JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE GOVERNMENT OF MALAYSIA
PRIME MINISTER'S DEPARTMENT
ECONOMIC PLANNING UNIT
MALAYSIA

THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

VOLUME 1

SUMMARY

(FINAL REPORT)

JANUARY 1999

CTI ENGINEERING CO., LTD.
IN ASSOCIATION WITH
PASCO INTERNATIONAL INC.

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VOLUME 4 DATA BOOK

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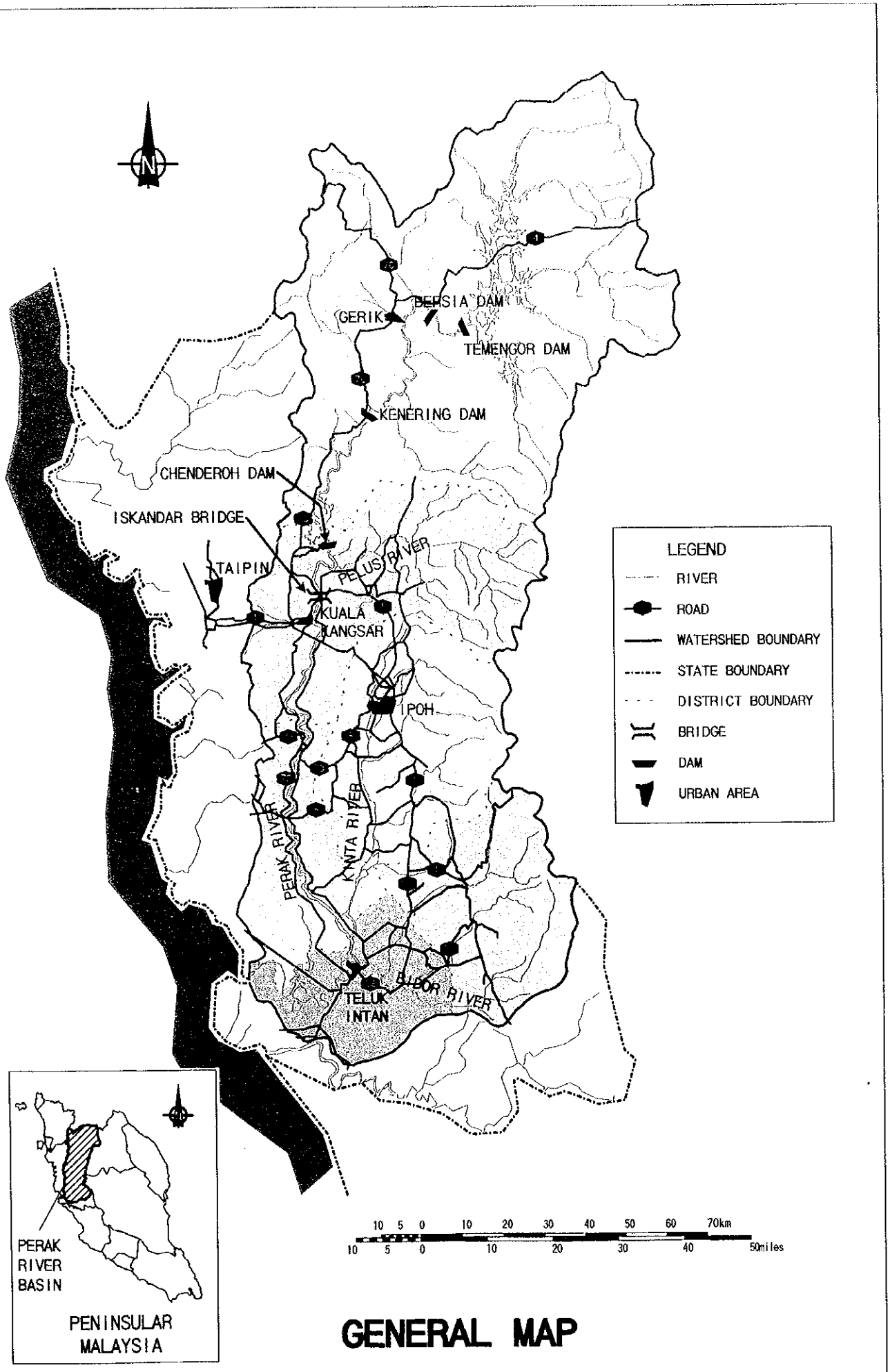

N
GERIK
BERSIA DAM
TEMENGOR DAM
KENERING DAM
CHENDEROH DAM
ISKANDAR BRIDGE
TAIPIN
PELUS RIVER
KUALA KANGSAR
IPOH
PERAK RIVER
KINTA RIVER
TELUK INTAN
SUNGAI BIDOR
LEGEND
RIVER
ROAD
WATERSHED BOUNDARY
STATE BOUNDARY
DISTRICT BOUNDARY
BRIDGE
DAM
URBAN AREA
10 5 0 10 20 30 40 50 60 70km
10 5 0 10 20 30 40 50miles
PERAK RIVER BASIN
PENINSULAR MALAYSIA

GENERAL MAP

PREFACE

In response to a request from the Government of Malaysia, the Government of Japan decided to conduct a master plan and feasibility study on the Establishment of the River Basin Information System in Malaysia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team, headed by Mr. Makihiko Otogawa of CTI Engineering Co., Ltd., and composed of members from CTI Engineering Co., Ltd. and Pasco International Inc., to Malaysia four (4) times between March 1997 and October 1998. In addition, JICA set up an advisory committee headed by Mr. Tomonori Abe, Director of Second Research Department, Foundation of River & Basin Integrated Communications, Japan in March 1997, and Mr. Shuji Unno, Director of Second Research Department, Foundation of River & Basin Integrated Communications, Japan after September 1998, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Malaysia, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the Study.

January, 1999

Kimio Fujita
President
Japan International Cooperation Agency

January 1999

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Sir:

We are pleased to submit herewith the Final Report for the Study on the Establishment of the River Basin Information System in Malaysia. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and the Japan International Cooperation Agency (JICA), as well as the formulation of a plan for the establishment of the river basin information system. Also included are the comments made by the Economic Planning Unit, Department of Irrigation and Drainage, and other authorities concerned of the Government of Malaysia during the technical discussion on the Draft Final Report in Malaysia.

The Final Report presents the Master Plan for the establishment of the river basin information system. It also presents the Feasibility Study on the development of a pilot system, called the "Operational System", and the results of the actual development works for the System.

In view of the urgency and necessity of socio-development, we recommend that the Government of Malaysia should adopt all means possible to promote the establishment of the river basin information system to the next stage of project implementation at the earliest possible time.

Finally, we wish to take this opportunity to express our sincere gratitude to the Government of Japan, particularly, JICA, the Ministry of Foreign Affairs, the Ministry of Construction and other offices concerned. We also wish to express our deep appreciation to the Economic Planning Unit, the Department of Irrigation and Drainage and other related authorities concerned of the Government of Malaysia for the close cooperation and assistance extended to the JICA Study Team during the Study.

Very truly yours,

MAKIHIKO OTOGAWA
Leader
JICA Study Team

EXECUTIVE SUMMARY

1. BACKGROUND

Recent developments in land use have been increasing flood damage potential and creating water shortage areas throughout Malaysia. Riverbed erosion and/or sedimentation also have lead to the deterioration of river environment. The ongoing dynamic changes on river condition require a comprehensive and consistent river basin management to realize a well-balanced river development and environmental improvement.

The execution of river basin management is, however, extremely difficult due to lack of an integrated and systematic information system to coordinate the voluminous river basin information at present. In due consideration of the circumstances, "The Study on the Establishment of the River Basin Information System in Malaysia" (hereinafter referred to as "the Study") was conducted by the Japan International Cooperation Agency (JICA) for a period of about 18 months from March 1997 to December 1998.

2. OBJECTIVES OF THE STUDY

The primary objective of the Study was to establish a long-term development plan of river basin information system (RBIS). In line with this long-term development plan, the detailed plan and design of a pilot system (hereinafter called "the Operational System") were carried out. Furthermore, the actual development of the Operational System was undertaken during the study period to impart technical knowledge on system management and, further, to immediately provide the necessary river basin information.

The objective study area was the entire Perak river basin that is located in Perak State and with a catchment area of about 14,700 km^2. Thus, the proposed river basin information system is a basin-wide system, but future system expandability nationwide has been considered in the plan formulation.

3. OUTLINE OF PROPOSED PLAN

3.1 Basic Policy

The river basin information system aims at collecting all necessary information to support the comprehensive river basin management and at furnishing them to the relevant government agencies as well as the public system users. To realize its goal, system development plans

were formulated in due consideration of the important issues on river basin management that encompasses various categories such as (1) flood management, (2) water supply management, (3) river environmental management, and (4) watershed management.

3.2 Proposed System Network and Devices

3.2.1 The River Basin Information System Proposed in the Long Term Development Plan

The system network plan is oriented to centralized data management at the Federal operation center. All objective information are finally transmitted to and disseminated from the center.

