JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF IRRIGATION AND DRAINAGE
MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT
MALAYSIA

THE PREPARATORY SURVEY FOR INTEGRATED RIVER BASIN MANAGEMENT INCORPORATING INTEGRATED FLOOD MANAGEMENT WITH ADAPTATION OF CLIMATE CHANGE

FINAL REPORT

Volume 2. Muar River Basin

JANUARY 2011

CTI ENGINEERING INTERNATIONAL CO., LTD.

YACHIYO ENGINEERING CO., LTD.

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The Currency Exchange Rate as of September 13, 2010 is as follows:

RM 1.00 = JPY 27.08

List of Reports

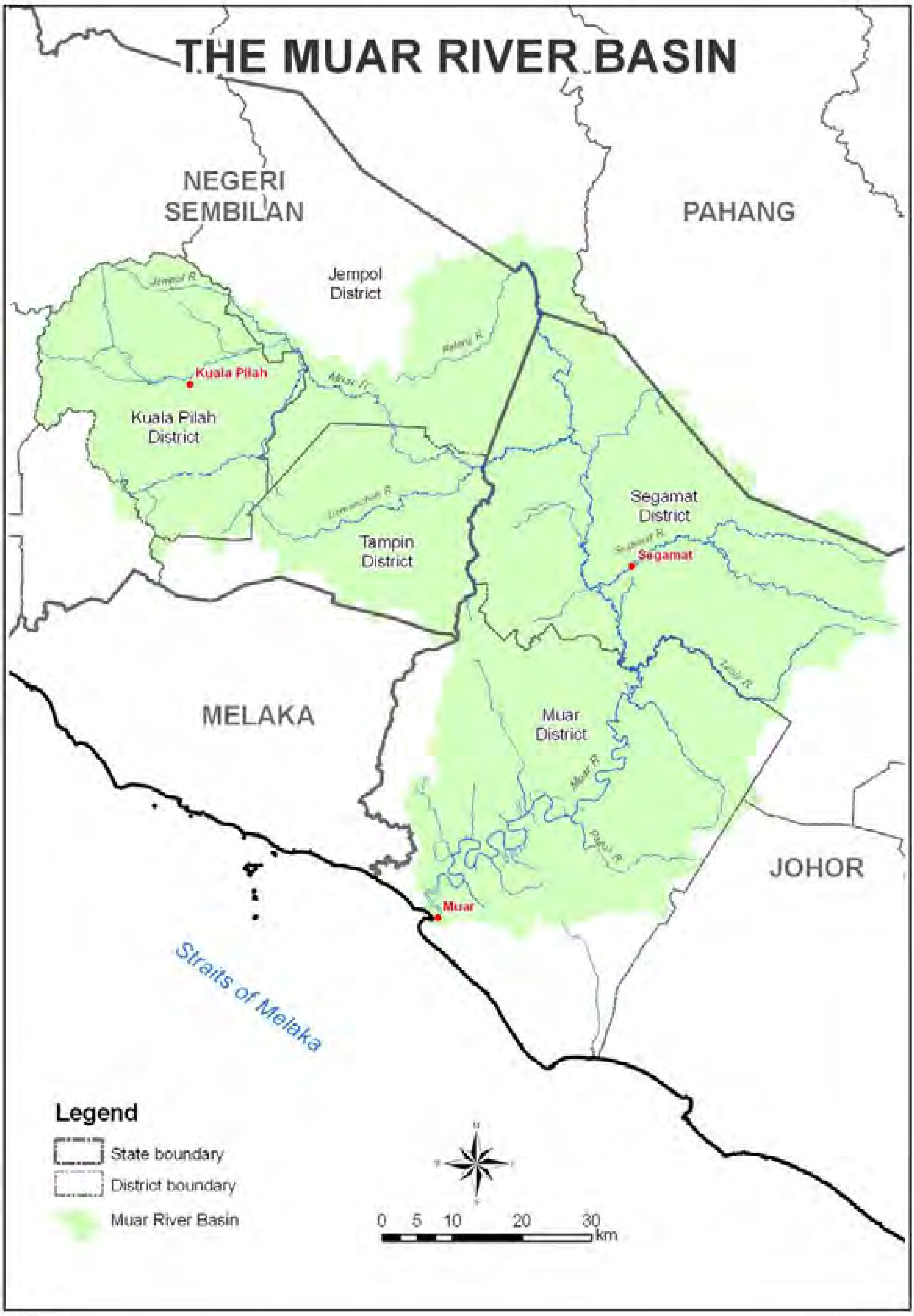
Summary

Volume 1: Common Contexts

Volume 2: Muar River Basin

Volume 3: Pahang River Basin

VOLUME 2.
MUAR RIVER BASIN


THE MUAR RIVER BASIN
NEGERI SEMBILAN
PAHANG
Jempol District
Kuala Pilah
Kuala Pilah District
Tampin District
Segamat District
Segamat
MELAKA
Muar District
JOHOR
Muar
Straits of Melaka
Legend
State boundary
District boundary
Muar River Basin
0 5 10 20 30 km

The Muar River

River mouth of the Muar River, adjacent to Muar Town.

Midstream of the Muar River, adjacent to the confluence with the Chodan River, Segamat, Johor.

Water Utilization

There are some minor fishing activities along the Muar River. This picture was taken at Panchor while the fisherman unloading the freshwater prawns from his boat.

There are a number of water intake points along the Muar River. This picture shows the pumping station at Kpg. Jambu Lapan, Negeri Sembilan.

Environmental Issues

Wastewater from wet markets is one of the main sources of pollution load to the rivers. This picture was taken at the Labis wet market whereby wastewater together with some solid wastes from poultry slaughtering activities was discharged into a drain that flows into the Labis River right next to the market.

Flood Management Facilities

A flood warning siren was installed at Kpg. Raja Pagoh, adjacent to Pagoh Town, after the 2006/2007 flood.

2006 Flood

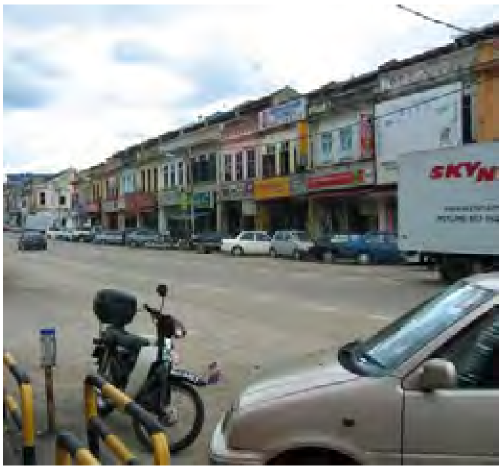
Panchor Town of Muar District suffered serious flood in December 2006. As shown in this picture, half of the ground floor of these shophouses was flooded.

Inundated areas of Segamat Town during the December 2006 flood. Local people were evacuating from the area.

Gemas River

Gemas River and flood warning siren adjacent to Kampung Tiong

Interview with local resident about flood damage
Date : 4th April 2010
Venue : Gemas Bharu, Segamat



Main Street of Gemas Town adjacent to Gemas railroad station

Interview with local resident about flood damage
Date : 3rd May 2010
Venue : Gemas Bharu, Segamat

The Preparatory Survey
for Integrated River Basin Management incorporating Integrated Flood Management with Adaptation of Climate Change

Final Report
Volume 2. Muar River Basin

Table of Contents

List of Tables

List of Figures

Abbreviations

AMRFF	Atmospheric model-based rainfall and flood forecasting system
AR4	IPCC Fourth Assessment Report
ARI	Average Recurrence Interval
ASMA	Alam Sekitar Malaysia Sdn. Bhd.
B/C	Benefit/Cost
BAKAJ	Johor Water Regulatory Body (*Badan Kawalselia Air Johor*)
BKSA	Water Regulatory Body (*Badan Kawalselia Air*)
BOD/BOD5	Biochemical oxygen demand
BORDA	Bremen Overseas Research and Development Association
COD	Chemical oxygen demand
CORPRI Model	Corporatization and Privatization Model
DID	Department of Irrigation and Drainage
DEWATS	Decentralised Wastewater Treatment Solution
DMRC	Disaster Management and Relief Committee
DO	Dissolved oxygen
DOCC	District Disaster Operations Control Center
DOE	Department of Environment
DTGSM	Peninsular Malaysia Geodetic Vertical Datum (*Datum Tegak Geodesi Semenanjung Malaysia*)
DTM	Digital Terrain Model
DVS	Department of Veterinary Service (*Jabatan Perkhidmatan Veterinar*)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EPU	Economic Planning Unit (Unit Perancang Economi)
EQA	Environmental Quality Act 1974
EQR	Environmental Quality Report
ESA	Environmental Sensitive Area
EXCO	Executive Council
GCM	General Circulation Model
GEV	General Extreme Value
GHG	Greenhouse gas
GRDP	Gross Regional Domestic Products
HH	Household
IEE	Initial Environmental Evaluation
IFM	Integrated Flood Management
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
IST	Individual septic tank
IWK	Indah Water Konsortium Sdn. Bhd.
IWRM	Integrated Water Resources Management
JAS	Department of Environment (*Jabatan Alam Sekitar*)
JBA	Water Supply Department *(Jabatan Bekalan Air*)
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JKPS	River Management Committee (*Jawatankuasa Pengurusan Sungai*)
JKR	Public Works Department (*Jabatan Kerja Raya*)
JMG	Department of Mineral and Geoscience (*Jabatan Mineral dan Geosains*)
JPBD	Department of Town and Country Planning (*Jabatan Perancangan Bandar dan Desa*)
JPBB	Disaster Management and Relief Committee *(Jawatankuasa Pengurusan dan Bantuan Bencana)*
JPBBD	District Disaster Management and Relief Committee (*Jawatankuasa Pengurusan dan Bantuan Bencana Daerah*)
JPPH	Valuation and Property Services Department (*Jabatan Penilaian dan Perkhidmatan Harta*)
JUPEM	Department Survey and Mapping Malaysia (*Jabatan Ukur dan Pemetaan Malaysia*)
Kg.	Village (*kampung*)
KL	Kuala Lumpur
LA	Local authority
LKIM	Malaysian Fisheries Development Board (*Lembaga Kemajuan Ikan Malaysia*)
LTFM	Linear Transfer Function Model
LUAN	Kedah Water Management Authority (*Lembaga Urus Air Negeri Kedah*)
LUAS	Selangor Water Management Authority (*Lembaga Urus Air Selangor*)
MaCGDI	Malaysian Center for Geospatial Data Infrastructure
MCM	Million cubic meter
Mld	Million liter per day
MMD	Malaysian Meteorologial Department
MRSO	Malaysian Rectified Skew Orthomophic
MyGDI	Malaysian Geospatial Data Infrastructure
NAHRIM	National Hydraulic Research Institute of Malaysia
NCLG	National Council for Local Government

NGVD	National Geodetic Vertical Datum
NH3-N	Ammoniacal nitrogen
NPV	Net present value
NRE	Natural Resources and Environment
NRW	Non-Revenue Water
NSC	National Security Council
NWQS	National Water Quality Standard
NWRC	National Water Resources Council
NWRD	National Water Resources Department
NWRS	National Water Resources Study (2000)
NWRS	National Water Resources Study, Malaysia (JICA, 1982)
NWSC	Suruhanjaya Perkhidmatan Air Negara
OJT	On-the-job training
PAAB	Water Asset Management Company (*Pengurusan Aset Air Berhad*)
PERHILITAN	Department of Wildlife and Natural Park Peninsular Malaysia (*Jabatan Perlindungan Hidupan Liar dan Taman Negara, Semenanjung Malaysia)*
PFA	Pig farm area
ppm	Part per million
PRECIS	Providing Regional Climate Impact Studies
PTG	Land and Mines Office (*Pejabat Tanah dan Galian*)
PWCC	PricewaterhouseCoopers Consulting Sdn. Bhd.
RBC	River Basin Committee
RB-DSS	National River Basin Decision Support System
RB-IMS	River Basin Infrastructure Management System
RBMO	River Basin Management Office
RBO	River Basin Organization
RB-SMS	River Basin Geographical Information System
RB-SMS	River Basin Simulation Modeling System
RCM	Regional Climate Model
RegHCM-PM	Regional Hydroclimate Model of Peninsular Malaysia
RM	Ringgit Malaysia
RMK-10	Tenth Malaysia Plan
RMK-8	Eighth Malaysia Plan
RMK-9	Ninth Malaysia Plan
RRB	National Register of River Basin Study
RRB2	Second Phase of the National Register of River Basin Study
RTU	Remote Terminal Unit
SAINS	Syarikat Air Negeri Sembilan Sdn. Bhd.
SAJ	Johor Water Company (*Syarikat Air Johor*)
SBMO	Sub-Basin Management Office
Sg.	River (*sungai*)
SPAN	Suruhanjaya Perkhidmatan Air Negara
SS	Suspended solids
st.	Station
STP	Sewage treatment plant
SWM	SWM Environment Sdn. Bhd.
SWRC	State Water Resources Council
TDS	Total dissolved solids
Tg.	Tanjung
TNB	Tenaga Nasional Berhad
TOR	Terms of Reference
TSS	Total suspended solids
UPEN	State Economic Planning Unit (*Unit Perancang Ekonomi Negeri*)
UPPP	Federal Project Implementation Unit (*Unit Pelaksanaan Projek Persekutuan*)
USD	US Dollar
USEPA	The United States Environmental Protection Agency
W.L.	Water Level
WRD	Water Resources Department
WQI	Water Quality Index

Measurement Units

(Length)

mm	:	millimeter(s)
cm	:	centimeter(s)
m	:	meter(s)
km	:	kilometer(s)

(Area)

mm^2	:	square millimeter(s)
cm^2	:	square centimeter(s)
m^2	:	square meter(s)
km^2	:	square kilometer(s)
ha	:	hectare(s)

(Weight)

g, gr	:	gram(s)
kg	:	kilogram(s)
ton	:	ton(s)

(Time)

s, sec	:	second(s)
min	:	minute(s)
h, hr	:	hour(s)
d, dy	:	day(s)
y, yr	:	year(s)

(Volume)

cm^3	:	cubic centimeter(s)
m^3	:	cubic meter(s)
l, ltr	:	liter(s)
mcm	:	million cubic meter(s)

(Speed/Velocity)

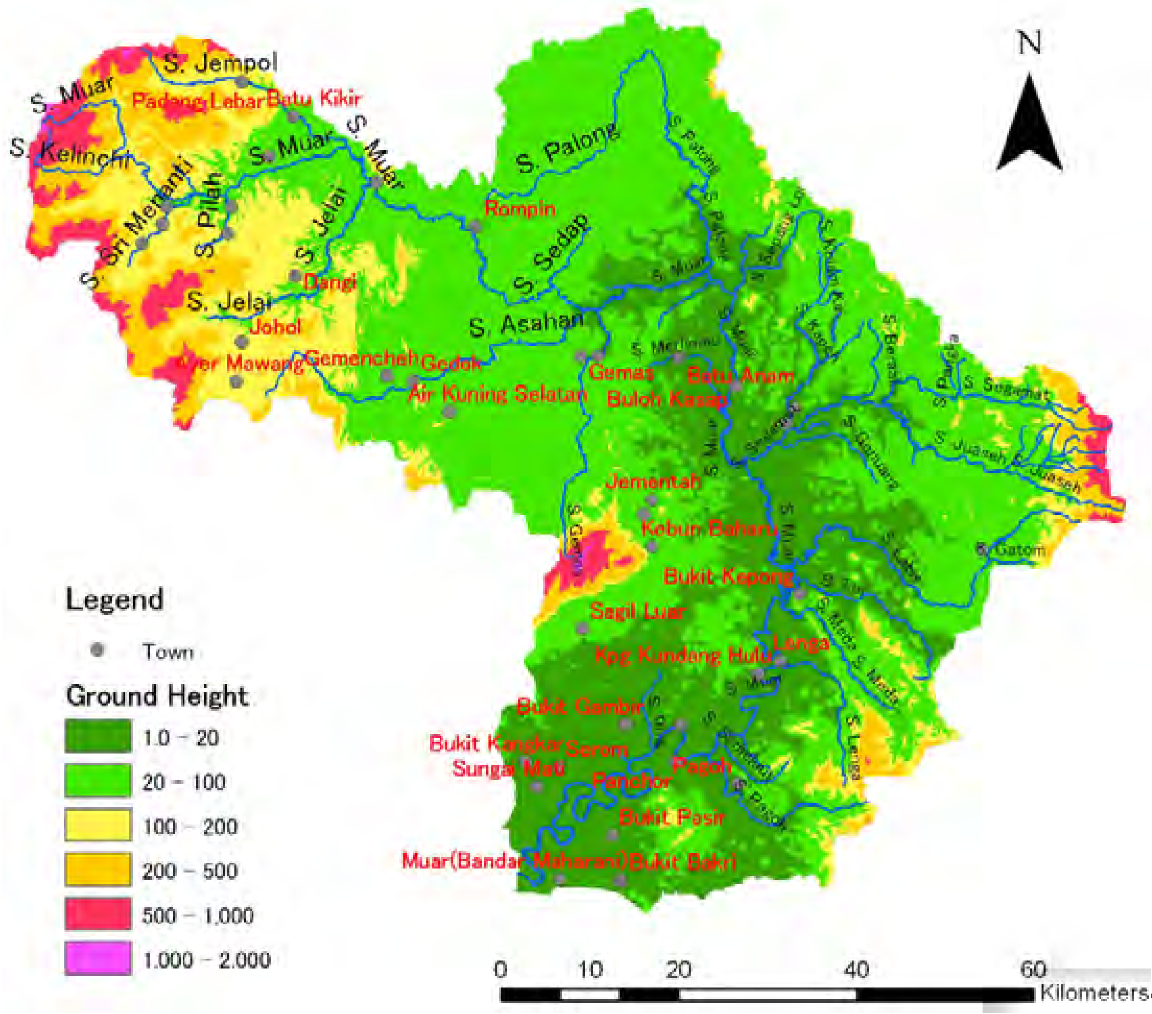
cm/s	:	centimeter per second
m/s	:	meter per second
km/h	:	kilometer per hour

CHAPTER 1 PHYSICAL AND BIOLOGICAL CONDITION

1.1 Topography

Since the Muar River Basin is situated at the southernmost edge of the Titiwangsa Mountain Range, mountains in the river basin ranging 500 to about 1000m in elevation are generally lower than those in the other river basins located in the north of the basin. The highest mountain in the river basin is Telapak Burok Mountain with the elevation of 1,193m, where tributaries are generated and flow eastward into the main river. The north to northeast basin boundary is delineated on the low lying ridge with the elevation from 20 to 100m. The eastern projecting mountainous area holds the Mount Besar with the summit elevation of 1,006m, which are the origin of major tributaries, Segamat River and Labis River.

Low-lying areas, which are situated along the lower and middle reaches of the Muar River and its tributaries, range from 1 to 20m in elevation. These areas which account for one forth of the river basin often have suffered from flood inundation due to the insufficient low capacity of the river channels. In the upper reaches from the confluence of the Asahan tributary, the river channel is steeper and narrow valley bottom plains are formed along the river.



Topo

Figure 1.1.1 Topographoical Map of Muar River Basin

1.2 Geology

According to a geological map provided by DID, sedimentary rocks and metamorphic rocks in the periods from Ordovician (Paleozoic) to Tertiary (Cenozoic) can be seen in the Muar River Basin. The geological formation of the basin consists essentially of Triassic sedimentary/metamorphic rocks, Igneous rocks (Granites and Basalts), and Permian and Quaternary sediments. The remainings are covered by Jurassic-Carboniferous sedimentary / metamorphic rocks, Ordovician-Silurian sedimentary / metamorphic rocks, as shown in **Figure 1.2.1**

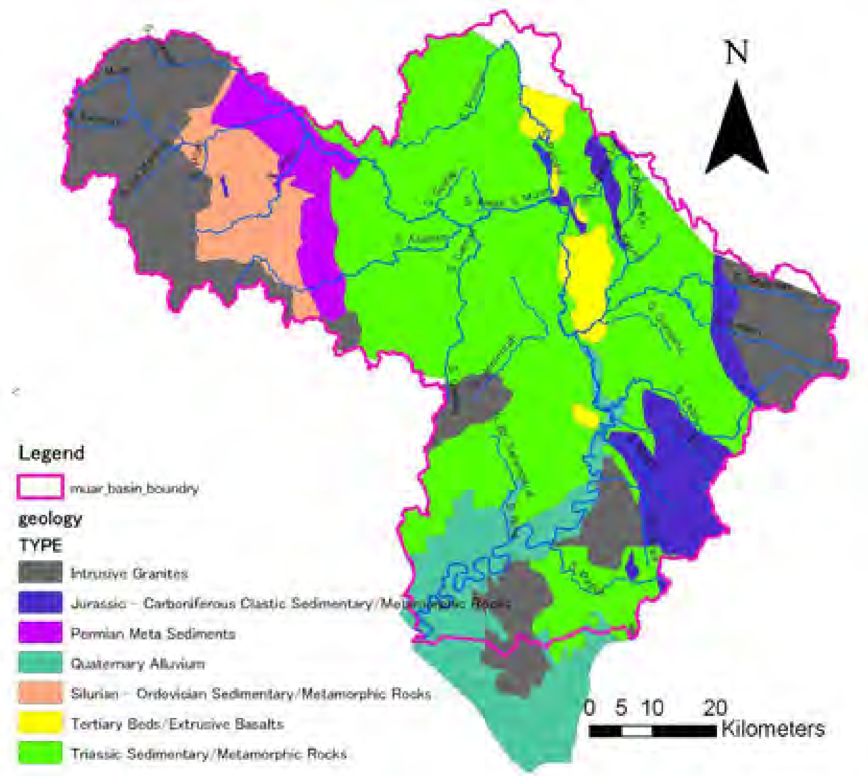


Figure 1.2.1 Geological Map of Muar River Basin

Major predominant geological systems in the Muar River Basin are described as follows:

In the coastal plain and the plain along the Muar River, Quaternary alluvial sediments extend tapering to the confluence of the Segamat tributary. Normally, the Quaternary system includes all of semi-consolidated and unconsolidated deposits consisting of boulders, gravels, sand, silt and clay. Those materials form various kinds of deposits such as river deposits, deltaic deposits, terrace deposits, marine coastal deposits and rhyolitic volcanic ash that has its origin from the eruption of the Lake Toba in Sumatra.

Half of the basin is dominated by the Triassic sedimentary/metamorphic rocks, especially in the central and northern areas of the basin. Normally, in Malaysia, sediments of Triassic to early Jurassic are seen but sediments of upper Permian to lower Triassic are rarely seen. The lower Triassic sediments are often composed of limestones and phyroclastic rocks. The middle to upper Triassic is characterized by flysch type sediments, consisting of mudstones, shales, sandstones and conglomerates.

Intrusive granite areas can be seen in the several parts of the basin. In the period from late Carboniferous to early Permian, granite intrusion or replacement took place in many parts of Peninsular Malaysia. The orogeny in the early Triassic also brought about an extensive granite intrusion and the latest granite intrusions happened in the early Tertiary.

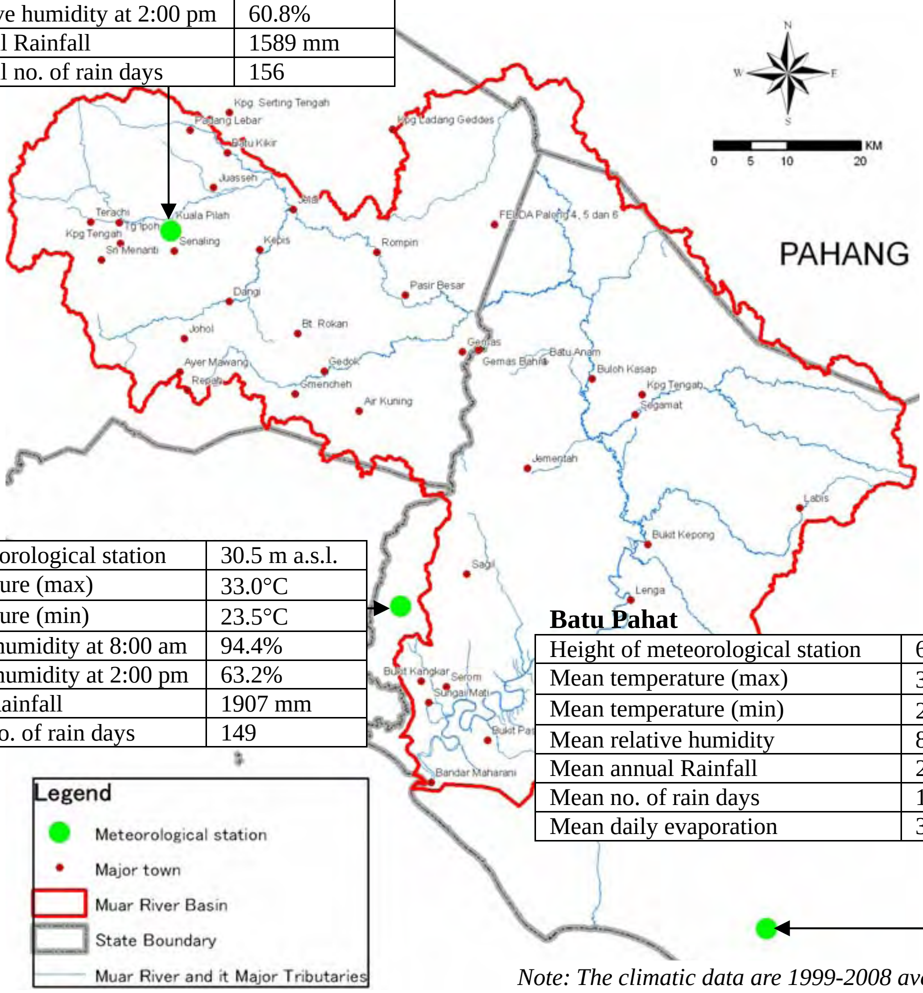
1.3 Meteorology and Hydrology

1.3.1 General Climatic Characteristics

The Muar River Basin is located at the southern west coast region of Peninsular Malaysia. Normally, maximum rainfalls occur around the months of October to December, while the driest month is February. The mean maximum and minimum daily temperatures are in the range of 32-33°C and 22-23°C respectively, while mean relative humidity is generally above 85% with daily evaporation of about 3 mm. **Figure 1.3.1** and **Figure 1.3.2** summarized the climatic characteristics of the region based on the meteorological data of meteorological stations in and adjacent to the Muar River Basin, i.e. at Kuala Pilah, Tangkak and Batu Pahat.

Kuala Pilah

Height of meteorological station	106.7 m a.s.l.
Mean temperature (max)	32.5°C
Mean temperature (min)	22.4°C
Mean relative humidity at 8:00 am	93.7%
Mean relative humidity at 2:00 pm	60.8%
Mean annual Rainfall	1589 mm
Mean annual no. of rain days	156



Tangkak

Height of meteorological station	30.5 m a.s.l.
Mean temperature (max)	33.0°C
Mean temperature (min)	23.5°C
Mean relative humidity at 8:00 am	94.4%
Mean relative humidity at 2:00 pm	63.2%
Mean annual Rainfall	1907 mm
Mean annual no. of rain days	149

Batu Pahat

Height of meteorological station	6.3 m a.s.l.
Mean temperature (max)	31.9°C
Mean temperature (min)	23.4°C
Mean relative humidity	86.5%
Mean annual Rainfall	2203 mm
Mean no. of rain days	190
Mean daily evaporation	3.1 mm

Note: The climatic data are 1999-2008 average.

Figure 1.3.1 General Climatic Characteristics of the Muar River Basin[1]

[1] Data source: Malaysian Meteorological Department

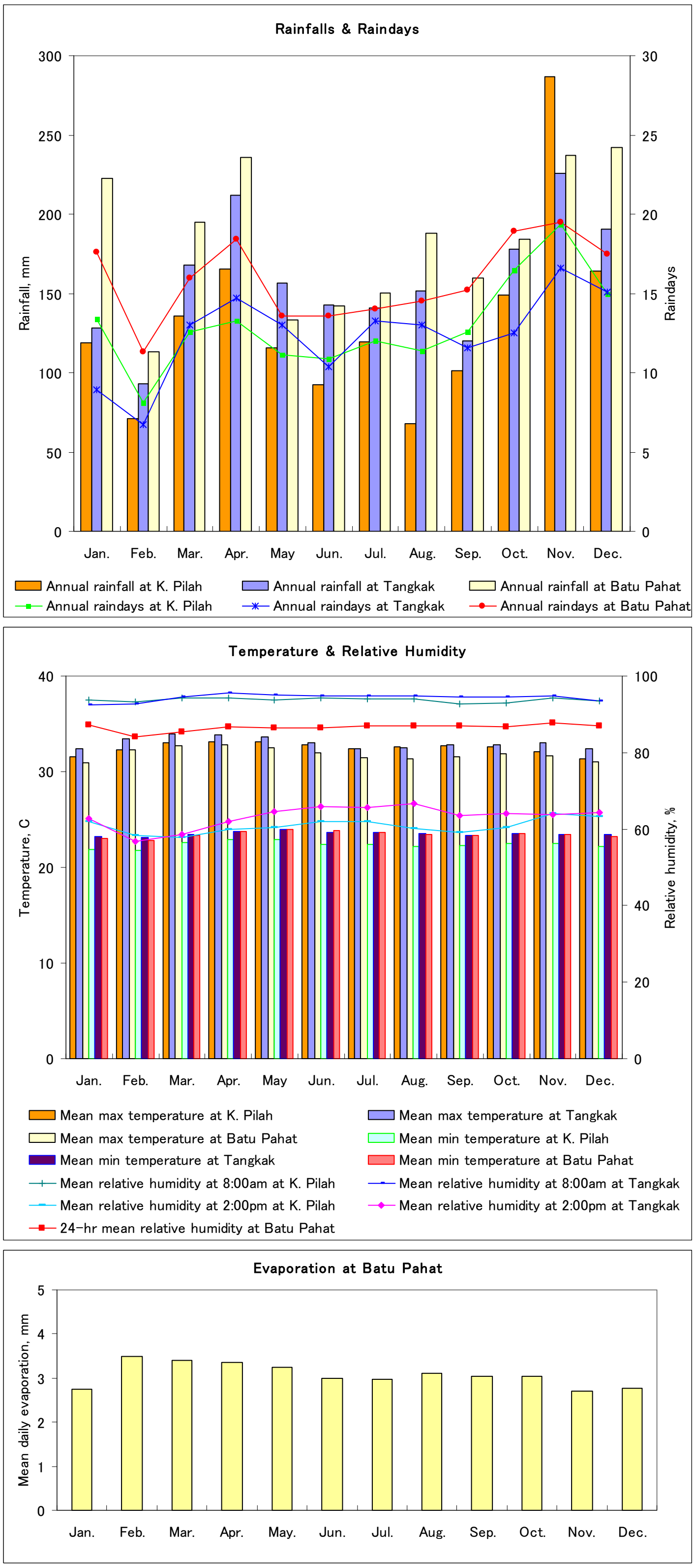


Figure 1.3.2 Climate Characteristics at Kuala Pilah, Tangkak and Batu Pahat, 1999-2008[2]

[2] Stations Hospital Kuala Pilah, Hopital Tangkak and Batu Pahat, Malaysian Meteorological Department, 2009.

1.3.2 Rainfall

10 rainfall stations were selected to assess the average annual rainfall (see chapter 4 for the selection process). Location and ID numbers of the rainfall stations are shown in **Figure 1.3.3** with the annual rainfall distribution. The annual rainfall varies from approximately 1200 to 2000mm within the basin and relatively high annual rainfall are observed in the east to southwest of the basin along the boundary. Rainy season starts from October and maximum monthly average rainfalls are observed in November to January next year in most of the stations. Annual basin mean rainfall obtained from 10 years rainfall data of 1999-2008 is 1824mm as shown in **Figure 1.3.4**

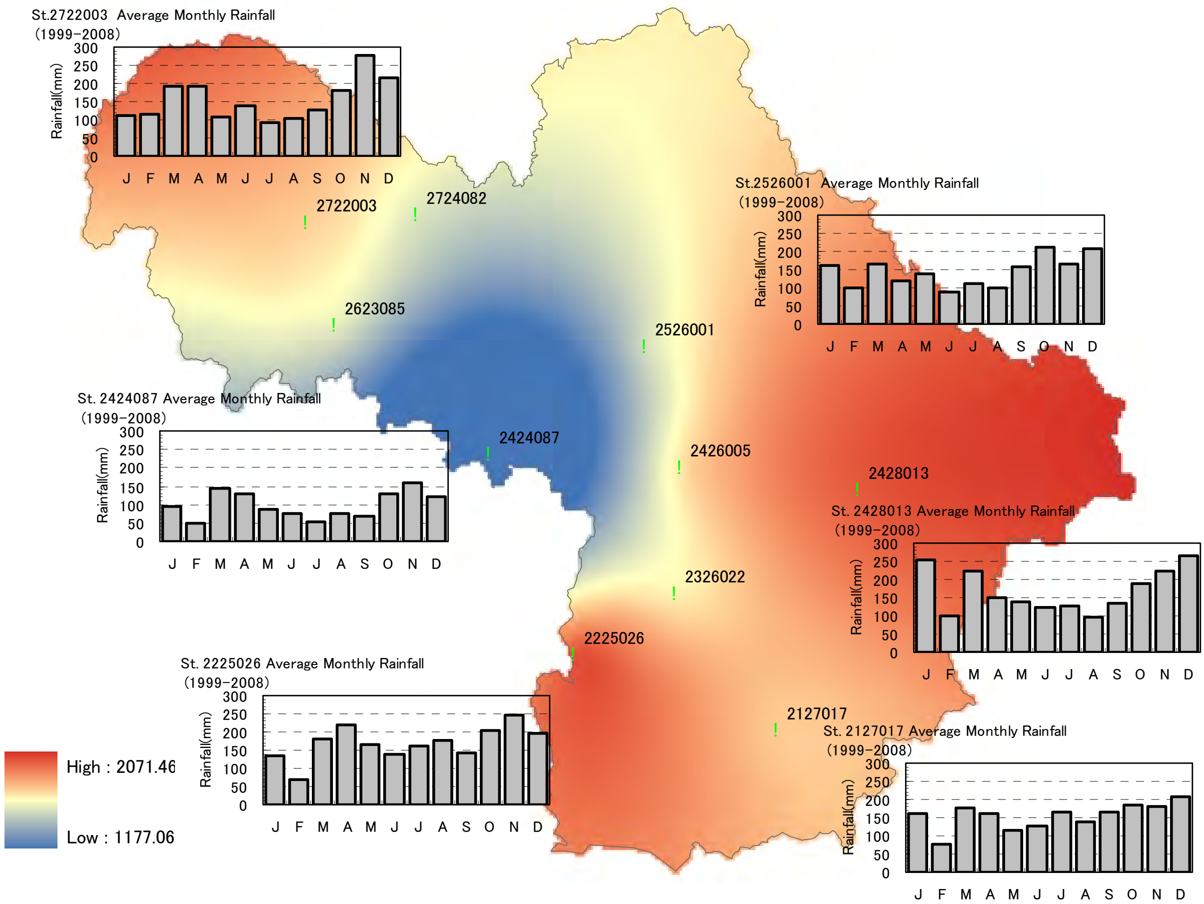


Figure 1.3.3 Annual Rainfall Distribution in Muar River Basin

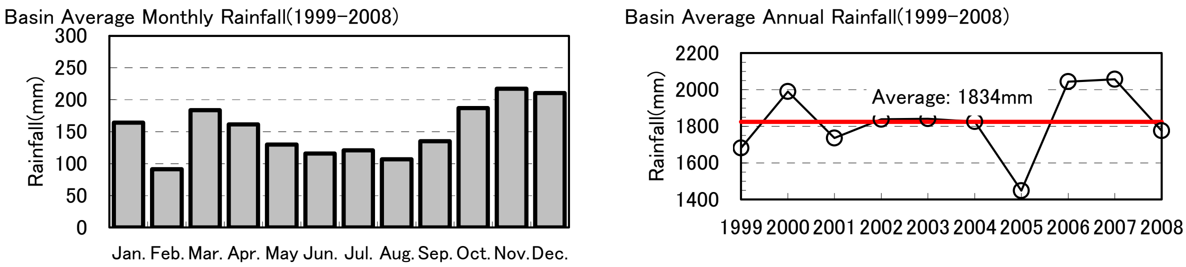


Figure 1.3.4 Basin Mean Monthly and Annual Rainfall based on 1999-2008 Data
(Left Panel: Monthly Rainfall, Right Panel: Annual Rainfall)

1.3.3 Tide

10 years (1999-2008) data of Tanjung Keling, the closest tide observation station to the Muar river mouth, was obtained from Department of Survey and Mapping (JUPEM). **Figure 1.3.5** shows the daily average, maximum and minimum sea level and **Table 1.3.1** shows ones for respective months based on 10 years observation. There are no significant seasonal variations observed in the sea level of Tanjung Keling. However, maximum sea levels are observed between October and December which coincides with rainy season of the Mura River Basin.

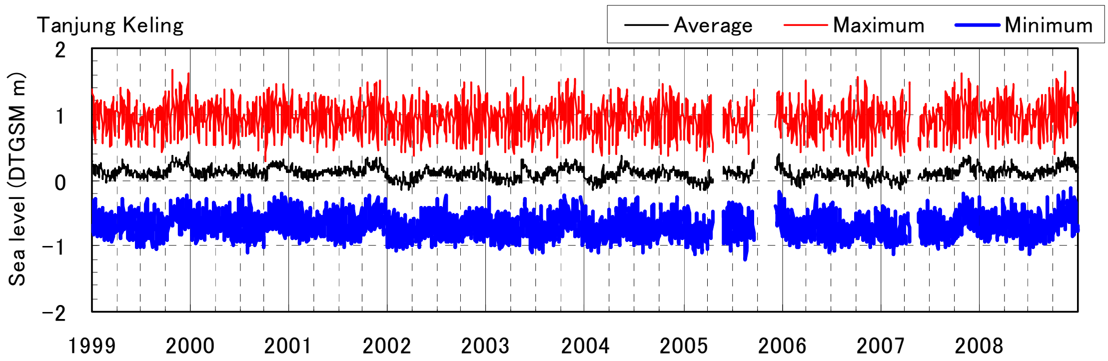


Figure 1.3.5 Daily Average, Maximum and Minimum Sea Level

Table 1.3.1 Monthly Average Sea Level at Tanjung Keling

(DTGSM m)

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec
1999	Average	0.17	0.10	0.07	0.17	0.14	0.08	0.07	0.09	0.10	0.19	0.25	0.24
	Maximum	1.37	1.21	1.27	1.40	1.36	1.21	1.16	1.11	1.35	**1.66**	1.48	1.62
	Minimum	-0.87	-0.91	-0.94	-0.88	-0.91	-1.01	-1.02	-1.06	-0.98	-0.91	-0.82	-0.75
2000	Average	0.10	0.10	0.13	0.13	0.14	0.11	0.14	0.13	0.11	0.17	0.23	0.20
	Maximum	1.28	1.17	1.24	1.28	1.37	1.37	1.30	1.27	1.33	1.39	1.45	**1.46**
	Minimum	-0.97	-0.91	-0.86	-0.88	-0.92	-1.00	-1.05	-1.11	-1.02	-0.78	-0.80	-0.89
2001	Average	0.15	0.12	0.08	0.09	0.14	0.12	0.13	0.15	0.12	0.21	0.21	0.16
	Maximum	1.38	1.28	1.33	1.31	1.27	1.24	1.20	1.27	1.41	1.48	1.48	**1.50**
	Minimum	-0.89	-0.98	-0.95	-0.89	-0.91	-0.99	-1.02	-0.96	-0.94	-0.83	-0.78	-0.89
2002	Average	-0.01	-0.01	-0.02	0.03	0.12	0.12	0.13	0.11	0.07	0.10	0.10	0.11
	Maximum	1.21	1.17	1.29	1.39	1.34	1.16	1.16	1.18	1.29	**1.48**	**1.48**	1.43
	Minimum	-1.08	-1.05	-1.01	-1.02	-0.92	-1.03	-0.94	-0.95	-1.01	-0.94	-0.94	-0.95
2003	Average	0.08	0.02	0.01	0.02	0.15	0.06	0.03	0.12	0.11	0.21	0.21	
	Maximum	1.33	1.17	1.32	1.39	1.57	1.23	1.13	1.26	1.47	**1.54**	1.53	
	Minimum	-1.00	-1.05	-1.01	-1.00	-0.99	-1.10	-1.11	-0.95	-0.99	-0.85	-0.85	
2004	Average	-0.01	-0.04	0.05	0.05	0.19	0.17	0.11	0.08	0.09	0.12	0.11	0.09
	Maximum	1.15	1.11	1.30	1.37	1.41	1.37	1.19	1.26	1.36	**1.45**	1.43	1.33
	Minimum	-1.07	-1.09	-0.98	-1.02	-1.00	-0.91	-1.00	-1.11	-0.97	-0.83	-0.97	-0.97
2005	Average	0.04	-0.03	-0.07			0.12	0.10	0.07				
	Maximum	1.25	1.15	1.22			1.20	1.19	1.26				
	Minimum	-1.03	-1.13	-1.09			-1.07	-1.00	-1.21				
2006	Average	0.13	0.01	0.04	0.08	0.12	0.07	0.10	0.07	0.05	0.09	0.01	0.05
	Maximum	1.32	1.21	1.50	1.37	1.29	1.08	1.12	1.25	1.42	**1.57**	1.50	1.28
	Minimum	-1.00	-1.03	-0.98	-0.95	-0.96	-1.09	-1.08	-1.02	-1.03	-0.90	-1.03	-0.97
2007	Average	0.08	-0.03	-0.01			0.08	0.08	0.10	0.09	0.15	0.29	0.17
	Maximum	1.19	1.27	1.36			1.16	1.10	1.28	1.48	**1.61**	1.55	1.43
	Minimum	-1.02	-1.12	-1.00			-1.00	-1.05	-1.03	-0.99	-0.88	-0.74	-0.85
2008	Average	0.13	0.09	0.12	0.17	0.17	0.06	0.07	0.12	0.14	0.19	0.27	0.23
	Maximum	1.21	1.24	1.41	1.44	1.45	1.25	1.15	1.29	1.39	1.54	**1.65**	1.41
	Minimum	-0.93	-0.95	-0.91	-0.94	-0.88	-1.05	-1.12	-0.97	-0.93	-0.83	-0.75	-0.87
1998 -2008	Average	0.08	0.03	0.04	0.09	0.15	0.10	0.10	0.10	0.10	0.16	0.19	0.16
	Maximum	1.38	1.28	1.50	1.44	1.57	1.37	1.30	1.29	1.48	**1.66**	1.65	1.62
	Minimum	-1.08	-1.13	-1.09	-1.02	-1.00	-1.10	-1.12	-1.21	-1.03	-0.94	-1.03	-0.97

1.4 River Condition

1.4.1 River System

The length of the Muar River is about 310 km. It is classified as a federal river as it flows through four States, namely Negeri Sembilan, Pahang, Melaka and Johor. It originates from the southern tip of the Titiwangsa Range in Negeri Sembilan. Although most of the tributaries emerge within the state of Negeri Sembilan, the Gemencheh and Palong Rivers are originated within the territories of the states of Melaka and Pahang respectively. The Muar River flows eastward from Kuala Pilah District to Jempol District of Negeri Sembilan. It meets with the Gemencheh River that flows from the south before entering Segamat District of the state of Johor. After joining with the Palong River, it changes its direction to southward due to landform limitations surrounded by the Tahan Range in the east, the Mount Ledang in the west and the Mount Ma' Okil in the southeast. After joining with the Meda River adjacent to Mount Ma' Okil, the river reaches the alluvial plain, where the flow velocity drops and the river channel becomes wide and meandering. The River finally discharges into the Strait of Melaka after passing Muar Town. **Figure 1.4.1** shows the basic river network of the Muar River.

Figure 1.4.1 Muar River System

1.4.2 River Features

(1) Bed Slope

Table 1.4.2 shows the river bed profiles of the Muar River and its tributaries with chainage from the river mouth. The river bed of the main stream is almost flat from the river mouth to the chainage of 110km. The average bed slope is 0.019% (1/5,200) and 0.100% (1/1,000) between 110km and 200km and between 220km and 300km. The bed slope is as steep as 1.94% (1/51) above the chainage of 300km. The average bed slope of the Segamat River is 0.047% (1/2,100).

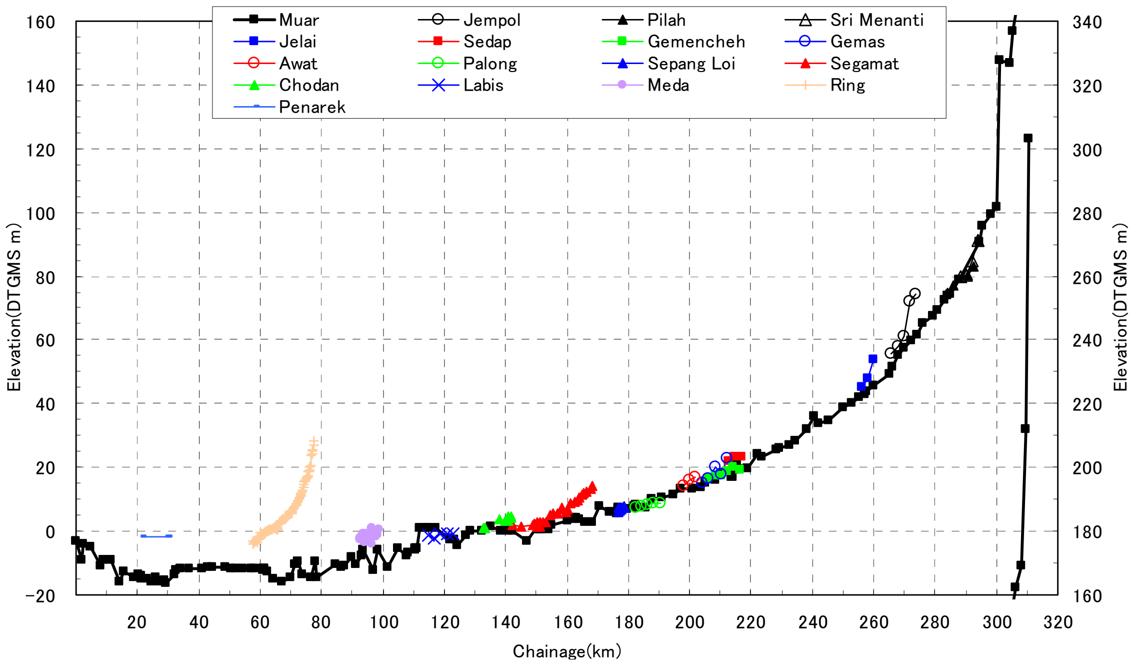


Figure 1.4.2 River Bed Profiles of Muar River and Tributaries

(2) River Discharge

Station 2527411 (Buloh Kasap) and Station 2528414 (the Segamat River) which are the most downstream water-gauge stations with discharge data in the main stream of the Muar River and the Segamat River were selected for further analysis on the river discharge characteristics of the basin (see **Capter4** for location of the observation stations). **Table 1.4.1** and **Figure 1.4.3** shows the monthly and annual average discharge with averaged month maximum/ minimum daily discharge based on the latest 10 years (1999-2008) data.

Table 1.4.1 10 year Average of Month Averaged and Minimum/ Maximum Daily Discharge (St. 2527411 and St. 2528414)

St. 2527411 (m^3/s)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Ave.	69.7	24.2	27.5	44.8	38.8	23.4	16.2	12.6	14.7	28.2	77.1	91.1	39.0
Max.	142.1	61.0	71.4	79.7	76.2	57.9	37.7	40.0	39.0	75.7	136.6	186.8	---
Min.	22.1	9.0	6.0	14.9	9.2	7.2	4.4	4.4	4.5	6.1	32.8	40.7	---

St. 2528414 (m^3/s)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug.	Sep.	Oct.	Nov.	Dec.	Ave.
Ave.	32.9	16.5	17.7	14.3	14.5	11.2	10.6	9.3	10.1	14.2	18.7	22.5	16.0
Max.	123.6	43.9	62.5	22.5	26.0	21.0	19.8	17.1	20.0	29.3	31.6	65.4	---
Min.	11.7	10.0	8.4	10.5	10.1	8.4	7.6	7.1	7.3	8.6	11.5	11.6	---

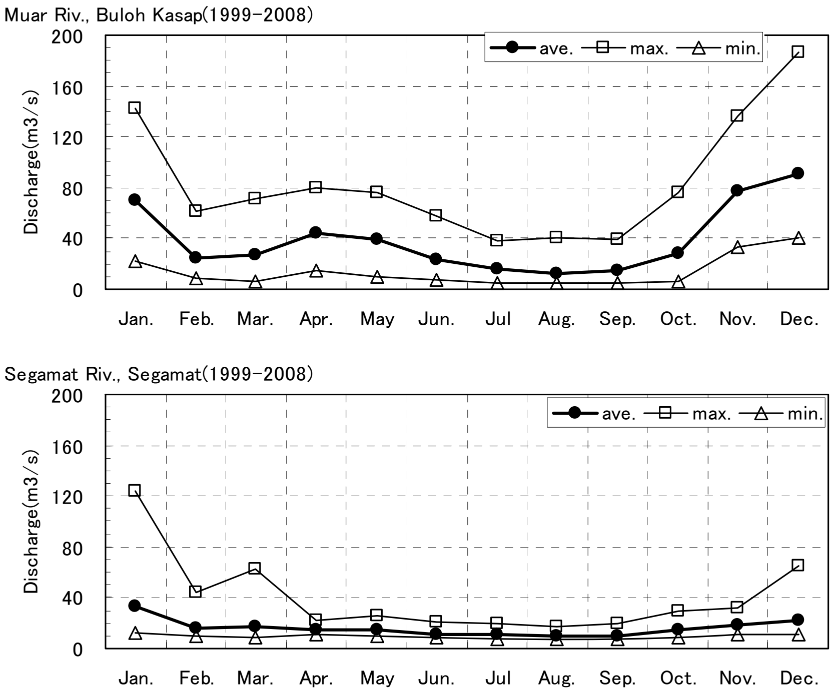


Figure 1.4.3 Monthly Average and Minimum/ Maximum Daily Discharge based on 1999-2008 Observation Data (St. 2527411 and St. 2528414)

River discharge rises above its annual average of 39m^3/s and 16m^3/s for St. 2527411 and St. 2528414 respectively from November to January next year which is consistent with the rainy season identified in **Section 1.3.2**. Most major flood events occur in November and January next year as seen in **Figure 1.4.4** which shows maximum daily discharge of each month obtained from the 10 years data.

