CHAPTER 5 OBJECTIVE INFORMATION FOR OPERATIONAL SYSTEM

The Master Plan in Chapter 4 is proposed as the long-term plan. To realize such long term plan, it is indispensable to obtain agreement of all related agencies to link and/or provide their own information to the proposed RBIS. A new institutional setup will also be required for the operation and maintenance of the proposed long-term plan. On the other hand, the digitizing works have not yet been completed on some essential information sources for the proposed river basin information source. Thus, it is virtually difficult to immediately establish the proposed Master Plan.

However, the present dynamic basin land development requires the early service of an integrated river basin information to support a consistent and comprehensive river basin management. To make up for such shortcomings, an Operational System is installed as a model case and its initial operation is to be made within this study period. The Operational System will also effect the transfer of technical knowledge on the operation and maintenance of the proposed system.

5.1 Objective Information to be Collected

The Operational System will collect all objective information proposed in the Master Plan other than the automatic water quality gauging information, the radar rainfall gauging information and the dynamic visual information. The objective information for the Operational System have been available in Malaysia and, at the same time, urgently and essentially required for the river basin management in the Perak river basin. The details of the objective information are as described hereinafter.

5.1.1 Gauging and Survey Information

The information is categorized into hydrology, water quality, river channel survey, flood damage and fauna/flora. The contents of hydrological information are as described below.

(1) Water Quality

The objective information for the Operational System is given as the database information on the water quality and water pollutant source currently monitored by DOE (refer to Table II-12). DOE monitors the river water quality of Perak River and its tributaries about three times in a year. As described in Subsection 3.2.3, the water sampling points for river water quality in the Perak river basin tends to increase and

has reached up to 53 points in 1996. The monitoring items include human life items (such as pH, DO, BOD5, COD, SS, NH3-N) as well as human health items (such as heavy metals, coliform, cyanide, phenolics, and pesticides) which are essential indices to clarify the river water quality and execute pollutant control. DID has also monitored river water quality since 30 years ago. However, DID is reducing the number of its water sampling points which are currently limited to 12 points and has ceased to monitor organic water pollutants such as DO, BOD5, and COD in the recent 10 years. PWB also monitors river water quality as the raw water quality for the treatment plant of domestic water supply, but both monitoring points as well as monitoring items by PWB are covered by the DOE monitoring network. Thus, the monitoring on water quality by DID as well as PWB is of little significance on the river basin management works as compared with the monitoring by DOE.

As stated above, DOE is regarded as the eligible data source for water quality, and the Operational System will collect the results of monitoring by DOE as its objective information. Details of the objective information for the water quality are as described below.

(a) Objective Items to be Collected by the System

The following 26 items are to be collected by the Operational System:

Category	Monitoring Items of Water Quality	
1. Related to Environment of human life	6 items	PH, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD_5), Suspended Solids (SS), Ammoniacal-nitrogen (NH_3-N)
2. Related to human health	19 items	Color, Oil and Grease, Detergents or Methylene Blue Active Substance (MBAS), Total Coliforms, Faecal Coliforms, Cadmium (Cd), Arsenic (As), Mercury (Hg), Total Chromium (T-Cr), Lead (Pb), Manganese (Mn), Aluminum (Al), Copper (Cu), Sulphide (S), Cyanide (CN), Nitrate (NO_3-N), Total Nitrogen (TN), Phosphate as Phosphorous (Po4-P), Pesticides, Phenolics
3. For Irrigation	1 item	Chloride (Cl)

(b) Monitoring Point

The Operational system will cover all of the current 53 sampling points by DOE as the source of objective water quality information. However, the current sampling points for water quality do not coincide with the river discharge gauging points, causing difficulties in estimating the pollutant loads.

In order to retrieve such unfavorable conditions, the Operational System will provide the substitutive database of discharge to support the water quality at the three (3) key sampling points. The substitutive database discharge is given from the record of the DID stream gauging station nearest to the sampling points. The key sampling points and their corresponding discharge gauging stations are as enumerated below:

River	Sampling Point for Water Quality	Discharge Gauging Point	
	(Sampling. Point No. of DOE)	Name of Point	DID Sta. No.
Perak	Sta. No. 4709611	Iskandar Bridge	4809443
Pelus	Sta. No. 4909671	Kg. Lintang	4911445
Kinta	Sta. No. 4410660	Weir G. Tg. Tualang	4310401

(c) Data Collection Method and Data Renewal Interval

DOE has recently entrusted a series of water sampling, laboratory test of samples and digitizing of the results of laboratory test to a private company, ASAM. The Federal DOE receives the digitized water quality data from ASAM and the Federal DOE stores the data into its PC hard disk using the application software "Microsoft Excel" and "Microsoft Access". The data renewal interval by ASAM is made three times a year in accordance with a definite schedule. After a discussion between the DOE and the Study Team, it was agreed that the Operational System will collect the digitized water quality data from Federal DOE in the form of diskette. The data renewal for the Operation System will be made three times a year in accordance with the above definite data renewal schedule of DOE.

(2) Water Pollutant Sources

DOE has identified the major point pollutant sources, clarifying their location and classification (mining, industry, pig farm, and factory for rubber/palm oil) and, further, as for the industrial pollutant source, clarifying types and operation time of industry (refer to Fig. II-11). DOE also has been monitoring the discharge and water quality from the point pollutant sources about 3 to 12 times a year. The inventory of the major point pollutant sources as well as the monitoring record of effluent discharge and water quality are essential for river environmental management and included as the objective information to be collected by the Operational System subject to the following conditions:

(a) Objective Items to be Collected by the System

The following three (3) items are to be collected by the Operational System:

(i) Location map of pollutant source

(ii) Classification of pollutant source

(iii) Type of industry identified as pollutant source

(c) Data Collection Method and Data Renewal Interval

The Operational System will collect non-digital information on the inventory of the major point pollutant source including the location map from Federal DOE once a year. In the same way as the aforesaid water quality, the Operational System will also collect the digitized results of monitoring on effluent from Federal DOE in floppy diskette three times a year.

(2) River Channel Survey

The river channel survey is essential information for the river management works to monitor the conditions of channel sedimentation, meandering and erosion and to clarify the updated river channel capacity. DID has completed the latest major channel survey on Perak River for the stretch of 176 km in length from the river mouth to Kuala Kangsar in 1980. DID also made the river channel survey on Kinta River for a stretch of 53 km from Anderson Bridge to the confluence with Tumboh River in 1992. However, the results of river channel survey are dispersed among the district offices of DID, and it is virtually difficult to collect and use them for the sake of the comprehensive river management works. The Study Team attempted to collect the results of river channel survey but could not obtain them during the field survey period. Moreover, such major survey works are not periodically made. DID presently carries out only spot cross-sectional survey at the river discharge gauging stations every year.

To retrieve the above conditions, it is required to establish regular cross-sectional survey points for the stretches of possible flood overflow and periodically carry out river channel survey on the fixed points. The present data stored by the district office also needs to be retrieved. Instead of the present data storing system, field survey works will be undertaken under the control of each DID district office and the results of the survey need to be forwarded to the State DID, transmitted to the Federal DID,

and finally stored in the database of the Operational System. The necessary contents of river channel survey are as enumerated below:

Item	Contents
Information to be Collected	(a) Accumulated distance of cross-sectional survey points (b) River bed level, bank level (d) X-Y coordinates of cross-sections
Stretch of river channel survey	Perak River : 181km (river mouth to Iskandar Bridge) Kinta River : 72km (Anderson Bridge in Ipoh city proper to confluence with Perak River)
Interval of cross-sectional survey	1 to 2km
Data Source/Competent Agency	Federal DID
Time interval of survey/data renewal	1 to 2 years

The Operational System will be equipped with the database to store the above contents. The actual data input during the study period was, however, difficult, because the Study Team could not obtain the results of the river channel survey as described above. In this connection, an attempt was made to estimate the channel longitudinal profile as well as the channel flow capacity based on the results of previous study on "Tumboh Integrated Rural Development Project, in 1982" (refer to Table II-13 and Fig. II-14). The Operational System will initiate the flood management on Perak River based on the estimated channel flow capacity and then update them by the revised river channel survey to be newly carried out in the future.

(3) Flood Damage

The state DID carry out a flood damage survey in every major flood. The results of the survey are compiled as an annual flood damage report and submitted to the Hydrology Division of Federal DID. The annual flood damage reports since the 1950's have accumulated to a tremendous volume and are very useful to clarify the flood hazard area and to estimate the potential flood damage which facilitates the flood mitigation management. The reports have been kept at both the State and Federal DID, but many of them have been scattered and lost. Such unfavorable condition may be attributed to the lack of staff to arrange the reports and the difficulties in filing the reports with various sizes of flood explanatory maps such as flood inundation map and flood isohyetal maps.

From these viewpoints, the results of the flood damage survey are adopted as one of the objective information for the Operational System and to be stored in the GIS

database in accordance with the recording format currently adopted by DID. The information to be stored are as enumerated below. The database together with actual input works on the major flood events (the flood in 1976, 1975 and 1994) for the Operational System were undertaken in the field survey period (refer to Table II-14).

Items	Contents
Information to be Collected	1. Extent of flood inundation area 2. Road and bridge inundated 3. Number of people affected 4. Flood damage value in monetary value 5. Agricultural damage 6. Epidemic caused by flood 7. Flood inundation map 8. Photographs of field
Data Source/Competent Agency	Federal DID
Time interval of survey/data renewal	Immediately after the major floods

(4) Fauna and Flora

The Department of Wildlife and National Park (DWNP) surveys the gender, size, location and habit of aquatic wildlife such as fishes, terrapins and crocodiles in the Perak river basin, recording them in the GIS database. The objective river stretch for the survey is selected as the natural reserve area every three years, and the survey thereof is made two times a year. The freshwater fishes tend to inhabit in the upper reaches from Teluk Intan. The major habitats of the fishes in the Perak River are as shown in Fig. II-15. The crocodiles also inhabit around the confluence of Perak River and Kinta River. The number of crocodiles has, however, remarkably reduced due to the water pollution from Kinta River, and the crocodiles in Perak River is currently specified as rare species. The Department also specify the following four protected areas in Perak river basin and the animals to be protected in the area (refer to Fig. II-16).

Name/Place	Area (ha)	Year Gazetted	Responsible Agency	Protected Animals & Plants
Batu Gajah Bird Reserve	4	1952	DWNP	Birds
Bota Kanan Tuntung Reserve	6	1993	DWNP	Terrapin
Chior	689	1903	DWNP/FD	
Sungkai	2,468	1921	DWNP	Deer

DWNP: Department of Wildlife & National Park FD: Forest Department

The Operational System will collect and update the aforesaid results of survey on fauna and flora based on the GIS database digitized by Department of Wild Life and Natural Park. The GIS database is by the PC Arc/Info, and the Department has agreed to supply the database to the Operational System in floppy diskettes. The agreement was, however, made for the initial system operation and further coordination on the continuous data supply is required to update the data.

5.1.2 Information on River Use and River Works

(1) Flood Mitigation

The state DID and the tin mining companies have carried out and proposed various structural measures for flood mitigation including channel improvement, construction of perimeter bund, and flood diversion channel, as listed in Tables II-15 to II-16 and Fig. II-17. The design flood levels adopted for these structural measures are 25-year return period for Perak River and 5 to 100-year return period for Kinta River. Detailed information on these structural measures is being kept by the DID district office. The integration of such information is indispensable in order to figure out the entire flood mitigation works in the basin and to formulate the consistent and optimum flood control plan based on the information on the existing flood control structures.