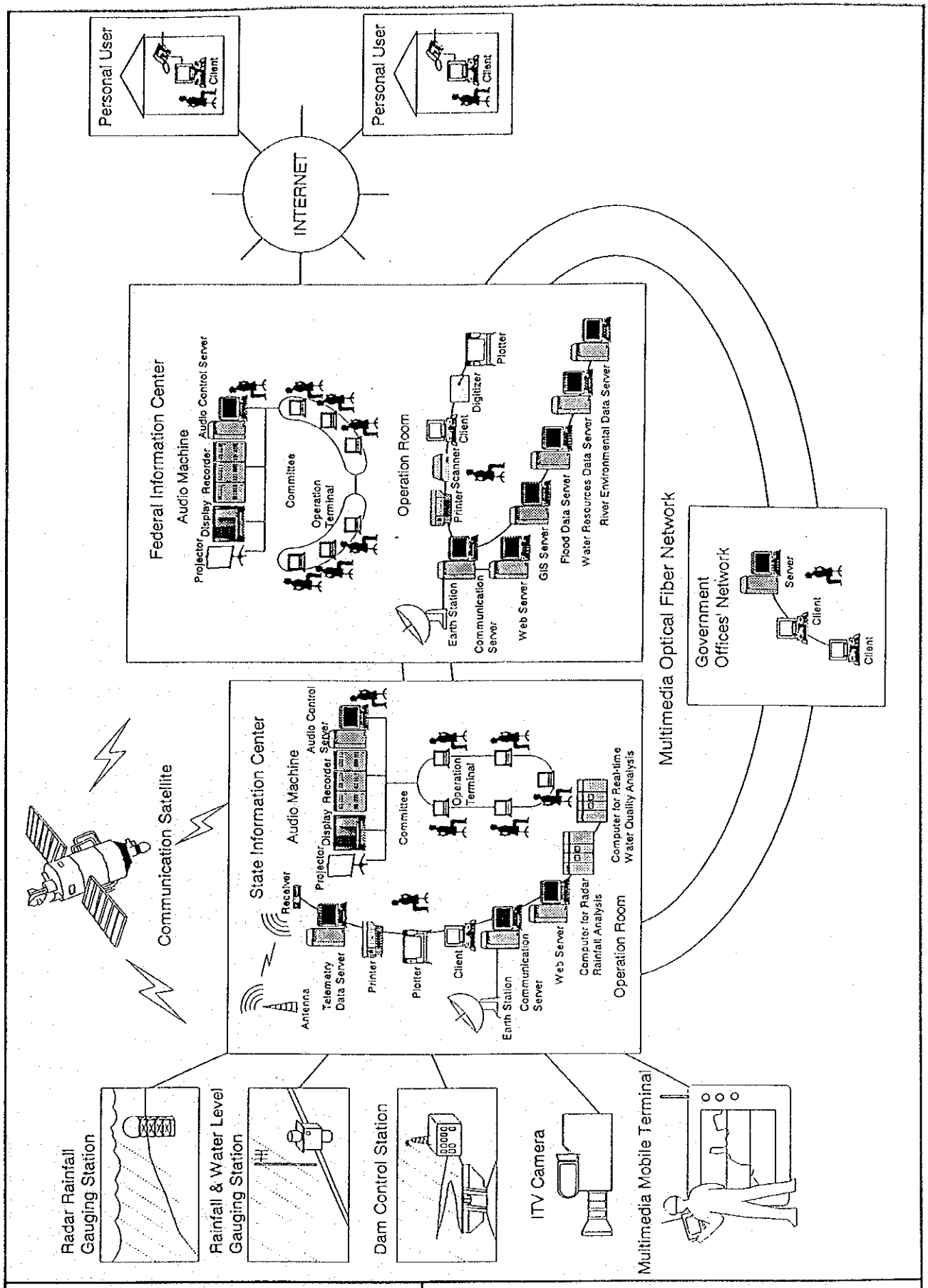
The system devices consist of the data gauging device, the data transmission device and the data processing device, covering the items shown in Fig. S-1. Among them, the proposed data gauging device include updated technology such as (1) Industrial Television (ITV) to monitor the dynamic visual information of the field; (2) radar rainfall gauge; and (3) automatic water quality gauge. These gauging devices will be practicable in Malaysia in the future as a result of the intensive technology development at present.

The optical fiber line is further applied as the main data transmission system, since the optical fiber network is going to cover the whole country, promising the best quality and reliability of transmitted data as projected in "Telecommunication Vision 2020".

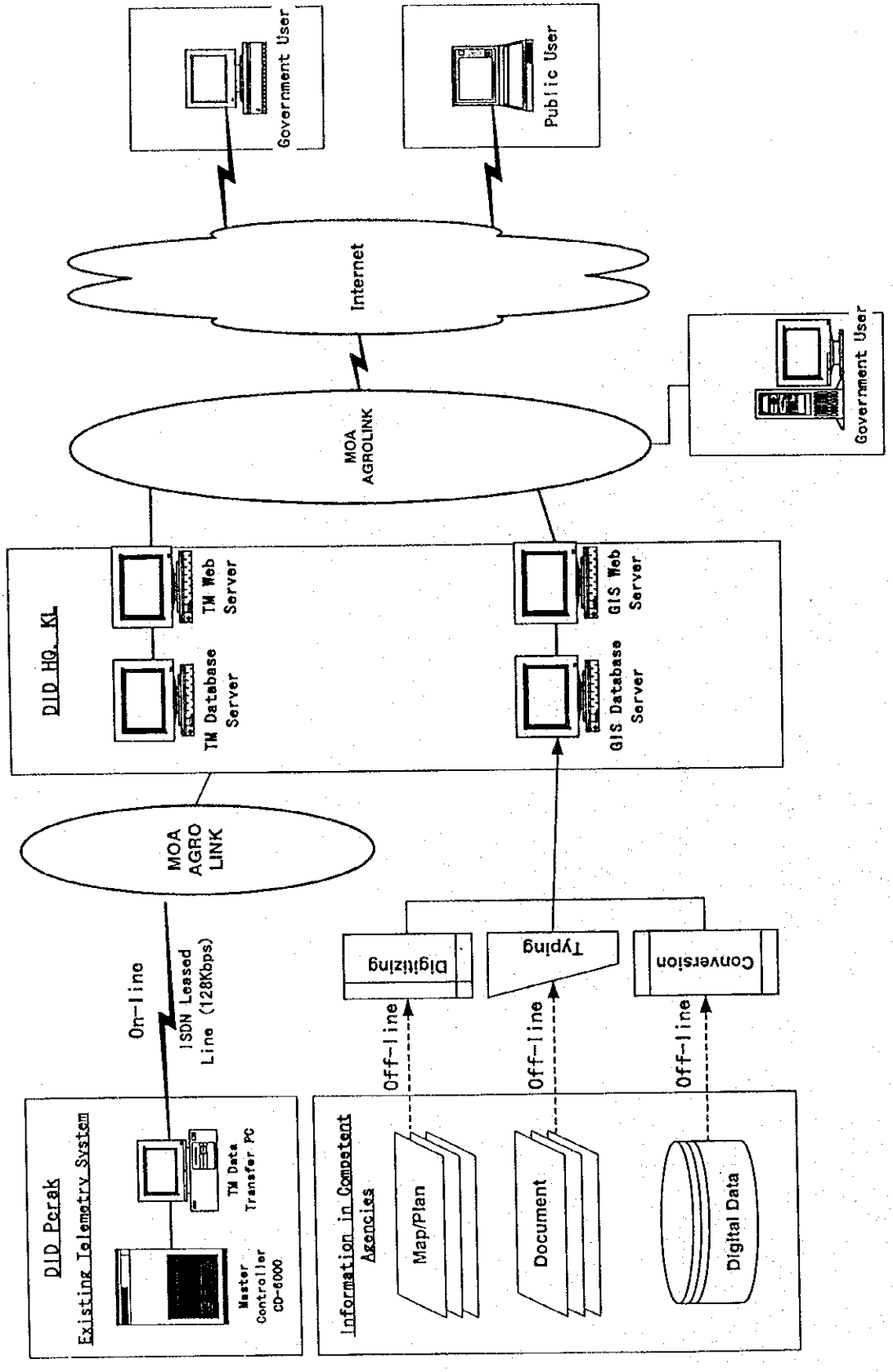
3.2.2 The Operational System Developed in the Study

As in the above long-term development plan, the network plan of the Operational System is oriented to centralized management at the Federal operation center (refer to Fig. S-2). In the system network, the database information is collectively imported from the relevant government agencies to the Federal operation center off-line. The real-time hydrological gauging data are also collected from the existing telemetry gauging stations and transmitted to the Federal operation center through the ISDN line (leased line) between Ipoh and Kuala Lumpur and the existing wide-area network in Kuala Lumpur (called "Agrolink"). Both of the real time information and the database information are finally disseminated from the Federal operation center, through the Internet, to the government agencies as well as the public users.

The Operational System applies the existing gauging facilities and the existing data transmission system (i.e., the aforesaid ISDN line and the Agrolink). Moreover, the Operational System includes the data processing equipment newly procured and installed by



THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. S-1 SYSTEM NETWORK AND DEVICE PROPOSED IN LONG-TERM DEVELOPMENT PLAN



THE STUDY ON THE ESTABLISHMENT OF THE RIVER BASIN INFORMATION SYSTEM IN MALAYSIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. S-2 SYSTEM NETWORK AND DEVICE PROPOSED FOR OPERATIONAL SYSTEM

JICA. The data processing equipment consists of two UNIX server machines and other peripheral hardware such as personnel computers, routers, input/output equipment, power supply/backup equipment, and database backup equipment.