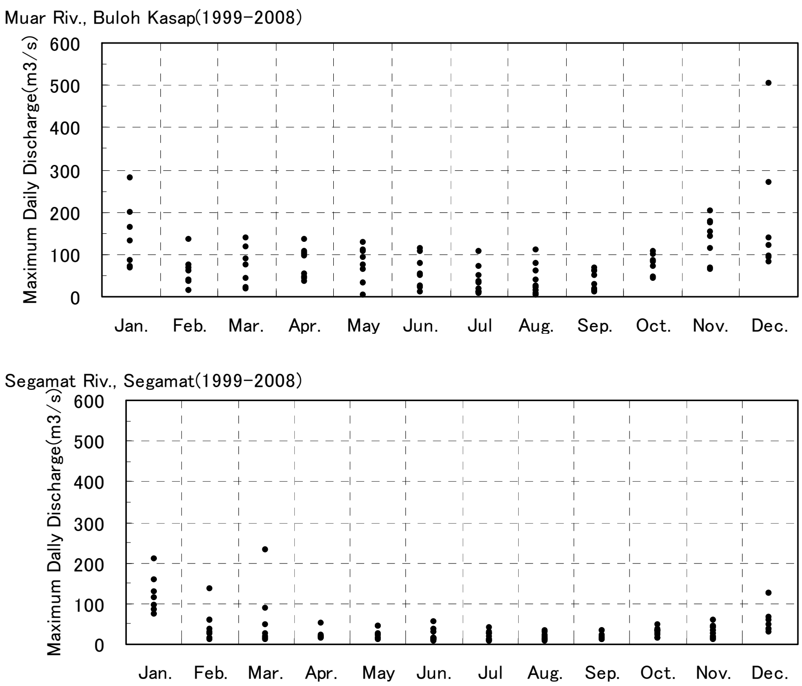


Figure 1.4.4 Monthly Maximum Daily Discharge (1999-2008, St. 2527411 and St. 2528414)

(3) Runoff Ratio

Annual discharge and average runoff ratio for the entire river basin was estimated based on the annual river discharge volume of St. 2527411 and St. 2528414, and annual basin mean rainfall data of latest 10 years (1999-2008). It should be noted that the catchment areas of the entire river basin, St 2527411 and St. 2528414 are 6,140km^2, 3,130km^2 and 658km^2 respectively. As shown in **Table 1.4.2** and **Figure 1.4.5**, average annual runoff ratio varies from approximately 0.2 to 0.4 and average is approximately 0.3.

Table 1.4.2 Annual Discharge and Rainfall Volume and Runoff Ratio of Muar River Basin

	Discharge (million m^3)	Rainfall (million m^3)	Runoff Ratio
1999	2,487	10,327	0.24
2000	2,726	12,217	0.22
2001	2,878	10,658	0.27
2002	3,090	11,285	0.27
2003	3,320	11,302	0.29
2004	3,378	11,213	0.30
2005	3,360	8,895	0.38
2006	3,306	12,554	0.26
2007	3,318	12,629	0.26
2008	3,301	10,903	0.30
Average	3,116	11,198	0.28

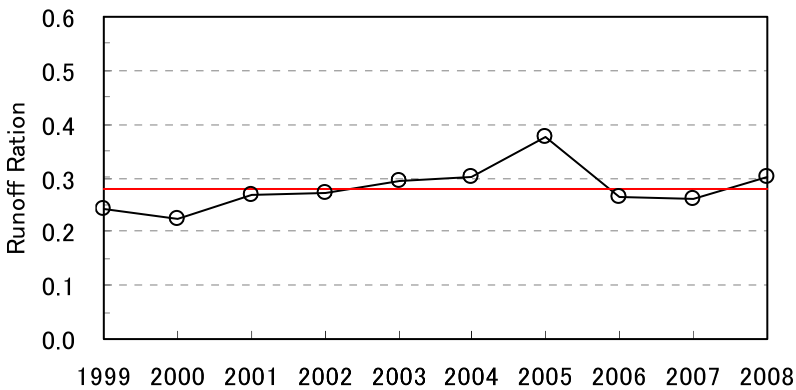


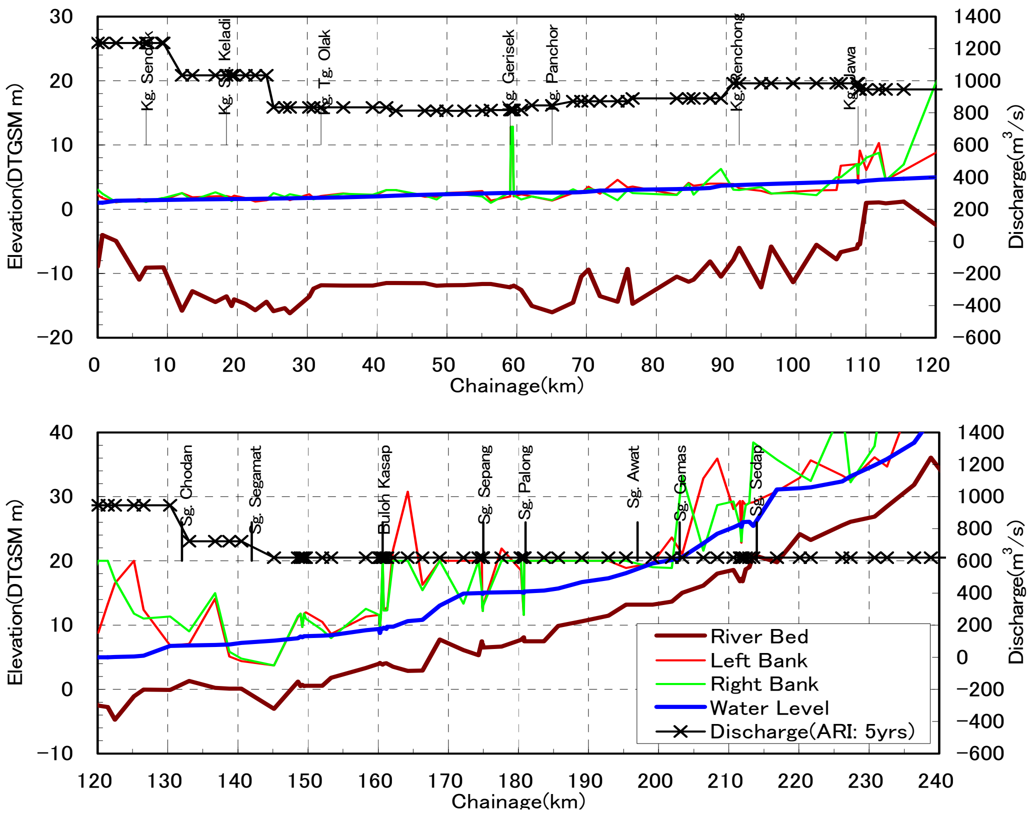
Figure 1.4.5 Annual Runoff Ratio

1.4.3 Flow Capacity and Regime

The existing flow capacities of the Muar River and its major tributaries were firstly estimated by the non-uniform calculation method using the mean higher high water level (EL+1.01m) at Tanjung Keling near the estuary of the Muar as the boundary condition at the downstream end. Then, the channel flow capacities were estimated through comparison of the flood water levels and the existing bank levels. The result is illustrated in **Figure 1.4.6**.

As judged from the figure, the most of sections in the lower stretches of the main river could hardly cope with the probable flood discharge of even the 5-year return period. It is because the ground levels of the river banks at Kg. Tanjung Temian, Kg. Jorak, Kg. Olak and Kg. Panchor etc. are as low as the high tide levels or lower.

The river gradient is so flat with many meandering loops in the lower stretches of the Muar River that the back water caused by the high tide affects even the middle stretches. Accordingly the flow capacities of the main river and the tributaries are decreased.



Discharge derived from "*Rancangan Tebatan Banjir Bagi Lembagan Subgai Muar (FASA1) Johor Hydrology Report(Revision1)*", *Sep. 2009.*

Figure 1.4.6 Flood Water Level Profile (5-Year Return Period) for Muar River

1.4.4 River Structures

Major river structures along the main stretch of Muar River in the lower streches between the river mouth and Buloh Kasap are described as below:

(1) Bridges

There are seven bridges between the river mouth to Buloh Kasap. All these bridges have sufficient clearance both for flood discharge and navigation. However, some old bridges with short spans and low girders that form bottlenecks of the main river courses and the tributaries are also seen. Abandoned ones left in the river channels are also obstacles to flood flow. They raise flood water to spill over the river banks.

Abandoned old bridge on the Muar River at Kg. Kuning Patah

Railway Bridge on Gemas River

Figure 1.4.7 Bridges Hindering River Flow

(2) Jetties

Many jetties exist in riverine villages or settlements along the Muar River constructed of wood or concrete. These jetties have either been built by the authorities such as DID, Marine Department, Fishery Department and local authorities or by individuals. Most wooden jetties are built for cross-river traffic purpose and for local people to moor their boats. There are at least four wooden jetties around Muar Town. Concrete jetties can be also found at the gravel quarry (0.7 km downstream of Gerisek Bridge), Gerisek Town, Panchor Town and Bukit Kepong Town.

Figure 1.4.8 Cross-river traffic at Kg. Kundang Ulu

(3) Bund

The bunds and control structures were constructed for tributaries such as Sg. Temian, Sg. Pergam, Sg. Tanjung Selabu and Sg. Tanjung Olak in the lower stretches to prevent the tidal inflow into the drainage system in the 1970-1980.

(4) Dam

Dams in the Muar River Basin are listed in listed in **Table 1.4.3**. Their major functions are water supply for domestic and agricultural use and none of them have capacity for flood control.

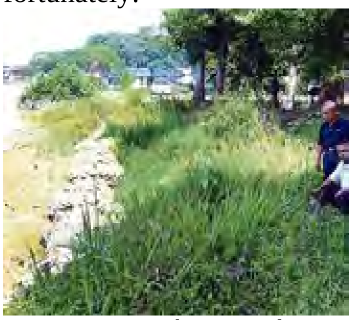
Table 1.4.3 Dam Structures

Name of Dam	Catchment Area (km2)	Active Storage Capacity (m3)	Reservoir Surface Area (km2)
Terip	23.0	2,081,000	4.0
Pedas	7.7	22,000	0.6
Upper Muar	148.0	3,242,000	14.5
Kelinchi	37.0	2,272,000	2.5
Gemench	37.0	1,307,000	3.0

1.4.5 Bank Erosion

Local presses highlighted the damage to cemetery by bank erosion at Kg. Melayu due to the 2006 flood. Johor State DID has carried out emergency bank protection measures against the local scourings by placing sand bags and gabion boxes around the erosion.

In April 2008 riverine road was damaged at Kg. Panchor by ground subsidence due to river erosion. Such bank erosion has been found near Jln. 32 at Kg. Bukit Kepong as well. However, it was not critical fortunately.



Emergency Work at Kg. Melayu

Riverine collapsed at the Night Market, Panchor in April 2008

Jln 32 at Kg. Bukit Kepong

Figure 1.4.9 Photographs of Bank Erosion Sites

Bank erosion is regarded as one of the major issue in the river management, and Muar District DID is monitoring its status in the downstream streches of Muar River. Bank erosion sites identified in the study through discussions with Muar District DID are shown in **Figure 1.4.10.**

Figure 1.4.10 Erosion Sites in Lower Muar

1.4.6 Sediment Erosion and Sediment Load

(1) Condition of Sedimentation

Generally, excessive soil erosion in the basin and consequent generation of sediment load in the river system causes silting in the river channels and mouth, which may result in increased threats of flood inundation due to decrease of the flow capacity of the channels, obstraction of boat navigation and reduction of storage capacities of dam reservoirs.

According to the National River Mouths Study 1994 by JICA, the river mouth of the Muar River was classified as the significant condition based on three aspects: (1) the Physical Aspect as determined from the comparison between the minimum depth of the river mouth and draft of the registered boat at the river mouth; (2) the Economical Aspect as determined by the number of fishermen using the river mouth; and (3) the Social Aspect as determined by complaints brought by fishermen.

At the present, such a sedimentation problem seems to appear only at the Segamat River not the river mouth according to discussions during the stakeholder meeting on 10th December 2009 held by DID and JICA.

(2) Erosion Potential

Suspended sediment load of the main stream at Buloh Kasap Station, which is located upstream of the confluence point of the Segamat River, is estimated 0.2 mil. tonnes per year, based on the record summarized in **Table 1.4.4**. Bed load have not been measured in a regular manner by DID and there are no authoritative archives.

Table 1.4.4 Daily Suspended Sediment Load at Buloh Kasap (tonne/day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Mean	424	730	749	574	909	286	165	56	127	264	926	1,222	6,432
Max.	5,605	8,737	6,007	6,638	4,397	3,236	3,705	696	1,177	2,097	4,349	5,471	-
Min.	8	7	5	2.5	2	2	2	3	4	7	15	19	-

Source: Master Plan Study on Flood Mitigation and River Management for the Muar River Basin, 2003

The average observed concentration of the suspended load is about 50 mg/l in the middle and lower stretches of the Muar River. Thus, the proportion of the bed load to the suspended load is considered to range 25 to 150 % based on the empirical rule descried by Mutreja (1986), Design of Small Dams (1983) and Borland and Maddock (1951). Assuming the proportion is 35 %, the bed load is estimated to be 0.8 mil. ton per year and 3.1 mil. tons per year of the total sediment.

1.4.7 River Landscaping and Riverfront Development

River landscaping and riverfront development is part of the river corridor management. It is now widely recognized that rivers have many other values in addition to drainage and water supply uses. The DID

Manual (March 2009) elaborated that one of the objectives of river corridor management is for enhancement of opportunities for public outdoor recreation, education and scenic enjoyment, which is deemed very closely related to river landscaping and riverfront development.

The planning and control of river landscaping and riverfront development are under the jurisdiction of local authorities. The general guidelines and concepts of river landscaping and riverfront development are contained in the Local Plan of each local authority. The existing Local Plans in the Muar River Basin has identified all the major existing riverfront recreational and landscape areas along the Muar River and its tributaries, and proposals have also been made for new riverfront parks and upgrading of existing riverfront recreational spots. **Figure 1.4.11** shows some of the proposed riverfront development concepts contained in the Local Plans.

Figure 1.4.11 Proposed Riverfront Recreational and Landscape Areas

1.5 Flood Condition

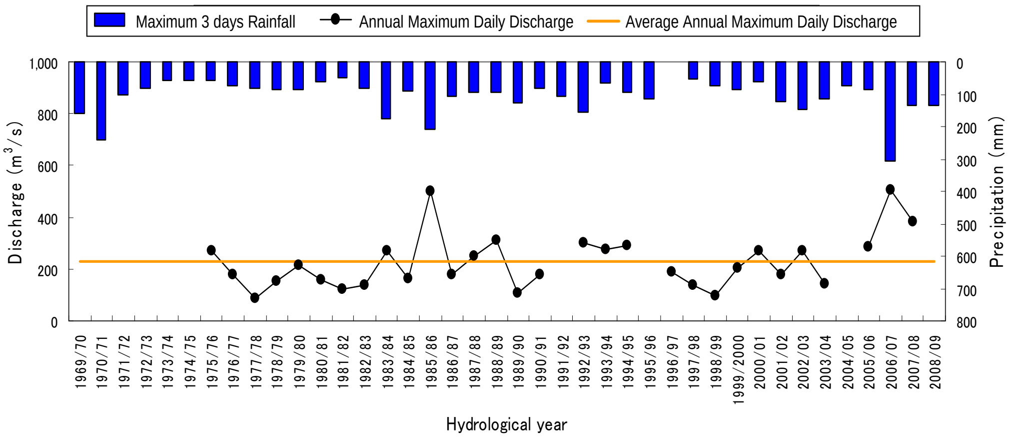
1.5.1 General Feature of Flood

According to collected water level records, flood peaks of the Muar River Basin usually appear in the period from October to March, mostly December to January under the influence of the north-east monsoon. The average annual maximum discharge over the last 30 years at the Buloh Kasap Station, which is the lowest discharge station on the main stream of the Muar River, is 244m^3/s with the maximum of 507 m^3/s observed in December 2006.

The flood prone area extends, depending upon the physical features, along the Muar River and its tributaries. The steepr basin topography allows flood water to flow fast along the upper stretches in the state of Negeri Sembilan, often resulting in overflow in the middle stretches even if flooding in the upper basin is not so significant. Especially, floodnig around the confluence of the Segamat River is severe due to the insufficient flow capacity and the influence of the back water from the Muar River as well as the high intensive rainfall of the Segamat River Basin.

1.5.2 Past Flood Event

According to the hydrological record for the last four decades (the record in this period is managed in good condition), the December 2006 flood was the largest flood followed by January 1971 flood. Incidentally, the 1926 Flood was recognized by Malaysian people as the largest flood since the 19th century; however, the information is meager. Since the January 1971 flood, several floods over the average annual maximum discharge have occurred but the 2006 and 1971 floods excel others in 3-day rainfall.



Note: 1971/72 discharge data was observed 2625412 (Jalan Gemas Station) which is located more than 40 km upstream of Buloh Kasap St.

Figure 1.5.1 Peak Discharge at Buloh Kasap Station and Basin Mean Rainfall

The scales of the 2006 and 1971 floods are 71 and 33 year ARI respectively based on the probability of 3-day basin mean rainfall. No extreme flood event occurred in the last 30 years other than these two floods, of which 3 day annual maximum basin mean rainfalls of the other events are within 1.1 to 20 yearARI. The flood conditions of the both floods are described below:

(1) January 1971 Flood

The January 1971 flood is the second largest flood in the past 4 decades with an inundation area of 380 km^2 and 50,000 affected people, which caused flood damages of 14.5 million US dollars including indirect damages. The scale of 1971 flood is estimated at about 33 years of ARI, based on the rainfall probability analysis using the 3 day rainfalls in **Chapter 4**. The basin mean daily rainfalls and water levels at Gemas and Segamat Station are illustrated in **Figure 1.5.2**, although unfortunately data series around the peak water level are missing. The figure shows that this flood was caused by series of heavy rainfalls which commenced on 28th December 1970 to 5th January 1971 with about 400mm in total basin mean rainfall. The antecedent rainfall from October may be also one of the causes of the significant flood.

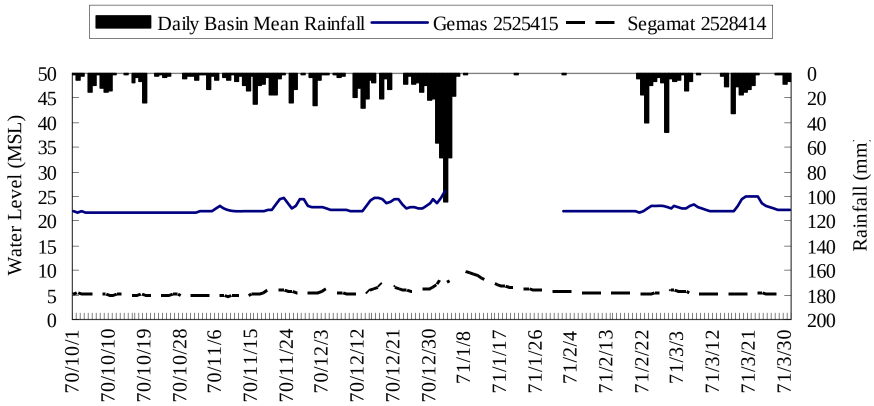
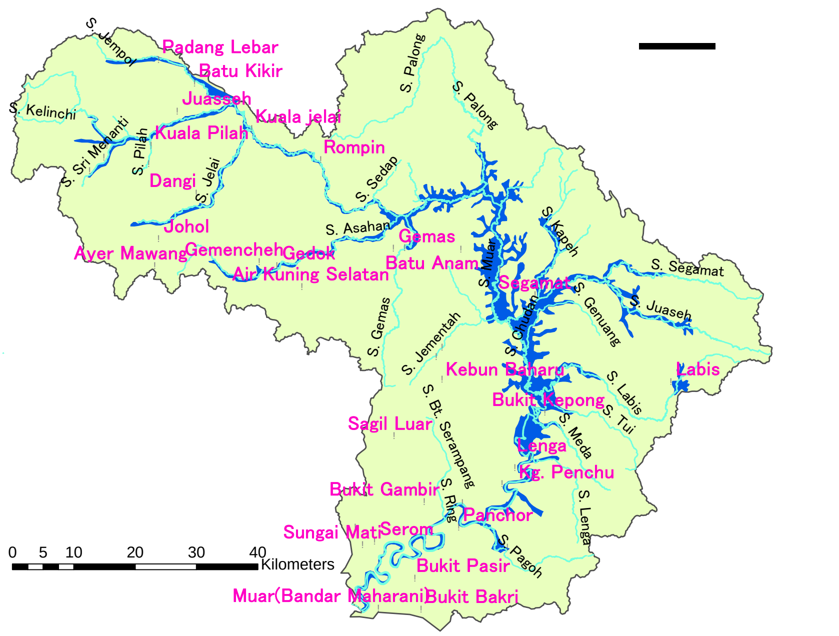


Figure 1.5.2 Peak Water Level at Gemas and Segamat Station and Basin Mean Rainfall

The flood inundation area of 1971 flood, which is reported by NWRS-1982 Study, is presented in **Figure 1.5.3**.



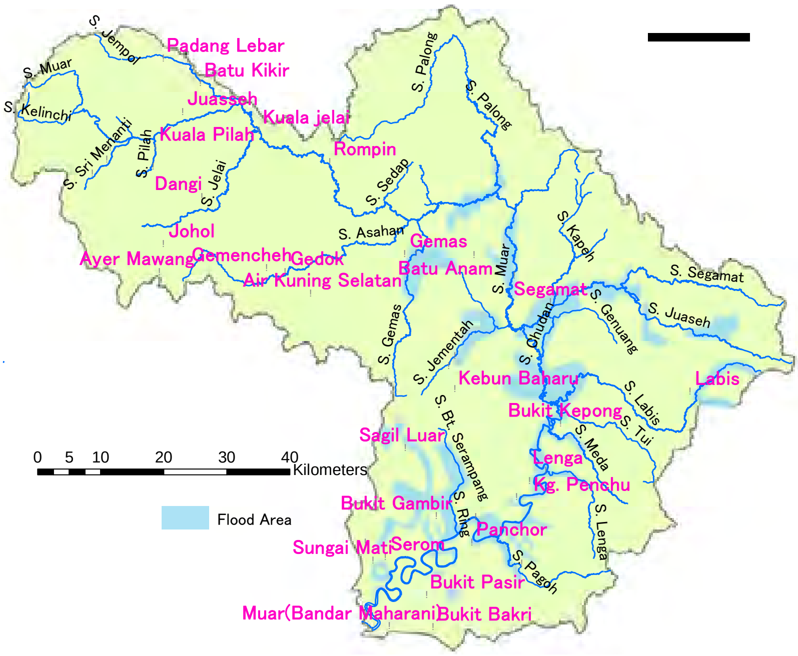
Source: NWRM-1982

Figure 1.5.3 Flood Inundation Map of January 1971 Flood

(2) 2006/07 Flood

According to the Flood Report by DID Johor State, the state of Johor have been hit twice by floods between December 2006 and January 2007, that is, the first one occurred on 19th to 31st December 2006 and the second one occurred on 12th to 17th January 2007. In the Muar River Basin, especially Segamat and Muar Districts were largely damaged compared with the districts of Negeri Sembilan because the rainfall intensity increased from west to east according to an isotheral map by DID.

In the Muar River Basin, the heavy flood was caused by the heavy rainfall that continued for 4 days from 11th January 2007 to 14th January 2007. The scale of the flood is estimated over at 70 years of ARI with 307mm in 3 days basin mean rainfall. As to the rainfall in Segamat District, which was damaged severely, the highest rainfall at Ladang Chan Wing rainfall station was recorded at 189mm for 24 hours and 445mm for 48 hours. The Scale of the point rainfall at some stations in Segamat District recorded those of more than 100 years of ARI.



Source: DID

Figure 1.5.4 Flood Inundation Map of 2006/2007 Flood

The water levels of the Muar River at Buluh Kasap and at Bukit Kepong exceeded the danger levels by 2.07 and 1.72 m respectively. The exceedance from the danger level at Bukit Kepong lasted about one week. The number of evacuees during the flood is summarized in **Table 1.5.1**.

Table 1.5.1 Number of Evacuees

State	District	Number of Evacuee
Johor	Muar	5,611
	Segamat	6,593
Negeri Sembilan	N/A	N/A

Inundation depth, inundation area and duration of the flood along the river were summarized in the flood report by DID as shown in **Table 1.5.2**.

Table 1.5.2 Situation of 2006/07 Flood

River or Basin Name	Inundation Depth	Duration
Bukit Kepong	0.50 to 1.28 m	7 to 10 days
Serom River	1.40 to 2.50 m	10 days
Lenga River	1.35 to 1.60 m	10 to 12 days
Jorak/Pagoh	1.50 to 2.17 m	8 days
Bukit Serampang River	0.68 to 1.82 m	10 days
Kundang	0.60 to 1.50 m	8 to 10 days
Air Hitam	1.30 to 1.36 m	10 days
Terap River/Raya River	0.42 to 0.56 m	6 to 9 days
Bakri	0.54 to 1.00 m	7,8 days
Muar	0.50 to 2.50 m	3 to 7 days
Segamat River	1.00 to 2.80 m	7 days

1.5.3 Inundation Area

(1) Flood Map

For the purpose of identification of the vulnerable area to flood and determination of the range of flood inundation simulation, the probable flood area was delineated based on the existing flood maps including the 1971 flood map by NWRM-1982, the flood map by National Register of River Basin and 2007 flood map by DID) as shown in **Figure 1.5.5**.

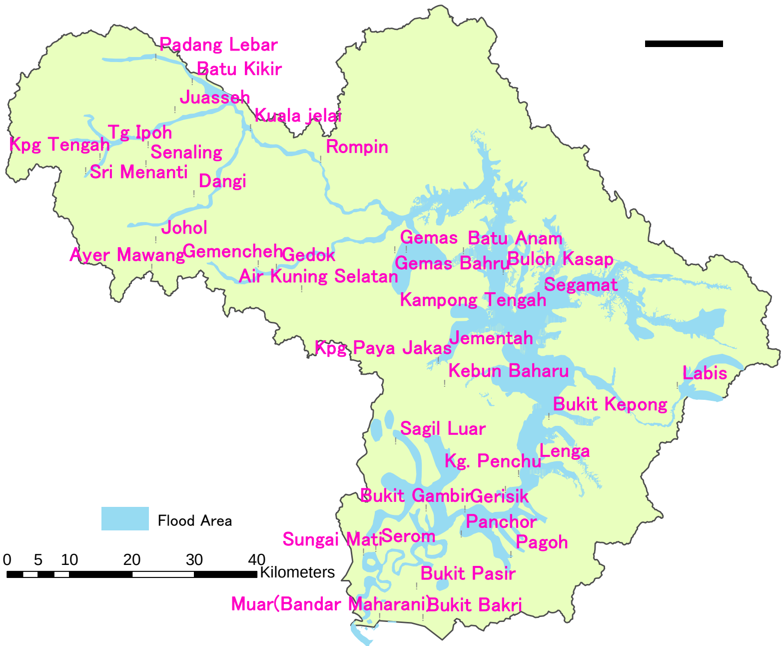


Figure 1.5.5 Flood Map for Identification of Vulnerable Area

(2) Vulnerable Areas to Flood

Considering the above-mentioned past flood records and flood maps, vulnerable areas at a level of major settlement areas are picked up as shown in **Table 1.5.3**. The population in this table indicates that of tiny populated towns or centers of local authorities. As for the cause of flood, "Overflowing of river" is checked if the area is located inside the flood inundation areas in **Figure 1.5.5,** while the "inadequate drainage system" is checked in case the present scale of trunk of the drainage system is less than 25 years of ARI.

Table 1.5.3 Vulnerable Area to Flood

Urban Area (town and the center of local authority)	Population (2000)	Major Cause of Flood		Inside Probable Flood Area	Along Muar River	Along Tributary	Opinion of WG-members/ Stakeholders (to be protected)
		Overflowing of River	Inadequate Drainage System				
Bukit Gambir	4,538	✔	N/A	✔		✔	
Gerisik	1,429	✔	N/A	✔	✔		
Panchor	681	✔	N/A	✔	✔		
Pagoh	1,597	✔	N/A	✔		✔	✔
Kundang Hulu	672	✔	N/A	✔	✔		
Lenga	752	✔	N/A	✔	✔	✔	
Bukit Kepong	349	✔	N/A	✔	✔		
Labis	6,868	✔	N/A	✔		✔	✔
Jementah	5,199	✔	N/A	✔		✔	
Tengah	240	✔	N/A	✔		✔	
Segamat	29,647	✔	N/A	✔		✔	✔
Buloh Kasap	2,680	✔	N/A	✔	✔		
Batu Anam	3,066	✔	N/A	✔	✔		
Gemas	2,306	✔	N/A	✔		✔	✔
Rompin	176	✔	N/A	✔	✔		

In the Flood Mitigation Working Group of Johor, the WG members mentioned importance of the protection for Pagoh, Labis, Gemas and Segamat towns because these towns are more vulnerable than the others from a viewpoint of severity from the high-frequency flood. According to the WG members, since the other towns are located in relatively high places or are smaller in town size, the flood damages are not so significant if the flood is smaller than the 2006/07 flood.

1.6 Ecosystem

1.6.1 Terrestrial Flora and Fauna

As reported in the National Water Resources Study 2000-2050, natural vegetation in the Muar River Basin generally comprises hill forests, shrub forests, swamp forests and grasslands. It ranges from mangroves along the coastal fringes in Muar District of the State of Johor to the mixed-dipteropcarp forests in the low lying and hilly areas and the montane forests of the highlands. The general characteristics of different types of forest are listed in **Table 1.6.1**.

Table 1.6.1 Common Flora Species in the Muar River Basin[3]

Forest type	Characteristics
Lowland Dipterocarp forest	This type of forest generally covers terrestrial areas below 800 m a.s.l. Some of the important flora species are *Shorea* (Meranti), *Balanocarpus* (Chengal), *Vatica* (Resak), *Dipterocarpus* (Keruing), *Hopea* (Merawan), *Intsia* (Merbau) and *Dyera* (Jelutong).
Hill Dipterocarp forest	This type of forest normally found at areas exceeding 1000 m a.s.l. Some of the endemic vegetations are oaks, eugenies and conifers.
Upper Dipterocarp forest	The upper Dipterocarp forests at the higher altitude are rich in *Shorea platyclados*, *Agathis dammara* (Damar Minyak) and *Swintonia spicifera* (Merpauh). At the more level areas, species such as the Seraya and *Bala nocarpus hei mii* (Chengal) can be found.
Peat swamp forest	This can be found at Segamat area. The common flora species are Jelutong and Nyatuh, including species of *Anacardiaceae*, *Sapotacaeae* and *Myrtaceae*.
Mangrove forest	This can be found at the coastal area of the Basin. The common flora species are *Rhizophora* (Bakau), *Nipafruticans* (Nipah palms) and *Onco sperma trigillarium* (Nibong palms).

1.6.2 Aquatic Flora and Fauna

Based on the National Water Resources Study 2000-2050, it is found that study and information on freshwater habitats in the Muar River Basin is insufficient. Generally, the common aquatic fauna is dominated by detritivorous rotifers, detritivorous and carnivorous insects, especially bugs, beetles, dragonflies, crustaceans, fish and amphibians.

At brackish water swamps and estuaries regions, rich variety of nipah and mangrove fauna and flora can be found. These areas are important breeding grounds of shallow-sea prawns and fish such as mullets and freshwater prawn (udang galah).

1.6.3 Environmental Sensitive Areas

Effective and sustainable management of natural environment is one of the vital aspects of integrated river basin management. Forests play a vital role in safeguarding water supply, providing forest produce and recreational places, and acting as a gene pool. Wetlands play an important role in flood mitigation and recharging groundwater storage. Currently, Protected Areas (PA) in Peninsular Malaysia include gazetted National and State Parks, Wildlife Reserves/Sanctuaries and Protected Forests. Despite these PA being gazetted, there are provisions that allow degazettement for short-term economic purposes.[4]

In order to ensure effective management of these environmentally sensitive areas, under the National Physical Plan, the Government has demarcated these areas as Environmental Sensitive Areas (ESA).

[3] Summarized from the National Water Resources Study 2000-2050
[4] National Physical Plan

There are three ranks of ESA. The criteria for demarcation of ESA and the development control imposed on these areas are shown in **Table 1.6.2**, and **Figure 1.6.1** shows the ESA zones in and surrounding the Muar River Basin.

Table 1.6.2 Criteria and Development Control for ESA

Rank	Criteria for demarcation*	Development control
ESA Rank 1	All protected areas, potential protected areas, wetlands, catchment areas of existing and proposed dams and areas above 1000 m a.s.l.	No development, agriculture or logging shall be permitted except for low-impact nature tourism, research and education.
ESA Rank 2	All other forests, wildlife corridors, buffer zones around ESA Rank 1 areas and area within 300-1000 m a.s.l.	No development or agriculture. Sustainable logging and low impact nature tourism may be permitted subject to local constraints.
ESA Rank 3	Buffer zones around ESA Rank 2 areas, catchment areas for water intakes, areas for groundwater extraction, areas with erosion risk greater than 150 ton/ha/year, areas within 150-300 m a.s.l.	Controlled development where the type and intensity of the development shall be strictly controlled depending on the nature of the constraints.

*In relation to IRBM

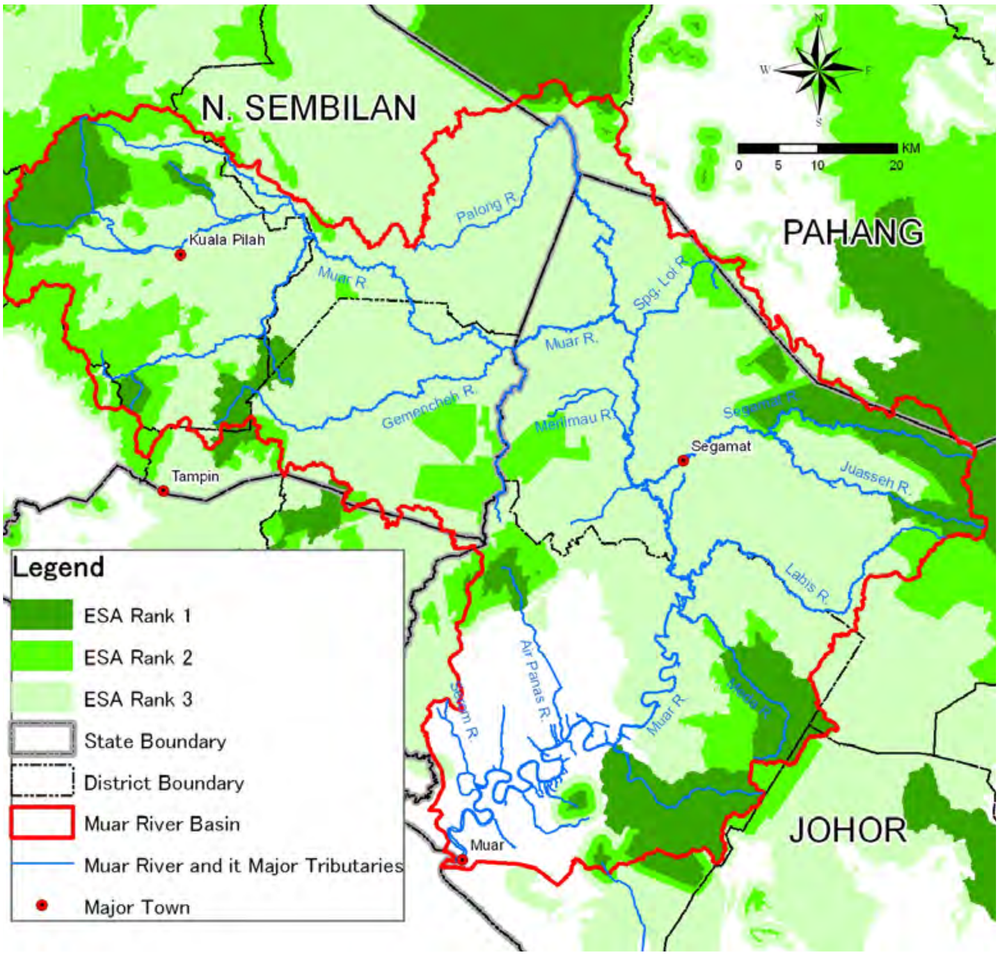


Figure 1.6.1 Environmental Sensitive Areas (ESA) in the Muar River Basin[5]

[5] National Physical Plan

1.7 Water Resources Potential

1.7.1 Surface Water

Muar River Basin is composed of four states, namely Negeri Sembilan, Johor, Melaka and Pahang, and the former two states covers 97.4 % of the entire basin. The total catchment area of the Muar River Basin is 6,140km^2, and the area covered by each state are 2,400km^2 (39.1%), 3,580km^2 (58.3%), 10km^2 (0.2%) and 150km^2 (2.4%) respectively.

Figure 1.7.1 presents water balance in the entire Muar River Basin that was obtained from a long-term runoff analysis, of which details are given in **Section 4.5.** This figure includes future cases with impacts of climate change.

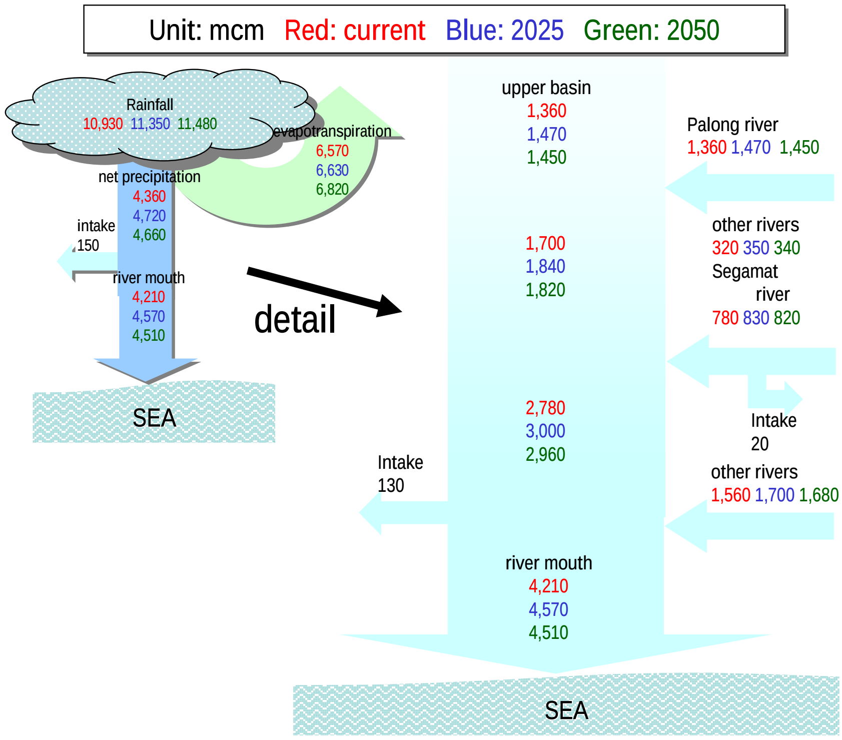


Figure 1.7.1 Annual Water Budget of Muar River Basin

According to this figure, the present total annual runoff volume is 4,210 million m^3. This corresponds to 710mm of effective rainfall, or 6,600 m^3 per capita of the river basin population, as shown in **Table 1.7.1**. Although the annual runoff volume per catchement is slightly less than the peninsular average, the per capita volume is almost as much as the average. It can be said that the Muar River Basin is a river basin of average surface water resource in Peninsular Malaysia.

Table 1.7.1 Comparison of Surface Water Resources

River Basin	Pahang	Muar	Peninsular Malaysia
Annual Runoff Volume (million m^3)	30,586	4,360	152,330***
Catchment Area (km^2)	28,770	6,140	131,344
Basin Population (thousand)	1,190*	660*	22,056**
Annual Runoff Volume per Catchment Area (million m^3/km^2)	1.063	0.710	1.159
Annual runoff volume per capita (m^3)	25,702	6,606	6,907

* Estimated population at 2010 by JICA Study Team
** Population at 2008 (Department of Statistics, Malaysia)
*** Data source : National Water Resources Study 2000-2050

1.7.2 Groundwater

According to "National Water Resources Study 2000 -2050 (NWRS 2000-2050)", there is no groundwater utilization for potable water supply purposes in the Muar River Basin. GSD conducted a few hydrogeological surveys in the Muar River Basin in 1980s and 1990s by GSD as summarized in **Table 1.7.2**. These surveys revealed that the groundwater potential of coastal alluvial deposits is limited due to predominantly clayey nature of the alluvium.

With respect to the possibility of groundwater as an alternative source of water, NWRS 200-2050 suggested that the role of ground water is limited and can only confined to small users who are located beyond the reaches of the existing distribution systems or where there are constraints in capacities of existing mains serving these areas.

Table 1.7.2 Results of Hydrogeological Surveys in Muar River Basin

Survey Area in Muar River Basin	Survey Results	Survey
Gemas, Tampin District, Negeri Sembilan	Three wells within the Combat Army Training Center at Gemas can give a combined yield of 0.64 Mld. The other three wells in Gemas can produce 2.06 Mld.	Groundwater Resource Study of Seri Gading Area, Johor and Rembau-Tampin-Gemas Area, Negeri Sembilan, 1981-1985
Bukit Gambir, Muar District, Johor	4 holes out of 5 jetted holes yielded brackish to saline water and the other hole was dry.	Hydrogeological Investigations at the Bukit Gambir Area, Muar District, 1991

1.7.3 Drought Events

Malaysia had rarely experienced continuous drought phenomena until severe droughts occurred in 1982-1983 and 1997-1998 by the El-Nino phenomena. Half of Malaysian territory was affected during the droughts and faced shortage of water in all states, among them Sabah and Sarawak was the most severely affected. In Muar River Basin, no serious drought event has been reported, although slight droughts affected limited irrigation areas in 1998 and 2007.

CHAPTER 2 SOCIOECONOMIC CONDITION

2.1 Local Government

Malaysia is a federal nation consisting of eleven (11) states (Johor, Kedah, Kelantan, Melaka, Negeri Sembilan, Pahang, Penang, Perak, Perlis, Selangor and Terengganu) in peninsular, two (2) states (Sabah and Sarawak) in East Malaysia and three federal territories.

In principle, excluding Kelantan state, the local administrative unit in Malaysia is composed of three layers: State, Administrative District and Local Authority. As stipulated in Local Government Act (Act 171) in 1976, Local Authority is defined as City Council, Municipal Council and District Council.

The Muar River Basin (6,140 km^2) involves four states of Johor (58.3%, 3,580km^2),Negeri Sembilan (39.1%, 2,400km^2), Pahang (2.4%, 150km^2) and Melaka (0.2%, 10km^2). Two states of Johor and Negeri Sembilan occupy as much as 97.4%. The administrative units in local level in the two states are summarized in **Table 2.1.1**.

Table 2.1.1 Local Administrative Units in Johor and Negeri Sembilan States

State	Administrative District	Local Authorities		
		City Council	Municipal Council	District Council
Johor	- Johor Bahru - Kulaijaya - Pontian - Kota Tinggi - Kluang - Segamat - Ledang - Muar - Batu Pahat - Mersing	- Johor Bahru	- Johor Bahru Tengah - Batu Pahat - Kluang - Kulai - Muar - Pasir Gudang	- Kota Tinggi - Labis - Mersing - Pontian - Segamat - Simpang Renggam - Tangkak - Yong Peng
N. Sembilan	- Jelebu - Jempol - Kuala Pilah - Port Dickson - Rembau - Seremban - Tampin	-	- Seremban - Nilai - Port Dickson	- Jelebu - Jempol - Kuala Pilah - Rembau - Tampin

The National Council for Local Government (NCLG) was established in accordance with the amendment of Federal Constitution in 1960. NCLG is chaired by the Minister of Housing and Local Government and consists of federal ministers pertaining to the local administration and representatives from each state government. NCLG is the superior body to formulate national policies for the promotion, development and control of local government for the legislative administration. All state governments have obligation to consult with NCLG when they propose new constitutions and legal reforms regarding local government authorities.

2.2 Legislation and Institution

2.2.1 Legislation

(1) Legislative Framework for River Basin Management

The Waters Enactment No. 3 in 2007 and the Waters Enactment No. 66 in 1921 were formulated in Negeri Sembilan state and Johor state respectively by revising the previous Waters Act 1920 (Cap. No. 146). These Enactments stipulate the authorities of State Authority, the rules for river management including transfer of raw water, land development along the river, prohibition of activities, penalties, and so on.

The most remarkable feature of the Waters Enactment in Negeri Sembilan state is to appoint a public officer as the Water Resource Director in order to carry out the provision of the Enactment properly. The director of Water Regulatory Body (Badan Kawal Selia Air or BKSA) is appointed as Water Resources Director and its functions and authorities stipulated in the Enactment are described below.

- The functions of the Director shall be to regulate and control the allocation of raw water in any water resources within the State in particular:
  - to advise the State Authority generally on matters relating to water resources,
  - to coordinate policies in relation to usage of raw water and provide advice to the State Authority as to the policies, methods and measures to be adopted to promote, nurture and facilitate the sustainable development, efficient use and conservation of water resources for public health,
  - to regulate and control the allocation of inter basin transfer of raw water within the State and advise the State Authority in respect of the transfer of raw water from, between and among states,
  - to advise the State Authority on the declaration of water catchment areas,
  - to coordinate, promote and implement policies to ensure the continuity and quality of supply of raw water, and,
  - to promote the importance, and encourage the efficient use, of raw water.
- The Director shall have power to do all things reasonably necessary for or incidental to the discharge of its functions under this Enactment in particular:
  - to issue license for activities stipulated in subsection 5(2), 7(4) and 7A(3),
    * subsection 5(2) is concerning "Prohibition of Acts Affecting Rivers".
    * subsection 7(4) is concerning "Prohibition of Diversion or Abstraction of Water from River".
    * subsection 7A(3) is concerning "Prohibition of Pollution of River".
  - to formulate charges and fees, payments and other charges in relation to the performance of its functions and exercise of its powers under this Enactment, and,
  - to exercise all functions and powers and perform all duties which under or by virtue of any other written law may be vested or delegated to it.

The Waters Enactment of Negeri Sembilan state emphasizes the control and regulation of raw water supply and environmental conservation through the issuance of relevant licenses by the Director. Type, application, termination and penalties of required licenses for abstraction, supply and diversion of raw water are clearly stipulated in the Enactment. Moreover, the State Authority can issue a raw water protection order if there is a significant and immediate threat or risk to the quantity or quality of raw water.

On the other hand, Waters Enactment in Johor state does not clearly stipulate the authority for policy coordination and implementation with relevant agencies for river basin management. Meanwhile, even though an appointment of official as Water Resources Director is not required in Johor state, licensing for activities such as diverting raw water from the river, building any bridge, jetty or landing stage over and beside the river, etc. shall be approved by the Commissioner of Land and Mines or licensing officer appointed by the State Secretary. Therefore, it is assumed that water resource is considered as a state property as well as land.

(2) Legislative Framework for Flood Management

In Malaysia, law specified for flood management has not been formulated. Instead, there are the following guidelines for flood management.

- Directive No. 20 regarding the Policy and Mechanism on National Disaster and Relief Management, National Security Council, 1997

- Standard Procedures on Flood Relief Mechanism, National Security Council, 2001.
- Circular No. 2/2003 regarding Guidelines for Management of Flood Disaster during the Monsoon Seasons and Flash Flood, DID, 2003.

Directive No. 20 stipulates the mechanism for the natural disaster management. Under this integrated emergency management system in the Directive, the functions and responsibilities of various relevant agencies in federal, state and district level are defined for the smooth and practical implementation of disaster relief. Regarding the flood disaster management, Standard Procedures on Flood Relief Mechanism stipulates the tasks and functions of relevant institutions against flood disaster.

Circular No. 2 stipulates the tasks and functions of DID before, during and after the occurrence of flood disaster. This describes the necessary preparation and actions of state and district DID in each phase to minimize the damages by flood disaster.

2.2.2 Institution

(1) Institutional Framework for River Basin Management

In the State level, the various government agencies are involved for river basin management in Malaysia as shown in **Table 2.2.1**.

Table 2.2.1 Tasks of Relevant Agencies for River Basin Management

State Government Agency	Tasks related to River Basin Management
State Economic Planning Unit	- To formulate economic development plans
Department of Irrigation and Drainage	- To implement infrastructure works including irrigation, drainage, flood mitigation & river works - To collect hydrological data - To advise matters on water, river sand mining, flood mitigation, river reserves & development of river bank to the Department of Lands and Mines - To maintain the river facilities
Water Regulatory Body (BKSA)	- To advise state government for regulation of water supply system - To regulate water supply operators for appropriate water use
Department of Environment	- To monitor and control water quality of river system
Land Office	- To control and regulate land use & development
Local Authorities	- To be responsible for urban sanitation, solid waste collection, etc.

The functions of state DID are similar with those of federal DID. However, state DID has more operational functions in the state. State DID conducts infrastructural works related to irrigation, drainage, flood mitigation works, river works, etc by state funds. Hydrological data collection is also one of its tasks. Moreover, after the construction, most relevant river facilities are maintained by state DID. It also provides technical advices to the Land Office and other relevant government agencies in respect to water-related issues.

In December 1993 and July 2009, the Water Regulatory Body (Badan Kawal Selia Air or BKSA) was established for the regulation of raw water supply in Johor state and Negeri Sembilan state respectively. BKSA in Johor state so called BAKAJ regulates the raw water use for water supply services and the licensees for water supply services, and enforces the Waters Enactment No. 66 in 1921 and other relevant regislatives. BKSA in Negeri Sembilan state also regulates the raw water use for commercial purposes such as hydropower generation, industry, etc. excluding agricultural irrigation, to monitor the water use and quality, to manage the catchment area, and to enforce the Waters Enactment No. 3 in 2007 and other relevant regislatives.

In addition, the State Water Resources Council, which is chaired by chief minister and consists of representatives from relevant agencies, was established in Johor State. The main function of this

Council is to discuss on state policies and programs concerning river basin management through the coordination with relevant agencies.

(2) Institutional Framework for Flood Management

In Malaysia, National Security Council (NSC) has responsibility for the disaster management including natural disasters (landslide, flood, storm, etc.) and other types of disasters (industrial disasater, fire outbreaks, etc.) ans has branch offices in both states and districts.

The disaster management is handled according to the level of incident based on the following definition of disaster as stipulated in Directive No. 20.