In addition to the above flood mitigation structures, there exist four (4) hydropower dams controlled by TNB. Among the four (4) existing dams, Bersia, Kenering and Chenderoh have little flood regulation effect due to their limited dam reservoir capacity. However, the Temenggor Dam has by far larger flood regulation effect than the other dams. The Temenggor Dam draws down its normal reservoir water level to EL. 242 m from its full supply level of EL. 248 m in every October (north-east monsoon), providing the reservoir capacity of about 950 million m^3 to regulate the flood inflow discharge to the dam reservoir.

The Operational System will integrate all information related to the above existing and proposed flood mitigation facilities and update them whenever the flood mitigation work is newly completed and/or projected. The contents of information to be stored in the database of the Operational System are as tabulated below.

Item	Contents
Information on River Channel Works to be Collected	(a) Name of flood control scheme (b) Objective river for the scheme (c) Type of flood control works (d) Design flood level (e) Location and/or stretch of the scheme (f) Competent agency to maintain the scheme for the existing scheme or to proposed the scheme (g) Completion time of the scheme for the existing scheme or target completion time for the projected scheme
Information on Dam Flood Regulation Effect	(a) Name of dam and structural features of dam reservoir (b) Flood control capacity made by drawing down of the reservoir level and the period of drawing down
Data Source/Competent Agency	State DID and TNB
Time interval of survey/data renewal	Whenever the flood control work is newly completed and or proposed

(2) Water Supply Management

The Operational System will store comprehensive information on the existing and projected water intake and provide it to the agencies related to river administration and water supply works. The contents of the information to be stored are as enumerated below:

Item	Contents
Information to be Collected	(a) Location map and inventory of intake facilities (b) Water demand from the river source (c) Location map and inventory of irrigation scheme (d) Location map and inventory of domestic/industrial service area
Data Source/Competent Agency	State DID (for Irrigation Water Supply) Perak Water Board (for Domestic/Industrial Water)
Time interval of survey/data renewal	Once a year

(3) Ecotourism Management

The major attractions in the ecotourism of Perak River includes camping/lodging along the river, boating on the river, sightseeing on the historical monuments along the river and canoe expedition in the lake of dam reservoir (refer to Figs. II-18 to II-20). All of these attractions other than canoe expedition are currently being provided by a private company along the stretch between Pasir Sarak and Kuala Kangsar, but the stretch for the attractions are scheduled to expand to Chenderoh Dam by the year 2005.

The Operational System will collect and update the following items so as to promote ecotourism in the Perak river basin:

(a) Location and contents of camping and lodging facilities;

(b) Contents of boating and canoe expedition; and

(c) Location of major spots for sightseeing along the river.

The information source for the above items is Yayasan Perak, and updating of the information will be made once every three years.

(4) Other Information Relative to River Management

The major information are on bridges and river sand mining works. As for the bridges, there are twelve (12) trunk bridges crossing over Perak River and its tributaries (refer to and Fig. II-21). The information on these bridges (location, structural features, etc.) are, however, scattered among the Federal PWD, the PLUS (the privatized firm controlling the highway) and the State PWD. Thus, no integrated information is available causing difficulties in formulating the river channel improvement plan and other river work plans.

There are also 36 sand mining sites along the Perak River between Kenering Dam and the river mouth. The sand mining may cause adverse effects on the river morphology, the riverside environment and the river navigation. The Department of Land and Mining issues annual licenses for sand mining. The mining records are, however, dispersed among the district offices of the Department, and therefore, it is virtually difficult to comprehend the overall sand mining activities in the entire river basin. From the above, the Operational System will collect the information on bridges and sand mining activities, and the contents of the information to be collected are as enumerated below:

Item	Contents
Items of information on bridge	(a) Location of bridges (b) Competent agency for maintenance of bridges (c) Structural features of bridges
Items of information on sand mining activities	(a) Location of sand mining sites (b) Annual mining volume granted
Data source/competent agency	(a) Department of PWD, PLUS (for bridge information) (b) Department of Land and Mining (for mining information)
Time interval of data renewal	Once a year

5.2 Objective Information to be Disseminated

The objective information is disseminated in either the map form, the tabular form or the graphic form. The details of the objective information are as listed in Table II-17, including the name of information, renewal interval, and agency as data source. The map information also specifies the data type (polygon, line or point) and attributes attached to the information.

As shown in Table II-17, all objective information are classified in two dissemination level according to the assumed users; i.e., Level 1 for the exclusive use of the government agencies, and Level 2 for information to the public users. The principal criteria of the classification are the same as those in the Master Plan (refer to Subsection 4.2.2). However, some information specified as Level 2 in the Master Plan were provisionally shifted to Level 1 information for the initial operation of the Operational System, through a series of discussions with the officials concerned of the Government of Malaysia. The following are the major items shifted to Level 1 and the major reasons why such provisional shifting was made:

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

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

(c) Some of the information on flood management assumed as Level 2 information in the Master Plan are re-classified into Level 1 Information due to uncertainty of their contents. These information classified into Level 1 are the location

map and inventory of projected flood mitigation scheme, the results of river channel survey and the extent of flood inundation area.

The Operational System will disseminate both the real-time information and the non-real time information (i.e., database information). The real-time information contain the hydrological data (rainfall, river water stage and river discharge) transmitted from the telemetry gauging stations. Details of the real-time information are as described in Sector 1, Hydrology. As for the non-real time information, it was decided though a series of discussions with the officials concerned of the Government of Malaysia that the Operational System will disseminate the objective information through seven (7) categories according to the purposes of the river basin management. The seven (7) categories are as enumerated below, and their detailed contents are described in the following subsections.

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

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

(c) Information on River Structures presents the detailed structural features and location of bridges, river intake facilities and dams.

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

(e) Information on Water Supply Management presents the water intake facilities and statistics of comprehensive water demand so as to support the water supply management.

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

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

5.2.1 Real-time Information

The Operational System will disseminate the telemetry hydrological gauging information (rainfall, river water stage and river discharge) for the sake of flood and drought management.

(1) Flood Management

The Operational System will disseminate the following flood information, on real-time base, during the flood period from October to January.

(a) Hourly rainfall and stream water level collected from the existing DID's telemetry gauging stations;

(b) Hourly outflow discharge from Chenderoh Dam informed from TNB; and

(c) Three (3) levels of warning message in case of water level exceeding the alert level, the warning level and the danger level.

The information of the above item (c) in particular will be useful to the public to have the effective flood prevention and evacuation. The information also will be useful to TNB in particular among the government users. The existing four (4) hydropower dams are used by TNB principally for peak load generation, while in the event of a major flood, the dam reservoir operation is changed to supply the base load generation in order to minimize the dam outflow discharge. Through these dam reservoir operation, the existing hydropower dams have a substantial flood control effect for the downstream from the dam sites. However, such reservoir operation is not always effectively made, due to lack of an effective dissemination system for real-time flood information to TNB. The Operational System will retrieve such unfavorable conditions through on-line dissemination of the real-time flood information to TNB in Kuala Lumpur as well as the dam control center in the project.

(2) Drought Management

The Operational System will monitor the river discharge at Iskandar Bridge and the outflow discharge from Chenderoh Dam once a day, on real-time base, through the

existing DID telemetry gauging stations and information from TNB. The monitoring will be made during the dry season from June to August, and the monitored information will be disseminate to various water users such as PWB, DID, and TNB to facilitate their drought management operations.

The major intake facilities are placed in the downstream from Iskandar Bridge, and TNB had agreed that the existing hydropower dams are to release the dam outflow discharge to guarantee the minimum maintenance flow of 4,000 cusec at the Iskandar Bridge. The real-time information will be availed of to ensure the guaranteed discharge.

Moreover, when extreme drought occurs and TNB could not guarantee the agreed discharge, the real-time information will clarify whether the river flow discharge could be sufficient as compared with the water intake volume in the downstream. Should the river discharge be insufficient to the water intake volume, the drought management will start based on the real-time information, allocating the necessary retrenchment for each water intake point of PWB and DID.

5.2.2 Non Real-time Information (Database Information)

(1) General Information

The general features of the entire Perak river basin will be presented through the Operational System. The major items of the information in this category are classified into: (a) the base map information, and (b) the population/housing census.

(a) Base Map Information

The information presents the following topographic map, geological map and soil map as the base map of the entire river basin:

(1) Topographic map	The map is used as the base map of the river basin, containing basin boundaries, river lines, contour lines, major loads, major towns and major bridges.
(2) Geological map	The map presents the geological classification of the river basin.
(3) Soil map	The map presents the soil classification of the river basin.

(b) Population/Housing Census

The Operational System will disseminate the following three (3) data sets:

Information Item	General Socio-economy	Population and Household	Administrative Boundary
Map/Data	Database	Database	Map Scale (1:50,000)
Data Type	Data File	Data File	Polygon
Attributes/ Data Item	State, Area, Population, GRDP	Mukim, Area, Population and Households	Name of Mukim

The utilization of population, households and administrative boundary is expanding with the combination of other data sets such as regional development and flood inundation area. Administrative boundary in particular will be frequently utilized in the other river information issues such as river water and watershed management, as the background data.

(2) Hydrological Information

The Operational System will furnish the following meteorological and hydrological features of the river basin to serve as basic data for plan formulation of flood management, water supply management and other various river management works:

(a) Inventory and location map of the meteorological and hydrological gauging stations;

(b) Hourly, daily and monthly values of hydrological data (rainfall, river stage/discharge and suspended sediment discharge);

(c) Annual minimum and maximum of hydrological data (rainfall, river stage/discharge and suspended sediment discharge);

(d) Monthly averages of air temperature, relative humidity, sunshine hours, rainfall, and evaporation;

(e) Discharge and suspended sediment discharge rating curves; and

(f) Tide table at Bagan Datoh.

(3) Information on River Structures

The Operation System will present the detailed structural features and location maps of the following river structures to support the river improvement works and other various river works:

(a) The existing twelve (12) trunk bridges crossing Perak River, which consist of ten (10) federal bridges, one (1) highway, and one (1) state bridge;

(b) All existing and projected water intake facilities both for irrigation and domestic/industrial water supply; and

(c) The existing four (4) hydropower dams; namely, Temengor Dam, Bersia Dam, Kenering Dam and Chenderoh Dam.

(4) Information on Flood Mitigation

The information is related to the flood mitigation works, flood inundation area and flood damage. The information aim at supporting the clarification of updated flood conditions of the river basin, the formulation of the optimum flood mitigation plan, and the execution of the operation and maintenance of flood mitigation schemes.

(a) Flood Mitigation Works

The Operational System will present the inventory and the location map of all existing and projected flood mitigation schemes including their design flood level as well as their structural features (refer to Fig. II-17 and Tables II-15 and II-16). The information will facilitate to know the updated comprehensive flood protection level in the river basin and avail of the future flood mitigation plan.

(b) Probable Flood Run-off Discharge and Channel Flow Capacity

The probable flood run-off discharge is essential to formulate the flood mitigation plan, and needs to be estimated through hydrological statistic analysis and flood simulation. The development of a detailed calculation/simulation model is, however, required to such statistical analysis or flood simulation. Since it was virtually difficult to prepare such calculation/simulation models within the study period, the Operational System applied the results of estimation in the previous studies as the initial values of probable run-off discharge (refer to Table II-18). The updating on the probable discharge may be made, as the need arises, through the hydrological statistics analysis and the hydrological/hydraulic simulation. The hydrological data in this Operational System will avail of such statistical analysis and flood simulation.

(c) River Channel Flow Capacity

The results of river channel surveys together with the aforesaid probable flood run-off discharge are the essential information for the river channel flow capacity. However, the cross-sections and longitudinal profiles of the river channels have been scattered, and the Study Team could not obtain them during the study period. Under such conditions, an attempt was made to install a database of river channel survey in the Operational System so as to store the new channel survey results and to avoid missing data. At the same time, the following information were extracted from the previous study reports and compiled into the database of the Operational System as the initial indices to evaluate the present river channel flow capacity:

(i) Profiles of bank levels and the probable flood water levels of 5 to 100-year return period (refer to Table II-13 and Figs. II-14 and II-22);

(ii) River channel flow capacity evaluated to each river stretch (refer to Table II-19).