4. PROJECT COST

Project cost has been estimated as given below:

Description	Estimated Cost
(1) The System proposed in long-term plan	
(a) Initial investment cost	RM 19.56 million
(b) Annual operation and maintenance cost	RM 4.00 million/year
(2) The Operational System	
(a) Initial investment cost	RM 2.96 million
(b) Annual operation and maintenance cost	RM 0.21 million/year

The initial investment cost of the system proposed in the long-term development plan is to be disbursed from the 8th Malaysia Plan to the 11th Malaysia Plan (2001 to 2020), and full operation and maintenance costs would ensue from 2020 onward. On the other hand, the initial investment cost of the Operational System has been disbursed within the study period (1997-98) and, therefore, annual operation and maintenance cost will ensue starting from the period after the Study.

5. PROJECT EVALUATION

5.1 Economic Evaluation

The river basin information system inclusive of the Operational System will facilitate easy and quick access to consistent and comprehensive river basin information reducing the time and manpower for river basin management works. Moreover, the real-time hydrological gauging data given by the system will facilitate more flexible reservoir operation of the existing hydropower dams effecting flood management and water supply management. In due consideration of these benefits, economic evaluation was made and, as a result, the following economic internal rate of return (EIRR) was estimated:

(1) The river basin information system in the long-term development plan	10.8%
(2) The Operational System developed in the study	17.1%

As estimated above, the proposed plan generates the EIRR of more than 10% and, therefore, its economic viability was verified.

5.2 Technical Evaluation

In Malaysia, information technology is being intensively developed and information is being opened through the wide area network. In this connection, the proposed river basin information system could be regarded as a model case of such wide area communications services. The National Land Information System (NaLIS) and the Hydrological Information System (HIS) will also start their wide area communications services on land information and hydrological information, respectively.

The proposed river basin information system involves various kinds and levels of government and semi-government agencies as information sources as well as information users. Under such circumstances, the wide area network will facilitate the easy and the system expandability to meet the increment of information sources and information users.

However, the wide area network communication will also generate several important issues such as (1) the protection of data confidentiality and/or copyright, and (2) the creation of interchangeability of various information systems. To cope with these issues, the following plans are proposed: (1) classification of the information into those for exclusive use of government and for use of private sectors, and (2) standardized processing of database information. These plans could be guidelines and/or directions on the data sharing among agencies and, based on them, proper coordination among the relevant agencies would be indispensable to ensure optimum wide area network communication.

6. RECOMMENDATIONS

The major recommendations in the proposed plan are as given below:

(1) Development of River Basin Information System

The proposed river basin information system is indispensable to support a comprehensive and consistent river basin management. The development of the system should be implemented in accordance with the schedule proposed in this Study in consideration of the following:

(a) Information involved in the system should be given priority in due consideration of their significance for river basin management.

(b) The development of the system should be oriented to system expandability and interchangeability with the other relevant database information systems.

(c) The system backup and security should be strengthened. The Operational System provisionally disseminates its information through the Internet. However, such data dissemination may not always be reliable during flood time; hence, it is recommended that the reliability of the Internet should be clarified in developing the system, and a dedicated line should be employed for use of the relevant agencies according to circumstances.

(2) Sustainable System Management

The Operational System was completed during the study period as an initial system of the proposed river basin information system, and the important issues concern sustainable system operation, maintenance and management. To resolve these issues, the system administrator should make efforts to develop human resources for system management as well as to import progressive information technology.

(3) Institutional Setup for System Development and Management

The institutional setup for system development and sustainable system management should be established as proposed in Chapter 8 of this Volume 1 of the report. The organization in the institutional setup plan is oriented to the inter-agency coordination body involving various relevant government and semi-government agencies to maximize mutual benefits in sharing information with the related agencies as well as the public users.

THE STUDY ON THE ESTABLISHMENT OF
THE RIVER BASIN INFORMATION SYSTEM
IN MALAYSIA

VOLUME 1

SUMMARY

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ABBREVIATIONS AND GLOSSARY

GOVERNMENT OFFICES

AIFM	:	Asian Institute of Forest Management
DGSM	:	Department of Geological Survey of Malaysia
DID	:	Department of Irrigation and Drainage
DGSM	:	Department of Geographic Survey of Malaysia
DOA	:	Department of Agriculture
DOE	:	Department of Environment
DOF	:	Department of Fisheries
DOLM	:	Department of Lands and Mines
DOS	:	Department of Statistics
DSMM	:	Department of Survey and Mapping, Malaysia
DSMP	:	Department of Survey and Mapping, Perak
DWNP	:	Department of Wildlife and National Parks
EPU	:	Economic Planning Unit
ESRI	:	Environmental System Research Institute
EXCO	:	State Executive Council
FAMA	:	Federal Agricultural and Marketing Authority
FD	:	Forest Department
FDPM	:	Forest Department of Peninsular Malaysia
JICA	:	Japan International Cooperation Agency
JPLH	:	Pepper Marketing Board
LAP	:	Lembaga Air Perak (PWB: Perak Water Board)
LGD	:	Local Government Department
LKIM	:	Fisheries Development Authority of Malaysia
LPP	:	Farmers Organization Authority
MD	:	Marine Department
MIMOS	:	Malaysian Institute of Microelectronics
MMS	:	Malaysia Meteorological Service
MOA	:	Ministry of Agriculture
NCDP	:	National Committee on Database Processing
NIC	:	Network Information Center (under Ministry of Agriculture)
NITC	:	National Information Technology Council
NLDC	:	National Load Dispatch Center (under TNB)
NOC	:	Network Operation Center (under Ministry of Agriculture)
NRSC	:	National Remote Sensing Committee
PWB	:	Perak Water Board
PWD	:	Public Works Department
SEDC	:	State Economic Development Corporation
SEPC	:	State Economic Planning Committee
SEPU	:	State Economic Planning Unit
SPC	:	State Planning Committee
TCPD	:	Town and Country Planning Department Peninsular Malaysia
TNB	:	Tenaga Nasional Berhad (National Power Limited)
WMO	:	World Meteorological Organization

TECHNICAL TERMS FOR INFORMATION SYSTEM

ASCII	:	American Standard Code for Information Interchange
ATM	:	Asynchronous Transfer Mode
AVR	:	Automatic Voltage Regulator
C/S	:	Client-Server System

CAD	:	Computer Aided Design/Drafting
CD-R	:	Compact Disc Recordable
CD-ROM	:	Compact Disc Read Only Memory
CPU	:	Central Processing Unit
DB	:	Database
DDS/DAT	:	Digital Data Storage/Digital Audio Tape
DXF	:	Drawing Exchange Format (Drawing Interchange File)
EDP	:	Electronic Data Processing
FD	:	Floppy Disk
FEP	:	Front End Processor
FFW	:	Flood Forecasting and Warning
FSL	:	Full Supply Level
FTP	:	File Transfer Protocol
GIS	:	Geographic Information System
GUI	:	Graphic User Interface
HD	:	Hard Disk
HIS	:	Hydrological Information System
HTML	:	Hypertext Markup Language
IMS	:	Internet Map Server
INFOMIS	:	Integrated Forest Management Information System
IP	:	Internet Protocol
IPS	:	Image Processing System
ISDN	:	Integrated Services Digital Network
IT	:	Information Technology
ITV	:	Industrial Television
JARING	:	Joint Advanced Research Integrated Networking
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
MESAT	:	Malaysia East Asia Satellite
MIS	:	Management Information System
MSL	:	Minimum Supply Level
NaLIS	:	National Infrastructure For Land Information System
NFIS	:	National Forestry Information System
OCR	:	Optical Character Reader
O/M	:	Operation and Maintenace
OS	:	Operating System
RSO	:	Rectified Skew Orthomorphic
PA-RISC	:	Precision Architecture-Reduced Instruction Set Computing
PC	:	Personal Computer
PCI	:	Peripheral Component Interconnect
PFIA	:	Probable Flood Inundation Area
PIT	:	Portable Information Terminal
PSTN	:	Public Switched Telephone Network
RAM	:	Random Access Memory
RAS	:	Remote Access Server
RDBMS	:	Relational Database Management System
RS	:	Remote Sensing
SCSI	:	Small Computer System Interface
SMTP	:	Simple Mail Transfer Protocol
TCP/IP	:	Transmission Control Protocol/Internet Protocol
TIDEDA	:	Computer Program for Processing Time-Dependent Data
TIN	:	Triangulated Irregular Network
TM	:	Telemetry
UPS	:	Uniterruptible Power Supply
URL	:	Uniform Resource Locator

USLE	:	Universal Soil Loss Equation
VC	:	Virtual Channel
VP	:	Virtual Path
WAN	:	Wide Area Network
WWW	:	World Wide Web

WATER QUALITY TEST/ELEMENTS

Al	:	Aluminum	N	:	Nitrogen
As	:	Arsenic	Na	:	Sodium
BOD	:	Biological Oxygen Demand	NH3-N	:	Ammonical Nitrogen
Ca	:	Calcium	NO3-N	:	Nitrate
Cd	:	Cadmium	P	:	Phosphorous

WATER QUALITY TEST/ELEMENTS (CONTINUETION)

Cl	:	Chloride	Pb	:	Lead
CN	:	Cyanide	PCB	:	Polychlorinated Biphenyl
COD	:	Chemical Oxygen Demand	Po4-P	:	Phosphate as Phosphorous
Cu	:	Copper	Ra	:	Radium
DO	:	Dissolved Oxygen	S	:	Sulphide
F	:	Fluoride	Sr	:	Strontium
Fe	:	Iron	SS	:	Suspended Solids
Hg	:	Mercury	T-Cr	:	Total Chromium
K	:	Potassium	T-P	:	Total Phosphorus
MBAS	:	Methylene Blue Active Substance	TN	:	Total Nitrogen
Mg	:	Magnesium	WQI	:	Water Quality Index
Mn	:	Manganese			

