GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA

STATE REPORT

VOL. 2

PERAK

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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LIST OF REPORTS

MAIN REPORT

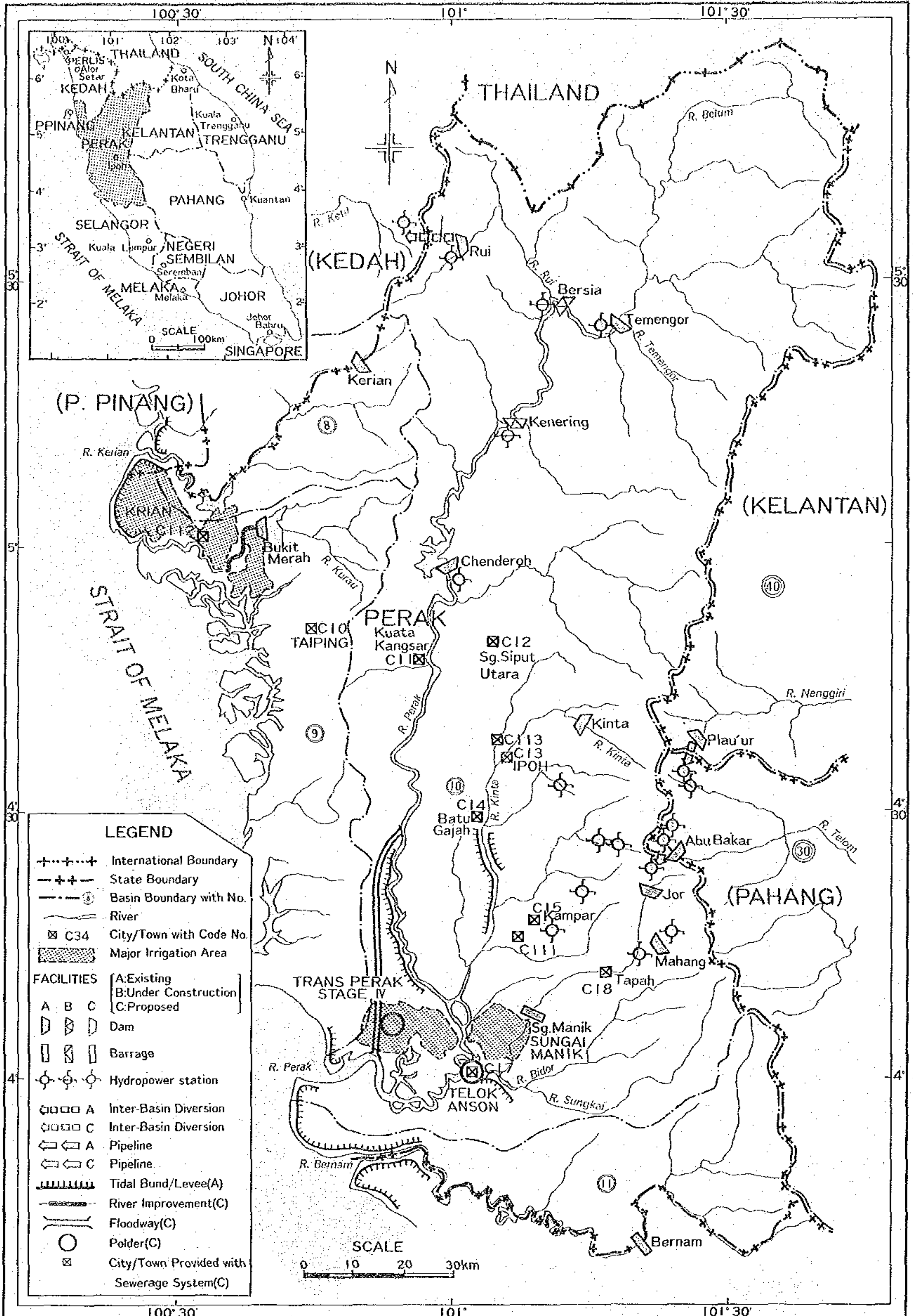
Vol. 1. MASTER ACTION PLAN
Vol. 2. WATER RESOURCES DEVELOPMENT AND USE PLAN

STATE REPORT

Vol. 1. PERLIS/KEDAH/P. PINANG
Vol. 2. PERAK
Vol. 3. SELANGOR
Vol. 4. N. SEMBILAN/MELAKA
Vol. 5. JOHOR
Vol. 6. PAHANG
Vol. 7. TRENGGANU
Vol. 8. KELANTAN
Vol. 9. SABAH
Vol. 10. SARAWAK

SECTORAL REPORT

Vol. 1. SOCIO-ECONOMY
Vol. 2. METEOROLOGY AND HYDROLOGY
Vol. 3. GROUNDWATER RESOURCES
Vol. 4. GEOLOGY
Vol. 5. RIVER CONDITIONS
Vol. 6. WATER QUALITY
Vol. 7. ECOLOGY
Vol. 8. POWER MARKET
Vol. 9. DOMESTIC AND INDUSTRIAL WATER SUPPLY
Vol. 10. AGRICULTURE
Vol. 11. IRRIGATION WATER DEMAND
Vol. 12. INLAND FISHERY
Vol. 13. INLAND NAVIGATION, WATER-RELATED RECREATION
Vol. 14. WATERSHED MANAGEMENT
Vol. 15. WATER RESOURCES ENGINEERING
Vol. 16. WATER SOURCE AND HYDROPOWER DEVELOPMENT PLANNING
Vol. 17. PUBLIC EXPENDITURE AND BENEFICIAL AND ADVERSE EFFECTS
Vol. 18. WATER RESOURCES MANAGEMENT
Vol. 19. WATER LAWS AND INSTITUTIONS



Recommended Plan
for the State of Perak

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

CONTENTS

Page

1. INTRODUCTION 1
2. BACKGROUND 2
   2.1 The Land 2
   2.2 The Rivers 2
   2.3 Watershed 3
   2.4 Present Socio-economic Condition 3
3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE 5
   3.1 Domestic and Industrial Water Supply 5
   3.2 Irrigation 5
   3.3 Flood Mitigation 6
   3.4 Power Generation 6
   3.5 Inland Fishery 6
   3.6 Inland Navigation 6
   3.7 Sewerage System 6
   3.8 Water Purification System in Private Sector 7
   3.9 Watershed Management 7
   3.10 Dams 8
4. FUTURE WATER DEMAND AND ASSOCIATED PROBLEMS 9
   4.1 Projected Socio-economic Condition 9
   4.2 Basin Division 10
   4.3 Domestic and Industrial Water Demand 10
   4.4 Irrigation Water Demand 10
   4.5 Fish Pond Water Demand 11
   4.6 River Utilization Ratio and Water Deficit 11
   4.7 Water Quality 12
   4.8 Watershed Problems 13
5. STRATEGIES FOR WATER RESOURCES DEVELOPMENT AND USE 14
   5.1 Problem Areas 14
   5.2 Maintenance of Low Flow 14
   5.3 Development of Water Supply and Irrigation Systems 15
   5.4 Source Development 16

Page

5.5	Water Pollution Abatement	16
5.6	Hydropower Development	17
5.7	Flood Mitigation	18
5.8	Inland Fishery	18
6.	ALTERNATIVE STUDIES	20
6.1	Scope of Alternative Studies	20
6.2	Water Demand and Supply Balance Alternatives	20
6.3	Hydropower Development Alternatives	22
6.4	Water Pollution Abatement Alternatives	22
6.5	Flood Mitigation Alternatives	23
7.	RECOMMENDED PLAN	25
7.1	Public Water Supply and Irrigation Development Plan	25
7.2	Source Development	25
7.2.1	Kerian and Kurau river basins source development plan	25
7.2.2	Kinta valley source development plan	25
7.2.3	Rui dam project	26
7.3	Water Pollution Abatement Plan	26
7.4	Flood Mitigation Plan	26
7.4.1	Kurau river flood mitigation plan	26
7.4.2	Perak river flood mitigation plan	27
7.5	Cost Estimate	27
7.6	Beneficial and Adverse Effects	28
7.6.1	National economic development	28
7.6.2	Environmental quality	29
7.6.3	Social well-being	30
8.	PLAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH	31
8.1	Assumed GDP Growth Rate	31
8.2	Parameters Predominantly Related to GDP per Capita	31
8.3	Assumed Targets	31
8.4	Development Plan	31
8.5	Public Expenditure	31
8.6	Beneficial and Adverse Effects	32

