GOVERNMENT OF MALAYSIA

NATIONAL WATER RESOURCES STUDY, MALAYSIA

STATE REPORT

VOL. 3

SELANGOR

OCTOBER 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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LIST OF REPORTS

MAIN REPORT

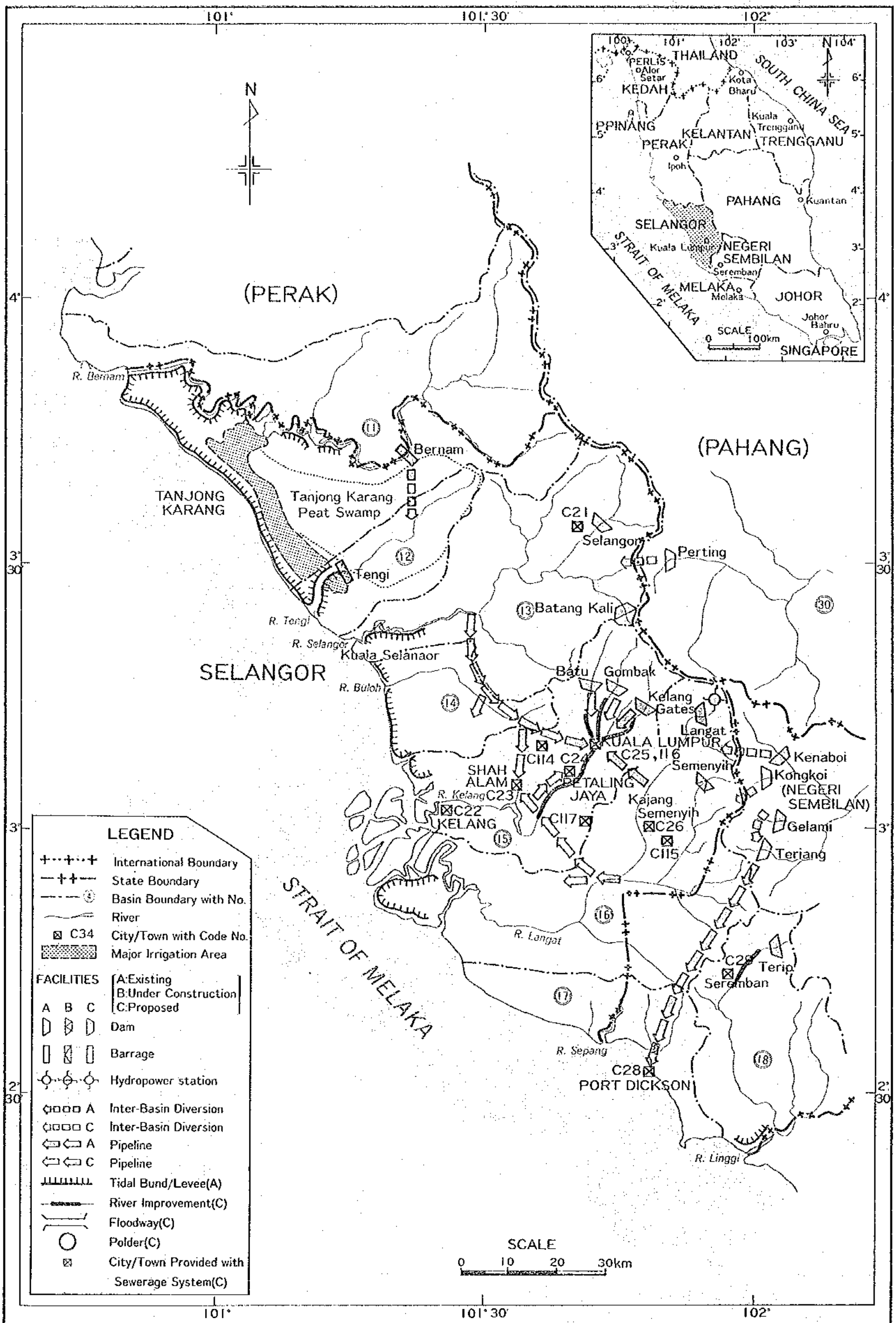
Vol. 1. MASTER ACTION PLAN
Vol. 2. WATER RESOURCES DEVELOPMENT AND USE PLAN

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 Selangor

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

CONTENTS

TABLES

FIGURES

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 m3 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 3 for the State of Selangor herein presented describes the matters for the State including the Federal Territory.

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 Selangor of 6,670 sq.km including Kuala Lumpur is located in the central part of the west coast of Peninsular Malaysia, between 100°49′ and 101°58′ east in longitude and 2°36′ and 3°53′ north in latitude. It faces the Strait of Melaka and adjoins the States of Perak in the north, Pahang in the east and Negeri Sembilan in the south.

East edge of the State is mountainous. A swamp area lies in the northern-most part. The rest is low hills and plains. Rivers are the Bernam, Selangor, Kelang, Langat, Sepang and other small rivers. The Bernam river in the north and the Sepang river in the south are located along the state boundary. Part of the Langat river basin belongs to the State of Negeri Sembilan.

Eastern boundary of Selangor is the Main Range composed of massive granitic rocks and small isolated areas of Silurian meta-sediments. Silurian crystalline limestones are well developed on the margin of granite masses around Kuala Lumpur. Middle zone between the Main Range and the west coast is occupied by the meta-sedimentary facies of Devonian, Carboniferous and locally Silurian. Shales, schists and quartzites are the predominant geologic feature. Tin mines are widely scattered in the intermountain alluvials. One third of the State is covered by the coastal alluvial plain. Major faults with northwesterly trends are recorded in the zone of the Main Range.

Sedentary soils occurring on undulating plains and mountains occupy 40% of the total for the State. The areal extent of alluvial soils on coastal plains and riverine flood plain is 4,522 sq.km, accounting for 55% of the total of the State. Of this, 1,811 sq.km are evaluated as suitable for paddy, 1,021 sq.km for coconut and 945 sq.km for oil palm and cocoa. For rubber, 2,542 sq.km is evaluated as suitable to marginal among which 1,598 sq.km extends over sedentary soil area.

Climate is usually hot and wet. Average annual rainfall is 2,000 mm - 2,500 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 Subang (El.16.5 m) are summarized in Table 1.

2.2 The Rivers

Run-off in rivers wholly or partly located in Selangor is estimated based on 1961 - 1979 records at the hydrological stations No.3813411 in the Bernam river and No.3414421 in the Selangor river. The surface run-off is 12 billion cu.m/y or 50% of rainfall of 24 billion cu.m/y. Evapotranspiration is 10 billion cu.m/y and groundwater recharge is 2 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 Buloh, Kelang and Langat rivers. Operation of mines, opening-up of residential areas, road construction and logging are major causes of high concentration of suspended solid (SS). In the 1978/1979 observation, SS concentration was more than 500 mg/lit in some stretches of the Bernam, Selangor, Buloh, Kelang and Langat rivers.

Alluvial aquifers occur in the flood plains of the Bernam, Tenggi and Kelang rivers and rolling plain, but sea water intrudes near the seashore. Rock aquifers may be found in the limestone and the sedimentary rocks of Silurian to Triassic.

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

2.3 Watershed

Natural vegetation occupies 2,570 sq.km comprising hill forest of 1,913 sq.km, scrub forest of 159 sq.km, swamp forest of 294 sq.km and grassland of 204 sq.km. The varieties range from the mangroves on coastal fringes to the mixed dipterocarp forests in lowlying and hilly areas and the montane forests of the highlands.

The total forest decreased from 2,542 sq.km or 30% of the whole State in 1966 to 2,366 sq.km or 28% 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 less than 100 mg/lit at present in all rivers of the State, showing less effect by the surface soil loss occurred in the catchment areas.

2.4 Present Socio-economic Condition

As illustrated in Fig.1, the State of Selangor is administratively divided into ten districts; Federal Territory is regarded as a district in this Study. Towns having population of more than 10,000 in 1980 were Kelang, Petaling Jaya, Kuala Lumpur, Kuala Kuba Baru, Shah Alam, Ampang, Serdang Baru, Kajang Chua and Semenyih.

Population of Selangor was 2.6 million in 1980 and the average annual growth rate was 4.2% during the period from 1970 to 1980. Population density increased from 206 persons/sq.km in 1970 to 311 persons/sq.km in 1980.

Gross regional product (GRP) increased from M$3,722 million in 1971 to M$7,894 million in 1980 in factor cost at 1970 constant price with the average annual growth rate of 8.7%. GRP of manufacturing sector shared M$940 million or 25.3% of the total in 1971 and M$2,462 million or 31.2% in 1980. Per capita GRP was M$3,085 in 1980 in factor cost at 1970 constant price and its average annual growth rate between 1971 and 1980 was 4.4%.

Major land use patterns in 1979 were forest of 2,346 sq.km, grassland of 204 sq.km, annual and perennial crop land of 3,416 sq.km, swamp of 1,842 sq.km and miscellaneous land of 453 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 128,000 ha for rubber, 95,300 ha for oil palm, 49,200 ha for coconut and 17,400 ha for cocoa. During the last five years since 1975, newly planted area under FELDA and FELCRA schemes totaled 300 ha for rubber. RISDA replanted 1,900 ha of rubber in the existing smallholders' rubber areas during the said period, while private estates reduced by 13,300 ha their planted area of rubber mainly for the purpose of conversion to oil palm. The annual production in 1979 totaled 123,200 tons of rubber as dry rubber content, 1,481,900 tons of oil palm as fresh fruit bunch and 114,400 tons of coconut as copra and 2,070 tons of cocoa as dry beans. Out of the above harvests, private estates produced 73,400 tons of rubber and 1,377,300 tons of oil palm, 3,600 tons of coconut and 2,070 tons of cocoa. The remaining ones were put out from RISDA, FELDA and FELCRA schemes as well as smallholders.

In 24 mills located within the State, 432,000 tons of crude palm oil and 134,700 tons of palm kernel were extracted from oil palm through processing 1,933,600 tons of fresh fruit bunch brought in the mills throughout 1979.

In 1979/80, paddy was planted in 38,700 ha comprising main season wet paddy of 19,200 ha and off-season wet paddy of 19,500 ha. As the whole paddy field was 22,600 ha, the crop intensity in 1979/80 became 1.71. The total rice production in 1979/80 was 71,600 tons among which 37,700 tons were harvested in the main season and the remaining 33,900 tons were off-season wet paddy rice. This production met 10% of the estimated local consumption of 341,400 tons in the State in 1979/80.

During the period from 1970/71 to 1979/80, rice production fluctuated between 67,100 tons in 1978/79 and 92,300 tons in 1973/74 largely affected by climatic condition, even though paddy field which was provided with irrigation facilities decreased from 21,300 ha to 19,800 ha.

3. PRESENT CONDITION OF WATER RESOURCES DEVELOPMENT AND USE

3.1 Domestic and Industrial Water Supply

Public water supply in Selangor is administered by the Selangor Waterworks Department (WD) of the State Government. The WD prepares its own financial documents along the line of commercial accounting system.

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.

The twenty WD waterworks delivered 534,200 cu.m/d of water on an average. The population served water through WD networks was estimated at 2.18 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 20,000 people were served water by the untreated water supply system in 1980. The water users are suggested to boil water before drinking.

In consequence, 2.20 million people out of the total State population of 2.56 million were estimated to be served water through WD and RESP, corresponding to the service factor of 86% in 1980.

3.2 Irrigation

There are 22,600 ha of paddy fields consisting of the Tanjong Karang Irrigation Project (19,300 ha), 22 small-scale irrigation schemes (1,000 ha in total) which are presently not well maintained and 2,300 ha of rainfed area. The Tanjong Karang Irrigation Project is located in the northwest corner of the State as shown in Fig.3. Main source of irrigation water is the Bernam river. Through the headworks on the Bernam river and a 15 km feeder canal excavated in the peat swamp, the Bernam river water is diverted to the Tinggi river. The intake for the Tanjong Karang scheme is constructed on the Tinggi river collecting not only the diverted water but also excess water from the Tinggi river and the swamp. This swamp acts as a natural reservoir. In the past, water shortage has never occurred in the project area. Paddy yield is 3.1 - 3.6 tons/ha in the main season and 2.8 - 3.6 tons/ha in the off-season according to the records from 1973 to 1978.

3.3 Flood Mitigation

Flood occurs between August and January, mostly in November, but flash flood occurs almost throughout the year. The damage by the recorded maximum flood in the State is estimated to be M$58.0 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 Inland Fishery

There are 106 ha of freshwater constructed ponds and 305 ha of tin mining pool used for fish culturing. The water use of the constructed ponds in 1979 was 1.44 million cu.m/y.

3.5 Inland Navigation

Timber transport plays an important role in the Kelang and Aur rivers with more than 200 tongkangs in total. Oil tankers with the maximum gross tonnage of 4,000 and the maximum draft of 7.5 m unload petroleum at the Shell jetty which is located about 1.6 km upstream from the river mouth of the Kelang river.

3.6 Sewerage System

The sewerage system is installed solely in Kuala Lumpur. Most sewage in this system is disposed to the sea after treated. The installation of septic tank is compulsory by regulations in other unsewered urban areas, while domestic sewage is directly discharged into nearby water course or onto land in rural area.

3.7 Water Purification System in Private Sector

The Federal DOE started to monitor the river water quality since 1978 in Selangor with the frequency ranging from twice a year to once a month in 6 river water quality control regions.

There are 25 rubber factories in the State. These factories produce SMR, latex concentrate and conventional grade of 505 tons/day and they discharge effluent of 3.98 million cu.m/y to nearby watercourses. The water quality at outlets of factories ranges from 45 to 3,390 mg/lit in BOD concentration and from 80 to 1,490 mg/lit in SS concentration.

There are 23 oil palm mills in operation of which total milling capacity amounts to 6,292 tons/hr in fresh fruit bunch (FFB). The volume of effluent from these mills is 903,000 cu.m/y. The treated or raw effluent is and will be discharged from 18 mills into watercourses and from 5 mills onto land. The water quality ranges from 100 to 1,000 mg/lit in BOD concentration and SS concentration ranges from 100 to 600 mg/lit.