UNITS OF MEASUREMENT

(Area)			*(Other Measurements)*		
Ha, ha	:	Hectare	Cu., cu.	:	cubic
m^2	:	square meter	cusec	:	cubic feet per second
km^2	:	square kilometer	m3/s	:	cubic meter per second
			dia.	:	diameter
(Weight)			DPI	:	dot per inch
Kg, kg	:	Kilogram	GB	:	gigabyte
ton	:	1,000 kg	Kbps	:	kilo bit per second
			KB	:	kilo byte
(Volume)			Km, km	:	kilometer
GRT	:	Gross Relative Tonnage	Mbps	:	megabit per second
L, l, ltr	:	Liter	sec, s		second
m^3	:	cubic meter	Sq., sq.		square
MCM		million cubic meters			
(Electric)					
MHz	:	Megahertz	H	:	hertz
VA	:	volt ampere	kW	:	kilowatt
W	:	Watt	V		volt, voltage

MALAYSIAN TERMS

Jl.	:	jalan (road)
Kg.	:	kampong (village)
P., Pulau	:	island
Mk.	:	Mukim

CURRENCY

RM	:	Malaysian Ringgit
US$		United States Dollar
¥	:	Japanese Yen
Sg.	:	sungai (river)

OTHERS

EIRR	:	Economic Internal Rate of Return
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
GRDP	:	Gross Regional Domestic Products
LSD	:	Land and Survey Datum
MP	:	Malaysia Plan
OJT	:	On-the-Job Training
RBIS	:	Rver Basin Information System
RSO	:	Rectified Skewed Orthomorphic
VJR	:	Virgin Jungle Reserve

1. INTRODUCTION

Recent developments in land use have been increasing flood damage potential in low-lying areas along rivers. River water resources also could not meet the rapid increment and diversification of water demand, and water shortage is spreading throughout Malaysia. Moreover, riverbed erosion and/or sedimentation are leading to the deterioration of river environment. In addition to these problems, the value of riverside space (waterfront) as an amenity, as well as the conservation of river environment is going to be a major public concern because development nearby rivers has been going on especially at urban centers.

The ongoing dynamic changes on the value of rivers require a comprehensive and consistent river basin management to realize a well-balanced river development and environmental improvement. The execution of such river basin management is, however, extremely difficult due to lack of an integrated and systematic information system to coordinate the voluminous river basin information at present. In due consideration of the circumstances, "The Study on the Establishment of the River Basin Information System in Malaysia" (hereinafter referred to as "the Study") was conducted by the Japan International Cooperation Agency (JICA) for a period of about 18 months from March 1997 to December 1998.

The Study aims at establishing the river basin information system (RBIS) for the Perak river basin in Perak State. The major objectives of the Study are as given below.

(1) Master Plan Study: To clarify the major issues on the present river basin management in Perak river basin, and to formulate a long-term strategic plan for the river basin information system.

(2) Feasibility Study: To prepare the detailed plan and specifications of a pilot river basin information system (called the "Operational system").

(3) Development of Operational System: To develop the Operational System within the study period, to effect the transfer of knowledge on system management and the immediate information service.

(4) Transfer of Knowledge: To effect the transfer of technical knowledge on river basin information including the aforesaid knowledge on management of the Operational System.

2. PRESENT FEATURES OF THE PERAK RIVER BASIN

As stated above, the study area is the Perak river basin, which is located in Perak State and with a catchment area of about 14,700 km^2 covering about 70% of the State. The Perak River originates from the northern mountain range of more than EL. 4,000 feet (about 1,200 m), running southward and finally flowing into the Strait of Malacca (refer to Fig. 2-1). The major tributaries of the river are the Pelus, Kinta and Bidor rivers. Among these tributaries, the Kinta River flows down through Ipoh, the state capital.

The river basin has the annual rainfall of about 2,300 mm which is higher than the river basins in the southwest coast (less than 2,000 mm) but lower than those in the north-east coast (more than 2,500 mm). The dominant rainy season occurs during the inter-transitional monsoon seasons, from April to May and from October to November. The maximum monthly rainfall in a year usually occurs from October to November.

The river has a very gentle slope of less than 1/5,000 in the downstream from the river mouth up to about 250 km upstream. Due to such long gentle river channel, the river tends to accumulate excessive sediment leading to the shallow riverbed. The sediment deposits in the river have also been aggravated by the logging activities in the upper reaches and the previous large sand volume dumped from tin mining sites in the basin. The current logging activities have also produced a conspicuous value of Suspended Solids (SS) which leads to the turbidity of the river. DOE as well as the Perak Water Board (PWB) points out that turbidity of the Perak river water is serious, causing difficulties in treating the water for domestic and industrial water supply.

Forest land spreads out in the upper reaches covering 60% of the basin, while agricultural lands are developed on the alluvium plain in the middle and lower reaches covering 30% (refer to Table 2-1and Fig. 2-2). One of the particular characteristics of the Perak river basin is given to the settlement area taking about 6% of the whole catchment area, the second highest rate in Malaysia following the Klang river basin.

The total basin population as of 1996 was estimated at about 1,162,000 and tends to concentrate in the Kinta river basin and the lower reaches of the Perak River. The state capital, Ipoh City, has the second largest urban population of about 469 thousand, next to Kuala Lumpur.

3. MAJOR ISSUES ON PRESENT RIVER BASIN MANAGEMENT

Various agencies are related to river gauging and/or monitoring works in the Perak river basin. Among others, the Department of Irrigation and Drainage (DID) and the Department of Environment (DOE) are the leading agencies on gauging and control of river discharge and river water quality, respectively. However, there seldom exists a unified monitoring point for both river flow discharge and river water quality made by the DID and DOE. As a result, a consistent river gauging data is hardly obtained.

The Tenaga Nasional Berhad (TNB) also controls the four (4) hydropower dams in the upper reaches of Perak River. The dams seriously affect the downstream river flow regime, but information on dam operating conditions by TNB and the information on river flow discharge monitored by DID are seldom exchanged. As a result, full coordination between TNB and DID is hardly made, which affects the consistent flood control as well as drought management.

Moreover, the DID and the Perak Water Board (PWB) manage the irrigation water supply and the domestic/industrial water supply in the Perak river basin, respectively. The information on water supply is, however, not mutually exchanged between them and, therefore, the overall water intake volume from the river is not known. Such conditions cause difficulties in rationally judging the applicability of the projected intake volume taking account of the finite water resources of the river.

In addition to the above agencies in charge of river works, various agencies also undertake basin land conservation and/or development works. Information on basin land development is, however, hardly given to the competent agencies for the river gauging and/or monitoring works. As a result, difficulties arise in clarifying the relationship between the river gauging data such as river flow discharge and river water quality and the basin land development conditions.

Most of the agencies related to river basin management control the basic information at the Federal level, while the actual river maintenance and/or management works are in principle executed at the State level based on the information given from the Federal government. Such centralized information system causes several inconveniences, in particular, the delay of information given to the State governments.

4. INVENTORY OF PRESENTLY AVAILABLE INFORMATION ON RIVER BASIN MANAGEMENT

The availability of existing major information on river basin management for the Perak River is as described below.

4.1 River Basin Gauging Information

There are 67 rainfall gauging stations and 14 stream gauging stations in the Perak river basin. The gauging works are undertaken by several agencies such as DID, TNB, Malaysian Meteorological Service (MMS) and PWB. Among them, DID manages most of the gauging stations, that is, 62 rainfall gauging stations and 12 stream gauging stations (refer to Figs. 4-1 and 4-2). The Hydrology Division of DID have also established a database system to store the gauged data at the Federal level. In spite of the database system, however, the existing gauging/monitoring stations, particularly, the rainfall gauging stations are not adequately distributed in the river basin due to the difficult accessibility and/or shortage of manpower for operation and maintenance of the gauging equipment.

DOE also monitors the river water quality at 52 water sampling points (refer to Fig.4-3). The monitoring items include human life items (such as pH, DO, BOD5, COD, SS, NH3-N) as well as human health items (such as heavy metals, coliform, cyanide, phenols, and pesticides) which are essential indices to clarify the river water quality and execute pollutant control.

The Federal DOE performs a series of monitoring works (water sampling, laboratory test and storing of water quality data). It also performs digitizing works on all water quality data. The current water sampling points as well as water quality items monitored are deemed to be adequate. The particular problem in the monitoring of water quality is the delay of transmission of information from the Federal DOE to the State DOE.

4.2 Information on Field Survey

Major information required for river basin management are the results of river channel survey, flood damage survey, and survey on fauna and flora in the river. The DID is the main competent authority for the river channel survey. However, no periodical river channel survey for a substantial part of the river has been carried out since the 1970s. Moreover, many of the channels survey results before 1970s have been scattered and lost. The DID currently carries out only spot cross-sectional surveys at the river discharge gauging points.

The State DID also carry out flood damage survey after the occurrence of every major flood. The results of flood damage survey are compiled as an annual flood damage report and submitted to Federal DID. The annual flood damage reports since 1950s have accumulated to a massive volume, and are very useful to know the actual flood conditions and facilitate the future flood mitigation works. Many of the reports are, however, scattered and lost at both Federal and State levels due to shortage of staff to well arrange such extensive collection of reports and difficulties in filing the reports which contain various sizes of drawings.