TABLES

		Page
1.	METEOROLOGICAL DATA IN PERAK	33
2.	RIVER CHARACTERISTICS IN PERAK (1/2)	34
3.	RIVER CHARACTERISTICS IN PERAK (2/2)	35
4.	FLOODED AREA BY RECORDED MAXIMUM FLOOD IN PERAK	36
5.	LIST OF EXISTING AND PLANNED DAMS IN PERAK	37
6.	HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN PERAK	38
7.	HISTORICAL AND PROJECTED GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP IN PERAK	39
8.	BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN PERAK ...	40
9.	ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PERAK	40
10.	NET UNIT MANUFACTURING WATER USE PER GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP	41
11.	ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN PERAK	42
12.	ESTIMATED AREA OF IRRIGATED PADDY FIELD IN PERAK	43
13.	ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN PERAK	43
14.	RIVER UTILIZATION RATIO BY BASIN IN PERAK FOR 1990 AND 2000	44
15.	ANNUAL DEFICIT BY BASIN IN PERAK FOR 1990 AND 2000	45
16.	ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES IN PERAK	46
17.	DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL IN PERAK	46
18.	PROPOSED FLOOD FORECASTING AND WARNING SYSTEM IN PERAK ...	47
19.	WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN PERAK	48
20.	WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN PERAK	49
21.	WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN PERAK	50

22. OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN PERAK 51

23. RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PERAK 52

24. RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK 53

25. RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK 53

26. RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PERAK 54

27. RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN TREATMENT CAPACITY IN PERAK 55

28. ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PERAK 55

29. POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN PERAK 56

30. RECOMMENDED FLOOD MITIGATION PROGRAM IN PERAK 57

31. ASSUMED UNIT CONSTRUCTION COST (1/2) 58

32. ASSUMED UNIT CONSTRUCTION COST (2/2) 59

33. ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK 60

34. ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK 60

35. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PERAK 61

36. SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN PERAK 62

37. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PERAK 63

38. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PERAK 64

39. SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN PERAK 65

40. ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 66

41. ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 67

42. RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 68

43. RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 69

44. RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 69

45. RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 70

46. RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 71

47. ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 71

48. RECOMMENDED FLOOD MITIGATION PROGRAM IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 72

49. ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 73

50. ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 73

51. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 74

52. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 75

53. BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH 76

FIGURES

1. Map of the State of Perak
2. Present Land Use
3. Location of Paddy Field
4. Flood Prone Area in Perak
5. Location of Demand Centers and Pollution Sources
6. Relationship between BOD Concentration and Environmental Feature and River Water Quality Limit
7. Location of Potential and Proposed Water Source Facilities, Alternative B1
8. Flood Mitigation Alternatives, Alternative F1
9. Flood Mitigation Alternatives, Alternative F2
10. Flood Mitigation Alternatives, Alternative F3
11. Recommended Water Demand and Supply Balance Program for Kinta Valley, and Kerian and Kurau River Basins

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 m = 3.28 ft = 1.094 yd 1 km = 0.621 mile	1 inch = 2.54 cm 1 ft = 30.48 cm 1 yd = 91.44 cm 1 mile = 1.609 km
Area	1 cm^2 = 0.155 sq.in 1 m^2 = 10.76 sq.ft 1 ha = 2.471 acres 1 km^2 = 0.386 sq.mile	1 sq.ft = 0.0929 m^2 1 sq.yd = 0.835 m^2 1 acre = 0.4047 ha 1 sq.mile = 2.59 km^2
Volume	1 cm^3 = 0.0610 cu.in 1 lit = 0.220 gal.(imp.) 1 kl = 6.29 barrels 1 m^3 = 35.3 cu.ft 10^6 m^3 = 811 acre-ft	1 cu.ft = 28.32 lit 1 cu.yd = 0.765 m^3 1 gal.(imp.) = 4.55 lit 1 gal.(US) = 3.79 lit 1 acre-ft = 1233.5 m^2
Weight	1 g = 0.0353 ounce 1 kg = 2.20 lb 1 ton = 0.984 long ton = 1.102 short ton	1 ounce = 28.35 g 1 lb = 0.4536 kg 1 long ton = 1.016 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 kg/cm^2 = 14.2 psi 1 ton/ha = 891 lb/acre 10^6 m^3 = 810.7 acre-ft 1 m^3/s = 19.0 mgd	1 cusec = 0.0283 m^3/s 1 psi = 0.703 kg/cm^2 1 lb/acre = 1.12 kg/ha 1 acre-ft = 1,233.5 m^3 1 mgd = 0.0526 m^3/s
Local Measures	1 lit = 0.220 gantang 1 kg = 1.65 kati 1 ton = 16.5 pikul	1 gantang = 4.55 lit 1 kati = 0.606 kg 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 2 herein presented describes the matters for the State of Perak.

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 Perak of 20,950 sq.km is located in the central part of the west coast of Peninsular Malaysia, between 100°22′ and 101°45′ east in longitude and 3°40′ and 5°56′ in latitude. It faces the Strait of Melaka and adjoins the States of Kelantan, Pahang, Selangor, Pulau Pinang and Kedah and Thailand in the north.

Eastern and northern parts of the State are mountainous. Southernmost and coastal area is featured by swamps. The rest is low hills and plains. Rivers run parallel or perpendicular to the geological trend. They are the Perak, Kinta, Kerian, Kurau, Bernam and other small rivers. The Kerian river in the north and Bernam river in the south run along the state boundaries.

Major part of the northern Perak is situated on an extensive zone of granite and Silurian meta-sediment complex. It covers more than 80 km of width from the Main Range to the western watershed of the Perak river. In the southern Perak, the granite narrows to a 20 km wide belt along the border with Pahang. Belts of Devonian and partly Carboniferous meta-sedimentary facies are developed on its western margin, consisting mainly of shales and quartzites. Crystalline limestones are extensively developed in a 90 km long north-south trending zone around Ipoh, Batu Gajah and Kampar. Small patch of Triassic sediments is located on the western margin of granite mass in the reaches of the Kerian river and the Kurau river. Trends of geological structure, represented by faults and folding axes, are north-southerly direction. Alluvial plain is extensively developed around the lower reaches of the Perak river and along the west coastal line.

Soils are mostly sedentary soils occurring on undulating plains and mountains. The areal extent of alluvial soils on coastal plains riverine flood plain and terraces is 6,033 sq.km, accounting for 29% of the total for the State. Of this, 3,160 sq.km are evaluated as suitable for paddy, 815 sq.km for coconut, 497 sq.km for oil palm and cocoa, and 152 sq.km for tree cropping. Its areal extent is 2,677 sq.km for rubber, oil palm and coconut, and 2,674 sq.km for rubber, respectively.

Climate is usually hot and wet. Average annual rainfall is about 2,000 mm. Rainfall has the peaks during both the post-equinoctial transition periods between monsoons, often most in April but with shorter duration and the second most in October and November with longer duration. Meteorological data at Sitiawan (El. 7.0 m) are summarized in Table 1.

2.2 The Rivers

Run-off in rivers wholly or partly located in the State of Perak is estimated based on 1961 - 1979 records at the hydrological stations No.5007421 in the Kurau river and No.4311464 in the Kinta river. The surface run-off is 26 billion cu.m/y or 47% of rainfall of 55 billion cu.m/y. Evapotranspiration is 25 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 Kinta river. Operation of mines is major cause of high concentration of suspended solid (SS). In the 1978/1979 observation, SS concentration was more than 500 mg/lit in some stretches of the Kinta and Bernam rivers.

Rich alluvial aquifers occur in the flood plains of the Perak river but sea water intrudes near the seashore. Rock aquifers may be found in the limestones and the sedimentary rocks of Silurian to Triassic.

The river characteristics in terms of river morphology, estuary, sediment and sea water intrusion in Perak is as shown in Table 2 and 3.

2.3 Watershed

Natural vegetation occupies 10,691 sq.km comprising hill forest of 7,652 sq.km, scrub forest of 628 sq.km, swamp forest of 2,056 sq.km and grassland of 355 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 area decreased from 12,303 sq.km or 58% of the whole State in 1966 to 10,336 sq.km or 49% 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 100 and 400 mg/lit at present in the middle and lower reaches of the Perak river due to the surface soil loss occurred in its catchment area.

2.4 Present Socio-economic Condition

As illustrated in Fig.1, the State of Perak is administratively divided into nine districts. Towns having population of more than 10,000 in 1980 were Bagan Serai, Taiping, Kuala Kangsar, Sg.Siput Utara, Ipoh, Batu Gajah, Kampar, Baru Mambang, Telok Anson and Tapah.

Population of Perak was 1.9 million in 1980 with the average annual growth rate of 1.4% during the period from 1970 to 1980. Population density increased from 78 persons/sq.km in 1970 to 89 persons/sq.km in 1980.

Gross regional product (GRP) increased from M$1,875 million in 1971 to M$2,882 million in 1980 in factor cost at 1970 constant price with the average annual growth rate of 4.9%. GRP of manufacturing sector shared M$183 million or 9.8% of the total in 1971 and M$511 million or 17.7% in 1980. Per capita GRP was M$1,537 in 1980 in factor cost at 1970 constant price and its average annual growth rate between 1971 and 1980 was 3.4%.