3.8 Watershed Management

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

At the end of 1979, the forest land was categorized into forest reserves of 2,138 sq.km, wild life and other reserves of 69 sq.km and Crown or State land of 159 sq.km. Out of the forest reserves, 1,834 sq.km was classified as productive forests comprising 1,611 sq.km of inland forests and 223 sq.km of mangrove forests. The remaining 304 sq.km were unproductive forests consisting of 302 sq.km of protective hill forest and 2 sq.km of mangrove forests. In the inland forest reserves, there remain 532 sq.km of unexploited forests which have been committed or licenced for development. The actual area opened for harvesting during 1979 was 30 sq.km corresponding to 6% 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 range between 100 and 200 mg/lit in the lower reach of the Selangor 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.

3.9 Dams

Table 5 lists seven dams in various stages in Selangor.

There are five small dams in operation in the State. Out of them, one is a natural swamp for irrigation purpose and others are mainly for water supply; the Kelang Gates and Batu dams also have the function of flood control.

The Langat dam is under construction and the Selangor dam is under planning stage.

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 Selangor is described hereunder.

The average annual growth rate of population in the period from 1980 to 2000 was estimated to be 3.2%. Projected population is 3.66 million in 1990 and 4.85 million in 2000, respectively. Table 6 shows the projected population by urban and rural area in the State of Selangor. 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$10,478 million in 1985, M$15,023 million in 1990 and M$29,459 million in 2000 with the average annual growth rate of 6.8% between 1980 and 2000.

Projected gross value of output in manufacturing sector will increase from M$8,268 million in 1980 to M$11,709 million in 1985, M$17,505 million in 1990 and M$32,584 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 438,700 tons in 1990 and 581,500 tons in 2000. To raise the average rice self-sufficiency rate in Peninsular Malaysia up to 85% in 1990 and 2000 as well, implementation of the following irrigation development plan is indispensable: (1) stabilization of irrigation water supply during the wet season to the existing irrigated paddy field of 15,400 ha. The total rice production is anticipated to decrease from 113,400 tons in 1990 to 112,000 tons in 2000 due to the conversion of the rainfed paddy to other farm land.

Oil palm planting area was projected to decrease to 91,000 ha in 1990 and 89,000 ha in 2000. The prospected processing volume of oil palm in the State will be 1.95 million tons as fresh fruit bunch in 1990 and 3.33 million tons in 2000.

Rubber planting area was projected to be kept in the present hectarage of 124,600 ha in 1990 and 2000. The total processing amount was projected to be 230,000 ton as dry rubber content in 1990 and 260,000 ton in 2000.

4.2 Basin Division

For the purpose of the Study, the land was divided into Basins each being a river basin or a group of river basins as shown in Fig.5. Each Basin is further divided into effective area and ineffective area. The former is the upper part of the Basin in which part of the water uses was assumed to return into lower stretches of the river. The latter is the remainder of the Basin, in which water used and surface flow originating therefrom were assumed to run totally into the sea. The boundary of the two areas is normally located below the lowest intake site, herein called the balance point, in the major river in the Basin. The total catchment area, effective area, the location of balance point and assumed river maintenance flow (see Section 5.2) are as shown in Table 8.

As shown in Fig.4, six Basins are wholly or partly located in the State of Selangor: located within the State are a southern part of the Bernam Basin, whole of the Tengi, Selangor, Buloh and Kelang Basins, and the most part of the Langat and the Sepang Basins.

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 Selangor, the total water demand will reach 787 million cu.m/y in 1990 and 1,201 million cu.m/y in 2000 as shown in Table 11. Major demand centers are Kuala Lumpur, Petaling Jaya, Kelang and Shah Alam among which Petaling Jaya has the largest demand for industrial water and Kuala Lumpur has the 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 Labuan in the State of Sabah, groundwater use was assumed. For rural water supply, the share of groundwater use was assumed based on the estimated safe yield for each district.

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

4.4 Irrigation Water Demand

The irrigated land development was projected taking into account information obtained from DID and the assumed rate of self-sufficiency in domestic rice production in the State. As shown in Table 12, the projected irrigation area will be maintained at the same level through 2000. The ratio of double cropping area to the total irrigation area will also be maintained at the level of 100% through 2000.

The irrigation water demand was calculated for 1990 and 2000 as shown in Table 13. Irrigation efficiency applied is 55% for both major and minor irrigation projects. The annual irrigation water demand will be maintained at the level of 567 million cu.m in 1990 through 2000.

4.5 Fish Pond Water Demand

The future hectarage of freshwater fish pond was projected to increase from 126 ha in 1980 to 368 ha in 1990 and 688 ha in 2000. The total water demand for freshwater fish culture will rise from 1.72 million cu.m/y in 1980 to 5.01 million cu.m/y in 1990 and 9.35 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 Selangor, the two Basins among the concerned six were estimated to have a river utilization equal to or more than 10% in 2000; the other four Basins to have the ratio of less than 10%.

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

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

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

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

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

Certain discharge is necessary to sustain normal water use and environmental condition in the river. It is herein called the river maintenance flow as will be explained in more detail in Section 5.2. The rate of river maintenance flow was assumed as shown in Table 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 10 urban areas, 23 palm oil mills, 25 rubber factories, animal husbandry in the rural areas. However, waste water from Kelang was assumed to be directly discharged to the sea.

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 Selangor will be more than 10 mg/lit except for the Tengi, Selangor and Langat rivers in 1990 and 2000. This projection states that rivers along which inland-cities/towns such as Kuala Lumpur, Petaling Jaya, Shah Alam and Kajang Chua are situated will be grossly 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 500 tons/sq.km. This erosion rate is generally high, because soils are erodable and natural forest has been converted to other land to a large extent.

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

If all natural forest on slope of less than 6 degrees is disturbed, erosion rate will increase to 1,050 tons/sq.km. An exercise indicates that erosion rate is 800 tons/sq.km, if natural forest on slope of less than 2 degrees is cleared and converted to rubber farm.

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

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

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

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

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

5. STRATEGIES FOR WATER RESOURCES DEVELOPMENT AND USE

5.1 Problem Areas

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

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

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

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

(2) development of water supply and irrigation systems;

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

(4) hydropower development;

(5) conservation of water quality; and

(6) flood mitigation.

5.2 Maintenance of Low Flow

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

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

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

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

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

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 Bernam, Buloh, Kelang, Lungat and Sepang Basins.

If there still remains a river stretch of higher BOD concentration than the proposed limit, the construction of a sewerage system in the urban area upstream of the river stretch was proposed: the public sewerage systems in Shah Alam, Petaling Jaya and Kuala Lumpur were proposed for the Alternative P2 and the public sewerage systems in these three cities and Kajan/Semenyih were proposed for the Alternative P1.

No treatment measures were assumed for the sewage from the towns of less than 50,000 in population and rural areas and for the effluent from animal husbandry. With these conditions, it was estimated that some river 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 program for Kelang Valley, Bernam and Tengi river basins.

7.2.1 Kelang valley source development plan

The Kelang valley including Kuala Lumpur, Petaling Jaya, Shah Alam and Kelang is most populated and industrialized region in Malaysia. Total population is mostly urban and it is estimated to be 1.8 million for 1980, 2.7 million for 1990 and 4 million for 2000. Domestic and industrial water demand was already 367 million cu.m or 34% of natural flow, in 1980 and it will grow to 686 million cu.m/y by 1990 and 1,091 million cu.m/y by 2000, even if water intensive industries remain at 1985 level.

The Kelang Gates dam is located in the valley. It was heightened recently in order to integrate the flood mitigation purpose. The Langat dam and a pipeline to divert water from the Langat river to the Kelang valley was completed. The Batu dam is going to be constructed in a tributary of the Kelang river for domestic and industrial water supply in the suburbs of Kuala Lumpur, where many housing and industrial development projects are being implemented. In order to prepare for tight water demand and supply balance in the Kelang valley, the construction of the Semenyih dam in a tributary of the Langat river and a pipeline from Semenyih river to the Kelang valley is being implemented.

Total water supply capacity of these dams, estimated to be 168 million cu.m/y, together with available natural flow is just enough to meet the present water demand, and additional source development is still urgently needed in view of high increase in demand.

The additional projects recommended are the Selangor and Batang Kali dams in the Selangor river, pipeline system between the Selangor river to the Kelang valley, the Gombak dam in a tributary of the Kelang river, the Kenaboi and Kongkoi dams with basin transfer system in the Teriang river system of the Pahang river basin, and the Perting dam and basin transfer system in a tributary of the Pahang river.

7.3 Water Pollution Abatement Plan

The recommended plan for the water pollution abatement in the river is the construction of public sewerage systems in Shah Alam, Petaling Jaya, Kuala Lumpur and Kajang/Semenyih and the improvement of purification method in palm oil mills and rubber factories in the Bernam, Buloh, Kelang, Langat and Sepang Basins.

Although it is ineffective for the water pollution abatement in the river, sewerage development in Kelang 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 30.

7.4 Flood Mitigation Plan

The recommended plan for flood mitigation is mentioned hereunder and is summarized in Tables 31.

7.4.1 Kelang river flood mitigation plan

Flood problem is serious in the Kelang valley being densely populated. In 1971, the Kelang river flooded 142 sq.km affecting 177,000 people. The flood damage was estimated to be M$36 million at 1980 price. The Kelang Gates dam supplying domestic and industrial water to Kuala Lumpur was heightened to incorporate the flood mitigation purpose. The Batu dam was designed as a multipurpose project for water supply and flood control. The recommended plan includes 36 km of channel improvement and the multipurpose development of the proposed Batu and Gombak dams for water supply and flood mitigation.

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 32 and 33. 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 34 and 35.

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 36 and 37 for water demand and supply balance, in Table 38 for water pollution abatement and in Table 39 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 40. The hectarage of newly reclaimed land and upgraded lands from rainfed paddy to irrigated or control drainaged paddies, single crop to double crop and minor scheme to major scheme were estimated for the future. Then the irrigation benefit is obtained as the incremental net production value.

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

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

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

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

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

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

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

7.6.2 Environmental quality

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

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

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

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

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

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

7.6.3 Social well-being

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

8. PLAN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

8.1 Assumed GDP Growth Rate

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

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

8.2 Parameters Predominantly Related to GDP Per Capita

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

8.3 Assumed Targets

The service factor and per capita daily use (PCDU) in domestic water supply and rate of irrigation development may be affected by the economic growth and by the socio-economic policy as well. It is herein assumed that, in case of the lower economic development, the target service factor and PCDU in domestic water supply for 2000 is delayed by five years but the rate of irrigation development does not change even under the lower economic development. The estimated service factor and PCDU under the condition of lower economic growth are shown in Table 41. The domestic and industrial water demand estimated under the condition of lower economic growth is shown in Table 42.

8.4 Development Plan

The development plan under the condition of lower economic growth is tabulated in Tables 43 through 50.

8.5 Public Expenditure

The public development and recurrent expenditures are estimated for the case of lower economic growth as shown in Tables 51 and 52.

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 53 through 55.

TABLES

Table 1 METEOROLOGICAL DATA IN SELANGOR

Subang, El 16.5 m

	Mean Air Temperature (°C)	Relative Humidity (%)	Sunshine Hours (hrs.)	Open Water Evaporation (mm)	Rainfall (mm)
Jan.	25.9	82.5	6.35	139	169
Feb.	26.3	81.2	6.75	139	128
Mar.	26.6	82.2	6.93	160	206
Apr.	26.7	84.9	6.76	154	260
May	27.0	84.3	6.83	149	180
June	26.7	83.9	6.28	141	120
July	26.3	83.4	6.52	142	139
Aug.	26.4	83.0	6.14	144	136
Sep.	26.2	84.6	5.32	143	182
Oct.	26.2	85.6	5.52	140	274
Nov.	25.9	86.8	4.93	130	271
Dec.	25.8	85.7	5.13	124	231
Annual	26.3	84.0	6.12	1,705	2,296

		Mean Air Temperature (°C)	Relative Humidity (%)
Daily	Max.	36.0	98.3
	Min.	18.1	55.9

Table 2 RIVER CHARACTERISTICS IN SELANGOR (1/2)

Basin No.	Item		Description
11	Bernam river		
	(A)	River Morphology	Heavy meanders in lower tidal reaches and sluggish course in middle reaches. No adverse behavious reported. Minor bank erosion observed at localized places.
	(B)	Estuary	Estuary 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.
13	Selangor river		
	(A)	River Morphology	Heavy meanders in tidal reaches, sluggish course in swamp areas. Minor erosion at localized places. No adverse problems reported, except bank erosion at outer meander near Kuala Selangor town.
	(B)	Estuary	Silting at river mouth causing a little difficulty of fish boat navigation during low tide.
	(C)	Sediment*	Sediment yield from tin mines along main stream and tributaries. Riverbed silting remarkable in area upstream from Batang Berjuntai.
	(D)	Sea Water Intrusion	Possibly not up to Sg. Lambai confluence. No present problem.

Remarks; *: Major problems requiring some improving measures

Table 3 RIVER CHARACTERISTICS IN SELANGOR (2/2)

Basin No.	Item	Description
15	Klang river	
	(A) River Morphology	No active meanders reported. Stable banks in canalized channel. Minor local erosion at meanders in upper reach. Bank loosening in lower reaches due to tidal action.
	(B) Estuary	No major problems at present. Soils loosened from banks may be contributing siltation at river mouth.
	(C) Sediment*	Sand bars/shoals in upper reaches. Possibly high yield of sediment from housing development sites and tin mines. Estimated yield rate at Klang Gate Dam: 476 $m^3/km^2/y$.
	(D) Sea Water Intrusion	No present problem (no water intake facilities in tidal reach). Tidal effect possibly up to Sg. Damansara Confluence.
16	Langat river	
	(A) River Morphology	Meanders in tidal reaches, sluggish river course in swampy land. Generally stable banks in upper/middle reaches. Banks in lower tidal reaches are loosening, possibly causing aggradation of riverbed.
	(B) Estuary	Silting at river mouth causes the difficulty of navigation and seems to aggravate flood levels. Sediment from upstream area rather than from sea.
	(C) Sediment*	Sediment problem existing. Yield from various land development and tin mines. River flow turbid in whole reach downstream from Cherus Town.
	(D) Sea Water Intrusion	No present problem (no water intake facility in lower reach). Tidal effect up to Kg. Sabohan Bagan (90 km).