The Department of Wildlife and National Parks is in charge of the survey of fauna and flora in the river, dispatching survey teams to clarify the gender, size, location and habitat of fauna and flora. The Federal Department stores the results of surveys and, the database system to digitize the results of survey is being developed by the Department.

4.3 Information on River Management

There are various information concerning river management. The major items are as given below.

(1) Information on Flood Management

The State DID and the tin mining companies have carried out and proposed various structural measures for flood mitigation including channel improvement, construction of perimeter bund, and flood diversion channel, as listed in Tables 4-1 to 4-2 and Fig. 4-4. The detailed information on these structural measures are currently kept by the DID district offices, and integration of such information is indispensable in order to figure out the entire flood mitigation works in the basin and to formulate the consistent and optimum flood control plan.

(2) Information on Water Supply

There are eleven (11) water intake facilities for irrigation and thirty-two (32) intake facilities for domestic and industrial water along the main stream of Perak River. These intake facilities fulfill the water the detailed structural features of these intake facilities as well as their objective supply is separately kept by DID for irrigation and PWB for domestic and industrial water supply.

(3) Information on Ecotourism

Yayasan Perak organizes ecotourism in Perak River, furnishing information on the attractions (refer to Figs. 4-7 to 4-9). The local authority also manages the riverside parks. Information such as those related to river environment are useful to facilitate public awareness on the river and regarded as one of the important information for the proposed river basin information system.

(4) Information on Bridges

There are twelve (12) trunk bridges crossing over the Perak River and its tributaries (refer to Fig. 4-10). The bridges are ten (10) federal bridges, one (1) highway bridge and one (1) state bridge. The information on the structural features of these bridges are, however, separately stored by the Federal Government, the Plus (the privatized firm controlling the highway), and the State Government. Thus, no integrated information source on the bridge structures is available, causing difficulties in obtaining overall information on the river basin.

(5) Information on River Sand Mining

There are 36 sand mining sites along the Perak River between the Kenering Dam and the river mouth (refer to Fig. 4-11). The Department of Land and Mining issues annual licenses for sand mining. The mining records are, however, dispersed in its district offices.

4.4 Basin Land Information

The following maps have been identified as the present available basin land information which could be useful for the watershed management in particular:

Items	Major Objectives to Clarify
(1) Land Use Map	The present land use conditions in the entire river basin
(2) Forest Conservation Map	The non-logging and logging areas in the upper reaches
(3) Soil Map	Soil conditions in the basin including conditions of soil erosion and production of basin sediment runoff
(4) Topographic Map	Topographic conditions in the basin
(5) Cadastral Map	Landowner and detailed classification of land use
(6) Structural Plan	Urban and industrial development plan particularly in the flood prone area

The above map information are availed of by ten (10) government agencies, and most of the agencies have developed or are going to develop their digital maps supported by the Geographical Information System (GIS) for their particular purposes (refer to Table 4-3).

5. EXISTING RELEVANT INFORMATION SYSTEM

5.1 Data Processing System

A majority of the related government agencies apply the Geographic Information System (GIS) for database management and the UNIX system as the operation system (refer to Table 5-1). The main software for GIS is the Arc/Info that requires, in general, a huge memory capacity of the processing machine and, therefore, usually runs through the client-server system. To minimize the required memory for the GIS processing, the application program Arc/View is also used by several agencies of the government. Since Arc/View and Arc/Info were developed by the same manufacturer and are compatible with each other, the DID Hydrology Division, DOE and the Forest Department apply Arc/Info on the UNIX machine (client-server system) and the Arc/View on personal computers.

All information in the existing systems other than the system of the Fishery Department are transferred within the extent of Local Area Network (LAN), providing the information only to in-house users. Thus, most of the existing systems do not apply a Wide Area Network (WAN) using the Intranet and/or the Internet.

5.2 Data Transmission System

Telekom Malaysia, the biggest telecommunication company in Malaysia, aims to establish an effective and comprehensive optical fiber network linking Peninsular Malaysia, Sabah and Sarawak. The Malaysian East Asia Satellite (MEASAT-1) was also launched in January 1996 as the first stationary telecommunications satellite of Malaysia. The purpose of the satellite is to realize sophisticated telecommunications services such as satellite TV and multimedia data transmission. In addition to the MESAT-1, launching of other eight (8) satellites are scheduled.

In parallel with the expansion of telecommunication infrastructure, the first government wide area network called AGROLINK was established by the Ministry of Agriculture (MOA) and started operation in 1995 (refer to Fig. 5-1). At present the optical fiber cable under AGROLINK links all departments of MOA located in Kuala Lumpur and the State of Penang.

6. MASTER PLAN OF RIVER BASIN INFORMATION SYSTEM

The long-term development plan for the river basin information system (RBIS) has been formulated in this study. The plan includes the objective information of the RBIS, system configuration, the project cost, project implementation schedule and project evaluation.

6.1 Objective Information

The proposed information source for the system covers 21 items that extend over the following five categories: (1) river basin gauging and monitoring information; (2) information on river works; (3) information on field survey; (4) basin land information; and, (5) basin census information (refer to Table 6-1). Field visual information, rainfall information by radar gauge, and water quality by automatic sensors are currently not available in Malaysia, but in view of the technologies being developed, those information are proposed as part of the proposed information sources to effect the river basin management, particularly, emergency disaster management.

The above information will be processed and formed into the objective information to be disseminated. The information proposed to be disseminated covers seventy (70) items classified under five (5) categories (refer to Table 6-2); namely, (1) general information such as features of river basin and hydrological information; (2) information related to flood management; (3) information related to water supply and water resources management; (4) information related to environmental management; and, (5) information related to watershed management.

All information should be open in principle to the public so that public users could understand and cooperate with the ongoing and project river management works and/or river construction works. However, some information need to be confidential due to regulation/law and the necessity of national security and copyrighting. Moreover, some information may cause confusion to public users or lead the public users to unfavorable land speculation. Such information should be used exclusively by the government agencies.

In line with the above criteria, the information is disseminated in two levels of use: Level 1 for the exclusive use of government agencies, and Level 2, which is open to public users. Out of the 70 items of information to be disseminated, 13 items are proposed for Level 1 and the other 57 items for Level 2. The items classified under Level 1 include the topographic maps, the possible flood inundation areas, the logging activities and the structural plans in the basin.

6.2 System Network

The optimum system network plan is proposed as shown in Fig. 6-1 after a comparative study on various alternative plans. In the optimum plan, the processing devices for non-real-time information (i.e., database server machines) are placed at the Federal level, while the processing devices for real-time information are at the State level.

Statistical data and other non-real-time information are input at both the state and federal levels, and all of them are collectively transmitted to and processed at the Federal level. On the other hand, all real-time information (i.e., field gauging and monitoring data) are collected and processed at the state level and then transmitted to the Federal level. Thus, both non-real time and real time information are finally centralized at the Federal level. The government users could access to the information at the Federal level through the exclusive communication network, while the public users could access them through the public telephone network.

The system network plan is oriented to the centralized management at the Federal level to facilitate the future nationwide expansion of the system without dynamic change of system configuration. The effectiveness of the system also can be identified in easy and quick accessibility to the database. On the other hand, the data transmission and access speed largely depends on the network data transfer capability. In this context, the optical fiber system, which is being developed throughout Malaysia, is highlighted to promise the required data transfer capacity.

6.3 System Devices

The system devices are proposed as mentioned in the following Subsections in due consideration of the current and potential technological development so as to set up the long-term target of the objective river basin information system in Malaysia (refer to Table 6-3).

6.3.1 Proposed Gauging and Monitoring Device

The gauging items for the proposed system include rainfall, water stage and discharge, river suspended sediment, and water quality. In addition to the gauging items, monitoring facilities for the actual visual and audible field conditions are also proposed.

(1) Rainfall Gauge

The proposed devices consist of the eight (8) existing telemetry point rainfall gauges/stations and one (1) newly proposed radar rainfall gauge. The radar rainfall gauge is placed at the top of Mt. Soh which has an elevation of 1,324 feet, having the effective gauging range of about 120 km in radius (refer to Fig. 6-2). The proposed radar rainfall gauge could cover the entire watershed of the Perak river basin. The existing telemetry rainfall gauging stations are to gauge point rainfall and calibrate the estimated rainfall by radar.

(2) Gauge of River Stage, River Discharge and River Suspended Loads

The following are proposed as the telemetry gauging stations. The total number of gauging stations is sixteen (16) which consist of thirteen (13) existing gauging stations and three (3) newly proposed gauging stations (refer to Fig. 6-3).

Class	Gauging Objects	Location
Principal Gauging Station	River Stage, Discharge, Suspended Load and Water Quality	Existing three (3) principal stations of DID and the additional two (2) stations downstream of major intake points
Secondary Gauging Station	River Stage, Discharge and Suspended Sediment	Existing seven (7) secondary gauging stations of DID for the suspended sediment
Tertiary Gauging Station	River Stage and Discharge	Existing three (3) secondary gauging stations of DID other than above
Tidal Gauging Station	River Stage	One (1) gauging station newly proposed at river mouth

(3) Water Quality Gauge

The proposed river basin information system takes all water quality data gauged by DOE at the existing 52 sampling points. In addition, automatic telemetry gauging stations are newly proposed at the five (5) principal gauging stations for river discharge. The objectives of the automatic telemetry gauging are water temperature, electrical conductivity, dissolved oxygen, pH, and turbidity.

