CHAPTER 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 the 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 because the existing related legislation and policies need to be reviewed and revised. Moreover, 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 for RBIS:

(1) RBIS is not to take over the current river basin management practice by the various government/semi-government agencies, or the future river basin management to be controlled by the National River Authority. Instead, the objective of RBIS is to furnish the comprehensive river basin information to support river basin management. Accordingly, RBIS is not to prescribe any institutional setup for the current river management practices and/or the future National River Authority. Thus, the institutional setup plan is formulated as a model case for management of one river basin scale (i.e., Perak river basin) but the future nationwide expandability of RBIS is also incorporated into the plan.

(2) The management body of 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 a function to collect and link the existing data information sources so as to maximize the mutual benefits in sharing information among the related agencies as well as the public system users.

8.2 Proposed Institutional Setup Plan

The proposed organization for management of RBIS is composed of tiers with the RBIS Steering Committee as the top supported by the RBIS Technical Committee as the second level and the

RBIS Technical Center as the third level. The formation, roles, composition and functions of each tier are as described below.

8.2.1 Steering Committee

In Malaysia, information technology is being intensively developed and information is being opened through the wider area network. In fact, RBIS has already been equipped with the wide area network communication system. Moreover, the National Land Information System (NaLIS) and the Hydrological Information System (HIS) are going to develop their wide area communications services for land information and hydrological information, respectively. Such progressive information technology will facilitate the easy and effective data communication but at the same time, generate several issues as enumerated below:

(1) Protection of data confidentiality and/or copyright of data;

(2) Standardization and synthesis of the related information systems so as to create interchangeability among the systems;

(3) Development of the human resources to cope with the advanced information technology; and

(4) Import of progressive information technology.

RBIS involves various kinds and levels of government and semi-government agencies as its information sources. Accordingly, the above items are significant issues on the management of RBIS, and the Steering Committee will determine the policies to cope with the issues and provide the guidelines/directions on utilization of the objective information through coordination with the related government agencies. The Steering Committee will also monitor the national policies on information technology through activities of the following related national councils and committees and reflect them to the management of information of the RBIS.

Name of Council and Committee	Tasks Related to Management of RBIS
National Land Information System (NaLIS) Central Council	• Formulate policies on development, implementation and operation of the National Land Information System
National Information Technology Council (NITC), and National Committee on Database Processing (NCDP)	• Formulate policies, strategies and standards on the utilization and development of information technology (IT). • Monitor and evaluate the programs, projects and activities pertaining to use and development of IT. • Enhance and encourage the use and development of IT.
National Remote Sensing Committee (NRSC)	• Formulate national policy on remote sensing technology.
National Mapping Committee	• Coordinate and advice all mapping and charting activities undertaken by government agencies.

The information center of RBIS is placed at the Federal DID under the Ministry of Agriculture, and all information is provisionally collected and/or provided through the existing wide area network called "Agrolink" which is under the control of the Ministry of Agriculture. Thus, the Ministry of Agriculture is the core ministry for RBIS. Due to these background, the Secretary General of the Ministry of Agriculture is proposed as the Chairman of the Steering Committee, and the Secretariat of the Committee is further proposed to be the Information Technology Unit of the Ministry of Agriculture and the River Division of Federal DID. The members of the Steering Committee will be the representatives of the following government agencies which are closely related to the formulation of the national policy on information technology:

(1) Economic Planning Unit, Prime Minister's Department

(2) Malaysian Administrative & Management Unit, Prime Minister's Department (as representative of National Data Processing Committee)

(3) Department of Survey and Mapping (as representative of National Mapping Committee)

(4) Ministry of Land Cooperative Development (as representative of the NaLIS Central Council)

(5) Malaysian Institute of Micro-electric Systems (as representative of the National Information Technology Council))

(6) Malaysian Center for Remote Sensing (as representative of the National Remote Sensing Committee)

(7) National Hydraulic Research Institute, Malaysia

(8) State Representatives

(9) Department of Irrigation and Drainage (as Secretariat of the Steering Committee)

8.2.2 Technical Committee

Based on the aforesaid policies formulated by the Steering Committee, the Technical Committee will determine all technical standards to prescribe the management of RBIS. At the same time, the Committee will undertake all technical monitoring and evaluating works required to manage the RBIS Technical Center. The detailed tasks of the Technical Committee are as enumerated below:

(1) To determine and update the format, procedure and all other necessary technical arrangement for data input/output through coordination with the information sources and users of RBIS;

(2) To determine and update all necessary protocols for data communication;

(3) To determine the mechanism of system use charges;

(4) To evaluate and approve the technical manual on daily system management prepared by the Technical Center;

(5) To monitor the information technologies practiced in Malaysia as well as import them to the management of RBIS; and

(6) To evaluate the accessibility, availability, quality and effectiveness of information and reflect the results of evaluation to the management of RBIS.

The Technical Committee will be chaired by the Director General of DID, who is also responsible for all systems operation and management. The River Division of Federal DID will act as the Secretariat to the Committee. The members of the Committee will consist of all government and semi-government agencies designated as information sources and/or users of RBIS. The members will include, but not necessarily be confined to the following:

(1) Federal Agency

(a) Department of Irrigation and Drainage (Hydrology Division);

(b) National Hydraulic Research Institute, Malaysia

(c) Department of Survey and Mapping, Malaysia, as the data source of topographic map information;

(d) Department of Agriculture as the data source of land use and soil map;

(e) Department of Environment as the data source of river water quality and basin pollutant source;

(f) Malaysia Meteorological Service as the data source of meteorological information source;

(g) Department of Geological Survey of Malaysia as the data source of geographic map information;

(h) Department of Statistics as the source of socio-economic census data; and

(i) Public Works Department as the data source of bridges.

(2) State Agency of Perak

(a) Economic Planning Unit as the data source of state development plan;

(b) Department of Irrigation and Drainage as the data source of telemetry gauging data and, at the same time, as the water user of irrigation;

(c) Perak Water Board as the water user of domestic and industrial water supply;

(d) Forest Department as the data source on basin forest conditions;

(e) Yayasan Perak as the data source of eco-tourism on Perak River;

(f) TNB as the data source of dam information;

(g) Department of Environment as the data source of river water quality and basin pollutant source;

(h) Town and Country Planning Department as the data source of structural plans;

(i) All other state authorities designated as data source and/or data user of RBIS; and

(j) All local authorities designated as data source and/or data user of RBIS.

8.2.3 Technical Center

The Technical Center is placed at the River Division of Federal DID, and its sub-center is placed at the State DID in Perak. The task of the Technical Center is to undertake all necessary operation and maintenance of hardware, software and database of RBIS. The Technical Center will also service the system users, supplying newsletters and highlighting the latest developments in functions of RBIS so as to advertise RBIS. As for the branch center at the State DID, its task is to operate and maintain the telemetry data management system.

To ensure the effective daily operation and maintenance, the following staff should be engaged as a minimum requirement:

(1) One river engineer, one network manager, one database manager and digitizer operator at the Technical Center in Kuala Lumpur; and

(2) One systems operator for the telemetry data management system at the Technical Sub-center in Perak State.

All staff will need particular knowledge on the system's operation. Among the staff, the River Engineer and the Network Manager in particular have the most important role of taking care of the overall system. Other staffs will take part in management work; that is, the Database Manager will be in charge of database management, the Digitizer Operator will undertake the actual digitizing works for various map information, and the Systems Operator will operate and maintain the telemetry management system in the sub-center at the State DID of Perak. Thus, the Technical Center will undertake daily systems operation and management. The major items for the daily operation and maintenance are as enumerated below:

(1) To periodically update the database as well as the constants of rating curve (water stage – discharge relation curve) for real-time information;

(2) To revise the database structure in order to expand the items of information in the database upon instruction from the Technical Committee;

(3) To update the web homepages in accordance with the revision of contents of the database and/or real-time information;

(4) To update the arrangement of the system IP address in accordance with the altered system users and/or request from the Agrolink Network Manager;

(5) To review and revise the "System Management and Operation Manual" which has been initially prepared by the JICA Study Team and to prepare the revised technical manual for approval of the Technical Committee;

(6) To operate the web servers both for database and the real-time information as required;

(7) To undertake system troubleshooting, referring to the "System Management and Operation Manual"; and

(8) To entrust the recovery of fatal system damages to a professional engineering firm.

8.2.4 Alternatives to the Composition of the Management Body

The RBIS proposed in this Study limits its objective coverage area only to the Perak river basin, although the ultimate goal is to have a nationwide coverage. Thus, proposed is a prototype system that may be expanded in the future. The composition of members proposed to manage and operate the prototype RBIS for the Perak river basin in Sub-sections 8.2.1 to 8.2.3 is practicable and easy to set up. However, the set-up may need to be modified depending on the conditions given below:

(1) The RBIS for the Perak river basin could, in principle, be managed at the Federal level. However, as the RBIS expands and increases its coverage of objective river basins, the issues of each river basin and/or each state pertaining to the RBIS will also diversify. To cope with such circumstances, the participation of State Governments will need to be reinforced to involve them as the core members for the management body of the RBIS.

(2) Since a wide-area network information service related to RBIS like the NaLIS is going to prevail in Malaysia, the management body should maintain consistency of information services to ensure more effective information management.

(3) As presented in Section 3.1, the National River Authority may be established to oversee a comprehensive river basin management. Should the National River Authority be established, the management body of the RBIS will need to be attached to the Authority.

In due consideration of the above conditions, several alternatives on the composition of the management body of the RBIS are conceived as presented below.

(1) Alternative 1 (Oriented to Management Body during Transition Period of Expansion of RBIS)

As the RBIS expands its objective river basins, the Federal and State members of the management body will increase as data sources and/or data users. Under such conditions, coordination among the agencies involved is very important to reinforce the functions of the Steering Committee and the Technical Committee.

Among the agencies involved, the Federal Economic Planning Unit (EPU) is the central coordination body for those related to river basin development and water use. It serves as the forum for central policy and decisions on river basin management. Based on this concept, the Chairman and Secretariat of the Steering Committee during the transition period of expansion should come from the Federal Economic Planning Unit.

The membership of the Steering Committee is in accordance with the one proposed in Subsection 8.3.1. However, the Steering Committee involves State representatives as members, which may increase as the RBIS expands its coverage over the many state territories. To maintain the appropriate scale of the Steering Committee, the State Representative should be the Chairman of the State Technical Committee (i.e., an executive officer from State EPU).

To clarify and cope with the requirements of various state agencies, Technical Committees will need to be established at the Federal and in each State Level. The Chairman and Secretariat of the Technical Committees will be drawn from the Federal EPU and the State EPUs (UPENs). Such a set-up would ensure a closer relationship between the Federal and State governments and, at the same time, facilitate coordination among DID, PWD, DOE and other various Federal and State agencies involved in water use. The Technical Committee will involve all agencies designated as data sources and/or data users of RBIS as proposed in Subsection 8.2.2.

The Technical Center and its Sub-center are placed, for the present, at the Federal DID in Kuala Lumpur and the State DID of Perak, respectively. During any transition period of expansion of RBIS, the Technical Center would be maintained by Federal DID, while Technical Sub-centers would be established in each State that comes within the coverage of RBIS. The Technical Center and its Sub-centers can be incorporated and/or privatized through concession, as alternative choice, for effective management and operation. The staffs required for the Technical Center are as described in Subsection 8.2.3.

(2) Alternative 2 (Oriented to Management Body Proposed in NaLIS)

Both NaLIS and RBIS aim at providing the on-line access to land and river basin information, respectively, as index of national resources, and the major users of such information are the State governments. Thus, NaLIS and RBIS are closely related to each other, and a consistent institutional setup for NaLIS and RBIS could facilitate a more effective usage of information.

The NaLIS Central Council (NCC) is proposed as the top-level forum to decide the policy for development, implementation and operation of NaLIS. The Prime Minister is proposed to be the Chairman of NCC considering that NaLIS is a Federal project to achieve the national objectives towards better land management. To maintain consistency with the organization of NaLIS, the Prime Minister is also conceived as the Chairman of the Steering Committee under the RBIS. The proposed Secretariat of NCC is entrusted to the

Ministry of Land and Cooperative Development, the technical core agency of NaLIS. In the same way, the Secretariat of RBIS is entrusted to the Ministry of Agriculture, the technical core agency of RBIS.

NaLIS contains the NaLIS Regulatory Authority (NRA) as the second level to oversee data standards, data copyright, data quality, data security, data charges and other regulatory works. Thus, NRA has functions similar to those of the proposed Technical Committee of RBIS. The Chairman and Secretariat of NRA is the Ministry of Land and Cooperation Development at the Federal level and the State Department of Land and Cooperation Development at the State level. In the same manner, the Chairman and Secretariat of the Technical Committee of RBIS proposed under this Alternative is the Federal DID at the Federal level and the State DID at the State level. As for the members of the Steering Committee, Technical Committee and Technical Center, they will be in accordance with those proposed for Alternative 1.

As stated above, this Alternative 2 is oriented to the consistent membership of NaLIS, and would be effective only when NaLIS and RBIS prevail in Malaysia with a substantial coverage area. Due to such conditions, setting up of this Alternative may take time and should follow the set up proposed as Alternative 1.

(3) Alternative 3 (Oriented to River Authority)

As stated in Section 8.1, the Ministry of Agriculture is looking into the setting up of the National River Authority. Upon establishment, the Authority will oversee the nationwide river basin management.

The State DID of Selangor also is now undertaking the "Pilot River Basin Management Study of Selangor River" to formulate an appropriate river basin management plan for Selangor River in particular. The Study proposes the Selangor River Authority (SRA) to undertake actual monitoring and coordinating works for the river basin management. All proposals made by SRA are clarified by EXCO and finally approved by Menteris Besar of Selangor State.

The Study may implicate a model of the institutional setup for individual river basin management. Several state river authorities like SRA may be established, one for each river basin, and the National River Authority will have jurisdiction over such state river basin management bodies.

The RBIS will have the role to provide the necessary river basin information to the National River Authority as well as the State River Authorities. To facilitate such a role, it is proposed that the Chairman and Secretariat of the Steering Committee at the Federal Level of RBIS are the Prime Minister and the National River Authority, respectively. The membership to the Steering Committee will involve the State representatives as well as the representatives of all federal agencies that are closely related to the formulation of the national policy on information technology, as proposed in Subsection 8.2.2.

As for the Technical Committee, the Federal Committee and State Committee will be established as proposed in Alternatives 1 and 2. As in the Steering Committee, the Prime Minister and the National River Authority will act as Chairman and Secretariat of the Technical Committee at the Federal Level, while Menteris Besar and the State River Authorities will be the Chairman and Secretariat of the Technical Committee at the State Level. The membership of the Technical Committee will involve all agencies designated as data sources and/or data users of RBIS.