Remarks; *: Major problems requiring some improving measures

Table 4 FLOODED AREA BY RECORDED MAXIMUM FLOOD IN SELANGOR

Basin No.	River Basin	Year	Flooded Area (km^2)	Population 1980 (10^3)	Estimated Damage at 1980 Condition (M$$10^6$)
11	Bernam	1971	51	8	1.1
12	Tengi	1971	68	3	0.4
13	Selangor	1971	168	23	3.9
14	Buloh	1971	107	24	2.3
15	Kelang	1971	158	178	35.5
16	Langat	1971	542	109	14.8
17	Sepang	1971	18	-	-
	Total		1,112	345	58.0

Table 5 LIST OF EXISTING AND PLANNED DAMS IN SELANGOR

	Name	River	Purpose/ Year of Commission	Organi- zation	Catch- ment Area (km^2)	Active Storage Capacity (10^6 m^3)	Net Supply Capacity ($10^3 m^3/d$)
	Existing						
12.	Swamp (Natural)	Tengi	IR	DID		(148)	(350-470)
15.	Kelang Gates dam	Kelang	WS + FM	DID&SWW	76	32	53
15.	Damansara dam	Kelang	WS	SWW	-	-	0
16.	Langat dam under construction	Langat	WS	SWW	41	(30)	32
16.	Semenyih dam	Langat	WS/1985	SWW	54	41	44
15.	Batu dam	Batu	FM+WS/1985	DID&SWW	50	28	39
	Planned						
16.	Selangor dam	Selangor	WS/1990	SWW	201	-	-

Remarks; WS: Domestic and industrial water supply
FM: Flood mitigation
( ) assumed

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

Unit: 10^3

District	City/Rural	Historical 1980	Projected 1985	Projected 1990	Projected 2000	Average Annual Growth (%) 1980–2000
28. Sabak Bernam	Rural	112	114	114	112	1.0
29. Kuala Selangor	Rural	123	126	127	122	0.0
30. Ulu Selangor	21. Kuala Kubu Baru	11	12	13	16	1.9
	Rural	78	81	82	77	-0.1
	District Total	89	93	95	93	0.2
31. Gombak	Rural	171	244	273	160	-0.3
32. Kelang	22. Kelang	209	271	359	613	5.5
	Rural	94	97	97	93	-0.1
	District Total	303	368	456	706	4.3
33. Petaling	23. Shah Alam	26	42	66	141	8.8
	24. Petaling Jaya	232	337	484	927	7.2
	114. Sg. Buloh	6	7	9	13	3.9
	Rural	115	123	125	114	0.0
	District Total	379	509	684	1,195	5.9
34. Federal Territory	25. Bandaraya KL	998	1,179	1,419	2,039	3.6
	116. Ampang	14	14	15	18	1.3
	117. Serdang Baru	18	19	21	25	1.7
	Rural	0	0	0	0	0
	District Total	1,030	1,212	1,455	2,082	3.6
35. Ulu Langat	26. Kajang Chua	32	37	43	58	3.0
	115. Semenyih	10	11	12	14	1.7
	Rural	148	200	219	145	-0.3
	District Total	190	248	274	217	0.5
36. Kuala Langat	Rural	111	119	122	110	0.0
37. Sepang	Rural	50	54	56	49	0.1
Total	Urban Total	1,556	1,929	2,441	3,864	4.7
	Rural Total	1,002	1,158	1,215	982	0.1
	State Total	2,558	3,087	3,656	4,846	3.2

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

Unit: M$$10^6$

Item	Year 1980	1985	1990	2000
Food	2,747	3,068	3,514	2,663
Textile	262	322	410	435
Wood	299	214	197	116
Paper	140	261	268	268
Publishing	525	977	1,979	6,069
Chemical	1,457	2,304	2,366	2,366
Rubber	434	555	823	1,196
Non-metal	329	462	711	1,198
Basic metal	173	288	517	1,318
Machinery	1,891	3,237	6,692	16,899
Others	11	21	28	56
Total	8,268	11,709	17,505	32,584

Remarks; In factor cost at 1970 prices

Table 8 BASIN AREA AND ASSUMED RIVER MAINTENANCE FLOW IN SELANGOR

Basin No.	Basin	Total Catchment Area (km^2)	Effective Catchment Area (km2)	Balance Point (km)	River Maintenance Flow (m^3/s)
11	Bernaw	3,335	2,325	53	15.6
12	Tenji+	565	420	15	3.4
13	Selangor	1,820	1,685	32	19.6
14	Buloh+	560	295	15	2.2
15	Kelang	1,425	1,150	29	10.5
16	Langat	1,815	1,420	44	15.8
17	Sepang+		260	12	2.2

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

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

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

City/Rural	Service Factor (%) Estimated 1980	Service Factor (%) Projected 1985	1990	2000	Per Capita Daily Use (lpcd) Estimated 1980	Per Capita Daily Use (lpcd) Projected 1985	1990	2000
1. Urban Area								
21 Kuala Kubu Baru	80	85	90	100	160	175	190	220
22 Kelang	100	100	100	100	170	185	200	250
23 Shah Alam	80	85	90	100	160	175	190	220
24 Petaling Jaya	100	100	100	100	170	185	200	250
25 Bandaraya Kl	100	100	100	100	190	215	240	270
26 Kajang Chua	80	85	90	100	160	175	190	220
114 Sg. Buloh	83	85	100	100	115	148	180	220
115 Semenyih	80	85	90	100	160	175	190	220
116 Ampang	80	85	90	100	160	175	190	220
117 Serdang Baru	80	85	90	100	160	175	190	220
2. Rural Area								
PWD Rural	65	75	84	99	75	100	125	175
MOH Rural	2	2	2	1	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 SELANGOR

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980 D&I	Projected 1985 D	1985 I	1985 Total	1990 D	1990 I	1990 Total	2000 D	2000 I	2000 Total
11		Rural	24.1	9.9	12.1	22.0	13.0	13.4	26.4	17.8	18.1	35.9
12		Rural	3.3	1.1	1.8	2.9	1.4	1.3	2.7	2.1	0.9	3.0
13	21	Kuala Kubu Baru	2.2	0.9	2.1	3.0	1.1	2.3	3.4	1.7	2.4	4.1
		Rural	30.7	9.1	17.5	26.6	12.9	12.8	25.7	15.6	8.9	24.5
	Basin Total		32.9	10.0	19.6	29.6	14.0	15.1	29.1	17.3	11.3	28.6
14	114		1.1	0.3	1.2	1.5	0.5	1.4	1.9	1.4	2.4	3.8
		Rural	6.1	2.3	3.6	5.9	3.1	2.8	5.9	4.5	2.4	6.9
	Basin Total		7.2	2.6	4.8	7.4	3.6	4.2	7.8	5.9	4.8	10.7
15	22	Kelang	46.7	24.1	48.6	72.7	34.5	56.4	90.9	73.6	77.6	151.2
	23	Shah Alam	5.3	3.1	7.9	11.0	5.5	11.5	17.0	15.6	21.7	37.3
	24	Petaling Jaya	125.6	29.9	174.7	204.6	46.5	203.9	250.4	111.3	279.8	391.1
	25	Bandaraya Kl	157.6	127.4	108.7	236.1	163.6	126.9	290.5	294.6	174.5	469.1
	116	Ampang	1.3	1.0	0.8	1.8	1.2	0.9	2.1	1.9	1.2	3.1
	117	Serdang Barn	3.6	1.5	3.3	4.8	1.7	3.7	5.4	2.6	3.6	6.2
		City Total	340.1	187.0	344.0	531.0	253.0	403.3	656.3	499.6	558.4	1058.0
		Rural	27.3	13.8	14.0	27.8	19.1	10.9	30.0	23.8	8.7	32.5
	Basin Total		367.4	200.8	358.0	558.8	272.1	414.2	686.3	523.4	567.1	1090.5
16	26	Kajang Chua	6.6	2.7	7.1	9.8	3.6	7.3	10.9	6.1	8.4	14.5
	115	Semenyih	2.1	0.8	2.1	2.9	1.0	1.8	2.8	1.5	1.8	3.3
		City Total	8.7	3.5	9.2	12.7	4.6	9.1	13.7	7.6	10.2	17.8
		Rural	28.6	14.1	14.4	28.5	19.7	10.7	30.4	24.7	8.1	32.8
	Basin Total		37.3	17.6	23.6	41.2	24.3	19.8	44.1	32.3	18.3	50.6
17	28	Port Dickson	24.5	2.5	46.5	49.0	3.6	61.5	65.1	6.8	96.9	103.7
		Rural	5.9	2.6	3.1	5.7	3.7	2.4	6.1	5.3	1.9	7.2
	Basin Total		30.4	5.1	49.6	54.7	7.3	63.9	71.2	12.1	98.8	110.9
Total			502.6	247.1	469.5	716.6	335.7	531.9	867.6	610.9	719.3	1330.2
(State Total for Selangor)			(469.7)	(237.8)	(420.3)	(658.1)	(323.3)	(464.1)	(787.4)	(591.9)	(609.1)	(1201.0)

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

Table 12 ESTIMATED AREA OF IRRIGATED PADDY FIELD IN SELANGOR

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
11.	Bernam	Major	19,263	19,263	19,263	19,263	19,263	19,263

Table 13 ESTIMATED IRRIGATION WATER DEMAND FOR PADDY IN SELANGOR

Unit: 10^6 m^3/y

Basin No.	Basin Name	Scheme	1980	1990	2000
11.	Bernam	Major	624	567	567

Table 14 RIVER UTILIZATION RATIO BY BASIN IN SELANGOR FOR 1990 AND 2000

Unit: 10^6 m^3/y

Basin No.	Basin Name	Surface** Runoff (1)	1990 Demand* D&I	1990 Demand* Irr.	1990 Demand* Total (2)	1990 Ratio (2)/(1) (%)	2000 Demand D&I	2000 Demand Irr.	2000 Demand Total (2)	2000 Ratio (2)/(1) (%)
11	Bernam	2,564	27	567	594	23	36	567	603	24
12	Tengi	347	3	0	3	1	3	0	3	1
13	Selangor	1,992	29	0	29	1	29	0	29	1
14	Buloh	222	8	0	8	4	11	0	11	5
15	Kelang	1,070	687	0	687	64	1,060	0	1,060	99
16	Langat	1,604	45	41	86	5	51	41	92	6
17	Sepang	224	71	3	74	33	111	3	114	51

Remarks; *: Source demand
**: Surface runoff in effective area

Table 15 ANNUAL DEFICIT BY BASIN IN SELANGOR 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										
11	324.5	1978	86.9	1977	77.7	1970	76.3	1979	66.1	1961
12	0.5	1978	0.4	1963	-	-	-	-	-	-
13	17.2	1978	12.7	1963	3.6	1979	0.1	1962	-	-
14	0.4	1978	0.3	1963	-	-	-	-	-	-
15	101.7	1978	92.9	1963	63.1	1979	50.3	1965	45.2*	1977
16	33.3	1978	26.6	1963	13.9	1979	4.6	1977	3.3	1965
17	23.6	1978	21.8	1963	14.8	1979	11.8	1965	10.7	1977
2000										
11	326.3	1978	87.8	1977	78.3	1970	76.9	1979	66.6	1961
12	0.5	1978	0.4	1963	-	-	-	-	-	-
13	17.3	1978	12.7	1963	3.7	1979	0.1	1962	-	-
14	0.5	1978	0.4	1963	-	-	-	-	-	-
15	168.0	1978	161.5	1963	116.2	1979	98.1	1965	87.5	1977
16	33.7	1978	26.9	1963	14.2	1979	4.8	1977	3.4	1965
17	46.7	1978	44.7	1963	34.2	1979	28.4	1965	25.5	1977

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

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 SELANGOR

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	145	0.6	0
Rural }	2000	1.0	110	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 SELANGOR

Basin No.	River Basin	People Rel'ved by F/F (10^3)	Construction Cost (M$$10^6$)	Construction Period
13	Selangor	4.4	0.5	5MP
15	Kelang	113.2	1.5	4MP
16	Langat	20.6	0.5	5MP
Total		138.2	2.5	

Table 19 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B1 IN SELANGOR

(1) DAM

Location State*	Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M$$10^6$)	Construction Period
Perak	11	Geling dam	IR	56	30	32	89	1985-1989
Perak	11	Bil dam	IR	26	13	15	74	1985-1989
Perak	11	Sungkai dam	IR	193	161	100	530	1985-1989
Perak	11	hypothetical	IR	-	-	153	811	1985-1989
Selangor	13	Selangor dam	WS	201	270	186	541	1985-1989
Selangor	13	Batan Kali dam	WS	49	72	45	76	1985-1989
Selangor	15	Batu dam	WS	50	28	39	80 U/C	1982-1985
Selangor	15	Gombak dam	WS	87	28	60	28	1986-1990
Selangor	16	Semenyih dam	WS	54	15	44	89 U/C	1982-1985
N. Sembilan	30	Kenaboi dam	WS	118	-	83	237	1988-1992
Pahang	30	Perting dam	WS	88	119	59	214	1994-1998
N. Sembilan	30	Kong Koi dam	WS	54	69	33	224	1992-1996

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)	Construction Period
13	Selangor diversion (pipe line)	Selangor 13 to 15	15	**	1985-1989
16	Semenyih diversion (pipe line)	Selangor 16 to 15		**	U/C 1981-1985
30	Kenaboi diversion (tunnel)	N. Sembilan, Selangor 30 to 16-15	5	11	1988-1992
30	Perting diversion (tunnel)	Pahang, Selangor 30 to 13-15	4	6	1994-1998
30	Kong Koi diversion	N. Sembilan, Selangor 30 to 16-15	2	2	1992-1996

Remarks; IR = Irrigation; WS = Water supply; U/C = Under construction
Construction cost is the financial cost at 1980 constant price.
* = The State where the facilities are located.
** = Cost included in water supply distribution facilities.
*** = Actual site is not identified in a map, yet.