(4) Monitoring on Field Visual Information

The industrial television (ITV) is proposed at ten (10) spots in the river basin to monitor the dynamic visual and audible scenes of the remote field, particularly, the flood conditions or the unfavorable activities along the river. The ITV system consists of a television camera installed at the field sites and optical fiber cable to

connect between the television camera and the remote office. One (1) set of portable information terminal (PIT) is also proposed to transmit digital data and images of the field scenes through the public telephone lines from the field to the offices. The PIT could provide only the static scenes of the field but not the dynamic scenes unlike the aforesaid ITV; however, the cost of PIT is much cheaper than ITV and the PIT could take the field data at flexible points.

6.3.2 Data Input and Processing Device of Non-Real Time Information

The following devices are proposed for the RBIS:

(1) Data Input Device

The RBIS will input non-real time data such as maps/drawings and attribute data (alphabetical and/or numeric data). In view of the viability of updated technologies, the following hardware and software are proposed as input devices of the objective river basin information system:

(a) Scanner supported by the software of raster/vector transformation as the input device for map and drawing information; and

(b) Optical Character Reader (OCR) for input of alphabetical and numeric data.

(2) Data Processing Devices

The client/server system (C/S) is applied for the processing of non-real time information. The software for processing is the Geographic Information System (GIS) running on the UNIX as the server machine. Ten (10) server machines are proposed to perform the exclusive task for each of the river management works and to control the traffic of data supplied from the servers and the Internet information. Two (2) computers and one (1) telemetry data server (UNIX machine) are further proposed. The computers are proposed to analyze and process the gauged radar rainfall and water quality, while the telemetry data server is for the following purposes:

(a) To convert the telemetry river stage data to river discharge;

(b) To process the visual information monitored by ITV and/or PIT; and

(c) To distinguish the radar rainfall gauging data and/or the automatic water quality rainfall data and transmit them to the exclusive computer machine for radar gauge analysis and/or water quality analysis.

6.3.3 Data Dissemination Device

The dissemination devices are proposed according to different types of users, as below.

(1) Display Device in System Operation Rooms

All real-time and non-real time information is accessed through the client machine placed at the system operation room. In addition, the audio machine is proposed to display the visual and sound information of the fields on a large screen. The proposed audio machine consists of projector, display, recorder and audio control server.

(2) Dissemination to Related Government Agencies

All real-time information as well as non-real time information is transmitted through the Internet to the personal computers at the government offices. The exclusive optical fiber network is used for the data transmission. The government agencies could also obtain the non-real information stored in CD-ROM.

(3) Dissemination to Public Users

The on-line dissemination is made through the Internet using the public telephone lines. The Web server will control some of the information that is not open to public users. The public users can also obtain information through CD-ROM, but confidential information not suitable for public users are not stored in CD-ROM.

6.3.4 Data Transmission Device

Among various devices, the optical fiber line is selected as the optimum trunk line of data transmission in view of the following reasons:

(1) Among the transmission facilities, the optical fiber line promises the best quality and reliability of transmitted data;

(2) The optical fiber line is indispensable to transmit dynamic visual information; and

(3) As proposed in Telecommunication Vision 2020, the optical fiber network is going to cover the whole country of Malaysia by the year of 2020.

The optical fiber line is a ground cable line; therefore, it has the possibility to be cut off. To cope with such failure of the trunk line, the satellite communication line is proposed as the back-up transmission device. In addition to the optical fiber line and the satellite communication line applied as trunk communication lines, the telemetry radio line and/or the public telephone line are also applied as the branch communication lines. The telemetry radio line is to transmit the real-time gauging data to the server machines, while the public telephone line is for data dissemination using the Internet.

6.4 Project Cost

The initial investment cost and the annual operation and maintenance cost of the system is estimated, based on 1997 price levels, at about RM 19.6 million and RM 4.00 million/year, respectively. The initial investment cost covers the procurement and installation of system devices as listed in Table 6-4. As for the annual operation and maintenance cost, the following items are included: (a) maintenance of equipment and purchase of spare parts, (b) manpower for system operation, and (c) lease of the data transmission system. Among the items, the manpower for system operation is as estimated below:

Designation	Number of Staff	Required Activity
River Engineer	2	To clarify the contents of the river basin information.
Network Manager	1	To manage the data transmission in the proposed system.
Database Manager	2	To manage the database servers.
Digitizer Operator	1	To manage the digitizing work.

6.5 Project Implementation Schedule

The implementation schedule for development of the RBIS is as shown in Fig. 6-4. In the implementation schedule, installation of the fundamental devices for the RBIS is scheduled within the 8th Malaysia Plan. The fundamental devices include the hydrological gauging system, the data processing system and the data transmission system. A series of devices established under the 8th Malaysia Plan would promise the full operational condition of the entire system. After the devices in the 8th Malaysia Plan, the following futuristic systems are scheduled in the 9th to 11th Malaysia Plans in due consideration of their particular features.

(1) Automatic water quality gauging system	9th Malaysia Plan
(2) Radar rainfall gauging system	10th Malaysia Plan
(3) ITV and satellite communication system	11th Malaysia Plan

6.6 Project Evaluation

6.6.1 Qualitative Improvements by the RBIS

The proposed information system will facilitate easy and quick access to more consistent and comprehensive river basin information reducing the time and manpower for the river basin management. At the same time, the system will improve the quality of information and enable the river administrator to have more sound engineering justifications on river development works (refer to Table 6-5). The system will also expand the users of the information including the government and non-government users so as to obtain better and common understanding as well as cooperation for the river basin management.

6.6.2 Economic Benefit of the RBIS

The RBIS will disseminate the telemetry hydrological gauging information on real-time base and further database information. Such real-time information as well as database information could be availed for various river basin management works bearing the economic benefit as enumerated below.

(1) Economic Benefit in Water Supply Management

As described in Section 9.1, the water deficit in the Perak river basin may possibly occur, as experienced in 1990, with a recurrence probability of 5-year return period. This water deficit is attributed to lack of integrated hydrological monitoring system between DID and TNB. The RBIS will release the real-time information on river discharge at the downstream from the hydropower dams so that TNB could have more flexible reservoir operation of the existing hydropower dams based on the information and solve the probable water deficit with minimal reduction of power reduction.

The water deficit causes reduction of irrigation water supply leading to reduction of paddy production. The annual average value of the production loss is estimated at RM 0.34 million/year that could be regarded as the annual average economic benefit of RBIS (refer to Subsection 9.1.2).

(2) Economic Benefit in Flood Mitigation

Among the existing hydropower dams, the Kenering and Chenderoh dams currently have no flood mitigation effect to the lower reaches from the dams. However, the hydrological information (storm rainfall and flood river flow discharge) by the RBIS could be available for the reservoir operation of the two dams for flood mitigation without adverse effect to power generation.

The detailed study on the potential flood mitigation effect by the Kenering and Chenderoh dams are made in Section 9.2.2. According to the results of the study, the annual flood damage value is estimated at RM 2.6 million/year under the present reservoir operation of the Kenering and Chenderoh dams. On the other hand, the value is reduced to RM 2.0 million/year when RBIS starts to provide the real-time information and the Kenering and Chenderoh dams effect flood mitigation in the lower reaches. The reduction of RM 0.6 million/year is regarded as an annual average economic benefit of the RBIS.

(3) Economic Benefit of Database Information

The database information from the RBIS could facilitate the reduction of time and, particularly, manpower for the study and/or formulation of river development plans. The annual expenditures for river development plans in 1991 to 1997 was estimated, referring to the State DID Annual Reports, as shown in Table 6-6. Then, the proposed system is assumed to save about one-third of the actual expenditure in 1997 equivalent to the average amount currently spent for access and collection of basic information for the river development plans. This assumption is made according to the interview survey from State DID and the experience of the Study Team. As the result, the current possible reduction of expenditure as of 1997 is estimated at about RM 0.5 million/year, which could be regarded as the economic benefit by the RBIS.

The national expenditure for river management has remarkably increased at the rate of 13.8% per year for the recent 30 years. In line with such increment of national expenditure, the expenditure for the river development plans for Perak River will certainly increase, leading to the increment of the above economic benefit by the RBIS. From these points of view, the annual benefit as of 1997 is assumed to increase in the future at the rate of 13.8% per year until the year 2020 which is set as the target year of the long-term national development plan in Malaysia.

6.6.3 Economic Rate of Return of the Project

The economic evaluation for the project was made based on the economic internal rate of return (EIRR), using the annual flow of economic benefit and cost (refer to Table 6-7). In the annual flow, the economic cost was assumed to be 90% (the conversion factor) of the project financial cost. The project period is also assumed to be 10 years after completion of the project, taking into account the durability of system devices.

As a result, the EIRR for the proposed project is estimated at 10.8% and judged to be within the applicable opportunity cost (10 to 12%). Thus, the EIRR shows that the proposed project is economically justifiable. Moreover, the EIRR is subject to the economic cost estimated from the current market price of system devices. However, the current price, in particular, the price of computers will certainly go down in the future due to the expansion of users and the technology improvement and, therefore, the potential EIRR for the project will be higher than the estimated value of 10.8%.

7. FEASIBILITY STUDY AND DEVELOPMENT OF THE OPERATIONAL SYSTEM

The RBIS discussed in Chapter 6 is proposed as the long-term plan, and virtually difficult to be established immediately. However, the present dynamic basin land development requires the early service of an integrated river basin information to support a consistent and comprehensive river basin management. To make up for such shortcomings, a development plan of a pilot system (hereinafter referred to as "the Operational System") was formulated and, based on the plan, the actual system development has been performed within this study period. The system's initial operation was further made during the study period in order to effect the transfer of technical knowledge on system operation and maintenance.

