GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA

STATE REPORT

VOL. 5

JOHOR

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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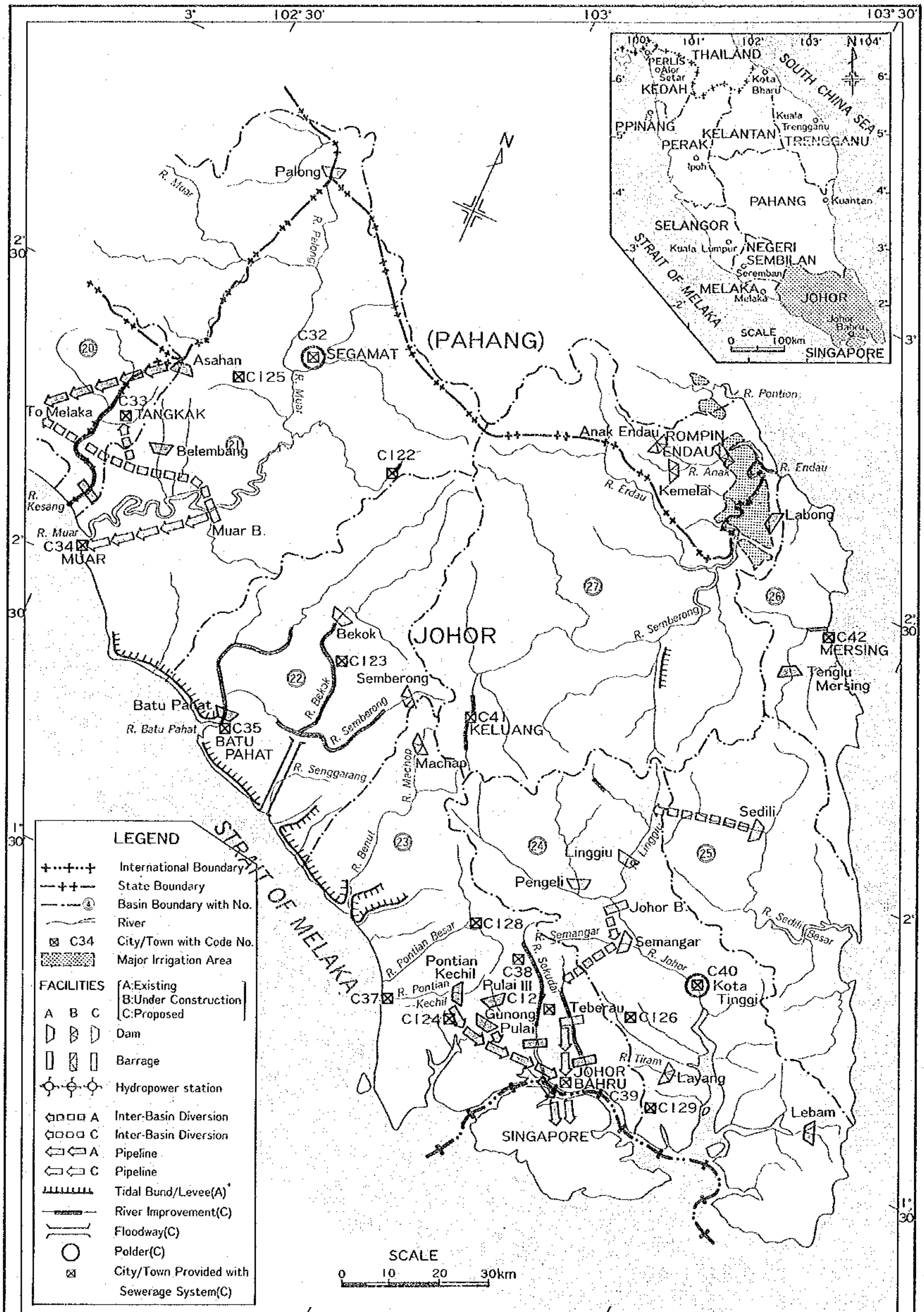

Recommended Plan
for the State of Johor

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
JAPAN INTERNATIONAL COOPERATION AGENCY

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ABBREVIATIONS

(1) Plan

FMP	:	First Malaysia Plan
SMP	:	Second Malaysia Plan
TMP	:	Third Malaysia Plan
4MP	:	Fourth Malaysia Plan
5MP	:	Fifth Malaysia Plan
6MP	:	Sixth Malaysia Plan
7MP	:	Seventh Malaysia Plan
NEP	:	New Economic Policy
OPP	:	Outline Perspective Plan
RESP	:	Rural Environmental Sanitation Program

(2) Domestic Organization

DID (JPT)	:	Drainage and Irrigation Department
DOA	:	Department of Agriculture
DOE	:	Division of Environment
DOF	:	Department of Forestry
DOFS	:	Department of Fishery
DOM	:	Department of Mines
DOS	:	Department of Statistics
EPU	:	Economic Planning Unit
FAMA	:	Federal Agricultural Marketing Authority
FELCRA	:	Federal Land Consolidation and Rehabilitation Authority
FELDA	:	Federal Land Development Authority
ICU	:	Implementation and Coordination Unit
MARDI	:	Malaysian Agricultural Research and Development Institute
MIDA	:	Malaysian Industrial Development Authority
MLRD	:	Ministry of Land and Regional Development
MMS	:	Malaysian Meteorological Service
MOA	:	Ministry of Agriculture
MOF	:	Ministry of Finance
MOH	:	Ministry of Health
MOPI	:	Ministry of Primary Industries

MRRDB : Malaysia Rubber Research and Development Board

NDPC : National Development Planning Committee

NEB (LLN): National Electricity Board

PORIM : Palm Oil Research Institute of Malaysia

PWD (JKR): Public Works Department

RDA : Regional Development Authority

RISDA : Rubber Industry Small-holders Development Authority

RRIM : Rubber Research Institute of Malaysia

SEB : Sabah Electricity Board

SEBC : State Economic Development Corporation

S(E)PU : State (Economic) Planning Unit

SESCO : Sarawak Electricity Supply Croporation

UDA : Urban Development Authority

(3) International or Foreign Organization

ADAA : Australian Development Assistance Agency

ADB : Asian Development Bank

ASCE : American Society of Civil Engineers

FAO : Food and Agriculture Organization of the United Nations

IBRD : International Bank for Reconstruction and Development

ILO : International Labour Organization

IMF : International Monetary Fund

IRRI : International Rice Research Institute

JICA : Japan International Cooperation Agency

JSCE : Japan Society of Civil Engineers

MOC : Ministry of Construction, Japan

OECD : Organization for Economic Cooperation and Development

OECF : Overseas Economic Cooperation Fund, Japan

UK : United Kingdom

UNDP : United Nations Development Program

UNSF : United Nations Special Fund

US or USA: United States of America

US/AID : United States Agency for International Development

USBR : United States Bureau of Reclamation

WHO : World Health Organization

WMO : World Meteorological Organization

(4) Others

B	:	Benefit
BOD	:	Biochemical Oxygen Demand
C	:	Cost
CIF	:	Cost, Insurance and Freight
COD	:	Chemical Oxygen Demand
D&I	:	Domestic and Industrial
dia	:	Diameter
EIRR	:	Economic Internal Rate of Return
El.	:	Elevation above mean sea level
Eq.	:	Equation
Fig.	:	Figure
FOB	:	Free on Board
FSL	:	Full Supply Level
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
H	:	Height, or Water Head
HWL	:	Reservoir High Water Level
LWL	:	Reservoir Low Water Level
O&M	:	Operation and Maintenance
Q	:	Discharge
Ref.	:	Reference
SITC	:	Standard International Trade Classification
SS	:	Suspended Solid
V	:	Volume
W	:	Width

ABBREVIATIONS OF MEASUREMENT

Length

mm = millimeter
cm = centimeter
m = meter
km = kilometer
ft = foot
yd = yard

Area

cm^2 = sq.cm = square centimeter
m^2 = sq.m = square meter
ha = hectare
km^2 = sq.km = square kilometer

Volume

cm^3 = cu.cm = cubic centimeter
l = lit = liter
kl = kiloliter
m^3 = cu.m = cubic meter
gal.= gallon

Weight

mg = milligram
g = gram
kg = kilogram
ton = metric ton
lb = pound

Time

s = second
min = minute
h = hour
d = day
y = yard

Electrical Measures

V = Volt
A = Ampere
Hz = Hertz (cycle)
W = Watt
kW = Kilowatt
MW = Megawatt
GW = Gigawatt

Other Measures

% = percent
PS = horsepower
° = degree
' = minute
" = second
°C = degree centigrade
10^3 = thousand
10^6 = million
10^9 = billion (milliard)

Derived Measures

m^3/s = cubic meter per second
cusec = cubic feet per second
mgd = million gallon per day
kWh = Kilowatt hour
MWh = Megawatt hour
GWh = Gigawatt hour
kWh/y = kilowatt hour per year
kVA = kilovolt ampere
BTU = British thermal unit
psi = pound per square inch

Money

M$ = Malaysian ringgit
US$ = US dollar
¥ = Japanese Yen

CONVERSION FACTORS

	From Metric System	To Metric System
Length	1 cm = 0.394 inch	1 inch = 2.54 cm
	1 m = 3.28 ft = 1.094 yd	1 ft = 30.48 cm
	1 km = 0.621 mile	1 yd = 91.44 cm
		1 mile = 1.609 km
Area	1 cm^2 = 0.155 sq.in	1 sq.ft = 0.0929 m^2
	1 m^2 = 10.76 sq.ft	1 sq.yd = 0.835 m^2
	1 ha = 2.471 acres	1 acre = 0.4047 ha
	1 km^2 = 0.386 sq.mile	1 sq.mile = 2.59 km^2
Volume	1 cm^3 = 0.0610 cu.in	1 cu.ft = 28.32 lit
	1 lit = 0.220 gal.(imp.)	1 cu.yd = 0.765 m^3
	1 kl = 6.29 barrels	1 gal.(imp.) = 4.55 lit
	1 m^3 = 35.3 cu.ft	1 gal.(US) = 3.79 lit
	10^6 m^3 = 811 acre-ft	1 acre-ft = 1233.5 m^2
Weight	1 g = 0.0353 ounce	1 ounce = 28.35 g
	1 kg = 2.20 lb	1 lb = 0.4536 kg
	1 ton = 0.984 long ton	1 long ton = 1.016 ton
	= 1.102 short ton	1 short ton = 0.907 ton
Energy	1 kWh = 3,413 BTU	1 BTU = 0.293 Wh
Temperature	°C = (°F − 32) · 5/9	°F = 1.8°C + 32
Derived Measures	1 m^3/s = 35.3 cusec	1 cusec = 0.0283 m^3/s
	1 kg/cm^2 = 14.2 psi	1 psi = 0.703 kg/cm^2
	1 ton/ha = 891 lb/acre	1 lb/acre = 1.12 kg/ha
	10^6 m^3 = 810.7 acre-ft	1 acre-ft = 1,233.5 m^3
	1 m^3/s = 19.0 mgd	1 mgd = 0.0526 m^3/s
Local Measures	1 lit = 0.220 gantang	1 gantang = 4.55 lit
	1 kg = 1.65 kati	1 kati = 0.606 kg
	1 ton = 16.5 pikul	1 pikul = 60.6 kg

Exchange Rate
(As average between July and December 1980)

$1 = M$2.22
¥100 = M$1.03

1. INTRODUCTION

Malaysia's rapid development has begun to strain her water resources. Increasingly water stress has occurred in places where previously water was found abundant for use. The responsibility for water resources development and management in Malaysia has traditionally been fragmented among various departments and agencies in accordance with their respective functions and activities related to water. In the absence of a comprehensive system to coordinate the multifarious activities in water resources development and management, these activities tend to take place in isolation. This may lead to competition in water use and even duplication of activities and functions. An integrated approach to water resources development and management is therefore necessary to ensure future efficient use of water and other resources, and a study in this regard has become necessary.

The National Water Resources Study, Malaysia, has been carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with officials of the Government of Malaysia for 3 years since October, 1979 in order to establish a basic framework for the orderly planning and implementation of water resources development programs and projects and for rational water resources management consistent with the overall national socio-economic development objective.

The Final Report submitted now comprises Volume 1 Master Action Plan and Volume 2 Water Resources Development and Use Plan, being supported by the State Reports and Sectoral Studies.

The Master Action Plan contains recommendations on actions to be taken by the Federal and State Governments to ensure efficient and effective execution of water resources development and management in the future, including the national water policy, implementation program, financial system, water administration, institutional framework, legal provisions and further study.

The Water Resources Development and Use Plan is a translation of the national water policy into a long-term national master plan for water resources development, reflecting the needs based on socio-economic goals and also the availability of water and other resources as well as the extent and distribution of water stress.

Each volume of the State Reports is a version of the Water Resources Development and Use Plan compiled for a State or a group of States, including more information regarding the specific State or States. The State Report Volume 5 herein presented describes the matters for the State of Johor.

The Water Resources Development and Use Plan was prepared to show general direction of water resources development in Malaysia, identifying future problems and needs and availability of water and other resources, based on analysis and interpretation of readily available data and information. Individual projects indicated are, therefore, only notional and no intention has been made to define any of their details.

2. BACKGROUND

2.1 The Land

The State of Johor of 19,140 sq.km is located in the southernmost part of the Peninsular Malaysia, between 102°29′ and 104°18′ east in longitude and 1°16′ and 2°50′ north in latitude. It faces the Strait of Melaka in the west, the South China Sea in the east and Singapore which lies just a couple of miles away across the Strait of Johor.

The State mainly consists of plains and low hills with some mountainous areas in northern and central parts. Western coast is featured by swamps. Rivers run almost perpendicular to the geological trend. They are the Johor, Mersing, Muar, Batu Pahat, Kesang, Sekdai, Sedili Besar, Endau and other small rivers.

Central part of Johor is occupied by intrusive granite masses in the southernmost extension of the eastern range. Patches of granitic rocks are also distributed to the east of the eastern range, among the area of Permian meta-sedimentary rocks which includes wide-spread volcanic facies consisting of andesitic-rhyolitic flows, tuffs and agglomerates. Western side of the granite zone is widely covered by Triassic meta-sedimentary rocks of marine origin, which are overlain by alluvial deposits developing for 10 to 20 km of width along the southwestern coast. Tertiary sedimentary facies of continental basin deposits which is rare in Peninsular Malaysia is located in small patches in the upper reaches of the Johor river and in the south of Jementah mountain. Also, basic volcanic facies of Tertiary is located in the upper reaches of the Muar river. General trend of geological structure of the Peninsula veers from north-northwesterly direction to northwesterly direction in this area.

Soils are mostly sedentary soils occuring on undulating plains. The areal extent of alluvial soils on coastal plains, riverine flood plain and terraces is 7,674 sq.km, acounting for 40% of the total of the State. Of this, 4,729 sq.km are evaluated as suitable for paddy.

Climate is usually hot and wet. Average annual rainfall is 2,000 mm - 2,500 mm. In the western part of the State, rainfall has a rather uniform distribution throughout the year. Meteorological data at Johor Bahru (El.38.0 m) are summarized in Table 1. In the eastern part of the State, meteorological condition is similar to that in the east coast with heavy rainfall during the northeast monsoon.

2.2 The Rivers

Run-off in rivers wholly or partly located in the State of Johor is estimated based on 1961 - 1979 records at the hydrological stations No.2527411 in the Muar river and No.1737451 in the Johor river. The surface run-off is 21 billion cu.m/y or 34% of rainfall of 62 billion cu.m/y. Evapotranspiration is 38 billion cu.m/y and groundwater recharge is 4 billion cu.m/y.

Organic pollution in the rivers is caused by domestic and industrial sewage, effluent from rubber factories, palm oil millls and animal husbandries. Biochemical oxigen demand (BOD) concentration of more than 5 mg/lit was measured during 1978/1979 in the Johor and Endau rivers. Operation of mines, opening-up of residential areas, road construction and logging are major causes of high concentration of suspended solid (SS). In the 1978/1979 observation, SS concentration was more than 200 mg/lit in some stretches of the Muar, Batu Pahat and Endau rivers.

Alluvial aquifers occur in the coastal plain along the sea coast and rolling plain, but sea water intrudes evidently near the seashore. Rock aquifers are poor.

The river characteristics in terms of river morphology, estuary, sediment and sea water intrusion in Johor is as shown in Tables 2 through 4.

2.3 Watershed

Natural vegetation occupies 5,730 sq.km comprising hill forest of 3,856 sq.km, scrub forest of 719 sq.km, swamp forest of 921 sq.km and grassland of 234 sq.km. The varieties range from the mangroves on coastal fringes to the mixed dipterocarp forests in lowlying and hilly areas and the montane forests of the highlands.

The total forest decreased from 9,583 sq.km or 50% of the whole State in 1966 to 5,496 sq.km or 29% in 1979 by forest exploitation not only for logging purpose but also for execution of agricultural land development schemes.

Through the soil erosion potential evaluation in the Study, it was preliminarily estimated that the concentration of suspended solid was between 200 and 400 mg/lit at present in the middle and lower reaches of the Muar river due to the surface soil loss occurred in its catchment area.