The National River Authority also will have jurisdiction over the Technical Center for RBIS, and a Technical Sub-center will be established in each State, controlled by the State River Authority. The Technical Center and its Sub-center could be incorporated and/or privatized through concession, as alternative choice, for effective management and operation. The staffs required for the Technical Center are as described in Subsection 8.2.3.

This Alternative 3 is subject to establishment of the National River Authority. However, the setting up of the Authority will require further time since the existing legislation and policies need to be reviewed and revised as mentioned in Section 8.1. Moreover, this Alternative may need to be modified according to the condition of NaLIS. Thus, this Alternative is regarded as an issue to be examined in the far future.

CHAPTER 9 CASE STUDY ON THE USE OF RBIS FOR RIVER BASIN MANAGEMENT

The use of information in the RBIS for river basin management is described in Chapters 7 and 8. A case study was carried out to further clarify in detail how the RBIS information (i.e., the real-time information as well as the database information) could contribute to the actual river basin management. At the same time, estimated was the economic benefit associated with the contribution of the RBIS to the river basin management. The results of the case study are as described hereinafter.

9.1 Water Supply Management

9.1.1 Long-term Projection for Water Supply

TNB agreed with DID in 1975 that the existing hydropower dams would release discharge to guarantee a minimum flow of 4,000 cusec (about 113.2 m^3/s) at the Iskandar Bridge (refer to Subsection 3.2.2). The guaranteed discharge at the Iskandar Bridge was then set up more than 20 years ago, and the water demand will certainly increase in the future due to intensive urban/industrial development exceeding the presently guaranteed discharge. Unless a long-term water supply plan is projected, a serious water shortage may suddenly come out in the future. In line with the long term water supply plan, the present guaranteed discharge needs to be updated through coordination with TNB, or new water resources should be developed.

Such long-term projection on water supply and demand is, however, virtually difficult without database information on the integrated water demand and intake facilities. On the other hand, the RBIS contains the database on all water demand including domestic/industrial water demand as well as irrigation water demand. The RBIS also contains the database of the long-term river flow regime of Perak. Therefore, the river administrator could estimate, through these database, the available water supply for the overall water demand.

Through the database initially stored in the RBIS, the overall water demand could be estimated as listed below. According to the estimation, the future domestic and industrial water demand will have a remarkable increment. In contrast to domestic and industrial water demand, no new and extensive irrigation scheme is projected and, therefore, the increment of irrigation demand is assumed to be nil.

Item of Demand	Present Water Demand	Future Water Demand		
		2005	2010	2020
Domestic and Industrial	15.8 m^3/s	21.5 m^3/s	25.5 m^3/s	43.4 m^3/s
Irrigation	31.6 m^3/s	31.6 m^3/s	31.6 m^3/s	31.6 m^3/s
River Maintenance	65.8 m^3/s	65.8 m^3/s	65.8 m^3/s	65.8 m^3/s
Total	113.2 m^3/s (4,000 cusec)	118.9 m^3/s (4,201 cusec)	122.9 m^3/s (4,343 cusec)	140.8 m^3/s (4,975 cusec)
Percentage of demand to annual average river flow at Iskandar Bridge*	59%	62%	64%	73%

* The annual average flow discharge at Iskandar Bridge is estimated at 192m^3/s from the hydrological data gauged before dam construction (1961-1977).

The guaranteed discharge could ensure the present domestic/industrial water demand and irrigation water. The difference of 65.8 m^3/s between the water demand and the guaranteed discharge is regarded as river maintenance flow. Difficulties in abstracting the river water by pump are now being experienced due to the low river water stage during a drought period. Judging from such difficulties, the river maintenance flow of 63.5 m^3/s is regarded as the minimum requirement even in the future as assumed above. As a result, the future water demand exceeds the present guaranteed discharge, and the deficit of about 1,000 cusec is foreseen by the year 2020. Moreover, the future water demand will reach 73% of the annual average river flow discharge in 2020. Thus, an extremely high rate of water utilization is estimated.

The river administrator is required to update the projection on future water demand through continuous monitoring, and periodically renew the database of water demand in accordance with the results of monitoring. Based on the projection on water demand, the river administrator is further required to have the following water supply management:

(1) Coordination with TNB to increase the guaranteed discharge from existing dams;

(2) Coordination with water users to control the excessive increment of water demand; and

(3) Development of new water resources.

9.1.2 Daily Water Supply Management

(1) Issues on Daily Water Supply Management

The DID Hydrology Division now monitors the daily flow discharge at the Iskandar Bridge. The gauged discharge is, however, not transmitted to TNB. Since TNB could not monitor the flow discharge at Iskandar Bridge, it releases a maintenance

discharge of 3,000 cusec (about 85 m^3/s) from the Chenderoh Dam regardless of river flow discharge at the Iskandar Bridge. The dam maintenance discharge of 3,000 cusec has been verified through the gauging records as shown in Table 9-1 and Fig. 9-1.

There is a difference of 1,000 cusec between the guaranteed discharge of 4,000 cusec at the Iskandar Bridge and the maintenance flow of 3,000 cusec (85 m^3/s) from the Chenderoh Dam. The difference is supposed to be supplemented by the runoff discharge from the Pelus River that joins the Perak River at about 9 km downstream from the Chenderoh Dam. However, the runoff discharge from the Pelus River is a natural phenomenon, falling often below 1,000 cusec (23.8 m^3/s) (refer to Table 9-1 and Fig. 9-2).

The gauging record shows that a dominant deficit of the guaranteed discharge at the Iskandar Bridge occurred in August to September 1990 (refer to Table 9-2 and Figs. 9-3 to 9-4). During the period, the Chenderoh Dam had certainly released the dam outflow discharge of more than 3,000 cusec, while the runoff discharge from the Pelus river basin was far lower than 1,000 cusec. As the result, the deficit continued for a period of about one month having the average deficit of 6 m^3/s and the maximum deficit of 20 m^3/s (refer to Table 9-2 and Fig. 9-4).

(2) Use of RBIS for Daily Water Supply Management

The above water deficit is attributed to lack of integrated hydrological monitoring system between DID and TNB. To cope with such unfavorable condition, the RBIS has functions to monitor the river flow discharge of the Perak River at the Iskandar Bridge and the Pelus River at Kg. Lintang. At the same time, the RBIS could also monitor the outflow discharge from the Chenderoh Dam. All of these monitored data are on the real-time base being transmitted through WAN of the RBIS, to the system administrator (DID) as well as related agencies such as TNB and PWB (in charge of domestic and industrial water supply). The recurrence probability of the 1990's water deficit is estimated at about 5 years based on one-month runoff discharge volumes of August from the Pelus River (refer to Fig. 9-5). In another words, the water deficit of the Pelus River as experienced in 1990 possibly occurs once in every five years.

When the RBIS detects that the runoff discharge from the Pelus River falls below 1,000 cusec, the dam maintenance discharge (i.e., 3,000 cusec) is required to be

increased to guarantee the river flow discharge at the Iskandar Bridge (i.e., 4,000 cusec). In contrast, TNB does not necessarily need to release the maintenance discharge of 3,000 cusec when the runoff discharge from the Pelus River is sufficient, exceeding 1,000 cusec. Thus, the RBIS enables TNB to operate more flexible dam outflow depending on the runoff discharge from the Pelus River.

TNB is much concerned in maintaining the reservoir level for hydropower generation, while the reservoir level may be lowered due to incremental dam outflow discharge for water supply. In this connection, an attempt was made to simulate the necessary dam outflow discharge as well as dam reservoir level that could guarantee the discharge of 4,000 cusec in the case of the aforesaid deficit in 1990.

The results of simulation are as shown in Table 9-3. During the deficit, Chenderoh Dam had released 92.5 m^3/s (3,268 cusec) as daily average. On the other hand, the average dam outflow discharge was increased to 94.4 m^3/s to offset the deficit.

The increment of dam outflow discharge will be made by the release of discharge from the Temengor dam reservoir that is by far larger than those of the other three dams. The consumption of dam reservoir volume is estimated at 5,440,600 m^3 which corresponds to only 0.4% of the live storage volume, lowering 11 cm of reservoir level. Thus, the increment of the dam outflow discharge will cause a minimal effect on the dam reservoir level as well as the power generation.

(3) Economic Benefit of RBIS

As described above, the water deficit in 1990 lasted for about one month and the daily average deficit during the period is estimated at about 6 m^3/s. Such water deficit directly causes the deficit of irrigation water supply leading to the reduction of the paddy production.

From the above viewpoints, an attempt was made to estimate the production loss of paddy that corresponds to the average deficit of 6 m^3/s in 1990. For the estimation, the following assumptions were made:

(a) The average yield of paddy crop is estimated at 3.6 ton/ha referring to the results of the Study "Modernization of Irrigation Water Management System 1998, by JICA". The economic farm gate price is also assumed at about RM 630/ha. Multiplying the average crop yield by the economic farm gate

price, the gross production value is estimated at RM 2,268/ha, while the paddy production cost is estimated at RM 1,805/ha, as shown in Table 9-4. The unit net production value of paddy is expressed as the balance between the gross production value and the production cost and, therefore, estimated at RM 463/ha.

(b) The available irrigation area for a unit of water supply is estimated at about 604 ha/m^3/s which comes out of the present total irrigation area (19,097 ha) divided by its monthly peak water demand (31.61 m^3/s) in the Perak river basin.

Based on the above assumptions, the production loss of paddy that corresponds to the average deficit of 6 m^3/s in 1990 is estimated at about RM 1.7 million. The recurrence probability of the water deficit in 1990 is estimated at 5-year return period as described above and, thereby, the annual average value of the production loss is estimated at RM 0.34 million (RM1.7million/5years).

The RBIS enables TNB to have a flexible dam reservoir operation so that the occurrence of water deficit as experienced in 1990 could be offset by a release from the existing hydropower dam with minimal reduction of power generation. Accordingly, the average value of the production loss (RM 0.34 million) could be regarded as the annual average economic benefit of the RBIS.

9.2 Flood Management

9.2.1 Flood Control by Existing Hydropower Dam

(1) Present Potential Flood Control Effect by Existing Hydropower Dams and Issues

The three (3) existing hydropower dams, namely, Bersia, Kenering and Chenderoh currently have the gate operation to maintain their reservoir level at FSL (full supply level) even during a flood season (October to January) and, therefore, have no substantial flood mitigation effect. In contrast, Temengor Dam draws down its reservoir level from its FSL of EL. 248 m (reservoir volume of 6,050 million m^3) to EL. 242 m (reservoir volume of 5,100 million m^3) during the flood season to make a flood storage space of 950 million m^3.

The probable flood dam inflow hydrographs into the Temengor Dam were estimated based on the previous study results of "Lower Perak Flood Mitigation Study, October

1980 by JICA" (refer to Fig. 9-6(1/2)). As the result, it was clarified that the flood storage space (950 million m^3) of Temengor Dam could absorb the whole flood inflow volume of less than 20-year return period flood without spilling out, as shown below.

Probable Flood Inflow Volume to Temengor Dam

Return Period of Flood	Dam Inflow Volume (million m^3)
10-year	564
20-year	843
50-year	1,276
100-year	1,587

The present flood inundation of the Perak River tends to spread out in the lower reaches of Nording Bridge, when the river flow discharge at Nording Bridge exceeds 850 m^3/s. Nording Bridge is located on Perak River at about 187 km downstream from the Temengor Dam. On the premises of the above flood mitigation effect by Temengor Dam, the flood simulation was made and the following was estimated as the probable flow discharge at Nording Bridge.

Probable Flood Discharge at Nording Bridge

Return Period of Flood	Flow Discharge (m^3/s)
10-year	1,725
20-year	2,033
50-year	2,727
100-year	3,621

As shown above, the estimated probable discharge exceeds the critical discharge of 850 m^3/s at Nording Bridge. Thus, in spite of the extensive flood mitigation effect by Temengor Dam, flood inundation still occurs in the lower reaches of Perak River. In fact, flood inundation occurred even after completion of Temengor as experienced in 1985, 1991 and 1994.

To cope with flood inundation, an attempt was made to evaluate whether the current gate operation rule of the other three dams (Bersia, Kenering and Chenderoh) could be changed to draw down the reservoir level in advance of the flood and to effect the flood mitigation for the lower reaches.

Among the existing hydropower dams, Bersia Dam that is located just downstream from the Temengor Dam has a small reservoir volume of about 12 million m^3

between FSL and MSL (minimum supply level) and, thereby, minimal potential flood mitigation effect is expected of the dam. On the other hand, the Kenering and Chenderoh dams have rather large storage capacities of about 70 million m^3 and 60 million m^3, respectively, between FSL and MSL. These storage capacities are likely to be influential for the flood mitigation in the lower reaches.

To activate such a potential flood control capacity, it is indispensable to release the discharge and draw down the reservoir level from FSL during the initial stages of flood. Moreover, the released discharge to draw down the reservoir level should not cause any overflow of lower stretch from the dams.

Temengor Dam spills out discharge in case of the probable flood discharge of more than 50-year return period. Such spilled discharge causes a large constant dam inflow discharge of more than 600 m^3/s into Kenering Dam [refer to Fig. 9-6(2/2)]. The inflow volume into Kenering Dam is estimated at about 533 million m^3 in 50-year return period, and about 853 million m^3 in 100-year return period, which are far larger than the reservoir capacity of the Kenering and Chenderoh dams. Due to such large constant dam inflow discharge, both of the Kenering and Chenderoh dams hardly draws down their reservoir level having no substantial flood mitigation effect on the flood scale of 50 and 100-year return period.

As for the flood scale of 10 and 20-year return period, however, Temengor Dam absorbs the whole dam inflow discharge without spilling. Due to such effect of Temengor Dam, the small discharge flows into the Kenering Dam. The dam inflow volume is estimated at about 143 million m^3 in 10-year return period 165 m^3 in 20-year return period; these dam inflow volume are far smaller than those in 50 and 100-year return period. Moreover, the initial dam inflow discharge to Kenering Dam is extremely small, and the peak inflow comes out only 72 hours after a storm rainfall is observed. Due to the small dam inflow volume as well as the time lag of peak dam inflow, the Kenering and Chenderoh dams could draw down their reservoir levels in advance to have a flood control space of about 260 million m^3. This flood control space could have the significant reduction of peak discharge at Nording Bridge as shown below (refer to Figs. 9-7 to 9-9).