7.1 Objective Information

The Operational System will collect all objective information proposed in the Master Plan other than the following items that are still not made practicable in Malaysia: automatic water quality gauging information, radar rainfall gauging information and dynamic visual information. Thus, the objective information for the Operational System are already available in Malaysia and, at the same time, urgently and essentially required for the river basin management in the Perak river basin.

The above information are processed and disseminated in either the map form, tabular form or graphic form. The details of the objective information are as listed in Table 7-1, including the name of information, renewal interval, and the agency as data source. As shown in Table 7-1, all objective information are classified into two dissemination levels according to the assumed users; i.e., Level 1 for the exclusive use of the government agencies, and Level 2 for the public users. The principal criteria for the classification are the same as those in the Master Plan (refer to Section 6.1). However, some information specified as Level 2 in Master Plan were provisionally shifted to Level 1 information for the initial operation of the Operational System through a series of consultation with the Government of Malaysia. The following are the major items shifted to Level 1 and the major reasons why such provisional shifting was made:

(1) In the Master Plan it is proposed that all hydrological database will be open to the public so as to promote more active research on river hydrology. However, a substantial part of hydrological information are originally from the existing database by the DID Hydrology Division, and use of information is currently charged by the Division. Under such conditions, the hydrological database is provisionally dealt with as the information for exclusive use of the government agencies.

(2) In the Master Plan, the real-time hydrological gauging information is also proposed to be open to the public so as to facilitate the evacuation from flood. However, the State DID, the competent agency for the real-time hydrological gauging, revealed possible errors in gauging results, and requires time to improve the accuracy of gauging data. Due to these conditions, the information was provisionally dealt with as the information for exclusive use of the government agencies.

(3) Some of the information on flood management assumed as Level 2 information in the Master Plan are reclassified into Level 1 Information due to uncertainty of their contents. The information classified into Level 1 are the location map and the inventory of projected flood mitigation scheme, results of river channel survey, and extent of flood inundation area.

The Operational System will disseminate both the real-time and non-real time information (i.e., database information). The real-time information contain the hydrological data (rainfall, river water stage and river discharge) transmitted from the existing telemetry gauging stations. As for the non-real time information, it was decided though a series of consultation with the Government of Malaysia that the Operational System will disseminate

the objective information through the following seven (7) categories according to the purposes of the river basin management:

(1) General Information presenting the basin natural conditions and socio-economic conditions to provide the general features of Perak river basin.

(2) Hydrological Information covering the database on all hydrological gauging data (rainfall, river water stage, river discharge, suspended discharge and tidal data), the meteorological information (temperature, relative humidity, sunshine and evaporation).

(3) Information on River Structures presenting detailed structural features and location of bridges, river intake facilities and dams.

(4) Information on Flood Mitigation presenting the flood conditions as well as the existing and proposed flood mitigation facilities to support the flood management works.

(5) Information on Water Supply Management presenting water intake facilities as well as statistics on comprehensive water demand to support the water supply management;

(6) Information of River Environmental Management presenting the water quality/water pollutant source, fauna and flora in the river basin, ecotourism on Perak River and river sand mining to support river environmental management.

(7) Information on Watershed Management including information on urban and industrial development states, the logging activities and the land use states in the river basin to provide the basic information for watershed management.

7.2 System Network

The network plan for the Operational System is oriented to the centralized management at the Federal level as proposed in the Master Plan. That is, both database information and real time information are collected to and disseminated from the Federal level. To realize such a centralized system, the network is made through the following four (4) sub-nets (refer to Fig. 7-1):

(1) State DID Sub-Net

This sub-net covers the existing telemetry gauging network operated by State DID. All real-time hydrological gauging information is collected to this sub-net, and finally transmitted to the Federal DID sub-net mentioned below.

(2) ISDN Sub-net

The Government of Malaysia had leased a dedicated ISDN line of 64 Kbps from Telekom Malaysia to transmit the above hydrological gauging information on real-time base from State DID to Federal DID. That is, the State DID in Ipoh transmits the information through the ISDN line to the existing access point of the Agrolink in Kuala Lumpur mentioned below and, finally, to Federal DID.

(3) Agrolink Sub-net

This existing network links all departments of MOA located in Kuala Lumpur including the Federal DID. The IP address for the Operational System is allocated inside Agrolink, and the Agrolink Domain Server manages all information received in and dispatched from the Operational System. The Agrolink Domain Server also manages the global network to open the information from the Web Server in the Federal Sub-net through the Internet. Thus, Agrolink facilitates the traffic control of all information into and from the Federal Sub-net. The users can access the Web Homepage of the Operational System through Internet by the URL address "gis.moa.my."

(4) Federal DID Sub-net

The information center of the Operational System is placed at Federal DID in Kuala Lumpur. All system server machines are placed in this Federal DID Sub-net, and both real-time and non real-time information are finally collected, processed and disseminated from the Federal DID Sub-net.

7.3 System Hardware

Different hardware comprises the Operational System, as described below.

7.3.1 Gauging Device

The Operational System covers the hydrological gauging data and water quality gauging data. Moreover, the hydrological gauging data includes real-time and non-real-time data. The water quality data for the Operational System is given from the databank controlled by DOE, which covers 52 monitoring points (refer to Section 4.1).

As for the real-time hydrological information, the Operational System applies the existing telemetry gauging network managed by State DID of Perak (refer to Fig. 7-2). The Operational System also imports the hydrological database (i.e., non-real-time information) from the existing "Hydrological Data Bank System" at the Hydrology Division of Federal DID in Kuala Lumpur. The source of the hydrological database is the existing non-telemetry gauging network (refer to Fig. 7-4).

7.3.2 Data Processing Device

The Operational System is equipped with different hardware as described below, and all of them have been installed at either the Federal DID office in Kuala Lumpur or the State DID office of Perak in Ipoh. The inventory of all hardware in the Operational System is as shown in Table 7-2.

(1) Router

The router is the important device to link the sub-nets under the Operational System. In the System, two (2) routers were newly installed at State DID in Ipoh and the Agrolink Control Center in Kuala Lumpur. Both routers check the IP address and ISDN number of external access and ignore illegal packets. The routers also check all packets dispatched from the Operational System to external sub-net, and reject them, unless they are the static routing packets transmitted between the two routers.

(2) Workstation

The Operational System has two (2) units of UNIX workstations (HP-UX) placed at the Federal DID sub-net. The first unit is called "GIS Server" which processes non-real time information such as geological and texture database information and disseminates them through the Internet and/or Intranet. The other is the "TM Server"

to receive real-time information transmitted from State DID and disseminate them to the Internet and/or Intranet.

Each of the workstations has a total hard disk capacity of 9 GB, which is divided into several partitions and, out of the total disk capacity, the largest portion of about 3.6 GB is allocated to the database and its associated use. The hard disk also reserves a vacant space of 1 GB for future system expansion and system swap space.

(3) Peripheral Hardware

In addition to the routers and workstations, the Operational System contains the following peripheral hardware:

(a) Two (2) units of personal computer (Pentium 11/233Mhz) which are installed as client machine applying the "Windows NT4.0" system as OS (operating system).

(b) Input and output devices which include one (1) unit of table digitizer of A0 size, one (1) unit of color Inkjet plotter of A0 size, and two (2) units of postscript printer.

(c) Power regulator and backup supply devices which consist of two (2) units of "Automatic Voltage Regulator" (AVR) and three (3) units of "Un-interruptible Power Supply" (UPS).

(d) Backup device for database which consist of "4mm Tape Drive" directly linked to the UNIX server machine at Federal DID sub-net, and CD-R drive linked to the client machine at Federal DID sub-net.

7.3.3 Data Transmission Device

The Operational System applies a combination of the following existing data transmission systems:

(1) The telemetry network for flood forecasting and warning in the Perak river basin which is used as the data transmission device to collect the real-time hydrological gauging data;

(2) ISDN line (64 kbps) leased from Telekom Malaysia for data transmission between the State DID of Perak and the access point of Agrolink in Kuala Lumpur;

(3) Agrolink used as the wide area network within Kuala Lumpur; and

(4) Public telephone lines for data transmission to the public users.

7.4 System Software

The Operational System applies the following operating systems and software:

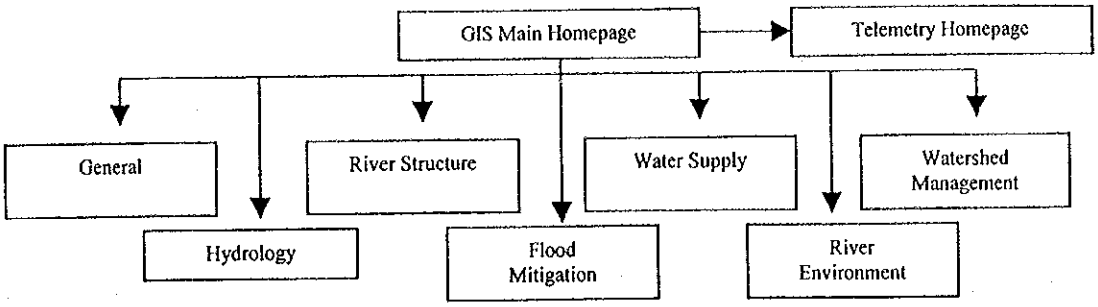
7.4.1 Operating System

The "Netscape Enterprise Server" was installed as WWW browser in the system server and, through this operating system, the users can access to the homepages of the Operational System. A series of software for Geographic Information System (GIS) was also installed in the GIS Sever to manage the database. This software consists of "Arc/Info", "Arc/View" and "Arc/View Internet Map Server (IMS)". The "Arc/Info" is used as the database management software administrating all necessary analysis on the Geographic Information System. The "Arc/View" is also used as a viewer to present the GIS data, and at the same time used as software for data input. Moreover, the "Arc/View IMS" is used to dynamically open the GIS data through Internet.