Major land use patterns in 1979 were forest of 10,336 sq.km, grassland of 355 sq.km, annual and perennial crop land of 5,152 sq.km, swamp of 2,056 sq.km and miscellaneous land of 3,157 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 237,200 ha for rubber, 90,000 ha for oil palm, 54,200 ha for coconut and 26,200 ha for cocoa. During the last five years since 1975, newly planted area under FELDA and FELCRA schemes totaled 3,900 ha for rubber and 11,000 ha for oil palm. RISDA replanted 12,200 ha of rubber in the existing smallholders' rubber areas during the said period, while private estates reduced by 9,800 ha their planted area of rubber mainly for the purpose of conversion to oil palm. The annual production in 1979 totaled 216,700 tons of rubber as dry rubber content, 1,124,000 tons of oil palm as fresh fruit bunch and 119,100 tons of coconut as copra and 9,220 tons of cocoa as dry beans. Out of the above harvests, private estates produced 76,000 tons of rubber and 1,063,800 tons of oil palm, 15,900 tons of coconut and 9,220 tons of cocoa. The remaining ones were put out from RISDA, FELDA and FELCRA schemes as well as smallholders.

In 23 mills located within the State, 309,500 tons of crude palm oil and 69,300 tons of palm kernel were extracted from oil palm through processing 1,385,000 tons of fresh fruit bunch brought in the mills throughout 1979.

In 1979/80, paddy was planted in 70,400 ha comprising main season wet paddy of 33,300 ha, main season dry paddy of 800 ha and off-season wet paddy of 36,300 ha. As the whole paddy field was 51,900 ha, the crop intensity in 1979/80 became 1.36. The total rice production in 1979/80 was 121,800 tons among which 60,200 tons were harvested in the main season including 600 tons of dry paddy rice and the remaining 61,600 tons were off-season wet paddy rice. This production met 35% of the estimated local consumption of 178,300 tons in the State in 1979/80.

During the period from 1970/71 to 1979/80, rice production fluctuated between 111,700 tons in 1977/78 and 169,000 tons in 1973/74 largely affected by climatic condition, even though paddy field which was provided with irrigation facilities increased from 47,600 ha to 48,600 ha.

3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

3.1 Domestic and Industrial Water Supply

Public water supply in Perak is administered by the Waterworks Department (WD) of the State Government.

The WD 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, the thirty nine WD waterworks delivered 274,000 cu.m/d of water on an average. The population served water through WD networks was estimated at 1.28 million 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 70,000 people were served water by the untreated water supply system in 1980. The water users are suggested to boil water before drinking.

In consequence, 1.35 million people out of the total State population of 1.87 million were estimated to be served water through the Waterworks Department and RESP, corresponding to the service factor of 72% in 1980.

3.2 Irrigation

There are 51,900 ha of paddy fields: 48,500 ha are irrigated and 3,400 ha are rainfed. Double cropping area is 42,100 ha in 1980, which is 87% of the total irrigated area. Existing major schemes are the Kerian and the Sungai Manik irrigation schemes. Both schemes are under tertiary irrigation and drainage development with financial assistance by IBRD.

The Kerian irrigation scheme (25,000 ha) is located in the northwest corner of the State, with some 1,500 ha extending into the State of Pulau Pinang as shown in Fig.3. The main water source is the Bukit Merah reservoir constructed on the Kurau river. The irrigation water for the scheme is supplemented by a pumping station in the project area through a channel from the Kerian river. The Sungai Manik irrigation scheme (6,600 ha) is located in southern Perak. Irrigation water is taken from the Batan Padang river by headworks constructed in 1939. Small-scale irrigation schemes of 20,000 ha consist of 48 gravity irrigation and 11 pumping schemes. The average size of small-scale schemes is 316 ha. Paddy yield is 2.5 - 2.8 tons/ha in the main season and 2.6 - 3.0 tons/ha in the off-season.

3.3 Flood Mitigation

Flood occurs between July and February, mostly in October to December. The damage by the recorded maximum flood in the State is estimated to be M$64.2 million at 1980 price level. Table 4 lists the inundated area and estimated damage by the recorded maximum flood by Basin. The inundated area is illustrated in Fig.4.

3.4 Power Generation

The main stream of the Perak river has been utilized for power generation. The Chenderoh power station of 270 MW having a reservoir of 66 million cu.m in active storage capacity has been operated by the Perak Hydropower Company in the middle reach of the Perak river since 1930. The Temengor dam of 1,270 million cu.m in active storage capacity was completed in the upstream reach in 1979 for power generation of 348 MW. Between the above-mentioned sites, the Bersia power station of 72 MW and the Kenering power station of 120 MW are under construction. NEB has operated the Camelon Highland Scheme which is a series of hydropower stations spanning the States of Perak, Pahang and Kelantan. Within the State of Perak, there are three power stations belonging to the Camelon Highland Scheme: The Sultan Yussuf power station of 100 MW, the Sultan Idris II power station of 150 MW and the Odak power station of 4.2 MW. The Jor power station of 100 MW is also operated by NEB. There are several hydropower station of private companies, their installed capacity ranging between 0.43 MW and 2 MW.

3.5 Inland Fishery

There are 386 ha of freshwater constructed ponds and 2,950 ha of tin mining pool used for fish culturing. The water use of the constructed ponds in 1979 was 5.24 million cu.m/y.

3.6 Inland Navigation

The existing river traffic in the Perak river comprises passenger, cargo, marine fishing and river fishing boats as well as tankers carrying petroleum. Some 140 passenger boats are operated around Teluk Anson. More than 100 cargo boats transporting mainly agricultural goods such as copra, oil palm fruits and paddy navigate to and from Teluk Anson. Oil tankers navigate from the river mouth during high tides to go upstream and unload their cargo at the railway wharf in Teluk Anson.

In the Bernam river, limited number of passenger and cargo boats and palm oil tankers ply in the river.

3.7 Sewerage System

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

3.8 Water Purification System in Private Sector

The Federal DOE started to monitor the river water quality since 1978 in Perak with the frequency ranging from twice a year to once a month in 5 river water quality control regions.

There are 27 rubber factories in the State. These factories produce SMR, latex concentrate and conventional grade of 443 tons/day and they discharge effluent of 5.36 million cu.m/y to nearby watercourses. The water quality at outlets of factories ranges from 32 to 4,330 mg/lit in BOD concentration and from 48 to 970 mg/lit in SS concentration.

There are 24 oil palm mills in operation of which total milling capacity amounts to 5,420 tons/hr in fresh fruit bunch (FFB). The volume of effluent from these mills is 862,000 cu.m/y. The treated or raw effluent is and will be discharged from 19 mills into watercourses and from 5 mills onto land. The water quality ranges from 50 to 16,000 mg/lit in BOD concentration and SS concentration ranges from 50 to 27,000 mg/lit.

3.9 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 6,755 sq.km, wild life and other reserves of 37 sq.km and Crown or State land of 3,544 sq.km. Out of the forest reserves, 3,949 sq.km was classilied as productive forests comprising 3,603 sq.km of inland forests and 346 sq.km of mangrove forests. The remaining 2,806 sq.km were unproductive forests consisting of 2,746 sq.km of protective hill forest and 59 sq.km of mangrove forests. In the inland forest reserves, there remain 1,676 sq.km of unexploited forests which have been committed or licenced for development. The actual area opened for harvesting during 1979 was 160 sq.km corresponding to 9% of the unexploited forests.

Besides forest exploitation, execution of large-scale 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 middle and lower reaches of the Perak river, 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.

3.10 Dams

Table 5 lists seven dams at various stages in Perak.

There are five dams in operation of which the Bukit Merah dam is that for irrigation purpose and other four dams are those for hydropower generation. The Temengor dam is the biggest one and its major dimensions are as described in 3.4. The Bersia and Kenering dams are now under construction and are scheduled to be commissioned in 1983.

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 Perak is described hereunder.

The average annual growth rate of population in the period from 1980 to 2000 was estimated to be 0.6%. Projected population is 2.05 million in 1990 and 2.11 million in 2000, respectively. Table 6 shows the projected population by urban and rural area in the State of Perak. 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$3,891 million in 1985, M$5,528 million in 1990 and M$10,224 million in 2000 with the average annual growth rate of 6.5% between 1980 and 2000.

Projected gross value of output in manufacturing sector will increase from M$1,664 million in 1980 to M$3,059 million in 1985, M$5,473 million in 1990 and M$12,106 million in 2000 at factor cost in 1970 prices as shown in Table 7.

The future rice consumption in the State was estimated to be 246,000 tons in 1990 and 253,200 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 4,300 ha and the newly reclaimed paddy field of 7,700 ha, (2) stabilization of irrigation water supply during the wet season to the existing irrigated paddy field of 48,500 ha and (3) development of new irrigation water resources during the dry season to increase by 1,200 ha double cropping area among the existing irrigated paddy field. The total rice production anticipated under the above plans will be 233,000 tons in 1990 and 278,100 tons in 2000.

Oil palm planting area was projected to increase to 118,000 ha in 1990 and 130,100 ha in 2000. The prospected processing volume of oil palm in the State will be 1.47 million ton as fresh fruit bunch in 1990 and 2.43 million tons in 2000.

Rubber planting area was projected to be kept in the present hectarage of 243,300 ha in 1990 and 2000. The total processing amount was projected to be 0.22 million ton as dry rubber content in 1990 and 0.31 million 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 8.