Table 20 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B2 IN SELANGOR

(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 (M10^6)	Construction Period
Selangor	11	Geling dam	IR	56	12	13	36	1985-1989
Selangor	13	Selangor dam	WS	201	270	190	575	1985-1989
Selangor	13	Batang Kali dam	WS	49	72	45	76	1986-1990
Selangor	15	Batu dam	WS	50	28	39	80	U/C 1982-1985
Selangor	15	Gombak dam	WS	87	28	60	28	1988-1992
Selangor	16	Semenyih dam	WS	54	41	44	89	U/C 1982-1985
N. Sembilan	30	Kenaboi dam	WS	118	136	83	237	1990-1994
Pahang	30	Perting dam	WS	88	119	59	214	1994-1998

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
13	Selangor diversion (pipe line)	Selangor 13 to 15	15	**	1985-1989
16	Semenyih diversion (pipe line)	Selangor 16 to 15		**	U/C 1981-1985
30	Kenaboi diversion (tunnel)	N. Sembilan, Selangor 30 to 16-15	5	11	1990-1994
30	Perting diversion (tunnel)	Pahang, Selangor 30 to 13-15	4	6	1994-1998

Remarks; IR = Irrigation; WS = Water supply; U/C = Under construction
Construction cost is the financial cost at 1980 constant price
* = The State where the facilities are located.
** = Cost included in water supply distribution facilities.

Table 21 WATER SOURCE DEVELOPMENT PLAN FOR ALTERNATIVE B3 IN SELANGOR

(1) DAM

Location: State*	Location: Basin No.	Facilities	Purpose	Catchment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Construction Cost (M10^6)	Construction Period
Selangor	13	Selangor dam	WS	201	270	182	504	1985-1989
Selangor	13	Batang Kali dam	WS	49	72	45	76	1992-1996
Selangor	15	Batu dam	WS	50	28	39	80	U/C 1981-1985
Selangor	15	Gombak dam	WS	87	28	28	7	1994-1998

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
13	Selangor diversion (pipe line)	Selangor, 13 to 15	14	**	1985-1989
16	Semenyih diversion (pipe line)	Selangor 16 to 15		**	U/C 1981-1985

Remarks; WS = Water supply; U/C = Under construction
Construction cost is the financial cost at 1980 constant price.
* = The State where the facilities are located.
** = Cost included in water supply distribution facilities.

Table 22 OUTLINE OF FLOOD MITIGATION PROGRAM BY ALTERNATIVE IN SELANGOR

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								
11	Bernam	11	-	-	-	-	8	2	5
13	Selangor	18	-	-	-	-	9	8	24
14	Buloh	24	-	-	-	-	25	9	13
15	Kelang	73	2	-	-	-	268	14	143
16	Langat	109	-	-	-	-	115	54	84
	Total	235	2	-	-	-	425	87	269
	ALTERNATIVE F2								
15	Kelang	36	2	-	-	-	216	4	136
	ALTERNATIVE F3								
11	Bernam	11	-	-	-	-	8	2	5
14	Buloh	24	-	-	-	-	25	9	13
15	Kelang	73	2	-	-	-	268	14	143
16	Langat	109	-	-	-	-	115	54	84
	Total	217	2	-	-	-	416	79	245

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 SELANGOR

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
13	21	Kuala Kubu Baru	6.0	85	10.2	6.8	90	11.7	8.8	100	16.0
14	114	Sg. Buloh	2.7	85	6.0	3.6	90	8.1	7.9	100	13.0
15	22	Kelang	145.7	100	271.0	189.0	100	359.0	338.6	100	613.0
	23	Shah Alam	21.1	85	35.7	33.7	90	59.4	80.0	100	141.0
	24	Petaling Jaya	353.4	100	337.0	447.7	100	484.0	757.0	100	927.0
	25	Bandaraya Kl	547.9	100	1179.0	684.4	100	1419.0	1151.0	100	2039.0
15	116	Ampang	4.1	85	11.9	5.2	90	13.5	7.7	100	18.0
	117	Serdang Baru	9.3	85	16.2	11.0	90	18.9	13.2	100	25.0
16	26	Kajang Chua	18.6	85	31.5	21.6	90	38.7	31.0	100	58.0
	115	Semenyih	5.8	85	9.4	5.8	90	10.8	7.1	100	14.0
	Total		1114.6	99	1907.9	1408.8	99	2423.1	2402.3	100	3864.0

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 SELANGOR

Basin No.	Basin Name	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
11	Bernam	52.4	72.8	183.3	67.5	80.8	203.7	95.8	91.4	205.0
12	Tengi	7.2	74.7	19.8	7.2	84.3	22.5	9.0	99.2	25.4
13	Selangor	63.3	75.0	171.6	68.4	84.3	204.7	72.0	99.0	184.8
14	Buloh	13.6	75.0	43.0	14.2	84.3	48.9	17.8	98.9	53.8
15	Kelang	63.6	75.0	258.9	75.6	84.3	306.5	88.3	99.0	282.9
16	Langat	68.1	74.9	264.2	81.1	83.8	315.0	92.8	96.0	290.2
17	Sepang	13.6	74.6	50.1	15.7	82.3	56.6	19.0	91.2	60.9
Total		281.8	-	990.9	329.7	-	1,157.9	394.7	-	1,103.0
Selangor		258.6	75.0	868.7	279.4	84.3	1,025.1	330.9	99.0	971.3

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 SELANGOR

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
11	Bernam	0.4	9.3	23.4	0.6	9.9	25.0	0.6	8.6	19.4
12	Tengi	0.0	1.9	0.5	0.0	1.9	0.5	0.0	1.1	0.3
13	Selangor	0.0	1.9	4.4	0.1	1.7	4.2	0.0	1.0	1.9
14	Buloh	0.0	1.9	1.1	0.0	1.7	1.0	0.0	0.9	0.5
15	Kelang	0.1	1.9	6.6	0.1	1.7	6.3	0.0	1.0	2.9
16	Langat	0.2	2.6	9.1	0.2	2.7	10.2	0.3	4.0	12.1
17	Sepang	0.0	4.6	3.1	0.1	5.7	3.9	0.2	8.8	5.9
Total		0.7	-	48.2	1.1	-	51.1	1.1	-	43.0
Selangor		0.2	1.9	22.5	0.3	1.7	21.0	0.0	1.0	9.7

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 26 RECOMMENDED WATER SOURCE DEVELOPMENT PLANS IN SELANGOR

(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
Selangor	13	Selangor dam	WS	201	270	186	541		1985-1989
Selangor	13	Batang Kali dam	WS	49	72	45	76		1985-1989
Selangor	15	Batu dam	WS	50	28	39	80	U/C	1981-1985
Selangor	15	Gombak dam	WS	87	28	60	28		1986-1990
Selangor	16	Semenyih dam	WS	54	42	44	89	U/C	1981-1985
N. Sembilan	30	Kenaboi dam	WS	118	136	83	237		1988-1992
Pahang	30	Perting dam	WS	88	119	59	214		1994-1998
N. Sembilan	30	Kong Koi dam	WS	54	69	33	224		1992-1996

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M$$10^6$)		Construction Period
13	Selangor diversion (pipe line)	Selangor 13 to 15	15	**		1985-1989
16	Semenyih diversion (pipe line)	Selangor 16 to 15		**	U/C	1981-1985
30	Kenaboi diversion (tunnel)	N. Sembilan, Selangor 30 to 16-15	5	11		1988-1992
30	Perting diversion (tunnel)	Pahang Selangor 30 to 13-15	4	6		1994-1998
30	Kong Koi diversion	N. Sembilan, Selangor 30 to 16-15	2	2		1992-1996

Remarks; WS = Water supply; U/C = Under construction
Construction cost is the financial cost at 1980 constant price.
* = The State where the facilities are located.
** = Cost included in water supply distribution facilities.

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

Unit: m^3/d

Basin No.	Basin Name	1981 - 1990 Palm Oil	1981 - 1990 Rubber	1981 - 1990 Total	1990 - 2000 Palm Oil	1990 - 2000 Rubber	1990 - 2000 Total
11	Bernam	1,996	96	2,092	208	220	428
14	Buloh	592	292	884	1,008	160	1,168
15	Kelang	960	4,520	5,480	160	1,134	1,294
16	Langat	876	1,300	1,976	904	4	908
17	Sepang	80	72	152	240	76	316
Total		4,304	6,280	10,584	2,520	1,594	4,114

Table 28 RECOMMENDED PUBLIC SEWERAGE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN SELANGOR

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)
15	C23	Shah Alam	25	60	40	89	100	141
15	C24	Petaling Jaya	276	45	218	949	100	927
15	C25	W. Persekutuan	343	50	710	1,030	100	2,039
16	C26	Kajang/Semenyih	9	35	15	35	100	58
Total			653	-	983	2,103	-	3,165

Remarks; There is a sewerage system in C25, served 150,000 people with a treatment capacity of 56,000 m^3/d in 1980.

Table 29 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN SELANGOR

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)
15	C22	Klang	49	20	72	180	50	307
Total			49	-	72	180	-	307

Table 30 POLLUTION LOAD IN 2000 BY BASIN UNDER WITH-AND-WITHOUT IMPLEMENTATION OF RECOMMENDED PLAN IN SELANGOR

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)
11	Bernam	9	0	2	11	6	0	0	1	1	0
12	Tengi	0	0	0	0	0	0	0	0	0	0
13	Selangor	3	1	1	5	3	3	1	1	5	3
14	Buloh	7	1	2	10	46	0	1	2	3	40
15	Kelang	11	126	2	139	105	0	36	2	38	14
16	Langat	8	3	2	13	9	8	1	2	11	6
17	Sepang	1	0	1	2	20	0	0	1	1	6
	Total	39	131	10	180	-	11	39	9	59	-

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

Table 31 RECOMMENDED FLOOD MITIGATION PROGRAM IN SELANGOR

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									
14	Buloh	-	-	-	-	-	-	-	-
15	Kelang	20	-	2	-	-	126	13	82
16	Langat	-	-	-	-	-	-	-	-
	Total	20	-	2	-	-	126	13	82
By 2000									
15	Kelang	36	-	2	-	-	216	3	136

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

Table 32 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 33 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 34 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE FOR RECOMMENDED PLAN IN SELANGOR

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	231	732	368	177	1,490
Irrigation	0	0	0	0	0
Inland Fishery	3	14	57	39	113
Public Water Supply	874	1,588	1,674	670	4,806
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	447	736	731	293	2,207
Public Sewerage (Others)	34	58	59	23	174
Flood Mitigation	24	60	55	-	139
Total	1,613	3,188	2,944	1,202	8,929

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 35 ESTIMATED ANNUAL RECURRENT EXPENDITURE FOR RECOMMENDED PLAN IN SELANGOR

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	7	24	33	64
Irrigation	0	0	0	0	0
Inland Fishery	0	1	4	8	13
Public Water Supply	0	149	313	454	916
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	0	149	295	418	862
Public Sewerage (Others)	0	11	23	33	67
Flood Mitigation	0	4	35	61	100
Total	0	321	694	1,007	2,022

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 36 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN SELANGOR

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	(M$$10^6$)	0
D&I water supply	(M$$10^6$)	316
Fish culture	(M$$10^6$)	4
Reservoir recreation	(M$$10^6$)	6
Total	(M$$10^6$)	326
1.2 Economic Cost		
Irrigation	(M$$10^6$)	0
D&I water supply	(M$$10^6$)	271
Fish culture	(M$$10^6$)	4
Dams, barrages & diversion facilities	(M$$10^6$)	42
Total	(M$$10^6$)	317
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)	10
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)	12
Number of people served by proposed public water supply in 2000	(10^3)	4,845
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	4

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

Table 37 SAFE SUPPLY PERIOD AND SAFE RIVER MAINTENANCE FLOW PERIOD IN 2000 WITH RECOMMENDED PLAN IMPLEMENTED IN SELANGOR

Unit: days

Basin No.	Basin Name	Safe Supply Period		Safe Maintenance Flow Period	
		Plan Implemented	Natural Flow	Plan Implemented	Natural Flow
11	Bernam	365	156	279	131
12	Tengi	365	280	365	270
13	Selangor	365	300	365	260
15	Kelang	365	159	365	143
16	Langat	365	299	365	245
17	Sepang	365	143	365	133

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

Table 38 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN SELANGOR

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	($M\$10^6$)	58
Saving in pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	58
1.2 Economic Cost		
Sewerage	($M\$10^6$)	120
Private purification facilities /2	($M\$10^6$)	2
Pre-treatment for D&I water supply	($M\$10^6$)	0
Total	($M\$10^6$)	122
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 = 497 km)	(km)	428/371 /1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 497 km)	(km)	378/307 /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)	3,472
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 Perak and N.Sembilan.

/2: Including the rubber factories and palm oil mills in such part of the State of Perak and N.Sembilan as located in Basin 11, 16 and 17.