7.4.2 Application Software

Two kinds of application software were developed specifically for the Operational System. One is the "Telemetry System Application" which aims at supporting the management of real-time hydrological information gauged by the existing telemetry gauging stations in the Perak river basin. The main function of this application is to automatically collect all hydrological information, and to send them periodically to the Web server at Federal DID in Kuala Lumpur.

The other software is the "GIS System Application" which allows system users to access the database of the Operational System through the Internet and process them for the sake of their own purposes. Through this application, the Operational System opens the main homepage as shown in Fig. 7-5. The main homepage provides the hierarchy of web pages as shown below, and hence the users can further access any of the categories.



7.5 Project Implementation Schedule and Project Cost

7.5.1 Project Implementation Schedule

The development of the Operational System was made within one year as shown in Fig. 7-6. The system planning and designing by the JICA Study Team took about 4.0 months, and procurement of hardware and software including tendering, procurement, delivery and installation/adjustment of hardware and software was about 3.0 months. In the middle of delivery of hardware and software, DID completed all necessary preparatory works such as preparation of operation room, power supply, and leased ISDN line taking 1.5 months. Finally all data input and programming works were made in 4.0 months.

7.5.2 Project Cost

The development of the Operational System has taken an initial investment of RM 2.92 million covering the items shown below. Among the items, system planning and designing was undertaken by the JICA Study Team and, in accordance with the system design, the system hardware and software were procured (refer to Table 7-3). The software development as well as initial data input was subcontracted to a local consulting firm at an aggregate cost of RM 1.06 million (refer to Tables 7-4 and 7-5).

Item	Cost
(1) System planning and designing	RM 1.04 million
(2) Procurement of hardware	RM 0.35 million
(3) Procurement of software	RM 0.47 million
(3) Development of software	RM 0.13 million
(4) Initial data input	RM 0.93 million
Total Initial Investment Cost	RM 2.92 million

The annual operation and maintenance cost of the Operational System is estimated at RM 0.21 million/year covering the items shown below. Among the items, the maintenance cost of hardware is assumed at 15% of the initial procurement cost including procurement of

spare parts, while the cost for data renewal is 10% of the initial data input cost. Moreover, the lease cost of the ISDN line (64Kbps) is in accordance with the price list of Telekom Malaysia, and the cost of manpower for system management is assumed according to the necessary staff.

Item	Cost
(1) Maintenance of Hardware	RM 0.05 million/year
(2) Manpower for System Management	RM 0.02 million/year
- River Engineer1 (2.0 M/M/year)	
- Network Manager (3.6 M/M/year)	
- Database Manager (12.0 M/M/year)	
- Telemetry Engineer (0.5 M/M/year)	
- Digitizer Operator (5.0 M/M/year)	
(3) Lease Cost of ISDN Line	RM 0.05 million/year
(4) Data Renewal	RM 0.09 million/year
Total Annual O/M Cost	RM 0.21 million/year

7.6 Technical Evaluation

The Operational System deals only with information for the Perak river basin; therefore, nationwide expansion of the system for comprehensive and consistent river basin management in the entire country will be a significant improvement. Various government agencies are developing their own information systems at present and some of these systems could be useful data sources for users of the Operational System. Moreover, the information systems will be linked through a wide area network for easy sharing of information among the government agencies as well as the public users. From this concept, technical evaluation was made on the future nationwide expandability of the Operational System and the system linkage with other related information systems.

7.6.1 System Expandability

The existing Agrolink provides the Operational System with sufficient IP addresses with a potential capacity of system operation for nationwide river basin management. Moreover, the current workstation of the Operational System reserves unused hard disk capacity for future system expansion and, at the same time, could easily expand its capacity by increasing of the units of workstations. Thus, the Operational System has the potential capacity to expand for nationwide coverage.

The system expandability is, however, subject to the management of objective information currently adapted in the Operational System. Should the system manage futuristic information such as radar rainfall data and dynamic visual scenes of the field, the data

management volume will drastically increase, and the transmission capacity of Agrolink (2 Mbps) would be insufficient. Thus, the Agrolink needs to be shifted to a permanent wide area network in the future solely dedicated to the Operational System as proposed in the Master Plan.

7.6.2 Linkage with Other Related Information Systems

The DOA has a plan to open its land use and soil map information through a wide area network to extend and facilitate the use of such information. Likewise, the DID is now developing a system called "Hydrological Information System (HIS)" which could open the hydrological database to the wide area network. The development of both the systems of DOA and DID is still been made. However, the intensive multimedia communication development at present will certainly increase such wide area network information systems like those being developed by DOA and DID. Accordingly, the linkage of the Operational System with other related information systems will be a significant issue hereafter.

The web server of the Operational System designed under Agrolink facilitates the linkage with other external information systems. The linkage is, however, availed of only when the external information systems are equipped with a wide area network communication system through the following development steps:

(1) The external system sets up a web server as well as a web application. Should the system intend to open GIS data, it also needs to setup an Internet map server;

(2) The external system links its web server with the Internet and/or Intranet; and

(3) The external system opens a network entry to the Operational System.

7.7 Economic Evaluation

7.7.1 Economic Benefit of the Operational System

As described in Subsection 6.6.2, the proposed RBIS master plan contains the following three kinds of economic benefit:

(1) Improvement of water deficit by dam reservoir operation that could be realized through the real-time information on the low river flow discharge in the lower reaches;

(2) Reduction of flood damage by dam operation that could be realized through the real-time information on the basin-wide storm rainfall and the flood river flow discharge; and

(3) Reduction of time and manpower for the formulation of river development plans that could be realized through the database information.

The Operational System is equipped with telemetry river flow gauging system that could have the same function for water supply management as the proposed RBIS master plan. Accordingly, the Operational System could achieve the same economic benefit for the above Item (1) as the RBIS.

As for Item (2), the RBIS is equipped with a radar rainfall gauge that could enable clarification of wide area conditions of rainfall to effect the objective flood control of an item. However, such radar rainfall gauge is to be installed in line with the long-term development plan and, therefore, has not been installed with the Operational Plan. Due to lack of radar rainfall gauge, the Operational System could hardly fulfill the above Item (2).

In connection with Item (3), RM 0.5million/year is estimated as the present annual average economic value by the proposed RBIS master plan. Since the Operational System is equipped with a comprehensive database information on river basin management, it could achieve the same economic benefit (RM 0.5million/year) as the proposed RBIS master plan. It is further assumed that the RBIS master plan would increase the present economic benefit on Item (3) in the future, as expenditures for river management increase. However, the Operational System will hardly realize such increment of benefit due to its limited data processing capacity.

In due consideration of the above circumstances, the annual average economic benefit of the Operational System is estimated at RM 0.84 million/year as given below:

(a) Improvement of water deficit by real-time information	RM 0.34 million
(b) Reduction of time for formulation of river development plans	RM 0.50 million
Total	RM 0.84 million

7.7.2 Economic Cost and Economic Rate of Return of the Project

The economic evaluation for the project was made based on the economic internal rate of return (EIRR), using the annual cash flow of economic benefit and cost given in Table 7-6, where the economic cost is expressed at 90% of the project cost. In the annual cash flow, the

initial investment cost is disbursed within the first year as made in this Study, and the annual operation and maintenance cost would ensue from the second year onward. The project life is assumed to be 10 years after completion of the project in due consideration of durability of the system devices. As a result, the EIRR for the proposed project is estimated at 17.1% and judged to be more than the applicable opportunity cost (10 to 12%). Thus, the EIRR shows that the proposed project is economically justifiable.

8. INSTITUTIONAL SETUP PLAN

8.1 Principles

The Cabinet at its meeting on July 23, 1997 had directed the Ministry of Agriculture to look into the setting up of the National River Authority. The Authority has the task to oversee comprehensive river basin management including flood management, water supply management, and river environmental management. The RBIS could ultimately facilitate such comprehensive river basin management through its serving of various river basin database information on river basin as well as real-time hydrological gauging information.

However, the setting up of the Authority will require further time since the existing related legislation and policies need to be reviewed and revised. Moreover, the RBIS has been initially developed only as a basin-wide system for the Perak river basin, and it will take a substantial time to expand the system to the nationwide scale and to fully support the task of the National River Authority. In due consideration of the these conditions, the following principles are given to formulate the institutional setup plan of the RBIS:

(1) The RBIS is not to take over the current river basin management practices of the various government/semi-government agencies, or the future river basin management of the National River Authority. Instead, the objective of the RBIS is to furnish the comprehensive river basin information to support river basin management. Accordingly, the RBIS is not to prescribe any institutional setup for the current river management bodies and/or the future National River Authority.

(2) The management body of the RBIS is also not to take over the data management work that is currently undertaken by various government and semi-government agencies. Instead, the management body will have the function to collect and link the existing data information sources to maximize the mutual benefits in the sharing of information among the related agencies as well as the public system users.