As shown in Fig.4, four Basins are wholly or partly located in the State of Perak: located within the State are the most part of the Kerian Basin, whole of the Kurau and Perak Basins, a northern part of the Bernam 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 9 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 10.

In Perak, the total water demand will reach 327 million cu.m/y in 1990 and 596 million cu.m/y in 2000 as shown in Table 11. Major demand centers are Tapah, Ipoh, Taiping and Telok Anson among which Ipoh has the largest industrial water as well as largest domestic water demand 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 Lanbuan 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 center 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 12, the projected irrigation area will increase from 48,500 ha in 1980 to 59,300 ha through 2000. The ratio of double cropping area to the total irrigation area is 87% in 1980 and will be 87% in 1990 and 90% in 2000.

The irrigation water demand was calculated for 1990 and 2000 as shown in Table 13. Irrigation efficiency applied is 55% with the exception of Kerian project (65%) for both major and minor irrigation projects. The annual irrigation water demand will be 1,468 million cu.m in 1990 and 1,495 million cu.m in 2000, respectively.

4.5 Fish Pond Water Demand

The future hectarage of freshwater fish pond was projected to increase from 458 ha in 1980 to 726 ha in 1990 and 1,360 ha in 2000. The total water demand for freshwater fish culture will rise from 6.28 million cu.m/y in 1980 to 9.89 million cu.m/y in 1990 and 18.45 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 14 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 14. In the State of Perak, the three Basins among the concerned four were estimated to have a river utilization equal to or more than 10% in 2000; only the Kerian Basin 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 8.

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 15.

The water deficit shown in Table 15 was calculated under without-dam condition. If the estimated supply capacity of the existing and under-construction dams listed up in Table 5 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 11 urban areas, 24 palm oil mills, 27 rubber factories, animal husbandry in the rural areas.

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 16. 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 17. 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 Perak will not be more than 10 mg/lit in 1990 and 2000. This projection states that most rivers will be mildly polluted in 1990 and 2000.

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 350 tons/sq.km.

If all natural forest on slope of less than 6 degrees is disturbed, erosion rate will increase to 1,150 tons/sq.km. An exercise indicates that erosion rate is 700 tons/sq.km, if natural forest on slope of less than 2 degrees is cleared and converted to rubber farm. Reforestration in the disturbed forest can reduce erosion in a long run.

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 8 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 18.

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.

In the State of Perak, water resources are generally abundant, except for the Kinta valley and Keriang and Kerang river basins, where the construction of dams is proposed. A dam in an upper tributary of the Perak river is proposed and included in the alternatives with a main purpose to divert water to the Perlis/Kedah/Pulau Pinang region where water shortage is serious at present and all increasing water demand cannot be met even all storage potential within the region is developed.

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 19 through 21 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 Kurau, Perak and Bernam 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: it is not the case in the State of Perak and therefore, the two alternatives are identical.

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 stretches 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 provided 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 22.

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 Alternative 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 WD 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 23 through 25. 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 12.

7.2 Source Development

The recommended water source development plan for balancing water demand and supply is summarized in Table 26. The water source development plan in the problem area is mentioned hereunder.

Fig.11 illustrates the recommended water demand and supply balance program for Kinta Valley, Kerian and Kurau river basins.

7.2.1 Kerian and Kurau river basins source development plan

The Kerian Irrigation Project of 23,490 ha is entirely located in the northwest coast of the State of Perak, but 1,504 ha out of the total area is located in the State of Pulau Pinang. It takes water from the Kerian and Kurau rivers. The Bukit Merah dam in the Kurau river and Kerian barrage serve for irrigation. The tertiary irrigation and drainage development is on-going as a part of Kerian-Sungei Manik Integrated Agricultural Development Project, assisted by IBRD. There are minor irrigation areas of about 3,600 ha, which will increase to 4,000 ha by 2000. Population of 350,000 will grow to 670,000 in the two river basins. It is estimated that these river basins will often suffer from water deficit in the near future. The construction of the Kerian dam is recommended in the Kerian river, which is the boundary between the State of Kedah and the State of Perak.

7.2.2 Kinta valley source developmennt plan

The Perak river basin as a whole has an ample water for use and more water will become available, if the Temengor dam is fully operated. The problem area is the Kinta valley, where Ipoh is located. Population in Ipoh is estimated to be 320,000 for 1980, 377,000 for 1990 and 446,000 for 2000. Natural flow in the Kinta valley will become insufficient before 1990, because of high increase in domestic and industrial water demand in Ipoh, which is estimated to be 41 million cu.m in 1980, 84 million cu.m in 1990 and 154 million cu.m in 2000. It is recommended to construct the Kinta dam in the upstream reaches of the Kinta river.

7.2.3 Rui dam project

The Rui dam and diversion tunnel are recommended to regulate water in an upper tributary of the Pahang river and to convey water to the Perlis/Kedah/Pulau Pinang region, where total water demand is expected to grow from 2.9 billion cu.m in 1980 to 3.2 billion cu.m in 1990 and 3.7 billion cu.m in 2000. The dam 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.

The reservoir created by the Rui dam has to submerge the Pong power station of 2MW and it will reduce a minor portion of secondary output at the Kenering and Chendeloh power stations, which are located downstream. On the other hand a power generation of about 4MW is probably possible by utilizing the water head at the outlet of the proposed diversion tunnel. Development of this potential and adjustment of water release to the benefit of the downstream power station should be taken into account in planning the Rui dam.

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 Ipoh and Telok Anson and the improvement of purification method in palm oil mills and rubber factories in the Kurau, Perak and Bernam Basins.

Although it is ineffective for the water pollution abatement in the river, sewerage development in Taiping, Ipoh and Telok Anson is assumed from the viewpoint of public health.

The recommended plan for water pollution abatement including the assumed sewerage development is shown in Tables 27 through 29.

7.4 Flood Mitigation Plan

The recommended plan for flood mitigation is mentioned hereunder and is summarized in Table 30.

7.4.1 Kurau river flood mitigation plan

The Kurau river often inundate the land especially below the Bukit Merah dam. The recommended plan is to protect the Kerian irrigation project from flooding by providing channel improvement for 13 km of river stretch which is located across the irrigation area.

7.4.2 Perak river flood mitigation plan

The Perak river flooded 1,300 sq.km in 1967. The affected population was estimated to be 200,000 mostly in the downstream area. The same magnitude of flood if occurs in the future will still cause serious problem in the downstream areas, though the Temengor dam can largely decapitate the flood discharge. Teluk Anson, populated by 53,000, sometimes suffers from flooding due to high spring tide. Bank erosion is also significant near Teluk Anson. The recommended plan includes the construction of a 50 km long floodway to divert flood flow from the middle stretch of the Perak river to the estuary, construction of a low ring bund (polder) surrounding Teluk Anson and bank protection work in the river stretch near Teluk Anson.

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 31 and 32. 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 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 sector for the recommended plan was estimated as shown in Tables 33 and 34.

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 35 and 36 for water demand and supply balance, in Table 37 for water pollution abatement and in Table 38 for flood mitigation.

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 39. 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 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 sustanined 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 5mg/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 40. The domestic and industrial water demand estimated under the condition of lower economic growth is shown in Table 41.

8.4 Development Plan

The development plan under the condition of lower economic growth is tabulated in Tables 42 through 48.

8.5 Public Expenditure

The public development and recurrent expenditures are estimated for the case of lower economic growth as shown in Tables 49 and 50.

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 51 to 53.

TABLES

Table 1 METEOROLOGICAL DATA IN PERAK

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		Mean Air Temperature (°C)	Relative Humidity (%)	Sunshine Hours (hrs.)	Open Water Evaporation (mm)	Rainfall (mm)
Jan.		25.9	83.7	6.85	142	128
Feb.		26.4	82.5	7.05	141	143
Mar.		26.8	82.7	7.12	164	122
Apr.		27.1	84.7	7.13	159	144
May		27.0	84.5	6.76	151	99
June		26.9	83.8	6.51	145	101
July		26.5	83.4	6.61	144	108
Aug.		26.5	83.7	6.36	147	142
Sep.		26.3	85.3	5.57	144	194
Oct.		26.2	86.2	5.44	138	217
Nov.		26.0	87.1	5.16	129	299
Dec.		25.8	86.9	5.45	126	189
Annual		26.5	84.5	6.33	1,730	1,886
Daily	Max.	35.7	99.1			
	Min.	17.7	61.0			

Table 2 RIVER CHARACTERISTICS IN PERAK (1/2)

Basin No.	Item		Description
8	Kerian river		
	(A)	River Morphology	Meanders in tidal reaches and sluggish course in middle reaches. Bank erosion observed at meanders in middle reaches may be contributing sediment yield.
	(B)	Estuary	No noteworthy problems reported. Marine mud depositing on both banks of river mouth, but no difficulty in navigation.
	(C)	Sediment	Sand shoals observed at meanders in upper and middle reaches. High yield of sediment due to land development and logging. Ijok diversion headwork silted.
	(D)	Sea Water Intrusion	Up to tidal gate at Parit Bantar. No problem existing at present (no water intakes in reach downstream from barrage).
9	Kurau river		
	(A)	River Morphology	Heavy meanders in tidal reaches, but banks are generally stable. No adverse problems reported.
	(B)	Estuary	Marine mud intruding into river mouth, causing gradual change of flow direction southward. But, no major difficulty of navigation.
	(C)	Sediment	Mild yield of sediment, but silting problem arising in reach upstream from Pondok Tanjong Town, due to illegal cultivation in forest area.
	(D)	Sea Water Intrusion	No adverse problems reported.