Peak Discharge Without- and With-Flood Control by Kenering and Chenderoh Dam

Peak Discharge	Without Flood Control by Dam		With Flood Control by Dam	
	10-year RP	20-year RP	10-year RP	20-year RP
Outflow from Kenering Dam	942 m^3/s	1,101 m^3/s	300 m^3/s	300 m^3/s
Outflow from Chenderoh Dam	1,037 m^3/s	1,219 m^3/s	565 m^3/s	591 m^3/s
Flow at Nording	1,725 m^3/s	2,727 m^3/s	1,381 m^3/s	1,549 m^3/s

(2) Use of RBIS for Dam Flood Control

The above flood mitigation effect by the Kenering and Chenderoh dams is subject to lowering of dam reservoir level in advance before a flood arrives to their dam reservoirs, and the real-time information on the rainfall and river flow discharge is indispensable. Hence, the RBIS will be useful to monitor and distribute such real-time information.

The RBIS has a function to monitor the real-time flood information on the storm rainfall, the river flow of downstream, and dam outflow discharge from Chenderoh Dam. Furthermore, the RBIS distributes the information, through WAN, to TNB as well as DID. Once these information are recognized through the RBIS, DID could clarify the allowable discharge, on real-time base to be released from Chenderoh Dam in due consideration of the channel flow capacity as well as the runoff discharge from Pelus River (i.e., non-dam catchment area). Based on the clarification by DID, TNB could release the discharge and draw down the reservoir level so as to make a flood control space during the initial stages of flood until the dam inflow discharge reaches to a certain level. After drawing down of the reservoir level, the dam could start to store the flood inflow discharge so as to reduce the river flow discharge in the downstream.

Thus, TNB and DID could exchange dam reservoir information and hydrological information through the RBIS. As a result, the dam outflow discharge is effectively controlled for the sake of flood mitigation in the lower reaches. Moreover, DID could foreseen the influence of dam outflow to the downstream based on the information on dam conditions from TNB so as to undertake more effective flood forecasting and warning.

9.2.2 Evaluation of Flood Damage Potential

In flood management works, major concerns are addressed to the flood damage potential, an essential index for economic evaluation on new flood mitigation projects. Database of the

RBIS would facilitate to estimate the annual average damage expressed in a monetary value. The use of the database to estimate the flood damage potential is hereinafter outlined together with the results of estimation.

(1) Extent of Flood Inundation Area and Estimation of Land Use within the Area

As described above, the flood inundation of Perak River starts to spread out in the lower reaches from Nording Bridge when the river flow discharge at Nording Bridge exceeds 850 m^3/s. The inundation by varied flood scales have almost the same extent due to the plain topography, although the maximum inundation depth and duration of inundation change according to the scale (refer to Fig. 9-10). The RBIS furnishes the map information on flood inundation extent as well as land use on the basis of the topographic map of 1 to 50,000. Both of the maps are supported by the Geographic Information System (GIS) and, therefore, the land use within the extent of flood inundation could be easily clarified through overlaying the two maps. Through overlaying of maps, the area of each land use item could be estimated as below:

Land Use within Extent of Flood Inundation of Perak River

Land Use Item	Area within the Extent of Flood Inundation (ha)
Paddy	1,543
Rubber	4,451
Oil Palm	57
Other Tree Crop	2,696
Mix. Horticulture	40
Forest, Swamp, Grassland	4,289
Total	13,076

(2) Estimation of Number Houses in Flood Inundation Area

The RBIS contains the database of housing census by Mukim (i.e., minimum administrative unit) as well as the GIS information on boundaries of Mukim and the probable flood inundation area. The number of houses in the flood inundation area could be estimated through the overlay function of the GIS system in the RBIS using the database and the GIS information (refer to Fig. 9-11). The results of estimation are as shown below.

Estimation on Number of Houses in Flood Inundation Area

Name of Mukim	Average Housing Density (houses/km^2)	Area to be Inundated (km^2)	Number of Houses in Inundation Area
Lanu Kubong	26.54	0.05	1
Bandar	17.02	14.88	253
Bota	21.40	9.02	193
Kampong Gajah	26.15	10.78	282
Lambor Kanan	20.98	19.89	417
Lambor Kiri	9.90	4.19	41
Pasir Panjang Hulu	6.68	20.97	140
Pasir Salak	15.97	10.35	165
Pulau Tiga	7.81	40.63	317
Total	16.28	130.76	1,811

(3) Estimation of Probable Flood Damage Value

The probable flood damage value could be estimated through the following formula.

$$D(i) = \bullet\{(Q(j) \times UV(j) \times F(j)\}$$

Where;

D(i) : Probable flood damage of i-year return period;
Q(j) : Quantity of damageable assets;
UV(j): Unit value of damageable assets;
F(j) : Damage factor of damageable assets

The damageable assets cover the agricultural assets and housing assets, and their damageable quantity ($Q_{(j)}$) is given from the above area of land use within the flood inundation area. The unit value of damageable assets ($UV_{(j)}$) is also estimated from the current market price. Moreover, the damage factor ($F_{(j)}$), is assumed referring to the following previous study results:

(a) A relationship between the flood damage factor and the maximum flood inundation depth/flood duration is given from "National Water Resources Study, Malaysia, October 1982, by JICA" (refer to Table 9-5).

(b) A relationship between the peak flood discharge at Nording Bridge and the maximum flood inundation depth is given from "Tumboh Block Integrated Rural Development Study, Flood Investigations, May 1985" (refer to Fig. 9-12).

(c) The flood duration is estimated as the duration of river flow discharge at Nording Bridge over 850 m^3/s as described in "Tumboh Block Integrated Rural Development Study, Flood Investigations, May 1985".

The probable flood hydrographs at Nording Bridge was estimated, as described above, assuming the present dam operation rule as well as the revised operation rule for the Kenering and Chenderoh dams (refer to Fig. 9-9). The maximum inundation depth/flood duration is given from the probable flood hydrographs and, as a result, the probable flood damage value could be estimated as shown in Tables 9-6 and 9-7.

(4) Annual Flood Damage Value

The annual flood damage value is estimated through the following formula:

$$Dave = \bullet\{ D_{(i)} \times P_{(i)} \} dP \cong \bullet\{(D_{(i-1)} + D_{(i)}) / 2 \times (P_{(i-1)} - P_{(i)})\}$$

Where;

D_{ave} : Annual average flood damage value;

$D_{(i)}$: Probable flood damage value of i-year return period;

$P_{(i)}$: Occurrence probability of i-year return period;

The results of estimation are shown in Table 9-8. Under the present dam operation rule of the Kenering and Chenderoh dams, the annual average flood damage value is estimated at RM 2.6 million. When the RBIS is introduced and the Kenering and Chenderoh dams are used for flood control as described above, the annual average flood damage value is reduced to RM 2.0 million. The reduced value of RM 0.6 million is regarded as an annual average economic benefit of the RBIS.

Thus, the annual flood damage value could be systematically estimated through the map information on land use map and the flood inundation extent. These map information could be renewed periodically, so that the annual flood damage could be updated and used as the basic data for projection of future flood mitigation schemes.

9.3 Watershed Management

9.3.1 Purpose of the Study

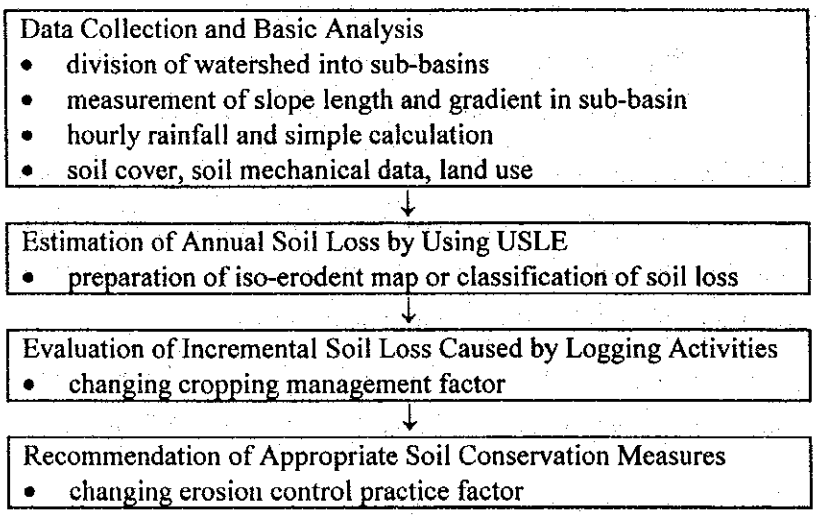
Watershed management aims to restore or enhance productivity through the prevention of permanent and irreversible deterioration of soil fertility. In order to attain a sound waterway management, continuous and effective efforts on watershed management is also essential to

reduce sedimentation along the irrigation channels and river courses. In this context, DOA, the responsible agency for soil conservation, FD, the responsible agency for logging activities as the major cause of soil erosion, and DID have to cooperate with each other for the achievement of effective watershed management. The computer network such as the RBIS can strengthen the cooperation among the agencies concerned. This section will present how the RBIS can be utilized for the watershed management.

9.3.2 Procedure of Erosion Control

Focusing on river management, the major concern should be placed on erosion control in the watershed. The typical procedure of erosion control, in particular soil loss computation using the RBIS is explained in this Chapter. The Universal Soil Loss Equation (USLE), which was developed in the United States in the 1960's, is a worldwide applicable model for soil loss calculation. Thus the USLE is adopted in the study.

The procedure of estimation is presented in the following chart.



9.3.3 Methodology of Soil Loss Estimate

The following are brief explanations for the basic equation and component factors.

(1) Basic Equation

The basic equation of Universal Soil Loss Equation (USLE) is written as:

$$A = RKLSCP$$

Where, A is the computed soil loss per unit area; and R is the rainfall factor expressing the erosion potential of rainfall in the locality (also called index of erosivity or erosion index). On the other hand, K is the soil erodibility factor representing the average soil loss per unit of rainfall factor R from a particular soil in cultivated continuous fallow on a 9% slope and 22.1 m long. L and S are the topographic factors for adjusting the estimate of soil loss for a specific land length of slope (L) and gradient (S). C is the cropping management factor representing the ratio of soil quantity eroded from land that is cropped under identical slope and rainfall conditions. P is the erosion control practice factor representing the ratio of soil loss with contouring, strip-cropping or terracing to that with straight-row farming.

(2) Rainfall Factor (R)

The rainfall factor R is Wischmeier's erosion index (EI_{30}-index), i.e., the total kinetic energy of rainstorm (E) times its maximum intensity over 30 minutes (I_{30}), divided by 100. In order to arrive at the total kinetic energy, the precipitation is divided into periods with approximately the same rainfall intensity. For each period the kinetic energy is calculated according to:

$$E = 210.2 + 89 \log I,$$

Where,

E = kinetic energy in Joules/m^2 per cm of rain.

I = average rainfall intensity of the considered period in cm/hr.

The kinetic energy calculated for each period is multiplied by the cm of rain (r) that fell during that period. Finally the total kinetic energy is calculated through summation of these products. To obtain the R value, the total kinetic energy is multiplied by twice the maximum average 30-minute intensity (I_{30}) and divided by 100.

$$R = \sum(E \times r) \times 2\, I_{30} / 100$$

(3) Soil Erodibility Factor (K)

The soil erodibility factor K had been evaluated on experimental plots by solving the equation K = A/(RLSCP). A nomograph was subsequently devised that enabled evaluation of the K-value from five simple soil parameters:

(a) percent silt + very fine sand (0.002 mm - 0.10 mm particle size);

(b) percent sand (0.10 mm - 2.0 mm particle size);

(c) percent organic matter;

(d) structure; and

(e) permeability.

Structure is coded as: 1 = very fine granular and very fine crumb (< 1 mm); 2 = fine granular and fine crumb (1 mm - 2 mm); 3 = medium granular, medium crumb (2 mm – 5 mm) and coarse granular (5 mm - 10 mm); and 4 = platy, prismatic, columnar, blocky and very coarse granular.

Permeability is also coded as: 1 = rapid to very rapid; 2 = moderately rapid; 3 = moderate; 4 = moderately slow; 5 = slow; and 6 = very slow.

The soil-erodibility nomograph is presented in Fig. 9-13. The procedure for evaluating the K factor with this graph is as follows:

(a) Enter the nomograph on the vertical scale at the left with the appropriate percentage silt + very fine sand.

(b) Proceed horizontally to intersect the correct percent-sand curve, interpolating to the nearest percent.

(c) Proceed vertically to the correct organic matter content.

(d) Proceed horizontally to the right.

(e) For soils with a fine granular or fine crumb structure and moderate permeability; the value of K can be read directly from the first approximation of K scale on the right hand edge of the first section of the nomograph.

(f) For all other soils, continue horizontally to intersect the correct structure curve.

(g) Proceed vertically to the correct permeability curve.

(h) Proceed horizontally to the soil-erodibility scale on the left-hand edge of the second section of the nomograph to read the value of K.

(4) Slope Length Factor L and Slope Gradient Factor S

Slope length is defined as the distance from the point of origin of overland flow to either of the following: (a) the point where the slope decreases to the extent that deposition begins, or (b) the point where runoff enters a well defined channel that may be part of a drainage network or a constructed channel such as a terrace of diversion. For practical estimate, the combined effect for slope length and slope gradient can be calculated according to the following equations:

(a) For slopes up to 20% and 350 m long:

$$LS = \lambda 0.5\ (0.0138 + 0.00965s + 0.00138s2)$$

(b) For slopes from 10% up to 50% and up to 800 m long:

$$LS = (\lambda / 22.1)^{0.6} \times (s / 9)^{1.4}$$

Where, λ = field slope length (m), s = slope gradient (%)

(5) Cropping Management Factor (C)

Cropping management factor C describes the total effect of vegetation, residue, soil surface and management on soil. The value of C needs to be established experimentally in many cases.

For permanent pasture, range lands, idle lands and woodlands, tables have been published from which the average annual C value can be read. These tables are reproduced as Table 9-9 and Table 9-10.

(6) Erosion Control Practice Factor P

The effect of erosion control measures is thought to be an independent variable, therefore, it is not included in the cropping management factor. The soil loss ratios for erosion control practices vary according to slope gradient. Soil loss ratios for contouring, contour strip-cropping and terracing are given in Table 9-11.

(7) Sediment Delivery

Not all of the eroded material is effectively sluiced through the river system and delivered to the sea. The rate at which sediment is discharged to the oceans is

usually less and often much less than one-fourth of the rate at which it is eroded from the land surface.