(d) Probable Extent of Flood Inundation

Flood from the Perak River starts to spread out in the lower reaches from Nording Bridge (located about 47 km downstream from Iskandar Bridge), when the river flow discharge at Nording Bridge exceeds the probable discharge of 2-year return period (850 m^3/s). The inundation by various flood scales has almost the same extent due to the plain topography, although the maximum inundation depth and duration of inundation change according to the scale. In this Study, the extent of such inundation area was delineated, as shown in Fig. II-23, based on the results of the previous study on "Tumboh Block Integrated Rural Development Study Flood Investigation, Mat 1985". The Operational System will apply the extent of flood inundation as the initial information. The information is, however, subject to updating based on the results of river channel survey newly made in the future.

(e) Flood Damage Record

The Operational System will have a database of flood damage record, where the results of flood damage survey by DID will be compiled. The contents of the flood damage record are as listed in Table II-14.

(5) Information on Water Supply Management

The Operational System will disseminate the information on all intake facilities as well as water demand. The information will be availed of to clarify the comprehensive water intake volume for irrigation supply and domestic/industrial water supply in the entire river system and to support the justification adequacy of the projected water supply plans. The major items of information to be disseminated by the Operational System are as enumerated below:

(a) Location map and inventory of Intake facilities (refer to Figs. II-7 to II-8 and Tables II-20 to II-21);

(b) Location map and inventory of irrigation scheme (refer to Fig. II-24 and Table II-22);

(c) Location map and inventory of domestic/industrial water supply area and population (refer to Fig. II-25 and Table II-23);

(d) Monthly water demand for irrigation (refer to Table II-24); and

(e) Daily average water demand for domestic and industrial water (refer to Table II-25).

(6) Information on River Environmental Management (Water Quality Management)

The water quality management aims at controlling effluent from pollutant sources, preserving the desirable water quality in various categories such as public water supply, ecotourism/water recreation, and protection of aquatic wildlife. To facilitate these purposes of water quality management, the Operational System will disseminate the following items:

(a) Location Map and Inventory of Sampling Points

The latest sampling points are displayed through GIS and their latest results of water quality monitoring are presented as the attributes of the sampling points (refer to Figs. II-9). The inventory of the sampling points are also presented in tabular form (refer to Table II-26).

(b) Results of Monitoring on Water Quality

The results of monitoring on water quality are presented in tabular form including monitored Station No., name of monitored river, monitoring date, and water quality at the sampling points (refer to Table II-27). Moreover, the discharge at the three monitoring points as selected in Subsection 5.1.1, will be added to the results on water quality to facilitate the loads of water quality.

(c) Water Quality Index Map on Each River Section

The Operational System will present the "Water Quality Index (WQI)" of each water sampling point in accordance with the classification by DOE (refer to Fig. II-26). The WQI is classified into the following five (5) levels:

Class I	Suitable for public water supply without treatment
Class II	Suitable for public water supply on the premises of the conventional treatment
Class III	Available for public water supply subject to extensive treatment plant
Class IV	Available only for irrigation water supply
Class V	Not good for any water supply

Through the WQI map, the system user could comprehend the overall states of water quality of the Perak river system.

(d) Location Map of Point Pollutant Source

The Operational System will display the location map of the point pollutant sources identified by DOE through GIS (refer to Fig. II-11).

(7) Information on River Environmental Management (Other than Water Quality)

In addition to the above information on water quality, the Operational System will disseminate the following information as category of river environmental management:

(a) Fauna and Flora

Based on the survey data on fauna and flora collected from the Department of Wildlife and National Park, the Operational System will present the following items as basic information for the protection of aquatic wildlife in the Perak River:

(i) Location of aquatic wildlife's habitat in the Perak river basin (refer to Fig. II-15);

(ii) Location map of the protected area for wildlife gazetted by the Department of Wildlife and National Park (refer to Fig. II-16); and

(iii) Survey results of fauna and flora in the Perak river basin, including the name of fauna and flora as well as location of habitat.

(b) Ecotourism

The Operational System will disseminate the updated attractions of ecotourism in the Perak river basin, through the Internet, to the public. The items to be disseminated are as enumerated below:

(i) Guidance of Perak river safari (refer to Fig. II-27);

(ii) Inventory of attractions and lodging facilities for the ecotourism (Table II-28);

(iii) Location map of river parks along the Perak River (refer to Fig. II-18);

(iv) Location map of camping sites along the Perak River (refer to Fig. II-19);

(v) Royal mausoleums along the Perak River (refer to Fig. II-20);

(vi) Photographs of major visiting points;

(vii) Time-table and participation fee for the expedition; and

(viii) Address and phone number to contact.

CHAPTER 6 CASE STUDY ON USAGE OF THE OPERATIONAL SYSTEM

The general usage of the information in the Operational System has been described in Chapters 4 and 5. A case study has also been carried out to further clarify how the 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 information to the river basin management. The results of the case study are described in this Chapter, as presented below.

6.1 Water Supply Management

6.1.1 Long-term Projection for Water Supply

(1) Issues on Long-term Water Supply Projection

As described in Subsection 3.2.2, the existing hydropower dams release discharge to guarantee a minimum flow of 4,000 cusec (about 113.2 m3/s) at Iskandar Bridge, but such guaranteed discharge has already reached the critical minimum level to avail of pump abstraction.

The guaranteed discharge was set up more than 20 years ago. On the other hand the water demand will certainly increase in the future due to intensive urban/industrial development and/or agricultural development, exceeding the present guaranteed discharge. Unless a long-term water supply plan is formulated, a serious water shortage could suddenly appear in the future. In line with the long-term water supply plan, the presently guaranteed discharge also needs to be updated through coordination with TNB and/or the new water resources 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 facility. The present water intake facilities are independently managed by DID (for irrigation water supply) and PWB (for domestic/industrial water supply), and their information are not mutually exchanged between these agencies. Thus, no unified agency is monitoring the overall water demand, and the adequacy of infinite water resources of the Perak River is never evaluated. Hence, RBIS will provide the comprehensive database for water supply management, facilitating the long-tem projection on water supply and balance.

(2) Use of RBIS for Long-term Water Supply Projection

RBIS contains the database on all water demand including domestic/industrial water demand as well as irrigation water demand (refer to database under the title "Water Supply Management"). RBIS also contains the database of a long-term river flow regime of Perak River (refer to the database under the title "Hydrology"). The system users could estimate, through the database, the available water supply for the overall water demand.

Through the database initially stored in 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 (refer to Table II-25). In contrast to domestic and industrial water demand, no new extensive irrigation scheme has been planned; therefore, the increment of irrigation demand is assumed to be nil.

Item of Demand	Present Water	Future Water Demand		
	Demand	2005	2010	2020
Domestic and Industrial	15.8 m^3/s	21.5 m^3/s	25.5 m^3/s	34.4 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	118.9 m^3/s	122.9 m^3/s	131.8 m^3/s
	(4,000 cusec)	(4,201 cusec)	(4,343 cusec)	(4,657 cusec)
Percentage of demand to annual average river flow at Iskandar Bridge*	59%	62%	64%	69%

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

The future water demand will exceed the presently guaranteed discharge, and the deficit of about 1,000 cusec is foreseen by the year of 2020. Moreover, the future water demand will reach up to 69% 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 requested to execute the following water supply management items:

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

(b) Coordination with water users to control the excessive increment of water demand, and

(c) Development of new water resources.

6.1.2 Daily Water Supply Management

(1) Issues on Daily Water Supply Management

DID Hydrology Division presently monitors the daily flow discharge at 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 Chenderoh Dam regardless of the river flow discharge at Iskandar Bridge. The dam maintenance discharge of 3,000 cusec is verified through the gauging records, as shown in Table II-29 and Fig II-28.

There is a difference of 1,000 cusec between the guaranteed discharge of 4,000 cusec at Iskandar Bridge and the maintenance flow of 3,000 (85 m^3/s) cusec from Chenderoh Dam. This difference is supposed to be supplemented by the runoff discharge from Pelus River that joins the Perak River at about 9 km downstream from Chenderoh Dam. However, the runoff discharge from Pelus River is a natural phenomenon, often falling below 1,000 cusec (23.8 m^3/s) (refer to Table II-29 and Fig. II-29).

The gauging record shows that a large deficit on the guaranteed discharge at Iskandar Bridge occurred in August to September 1990 (refer to Table II-30 and Figs. II-30 to II-31). During the period, the Chenderoh Dam released the dam outflow discharge of more than 3,000 cusec, although 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 with the average deficit of 6 m^3/s and the maximum deficit of 20 m^3/s (refer to Table II-30 and Fig. II-31).

The recurrence probability of the 1990's water deficit is estimated at about 5 years based on the one-month runoff discharge volume of August from the Pelus River (refer to Fig. II-32). In other words, the water deficit of Pelus River as experienced in 1990 possibly occurs once every five years.

(2) Usage of RBIS for Daily Water Supply Management

The above water deficit is attributed to the lack of an integrated hydrological monitoring system between DID and TNB. When the operation of RBIS starts, the hydrological information could be mutually exchanged among the agencies concerned and the water deficit would improve.

RBIS has functions to monitor the river flow discharge of Perak River at Iskandar Bridge and Pelus River at Kg. Lintang. At the same time, RBIS could also monitor the outflow discharge from Chenderoh Dam. All of these monitored data are on the real-time base being transmitted through WAN of RBIS, to the system administrator (DID) as well as the related agencies such as TNB and PWB (in charge of domestic and industrial water supply).

When RBIS detects that the runoff discharge from Pelus River falls below 1,000 cusec, the dam maintenance discharge (i.e., 3,000 cusec) is required to be increased so as to guarantee the river flow discharge at Iskandar Bridge (i.e., 4,000 cusec). On the contrary, TNB does not necessarily need to release the maintenance discharge of 3,000 cusec when the runoff discharge from Pelus River is sufficient, exceeding 1,000 cusec. Thus, the RBIS will enable TNB to execute a more flexible dam outflow operation depending on the runoff discharge from the Pelus River.

TNB is much concerned in maintaining the reservoir level for the sake of hydropower generation. However, 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 II-31. During the deficit, Chenderoh Dam released 92.5 m^3/s (3,268 cusec) as daily average. On the other hand, the average dam outflow discharge increased to 94.4 m^3/s to offset the deficit. The increment of dam outflow discharge will ensue from the release of discharge from the Temengor dam reservoir that is much larger than 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 or a lowering of 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 power generation.

Should difficulty arise in ensuring the guaranteed discharge due to insufficiency of dam reservoir volume, the river administrator needs to clarify again how much deficiency comes out, and initiate the following drought management operations:

(a) Declare drought management to water users;

(b) Determine the priorities of retrenchment of each water intake; and

(c) Set the actual retrenchment rate of water intake.

RBIS contains the database of all water intake facilities in the Perak river basin, providing information on their location, intake capacity and service area. The database could facilitate to determine the priorities of retrenchment by each water intake in the above drought management.

(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 was estimated at about 6 m^3/s. Such water deficit directly caused the deficit of irrigation water supply leading to the reduction of paddy production. From these viewpoint, 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 was estimated at 3.6 ton/ha, referring to the results of the Study on "Modernization of Irrigation Water Management System 1998, JICA". The economic farm gate price was also assumed at about RM 630/ha. Multiplying the average crop yield by the economic farm gate price, the gross production value was estimated at RM 2,268. On the other hand, the paddy production cost was estimated at RM 1,805/ha, as shown in Table II-32. 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 was estimated at about 604 ha/m^3/s which was derived by dividing the present total irrigation area in the Perak river basin (19,097 ha) with the monthly peak water demand (31.61 m^3/s).