Table 39 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN SELANGOR

Item		Recommended Plan
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M$ 10^6)	3.2
1.2 Economic Cost		
Flood mitigation work	(M$ 10^6)	5.3
1.3 EIRR	(%)	5.0
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	36
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	216
Population served by proposed flood warning system in 2000	(10^3)	138
Area relieved from flood hazards	(10^3 ha)	3
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	2

Table 40 SUMMARY OF FUTURE ECONOMIC NET VALUE OF WET PADDY BY TYPE OF SCHEME IN SELANGOR

	Yield (ton/ha)	Unit Price (M$/ton)	Gross Value (M$/ha)	Production Cost (M$/ha)	Net Value (M$/ha)
(1) Major Irrigation Scheme (Tanjong Karang)					
Double cropping	9.2	640	5,888	1,798	4,090
Single cropping	4.4	640	2,816	883	1,933
(2) Minor Irrigation Scheme					
Double cropping	-	-	-	-	-
Single cropping	-	-	-	-	-
(3) Rainfed Scheme					
Single cropping	-	-	-	-	-

Table 41 ESTIMATED AND PROJECTED SERVICE FACTOR AND PER CAPITA DAILY USE OF DOMESTIC WATER IN SELANGOR 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								
21 Kuala Kubu Baru	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
22 Kelang	100.0	100.0	100.0	100.0	170.0	180.0	195.0	240.0
23 Shah Alam	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
24 Petaling Jaya	100.0	100.0	100.0	100.0	170.0	180.0	195.0	240.0
25 Bandaraya KL	100.0	100.0	100.0	100.0	190.0	220.0	235.0	260.0
26 Kajang Chua	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
114 Sg. Buloh	67.0	94.0	85.0	95.0	75.0	95.0	115.0	210.0
115 Semenyih	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
116 Ampang	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
117 Serdang Baru	80.0	85.0	90.0	95.0	160.0	170.0	185.0	210.0
2. Rural Area								
PWD Rural	65.0	75.0	83.3	95.0	75.0	95.0	115.0	155.0
MOH Rural	2.0	1.9	1.7	1.0	40.0	45.0	55.0	65.0
3. Non-Pipe-Served Area	-	-	-	-	40.0	40.0	40.0	40.0

Table 42 ESTIMATED AND PROJECTED D&I WATER DEMAND BY BASIN UNDER THE CONDITION OF LOWER ECONOMIC GROWTH IN SELANGOR

Unit: 10^6 m^3/y

Basin No.		City/Rural	Estimated 1980	Projected 1985			1990			200		
			D&I	D	I	Total	D	I	Total	D	I	Total
11		Rural	24.1	9.5	16.6	26.1	12.3	14.4	26.7	17.8	14.7	32.5
12		Rural	3.3	1.0	2.5	3.5	1.3	1.7	3.0	1.9	1.1	3.0
13	21	Kuala Kubu Baru	2.2	0.8	2.0	2.8	1.0	2.1	3.1	1.2	2.1	3.3
		Rural	30.7	8.9	23.8	32.7	13.3	16.8	30.1	24.9	10.9	35.8
		Basin Total	32.9	9.7	25.8	35.5	14.3	18.9	33.2	26.1	13.0	39.1
14	114		1.1	0.3	1.2	1.5	0.5	1.3	1.8	1.1	1.6	2.7
		Rural	6.1	2.1	4.6	6.7	2.9	3.5	6.4	4.3	2.7	7.0
		Basin Total	7.2	2.4	5.8	8.2	3.4	4.8	8.2	5.4	4.3	9.7
15	22	Kelang	46.7	23.3	43.7	67.0	31.8	50.5	82.3	58.6	67.9	126.5
	23	Shah Alam	5.3	3.0	6.8	9.8	5.1	9.8	14.9	12.4	18.2	30.6
	24	Petaling Jaya	125.6	28.8	157.7	186.5	42.9	182.4	225.3	88.5	244.3	332.8
	25	Bandaraya KL	157.6	123.3	98.3	221.6	151.6	113.9	265.5	211.2	152.4	363.6
	116	Ampang	1.3	1.0	0.8	1.8	1.1	0.9	2.0	1.4	1.1	2.5
	117	Serdang Barm	3.6	1.4	3.2	4.6	1.6	3.4	5.0	2.0	3.2	5.2
		City Total	340.1	180.8	310.5	491.3	324.1	360.9	595.0	374.1	487.1	861.2
		Rural	27.3	13.3	18.1	31.4	19.8	13.6	33.4	36.3	9.9	46.2
		Basin Total	367.4	194.1	328.6	522.7	253.9	374.5	628.4	410.4	497.0	907.4
16	26	Kajang Chua	6.6	2.6	6.0	8.6	3.3	6.4	9.7	4.6	7.5	12.1
	115	Semenyih	2.1	0.8	2.0	2.8	0.9	1.7	2.6	1.1	2.1	3.2
		City Total	8.7	3.4	8.0	11.4	4.2	8.1	12.3	5.7	9.6	15.3
		Rural	28.6	13.7	19.0	32.7	20.6	13.7	34.3	38.3	9.5	47.8
		Basin Total	37.3	17.1	27.0	44.1	24.8	21.8	46.6	44.0	19.1	63.1
17	28	Port Dickson	24.5	2.4	43.5	45.9	3.4	51.2	54.6	5.1	66.8	71.9
		Rural	5.9	2.5	4.0	6.5	3.3	3.0	6.3	4.9	2.2	7.1
		Basin Total	30.4	4.9	47.5	52.4	6.7	54.2	60.9	10.0	69.0	79.0
Total			502.6	238.7	453.8	692.5	316.7	490.3	807.0	515.6	618.2	1,133.8
Selangor			469.8	228.5	406.5	635.0	305.2	434.0	739.2	499.4	542.6	1,042.0

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

Table 43 RECOMMENDED WATER SUPPLY DEVELOPMENT PLAN FOR CITIES/TOWNS IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	Code No.	City/Town	1985 TC	1985 SF	1985 SP	1990 TC	1990 SF	1990 SP	2000 TC	2000 SF	2000 SP
13	21	Kuala Kuku Baru	5.5	85	10.2	6.3	90	10.8	6.8	95	12.4
14	114	Sg. Buloh	2.7	85	6.0	3.6	90	8.1	5.8	95	10.5
15	22	Kelang	136.2	100	269.0	172.1	100	340.0	279.2	100	508.0
	23	Shah Alam	18.9	85	35.7	29.9	90	55.8	64.9	100	117.0
	24	Petaling Jaya	324.7	100	333.0	404.1	100	458.0	635.1	100	768.0
	25	Bandaraya KL	520.1	100	1167.0	628.8	100	1343.0	866.0	100	1691.0
	115	Seminyih	5.5	85	9.4	5.5	90	9.9	6.6	95	11.4
	116	Ampang	4.1	85	11.9	4.9	90	12.6	6.0	95	14.3
	117	Serdang Baru	8.8	85	16.2	9.9	90	18.0	11.0	95	20.0
16	26	Kajang Chua	16.7	85	30.6	19.2	90	36.0	25.2	95	45.6
	Total		1043.2	99	1889.0	1284.3	99	2292.2	1906.6	100	3198.2

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 44 RECOMMENDED TREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN SELANGOR 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
11	Bernam	61.5	72.8	184.2	67.2	79.5	205.2	86.8	87.4	228.6
12	Tengi & Others	8.4	74.7	19.8	7.8	83.3	22.4	8.7	94.8	25.7
13	Selangor	76.9	75.0	175.6	79.3	83.3	228.8	103.7	95.0	330.9
14	Buloh & Others	14.5	75.0	43.1	15.4	83.3	49.4	13.8	95.1	58.3
15	Kelang	71.1	75.0	263.9	84.1	83.3	339.5	127.2	95.0	480.8
16	langet	77.5	74.8	269.0	89.8	82.9	350.0	135.9	94.2	507.4
17	Sepang & Others	14.8	74.7	50.2	15.4	81.2	56.1	19.0	89.6	64.0
Total		324.7	-	1,005.8	359.0	-	1,251.4	495.1	-	1,695.7
Selangor		297.2	75.0	883.9	328.8	83.3	1,121.3	454.2	95.0	1,560.5

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 psersons

Table 45 RECOMMENDED UNTREATED WATER SUPPLY DEVELOPMENT PLAN FOR RURAL AREA IN SELANGOR 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
11	Bernam	0.4	9.3	23.6	0.6	9.8	25.4	0.7	9.9	26.0
12	Tengi+	0.0	1.9	0.5	0.0	1.9	0.5	0.0	1.1	0.3
13	Selangor	0.0	1.9	4.5	0.1	1.7	4.7	0.1	0.9	3.3
14	Buloh+	0.0	1.9	1.1	0.0	1.7	1.0	0.0	1.0	0.6
15	Kelang	0.1	1.9	6.8	0.1	1.7	6.9	0.1	1.0	4.9
16	Langat	0.2	2.6	9.2	0.2	2.5	10.5	0.3	2.0	10.6
17	Sepang+	0	4.5	3.0	0.1	5.5	3.8	0.1	7.0	5.0
Total		0.7	-	48.7	1.1	-	52.8	1.3	-	50.7
Selangor		0.1	1.9	22.8	0.3	1.7	22.9	0.3	1.0	15.9

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 46 RECOMMENDED WATER SOURCE DEVELOPMENT PLAN IN SELNAGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

(1) DAM

Location: State*	Location: Basin No.	Facilities	Pur-pose	Catch-ment Area (km^2)	Active Storage Capacity (10^6m^3)	Net Supply Capacity ($10^6m^3/y$)	Con-struction Cost (M10^6)	Con-struction Period
Selangor	13	Selangor dam	WS	201	270	182	504	1985-1989
Selangor	13	Batang Kali dam	WS	49	72	45	76	1985-1989
Selangor	15	Batu dam	WS	50	28	39	80	U/C 1982-1985
Selangor	15	Gombak dam	WS	87	28	60	28	1988-1992
Selangor	16	Semenyih dam	WS	54	41	44	89	U/C 1982-1985
N. Sembilan	30	Kenaboi dam	WS	118	136	83	237	1991-1995

(2) DIVERSION FACILITIES

Basin No.	Diversion Facilities	Basin Transfer (Basin No.)	Diversion Discharge Capacity (m^3/s)	Construction Cost (M10^6)	Construction Period
13	Selangor diversion (pipe line)	Selangor 13 to 15	14	**	1985-1989
16	Semenyih diversion (pipe line)	Selangor 16 to 15		**	U/C 1981-1985
30	Kenaboi diversion (tunnel)	N. Sembilan, Selangor 30 to 15	5	11	1991-1995

Remarks; WS = Water supply; U/C = Under construction
Construction cost is the financial cost at 1980 constant price.
* = The State where the facilities are located.
** = Cost included in water supply distribution facilities.

Table 47 RECOMMENDED PLAN FOR IMPROVEMENT OF PURIFICATION SYSTEM IN PALM OIL MILLS AND RUBBER FACTORIES IN SELANGOR 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
11	Bernam	1,996	96	2,092	208	220	428
14	Buloh	592	292	884	1,008	160	1,168
15	Kelang	960	4,520	5,480	160	1,134	1,294
16	Langat	676	1,300	1,976	904	4	908
17	Sepang	80	72	152	240	76	316
	Total	4,304	6,280	10,584	2,520	1,594	4,114

Table 48 RECOMMENDED PUBLIC SEWERAGE DEVELOPMENT PLAN FOR WATER POLLUTION ABATEMENT IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
15	C23	Shah Alam	20	55	34	73	100	117
15	C24	Petaling Jaya	221	40	183	810	100	768
15	C25	W. Persekutuan	282	45	604	856	100	1,691
16	C26	Kajang/Semenyih	7	30	12	26	90	43
		Total	530	-	833	1,765	-	2,619

Remarks; There is a sewerage system in C25, served 150,000 people with a treatment capacity of 56,000 m^3/d in 1980.

Table 49 ASSUMED PUBLIC SEWERAGE DEVELOPMENT NOT AFFECTING RIVER WATER QUALITY IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Basin No.	City/Town No.	City/Town Name	1990 Treatment Capacity ($10^3 m^3/d$)	1990 Service Factor (%)	1990 Served Population (10^3)	2000 Treatment Capacity ($10^3 m^3/d$)	2000 Service Factor (%)	2000 Served Population (10^3)
15	C22	Klang	40	20	68	151	50	254

Table 50 RECOMMENDED FLOOD MITIGATION PROGRAM IN SELANGOR 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									
14	Buloh	-	-	-	-	-	-	-	-
15	Kelang	20	-	2	-	-	120	13	82
16	Langat	-	-	-	-	-	-	-	-
	Total	20	-	2	-	-	120	13	82
By 2000									
15	Kelang	36	-	2	-	-	204	3	136

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 51 ESTIMATED PUBLIC DEVELOPMENT EXPENDITURE OF RECOMMENDED PLAN IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	227	540	259	0	1,026
Irrigation	0	0	0	0	0
Inland Fishery	3	14	51	39	107
Public Water Supply	754	1,299	1,327	531	3,911
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	366	647	673	270	1,956
Public Sewerage (Others)	28	50	53	21	152
Flood Mitigation	24	60	55	0	139
Total	1,402	2,610	2,418	861	7,291

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 52 ESTIMATED ANNUAL RECURRENT EXPENDITURE OF RECOMMENDED PLAN IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Unit: M$$10^6$

Sector	4MP	5MP	6MP	7MP	Total
Source Development	0	7	19	26	52
Irrigation	0	0	0	0	0
Inland Fishery	0	1	3	7	11
Public Water Supply	0	127	258	370	755
Public Water Supply; Pre-treatment facilities	0	0	0	0	0
Public Sewerage (Effective for river water pollution abatement)	0	125	256	369	750
Public Sewerage (Others)	0	9	20	29	58
Flood Mitigation	0	4	35	61	100
Total	0	273	591	862	1,726

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 53 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER DEMAND AND SUPPLY BALANCE IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Irrigation	($M\$10^6$)	0
D&I water supply	($M\$10^6$)	257
Fish culture	($M\$10^6$)	4
Reservoir recreation	($M\$10^6$)	6
Total	($M\$10^6$)	269
1.2 Economic Cost		
Irrigation	($M\$10^6$)	0
D&I water supply	($M\$10^6$)	223
Fish culture	($M\$10^6$)	4
Dams, barrages & diversion facilities	($M\$10^6$)	31
Total	($M\$10^6$)	258
1.3 EIRR	(%)	11
2. Environmental Quality		
2.1 Beneficial Effect		
Safe maintenance flow period (2000)		See Table
Surface area of lake created	(km^2)	10
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)	12
Number of people served by proposed public water supply in 2000	(10^3)	4,775
Safe supply period (2000)		See Table
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^2)	4

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

Table 54 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR WATER POLLUTION ABATEMENT IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Sewerage	(M$$10^6$)	43
Saving in pre-treatment for D&I water supply	(M$$10^6$)	0
Total	(M$$10^6$)	43
1.2 Economic Cost		
Sewerage	(M$$10^6$)	105
Private purification facilities/2	(M$$10^6$)	2
Pre-treatment for D&I water supply	(M$$10^6$)	0
Total	(M$$10^6$)	107
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 = 497 km)	(km)	448/372/1
Length of river stretch where BOD concentration is not more than 5 mg/lit in 2000 compared with without project condition (Study length = 497 km)	(km)	378/232/1
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effects		
Number of people served by proposed sewerage system in 2000	(10^3)	2,873
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 Perak and N.Sembilan.

/2: Including the rubber factories and palm oil mills in such part of the State of Perak and N.Sembilan as located in Basin 11, 16 and 17.