2.4 Present Socio-economic Condition

As illustrated in Fig.1, Johor is administratively composed of eight districts. Towns having population of more than 10,000 in 1980 were Segamat, Labis, Tangkak, Muar, Batu Pahat, Yong Peng, Pontian Kechil, Pekan Nanas, Kulai, Johor Bahru, Kota Tinggi, Keluang and Mersing in Johor.

Population and gross regional product (GRP) of the State of Johor are described hereunder.

Population of Johor was 1.7 million in 1980, with the average annual growth rate of 2.5% during the period from 1970 to 1980. Population density increased from 69 persons/sq.km in 1970 to 89 persons/sq.km in 1980.

Gross regional product (GRP) increased from M$1,436 million in 1971 to M$2,857 million in 1980 in factor cost at 1970 constant price with the average annual growth rate of 7.9%. GRP of manufacturing sector shared M$217 million or 15.1% of the total in 1971 and M$679 million or 23.8% in 1980. Per capita GRP was M$1,677 in 1980 in factor cost at 1970 constant price and its average annual growth rate between 1971 and 1980 was 5.3%.

Major land use patterns in 1979 were forest of 5,496 sq.km, grassland of 234 sq.km, annual and perennial crop land of 8,717 sq.km, swamp of 1,685 sq.km and miscellaneous land of 3,127 sq.km. The land use in 1974 is shown in Fig.2.

Rubber, oil palm, coconut and cocoa are planted for earning of foreign currency by export. The total planted area as of 1979 was 473,300 ha for rubber, 260,500 ha for oil palm, 67,900 ha for coconut and 12,700 ha for cocoa. During the last five years since 1975, newly planted area under FELDA and FELCRA schemes totaled 4,200 ha for rubber and 36,600 ha for oil palm. RISDA replanted 16,300 ha of rubber in the existing smallholders' rubber areas during the said period, while private estates reduced by 16,500 ha their planted area of rubber mainly for the purpose of conversion to oil palm. The annual production in 1979 totaled 413,600 tons of rubber as dry rubber content, 3,072,300 tons of oil palm as fresh fruit bunch and 164,800 tons of coconut as copra and 1,100 tons of cocoa as dry beans. Out of the above harvests, private estates produced 153,000 tons of rubb9r, 2,479,000 tons of oil palm, 100 tons of coconut and 1,100 tons of cocoa. The remaining ones were put out from RISDA, FELDA and FELCRA schemes as well as smallholders.

In 34 mills located within the State, 660,300 tons of crude palm oil and 143,800 tons of palm kernel were extracted from oil palm through processing 2,955,400 tons of fresh fruit bunch brought in the mills throughout 1979.

In 1979/80, paddy was planted in 3,900 ha comprising main season wet paddy of 2,400 ha and off-season wet paddy of 1,500 ha. As the whole paddy field was 8,000 ha, the crop intensity in 1979/80 became 0.49. The total rice production in 1979/80 was 6,000 tons among which 4,200 tons were harvested in the main season and the remaining 1,800 tons were off-season wet paddy rice. This production met 1% of the estimated local consumption of 162,100 tons in the State in 1979/80.

During the period from 1970/71 to 1979/80, rice production fluctuated between 4,900 tons in 1976/77 and 10,100 tons in 1975/76 largely affected by climatic condition, even though paddy field which was provided with irrigation facilities decreased from 4,700 ha to 3,700 ha.

3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

3.1 Domestic and Industrial Water Supply

Public water supply in Johor is administered by the Water Supply Division of Public Works Department (PWD) of the State Government.

PWD supplies piped and treated water to the major towns in urban area and also to the minor towns and villages in rural area. The urban water supply system also commands some suburban rural areas nearby. The pipeline is connected to individual taps.

In 1978, thirty nine PWD waterworks delivered 208,200 cu.m/d of water on an average. The population served water through PWD networks was estimated at 872,000 in 1980.

In the interior and isolated rural areas, untreated water supply system has been developed by the State Government by either withdrawing water from small river or digging shallow wells equipped with hand pumps with materials and technical advices from MOH, under the Rural Environmental Sanitation Program. It was estimated that 38,000 people were served water by the untreated water supply system in 1980. The water users are suggested to boil water before drinking.

In consequence, 947,000 people out of the total State population of 1.70 million were estimated to be served water through PWD and RESP, corresponding to the service factor of 56% in 1980.

3.2 Irrigation

There are 8,000 ha of paddy fields: 4,700 ha are irrigated and 3,300 ha are rainfed. No major schemes are located in the State. There exist 19 irrigation schemes consisting of 10 gravity irrigation, 7 pumping irrigation and 2 control drainage schemes. The largest irrigation schemes is the Assam Bukok control drainage scheme with a service area of 1,159 ha. The average size of irrigation schemes in the State is 239 ha. Location of irrigation areas is shown in Fig.3. Among total irrigation areas, 3,600 ha are double cropping paddy. Present paddy yield is 2.0 - 3.3 tons/ha in the main season and 2.0 - 2.7 tons/ha in the off-season according to the records from 1973 to 1978.

3.3 Flood Mitigation

Flood occurs between September and March, mostly in December. The damage by the recorded maximum flood in the State is estimated to be M$38.2 million at 1980 price level. Table 5 lists the inundated area and estimated damage by the recorded maximum flood by Basin. The inundated area is illustrated in Fig.4.

3.4 Inland Fishery

There are 213 ha of freshwater constructed ponds and 29 ha of tin mining pool used for fish culturing. The water use of the constructed ponds in 1979 was 2.89 million cu.m/y.

3.5 Inland Navigation

In the Johor river, passenger boats ply three routes. In the Pontian Besar river, only a few river fishing boats navigate the river other than marine fishing boats.

3.6 Sewerage System

No sewerage system is installed in Johor. The installation of septic tank is compulsory by regulations in other unsewered urban areas, while domestic sewage is directly discharged into nearby water course or onto land in rural area.

3.7 Water Purification System in Private Sector

The Federal DOE started to monitor the river water quality since 1978 in Johor with the frequency ranging from twice a year to once a month in 9 river water quality control regions.

There are 50 rubber factories in the State. These factories produce SMR, latex concentrate and conventional grade of 609 tons/day and they discharge effluent of 6.24 million cu.m/y to nearby watercourses. The water quality at outlets of factories ranges from 22 to 2,350 mg/lit in BOD concentration and from 46 to 800 mg/lit in SS concentration.

There are 34 oil palm mills in operation of which total milling capacity amounts to 10,988 tons/hr in fresh fruit bunch (FFB). The volume of effluent from these mills is 2.11 million cu.m/y. The treated or raw effluent is and will be discharged from 16 mills into watercourses and from 18 mills onto land. The water quality ranges from 35 to 35,000 mg/lit in BOD concentration and SS concentration ranges from 85 to 30,000 mg/lit.

3.8 Watershed Management

The State Forestry Department is responsible for administration and regulation of forest exploitation, forest revenue collection, management and development of the State's forest resouces, and for planning and coordinating the development of wood-based industries.

At the end of 1979, the forest land was categorized into forest reserves of 4,831 sq.km, wild life and other reserves of 442 sq.km and Crown or State land of 223 sq.km. Out of the forest reserves, 3,954 sq.km was classified as productive forests comprising 3,773 sq.km of inland forests and 181 sq.km of mangrove forests. The remaining 877 sq.km were unproductive forests consisting of 802 sq.km of protective hill forest and 75 sq.km of mangrove forests. In the inland forest reserves, there remain 2,212 sq.km of unexploited forests which have been committed or licenced for development. The actual area opened for harvesting during 1979 was 137 sq.km corresponding to 16% of the unexploited forests.

Besides forest exploitation, execution of large-scaled land development schemes for tree crop plantations, housing estates and construction of highway in mountainous and hilly areas have caused sheet and gully erosion problems on steeply dissected land.

All the activities mentioned above are also sources of man-made sedimentation. In the future, the suspended solid concentration of river flow will be over 500 mg/lit in the lower reach of Muar river and range between 100 and 300 mg/lit in the lower reaches of the Batu Pahat and Endau rivers, if all the present forest lands having a slope of less than 2 degrees and non-erodable soils are converted to tree crop plantations and those located on slope lands ranging from 3 to 6 degrees and on erodable soil areas with a slope of less than 2 degrees are exploited for logging purpose. In case that regeneration of the existing exploited forests will be artificially accelerated by conducting enrichment planting and regular planting in parallel with the above-mentioned development, the suspended solid concentration will not be substantially reduced.

3.9 Dams

Table 6 lists the dams at various stages in Johor.

There are six small dams in operation in the State. Out of them, five dams are those for water supply purpose and a dam is for flood control purpose.

There are two dams now under construction and another two under planning stage.

In addition, there are three small dams located in Johor and a tidal barrage located at the borders of Johor and Melaka. The above three dams are those for the purpose of water supply mainly to Melaka.

4. FUTURE WATER DEMAND AND ASSOCIATED PROBLEMS

4.1 Projected Socio-economic Condition

The socio-economic framework was projected based on the planned values of 4MP and the Outline Perspective Plan (OPP) as well as the latest figures of 1980 Population Census as the preliminary field count. For the projection, an assumption was made that the 4MP/OPP target of GDP be achieved by 1990 and thereafter the growth rate be 7.5% between 1990 and 2000. Outcome for the State of Johor is described hereunder.

The average annual growth rate of population in the period from 1980 to 2000 was estimated to be 1.9%. Projected population is 2.11 million in 1990 and 2.49 million in 2000, respectively. Table 7 shows the projected population by urban and rural area in the State of Johor. In the Study, the urban area includes cities/towns each of which population in 2000 was estimated to be not less than 10,000.

GRP in factor cost at 1970 constant price was projected to be M$4,162 million in 1985, M$6,245 million in 1990 and M$12,673 million in 2000 with the average annual growth rate of 7.7% between 1980 and 2000.

Projected gross value of output in manufacturing sector will increase from M$2,389 million in 1980 to M$4,244 million in 1985, M$7,140 million in 1990 and M$15,433 million in 2000 at factor cost in 1970 prices as shown in Table 8.

The future rice consumption in the State was estimated to be 253,600 tons in 1990 and 298,400 tons in 2000. To raise the average rice self-sufficiency rate in Peninsular Malaysia up to 85% in 1990 and in 2000 as well, implementation of the following irrigation development plans is indispensable: (1) provision of irrigation system for the existing rainfed paddy field of 1,400 ha and the newly reclaimed paddy field of 7,200 ha, (2) stabilization of irrigation water supply during the wet season to he existing irrigated paddy field of 1,700 ha and (3) development new irrigation water resources during the dry season to increase by 900 ha double cropping area among the existing irrigated paddy field. The total rice production anticipated under the above plans will be 37,400 tons in 1990 and 56,000 tons in 2000.

Oil palm planting area was projected to increase to 286,500 ha in 1990 and 315,900 ha in 2000. The prospected processing amount of oil palm in the State will be 3.5 million tons as fresh fruit bunch in 1990 and 6.4 million tons in 2000.

Rubber planting area was projected to be kept in the present hectarage of 438,800 ha in 1990 and 2000. The total processing amount was projected to be 340,000 ton as dry rubber content in 1990 and 380,000 ton in 2000.

4.2 Basin Division

For the purpose of the Study, the land was divided into Basins each being a river basin or a group of river basins as shown in Fig.5. Each Basin is further divided into effective area and ineffective area. The former is the upper part of the Basin in which part of the water uses was assumed to return into lower stretches of the river. The latter is the remainder of the Basin, in which water used and surface flow originating therefrom were assumed to run totally into the sea. The boundary of the two areas is normally located below the lowest intake site, herein called the balance point, in the major river in the Basin. The total catchment area, effective area, the location of balance point and assumed river maintenance flow (see Section 5.2) are as shown in Table 9.

As shown in Fig.5, nine Basins are wholly or partly located in the State of Pahang: located within the State are eastern part of the Kesang Basin, downstream part of the Muar Basin, whole of the Batu Pahat, South-west Johor, Johor, Sedili Besar and Mersing Basins, a southern part of the Endau Basin and a part of Rompin Basin.

4.3 Domestic and Industrial Water Demand

Domestic and industrial water demand was projected based on the projected population and gross value of output in manufacturing sector for 1990 and 2000.

For the domestic water supply, it was assumed that the entire population in the State would be fully served by piped water supply in 2000. Assumption was made that 50% of the total industrial water demand would be served by piped water supply. Table 10 shows the assumed per capita daily use of domestic water and service factor. The unit net manufacturing water use per gross value of manufacturing output by commodity group was assumed as shown in Table 11.

In Johor, the total water demand will reach 338 million cu.m/y in 1990 and 578 million cu.m/y in 2000 as shown in Table 12. Major demand centers are Johor Bahru, Kulai, Keluang, Batu Pahat and Muar among which Johor Bahru has the largest demand for both the industrial water and domestic water in 2000.

All the urban water demand was assumed to be supplied by surface water both in 1990 and 2000. However, in Kota Bharu in the State of Kelantan and in Sandakan and Labuan in the State of Sabah, groundwater use was assumed. For rural water supply, the share of groundwater use was assumed based on the estimated safe yield for each district.

The location of demand centers of domestic and industrial water is shown in Fig.5.

4.4 Irrigation Water Demand

The irrigated land development was projected taking into account information obtained from DID and the assumed rate of self-sufficiency in domestic rice production in the State. As shown in Table 13, the projected irrigation area will increase from 4,700 ha in 1980 to 11,200 ha in 1990 and 13,400 ha in 2000. The ratio of double cropping area to the total irrigation area will be 76% in 1980, 68% in 1990 and 73% in 2000.

The irrigation water demand was calculated for 1990 and 2000 as shown in Table 14. Irrigation efficiency applied is 55% for both major and minor irrigation projects. The annual irrigation water demand will be 247 million cu.m in 1990 and 292 million cu.m in 2000, respectively.

4.5 Fish Pond Water Demand

The future hectarage of freshwater fish pond was projected to increase from 253 ha in 1980 to 573 ha in 1990 and 1,074 ha in 2000. The total water demand for freshwater fish culture will rise from 3.47 million cu.m/y in 1980 to 2.61 million cu.m/y in 1990 and 14.53 million cu.m/y in 2000.

4.6 River Utilization Ratio and Water Deficit

The relative burden of water use on a river is indicated by the river utilization ratio, which is the ratio of water demand to natural run-off. All natural flow cannot meet water demand, because it mostly runs to the sea as flood flow. It was estimated that natural flow would often fail to meet all water demand if the river utilization ratio is not less than 10% under the hydrological condition in Malaysia. The area with river utilization ratio of not less than 10% is, therefore, herein called the water stress area. Table 15 shows the estimated long-average natural run-off, projected water demand and river utilization ratio.

The river utilization ratio was calculated for each basin for 1990 and 2000 as shown in Table 15. In the State of Johor, the two Basins among the concerned seven were estimated to have a river utilization equal to or more than 10% in 2000; the other five Basins to have the ratio of less than 10%.

In order to determine the total requirement for storage supply and water diversion, the water deficit at the balance point was calculated for each Basin, assuming the hydrological condition in the recorded period.

Natural runoff in each basin was estimated on 5-day basis, based on daily hydrological records prepared by DID. The recorded period was 19 years from 1961 to 1979 for the Peninsular Malaysia and ranged from 10 to 15 years for Sabah and Sarawak.

Groundwater potential is still to be clarified. Groundwater development will be essential especially for the villages with difficulty of access of clean surface water. Groundwater use is assumed for some rural domestic water supplies based on the estimated safe yield in each district.

A part of water taken from a river returns to the river. It is herein called the return flow. The return flow from irrigated paddy was assumed to be 20% of irrigation water demand within the effective area. The return flow from domestic and industrial water use within the effective area was estimated depending on the purpose of water use ranging from 8 to 100%.

The water withdrawal is herein defined as the net reduction in river flow which is required to meet the water demand and it was calculated by the water demand deducted by the return flow and groundwater use.

Certain discharge is necessary to sustain normal water use and environmental condition in the river. It is herein called the river maintenance flow as will be explained in more detail in Section 5.2. The rate of river maintenance flow was assumed as shown in Table 9.

All the water demand can be met and all the water use can be sustained if river flow is more than the sum of water withdrawal and river maintenance flow, and if otherwise river flow is in deficit. The water deficit was calculated by the water withdrawal plus river maintenance flow less the natural run-off in each 5-day period.

The estimated water deficit varies depending on the assumed hydrological condition. Among the hydrological conditions in the recorded period of N years, that resulting the largest annual volume of water deficit is herein regarded as the driest condition and called 1/N drought, that resulting the second largest annual volume of water deficit is called 2/N drought, and so on. The estimated water deficit by Basin under 1/N to 5/N drought is as shown in Table 16.

The water deficit shown in Table 16 was calculated under without-dam condition. If the estimated supply capacity of the existing and under-construction dams listed up in Table 6 is taken into account, the above-mentioned water deficit will be reduced in Basins where dam is located. It is noted that the water deficit in each Basin was calculated only at the balance point and it indicates an overall balance in the Basin. There may be the cases that river flow is in deficit in some section upstream of the balance point if major demand is located upstream.

4.7 Water Quality

To estimate BOD concentration in the river, BOD load flowing into a river was calculated based on the water use by pollution source. Major pollution sources are the domestic and industrial water users comprising 18 urban areas, 34 palm oil mills, 50 rubber factories, animal husbandry in the rural areas. However, waste water from the following cities was assumed to be directly discharged to the sea: Johor Bahru, Muar, Pontian Kechil and Mersing.