Based on the above assumption, 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. Since the recurrence probability of the water deficit in 1990 is estimated at 5-year return period as described in Subsection 6.1.1, the annual average value of production loss is estimated at RM 0.34 million (=RM1.7 million/5 years), at least. RBIS will enable TNB to have flexible dam reservoir operations so that the occurrence of water deficit as experienced in 1990 could be justified by the release from the existing hydropower dam with a 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 RBIS.

6.2 Flood Management

6.2.1 Flood Control by Existing Hydropower Dam

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

The existing three (3) 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 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 Temengor Dam have been estimated based on the previous study results of "Lower Perak Flood Mitigation Study, October 1980 by JICA"(refer to Fig. II-33 (1/2)). As a result, it has been 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 listed 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 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, about 187 km downstream of Temengor Dam. On the premise of the above flood mitigation effect by Temengor Dam, the flood simulation was made and the following were 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 estimated 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 will still occur in the lower reaches of Perak River. In fact, the flood inundation occurred even after completion of Temengor Dam, as experienced in 1985, 1991 and 1994.

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

Among the existing hydropower dams, Bersia Dam which is located just downstream has a small reservoir volume of about 12 million m^3 between FSL and MSL (minimum supply level) so that a minimal potential flood mitigation effect is expected from the dam. On the other hand, the Kenering and Chenderoh dams have a rather large storage capacity of about 70 million m^3 and 60 million m^3, respectively,

between FSL and MSL. The storage capacities will likely influence flood mitigation in the lower reaches.

In order 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 stage of floods. Moreover, the released discharge to draw down the reservoir level should not cause any overflow of the 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 will cause a large constant dam inflow discharge of more than 600 m^3/s into Kenering Dam (refer to Fig. II-33(2/2)). The inflow volume into Kenering Dam is estimated at about 533 million m^3 in 50-year return period, and about 853 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 the Kenering and Chenderoh dams would hardly draw down their reservoir level, giving no substantial flood mitigation effect on the flood with a scale of between 50 and 100-year return period.

As for the flood scale of 10 and 20-year return period, Temengor Dam absorbs the whole dam inflow discharge without spilling. Due to such an effect of Temengor Dam, the small discharge flows into Kenering Dam. The dam inflow volume is estimated at about 143 million m^3 in 10-year return period and 165 m^3 in 20-year return period and these dam inflow volumes are far smaller than those in the 50 and 100-year return periods. Moreover, the initial dam inflow discharge to Kenering Dam is extremely small, and the peak inflow comes out only 72 hours after the storm rainfall is observed. Due to the small dam inflow volume as well as the small initial dam inflow discharge, the Kenering and Chenderoh dams could draw down their reservoir levels on the following conditions:

Possible Conditions to Draw Down Reservoir Level of Kenering and Chenderoh Dams

Dam	Conditions to Draw Down Reservoir Level	10-yr. Flood	20-yr. Flood
Kenering Dam	Possible duration to draw down (hour)*	54	52
	Maximum released discharge to draw down (m^3/s)	400	400
	Possible flood control space (million m^3)	256	258
Chenderoh Dam	Possible duration to draw down (hour)*	33	35
	Maximum released discharge to draw down (m^3/s)	800	800
	Possible flood control space (million m^3)	284	270

* Duration starting from the beginning of storm rainfall observed in the upper reaches of Temengor Dam.

As estimated above, the Kenering and Chenderoh dams could have a flood control space of about 260 to 280 million m^3, which have the significant reduction of peak discharge at Nording Bridge as listed below (refer to Figs. II-34 to II-36):

Peak Discharge Without and With Flood Control by Kenering and Chenderoh Dams

Peak Discharge	Without Flood Control by Dam		With Flood Control by Dam	
	10-year RP	20-year RP	10-year RP	20-year
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

The above flood mitigation is, however, 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, RBIS will be useful to monitor and distribute such real time information as described hereinafter.

(2) Usage of RBIS for Dam Flood Control

DID currently monitors the storm rainfall in the upper reaches of dams as well as the river flow discharge at Iskandar Bridge on the real-time base. Iskandar Bridge is located at about 47 km upstream from Nording Bridge, which is the key point of flood inundation of Perak River as described above. No dominant discharge runs off between Iskandar Bridge and Nording Bridge. Accordingly, the river flow discharge at Nording Bridge could be presented as almost the same value as that of Iskandar Bridge.

In spite of the above monitoring works by DID, TNB hardly receives the real-time hydrological information due to lack of on-line information linkage between DID and TNB. Accordingly, it is virtually difficult for TNB to draw down the reservoir level

of the Kenering and Chenderoh dams for the sake of flood mitigation. At the same time, the information on dam gate operation is hardly transmitted to DID, causing difficulties of flood forecasting and warning for the lower reaches.

RBIS has a function to monitor the real-time flood information on the storm rainfall, the river flow downstream and dam outflow discharge from Chenderoh Dam. Further, RBIS distributes these information, through WAN, to TNB as well as DID. Once these information are recognized through 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 an initial stage of flood until the dam inflow discharge reaches 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 RBIS. As a result, the dam outflow discharge could be controlled effectively for the sake of flood mitigation in the lower reaches. Moreover, DID could foresee the influence of dam outflow to the downstream based on the information on dam conditions from TNB so as to undertake a more effective flood forecasting and warning operations.

6.2.2 Evaluation of Flood Damage Potential

In the flood management works, major concerns are addressed to the flood damage potential that is an essential index for the economic evaluation of new flood mitigation projects. The database of RBIS will facilitate the estimation of annual average damage expressed in monetary term. The usage of database to estimate the flood damage potential is hereinafter presented 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 various 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.

RBIS will provide the map information on flood inundation extent as well as land use on the basis of the topographic map of 1 is 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 overlying of the two maps. Through overlying 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

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 flood inundation area could be estimated through the overlay function of the GIS system in RBIS using the database and the GIS information (refer to Fig. II-37). The results of estimation are as enumerated below:

Estimation of 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.

$$D_{(i)} = \Sigma \{(Q_{(j)} \times UV_{(j)} \times F_{(j)}\}$$

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) The 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 II-33).

(b) The 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. II-38).

(c) The flood duration is estimated as the duration of river flow discharge at Nording Bridge of over 850 m^3/s.

The probable flood hydrographs at Nording Bridge is 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. II-36). The maximum inundation depth/flood duration are given from the probable flood hydrographs and, as a result, the probable flood damage value could be estimated as shown in Tables II-34 and II-35.

(4) Annual Flood Damage Value

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

$$D_{ave} = \int \{ D_{(i)} \times P_{(i)}\} dP \fallingdotseq \Sigma \{(D_{(i-1)} + D_{(i)}) /2 \times (P_{(i-1)} - P_{(i)})\}$$

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 II-36. 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 RBIS is initiated 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 RBIS.

Thus, the annual flood damage value could be estimated systematically 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.

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TABLE

Table II-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 II-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 II-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 II-4 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 II-5 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 II-6 WATER INTAKE FACILITIES ON MAIN STREAM OF PERAK RIVER

Name of Intake Facilities	Design Capacity		Intake Majure	Remarks
	(cusecs)	(m3/s)		
1. Irrigation Water Intake (Existing)				
1-1 Kampung Tengah	45.0	1.27	Pumping	
1-2 Kubang Haji	205.0	5.80	Pumping	
1-3 Senin	30.0	0.85	Pumping	
1-4 Pendiat	120.0	3.40	Pumping	
1-5 Bota Kiri	160.0	4.53	Pumping	
1-6 Telok Bakong	90.0	2.55	Pumping	
1-7 Lambor Kiri	30.0	0.85	Pumping	
1-8 Pintu Masuk Telok Sena	800.0	22.64	Gravity	
1-9 Telok Sareh	110.0	3.11	Pumping	
Sub-total	1,590.0	45.0		
2. Domestic and Industrial Water Intake (Existing)				
2-1 Air Ganda	0.3	0.01	Pumping	
2-2 Kota Lama Kiri	10.2	0.29	Pumping	
2-3 Sultan Idris Shah II	122.8	3.48	Pumping	Real Time Operation Center Loacted
2-4 Kampung Paloh	20.5	0.58	Pumping	
2-5 Teluk Kepung	61.4	1.74	Pumping	
2-6 Kampung Gajah	4.1	0.12	Pumping	
Sub-total	219.3	6.21		
Total of Existing Intake Facilities	1,809.3	51.20		
3. Domestic and Industrial Water Intake (Proposed)				
3-1 Banding	1.0	0.03	Pumping	
3-2 Grik V	5.6	0.16	Pumping	
3-3 Bandar Baru Seri Iskandar	15.4	0.43	Pumping	
3-4 Hilir Perak	40.9	1.16	Pumping	
Sub-total	62.9	1.78		
Grand Total	1,872.3	53.0		

Table II-7 WATER INTAKE FACILITIES ON TRIBUTARIES OF PERAK RIVER

Name of Intake Facilities	Souce of Water/River	Design Capacity	
		(cusec)	(m^3/s)
Padang Rengas	Sg Kangar	4.1	0.12
Sungai Siput	Sg Kerbau	9.2	0.26
Felda Lasah	Sg Kunca	1.6	0.05
Manong	Sg Guar	1.0	0.03
Sauk	Sg Biong	2.9	0.08
Kroh III	Sg Kuak	1.5	0.04
Grik	Sg Kendrong	1.5	0.04
Kg Jong	Sg Berok	1.8	0.05
Felda Bersia	Sg Lebey	0.3	0.01
Lenggong	Sg Lenggong	1.0	0.03
Sumpitan	Sg Ibol	1.6	0.05
Lawin Kenayat	Sg Pulau	1.2	0.03
Klian Intan	Sg Kajang	0.2	0.00
Felda Nenering	Sg Kuak	0.3	0.01
Ulu Kinta	Sg Kinta	61.5	1.74
Sg Kampar	Sg Kampar	8.2	0.23
Sg Palai	Sg Palai	2.6	0.07
Sg Jelintoh	Sg Jelintoh	0.5	0.01
Bukit Temoh	Sg Woh	59.3	1.68
Gn Besout	Sg Sungkai	1.1	0.03
Trolak Selatan	Sg Trolak	2.0	0.06
Trolak Timur	Sg Trolak	0.6	0.02
Sungai Klah	Sg Tesong	2.5	0.07
Total		166.6	4.7

Table II-8 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 Ⅱ-9 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 II-10 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 II-11 (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 II-11 (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 II-11 (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 II-12 OBJECTIVE INFORMATION ON WATER QUALITY AND WATER POLLUTANT SOURCE TO BE COLLECTED

Objective Information	Renewal Interval of Information	Number of Monitoring Points	Contents of Information
River Discharge and Sediments/Suspended Soils	Once/year	3 points	1. Location of gauging points 2. Discharge data 3. Suspended soils data
River Water Quality	Once/year	52 points	1. Location of sampling points 2. Results of water quality tests
Water Pollutant Source	Once/year	89 points	1. Location of point pollutant source