Table 55 BENEFICIAL AND ADVERSE EFFECTS OF RECOMMENDED PLAN FOR FLOOD MITIGATION IN SELANGOR UNDER THE CONDITION OF LOWER ECONOMIC GROWTH

Item		Amount
1. National Economic Development		
1.1 Economic Benefit		
Damage reduction	(M$$10^6$)	2.2
1.2 Economic Cost		
Flood mitigation work	(M$$10^6$)	5.3
1.3 EIRR	(%)	2.6
2. Environmental Quality		
2.1 Beneficial Effect		
Length of improved stretch	(km)	36
2.2 Adverse Effect		-
3. Social Well-Being		
3.1 Beneficial Effect		
Number of protected people by proposed facilities in 2000	(10^3)	204
Population served by proposed flood warning system in 2000	(10^3)	131
Area relieved from flood hazards	(km^2)	3
3.2 Adverse Effect		
Number of people to be removed for construction of facilities	(10^3)	1

FIGURES

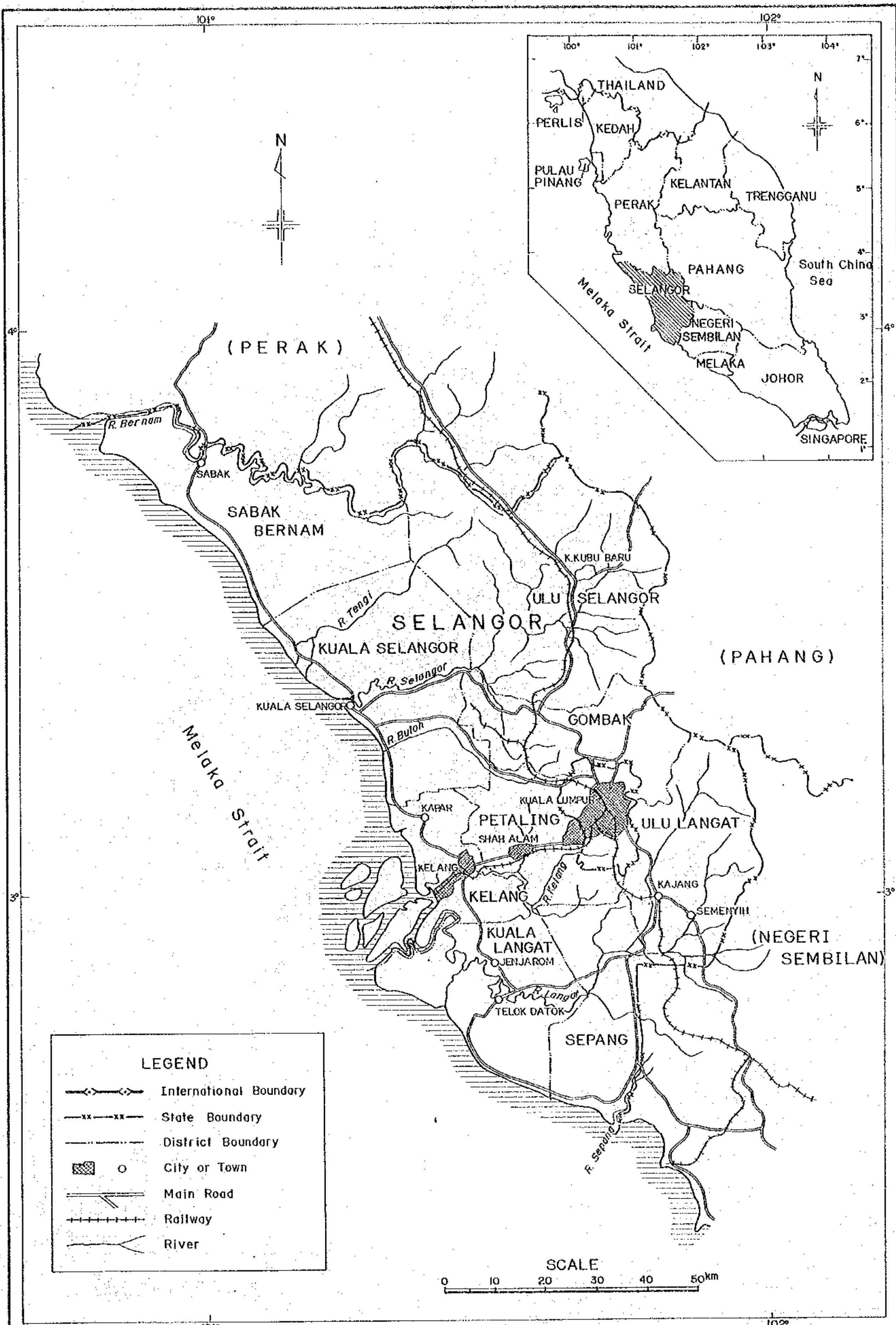


Fig. 1 Map of the State of Selangor

GOVERNMENT OF MALAYSIA
NATIONAL WATER RESOURCES STUDY MALAYSIA
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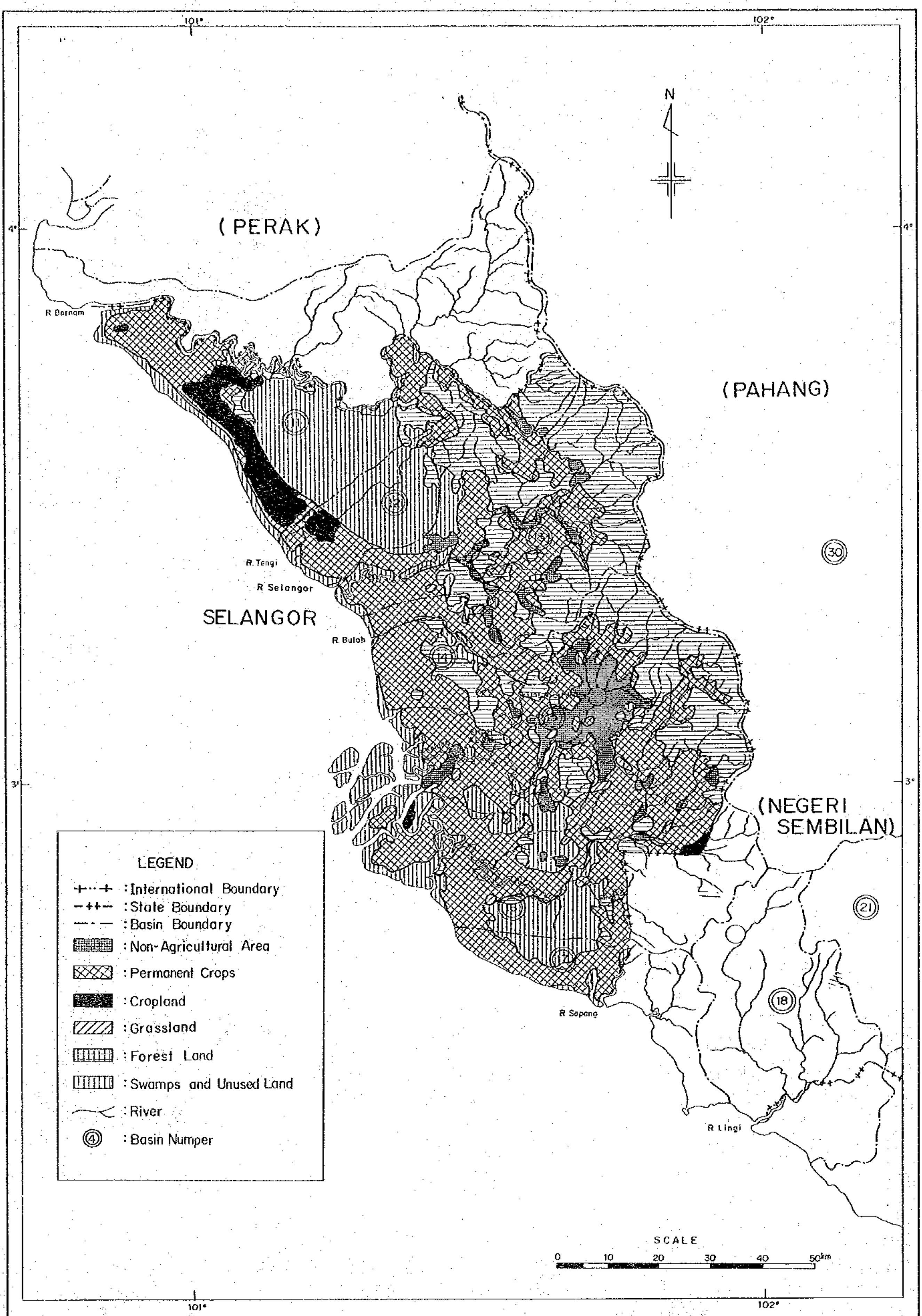

Fig. 2 Present Land Use

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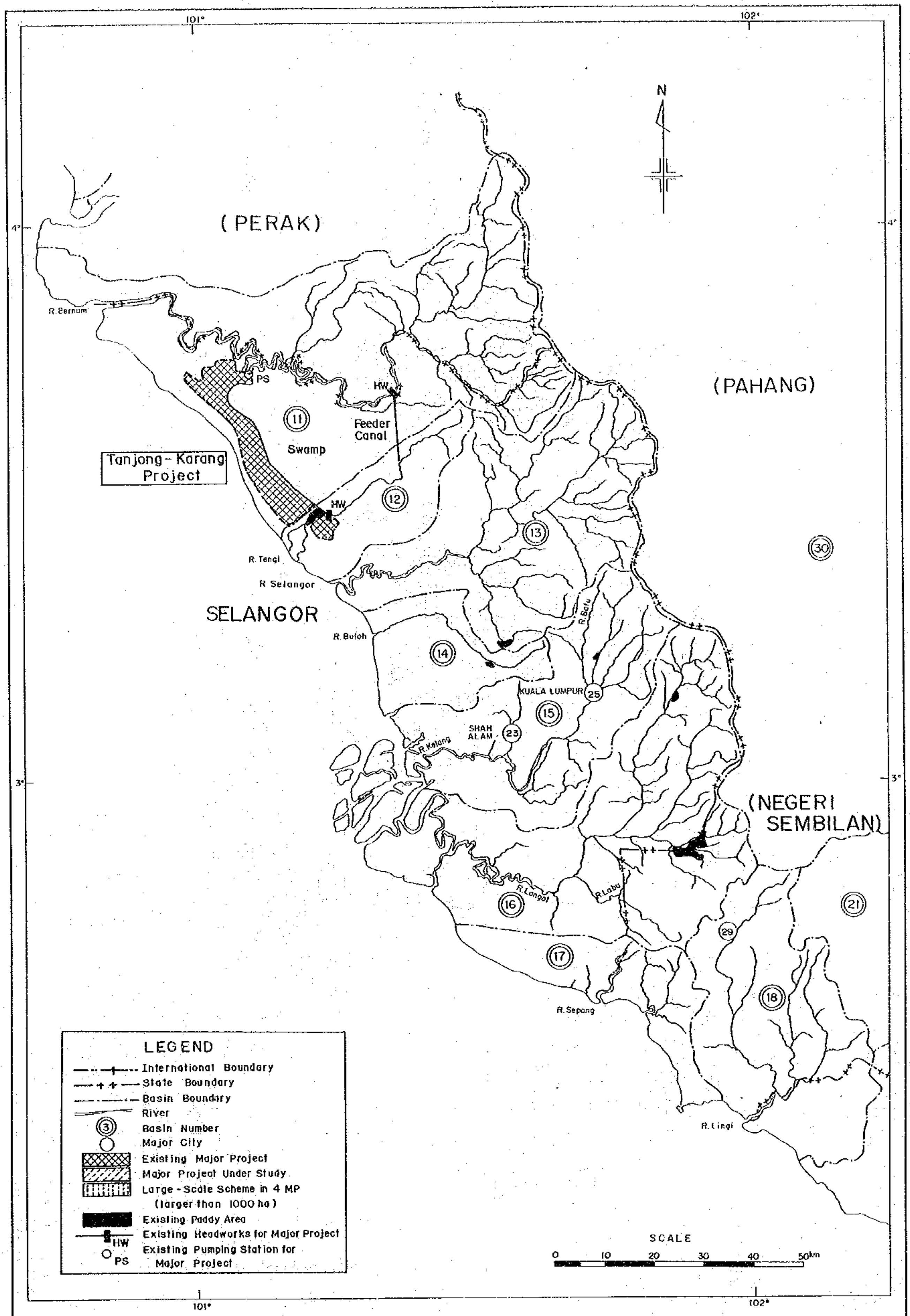

Fig. 3 Location of Paddy Field

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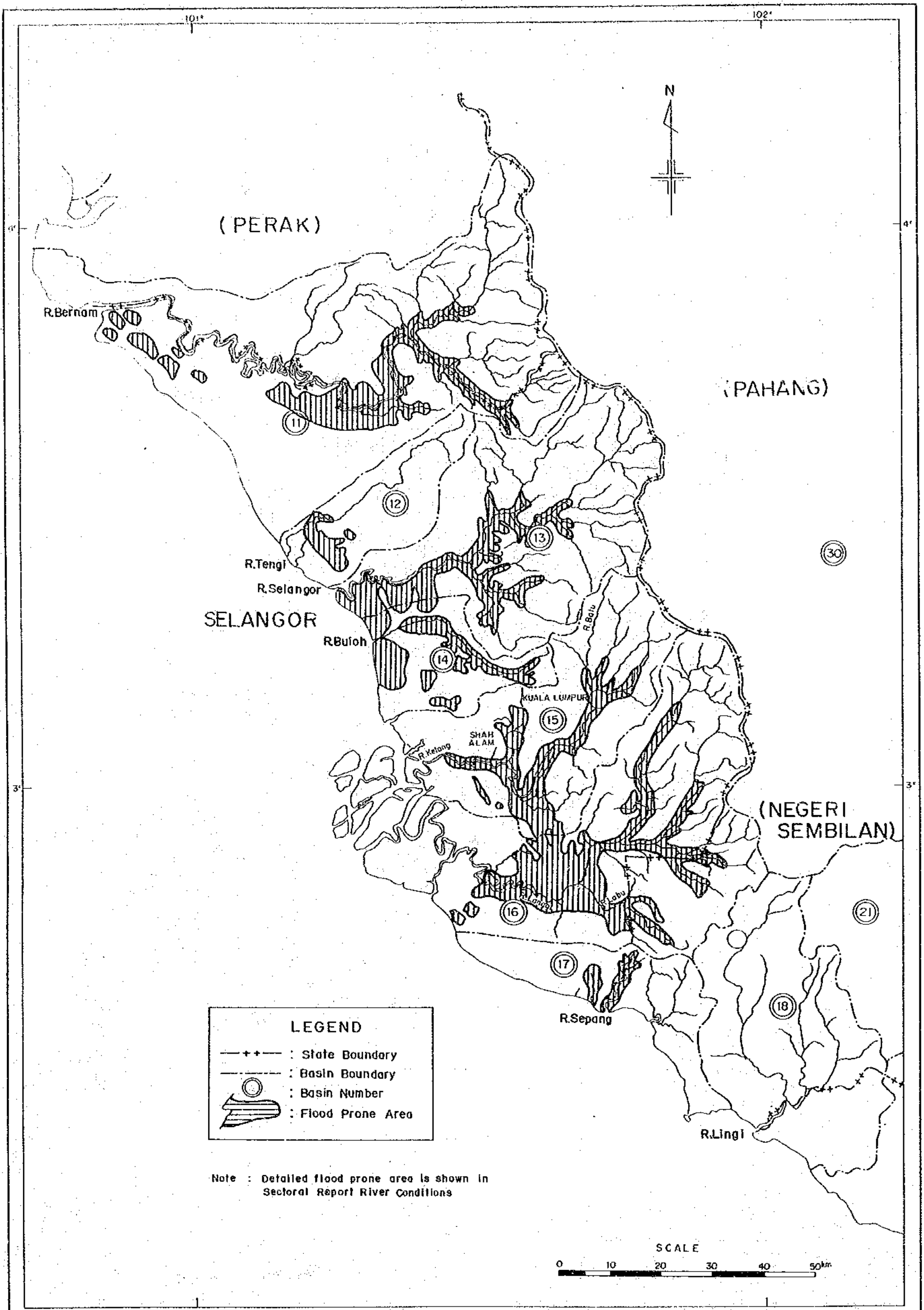