Table 3 RIVER CHARACTERISTICS IN PERAK (2/2)

Basin No.	Item	Description
10	Perak river	
	(A) River Morphology*	Natural trapezoidal cross sections in lower/middle reaches, gorge shape in upper reaches. Meandering in lower reaches, but not active except at Teluk Anson. Severe erosion at outer meanders at Teluk Anson Town.
	(B) Estuary	About 1.7 km width. No specific problem.
	(C) Sediment*	Sand bars and shoals in middle reaches but no remarkable change of riverbed levels in Taluk Sena - Kg. Gajah area. High sediment yield from Kinta tributaries (e.g. Paris).
	(D) Sea Water Intrusion	Tidal effect up to Kg. Gajah (84 km). Salt water intrusion up to Teluk Anson (58 km). No adverse problems at present. Small tidal gates protecting each drainage areas.
11	Bernam river	
	(A) River Morphology	Heavy meanders in lower tidal reaches and sluggish course in middle reaches. No adverse behaviour reported. Minor bank erosion observed at localized places.
	(B) Estuary	Estuary is wide and sufficiently deep for navigation. No major marine mud intrusion in river mouth.
	(C) Sediment	Silting problem at Bernam pump house near Began Terap. Sediment yield from tin mines along Sg. Juki, Sg. Baharai.
	(D) Sea Water Intrusion	No present problem. No water intakes in tidal areas.

Remarks; *: Major problems requiring some improving measures

Table 4 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN PERAK

Basin No.	River Basin	Year	Flooded Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
8	Kerian	-	9	-	-
9	Kurau	1980	48	12	1.6
	Beruas	1963	113	2	0.7
10	Perak	1967	1,295	375	60.8
11	Bernam	1971	191	5	1.1
	Total		1,656	394	64.2

Table 5 LIST OF EXISTING AND PLANNED DAMS IN PERAK

Name	River	Purpose/ Year of Commission	Organi- zation	Catchment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity (10^6 m^3/y)
Existing						
Bukit Merah	Kurau	IR	DID		20	76
Temengor	Perak	HY + (FM)	NEB	3,420	1,270	2,450
Chenderoh	Perak	HY + (FM)	NEB	6,653	66	540
Jor	Batang	HY	NEB			0
Mahang	Batang	HY	NEB			0
Under Construction						
Bersia	Perak	HY	NEB	3,600	10	350
Kenering	Perak	HY	NEB	5,540	70	1,170

Remarks; IR : Irrigation
HY : Hydropower
FM : Flood mitigation
( ): Incidental function

Table 6 HISTORICAL AND PROJECTED POPULATION OF DISTRICT BY CITY/TOWN AND RURAL AREA IN PERAK

Unit: 10^3

District	City/Rural	Historical 1980	Projected 1985	Projected 1990	Projected 2000	Average Annual Growth (%) 1980-2000
18. Hulu Perak	Rural	74	78	78	59	-1.1
20. Kerian	112. Bagan Serai	10	10	11	13	1.3
	Rural	158	159	159	146	-0.4
	District Total	168	169	170	159	-0.3
21. Larut dan Matang	10. Taiping	159	205	247	313	3.4
	Rural	111	96	97	210	3.2
	District Total	270	301	344	523	3.4
22. Kuala Kangsar	11. Kuala Kangsar	16	15	16	18	0.6
	12. Sg. Siput Utara	25	27	28	33	1.4
	Rural	112	112	112	107	-0.2
	District Total	153	154	156	158	0.2
23. Kinta	13. Ipoh	320	346	377	446	1.7
	14. Batu Gajah	12	12	12	14	0.8
	15. Kampar	27	26	27	30	0.5
	111. Baru Mambang	10	11	11	13	1.3
	113. Jelapang	9	9	10	12	1.4
	Rural	233	252	240	163	-1.8
	District Total	611	656	677	678	0.5
24. Perak Tengah	Rural	79	79	79	76	-0.2
25. Dinding	Rural	155	161	161	129	-0.9
26. Hilir Perak	17. Telok Anson	53	55	59	69	1.3
	Rural	166	171	171	142	-0.8
	District Total	219	226	230	211	-0.2
27. Batang Padang	18. Tapah	10	10	11	12	0.9
	Rural	136	144	144	105	-1.3
	District Total	146	154	155	117	-1.1
Total	Urban Total	651	726	809	973	2.0
	Rural Total	1,224	1,252	1,241	1,137	-0.4
	State Total	1,875	1,978	2,050	2,110	0.6

Table 7 HISTORICAL AND PROJECTED GROSS VALUE OF MANUFACTURING OUTPUT BY COMMODITY GROUP IN PERAK

Unit: M$$10^6$

Item	Year 1980	1985	1990	2000
Food	534	863	1,081	1,089
Textile	253	450	626	879
Wood	131	136	138	108
Paper	1	2	5	21
Publishing	19	51	112	415
Chemical	120	274	1,216	3,655
Rubber	196	363	589	1,139
Non-metal	199	404	681	1,521
Basic metal	56	134	264	889
Machinery	146	360	729	2,305
Others	9	22	32	85
Total	1,664	3,059	5,473	12,106

Remarks; In factor cost at 1970 prices

Table 8 BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN PERAK

Basin No.	Basin	Total Catchment Area (km^2)	Effective Catchment Area (km^2)	Balance Point (km)	River Maintenance Flow (m^3/s)
8	Kerian	1,420	1,360	7	10.2
9	Kurau	3,255	1,155	45	7.8
10	Perak	14,700	13,555	70	52.3
11	Bernam	3,335	2,325	53	15.6

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

Table 9 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PERAK

	Service Factor (%)				Per Capita Daily Use (lpcd)			
	Estimated	Projected			Estimated	Projected		
City/Rural	1980	1985	1990	2000	1980	1985	1990	2000
1. Urban Area								
10 Taiping	100	100	100	100	170	185	200	230
11 Kuala Kangsar	80	85	90	100	160	175	190	220
12 Sg. Siput Utara	80	85	90	100	160	175	190	220
13 Ipoh	100	100	100	100	170	185	200	230
14 Batu Gajah	80	85	90	100	160	175	190	220
15 Kampar	80	85	90	100	160	175	190	220
17 Telok Anson	80	85	90	100	160	175	190	220
18 Tapah	80	85	90	100	160	175	190	220
111 Baru Mambang	80	85	90	100	160	175	190	220
112 Bagan Serai	80	85	90	100	160	175	190	220
113 Jelapang	78	85	90	100	115	153	190	220
2. Rural Area								
PWD Rural	55	70	76	79	75	100	125	175
MOH Rural	6	19	21	21	40	48	55	70
3. Non-Pipe-Served Area	-	-	-	-	40	40	40	40

Table 10 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 11 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN IN PERAK

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	I	Total	1990 D	I	Total	2000 D	I	Total
8		Rural	1.8	0.4	0.8	1.2	2.3	1.1	3.4	3.2	1.8	5.0
9	10	Taiping	26.3	18.2	27.7	45.9	23.7	41.7	65.4	34.6	91.9	126.5
	112	Bagan Serat	2.5	0.7	3.9	4.6	0.9	6.1	7.0	1.4	13.4	14.8
		City Total	28.8	18.9	31.6	50.5	24.6	47.8	72.4	36.0	105.3	141.3
		Rural	16.0	15.8	5.3	21.1	20.7	14.4	35.1	34.4	30.4	64.8
	Basin Total		44.8	34.7	36.9	71.6	45.3	62.2	107.5	70.4	135.7	206.1
10	11	Kuala Kangsar	2.8	1.1	3.5	4.6	1.3	5.3	6.6	1.9	11.7	13.6
	12	Sg. Siput Utara	2.1	2.0	1.0	3.0	2.4	1.5	3.9	3.5	3.2	6.7
	13	Ipoh	41.2	30.7	31.5	62.2	36.2	47.4	83.6	49.3	104.4	153.7
	14	Batu Gajah	1.5	0.9	1.4	2.3	1.0	2.4	3.4	1.5	5.3	6.8
	15	Kempar	2.7	2.0	1.8	3.8	2.2	2.8	5.0	3.2	6.1	9.3
	17	Telok Anson	8.1	4.1	9.5	13.6	4.9	14.3	19.2	7.3	31.6	38.9
	18	Tapal	1.6	0.7	2.0	2.7	0.9	3.1	4.0	1.3	278.9	280.2
	111	Balu	1.2	0.8	1.2	2.0	0.9	1.8	2.7	1.4	4.0	5.4
	113	Jelapang	0.4	0.4	0.2	0.6	0.8	7.4	8.2	1.3	0.4	1.7
		City Total	61.6	42.7	52.1	94.8	50.6	86.0	136.6	70.7	445.6	516.3
		Rural	33.7	28.4	14.2	42.6	36.6	41.4	78.0	41.4	89.2	130.6
	Basin Total		95.3	71.1	66.3	137.4	87.2	127.4	214.6	112.1	534.8	646.9
11		Rural	24.1	9.9	12.1	22.0	13.0	13.4	26.4	17.8	18.1	35.9
Total			166.0	116.1	116.1	232.2	147.8	204.1	351.9	203.5	690.4	893.9
(State Total for Perak)			(147.3)	(110.6)	(105.1)	(215.7)	(138.9)	(188.4)	(327.3)	(182.9)	(412.7)	(595.6)