TABLE II-13 PROFILE OF RIVER CHANNEL AND PROBABLE WATER LEVEL

Sta. No.		Accumulated Distance	River Bed Level (m above MSL)	Left Bank Level (m above MSL)	Right Bank Level	Probable Water Level 700m3/s	900m3/s	1000 m3/s (15-year)	1400 m3/s (20-year)	1700 m3/s (50-year)	1950m3/s (100-yaer)	Remakes
74	47.9	0.0	-22.1	2.3	1.1	2.15	2.15	2.15	2.15	2.15	2.15	
73	51.7	3.8	-15.2	2.7	2.7	2.16	2.16	2.16	2.17	2.18	2.19	
72	57.7	9.8	-8.2	2.1	0.9	2.18	2.20	2.22	2.27	2.33	2.38	
71	60	12.1	-4.0	2.1	1.5	2.22	2.26	2.28	2.40	2.49	2.58	
70	62.6	14.7	-2.7	1.9	2.1	2.23	2.43	2.49	2.72	2.91	3.07	
69	66.3	18.4	-2.4	2.0	1.8	2.56	2.74	2.84	3.20	3.47	3.67	
68	70	22.1	0.0	3.7	4.0	3.36	3.65	3.78	4.22	4.49	4.70	
67A	72.4	24.5	1.4	5.3	5.0	4.56	4.99	5.14	5.53	5.75	5.92	Kg. Pasir
66	77.2	29.3	1.4	6.0	6.1	6.37	6.92	7.06	7.22	7.30	7.38	
65Q	79.7	31.8	2.1	7.4	6.9	6.62	7.12	7.26	7.51	7.66	7.79	
65A	81.6	33.7	2.7	7.7	7.4	6.92	7.38	7.53	7.85	8.05	8.20	Kg. Gajah
64	86.5	38.6	4.5	9.5	8.4	7.79	8.16	8.31	8.76	9.03	9.23	
63	89.5	41.6	5.2	10.1	11.0	8.40	8.76	9.14	9.60	9.88	10.09	
62	95.5	47.6	6.6	11.6	11.3	10.41	10.76	11.35	11.77	12.04	12.24	
61	97.2	49.3	6.8	12.2	13.7	10.94	11.34	11.81	12.22	12.48	12.68	Kg. Pasir Sena
60	98	50.1	7.8	11.9	12.1	11.07	11.47	11.90	12.34	12.62	12.82	
59	98.6	50.7	7.2	12.6	14.2	11.18	11.58	12.00	12.46	12.75	12.98	
58	100.1	52.2	7.8	12.2	16.8	11.58	11.97	12.32	12.82	13.13	13.35	
57	101.1	53.2	8.1	12.8	14.0	11.88	12.27	12.57	13.10	13.43	13.68	
56	101.7	53.8	8.1	13.3	12.9	12.04	12.43	12.66	13.22	13.56	13.81	
54	103	55.1	9.6	13.7	16.2	12.51	12.86	13.02	13.56	13.90	14.15	
50	105.9	58.0	9.6	14.6	12.7	13.54	13.85	14.08	14.56	14.86	15.08	
46	109	61.1	10.5	12.8	14.1	14.17	14.49	14.68	15.19	15.49	15.70	
45	109.7	61.8	10.8	16.1	16.8	14.24	14.55	14.75	15.24	15.54	15.74	
44	111.4	63.5	11.3	14.6	17.8	14.62	14.96	15.17	15.71	16.04	16.29	
43	112.5	64.6	10.6	21.1	21.1	14.93	15.27	15.50	16.05	16.40	16.66	Idris Shah Bridge
42	114.3	66.4	12.3	17.3	16.2	15.63	15.71	15.94	16.52	16.88	17.16	
39	116.5	68.6	12.2	18.7	19.5	16.17	16.50	16.71	17.27	17.63	17.91	
36	119.4	71.5	14.0	19.9	20.1	17.28	17.62	17.78	18.35	18.74	19.03	
35	121.3	73.4	13.7	21.6	20.7	17.67	18.03	18.21	18.83	19.22	19.52	
34	123.1	75.2	15.3	29.3	21.6	18.25	18.60	18.72	19.35	19.72	20.01	
33	125.2	77.3	16.0	21.8	21.5	18.91	19.26	19.33	19.96	20.35	20.66	
31M	127.6	79.7	16.1	21.2	25.0	19.35	19.72	19.85	20.47	20.87	21.18	Kg. Kubang Haji
30M	129.5	81.6	16.9	23.5	23.0	19.75	20.12	20.29	20.91	21.32	21.63	
29	131.5	83.6	15.8	24.2	23.2	20.16	20.54	20.73	21.36	21.78	22.10	
28	133.1	85.2	17.1	21.4	21.6	20.53	20.92	21.12	21.76	22.18	22.50	Nordin Bridge

Source: Tumboh Block Integrated Rural Development Study Flood Investigation, May 1985

Table II-14 CONTENTS OF FLOOD DAMAGE RECORD

Title	Items to be Recorded	
1. Extent of Flood Inundation Area	1 - 1	River Basin
	1 - 2	Administrative Area (District/Kampong)
	1 - 3	Area Flooded (km2)
	1 - 4	Maximum Depth of Flood (m)
	1 - 5	Duration of Flood (days)
	1 - 6	Cause of Flood
	1 - 7	Remarks
2. Road and Bridge Inundated	2 - 1	River Basin
	2 - 2	Location (Milestone/Name
	2 - 3	Length of Road Inundated (m)
	2 - 4	Maximum Depth of Flood (m)
	2 - 5	Duration of Flood (days)
	2 - 6	Remarks
3. Number of People Affected	3 - 1	River Basin
	3 - 2	Administrative Area (District/Kampong)
	3 - 3	Number of Evacuees
	3 - 4	Number of Death or Missing
	3 - 5	Number of Injured
	3 - 6	Remarks
4. Flood Damage	4 - 1	River Basin
	4 - 2	Administrative Area (District)
	4 - 3	Agriculture Damage (RM)
	4 - 4	Commercial Damage (RM)
	4 - 5	Industry Damage (RM)
	4 - 6	Public Facility Damage (RM)
	4 - 7	Domestic Property Damage (RM)
	4 - 8	Public Service Damage (RM)
	4 - 9	Remarks
5. Agricultural Damage	5 - 1	River Basin
	5 - 2	Administrative Area (District/Kampong)
	5 - 3	Tree Crops Damage (RM & Acre)
	5 - 4	Cash Crops Damage (RM & Acre)
	5 - 5	Paddy Damage (RM & Acre)
	5 - 6	Poultry Damage (RM & Acre)
	5 - 7	Husbandry Damage (RM & Acre)
	5 - 8	Remarks
6. Epidemic Caused by Flood	6 - 1	River Basin
	6 - 2	Administrative Area (District/Kampong)
	6 - 3	Type of Diseases
	6 - 4	Number of Patients
	6 - 5	Number of Causalities
	6 - 6	Remarks

Note: Maximum number of river basins is 20.

Table II-15 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 II-16 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 Pengklan 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 II-17(1/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(MAP INFORMATION)

Category	Name of Map and Scale of Original Map	Contents in the Map			Renewal Interval of Information	Agency as Data Source	Dissemination Level*
		Name of Data	Type of Data	Attribute			
General Information	1 Base Map (Scale: 1/500,000)	1.1.1 Basin Boundary	Polygon	Name of sub-basin	As required	DSMM	Level 2
		1.1.2 River Line	Line	Name of river			
		1.1.3 District Boundary	Polygon	Extent of sub-basin			
		1.1.4 Major Road	Line	Name of road			
		1.1.5 Major Town	Point	Name of town			
		1.1.6 Major Bridge	Point	Name of bridge Organization to maintain Structural features			
Hydrological Information	2 Location Map of Gauging Point (Scale: 1/500,000)	2.1.1 Gauging Point	Point	Name of station Type of station Gauging period Current equipment Catchment area (for water level St.) Gauging data	As required	DID and MMS	Level 2
Information on Flood Mitigation	3 Location Map of Flood Mitigation Scheme (Scale: 1/500,000)	3.1.1 Stretch of channel works	Line	Name of scheme Type of work Design flood level Competent agency	As required	DID	Level 2
		3.1.2 Dam and Other Flood Mitigation Structure	Point	Completion year Name of scheme Type of work Design flood level Competent agency	As required	DID and TNB	Level
	3 Flood Inundation Area (Scale: 1/500,000)	3.2.1 Flood Inundation Area	Polygon	Flood Scale (recurrence probability)	Annually	DID	Level 1
		3.2.2 Major Town Area	Polygon	Name of town			
		3.2.3 Mukim Boundary	Polygon	Name of Mukim			
Information on Water Supply Management	4 Location Map of Intake Point (Scale: 1/500,000)	4.1.1 Intake Point	Point	Name of intake facility Purpose of intake Structural type of intake Intake capacity Monthly average intake discharge Name of supply area Extent of supply area (ha)	Annually	PWB and DID	Level 2
		4.1.2 Irrigation Scheme	Polygon	Name of irrigation scheme Name of intake point Intake capacity Clopping schedule Monthly average intake discharge	Annually	DID	Level 2
		4.1.3 Domestic and Industrial Supply Area	Polygon	Name of service area Name of intake point Intake capacity Daily average water demand	Annually	PWB	Level 2

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table II-17(2/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(MAP INFORMATION)

Category	Name of Map and Scale of Original Map	Contents in the Map: Name of Data	Type of Data	Attribute	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Information on River Environmental Management	5.1 Location Map of River Water Quality Sampling Station (Scale: 1/500,000)	5.1.1 Sampling Station	Point	Name of sampling station	Annually	DOE	Level 2
	5.2 Location Map of Major Pollutant Sources (Scale: 1/500,000)	5.2.1 Major Pollutant Sources	Point	Type of industry Code of pollutant sources	Annually	DOE	Level 1
	6.1 Location Map of Protected Area (Scale: 1/500,000)	6.1.1 Protected Area	Polygon	Name of Protected Area Extent of protected area (ha)	Once/ 3 years	DWNP	Level 2
	7.1 Location Map of River Parks (Scale: 1/500,000)	7.1.1 River Parks	Point	Name of River Parks	Annually	LOCAL AUTHORITY	Level 2
	7.2 Location Map of Camp Sites (Scale: 1/500,000)	7.2.1 Camp Sites	Point	Name of Camp Sites	Annually	Yayasan Perak	Level 2
	7.3 Location Map of Royal Mausoleums (Scale: 1/500,000)	7.3.1 Royal Mausoleums	Point	Name of Royal Mausoleums	Annually	Yayasan Perak	Level 2
Information on Watershed Management	8.1 Geological Map (Scale: 1/500,000)	8.1.1 Geological Classification	Polygon Line	Name of class Fault	Non	DGSM	Level 2
	9.1 Reconnaissance Soil Map (Scale: 1/500,000)	9.1.1 Soil Classification	Polygon	Name of class	5 year (Only Urban Area)	DOA	Level 2
	10 Land Use Map (Scale: 1/50,000)	10.1.1 Land Use Classification	Raster	Name of Class	5 year in Principle	DOA	Level 2
			Polygon	Name of Class			Level 1
	11 Structure Plan (Scale : Variable)	11.1.1 Development Corridors	Raster	Name of Corridor	Target Year : 2020	TCPD	Level 2
		11.1.2 Future Land Use	Polygon	Name of Class			Level 1
		11.1.3 Major Projects	Point	Explanation Table			
	12 Forest Reserve Map (Scale: 1/50,000)	12.1.1 Forest Reserve and Protection Forest	Raster	Name of Protection Forest	Non	FD	Level 2
			Polygon	Name of Forest Reserve			Level 1
			Point	Name of Protection Forest and Area			
	13 Cadastral Map (Scale : 1/790)	13.1.1 Land Parcel Boundary 13.1.2 Land Parcel No.	Line Point	- Land Registration	Occasion at Need	DOLM, PWB	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table II-17(3/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(TABULAR INFORMATION)