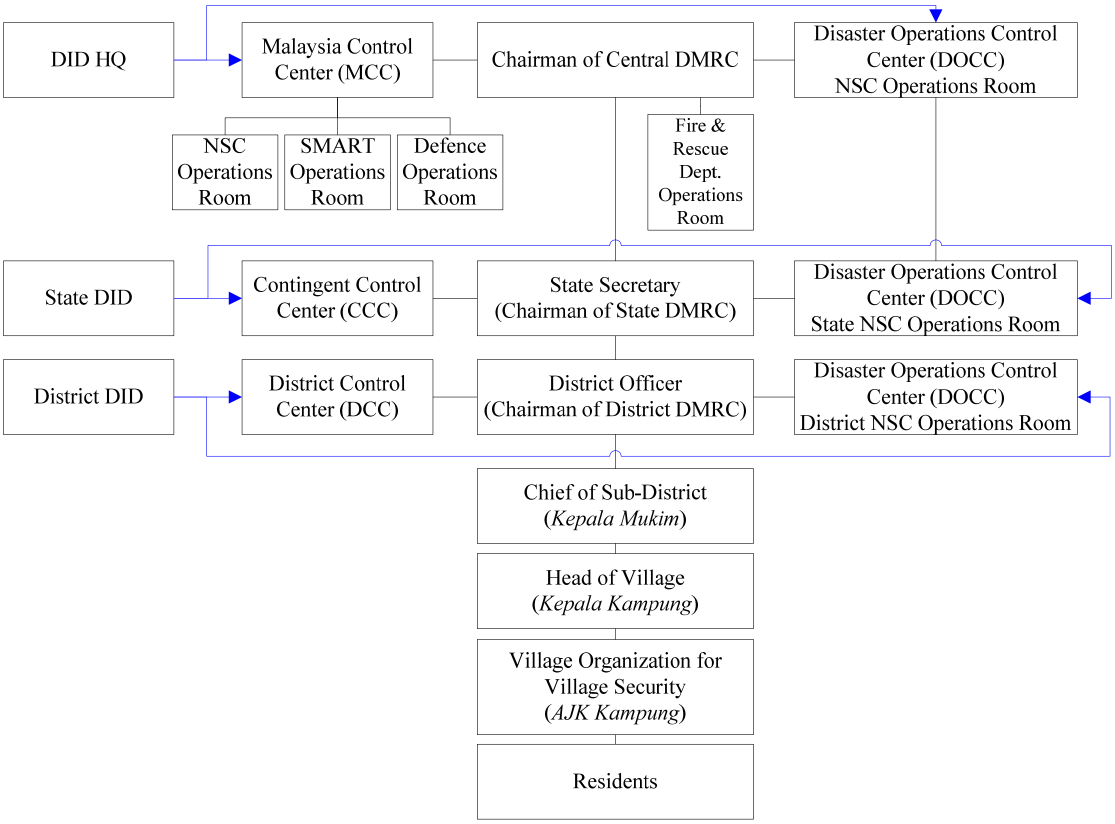
- Level I Disaster: Localized incident which the authority at the district level is able to control
- Level II Disaster: More serious incident covering more than two (2) districts and having potential of spreading to other areas which the authority at the state level is able to control
- Level III Disaster: Incident resulting from the Level II Disaster with more complexity covering more than two (2) states to be controlled by the authority at the central level

Moreover, for the purposes of managing the disasters, the Disaster Management and Relief Committee (DMRC or Jawatankuasa Pengurusan dan Bantuan Bencana: JPBB) is set up in the federal, state and district levels based on the disaster levels. DMRC is a coordination mechanism among the relevant government agencies for emergency response.

Since the flood disaster mostly threatens the local residents and their assets, District DMRC has a main role to save people’s lives and properties. According to Directive No. 20, District DMRC is chaired by District Officer and consists of relevant district agencies such as police, fire and rescueu department, health office, social welfare office, information office, etc. and local authorities with the following the main duties.

- to coordinate the disaster and relief management requirement, such as to determine the provision of logistics assistance and the requisition of equipment/machinery required and so on
- to activate the District Disaster Operations Control Center (DOCC)
- to determine the distribution of duties amont the agencies involved at the District DOCC
- to identify and set up evacuation center
- to ensure that the search and rescue operation are smoothly and effectively carried out

For the assessment and determination of flood disaster levels and necessity of evacuation, information on river water level which is mainly managed by state and district DID needs to be disseminated among the relevant agencies. Moreover, for the activation of DMRC with regard to the search and rescue operations, preparation of equipment and machinery, and other emergency assistance, smooth and immediate coordination among the above agencies is required. The chart for information channeling and communication in disaster and relief management is shown in **Figure 2.2.1**



Source: Directive No. 20 regarding the Policy and Mechanism on National Disaster and Relief Management, National Security Council, 1997, and interview results

Figure 2.2.1 Operational Procedure for Dissemination of River Level Information

2.3 Economic Profile

2.3.1 Gross Regional Domestic Products (GRDP)

The Muar River Basin mainly includes two states of Negeri Sembilan and Johor State. Then, the GRDP for these two states are to be checked. There are data on GRDP only in 2000, so that a status on it is as shown in the following table based on such data. For reference, the table shows together with those of Malaysia and those in the state of Pahang. Following table shows a summary of it.

Table 2.3.1 GRDP of Related States and Malaysia in 2000

a) GRDP in Total

At 1987 Constant Price (million RM)

	Malaysia	**N. Sembilan (1)**	**Johor (2)**	Pahang (3)
2000	209,365	**5,356**	**23,425**	9,794
Annual Growth Rate from 10 Year Ago	6.77%	**6.93%**	**7.76%**	8.60%

b) GRDP per Capita

At 1987 Constant Price (RM)

	Malaysia	**N. Sembilan (1)**	**Johor (2)**	Pahan (3)
2000	14,584	**6,228**	**13,954**	7,453
Annual Growth Rate from 10 Year Ago	8.29%	**7.32%**	**9.03%**	6.57%

Sources: (1) Rancangan Struktur Negeri Sembilan 2002 - 2020,
(2) Rancangan Struktur Negeri Johor 2002 - 2020, and
(3) Rancangan Struktur Negeri Pahan 2002 - 2020.

As shown in the above table, among the three states, the GRDP of Johor is the greatest. And, increasing ratio of GRDP per capita of Johor for the past 10 years is the highest crushing the others. From this viewpoint, it is easy to understand that industrial structure of Johor State must be different with others.

2.3.2 Labor Force and Industrial Perspectives in Related States

Labor forces in the related two states have been changed as shown in **Table 2.3.2**. In Negeri Sembilan State, it has been changed downward with -1.60 % against that in previous year, but has been changed upward with 3.23 %, 1.86 %, and 0.36 % after the 2006. In Johor State, it has been changed upward with 0.34 % in 2005, but it has been downward with –0.02 %. However, those in 2007 and 2008 have been changed upward with 0.55 % and 1.94 % respectively. By the way, in Pahang State, it has been changed upward with 1.29 % in 2005, but it has been changed downward with -1.56 % in 2006. And, it has been upward again with 5.04 % in 2007 and with 1.51 % in 2008. Economic active population has been increased in all the related states, but the reason is that the Labor Force Participation Rate has been fluctuated up and down.

And as shown in the said table, unemployment rate of Negeri Sembilan State has been 4.3 % in 2004, it has been fluctuated with a level of 6 %, it is rather high. But, in Johor State, it has been 1.1 % in 2004, and after that it has been changed with a level of latter half of 2 %, and it may be said that is rather normal comparing w2ith those in developed counties. In this connection, I Pahang State, it has been 1.9 % in 1.9 % in 20904, but it has been fluctuated with a level of 5 %, and that is also rather high level, but it is not so high as those in Negeri Sembilan State. On the whole, the unemployment rates are low level in 2004 in all 3 states, and this is may reflect the socio-economic status in that year.

Table 2.3.2 Labor Force in Related States

Description	Year	Negeri Sembilan	Johor	Pahang
Population in Age of 15 - 64 Years Old (1,000)	2004	**593.0**	**1,931.1**	887.4
	2005	**606.6**	**1,975.6**	911.9
	2006	**619.3**	**2,017.8**	935.3
	2007	**631.8**	**2,060.6**	958.3
	2008	**644.2**	**2,103.9**	980.8
Labor Force Participation Rate	2004	**65.6%**	**67.6%**	63.0%
	2005	**63.1%**	**66.3%**	62.1%
	2006	**63.8%**	**64.9%**	59.6%
	2007	**63.7%**	**63.9%**	61.1%
	2008	**62.7%**	**63.8%**	60.6%
Labor Force (1,000)	2004	**389.0**	**1,305.4**	559.1
	2005	**382.8**	**1,309.8**	566.3
	2006	**395.1**	**1,309.6**	557.4
	2007	**402.5**	**1,316.7**	585.5
	2008	**403.9**	**1,342.3**	594.4
Unemployment Rate	2004	**4.28%**	**1.10%**	1.85%
	2005	**6.45%**	**2.77%**	5.43%
	2006	**6.52%**	**2.71%**	5.51%
	2007	**6.44%**	**2.65%**	5.08%
	2008	**n.a**	**n.a**	n.a

Source: "State/District Data Bank" 2004, 2005, 2006, 2007, and 2008, Department of Statistics, Malaysia.

In the case of the mentioned status of labor force, what kind of occupation field they are engaged in? **Table 2.3.3** indicates a summary of actual status of occupation by the field.

Table 2.3.3 Share Rates of Labor Force by Occupation Field in Related States

(%)

State	Year	Agri-culture, Hunting and Forestry	Fishery	Mining and Quarry-ing	Manufact-uring	Electri-city, Gas and Water Supply	Const-ruction	Whole Sales, Retail Trade, Repair of Vehicles and Furniture	Hotels and Restau-rants	Trans-port, Storage and Com-muni-cation	Finan-cial Inter-mediat-ion	Real Estate, Renting and Business Activities	Public Admini-stration, Defenceand Compul-sory Social Security	Edu-cation	Health and Social Work	Other Com-munity Services	Private HH with Emp-loyed Persons	Extra-Territo-rial Organi-zations and Bodies	Total
Negeri Sembilan	**2003**	**15.8**	**0.1**	**0.3**	**21.7**	**0.4**	**9.3**	**12.7**	**7.6**	**6.0**	**1.5**	**4.2**	**7.2**	**6.0**	**2.0**	**2.1**	**3.1**	**0.0**	**100.0**
	2004	**15.6**	**0.2**	**0.3**	**21.6**	**0.8**	**7.8**	**14.9**	**7.7**	**5.6**	**2.3**	**4.1**	**6.4**	**6.0**	**1.6**	**2.4**	**2.7**	**0.0**	**100.0**
	2005	**13.7**	**0.1**	**0.3**	**20.8**	**1.1**	**8.7**	**14.5**	**7.8**	**6.1**	**2.1**	**3.9**	**8.0**	**6.1**	**2.0**	**2.1**	**2.7**	**0.0**	**100.0**
	2006	**15.5**	**0.1**	**0.4**	**20.2**	**0.5**	**8.1**	**14.1**	**7.0**	**5.8**	**2.3**	**3.7**	**10.0**	**5.5**	**2.2**	**2.2**	**2.4**	**0.0**	**100.0**
	2007	**16.0**	**0.1**	**0.2**	**18.2**	**0.6**	**9.7**	**15.6**	**7.4**	**5.1**	**2.0**	**4.5**	**7.7**	**6.4**	**2.1**	**2.2**	**2.1**	**0.1**	**100.0**
Johor	**2003**	**11.1**	**1.0**	**0.2**	**33.0**	**0.7**	**8.9**	**14.2**	**6.3**	**4.3**	**1.4**	**3.1**	**4.4**	**5.5**	**1.9**	**1.8**	**2.2**	**0.0**	**100.0**
	2004	**10.7**	**0.8**	**0.2**	**31.3**	**0.5**	**7.9**	**15.6**	**7.3**	**5.0**	**1.5**	**3.3**	**4.8**	**4.9**	**1.8**	**2.0**	**2.3**	**0.1**	**100.0**
	2005	**9.4**	**0.8**	**0.3**	**30.5**	**0.5**	**8.1**	**15.2**	**7.2**	**5.7**	**1.8**	**3.6**	**5.3**	**5.5**	**1.8**	**2.0**	**2.2**	**0.1**	**100.0**
	2006	**9.3**	**0.8**	**0.5**	**30.8**	**1.0**	**9.0**	**15.0**	**7.1**	**5.6**	**1.8**	**3.6**	**4.1**	**5.2**	**1.7**	**2.2**	**2.1**	**0.2**	**100.0**
	2007	**9.5**	**0.7**	**0.6**	**28.5**	**0.5**	**9.0**	**15.7**	**7.2**	**5.8**	**1.7**	**4.4**	**4.3**	**5.4**	**1.7**	**2.4**	**2.6**	**0.0**	**100.0**
Pahang	2003	24.7	0.9	0.5	12.4	0.4	10.0	14.3	8.4	2.8	1.1	2.9	7.6	7.8	2.3	2.3	1.5	0.1	100.0
	2004	25.6	0.7	0.3	10.3	0.3	8.8	15.8	9.0	3.5	0.9	2.5	8.8	6.7	1.9	2.5	2.2	0.2	100.0
	2005	27.8	0.9	0.4	11.1	0.5	7.8	15.6	8.1	3.6	1.2	1.9	7.9	6.7	2.6	2.8	1.1	0.0	100.0
	2006	28.3	0.8	0.4	11.8	0.6	7.4	14.3	9.0	2.7	1.3	2.4	6.8	7.2	2.4	3.1	1.4	0.1	100.0
	2007	28.0	1.5	0.3	10.0	0.7	7.0	14.2	9.4	2.9	1.5	2.9	7.7	7.0	2.2	2.7	2.0	0.0	100.0

Source: "State/District Data Bank" 2004, 2005, 2006, 2007, and 2008, Department of Statistics, Malaysia.

As shown in the above table, the share rate of population engaging in “Agriculture” is quite low, and the share rate of population engaging in “Manufacturing” is contrarily higher than in Agriculture. This tendency is more and more conspicuous in Johor State. It means that urbanization has been considerably advanced in Negeri Sembilan State and Johor State than Pahang State. And, it also means that, if the people living there suffer a natural disaster as flood, the status of damage may completely different with Pahang State.

2.3.3 Agricultural Crops

As seen in the precedent section, agriculture is one of the most important industries in the Muar River Basin. **Table 2.3.4** and **Table 2.3.5** show planted area by crop for the three states.

In both the states of Johor and Negeri Sembilan, oil palm is overwhelming other crops. Especially in Johor State oil palm occupies more than 80% of the agricultural lands, followed by fruits trees and vegetables. In Negeri Sembilan State the second is coconut and the third is rubber. It is noted that rubber and coconut are decreasing while oil palm is increasing.

Table 2.3.4 Planted Area by Major Crops in Related States

(ha)

State	Year	Paddy (All Season)	Rubber	Oil Palm		Coconut		Total
				Estate	Small Holding	Estate	Small Holding	
Negeri Sembilan	**2003**	**2,025**	**15,393**	**122,028**	**144,582**	**903**	**30,625**	**315,556**
	2004	**2,648**	**13,285**	**130,248**	**151,694**	**903**	**30,625**	**329,403**
	2005	**2,030**	**12,087**	**143,538**	**153,189**	**646**	**27,804**	**339,294**
	2006	**2,310**	**10,962**	**148,488**	**158,365**	**224**	**22,741**	**343,090**
	2007	**1,105**	**10,669**	**155,613**	**151,025**	**615**	**19,883**	**338,910**
Johor	**2003**	**2,479**	**8,771**	**515,057**	**12,519**	**0**	**1,309**	**540,135**
	2004	**2,451**	**7,642**	**514,674**	**10,897**	**0**	**1,296**	**536,960**
	2005	**1,421**	**6,913**	**514,683**	**11,606**	**0**	**1,302**	**535,925**
	2006	**1,892**	**6,888**	**513,060**	**12,584**	**0**	**1,302**	**535,726**
	2007	**2,639**	**6,806**	**519,616**	**15,229**	**0**	**1,302**	**545,592**
Pahang	2003	6,921	13,151	561,770	21,506	1,947	1,074	606,369
	2004	6,239	9,072	555,630	23,218	1,947	1,074	597,180
	2005	5,539	8,553	582,341	24,480	0	2,097	623,010
	2006	6,545	7,696	596,162	27,128	0	2,387	639,918
	2007	7,415	7,569	612,238	29,213	50	4,841	661,326

Source: "State/District Data Bank" 2004, 2005, 2006, 2007, and 2008, Department of Statistics, Malaysia.

Table 2.3.5 Planted Area by Other Crops in Related States

(ha)

State	Year	Fruits Trees	Veget-ables	Pulses	Peppers	Herbs/ Aromatic Crops	Flowers	Total
Negeri Sembilan	**2004**	**9,077**	**666**	**508**	**169**	**1**	**7**	**10,428**
	2005	**8,439**	**701**	**182**	**342**	**1**	**9**	**9,674**
	2006	**8,821**	**546**	**183**	**277**	**2**	**11**	**9,840**
	2007	**8,812**	**541**	**272**	**196**	**3**	**15**	**9,839**
	2008	**8,794**	**655**	**771**	**207**	**3**	**15**	**10,445**
	2009	**9,150**	**660**	**800**	**220**	**5**	**20**	**10,855**
Johor	**2004**	**67,785**	**13,621**	**2,794**	**285**	**201**	**1,063**	**85,749**
	2005	**69,149**	**12,385**	**3,171**	**n.a**	**108**	**1,021**	**85,834**
	2006	**64,031**	**11,415**	**3,855**	**n.a**	**110**	**1,033**	**80,444**
	2007	**61,094**	**11,058**	**3,631**	**n.a**	**72**	**1,039**	**76,894**
	2008	**57,144**	**11,826**	**3,262**	**631**	**73**	**1,040**	**73,976**
	2009	**59,450**	**11,880**	**3,280**	**670**	**80**	**1,045**	**76,405**
Pahang	2004	24,962	6,302	508	330	64	229	32,395
	2005	22,255	5,980	476	324	117	296	29,448
	2006	23,723	10,498	520	336	137	301	35,515
	2007	23,373	6,007	543	n.a	227	282	30,432
	2008	22,044	6,534	627	717	229	285	30,436
	2009	22,950	6,540	630	760	250	290	31,420

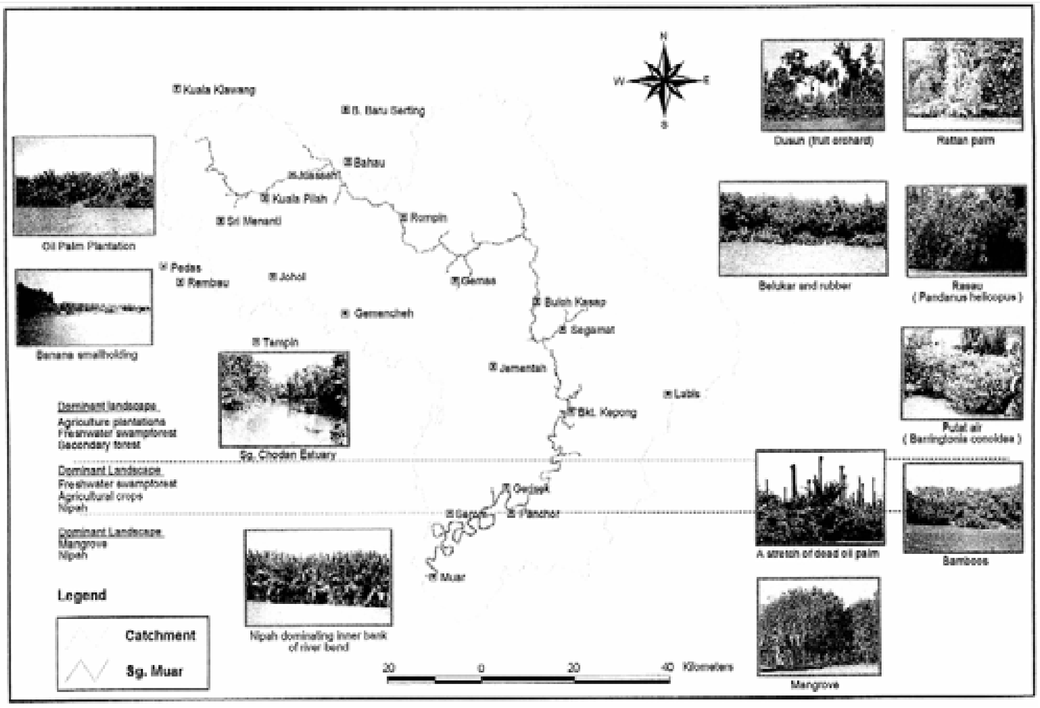
Source: "Perangkaan Agro-Makanan 2009" Ministry of Agriculture, Malaysia.

2.4 Agriculture, Stockbreeding and Fishery

2.4.1 Agriculture

According to “Master Plan Study on Flood Mitigation and River Management for Sg. Muar River Basin, march 2003” (hereinafter refer to as “the Master Plan Study for M.R.B”), the agriculture in the Muar River Basin can be summarized below.

- Agriculture is a dominant land use for the Muar River Basin.
- As described in the precedent section, oil palm is a dominant crop in the river basin.
- The existing landscape of the river corridor is shaped mainly by agricultural activities, oil palm, coconut, rubber, bananas and orchards as shown in **Figure 2.4.1**.



Source : the Master Plan Study for M.R.B

Figure 2.4.1 Riverine Vegetation along Muar River

- Large plantations are mostly owned by private corporations whereas other smaller plots are part of the rural land development schemes (Rancangan Kemajuan Tanah).
- Further upstream in Kuala Pilah district, paddy, cocoa, and sugar cane are also cultivated. Most of the plantations, particularly fruit orchards and coconut, are undertaken on a smallholding basis.
- Villagers along the river are also actively engaged in kampong cultivation in which a mixture of fruit, vegetables and cash crops are planted in small plots of land.

2.4.2 Livestock

Table 2.4.1 shows livestock from the year 2002 through the year 2006 in the Muar River Basin. It can be summarized as below.

- The number of livestock fluctuated within a small range for the 5 year period.
- Swine ranks first, holding a majority of the total number of livestock in the Muar River Basin as well as both in the Peninsular Malaysia and in the whole Malaysia.
- Cattle comes the next, holding more than 25 % of the total number of live stock in the Muar River Basin.
- The majority of swine in the Muar River Basin is being kept in Johor State portion.

Table 2.4.1 Livestock in the Muar River Basin

Year	Type of Livestock	Johor Portion	N. Sembilan Portion	Muar R. Basin	P. Malaysia	Sabah	Sarawak	Malaysia
2002	Cattle	8,670	13,108	21,778	663468	41,154	9,532	714,154
	Buffaloes	175	1,470	1,645	79,387	40,934	10,924	131,245
	Goats	2,950	2,363	5,313	196,777	28,940	9,078	234,795
	Sheep	350	4,957	5,307	118,715	1,747	5,374	125,836
	Swire	37,500	1,320	38,820	1,486,708	99,179	461,289	2,047,176
2003	Cattle	8,875	12,356	21,231	698,705	42,380	11,415	752,500
	Buffaloes	135	1,622	1,757	80,023	42,160	11,185	133,368
	Goats	2,980	4,030	7,010	207,522	29,800	9,655	246,977
	Sheep	335	5,952	6,287	109,004	1,800	4,327	115,131
	Swire	37,700	1,325	39,025	1,421,657	114,780	534,249	2,070,686
2004	Cattle	9,000	10,538	19,538	731,484	43,860	12,040	787,384
	Buffaloes	70	1,486	1,556	83,454	43,210	11,434	138,098
	Goats	3,080	3,102	6,182	225,520	29,370	9,504	264,394
	Sheep	284	5,751	6,035	109,511	1,840	4,147	115,498
	Swire	36,900	1,300	38,200	1,483,515	83,299	544,033	2,110,847
2005	Cattle	8,930	11,446	20,376	723,771	45,170	12,375	781,316
	Buffaloes	79	1,628	1,707	79,495	44,500	9,237	133,232
	Goats	2,483	4,187	6,670	247,460	30,250	9,960	287,670
	Sheep	257	6,067	6,324	109,898	1,890	4,134	115,922
	Swire	36,900	1,300	38,200	1,528,942	120,000	386,705	2,035,647
2006	Cattle	9,180	10,592	19,772	731,732	45,802	12,210	789,744
	Buffaloes	64	1,634	1,698	77,581	44,144	9,150	130,875
	Goats	2,870	8,742	11,612	245,769	30,280	9,811	285,860
	Sheep	230	7,984	8,214	106,849	1,824	3,770	112,443
	Swire	36,750	1,350	38,100	1,528,443	115,440	391,345	2,035,228

Source; Veterinary N. Sembilan

2.4.3 Fishery

According to "the Master Plan Study for M.R.B", there are two type of fisheries, capture fishery and aquaculture. The followings are summaries extracted from the study report, although some of the information has to be updated.

(1) Capture Fishery

Capture fishery is classified into three groups as marine fishery, inland fishery and recreational fishing.

(a) Marine Fishery

Marine fishery is active at the river mouth and islands, especially in the Johor side of the river.

- In 1996, the Muar landing point caters for over 758 artisanal fishermen and 141 boats.
- Fish landings in the same year amounted to 88.26 tonnes and the main fish species caught were pomfrets, skates and Spanish mackerel.
- Landings in the Muar landing point have declined. The trend is not isolated but reflective of an overall slide in fish landings from the Straits of Malacca since the early 1990s.
- Coupled with the continuing aging of the fishing population, it is likely that the importance of Muar as a fishing base would deteriorate further in the near future.

(b) Inland Fishery

Inland Fishery can be summarized as below according to “The Master Plan Study for M.R.B”.

- In the Johor State, there is substantial fishery within the Muar River, that is exploited by inland fishermen groups in Bukit Kepong, Panchor, Segamat and Labis.
- Most of the larger landing points are within the Muar and Segamat district, and major landing points include Muar, Panchor, Bukit Kepong, Pengkalan Kota and Labis.
- The Department of Fishery has provided substantial infrastructure for inland fishermen at Pengkalan Kota. In addition, smaller landing points landing points are found throughout the length of the Muar River.
- The Negeri Sembilan State does not license inland fishermen and there is neither data on the fishing effort nor landings.
- In 1998, there were over 152 fishing gear licensed in Muar district and a further 247 in Segamat. Most fishermen owned only one gear i.e. the number of fishing gear is roughly similar to the fishing population. The main fishing gears employed are the gill net (jaring) and fishing stakes (ambai).
- Total recorded landings in 1998 amounted to 76.4 tonnes with an estimated wholesale value of RM1.22 million. Most (66%) of the catch came from Muar district. The most important commodities caught in the Muar River were udang galah (Macrobrachium rosenbergii) (which accounted for 31% of the catch) and baung (Mystus nemurus) (29%) .
- Overall landings between 1996 and 1998 years have shown an increasing trend as shown in **Figure** 2.4.2. In the past, udang galah was clearly the focus of the fishery for many years, more than 90% of the catch. However, from 1996, the relative importance of udang galah declined in favour of fish, mainly the baung, haruan and ketutu.

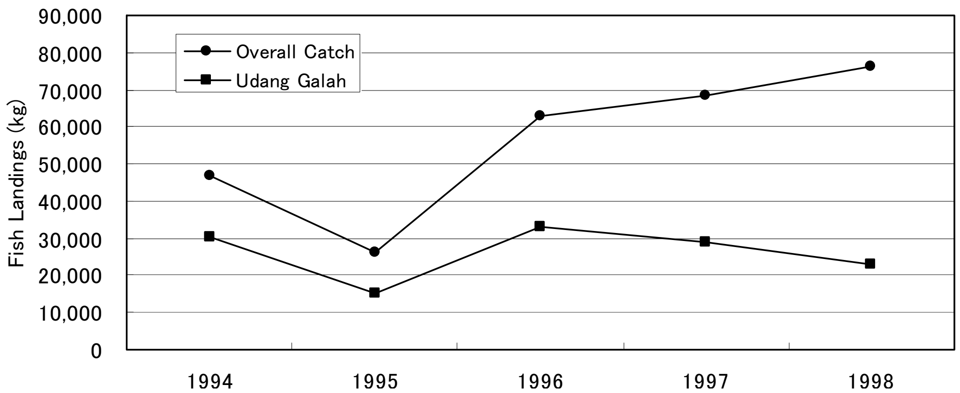


Figure 2.4.2 Trends in Inland Fisheries Landings in the Muar River Basin

(c) Recreational Fishing

The use of Muar River as a recreational fishing can be also summarized as below, based on "The Master Plan Study for M.R.B".

- There are two major groups that utilize Muar River for recreational fishing. These are local residents who fish from time to time in Muar River, particularly during off-hours and weekends. The residents are mainly from major urban enclaves such as Muar, Segamat, Tampin, Kuala Pilah and Malacca. The number of individuals involved is not known.
- Domestic (from outside the Muar River Basin) and foreign (mainly Singaporean) tourists who fish in the Muar River on a regular basis. These sports fishers are most structured in their use pattern, usually fishing during their vacation, which mainly coincides with the school holidays. Not being resident in the area, these fishers hire boats and guide services to take to them to the fishing grounds within the Muar River.
- Of the first group, local fishers cast mainly from the riverbank. Boat fishing was uncommon and those who were involved in it generally had their own boats.
- The estimated recreational fishing demand is summarized in **Table 2.4.2**.

Table 2.4.2 Estimated Recreational Fishing Demand in the Muar River Basin

Visitor Type	Estimated Fishing Demand (man-days/yr)*	Estimated Value (RM)
Local (river)	476,410	4,764,100
Local (put-and-take ponds)	14,628	1,170,000
Tourists (Domestic/Foreign)	1,520	60,800
Total	492,558	5,994,900

Source: The Master Plan Study for M.R.B,
* 1 man-day = 8 hours

(2) Aquaculture

In addition to capture fisheries, the river also supports the aquaculture industry. Oyster (Crassostrea beechen) faming was undertaken in the estuary at one time, but has since ceased due to poor returns. Cockle (Anandara granosa) spat is also found at the mouth of the river, but densities are insufficient to sustain culture activities. At present, only cage farms raising finfish operate in the river. The cage farms are located in two areas:

- In Muar River estuary immediately astride Sultan Ismail bridge, there are 3 farms with a total productive capacity of 156 cages or 1,404.72 m^2. The cages raise euryhaline or estuarine fish such as the sea bass (Lates calcarifer) and tilapia (Oreochromis sp.) as shown in **Table 2.4.3**.

Table 2.4.3 Production from Estuarine Cage Farms in the Muar Estuary (1998)

Species	Production (kg)	Value (RM)
Sea bass	7,780	116,700
Tilapia	886	4,430
Crabs	1,090	5,450
Total	9,756	126,580

Source: Department of Fisheries, Muar

- In Brohol, just before Panchor, there are 8 farms with a productive capacity of 46 cages or 417.81 m^2. These cages raise freshwater fish such as Tilapia, Pacu (Collosoma sp.) and Baung (Mystus sp.). Production from the estuarine cages amounted to 9.7 tonnes of which over 90% consisted of sea bass. The fish was consigned largely to restaurants in Muar. A limited amount was shipped out to meet the requirements of restaurants in Johor and Singapore. The freshwater cages in Brohol are in the verge of abandonment.

- Production in 1998 amounted to only 300kg, all tilapia. The cages are in poor condition and some farms are no longer being worked . The reasons for their abandonment have not yet been ascertained. Therebappears little interest by the present cage farmers to increase their farm size. Two of the farmers who were interviewed identified pollution as a major consistent. In 1995, pollution wiped over RM100,000 worth of stock. The source of the pollution was not identified. At present, the farmers are still cautious about a large quantity of stock in their cages. Losses through pollution amount to about 30%, but given the acceptable level.

2.5 Water Use and Water Resources

2.5.1 Outline of Water Resources Development

The Muar River Basin is also so rich in water resources that part of its river water is supplied to to Melaka State over the basin boundry. The river water has been developed for domestic and industrial water supply and for irrigation. In line with increase of population, modernization of life style and industrial development water demand for domestic and industrial water supply has been increasing, while irrigation water demand is expected to decrease due to decline of rise production. There are six dam reservoirs for domestic and industry water supply in the Muar River Basin. Moreover, a lot of intake structures such as pumps and weirs that rely upon run of river flow are used for water abstraction from the main river and its tributaries. Groundwater has been hardly developed yet.

2.5.2 Domestic and Industrial Water Supply

(1) Water Supply Services

As explained in **Section 2.2 of Part 1 Common Context**, reform of water supply and sewerage sectors is going on in Malaysia with the objective of creating an efficient and sustainable water services industry as shown in **Figure 2.5.1**. The water services industry will be privatised and integrated with the sewerage industry.

The reform is now at the final stage, although its transitional operation is already being implemented in some states under the regulation of SPAN. According to the 10^{th} National Plan, the reform will be completed in the planning period, in which establishement of tariff-setting mechanism to to allow full cost recovery will be completely phased in and water supply and sewerage services will be integrated and initial efforts will be made to introduce integrated water and sewerage tariffs.

Negri Sembilan States migrated into the new regeme in 2008 with SAINS, a corporatized company as water supply services operator, and Johor migrated in 2009 with SAJH, a corporatized company, too.

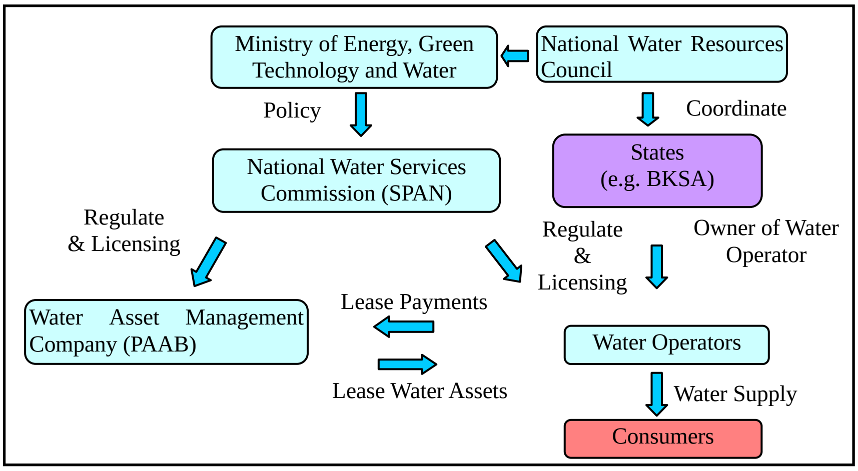


Figure 2.5.1 New Legislative Framework on Water Supply Services

(2) Treatment Plants and Consumption

There are 30 water treatment plants in the Muar River Basin. The total water supply capacity is 517,450 m3/day (517 mld), and the annual consumption volume is 141 to 154 milion m3/year according to their operation records between 2004 and 2008, accounting for as small as 3 to 4% of the total surface water potential of 4.2 billion m3. **Figure 2.5.2** presents location of the water treatment plants, and **Table 2.5.1** gives a list of the water treatment plants. **Table 2.5.2** presents the current consumption volume by district.

Figure 2.5.2 Location of Treatment Plants in Muar River Basin

Table 2.5.1 Treatment Plants in Muar River Basin

No.	District and Name of Treatment Plant	Raw Water Sources	Design Capacity (m^3/day)	Remarks
	Kuala Pilah			
1	Ulu Bendul	Sg. Batang Terachi	2,700	
2	Talang	Empangan Talang	1,100	
3	Kuala Pilah	Sg. Muar	9,100	
4	Bukit	Sg. Muar	2,300	
5	Tengkek	Sg. Tengkek	2,300	
6	Kepis	Sg. Jelai	3,400	
	Sub-total		20,900	N. Sembilan
	Tampin			
1	Gemencheh	Empangan Gemenchen	45,400	
2	Dangi	Sg. Jelai	13,600	
3	Pasir Besar	Sg. Muar	22,700	
4	Gemas Baru	Sg. Muar	36,300	
	Sub-total		118,000	

No.	District and Name of Treatment Plant	Raw Water Sources	Design Capacity (m^3/day)	Remarks
	Jempol			N. Sembilan
1	Bahau	Sg. Muar	3,700	
2	Jempol	Sg. Muar/Sg. Jempol	36,300	
3	Kuala Jelai	Sg. Muar/Sg. Jelai	68,100	
	Sub-total		108,100	
	Total		241,300	
	Muar			Johor State
1	Bkt Serampang	Sg. Muar	4,550	
2	Gerisek	Sg. Muar	45,460	
3	Gombang	Sg. Muar	3,180	
4	Panchor 1	Sg. Muar	12,730	
5	Panchor 2	Sg. Muar	36,360	
6	Panchor 3	Sg. Muar	36,360	
7	Panchor 4	Sg. Muar	18,180	
8	Gunung Ledang	Empangan Gunung Ledang	13,640	
	Sub-total		170,460	
	Segamat			
1	Pemanis	Sg. Segamat Kecil	2,270	
2	Jementah	Sg. Jementah	2,270	
3	Palong Timur	Sg. Muar	6,820	
4	Bukit Hampar	Sg. Segamat	14,180	
5	Kg. Tengah 1	Sg. Segamat	13,000	
6	Kg. Tengah 2	Sg. Segamat	31,360	
7	Air Panas A	Sg. Juaseh	14,080	
8	Air Panas B	Sg. Juaseh	4,550	
9	Air Panas C	Sg. Juaseh	11,460	
	Sub-total		99,990	
	Total		270,450	
	G. Total		517,450	

Table 2.5.2 Current Consumption of Domestic Water in Muar River Basin

No.	District	2004	2005	2006	2007	2008	State
1	Kuala Pilah	4,695,091	4,790,910	4,888,683	5,284,148	6,322,498	N. Sembilan
2	Tampin	26,458,360	27,830,111	30,385,168	33,365,392	33,629,613	
3	Jempol	33,418,608	34,100,620	34,796,551	34,606,052	35,799,077	
Sub-Total		64,572,060	66,721,641	70,070,402	73,255,592	75,751,041	
1	Muar	52,083,765	52,394,516	51,112,311	51,975,670	53,214,160	Johor
2	Segamat	25,321,008	25,021,746	25,200,777	25,214,730	25,911,140	
Sub-Total		77,404,772	77,416,262	76,313,088	77,190,400	79,125,300	
Total		141,976,832	144,137,903	146,383,490	150,445,992	154,876,341	

(3) Dam Reservoirs

There are 6 existing dam reservoirs in the Muar River Basin. In addition to them, 2 dam reservoirs are proposed. Their location of the existing and proposed dam reservoirs are shown in **Figure 2.5.3**.

Table 2.5.3 Existing and Proposed Dams in Muar River basin

No.	Dam	Existing	Proposed	Catchment Area (km^2)	Capacity (Million m^3)	State
1	Talang (Ulu Muar)	X		144.0	53	N. Sembilan
2	Upper Muar	X		148.0	3,242	
3	Kerinchi	X		37.0	50	
4	Gemencheh	X		36.9	30.8	
5	Langkap		X	Not available		
6	Juasseh	X		29.47	33.2	Johor State
7	Gunung Ledang	X		10.29	0.3	
8	Segamat		X	67.9	60	
9	Meda		X	120.5	190	

Source: SAINS N. Sembilan, BAKAJ Johor

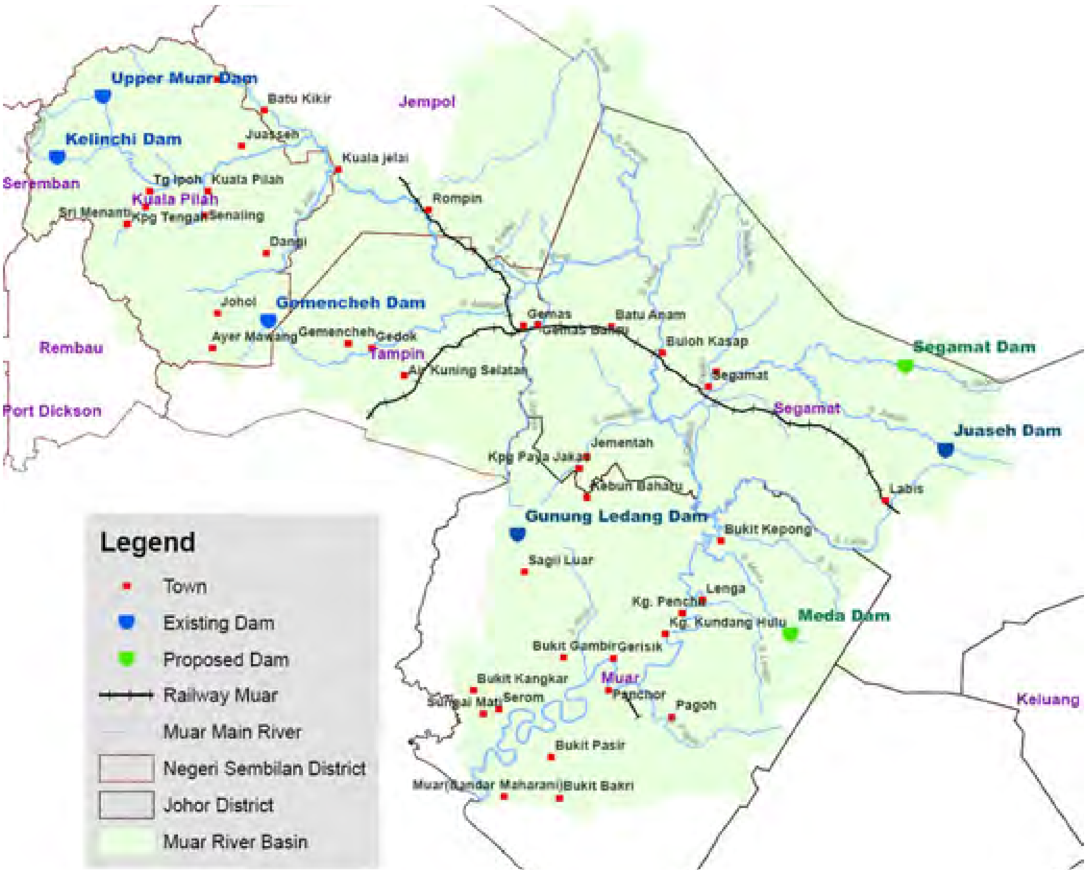


Figure 2.5.3 Existing and Proposed Dam Reservoirs

(4) Water Demand

The water demand for domestic and industrial water supply has been estimated under three types of projection scenarios, namely Low Growth, Planning Growth and High Growth, according to "National Water Resources Study 2000-2050". Taking advantage of this estimation, the water demand by district was arranged as shown in **Table 2.5.4**. The tatal water demand is estimated at 1.7 billion m^3/year for the low growth scenario, at 2.3 billion m^3/year for the planning growth scenario, and 2.6 billion m^3/year for the high growth scenario respectively.

Table 2.5.4 Domestic and Industrial Water Demand in Muar River basin

Scenario	State	District	Annual Water Demand (Million m^3/year)					
			2000	2010	2020	2030	2040	2050
Low Growth	N. Sembilan State	K. Pilar	33	41	49	59	67	77
		Tampin	40	53	67	84	99	116
		Jempol	77	103	128	158	186	216
	Johor State	Muar	115	141	176	220	263	286
		Segamat	69	86	106	125	208	228
	Total		336	425	525	646	824	922
Planning Growth	N. Sembilan State	K. Pilar	35	45	56	69	81	94
		Tampin	42	59	77	98	119	142
		Jempol	81	114	147	186	223	264
	Johor State	Muar	158	195	230	276	321	368
		Segamat	112	142	178	216	254	293
	Total		428	554	688	846	999	1,159
High Growth	N. Sembilan State	K. Pilar	36	50	65	81	97	115
		Tampin	44	64	88	116	143	173
		Jempol	84	124	169	219	267	322
	Johor State	Muar	158	204	254	314	369	431
		Segamat	112	150	197	246	292	343
	Total		435	593	774	975	1,169	1,384

Source: National Water Resources Study 2000-2050

(5) Proposed Source Works

To catch up with the increasing water demand, investment should be made continueously. **Table 2.5.5** presents sources works proposed for the Muar River Basin compiled by the JICA Study Team based on collected information from SAIN Negeri Sembilan, BAKAJ Johor and "National Water Resources Study 2000-2050".

Table 2.5.5 Proposed Source Works in Muar River Basin

District	Current Supply Capacity (Mld)	Source Works	Year of Commissioning	Increased Capacity	State
K. Pilah	20.9	Kualah Pilah WTP Phase 2, 40 MLD	2023	60.9	Negeri .Sembilan State Portion
Tampin	118.0	Barrage, 115 Mld Rembau WTP Stage I, 36 Mld Dangi WTP Phase II, 40 Mld Rembau WTP Stage II, 36 Mld Rembau WTP Stage I,II 36 Mld	2010 2010 2014 2028 2041	233.0 269.0 309.0 345.0 381.0	
Jempol	241.3	Jelai WTP Phase II Stage I, 45Mld Jelai WTP Phase II Stage II, 45Mld Jelai WTP Phase III, 45Mld Jelai WTP Phase IV, 60Mld	2001 2003 2030 2039	286.3 331.3 376.3 436.3	
Muar&Segamat	270.45	Segamat Dam 450 Mld Meda Dam 550 Mld	2018 2037	720.45 1,220.45	Johor State Portion

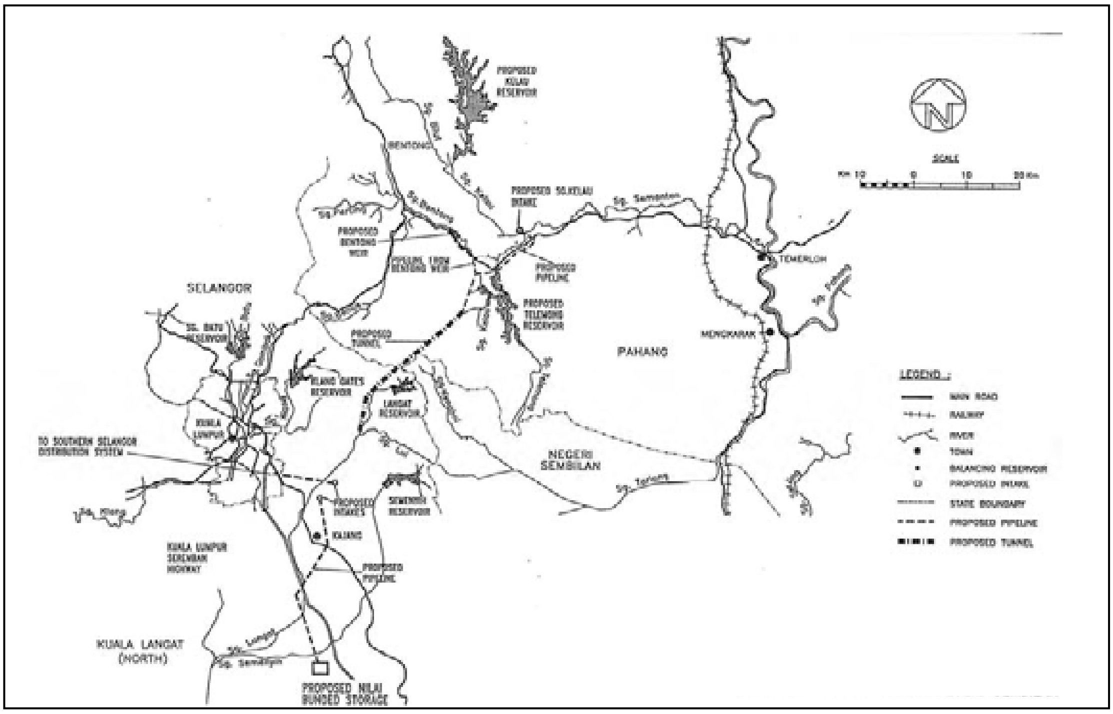
Source: SAIN Negeri Sembilan, BAKAJ Johor and National Water Resources Study 2000-2050

(6) Inter-state Water Transfer

Inter-state Water Transfer projects were recommended in "National Water Resources Study 2000-2050". In line with the recommendation, the Pahang-South Selangor Water Transfer Project is now being implemented. The Johor-Melaka water transfer in which 110 MLD of the Muar River Water is transferred to Durian Tunggal Dam in Melaka State, is proposed to be expanded.

(a) Pahang-Selangor-Negeri Sembilan

There is a plan to expand the on-going Pahang-Selangor Water Transfer to supply the Pahang River water to Negeri Sembilan. In this plan, 1,000 mld of the total amount 3,170 mld will be transferred to Negeri Sembilan.



Source: National Water Resources Study 2000-2050

Figure 2.5.4 Transfer Route from Pahang to South Selangor and Negeri Sembilan

(b) Johor to Melaka

According to "National Water Resources Study 2000-2050", the exsiting water transfer to Melaka from the Muar River is 110 Mld will be increased to 778 Mld by the year of 2050 with two new dams, Segamat Dam and Meda Dam and some intake facilities in the Muar River Basin. Sagamat Dam and Meda Dam are planed to be commissioned in 2018 and 203 respectively. The transfer route is as shown in **Figure 2.5.5**.

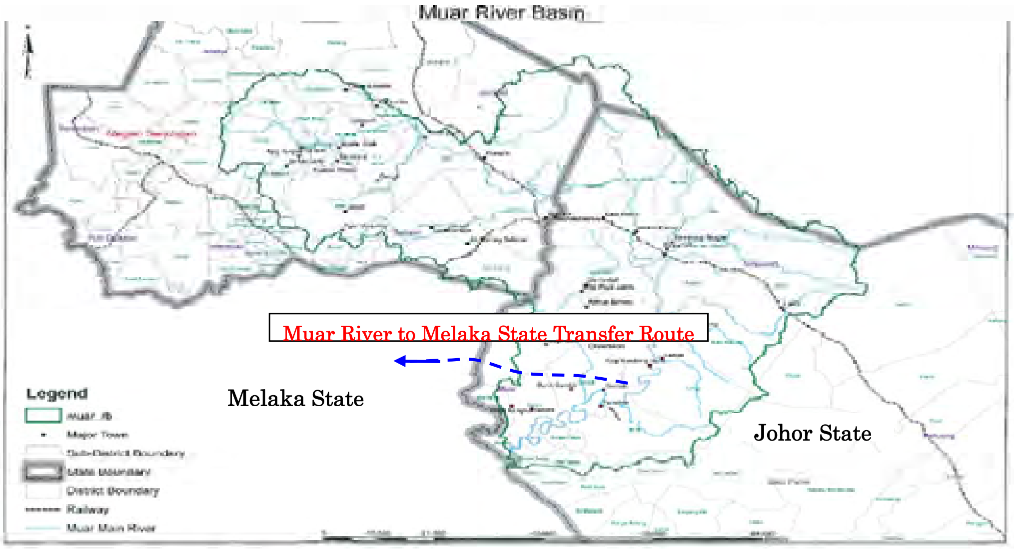


Figure 2.5.5 Water Transfer Route (Johor to Melaka)

2.5.3 Irrigation

(1) Iriigation Scheme

There are 16 irrigation schemes in the Muar River Basin as shown in **Table 2.5.6**. The areas in Negeri Sembilan State and Johor State are 2,488 ha and 581 ha respectively, with 3,069 ha in total. The location of those schemes and irrigation intakes are shown in **Figure 2.5.6**.