The ratio of soil loss from hillsides to the sediment yield of a catchment is called the sediment delivery ratio of the catchment. The ratio varies with drainage basin size, and with the overall steepness of the catchment. If local data are available, the variation of sediment yield with these factors can be quantified, but if such data are lacking, Fig. 9-14 may be used to estimate the sediment delivery ratio.

9.3.4 Utilization of the RBIS for Soil Loss Calculation

(1) Information Stored and to be Stored in the RBIS

Concerning watershed management, so far, the Operational System of the RBIS contains the following information:

(a) Topographic information based on the topo-map with a scale of 1:50,000;

(b) Recorded real-time rainfall received from fourteen (14) gauges;

(c) Soil cover based on the reconnaissance soil map;

(d) Current land use based on the sources in 1990;

(e) Forest conservation information based on the map with a scale of 1 : 63,360; and

(f) Logging data file compiled in 1997 by FD.

Further the RBIS will obtain the following detailed information related to watershed management in the future:

(a) Digital Topo-map with a Scale of 1:50,000

The limited data were digitized from the 1:50,000 topo-map and were stored in the Operational System because of the limited time and budget. In particular, the contour lines were digitized at 100 m interval in the areas located above 100 m in elevation.

On the other hand, the digitizing works on topographic maps with a scale of 1:50,000 are now being carried out by DSMM, and will be completed by the

year 2002. After compilation of the digital map in the area covering the Perak river basin, the RBIS can store or link to the full-scale digital map.

(b) Semi-detailed Soil Map

The semi-detailed soil map is being surveyed at present. This survey is based on the topo-map with a scale of 1 : 25,000 and sampling density is a 1 km interval. The semi-detailed soil map is considered as the appropriate data from the required accuracy for soil loss calculation, although a long time is still necessary for completion of this database system.

(c) Forest Reserve Map

The Operational System stores the digitized data of forest compartment of which the boundaries are drawn on a blank map with a scale of 1 : 63,360. Therefore, the accuracy of boundary data is considered to be low. However, FD is planning to digitize the forest compartment map drawn on the topo-map with a scale of 1:50,000. After completion of the digitized work, the RBIS can store or link to the more accurate digital map.

(2) Present Status for estimation of Erosion Factors

As described in Item (1), most of the digitized data cannot be completely prepared in the Operational System for the purpose of soil loss calculation. These conditions are summarized in the following table, and calculation procedure of each factor is explained thereafter.

Erosion Factor	Present Status	Future Prospect
Rainfall (R)	completed	-
Soil Erodibility (K)	not available	integrating the information on semi-detailed soil map
Slope Length (L) & Slope Gradient (S)	not available	integrating the survey results being executed by DOA
Cropping Management (C)	additional survey - clarification through field survey	data renewal for the current land use
Erosion Control Practice (P)	additional survey - collection of field information	data renewal for the current practice

Rainfall Factor R

The RBIS stores hourly rainfall data received from the fourteen (14) automatic rainfall gauges. Using these data, the calculation process of rainfall factor R for annual value is described below.

(a) Selection of Hydrological Average Year

Among the stations observing daily rainfall, three (3) rainfall stations are selected considering their locations in the entire basin, recording periods and data availability. These are Bikam (No. 4012143), Telok Sena (No. 4209093) and Bekalan Talang (No. 4708084).

Their annual rainfall series are tabulated and delineated in Fig. 9-15. Comparing average annual rainfall and annual values at each station, the year 1979 is selected as a hydrological average year of which annual values approximate the average values at all of the three stations.

(b) Selection of Rainfall Stations from Data Availability

Among the fourteen (14) stations observing hourly rainfall, the rainfall data of only four (4) stations are available for further calculation of R factor. The data of the other ten (10) stations are composed of missing data in some parts. The stations selected are Telok Intan (No. 4010001), Telok Sena (No. 4209093), Pejabat Daerah Kampar (No. 4311001) and Kubang Haji (No. 4409091).

(c) Selection of Storms

For calculation of R factor, the representative storms are selected at each station, judging from the following criteria:

(i) having an intensity of more than 25 mm/hr in a continuous rain (If the rain stops for more than three hours, the rains in both sides of the non-rainfall period are regarded as different rain groups.); or

(ii) having a total amount of more than 25 mm in a continuous rain.

(d) Estimation of R factor

The annual rainfall factor R is calculated at each rainfall station following the equations as explained in Section 5.3(2). The estimate results are presented in Fig. 9-16.

As shown in Fig. 9-16, the rainfall stations being able to provide the available data for R estimation are only limited in the areas with relatively low altitudes. On the other hand, major problems concerning soil erosion are occurring on the hill and mountain slopes. Thus the following continuous efforts are necessary to increase the accuracy of R estimation and, further, to strengthen the watershed management:

(i) denser rainfall observatory network covering the hills and mountains, and

(ii) more proper rainfall observation for lessen the data missing periods.

Soil Erodibility Factor K

As described in Section 9.3.3(3), five parameters are necessary to estimate the soil erodibility factor K, namely, percent silt + very fine sand, percent sand, percent organic matter, structure and permeability. After completion of the soil sampling survey being carried out in parallel with the semi-detailed soil map preparation, these data will be available.

Slope Length Factor L and Slope Gradient Factor S

At present DOA is estimating these factors in the whole Malaysia, using topographic map with a scale of 1:25,000. This work will be completed in 1999. The information on the work results can be utilized in the RBIS.

Cropping Management Factor C

Based on the current land use map, each land use category except for residential use and urban areas has to be converted to the value of C. The additional survey is necessary in order to establish the relationship between land use type and cropping conditions of canopy and vegetation cover. For this purpose, sampling survey using remote sensing or aerial-photo interpretation combined with field survey may be a suitable method.

Erosion Control Practice Factor P

Soil conservation works such as contouring and selection of appropriate crops are being executed to the small-scale landholders or advised to the large-scale estate and plantation owners by DOA. However, these data has not been compiled for the database system.

(3) Concept of Future RBIS Utilization for Erosion Control

In order to attain the effective watershed management, the Operational System, in particular, the stored data, has to be upgraded as described before. In parallel with necessary improvement of the RBIS, the database system of the related agencies such as DOA and FD will also be upgraded, including the spatial data for the GIS system.

In this context it is considered to be advantageous that the RBIS has a linkage to the related database of DOA and FD instead of storing the necessary data by copying from the database. The concept is illustrated in Fig. 9-17. In this figure the soil loss tolerance is mentioned. This value should be established in the further study judging from the following factors:

(a) Sedimentation in the water control structures such as open ditches, ponds, irrigation canals;

(b) Occurrence of excessive sheet erosion, accompanied by gully formation; and

(c) Loss of plant nutrients.

REFERENCES

Study Reports

(1) Lower Perak Flood Mitigation Study, Draft Final Report, October 1980, JICA

(2) Tumboh Block Integrated Rural Development Study, Flood Investigations, May 1985, Lyall Macoun and Joy. McGowan International PTY LTD.

(3) Study on Erosion Control and Preparation of Master Plan to Alleviate Tidal Flooding at Teluk Intan, Perak, Final Report Vol. 2 River Bank Erosion Study, January 1992, DID, Ranhill Bersekutu SDN BHD.

(4) Kinta River Flood Mitigation and Catchment Area Rehabilitation Project, Final Report Vol. 1,3B and A, January 1994, DID, HSS Integrated SDN BHD, and Tonkin and Taylor International LTD.

(5) Geographic Information System Report of Department of Agriculture, 1993, DOA.

(6) The Study on Modernization of Irrigation Water Management System in the Granary Areas of Peninsular Malaysia, Interim Report, August 1997, JICA, Nippon Koei Co., Ltd.

(7) National Water Resources Study, Malaysia, Sectoral Report Vol. 1 Socio-economy, October 1982, JICA.

(8) National Water Resources Study, Malaysia, Sectoral Report Vol.2 Meteorology and Hydrology, October 1982, JICA

(9) National Water Resources Study, Malaysia, Sectoral Report Vol. 5 River Conditions, October 1982, JICA.

(10) National Water Resources Study, Malaysia, Sectoral Report Vol. 11 Irrigation Water Supply, October 1982, JICA.

(11) National Water Resources Study, Malaysia, Sectoral Report Vol. 19 Water Laws and Institutions, October 1982, JICA

(12) Classification of Malaysian Rivers, Vol. 1 Executive Summary, 1994, DOE.

(13) Classification of Malaysian Rivers, Vol. 2 Methodology and Classification of Ten Rivers, 1994, DOE.

(14) The Quaternary Deposits in the Coastal Plains of Peninsular Malaysia, 1986, J.H.A. Bosch.

(15) Young Quaternary Sediments in the Coastal Plain of Southern Perak Peninsular Malaysia, 1986, J.H.A. Bosch.

(16) Development of Criteria and Standards for Water Quality (Phase II), Final Report, Vol. I Executive Summary, February 1990, DOE.

(17) Development of Criteria and Standards for Water Quality (Phase II), Final Report, Vol. IV River Classification-Sg. Perak Basin, February 1990, DOE.

(18) Urban Development Policy and Programme Study, Malaysia,, October 1986, COWIconsult

(19) Geology and Mineral Resources of the Lumit-Teluk Intan Area, Perak Darul Ridzuan, Map Report 3, 1991, Department of Geological Survey of Malaysia

(20) Young Quaternary Sediments in the Coastal Plain of Southern Perak, Peninsular Malaysia, Report No. QG/1, 1986, Department of Geological Survey of Malaysia

(21) Geological and Mineral Resouces of the Kinta Valley, Perak, 1960, Department of Geological Survey of Malaysia

(22) Geology and Mineral Resources of the Taiping-Kuala Kangsar Area, Perak Darul Ridzuan, Map Report 1, 1990, Department of Geological Survey of Malaysia

(23) Rancangan Struktur Sebahagian Daerah Kinta (Kinta District Structure Plan), 1996, Pihak Berkuasa Perancang Tempatan (Local Planning Authority)

(24) Perangkaan Utama Negeri Perak (Principal Statistics of Perak State), 1996, Economic Planning Unit, Perak State

(25) Geological and Mineral Resources of the Kinta Valley, Perak, 1960, Department of Geological Survey of Malaysia

(26) Perak Menjanjikan Emas, 1996, Mustaffa Ismail

(27) Progress Report on INFOMIS Applications in Malaysia, November 1994, Zulkefli Mokhtar, Kasinathan Kengaiah.

(28) Feasibility Study for National Information System (NaLIS), December 1995, Ministry of Land & Co-operative Development

Publications

(1) Streamflow and River Suspended Sediment Records, DID

(2) Rainfall and Evaporation Records for Malaysia, DID

(3) Annual Summary of Meteorological Observations, MMS

(4) Monthly Abstract of Meteorological Observations, MMS

(5) Hydrological Databank Internal Information Bulletin, No. 1, April 1980, DID

(6) Manual of Department of Irrigation and Drainage, Hydrology (Revised and Updated) 1988, 1991, DID

(7) Tide Tables 1992, Vol. 1, 1991, Royal Malaysia Navy

(8) TIDEDA Reference Manual (Second Edition), 1992, Publication No. 24 of the Hydrology Center, Christchurch, New Zealand, M. W. Rodgers and S. M. Thompson

(9) Sistem Ramalan dan Amaran Banjir di Bahagian Hidrologi, January 1995, DID

(10) Malaysia Environmental Quality Report, 1995, DOE.

(11) Environmental Quality Data 1992-1995, DOE

(12) Manual on Drinking Water Quality Surveillance, November, 1983, Ministry of Health.

(13) National Guidelines for Drinking Water Quality.

(14) National Program on Drinking Water Quality Surveillance, October 1983, Ministry of Health.

(15) TeleWin User's Manual (Telemetry Software for Windows), 1995, Powermatic Sdn. Bhd.

(16) Inventory of Hydrological Stations in Malaysia (25th Edition), 1997, DID

(17) Inventori Sistem Amaran Banjir, 1997, DID

(18) Maps on Mean Monthly, Mean Seasonal and Mean Annual Rainfall for Peninsular Malaysia (1950 -1985), Water Resources Publication No. 19, DID

(19) Training Manual for JPS Perak Telemetry System (TeleWin32 Ver 3.0), Powermatic Sdn. Bhd.

(20) Temengor, Bersia, Kenering, Chenderoh and Sungai Piah Hydroelectric Power Stations, TNB Brochures

(21) JPS Perak Telewin System Manual, October 1995, Powermatic Corp.

(22) Application of Remote Sensing and Geographical Information System in Forest Management in Peninsular Malaysia, December 1994, Forest Department

(23) Hydrological Databank Internal Information Bulletin, No. 1, April 1980, DID

(24) Economic Report 1996/1997, Ministry of Finance

(25) Social Statistics Bulletin Malaysia, 1996, Department of Statistics

(26) Annual Report 1995, 1995, MMS

(27) Annual Report, 1991 to 1996, DID (Federal)

(28) Annual Report, 1991 to 1996, DID (State of Perak)

(29) State/District Data Bank Malaysia, 1994, Department of Statistics

(30) Yearbook of Statistics Malaysia, Department of Statistics

(31) Vital Statistics Malaysia, 1996, Department of Statistics

(32) Taklimat Pembangunan Negeri Perak Darul Ridzuan (Brief of Perak State Development), November 1996, Y. Bhg. Datuk Abdul Halim bin Ali,

(33) General Report of the Population Census Vol. 1, 2, 3, 1991, Department of Statistics

(34) State Housing Report, 1991, Perak

(35) Seventh Malaysia Plan (1996-2000), 1996

(36) 1997 Malaysian Budget, 1997, Arthur Andersen HRM Sdn Bhd

(37) Statistical Handbook, Agriculture Malaysia 1990, Ministry of Agriculture

(38) Mukim Preliminary Count Report, 1991, Department of Statistics

(39) Federal Constitution

(40) State Constitutions

(41) Water Enactment

(42) Water Supply Enactment

(43) Environmental Quality Act

(44) Local Government Act

(45) Sistem Ramalan dan Amaran Banjir di Bahagian Hidrologi, January 1995, DID

(46) GIS Online, Information Retrieval Mapping and the Internet, 1997, Brandon Plewe

(47) ArcInfo System Management Manual, 1997, ESRI

(48) ArcView Users Manual, 1997, ESRI

(49) ArcView Internet Map Server Users Manual, 1998, ESRI

(50) Netscape Enterprise Server Manual, 1997, Netscape

(51) HP Workstation System Management Manual, 1998, HP

Information on Internet Homepages

(1) Department of Irrigation and Drainage Homepage (http://agrolink.moa.my/jps/), 1997, DID