Fig. 4 Flood Prone Area in Selangor

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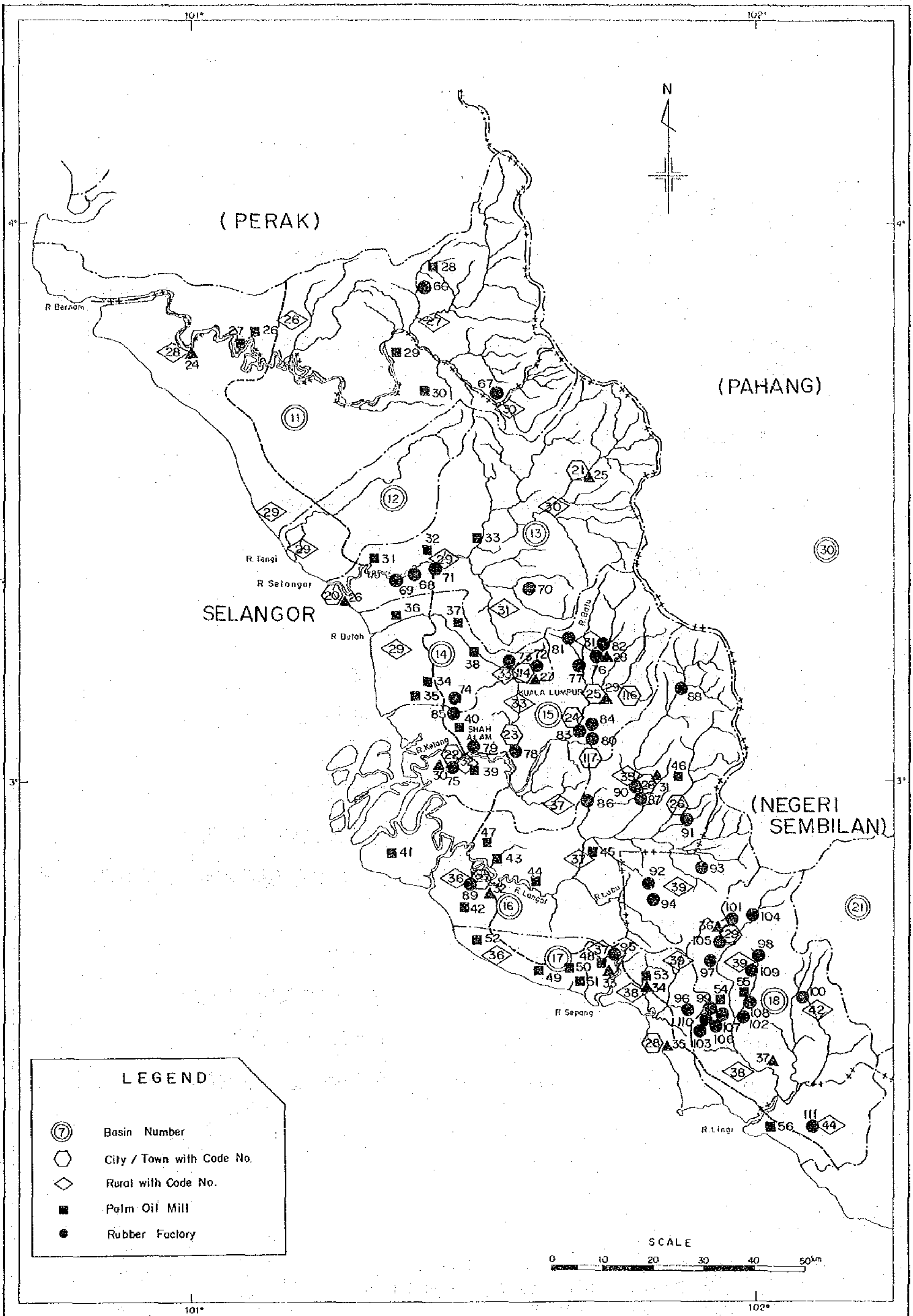

Fig. 5 Location of Demand Centers and Pollution Sources

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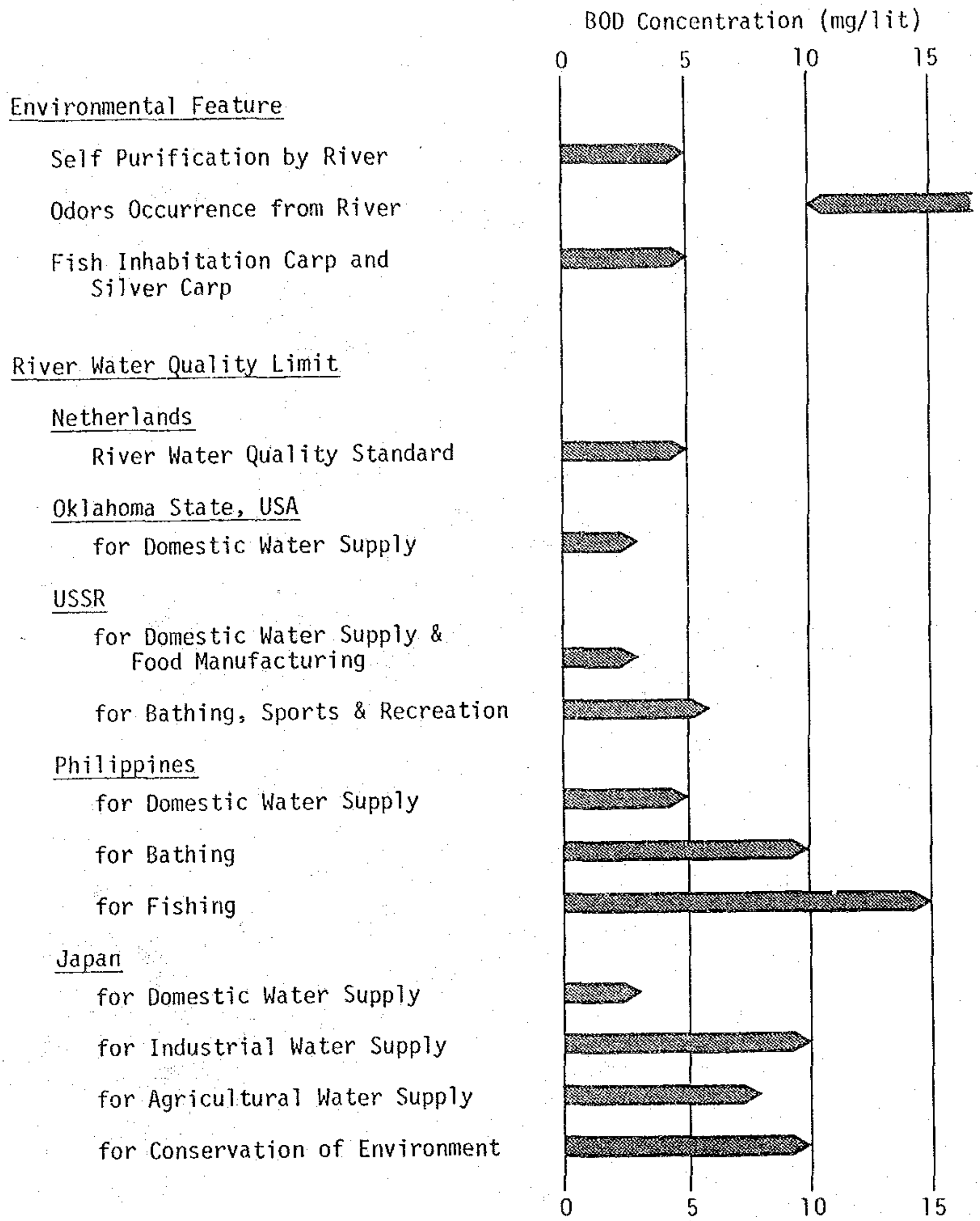

Fig. 6 Relationships between BOD Concentration and Environmental Feature and River Water Quality Limit

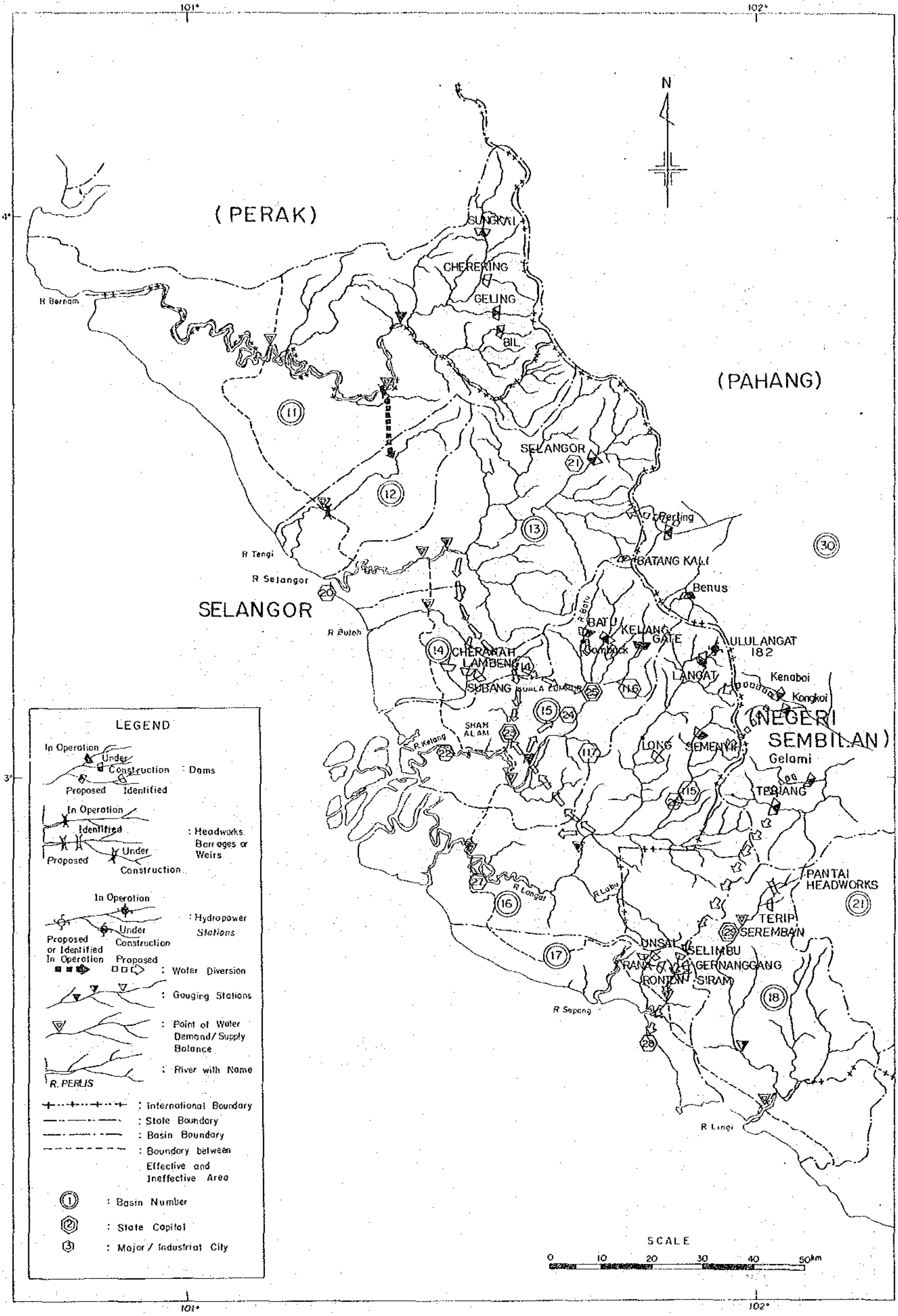

Fig. 7 Location of Potential and Proposed Water Source Facilities, Alternative B1