Table 2.5.6 Irrigation Schemes in the Muar River Basin

Scheme	Irrigation Area (ha)	State
Kuala Pilah		N. Sembilan State
Skim Pengairan Padi Sungai Muar 1 & 2	567	
Skim Pengairan Terachi bt 14	117	
Skim Pengairan Terachi bt 17	146	
Skim Pengairan Tanjing Ipoh	340	
Skim Pengairan Ulu Jempol 1,2,3,4,5	562	
Skim Pengairan Ulu Ghalib	12	
Skim Pengairan Kg. Birah	12	
Tampin		
Skim Pengairan Kg. Londah	194	
Skim Pengairan Kg. Bangkahulu	87	
Jempol		
Skim Pengairan Kuala Jempol 1	226	
Skim Pengairan Kuala Jempol 2	225	
Sub-Total	2,488	
Muar		Johor State
Sawah Ring	267	
Pulau Penarek	50	
Kesang Gate	32	
Kesang Tasek	67	
Teluk Rimba	165	
Sub-Total	581	
Total	3,069	

Source: D.I.D N. Sembilan and D.I.D Johor

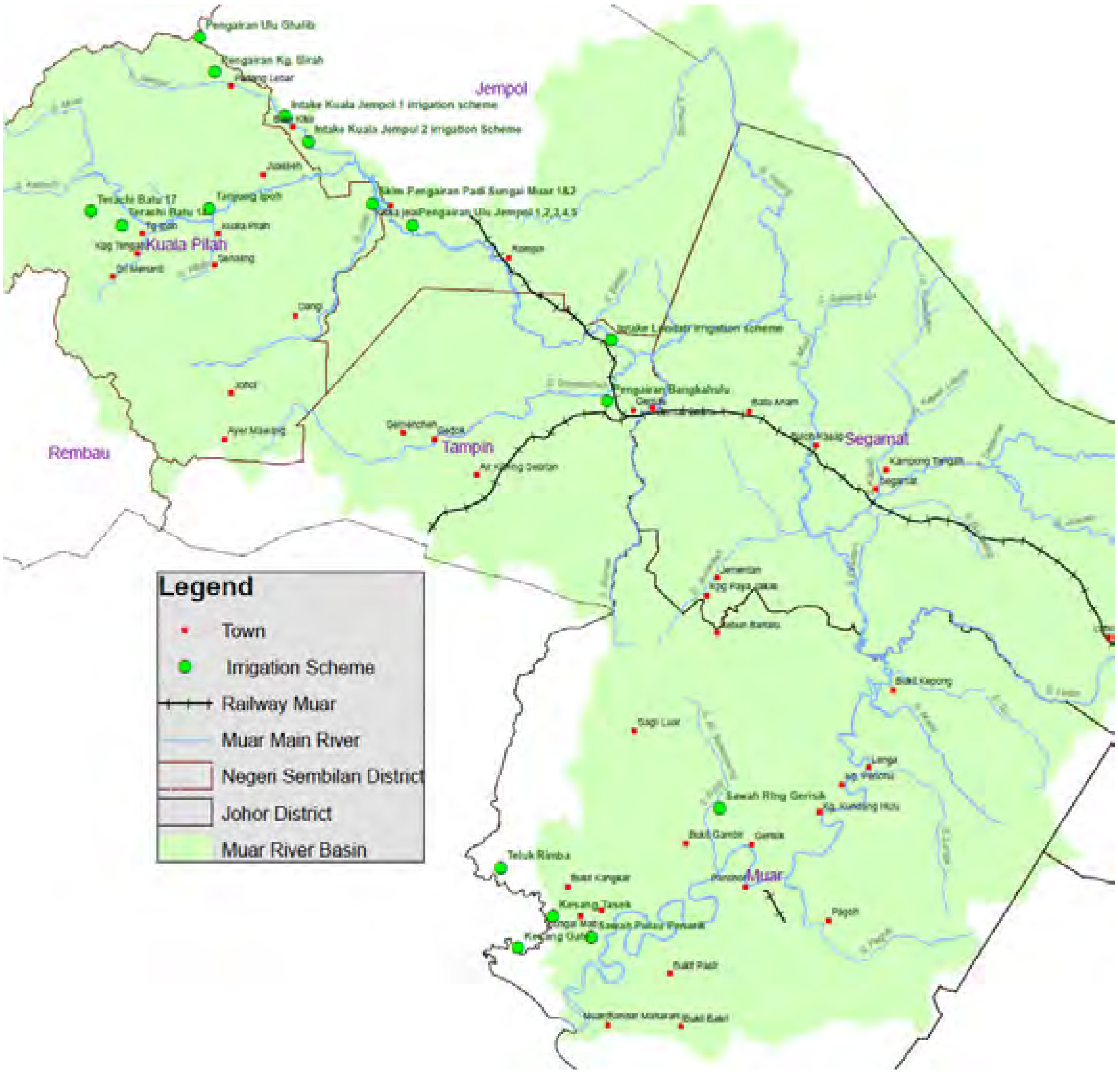


Figure 2.5.6 Irrigation Schemes in Muar River Basin

(2) Cropping Pattern

According to "National Water Resources Study 2000-2050", current cropping pattern is summarized as below:

For small irrigation run-of-river schemes, water is normally diverted from a headworks into a canal and conveyed by gravity to the fields.

In most of the larger irrigation schemes proper design requires that planting dates are staggered according to irrigation blocks in order to minimize peak demand especially during the presaturation period, as well as to attenuate peak labour and machinery demand.

There are no granary scheme in the Muar River Basin, but there are many small-scale schemes as mini granary and non-granary schemes, and the irrigation schedule for them is generally given in **Table 2.5.7**.

Table 2.5.7 Irrigation Schedule for non-granary schemes

Season	Start Irrigation	Stop Irrigation
Main Season	August	February
Off-Season	March	July

(3) Water Demand for Irrigation

According to "the National Water Resources Study 2000-2050", there are no Granary areas, while there are many minor schemes both in Negeri Sembilan State and Johor State. Many of irrigation schemes have been abandoned because of a combination of (largely) social factors, lack of labour in rural area, out-migration of able-bodied workers, etc, resulting in an overall very low cropping intensity. In the long term, these schemes are likely to be converted for housing or high value crop cultivation.

There will be a decrease in irrigation demand through the year 2050. Consequently, the water demand for Irrigation in the Muar River basin is compiled based on the estimation in "the National Water Resources Study 2000-2050" as shown in **Table 2.5.8**.

Table 2.5.8 Projected Annual Irrigation Water Demand Muar River basin

Irrigation Schemes	Annual Irrigation Water Demand (Million m^3)						Remarks
	2000	2010	2020	2030	2040	2050	
Mini Granary Schemes	3	2	2	2	2	2	N. Sembilan State
Minor Irrigation Scheme	54	27	27	27	27	27	
Mini Granary Schemes	12.8	6.4	6.4	6.4	6.4	6.4	Johor State
Minor Irrigation Scheme	20	10	10	10	10	10	
Mini Granary Schemes	15.8	8.4	8.4	8.4	8.4	8.4	Muar River Basin
Minor Irrigation Schemes	74	37	37	37	37	37	
Total	89.8	45.4	45.4	45.4	45.4	45.4	

Sourc: National Water Resources Study 2000-2050

2.5.4 Navigation

(1) Current Situation

According to "the Master Plan Study for M.R.B", the inland navigation in Peninsular Malaysia comprises of 5 activities as shown below:

a) Marine Fishing Boats
b) River Fishing Boats
c) Passenger Boats
d) Cargo Boats
e) Traffic by villagers for daily activities including attending school, commuting and shopping

In the Muar River Basin, the navigation is mainly confined b) and e) with exception of Kuala Muar which also includes a) and d). The situation of the navigation within Muar River Basin is summarized below:

- According to En. Taib b. Majid (Head of the Marine Department in Muar, 1998), there are almost no accidents involving boats reported to the department for the past few years.
- There is a rock outcrop near Kg. Liang Batu (about 3 km downstream of Kundang Ulu), and it is located mid-river fronting the villager's mosque.
- During high water, there is anxiety boat crashing into the rock.
- The Marine Department advised that at high water, boats should avoid travelling mid-river and navigate closer to the banks.
- There can be found no proper lighting along the river except for at the river mouth, at several concrete jetties and water intake points.
- Sufficient warning of the presence of imbedded poles (foe anchoring fishing nets) traversing parts of the river for fishing should be provided to boats.
- Water hyacinths, dead palms, semi-submerged large branches can be found within the river at intermittent locations and those are a danger to unwary boat users.

- In places where are no bridges, boats play a major role ferrying passengers (with the occasional vehicles) across river in the local people's lives.
- There are 6 known river crossing points along the Muar River (until Buloh Kasap) that are still frequented by the locals. (refer to **Table 2.5.9**)

Table 2.5.9 River Crossings on Muar River (until Buloh Kasap)

Point	River Crossing	
	Left Bank	Right Bank
1	Kg. Tg. Selabu	Serom Panggong
2	Jorak	Kg. Kolam
3	Kg. Sg. Ranggam	Kg. Sg. Bilah
4	Kg. Berohol	Ldg. Nordanal
5	Kg. Tg. Sialang	Kundang Ulu
6	Kg. Gombang	Kg. Tk. Panchu

- All vessels used are wooden boats with the exception of the river crossing between Kg. Brohol and Ladang Nordanal.
- A small ferry with a frontal ramp is used to ferry people and vehicles between Kg. Berohol and Ladang Nordanal.
- The wooden boats also occasionally transport bicycles and motorcycles.
- A number of the boats used for river crossing purposes are not registered with the Marine Department

2.5.5 Hydro-Electric Power Generation

There is no hydro-electric Power Generation in the Muar River Basin.

2.6 Water Quality Management

As part of the integrated river basin management, it is necessary to control the river water quality according to its intended uses. The Department of Environment (DOE) is the key agency in water quality management. As illustrated in **Figure 2.6.1**, DOE has three main roles in this respect, i.e. safeguarding the river water quality (the environment), monitoring of the water quality status and environmental education. This section elaborates the first two of the said roles. Subsequently, major sources of water pollution in the Basin are explained and the existing water quality management measures (administrative measures) being implemented against these pollution sources are highlighted.

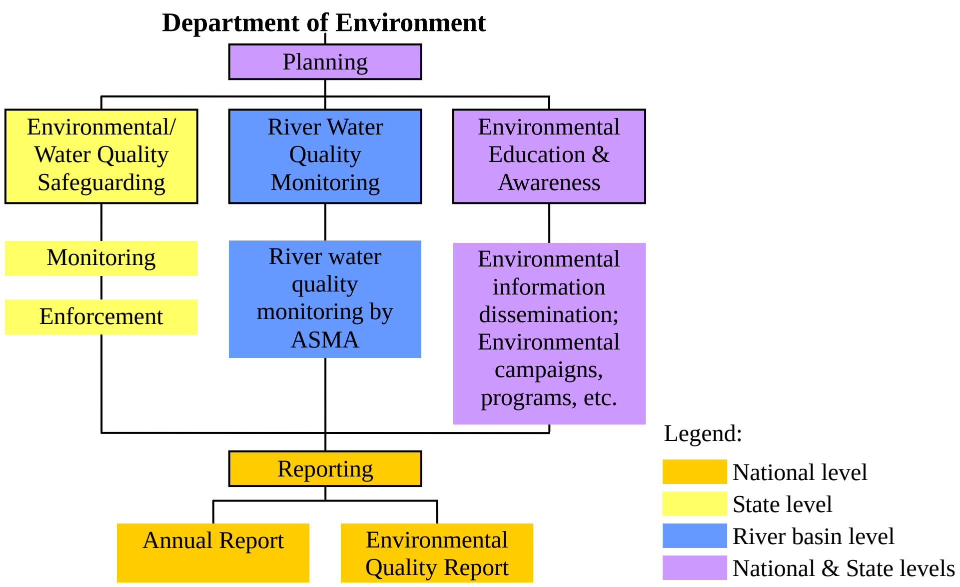


Figure 2.6.1 Water Quality Management Framework of DOE

2.6.1 Environmental/Water Quality Safeguarding

The environmental/water quality safeguarding role of DOE in relation to the integrated river basin management (IRBM) is governed by the **Environmental Quality Act 1974** (EQA) and its Regulations, Orders and Rules. **Table 2.6.1** summarizes the main activities under DOE's jurisdiction (in relation to IRBM).

Table 2.6.1 Summary of Main Activities under DOE's Jurisdiction in Water Quality Management

No	Activities	Main EQA Regulation/Order	Aspects under control	Main control mechanism
1	'Prescribed Activities' (refer to EQA): – Agricultural activities; – Airport constructions; – Drainage and irrigation projects; – Land reclamation works; – Fishery activities; – Forestry activities; – Housing developments; – Industrial activities; – Infrastructure developments; – Port constructions; – Mining activities; – Petroleum industrial activities and developments; – Power generation and transmission projects; – Quarrying activities; – Railway constructions; – Transportation developments; – Resort and recreational development; – Waste treatment and disposal activities; – Water supply works.	EQ (Prescribed Activities) (Environmental Impact Assessment) Order 1987	Overall environmental impacts	Preliminary EIA Detailed EIA Post-EIA monitoring and auditing
2	Premises which discharge sewage onto or into any soil, or into any inland waters or Malaysian waters, other than any housing or commercial development or both having a population equivalent of less than 150.	EQ (Sewage) Regulations 2009	Sewage discharges	Notification of new source of sewage discharge or release to DOE. Self monitoring of sewage discharge. Operation of STP by 'competent person'. Compliance with Standards A or B. (refer to EQA)
3	Premises which discharge or release industrial effluent or mixed effluent, onto or into any soil, or into inland waters or Malaysian waters (other than the premises as specified in the First Schedule of the EQ (Industrial Effluent) Regulations 2009).	EQ (Industrial Effluent) Regulations 2009	Industrial effluents and mixed effluents	Notification of new or altered sources of discharge of industrial effluent or mixed effluent to DOE. Compliance with the 'Guidance Document on the Design and Operation of Industrial Effluent Treatment System'. Self monitoring of effluent. Operation of effluent treatment system by

No	Activities	Main EQA Regulation/Order	Aspects under control	Main control mechanism
				'competent person'. Compliance with Standards A or B. (refer to EQA)
4	Solid waste transfer stations and landfills which discharge or release leachate.	EQ (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009	Leachate from solid waste transfer stations and landfills	Notification of new sources of leachate discharge to DOE. Self monitoring of leachate. Compulsory on the provision of leachate treatment system. Operation of leachate treatment by 'competent person'. Compliance with Standards A or B. (refer to EQA)
5	Premises occupied or used for the production or processing of: – Raw natural rubber in technically specified from, latex from including prevulcanised or the form of modified and special purpose rubber; and – Conventional sheet, skim, crepe or any other form of raw rubber not already described in quantities of 5 tonnes or more per day or with a production or processing capacity of a similar quantity.	EQ (Prescribed Premises) (Raw Natural Rubber) Regulations 1978	Industrial effluents	Written Permission Parameter limits for watercourse discharge (refer to EQA
6	Premises occupied or used for the processing of oil-palm fruit or oil-palm fresh-fruit bunches into crude palm-oil, whether as an intermediate or final product.	EQ (Prescribed Premises) (Crude Palm-Oil) Regulations 1977	Industrial effluents	Written Permission Parameter limits for watercourse discharge of effluent (refer to EQA)
7	'Scheduled Wastes': – SW1: Metal and metal-bearing wastes; – SW2: Wastes containing principally inorganic constitutes which may contain metals and organic materials; – SW3: Wastes containing principally organic constituents which may contain metals and inorganic materials; – SW4: Wastes which may contain either inorganic or organic constituents; – SW5: Other wastes (any residues from treatment or recovery of scheduled wastes above)	EQ (Scheduled Wastes) Regulations 2005	Storage, transportation, treatment and disposal of toxic and hazardous wastes	Written Permission Inventory of Schedule Wastes Consignment Note for Scheduled Wastes

2.6.2 River Water Quality Monitoring

(1) Water Quality Monitoring By DOE

DOE is the key government agency responsible in the monitoring and enforcement of river water quality. Through Alam Sekitar Malaysia Sdn. Bhd. (ASMA), DOE conducts regular water quality monitoring for 143 river basins (2007) throughout Malaysia. The total number of monitoring stations for the whole country is 1,064 (2007) while there are 39 stations (2007) within the Muar River Basin[1].

(2) Water Quality Classification

The Water Quality Index (WQI) is being used by DOE as the basis for general assessment of a watercourse in relation to pollution load categorization and designation of its beneficial uses as stipulated in the National Water Quality Standards for Malaysia (NWQS).

WQI is calculated from six (6) main parameters contained in the NWQS, namely dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammoniacal nitrogen (NH_3-N), suspended solids (SS) and pH. The basis of water quality classification based on WQI is shown in **Table 2.6.2**.

Table 2.6.2 DOE Water Quality Index Classification[2]

Parameter	Unit	Class				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1-0.3	0.3-0.9	0.9-2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1-3	3-6	6-12	> 12
Chemical Oxygen Demand	mg/l	< 10	10-25	25-50	50-100	> 100
Dissolved Oxygen	mg/l	> 7	5-7	3-5	1-3	< 1
pH	-	> 7.0	6.0-7.0	5.0-6.0	< 5.0	> 5.0
Total Suspended Solid	mg/l	< 25	25-50	50-150	150-300	> 300
WQI		**> 92.7**	**76.5-92.7**	**51.9-76.5**	**31.0-51.9**	**< 31.0**

(3) Water Quality Status

As mentioned above, there are 39 water quality stations within the Muar River Basin (see **Figure 2.6.2**). The Malaysia Environmental Quality Report (EQR) 2007[3] published by DOE reported that the overall WQI of the Muar River and its tributaries is '82', which is comparable to Class II water quality and can be considered as 'Clean'. Based on the same report, the WQI of the Muar River (mainstream) in 2007 was 83, which falls within Class II of the WQI. Among the 17 main tributaries being monitored, only the Air Panas River falls within Class I (WQI 93), while the Merlimau River, the Senarut River, the Serom River and the Spg. Loi River are comparable to Class III, which means that these rivers are slightly polluted.

Table 2.6.3 presents the water quality trend of the Muar River and its major tributaries from 2004 to 2007[4] while **Figure 2.6.3** illustrates the water quality classes according to the 2007 water quality monitoring results. On a whole, from the monitoring results, it can be generally concluded that the water quality of the Muar River Basin is in a reasonably clean (Classes I & II) to moderately clean (Class III) conditions.

Merlimau, Senarut, Serom and Spg. Loi Rivers are under Class III water quality. From the evaluation on the detailed water quality monitoring data provided by DOE, it is suspected that the main reason of the deterioration of water quality at the aforementioned four rivers is due to runoff of fertilizers from the adjacent plantations and small holders agricultural activities. This is evidenced from the seasonal increases of NH_3-N, NO_3, PO_4, BOD and COD. Also, in general the mainstream of the Muar River and most of its tributaries are facing the problem of siltation, which could be due to riverbank erosion, sand dredging activities as well as land developments such as plantations and urban developments. This can be seen from the high readings of TSS, TDS and turbidity.

[1] Malaysia Environmental Quality Report 2007
[2] Malaysia Environmental Quality Report 2007
[3] Latest available report
[4] Latest available data

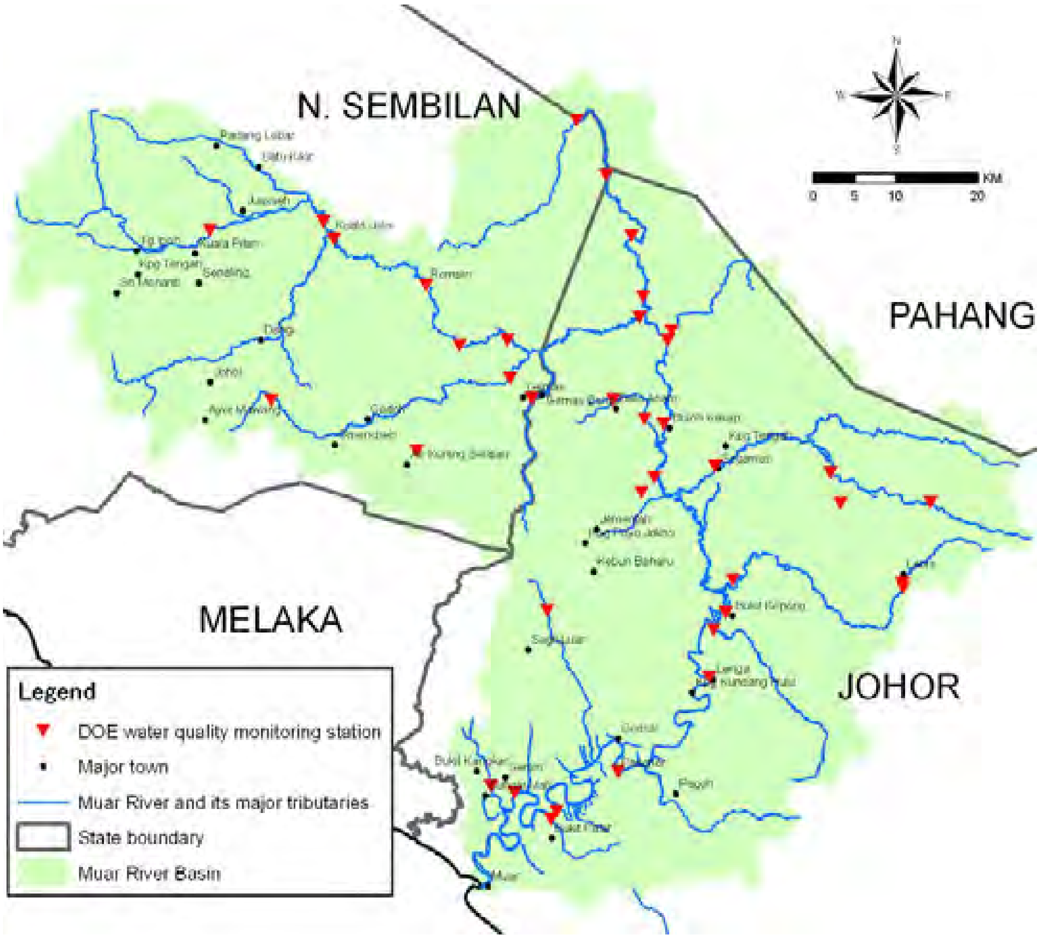


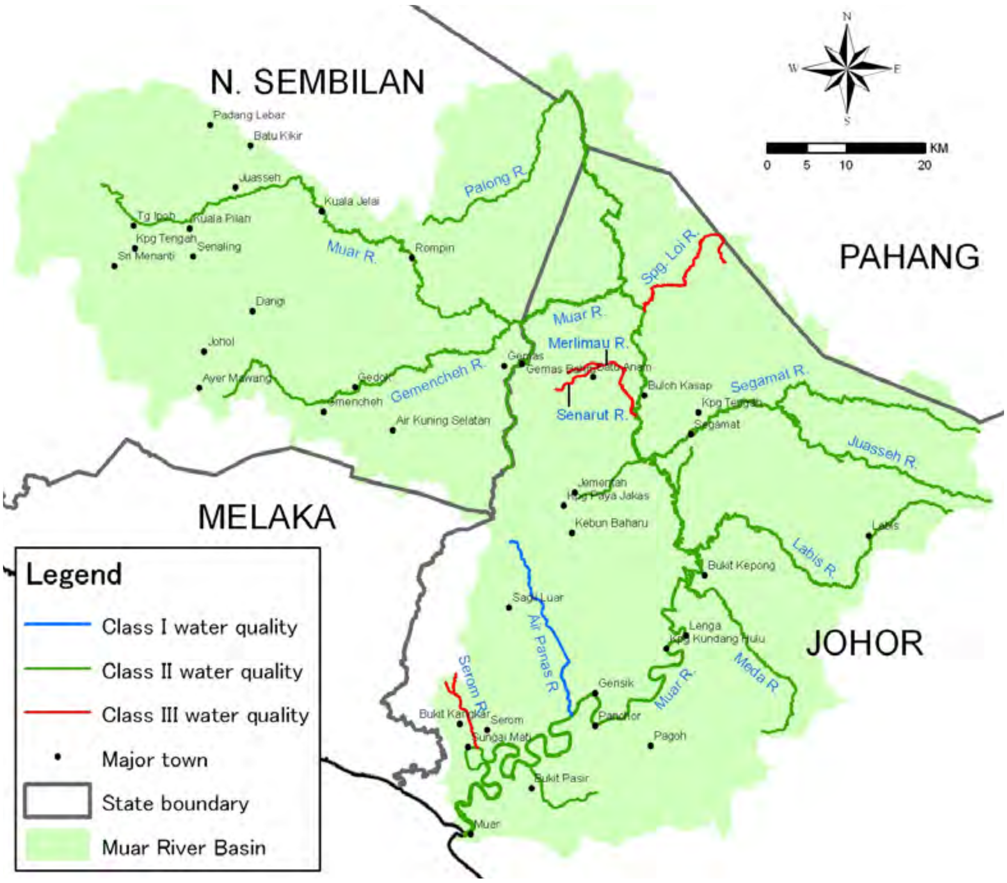
Figure 2.6.2 DOE Water Quality Monitoring Stations (2007)

Table 2.6.3 Water Quality Status of the Muar River and its Tributaries, 2004-2007[5]

River	No. of station (2007)	2007			2006			2005			2004		
		WQI	River status	Class	WQI	River status	Class	WQI	River status	Class	WQI	River status	Class
Air Panas	1	93	C	I	91	C	II	92	C	II	-	-	-
Gemas	1	84	C	II	80	SP	II	74	SP	III	-	-	-
Gemencheh	2	84	C	II	83	C	II	88	C	II	89	C	II
Juasseh	1	87	C	II	88	C	II	87	C	II	87	C	II
Kelamah	1	79	SP	II	59	P	III	65	SP	III	76	SP	III
Labis	3	84	C	II	77	SP	II	75	SP	III	82	C	II
Meda	1	87	C	II	87	C	II	81	C	II	-	-	-
Merbudu	1	82	C	II	83	C	II	83	C	II	69	SP	III
Merlimau	1	73	SP	III	68	SP	III	63	SP	III	73	SP	III
Muar	**16**	**83**	**C**	**II**	**85**	**C**	**II**	**84**	**C**	**II**	**82**	**C**	**II**
P. Menkuang	1	87	C	II	85	C	II	88	C	II	86	C	II
Palong	4	81	C	II	83	C	II	83	C	II	84	C	II
Segamat	1	82	C	II	85	C	II	87	C	II	87	C	II
Senarut	1	75	SP	III	61	SP	III	50	P	IV	77	SP	II
Serom	1	70	SP	III	72	SP	III	69	SP	III	63	SP	III
Spg. Loi	1	69	SP	III	66	SP	III	76	SP	III	80	SP	II
Temarong (NS)	0	-	-	-	-	-	-	-	SP	II	92	C	II
Tenang	1	81	C	II	73	SP	III	78	SP	III	76	SP	III

Class III water quality that requires attention

[5] Malaysia Environmental Quality Report 2004-2007



Note: Classification based on the water quality of monitoring station(s) at each river/stream.

Figure 2.6.3 Water Quality Status of the Muar River and its Major Tributaries, 2007[6]

2.6.3 Management of Pollution Sources

As the reduction of pollutants from source is widely regarded to be the best approach in water pollution management, as part of the integrated water quality management, it is necessary to look into all the above pollution sources. However, as explained in the Inception Report that preparation of IRBM is at conceptual level, no detailed investigation on each of the pollution sources will be carried out in this study. Instead, the following subsections will elaborate the present administrative environmental/water quality management measures being implemented by the Government for the main pollution sources i.e. sewage, industrial effluents, solid waste disposal, wastewater discharge from livestock farms, sediment load from agricultural, logging and sand dredging activities. In the subsequent stage of the study, policies and strategies to manage these pollution sources will be proposed.

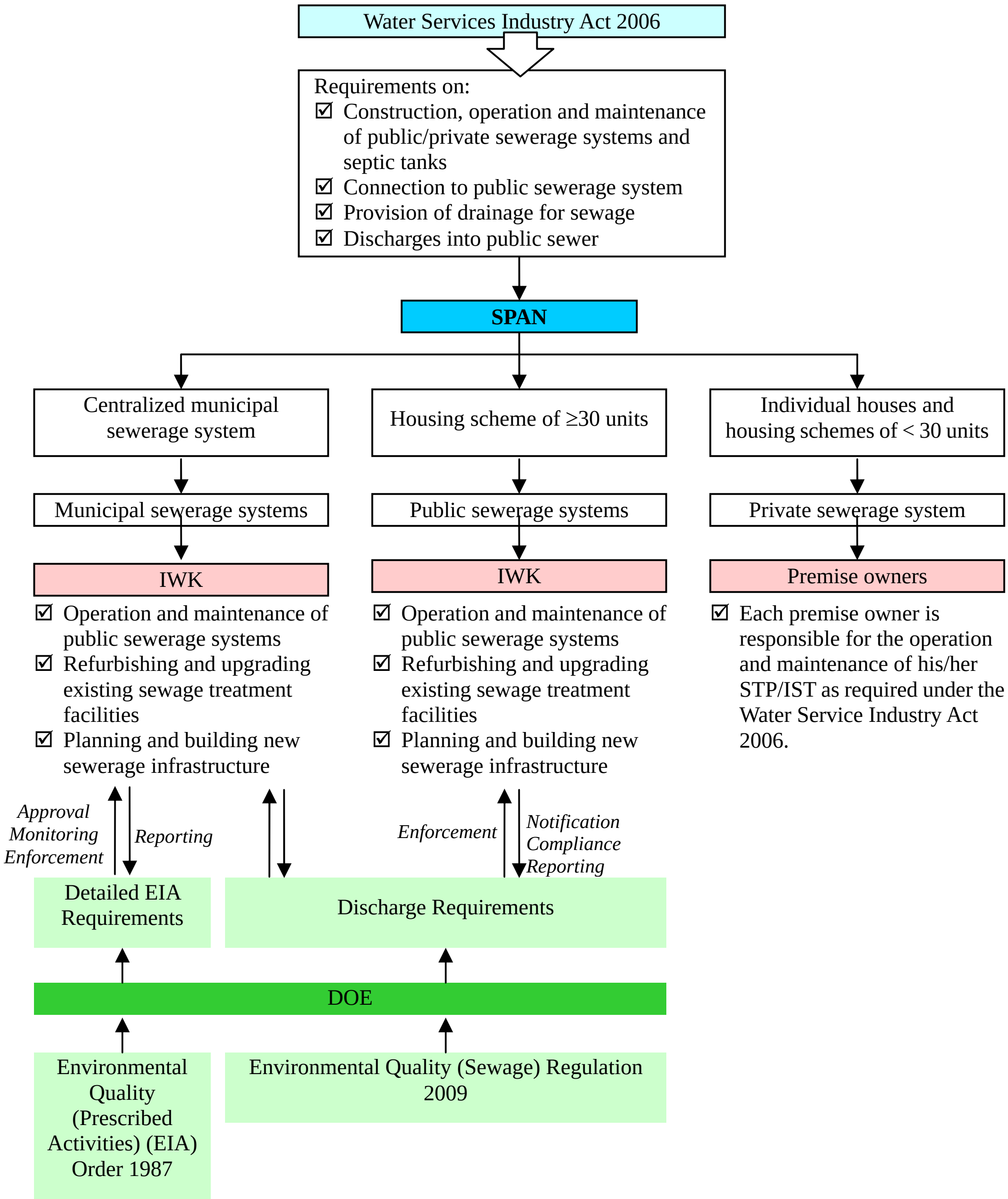
(1) Sewage

Generally, sewage means any liquid or wastewater discharge containing human excreta, animal or vegetable matters in suspension or solution derived from domestic activities[7].

(a) Sewerage Management

Sewerage management sector is governed mainly by the Water Services Industry Act 2006 (Act 655), while the Environmental Quality (Sewage) Regulations 2009 under the Environmental Quality Act 1974 (Act 127) regulates effluents from sewage treatment plants. **Figure 2.6.4** illustrates the overall concept of sewerage management in relation to water quality control.

[6] Based on the data of Malaysia Environmental Quality Report 2007
[7] Water Services Industry Act 2006 (Act 655) and Environmental Quality (Sewage and Industrial Effluents) Regulations 1979



SPAN: Suruhanjaya Perkhidmatan Air Negara
IWK: Indah Water Konsortium Sdn. Bhd.

Figure 2.6.4 Framework of Sewerage Management in relation to Water Quality Management

(b) Sewerage Service

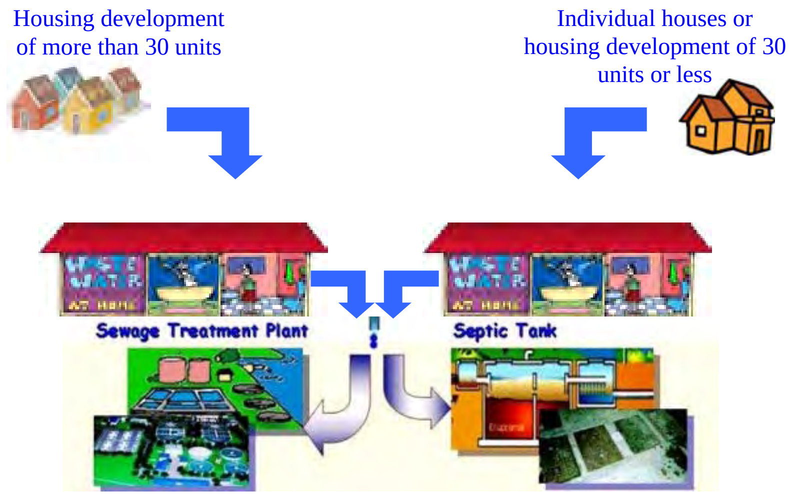
There are two main types of sewerage systems/services as shown in **Figure 2.6.5**. Generally, all houses under housing schemes of more than 30 units are connected to public sewage treatment plants (STPs), whereas, individual houses and housing schemes of 30 units or less are provided with individual septic tanks (ISTs). Indah Water Konsortium Sdn. Bhd. (IWK), a wholly-owned company of the Minister of Finance Incorporated, is responsible for operating and maintaining the public sewage treatment plants and network of underground sewerage pipelines.

(c) Discharge Requirement

The newly enforced Environmental Quality (Sewage) Regulations 2009 stipulates that discharges from sewage treatment plants must comply with either Standard A or Standard B under the Second Schedule of the said Regulations. Generally, discharges into any inland waters within the catchment areas (water supply catchment areas) must comply with Standard A. On the other hand, discharges into any other inland water shall comply with Standard B. However, depends on the date of approval of the subject sewage treatment plant, the discharge requirements are different.

(d) Issues and Needs

As mentioned above, IWK is responsible for operating and maintaining the public sewage treatment plants, refurbishing and upgrading existing sewage treatment facilities as well as the planning and building new sewerage infrastructure. Under the present requirement, all housing schemes with 30 or more units of houses are required to have centralized STPs. These STPs are being built by the housing developers and operated and maintained by IWK. (see **Figure 2.6.5**)



☑ STPs are built by the developers, while IWK is responsible for the operation and maintenance of the STPs.

☑ ISTs are suitable for single dwellings or individual buildings with population equivalent (PE) up to 150 and installed where there is no central sewerage system.

☑ They only partially treat sewage.

☑ Under the Water Services Industry Act 2006, owner of premises with septic tanks is responsible for the maintenance of the septic tank, whereby desludging should be done licensed operators at least once in every two years.

Figure 2.6.5 Concept of Sewerage Service

For the case of housing schemes of less than 30 units, individual houses and village houses, only individual septic tanks (IST) are required. These houses are required to desludge their ISTs at least once every two years. Under the Malaysian Sewerage Industry Guidelines, it is stated that ISTs are regarded only as temporary treatment system before connecting to the centralized sewer systems. There are three issues that must be highlighted:

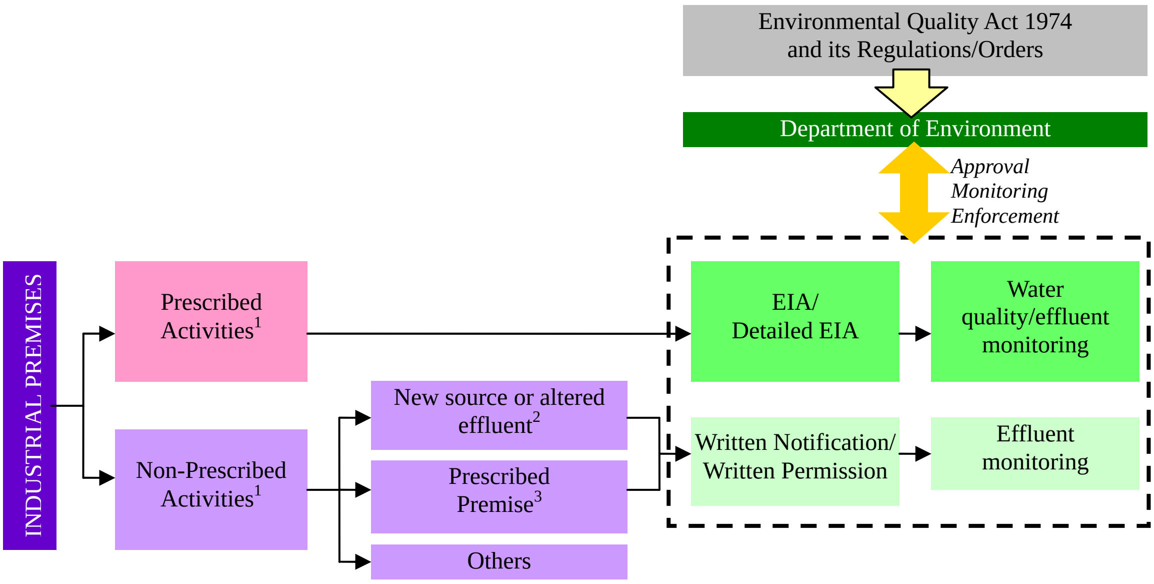
- Despite that all the subject house owners are required to desludge their ISTs at least once in every two years, there are still some non-compliances and it is very difficult to monitor and enforce.
- A large portion of village houses are being built without following the procedures stipulated by the local authorities and without obtaining any Occupation Permits, thus it is very difficult to ensure the provision of proper IST according to the Malaysian Sewerage Industry Guidelines for Septic Tanks published by SPAN.
- The sewerage development by IWK is guided by the Sewerage Catchment Strategies that which only cover the urban areas, while those areas beyond these service areas will not be provided with any centralized sewerage system, at least for the near future.

(2) Industrial Effluent

Industrial effluent means liquid water or wastewater produced by reasons of the production processes taking place at any industrial premises[8]. Depends on the type of industrial premises, discharge of untreated industrial effluent may result in contamination of surface and groundwater.

(a) Control of Industrial Effluent

The control of industrial effluent is mainly governed by the Environmental Quality Act 1974, specifically the Environmental Quality (Industrial Effluents) Regulations 2009. The main agency in regulating industrial effluent is DOE. **Figure 2.6.6** below illustrates the basic framework on the control of industrial effluents.



1 Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987
2 As stipulated under Regulation 4, Environmental Quality (Industrial Effluents) Regulations 2009
3 (a) The Crude Palm Oil Mill; (b) The Raw Natural Rubber Processing Mill; and (c) The Treatment and Disposal Facilities of Scheduled Waste

Figure 2.6.6 Basic Framework on the Control of Industrial Effluents

[8] Environmental Quality (Sewage and Industrial Effluents) Regulations 1979

(b) Discharge Requirements

The control of discharges industrial effluent is under the jurisdiction of DOE. The newly enforced Environmental Quality (Industrial Effluents) Regulations 2009 under the Environmental Quality Act 1974 stipulated that construction of any premises that may result in a new or altered source of discharge of industrial effluent or mixed effluent must notify the Director General of DOE in writing. It is also stipulated that discharge must comply with either Standard A or Standard B of effluent conditions as specified under the Fifth Schedule of the abovementioned Regulations

(c) Issues and Needs

From the discussions with DOE Negeri Sembilan and Johor as well as other members of the Water Quality Working Group of Negeri Sembilan and the Environment Working Group of Johor, it is found that there is generally no major issue in relation to water quality management except that:

- The drinking water treatment sludge is being discharged into rivers without proper treatment. The possible pollution loads include alum, alluminium and iron. Under the Environmental Quality (Scheduled Wastes) Regulations 2005, the said sludge is being classified as ‘Scheduled Waste’ whereby there are strict requirements on its handling, transportation, storage and disposal. Also, under the newly enforced Environmental Quality (Industrial Effluent) Regulations 2009, prior written permission from DOE is required for any discharge or disposal of any sludge generated from water treatment plant onto or into any soil, land or inland water (Section 23).

(3) Solid Wastes

The Solid Waste and Public Cleansing Management Act 2007 (Act 672) defines solid waste as any scrap material or other unwanted surplus substance or rejected products arising from the application of any process, any substance required to be disposed of as being broken, worn out, contaminated or otherwise spoiled, or any other material that is required by the authority to be disposed of.

Solid waste is another source of river water pollution. Improper solid waste management may result in indiscriminate disposal of solid wastes which eventually may result in deterioration of surface and groundwater quality. Improper management of solid waste disposal sites such as sanitary landfills may also result in seepage of high contaminating leachate into groundwater.

(a) Solid Waste Management

In the Muar River Basin, SWM Environment Sdn Bhd (SWM) is responsible for the managing the storage, collection, transfer, haulage, intermediate processing and disposal of solid waste. **Figure 2.6.7** general framework of solid waste management in the Muar River Basin in relation to water quality management.

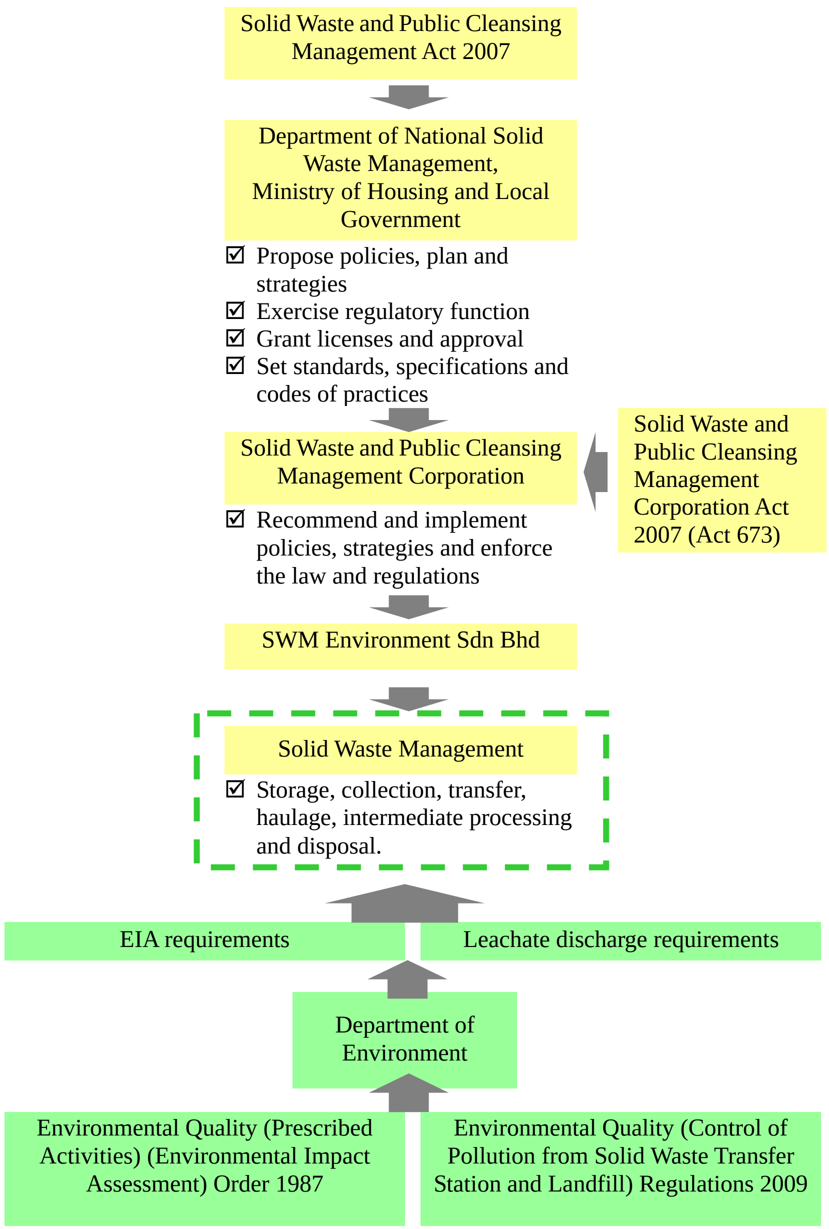


Figure 2.6.7 Basic Framework of Solid Waste Management

(b) Discharge Requirements

The construction of solid waste landfill facilities and incineration plants is subject to the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, whereby Detailed Environmental Impact Assessment (Detailed EIA) study is required. Besides, the control of discharges from these facilities is subject to the requirements of the newly enforced Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009. It is stipulated that discharge must comply with the standard specified under the Second Schedule of the abovementioned Regulations.

(c) Issues and Needs

Based on the discussions with Working Groups, issues and needs with respect to solid waste management in relation to integrated river basin management for the Muar River Basin are:

- Members of Working Groups commented that presently the landfills and dumpsites are not properly managed. With the enforcement of the Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009, SWM must ensure that all the solid waste transfer stations and landfills under its jurisdiction comply with the Regulations. Among the new requirements is the provision of leachate treatment systems for all solid waste transfer stations and landfills.
- Currently, the service areas of SWM only cover the operation area of local authorities. Areas outside of these local authorities are not provided with any solid waste management service. Although the population size is comparatively smaller, indiscriminate disposal of solid wastes may result in deterioration of both surface and ground water quality.

(4) Livestock Farms

Waste discharge, either in the form of waste water or animal feaces, is another significant source of river water pollution. The common livestock in the Muar River Basin includes poultry, cattle, goat and pig. Pollution load from pig farm is particularly significant that must not be ignored in the integrated river basin management.

In Negeri Sembilan, the licensing of livestock farms is under the jurisdiction of local authorities, while in Johor, pig farming activities are regulated by the Johor State Department of Veterinary Service (see **Figure 2.6.8**).

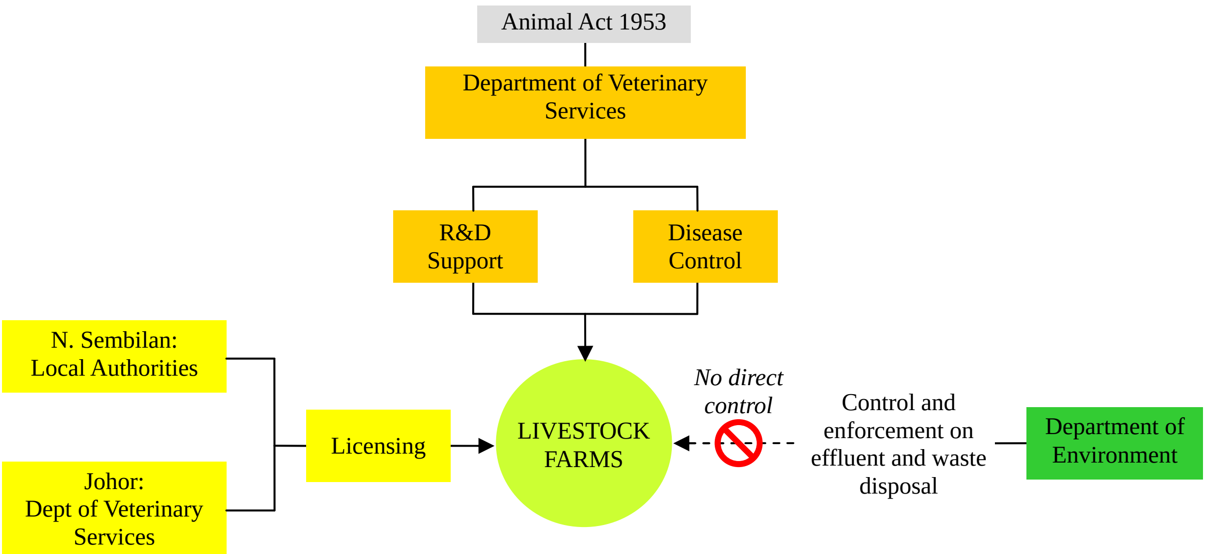


Figure 2.6.8 Framework of the Management of Livestock Farms in relation to Water Quality Management

(a) Issues and Needs

There are quite a number of smallholder pig farms in the Muar River Basin. Since over 10 years ago, the Malaysian Government has initiated the concept of regrouping the individual pig farms into centralized modern pig farm areas (PFA) with proper wastewater treatment facilities. In Negeri Sembilan, a PFA was built at Bukit Pelanduk (adjacent to the Muar River Basin). However, according to Working Group members, there are problems in relocating the existing individual farms to the PFA. While for the case of Johor, presently there is no PFA in or adjacent to the Muar River Basin. All the pig farms are operating individually but the Department of Veterinary Services is imposing ‘zero discharge’ requirement on the license condition.

(5) Agricultural and Logging Activities

Large scale agricultural and logging activities are among the main causes of river siltation. This happens mainly during the development stage of plantations when natural vegetation and land cover are removed during earthworks for terracing and road construction etc. Besides, runoff of agrochemicals is also polluting the rivers. **Figure 2.6.9** illustrates the environmental management framework of large scale agricultural and logging activities.

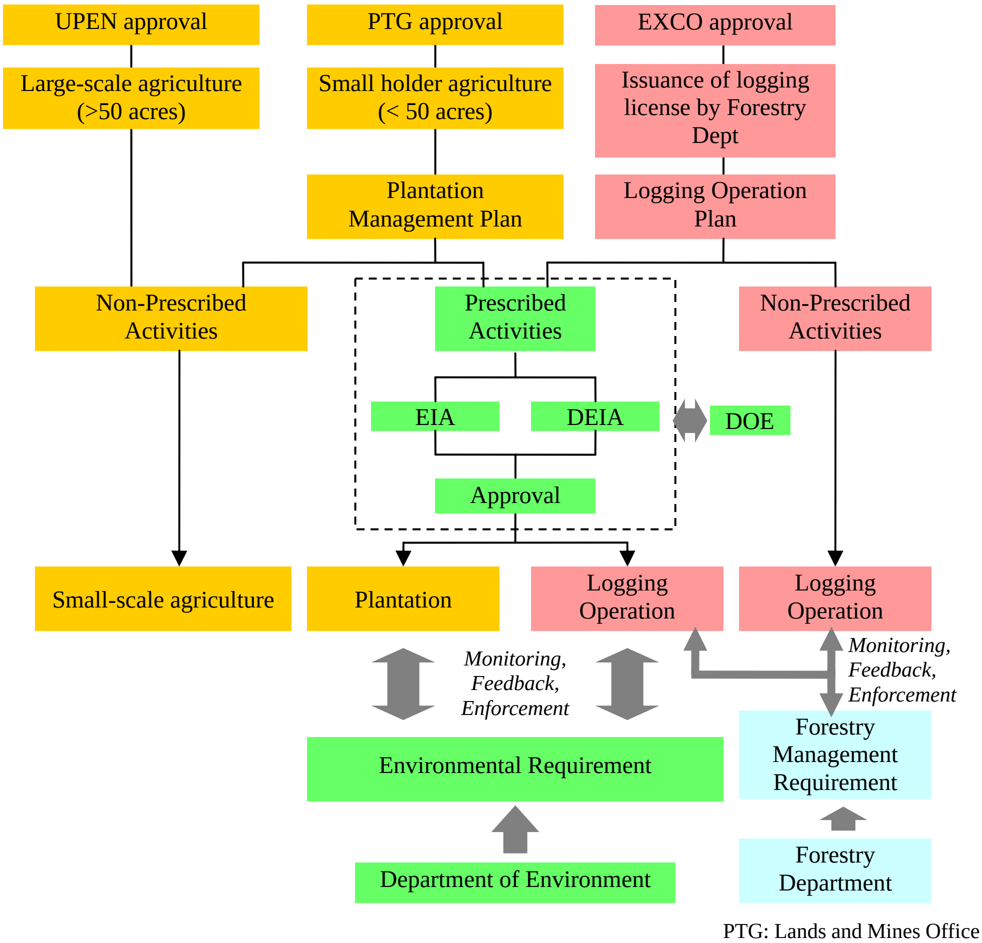


Figure 2.6.9 Environmental Framework of Large Scale Agricultural and Logging Activities

(a) Issues and Needs

One of the main concerns of agricultural activities on water quality management is the runoff of agrochemicals such as pesticides and fertilizers into waterways. For large scale agricultural activities, they are partially monitored by DOE through the EIA requirements. For the smallholders' farms, both DOE and DOA have no directly control on the application of pesticides and fertilizers. Nonetheless, DOA is carrying out various awareness programs to urge the farmers to apply only the environmental friendly pesticides and fertilizers.