(2) Tenaga Nasional Berhad Homepage (http://www.tnb.com.my/), 1997,TNB

(3) Malaysian Meteorological Service Homepage (http://www.kjc.gov.my/), 1997, MMS

(4) State Perak Homepage (http://www.perak.gov.my/), 1997, Perak State

TABLE

Table 2-1 LAND USE CONDITIONS IN PERAK RIVER BASIN (AS OF 1980 AND 1990)

Classification of Land Use	Area in 1980		Area in 1990	
	(ha)	(%)	(ha)	(%)
1 Settlement and Associated Non-Agriculture Lands	**889**	**5.86**	**821**	**5.41**
1 - 1 Urban and Associated Area			187	1.23
1 - 2 Estate Building and Associated Areas			4	0.03
1 - 3 Tin Mining Areas			601	3.96
1 - 4 Power Line Right of Ways			29	0.19
2 Agricultural Area (Non-Paddy Area)	**2,916**	**19.21**	**3,642**	**23.99**
2 - 1 Horticulture			319	2.10
2 - 2 Rubber			1,944	12.81
2 - 3 Palm			1,100	7.24
2 - 4 Others			279	1.84
3 Paddy Area	**145**	**0.96**	**271**	**1.79**
4 Forest Lands	**10,320**	**67.98**	**9,490**	**62.52**
4 - 1 Forest			8,953	58.98
4 - 2 Scrub Forest			344	2.27
4 - 3 Recently Cleared Land			32	0.21
4 - 4 Grass Land			159	1.05
4 - 5 Pasture			1	0.01
5 Swamps, Marshlands and Wetland Forests	**910**	**5.99**	**661**	**4.36**
5 - 1 Wetland and Associated Forest			486	3.20
5 - 2 Unused Land			175	1.15
6 Non-classified			**295**	**2.99**
TOTAL	**15,180**	**100**	**15,180**	**100**

Source : Land use map prepared by DOA in 1990 and National Water Resources Study in 1982 by JICA

Table 2-2 LAND USE CONDITIONS IN MAJOR RIVER BASINS (AS OF 1980)

River Basin	Settlement Area		Agricultural Area				Forest and Swamp Area						Total
			Non-Paddy Area		Paddy Area		Pasture and Grass Land		Forest Area		Swamp Area		
	(km2)	(%)	(km2)	(%)	(km2)	(%)	(km2)	(%)	(km2)	(%)	(km2)	(%)	(km2)
Perlis	0	0	181	23	428	54	0	0	181	23	0	0	790
Kedah	0	0	1,059	29	1,145	31	43	1	1,448	39	0	0	3,695
Muda	0	0	1,597	38	124	3	0	0	2,489	59	0	0	4,210
Perak	**889**	**6**	**2,916**	**19**	**145**	**1**	**0**	**0**	**10,320**	**68**	**910**	**6**	**15,180**
Bernam	22	1	1,183	35	194	6	0	0	904	27	1,033	31	3,335
Klang	269	21	442	34	0	0	0	0	404	31	173	13	1,288
Linggi	19	1	1,041	73	0	0	0	0	322	23	38	3	1,420
Melaka	51	5	719	71	51	5	0	0	154	15	34	3	1,010
Muar	45	1	3,398	52	0	0	0	0	3,040	46	112	2	6,595
Pahang	21	0	5,293	18	21	0	21	0	22,756	78	1,188	4	29,300
Trengganu	20	0	487	10	122	3	61	1	3,960	85	0	0	4,650
Kelantan	0	0	1,825	14	374	3	23	0	10,878	83	0	0	13,100
Kinabatangan	0	0	0	0	0	0	0	0	15,006	89	1,794	11	16,800
Rejang	0	0	10,692	21	0	0	21	0	36,222	71	4,379	9	51,315
Sarawak	0	0	2,370	70	0	0	42	1	440	13	545	16	3,398
Total	1,336	1	33,205	21	2,604	2	212	0	108,524	70	10,206	7	156,086

Source : National Water Resources Study, 1982 by JICA

Table 2-3 POPULATION DENSITY IN MAJOR RIVER BASINS

River Basin	Catchment Area (km2)	Population	Population Density (person/km2)
Perlis	790	183,824	233
Kedah	3,695	568,187	154
Muda	4,210	354,558	84
Perak	**15,180**	**1,161,778**	77
Bernam	3,335	168,310	50
Klang	1,288	1,839,623	1,428
Liggin	1,420	157,886	111
Melaka	1,010	141,581	140
Muar	6,595	444,909	67
Pahang	29,300	904,598	31
Terengganu	4,650	211,352	45
Kelantan	13,100	328,862	25
Kinabatangan	16,800	73,724	4
Rejang	51,315	404,556	8
Sarawak	3,398	286,484	84
Total	156,086	7,230,233	46

Source: Yearbook of Statistic, Malaysia 1996

Table 2-4 INVENTORY OF DID HYDROLOGICAL STATIONS FOR MAJOR RIVER BASINS

River Basin	Catchment Area	Rainfall Station				River Stage and Discharge Station				Evaporation Station	Suspended Sediment Station
		Non-recording	Record-ing	Total	Density	Non-recording	Record-ing	Total	Density		
	(km^2)	(nos.)	(nos.)	(nos.)	(km^2/stations)	(nos.)	(nos.)	(nos.)	(km^2/stations)	(nos.)	(nos.)
Peninsular Malaysia											
(West Coast Area)											
Perlis	790	10	3	13	61	2	3	5	158	1	2
Kedah	3,695	23	4	27	137	0	0	0	0	0	0
Muda	4,210	16	4	20	211	0	3	3	1,403	1	1
Perak	15,180	49	13	62	245	0	12	12	1,265	0	10
Bernam	3,335	18	2	20	167	2	3	5	667	1	3
Klang	1,288	14	9	23	56	0	3	3	429	2	3
Linggi	1,420	14	2	16	89	1	2	3	473	1	1
Melaka	1,010	10	1	11	92	0	2	2	505	0	1
Muar	6,595	37	7	44	150	3	4	7	942	2	3
Subtotal	37,523	191	45	236	159	8	32	40	938	8	24
(East Coast Area)											
Pahang	29,300	69	16	85	345	2	9	11	2,664	2	9
Terengganu	4,650	11	6	17	274	0	2	2	2,325	0	1
Kelantan	13,100	26	10	36	364	0	3	3	4,367	3	3
Subtotal	47,050	106	32	138	341	2	14	16	2,941	5	13
Total	84,573	297	77	374	226	10	46	56	1,510	13	37
Sabah and Sarawak											
Kinabatangan	16,800	0	8	8	2,100	0	3	3	5,600	1	0
Rejang	51,315	12	10	22	2,333	1	2	3	17,105	4	0
Sarawak	3,398	5	1	6	566	2	1	3	1,133	4	0
Total	71,513	17	19	36	1,666	3	6	9	7,946	9	0

Source :

1 DID (1991) "Hydrological Data - Rainfall and Evaporation Records for Malaysia, 1986-1990"

2 DID (1995) "Hydrological Data - Streamflow and River Suspended Sediment Records, 1986-1990"

Table 2-5 RIVER WATER QUALITY TREND IN MAJOR RIVER BASINS

River Basin	Annual Water Quality Index (WQI) Evaluated by DOE*							Trend
	1989	1990	1991	1992	1993	1994	1995	
Perlis	68	72	70	71	68	69	68	Deteriorated
Kedah	77	77	76	78	78	82	63	Unchanged
Muda	79	81	80	79	81	76	73	Deteriorated
Perak	**81**	**81**	**79**	**72**	**70**	**75**	**73**	**Deteriorated**
Bernam	80	73	75	70	73	76	80	Unchanged
Klang	60	56	56	58	53	52	55	Deteriorated
Linggi	69	68	66	67	65	71	69	Unchanged
Melaka	80	72	62	70	67	67	71	Deteriorated
Muar	81	80	75	76	75	75	75	Deteriorated
Pahang	86	85	84	82	79	84	81	Deteriorated
Terengganu	86	83	86	78	72	80	86	Unchanged
Kelantan	86	82	78	76	73	81	84	Deteriorated
Kinabatangan	---	---	---	---	80	78	75	Improved
Rejang	86	82	85	85	80	83	77	Deteriorated
Sarawak	86	86	86	84	81	82	82	Deteriorated

Note:* : WQI > 80 : Clean
60< WQI <80 : Slightly polluted
WQI < 60 : Polluted

Table 2-6 ORGANIC WASTE LOAD BY MAJOR RIVER BASINS (AS OF 1998)

River Basin	BOD ($t/yr/km^2$)	COD ($t/yr/km^2$)	SS ($t/yr/km^2$)	T-N ($t/yr/km^2$)	T-P ($t/yr/km^2$)
Kedah	1.45	1.99	1.94	0.008	0.005
Perak	**1.17**	**2.07**	**1.52**	**0.089**	**0.011**
Klang	12.08	22.22	116.99	1.651	0.204
Linggi	5.31	11.69	9.99	0.646	0.152
Melaka	3.46	5.53	4.58	0.287	0.034
Muar	0.99	1.71	1.39	0.111	0.013
Pahang	0.29	0.61	0.44	0.038	0.002
Trengganu	0.77	1.14	0.98	0.015	0.002
Average	1.10	2.01	3.85	0.108	0.014

Table 3-1 WATER QUALITY ANNUAL TREND AT CHECK POINT

River Name : SG. PERAK Station No. 4709611

Year	Date	BOD5 (mg/L)	COD (mg/L)	NH3-N (mg/L)	SS (mg/L)	pH	DO (mg/L)
1992	12-May	1.0	4.0	0	10	7.00	
1992	27-Aug	1.0	7.0	0	10	7.00	
1992	17-Nov	1.0	14.0	0	40	6.00	
1993	10-Mar	0.4	3.6	0.24	35	6.00	
1993	24-May	2.2	11.0	0.16	90	5.44	
1993	18-Jun	0.6	7.1	0.18	15	6.79	
1993	9-Aug	0.5	4.0	0.12	5	6.42	
1993	17-Sep	1.1	14.5	0.18	15	7.11	
1993	22-Nov	1.0	22.4	0.13	67	7.90	
1994	1-Jan	1.0	7.0	0.10	15	6.91	
1994	17-May	1.4	30.0	0.07	30	6.43	
1994	14-Jul	1.4	41.0	1.03	20	6.30	
1994	15-Nov	0.9	29.0	0.16	35	6.97	
1995	13-Feb	0.5	3.9	0.09	5	7.02	
1995	10-Apr	5.5	35.3	0.16	10	7.00	
1995	27-Jul	1.4	19.8	0.08	25	6.40	
1995	19-Sep	1.0	7.7	0.18	70	6.50	
1996	4-Apr	1.4	7.1	0.47	30	6.70	4.2
1996	15-Aug	0.9	7.7	0.47	13	7.00	7.8
1996	3-Dec	1.0	12.0	0.25	244	6.70	6.1

River Name : SG. KINTA Station No. 4410660

Year	Date	BOD5 (mg/L)	COD (mg/L)	NH3-N (mg/L)	SS (mg/L)	pH	DO (mg/L)
1992	21-Feb	9.0	18.0	1.00	250	7.00	
1992	4-May	1.0	4.0	5.00	205	8.00	
1992	21-May	6.0	38.0	1.00	320	7.00	
1992	20-Aug	5.0	30.0	2.00	275	8.00	
1992	19-Nov	2.0	22.0	1.00	545	7.00	
1993	14-Jan	6.2	24.8	2.13	190	6.88	
1993	9-Mar	8.0	35.6	2.14	930	6.66	
1993	26-May	1.2	33.2	0.29	460	7.22	
1993	29-Jul	3.2	27.0	0.53	70	7.18	
1993	28-Sep	2.8	28.9	0.66	170	7.26	
1993	24-Nov	2.6	22.2	0.53	386	7.05	
1994	21-Feb	7.0	31.0	0.92	90	7.31	
1994	23-Mar	5.6	15.0	0.79	150	7.15	
1994	26-May	3.2	23.0	0.54	215	6.92	
1994	29-Jul	8.6	31.0	2.48	75	7.30	
1995	9-Feb	12.2	27.2	2.90	60	7.40	
1995	4-May	6.6	15.2	0.68	260	6.90	
1995	13-Jul	7.4	22.1	1.05	190	7.20	
1995	29-Sep	2.6	30.5	0.63	440	7.00	
1996	20-Mar	7.1	59.9	1.19	525	7.20	4.2
1996	23-Jul	4.1	14.6	0.98	81	8.20	4.3
1996	14-Nov	2.2	17.0	0.95	367	6.80	3.8