It was assumed that BOD concentration in the effluent remains at the present level, except that the land disposal system is progressively applied in the palm oil mills and rubber factories as shown in Table 17. BOD concentration along the main streams of rivers was calculated for the condition that the rate of run-off at just downstream of each outlet of effluent was equal to the assumed rate of river maintenance flow at that point, and the residual purification ratio varies in the range of 0.7 to 0.9 according to the characteristics of the rivers.

Discharge ratio, run-off ratio and BOD concentration assumed by type of pollution source for 1990 and 2000 are as shown in Table 18. A portion of water is consumed by being incorporated in products, by evaporation and by leakage in the process it is used and treated. The ratio of water after consumption to that before consumption is called the discharge ratio. A portion of water is again lost during the travel that water is released by the consumer and it enters into a river. The ratio of water reaching the river to that discharged by the consumer is the run-off ratio.

The projected maximum BOD concentration in Johor will be more than 10 mg/lit except for the Sedili Besar and Mersing rivers in 1990 and 2000. This projection states that most rivers will be grossly polluted in 1990 and 2000, because of the location of palm oil mills, rubber factories and inland-cities/towns such as Keluang, Segamat, Kulai and Kota Tinggi.

4.8 Watershed Problems

Annual rate of soil erosion ranges from about 30 tons/sq.km in natural forest to over 6,000 tons/sq.km in cleared land shifting cultivation land. Soil erosion reduces productivity in soil and also causes sedimentation in rivers. Erosion potential was studied in relation with soil erodability, slope and land use.

Present annual erosion rate is estimated to be 450 tons/sq.km. This erosion rate is generally high, because soils are erodable and natural forest has been converted to other land to a large extent.

In Johor, however, substantial reduction in erosion is not expected from reforestration in the presently disturbed forest, because agricultural land occupying a large area is the major contributor to erosion. Reforestration in the disturbed forest can reduce erosion in a long run.

If all natural forest on slope of less than 6 degrees is disturbed, erosion rate will increase to 1,750 tons/sq.km. An exercise indicates that erosion rate is 750 tons/sq.km, if natural forest on slope of less than 2 degrees is cleared and converted to rubber farm.

Based on these considerations, the following conclusions are preliminarily drawn:

(1) Forest clearing should be limited within the land of 2 degrees in slope.

(2) After clearing forest, such land use as appropriately protecting soils against erosion should be undertaken.

(3) As a long-term program for preservation of productive forest and soil conservation, reforestation should be undertaken in the disturbed forest.

It has been believed that forest clearing results in reduction of low river flow and increase of flood discharge. Experimental records in this respect in other countries are inadequate to draw conclusions applicable to Malaysia. There are also some experimental data in Malaysia but they are still insufficient for quantification. This aspect has not been analysed, but this does not mean that the importance of forest conservation in water resources conservation can be neglected.

5. STRATEGIES FOR WATER RESOURCES DEVELOPMENT AND USE

5.1 Problem Areas

Water resources use can be classified into instream uses, consumptive uses and energy potential use. Instream uses include navigation, fish catch and recreation. Consumptive uses are domestic and industrial water supply and irrigation. Energy potential use is hydropower generation. Water resources are liable to be deteriorated by man-made actions. Rivers are polluted by sewage and industrial effluent. Mining, logging, urban area development and road construction increases sedimentation in the rivers. Water resources have adverse characteristics such as drought and flood. Drought may constrain ordinary water uses. Rivers inundate vast lands and causes damages even loss of life.

Engineering measures are envisaged, corresponding to the characteristics of water resources and their use. Maintenance of low flow is required for sustaining not only instream water use but consumptive water use and environmental quality. Domestic and industrial water supply system and irrigation system and fishponds are provided to give consumptive water users access to water, also adjusting water quality to the use. When consumptive water use increases, competition may take place among the instream water users and consumptive water users, especially in the dry spell. Dams and basin transfer facilities are source development measures to augment low flow in the river so that all water uses can be sustained. Hydropower station is a measure to develop hydroelectric potential. Pollution abatement is to adjust water quality to water uses and requirement from the viewpoint of environmental quality.

The strategies for the water resources development and use are set for the following categories:

(1) maintenance of low flow necessary for sustaining various water uses and environmental quality;

(2) development of water supply and irrigation systems;

(3) source development for balancing water demand and supply;

(4) hydropower development;

(5) conservation of water quality; and

(6) flood mitigation.

5.2 Maintenance of Low Flow

Water has been utilized as need arises without causing any hazard yet to other water use in most rivers in Malaysia. The reduction of river flow due to intensified water use will, however, hurt various water users. The adverse effect of a small reduction of river flow may not be hazardous, but hazard becomes significant and irretrievable if small reductions accumulate.

It is proposed to establish the concept of river maintenance flow. The river maintenance flow is the minimum discharge which is required to maintain water depth, flow velocity, water quality, channel stability, aquatic eco-system and scenery to the extent necessary for navigation, fish catch, operation and maintenance of intakes, maintenance of river facilities, sea water repulsion, prevention of estuary clogging, conservation of groundwater, preservation of riparian land and people's amenity.

The river maintenance flow is the indicator of the allowable limit of water withdrawal from the river and is to be considered in allocating and developing water resources. Water withdrawal should not be increased, if it is expected to impair the river maintenance flow frequently. Source development such as construction of dam and inter basin water diversion system will be conducted, if it is necessary to augment low flow in the river to allow expected increase in water withdrawal, while sustaining the river maintenance flow. An estuary barrage will be constructed, if it contributes to the reduction of the required rate of river maintenance flow through preventing sea water intrusion and through maintaining water level for the intakes located in the estuary area.

The river maintenance flow should be sustained to the extent possible, but its temporary reduction can be allowed to a certain extent. The river flow which corresponds to the subsistence level of water uses is herein called the essential river maintenance flow. The river maintenance flow may not be reduced to the essential river maintenance flow even if an extreme drought takes place. When the essential river maintenance flow is needed to be sustained under any drought, water withdrawal from the river should be reduced.

The river maintenance flow should be determined individually for each river, based on the conditions particular to the river. The river maintenance flow may require a costly development, if its rate is set considerably high. It should be determined based on the minimum requirement in each river. On the other hand, the river maintenance flow should not be so low as the recorded minimum flow, which is too small to sustain the existing water uses and environmental quality. It is preliminarily assumed that the rate of river maintenance flow is equal to the daily natural discharge of 97% in probability of exceedence as shown in Table 9 and that of essential river maintenance flow is equal to the daily natural discharge of 99% in probability of exceedence, referring to examples in several countries.

5.3 Development of Water Supply and Irrigation Systems

Water supply system and irrigation system have been developed, in order to transmit water from sources and to distribute it to the consuming ends.

Domestic and industrial water supply is conducted along with the objectives of national economic development, regional development and social well-being improvement. The service factor of urban water supply system is already high, and the development of rural water supply system has been forcefully promoted in the recent years. Taking into account the Government policy prevailing, it is assumed that the public water supply system will be developed to supply domestic water to all people by 2000 and to supply 50% of industrial water, except that 10% of rural people in Sabah and Sarawak will still not be publicly supplied, because of remoteness and non-availability of suitable water source.

Irrigation development on paddy, including the tertiary development is carried out along with the objectives of national economic development, improvement of food self-sufficiency and increase in farmers' real income. It is assumed that the irrigation facilities will be provided in accordance with the projected land development schedule.

5.4 Source Development

Balancing water demand and supply is the requisite for water resources development and use. The water demand projection was made assuming that concerned agencies would take appropriate measures for water saving such as recyclic use of water and increase in efficiency of facilities and utilization of sea water. Where frequent water deficit are foreseen even with these water saving measures, the development of source facilities such as water storage and/or interbasin diversion are proposed.

The strict adherence to the river maintenance flow will result in the construction of costly facilities even in the rivers in which water use is small compared with natural flow. Analysis showed that all the water demand could be met for more than 85% of time in the rivers of less than 10% in river utilization, if a temporary reduction in the river maintenance flow to a minor extent is permitted. With these considerations, it is proposed that the source development should be implemented only in the rivers in which the river utilization ratio will be more than 10%.

5.5 Water Pollution Abatement

Water pollution abatement is considered from the viewpoint of environmental quality and maintenance of water uses. River water can be treated ordinarily for domestic and industrial use, if its quality is on an adequate level from the viewpoint of environmental quality.

The concept of water quality standard in the river should be established as the indicator showing the target of water pollution abatement, which is performed by reducing pollution load discharged into the river.

The biochemical oxygen demand (BOD) is the oxygen used to meet the metabolic needs of aerobic micro-organisms in water rich in organic matter. Self-purification mechanism of river is greatly reduced and the aquatic ecosystem is also affected if BOD concentration in the rivers is more than 5 mg/lit. Odour occurs if the BOD concentration is over 10 mg/lit. Pre-treatment is necessary if BOD concentration in raw water is more than 2 mg/lit for domestic water supply and 5 mg/lit for industrial water supply. River water quality standards in terms of BOD concentration in several countries are illustrated in Fig.6. The target for water pollution abatement is set in terms of BOD concentration in the river, because BOD concentration is the most common and important parameter of man-made pollution of inland water.

The measures for organic pollution abatement in the river are the improvement of purification system of effluent from the palm oil mills and rubber factories as well as public sewerage development.

5.6 Hydropower Development

Power demand in Malaysia is growing at a high rate, while the existing power supply system largely depends on thermal power. Nation's energy policy directs the development of hydroelectric potential and the saving in fuel resources.

Hydroelectric potential in Sarawak has been estimated to be more than 20,000 MW. The Upper Rajang Hydroelectric Development is being studied in order to develop hydropower of 4,550 MW in the upper Rajang river in Sarawak. Power generated will be transmitted not only to Sabah and Sarawak but to Peninsular Malaysia by constructing submarine transmission line of 700 km. The total construction cost of the development has been estimated to be M$11 billion including the interconnection system. Further development including power supply to ASEAN countries has also been envisaged.

Due to uncertainties in the inter-connection systems for power transmission to Peninsular Malaysia and Sabah and also in the establishment of energy intensive industries in the State of Sarawak, this vast potential is, however, assumed to be made available only after the year 2000. The strategy of hydropower development is thus set to contribute to bridge power demand and supply balance up to 2000.

According to a recent projection by NEB, the maximum power demand in Peninsular Malaysia in 2000 will be 9,140 MW, while the installed capacity of existing and under construction hydropower totals only 1,206 MW at present. It is recommended that all known potential of economical hydropower of 1,026 MW in Peninsular Malaysia should be developed by 2000 for the maximum contribution in balancing power demand and supply.

There is a large power potential in Sabah and Sarawak, in addition to that in the Rajang river. The maximum power demand in 2000 has been projected to be a little over 1,000 MW each. Although power demand is generally fragmented into small isolated demand centers, hydropower development should be envisaged for such major demand centers as Kota Kinabalu in which the maximum power demand will be 460 MW in 2000 and Kuching in which the maximum power demand will grow to 295 MW by 2000. Such hydropower development should be capable of supplying to Tawau, Sandakan and Labuan if some or all of them are interconnected with Kota Kinabalu. It is recommended to develop hydropower in Sabah and Sarawak to such an extent that the incremental power demand in major demand centers can be met up to 2000.

5.7 Flood Mitigation

Flood mitigation contributes to the national economic development and social well-being by reducing flood damage and protecting people's life. The measures for flood mitigation should be provided in consonance with the socio-economic development.

The structural measures for the flood mitigation are channel improvement, bypass floodway, polder, flood control dam and their combinations as described below:

(1) Channel improvement: Channel improvement will increase the discharge capacity of river by reshaping the river channel and constructing levees including protection work against erosion and sedimentation in the river.

(2) Bypass floodway: Bypass floodway is a short-cut canal for flood where there are certain constraints for channel improvement. The discharge capacity of the floodway is usually determined to allow releasing the excess water of the original channel.

(3) Polder (Ring Bund): Polder is a ring bund to protect an area of high damage potential. It includes the construction of drainage canal and drainage pump for the protected area.

(4) Flood control dam: A flood control dam will retain flood temporarily. A single purpose flood control dam can hardly be justified, unless the flood damage is tremendous. The inclusion of flood control purpose into the dams proposed for other purposes is studied. The flood control space in the dam is determined to reduce the design flood discharge to 1/4, as a rule.

Non-structural measures are proposed for such river stretch as where structural measures are not applicable or where supplemental measures are required. They are the restriction of development and resettlement plan as described below:

(1) Restriction of development: The restriction of development is the control of damageable values in the flood vulnerable areas by restricting new development.

(2) Resettlement plan: The resettlement plan is also the restriction of development but it includes the resettlement of people.

In addition to the above-mentioned measures, flood forecasting and warning system is proposed for some river basins having more than 5,000 inhabitants liable to flood hazard as shown in Table 19.

5.8 Inland Fishery

Development of inland fishery contributes to the national economic development and social well-being by providing fish protein source and for eradicating poverty through providing employment opportunity in rural areas.

Inland fisheries activities comprise fishing and culturing in various waters such as rivers, lakes and reservoirs, tin mining pools, paddy fields, constructed ponds and mangrove areas. Along with the Government's policy for fish culture development presented in 4MP, the areal development was estimated in this Study. The beneficial and adverse effects of inland fishery development are shown in those of recommended plan for water demand and supply balance.

6. ALTERNATIVE STUDIES

6.1 Scope of Alternative Studies

In Chapter 5, the rate of river maintenance flow was provisionally assumed and the targets for domestic and industrial water supply, irrigation, water demand and supply balance and hydropower development were set. Herein presented are such alternative studies as those for water demand and supply balance plan by varying risks in supply, hydropower development plan by power supply system development plan, pollution abatement plan by target water quality standard, and flood mitigation plan for varying target of protection. Hydropower development alternatives are presented only for Sabah. For Peninsular Malaysia, it was assumed that all the known power potential should be fully developed by 2000 following the preliminary development schedule prepared by NEB. For Sarawak, as mentioned in 5.6, the hydropower potential was assumend to be so developed as to bridge demand and supply up to 2000.

The criteria for alternative setting and for comparison of the public expenditure and beneficial and adverse effects of alternatives are described hereunder, wherein, costs and effects were all estimated based on the criteria described in Chapter 7.

6.2 Water Demand and Supply Balance Alternatives

Both the instream water use and the consumptive water use can be sustained if river flow is more than the river maintenance flow. If otherwise, river flow should be augmented by developing source facilities such as dam for regulation of river flow or diversion facilities to transfer water from a river to another. A source development plan was proposed for each water stress Basin of which river utilization ratio in the projected year would be not less than 10% and the existing source facilities could not meet the estimated water deficit.

Natural flow varies not only seasonally but from year to year to a large extent. Any measures cannot meet all water demand under an extremely dry condition. In planning source facilities, water supply capacity is usually determined allowing a certain risk. If the risk is set considerably small, the source facilities are costly and if otherwise, adverse effects such as reduction in production and people's dissatisfaction may take place. The water demand and supply balance alternatives were proposed assuming different levels of risk.

Alternative sizes of the proposed source facilities were determined based on the following criteria:

Alternative B1: The supply capacity of source facilities is determined against the driest condition ever recorded; 1/N drought where N denotes the length of hydrological records in years.

Alternative B2: The supply capacity of source facilities is determined against the second driest condition ever recorded; 2/N drought.

Alternative B3: The supply capacity of source facilities is determined against the fourth driest condition (4/N drought) for Peninsular Malaysia and the third driest condition (3/N drought) for Sabah and Sarawak, ever recorded. This was proposed based on the difference in the length of hydrological records. (These conditions approximately correspond to 5-year drought according to Hazen's plotting method.)

A dam is constructed to retain water in the flood period and release it to augment river flow for the use in the dry period. Once a dam is constructed, inflow into the dam can be retained at any time, so far the storage capacity is available. It is required for a dam to release water at a rate which, together with the natural flow from the downstream catchment area, is sufficient to supply water demand while sustaining the river maintenance flow. In other words, the supply capacity of a dam is determined to supply all the water deficit. By doing so, the dam can develop water to meet the future water demand not affecting adversely on the existing water users.

The proposed dams were those either identified on 1/63,360 or 1/50,000 maps or proposed in previous studies. The water supply capacity of each dam was estimated based on hydrological record and on assumed storage capacity. The total water supply capacity of the proposed dams in a basin was determined to meet the total water deficit in the basin, allowing an operational loss which was assumed to be 10 to 20% of the water deficit.

If the total water supply capacity of all the proposed dams in a basin is not enough, diversion of water from other basin was proposed and, if necessary, the construction of a dam in the latter basin was further proposed.

The estimated public development expenditure and manpower requirement showed a large differences among the alternatives, indicating that a high guarantee of supply would be costly and requires a large manpower. A high guarantee of supply would bring a low value of internal rate of return, because benefit is little sensitive to the risk of supply. Alternative B1 can guarantee safe supply all the time even under the driest condition ever recorded but some interruption in safe supply have to be involved in the other alternatives. Considerations were made also of adverse effects such as removal of people from the proposed reservoir areas and change in fish fauna, and beneficial effects such as fish culture and recreation in a lake created.