(6) Sand Dredging

Some parts of the Muar River and its tributaries are under licenses for sand dredging. Although to some extent sand dredging activities help in issues related to sedimentation and rise of riverbed, improper management of these dredging activities may result in adverse environmental impacts such as siltation of river water, riverbank erosion and loss of aquatic flora and fauna.

For sand dredging projects involving an area of 50 hectares and above, they are subject to EIA requirements under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. The environmental management of these projects, as stipulated in the EIA Reports, shall be closely monitored by DOE. However, for the case of small scale project, as no EIA is required, DOE has no direct involvement in those projects. There is no direct monitoring of environmental impacts of these projects. **Figure 2.6.10** illustrates the basic framework of sand dredging activities in relation to environmental management.

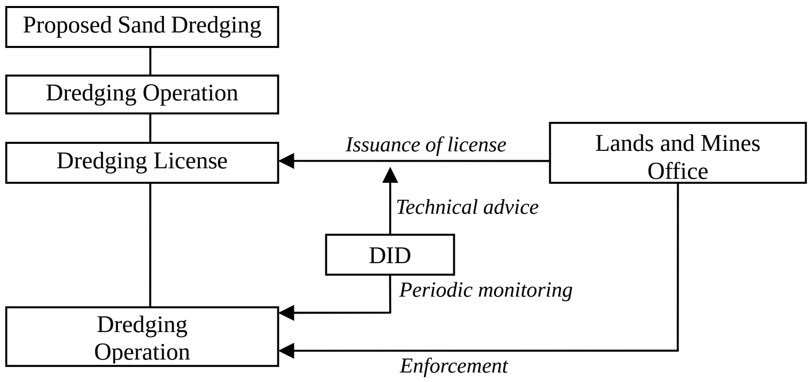


Figure 2.6.10 Framework of Sand Dredging Activities in relation to Environmental Management

(a) Issues and Needs

Although the licensees are submitting regular reports to the Lands and Mines Office, these reports are focusing more on dredge volume rather than environmental management aspects. During the application of dredging license, DID is responsible in providing technical evaluation on the proposed dredging method and so on while during operational stage, DID is responsible to monitor the dredging activities. From the Working Group discussions, it is understood that the monitoring has been ineffective as DID has no enforcement power in this respect.

As mentioned above, only those projects with 50 hectares of more are subject to EIA requirements. Environment management for projects below EIA requirements is ineffective in general. Data shows that most of the sand dredging licenses in the Muar River Basin are below two hectares, which are not subject to EIA requirement. It is thus crucial to ensure proper environmental management by these operators.

(7) Other Sources of Pollution

The above subsections elaborated six main water pollution sources. There are still many other sources of pollution, which mostly are urban-based, for instance wastewater discharge from wet markets, restaurants, hawker centers and abattoirs, disposal of oil and grease from vehicle workshops and construction sites, sewage disposals from village houses, etc. Due to time limitation, the present study is not investigating all these pollution sources in detail. However, these aspects must be taken into consideration when formulating the integrated water quality management policies and strategies in the subsequent stage of the study.

2.7 Land Use

Land use planning in Malaysia is practiced at three tiers of government. At the national level, land use planning is mainly guided by the National Physical Plan, while at the State level, it is guided by the Structure Plans. Land use planning at the local level (district or local authority area) is guided by the Local Plans. **Table 2.7.1** below summarized the land use planning framework in Malaysia.

Table 2.7.1 Land Use Planning Framework in Malaysia

Level	Plan	Responsible Agency
National	National Physical Plan	JPBD
State	Structure Plans	JPBD
District/Local Authority Area	Local Plans	JPBD/LA

JPBD: Town and Country Planning Department; LA: Local Authority

2.7.1 Regional Development Context

The regional development pattern of the Muar River Basin is mainly guided by the National Physical Plan, the National Urbanization Policy and the Johor and Negeri Sembilan Structure Plans. It is envisaged that the present trend of development will prevail at least for the next 10 to 15 years. The major urban development will continue to focus at Muar Town and Segamat Town in Johor and Kuala Pilah Town in Negeri Sembilan. For the case of Muar Town, the Muar-Batu Pahat-Kluang region of Johor has been identified as a District Growth Conurbation. Hence, it is expected that Muar Town will be benefited from the regional development of the said urban conurbation. While in Negeri Sembilan, the urban development is likely to be focusing at Kuala Pilah. Rapid urban development is foreseeable in this area due to spillover of developments from the Kuala Lumpur Conurbation.

The following subsections explain the growth conurbation and urban hierarchy in the Muar River Basin.

(1) Growth Conurbation

The National Physical Plan has identified the major growth conurbations and urban growth centers in Peninsular Malaysia as shown in **Figure 2.7.1**. From the figure, it can be seen that the Muar River Basin is not located within any national, regional and sub-regional growth conurbations. However, the National Physical Plan and the National Urbanization Policy have identified that the Muar-Batu Pahat-Kluang region as a District Growth Conurbation that known as the ‘Muar-Batu Pahat-Kluang Conurbation’. Muar Town forms the northern region of the said Conurbation. Hence, it is expected that urban growth rates of Muar Town would be relatively higher compared to other regions of the Basin.

Figure 2.7.1 Major Growth Conurbations of Peninsular Malaysia[9]

(2) Urban Hierarchy

Under the National Physical Plan and the National Urbanization Policy, the major urban centers in Peninsular Malaysia are being divided into several hierarchies according to their designated functions. The major urban centers in the Muar River Basin include three hierarchies of urban center i.e. Sub-Regional Centers, Major Settlement Centers and Minor Settlement Centers as listed in the Johor and Negeri Sembilan Structure Plans (**Figure 2.7.2**). The National Urban Policy provides details on the target populations and necessity amenities for each hierarchy of settlement centers as.

[9] National Physical Plan, 2005

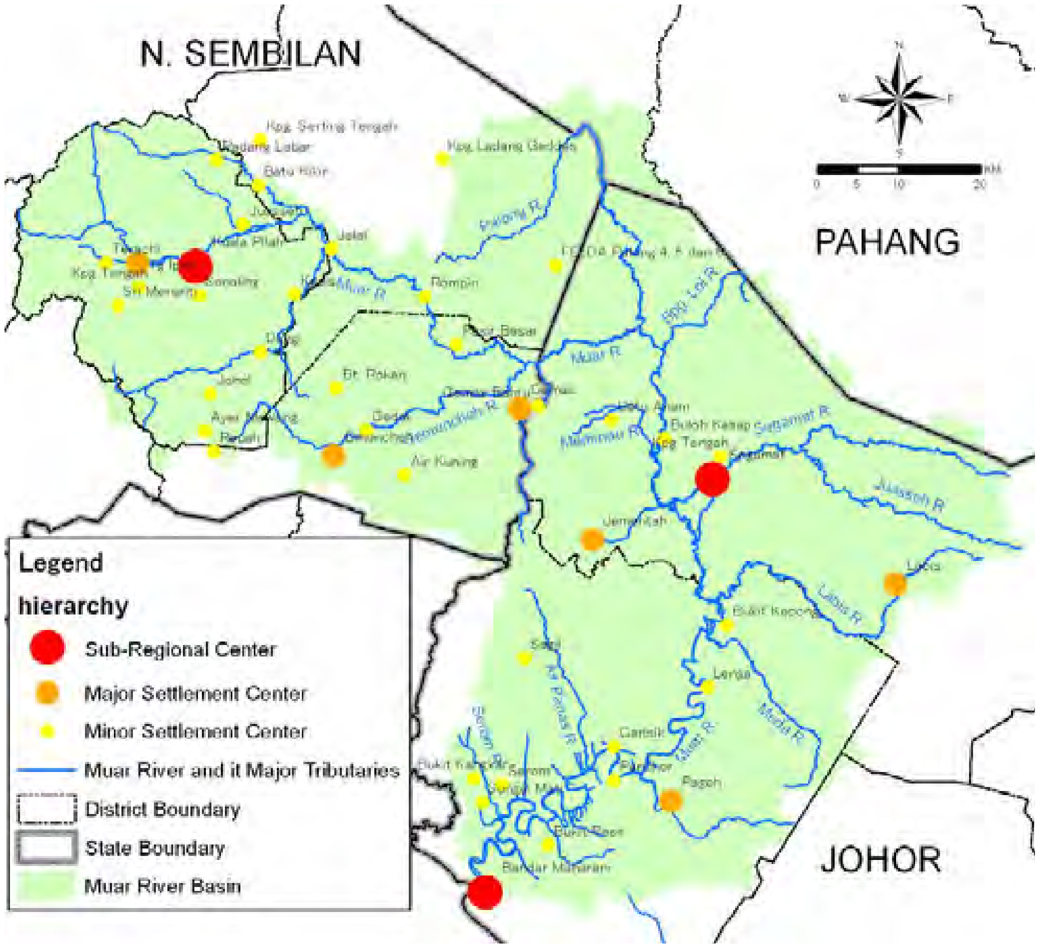


Figure 2.7.2 Urban Hierarchy[10]

2.7.2 Land Use in the Muar River Basin

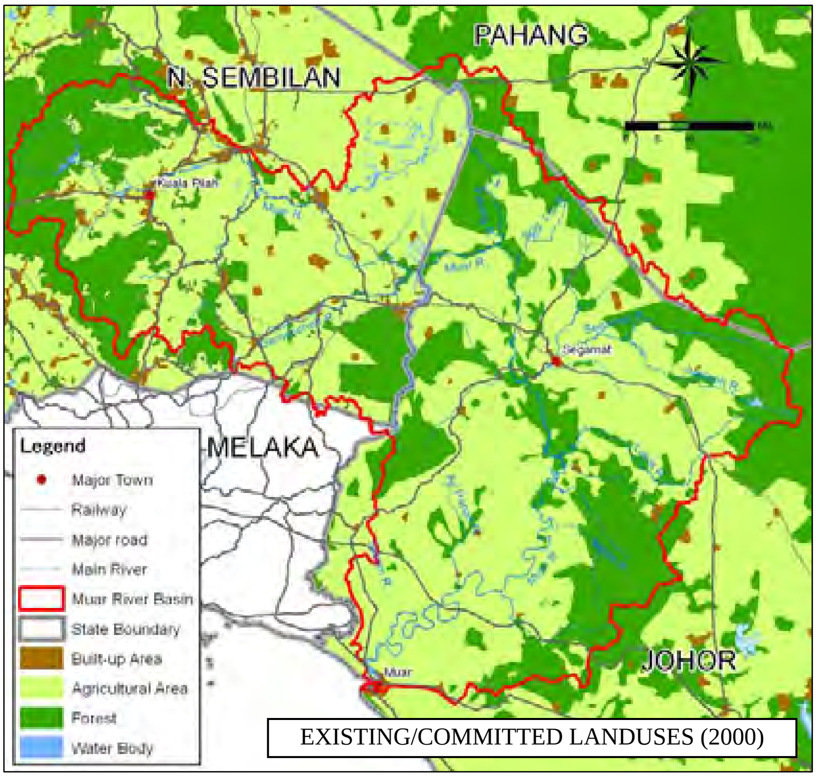
Land use affects surface runoff. It is an important factor that must be considered in flood management. Also, conversion of forests to agricultural and urban usages may give pressures to water quality hence it must be taken into consideration in water quality management and water catchment management. This section compiles the land use information of the Muar River Basin which serves as the supporting information in the integrated river basin management and integrated flood management.

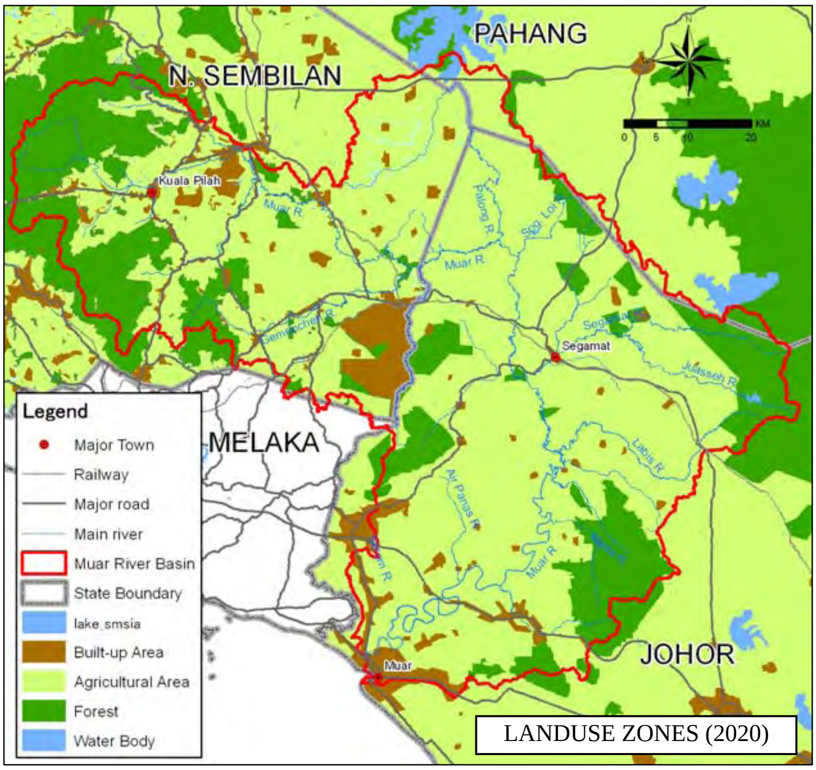
Based on the information from the Negeri Sembilan and Johor Structure Plans, existing land uses (2000 land uses) and land use zoning plan (2020) of the Muar River Basin are compiled in **Figure 2.7.3**. The following **Table 2.7.2** summarized the land use breakdowns.

Table 2.7.2 Breakdown of Existing and Future Land Uses

Land Use	Existing/Committed (2000)		Future (2020)	
	Land area (km^2)	%	Land area (km^2)	%
Built-up areas	163	2.7	438	7.1
Agricultural areas	3,909	63.7	4,367	71.1
Forests	2,031	33.1	1,306	21.3
Waterbody	36	0.6	29	0.5
Total	6,140	100.0	6,140	100.0

[10] Rancangan Strukture Negeri Sembilan 2001-2020, Rancangan Strukture Negeri Johor 2020





Note: Built-up areas are areas under predominantly urban use but comprising a variety of land uses such as residential, commercial, industrial and institutional uses together with supporting facilities such as roads, public utilities, open spaces, parks and vacant lands.

Figure 2.7.3 Existing/Committed Land Uses (2000) and Land Use Zones (2020) in Muar River Basin[11]

[11] Johor, Negeri Sembilan and Pahang Structure Plans (with some changes according to the respective local plans)

2.7.3 River Reserve

River reserve is the lands adjoining both banks of river that has been *gazetted* under Section 62 of the National Land Code as reserved land (State land) for public purpose ('River Reserve'). It is one of the important elements in river corridor management. Among the main functions of river reserves are:

- As the buffer zones to protect adjacent properties and communities from riverbank erosions and during the event of floods;
- As reserved lands for river improvement works/infrastructure; and
- Conservation of flora and fauna.

(1) Widths of River Reserves

Under the DID Manual, it is recommended that the minimum widths of river reserves shall be as shown in **Table 2.7.3**.

Table 2.7.3 Minimum River Reserve Widths

Top width of river	Minimum reserve width an each bank
> 40 m	50 m
30-40 m	40 m
20-30 m	30 m
10-20 m	20 m
5-10 m	10 m
< 5 m	5 m

(2) Gazette of River Reserves

Although it is stipulated in the DID Manual that all lands along the rivers shall be set aside as river reserves (see **Table 2.7.3**), DID has no legal jurisdiction and control on those lands not unless they are *gazetted* as 'river reserves' under Section 62 of the National Land Code. Once *gazetted*, DID will have full legal jurisdiction on the usage of lands within the river reserves for public purposes such as flood mitigation, river channel improvement etc.

According to DID, gazetting of river reserves under Subsection 62 has not been implemented. Gazetting under Subsection 13, which is less stringent, has been implemented only for three states of Pahang, Johor and Selangor (Klang River only). This has resulted in that some of the rivers are flowing within alienated lands. Also, it may hamper the execution of river improvement projects.

(3) Development within River Reserves

For all developments involving river and/or river reserve, strict procedures that different from the normal developments must be followed. **Figure 2.7.4** illustrates the general flows of development involving river and/or river reserve. DID publication entitled 'Pembangunan Melibatkan Sungai dan Rizab Sungai'(Garis Panduan DID Bil.1 Tahun 2000) provides further detail on this matter.

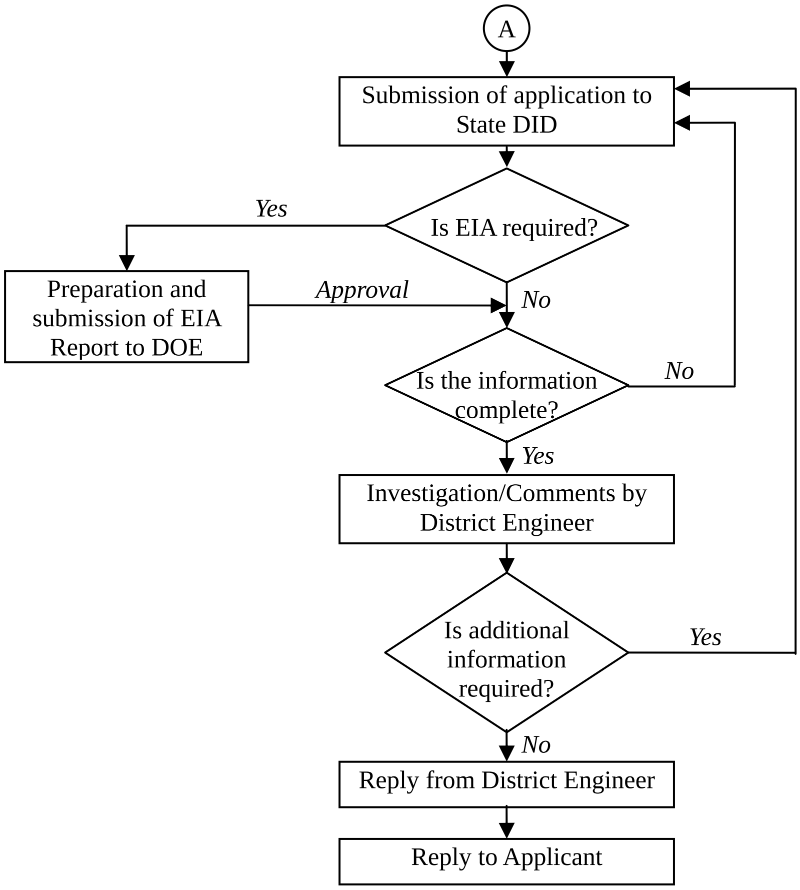


Figure 2.7.4 Typical Flow of Application for Development Involving River/River Reserve

2.8 River Basin Information Management

One of the vital prerequisites for effective integrated river basin management is a comprehensive and effective river basin information management system that can be shared among the related agencies in basin management.

2.8.1 National Spatial Data Infrastructure

To fulfill the need for land and geospatial information for planning and development, the Government has initiated the development of a Geospatial Data Infrastructure (MyGDI). The Malaysian Center for Geospatial Data Infrastructure (MaCGDI) under the Ministry of Natural Resources and Environment has the responsibility to coordinate the development and implementation activities of MyGDI. **Figure 2.8.1** illustrates the position of MaCGDI in the overall MyGDI management structure.

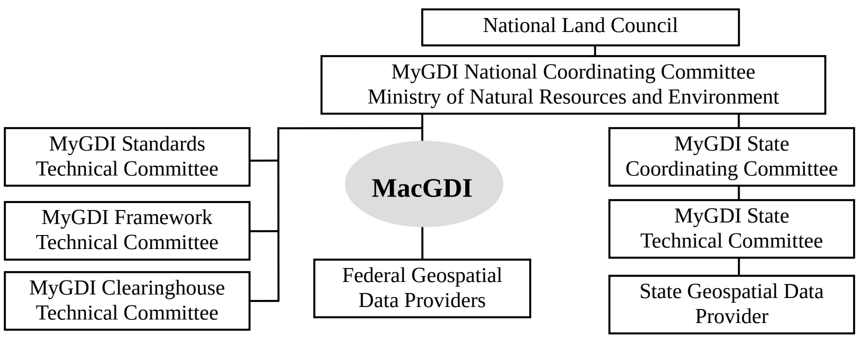


Figure 2.8.1 MaCGDI in the overall MyGDI Management Structure[12]

[12] MaCGDI, 2009

MaCGDI serves as the clearinghouse for GIS databases of various agencies as shown in **Figure 2.8.2**.

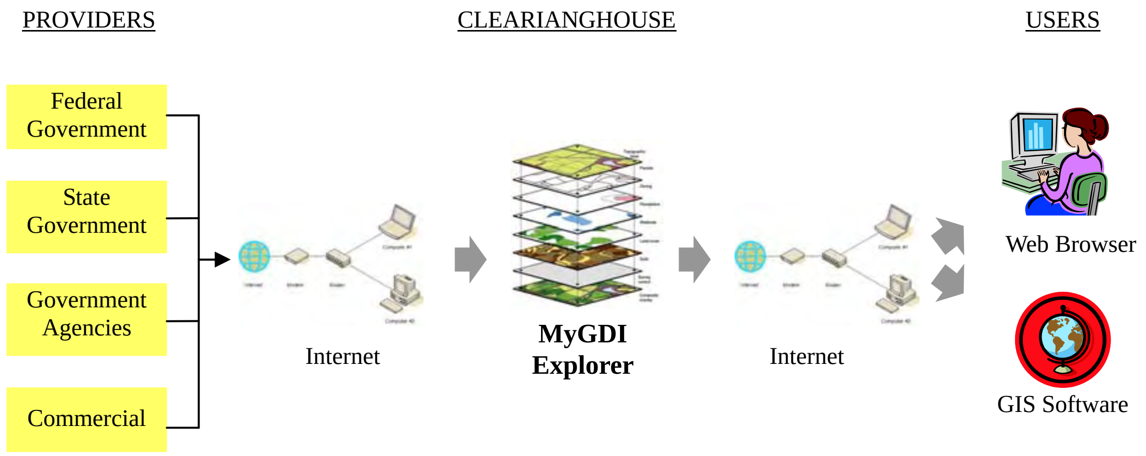


Figure 2.8.2 Concept of MaCGDI's Role in Promoting Data Sharing among Data Providers and Users[13]

2.8.2 River Basin Information System by DID

In 2001, through DID, the Government commissioned the National Register of River Basins Study (RRB1) to facilitate the formulation of a management system to support integrated river basin management in the country. The said study proposed the establishment a National River Basin Decision Support System (RB-DSS) to facilitate the integrated management of all river basins in the country (see **Figure 2.8.3**). Generally, DID acts as the secretariat to develop, maintain and update the river basin database whereas all other agencies involving in river basin management shall provide data inputs. While RB-GIS and RB-SMS shall mainly be kept and maintained by DID, RB-IMS shall be an open database available to all users via internet (with security control). The overall framework of development, maintenance, updating and accessibility of the RB-DSS is illustrated in **Figure 2.8.4**.

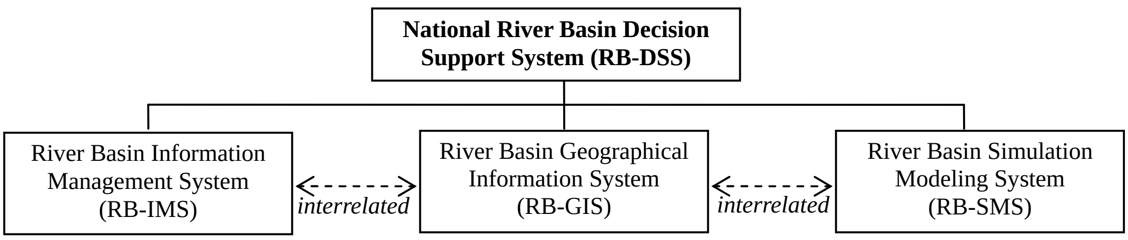


Figure 2.8.3 Proposed Structure of River Basin Information under the National Register of River Basin Study 2001

[13] MaCGDI, 2009

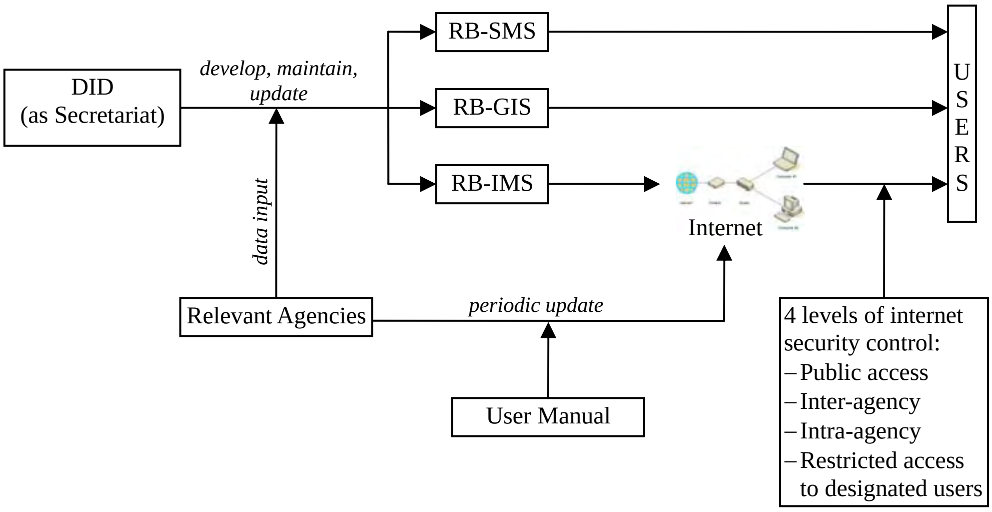


Figure 2.8.4 Framework of RB-DSS Development and Maintenance

At the time of writing this report, the RRB2 study (pilot study) was still in progress. However, a web-based RB-IMS known as 'River Basin Information System' (RBIS) has been developed for trial run within the DID internet network, which in future will be opened to the public. In the RBIS, the data and information are grouped in 16 categories as listed in **Table 2.8.1**.

Table 2.8.1 Categorization under the RBIS

Category	Description
1. Administrative and management boundaries	Boundaries of administrative, river basin and sub-basins.
2. Policy guidelines	Policies guidelines that are important for the management of water and land resources in a river basin.
3. Legal and regulatory requirements	Legal and regulatory requirements pertinent to the management of an administrative unit, which include legislations, standards and guidelines.
4. Institutional set-up	Institutional involved in the management of an administrative unit or river basin.
5. Community stakeholders	Community stakeholders in an administrative unit or river basin.
6. Existing environment	Thematic databases describing the existing environment in three categories i.e. natural resources environment, economic development environment, socio development environment.
7. Management issues and problems	Land and water management issues and problems pertinent to the management of an administrative unit or river basin.
8. Management objectives and targets	Management objectives and targets for every management issues and problems identified in an administrative unit or river basin.
9. Management programs	Management programs associated with each management issue and problem.
10. Monitoring and enforcement	Monitoring items and enforcement agencies associated with each management program.
11. Education and awareness	Education and awareness program carried out in an administrative unit or river basin.
12. Research and development	Related research and development projects in an administrative unit or river basin.
13. Emergency preparedness and response	Related Emergency Preparedness and Response Plans in an administrative unit or river basin.
14. Budget and finance	Budgets and financial resources associated with each of the above management programs and projects.
15. Documents management	Summary of relevant study documents.
16. Management review	Management review report on the progress in addressing the management issues and problems in the administrative unit or river basin.

CHAPTER 3 CLIMATE CHANGE IMPACT ANALYSIS

3.1 Introduction

Climate Change that accompanies global warning is now becoming a serious concern to be shared by all people in the world. The 4th Assessment Report was published in 2007 by the Intergovernmental Panel on Climate Change (IPCC) showing more realistic impacts of climate change, as presented in **Table 3.1.1**. Namely in coastal and low-land areas, especially, both the frequencies and scales of floods, storm-surge and other disasters are predicted to increase due to sea level rise, frequent heavy precipitation events. Serious droughts are also likely to increase due to a greater degree of fluctuation in precipitation. Climate change, unless people address it appropriately, may shake the foundation of people's life, as well as those on ecosystems, water resources, foods, industries, and human health.

Table 3.1.1 Impact Projection on Asia Region by IPCC

Item	Projection
Water Availability	By the 2050s, freshwater availability in Central, South, East and South-East Asia, particularly in large river basins, is projected to decrease.
Flooding	Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.
Natural resources and Environment	Climate change is projected to compound the pressures on natural resources and the environment associated with rapid urbanization, industrialization and economic development.
Endemic morbidity and mortality	Endemic morbidity and mortality due to diarrheal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle.

Source: "Climate Change 2007: Synthesis Report, IPCC"

To cope with these impacts, the IPCC report suggests that it be as important to promote "adaptation" to climate change as to promote "mitigation" since climate change "mitigation" centered around the reduction of greenhouse gases has limitations, and the climate change impacts would continue over centuries even when "mitigation" is implemented. Malaysia also committed in the 10th Malaysia Plan to adopt a dual strategy in addressing climate change impacts: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce of green house gases.

In accordance with the suggestion of IPCC and the Malaysian policy, this Preparation Survey aims to propose adaptation measures to anticipated impacts of climate change, especially those on flood phenomena. For this purpose, firstly it is studied by closely examining observed meteorological and hydrological data whether there are any tangible signs of climate change or not. Then, existing climate change projection results by foreign and domestic research institutes are analyzed to project climate change impacts localized in the target river basin, the Muar River Basin.

3.2 Analysis of Observed Data

Following items were analyzed to illustrate change in observed data of the years.

- Temperature data;
- Rainfall data; and
- Tide data.

Location of meteorological stations operated by MMD and hydrological stations operated by DID could be found in **Figure 3.2.1**.

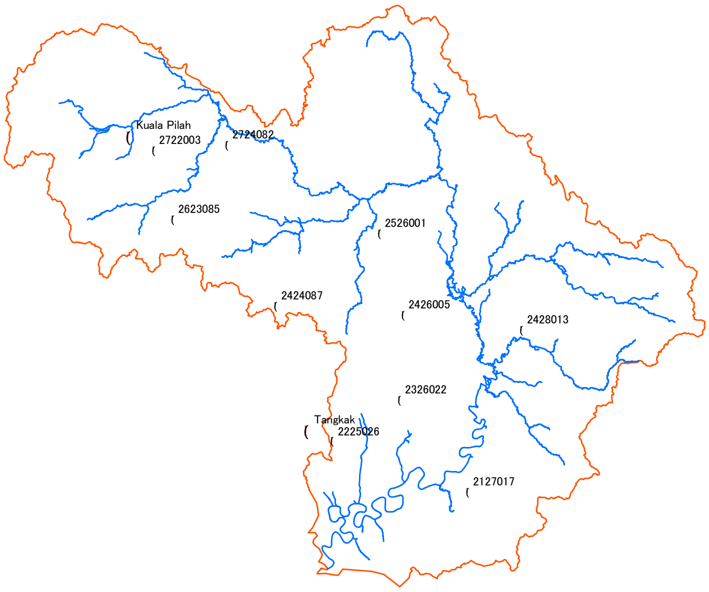


Figure 3.2.1 Location of Meteorological and Hydrological Stations

3.2.1 Temperature Data

Figure 3.2.2 shows the observed monthly average temperature of Kuala Pilah and Tangkak, together with 5-year moving average and its trend. As indicated in the figures, both observed data show temperature rise. Approximate increase rates are 0.024°C/year and 0.036°C/year for Kuala Pilah and Tangkak respectively.

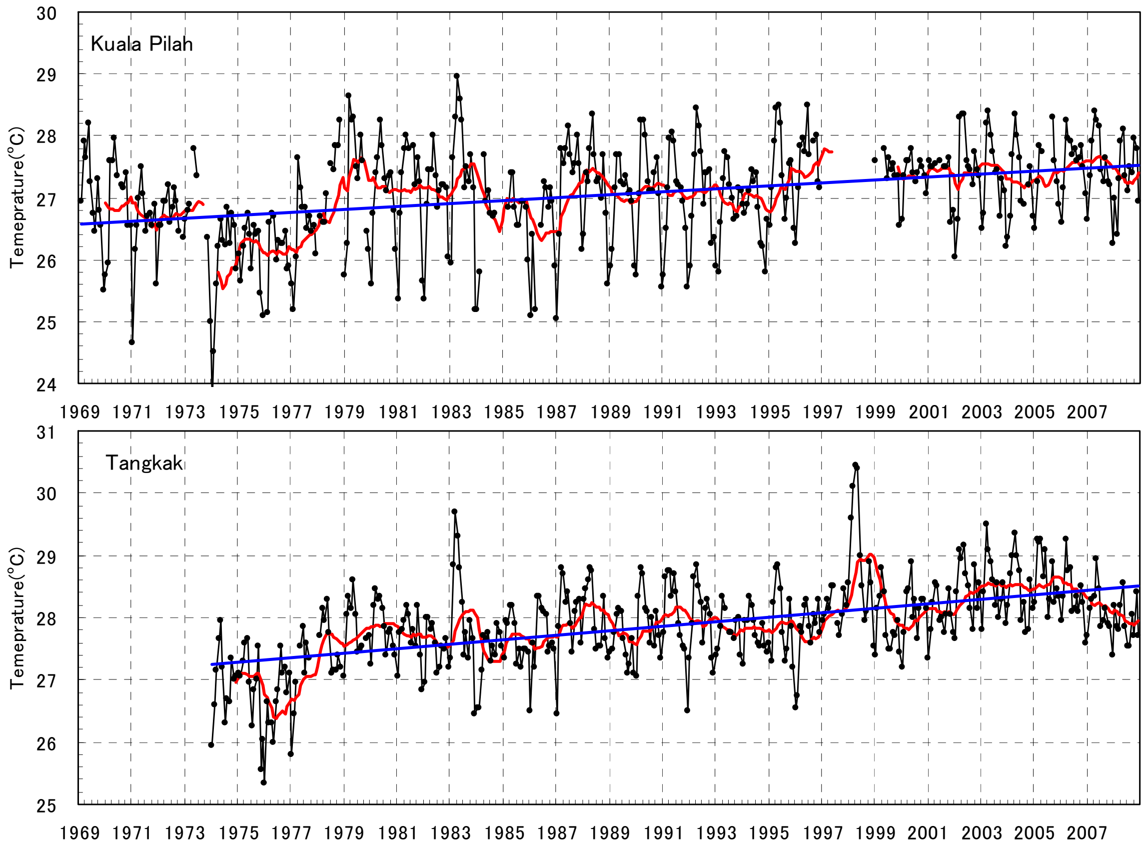


Figure 3.2.2 Observed Temperature Data (Upper panel: Kuala Pilah, Lower Panel: Tangkak)

Figure 3.2.3 shows month average temperature of 1989-1998 and 1999-2008, and their difference. As indicated in the figure, temperature rise are observed in all month except for June, and marked rise could be seen in January to March and September to December.

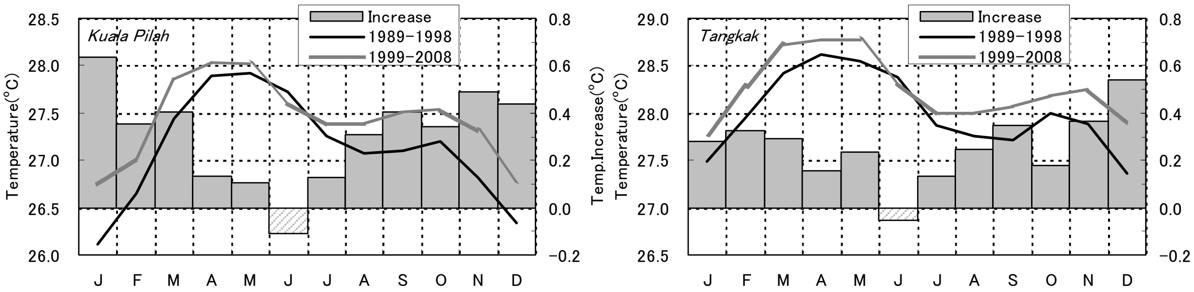
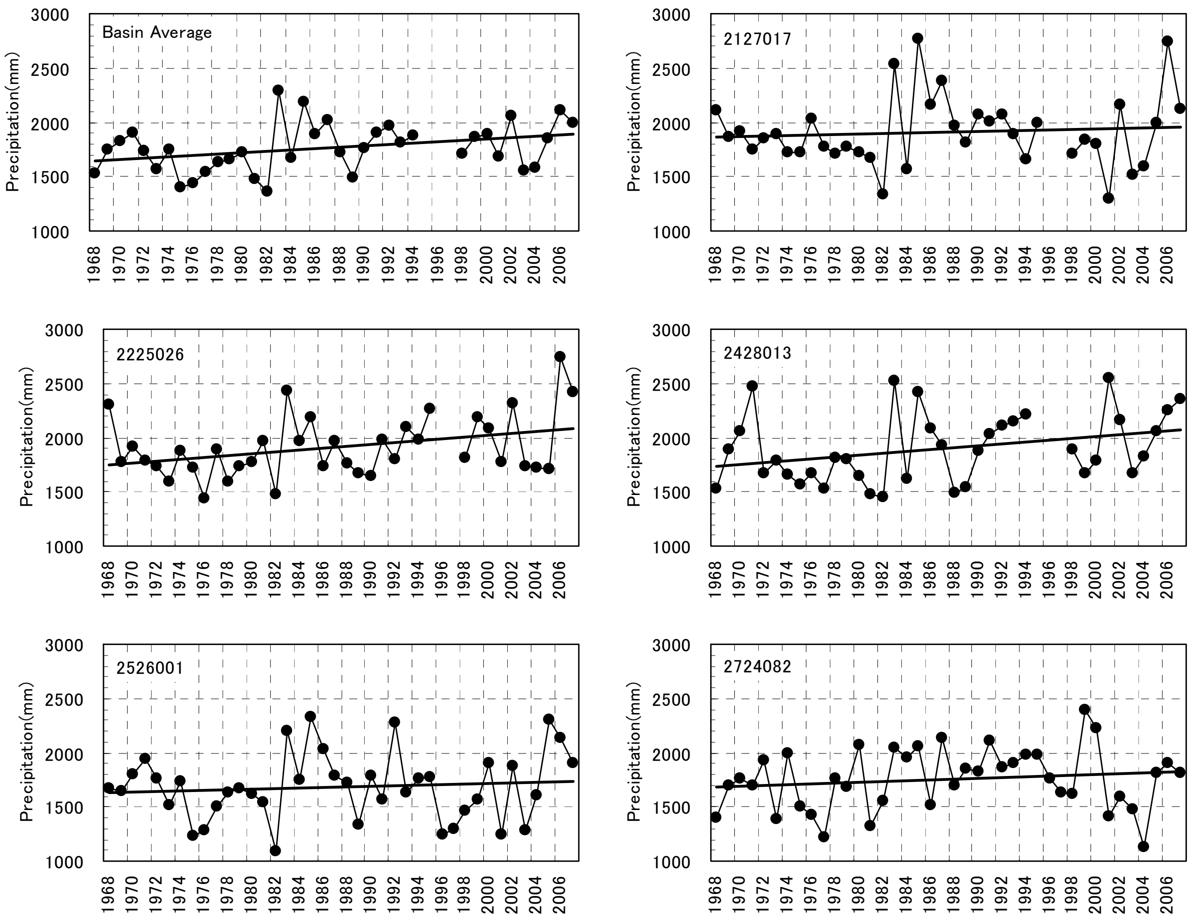


Figure 3.2.3 Month Average Temperature of 1989-1998 and 1999-2008
(Left panel: Kuala Pilah, Right Panel: Tangkak)

3.2.2 Rainfall Data

(1) Annual Precipitation

As in **Figure 3.2.4**, observed rainfall data in Muar River Basin indicate increasing trend in annual rainfall. All data show the increase in annual precipitation, and among them ones of station 2225026 and 2428013 are conspicuous.



**Hydrological year: July until June next year*

Figure 3.2.4 Observed Annual Precipitation

Figure 3.2.5 shows month average rainfall of 1969-1988 and 1989-2008, and their difference. As indicated in the figure, all observed data as well as basin average rainfall show increase in January and December, and decrease in February and September.

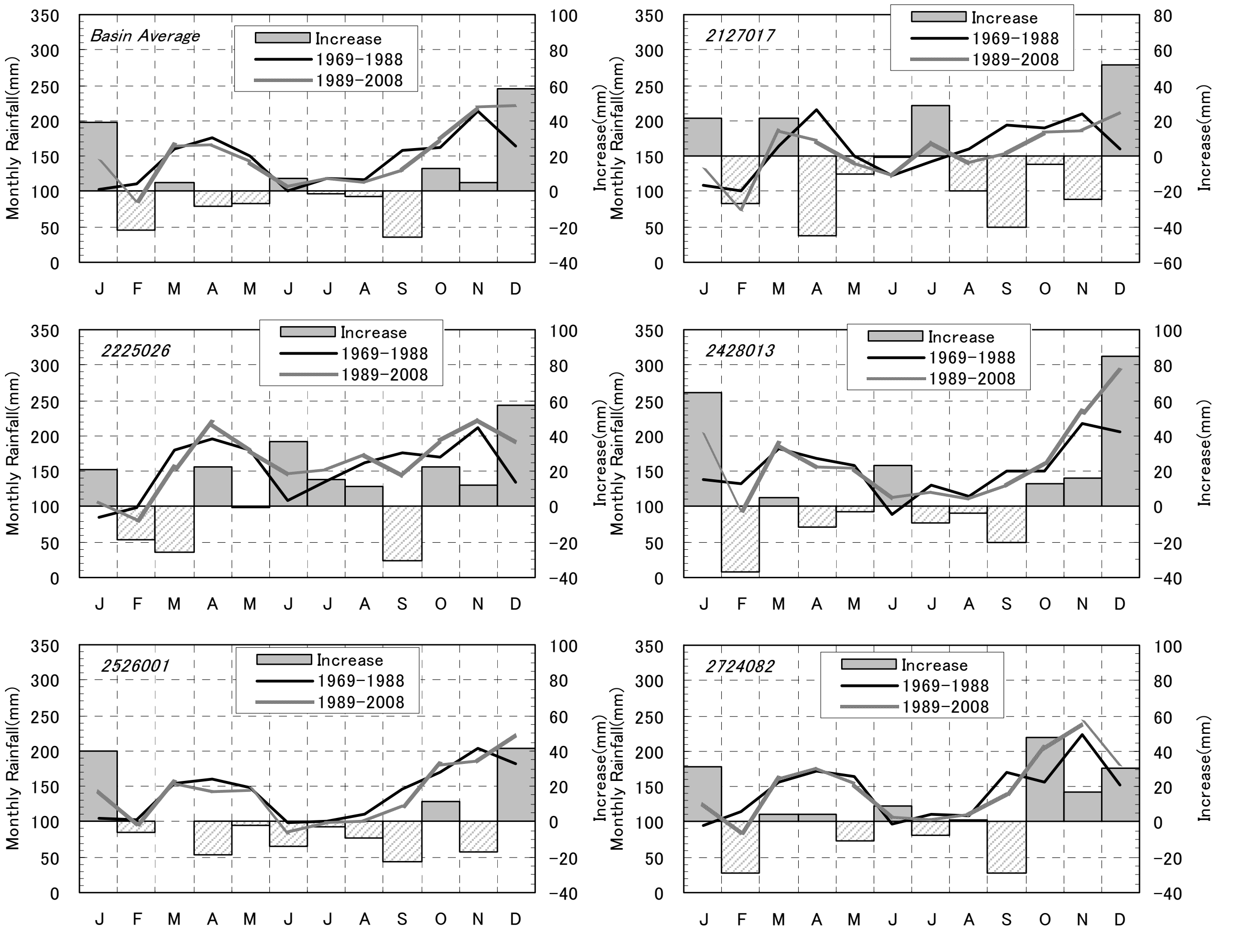
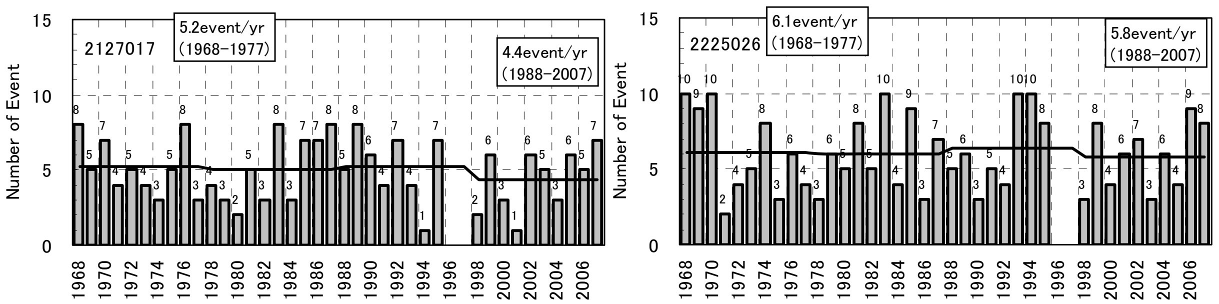


Figure 3.2.5 Month Average Rainfall of 1989-1998 and 1999-2008

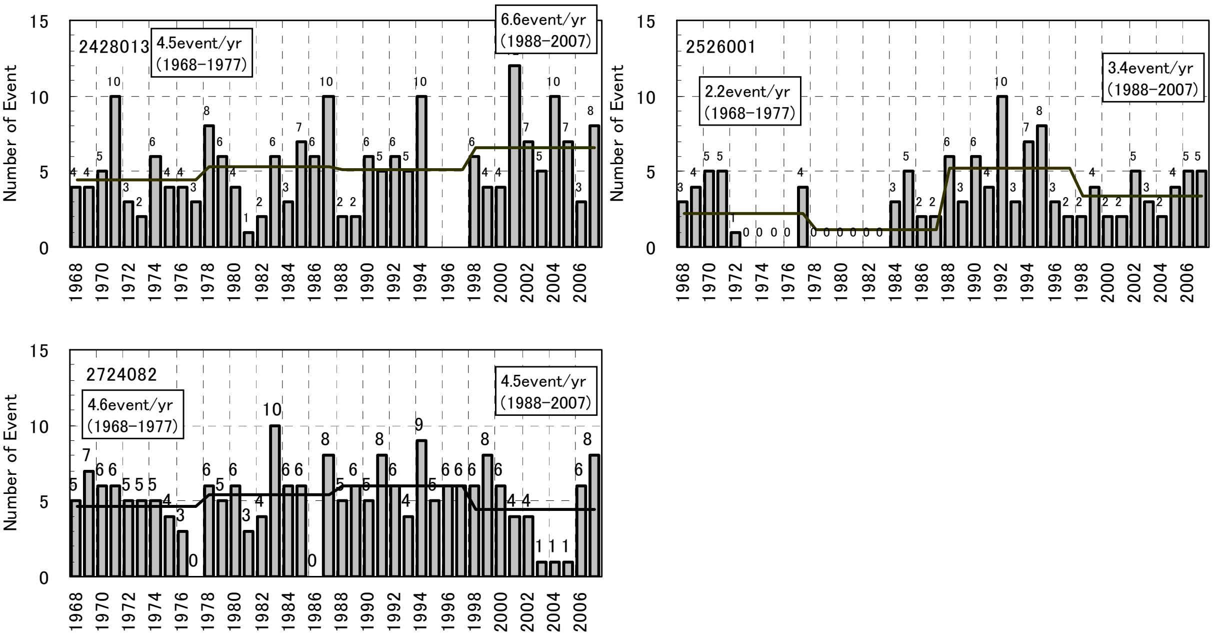
(2) Rainfall Event

Figure 3.2.6 shows number of rainfall events with daily rainfall exceeding 50mm in the past 40years. Average number of event in 1998-2007 increased in station 2428013 and 2526001 relative to that of 1968-1977. No significant change or slight decrease could were observed in data of other stations.