Table 4-1 LOCATION OF RIVER WATER QUALITY SAMPLING POINTS

BIL	STATION NO.	RIVER NAME	D_KM	LATITUDE LONGITUDE	WATER USE	LOCATION
1	3908602	Perak	13.00	3d 59m 100d 48m	Fishery	Kampung Sungai Dulang.
2	3911610	Sungkai Mati	70.84	3d 59m 101d 06m	Fishery	Jamb. Jln Telok Intan/Bidor.
3	3911657	Sungkai	0.48	3d 59m 101d 07m	Fishery	Bt 52, Jln Bidor/Telok Intan.
4	3911692	Sungkai Mati	74.90	3d 57m 101d 08m	Industry	Dekat KKS Ganda, Teluk Intan
5	3913658	Sungkai	28.80	3d 59m 101d 18m		Pekan Sungkai.
6	3913680	Klah	50.30	3d 57m 101d 21m		Felda Trolak.
7	3913681	Klah	48.60	3d 57m 101d 20m		Felda Trolak.
8	4010603	Bidor	2.20	4d 00m 101d 00m		Jambatan Keretapi, Telok Intan.
9	4010605	Perak	39.70	4d 02m 101d 02m	Irrigation	Gudang Keretapi Telok Intan.
10	4010607	Btg Padang	75.67	4d 01m 101d 05m	Irrigation	Jam. Kg Gloochester, Telok Intan.
11	4011651	Bidor	11.68	4d 00m 101d 08m	Domestic	Simpang Changkat Jong.
12	4011655	Btg Padang	16.00	4d 01m 101d 08m	Domestic	Tanjung Keramat.
13	4109606	Perak	130.20	4d 11m 101d 56m	Drinking	Pekan Kampung Gajah.
14	4112654	Bidor	46.40	4d 06m 101d 17m		Pekan Bidor.
15	4112693	Klian Baru	94.10	4d 09m 101d 15m		Dekat KKS Cahaya Muda, Tapah.
16	4112694	Klian Baru	92.80	4d 10m 101d 15m		Jalan Besar Tapah/Bidor.
17	4119630	Kinta	1.00	4d 07m 101d 00m	Fishery	Pangkalan Feri Kg Gajah.
18	4210670	Tumboh	121.60	4d 13m 101d 00m	Fishery	Jam. Jln Kg Gajah/Tg. Tualang.
19	4212688	Batang Padang	94.60	4d 12m 101d 16m	Domestic	Jambatan Pekan Tapah
20	4212689	Chenderiang	105.60	4d 16m 101d 14m		Pekan Chenderiang
21	4212690	Chenderiang	97.60	4d 14m 101d 13m		Simpang Tiga, Chenderiang
22	4308674	Perak	99.80	4d 21m 100d 53m	Drinking	Jambatan Nordin, Bota Kanan.
23	4309679	Seluang	38.00	4d 22m 100d 57m	Irrigation	Bota Kanan.
24	4310669	Kinta	32.00	4d 19m 101d 04m	Fishery	Wier Tanjung Tualang.
25	4311628	Kampar	17.60	4d 22m 101d 10m	Drinking	Logi Pembersihan Air, Kuala Dipang.
26	4311664	Kampar	3.20	4d 20m 101d 06m	Domestic	Kampung Lanjut, Malim Nawar.
27	4407609	Perak	87.00	4d 28m 100d 44m	Drinking	Jambatan Nordin.
28	4410660	Kinta	44.80	4d 28m 101d 03m		Batu Gajah.
29	4410665	Raia	14.40	4d 28m 101d 05m	Industry	Ladang Kinta Kellas.
30	4510640	Pinji	4.00	4d 32m 101d 03m		Kg Kuala Pinji.
31	4510662	Kinta	45.00	4d 35m 101d 04m		Pengkalan Pegoh, Jln Datok, Ipoh.
32	4510672	Serokai	164.20	4d 33m 101d 04m		Pengkalan Pegoh
33	4510673	Serokai	13.00	4d 34m 101d 02m		Belakang Kilang ARE.
34	4511668	Raia	28.48	4d 32m 101d 07m	Industry	Keramat Pulai.
35	4610666	Pari	3.20	4d 36m 101d 04m		Jalan Silibin, Ipoh.
36	4611675	Kinta	75.20	4d 37m 101d 06m		Lebuhraya Ipoh, Changkat Jering.
37	4611676	Pinji	78.80	4d 36m 101d 08m		Pekan Tambun.
38	4709611	Perak	115.00	4d 46m 100d 56m	Fishery	Pekan Kuala Kangsar.
39	4709685	Kangsar	121.40	4d 46m 100d 54m	Domestic	Kampung Kuala Dal, Kuala Kangsar
40	4709686	Kangsar	118.20	4d 46m 100d 55m		Kampung Talang, Kuala Kangsar
41	4710677	Pari	86.10	4d 42m 101d 05m		Kuala Kuang, Chemor.
42	4711678	Kuang	91.50	4d 44m 101d 07m		Pekan Chemor.
43	4810644	Pelus	5.92	4d 53m 101d 01m	Domestic	Kampung Pulau Mentimun.
44	4810695	Kepayang	148.10	4d 50m 101d 01m		Changkat Salak, Sungai Siput
45	4810696	Kepayang	145.40	4d 51m 101d 00m		Changkat Salak Sungai Siput
46	4909671	Cuar	8.00	4d 54m 100d 55m	Irrigation	Dekat Kampung Cuar.
47	4909687	Cuar	137.40	4d 54m 100d 54m	Irrigation	Kampung Cuar, Kati, Kuala Kangsar
48	4911682	Kerdah	156.40	4d 54m 101d 06m	Irrigation	Ladang Sungai Reyla, Sungai Siput
49	4911683	Kerdah	153.20	4d 55m 101d 06m		Ladang Sg.Krudda,Sg.Siput
50	4911684	Pelus	153.40	4d 56m 101d 06m	Domestic	Lintang, Sungai Siput
51	5010615	Perak	239.20	5d 05m 101d 00m	Fishery	Kampung Labit, Lenggong.
52	5110691	Perak	224.00	5d 08m 101d 02m	Fishery	Kg.Bukit Sapi, Lenggong

Table 4-2 FEATURES OF EXISTING FLOOD MITIGATION WORKS

River System	Name of Scheme	Type of Work	Design Flood Level (Return Period)	Stretch	Year of Completion
Perak	Tran-Perak Stage IV Embankment	Perimeter Bund	25-year *	66km from Kubang Haji to Kg. Bakong	1976
	Lambor Kiri	Perimeter Bund	25-year *	5km from Kg. Bakong to Telok Sena	
	Stage 1 Drain Embankment	Perimeter Bund	25-year *	22km from Telok Sena to Kayan River	
Kinta	Ipoh Flood Mitigation Scheme	Dredging and Embankment of River Channel	25-year	6km Downstream of Anderson Road Bridge	Early of 1930's
	Kinta Conservancy Scheme	Alignment, Dredging and Embankment	10 to 100-year**	34km 5.3km downstream of Pari River confluence to Cenderiang confluence	1971
	Malaysia Mining Company Kinat Diversion	Alignment, Dredging and Embankment	5-year	8km (Downstream from confluence of Cenderiang River)	1980
	Pari Scheme	Channel Improvement	50-year	8km Pari River from confluence with Kinta river	1992

* Observed flood level in 1964 is adopted as the design High Water Level, and 0.2ft (0.6m) of freeboard is added on the HWL

** 100-year for 7km section upstream for confluence of Raja River
50-year for 11km section between confluence of Raja and Teja Rivers
10-year for 16km between confluence of Teja and Cenderiang Rivers

Table 4-3 PROPOSED FLOOD MITIGATION SCHEME

River System	Name of Scheme	Type of Works	Design Flood Level (return period)	Stretch	Remarks
Perak	Perak Flood Bypass Scheme	Combination of Channel Improvement and Flood Bypass Channel	100-year	66km from Kg. Bakong on Perak River to Kayan River (Flood Bypass)	1000m3/s as flow capacity for improved river and 950 m3/s for flood bypass channel
Kinta	Lower Kinta Diversion	Combination of Diversion Channel and Construction of Bund	25-year	1.5km from confluence with Tumboh River to confluence with Kroh River	Proposed by Tumboh Block Integrated Agricultural Development Project
	Sg. Kinta Upgrading	Channel Improvement	100-year	7.4km form Tasek Road Bridge to Anderson Bridge	
	Bund Upgrading (1)	Combination of Improvement of Bound and Bund Spillway	100-year	20km of bund improvement from Anderson Bridge to Batu Gaja	Overspill of on east bank of 8.7km in length (downstream from Old Pengkian Bridge, and on west bank of 14km in length
	Bund Upgrading (2)	Combination of Improvement of Bund and Bund Spillway	25-year	15km of bund improvement from Batu Gajah to confluence with Cenderiang	Supported by overspill bund by Raja Flood-Way, Kampar Floodway and Lower Kinta Floodway

Table 4-4 INVENTORY OF INTAKE FACILITY FOR IRRIGATION

Intake Facility		Name of River	Intake Facility	Design Capacity		Irrigation Scheme		Area (ha)
No.	Name			(cusec)	(m3/sec)	No.	Name	
1	Kampung Tengah	Sg. Perak	Pump	45.0	1.274	I	Belanja Kanan	101
2	Kubang Haji	Sg. Perak	Pump	205.0	5.802	V	Trans-Perak	1,250
3	Senin	Sg. Perak	Pump	30.0	0.849	III	Senin	130
4	Pendiat	Sg. Perak	Pump	120.0	3.396	II	Bota Lambor	828
5	Telok Bakong	Sg. Perak	Pump	90.0	2.547	II	Bota Lambor	
6	Bota Kiri	Sg. Perak	Pump	160.0	4.528	V	Trans-Perak	820
7	Lambor Kiri	Sg. Perak	Pump	30.0	0.849	VI	Lambor	202
8	Pintu Masuk Telok Sena	Sg. Perak	Headwork	800.0	22.640	VII	IADP Seberang Perak	8,708
9	Telok Sareh	Sg. Perak	Pump	110.0	3.113	IV	Bukit Tunggal	745
10	Sungai Manik Headworks	Sg. Perak	Headwork			VIII	IADP Sungai Manik	6,318
11	Cikus Pumstation	Sg. Perak	Pump	46.0	1.290	VIII	IADP Sungai Manik	
Total				1636.0	46.3			19,102

Table 4-5 INVENTORY OF INTAKE FACILITY FOR DOMESTIC AND INDUSTRY WATER

Intake Facility No.	Intake Facility Name	Name of River	Intake Facility	Design Capacity (cusec)	Design Capacity (m3/sec)	Service Area No.
1	Pengkalan Hulu	Sg. Kuak	Pump	1.5	0.04	I
2	Felda Nenering	Sg. Kuak	Pump	0.3	0.01	II
3	Klian Intan	Sg. Kajang	Pump	0.2	0.01	III
4	Kg. Jong	Sg. Berok	Pump	1.8	0.05	IV
8	Gerik	Sg. Kenderong	Pump	1.5	0.04	IV
5	Felda Bersia	Sg. Lebey	Pump	0.3	0.01	V
6	Pulau Bandang	Sg. Perak	Pump	1.0	0.03	VI
7	Gerik V	Sg. Perak	Pump	5.6	0.16	VII
9	Air Ganda	Sg. Perak	Pump	0.3	0.01	VIII
10	Lawwin Kinayat	Sg. Pulau	Pump	1.2	0.03	IX
11	Sumpitan	Sg. Ibol	Pump	1.6	0.05	X
13	Lenggong	Sg. Lenggong	Pump	1.0	0.03	X
12	Ulu Soh	Sg. Soh				XI
14	Padang Rengas	Sg. Kangsar	Pump	4.1	0.12	XII
15	Kota Lama Kiri	Sg. Perak	Pump	10.2	0.29	XII
16	Sungai Siput	Sg. Kerbau	Pump	9.2	0.26	XIII
17	Felda Lasah	Sg. Kunca	Pump	1.6	0.05	XIV
18	Manong	Sg. Guar	Pump	1.0	0.03	XV
19	Sauk	Sg. Biong	Pump	2.9	0.08	XVI
20	Petlop 1	Sg. Pelus				XVII
21	Ulu Kinta	Sg. Kinta	Pump	61.5	1.74	XVIII
22	Sultan Idris Shah II	Sg. Preak	Pump	122.8	3.48	XVIII
23	Sungai Jelintoh (Gopeng)	Sg. Jelintoh	Pump	0.5	0.01	XIX
24	Sungai Kampar	Sg. Kampar	Pump	8.2	0.23	XIX
25	Sungai Palai	Sg. Palai	Pump	2.6	0.07	XIX
26	Teluk Kepayang	Sg. Perak	Pump	61.4	1.74	XX
27	Kg. Paloh	Sg. Perak	Pump	20.5	0.58	XX
28	Kg. Gajah	Sg. Perak	Pump	4.1	0.12	XXI
29	BB Sri Iskandar	Sg. Perak	Pump	15.4	0.44	XXII
30	Bukit Temoh	Sg. Who	Pump	59.3	1.68	XXIII
31	Gunong Besout	Sg. Sungkai	Pump	1.1	0.03	XXIV
32	Sungkai Klah (Baru)	Sg. Tesong	Pump	2.5	0.07	XXIV
Total				405.2	11.5	

Table 4-6 INVENTORY OF IRRIGATION SCHEME

Irrigation Scheme		Net Irrigation Area (Ha)	Intake Facility			
No.	Name		Name		Caoacity (m3/s)	Water Source (River)
I	Belanja Kanan	101	1. Kampung Tengah		1.27	Perak
II	Bota Lambor	828	4. Pendiat (3.4m3/s)	5. Telok Bakong (2.55m3/s)	5.94	Perak
III	Senin	130	3. Senin		0.85	Perak
IV	Bukit Tunggal	745	9. Telok Sareh		3.11	Perak
V	Tran-Perak	2,070	2. Kubang Haji (5.8m/s)	6. Bota Kiri (4.53m3/s)	10.33	Perak
VI	Lambor	202	7. Lambor Kiri		0.85	Perak
VII	IADP Seberang Perak	8,708	8. Pintu Masul Telok Sena			Perak
VIII	IADP Sungai Manik	6,318	10. Sungai Manik Headworks	11. Chikus Pump Station		Batang Pandan