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

Table 12 ESTIMATED AREA OF IRRIGATED PADDY FIELD IN PERAK

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
8.	Kerian	Minor	767	767	1,300	1,162	1,300	1,300
9.	Kurau+	Major/1	21,986	20,938	21,986	20,938	21,986	20,938
		Minor	2,543	2,543	2,700	2,700	2,700	2,700
10.	Perak	Major	6,555	5,900	16,269	13,944	16,269	15,614
		Minor	16,663	11,993	17,044	12,997	17,044	12,997
Total			48,514	42,141	59,299	51,791	59,299	53,549

Remarks; /1 Portion of the Krian Irrigation Project is incorporated in the State of P. Pinang.

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

Table 13 ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN PERAK

Unit: 10^6 m^3/y

Basin No.	Basin Name	Scheme	1980	1990	2000
8.	Kerian	Minor	24	35	37
9.	Kuran+	Major	460	424	424
		Minor	80	77	77
10.	Perak	Major	228	454	479
		Minor	501	478	478
Total			1,293	1,468	1,495

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

Table 14 RIVER UTILIZATION RATIO BY BASIN IN PERAK 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) (%)
8	Kerian	2,037	3	54	57	3	5	61	66	3
9	Kurau	1,560	108	518	626	40	206	518	724	46
10	Perak	12,848	208	932	1,140	9	375	957	1,332	10
	*C13 Ipoh	830 (C.A875)	85	0	85	10	155	0	155	19
11	Bernam	2,564	27	567	594	23	36	567	603	24

Remarks; * : Figures for sub-basin
C.A : Catchment area in km^2

Table 15 ANNUAL DEFICIT BY BASIN IN PERAK FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Drought Level 1/N Deficit	1/N Year	2/N Deficit	2/N Year	3/N Deficit	3/N Year	4/N Deficit	4/N Year	5/N Deficit	5/N Year
1990										
8	10.4	1965	7.1	1968	6.6	1963	6.1	1979	5.1	1962
9	260.6	1963	212.7	1968	130.7	1979	129.3	1962	127.3	1965
10	182.7	1972	181.2	1973	166.3	1978	88.0	1971	69.8	1975
*Ipoh	13.9	1978	13.8	1973	13.5	1972	9.1	1971	4.9	1975
11	324.5	1978	86.9	1977	77.7	1970	76.3	1979	66.1	1961
2000										
8	10.8	1965	8.1	1968	7.3	1963	6.4	1979	5.8	1962
9	280.9	1963	231.6	1968	146.1	1979	143.1	1962	140.1	1965
10	192.5	1972	189.3	1973	180.5	1978	97.8	1971	75.3	1975
*Ipoh	42.3	1978	28.3	1972	26.2	1971	26.0	1973	17.1	1975
11	326.3	1978	87.8	1977	78.3	1970	76.9	1979	66.6	1961

Remarks; *: Annual deficit in sub-basin

Table 16 ASSUMED DEVELOPMENT OF LAND DISPOSAL IN PALM OIL MILLS AND RUBBER FACTORIES IN PERAK

Unit: %

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

Table 17 DISCHARGE RATIO, RUNOFF RATIO, INFILTRATION RATIO AND BOD CONCENTRATION OF EFFLUENT ASSUMED UNDER PRESENT PURIFICATION LEVEL IN PERAK

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	165	0.6	0
Rural }	2000	1.0	145	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 18 PROPOSED FLOOD FORECASTING AND WARNING SYSTEM IN PERAK

Basin No.	River Basin	People Rel'ved by F/F (10^3)	Construction Cost (M$$10^6$)	Construction Period
10	Perak/1	162.9	0.7	4MP

Remarks; /1: Additional flood forecasting stations be recommended.

Table 19 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN PERAK

(1) DAM

Location: State***	Location: 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
Perak	10	Kinta (B) dam	WS	155	53	55	364	1985-1989
Kedah/ Perak	8	Kerian dam	WS,IR	112	208	134	1,356	1985-1989
Kedah/ Perak	8	Sira dam	WS,IR	29	32	47	178	1985-1989
Kedah/ Perak	9	9-A(2) dam	WS,IR	-	-	15	18	1990-1994
Perak	10	Rui dam	WS,IR	215	313	163	796**	1983-1987

(2) DIVERSION FACILITIES

State	Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
Perak	10	Rui diversion (Tunnel)	Perak to Kedah 10 to 5	11	**	1983-1987
Pinang	8	Kerian diversion (Canal)	Perak 8 to 9	10	*	1985-1989
			Perak to Pinang 8 to 6	-	*	-

Remarks; Construction cost is the financial cost at 1980 constant price.
IR = Irrigation; WS = Water supply
* = Cost included in irrigation facilities.
** = For diversion to Muda river.
***= The state where the facilities are located.

Table 20 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN PERAK

(1) DAM

Location: State***	Location: 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
Perak	10	Kinta (B) dam	WS	155	27	37	169	1985-1989
Kedah/ Perak	8	Kerian dam	WS,IR	112	92	120	970	1985-1989
Perak	10	Rui dam	WS,IR	215	313	163	796**	1983-1987

(2) DIVERSION FACILITIES

State	Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
Perak	10	Rui diversion (Tunnel)	Perak to Kedah 10 to 5	11	**	1983 - 1987
Pinang	8	Kerian diversion (Canal)	Perak 8 to 9	8	*	1985 - 1989
			Perak to Pinang 8 to 6	-	*	

Remarks; Construction cost is the financial cost at 1980 constant price.
IR = Irrigation; WS = Water supply
* = Cost included in irrigation facilities.
** = For diversion to Muda river.
***= The state where the facilities are located.

Table 21 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN PERAK

(1) DAM

Location: State***	Location: 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
Perak	10	Kinta (B) dam	WS	155	25	35	155	1985-1989
Kedah/ Perak	8	Kerian dam	WS,IR	112	9	40	54	1985-1989

(2) DIVERSION FACILITIES

State	Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
Pinang	8	Kerian diversion (Canal)	Perak 8 to 9	3	*	1985 - 1989
			Perak to Pinang	-	*	

Remarks; Construction cost is the financial cost at 1980 constant price.
IR = Irrigation; WS = Water supply
* = Cost included in irrigation facilities
***= The state where the facilities are located.

Table 22 OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN PERAK

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$)
	ALTERNATIVE F1								
9	Kurau	23	-	-	-	-	14	4	22
10	Perak	38	-	50	1	-	340	75	584
	Total	61	-	50	1	-	354	79	606
	ALTERNATIVE F2								
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	-	50	1	-	256	93	315
	Total	13	-	50	1	-	259	95	333
	ALTERNATIVE F3								
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	-	50	1	-	256	93	315
	Total	13	-	50	1	-	259	95	333

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 23 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PERAK

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
9	10	Taiping	96.7	100	205.0	134.5	100	247.0	243.0	100	313.0
	112	Bagan Serai	8.2	85	8.5	12.1	90	9.9	24.4	100	13.0
10	11	Kuala Kangsar	8.8	85	12.8	12.5	90	14.4	21.6	100	18.0
	12	Sg. Siput Utara	7.1	85	23.0	9.3	90	25.2	11.8	100	33.0
	13	Ipoh	140.3	100	346.0	180.5	100	377.0	306.0	100	446.0
	14	Batu Gajah	4.9	85	10.2	6.6	90	10.8	12.6	100	14.0
	15	Kampar	8.5	85	22.1	11.0	90	24.3	18.9	100	30.0
	17	Telok Anson	26.3	85	46.8	36.2	90	53.1	69.6	100	69.0
	18	Tapah	5.2	85	8.5	7.7	90	9.9	14.5	100	12.0
	111	Baru Mambang	4.1	85	9.4	5.5	90	9.9	10.1	100	13.0
	113	Jelapang	1.6	85	7.7	2.7	90	9.0	4.7	100	12.0
	Total		311.7	96	700.0	418.6	98	790.5	737.2	100	973.0

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 24 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
8	Kerian	4.5	58.8	28.4	6.6	65.4	31.6	10.2	68.4	32.2
9	Kurau	48.5	70.1	281.4	84.1	76.3	307.4	159.4	78.7	371.4
10	Perak	97.9	70.0	509.3	187.2	76.3	545.9	315.2	78.7	446.5
11	Bernam	52.4	72.8	183.3	67.5	80.8	203.7	95.8	91.4	205.0
Total		203.3	-	1,002.4	345.4	-	1,088.6	580.6	-	1,055.1
Perak		162.7	70.0	876.6	302.6	76.3	946.9	510.2	78.7	894.9