It is recommended that Alternative B1 should be selected for the Basins where domestic and industrial water demand is predominant in accordance with the common understanding in Malaysia that domestic and industrial water supply should be sustained even under the serious drought.

Irrigation facilities have been designed against a drought of 5-year in return period in Malaysia, this criterion corresponds to the criteria in Japan, Korea, Indonesia and other countries in Southeast Asia. Under the condition that irrigation demand is already high, grading-up of the above-mentioned criterion will immediately require a large investment for source development. With these considerations, it is recommended to select Alternative B3 for the Basins where water is predominantly used for irrigation.

The location of potential and proposed water source facilities is shown in Fig.7 for Alternative B1. The alternative plans for water demand and supply balance are shown in Tables 20 through 22 for Alternatives B1, B2 and B3 respectively.

6.3 Hydropower Development Alternatives

A hydropower development plan for Peninsular Malaysia was recommended without alternative study.

6.4 Water Pollution Abatement Alternatives

Two alternative plans for water pollution abatement were proposed setting target BOD concentration in the river as mentioned below.

Alternative P1: 5 mg/lit in BOD concentration in 1990 onwards

Alternative P2: 10 mg/lit in BOD concentration in 1990 onwards

If the reduction of BOD concentration in a stretch of a river is found necessary to attain the target, the improvement of purification method in all palm oil mills and rubber factories in the river was, first of all proposed. The Basins where the improvement was proposed for both the alternatives for 1990 and 2000 were the Kesang, Muar, Batu Pahat, Sekudai, Johor, Endau and Rompin Basins.

If there still remains a river stretch of higher BOD concentration than the proposed limit, the construction of a sewerage system in the urban area upstream of the river stretch was proposed: the public sewerage systems in Kulai/Senai and Kluang were proposed for the Alternative P2 and the public sewerage systems in these two cities and Segamat were proposed for the Alternative P1.

No treatment measures were assumed for the sewage from the towns of less than 50,000 in population and rural areas and for the effluent from animal husbandry. With these conditions, it was estimated that some river stretc-es in the west coast of Peninsular Malaysia would show higher BOD concentration than the target value.

The ordinary treatment method for the domestic water supply is the sedimentation, filtration and chlorination, if BOD concentration in raw water is not more than 2 mg/lit. The ordinary treatment method for the industrial water supply is the sedimentation, if BOD concentration in raw water is not more than 5 mg/lit. Pre-treatment facilities are needed to varying extent for raw water with BOD concentration above these limits. For BOD concentration in raw water more than the above-mentioned limit but not more than 20 mg/lit, pre-treatment is carried out by the rapid sand-filter bed and activated carbon absorption (secondary treatment). For BOD concentration between 20 and 200 mg/lit, an aerated lagoon process such as aerated lagoon or maturing pond (primary treatment) is further needed. The cost for pre-treatment facilities was taken into account for the economic comparison of the alternatives.

The public development expenditure and manpower requirement were estimated in this Study to hardly vary between the two alternatives. The results of economic benefit cost analysis also showed little difference between the alternatives; although the economic cost is larger than the economic benefit, the water pollution abatement should be conducted from the viewpoint of environmental and social well-being impacts. Meanwhile, the problem is that the public development expenditure and manpower requirement would be largely concentrated in the earlier part of development, i.e., in 4MP and 5MP periods. In order to avoid this concentration, it is necessary to slow-down the rate of development up to 1990. With these considerations, it is recommended that the pollution in the river should be gradually abated by setting the target BOD concentration at 5 mg/lit for 2000.

6.5 Flood Mitigation Alternatives

Three alternatives are proposed for the flood mitigation:

Alternative F1: Structural measures are providad by 2000 for the entire river system to protect 90% of people within the flood prone area.

Alternative F2: Structural and non-structural measures are provided by 2000 for densely populated areas to protect 50% of people within the flood prone area.

Alternative F3: Structural and non-structural measures are provided by 2000 so far as such measures are economically viable.

The return period of design flood is assumed to be 20-year for the river stretch where the estimated annual flood damage is less than M$20,000/km and the population is 500 persons/km, and 50-year for the other river stretches, but 100-year if loss of life has been recorded.

The problem rivers were divided into stretches of 30 to 60 km in length. The measures explained in Section 5.7 were compared and the most economical measures was selected for each river stretch. The resulted alternative plans for the State are as outlined in Table 23.

Alternative F1 appeared to require a prohibitively large expenditure for the whole Malaysia. Alternative F3 should be implemented if considered from the viewpoint of national economic development, but it will increase the disparity between developed and underdeveloped areas. Taking into account the fact that social well-being objective has been emphasized through discussions between Malaysian Government officials and the Study Team, it is recommended that Alternative F2 should be taken up for the period up to 2000. The flood mitigation alternatives including Alternatives F1, F2 and F3 are illustrated in Figs.8 through 10.

7. RECOMMENDED PLAN

A Water Resources Development and Use Plan is recommended, based on the comparison of alternatives. Its outline is illustrated in Cover Map.

7.1 Public Water Supply and Irrigation Development Plan

Public water supply system including PWD system and RESP system is recommended to be provided to meet all the urban and rural domestic water demands and 50% of industrial water demand by 2000 in accordance with the plan shown in Tables 24 through 26. However, 10% of the rural people in Sabah and Sarawak will still not be publicly supplied, because of the remoteness and non-availability of suitable water source.

Irrigation water supply system will be constructed in accordance with the schedule assumed in Table 13.

7.2 Source Development

The recommended water source development plan for balancing water demand and supply is summarized in Table 27. The water source development plan in the problem area is mentioned hereunder.

Fig.11 illustrates the recommended water demand and supply program for south Johor region.

7.2.1 Melaka/Muar region source development plan

Population in the Muar river basin is estimated to be 552,000 for 1980, 606,000 for 1990 and 629,000 for 2000. There are minor irrigation projects of 7,000 ha and it will grow to 8,600 ha by 1990 and 9,100 ha by 2000. Total water demand in the basin is estimated to be 227 million cu.m for 1980, 308 million cu.m for 1990 and 358 million cu.m for 2000. Water resources are ample but possible dam sites are limited, because land is flat and intensively cultivated.

Water demand and supply in the State of Melaka seem to be just balanced at present and there is no other suitable dam site to meet the incremental water demand in the future, because of small basin area with flat topography. Water diversion from the Muar river basin is necessary.

The recommended plan includes the Palong dam in the upper reaches of the Palong river, a tributary of the Muar river, the Muar dam in the uppermost reaches of the Muar river, the Muar barrage in the lower reaches of the Muar river and a diversion canal between the Muar barrage and Melaka.

The dams needed for balancing water demand and supply in other states than those where the dams are located should be planned to store flood water for diversion, while such amount of low flow as required for use including the river maintenance flow should be released to the rivers where dams are located for the use within the State. By planning so, the facilities can provide more stable flow to the users within the State and also they can contribute to flood mitigation in the State.

7.2.2 South Johor source development plan

Population in Johor Bahru is estimated to be 266,000 for 1980, 439,000 for 1990 and 686,000 for 2000. The corresponding domestic and industrial water demand is estimated to be 37 million cu.m for 1980, 85 million cu.m for 1990 and 159 million cu.m for 2000 assuming that the establishment of water intensive industries is restricted. Raw water taken to Singapore was 198 million cu.m in 1980 and it is increasing rapidly. It is estimated that raw water to Singapore will be 316 million cu.m in 1990 and will reach to 414 million cu.m by 2000, the maximum volume in the agreement between the Government of the State of Johor and City Council of Singapore, by 2000. The supply capacity of 7 million cu.m/y by the existing 3 dams is not enough and the rivers in the vicinity of Johor Bahru is too small to supply these demands.

It is recommended to develop the Johor and Sedili Besar rivers for domestic and industrial water supply to Johor Bahru and Singapore. The Semengar dam and Linggiu dam will be constructed in the tributaries of the Johor river. The Johor barrage will be constructed in the main stream of the Johor river in order to develop water by combined operation with the Linggiu dam and divert it from the Johor river to the Semengar dam. Water in the Semengar dam will be diverted to the Teberau river, in which the Teberau barrage will be constructed for the supply to Johor Bahru and Singapore. These development cannot meet all water demand in 1990. The Sedili dam will be also constructed in the Sedili Besar river and water will be diverted from the Sedili dam to the Linggiu dam. In order to meet the incremental water demand up to 2000, the Pengeli dam will be further constructed in a tributary of the Johor river.

7.3 Water Pollution Abatement Plan

The recommended plan for the water pollution abatement in the river is the construction of public sewerage systems in Segamat, Kulai/Senai and Kluang and the improvement of purification method in the palm oil mills and rubber factories in the Kesang, Muar, Batu Pahat, Sekudai, Johor, Endau and Rompin Basins.

Although it is ineffective for the water pollution abatement in the river, sewerage development in Johor Bahru is assumed from the viewpoint of public health.

The recommended plan for water pollution abatement including the assumed sewerage development is shown in Tables 28 through 31.

7.4 Flood Mitigation Plan

The recommended plan for flood mitigation is mentioned hereunder and is summarized in Table 32.

7.4.1 Kesang river flood mitigation plan

The Kesang river flooded 114 sq.km in 1971. A preliminary channel improvement has been completed for the lower stretch up to the confluence between the Kesang river and Chohong river. The recommended plan is widening of the above-mentioned river stretch and improvement of the Chohong river approximately as scheduled under 4MP.

7.4.2 Muar river flood mitigation plan

Flat valley of the Muar river is intensively utilized for paddy cultivation. Flood in 1971 inundated an area of 380 sq.km in which 50,000 people live. The recommended plan for protection of paddy field includes integration of a flood control space of 24.4 million cu.m in the Muar dam which is proposed for balancing water demand and supply. The construction of ring bund is also recommended to protect a southwestern part of Segamat town.

7.4.3 Batu Pahat river flood mitigation plan

Rubber and oil palm farms in the Batu Pahat river basin suffer from ill-drainage flooding. The Batu Pahat river bifarcating into the Simpang Kiri, Bekok and Semberong rivers flooded 350 sq.km where 30,000 people live. As a part of the West Johor Agricultual Development Project, the Semberong dam is being constructed and the Bekok dam has been planned for the purpose of flood mitigation. In addition to these, it is recommended to provide channel improvement of 32 km for the Simpang Kiri river, 40 km for the Bekok river and 21 km for the Semberong river and to construct a bypass floodway of 19 km by enlarging the Senggerang river between the confluence of the Bekok and Semberong rivers and the sea.

With respect to the South-West Johor river basins, no Specific study was attempted with a view that the most of flood problems have been solved by the implementation of the South-west Johor Project including the Machap dam.

7.4.4 Sekudai river flood mitigation plan

Channel improvement of 25 km above the existing tidal gate to protect the area including Kulai town is recommended as a continuation of the on-going project.

7.4.5 Johor river flood mitigation plan

It is recommended to construct a ring bund to protect 4,700 people in Kota Tinggi.

7.4.6 Mersing river flood mitigation plan

The Mersing river flooded 42 sq.km and affected 16,000 people in 1971. It is recommended to protect Mersing town of 15,000 in population and agricultural lands by providing channel improvement for 6 km upstream of the town.

7.4.7 Endau river flood mitigation plan

The damage potential in the Endau river basin is small except the Mengkibol river, one of the tributary located in the southwest of the river basin and lower most stretch of the main stream where the Sawah Endau irrigation project is under construction. It is recommended to protect Keluang town of 55,000 in population and its vicinity by providing channel improvement for 11 km along the Mengkibol river. The Sawah Endau irrigation project should include necessary protection for the project area.

7.5 Cost Estimate

The construction costs of the proposed facilities were estimated at the constant price in December, 1980.

The construction costs consist of direct construction cost (contract amount), engineering and administration, land acquisition and physical contingency. The direct construction cost was estimated based on the actual costs and previous estimate for similar projects in Malaysia. Major unit costs assumed are listed in Tables 33 and 34. The physical contingency was assumed to be 30%. The construction cost is disbursed in five years antecedent to the year of commission of the proposed facilities. The construction cost of the untreated rural water supply, however, was assumed to be disbursed in one year exceptionally.

The construction costs were estimated for all the proposed facilities to be commissioned in 1985 onward, including storage and diversion facilities, domestic and industrial water supply system, irrigation system, flood mitigation facilities and public sewerage system, but the sunk cost was not estimated.

The facilities recommended for the Melaka/Muar region source development plan serves for the water demand and supply balance in the States of Johor, Melaka and Negeri Sembilan. The costs for those facilities are tentatively divided in proportion to the water demand in each state. The expenditure for the source facilities shown in Table 35 and 36 represents the cost thus distributed to the State of Johor.

The purification facilities for the palm oil mills and rubber processing factories were assumed to be privately financed.

According to the present practice, it was assumed that the construction cost of sewerage system borne by private sector is the house connections in the existing town area, and branch sewers and house connections in the new town areas. In estimating the sewerage treatment capacity in the new town area, it was assumed that the population within the existing town area will remain unchanged and the treatment capacity is allocated in proportion to the population.

The development expenditure and recurrent expenditure in public and sector for the recommended plan was estimated as shown in Tables 35 and 36.

7.6 Beneficial and Adverse Effects

The beneficial and adverse effects of the recommended plans were evaluated from the viewpoints of national economic development, environmental quality and social well-being. The beneficial and adverse effects of the recommended plans comprising each aspect of national economic development, environmental quality and social well-being are presented in Tables 37 and 38 for water demand and supply balance, in Table 39 for water pollution abatement and in Table 40 for flood mitigation.

It is noted that all the beneficial and adverse effects are those which accrue within the State of Johor and the cost for the Melaka/Muar source development is that tentatively allocated to the State of Johor only.

7.6.1 National economic development

The beneficial and adverse effects of the recommended plans for the national economic development account are calculated as the annual equivalent of economic benefits and costs, assuming a discount rate of 8% for an evaluation period of 50 years between 1981 and 2030.

The prices of internationally traded goods and services were estimated based on the World Bank projection up to 1990, or the international market price in December, 1980. The prices of locally traded goods and services were the normalized price in December, 1980. The transfer payments such as tax and local contractors' profit are deducted from all prices. The ratio of transfer payment to the financial cost was assumed to be 20% of financial cost referring to the ratio of tax revenue to GDP at purchasers' price in 1980 in 4MP.

The domestic and industrial water supply benefit was estimated based on the least-costly alternative facilities cost criteria. The cost of the above-mentioned alternative facilities including dams and the proposed intake, conveyance, treatment and distribution systems is regarded as the benefit of domestic and industrial water supply without drought damage.

There should be established a rule for the emergency operation against the drought in which both the rate of water withdrawal and rate of river maintenance flow should be sustained as much as possible and the river flow should be kept not below the essential river maintenance flow. Herein a simplified rule was assumed: water withdrawal for use continues until the river flow after the water withdrawal lowers to the essential river maintenance flow and thereafter the water withdrawal is reduced so that river flow no longer lowers. Consequently, the reduction in supply for domestic and industrial water and irrigation water is calculated through the period in which run-off record is available, allowing low flow after the water withdrawal to be equal to the essential river maintenance flow. The reduction in benefit is calculated assuming that it is proportional to the reduction in the supply.

The economic farmgate price of paddy during the evaluation period was estimated to be M$640/ton based on the projected price of 5% broken rice, FOB Bangkok. Estimated paddy yield, gross value, production cost and net value are estimated for 1990 and 2000 as shown in Table 41. The hectarage of newly reclaimed land and upgraded lands from rainfed paddy to irrigated or control drainaged paddies, single crop to double crop and minor scheme to major scheme were estimated for the future. Then the irrigation benefit is obtained as the incremental net production value.

The sewerage benefit is the willingness-to-pay by served people and saving in the cost of purification of industrial waste. It was herein assumed to be 0.6% of real income of served people and to be the same percentage of gross value of manufacturing production of served industries.

Pre-treatment facilities are necessary if BOD concentration in raw water is more than 2 mg/lit for domestic water supply and 5 mg/lit for industrial water supply. Its costs can be saved, if the proposed water pollution abatement measures reduce BOD concentration in the river below this limit. This saving in cost is counted as a part of water pollution abatement benefit.

Under the flood mitigation benefit, average value of reduction in annual damage by the proposed measures only is counted, while land enhancement benefit is counted in the irrigation benefit. It is assumed that the damageable value in the flood prone area will increase at a rate of gross regional product of the state.

The fish culture benefit was estimated to be M$2,000/ha for the fish pond and M$1.6 million/reservoir for the cage culture in the created reservoir.

Benefit of the created lake recreation is estimated by willingness-to-pay of the visitors to the lake. The willingness-to-pay is measured in terms of the travelling, or fuel cost of the vehicles to the recreation area. The said cost is assumed to be M$0.1/km.

The economic cost is calculated as the annual equivalent of the construction cost and OMR cost. It is noted that the private sector cost of industrial water supply facilities, purification facilities in palm oil mills and rubber factories and sewerage facilities are included in the economic cost of water pollution abatement measures.

The economic internal rate of return (EIRR) is calculated as the discount rate with which the present worth of benefit equals to that of cost.

7.6.2 Environmental quality

The beneficial and adverse effects of the recommended plans from the viewpoint of environmental quality are descriptively displayed.