**Hydrological year: July until June next year*

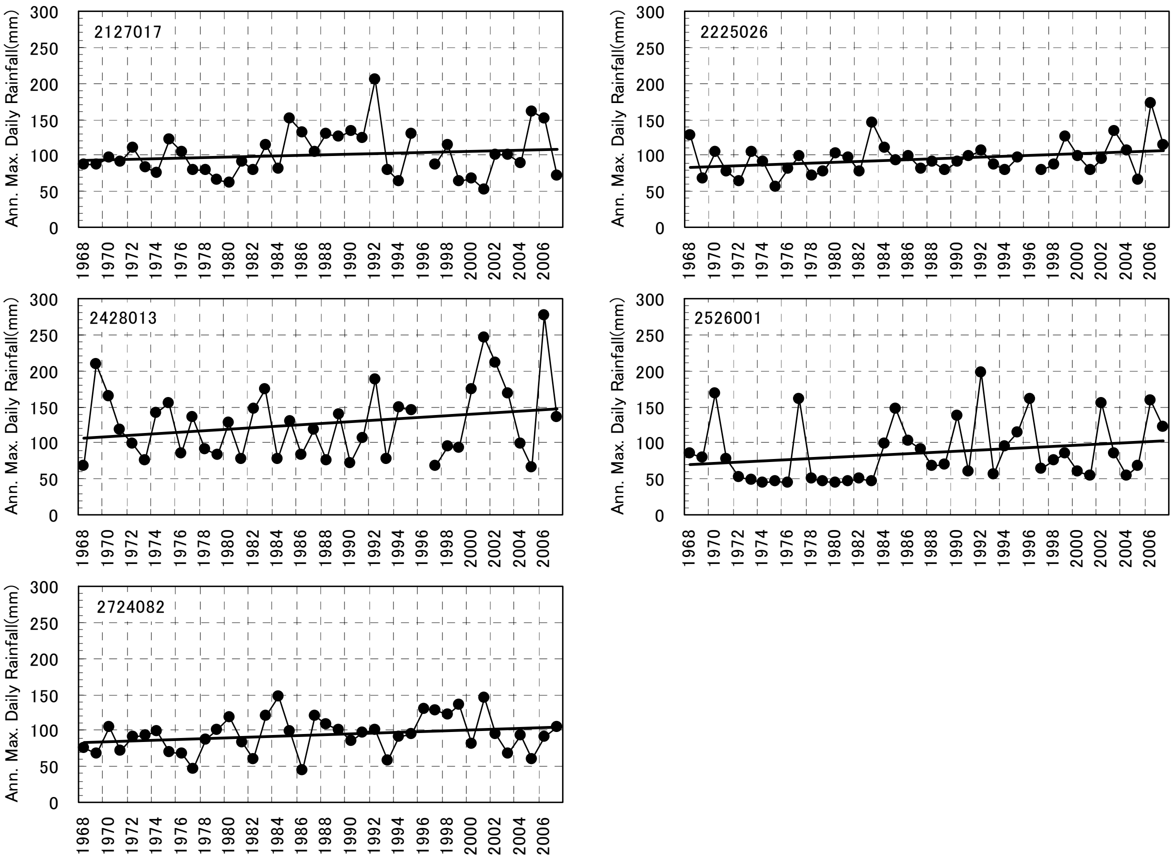
Figure 3.2.6(1) Number of Events with Daily Rainfall Exceeding 50mm



**Hydrological year: July until June next year*

Figure 3.2.6(2) Number of Events with Daily Rainfall Exceeding 50mm

Increasing trend could be seen in the annual maximum daily rainfall during the period of 1968-2007 as shown in **Figure 3.2.7**. It could be the indication of increase in intense rainfall event.



**Hydrological year: July until June next year*

Figure 3.2.7 Annual Maximum Daily Rainfall

(3) Consecutive Days with No Rainfall

Here the term "consecutive days with no rainfall" is defined as number of consecutive days with rainfall below 1mm/day. As shown in **Figure 3.2.8**, no significant change or slight decrease are observed in all stations except for data in station 2526001 which shows increasing trend.

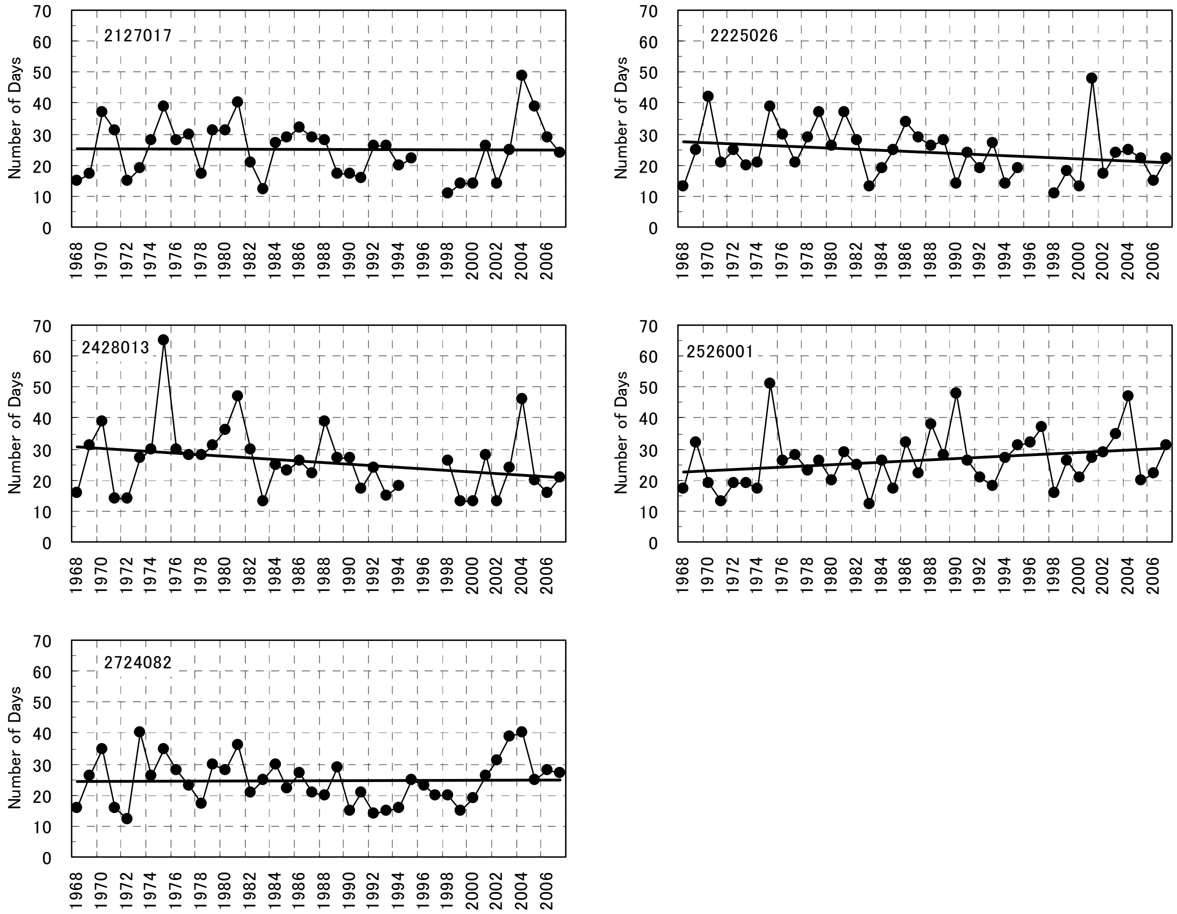


Figure 3.2.8 Annual Maximum Consecutive Days with No Rainfall

3.2.3 Tide Data

Figure 3.2.9 is monthly averaged sea level of Tanjung Keling with its 1year moving average and trend line. The figure tells us that sea level has rising trend at Tanjung Keling with approximate rate of 2mm/year and annual average sea level has rose 4-5cm since 1985.

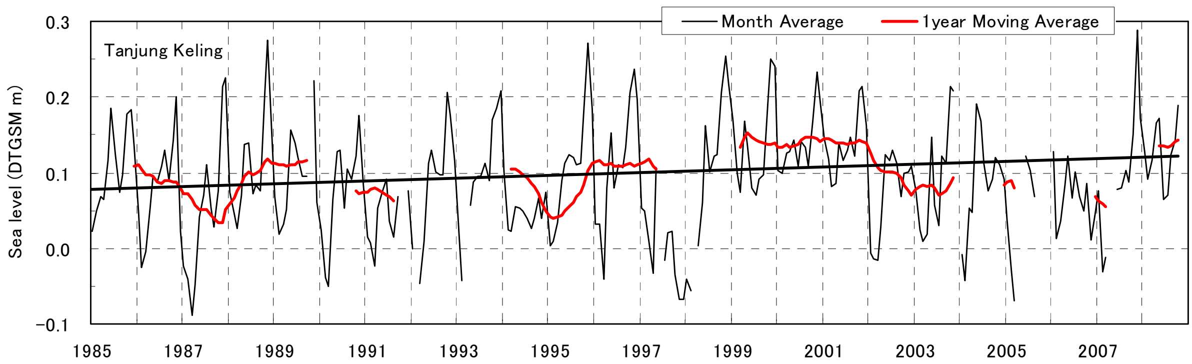


Figure 3.2.9 Monthly Average Sea Level at Tanjung Keling since 1985

3.2.4 Overview of the Observed Data

Following trends were revealed through above analysis of the observed data.

- Temperature data of two meteorological stations indicate rise by 0.024-0.036^{o}C/year;
- Average monthly temperature of 1999-2008 were higher than ones of 1989-1998 in all month except for June;
- Annual precipitation of Muar River Basin showed increasing trend;
- No significant trend was observed in the number of event with daily rainfall exceeding 50mm/day. However, observed increasing trend in annual maximum rainfall could be an indication of increase in intense rainfall event;
- No significant trend was seen in annual maximum consecutive days with no rainfall; and
- Sea level has rising trend and its rate since 1985 is approximately 2mm/year.

3.3 Availability of Climate Change Projection Data

3.3.1 GCM Data

GCMs (Global Circulation Models) aim to project global scale climate change with coarse spatial resolution. 19 GCMs out of 25 have daily surface average projection outputs until end of 21 century available for study purposes. The 19 GCMs are listed in **Table 3.3.1** with period of projection, which were used for further analysis.

Table 3.3.1 Data Availablity of GCMs

Model ID	Data Availability	
	20C3M*	A1B
BCC-CM1, China		
BCCR-BCM2.0, Norway	1981-1999	2056-2065, 2081-2099
CCSM3, USA	1950-1999	2046-2065, 2080-2099
CGCM3.1(T47), Canada	1961-2000	2046-2065, 2081-2100
CGCM3.1(T63), Canada	1961-2000	2046-2065, 2081-2100
CNRM-CM3, France	1961-2000	2046-2065, 2081-2100
CSIRO-Mk3.0, Australia	1981-2000	2046-2065, 2081-2100
CSIRO-Mk3.5, Australia	1981-2000	2046-2065, 2081-2100
ECHAM5/MPI-OM, Germany	1981-2000	2046-2065, 2081-2100
ECHO-G, Germany/Korea	1959-1998	2043-2062, 2078-2098
FGOALS-g1.0, China		
GFDL-CM2.0, USA	1981-2000	2046-2065, 2081-2100
GFDL-CM2.1, USA	1981-2000	2046-2065, 2081-2100
GISS-AOM, USA	1961-2000	2046-2065, 2081-2100
GISS-EH, USA		
GISS-ER, USA	1961-2000	2046-2065, 2081-2100
INGV-SXG, Italy	1981-2000	2046-2065, 2081-2100
INM-CM3.0, Russia		
IPSL-CM4, France	1961-2000	2045-2064, 2080-2099
MIROC3.2(hires), Japan	1981-2000	2046-2065, 2081-2100
MIROC3.2(medres), Japan	1961-2000	2046-2065, 2081-2100
MRI-CGCM2.3.2, Japan	1981-2000	2046-2065, 2081-2100
PCM, USA	1890-1999	2040-2059, 2080-2099
UKMO-HadCM3, UK		
UKMO-HadGEM1, UK		

*Historical experiment of 20 Century

Daily outputs of the grid that includes the center of the basin were extracted from the GCM result to represent the whole basin as shown in **Figure 3.3.1**.

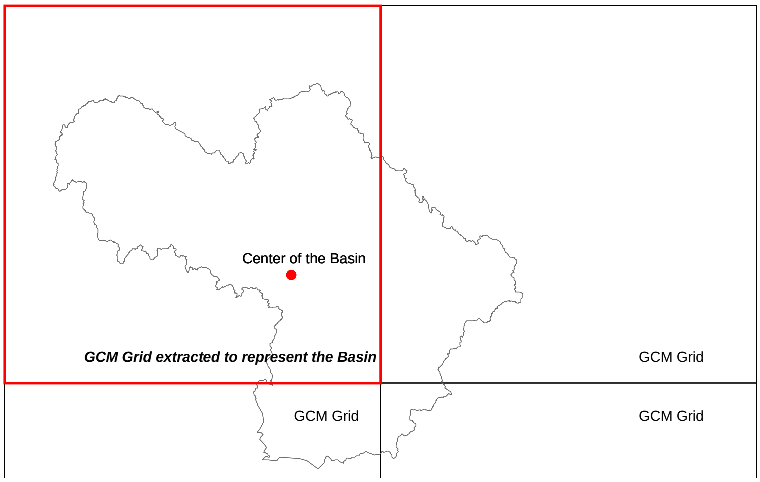


Figure 3.3.1 Schematic view of the Grid Extracted to Represent the Basin

3.3.2 RCM Data

In addition to the available GCM results above, projection data of two Malaysia-made Regional Climate Models (RCMs) are available. NAHRIM and University of California jointly developed Regional Hydroclimate Model of Peninsular Malaysia (RegHCM-PM) with spatial resolution of 9km (longitude and latitude). Malaysian Meteorological Department (MMD) has developed a Regional Climate Model (RCM) as well with spatial resolution of 50km, covering Southeast Asia including whole Malaysia utilizing Providing Regional Climate Impact Studies (PRECIS) model developed by Hadley Centre, UK. Available data are as shown in **Table 3.3.2**.

Table 3.3.2 Data Availability of RCMs

RegHCM-PM by NAHRIM - Period of Historical Experiment: 1984-1993 - Scenario for projection: IS92a - Projection Period: 2026-2035, 2041-2050 - Target Area: Peninsula Malaysia - Spatial Resolution: 9km x 9km - Available outputs: Precipitation (daily), Temperature (daily) etc.
PRECIS by MMD - Period of Historical Experiment: 1960-1990 - Scenario for projection: A1B - Projection Period: 2001-2099 - Target Area: Southeast Asia - Spatial Resolution: 50km x 50km - Available outputs: Precipitation (daily), Temperature (daily) etc.

All daily outputs of the grids partially or completely covers the basin were extracted from the RCM results for further analysis.

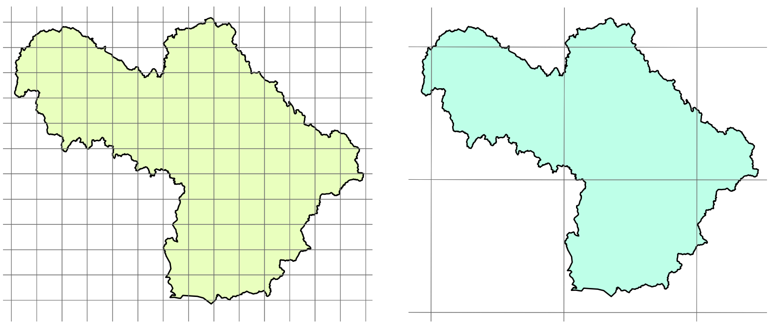


Figure 3.3.2 Grid of RCMs (Left Panel: RegHCM-PM, Right Panel: PRECIS)

3.3.3 Emission Scenarios

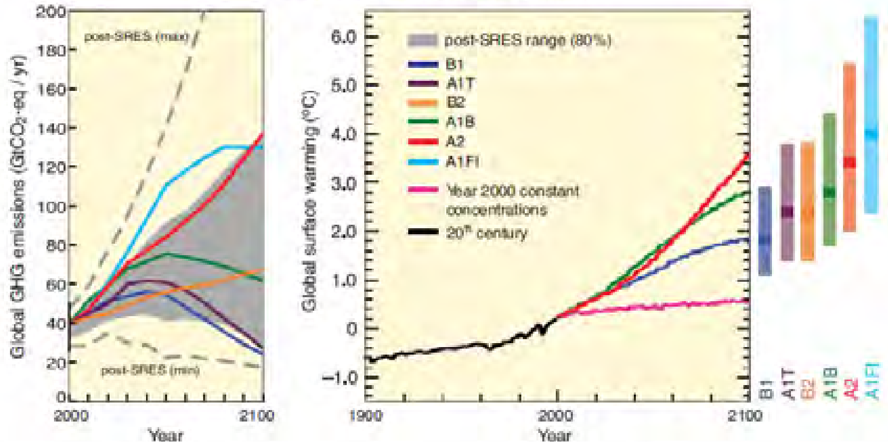
Projection of climate change impacts depend upon the scenario of future greenhouse gases emission. IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios - SRES). The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions.

The SRES team defined four narrative storylines, labeled A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century for large world regions and globally. Each storyline represents different demographic, social, economic, technological, and environmental developments that diverge in increasingly irreversible ways. Moreover, three scenarios were further developed from A1 scenario, characterising alternative developments of energy technologies: A1FI (fossil intensive), A1T (predominantly non-fossil) and A1B (balanced across energy sources). These six scenarios are summarized in **Table 3.3.3**.

Table 3.3.3 SRES Scenarios

SRES Senario	World assumed by the scenario	Direction of Technology
A1FI	A world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies.	Fossil intensive
A1T		Predominantly non-fossil
A1B		Balanced across all sources
A2	A very heterogeneous world with high population growth, slow economic development and slow technological change	
B1	A convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy.	
B2	A world with intermediate population and economic growth, emphasising local solutions to economic, social, and environmental sustainability	

In this survey the A1B scenario, which gives mid-range projection values, is selected as a representative scenario of the six scenarios. Namely projection results only under the A1B scenario were collected and used for the following analysis. As for Regarding RegHCM-PM by NAHRIM, projection results under the old scenario, IS92a[1] were used, because the old scenario projections are alone available for this model. Whatever scenario is applied, impact projection results are not significantly different until around 2050 at least, as shown in **Figure 3.3.3**



Source: AR4

Figure 3.3.3 Projections of Surface Temperatures for SRES Scenarios

[1] IS92a: a 'business-as-usual' type scenario, had been in wide use by the climate modelling and vulnerability, impacts and adaptation communities, but the SRES scenarios are now commonly used.

3.4 Climate Change Impact Analysis with Climate Model Result

3.4.1 Impact on Temperature

Figure 3.4.1 and **Table 3.4.1** show temperature change between 2001 and 2100 relative to the last decade average of 20 Century (1991-2000) in Muar River Basin. All 19 GCMs shows rise in the future temperature of Muar River Basin ranging 1.0 to 3.2°C at 2046-2055 and 1.6 to 4.5 °C at 2086-2095 with average of 1.6 °C and 2.6 °C respectively compared with end of 20 Century. Two RCMs namely RegHCM-PM and PRECIS shows rise in the future temperature as well which is consistent with the results of GCMs.

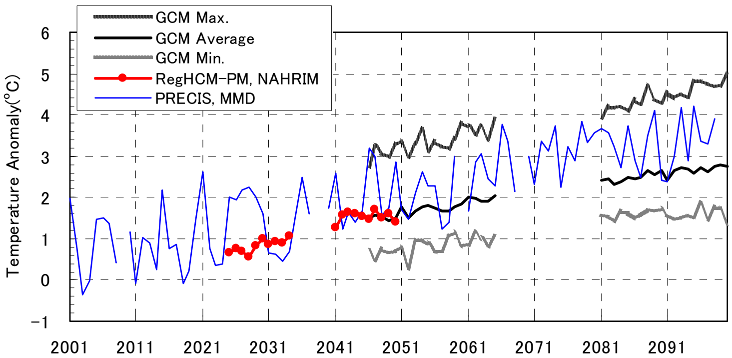


Figure 3.4.1 Temporal Plot of Projected Surface Temperature

Table 3.4.1 Projected Surface Temperature of Muar River Basin**

Model	Temperature. Change (°C at 2046-2055* relative to 1991-2000)		Temperature. Change (°C at 2086-2095 relative to 1991-2000)	
	Average	Range	Average	Range
GCMs	+1.6°C	+1.0-3.2°C	+2.6°C	+1.6-4.5°C
RegHCM-PM	+1.5°C	-	-	-
PRECIS	+2.3°C	-	+3.2°C	-

* 2041-2050 for RegHCM-PM
** Under A1B Scenario. I92a Scenario for RegHCM-PM.

3.4.2 Impact on Rainfall and Evapotranspiration

Before the climate change impact analysis on precipitation, GCMs with insufficient agreement with observed precipitation was excluded from further analysis. GCM results and long term monthly average were compared as shown in **Figure 3.4.2**.

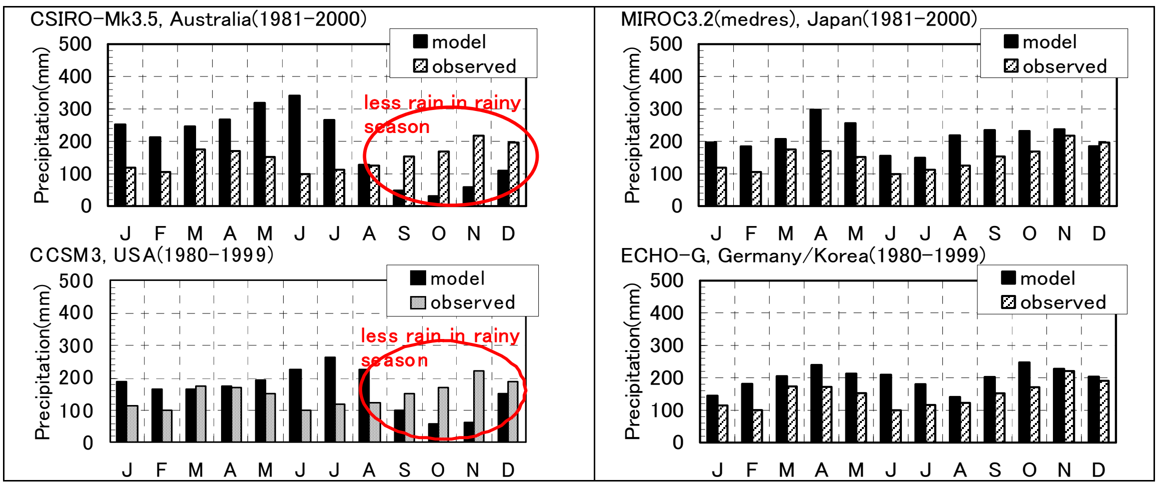


Figure 3.4.2 Comparison of GCM Results to Observed Data (Left Panel: Example of GCMs excluded from further analysis, Right: Example of GCMs used for further analysis)

13 GCMs shown in **Table 3.4.2** were selected for further analysis.

Table 3.4.2 GCMs Utilized for Climate Change Impact Analysis on Precipitation

- BCCR-BCM2.0, Norway	- GFDL-CM2.1, USA
- CGCM3.1(T47), Canada	- GISS-AOM, USA
- CGCM3.1(T63), Canada	- INGV-SXG, Italy
- CNRM-CM3, France	- MIROC3.2(hires), Japan
- ECHAM5/MPI-OM, Germany	- MIROC3.2(medres), Japan
- ECHO-G, Germany/Korea	- MRI-CGCM2.3.2, Japan
- GFDL-CM2.0, USA	

RegHCM-PM and PRECIS are proved to have sufficient agreement with observed data by NAHRIM and MMD respectively. Detail could be found in:

- *Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia, NAHRIM, September 2006;* and

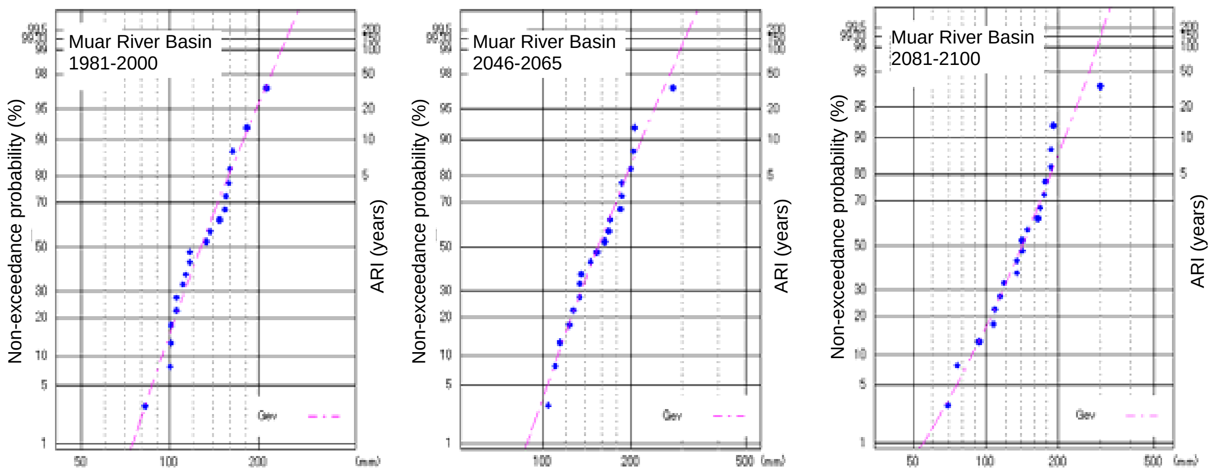
- *Climate Change Scenario for Malaysia2001-2099, MMD, January 2009*.

(1) Impact on Heavy Rainfall Event

In this section climate change impact on heavy rainfall event was be analyzed based on GCM and RCM results.

According to the *"Master Plan Study on Flood Management for Sg. Muar Basin 2003"*, 72hrs rainfall gives critical peak flood discharge. Therefore, annual maximum 3 day rainfalls were calculated based on the results of GCMs and RCMs for the period of 2046-2065 and 2081-2100 which corresponds to approximately 40 years and 90 years from present. Then rainfalls with average recurrence interval (ARI) of 100, 50, 30, 20, 10, 5, 2 years return period were calculated and compared to that of current condition (1981-2000) to obtain incremental ratios for rainfall with various ARIs.

Figure 3.4.3 shows the relation between non-exceedance probability and 3 day rainfall for "CGCM3.1(T47), Canada", one of the GCMs. 3day rainfalls with various ARI and their incremental ratio relative to present could be obtained as **Table 3.4.3** based on probability analysis as in the figure.



General Extreme Value (GEV) distribution, Plotted on Log-Normal Probability Paper

Figure 3.4.3 Frequency Plot of Muar River Basin based on Result of CGCM3.1(T47), Canada

Table 3.4.3 3 day Rainfall and Incremental Ratio obtained based on CGCM3.1(T47), Canada (Upper table: 3 day Rainfalls, Lower table: Incremental ratio relative to 1990(1981-2000))

3 day Rainfall (mm)

	ARI (years)						
	100	50	30	20	10	5	2
1990	238.0	220.3	207.1	196.4	177.6	157.7	127.2
2050	295.9	273.4	256.5	242.9	219.0	193.7	154.9
2090	289.3	268.5	252.2	238.7	213.9	186.3	141.1

Incremental Ratio relative to 1990 (1981-2000)

	ARI (years)						
	100	50	30	20	10	5	2
1990	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2050	1.24	1.24	1.24	1.24	1.23	1.23	1.22
2090	1.22	1.22	1.22	1.22	1.20	1.18	1.11

The average incremental ratio was obtained by applying above analysis to all GCMs and RCMs. The projected 3day rainfall incremental ratios of 2025 with ARI of 100 years obtained are shown in **Figure 3.4.4**. Incremental Ratios vary in the range of 1.0 to 2.0 and the arithmetic average of all model result could be obtained as 1.2.

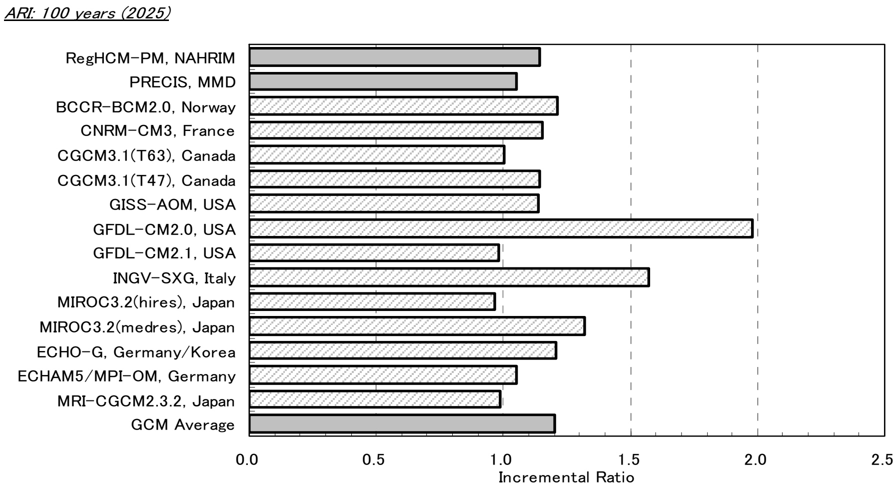


Figure 3.4.4 Incremental Ratios of 3 days Rainfall with ARI of 100 years Obtained from All GCMs and RCMs (2025)

Table 3.4.4 shows the future projected increase in the probable 3 day rainfalls for various ARI. The results indicate 10-40% increase in the 3 day rainfalls by the year 2050, then it shows slight or almost no increase until end of the century.

Table 3.4.4 Incremental Ratio of 3 day Rainfalls for Various ARI and Period

ARI (years)	Period	RegHCM-PM	PRECIS	GCM Average	Average*	Maximum**	Proportion of models that show increase
100	2025	1.14	1.05	1.21	1.1(1.2)	1.2(2.0)	80%(12/15)
	2050	1.06	1.09	1.36	1.2(1.3)	1.4(2.7)	80%(12/15)
	2090	-	0.98	1.29	1.1(1.3)	1.3(2.5)	64%(9/14)
50	2025	1.22	1.02	1.18	1.1(1.2)	1.2(1.8)	87%(13/15)
	2050	1.16	1.03	1.31	1.2(1.3)	1.3(2.3)	87%(13/15)
	2090	-	0.98	1.28	1.1(1.3)	1.3(2.2)	57%(8/14)
20	2025	1.29	0.99	1.15	1.1(1.2)	1.3(1.5)	80%(12/15)
	2050	1.26	0.98	1.26	1.2(1.2)	1.3(1.9)	80%(12/15)
	2090	-	0.98	1.26	1.1(1.2)	1.3(2.0)	71%(10/14)
10	2025	1.31	0.97	1.13	1.1(1.1)	1.3(1.4)	80%(12/15)
	2050	1.31	0.94	1.23	1.2(1.2)	1.3(1.7)	80%(12/15)
	2090	-	0.99	1.25	1.1(1.2)	1.3(2.0)	71%(10/14)

**Numbers in the parenthesis are arithmetic average of all models*
***Numbers in the parenthesis are maximum of all models*

Flood risk could be further aggravated as a result of projected increase in heavy rainfall events as analyzed above. **Figure 3.4.5** is simulation result of flood area in rainfall event of 100 years return period under current and 2025 condition (see **Chapter 4** for simulation model). Predicted total flood area with water depth above 10cm is 266km^2 in current condition while 405km^2 under projected 2025 condition. It should be noted that future land use change is also considered in the simulation. However, given that no significant change in land use is expected by 2025, major cause of the increase is assumed to be due to climate change.

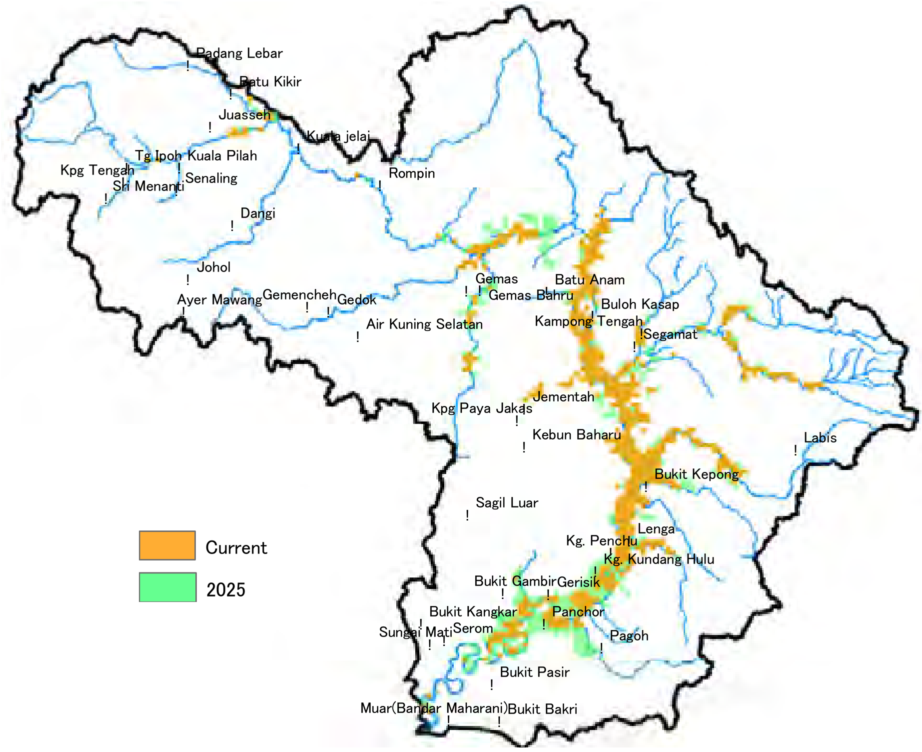


Figure 3.4.5 Simulated Flood Area under Current and Future Conditions

(2) Impact on Annual Precipitation and Evapotranspiration

Climate Change impact on annual and monthly precipitation and evapotranspiration was be analyzed in this section based on GCM and RCM results.

Models used in this analysis are listed in **Table 3.4.5**. They are the models listed in **Table 3.4.2** with both rainfall and evapotranpiration results available.

Table 3.4.5 GCMs and RCMs used for Analysis

- RegHCM-PM, NAHRIM	- CHO-G, Germany/Korea
- PRECIS, MMD	- GFDL-CM2.0, USA
- BCCR-BCM2.0, Norway	- GISS-AOM, USA
- CGCM3.1(T47), Canada	- INGV-SXG, Italy
- CGCM3.1(T63), Canada	- MIROC3.2(hires), Japan
- CNRM-CM3, France	- MIROC3.2(medres), Japan
- ECHAM5/MPI-OM, Germany	- MRI-CGCM2.3.2, Japan

Incremental ratios of precipitation and evapotranspiration due to climate change impact are summarized in **Figure 3.4.6** and **Table 3.4.6**.

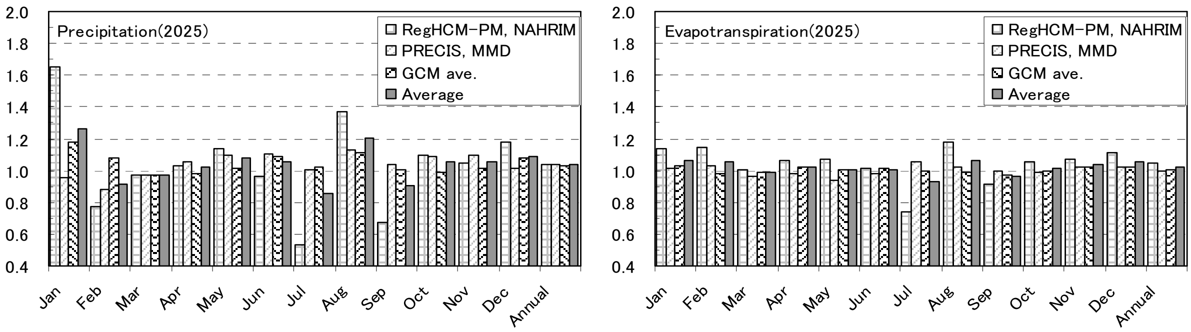


Figure 3.4.6 Monthly and Annual Precipitation and Evapotranspiration Incremental Ratio of 2025 Relative to 1990

Table 3.4.6 Incremental Ratio of Annual and Monthly Precipitation and Evapotranspiration Relative to 1990

Precipitation

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
2025	RegHCM-PM	1.65	0.78	0.98	1.03	1.14	0.97	0.53	1.37	0.68	1.09	1.04	1.18	1.04
	PRECIS	0.95	0.88	0.97	1.05	1.10	1.10	1.00	1.13	1.03	1.09	1.09	1.01	1.04
	GCMs	1.18	1.08	0.97	0.98	1.01	1.09	1.03	1.11	1.01	0.99	1.02	1.08	1.03
	Average	1.26	0.91	0.97	1.02	1.08	1.05	0.85	1.20	0.91	1.06	1.05	1.09	1.04
2050	RegHCM-PM	1.22	0.76	0.95	1.18	1.21	1.04	0.68	1.07	1.00	1.12	0.88	0.90	1.00
	PRECIS	0.92	0.80	0.95	1.09	1.17	1.17	1.01	1.22	1.06	1.15	1.16	1.02	1.07
	GCMs	1.31	1.14	0.95	0.97	1.02	1.15	1.04	1.19	1.01	0.98	1.03	1.14	1.05
	Average	1.15	0.90	0.95	1.08	1.13	1.12	0.91	1.16	1.02	1.08	1.02	1.02	1.04

Evapotranspiration

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ann.
2025	RegHCM-PM	1.14	1.14	1.01	1.07	1.07	1.01	0.74	1.18	0.91	1.05	1.07	1.11	1.05
	PRECIS	1.02	1.03	0.96	0.98	0.94	0.98	1.05	1.02	1.00	0.99	1.02	1.02	1.00
	GCMs	1.03	0.98	0.99	1.02	1.01	1.01	1.00	0.99	0.97	1.00	1.02	1.02	1.00
	Average	1.06	1.05	0.99	1.02	1.01	1.00	0.93	1.06	0.96	1.01	1.04	1.05	1.02
2050	RegHCM-PM	1.07	1.03	1.00	1.12	1.20	1.02	0.89	1.06	1.15	1.10	1.06	0.98	1.06
	PRECIS	1.03	1.05	0.94	0.96	0.90	0.97	1.09	1.03	1.00	0.98	1.03	1.04	1.00
	GCMs	1.05	0.97	0.98	1.04	1.02	1.02	1.00	0.98	0.95	1.00	1.04	1.04	1.01
	Average	1.05	1.02	0.98	1.04	1.04	1.00	0.99	1.03	1.03	1.03	1.04	1.02	1.02

The results show no significant change in both annual precipitation and evapotranspiration. However, projected monthly precipitation shows 26% increase and 15% decrease at January and August respectively in 2025 relative to 1990.

3.4.3 Sea Level Rise

Sea level is projected to rise as a result of global warming**. Table 3.4.7** shows model-based projection of global average sea level rise for 2090-2099. Sea level rise by 2025 could be estimated to be 12cm relative to 1980-1999 under A1B scenario based on linear interpolation. However, it should be noted values may differ in the future due to limited understanding on important effects deriving sea level rise as stated in the IPCC report.

Table 3.4.7 Projected Global Average Sea Level Rise

Case	Sea level rise (m at 2090-2099 relative to 1980-1999)
B1 scenaio	0.18-0.38
A1T scenario	0.20-0.45
B2 scenaio	0.20-0.43
A1B scenaio	0.21-0.48
A2 scenaio	0.23-0.51
A1FI scenaio	0.26-0.59

Source: IPCC, AR4

CHAPTER 4 BASIC ANALYSIS AND SURVEY FOR IRBM AND IFM PLANNING

4.1 Digital Terrain Modeling and GIS Database

Digital Terrain Model (DTM) and GIS database for Muar River Basin were developed in the study based on following data provided by the Government of Malaysia.

a) ESRI Shape GIS data of 1/50,000-scale topographic maps for all Malaysia;
b) Geo-referenced scanned images of 1/50,000-scale topographic maps for the study area;
c) ESRI Shape land use data developed by JPBD;
d) ESRI Shape basin boundary data of Muar River Basin; and
e) LiDAR survey data (1 meter posting) which covers flood prone area in Muar River Basin.

Created DTM and GIS database are basic data which serve as basis for further analyses conducted in the study.

4.1.1 Generation of DTM

The contour lines and the spot heights and the LiDAR survey data **a)** and **e)** above were combined to generate the DTM for Muar River Basin. The specifications of the DTM are shown below.

- Coordinates system: Kertau RSO Malaya Meters (See **4.1.2** Generation of GIS Database)
- Vertical datum: DTGSM / Grid size or Spacing: 50m / Data format: ESRI Grid ASCII
- Significant digit: One digit below decimal point (e.g. 55.4)

Before merging two different data, the vertical datum of 1/50,000-scale topographic maps in LSD (Land Survey Datum, defined at Port Swettenham, now Pelabuhan Kelang, in 1912 by the British Admiralty) were converted to DTGSM (Peninsular Malaysia Geodetic Vertical Datum, defined from Tidal Observation at Port Kelang in 1984-1993). A conversion formula between LSD and DTGSM is:

DTGSM = LSD – 0.122m

, which was obtained based on national benchmarks located in the target river basin. Then, two data above were merged to generate 50m grid DTM for the whole basin. Elevation data of LiDAR survey, which is expected to be more accurate relative to ones of 1/50,000 topographic map, was applied for areas covered with both data. **Figure 4.1.1** and **Figure 4.1.2** shows the 50m grid DTM generated from the LiDAR survey data and final 50m grid DTM respectively.

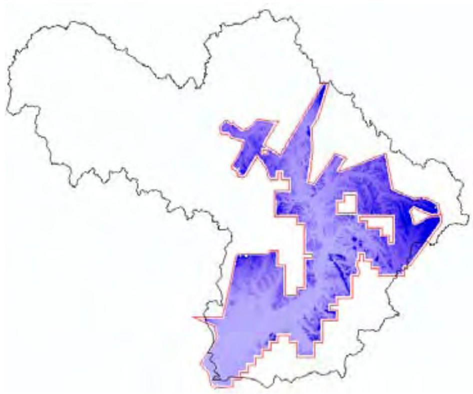


Figure 4.1.1 DTM by LiDAR Survey Data

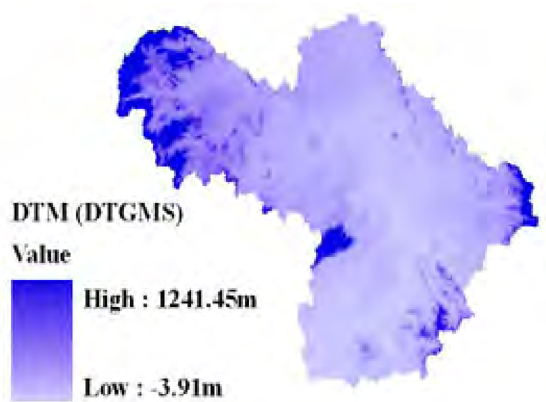


Figure 4.1.2 DTM for Muar River Basin

4.1.2 Development of GIS Database

The GIS database was developed by editing the ESRI Shape geographic data provided by DID and land use data by JPBD. The detail specification of geographic data and main categories of land use data are shown in **Table 4.1.1** and **Table 4.1.2** respectively.

Table 4.1.1 Map Projection, Coordinates System and Vertical Datum

Projection: Rectified_Skew_Orthomorphic_Natural_Origin	Geographic Coordinate System: GCS_Kertau
False_Easting: 804671.299775	Angular Unit: Degree (0.017453292519943299)
False_Northing: 0.000000	Prime Meridian: Greenwich (0.000000000000000000)
Scale_Factor: 0.999840	Datum: D_Kertau
Azimuth: -36.974209	Spheroid: Everest_1830_Modified
Longitude_Of_Center: 102.250000	Semimajor Axis: 6377304.063000000100000000
Latitude_Of_Center: 4.000000	Semiminor Axis: 6356103.038993154700000000
XY_Plane_Rotation: -36.869898	Inverse Flattening: 300.801699999999980000
Linear Unit: Meter (1.000000)	
Vertical datum:	
LSD (See 4.1.1 Generation of DTM)	

Table 4.1.2 Main Categories of the Land Use Data

Current	Activity
Agriculture	Animal Husbandry, Oil Palm, Open Ground, Other Crops, Other Main Crop, Paddy, Rubber, vacant land, Village, Water Scheme
Business and Services	Business and Services, Market, Ranhill Office, Services, Trade Complex
Forest	Forest, Land Forest, Natural Mangrove, Sea Swamp Forest
Industry	Light Industry, Medium Industry, Mine / Quarry
Infrastructure and Utility	Drain, Electric Supply, Infrastructure, Telecommunication, Waste Disposal, Water Supply
Institution and Community Facilities	Cemetery, Community Facilities, Education, Government Used, Health, Religious, Security, Welfare House
Open Ground and Recreation	Landscape/ Recreation, Open Ground, Separate Zone, Sports Facilities, vacant land
Residence	Organized Housing, Organized Residence, Village, Village Housing
Transport	Main Road, Road, Transport Facilities
Vacant Land	Idle Land, vacant land
Water Body	Natural, River, Sea, Water Body

The example of the developed GIS database is shown in **Figure 4.1.3** and its layer structure is shown in **Figure 4.1.3** .

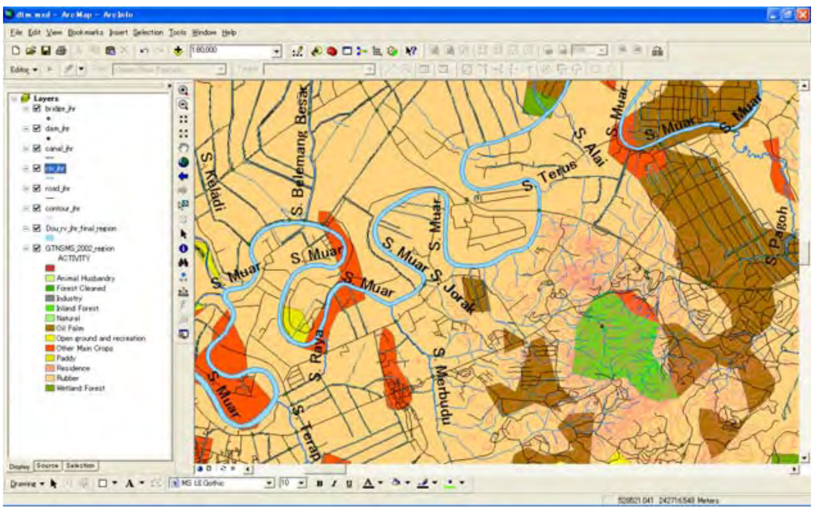


Figure 4.1.3 Example of the Created GIS Database

Table 4.1.3 Layer Structure of GIS Database

Category	Data Type	Description
Administrative boundary	Polygon	State boundary, District boundary, Municipal boundary
Road	Line	Airport, Motorized track (class 4), Causeway, Dual carriageway, Dual highway, Footpath, Motorized track (class 3), Road under construction, Main road - one way 1b, Main road - two way 1a, Single highway, Unsurfaced road - one way 2b, Unsurfaced road - two way 2a
Railroad	Line	Double track, Single track, Light rail, Other rail, Rail station
Water body	Point	Waterfall
	Line	Double line river, Single line river, Island, Single line river and center line of double line river, Canal, Rapid,
	Polygon	Double line river, Lake, Swamp, Mud, Reservoir
Water related feature	Point	Dam, Bridge
	Line	Island, Shoreline, Water pipe
	Polygon	Island, Sand
Town	Point	Town
Land use	Polygon	Tin mine, Rock
Digital terrain model	Point	Digital Terrain Model (50m interval)
	Grid	Digital Terrain Model (50m grid)

Note: An extension of each Shape file name, _XXX shall be used to identify the target state or basin. The definition is following; Pahang State: _phg, Negeri Sembilan State: _ns, Melaka State: _mlk, Johor State: _jhr, Pahang River Basin: _phgrb, Muar River Basin: _muar

4.2 Population Projection

Population is one of the key factors in socio-economic analysis.

In Malaysia, states are divided into several districts and there are two administrative boundaries under districts, namely “Sub-District (“MUKIM” in Malay)” and “Local Authority”. The former is an administrative classification which divides districts to several parts. Therefore, total population of “Sub-Districts” is the same one of the district. On the other hand, the term local authority is another administrative classification under district which covers legally designated built up areas and equipped with its own government. Muar River Basin is covered mainly by two states, namely Negeri Sembilan and Johor. Four districts among seven in Negeri Sembilan State and two districts among eight in Johor are in the Muar River Basin.

Population until 2025, the target year of the IRBM and IFM plan (see chapter 6), for both sub-districts and local authorities within the basin were projected based on existing data. Results are shown in following tables.

Table 4.2.1 Population Projection by Sub-District for Negeri Sembilan State

District	Sub-District	1980	1991	2000	2010	2015	2020	2025
Jelebu			40,012	37,194	38,270	40,265	42,692	45,556
	Galami Lemi	6,121	7,981	8,427	8,910	9,675	10,505	11,407
	Hulu Kelawang	2,203	1,826	1,295	1,033	955	883	817
	Hulu Teriang	4,510	3,653	4,024	5,568	6,787	8,303	10,118
	Kenaboi	1,075	1,287	1,322	1,358	1,430	1,505	1,585
	Kuala Kelawang	5,308	5,334	4,331	3,761	3,770	3,778	3,787
	Peradong	2,163	1,845	1,770	1,882	2,015	2,200	2,436
	Pertang	10,495	12,350	10,714	10,826	10,883	10,940	10,997
	Teriang Hilir	4,855	5,736	5,311	4,930	4,750	4,577	4,410
Kuala Pilah				63,541	63,899	65,096	66,596	67,577
	Ampang Tinggi	8,087	8,768	9,138	9,352	9,380	9,357	9,282
	Johor	10,433	10,236	8,885	8,559	8,559	8,559	8,559
	Juasseh	6,352	9,134	8,630	10,173	11,299	12,516	13,368
	Kepis	4,991	4,990	3,782	3,290	3,164	3,051	2,750
	Langkap	191	218	356	632	818	1,036	1,287
	Parit Tinggi	347	311	267	234	221	209	197
	Pilah	13,719	14,132	14,356	14,485	14,502	14,487	14,440
	Sri Menanti	6,035	4,649	3,918	3,531	3,506	3,592	3,791
	Terachi	5,902	5,042	4,445	3,894	3,663	3,462	3,290
	Ulu Jempol	4,199	3,276	2,903	2,892	3,046	3,306	3,672
	Ulu Muar	6,763	7,424	6,861	6,858	6,939	7,022	6,942
Tampin				77,021	91,069	99,470	108,151	118,692
	Ayer Kuning	8,379	6,661	5,270	3,740	2,981	2,226	1,475

District	Sub-District	1980	1991	2000	2010	2015	2020	2025
	Gemas	17,343	27,355	27,254	35,382	40,379	45,358	51,897
	Gemencheh	17,140	19,037	19,503	19,986	20,232	20,480	20,732
	Keru	949	844	818	852	894	953	1,029
	Repah	1,976	1,780	2,563	2,970	3,197	3,442	3,705
	Tampin Tengah	11,044	15,913	20,781	27,123	30,663	34,448	38,479
	Tebong	599	705	832	1,016	1,124	1,244	1,375
Jempol				125,010	132,087	135,224	138,280	141,842
	Jelai	67,159	19,006	21,295	27,182	30,174	33,398	37,054
	Kuala Jempol	16,802	9,403	10,566	11,948	12,705	13,511	14,367
	Rompin	21,461	50,545	50,002	49,467	49,202	48,939	48,676
	Serting Hilir	7,674	25,454	26,902	28,472	28,704	28,550	28,397
	Serting Ulu	14,065	17,625	16,245	15,017	14,438	13,882	13,347

Source of basic data in 1980, 1991, 2000: Department of Statistics, Malaysia.