Category	Name of Table	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Hydrological Information	1.1 Inventory of gauging station	Annually	DID	Level 2
	1.2 Hourly rainfall in northeast monsoon period (Oct. - Jan.)**	Annually & Real-time	DID	Level 2
	1.3 Daily and monthly rainfall	Annually	DID	Level 2
	1.4 Annual maximum rainfall	Annually	DID	Level 2
	1.5 Hourly river stage/discharge in northeast monsoon period(Oct. - Jan.)**	Annually & Real-time	DID	Level 2
	1.6 Daily and monthly river stage/discharge	Annually	DID	Level 2
	1.7 Annual maximum and minimum river stage/discharge	Annually	DID	Level 2
	1.8 Discharge rating table	Annually	DID	Level 2
	1.9 Monthly suspended sediment	Annually	DID	Level 2
	1.10 Annual maximum and minimum suspended sediment	Annually	DID	Level 2
	1.11 Sediment rating table	Annually	DID	Level 2
	1.12 Hourly and/or daily dam outflow discharge	Real-time	TNB	Level 2
	1.13 Monthly meteorological information	Annually	MMS (statistical book)	Level 2
	1.14 Tidal levels	Annually	Royal Malaysian Navy	Level 2
Information on Flood Mitigation	2.1 Inventory of Existing Flood Mitigation Scheme	As required	DID	Level 2
	2.2 Inventory of Projected Flood Mitigation Scheme	As required	DID	Level 2
	2.3 Probable Flood Peak Discharge	As required	DID	Level 2
	2.4 Longitudinal Profile of River Channel and Probable Flood Level	As required	DID	Level 2
	2.5 River Channel Flow Capacity	As required	DID	Level 2
	2.6 Flood Damage Record	Annually	DID	Level 2
Information on Water Supply Management	3.1 Inventory of Intake Facility		PWB and DID	Level 2
	3.2 Inventory of Irrigation Scheme		DID	Level 2
	3.3 Inventory of Domestic and Industrial Water Supply		PWB	Level 2
	3.4 Monthly Water Demand		PWB and DID	Level 2

*: Level1 disseminates to the government agency only, while Level 2 opens to Public
**: Include the real-time information

Table II-17(4/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(TABULAR INFORMATION)

Category	Name of Table	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Information on River Environmental Management	4.1 Inventory of River Water Quality Sampling Station	Once a year	DOE	Level 2
	4.2 Inventory of Pollutant Sources	Once a year	DOE	Level 1
	4.3 River Water Quality Results on human life	3 times a year	DOE	Level 2
	4.4 River Water Quality Results on other items	3 times a year	DOE	Level 2
	4.5 Effluent Water Quality & Discharge survey data	3 times a year	DOE	Level 2
	4.6 General Rating Scale for WQI	Database	DOE	Level 2
	4.7 Effluent Water Quality Standards	Database	DOE	Level 2
Information on Watershed Management	5.1 Major Projects (Development Category, Name, Owner, Location, Area, Cost)	Target Year : 2020	TCPD	Level 1
	6.1 Forest Compartment Relational Table	Non	FD	Level 1
	6.2 Forest Management Record Table	Yearly		
	6.3 Logging Volume (Computation Result)	-		
	7.1 Land Registration Table	Occasion at Need	DOLM	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table II-17(5/5) OBJECTIVE INFORMATION TO BE DISSEMINATED
(GRAPHIC INFORMATION)

Category	Name of Graph	Renewal Interval of Information	Agency as Data Source	Dissemination Level*
Hydrological Information	1.1 Rainfall intensity curve at Ipoh	-	DID	Level 2
	1.2 Mean monthly rainfalls at sub-regions	-	DID	Level 2
Information on Flood Mitigation	2.1 Longitudinal channel profile and probable water level		DID	Level 2
	2.2 Profile of river channel flow capacity		DID	Level 2
Information on River Environmental Management	3.1 Water Quality Results of each sampling point	Once a year	DOE	Level 2
	3.2 Effluent Load of Major Pollutant Sources	Once a year	DOE	Level 1
	3.3 Longitudinal Variation of River Water Quality	Once a year	DOE	Level 2
	3.4 Annual Trend of Water Quality at Class 1 point (3 points)	Once a year	DOE	Level 2
	4.1 Distribution of Aquatic Wildlife	Once per 3 years	DWNP	Level 2
Information on Watershed Management	5.1 Historical Logging Volume	1 Year	FD	Level 1

*: Level1 disseminates to the government agency only, while Level 2 opens to Public

Table II-18 PROBABLE FLOOD PEAK DISCHARGE

River	Location	Catchment Area (km2)	Distance * (km)	Probable Flood Discharge (m3/s)				
				5-y	10-yr	20-yr	50-yr	100-yr
Perak	Temengor Dam Inflow	3,420	327			6,700	10,400	13,800
	Temengor Dam Outflow**	3,420	327			750	1,230	1,900
	Chenderoh Dam Inflow	6,553	251	720	1,170	1,400	1,770	2,050
	Chenderoh Dam Outflow**	6,553	251	720	1,150	1,340	1,670	1,900
	Iskandar Bridge	8,188	184	730	850	1,400	1,700	1,950
Kinta	Ipoh	313	72	52	59	65	72	180
	Confluence of Pari River		68	111	125	139	153	280
	Confluence of Pinji River		59	152	170	190	208	
	Confluence of Raja River	1,054	56	207	233	259	284	350
	Confluence of Teja River		44	247	277	308	339	
	Confluence of Kampar River	1,700	39	352	396	440	483	
	Confluence of Cendering River		29	406	456	508	558	
	Confluence of Tumboh		19	479	538	599	659	
	Confluence of Keroh river		6	445	503	562	621	

* : Distance from the river mouth for Perak River and distance from the confluence with Perak River for Kinta River

** Subject to the present reservoir operation rule (peak flood discharge is regulated by the Temengor reservoir capacity of 10 x $10^8 m^3$ allocated between the Full Supply Level (248.5m above MSL) and the level drawn down in October (242m above MSL)

*** : Source: Tumboh Block Integrated Rural Development Study Flood Investigation, May 1985

Table II-19 RIVER CHANNEL FLOW CAPACITY

River	Stretch	Distance		Flow Capacity (Retur Period) (years)
		Section (km)	Accumulated (km)	
Perak	Confluence with Kinta River to Kg. Gaja	15.0	15.0	less than 10
	Kg. Gaja to about 7.5km upstream from Kg. Gaja	7.5	22.5	10 to 20
	7.5km upstream from Kg. Gaja to 2km upstream from Telok Sena	9.5	32.0	less than 10
	2km upstream from Telok Sena to 6km upstream from Telok Sena	4.0	36.0	10 to 20
	6km upstream from Telok Sena to 10km upstream from Telok Sena	4.0	40.0	less than 5
	10km upstream from Telok Sena to Idris Shah Bridge	6.0	46.0	5 to 100
	Idris Shah Bridge to Parit	16.0	62.0	more than 100
	Parit to Nordin Bridge	4.0	66.0	
Kinta	Anderson Road Bridge to Confluence of Pari River	3.7	3.7	10
	Between confluence's of Pari and Pinji Rivers	8.8	12.5	5
	Between confluence of Pinji and Raja Rivers	3.5	16.0	50
	Between confluence of Raja and Teja Rivers	11.0	27.0	25
	Between confluence's of Teja and Kampar Rivers	6.0	33.0	5
	Between confluence's of Kampar and Cenderiang Rivers	10.0	43.0	less than 5
	Between confluence's of Cenderiang and Tumboh Rivers	10.0	53.0	less than 5
	Between confluence's of Tumboh and Perak Rivers	19.0	72.0	less than 5

Table II-20 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 II-21 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 II-22 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 II-23 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 Kansar	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. Jaleng	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. Perlop 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 Isksndar	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 II-24 MONTHLY AVERAGE IRRIGATION DEMAND TO BE TAKEN FROM RIVER

Irrigation Scheme	Irrigation Area (ha)	Intake Capacity (m3/s)	Irrigation Schedule		Monthly Average Irrigation Demand to be Taken From River (m3/s)											
			Main Season	Off Season	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Belanja Kanan	101	1.27	Aug. to Dec	Feb. to Dec.	0.00	0.22	0.15	0.18	0.19	0.12	0.00	**0.30**	0.18	0.25	0.13	0.09
Bota Lambor	828	5.94	Aug. to Dec	Feb. to Dec.	0.00	1.84	1.21	1.47	1.60	0.98	0.00	**2.46**	1.46	2.02	1.10	0.72
Senin	130	0.85	Aug. to Dec	Feb. to Dec.	0.00	0.29	0.19	0.23	0.25	0.15	0.00	**0.39**	0.23	0.32	0.17	0.11
Bukit Tunggal	745	3.11	Aug. to Dec	Feb. to Dec.	0.00	1.66	1.09	1.32	1.44	0.88	0.00	**2.21**	1.31	1.81	0.99	0.65
Trans-Perak	2,070	10.33	Aug. to Dec	Feb. to Dec.	**3.54**	1.96	1.30	2.70	3.15	2.40	2.73	1.11	1.82	2.72	3.21	0.63
Lambor	202	0.85	Aug. to Dec	Feb. to Dec.	0.00	0.45	0.29	0.36	0.39	0.24	0.00	**0.60**	0.36	0.49	0.27	0.13
IADP Seberang Perak	8,708		Sept. to Feb.	March to Aug.	4.20	9.27	17.23	11.07	10.40	14.00	5.20	9.50	**19.97**	12.70	8.53	11.60
IADP Sungai Manik	6,313		Dec. to July	June to Jan.	**11.97**	10.10	6.40	4.57	4.40	7.77	10.53	8.27	6.30	3.37	1.17	7.17
Total	19,097	22.35			19.70	25.79	27.86	21.89	21.82	26.53	18.46	24.84	**31.61**	23.67	15.58	23.20

Note : Irrigation Water Demand is subject to the 1 to 5 year drought probability

Source : 1. For irrigation schemes other than IADP Seberang Perak and Sungai Manik : The Study on Modernization of Irrigation Water Management System, Interim Report, 1997, by JICA (Irrigation efficiency is assumed at 60%)

2. For other irrigation schemes ; National Water Resources Study, Malaysia, Sectoral Report Vol II, 1982, by JICA (Irrigation efficiency is assumed at 45%)

Table II-25 DAILY AVERAGE DOMESTIC AND INDUSTRIAL WATER DEMAND

Description		1998	2005	2010	2020
Served Population [1]	Urban (10%)	152,167	170,051	184,097	224,526
	Rural (90%)	1,369,501	1,530,456	1,656,874	2,020,735
	Total	1,521,668	1,700,507	1,840,971	2,245,261
Per Capita Consumption (l/day) [2]	Urban	245	261	270	298
	Rural	199	219	230	262
Percent of Population Supplied (%) [2]	Urban	100.0%	100.0%	100.0%	100.0%
	Rural	95.0%	98.0%	99.0%	99.5%
Water Wastage (%) [2]	Urban	25%	20%	19%	15%
	Rural	30%	30%	28%	25%
Domestic Water Demand (m3/s)	Urban	0.54	0.62	0.68	0.89
	Rural	3.90	4.94	5.59	7.62
	Total	4.43	5.56	6.27	8.51
Industrial Water Demand (m3/s) [3]	Urban	7.92	11.14	13.44	18.05
	Rural	3.39	4.80	5.82	7.84
	Total	11.31	15.95	19.26	25.88
Total Water Demand (m3/s)	Urban	8.46	11.76	14.13	18.94
	Rural	7.28	9.75	11.40	15.46
	Total	15.75	21.51	25.53	34.40

Note: (1) Population in 1998 is given from PWB, while population in 2005 to 2020 is estimated from the population growth projected in "Kinta District Structural Plan.

(2) Data are given from PWB.

(3) Industrial water demand is based on the projection in National Water Resources Study, Malaysia Sectoral Report Vol. 9 in 1982.