The river maintenance flow is the requisite for the conservation of river environment and adequate water use. The effect on the river maintenance flow is evaluated as the number of days when the river maintenance flow can be sustained in the driest year ever recorded.

The water surface of created reservoir provides favorable scenery, place of recreation and enhancement of wildlife. The beneficial effect of created lake is counted by the water surface area.

The reduction in length of river stretches in which BOD concentration will be more than 5 mg/lit is regarded as the beneficial effect of water pollution abatement.

The channel improvement stabilizes the river channel and provides favorable condition for navigation and other instream water use. The length of improved river stretches is counted as a parameter showing the beneficial effect on environmental quality.

If a dam is constructed, some species of fish would probably disappear in certain length of river stretch immediately downstream of the dam showing an adverse effect on ecological system, though such adverse effect can be compensated by possible cage culture in the created reservoir.

7.6.3 Social well-being

The income increase, health improvement, life saving, and reduced risk in water supply are counted as the beneficial effect from the viewpoint of social well-being. The adverse effect is the inevitable removal of people for the purpose of construction of proposed facilities.

8. PLAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

8.1 Assumed GDP Growth Rate

The recommended plan mentioned in the foregoing Chapter 7 is based on an assumption that the growth rate of GDP is 7.7% in the period from 1980 to 1985, 8.4% from 1985 to 1990, and 7.5% from 1990 to 2000, in accordance with 4MP and OPP.

For reference, a plan under a lower economic growth was prepared, assuming that Malaysia's economy might be affected by a long-lasting world-wide economic depression. The growth rate of GDP assumed was 7% in the period from 1980 to 1985, 6% from 1985 to 1990, and 5% from 1990 to 2000.

8.2 Parameters Predominantly Related to GDP Per Capita

The parameters dominated by GDP per capita are the urbanization ratio, share of manufacturing sector in GDP, gross value of industrial output, power consumption per capita, domestic water consumption per capita and value of flood damage, so far related with the water resources development and use. These parameters under the condition of lower economic growth were estimated assuming a functional relationship with GDP per capita.

8.3 Assumed Targets

The service factor and per capita daily use (PCDU) in domestic water supply and rate of irrigation development may be affected by the economic growth and by the socio-economic policy as well. It is herein assumed that, in case of the lower economic development, the target service factor and PCDU in domestic water supply for 2000 is delayed by five years but the rate of irrigation development does not change even under the lower economic development. The estimated service factor and PCDU under the condition of lower economic growth are shown in Table 42. The domestic and industrial water demand estimated under the condition of lower economic growth is shown in Table 43.

8.4 Development Plan

The development plan under the condition of lower economic growth is tabulated in Tables 44 through 51.

8.5 Public Expenditure

The public development and recurrent expenditures are estimated for the case of lower economic growth as shown in Tables 52 and 53.

8.6 Beneficial and Adverse Effects

The beneficial and adverse effects of the water resources development and use plan for the case of lower economic growth are summarized in Tables 54 through 56.

TABLES

Table 1 METEOROLOGICAL DATA IN JOHOR

Station	Month	Mean Air Temperature (°C)	Relative Humidity (%)	Sunshine Hours (hrs.)	Open Water Evaporation (mm)	Rainfall (mm)
Johor Bahru (El. 38 m)						
	Jan.	25.0	83.5	N.A.	142	161
	Feb.	25.1	83.6	N.A.	130	176
	Mar.	25.5	84.6	N.A.	148	228
	Apr.	25.8	87.1	N.A.	137	251
	May	26.0	87.3	N.A.	135	208
	June	25.6	87.6	N.A.	124	145
	July	25.3	87.5	N.A.	132	144
	Aug.	25.5	87.2	N.A.	138	158
	Sep.	25.4	87.3	N.A.	136	185
	Oct.	25.4	87.4	N.A.	145	202
	Nov.	25.2	88.9	N.A.	135	263
	Dec.	25.0	87.7	N.A.	133	298
	Annual	25.4	86.7	N.A.	1,635	2,419

Table 2 RIVER CHARACTERISTICS IN JOHOR (1/3)

Basin No.	Item	Description
20	Kesang river	
	(A) River Morphology	Sluggish courses in lower reaches, but canalization completed up to Kg. Simpang Bekoh.
	(B) Estuary	No major problem reported.
	(C) Sediment	Presumably high yield of sediment, in view of mining activity, logging operation, recent land development and less forest cover, but observed S/S records show little yield. Detailed observation recommended.
	(D) Sea Water Intrusion	Up to tidal gate. No adverse problem at present.
21	Muar river	
	(A) River Morphology	Meanders in lower tidal reaches, but stable at present. Only minor erosions at local places in upper reaches and in mangrove bank areas. River generally in a stable regime. Propagation of water plants active in lower reaches.
	(B) Estuary	No problem existing.
	(C) Sediment	Upstream area developed mostly for rubber plantation, but no noteworthy sediment problems.
	(D) Sea Water Intrusion*	Up to Kg. Kepong (110 km from river mouth). Sometimes, interruption of pumping.
22	Batu Pahat river	
	(A) River Morphology*	Some meanders in middle reaches of Simpang Kiri., Simpang Kanan and Lenik rivers. Shallow channels at meanders causing floods at smaller discharge. Bank generally stable.
	(B) Estuary	Sand bars on west bank, but seems not to cause adverse effect on flood level in upstream. No navigation difficulty reported.

Remarks; *: Major problems requiring some improving measures

Table 3 RIVER CHARACTERISTICS IN JOHOR (2/3)

Basin No.	Item	Description
	(C) Sediment*	No excessive sediment yield observed, except housing project on left bank of Simpang Kanan (near Batu Pahat town) causing silting in nearby areas.
	(D) Sea Water Intrusion	Up to Seri Medang on Simpang Kiri and Pt. Raja on Simpang Kana. No major adverse problem at present.
23	Scudai & Tebran river	
	(A) River Morphology	No meanders except minor ones in lower tidal areas. Bank erosion only at local places.
	(B) Estuary	No problem existing.
	(C) Sediment*	Housing development in middle reaches, producing sediment and causing aggradation of river bed levels.
	(D) Sea Water Intrusion	Up to PUB's tidal gates (PUB: Public Utility Board of Singapore). No adverse problem at present.
24	Johor river	
	(A) River Morphology	No noteworthy meanders and erosions at present. River mostly flows in swamp jungle areas.
	(B) Estuary	No problems existing.
	(C) Sediment	Comparatively low yield rate 76 $m^3/km^2/y$ for Sg. Sayong at Layang-Layang (98 km^2). No adverse problem reported.
	(D) Sea Water Intrusion *	Up to a point upstream from confluence with Sg. Pelapha (approx. 50 km). Water supply at PUB pumping station sometimes affected.
25	Sedili Besar river	
	(A) River Morphology	Meanders in lower tidal reaches. No noteworthy erosion. River flows mostly in swamp jungle areas, and generally in a stable regime.

Remarks; *: Major problems requiring some improvement measures

Table 4 RIVER CHARACTERISTICS IN JOHOR (3/3)

Basin No.	Item	Description
	(B) Estuary	No major problem at present, but littoral sediment intruding into river mouth over a mile long. In further upstream area, water depth is deep, 5 - 6 m, up to Kg. Mawai. Some rock outcrops at river mouth.
	(C) Sediment	No problem observed.
	(D) Sea Water Intrusion	Up to some upstream point from junction with Sg. Kayu. No adverse problem at present.
26	Mersing river	
	(A) River Morphology	No noteworthy meanders and erosion. River in a stable regime.
	(B) Estuary*	Coastal sand dunes on both banks of river mouth, causing the navigation of marine fish boats difficult. Course of navigation channel moving year by year due to erratic bed scour by monsoon flow.
	(C) Sediment	No problem reported.
	(D) Sea Water Intrusion	No problem reported.
27	Endau river	
	(A) River Morphology	Meanders existing in lower tidal reaches but not active. Banks seem stable with only minor erosion at local places (Sembrong, Kahan rivers). Rapids existing near Kuala Sg. Jasin.
	(B) Estuary	No major problem at present, but sand dune developing on both banks. River mouth shallow, but seems in a equilibrium condition.
	(C) Sediment	No problems existing. No sand bars/ shoals observed.
	(D) Sea Water Intrusion	Tidal effect up to 80 km along river course. Confluence with Sg. Mentelong is saline at regular interval.

Remarks; *: Major problems requiring some improving measures

Table 5 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN JOHOR

Basin No.	River Basin	Year	Flooded Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
20	Kesang	1971	23	4	1.5
21	Muar	1971	295	33	5.1
22	Batu Pahat	1971	350	30	10.8
23	Benut, S.W.	1969	592	90	8.7
	Johor Rivers				
	Sekudai	1978	16	13	1.8
	Teberau	1978	19	8	1.1
24	Johor	1969	106	31	3.0
25	Sedili Kechil	1969	87	2	0.1
	Sedili Besar	1969	196	-	-
26	Mersing	1971	42	16	1.2
	Junglu	1971	6	2	0.1
	Sisek	1971	14	-	-
	Jeriang Kechil	1971	10	-	-
	Jeriang Besar	1971	10	-	-
27	Endau	1969	516	34	4.8
	Sub-total		2,317	263	38.2

Table 6 LIST OF EXISTING AND PLANNED DAMS IN JOHOR

Name	River	Purpose/ Year of Commission	Organi- zation	Catch- ment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^6 m^3/y)
Existing						
Pontian/ Kechil	Pontian/ Kechil	WS	SUB	12	-	
Gunong Pulai	Pulai	WS	SUB	6	-	Total of the 3 dams
Pulai III	Pulai	WS	SUB	2	-	19
Lebam	Lebam	WS	PWD	19	3	27
Tenglu/ Mersing	Mersing	WS	PWD	-	-	-
Batu Pahat	Simpang	FM	-	-	-	0
Kesang barrage	Kesang	TB	DID	-	-	-
Asahan dam	Kesang	WS	MWB	-	-	0
Belembang dam	Muar	WS	PWD	-	-	0
Gunong Ledang weir		-	PWD	-	-	0
Pengkalan Bukit weir		-	PWD	-	-	0
Under Construction						
Semberong	Semberong	FM+ (WS)	DID(PWD)	130	13	58
Layang	Layang	WS	PWD	31	36	90
Under Planning						
Machap	Benut	FM+ (WS)	DID(PWD)	78	30	0
Tiram	Tiram	WS(1987)	PWD	-	-	-

Remarks; WS: Domestic and industrial water supply
FM: Flood Mitigation
TB: Tidal barrage

Table 7 HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN JOHOR

Unit: 10^3

District	City/Rural	Historical 1980	Projected 1985	1990	2000	Average Annual Growth (%) 1980-2000
47. Segamat	32. Segamat	37	49	64	104	5.3
	122. Labis	12	12	14	17	1.8
	125. Jementah	8	9	10	12	2.0
	Rural	107	111	113	106	0.0
	District Total	164	181	201	239	1.9
48. Muar	33. Tangkak	14	15	16	19	1.5
	34. Muar	70	72	77	90	1.3
	Rural	227	229	231	227	0.0
	District Total	311	316	324	336	0.4
49. Batu Pahat	35. Batu Pahat	70	78	88	114	2.5
	123. Yong Peng	11	11	12	14	1.2
	Rural	215	223	225	214	0.0
	District Total	296	312	325	342	0.7
50. Pontian	37. Pontian Kechil	22	32	44	75	6.3
	124. Pekan Nanas	10	10	11	13	1.3
	Rural	98	96	95	98	1.0
	District Total	130	138	150	186	1.8
51. Johor Bahru	38. Kulai	26	35	47	78	5.6
	39. Johor Bahru	266	343	439	686	4.9
	126. Ulu Tiram	7	10	12	20	5.4
	127. Senai	7	9	10	15	3.9
	128. Kelapa Sawit	7	8	9	12	2.7
	129. Masai	6	9	12	22	6.7
	Rural	125	130	131	124	0.0
	District Total	444	544	660	957	3.9
52. Kota Tinggi	40. Kota Tinggi	15	18	22	34	4.2
	Rural	102	126	134	99	-0.1
	District Total	117	144	156	133	0.6
53. Kluang	41. Kluang	55	60	67	84	2.1
	Rural	142	166	174	139	0.1
	District Total	197	226	241	223	0.6
54. Mersing	42. Mersing	15	19	25	41	5.2
	Rural	30	31	31	30	1.0
	District Total	45	50	56	71	2.3
Total	Urban Total	658	799	979	1,450	4.0
	Rural Total	1,046	1,112	1,134	1,037	0.0
	State Total	1,704	1,911	2,113	2,487	1.9

Table 8 HISTORICAL AND PROJECTED GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP IN JOHOR

Item	Year 1980	1985	1990	2000
Johor				
Food	906	1,448	2,087	2,404
Textile	294	518	829	1,333
Wood	243	251	291	262
Paper	26	69	71	71
Publishing	20	52	133	564
Chemical	201	453	465	465
Rubber	397	726	1,356	2,998
Non-metal	29	59	114	292
Basic metal	1	2	6	21
Machinery	265	647	1,756	6,926
Others	7	19	32	97
Total	2,389	4,244	7,140	15,433

Remarks; In factor cost at 1970 prices

Table 9 BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN JOHOR

Basin No.	Basin	Total Catchment Area (km^2)	Effective Catchment Area (km^2)	Balance Point (km)	River Maintenance Flow (m^3/s)
20	Kesang	705	675	4	0.8
21	Muar	6,595	6,170	20	8.2
22	Batu Pahat	2,600	2,255	3	4.5
23	Pontian Kechil	2,660	1,800	8	11.6
24	Johor	3,250	2,490	42	14.1
25	Sedili Besar	1,820	1,495	16	9.7
26	Mersing	880	465	14	3.8
27	Endau	4,740	4,350	25	30.2

Remarks; The location of balance point is the river length in km measured upstream from the estuary.

Table 10 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN JOHOR

City/Rural	Service Factor (%) Estimated 1980	Service Factor (%) Projected 1985	1990	2000	Per Capita Daily Use (lpcd) Estimated 1980	Per Capita Daily Use (lpcd) Projected 1985	1990	2000
1. Urban Area								
32 Segment	80	85	90	100	160	175	190	230
33 Tangkak	80	85	90	100	160	175	190	220
34 Muar	80	85	90	100	160	175	190	220
35 Batu Pahat	80	85	90	100	160	175	190	230
37 Pontian Kechil	80	85	90	100	160	175	190	220
38 Kulai	80	85	90	100	160	175	190	220
39 Johor Bahru	100	100	100	100	170	185	200	250
40 Kota Tinggi	80	85	90	100	160	175	190	220
41 Keluang	80	85	90	100	160	175	190	220
42 Mersing	80	85	90	100	160	175	190	220
122 Labis	80	85	90	100	160	175	190	220
123 Yong Peng	80	85	90	100	160	175	190	220
124 Pekan Nanas	80	85	90	100	160	175	190	220
125 Jementah	32	85	90	100	115	153	190	220
126 Ulu Tiram	32	85	90	100	115	153	190	220
127 Senai	32	85	90	100	115	153	190	220
128 Kelapa Sawit	32	85	90	100	115	148	180	220
129 Masai	32	85	90	100	115	153	190	220
2. Rural Area								
PWD Rural	28	54	74	100	75	100	125	175
MOH Rural	4	5	4	0	40	48	55	70
3. Non-Pipe-Served Area	-	-	-	-	40	40	40	40

Table 11 NET UNIT MANUFACTURING WATER USE PER GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP

Unit: $m^3/d/M\$10^6/y$

	Commodity Group	Assumed/1 1975	Estimated/2 1980	Projected 1985/2	Projected 1990 & 2000
1.	Food	77.0	75.0	73.0	71.0
2.	Textile	79.0	77.0	75.0	73.0
3.	Wood Product	12.0	12.3	12.7	13.0
4.	Paper Product	581.0	560.7	540.3	520.0
5.	Publishing	10.0	10.0	10.0	10.0
6.	Chemicals	140.0	136.7	133.3	130.0
7.	Rubber Manufacturing	126.0	105.7	85.3	65.0
8.	Non-metal	88.0	86.7	69.3	68.0
9.	Basic Metal	53.0	51.7	50.3	49.0
10.	Machinery	16.0	17.3	18.7	20.0
11.	Miscellaneous	48.0	48.3	48.7	49.0

Remarks; /1: Assumed from data in Japan in 1970
/2: Obtained by interpolation

Note; The values indicated are net manufacturing water use (excluding the water used cyclically) per $M\$10^6$ of the gross value of manufacturing output at 1970 price.