Table 4-7 INVENTORY OF DOMESTIC AND INDUSTRIAL WATER SUPPLY AREA

Region	District	Supply Area		Intake Facility	Water Source	Intake Volume (m3/s)	Catchment (km2)	Population to be Served
		No.	Name of Settlement Area					
Northern Region	1. Hulu Perak	I	Pengkalan Hulu, Kompleks Kastam, Sila rujuk peta, Kg. Raja Paya, Kg. Bkt. Buluh	1. Pengkalan Hulu	Sg. Kuak, Sg. Semangga	0.04	36.86	10,200
		II	Felda Lepang Nenering	2. Felda Nenering	Sg. Kuak	0.01	---	1,000
		III	Klian Intan	3. Klian Intan	Sg. Kajang	0.01	4.41	1,700
		IV	Kg. Lalang, Kerunai, Gerik, Gerik, Kg. Tawai	4. Kg. Jong, 8. Gerik	Sg. Berok, Sg. Kenderong	0.09	206.32	26,000
		V	Felda Bercia, Kg. Bercia	5. Felda Bersia	Sg. Lebey	0.01	32.40	1,260
		VI	Pulau Banding	6. Pulau Bandang*	Lake Temenggor	0.03	---	---
		VII	Bercia, Gerik	7. Gerik*	Lake Temenggor	0.16	---	---
		VIII	Felda Air Ganda, Kg. Air Ganda	9. Air Ganda	Sg. Perak	0.01	---	1,250
		IX	Lawin, Kenering	10. Lawwin Kinayat	Sg. Pulau	0.03	61.95	7,100
		X	Sumpitan, Air Kala, Lenggong, Kg. Cangkat Berangan	11. Sumpitan, 12. Lenggong	Sg. Ibol, Sg. Lenggong	0.08	33.15	18,400
		XI	Kg. Ulu Soh	13. Ulu Soh	Sg. Soh		39.49	200
	2. Kuala Kangsar	XII	Pdg. Rengas, Kg. Buaya, K. Kangsar, K. Kangsar, Sayong	14. Padang Rengas, 15. Kota Lama Kiri	Sg. Kangsar, Sg. Perak	0.41	8228.5	79,100
		XIII	Sg. Siput, Rimba Panjang, Kg. Jalong	16. Sungai Siput	Sg. Kerbau, Sg. Bemban	0.26	198.22	41,100
		XIV	Felda Lasah, Pulau Kamiri	17. Felda Lasah	Sg. Kunca	0.05	21.63	11,000
		XV	Manong, Kg. Ulu Piol, Senggang	18. Manong	Sg. Guar	0.03	23.88	10,600
		XVI	Sauk, Kg. Kuak, Liman Kati	19. Sauk	Sg. Biong	0.08	14.59	19,000
		XVII	Felda Perlop	20. Petlop 1	Sg. Pelus		---	450
Central Region 1	3. Kinta	XVIII	Ulu Kinta, Chemor, Tambun, Ipoh, Sg.Raya, Parit, Bota, Batu Gajah, Tg. Tualang, Ipoh	21. Ulu Kinta, 22. Sultan Idris Shah II	Sg. Kinta, Sg. Preak	5.22	9200.3	568,180
		XIX	Gopeng, Malim Nawar, K. Dipang, Kampar, Kota Baru, Kampar	23. Sungai Jelintoh (Gopeng), 24. Sungai Kampar, 25. Sungai Palai	Sg. Jelintoh, Sg. Kampar, Sg. Palai	0.31	364.13	100,000
Central Region 2	4. Manjung	XX	Lr Kiri, Ckt. Lada, Pasir Salak, Manjung, Tg. Belanja, Layang-Layang Kiri, Manjung	26. Teluk Kepayang, 27. Kg. Paloh	Sg. Perak	2.31	18,295.42	200,000
	5. Ocrak Tengah	XXI	Kg. Gajah, Pasir Panjang Hulu, Lr. Kanan	28. Kg. Gajah	Sg. Perak	0.12	9,278.83	19,000
		XXII	BB Sri Iskandar	29. BB Sri Iskandar*	Sg. Perak	0.44	9,145.00	---
Southern Region	6. Batang Padang	XXIII	Tapah, Chenderiang, Ayer Kuning, B. Padang, Bidor, Hilir Perak	30. Bukit Temoh	Sg. Wohh, Sg. Batang Padang	1.68	270.55	362,251
		XXIV	Gugusan Felda G. Besout, Kg. Kuala Slim, Felda Sg. Klah, Sungkai	31. Gunong Besout, 32. Sungkai Klah (Baru)	Sg. Sungkai, Sg. Tesong	0.10	393.75	43,877
					Total	11.48	55849.38	1,521,668

* Under Construction

Table 4-8 INVENTORY OF INFORMATION ON ECOTOURISM

ITEM	CONTENTS
Safari in Perak River	*Safari is usually held on middle reaches between Kuala Kangsar and Pasir Sarak by private company. *The development of safari in the whole Perak river including upper reaches will be completed up to 2005.
Historical monuments	*Kuala Kangsar and Pasir Sarak are two famous water front areas including historical monuments in Perak river basin. *The development of Pasir Sarak is now on-going and will be completed up to 1999. *The number of visitors Pasir Sarak; approximately 500 persons/day Kuala Kangsar; approximately 200 persons/day
Boat navigation	*Be usually held between Kuala Kangsar and Pasir Sarak. *Used boat is smaller The capacity of the crew; less than 10 persons If water depth drops below 0.3m, the boat may be stranded *Ordinary time-schedule from 9:00 to 17:00
Canoe expedition	*Be usually held between Chenderoh and Bagan Datoh. *Event schedule Jan., Apr., Aug., and other holiday *Expedition time-table for five days *Participation fee 50-100RM/person
Lodging facilities	*Kuala Kangsar 5 hotels, 55persons 11-100RM/person *Pasir Sarak under construction *Bercia 4 hostels, 40persons

Table 4-9 PRESENT MAP INFORMATION

Agency/Department		Ministry	Type of Map	Scale	Projection	Coverage	Data Source	Digitizing Status	GIS Status
DOA	Federal	MOA	Land Use Map	1:50,000	RSO	Whole Malaysia	Aerial photo, Ground truth, Satellite image for renewal	Completed	Exist (ARC/INFO)
			Reconnaissance Soil Map	1:500,000	RSO	P. Malaysia	Aerial photo, Ground truth	Completed	
			Semi-Detail Soil Map	1:25,000	RSO	P. Malaysia	Aerial photo, Soil sampling	On-going	
Dept. of Wildlife and National Park	Federal	MOSTE	Forest Cover and Protected Areas Map	1:1,000,000	RSO	P. Malaysia	Land Use Map (MOA) Digital Chart of World (ESRI) Ground survey	Completed	Exist (pc ARC/INFO)
Forest Dept.	Federal	MOPI	Forest Inventory Map	1:250,000	RSO	P. Malaysia	Ground survey	On-going	Exist (ARC/INFO)
			Forest Reserve Area, Forest Compartments Map	1:50,000 (1:63,360)	RSO	P. Malaysia	Aerial photo, Ground truth	On-going	
Forest Dept., Perak	State	MOPI	Forest Reserve Area, Forest Compartments Map	1:50,000 (1:63,360)	RSO	State	Aerial photo, Ground truth	On-going	On-going
Dept. of Geological Survey	Federal	MOPI	Geological Map	1:500,000	RSO	P. Malaysia	Aerial photo, Ground truth	On-going	Exist (ARC/INFO)
			Geological Map	1:250,000	RSO	State			
DSMM	Federal	MLCD	Topographic Map	1:50,000	RSO	Whole Malaysia	Aerial photo	On-going	No exist (Mapping System)
				1:25,000	RSO	Whole Malaysia	Aerial photo	On-going	
				1:10,000	RSO	Major City	Aerial photo	On-going	
DSMP	State	MLCD	Cadastral Map	1:800	Cassini	State	Ground survey	On-going	Exist (ARC/INFO)
Dept. of Land, Perak	State	MLCD	Cadastral Map	1:800	Cassini	State	Cadastral Map (DSMP)	On-going	On-going (NaLIS)
Perak Water Board	State	MWORKS	Cadastral Map	1:800	Cassini	State	Cadastral Map (Dept. of Land)	Completed	No exist (CAD System)
Town and Country Planning Dept., Perak	State	MHLG	Structure Plan	Various	RSO	State	Topographic Map (DSMM)	No plan	No exist (Proposed)

Abbreviation:
DOA: Dept. of Agriculture
DSMM: Dept. of Survey and Mapping Malaysia
DSMP: Dept. of Survey and Mapping Perak
MOA: Ministry of Agriculture
MOSTE: Ministry of Science, Technology and Environment
MOPI: Ministry of Primary Industry
MLCD: Ministry of Land and Cooperative Development
MWORKS: Ministry of Works
MHLG: Ministry of Housing and Local Government
NaLIS: National Infrastructure for Land Information System

Table 5-1(1/2) PRESENT AND PROPOSED INFROMATION SYSTEM CONFIGURATION

Agency/Department	Purpose	Software			Hardware		Network	No. of Stuff
		OS	GIS/RS	DB/others	Computer	Peripheral		
DID, Coastal Div.	Coastal Information Management	Windows	ArcView ArcCAD		PC	Digitizer Plotter Scanner(A4)	LAN	less than 5
DID, Hydrology Div.	Hydrological Data Management	UNIX (Server)		Infomix	UNIX Server		LAN	less than 5
		UNIX (Client)	Arc/Info ArcView	TIDEDA	Workstation	Digitizer Plotter		
		Windows (Client)	ArcView	TIDEDA	PC	Digitizer		
DOA	Land Use and Soil Database Management	UNIX (Server)		ORACLE	UNIX Server	Disk Storage & Back up Device	LAN	GIS: Officer x 1 Senior Technician x 1 Technician x 2 Operator x 4 RS: Officer x 1 Technician x 4
		UNIX (Client)	Arc/Info		Workstation	Digitizer Plotter		
		UNIX (Client)	ERDAS		Workstation	CCT Drive		
Fishery Dept.	Fisheries Management	UNIX (Server)		ORACLE	UNIX Server	8 mm Tape Back Device	WAN	In HQ x 7
		UNIX (Client)		In-house Application				
MOA	AGROLINK Network Administration, Home Page Production	UNIX		Web Server ftp Server BC Server	UNIX Server	Back Device	Internet Intranet LAN	In HQ System Engineer x 3 (full time) Application Group x 12 (temporally)
		WindowsNT		Video Server Audio Server IPC Server news Server BC Server	WindowsNT Server	Back Device		
DOE	River Environment Management	UNIX	Arc/Info ERDAS		Workstation	Digitizer Plotter	LAN	less than 5
		Windows	ArcView		PC			

Table 5-1(2/2) PRESENT AND PROPOSED INFROMATION SYSTEM CONFIGURATION

Agency/Department	Purpose	Software			Hardware		Network	No. of Stuff
		OS	GIS/RS	DB/others	Computer	Peripheral		
Dept. of Wildlife and National Park	Protected Areas Map Production	UNIX	Arc/Info		Workstation	Digitizer Plotter		less than 5
MACRES	Consultant, Training and Contract Research	UNIX	Geovision SPANS		Workstation	Digitizer Plotter	LAN	All of Staff x 90
		Windows	Geovision SPANS		PC	Digitizer Plotter		
Forest Dept.	Forestry Information Management	UNIX (Server)	Arc/Info		UNIX Server	DAT Drive Plotter	LAN	GIS Expert x 2 Digitizing Operator x 6
		UNIX (Client)	Arc/Info		Workstation			
		UNIX (Client)	ERDAS		Workstation			
		MS-DOS	Arc/Info		PC	Digitizer		
		MS-DOS	ERDAS ArcView			CCT Drive Color Printer		
Mines Research Institute	Geological Survey	UNIX	Arc/Info		Workstation	Digitizer Plotter		less than 10
DSMM	Topographic Mapping	OpenVMS	Sysdeco GINIS (Mapping Software, Norway) ER Mapper		Minicomputer Workstation	Digitizer Scanner Plotter Film Writer Cell Plotter	LAN	Officer x 20 Technician x 80
DSMP	Cadastral Survey and Mapping	UNIX	Arc/Info		UNIX Server Workstation	Digitizer Plotter MO Drive	LAN	less than 10
Perak Water Authority	Water Supply Facility Management, Delivery Network Analysis	Windows	AutoCAD		PC	Digitizer Plotter		less than 10
Town and Country Planning Dept., Perak	Urban Development Plan	UNIX PC	GenaMap MapInfo		UNIX Server Workstation	Digitizer Plotter MO Drive	LAN	NA (Proposed)

Table 6-1 OBJECTIVE INFORMATION TO BE COLLECTED AND THE PRESENT COMPETENT AGENCY FOR INFORMATION

Objective Information					Present Competent Agency for the Information
Major Category	Detailed Category	Real-time information	Non-real time information	Digitization of non real time information	
1. River Gauging and Monitoring Information	1. Hydrological information (rainfall, river stage/discharge, river suspended sediment load and tidal level)	yes	yes	Completed	DID, TNB (Federal)
	2. Dam reservoir information (inflow/outflow discharge and reservoir level)	yes	yes		
	3. Water Quality information and location map of water sampling point	yes	yes	Completed	DOE (Federal)
	4. Inventory and location of pollutant source		yes		DOE (State)
	5. Visual information of the field	yes			
2. Information on River Works	1. Flood control works (i) Inventory/location of existing flood control structures (ii) Flood mitigation plan		yes		DID (state)
	2. Water supply works (i) Inventory/location of existing intake points (ii) Water intake volume of each facilities		yes		PWB and DID (State)
	3. River Environmental Improvement Works (i) Inventory/location of echo-tourism facilities controlled by Yayasan Perak (ii) Location of river side park managed by local authority		yes		Yayasan Perak and Local Authority (State)
	4. River Sand Mining (i) Inventory of permit holders for sand mining (including mining volume, mining method, etc.) (ii) Location of mining sites		yes		Department of Land and Mining (State)
	5. Bridge Construction (i) Inventory and structural features of bridges (ii) Location of bridges		yes		Public Work Department (Fedral)
3. Information on Field Survey	1. Results of river channel survey (river plans, longitudinal profiles, river cross-sections)		yes		DID (State)
	2. Results of flood damage survey		yes		DID (Federal and State)
	3. Results of survey on fauna and flora		yes	On-going	DOWLNP (Federal)
4. Basin Land Information (Map Information)	1. Land use map		yes	Completed	DOA (Federal)
	2. Forest conservation map and annual logging volume		yes	On-going	Forest Department (State)
	3. Topographic map		yes	On-going	DSMM (Federal)
	4. Cadastral (land parcel) map		yes	On-going	PWB (State)
	5. Soil map		yes	Completed	DOA (Federal)
	6. Structural Plan (urban development and industrial development)		yes		Town and Country Dep. (State)
5. Basin Census information	1. Population		yes		EPU and Dep. of Statistics (State)
	2. Socio-economic statistics		yes		EPU and Dep. of Statistics (State)

Table 6-2(1/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
I. General	1. Features of River Basin		
	(1) Catchment area	4-3	Level 2
	(2) River system	4-3	Level 2
	(3) Length of river channel	4-3	Level 2
	(4) Socio-economic census in the basin	4-3, 5-2	Level 2
	2. Hydrological Information		
	(1) Inventory of gauging stations	1-1	Level 2
	(2) Location of gauging stations	1-1	Level 2
	(3) Rainfall data (hourly and daily)	1-1	Level 2
	(4) River stage data (mean daily, max. and min.)	1-1	Level 2
	(5) River discharge data (rating curve, mean daily, max. and min.)	1-1	Level 2
	(6) River suspended discharge (rating curve, mean daily, max. and min.)	1-1	Level 2
	3. River Structures (Bridges, Water Pipes, etc.)	2-5	
	4. Map Information		
	(1) Topographic map	4-3	Level 1
	(2) Soil map	4-5	Level 1
II. Flood Management	1. Real-time Flood Gauging and Monitoring Information		
	(1) Flood hydrological gauging information	1-1	Level 2
	(2) Dam reservoir gauging information	1-2	Level 2
	(3) Visual information of flood condition in the field	1-5	Level 2
	2. Existing and Projected Flood Mitigation Schemes		
	(1) Present channel flow capacity	3-1	Level 2
	(2) Design flood	2-1	Level 2
	(3) Structural features of facilities (dike, floodway, etc.)	2-1	Level 2
	(4) Location of facilities	2-1	Level 2
	3. Flood Inundation Area		
	(1) Probable basin run-off discharge	1-1	Level 1
	(2) Extent of probable flood inundation area (PFIA)	3-1, 4-3	Level 1
	(3) Socio-economic census in PFIA	5-1, 5-2	Level 1
	(4) Present land use in PFIA	4-1	Level 1
	(5) Structural Plan in PFIA	4-6	Level 1
	4. Flood Damage Record		
	(1) Hydrological conditions	3-2	Level 2
	(2) Extent of flood inundation area	3-2	Level 2
	(3) Road length inundated	3-2	Level 2
	(4) Number of people affected	3-2	Level 2
	(5) Flood damage amount	3-2	Level 2
	(6) Epidemic caused by flood	3-2	Level 2