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 25 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK

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
8	Kerian	0.3	27.1	13.1	0.4	30.2	14.6	0.5	31.6	14.9
9	Kurau	1.6	18.9	76.1	2.1	20.7	83.2	3.2	21.2	100.5
10	Perak	2.8	19.0	137.8	3.6	20.7	147.7	3.8	21.3	120.9
11	Bernam	0.4	9.3	23.4	0.6	9.9	25.0	0.6	8.6	19.4
Total		5.1	-	250.4	6.7	-	270.5	8.1	-	255.7
Perak		4.9	19.0	237.3	6.4	20.7	256.4	7.7	21.3	242.2

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 26 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PERAK

(1) DAM

Location: State***	Location: 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
Perak	10	Kinta (B) dam	WS	155	53	55	364	1985-1989
Kedah/ Perak	8	Kerian dam	WS,IR	112	9	40	54	1985-1989
Perak	10	Rui dam	WS,IR	215	145	140	447**	1985-1989

(2) DIVERSION FACILITIES

State	Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
Perak	10	Rui diversion (Tunnel)	Perak to Kedah 10 to 5	9	(14)	1985 - 1989
Pinang	8	Kerian diversion (Canal)	Perak 8 to 9	3	*	1985 - 1989
			Perak to Pinang 8 to 6	-	*	

Remarks; Construction cost is the financial cost at 1980 constant price.
IR = Irrigation; WS = Water supply
* = Cost included in other distribution facilities.
** = For diversion to Muda river.
***= The state where the facilities are located.
( )= Included in dam cost.

Table 27 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN TREATMENT CAPACITY IN PERAK

Unit: m^3/d

Basin No.	Basin Name	1981 - 1990 Palm Oil	1981 - 1990 Rubber	1981 - 1990 Total	1991 - 2000 Palm Oil	1991 - 2000 Rubber	1991 - 2000 Total
9	Kurau	0	0	0	0	520	520
10	Perak	1,520	6,840	8,360	1,476	4,200	5,676
11	Bernam	1,996	96	2,092	208	220	428
Total		3,516	6,936	10,452	1,684	4,940	6,624

Table 28 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PERAK

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)
9	C10	Taiping	71	45	111	246	80	250
10	C13	Ipoh	90	45	111	297	80	357
10	C17	Telok Anson	21	45	27	76	80	55
Total			182	-	249	619	-	662

Table 29 POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN PERAK

Basin No.	Basin Name	Without Project: BOD Load into River (ton/d) PR	UI	RA	Total	Without Project: Max. BOD in River (mg/lit)	With Project: BOD Load into River (ton/d) PR	UI	RA	Total	With Project: Max. BOD in River (mg/lit)
8	Kerian	5	0	0	5	3	5	0	0	5	3
9	Kurau	3	2	1	6	6	0	2	1	3	0
10	Perak	24	42	12	78	9	24	24	12	60	3
11	Bernam	9	0	2	11	6	0	0	1	1	0
	Total	41	44	15	100	-	29	26	14	69	-

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

Table 30 RECOMMENDED FLOOD MITIGATION PROGRAM IN PERAK

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$)
By 1990									
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	-	-	-	-	23	1	33
	Total	13	-	-	-	-	26	3	51
By 2000									
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	50	-	1	-	256	93	315
	Total	13	50	-	1	-	259	95	333

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 31 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 32 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 33 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	41	372	0	0	413
Irrigation	0	160	14	0	174
Inland Fishery	3	3	30	18	54
Public Water Supply	231	393	394	159	1,177
Public Water Supply; Pre-treatment facilities	3	5	3	1	12
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	140	236	236	95	707
Flood Mitigation	1	51	133	150	335
Total	419	1,220	810	423	2,872

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.

Table 34 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	2	10	10	22
Irrigation	0	0	12	13	25
Inland Fishery	0	0	1	3	4
Public Water Supply	0	39	78	111	228
Public Water Supply; Pre-treatment facilities	0	1	1	1	3
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	0	47	94	134	275
Flood Mitigation	0	0	26	92	118
Total	0	89	222	364	675

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.

Table 35 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PERAK

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	(M$$10^6$)	16
D&I water supply	(M$$10^6$)	128
Fish culture	(M$$10^6$)	2
Reservoir recreation	(M$$10^6$)	2
Total	(M$$10^6$)	148
1.2 Economic Cost		
Irrigation	(M$$10^6$)	5
D&I water supply	(M$$10^6$)	114
Fish culture	(M$$10^6$)	2
Dams, barrages & diversion facilities	(M$$10^6$)	13
Total	(M$$10^6$)	134
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)	9
2.2 Adverse Effect		
Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	3
3. Social Well-being		
3.1 Beneficial Effect		
Number of farm households benefited by proposed irrigation in 2000	(10^3)	29
Number of people served by proposed public water supply in 2000	(10^3)	2,110
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	1

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

Table 36 SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN PERAK

Unit: days

Basin No.	Basin Name	Safe Supply Period		Safe Maintenance Flow Period	
		Plan Implemented	Natural Flow	Plan Implemented	Natural Flow
9	Kurau	294	169	267	164
10	Perak (Kinta)	365	332	365	307
11	Bernam	365	156	279	131

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

Table 37 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PERAK

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	10
Saving in pre-treatment for D&I water supply	($M\$10^6$)	2
Total	($M\$10^6$)	12
1.2 Economic Cost		
Sewerage	($M\$10^6$)	35
Private purification facilities/2	($M\$10^6$)	1
Pre-treatment for D&I water supply	($M\$10^6$)	1
Total	($M\$10^6$)	37
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 = 510 km)	(km)	510/487/1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 510 km)	(km)	494/411/1
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	662
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 P.Pinang and Selangor.

/2: Including the rubber factories and palm oil mills in such part of the State of P.Pinang and Selangor as located in Basin 8, 9 and 11.

Table 38 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PERAK

Item			Recommended Plan
1.	National Economic Development		
1.1	Economic Benefit		
	Damage reduction	(M$$10^6$)	9.7
1.2	Economic Cost		
	Flood mitigation work	(M$$10^6$)	8.9
1.3	EIRR	(%)	8.5
2.	Environmental Quality		
2.1	Beneficial Effect		
	Length of improved stretch	(km)	13
2.2	Adverse Effect		
3.	Social Well-Being		
3.1	Beneficial Effect		
	Number of protected people by proposed facilities in 2000	(10^3)	259
	Population served by proposed flood warning system in 2000	(10^3)	163
	Area relieved from flood hazards	(10^3 ha)	95
3.2	Adverse Effect		
	Number of people to be removed for construction of facilities	(10^3)	4

Table 39 SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN PERAK

	Yield (ton/ha)	Unit Price (M$/ton)	Gross Value (M$/ha)	Production Cost (M$/ha)	Net Value (M$/ha)
(1) Major Irrigation Scheme					
- Krian					
Double cropping	8.9	640	5,696	1,587	4,109
Single cropping	4.2	640	2,688	769	1,919
- Trans Perak IV					
Double cropping	8.0	640	5,120	1,507	3,613
Single cropping	3.8	640	2,432	732	1,700
- Sungai Manik					
Double cropping	8.3	640	5,312	1,548	3,764
Single cropping	3.9	640	2,496	752	1,744
(2) Minor Irrigation Scheme					
Double cropping	7.5	640	4,800	1,507	3,293
Single cropping	3.5	640	2,240	722	1,518
(3) Rainfed Scheme					
Single cropping	2.0	640	1,280	676	604

Table 40 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN PERAK 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								
10 Taiping	100.0	100.0	100.0	100.0	170.0	180.0	195.0	220.0
11 Kuala Kangsar	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
12 Sg. Siput Utara	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
13 Ipoh	100.0	100.0	100.0	100.0	170.0	180.0	195.0	220.0
14 Batu Gajah	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
15 Kampar	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
17 Telok Anson	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
18 Tapah	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
111 Baru Mambang	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
112 Bagan Serai	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
2. Rural Area								
PWD Rural	55.0	70.0	74.8	77.9	75.0	95.0	115.0	155.0
MOH Rural	5.7	19.0	20.2	21.1	40.0	45.0	55.0	65.0
3. Non-Pipe-Served Area	-	-	-	-	40.0	40.0	40.0	40.0

