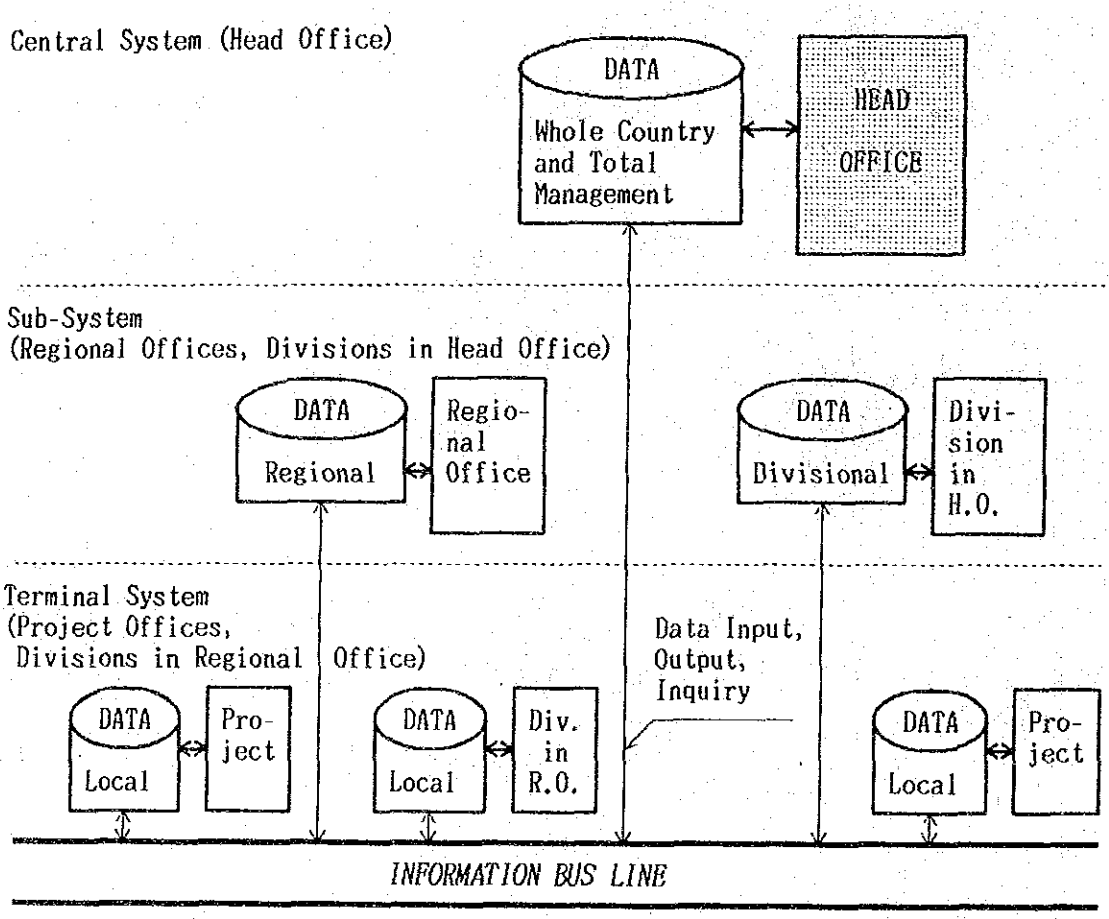


Figure 6-5 MAIN OBSERVATION STATION IN RIVER SYSTEM (LEVEL-4)



* Each office may have sub-systems with Divisional/Sectional data, as far as the sub-systems follow this concept.

Figure 10-1 IMAGE OF DATA STORAGE AND MANAGEMENT

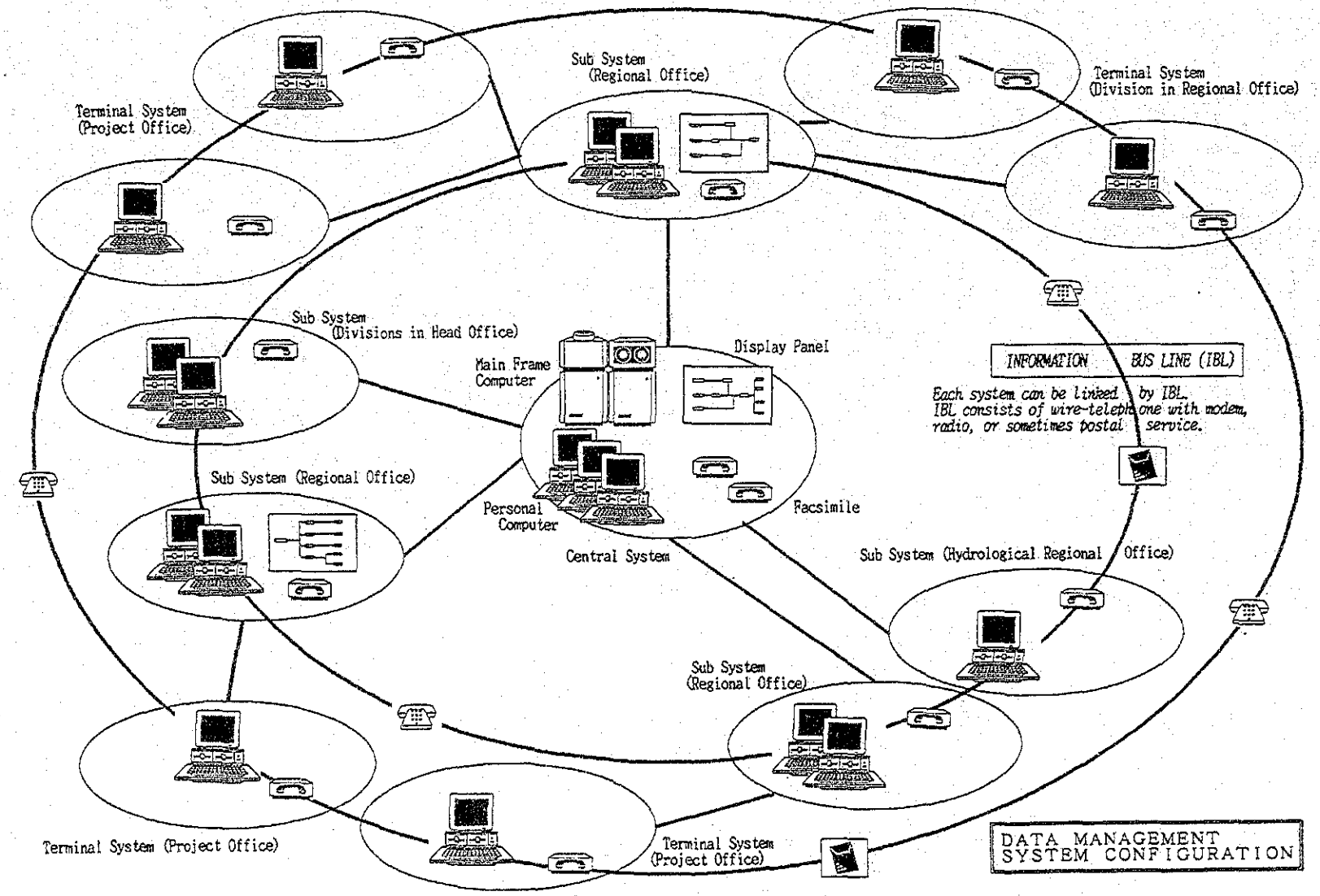


Figure 10-2 DATA MANAGEMENT SYSTEM CONFIGULATION