Table 12 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN JOHOR

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	1985 I	1985 Total	1990 D	1990 I	1990 Total	2000 D	2000 I	2000 Total
20	33	Tangkak	1.1	1.1	0.2	1.3	1.3	0.2	1.5	2.0	0.3	2.3
		Rural	13.5	4.0	1.0	5.0	5.1	0.9	6.0	7.8	11.0	18.8
	Basin Total		14.6	5.1	1.2	6.3	6.4	1.1	7.5	9.8	11.3	21.1
21	30	Kuala Pilah	1.6	0.9	1.6	2.5	1.1	2.1	3.2	1.7	3.4	5.1
	32	Segamat	4.2	3.6	3.6	7.2	5.4	4.9	10.3	11.5	8.7	20.2
	34	Muar	9.6	5.3	10.0	15.3	6.4	13.6	20.0	9.5	24.0	33.5
	122	Labis	2.2	0.9	3.0	3.9	1.1	3.9	5.0	1.8	7.0	8.8
	125	Jementah	1.1	0.4	1.6	2.0	0.8	1.8	2.6	1.3	2.7	4.0
	145	PT9	0.1	0.4	0.7	1.1	0.5	1.1	1.6	1.1	2.5	3.6
		City Total	18.8	11.5	20.5	32.0	15.3	27.4	42.7	26.9	48.3	75.2
		Rural	18.2	15.1	9.0	24.1	21.1	7.7	28.8	29.6	7.0	36.6
	Basin Total		37.0	26.6	29.5	56.1	36.4	35.1	71.5	56.5	55.3	111.8
22	35	Batu Pahat	10.4	5.8	11.7	17.5	7.4	15.8	23.2	12.6	27.7	40.3
	123	Yong Peng	3.5	0.8	5.6	6.4	1.0	7.7	8.7	1.5	13.7	15.2
		City Total	13.9	6.6	17.3	23.9	8.4	23.5	31.9	14.1	41.4	55.5
		Rural	10.1	9.3	4.5	13.8	14.2	3.6	17.8	22.5	3.4	25.9
	Basin Total		37.9	22.5	39.1	61.6	22.6	27.1	49.7	36.6	44.8	81.4
23	37	Pontian Kechil	5.4	2.4	8.0	10.4	3.7	10.6	14.3	7.9	19.0	26.9
	38	Kulat	9.4	2.4	15.7	18.1	3.6	21.3	24.9	7.6	37.6	45.2
	39	Johor Bahro	37.2	27.9	34.6	62.5	38.6	46.6	85.2	75.5	83.2	158.7
	124	Pekan Nanas	1.7	0.7	1.7	2.4	0.9	2.0	2.9	1.4	3.0	4.4
	127	Senai	0.9	0.4	1.6	2.0	0.8	1.8	2.6	1.6	3.3	4.9
	128	Kelapa Sawit	0.8	0.4	0.0	0.4	0.5	1.6	2.1	1.3	2.7	4.0
	129	Masai	0.2	0.4	1.6	2.0	1.0	2.4	3.4	2.3	5.0	7.3
		City Total	55.6	34.6	63.2	97.8	49.1	86.3	135.4	97.6	153.8	251.4
		Rural	9.5	7.1	5.1	12.2	10.6	4.4	15.0	17.5	4.2	21.7
	Basin Total		65.1	41.7	68.3	110.0	59.7	90.7	150.4	115.1	158.0	273.1
24	40	Kota Timggi	3.0	1.3	3.9	5.2	1.8	5.3	7.1	3.6	9.3	12.9
	126	Ulu Triam	4.6	0.7	8.7	9.4	1.0	11.6	12.6	2.1	20.7	22.8
		City Total	7.6	2.0	12.6	14.6	2.8	16.9	19.7	5.7	30.0	35.7
		Rural	6.7	3.3	5.0	8.3	6.8	4.2	11.0	9.4	4.4	13.8
	Basin Total		14.3	5.3	17.6	22.9	9.6	21.1	30.7	15.1	34.4	49.5
25		Rural	2.9	1.8	3.1	4.9	2.9	1.6	4.5	3.8	1.4	5.2
26	42	Mersing	2.5	1.4	2.9	4.3	2.0	4.6	6.6	4.2	8.8	13.0
		Rural	1.1	0.3	0.9	1.2	0.4	0.7	1.1	0.7	0.5	1.2
	Basin Total		3.6	1.7	3.8	5.5	2.4	5.3	7.7	4.9	9.3	14.2
27	41	Keluang	10.7	4.5	14.2	18.7	5.6	19.1	24.7	8.9	34.0	42.9
	C151		0.0	1.5	1.7	3.2	1.9	2.9	4.8	2.4	5.4	7.8
		City Total	10.7	6.0	15.9	21.9	7.5	22.0	29.5	11.3	39.4	50.7
		Rural	6.6	3.5	4.8	8.3	5.4	3.9	9.3	7.6	3.7	11.3
	Basin Total		17.3	9.5	20.7	30.2	12.9	25.9	38.8	18.9	43.1	62.0
Total			192.7	114.2	183.3	297.5	152.9	207.9	360.8	260.7	357.6	618.3
(State Total for Johor)			(159.4)	(96.9)	(161.3)	(258.2)	(138.3)	(199.8)	(338.1)	(243.7)	(334.4)	(578.1)

Remarks; Water demand: Total source demand
D: Domestic water demand
I: Industrial water demand

Table 13 ESTIMATED AREA OF IRRIGATED PADDY FIELD IN JOHOR

Unit: ha

Basin No.	Basin Name	Scheme	1980 Main Season	1980 Off Season	1990 Main Season	1990 Off Season	2000 Main Season	2000 Off Season
Johor								
20.	Kesang	Minor	721	592	800	592	800	592
21.	Muar	Minor	2,449	1,560	3,629	2,408	3,730	2,428
22.	Batu Pahat+	Minor	142	142	142	142	142	142
23.	Pontian Kechil	Minor	176	176	176	176	176	176
24.	Johor+	Minor	109	-	109	-	109	-
27.	Endau	Major	-	-	6,068	4,044	8,092	6,068
		Minor	1,150	1,150	304	304	304	304
Total for Johor			4,747	3,620	11,248	7,666	13,353	9,710

Note; + marked after the name of Basin shows the inclusion of other Basin than the stated Basin.

Table 14 ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN JOHOR

Unit: 10^6 m^3/y

Basin No.	Basin Name	Scheme	1980	1990	2000
Johor					
20.	Kesang	Minor	23	23	23
21.	Muar	Minor	72	99	101
22.	Batu Pahat+	Minor	5	5	5
23.	Pontian Kechil	Minor	6	6	6
24.	Johor+	Minor	1	1	1
27.	Endau	Major	-	105	148
		Minor	33	8	8
Total for Johor			140	247	292

Note; + marked after the name of Basin shows the inclusion of other Basin than the stated Basin.

Table 15 RIVER UTILIZATION RATIO BY BASIN IN JOHOR FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Basin Name	Surface Runoff in Effective Area (1)	1990 Source Demand D&I	1990 Source Demand Irr.	1990 Source Demand Total (2)	1990 Ratio (2)/(1) (%)	2000 Source Demand D&I	2000 Source Demand Irr.	2000 Source Demand Total (2)	2000 Ratio (2)/(1) (%)
Case of High Economic Growth										
20	Kesang	358	8	72	80	22	11	72	83	23
21	Muar	3,849	70	236	306	8	109	246	355	9
22	Batu Pahat	2,095	50	5	55	3	81	5	86	4
23	Pontian Kechil	1,940	158	6	164	8	280	6	286	15
	*C37 Pontian Kechil	1,085	42	6	48	4	67	6	73	7
	*C39 Johor Bahru	296	90	0	90	30	169	0	169	57
24	Johor	2,362	350	1	351	15	457	1	458	19
	*C40 & Singapore	669	328	1	329	49	422	1	423	63
25	Sedili Besar	1,632	5	0	5	0	5	0	5	0
26	Mersing	632	8	0	8	1	14	0	14	2
27	Endau	5,046	39	210	249	5	62	274	336	7

Remarks; *: Figures for Sub-basin.
: The ratio of less than 0.1% was assumed to be zero.

Table 16 ANNUAL DEFICIT BY BASIN IN JOHOR FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Drought Level 1/N De-ficit	1/N Year	2/N De-ficit	2/N Year	3/N De-ficit	3/N Year	4/N De-ficit	4/N Year	5/N De-ficit	5/N Year
1990										
20	25.6	1963	10.0	1965	2.9	1979	2.1	1968	2.0	1973
21	139.0	1963	27.4	1965	14.9	1961	10.3	1962	8.4	1968
22	51.1	1963	8.6	1965	8.4	1962	6.2	1961	4.7	1975
23	215.2	1963	73.8	1962	69.9	1961	60.7	1968	48.2	1971
*Johor Bahru	76.3	1963	43.7	1961	42.4	1971	41.7	1976	34.2	1962
24	352.4	1963	142.9	1961	125.6	1962	112.1	1968	108.2	1971
*C40 & Singapore	298.1	1963	237.2	1976	231.2	1976	215.3	1961	177.4	1972
25	114.0	1963	37.9	1962	25.3	1968	22.2	1961	12.3	1976
26	51.2	1963	17.3	1962	13.5	1961	12.9	1968	8.6	1971
27	433.2	1963	132.8	1962	106.9	1961	93.5	1968	71.0	1971
2000										
20	26.3	1963	10.5	1965	3.3	1979	2.1	1968	2.1	1973
21	161.3	1963	35.3	1965	23.1	1961	15.0	1962	11.0	1968
22	67.9	1963	15.0	1965	11.8	1962	11.1	1961	6.5	1975
23	276.3	1963	114.5	1961	98.8	1962	88.9	1971	88.9	1968
*Johor Bahru	131.7	1963	103.4	1976	100.7	1971	93.6	1961	77.4	1962
24	414.3	1963	189.0	1961	153.1	1971	152.8	1962	141.7	1968
*C40 & Singapore	368.7	1963	317.0	1976	309.9	1971	286.5	1961	241.7	1972
25	114.3	1963	38.0	1962	25.4	1968	22.3	1961	12.3	1976
26	54.9	1963	18.6	1962	15.6	1961	14.5	1968	10.2	1971
27	553.7	1963	156.9	1961	155.5	1962	129.9	1971	113.0	1968

Remarks: *: Annual deficit in sub-basin.

Table 17 ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES IN JOHOR

Unit: %

	1980	1990	2000
Palm oil mills	25	50	75
Rubber factories	0	10	20

Table 18 DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL IN JOHOR

Pollution Source	Year	Discharge Ratio	BOD Concentration (mg/lit)	Runoff Ratio	Infiltration Ratio
Domestic					
Urban sewerage	1999 & 2000	0.9	30	1.0	0.2
Urban non-sewerage	1990	0.9	160	0.6	0
	2000	0.9	140	0.6	0
Rural	1990 & 2000	0.8	200	0.1	0
Manufacture					
Urban sewerage	1990 & 2000	1.0	30	1.0	0.2
Urban non-sewerage }	1990	1.0	180	0.6	0
Rural }	2000	1.0	140	0.1	0
Palm Oil Mill					
With P.S./1	1990	0.55	50	0.6	0
	2000	0.3	50	0.6	0
Without P.S.	1990	0.55	22,000	0.6	0
	2000	0.3	22,000	0.6	0
Land disposal	1990	0.1	50	0.6	0
	2000	0.1	50	0.6	0
Rubber Factories					
With P.S.	1990	0.9	50	0.6	0
	2000	0.8	50	0.6	0
Without P.S.	1990	0.9	2,320	0.6	0
	2000	0.8	2,320	0.6	0
Land disposal	1990	0.1	50	0.6	0
	2000	0.1	50	0.6	0
Animal Husbandry	1990 & 2000	1.0	200/2	0.1	0

Remarks; /1: Purification System
/2: g/d/head

Table 19 PROPOSED FLOOD FORECASTING AND WARNING SYSTEM IN JOHOR

Basin No.	River Basin	People Rel'ved by F/F (10^3)	Construction Cost (M$$10^6$)	Construction Period
JOHOR				
21	Muar	11.7	1.1	5MP
23	Sekudai	9.2	1.0	4MP
	Tebrau	5.8	0.5	4MP
24	Johor	4.4	0.8	4MP

Table 20 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN JOHOR

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity ($10^6 m^3/y$)	Construction Cost (M$$10^6$)	Construction Period
24	Semangar dam	WS	160	137	123	54	1985-1989
24	Linggiu dam	WS	237	203	182	25	1985-1989
24	Pengeli dam	WS	143	65	84	30	1985-1989
25	Sedili dam	WS	227	124	164	18	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
21	Muar diversion (barrage & canal)	Johor to Melaka 21 to 19 & 20	15	160	1985-1989
23	Teberau diversion (barrage)	Johor 23 to 23 & Singapore	35	9*	1985-1989
24	Semangar diversion (canal)	Johor 24 to 23	35	36	1985-1989
24	Johor diversion (barrage & canal)	Johor 24 to 24	27	25	1985-1989
25	Sedili diversion (canal & pipe line)	Johor 25 to 24	10	83	1985-1989

Remarks; IR = Irrigation; WS = Water supply
Construction cost is the financial cost at 1980 constant price.
* = excludes the cost of distribution pipe line for water supply.

Table 21 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN JOHOR

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km2)	Active Storage Capacity (10^6 m3)	Net Supply Capacity (10^6m3/y)	Construction Cost (M$$10^6$)	Construction Period
24	Semangar dam	WS	160	137	123	54	1985-1989
24	Linggiu dam	WS	237	203	182	25	1985-1989
25	Sedili dam	WS	227	124	164	18	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
21	Muar diversion (barrage & canal)	Johor to Melaka 21 to 19 & 20	13	139	1985-1989
23	Teberau diversion (barrage)	Johor 23 to 23 & Singapore	30	9*	1985-1989
24	Semangar diversion (canal)	Johor 24 to 23	30	30	1985-1989
24	Johor diversion (barrage & canal)	Johor 24 to 24	22	21	1985-1989
25	Sedili diversion (canal & pipe line)	Johor 25 to 24	10	83	1985-1989

Remarks; IR = Irrigation; WS = Water supply
Construction cost is the financial cost at 1980 constant price.
* = excludes the cost of distribution pipe line for water supply.

Table 22 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN JOHOR

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6 m3)	Net Supply Capacity (10^6m3/y)	Construction Cost (M$$10^6$)	Construction Period
24	Semangar dam	WS	160	137	123	54	1985-1989
24	Linggiu dam	WS	237	203	182	25	1985-1989
25	Sedili dam	WS	227	87	115	13	1986-1990

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
21	Muar diversion (barrage & canal)	Johor to Melaka 21 to 19 & 20	8	80	1985-1989
23	Teberau diversion (barrage)	Johor 23 to 23 & Singapore	27	9*	1985-1989
24	Semangar diversion (canal)	Johor 24 to 23	27	27	1985-1989
24	Johor diversion (barrage & canal)	Johor 24 to 24	19	18	1985-1989
25	Sedili diversion (canal & pipe line)	Johor 25 to 24	7	67	1986-1990

Remarks; IR = Irrigation; WS = Water supply
Construction cost is the financial cost at 1980 constant price.
* = excludes the cost of distribution pipe line for water supply.

Table 23 OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN JOHOR

Basin No.	Basin Name	R.I. (km)	Dam (nos)	F.W. (km)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$\$10^6$)
JOHOR									
	ALTERNATIVE F1								
20	Kesang	19	-	-	-	-	4	2	7
21	Muar	163	-	-	-	-	33	20	424
22	Batu Pahat	109	1	19	-	-	32	29	166
23	Pontian Kechil	30	-	-	-	-	21	1	18
24	Johor	58	-	-	-	-	34	6	61
26	Mersing	9	-	-	-	-	26	1	8
27	Endau	37	-	-	-	-	34	6	20
	Total	425	1	19	-	-	184	65	704
	ALTERNATIVE F2								
20	Kesang	19	-	-	-	-	4	2	7
21	Muar	-	-	-	1	-	6	0	4
22	Batu Pahat	93	1	19	-	-	28	26	156
23	Pontian Kechil	25	-	-	-	-	18	1	15
24	Johor	-	-	-	1	-	5	0	8
26	Mersing	6	-	-	-	-	23	1	7
27	Endau	11	-	-	-	-	18	1	6
	Total	154	1	19	2	-	102	31	203
	ALTERNATIVE F3								
20	Kesang	19	-	-	-	-	4	2	7
21	Muar	-	-	-	1	-	6	-	4
22	Batu Pahat	109	1	19	-	-	32	29	166
23	Pontian Kechil	30	-	-	-	-	21	1	18
24	Johor	-	-	-	1	-	5	0	8
26	Mersing	9	-	-	-	-	26	1	8
27	Endau	37	-	-	-	-	34	6	20
	Total	204	1	19	2	-	132	40	232

Remarks;
R.I. : River improvement,
F.W. : Floodway,
Pold.: Polder,
N.S. : Non-structural measure, in person
P.P.: Population protected (the year 2000)
F.A.: Flood area relieved
C.C.: Construction cost