Table 41 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH IN PERAK

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	I	Total	1990 D	I	Total	2000 D	I	Total
8		Rural	1.8	1.7	0.9	2.6	2.1	1.0	3.1	2.9	1.5	4.4
9	10	Taiping	26.3	17.5	21.5	39.0	21.8	31.8	53.6	27.4	58.3	85.7
	112	Bagon Serat	2.5	0.7	3.1	3.8	0.9	4.6	5.5	1.1	8.5	9.6
		City Total	28.8	18.2	24.6	42.8	22.7	36.4	59.1	28.5	66.8	95.3
		Rural	16.0	15.0	8.1	23.1	18.6	11.5	30.1	25.3	20.4	45.7
		Basin Total	44.8	33.2	32.7	65.9	41.3	47.9	89.2	53.8	87.2	141.0
10	11	Kuala Kangsar	2.8	1.0	2.7	3.7	1.2	4.1	5.3	1.4	7.4	8.8
	12	Sg. Siput Utara	2.1	1.8	0.8	2.6	2.2	1.1	3.3	2.7	2.1	4.8
	13	Ipoh	41.2	29.6	24.3	53.9	33.4	36.0	69.4	39.1	66.0	105.1
	14	Batu Gajah	0.7	0.8	0.0	0.8	0.9	0.0	0.9	1.1	0.0	1.1
	15	Kempar	2.7	1.9	1.4	3.3	2.0	2.1	4.1	2.4	3.9	6.3
	17	Telok Anson	8.1	4.0	7.4	11.4	4.6	10.9	15.5	5.6	20.0	25.6
	18	Tapah	1.6	0.7	1.6	2.3	0.8	2.4	3.2	1.0	4.4	5.4
	111	Balu	0.6	0.8	0.0	0.8	0.9	0.0	0.9	1.1	0.0	1.1
		City Rural	59.8	40.6	38.2	78.8	46.0	56.6	102.6	54.4	103.8	158.2
		Rural	33.8	27.5	22.6	50.1	36.3	32.4	68.7	50.6	58.2	108.8
		Basin Total	93.6	68.1	60.8	128.9	82.3	89.0	171.3	105.0	162.0	267.0
11		Rural	24.1	9.5	16.6	26.1	12.3	14.4	26.7	17.8	14.7	32.5
Total			164.3	112.5	111.0	223.5	138.0	152.3	290.3	179.5	265.4	444.9
Perak			147.3	106.0	96.9	202.9	129.6	141.8	271.4	167.2	258.2	425.4

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

Table 42 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin	Code		1985			1990			2000		
No.	No.	City/Town	TC	SF	SP	TC	SF	SP	TC	SF	SP
9	10	Taiping	85.2	100	203.0	113.7	100	233.0	170.7	100	259.0
	112	Bagan Serai	6.9	85	8.5	9.6	90	9.9	16.2	95	10.5
10	11	Kuala Kangsar	7.1	85	12.8	9.9	90	13.5	15.3	95	14.3
	12	Sg. Siput Vtara	6.6	85	22.1	8.5	90	24.3	11.5	95	26.6
	13	Ipoh	126.0	100	342.0	154.8	100	357.0	217.3	100	370.0
	14	Batu Gajah	2.5	85	9.4	2.7	90	9.9	3.3	95	10.5
	15	Kampar	7.7	85	22.1	9.3	90	22.5	13.2	95	23.8
	17	Telok Anson	22.7	85	46.8	30.1	90	50.4	46.8	95	54.2
	18	Tapah	4.7	85	8.5	6.0	90	9.0	9.6	95	9.5
	111	Baru Mambang	2.5	85	9.4	2.7	90	9.9	3.3	95	10.5
	Total		271.9	97	684.6	347.3	98	739.4	507.2	99	788.9

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 43 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK 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
8	Kerian	4.5	58.8	28.4	5.7	64.5	31.2	8.4	67.8	32.8
9	Kurau & Others	52.1	70.1	280.7	71.1	74.8	296.5	110.0	77.9	307.4
10	Perak	113.3	70.0	520.4	162.2	74.8	573.7	264.6	77.9	613.3
11	Bernam	61.5	72.8	184.2	67.2	79.5	205.2	86.8	87.4	228.6
Total		231.4	-	1,013.7	306.2	-	1,106.6	469.8	-	1,182.1
Perak		184.1	70.0	887.9	261.3	74.8	966.1	419.8	77.9	1,022.8

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 44 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN PERAK 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
8	Kerian	0.3	27.1	13.1	0.4	29.8	14.4	0.5	40.0	15.0
9	Kurau	1.6	19.0	76.0	1.9	20.2	80.3	2.5	21.1	83.2
10	Perak	2.8	19.0	140.9	3.9	20.2	155.3	4.9	21.1	166.0
11	Bernam	0.4	9.3	23.6	0.6	9.8	25.4	0.7	9.9	26.0
Total		5.1	-	253.6	6.8	-	275.4	8.6	-	290.2
Perak		4.9	19.0	240.3	6.5	20.2	261.6	8.2	21.1	276.7

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 45 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

(1) DAM

Location								
State***	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
Perak	10	Kinta (B) dam	WS	155	20	28	133	1985-1989
Kedah/ Perak	8	Kerian dam	WS,IR	112	7	22	30	1985-1989
Perak	10	Rui dam	WS,IR	215	145	140	447**	1985-1989

(2) DIVERSION FACILITIES

State	Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
Perak	10	Rui diversion (Tunnel)	Perak to Kedah 10 to 5	9	**	1985 - 1989
Pinang	8	Kerian diversion (Canal)	Perak 8 to 9	2	*	1985 - 1989
			Perak to Pinang 8 to 6	-	*	

Remarks; Construction cost is the financial cost at 1980 constant price.
IR = Irrigation; WS = Water supply
* = Cost included in irrigation facilities.
** = For diversion to Muda river.
***= The state where the facilities are located.

Table 46 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: m^3/d

Basin No.	Basin Name	1981 - 1990 Palm Oil	1981 - 1990 Rubber	1981 - 1990 Total	1991 - 2000 Palm Oil	1991 - 2000 Rubber	1991 - 2000 Total
9	Kurau	0	0	0	0	520	520
10	Perak	1,520	6,840	8,360	1,476	4,200	5,676
11	Bernam	1,996	96	2,092	208	220	428
	Total	3,516	6,936	10,452	1,684	4,940	6,624

Table 47 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
9	C10	Taiping	39	30	70	135	65	168
10	C13	Ipoh	50	30	107	164	65	241
10	C17	Telok Anson	12	20	11	41	65	37
		Total	101	-	188	340	-	446

Table 48 RECOMMENDED FLOOD MITIGATION PROGRAM IN PERAK 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^2)	P.P. (10^3)	F.A. (10^3ha)	C.C. (M$$10^6$)
By 1990									
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	-	-	-	-	23	1	33
	Total	13	-	-	-	-	26	3	51
By 2000									
9	Kurau	13	-	-	-	-	3	2	18
10	Perak	-	50	-	1	-	265	93	315
	Total	13	50	-	1	-	268	95	333

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 49 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	16	144	0	0	160
Irrigation	0	160	14	0	174
Inland Fishery	3	3	30	18	54
Public Water Supply	157	256	248	100	761
Public Water Supply; Pre-treatment facilities	3	2	1	1	7
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	81	145	149	60	435
Flood Mitigation	1	51	133	150	335
Total	261	761	575	329	1,926

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.

Table 50 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	1	4	4	9
Irrigation	0	0	12	13	25
Inland Fishery	0	0	1	3	4
Public Water Supply	0	26	51	72	149
Public Water Supply; Pre-treatment facilities	0	0	1	1	2
Public Sewerage (Effective for river water pollution abatement)	0	0	0	0	0
Public Sewerage (Others)	0	28	57	82	167
Flood Mitigation	0	0	26	92	118
Total	0	55	152	267	474

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.

Table 51 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	(M$$10^6$)	16
D&I water supply	(M$$10^6$)	62
Fish culture	(M$$10^6$)	2
Reservoir recreation	(M$$10^6$)	2
Total	(M$$10^6$)	82
1.2 Economic Cost		
Irrigation	(M$$10^6$)	5
D&I water supply	(M$$10^6$)	57
Fish culture	(M$$10^6$)	2
Dams, barrages & diversion facilities	(M$$10^6$)	5
Total	(M$$10^6$)	69
1.3 EIRR	(%)	12
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	7
2.2 Adverse Effect		
Possible reduction in kind of fish immediately downstream of dams and barrages	(nos. of site)	3
3. Social Well-being		
3.1 Beneficial Effect		
Number of farm households benefited by proposed irrigation in 2000	(10^3)	29
Number of people served by proposed public water supply in 2000	(10^3)	2,089
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	1

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

Table 52 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	5
Saving in pre-treatment for D&I water supply	($M\$10^6$)	1
Total	($M\$10^6$)	6
1.2 Economic Cost		
Sewerage	($M\$10^6$)	22
Private purification facilities/2	($M\$10^6$)	1
Pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	23
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 = 510 km)	(km)	510/472/1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 510 km)	(km)	510/385/1
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	446
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 P.Pinang and Selangor.

/2: Including the rubber factories and palm oil mills in such part of the State of P.Pinang and Selangor as located in Basin 8, 9 and 11.

Table 53 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN PERAK UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M$$10^6$)	7.6
1.2 Economic Cost		
Flood mitigation work	(M$$10^6$)	8.9
1.3 EIRR	(%)	6.6
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	13
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	268
Population served by proposed flood warning system in 2000	(10^3)	168
Area relieved from flood hazards	(km^2)	95
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	4