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-2(2/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
III. Water Supply and Water Resources Management	1. Real-time Low Flow Gauging Information		
	(1) Low flow discharge gauging information	1-1	Level 2
	(2) Dam reservoir gauging information during a drought period	1-2	Level 2
	(3) Water quality gauging information	1-3	Level 2
	2. Existing and Projected Intake Facilities		
	(1) Inventory of facilities	2-2	Level 2
	(2) Location of facilities	2-2	Level 2
	(3) Design intake capacity	2-2	Level 2
	(4) Structural features	2-2	Level 2
	3. Existing and Projected Water Resources Development Facilities		
	(1) Inventory of facilities	2-2	Level 2
	(2) Location of facilities	2-2	Level 2
	(3) Structural features of facilities	2-2	Level 2
	(4) River maintenance discharge guaranteed by facilities	2-2	Level 2
	4. Irrigation Water Supply		
	(1) Monthly irrigation demand	2-2	Level 2
	(2) Extent and location of irrigation area	2-2	Level 2
	5. Domestic/industrial water supply		
	(1) Daily water demand	2-2	Level 2
	(2) Service area of public water supply	2-2	Level 2
	(3) Number of people to be supplied	2-2	Level 2
IV. Environmental Management	1. Real-time Water Quality Gauging Information	1-3	Level 2
	2. Channel Morphology		
	(1) River stretch of serious sedimentation	3-1	Level 2
	(2) River Stretch of serious erosion	3-1	Level 2
	(3) River stretch of serious meandering	3-1	Level 2
	3. Sand Mining		
	(1) Location of mining sites	2-4	Level 2
	(2) Annual mining volume	2-4	Level 2
	(3) List of permit holders	2-4	Level 2
	4. Water Quality		
	(1) Identified pollutant sources	1-3	Level 2
	(2) Results of water quality tests	1-2	Level 2
	5. Fauna and Flora in the River		
	(1) Results of field survey (sex, size, location and habit)	3-3	Level 2
	6. Echo-tourism		
	(1) Tourism-boat service (route, date for boating, fee, application method, etc.)	2-3	Level 2
	(2) Tourism spots along river (historical monuments, river parks, camping sites, etc.)	2-3	Level 2
	(3) Lodging facilities	2-3	Level 2

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-2(3/3) OBJECTIVE INFORMATION TO BE DISSEMINATED AND DISSEMINATION LEVEL

Category of Management	Information to be Disseminated	Information Source (Major Category No.- Detailed Category No. in Table II-9)	Dissemination Level *
V. Watershed Management	1. Logging Activities		
	(1) Classification of forest reserve area	4-2	Level 1
	(2) Annual logging volume	4-2	Level 1
	2. Present Land Use		
	(1) Land use map	4-1	Level 2
	(2) Existing major urban areas	4-1	Level 2
	(3) Existing major industrial estates	4-1	Level 2
	3. Structural Plans		
	(1) Overview map of structural plan	4-6	Level 1
	(2) Projected urban development areas (location, extent, target year, etc.)	4-6	Level 1
	(3) Projected industrial estates (location, extent, target year, etc.)	4-6	Level 1
	4. Cadastral Map	4-4	Level 1

* : Level 1 disseminates to the government agencies only, while Level 2 opens to the public.

Table 6-3 INVENTORY OF RIVER STREAM GAUGING STATIONS PROPOSED IN MASTER PLAN

Class of Gauging Station	Station Name		Location			Present Competent Authority	Telemetry Equipment	Remarks
			River System	Lat.	Lng.			
1. Principal Gauging Station	1-1	Jam. Iskandar	Perak	04° 49 ' 10 "	100° 57 ' 55 "	DID	Existing	Existing DID Principla Sta.
	1-2	Parit	Perak	04° 27 ' 40 "	100° 54 ' 05 "	DID	- ditto -	Existing DID FFW Sta.
	1-3	Kg. Gajah	Perak	04° 11 ' 05 "	100° 56 ' 30 "	DID	- ditto -	- ditto -
	1-4	Weir G. Tg. Tualang	Kinta	04° 19 ' 20 "	101° 04 ' 30 "	DID	- ditto -	Existing DID Principla Sta.
	1-5	Kg. Lintang	Pelus	04° 56 ' 15 "	101° 06 ' 10 "	DID	- ditto -	- ditto -
2. Secondary Gauging Station	2-1	Jln. Silibin, Ipoh	Pari	04° 36 ' 20 "	101° 04 ' 00 "	DID		Existing DID Secondary Sta.
	2-2	Keramat Pulai	Raia	04° 32 ' 00 "	101° 08 ' 20 "	DID		- ditto -
	2-3	Bt. 32 Jalan Tapah	Cenderiang	04° 13 ' 55 "	103° 13 ' 10 "	DID		- ditto -
	2-4	Tg. Keramat	Btg. Pandang	04° 08 ' 05 "	101° 08 ' 50 "	DID		- ditto -
	2-5	Sungkai	Sunkai	03° 59 ' 15 "	101° 18 ' 50 "	DID		- ditto -
	2-6	Malayan Bidor Bhd.	Bidor	04° 04 ' 30 "	101° 14 ' 40 "	DID		- ditto -
3. Tertiary Gauging Station	3-1	Tg. Rambutan	Kinta	04° 40 ' 10 "	101° 09 ' 30 "	DID	Existing	Existing DID Secondary Sta.
	3-2	Kg. Lamjut	Kampar	04° 20 ' 10 "	101° 06 ' 05 "	DID		- ditto -
4. Tidal Gauging Station	4-1	Bagan Dato	Perak	03° 58 ' 55 "	100° 47 ' 30 "			Newly Proposed
5. Dam Reservoir Gauging Station	5-1	Temengor Dam	Perak	05° 25 '	101° 19 '	TNB		
	5-2	Bersis Dam	Perak	05° 29 '	101° 14 '	TNB		
	5-3	Kenering Dam	Perak	05° 13 '	101° 05 '	TNB		
	5-4	Chenderoh Dam	Perak	04° 57 '	100° 59 '	TNB		

Table 6-4 COMPARISON OF CLIENT/SERVER SYSTEM WITH MAINFRAME SYSTEM

	The Client/Server System (distributed system)	The Mainframe System (integrated system)
Extendibility	1. Extended use of the existing system is possible 2. Addition of functions to suit the purpose of operations is easy. 3. Increase in the volume of data and the number of users can be met with the extenuation of server.	1. If a model different from the existing system is chosen, all the machines must be replaced. 2. Addition of functions to suit the purpose of operation is possible but limited. 3. The data volume and the number of users are fixed by the capacity of the computer.
Maintenance Management	1. Time and labor increase as the number of models and units increases.	1. Maintenance is easy because there is only one machine. 2. In some cases the system has to be stopped during maintenance.
Reliability	1. Since data is distributed and stored to plural units, the system never stops even if one unit fails.	1. The entire system stops if the computer fails.
Cost Efficiency	1. Construction of the system suited for the purpose of work is possible. 2. The open system allows choice of cost efficient models.	1. Initial investment is large. 2. The cost of application software is expensive because vendors are limited.

Table 6-5 INVESTMENT COST FOR RIVER BASIN INFORMATION SYSTEM PROPOSED IN MASTER PLAN

Devices	Unit Cost ('000 RM)	Quantity	Cost ('000RM)	%
1. Gauging/monitorind				
Radar rainfall gauge	4,230 /unit	1 unit	4,230	21.6
Real-time water quality gauge	160 /unit	5 units	800	4.1
Industrial television (ITV)	247 /unit	4 units	987	5.0
Portable information terminal (PIT)	7 /unit	1 unit	7	0.0
Sub-total			6,025	30.8
2. Data processing				
Setver machine (UNIX)	76 /unit	9 units	684	3.5
Computer for radar analysis	6,840 /unit	1 unit	6,840	35.0
Computer for water quality analisis	1,100 /unit	1 unit	1,100	5.6
Input device	126 /unit	2 units	252	1.3
Output device	32 /unit	1 unit	32	0.2
Terminal Adopter	6 /unit	2 units	12	0.1
Software	Lamp sum		705	3.6
Audio Machines	828 /unit	2 units	1,656	8.5
Sub-total			11,281	57.7
3. Data Transmission				
Maltiplex radio wave for rainfall radar	1,320 /unit	1 unit	1,320	6.7
Telemetry divice for water quality	90 /unit	5 units	450	2.3
Telemetry line for water level gauge	60 /unit	8 units	480	2.5
Sub-total			2,250	11.5
Grand Total			19,556	100

Table 6-6 QUALITATIVE IMPROVEMENT OF INFORMATION BY THE PROPOSED SYSTEM

Item of Information	Qualitative Improvement
1. Gauging data	(1) Rainfall gauging area is expanded by radar rainfall gauge covering the present blind area particularly in the upper reaches. (2) Gauging of water quality and river flow discharge is unified at the principal gauging points. (3) The dynamic visual and audible scenes of remote field could be monitored by the ITV system.
2. Information related to flood management	(1) Location and structure of previous and on-going flood mitigation works in the entire river basin are made available. (2) The river channel flow capacity of the entire river stretch is newly made available. (3) Extent of probable flood inundation area as well as land use and other socio-economic statistics in the possible flood inundation area are newly made available.
3. Information related to water supply and water resources management	(1) Location and structural features of all water supply and water resource facilities in the river basin are newly made available. (2) All water intake volume for the entire river basin system are integrated into a unified data base (3) All water demands with Perak river as the source are integrated into a unified data base. (4) Perspective of all water intake volume and the river flow discharge are monitored on the real-time base.
4. Information related to environmental management	(1) Information of river morphology (the river channel survey) are newly made available. (2) Integrated information on the ecotourism are newly made available. (3) Inventory of fauna and flora in Perak river are newly made available.
5. Map information	(1) The following map information for the entire Perak river basin are newly made available; (a) Classification of forest reserve area (b) Updated land use map (c) Structural Plan (urban and industrial development plan (d) Cadastral map

Table 6-7 ANNUAL EXPENDITURES FOR RIVER DEVELOPMENT PLANS BY STATE DID OF PERAK

Year	Expenditure	Man-month of Required Stuffs			
	(RM million)	Professional Engineer	Assistant Engineer	Technician	Total
1991	0.82	30	61	121	212
1992	0.88	33	65	130	228
1993	0.95	35	70	140	246
1994	N/A	N/A	N/A	N/A	N/A
1995	1.15	42	85	169	297
1996	1.12	41	83	166	290
1997	1.39	51	102	205	359

Note: The expenditure is solely for study and/or plan formulation excluding the construction cost.

Table 6-8 CASH FLOW OF ECONOMIC COST AND BENEFIT OF RIVER BASIN INFORMATION SYSTEM PROPOSED IN MASTER PLAN

(Unit: RM million)

Year	(1) Investment Cost	(2) Accumulated Investment Cost	(3) Maintenance Cost *	(4) Total Cost (1)+(3)	(5) Full Benefit	(6) Actual Benefit	(7) (1)-(6)	Remarks
2001	0.390	0.39	0.37	0.76	0.84	0.02	0.75	8th Malaysia Plan
2002	0.393	0.78	0.44	0.83	0.95	0.04	0.79	- ditto-
2003	0.396	1.18	0.51	0.91	1.09	0.07	0.83	- ditto-
2004	0.399	1.58	0.58	0.98	1.24	0.11	0.87	- ditto-
2005	0.403	1.98	0.65	1.05	1.41	0.16	0.89	- ditto-
2006	0.409	2.39	0.72	1.13	1.60	0.22	0.91	9th Malaysia Plan
2007	0.415	2.80	0.79	1.21	1.82	0.29	0.92	- ditto-
2008	0.421	3.23	0.87	1.29	2.07	0.38	0.91	- ditto-
2009	0.427	3.65	0.94	1.37	2.36	0.49	0.88	- ditto-
2010	0.434	4.09	1.02	1.45	2.68	0.62	0.83	- ditto-
2011	0.697	4.78	1.14	1.83	3.05	0.83	1.00	10th Malaysia Plan
2012	1.120	5.90	1.33	2.45	3.48	1.16	1.29	- ditto-
2013	1.800	7.70	1.64	3.44	3.96	1.73	1.71	- ditto-
2014	2.893	10.60	2.14	5.04	4.50	2.71	2.33	- ditto-
2015	4.649	15.25	2.95	7.60	5.12	4.43	3.17	- ditto-
2016	1.581	16.83	3.41	4.99	5.83	5.56	-0.58	11th Malaysia Plan
2017	0.537	17.36	3.50	4.04	6.63	6.53	-2.50	- ditto-
2018	0.183	17.55	3.53	3.71	7.55	7.51	-3.80	- ditto-
2019	0.062	17.61	3.54	3.60	8.59	8.58	-4.98	- ditto-
2020	0.021	17.63	3.54	3.57	9.78	9.78	-6.21	Project Completed
2021			3.54	3.54	9.78	9.78	-6.23	
2022			3.54	3.54	9.78	9.78	-6.23	
2023			3.54	3.54	9.78	9.78	-6.23	
2024			3.54	3.54	9.78	9.78	-6.23	
2025			3.54	3.54	9.78	9.78	-6.23	
2026			3.54	3.54	9.78	9.78	-6.23	
2027			3.54	3.54	9.78	9.78	-6.23	
2028			3.54	3.54	9.78	9.78	-6.23	
2029			3.54	3.54	9.78	9.78	-6.23	
2030			3.54	3.54	9.78	9.78	-6.23	
Total	17.63	153.28	69.06	86.69	172.33	149.01		
						EIRR=	10.8%	

Note :
Maintenance Cost includes the followings

(1) Maintenance cost of equipment (=15% of the accumulated economic investment cost)
(2) Man-power cost for system operation
(= The financial cost (RM 0.46 million) x economic conversion factor (0.9)) x (Accumulated investment cost) / (total investment cost)
(3) Lease cost of optical fiber system (=The financial lease cost (RM 0.34 million) x economic conversion factor (0.9))
(4) Lease cost of satellite communication system (The financial lease cost (RM 0.2 million) x economic conversion factor (0.9))
only during 11th Malaysia Plan