Table 24 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN JOHOR

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
20	33	Tangkok	3.6	85	12.8	4.1	90	14.4	6.6	100	19.0
21	32	Segamat	15.9	85	41.7	23.6	90	57.6	47.9	100	104.0
	34	Muar	30.4	85	61.2	39.5	90	69.3	64.9	100	90.0
	122	Labis	7.1	85	10.2	9.3	90	12.6	15.9	100	17.0
	125	Jementah	3.6	85	7.7	5.2	90	9.0	8.2	100	12.0
22	35	Batu Pahat	34.8	85	66.3	45.5	90	79.2	80.0	100	114.0
	123	Yong Peng	11.0	85	9.4	14.8	90	10.8	25.2	100	14.0
23	37	Pontian Kechil	18.9	85	27.2	26.8	90	39.6	52.3	100	75.0
	38	Kulai	30.7	85	29.8	42.7	90	42.3	79.5	100	78.0
	39	Johor Bahru	136.2	100	343.0	186.6	100	439.0	352.9	100	686.0
	124	Pekan Nanas	4.9	85	8.5	5.8	90	9.9	8.8	100	13.0
	127	Senai	3.6	85	7.7	5.2	90	9.0	9.9	100	15.0
	128	Kelapa Sawit	3.3	85	6.8	3.8	90	8.1	8.2	100	12.0
	129	Masai	3.6	85	7.7	6.6	90	10.8	14.5	100	22.0
24	40	Kota Tinggi	9.9	85	15.3	13.7	90	19.8	24.9	100	34.0
	126	Ulu Tiram	15.3	85	8.5	20.5	90	10.8	37.8	100	20.0
26	42	Mersing	9.9	85	16.2	12.9	90	22.5	26.0	100	41.0
27	41	Keluang	34.2	85	51.0	45.5	90	60.3	78.1	100	84.0
	Total		376.9	91	731.0	512.1	94	925.0	941.6	100	1450.0

Remarks; TC: Treatment capacity required in the corresponding year in 10^3 m^3/d

SF: Service factor in %

SP: Served population in 10^3

Table 25 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN JOHOR

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
20	Kesang	12.7	75.0	73.1	16.3	84.1	82.8	50.9	91.2	89.1
21	Muar	48.2	60.5	257.5	98.2	75.6	319.2	97.0	95.7	346.0
22	Batu Pahat	28.3	54.0	152.7	44.6	74.1	212.5	73.8	100.0	267.6
23	Pontian Kechil	22.0	54.0	116.6	34.4	74.1	160.9	57.6	100.0	208.7
24	Johor	12.4	54.0	71.5	24.1	74.1	102.5	33.5	100.0	112.0
25	Sedili Besar & Sedili Kechil	7.8	54.1	30.6	11.5	74.1	44.4	15.1	100.0	45.4
26	Mersing	2.1	54.4	4.9	2.7	74.4	6.7	3.6	100.0	8.7
27	Endau	14.2	54.5	59.8	20.8	74.1	81.7	28.6	99.9	90.7
Total		147.7	-	766.7	252.6	-	1,010.7	360.1	-	1,168.2
Johor		122.3	54.0	601.9	178.4	74.1	841.8	297.8	100.0	1,037.0

Remarks; TC: Treatment capacity required in the corresponding year in 10^3 m^3/d
SF: Service factor in %
SP: Served population in 10^3 persons

Table 26 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN JOHOR

Unit: 10^6 m^3/y

Basin No.	Basin Name	1985 SD	1985 SF	1985 SP	1990 SD	1990 SF	1990 SP	2000 SD	2000 SF	2000 SP
20	Kesang	0.1	5.4	5.3	0.1	6.8	6.7	0.3	8.8	8.6
21	Muar	0.6	6.0	25.7	0.7	6.4	27.2	0.5	4.3	15.4
22	Batu Pahat	0.2	4.8	13.6	0.5	3.9	11.2	0.0	0.0	0.0
23	Pontian Kechil	0.2	4.8	10.4	0.2	3.9	8.5	0.0	0.0	0.0
24	Johor	0.1	4.8	6.4	0.1	3.9	5.4	0.0	0.0	0.0
25	Sedili Besar & Sedili Kechil	0.1	4.8	2.7	0.1	3.8	2.3	0.0	0.0	0.0
26	Mersing	0.0	4.4	0.4	0.0	4.4	0.4	0.0	0.0	0.0
27	Endau	0.1	5.5	6.0	0.1	4.1	4.5	0.0	2.0	0.2
Total		1.4	-	70.5	1.8	-	66.2	0.8	-	24.2
Johor		1.0	4.8	53.5	1.0	3.9	44.3	0.0	0.0	0.0

Remarks; SD: Source demand in the rural area in the corresponding year in 10^6 m^3/y
SF: Service factor in the rural area in %
SP: Served population in the rural area in 10^3 persons

Table 27 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN JOHOR

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity ($10^6 m^3/y$)	Construction Cost (M$$10^6$)	Construction Period
24	Semangar dam	WS	160	137	123	54	1985-1989
24	Linggiu dam	WS	237	203	182	25	1985-1989
24	Pengeli dam	WS	143	65	84	30	1985-1989
25	Sedili dam	WS	227	124	164	18	1985-1989

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
21	Muar diversion (barrage & canal)	Johor to Melaka 21 to 19 & 20	15	160	1985-1989
23	Teberau diversion (barrage)	Johor 23 to 23 & Singapore	35	9*	1985-1989
24	Semangar diversion (canal)	Johor 24 to 23	35	36	1985-1989
24	Johor diversion (barrage & canal)	Johor 24 to 24	27	25	1985-1989
25	Sedili diversion (canal & pipe line)	Johor 25 to 24	10	83	1985-1989

Remarks; IR = Irrigation; WS = Water supply
Construction cost is the financial cost at 1980 constant price.
* = excludes the cost of distribution pipe line for water supply.

Table 28 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN TREATMENT CAPACITY IN JOHOR

Unit: m^3/d

Basin		1981 - 1990			1991 - 2000		
No.	Name	Palm Oil	Rubber	Total	Palm Oil	Rubber	Total
20	Kesang	192	1,060	1,252	0	144	144
21	Muar	1,292	7,076	8,368	1,332	1,224	2,556
22	Batu Pahat	688	764	1,452	1,812	220	2,032
23	Sekudai	292	704	996	704	388	1,092
24	Johor	2,876	1,900	4,776	2,572	256	2,828
27	Endau	1,852	244	2,096	1,684	188	1,872
28	Rompin	1,308	0	1,308	4	0	4
Total		8,500	11,748	20,248	8,108	2,420	10,528

Table 29 RECOMMENDED PUBLIC SEWERAGE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN JOHOR

Basin	City/Town		1990			2000		
No.	No.	Name	Treatment Capacity ($10^3m^3/d$)	Service Factor (%)	Served Population (10^3)	Treatment Capacity ($10^3m^3/d$)	Service Factor (%)	Served Population (10^3)
21	C32	Segamat	12	50	32	47	100	104
23	C38	Kulai/Senal	34	50	24	121	100	78
27	C41	Kluang	24	40	27	84	80	67
Total			70	-	83	252	-	249

Table 30 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN JOHOR

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
23	C39	Johor Bahru	89	40	176	330	80	549
Total			89	-	176	330	-	549

Table 31 RECOMMENDED FLOOD MITIGATION PROGRAM IN JOHOR

Basin No.	Name of River	R.I. (km)	F.W. (km)	Dam (nos)	Pold. (nos)	N.S. (10^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
JOHOR									
By 1990									
20	Kesang	8	-	-	-	-	2	1	4
21	Muar	-	-	-	-	-	-	-	-
22	Batu Pahat	24	-	1	-	-	5	4	75
23	Pontian Kechil	25	-	-	-	-	18	1	15
24	Johor	-	-	-	-	-	-	-	-
26	Mersing	-	-	-	-	-	-	-	-
27	Endau	-	-	-	-	-	-	-	-
	Total	57	-	1	-	-	25	6	94
By 2000									
20	Kesang	19	-	-	-	-	4	2	7
21	Muar	-	-	-	1	-	6	-	4
22	Batu Pahat	93	19	1	-	-	28	26	156
23	Pontian Kechil	25	-	-	-	-	18	1	15
24	Johor	-	-	-	1	-	5	-	8
26	Mersing	6	-	-	-	-	23	1	7
27	Endau	11	-	-	-	-	18	1	6
	Total	154	19	1	2	-	102	31	203

Remarks; R.I. : River improvement,
F.W. : Floodway,
Pold.: Polder,
N.S. : Non-structural measure, in person
P.P.: Population protected (the year 2000)
F.A.: Flood area relieved
C.C.: Construction cost

Table 32 POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN JOHOR

		Without Project					With Project				
		BOD Load into River (ton/d)				Max. BOD in River	BOD Load into River (ton/d)				Max. BOD in River
Basin No.	Basin Name	PR	UI	RA	Total	(mg/lit)	PR	UI	RA	Total	(mg/lit)
20	Kesang	2	0	0	2	37	1	0	0	1	9
21	Muar	20	7	1	28	30	0	5	1	6	7
22	Batu Pahat	11	9	2	22	85	0	3	2	5	16
23	Sekudai	5	10	0	15	117	0	3	1	4	13
24	Johor	24	6	1	31	52	0	6	0	6	1
25	Sedili Besar	3	0	0	3	3	3	0	0	3	3
26	Mersing	0	0	0	0	0	0	2	0	2	0
27	Endau	15	9	0	24	29	0	4	0	4	7
28	Rompin	5	9	0	14	9	2	4	0	6	5
	Total	85	50	4	139	-	6	27	4	37	-

Remarks; PR: Palm oil mill and rubber factory effluent
UI: Urban sewer and industrial effluent
RA: Rural sewer and animal husbandry

Table 33 ASSUMED UNIT CONSTRUCTION COST (1/2)

1. Compensation on Land (M$$10^6/km^2$)

Irrigated paddy	2.5	Urban area class S	100
Rainfed paddy	1.5	Urban area class A	10
Tree crop field classes A & B	1.5	Urban area class B	5
Tree crop field class C	0.5	Village area class A	5
Forest class A	0.5	Village area class B	1
Forest class B	0.1		

S: very good access, A: good access
B: poor access, C: very poor access

2. Resettlement (M$$10^3$/household)

Urban	30	Rural	10

3. Civilwork

Dam	M$48-66 per m^3 of embankment volume
Canal	M$50-94/m per m^3/s of discharge capacity
Tunnel	M$160-182/m per m^3/s of discharge capacity
Pipeline	M$990-1,980/m per m^3/s of discharge capacity
Barrage/Weir	M$1,320/m per m^3/s of 100-y maximum capacity
Pumping station	M$7,700-14,300 m^3/s of discharge capacity

4. River Facilities

Channel improvement (M$$10^6$/km)

200 m^3/s	0.2 - 0.4
500 m^3/s	0.3 - 0.6
1,000 m^3/s	0.4 - 0.8
10,000 m^3/s	1.2 - 2.9

Floodway (M$$10^6$/km)

200 m^3/s	0.2 - 0.5
500 m^3/s	0.4 - 0.9
1,000 m^3/s	0.5 - 1.2
2,000 m^3/s	0.7 - 1.8

Polder

Protection bund	M$150-700 x 10^3/km
Drainage system	M$540 x 10^3/km
Drainage pump	M$150-380 x 10^3 per m^3/s

Remarks; Unit construction costs include the engineering and administration cost, but the physical contingency is not included.

Table 34 ASSUMED UNIT CONSTRUCTION COST (2/2)

5. D&I Water Supply System

Pipeline	M$430/m per m^3/s of discharge capacity
Treatment plant	M$710 per m^3/d of capacity
Distribution system	M$1,300 per m^3/d of capacity

6. Sewerage System — M$157 x 10^6 per 100 x 10^3 m^3/d

7. D&I Pre-treatment System

Aerated lagoon	M$38 x 10^6 per 100 x 10^3 m^3/d
Rapid sandfilter bed	M$112 x 10^6 per 100 x 10^3 m^3/d

8. Power Facilities

Generating equipment

Rated head more than 140 m	M$275-440 per kW
Rated head 20 - 80 mm	M$550-880 per kW
Rated less than 30 m	M$1,320-1,540 per kW
Transmission line	M$162-194 x 10^3 per km

9. Irrigation Facilities

From rainfed paddy to irrigated paddy	M$11,370 per ha
From new reclaimed land to irrigated paddy	M$12,300 per ha
From irrigated single cropped paddy to double	M$6,150 per ha
Tertiary development and rehabilitation	M$5,470 per ha

Remarks; Unit construction costs include the engineering and administration cost, but the physical contingency is not included.

Table 35 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN JOHOR

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	31	289	28	0	348
Irrigation	9	97	34	0	140
Inland Fishery	3	3	64	35	105
Public Water Supply	246	468	507	203	1,424
Public Water Supply; Pre-treatment facilities	70	55	15	6	146
Public Sewerage (Effective for river water pollution abatement)	55	93	94	38	280
Public Sewerage (Others)	61	106	109	43	319
Flood Mitigation	46	52	64	44	206
Total	521	1,163	915	369	2,968

Remarks; (1): At 1980 constant price

(2): The amount shown for 4MP is the additional budget, assuming that the original budget can provide the capacity necessary up to 1985.

(3): Source development expenditures include a part of expenditure of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 36 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN JOHOR

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	2	7	8	17
Irrigation	0	1	8	11	20
Inland Fishery	0	0	3	7	10
Public Water Supply	0	43	92	134	269
Public Water Supply; Pre-treatment facilities	0	10	13	14	37
Public Sewerage (Effective for river water pollution abatement)	0	18	37	53	108
Public Sewerage (Others)	0	21	42	60	123
Flood Mitigation	0	23	49	78	150
Total	0	118	251	365	734

Remarks; (1): At 1980 constant price

(2): Recurrent expenditure on the capacity, which is to be constructed by the original budget for 4MP, is not included.

(3): Source development expenditures include a part of expenditure of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 37 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN JOHOR

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	($M\$10^6$)	10
D&I water supply	($M\$10^6$)	101
Fish culture	($M\$10^6$)	4
Reservoir recreation	($M\$10^6$)	5
Total	($M\$10^6$)	120
1.2 Economic Cost		
Irrigation	($M\$10^6$)	4
D&I water supply	($M\$10^6$)	87
Fish culture	($M\$10^6$)	4
Dams, barrages & diversion facilities	($M\$10^6$)	11
Total	($M\$10^6$)	106
1.3 EIRR	(%)	10
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	93
2.2 Adverse Effect		
Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	6
3. Social Well-being		
3.1 Beneficial Effect		
Number of farm households benefited by proposed irrigation in 2000	(10^3)	4
Number of people served by proposed public water supply in 2000	(10^3)	2,487
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	3

Remarks: (1) All effects by proposed hydropower project are not shown except irrigation, D&I water supply and lake recreation benefit.

(2) Economic cost for dams, barrages and diversion facilities includes a part of cost of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 38 SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN JOHOR

Unit: days

Basin No.	Basin Name	Safe Supply Period: Plan Implemented	Safe Supply Period: Natural Flow	Safe Maintenance Flow Period: Plan Implemented	Safe Maintenance Flow Period: Natural Flow
20	Kesang	365	212	365	207
21	Muar	365	132	365	132
23	Pontian Kechil	365	152	365	147
24	Johor	365	147	365	132

Remarks; Natural Flow: Natural flow only is depended upon, with neither existing nor proposed facilities.

Table 39 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN JOHOR

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	(M$$10^6$)	12
Saving in pre-treatment for D&I water supply	(M$$10^6$)	33
Total	(M$$10^6$)	45
1.2 Economic Cost		
Sewerage	(M$$10^6$)	30
Private purification facilities/2	(M$$10^6$)	3
Pre-treatment for D&I water supply	(M$$10^6$)	8
Total	(M$$10^6$)	41
2. Environmental Quality		
2.1 Beneficial Effects		
Length of river stretch where BOD concentration is not more than 10 mg/lit in 2000 compared with without project condition (Study length = 846 km)	(km)	812/444/1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 846 km)	(km)	671/182/1
2.2 Adverse Effect		
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	798
3.2 Adverse Effect		-

Remarks; /1: (Length of river stretch with Project)/(Length of river stretch without Project) and including the river stretch in the State of N.Sembilan, Melaka and Pahang.

/2: Including the rubber factories and palm oil mills in such part of the State of N.Sembilan, Melaka and Pahang as located in Basin 20, 21, 27 and 28.