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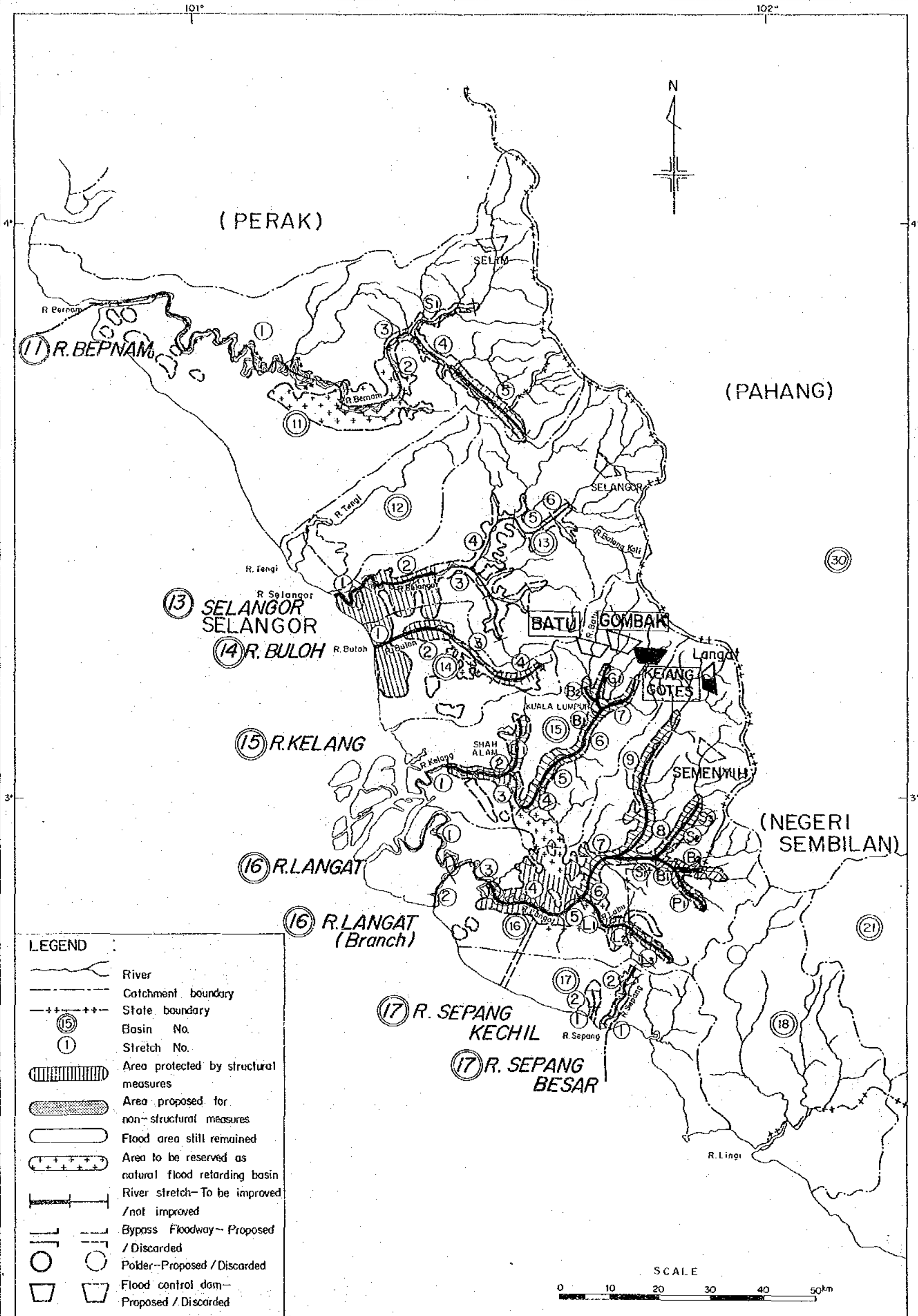

Fig 8 Flood Mitigation Alternatives, Alternative F1

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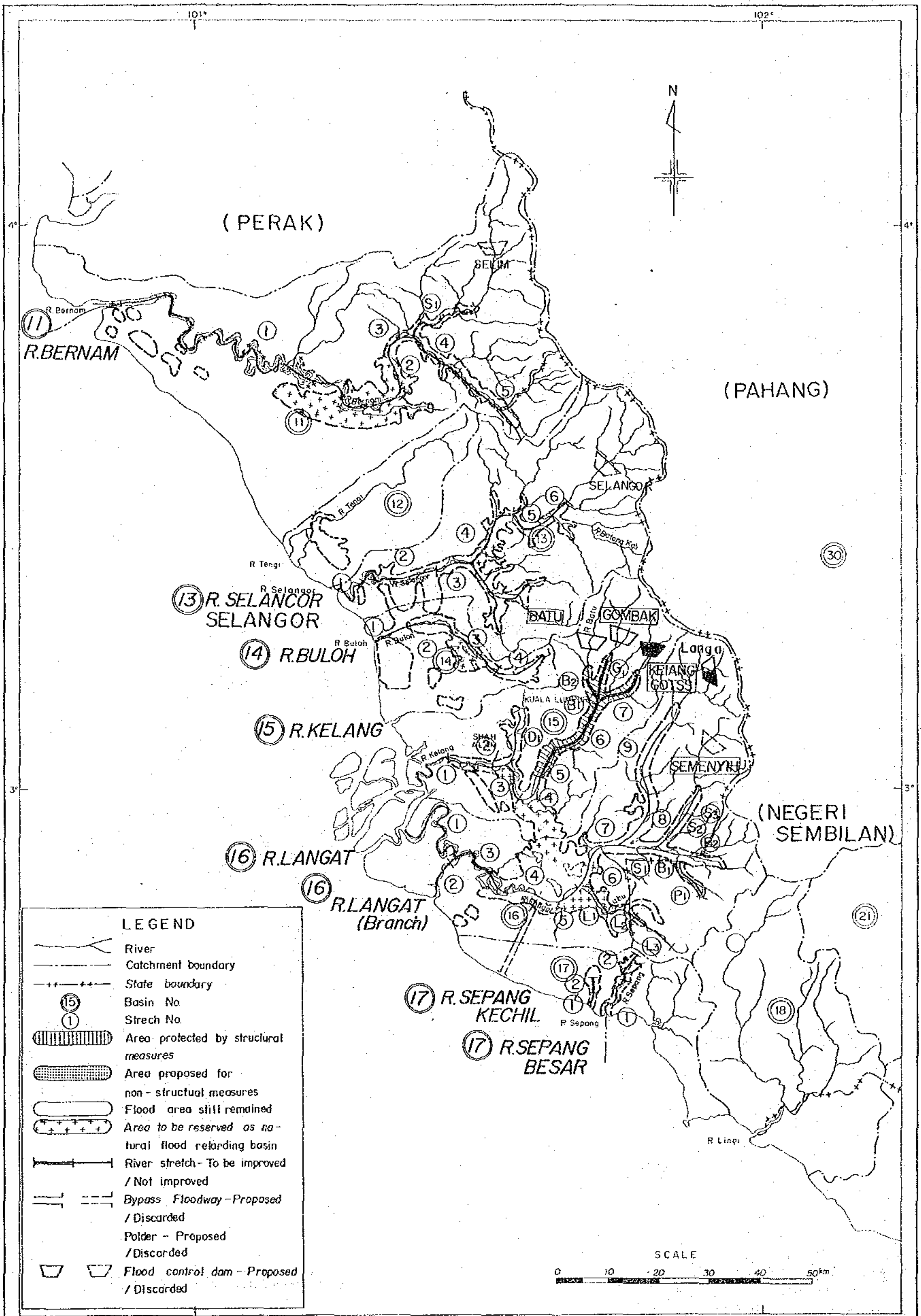

Fig. 9 Flood Mitigation Alternatives, Alternative F2

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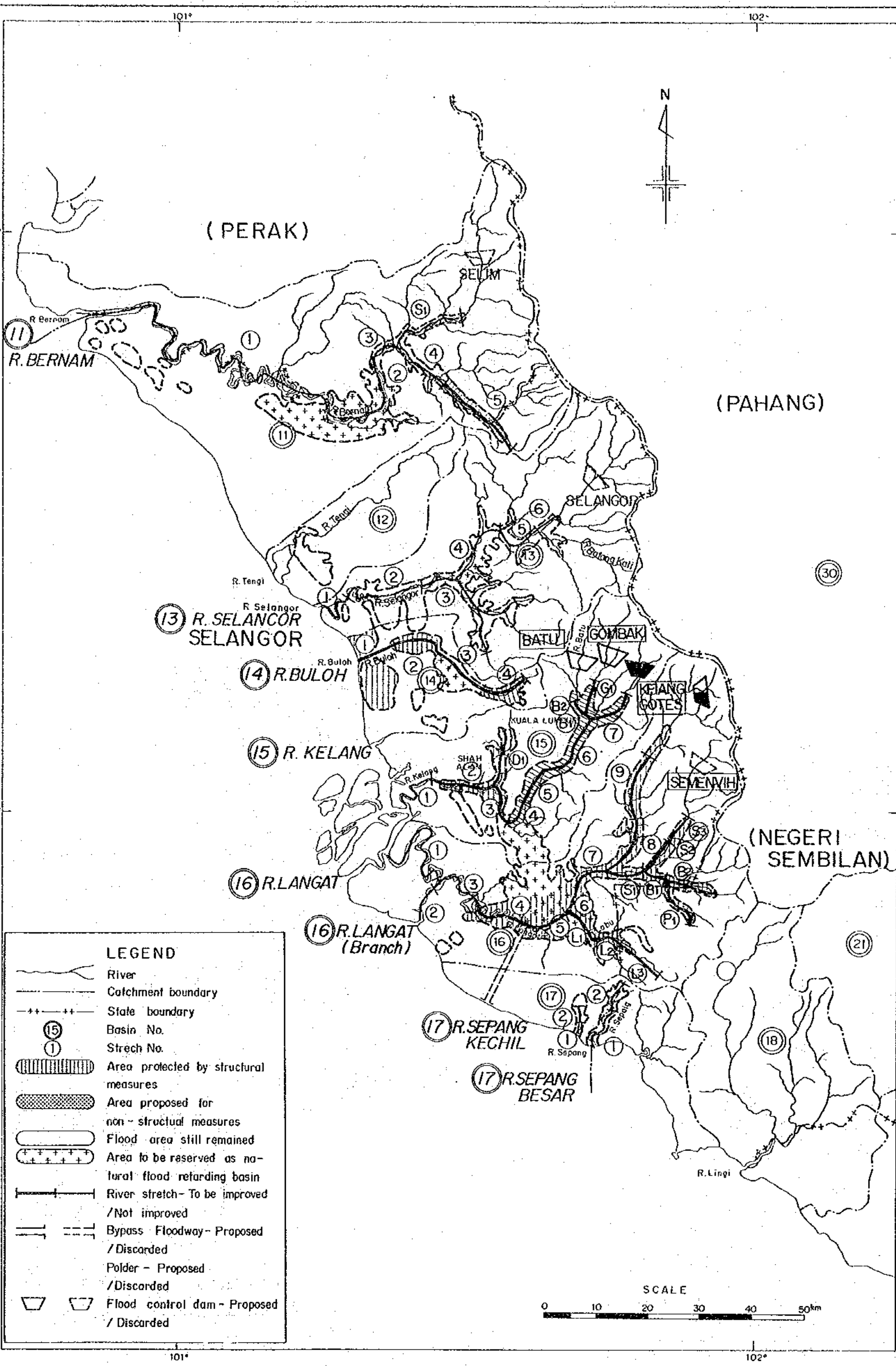

Fig.10 Flood Mitigation Alternatives, Alternative F3

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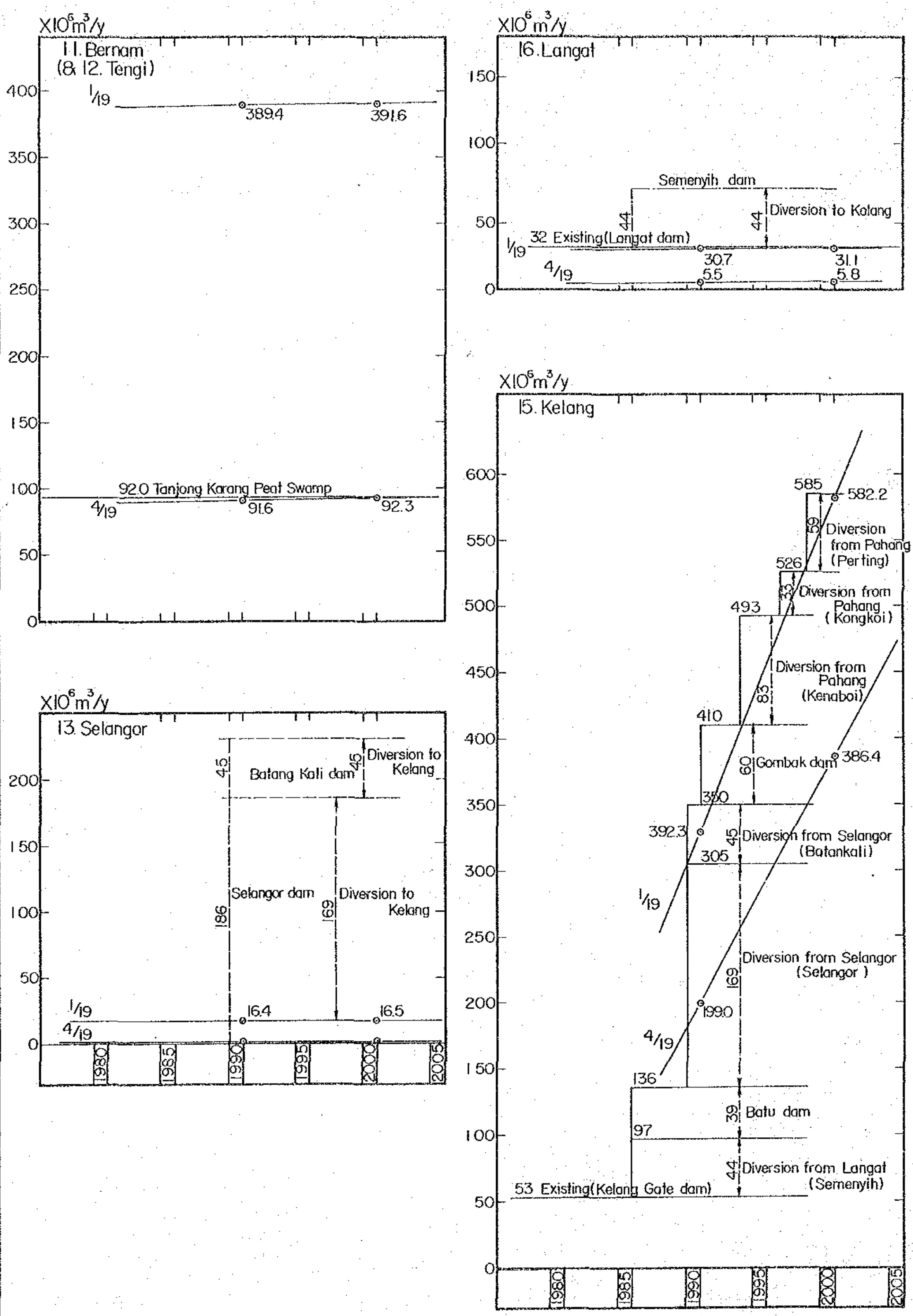

Fig. 11 Recommended Water Demand and Supply Balance Program For Kelang Valley, and Bernam and Tengi River Basins

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