Table 4.2.2 Population Projection by Local Authority for Negeri Sembilan State

District	Local Authority/Town		1980	1991	2000	2010	2015	2020	2025
Jelebu				40,012	37,194	38,270	40,265	42,692	45,556
	LA Jelebu				9,434	9,707	10,213	10,829	11,555
		Durian Tipus	459	390	272	216	209	201	194
		Jelebu Estate	856	606	423	336	342	349	355
		Kanpung Chennah		624	382	314	285	258	234
		Kuala Kelawang	2,395	2,055	1,378	1,073	1,025	980	937
		Pertang	1,676	1,420	1,046	857	836	815	795
		Simpang Durian	711	636	1,387	1,765	1,991	2,246	2,533
		Simpang Pertang	1,347	1,272	566	526	507	489	472
		Sungai Buloh	611	548	973	1,331	1,433	1,542	1,660
		Sungai Muntoh	679	632	417	378	369	361	352
		Titi	4,594	2,962	429	341	322	304	288
		Remainder of LA			2,161	2,569	2,893	3,283	3,735
Kuala Pilah					63541	63,899	65,096	66,596	67,577
	LA Kuala Pilah				43,767	44,014	44,838	45,872	46,547
		Ayer Mawang	551	423	277	260	252	245	237
		Dangi	1,030	891	764	711	686	662	639
		Johor	740	612	461	440	429	419	410
		Juasseh	329	232	56	50	48	45	43
		Kampong Tengah	368	226	240	251	255	259	263
		Kuala Jelai		71	38	30	27	24	21
		Kuala Pilah	11,954	11,613	10,445	10,281	10,200	10,120	10,041
		Padang Lebar	312	319	436	683	854	1,055	1,286
		Senaling	665	518	343	252	231	213	195
		Sri Menanti	301	158	75	68	65	62	59
		Tanjong Ipoh	1,187	1,112	1,007	924	903	882	861
		Remainder of LA			29625	30,061	30,887	31,886	32,491
Tampin				72,295	77,021	91,069	99,470	108,151	118,692
	LA Tampin				48,410	57,240	62,520	67,976	74,602
		Air Kuning Selatan	1,417	1,321	1,193	1,092	1,066	1,040	1,015
		Batang Melaka	677	602	538	484	471	459	447
		Bukit Naning	70	54	84	163	220	290	371
		Gedok	866	434	435	810	1,146	1,579	2,112
		Gemas	4,194	3,248	2,306	1,756	1,632	1,517	1,410
		Gemencheng Baru	1,250	2,018	2,213	2,436	2,496	2,557	2,619
		Gemencheng Lama	589	206	116	105	100	95	90
		Kampung Baru Gemas	1,497	1,180	836	748	728	708	689
		Tamping	9,847	11,566	7,493	7,057	6,952	6,849	6,747
		Remainder of LA			33,196	42,588	47,709	52,882	59,101
Jempol				122,033	125,010	132,087	135,224	138,280	141,842
	LA Jempol				58,298	61,598	63,061	64,486	66,147
		Bahau	10,260	8,580	7,771	7,069	6,904	6,742	6,585
		Batu Kikir	325	331	143	124	120	116	112
		Kuala Jelai	515	219	157	132	126	121	116
		Mahsan	460	171	379	425	416	407	398
		Rompin	297	232	176	159	155	151	147
		Serting		1,381	3,151	4,319	5,057	5,921	6,932
		Remainder of LA			46,521	49,370	50,284	51,029	51,858

Source of basic data in 1980, 1991, 2000: Department of Statistics, Malaysia.

Table 4.2.3 Population Projection by Sub-District for Johor State

District	Sub-District	1,980	1,991	2,000	2010	2015	2020	2025
Muar				330,355	391,014	432,436	481,117	537,064
	Ayer Hitam	8,466	7,392	7,695	9,279	10,563	12,176	14,117
	Bandar	72,409	78,038	79,086	82,475	84,224	86,010	87,833
	Bukit Kepong	2,771	8,757	10,174	11,945	12,944	14,025	15,197
	Bukit Serampang	11,736	8,999	8,999	11,363	13,478	16,215	19,574
	Gerisek	27,118	26,036	27,167	27,192	27,204	27,216	27,228
	Jalan Bakri	19,515	24,369	30,733	40,330	46,125	52,585	59,709
	Jorak	13,855	13,778	12,822	12,383	12,383	12,383	12,383
	Kesang	8,542	13,813	18,183	23,099	25,581	28,079	30,593
	Kundang	2,843	2,715	3,659	5,815	7,330	9,136	11,234
	Lenga	8,489	7,284	7,264	8,261	9,162	10,332	11,770
	Parit Bakar	10,403	10,974	12,640	15,757	17,814	20,205	22,929
	Parit Jawa	10,319	8,897	10,202	14,258	17,314	21,056	25,484
	Serom	20,409	18,463	21,148	28,646	34,177	40,897	48,804
	Sri Menanti	10,115	9,076	10,167	13,428	15,868	18,846	22,364
	Sungai Balang	13,126	12,100	13,124	16,229	18,558	21,404	24,768
	Sungai Raya & Kampung Bukit Pasir	7,544	6,690	7,609	10,338	12,376	14,864	17,801
	Sungai Terap	5,941	6,027	9,166	15,893	20,535	26,029	32,376
	Tangkak	37,484	38,396	40,517	44,324	46,801	49,659	52,900
Segamat				177,916	191,772	202,414	214,089	226,787
	Bandar Segamat	8,362	6,348	3,805	3,441	3,441	3,441	3,441
	Bekok	8,367	7,580	5,934	4,927	4,579	4,256	3,955
	Bulon Kasap	13,918	18,367	22,181	26,602	28,885	31,217	33,597
	Chaah	13,560	13,903	13,459	13,035	13,006	12,977	12,948
	Gemas	10,183	13,780	13,634	13,490	14,571	15,737	16,998
	Gemereh	4,862	6,507	6,692	7,377	8,098	8,889	9,758
	Jabi	2,516	9,052	9,000	8,974	8,974	8,974	8,974
	Jementah	12,239	15,329	16,211	17,915	19,381	21,005	22,765
	Labis	28,966	32,521	31,051	32,097	32,633	33,178	33,732
	Pogoh	10,855	12,593	16,233	22,619	26,736	31,469	36,818
	Sermin	1,898	2,036	1,740	1,672	1,639	1,607	1,576
	Sungai Segamat	34,775	39,545	37,976	39,622	40,471	41,339	42,225

Source of basic data in 1980, 1991, 2000: Department of Statistics, Malaysia.

Table 4.2.4 Population Projection by Local Authority for Johor State

District	Local Authority/Town		1980	1991	2000	2010	2015	2020	2025
Muar				301,804	330,355	391,014	432,436	481,117	537,064
	LA Muar Selatan				194,123	229,767	254,108	282,714	315,589
		Bandar Maharani	65,151	62,946	57,742	53,841	52,737	51,656	50,597
		Bukit Bakri	5,215	6,455	6,258	6,864	7,188	7,528	7,884
		Bukit Kepong	667	574	349	310	300	292	283
		Bukit Pasir	3,680	3,737	3,539	3,356	3,323	3,291	3,259
		Lenga	1,093	880	752	639	616	594	573
		Pagoh	2,499	2,062	1,597	1,293	1,222	1,154	1,091
		Panchor	1,088	949	681	557	519	483	450
		Parit Jawa	2,697	2,684	2,628	2,584	2,571	2,557	2,544
		Semerah	244	349	717	1,424	1,895	2,444	3,071
		Remainder of LA			119,860	158,900	183,737	212,714	245,836
	LA Muar Utara				57,364	67,897	75,090	83,543	93,258
		Bukit Gambir	4,586	3,627	4,538	7,340	9,448	12,026	15,076
		Bukit Kangkar	1,876	1,375	860	629	572	520	473
		Gerisek	2,309	1,790	1,429	1,164	1,107	1,052	1,000
		Kampong Kundang Ulu	936	711	672	586	578	570	562
		Kebun Baharu	838	678	639	620	612	603	595
		Sagil Luar	2,411	1,806	1,744	1,517	1,465	1,416	1,367
		Serom	2,096	1,791	1,892	2,374	2,761	3,246	3,828
		Sungai Mati	1,055	691	972	934	925	916	907
		Tangkak	13,251	11,216	9,187	7,816	7,631	7,556	7,482
		Remainder of LA			35,431	44,916	49,992	55,638	61,968
Segamat				177,561	177,916	191,772	202,414	214,089	226,787
	LA Segamat Selatan				34,438	37,120	39,180	41,440	43,898
		Bekok	4,035	3,195	2,784	2,372	2,297	2,224	2,153
		Chaah	6,211	4,638	3,384	2,688	2,539	2,397	2,264
		Labis	10,629	8,809	6,868	5,681	5,375	5,085	4,811
		Pekan Ayer Panas	1,085	756	688	572	546	522	498
		Sungai Karas			496	412	393	376	359
		Remainder of LA			20,218	25,395	28,031	30,836	33,812
	LA Segamat Utara				91,058	98,149	103,596	109,572	116,070
		Batu Anam	2,506	3,113	3,066	3,395	3,573	3,760	3,957
		Buloh Kasap	3,006	2,318	2,680	2,897	3,012	3,131	3,255
		Gemas Baharu	1,510	998	560	478	459	442	425
		Jementah	6,978	6,849	5,199	4,573	4,429	4,290	4,155
		Kampong Tengah	1,860	1,589	838	730	705	681	658
		Paya Jakas	393	338	331	307	306	304	303
		Segamat	34,008	32,359	29,647	27,800	27,357	26,922	26,493
		Remainder of LA			48,737	57,969	63,755	70,042	76,825

4.3 Hydrological Analysis

4.3.1 Objective and Analysis Process

The objective of this section is to identify the magnitude of floods for respective return periods which provide a basis to define designed safety level. This analysis is based on past rainfall data available in the basin.

Then a flood simulation model is developed which are composed of runoff model, 1-dimensional river channel model and 2-dimensional flood plain model. This flood model serves as a tool to evaluate flood risks, efficiency of potential flood mitigation measures and impacts of climate change.

4.3.2 Data Availability

Temporal rainfall data, river water level and discharge data were collected from DID Hydrology and Water Resources Division based on the inventory of the gauging stations.

Then rain gauging stations were selected for further analysis following the steps below.

- Step1: Stations currently in operation were selected;
- Step2: Stations with long term data were selected (i.e. station which started before Jan. 1980 when 75% of the current stations were in operation were selected);
- Step3: Reliable station with total missing data of less than 365 days since Jan. 1980 were selected;
- Step4: Station with reliable data (annual average data were examined as in **Figure 4.3.1** and station with unreliable data were excluded); and

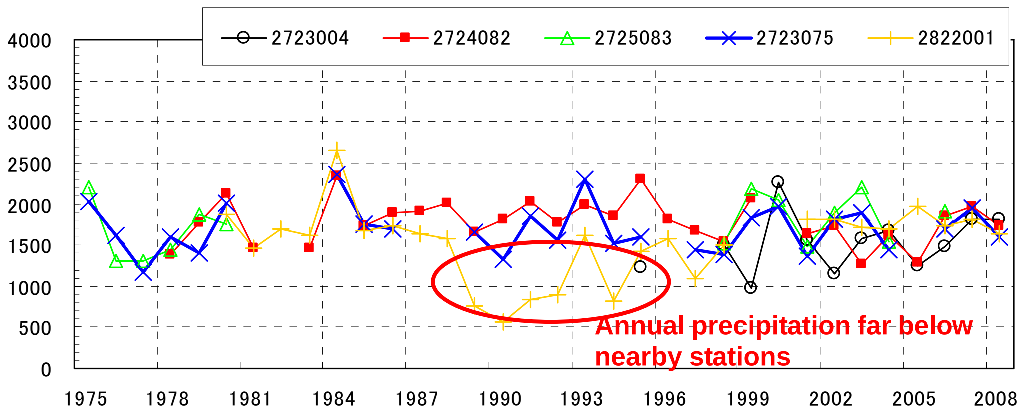


Figure 4.3.1 Example of Annual Precipitation Data Examination. Station 2822001 was Excluded from Further Analysis

- Step5: If there are two or more stations which fulfill the above criteria within approximately 10km distance, stations with less missing data were selected for final screening.

All gauging stations are listed in **Table 4.3.1** and **Table 4.3.2** with their location in **Figure 4.3.2**.

Table 4.3.1 List of Rain Gauge Stations

Station ID	Water Level		Discharge	
	Hourly Data Available Period	Daily Data Available Period	Hourly Data Available Period	Daily Data Available Period
2525415	1961/5/2-	1961/5/2-	1961/5/1-	1961/5/2-
2527411	1960/7/1-	1960/7/2-	1960/7/1-	1960/7/2-
2527490	2001/1/23-	2001/1/23-	-	-
2528414	1960/7/1-	1960/7/2-	1960/7/1-	1960/7/2-
2625413	1993/10/20-	1993/10/21-	-	-
2723401	1978/11/4-	1978/11/5-	1978/11/4-	1978/11/5-

Table 4.3.2 List of Rain Gauge Stations

Station ID	Hourly Data Available Period	Daily Data Available Period
2025001	1974/8/10-	1974/8/10-
2125028	-	1947/12/1-
2126024	-	1948/1/1-1960/6/30
2127017	-	1965/7/10-
2127018	-	1947/11/1-
2225026	-	1947/10/8-
2226019	-	1949/7/2-1994/9/30
2228016	-	1959/1/1-
2326020	-	1949/7/3-1967/3/31
2326022	-	1947/11/20-
2326023	-	1948/12/4-
2330009	1970/6/29-	1947/12/1-
2424087	-	1930/7/4-
2426005	-	1950/10/7-
2427001	-	1978/8/1-
2428011	-	1948/1/1-
2428013	-	1952/4/14-
2430009	2001/1/2-	2001/1/2-
2524001	-	1978/2/1-
2526001	2003/6/12-	1965/7/4-
2527004	2003/6/12-	2003/6/12-
2527007	-	1948/1/1-1961/10/31
2528001	-	1980/4/30-1999/6/30
2528002	2000/7/3-	1999/10/1-
2528014	-	1972/1/19-1975/4/30
2622078	1995/6/15-	1964/2/1-
2622079	-	1954/1/1-1970/12/31
2623085	2003/8/12-	1930/1/2-
2625084	2003/9/2-	1959/1/4-
2626002	2009/5/4-	1950/1/1-
2626003	2001/6/17-	2001/6/17-
2628001	-	1980/6/1-
2721073	-	1959/2/1-
2722003	2003/8/13-	1977/3/1-
2723001	-	1995/6/17-1996/1/2
2723004	1995/6/15-	1998/1/1-
2723075	-	1936/1/2-
2724082	-	1930/7/4-
2725083	-	1923/7/4-
2822001	1995/6/21-	1979/11/1-

Hatched rain gauge stations are ones selected for further analysis

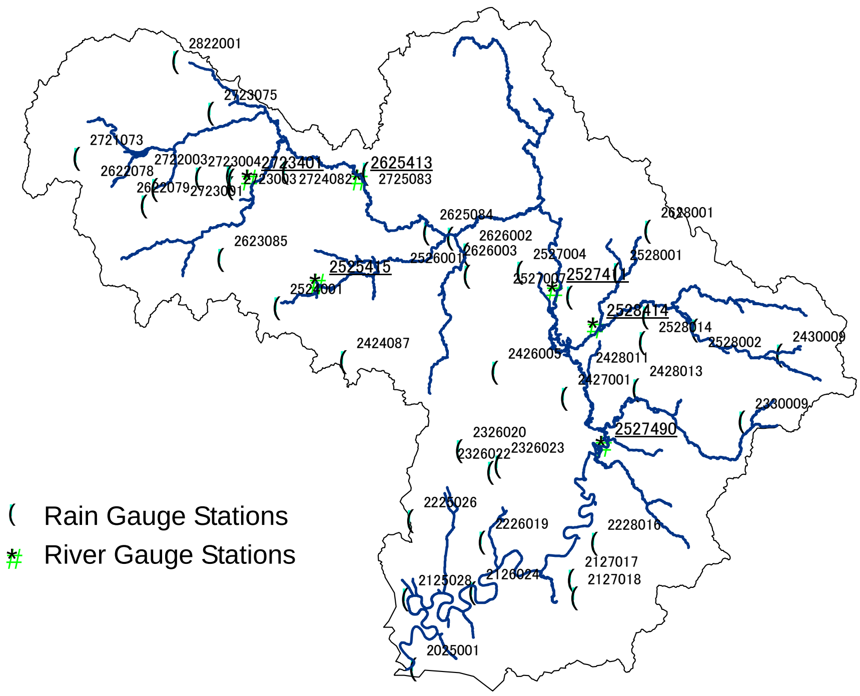


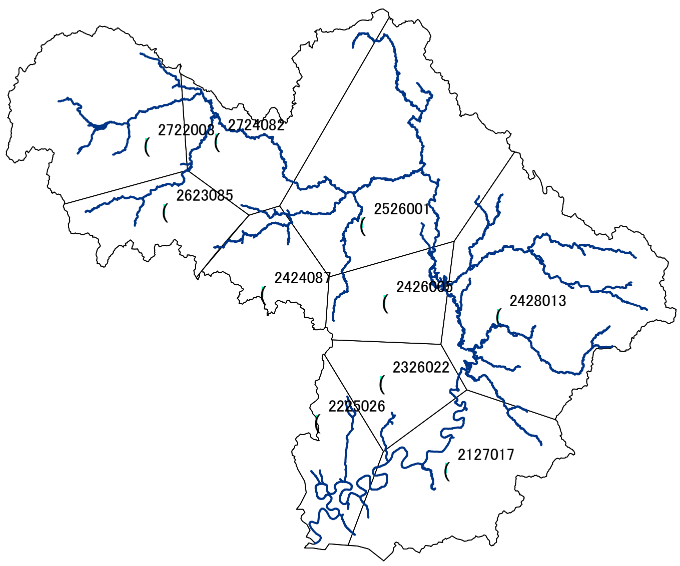
Figure 4.3.2 Location of Gauging Stations

4.3.3 Rainfall Analysis

Average recurrence interval (ARI) of rainfall is analyzed in this section based on the rainfall data obtained from 10 rain gauge stations selected in section **4.3.2**.

(1) Rainfall Duration

According to the *"Master Plan Study on Flood Management for Sg. Muar Basin 2003"*, 72hrs rainfall gives critical peak flood discharge. Therefore, 3 day basin mean rainfalls were calculated based on thiessen distribution represented by each rain gauge station as shown in **Figure 4.3.3.**

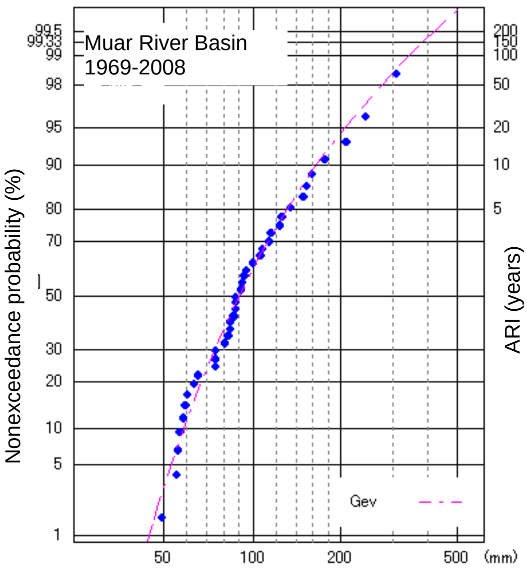


St. ID	Area(km^2)
2127017	735
2225026	336
2326022	323
2424087	280
2426005	335
2428013	1249
2526001	1146
2623085	363
2722003	797
2724082	574

Figure 4.3.3 Thiessen Distribution and Area Represented by Each Station

(2) Probability Analysis

Latest 40 years rainfall data were used to estimate rainfall for various return periods. **Figure 4.3.4** shows rainfalls for various return periods based on general extreme value distribution and return period for maximum rainfall in each year. It is estimated that ARI of maximum 3 day rainfall in 1971 and 2006 were 33 years and 71 years respectively.



General Extreme Value (GEV) distribution, Plotted on Log-Normal Probability Paper

Year	Maximum Rainfall	ARI	Year	Maximum Rainfall	ARI
1968	58.2	1.1	1988	92.1	2
1969	159.6	9	1989	125.2	4
1970	242.1	33	1990	83.3	1.7
1971	100.9	3	1991	108.1	3
1972	83.2	1.7	1992	153.1	8
1973	55.7	1.08	1993	64.6	1.4
1974	58.8	1.1	1994	95.7	2
1975	56.3	1.09	1995	113.6	3
1976	74.5	1.6	1996	*Not Available*	
1977	82.5	1.7	1997	54.9	1.07
1978	85.8	1.8	1998	75.2	1.7
1979	86.9	1.9	1999	86.7	1.9
1980	59.7	1.2	2000	63.1	1.2
1981	49.4	1.03	2001	123.1	4
1982	80.6	1.6	2002	148.9	7
1983	175.0	12	2003	114.8	4
1984	91.1	2	2004	74.7	1.6
1985	207.2	20	2005	87.4	1.9
1986	106.5	3	2006	306.9	71
1987	93.2	2	2007	134.2	5

**Hydrological year: July until June next year*

Figure 4.3.4 Result of Rainfall Probability Analysis (Muar River Basin)

Annual maximum 3 day rainfalls for various return periods are as in **Table 4.3.3**.

Table 4.3.3 Annual Maximum 3 day Rainfall for Various Return Periods

ARI(yrs)	200	150	100	80	50	30	20	10	5	3	2	1.5
3 day Rainfall (mm)	417.5	383.4	339.7	317.7	275.6	235.5	207.5	165.8	130.6	107.4	89.6	76.4

4.3.4 Development of the Flood Simulation Model

(1) Outline of the Model

(a) Runoff model

USEPA Nonlinear Runoff model was applied to calculate the discharge from each sub-basin. This model idealizes sub-basins into rectangle with flow direction perpendicular to the width, and could account for land use variation by classifying the sub-basin to three sub-areas shown in **Table 4.3.4** and **Figure 4.3.5**. This scheme is suitable for predictions in river basins which land use are subject to change in the future.

Table 4.3.4 Sub-basin Surface Classification

Sub-area	Perviousness	Depression Storage
A_1	Impervious	Yes
A_2	Pervious	Yes
A_3	Impervious	No

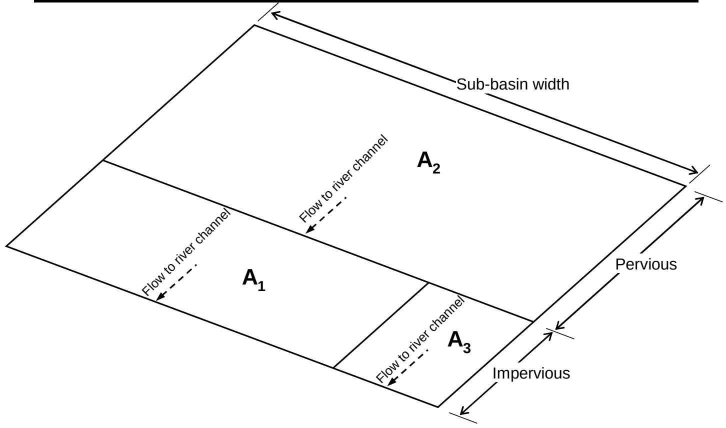


Figure 4.3.5 Sub-basin Schematization
(Flows from each sub-area go directly to river channel)

The flow to the river channel is computed by Manning's equation:

$$q = \frac{1}{n}(d - d_p)^{5/3} i^{1/2}$$, and

continuity equation:

$$\frac{\partial d}{\partial t} + \frac{\partial q}{\partial x} = r$$,

where
q = flow per unit width,
n = Manning's roughness coefficient,
d = water depth,
d_p = depression water depth,
r = rainfall intensity, and
i = slope.

Infiltration from pervious area was computed by uniform loss method which simulates infiltration as an initial followed by continues amount. The initial loss specifies the depth of rainfall infiltrates before any runoff occurs. The continuing absolute loss occurs after the initial loss has been satisfied as shown in **Figure 4.3.7**.

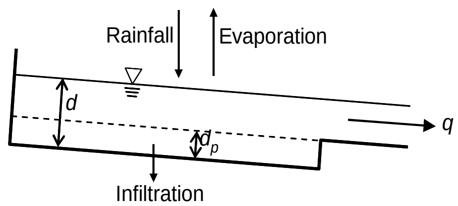


Figure 4.3.6 Nonlinear Reservoir Representation of Sub-basin

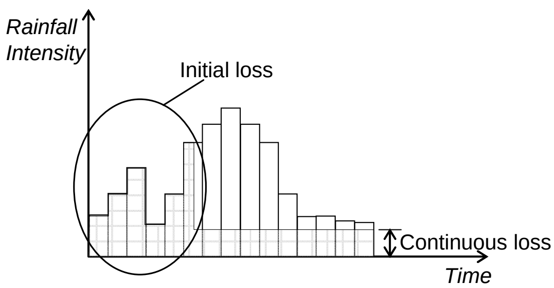


Figure 4.3.7 Schematic View of Infiltration Loss by Uniform Loss Method

(b) Hydraulic Model

Basic equation for channel flow is composed of the gradually varied one-dimensional unsteady flow equation and continuity equation.

The continuity equation with lateral inflow is:

$$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q$$

and momentum equation is written as:

$$\frac{\partial Q}{\partial t} + \frac{\partial}{\partial x}\left(\frac{Q^2}{A}\right) + gA\frac{\partial H}{\partial x} = -gn^2\frac{Q|Q|}{AR^{4/3}}$$

where

A = cross-sectional area,
Q = discharge,
q = lateral inflow,
H = hydraulic head,
R = hydraulic radius,
n = Manning's roughness coefficient, and
g = gravitational acceleration.

The equations for reproducing hydraulic behavior in the flood plains are two-dimensional shallow water equation and continuity equation as shown below.

$$\frac{\partial H}{\partial t} + \frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} = 0$$

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} = -g\frac{\partial H}{\partial x} - gu\frac{n^2\sqrt{u^2+v^2}}{h^{4/3}}$$

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -g\frac{\partial H}{\partial y} - gv\frac{n^2\sqrt{u^2+v^2}}{h^{4/3}}$$

where

u, v = velocity to x and y direction,
h = water depth,
H = hydraulic head,
n = Manning's roughness coefficient, and
g = gravitational acceleration.

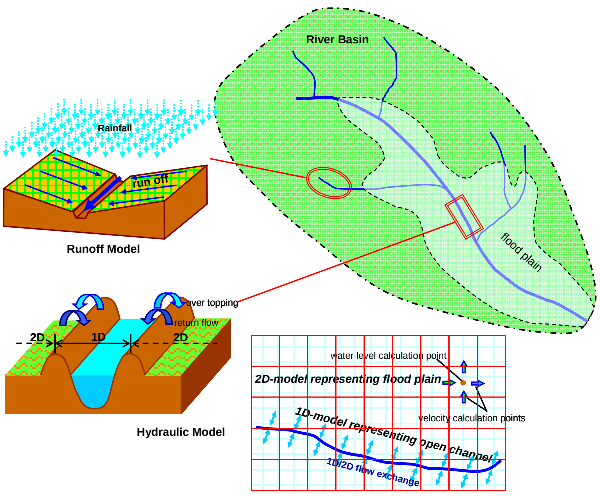
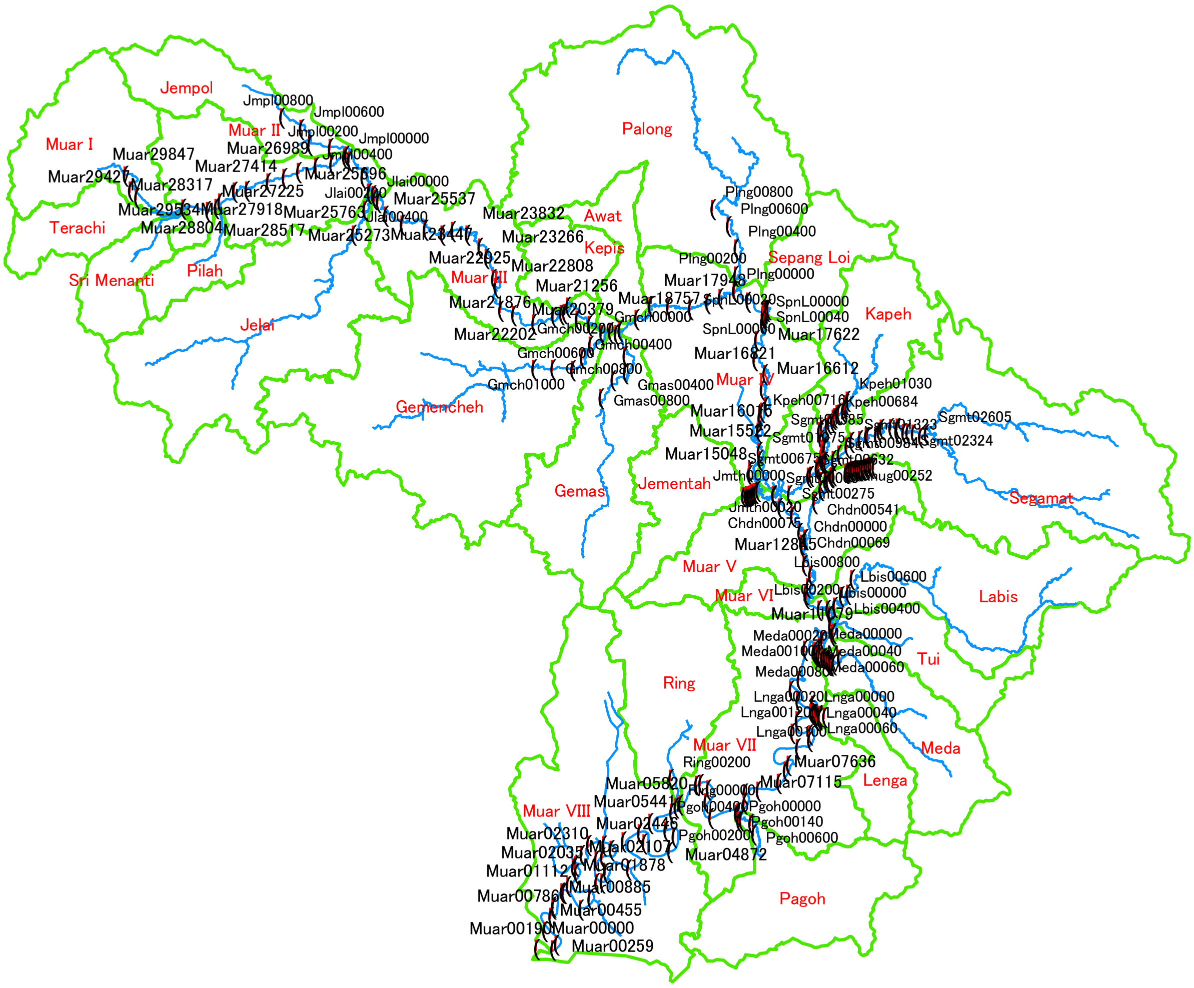


Figure 4.3.8 Schematic View of the Flood Simulation Model

(c) Muar River Basin Model

Muar River Basin was divided into 28 sub-basins based on its river network as in **Figure 4.3.9**, and hydrologic parameters were fixed as in **Table 4.3.5** through calibration. Parameter regarding land use is based on the land use data developed by JPBD which classifies the land use into five groups namely, "agricultural land", "forest", "water-body", "transportation, infrastructure and utility" and "buildup area". Latter two were categorized as impervious area in this study.



Red circle indicate the location of cross-section and numbers are chainage from the river-mouth or confluence point

Figure 4.3.9 Sub-basins and Channel Chainage of Muar River Basin

Table 4.3.5 Hydrological Model Parameters

Sub-basin	Catchment Area (km)	Runoff					Infiltration	
		Width (km)	Slope	Land Use	Area (%)	Roughness Coefficient	Initial Loss (mm)	Continuing Loss (mm/hr)
Muar I	183	20000	0.001	Pervious	99.9	0.1	30.0	0.4
				Impervious	0.1	0.014	-	-
Terachi	83	20000	0.0005	Pervious	90.1	0.1	30.0	0.4
				Impervious	9.9	0.014	-	-
Sri Menanti	77	20000	0.0005	Pervious	92.7	0.1	30.0	0.4
				Impervious	7.3	0.014	-	-
Pilah	56	10000	0.0005	Pervious	88.9	0.1	30.0	0.4
				Impervious	11.1	0.014	-	-
Muar II	220	10000	0.0005	Pervious	81.1	0.1	30.0	0.4
				Impervious	8.9	0.014	-	-
Jempol	135	20000	0.0005	Pervious	90.2	0.1	30.0	0.4
				Impervious	9.8	0.014	-	-
Jelai	390	20000	0.0005	Pervious	96.3	0.1	30.0	0.4
				Impervious	3.7	0.014	-	-
Muar III	211	5000	0.0002	Pervious	93.3	0.1	30.0	0.4
				Impervious	6.7	0.014	-	-
Kepis	73	5000	0.0002	Pervious	95.5	0.1	30.0	0.4
				Impervious	4.5	0.014	-	-
Gemencheh	503	3000	0.0002	Pervious	95.6	0.1	30.0	0.4
				Impervious	4.4	0.014	-	-
Gemas	242	3000	0.0002	Pervious	95.9	0.1	30.0	0.4
				Impervious	4.1	0.014	-	-
Awat	66	5000	0.0002	Pervious	95.7	0.1	30.0	0.4
				Impervious	4.3	0.014	-	-
Muar IV	286	3000	0.0003	Pervious	99.7	0.1	30.0	0.4
				Impervious	0.3	0.014	-	-
Palong	563	3000	0.0005	Pervious	97.5	0.1	30.0	0.4
				Impervious	2.5	0.014	-	-
Seoang Loi	116	5000	0.0002	Pervious	100.0	0.1	30.0	0.4
				Impervious	0.0	0.014	-	-
Jementah	126	3000	0.0002	Pervious	98.2	0.1	30.0	0.4
				Impervious	1.8	0.014	-	-
Segamat	550	7000	0.0002	Pervious	98.7	0.1	40.0	0.6
				Impervious	1.3	0.014	-	-
Kapeh	162	5000	0.0002	Pervious	99.5	0.1	30.0	0.4
				Impervious	0.5	0.014	-	-
Muar V	230	2000	0.0001	Pervious	99.3	0.1	30.0	0.4
				Impervious	0.7	0.014	-	-
Muar VI	35	2000	0.0001	Pervious	100.0	0.1	30.0	0.4
				Impervious	0.0	0.014	-	-
Labis	280	2000	0.0001	Pervious	99.9	0.1	30.0	0.4
				Impervious	0.1	0.014	-	-
Tui	101	2000	0.0001	Pervious	94.5	0.1	30.0	0.4
				Impervious	5.5	0.014	-	-
Meda	165	2000	0.0001	Pervious	100.0	0.1	30.0	0.4
				Impervious	0.0	0.014	-	-
Muar VII	346	2000	0.00001	Pervious	100.0	0.1	30.0	0.4
				Impervious	0.0	0.014	-	-
Lenga	81	2000	0.0001	Pervious	100.0	0.1	30.0	0.4
				Impervious	0.0	0.014	-	-
Pagoh	204	2000	0.0001	Pervious	99.5	0.1	30.0	0.4
				Impervious	0.5	0.014	-	-
Ring	198	10000	0.0001	Pervious	99.2	0.1	20.0	0.3
				Impervious	0.8	0.014	-	-
Muar VIII	455	2000	0.0001	Pervious	98.1	0.1	30.0	0.4
				Impervious	1.9	0.014	-	-

Hydraulic parameters were fixed as shown in **Table 4.3.6** through calibration.

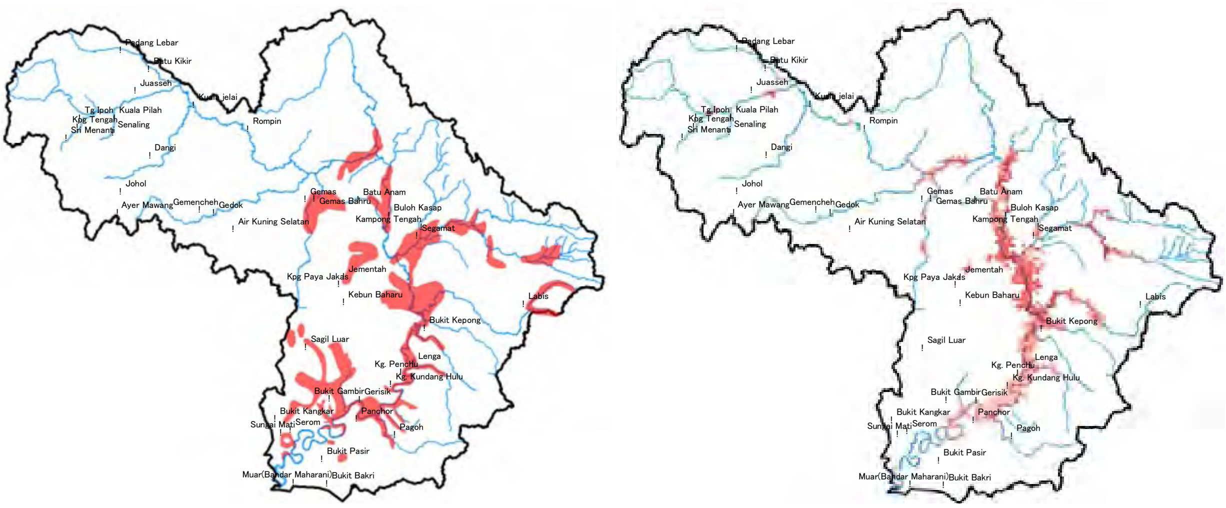
Table 4.3.6 Hydraulic Parameters

1D River Model	Roughness Coefficient	Main stream: Chainage 0 – 72.2km	0.02
		Main stream: Chainage 72.2 – 176.8km Tributaries: Chodan, , Genuang, Jementeh ,Kapeh, Labis, Lenga, Meda, Pagoh, Ring and Segamat	0.03
		Main stream: Chainage 176.8 and upstream Tributaries: Gemas, Gemencheh, Jelai, Jempol, Palong and Sepan Loi	0.035
2D Flood Model	Roughness Coefficient of Flood Plains		0.5
	Spatial Resolution		500m x 500m

(2) Validation of the Model

The flood simulation model was verified by reproducing December 2006 flood which caused the most sever flood damages in recent years. The ARI of the basin mean 3 day rainfall is estimated to be 71 years which is the largest rainfall in the last 40years. Sufficient observation data including flood map has been obtained in this flood which are indispensable data for model calibration.

Figure 4.3.10 shows flood areas based on observation and one developed based on the model result, and **Figure 4.3.11** is the temporal plots of observed river water level and calculated results. The figures indicate that the simulation result agrees well with observed data and it could be utilized to evaluate the impact of climate change as well as effectiveness of various flood mitigation measures.



Source: DID Segamat and Muar District Office

Figure 4.3.10 Model Verification: Flood Area
(Left Panel: Observation, Right Panel: Simulation Result)

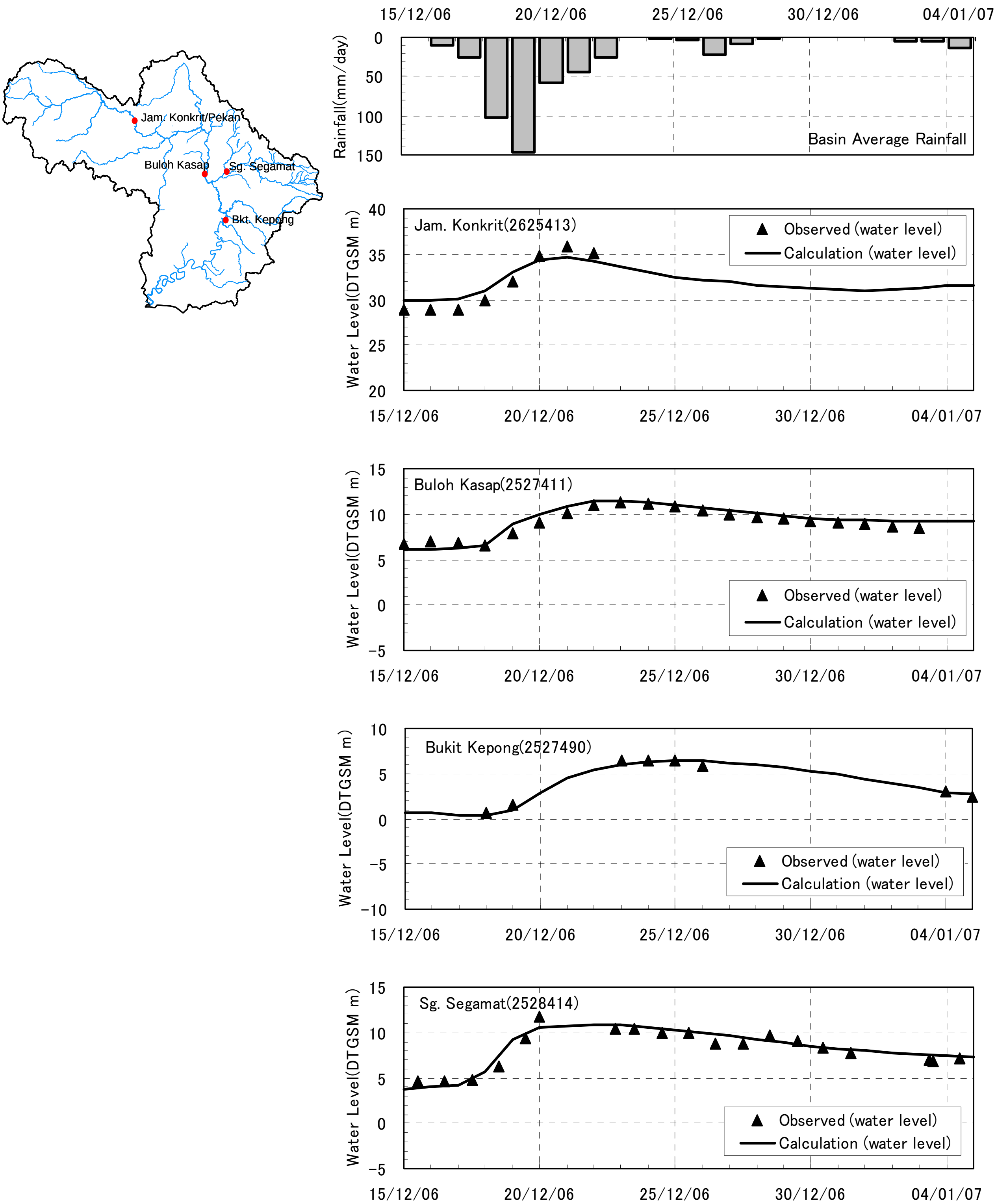


Figure 4.3.11 Model Verification: Observed Water Level versus Simulation Result

4.3.5 Flood Prediction

This section demonstrates flood simulation results conducted under various conditions including existence of potential flood mitigation measures. Details on flood mitigation measures could be found in **Chapter 6**.

(1) Calculation Condition

(a) Rainfall Pattern

As indicated in **Figure 4.3.12**, similar rainfall pattern is observed in Muar River Basin during major flood events. That is, there is relatively heavy rainfall along the east boundary of the basin and less rainfall in the west. Since December 2006 was largest flood event with sufficient observation data, this rainfall pattern was used for further analysis.

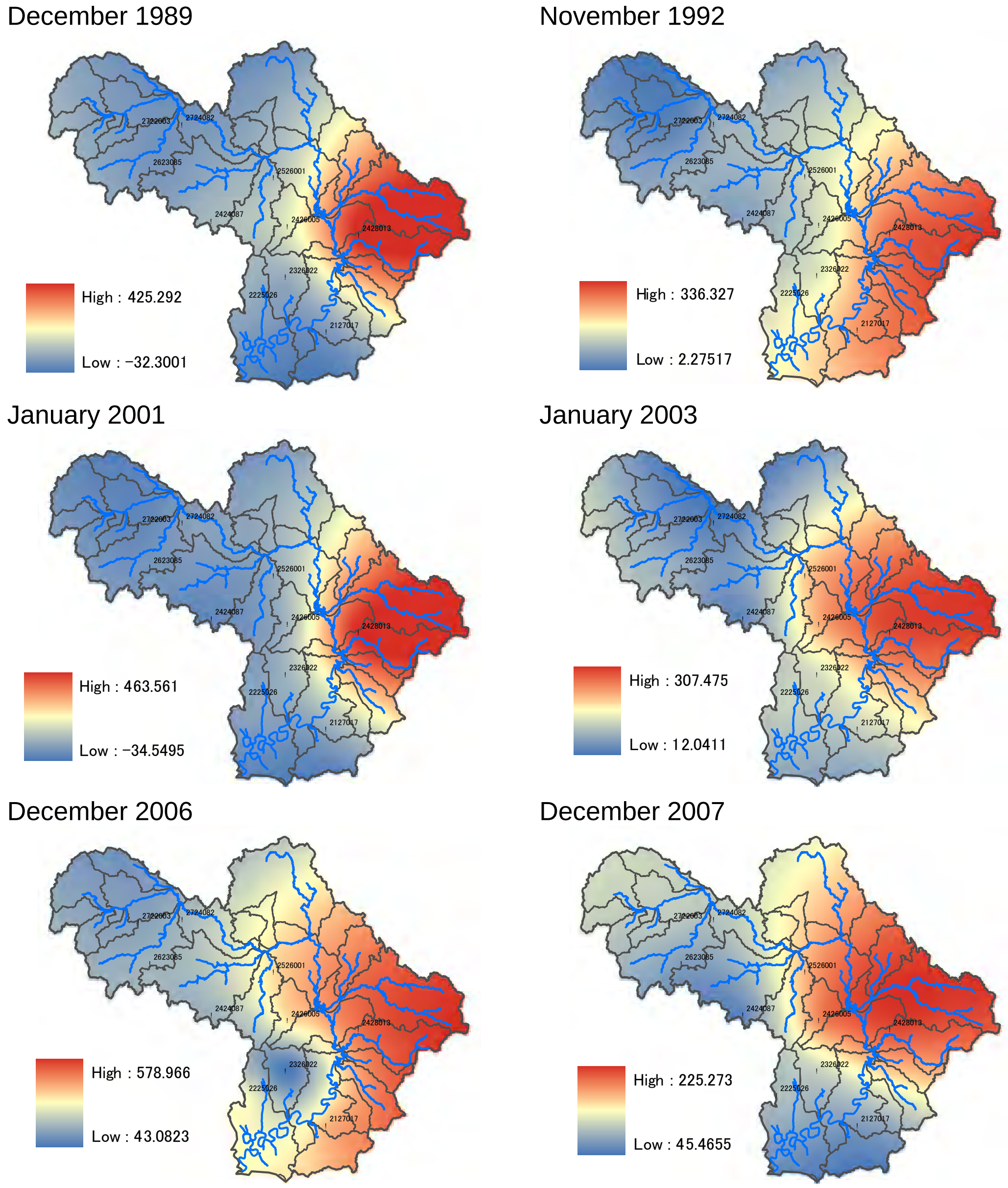


Figure 4.3.12 Rainfall Distribution in Major Flood Events

(b) Downstream Water Level

Downstream boundary conditions were fixed based on observed temporal tide data of Tanjung Kelang. That is, observed data was used for simulation under current condition, and 0.12m was added for simulation under 2025 condition in order to reflect the impact of sea level rise due to climate change.

(c) Enlargement Ratio and Incremental Ratio

Enlargement ratio was introduced to create rainfalls for various return periods. This ratio was multiplied to observed rainfall pattern in order to adjust the actual 3 day rainfall to rainfall of targeted return periods. In addition to this, incremental ratio was introduced for projection under 2025 condition to reflect the impact of climate change. The ratios are as in **Table 4.3.7**.

Table 4.3.7 Enlargement and Incremental Ratio for simulation

	Return Period						Dec. 2006 flood
	2	5	10	20	50	100	
3 day rainfall(mm)	89.6	130.6	165.8	207.5	275.6	339.7	306.9
Enlargement Ratio	0.29	0.43	0.54	0.68	0.90	1.11	-
Incremental Ratio	1.1	1.1	1.1	1.2	1.2	1.2	-

(d) Land Use

Future land use was calculated based on the JPBD data in order to reflect the change in runoff in the future. Parameters are shown in **Table 4.3.8.**

Table 4.3.8 Proportion of Pervious and Impervious Area

Sub-basin	Land Use	Area (%)		Sub-basin	Land Use	Area (%)	
		Current	2025			Current	2025
Muar I	Pervious	99.9	99.9	Seoang Loi	Pervious	100.0	100.0
	Impervious	0.1	0.1		Impervious	0.0	0.0
Terachi	Pervious	90.1	89.3	Jementah	Pervious	98.2	98.2
	Impervious	9.9	10.7		Impervious	1.8	1.8
Sri Menanti	Pervious	92.7	92.7	Segamat	Pervious	98.7	98.1
	Impervious	7.3	7.3		Impervious	1.3	1.9
Pilah	Pervious	88.9	88.9	Kapeh	Pervious	99.5	99.5
	Impervious	11.1	11.1		Impervious	0.5	0.5
Muar II	Pervious	81.1	76.7	Muar V	Pervious	99.3	98.5
	Impervious	8.9	23.3		Impervious	0.7	1.5
Jempol	Pervious	90.2	90.2	Muar VI	Pervious	100.0	97.4
	Impervious	9.8	9.8		Impervious	0.0	2.6
Jelai	Pervious	96.3	95.5	Labis	Pervious	99.9	99.3
	Impervious	3.7	4.5		Impervious	0.1	0.7
Muar III	Pervious	93.3	93.3	Tui	Pervious	94.5	94.5
	Impervious	6.7	6.7		Impervious	5.5	5.5
Kepis	Pervious	95.5	95.5	Meda	Pervious	100.0	99.9
	Impervious	4.5	4.5		Impervious	0.0	0.1
Gemencheh	Pervious	95.6	87.0	Muar VII	Pervious	100.0	96.0
	Impervious	4.4	13.0		Impervious	0.0	4.0
Gemas	Pervious	95.9	65.9	Lenga	Pervious	100.0	99.0
	Impervious	4.1	34.1		Impervious	0.0	1.0
Awat	Pervious	95.7	95.7	Pagoh	Pervious	99.5	91.6
	Impervious	4.3	4.3		Impervious	0.5	8.4
Muar IV	Pervious	99.7	99.7	Ring	Pervious	99.2	97.2
	Impervious	0.3	0.3		Impervious	0.8	2.8
Palong	Pervious	97.5	97.5	Muar VIII	Pervious	98.1	77.9
	Impervious	2.5	2.5		Impervious	1.9	22.1

(e) Simulated Cases

Segamat-Genuang Diversion Channel and Genuang and Chodan River improvement are currently under detail design stage and the project has already been decided by DID to be implemented. Therefore, existence of this flood mitigation measure was considered as prerequisite condition for further analysis. However, downstream river water level during flood events may rise relative to current condition as a result of the diversion construction. This was also pointed out in previous studies such as *Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar (Fasa 1), Johor 2009 by HSS Integrated*. In order to reduce flood area along the mainstream and negative impact to downstream by construction of the diversion, effect of seven short-cut channels were simulated as potential measures in this section. Short-cut channels were added from downstream to avoid negative impacts to the downstream, namely no short-cut channel, beside Sungai Sendok short-cut (located in the most downstream), will be constructed without existence of its downstream short-cut channel. Simulated cases are as listed in **Table 4.3.9**. Details of flood mitigation measures could be found in **Chapter 6**.