Source: Unpublished data prepared by Perak Water Board

TABLE II-26 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 II-27 RIVER WATER QUALITY IN PERAK RIVER BASIN IN 1996

SNO	RIVER NAME	DT	DISCHARGE	BOD	COD	AN	SS	DO	PH	WQI	I_DO	I_COD	I_BOD	I_AN		I_SS		I_pH	AVG_WQI
3911657	SUNGKAI	260196		0.7	11.6	0.34	50	6.00	6.60	82.90	88.23	83.7	97.4	69.1		72.0		97.75	
		230496		1.5	32.1	0.24	155	6.40	6.60	76.08	86.17	60.9	94.1	75.3		53.1		97.75	
		170996		0.6	7.7	0.13	69	7.00	7.20	84.95	86.17	88.9	97.9	86.9	77.07	64.6	63.24	98.65	81.31
3911658	SUNGKAI	260196		0.7	11.6	0.34	50	6.00	6.60	82.90	88.23	83.7	97.4	69.1		72.0		97.75	
		170596		0.5	14.5	0.26	30	6.00	6.60	84.51	88.23	79.8	98.3	73.2		81.1		97.75	
		231196		1.0	1.0	0.26	44	5.80	6.50	84.53	81.67	97.8	96.2	73.2	71.82	74.6	75.92	96.94	83.98
3911610	SUNGKAI MATI	230496		6.0	160.7	1.12	50	1.80	4.90	57.01	88.23	1.8	77.0	45.1		72.0		53.45	
		170996		1.2	19.2	0.32	32	5.10	6.30	81.95	88.23	73.6	95.3	69.9		80.1		94.92	
		231196		2.0	117.0	0.32	18	1.60	4.50	53.15	10.01	11.7	91.9	69.9	61.59	87.2	79.80	41.46	64.04
3911692	SUNGKAI MATI	230496		5.8	114.3	3.15	110	2.40	6.30	56.30	88.23	12.5	77.9	9.7		57.9		94.92	
		170996		6.5	19.2	3.43	21	4.80	7.00	69.91	88.23	73.6	74.9	6.0		85.6		99.35	
		231196		1.5	56.0	3.43	70	4.40	6.60	59.59	58.56	40.5	94.1	6.0	7.25	64.2	69.26	97.75	61.93
3813680	KLAH	260196		3.3	23.3	0.98	40	5.10	6.00	73.95	80.48	70.5	86.4	48.5		76.4		90.88	
		170596		2.9	10.9	0.13	30	5.20	5.90	82.62	79.25	84.6	88.1	86.9		81.1		89.27	
		291096		0.5	1.0	0.62	4	5.60	6.53	85.67	79.25	97.8	98.3	59.0	64.78	95.1	84.20	97.20	80.75
3913681	KLAH	250196		1.3	31.0	0.16	40	5.50	6.30	79.75	79.25	62.1	94.9	83.7		76.4		94.92	
		150596		3.8	10.9	0.37	45	4.80	5.90	76.84	72.79	84.6	84.3	67.9		74.2		89.27	
		291096		0.5	1.0	0.08	86	6.20	5.56	83.98	83.98	97.8	98.3	92.1	81.23	58.8	69.80	82.79	80.19
4112654	BIDOR	250196		0.9	31.0	0.53	5	5.80	6.10	80.29	83.98	62.1	96.6	62.0		94.5		92.36	
		160596		3.0	14.5	0.29	10	5.00	6.10	80.21	72.79	79.8	87.7	70.1		91.6		92.36	
		291096		0.5	1.0	0.39	3	5.80	6.73	87.15	79.25	97.8	98.3	67.1	66.40	95.7	93.94	98.61	82.55
4010603	BIDOR	230496		1.0	28.6	0.29	45	4.60	5.20	75.10	83.98	64.6	96.2	70.1		74.2		63.50	
		170996		2.2	15.4	0.24	90	5.30	7.10	78.78	83.98	78.6	91.1	75.3		57.6		99.06	
		231196		1.0	5.0	0.10	32	4.60	5.60	82.18	61.50	92.5	96.2	90.0	78.45	80.1	70.62	83.63	78.69
4011651	BIDOR	230496		1.2	28.6	0.37	120	5.50	5.50	74.00	83.98	64.6	95.3	67.9		56.8		81.48	
		170996		0.6	11.5	0.34	38	7.10	6.80	83.11	83.98	83.8	97.9	69.1		77.3		98.98	
		231196		0.5	1.0	0.26	115	6.00	6.50	82.83	85.09	97.8	98.3	73.2	70.05	57.3	63.82	96.94	79.98
4112693	KLIAN BARU	250196		0.7	15.5	0.21	20	6.00	6.80	85.66	87.21	78.5	97.4	78.5		86.2		98.98	
		150596		1.2	7.2	0.29	5	5.20	6.20	84.93	79.25	89.5	95.3	70.1		94.5		93.71	
		291096		0.5	1.0	0.08	5	6.00	6.23	91.48	86.17	97.8	98.3	92.1	80.20	94.5	91.73	94.08	87.36
4112694	KLIAN BARU	250196		6.2	77.5	12.54	50	4.00	7.20	56.30	70.06	27.4	76.2	0.0		72.0		98.65	
		150596		13.5	50.7	0.13	30	1.80	6.60	59.41	13.04	44.4	50.0	86.9		81.1		97.75	
		291096		0.5	12.0	1.30	1	5.00	7.07	79.63	70.06	83.1	98.3	41.1	42.66	96.9	83.34	99.16	65.11

TABLE II-28 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

Source: Pamphlet prepared by Yayasan Perak

Table II-29 FLOW REGIME AND NUMBER OF DAYS TO EXCEED CRITICAL MINIMUM DISCHARGE

(1) Item of Daily Discharge	(2) Critical Minimum Discharge	Year	Flow Regime			Number of Days			
			Ave.	95% Exceeding	Min.	(3) Days of (1)>(2)	(4) Days of (1)<(2)	(5) Days of Non-recording	(6) (3)/((3)+(4))
Outflow from Chenderoh Dam	84.9 m3/s* (3000 cusec)	1986	180	104	96	314	0	51	100%
		1987	211	119	97	324	0	41	100%
		1988	359	237	187	95	0	271	100%
		1989	190	118	100	278	0	87	100%
		1990	171	91	77	285	7	73	98%
		1991	170	103	82	339	1	25	100%
		1992	145	95	37	321	8	37	98%
		1993	153	72	33	205	17	143	92%
		Total	183	98	33	2,161	33	728	98%
Runoff Discharge from Pelus River Basin	28.3 m3/s** (1000 cusec)	1986	29	19	18	151	182	32	45%
		1987	45	19	18	145	190	30	43%
		1988	35	15	7	242	117	7	67%
		1989	41	22	21	255	51	59	83%
		1990	28	17	15	99	222	44	31%
		1991	31	12	5	127	213	25	37%
		1992	31	17	15	148	187	31	44%
		1993	42	23	22	173	68	124	72%
		Total	35	17	5	1,340	1,230	352	52%
Flow Discharge at Iskandar Bridge	113.2 m3/s** (4000 cusec)	1986	205	128	122	346	0	19	100%
		1987	261	140	117	354	0	11	100%
		1988	395	251	228	95	0	271	100%
		1989	226	147	133	337	0	28	100%
		1990	193	108	93	300	30	35	91%
		1991	199	123	112	362	3	0	99%
		1992	175	116	78	350	10	6	97%
		1993	213	121	100	329	5	31	99%
		Total	217	123	78	2,473	48	401	98%

* : Minimum outflow discharge from Chenderoh Dam
** : Minimum runoff to guarantee the discharge at Iskandar bridge in case of dam out flow of 3000 cusec
***: Minimum flow discharge to be guaranteed by outflow from Chenderoh Dam

Table II-30 WATER DEFICIT OF PERAK RIVER AT ISKANDAR BRIDGE

Year	Deficit Period	Number of Deficit Days	Average Deficit (m3/s)	Maximum Deficit (m3/s)
1990	Aug. 04 - Aug. 05	2	1.25	1.44
	Aug. 12 - Aug. 12	1	7.65	7.65
	Aug. 14 - Aug 14	1	0.53	0.53
	Aug. 16 - Aug. 22	7	8.91	17.76
	Aug. 24 - Aug. 27	4	9.09	20.12
	Sep. 02 - Sep.16	15	5.80	11.03
1991	Jul. 14 - July 14	1	0.27	0.27
	Sep. 01 Sep. 01	1	0.30	0.30
1992	Jan. 20 - Jan. 20	1	5.87	5.87
	Jan. 30 - Jan. 31	2	0.40	0.58
	Feb. 04 - Feb. 04	1	0.83	0.83
	Mar. 15 - Mar. 15	1	5.05	5.05
	Mar. 22 - Mar. 22	1	8.11	8.11
	Oct. 04 - Oct. 05	2	16.50	33.00
	Oct. 07 - Oct. 08	2	23.84	35.36
	Sep. 20 - Sep. 20	1	13.69	13.69
1993	Apr. 10 -Apr. 10	1	6.34	6.34
	Aug. 09 - Aug. 10	2	4.06	5.99
	Aug. 12 - Aug. 12	1	1.69	1.69
	Sep. 20 - Sep. 20	1	13.69	13.69
Total		48	7.12	35.36

Note: Deficit is counted when the daily average flow discharge at Iskandar Bridge is less than 4000cusec (113.2m3/s).

Table II-31 DAM RESERVOIR VOLUME TO MAINTAIN THE GUARANTEED DISCHARGE AT ISKANDAR BRIDGE

Date			(1) Observed Outflow from Dam (m^3/s)	(2) Observed Discharge at Iskandar Bridge (m^3/s)	(3) Observed Deficit * at Iskandar Bridge (m^3/s)	(4) Revised ** Outflow from Dam (m^3/s)	(5) Reservoir Volume Used to Supply the Deficit ((4)-(1)) x 86,400 (10^3 m^3)
Year	Mon.	Day					
1990	Aug.	16	94.1	111.2	2.0	96.1	172.8
1990	Aug.	17	93.7	112.7	0.5	94.2	47.5
1990	Aug.	18	89.9	107.5	5.7	95.5	489.9
1990	Aug.	19	91.2	108.4	4.8	96.0	414.7
1990	Aug.	20	82.2	99.3	13.9	96.2	1203.6
1990	Aug.	21	78.5	95.5	17.7	96.2	1528.4
1990	Aug.	22	78.5	95.4	17.8	96.3	1534.5
1990	Aug.	23	120.8	137.5	0.0	96.5	-2095.2
1990	Aug.	24	84.0	100.7	12.5	96.5	1081.7
1990	Aug.	25	78.2	94.8	18.4	96.6	1588.9
1990	Aug.	26	76.5	93.1	20.1	96.7	1738.4
1990	Aug.	27	76.9	93.3	19.9	96.9	1720.2
1990	Aug.	28	117.1	133.5	0.0	96.9	-1749.6
1990	Aug.	29	140.0	156.4	0.0	96.8	-3735.1
1990	Aug.	30	132.6	150.6	0.0	95.2	-3231.4
1990	Aug.	31	95.2	115.0	0.0	93.4	-158.1
1990	Sep.	1	126.5	143.6	0.0	96.1	-2622.2
1990	Sep.	2	88.1	108.0	5.2	93.3	452.7
1990	Sep.	3	85.3	103.5	9.7	95.1	838.9
1990	Sep.	4	89.4	107.1	6.1	95.5	527.0
1990	Sep.	5	87.0	104.0	9.2	96.2	796.6
1990	Sep.	6	85.2	102.2	11.0	96.3	953.0
1990	Sep.	7	85.4	102.2	11.0	96.4	951.3
1990	Sep.	8	92.8	113.1	0.1	92.9	8.6
1990	Sep.	9	91.4	108.6	4.6	96.1	398.3
1990	Sep.	10	91.4	108.4	4.8	96.2	415.6
1990	Sep.	11	84.9	104.4	8.8	93.7	756.9
1990	Sep.	12	84.9	106.3	6.9	91.8	594.4
1990	Sep.	13	84.9	111.7	1.6	86.5	133.9
1990	Sep.	14	84.9	110.6	2.6	87.5	222.0
1990	Sep.	15	84.9	109.7	3.5	88.4	302.4
1990	Sep.	16	84.9	111.4	1.9	86.8	159.8
			Ave. 92.5	Ave. 111.2	Ave. 6.9	Ave. 94.5	Total 5440.6 ***