Table 40 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN JOHOR

Item		Recommended Plan
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	($M\$10^6$)	5.1
1.2 Economic Cost		
Flood mitigation work	($M\$10^6$)	7.6
1.3 EIRR	(%)	5.8
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	154
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	102
Population served by proposed flood warning system in 2000	(10^3)	31
Area relieved from flood hazards	(10^3 ha)	31
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	3

Table 41 SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN JOHOR

	Yield (ton/ha)	Unit Price (M$/ton)	Gross Value (M$/ha)	Production Cost (M$/ha)	Net Value (M$/ha)
(1) Major Irrigation Scheme (Sawa Endau)					
Double cropping	8.0	640	5,120	1,633	3,487
Single cropping	3.8	640	2,432	788	1,644
(2) Minor Irrigation Scheme					
Double cropping	7.6	640	4,864	1,519	3,345
Single cropping	3.6	640	2,304	802	1,502
(3) Rainfed Scheme					
Single cropping	2.0	640	1,280	687	593

Table 42 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

	Service Factor (%)				Per Capita Daily Use (lpcd)			
	Estimated	Projected			Estimated	Projected		
City/Rural	1980	1985	1990	2000	1980	1985	1990	2000
1. Urban Area								
32 Segment	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
33 Tangkak	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
34 Muar	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
35 Batu Pahat	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
37 Pontian Kechil	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
38 Kulai	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
39 Johor Bahru	100.0	100.0	100.0	100.0	170.0	180.0	195.0	240.0
40 Kota Tinggi	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
41 Keluang	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
42 Mersing	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
122 Labis	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
123 Yong Peng	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
124 Pekan Nanas	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
125 Jementah	31.6	58.8	77.5	95.0	75.0	95.0	115.0	210.0
126 Ulu Tiram	31.6	85.0	90.0	95.0	75.0	170.0	185.0	210.0
127 Senai	31.6	58.8	90.0	95.0	75.0	95.0	185.0	210.0
129 Masai	31.6	58.8	90.0	95.0	75.0	95.0	185.0	210.0
2. Rural Area								
PWD Rural	28.0	54.0	73.6	97.5	75.0	95.0	115.0	155.0
MOH Rural	3.6	4.8	3.9	0.0	40.0	45.0	55.0	65.0
3. Non-Pipe-Served Area	-	-	-	-	40.0	40.0	40.0	40.0

Table 43 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	1985 I	1985 Total	1990 D	1990 I	1990 Total	2000 D	2000 I	2000 Total
20	33	Tangkak	1.1	1.0	0.1	1.1	1.2	0.2	1.4	1.5	0.2	1.7
		Rural	3.8	3.7	11.0	14.7	4.9	0.9	5.8	7.0	0.9	7.9
		Basin Total	4.9	4.7	11.1	15.8	6.1	1.1	7.2	8.5	1.1	9.6
21	30	Kuala Pilah	1.6	0.9	1.5	2.4	1.0	1.8	2.8	1.2	2.4	3.6
	32	Segamat	4.2	3.4	2.9	6.3	5.0	4.0	9.0	8.4	6.3	14.7
	34	Muar	9.7	5.1	9.6	14.7	5.9	11.4	17.3	4.2	7.3	21.5
	122	Labis	2.2	0.8	2.8	3.6	1.0	3.4	4.4	1.3	5.1	6.4
	125	Jementah	1.1	0.3	1.3	1.6	0.5	1.5	2.0	1.0	1.9	2.9
	145		0.2	0.3	0.6	0.9	0.4	0.0	0.4	0.6	1.6	2.2
		City Total	19.0	10.8	18.7	29.5	13.8	22.1	35.9	16.7	34.6	51.3
		Rural	18.2	14.5	8.8	23.3	20.5	7.5	28.0	32.4	7.2	39.6
		Basin Total	37.2	25.3	27.5	52.8	34.3	29.6	63.9	49.1	41.8	90.9
22	35	Batu Pahat	10.5	5.5	11.1	16.6	6.8	13.3	20.1	9.1	20.2	29.3
	123	Yong Peng	3.5	0.8	5.5	6.3	0.9	6.6	7.5	1.1	10.0	11.1
		City Total	14.0	6.3	16.6	22.9	7.7	19.9	27.6	10.2	30.2	40.4
		Rural	10.1	8.8	4.4	13.2	13.3	3.5	16.8	22.9	3.5	26.4
		Basin Total	24.1	15.1	21.0	36.1	21.0	23.4	44.4	33.1	33.7	66.8
23	37	Pontian Kechil	5.5	2.3	7.5	9.8	3.4	9.1	12.5	6.0	13.6	19.6
	38	Kulat	9.4	2.3	16.5	18.8	3.3	19.7	23.0	5.8	30.0	35.8
	39	Johor Bahru	37.4	26.9	33.1	60.0	35.7	39.6	75.3	60.1	60.0	120.1
	124	Pekan Nanas	1.7	0.7	1.6	2.3	0.8	1.7	2.5	1.0	1.9	2.9
	127	Senai	0.9	0.3	1.3	1.6	0.8	1.7	2.5	1.1	2.4	3.5
	129	Masai	0.8	0.7	1.5	2.2	1.0	2.0	3.0	1.7	3.4	5.1
		City Total	55.7	33.2	61.5	94.7	45.0	73.8	118.8	75.7	111.3	187.0
		Rural	9.5	7.0	5.0	12.0	10.2	4.4	14.6	17.2	4.4	21.6
		Basin Total	65.2	40.2	66.5	106.7	55.2	78.2	133.4	92.9	115.7	208.6
24	40	Kota Tinggi	3.0	1.3	3.8	5.1	1.7	4.5	6.2	2.7	6.8	9.5
	126	Ulu Tiram	4.2	0.7	7.6	8.3	1.0	9.1	10.1	1.5	13.8	15.3
		City Total	7.2	2.0	11.4	13.4	2.7	13.6	16.3	4.2	20.6	24.8
		Rural	6.7	4.4	4.9	9.3	7.1	4.2	11.3	13.4	4.6	18.0
		Basin Total	13.9	6.4	16.3	22.7	9.8	17.8	27.6	17.6	25.2	42.8
25		Rural	2.9	1.8	2.1	3.9	3.1	1.6	4.7	6.1	1.4	7.5
26	42	Mersing	2.5	1.4	2.9	4.3	1.9	3.9	5.8	3.2	6.6	9.8
		Rural	1.1	0.3	0.9	1.2	0.4	0.7	1.1	0.7	0.5	1.2
		Basin Total	3.6	1.7	3.8	5.5	2.3	4.6	6.9	3.9	7.1	11.0
27	41	Keluang	10.8	4.3	13.6	17.9	5.1	16.3	21.4	6.7	24.6	31.3
	C151		0.0	1.2	1.4	2.6	1.7	2.1	3.8	2.0	3.8	5.8
		City Total	10.8	5.5	15.0	20.5	6.8	18.4	25.2	8.7	28.4	37.1
		Rural	6.6	3.5	4.7	8.2	5.5	3.9	9.4	10.5	3.8	14.3
		Basin Total	17.4	9.0	19.7	28.7	12.3	22.3	34.6	19.2	32.2	51.4
Total			169.2	104.2	168.0	272.2	144.1	178.6	322.7	230.4	258.2	488.6
Johor			158.7	93.3	152.4	245.7	129.4	172.8	302.2	210.8	248.6	459.4

Remarks; D: Domestic water demand
I: Industrial water demand
Total: Total source demand

Table 44 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
20	33	Tangkak	3.3	85	12.8	3.8	90	13.5	4.9	95	15.2
21	32	Segamat	14.5	85	40.8	20.8	90	54.9	34.8	95	82.7
	34	Muar	29.3	85	60.4	34.8	90	65.7	38.6	95	70.3
	122	Labis	6.6	85	10.2	8.2	90	11.7	11.8	95	13.3
	125	Jementah	3.0	85	6.8	3.8	90	8.1	6.0	95	9.5
22	35	Batu Pahat	32.9	85	65.4	40.0	90	74.7	57.5	95	89.3
	123	Yong Peng	11.0	85	9.4	12.6	90	9.9	18.4	95	11.4
23	37	Pontian Kechil	18.1	85	26.4	23.8	90	36.9	38.4	95	58.9
	38	Kulai	31.8	85	29.8	39.5	90	39.6	62.5	95	61.8
	39	Johor Bahru	131.2	100	339.0	167.4	100	416.0	271.5	100	569.0
	124	Pekan Nanas	4.7	85	8.5	5.2	90	9.0	6.0	95	9.5
	127	Senai	3.0	85	6.8	5.2	90	9.0	6.8	95	11.4
	129	Masai	3.6	85	7.7	6.0	90	10.8	10.1	95	17.1
24	40	Kota Tinggi	9.3	85	15.3	12.1	90	18.9	18.4	95	26.6
	126	Ulu Tiram	13.7	85	8.5	17.0	90	10.8	25.2	95	15.2
26	42	Mersing	8.5	85	16.2	11.8	90	21.6	19.7	95	32.3
27	41	Keluang	32.9	85	50.2	39.7	90	56.7	57.0	95	65.6
	Total		357.4	92	714.2	451.7	95	867.8	687.6	97	1159.1

Remarks; TC: Treatment capacity required in the corresponsing year in 10^3 m^3/d

SF: Service factor in %

SP: Served population in 10^3

Table 45 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
20	Kesang	11.5	75.0	73.2	15.1	83.6	83.2	21.7	90.0	90.6
21	Muar & Others	46.1	60.6	260.5	65.4	75.0	333.5	104.6	91.3	422.0
22	Batu Pahat & Others	26.5	54.0	153.7	42.2	73.6	218.1	75.0	97.5	306.6
23	Pontian Kechil & Others	21.1	54.0	119.3	33.0	73.6	167.2	57.3	97.5	231.2
24	Johor & Others	15.4	53.9	74.0	22.3	73.6	114.4	46.1	97.5	179.3
25	Sedili Besar & Sedili Kechil	7.8	53.9	31.2	12.1	73.6	50.0	22.0	97.5	81.3
26	Mersing & Others	2.1	54.4	4.9	2.7	73.1	6.8	3.6	96.8	9.0
27	Endau	13.9	54.6	61.4	21.1	73.6	90.9	37.7	96.6	141.0
Total		144.4	-	778.2	213.9	-	1,064.1	368.0	-	1,461.0
Johor		117.5	54.0	610.3	182.6	73.6	881.3	321.6	97.5	1,264.0

Remarks; TC: Treatment capacity required in the corresponding year in 10^3 m^3/d
SF: Service factor in %
SP: Served population in 10^3 persons

Table 46 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Basin Name	1985 SD	1985 SF	1985 SP	1990 SD	1990 SF	1990 SP	2000 SD	2000 SF	2000 SP
20	Kesang	0.1	5.4	5.3	0.1	6.7	6.7	0.3	8.6	8.7
21	Muar	0.6	6.1	26.1	0.8	6.5	29.1	0.9	6.4	29.5
22	Batu Pahat	0.2	4.8	13.7	0.2	3.9	11.5	0.0	0.0	0.0
23	Pontian Kechil	0.2	4.8	10.7	0.2	3.9	8.8	0.0	0.0	0.0
24	Johor	0.1	4.8	6.6	0.1	3.9	6.0	0.0	0.0	0.0
25	Sedili Besar & Sedili Kechil	0.1	4.8	2.8	0.1	3.8	2.6	0.0	0.0	0.0
26	Mersing	0	4.4	0.4	0.0	4.3	0.4	0.0	0.0	0.0
27	Endau	0.1	5.7	6.4	0.1	4.4	5.4	0.0	0.9	1.3
Total		1.4	-	72.0	1.6	-	70.5	1.2	-	39.5
Johor		1.0	4.8	54.4	1.0	3.9	46.5	0.0	0.0	0.0

Remarks; SD: Source demand in the rural area in the corresponding year in 10^6 m^3/y
SF: Service factor in the rural area in %
SP: Served population in the rural area in 10^3 persons

Table 47 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

(1) DAM

Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity ($10^6 m^3/y$)	Construction Cost (M$$10^6$)	Construction Period
24	Semangar dam	WS	160	137	123	54	1985-1989
24	Linggiu dam	WS	237	203	182	25	1985-1989
24	Pengeli dam	WS	143	65	84	30	1985-1989
25	Sedili dam	WS	227	84	110	12	1986-1990

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Tramsfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
21	Muar diversion (barrage & canal)	Johor to Melaka 21 to 19 & 20	15	160	1985-1989
24	Teberau diversion (barrage)	Johor 23 to 23 & Singapore	32	9*	1985-1989
24	Semangar diversion (canal)	Johor 24 to 23	32	32	1985-1989
24	Johor diversion (barrage & canal)	Johor 24 to 24	24	22	1985-1989
25	Sedili diversion (canal & pipe line)	Johor 25 to 24	7	67	1986-1990

Remarks; IR = Irrigation: WS = Water supply
Construction cost is the financial cost at 1980 constant price.
* = excludes the cost of distribution pipe line for water supply.

Table 48 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: m^3/d

Basin No.	Basin Name	1981 - 1990 Palm Oil	Rubber	Total	1991 - 2000 Palm Oil	Rubber	Total
20	Kesang	192	1,060	1,252	0	144	144
21	Muar	1,292	7,076	8,368	1,332	1,224	2,556
22	Batu Pahat	688	764	1,452	1,812	220	2,032
23	Sekudai	292	704	996	704	388	1,092
24	Johor	2,876	1,900	4,776	2,572	256	2,828
27	Endau	1,852	244	2,096	1,684	188	1,872
28	Rompin	1,308	0	1,308	4	0	4
	Total	8,500	11,748	20,248	8,108	2,420	10,528

Table 49 RECOMMENDED PUBLIC SEWERACE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
21	C32	Segamat	10	45	28	35	100	87
23	C38	Kulai/Senai	26	45	20	89	100	65
27	C41	Kluang	16	30	19	54	70	48
		Total	52	-	67	178	-	200

Table 50 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
23	C39	Johor Bahru	59	30	125	202	65	370

Table 51 RECOMMENDED FLOOD MITIGATION PROGRAM IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Name of River	R.I. (km)	F.W. (km)	Dam (nos)	Pold. (nos)	N.S. (km^3)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
By 1990									
20	Kesang	8	-	-	-	-	2	1	4
21	Muar	-	-	-	-	-	-	-	-
22	Batu Pahat	24	-	1	-	-	4	4	75
23	Pontian Kechil	25	-	-	-	-	17	1	15
24	Johor	-	-	-	-	-	-	-	-
26	Mersing	-	-	-	-	-	-	-	-
27	Endau	-	-	-	-	-	-	-	-
	Total	57	-	1	-	-	23	6	94
By 2000									
20	Kesang	19	-	-	-	-	4	2	7
21	Muar	-	-	-	1	-	6	-	4
22	Batu Pahat	93	19	1	-	-	28	26	156
23	Pontian Kechil	25	-	-	-	-	17	1	15
24	Johor	-	-	-	1	-	5	-	8
26	Mersing	6	-	-	-	-	22	1	7
27	Endau	11	-	-	-	-	20	1	6
	Total	154	19	1	2	-	102	31	203

Remarks; R.I. : River improvement,
F.W. : Floodway,
Pold.: Polder,
N.S. : Non-structural measure,
P.P.: Population protected (the year 2000)
F.A.: Flood area relieved
C.C.: Construction cost

Table 52 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	23	288	0	0	311
Irrigation	9	97	34	0	140
Inland Fishery	3	3	58	41	105
Public Water Supply	205	356	388	155	1,104
Public Water Supply; Pre-treatment facilities	31	39	27	10	107
Public Sewerage (Effective for river water pollution abatement)	43	70	72	29	214
Public Sewerage (Others)	42	70	70	28	210
Flood Mitigation	46	52	64	44	206
Total	402	975	713	307	2,397

Remarks; (1): At 1980 constant price
(2): The amount shown for 4MP is the additional budget, assuming that the original budget can provide the capacity necessary up to 1985.
(3): Source development expenditures include a part of expenditure of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 53 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	1	7	7	15
Irrigation	0	1	8	11	20
Inland Fishery	0	0	3	7	10
Public Water Supply	0	35	73	106	214
Public Water Supply; Pre-treatment facilities	0	5	8	10	23
Public Sewerage (Effective for river water pollution abatement)	0	14	29	40	83
Public Sewerage (Others)	0	14	28	40	82
Flood Mitigation	0	23	49	78	150
Total	0	93	205	299	597

Remarks; (1): At 1980 constant price
(2): Recurrent expenditure on the capacity, which is to be constructed by the original budget for 4MP, is not included.
(3): Source development expenditures include a part of expenditure of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 54 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	(M$10^6)	10
D&I water supply	(M$10^6)	82
Fish culture	(M$10^6)	4
Reservoir recreation	(M$10^6)	7
Total	(M$10^6)	103
1.2 Economic Cost		
Irrigation	(M$10^6)	4
D&I water supply	(M$10^6)	70
Fish culture	(M$10^6)	4
Dams, barrages & diversion facilities	(M$10^6)	9
Total	(M$10^6)	87
1.3 EIRR	(%)	11
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	85
2.2 Adverse Effect		
Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	6
3. Social Well-being		
3.1 Beneficial Effect		
Number of farm households benefited by proposed irrigation in 2000	(10^3)	4
Number of people served by proposed public water supply in 2000	(10^3)	2,423
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	3

Remarks: (1) All effects by proposed hydropower project are not shown except irrigation, D&I water supply and lake recreation benefit.

(2) Economic cost for dams, barrages and diversion facilities includes a part of cost of the Melaka/Muar region source development plan allocated to the State of Johor.

Table 55 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	(M$$10^6$)	7
Saving in pre-treatment for D&I water supply	(M$$10^6$)	21
Total	(M$$10^6$)	28
1.2 Economic Cost		
Sewerage	(M$$10^6$)	21
Private purification facilities/2	(M$$10^6$)	3
Pre-treatment for D&I water supply	(M$$10^6$)	8
Total	(M$$10^6$)	32
2. Environmental Quality		
2.1 Beneficial Effects		
Length of river stretch where BOD concentration is not more than 10 mg/lit in 2000 compared with without project condition (Study length = 846 km)	(km)	832/446/1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 846 km)	(km)	753/232/1
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	570
3.2 Adverse Effect		-

Remarks; /1: (Length of river stretch with Project)/(length of river stretch without Project) and including the river stretch in the State of N.Sembilan, Malaka and Pahang.

/2: Including the rubber factories and palm oil mills in such part of the State of N.Sembilan, Malaka and Pahang as located in Basin 20, 21, 27 and 28.

Table 56 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN JOHOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	($M\$10^6$)	3.6
1.2 Economic Cost		
Flood mitigation work	($M\$10^6$)	7.6
1.3 EIRR	(%)	3.5
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	154
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	102
Population served by proposed flood warning system in 2000	(10^3)	31
Area relieved from flood hazards	(km^2)	31
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	3