*: Deficit to the guaranteed discharge of 4,000cusec (113.2 m3/s)

**: Outflow discharge to guarantee the discharge of 4,000cusec (113.2m3/s) at Iskandar Bridge

***: Corresponds to about 11cm in deference of reservoir water level of Temengor Dam

Table II-32 PRODUCTION COST OF PADDY

Description	Cost (RM/ha)
1 . Land Preparation	312
2 . Field Leveling	401
3 . Planting	305
4 . Pest/Disease Control	167
5 . Harvesting	576
6 . Land Tax	9
7 . Irrigation Fee	34
. Total	1,805

Table II-33 FLOOD DAMAGE FACTOR

Item	Flood Depth	Flood Duration	Damage Factor (%)	Remarks
Paddy (Production loss)	less than 0.5m	less than 2 days	30	
		3 to 4 days	37	
		5 to 6 days	40	
		more than 7 days	45	
	0.5 to 0.9 m	less than 2 days	33	
		3 to 4 days	40	
		5 to 6 days	43	
		more than 7 days	49	
	more than 1 m	less than 2 days	60	
		3 to 4 days	80	
		5 to 6 days	86	
		more than 7 days	96	
Rubber (Mortality of young tree)	more than 0.25 m	less than 7 days	5	Assume 9% of total planted area to be subject to mortality
		8 to 14 days	15	
		15 to 21 days	60	
		more than 22 days	100	
Oil Palm/Coconuts Palm (Mortality of young tree)	more than 0.25 m	less than 7 days	10	Assume 9% of total planted area to be subject to mortality
		8 to 14 days	20	
		15 to 21 days	70	
		more than 22 days	100	
Other Tree Crops (Mortality of young tree)	more than 0.25 m	less than 4 days	10	Assume 10% of total planted area to be subject to mortality
		5 to 8 days	25	
		9 to 12 days	60	
		more than 13 days	70	
House/Building	less than 0.5 m		3	
	0.5 to 1.0 m		5	
	1.0 to 2.0 m		7	
	2.0 to 3.0 m		11	
	more than 3 m		15	

Source: National Water Resources Study, Malaysia , Sectoral Report Vol. 5, Oct. 1982

Table II-34 ESTIMATED PROBABLE FLOOD DAMAGE OF PERAK RIVER UNDER CONDITION OF PRESENT DAM OPERATION

Item of Damage	Area Inundated	Quantity Damaged	Unit Value	10-year Flood		20-year-Flood		50-year Flood		100-year Flood	
				Duration (days) [1]	2.4	Duration (days) [1]	2.6	Duration (days) [1]	3.8	Duration (days) [1]	5.4
				Depth (m) [2]	0.5	Depth (m) [2]	0.9	Depth (m) [2]	1.7	Depth (m) [2]	2.8
				Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)
1. Direct Agricultural Damage											
1.1 Paddy	1,200 ha	1,200 ha	1,500 RM/ha	0.40	720	0.40	720	0.80	1,440	0.86	1,548
1.2 Rubber (Production Loss)	2,800 ha	2,800 ha	47 [3] RM/ha	1.19 [4]	156	1.31 [4]	173	1.92 [4]	252	2.71 [4]	356
1.3 Rubber (Mortality Loss)	2,800 ha	252 ha	5,200 RM/ha	0.05	66	0.05	66	0.05	66	0.05	66
1.4 Oil Palm (Mortality Loss)	2,500 ha	225 ha	3,500 RM/ha	0.10	79	0.10	79	0.10	79	0.10	79
1.5 Coconut Palm (Mortality Loss)	1,000 ha	60 ha	6,200 RM/ha	0.10	37	0.10	37	0.25	93	0.25	93
1.6 Other Tree Crop (Mortality Loss)	1,200 ha	120 ha	6,400 RM/ha	0.10	77	0.10	77	0.25	192	0.25	192
1.7 Mix Horticulture	4,000 ha	4,000 ha	4,699 RM/ha	0.10	1,880	0.10	1,880	0.25	4,699	0.25	4,699
Sub-Total (for 1.)					3,014		3,031		6,821		7,033
2. Direct Non-Agriculture Damage											
2.1 Private House		5,000 houses	11,000 RM/house	0.05	2,750	0.05	2,750	0.07	3,850	0.11	6,050
2.2 Shops & Commercial Sites		250 sites	13,000 RM/sites	0.05	163	0.05	163	0.07	228	0.11	358
2.3 Industrial Facilities		60,000 m^2	800 RM/m^2	0.05	2,400	0.05	2,400	0.07	3,360	0.11	5,280
2.4 Road		40 km	15,000 RM/km	1.00	600	1.00	600	1.00	600	1.00	600
Sub-Total (for 2.)					5,913		5,913		8,038		12,288
3. Indirect Damage											
3.1 Agricultural Damage [4]					603		606		1,364		1,407
3.2 Private/Public Houses [5]					4,369		4,369		6,116		9,611
3.3 Transportation [6]					600		600		600		600
Sub-total (for 3.)					5,572		5,575		8,080		11,618
Damage Total					14,498		14,518		22,938		30,938

Note:
(1): Duration of flood discharge over 850m3/s
(2): Maximum flood inundation depth
(3): 9.4kg/ha/day x RM5/kg
(4): Flood duration x 1/2
(5): 20% of "1. Direct Agricultural Damage"
(6): 150% of ("2.1 Direct Damage of Private House" + "2.2 Shops & Commercial Sites")
(7): 100% of "2.4 Direct Damage of Road"

Table II-35 ESTIMATED PROBABLE FLOOD DAMAGE OF PERAK RIVER UNDER CONDITION OF PROPOSED DAM OPERATION

Item of Damage	Area Inundated	Quantity Damaged	Unit Value	10-year Flood		20-year-Flood		50-year Flood		100-year Flood	
				Duration (days) [1]	2.3	Duration (days) [1]	2.4	Duration (days) [1]	3.8	Duration (days) [1]	5.4
				Depth (m) [2]	0.3	Depth (m) [2]	0.4	Depth (m) [2]	1.4	Depth (m) [2]	2.5
				Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)	Damage Factor	Flood Damage (10^3RM)
1. Direct Agricultural Damage											
1.1 Paddy	1,200 ha	1,200 ha	1,500 RM/ha	0.37	666	0.37	666	0.80	1,440	0.86	1,548
1.2 Rubber (Production Loss)	2,800 ha	2,800 ha	47 [3] RM/ha	1.13 [4]	148	1.21 [4]	159	1.92 [4]	252	2.71 [4]	356
1.3 Rubber (Mortality Loss)	2,800 ha	252 ha	5,200 RM/ha	0.05	66	0.05	66	0.05	66	0.05	66
1.4 Oil Palm (Mortality Loss)	2,500 ha	225 ha	3,500 RM/ha	0.10	79	0.10	79	0.10	79	0.10	79
1.5 Coconut Palm (Mortality Loss)	1,000 ha	60 ha	6,200 RM/ha	0.10	37	0.10	37	0.25	93	0.25	93
1.6 Other Tree Crop (Mortality Loss)	1,200 ha	120 ha	6,400 RM/ha	0.10	77	0.10	77	0.25	192	0.25	192
1.7 Mix Horticulture	4,000 ha	4,000 ha	4,699 RM/ha	0.10	1,880	0.10	1,880	0.25	4,699	0.25	4,699
Sub-Total (for 1.)					2,952		2,963		6,821		7,033
2. Direct Non-Agriculture Damage											
2.1 Private House		5,000 houses	11,000 RM/house	0.03	1,650	0.03	1,650	0.07	3,850	0.11	6,050
2.2 Shops & Commercial Sites		250 sites	13,000 RM/sites	0.03	98	0.03	98	0.07	228	0.11	358
2.3 Industrial Facilities		60,000 m^2	800 RM/m^2	0.03	1,440	0.03	1,440	0.07	3,360	0.11	5,280
2.4 Road		40 km	15,000 RM/km	1.00	600	1.00	600	1.00	600	1.00	600
Sub-Total (for 2.)					3,788		3,788		8,038		12,288
3. Indirect Damage											
3.1 Agricultural Damage [4]					590		593		1,364		1,407
3.2 Private/Public Houses [5]					2,621		2,621		6,116		9,611
3.3 Transportation [6]					600		600		600		600
Sub-total (for 3.)					3,812		3,814		8,080		11,618
Damage Total					10,551		10,564		22,938		30,938

Note:
(1): Duration of flood discharge over 850m3/s
(2): Maximum flood inundation depth
(3): 9.4kg/ha/day x RM5/kg
(4): Flood duration x 1/2
(5): 20% of "1. Direct Agricultural Damage"
(6): 150% of ("2.1 Direct Damage of Private House" + "2.2 Shops & Commercial Sites")
(7): 100% of "2.4 Direct Damage of Road"

Table II-36 ESTIMATED ANNUAL AVERAGE FLOOD DAMAGE

Under Condition of Present Dam Operation

(1) Return Period	(2) Occurrence Probability 1/(1)	(3) Probable Damage	(4) Occurrence Probability between $D_{(i-1)}$ and $D_{(i)}$ $(P_{(i-1)} - P_{(i)})$	(5) Average Damage between $D_{(i-1)}$ and $D_{(i)}$ $(D_{(i-1)} + D_{(i)})/2$	(6) Probable Damage between $D_{(i-1)}$ and $D_{(i)}$ (4) x (5)
		(10^3 RM)		(10^3 RM)	(10^3 RM)
2 -year	$P_{(1)}$= 0.50	$D_{(1)}$= 0	-	-	
10 -year	$P_{(2)}$= 0.10	$D_{(2)}$= 14,498	0.40	7,249	2,900
20 -year	$P_{(3)}$= 0.05	$D_{(3)}$= 14,518	0.05	14,508	725
50 -year	$P_{(4)}$= 0.02	$D_{(4)}$= 22,938	0.03	18,728	562
100 -year	$P_{(5)}$= 0.01	$D_{(5)}$= 30,938	0.01	26,938	269
Annual Average Flood Damage (Total of (6))					4,456

Under Condition of Proposed Dam Operation

(1) Return Perio	(2) Occurrence Probability 1/(1)	(3) Probable Damage	(4) Occurrence Probability between $D_{(i-1)}$ and $D_{(i)}$ $(P_{(i-1)} - P_{(i)})$	(5) Average Damage between $D_{(i-1)}$ and $D_{(i)}$ $(D_{(i-1)} + D_{(i)})/2$	(6) Probable Damage between $D_{(i-1)}$ and $D_{(i)}$ (4) x (5)
		(10^3 RM)		(10^3 RM)	(10^3 RM)
2 -year	$P_{(1)}$= 0.50	$D_{(1)}$= 0			
10 -year	$P_{(2)}$= 0.10	$D_{(2)}$= 10,551	0.40	5,276	2,110
20 -year	$P_{(3)}$= 0.05	$D_{(3)}$= 10,564	0.05	10,558	528
50 -year	$P_{(4)}$= 0.02	$D_{(4)}$= 22,938	0.03	16,751	503
100 -year	$P_{(5)}$= 0.01	$D_{(5)}$= 30,938	0.01	26,938	269
Annual Average Flood Damage (Total of (6))					3,410