Table 4.3.9 List of Simulated Cases

Simulation Cases		Calculated ARIs (years)	Prediction Condition*	Description
1. No flood mitigation measure	1.Current	2, 5, 10, 20, 50 and 100	Current	Without any flood mitigation measures under current condition
	2.Target year		2025	Without any flood mitigation measures under 2025 condition
2. Structural flood mitigation measure	1. Segamat - Genuang diversion channel and river improvement of Genuang and Chodan River		2025	Prediction under existence of Segamat-Genuang diversion, and improved Genuang and Chodan River
	2. 1 and one shortcut channel		2025	With Sg. Sendok short-cut channel in addition to above measures
	3. 1 and two shortcut channels		2025	With Belemang short-cut channel in addition to above measures
	4. 1 and three shortcut channels		2025	With Tg. Olak short-cut channel in addition to above measures
	5. 1 and four shortcut channels		2025	With Kundang short-cut channel in addition to above measures
	6. 1 and five shortcut channels		2025	With Penchu short-cut channel in addition to above measures
	7. 1 and six shortcut channels		2025	With Bkt. Serampang short-cut channel in addition to above measures
	8. 1 and seven shortcut channels		2025	With Bkt. Kepong short-cut channel in addition to above measures

** Land use and climatic conditions were reflected to simulations*

Figure 4.3.13 Location of Structural Mitigation Measures

(2) Calculation Condition

The simulated result shows rise in river water level as a result of climate and land use change which could be seen in **Table 4.3.10**. This indicates possible increase in flood risks in the future if no appropriate actions were implemented. Eight flood mitigation measures were simulated including the case without short-cut channel and the results are shown in the table, **Figure 4.3.14** and **Figure 4.3.15**. The result indicates that river water level in 100 years return period flood may rise between chainage 5 and 50 km (approx. 45km in section length) with construction of Segamat-Genuang Diversion Channel. As shown in **Figure 4.3.16**, residential areas between chainage 35km and upstream is already vulnerable to flood and construction of the diversion channel may further aggravate flood damages in the areas. On the other hand, impact of the diversion channel could be reduced with existence of a short-cut channel/ short-cut channels and river water level in flood prone area (i.e. chainage 35km and upstream) is predicted to be reduced if two or more short-cut channels were constructed. Effect of short-cut channel could also be seen in **Figure 4.3.17** as reduction of flood area along the mainstream. Further analysis on flood mitigation measures are conducted in **Chapter 6**.

Table 4.3.10 River Water Level of 100 years Return Period Flood at Selected Points

Case ID \ Location	Buloh Kasap	Bukit Kepong	Lenga	Panchor	Kg. Belemang	Muar	Bandar Segamat
1-1	11.37	5.95	4.69	3.42	1.52	1.31	10.75
1-2	12.37	6.95	5.59	4.31	2.32	1.45	12.06
2-1	12.22	6.92	5.57	4.26	2.47	1.42	10.72
2-2	12.22	6.92	5.57	4.20	2.35	1.42	10.72
2-3	12.22	6.89	5.52	4.02	2.15	1.46	10.72
2-4	12.22	6.81	5.33	3.55	2.04	1.44	10.72
2-5	12.22	6.73	5.10	3.59	1.97	1.46	10.72
2-6	12.22	6.48	4.52	3.70	2.00	1.45	10.72
2-7	12.21	6.42	4.51	3.69	2.04	1.46	10.72
2-8	12.22	6.07	4.53	3.72	2.01	1.45	10.72

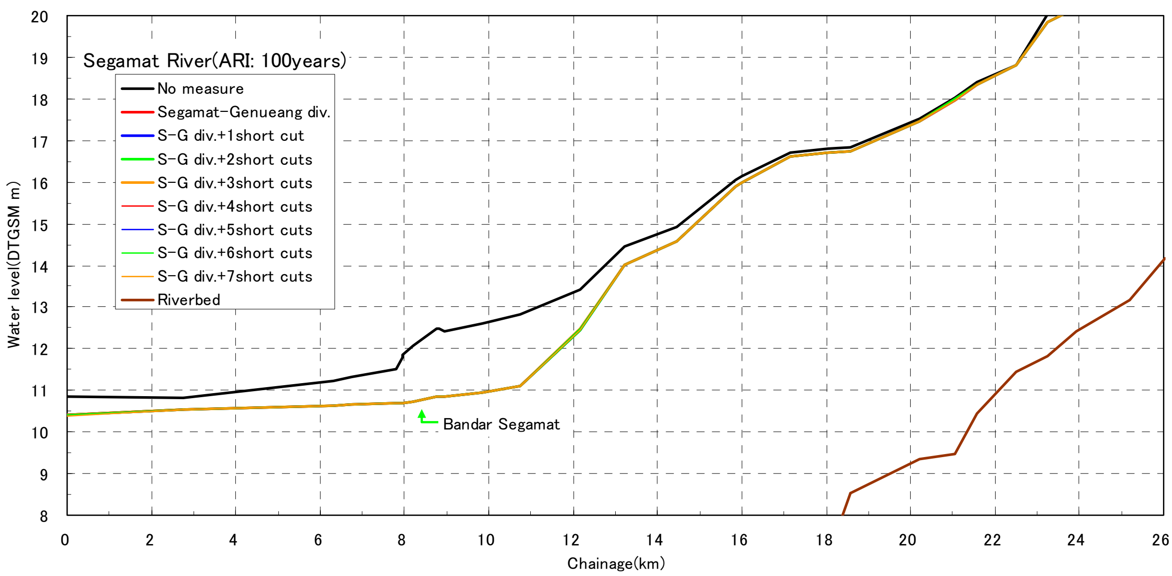


Figure 4.3.14 Water Level of Segamat River in 100 years ARI Flood Event

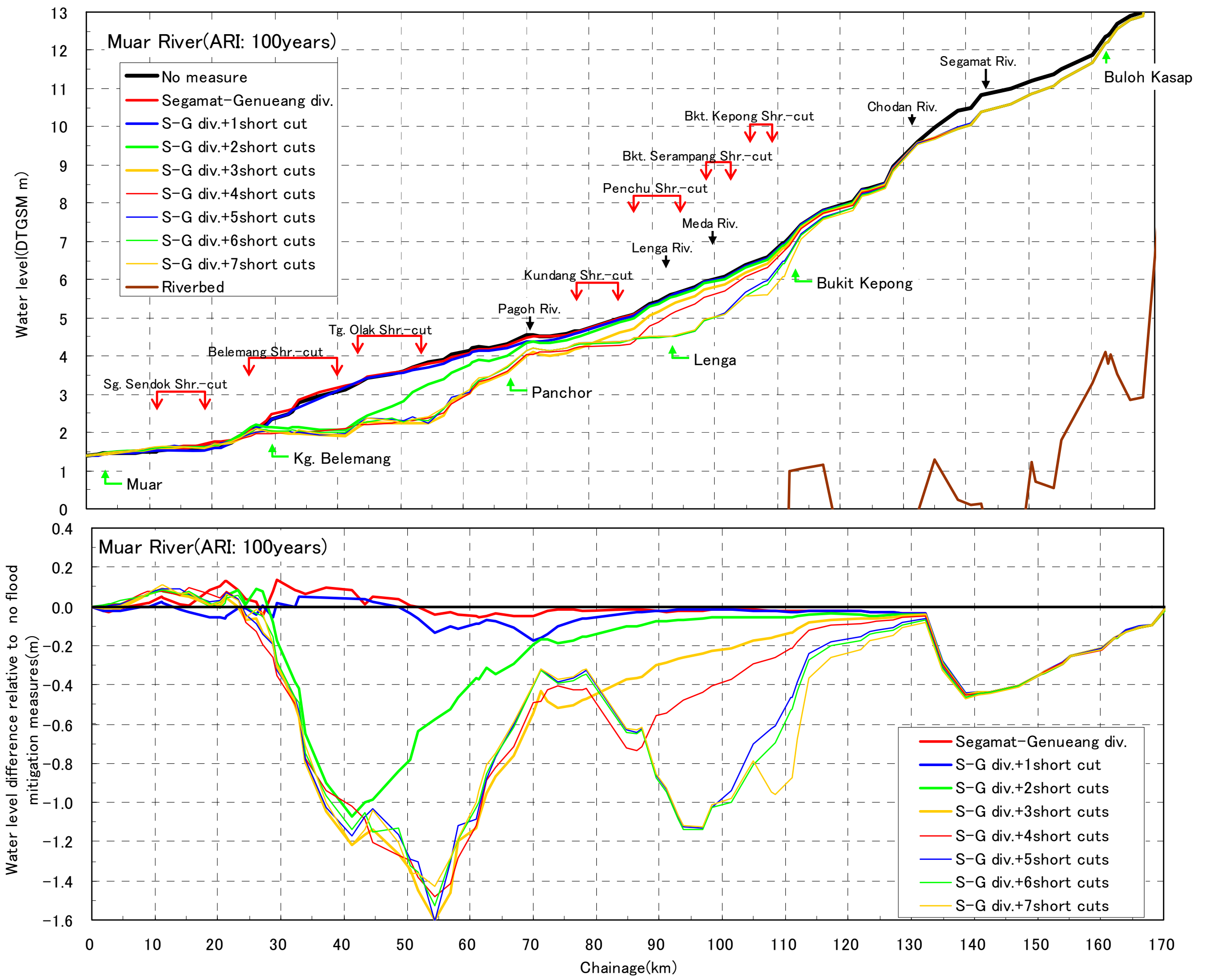


Figure 4.3.15 Water Level of Muar River and its Difference Relative to No Mitigation Measures in 100 years ARI Flood Event (Top Panel: Water level, Bottom Panel: Difference)

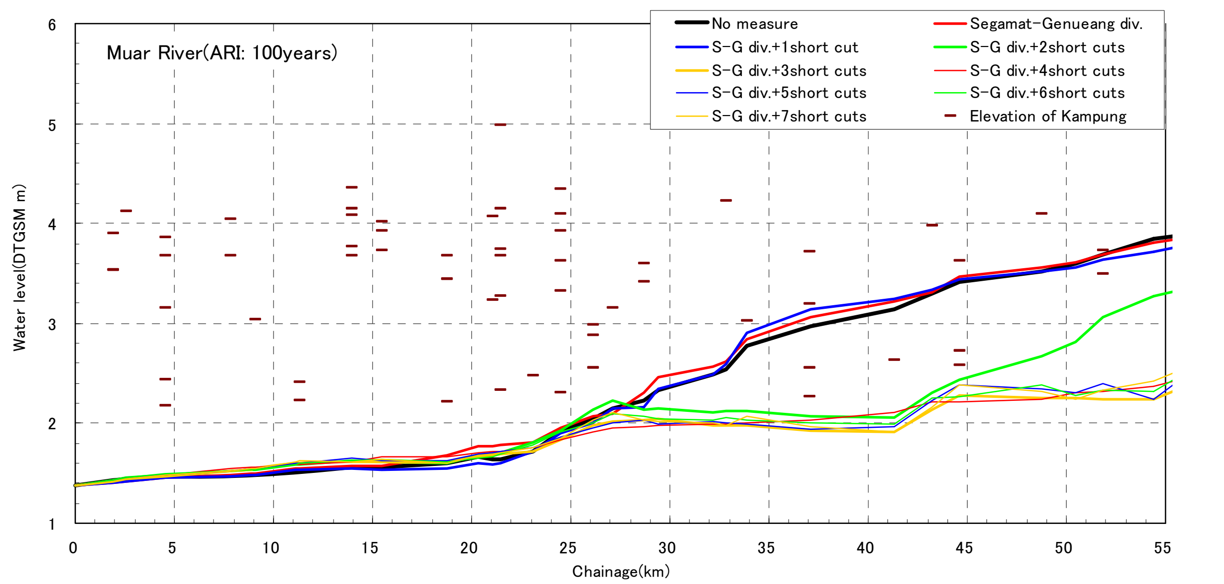


Figure 4.3.16 River Water Level of Muar River (Chainage: 0-55km) and Elevation of Kampungs along the Concerned Section

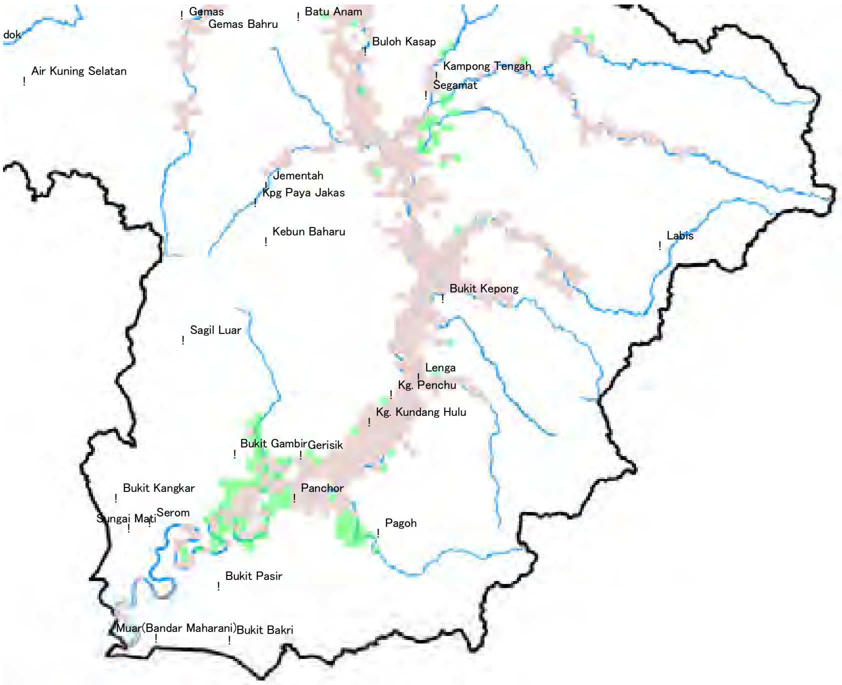
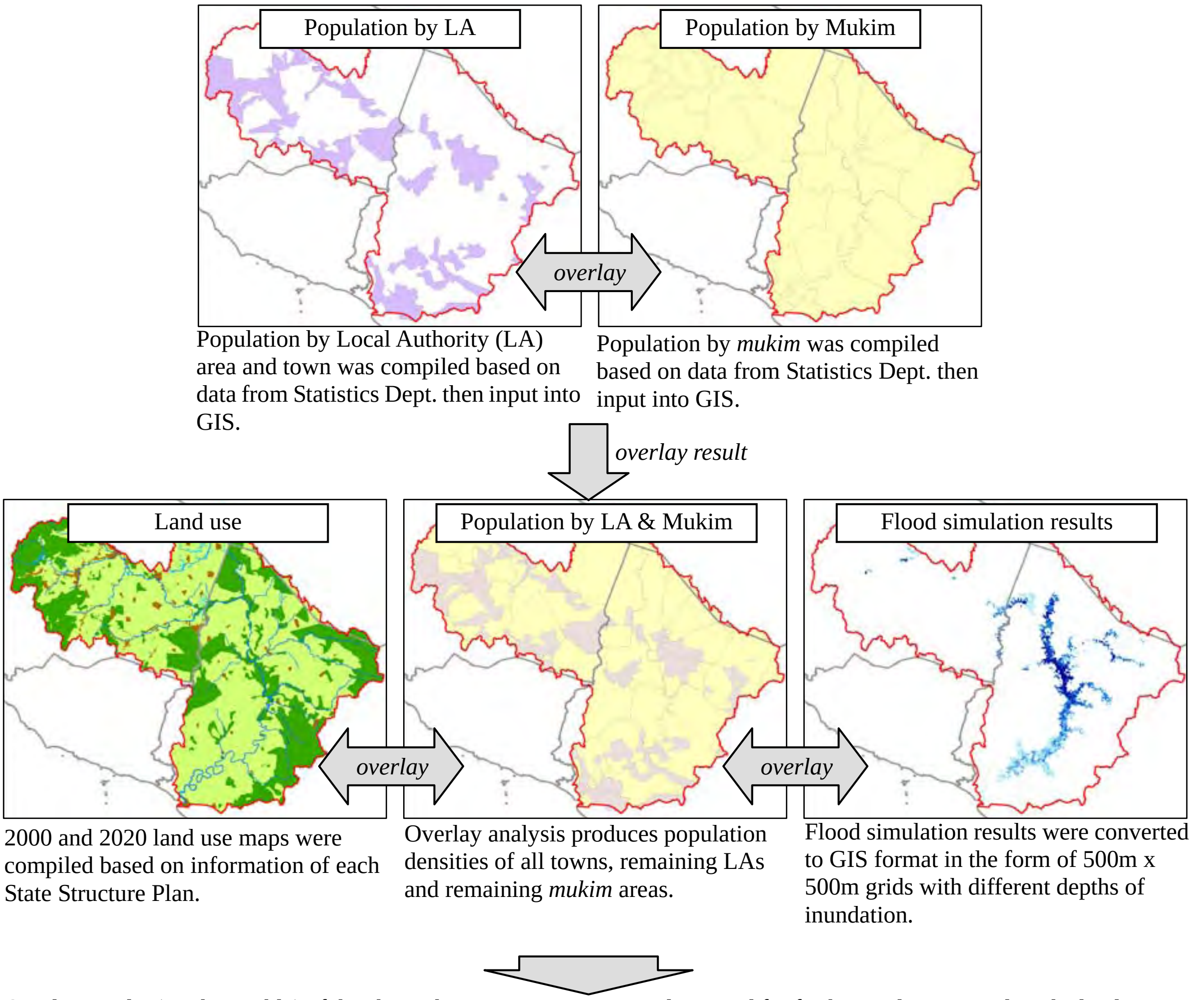


Figure 4.3.17 Simulated Flood Area by 100 years Return Period Flood Event under 2025 Condition

4.4 Methodology of Economic Analysis

4.4.1 Estimation of Flood Damage

For the estimation of flood damage, firstly it is necessary to know the land use and population of the inundation areas. In this respect, GIS (ArcView) and MS Excel were used to the analysis. The methodology is summarized in the following **Figure 4.4.1**.



Overlay results (attribute table) of the above three maps were exported to Excel for further analysis. Based on the land area and population density of each land use *polygon* and water depth (depth of inundation) for each simulation grid, total land area of each land use type by inundation depth for each simulation case can be obtained by totaling up the data as shown below.

Simulation grid no.	Land use	Area	Pop. density	Simulation Case 1					Simulation Case 2				
				Water depth	Agric	Forest	B.U.	Pop	Water depth	Agric	Forest	B.U.	Pop
1	Agriculture	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
1	Forest	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
2	Agriculture	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
2	Forest	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
2	Built up	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
3	Built up	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
4	Agriculture	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
4	Built up	xx km^2	xx/km^2	x m	xx km^2	xx km^2	xx km^2	yy	x m	xx km^2	xx km^2	xx km^2	yy
5	....	....	....	....	....	....	....	....	....	....	....	....	....
6	....	....	....	....	....	....	....	....	....	....	....	....	....
7	....	....	....	....	....	....	....	....	....	....	....	....	....
			TOTAL	**x m**	**xx km^2**	**xx km^2**	**xx km^2**	**yy**	**x m**	**xx km^2**	**xx km^2**	**xx km^2**	**yy**

Figure 4.4.1 Methodology for Estimation of Flood Affected Population and Land Uses

4.4.2 Economic Analysis

Economic analysis was conducted in following steps:

(1) Identify damage items which are likely to be incurred;
(2) Estimate unit value for each damage item;
(3) Estimate the annual average flood damages by calculating flood damages for various return periods under the “with project” and “without project” conditions;
(4) Calculate economic benefit of the project as differences in economic loss under “with project” and “without project”; and
(5) Compare the economic benefit with the cost of the projects, and evaluate its feasibility by indices such as economic internal rate of return (EIRR), net present value (NPV), and the B/C Ratio.

(1) Identification of Damage Item

Following damage items were identified considering the characteristics of Muar River Basin.

(a) Residential Areas

- Damages to domestic houses and housing movables
- Damages to livestock
- Business suspension losses of shops, restaurants, etc.
- Damages to public facilities such as roads, bridges, etc.
- Damages to public structures such as schools, public assembly halls including mosques, governmental offices etc. and their movables

(b) Agricultural Areas

- Damages to paddy
- Damages to rubber trees and production losses
- Damages to oil palm trees
- Damages to coconut trees
- Damages to other crop trees
- Damages to mixed horticultures

(2) Identification of Basic Unit of Damages

(a) Residential Areas

(i) Houses and Furniture of Domestic Households

Unit value of a domestic house was estimated to be 36,100 RM/bldg (at 2009 price) based on NWRS-1982 and the characteristics of the basin. Based on the similar projects in developing countries, value of movables in each house was estimated to be 80 % of unit value of a house. Applied damage rates by inundation depth are shown in **Table 4.4.1**.

Table 4.4.1 Damage Rates for Houses and Housing Movables

Inundation Depth (cm)	Damage Rate for House	Damage Rate for Housing Movables
Under Floor		
20 - 49	0.030	-
Below Floor		
50 - 99	0.072	0.191
100 - 199	0.109	0.331
200 - 299	0.152	0.499
Over 300	0.220	0.690

Source: The Japanese Ministry of Land, Infrastructure, Transport and Tourism Technical Criteria for River Works

Number of houses inundated was estimated by dividing the population in inundated area by the average size of the household, 4.41 persons/HH, in the basin.

(ii) Damages to Livestock

Damages to livestock were estimated by multiplying 13.8 to total damage to house and housing movables based on NWRS-1982.

(iii) Business Suspension Losses

According to NWRS-1982, business suspension loss is assumed at 3.5 times more than the total economic loss of houses and housing movables.

(iv) Damages to Public Facilities

Base on NWRS-1982, economic loss by damages to public facilities is assumed to account for 0.5 times of the total of economic losses by damage to houses, housing movables and livestock, and ones caused by business suspension losses.

(v) Damages to Public Structures

Based on NWRS-1982 and characteristics of the target river basin, unit value of public structures such as schools, public halls including mosques and governmental offices was assumed as 9,626,741 RM/bldg (at 2009 price) and value of movables and fittings is assumed to be 1.2 times of the value of building based on the similar project in developing countries. Adopted damage rates are shown in the following table. It is estimated that one public structure exists per every 5,000 residents.

Table 4.4.2 Damage Rates for Public Structures and Their Movables

Inundation Depth (cm)	Damage Rate for Buildings	Damage Rate of Movables
	Under Floor	
20 - 49	—	—
	Above Floor	
50 - 99	0.314	0.276
100 - 199	0.419	0.379
200 - 299	0.539	0.479
Over 300	0.632	0.562

Source: The Japanese Ministry of Land, Infrastructure, Transport and Tourism Technical Criteria for River Works

(b) Agricultural Areas

(i) Damages to Paddy

There are 2 types of rice farming in Malaysia, namely paddy rice and field rice, and the price range from 620 to 1,270 RM/ha for the former type and 540 to 1,010 RM/ha for the latter (at 1980 price). Unit farm gate price of 2,070 RM/ha was obtained by converting above prices into the present value and averaging them. It may be noted that unit yield of 3.4 tons/ha is considered in this price. Damage rate applied for paddy is shown in the following table. Duration of inundation is 7 days or more in all flood scale. Therefore, highlighted damage rate in the table was the adopted in this study.

Table 4.4.3 Damage Rates for Paddy

Inundation Depth (cm)	Under 50cm				50 cm - 99 cm				Over 100 cm			
Duration(days)	1 - 2	3 - 4	5 - 6	Over 7	1 - 2	3 - 4	5 - 6	Over 7	1 - 2	3 - 4	5 - 6	Over 7
Damage Rate (%)	21.00%	30.00%	36.00%	50.00%	24.00%	44.00%	50.00%	71.00%	37.00%	54.00%	64.00%	74.00%

Source: The Japanese Ministry of Land, Infrastructure,Transport and Tourism Technical Criteria for River Works

(ii) Damages to Rubber Trees and Production Loss

Based on NWRS-1982, only young trees below the age of three are withered due to inundation, and it is assumed that 3% of rubber trees in the plantation will be replaced with new trees every year. Therefore, 9%of the trees in plantation are not tolerant to flood events. Cost for planting new rubber trees to replace damaged ones is 6,931 RM/ha at 2009 price, and mortality rate of them by inundation is shown in the following table.

Table 4.4.4 Damage Rates for Rubber

Duration (days)	Inundation Depth(cm)	Damage Rate (%)
7	25	5
14	25	15
21	25	60
28	25	100

The amount of rubber that could be collected from plantation per day is 9.47 kg/ha, based on NWRS-1982, and suspension period was estimated to be 50% of inundation period. Farm gate price of rubber is assumed to be 6.57 RM/kg at 2009 price.

(iii) Damages to Oil Palm Trees

9% of the trees are below age of three which are vulnerable to inundation. Cost for planting new oil palm trees to replace damaged ones is 4,693 RM/ha at 2009 price, and mortality rate of oil palm is shown in the following table.

Table 4.4.5 Damage Rates for Palms

Duration (days)	Inundation Depth(cm)	Damage Rate (%)
7	25	10
14	25	20
21	25	70
28	25	100

(iv) Damages to Coconut Trees

Based on NWRS-1982, only young trees below the age of three are withered due to inundation, and it is assumed that 2% of coconut trees in the plantation are replaced with new trees every year. Therefore, 6%of the trees in plantation are not tolerant to flood events. Cost for planting new rubber trees to replace damaged ones is RM 8,279/ha at 2009 price, and mortality rate of them by inundation is shown in the following table. The damage rate of oil palm is applied for coconut trees as well.

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(v) Damages to the Other Crop Trees

Based on NWRS-1982, only young trees below the age of three are withered due to inundation, and it is assumed that 10% of the trees in plantation is below this age. The cost to replace damaged crop trees with new young trees is 8,520 RM/ha at 2009 price. Mortality rate is shown in the following table.

Table 4.4.6 Damage Rates for Other Crop Trees

Duration (days)	Inundation Depth(cm)	Damage Rate (%)
4	25	10
8	25	25
12	25	60
16	25	100

(vi) Damages to the Mixed Horticulture

Cost for planting new trees to replace withered ones below the age of 3 years due to inundation is assumed to be RM 6,979 /ha at 2009 price based on NWRS-1982. Damage rates applied are shown in the following table.

Table 4.4.7 Damage Rates for Horticulture

Duration (days)	Damage Rate (%)
4	10
8	25
12	50
16	75
20	100

Basic units of flood damages were obtained as following two tables as a result of above estimations. Anticipated benefit derived from improvement of the living condition by flood management measures were estimated and added in the table as well. The benefit is estimated to be 60 % of the total amount of damages to domestic houses and movables, livestock, public facilities and business suspension losses.

Table 4.4.8 Basic Unit of Damages in Built Up Areas

(RM/House or building As of 2009)

Inundation Depth (cm)		Basic Unit of Damages					Basic Unit of Indirect Damages and Benefit						Damages to Public Structures		
		Damages to Houses			Damages to Livestock		Business Suspension Losses		Damages to Public Facilities		Land Value Increased				
		Houses	Mova-bles	Sub-total	Amount	Accumu-lated	Amount	Accumu-lated	Amount	Accumu-lated	Amount	Accumu-lated	Structure	Movables	Total
Under Floor		1,083	—	1,083	—	1,083	—	1,083	542	1,625	975	2,599	—	—	—
Above Floor	50 - 99	2,599	2,079	4,679	64,544	69,222	16,375	85,597	42,799	128,396	77,038	205,434	3,022,797	1,001,150	4,023,947
	100 - 199	3,935	3,148	7,083	97,712	104,795	24,790	129,585	64,792	194,377	116,626	311,004	4,033,604	1,834,483	5,868,088
	200 - 299	5,487	4,390	9,877	136,259	146,136	34,570	180,706	90,353	271,058	162,635	433,694	5,188,813	2,982,530	8,171,343
	Over 300	7,942	6,354	14,296	197,217	211,513	50,035	261,548	130,774	392,321	235,393	627,714	6,084,100	4,103,117	10,187,218

Table 4.4.9 Basic Unit of Damages to Paddy and Other Crops

I. At Present Condition

(a) Paddy

Duration	Inundation Depth (m)	Basic Unit of Damages (RM/ha)	Weighted Average by Planted Area (RM/ha)
Over 7 Days	0.10 - 0.20	1,035	274
	0.20 - 0.50	1,035	274
	0.50 - 1.00	1,470	389
	1.00 - 1.50	1,532	405
	1.50 - 2.00	1,532	405
	2.00 - 3.00	1,532	405
	3.00 - 4.00	1,532	405
	Over 4.00	1,532	405

(b) Crops Other than Paddy

Return Period (year)	Duration (days)	Basic Unit of Damages (RM/ha)							Weighted Average by Planted Area (RM/ha)
		Rubber			Oil Palm	Coconuts Palms	Other Tree Crops	Horti-culture	
		Mortality	Product-ion Loss	Total	Mortality	Mortality	Mortality	Mortality	
2	9	94	280	374	47	99	511	2,617	556
5	11	94	342	436	86	99	511	2,617	583
10	12	94	373	467	105	99	511	2,617	597
20	13	94	404	498	124	99	852	3,926	809
50	15	374	467	841	163	348	852	3,926	974
100	16	374	498	872	182	348	852	3,926	988

II. At Future Condition in 2025

(c) Paddy

Duration	Inundation Depth (m)	Basic Unit of Damages by Inundation Depth (RM/ha)	Weighted Average by Planted Area (RM/ha)
Over 7 Days	0.10 - 0.20	1,035	274
	0.20 - 0.50	1,035	274
	0.50 - 1.00	1,470	389
	1.00 - 1.50	1,532	405
	1.50 - 2.00	1,532	405
	2.00 - 3.00	1,532	405
	3.00 - 4.00	1,532	405
	Over 4.00	1,532	405

(d) Crops Other than Paddy

Return Period (year)	Duration (days)	Basic Unit of Damages							Weighted Average by Planted Area (RM/ha)
		Rubber			Oil Palm	Coconuts Palms	Other Tree Crops	Horti-culture	
		Mortality	Product-ion Loss	Total	Mortality	Mortality	Mortality	Mortality	
2	9	94	311	405	84	99	213	1,309	373
5	11	94	342	436	84	99	213	1,309	386
10	12	94	404	498	84	99	511	2,617	608
20	13	94	436	529	296	348	511	3,926	852
50	15	374	498	872	296	348	852	3,926	995
100	16	374	529	903	296	348	852	3,926	1,008

The share rates of planted area by crops based on NWRS-1982 are as shown in the following table.

Table 4.4.10 Share Rate of Planted Area by Crops

Crops	Share Rate
Mixed Horticulture	14.64%
Rubber	39.99%
Oil palm	6.84%
Coconuts	10.17%
Other Tree Crops	1.90%
Paddy	26.46%
Total	100.00%

(3) Identification of Annual Average Flood Damage Reduction

Expected annual average flood damage reduction (may be converted into “Economic Benefit”) under occurance of 100years ARIreturn were estimated by using the above mentioned basic units and flood simulation result mentioned in the previous section.

Table 4.4.11 Annual Average Mitigated Flood Damages to Be Expected

(1,000 RM)

Projects	Amount
Segamat-Genuang Diversion	23,102
+ Sendok Channel Bypass	23,228
+ Belemang	31,071
+ Olak	36,377
+ Kundang Ulu	37,539
+ Penchu	39,660
+ Bukit Serampang	39,991
+ Bukit Kepong	40,351

4.5 Climate Change Impact Assessment on Water Resources

4.5.1 Introduction

There are concerns on possible degradation of river ecosystem or decrease in amount of available water resources as a result of the change in rainfall patter due to climate change. In this section, preliminary assessment of possible climate change impact on water resources in Muar River Basin was conducted based on impact analyses presented in the previous chapter.

First, tank model was developed in order to simulate long-term runoff in the Muar River Basin. Then, runoff simulation was conducted under the current and future condition. The simulation results was analyzed to assess the climate change impact on water resources.

4.5.2 Development of Long-term Runoff Model

(1) Sub-basins

Since observed data is indispensable to determine the parameters required in the tank model, Muar River Basin was divided in to three sub-basins as in **Figure 4.5.1** based on the location of gauging stations where reliable discharge data are available. Sub-basins are Muar(1), Segamat and Muar(2).

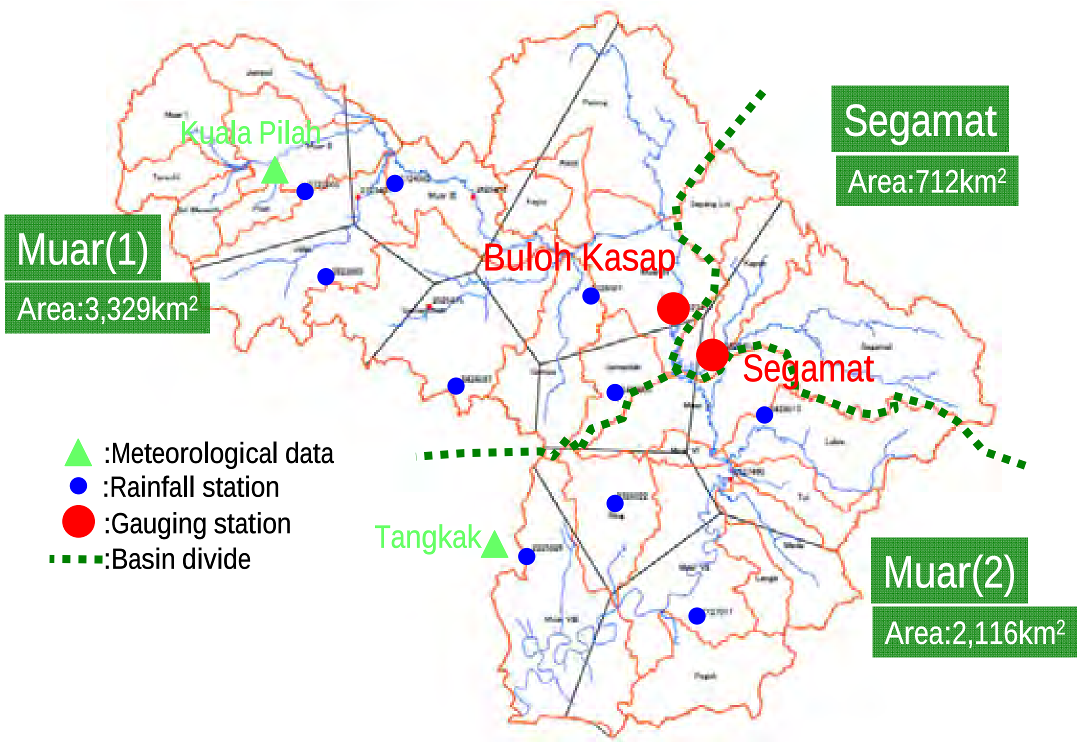


Figure 4.5.1 Sub-basins for Long-term Runoff Model

(2) Rainfall and Evapotranspiration

Rainfall and Evapotranspiration are two input data to the tank model. Amount of rainfall for respective sub-basin were obtained based on observed data using the Thiessen polygon as shown in **Figure 4.5.1**.

Potential evapotranspiration was estimated by FAO Penman-Monteith Method following the DID manual. The equation is given by:

$$ET_0 = \frac{0.048\Delta(R_n - G) + \gamma \dfrac{900}{T + 273r_a} u_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)}$$

where ET_0 is reference evapotranspiration (mm/day), R_n is net radiation (MJ/m2/day), G is soil heat flux (MJ/m2/day), T is mean daily air temperature at 2m height (^oC), u_2 is wind speed at 2m height (m/s), e_s is saturation vapor pressure (kPa), e_a is actual vapor pressure (kPa), Δ is slope vapour pressure curve, and γ is psychometric constant (kPa/ ^oC).

Meteorological data used to estimate ET_0 are tabulated in the following table. Location of meteorological stations could be found in **Figure 4.5.1**.

Table 4.5.1 Meteorological Data Used to Estimate Evapotranspiration

Sub-Basin	Temperature (month average, maximum and minimum)	Relative Humidity (month average)	Wind Speed (month average)	Solar Radiation (month average)
Muar(1)	Kuala Pilah		Malacca	Malacca
Segamat	Tangkak		Malacca	Malacca
Muar(2)	Tangkak		Malacca	Malacca

(3) Water Intake Data

Total monthly water intake of 2004 to 2008 from each sub-basin are shown in **Figure 4.5.2** which were obtained by accumulating actual amount of intake at irrigation schemes and water treatment plants within respective sub-basin. Location of irrigation intakes and treatment plants are shown in **Figure 4.5.3**. Intake amount were deducted from the calculated runoff discharge of each sub-basin.

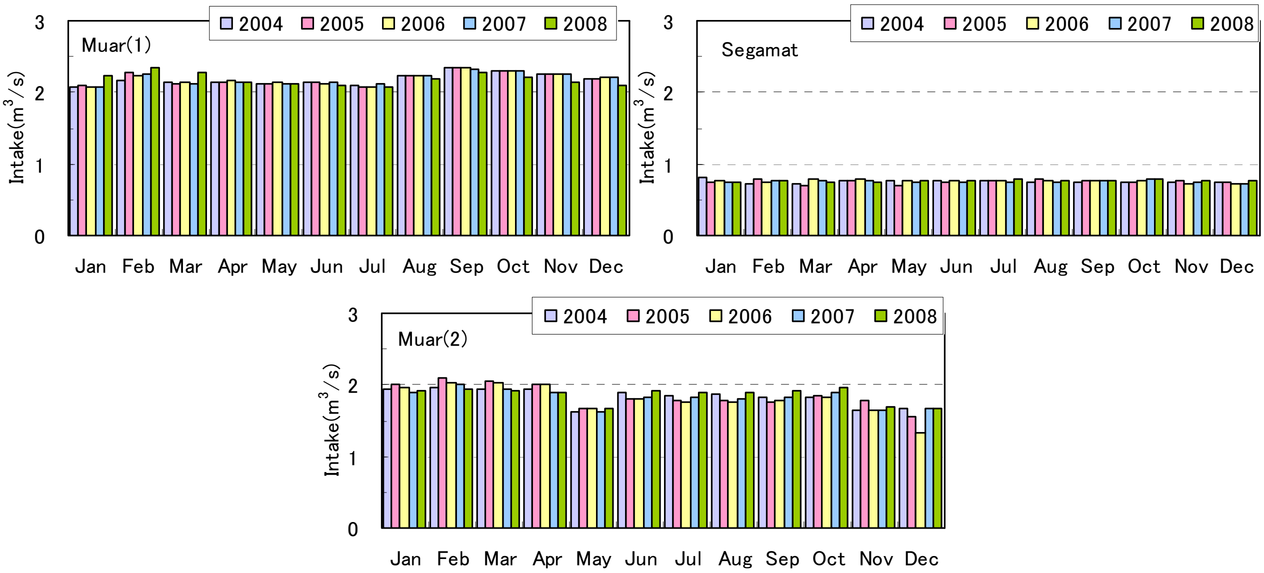


Figure 4.5.2 Total Intake in Sub-basins

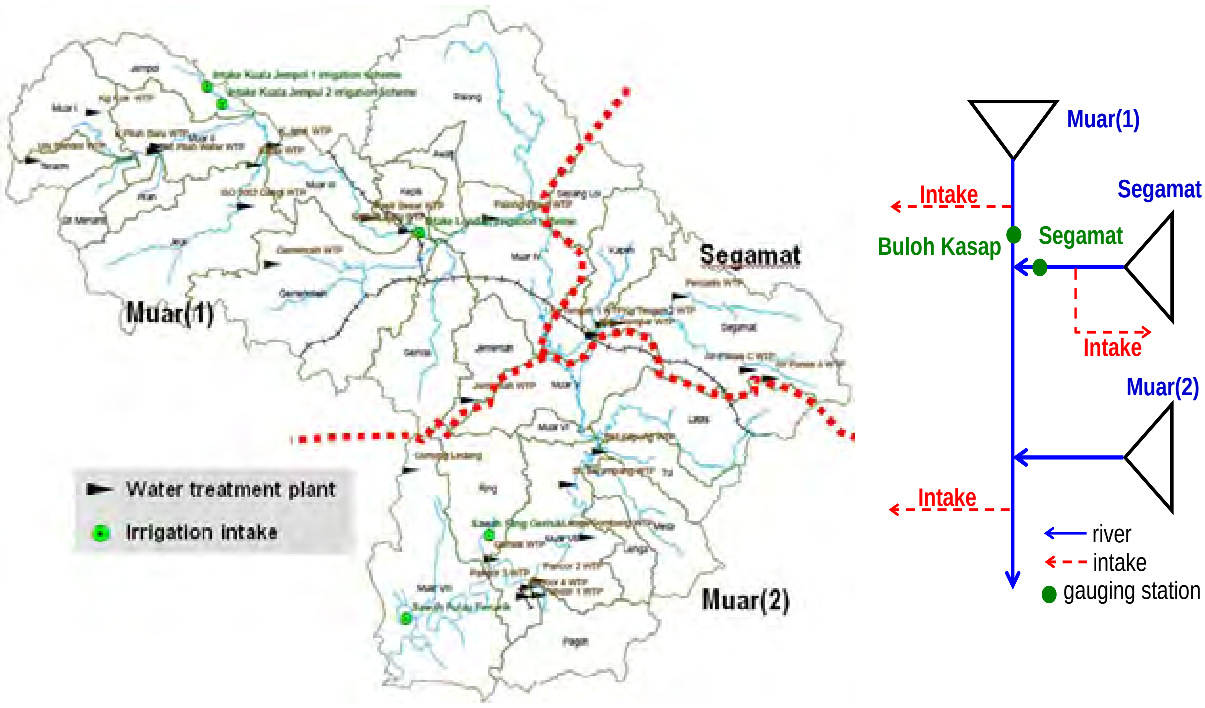
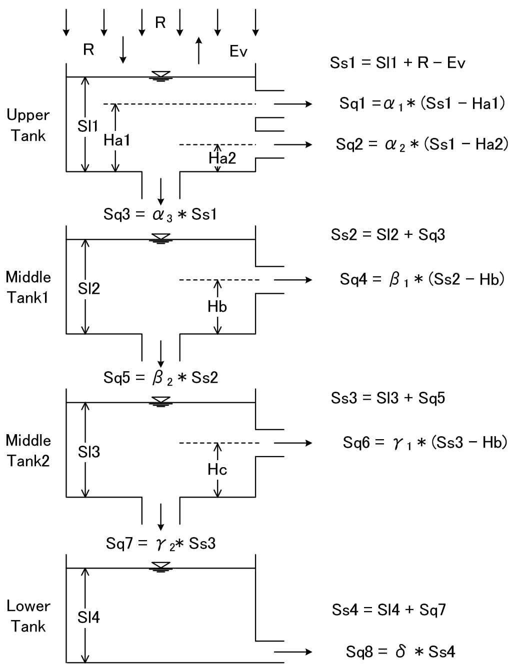


Figure 4.5.3 Irrigation Intake and Treatment Plant in Muar River Basin

(4) Tank Model Parameters and Their Verification

Four-layer tank model was introduced to simulate time lag between occurrence of rainfall and runoff in Muar River Basin in appropriate manner. The model parameters were fixed through trial processes and are tabulated in **Figure 4.5.4**.



Parameters

	Muar(1)	Segamat	Muar(2)
α_1	0.4	0.175	0.4
α_2	0.15	0.05	0.15
α_3	0.065	0.225	0.065
β_1	0.09	0.08	0.09
β_2	0.017	0.04	0.017
γ_1	0.05	0.012	0.05
γ_2	0.0025	0.0105	0.0025
δ	0.00025	0.002	0.00025

Initial condition

	Muar(1)	Segamat	Muar(2)
Ha1(mm)	30	50	30
Ha2(mm)	20	5	20
Sl1(mm)	30	10	30
Hb(mm)	10	30	10
Sl2(mm)	15	30	15
Hc(mm)	26	10	26
Sl3(mm)	27	70	27
Sl4(mm)	300	400	300

Figure 4.5.4 Schematic View of the Tank Model and Its Parameters

Figure 4.5.5 shows simulated and observed discharge of 2006-2008 at Buloh Kasap and Segamat. The figure tells us that the simulation result agrees well with the observed data and the model parameters are appropriate.

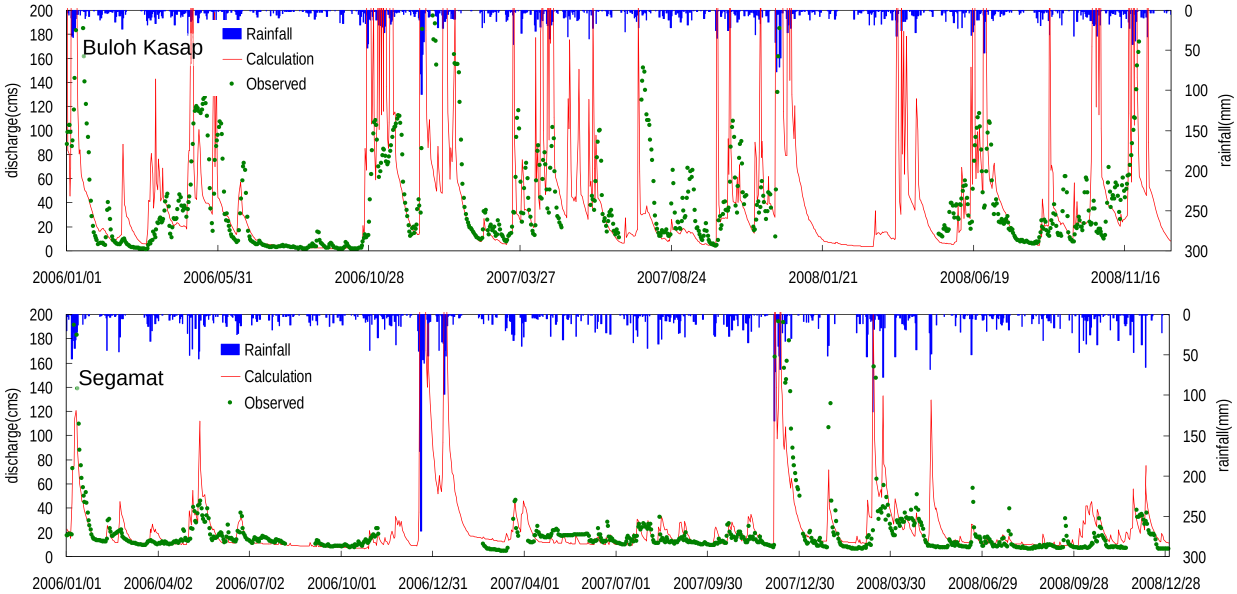


Figure 4.5.5 Model Verification: Observed and Simulated Discharge (Top panel: Buloh Kasap, Bottom panel: Segamat)

4.5.3 Climate Change Impact on Water Resources

In this section, above mentioned model were used to conduct long-term runoff simulation under the current and future condition (2025 and 2050). Then, the results under future conditions are compared with the one under the current condition to assess the possible climate change impact.

(1) Simulation Condition

Two simulation inputs, namely rainfall and evapotranspiration, of the long-term (10years) runoff analysis were obtained based on meteorological data of 1999-2008. That is to say, observed rainfall data of 1999-2008 and potential evapotranspiration obtained from observed meteorological data of the same period were the input to runoff simulation under current condition. For the future simulation cases incremental ratio of respective month obtained in **Chapter3** was multiplied to rainfall and potential evapotranspiration used for that of the current condition. Intake data were based on the current amount extracted from the river as the national water resources plan is currently under review to be updated and it was not possible to foresee future water demand at this point. Therefore, this projection enables to highlight the impact of climate change. It is noted that for years of which intake data is not available, those of the next year were be applied. This seems to be reasonable assumption since amount of intake does not vary much by year as seen in **Figure 4.5.2**.

Incremental ratios are tabulated in **Table 4.5.2**, and basin average monthly rainfall and evapotranspiration are shown in **Figure 4.5.6**.

Table 4.5.2 Incremental Ratio Relative to 1990

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Precipitation	2025	1.26	0.91	0.97	1.02	1.08	1.05	0.85	1.20	0.91	1.06	1.05	1.09
	2050	1.15	0.90	0.95	1.08	1.13	1.12	0.91	1.16	1.02	1.08	1.02	1.02
Evapo-transpiration	2025	1.06	1.05	0.99	1.02	1.01	1.00	0.93	1.06	0.96	1.01	1.04	1.05
	2050	1.05	1.02	0.98	1.04	1.04	1.00	0.99	1.03	1.03	1.03	1.04	1.02

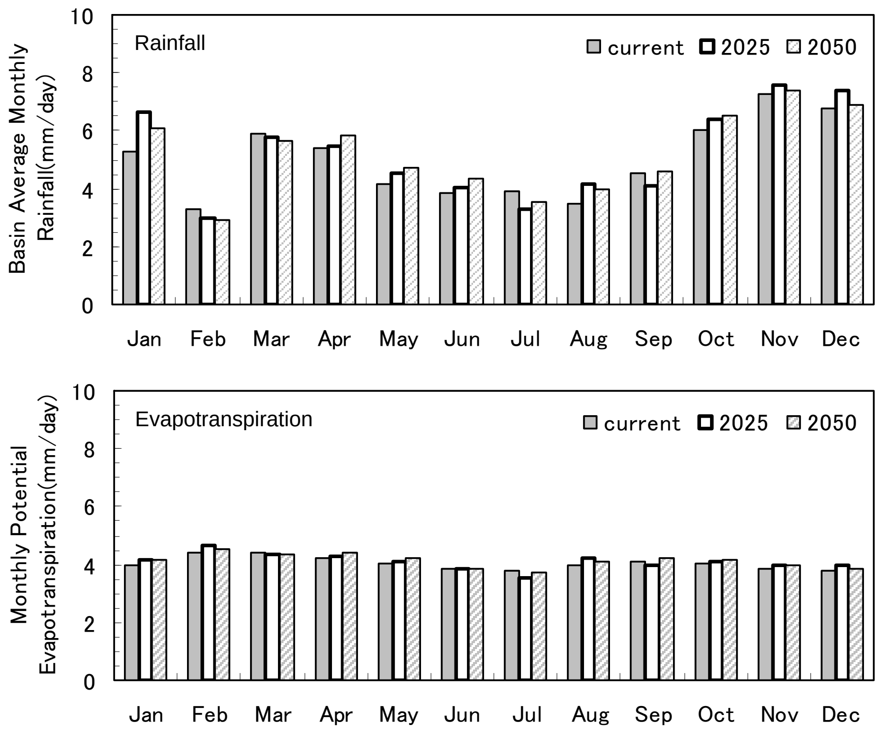


Figure 4.5.6 Average Monthly Rainfall and Evapotranspiration obtained based on Meteorological data of 1999-2008(Top Panel: Basin Average Rainfall, Bottom Panel: Potential Evapotranspiration)

(2) Simulation Result

Figure 4.5.7 and **Figure 4.5.8** shows 10 year simulation results of discharge under the current and future conditions. **Figure 4.5.8** tells us that annual average discharge is projected to increase in the future. However, no significant change could be seen between discharge of 2025 and 2050. Average monthly discharge of February, March and July are projected to decrease relative to the current condition.

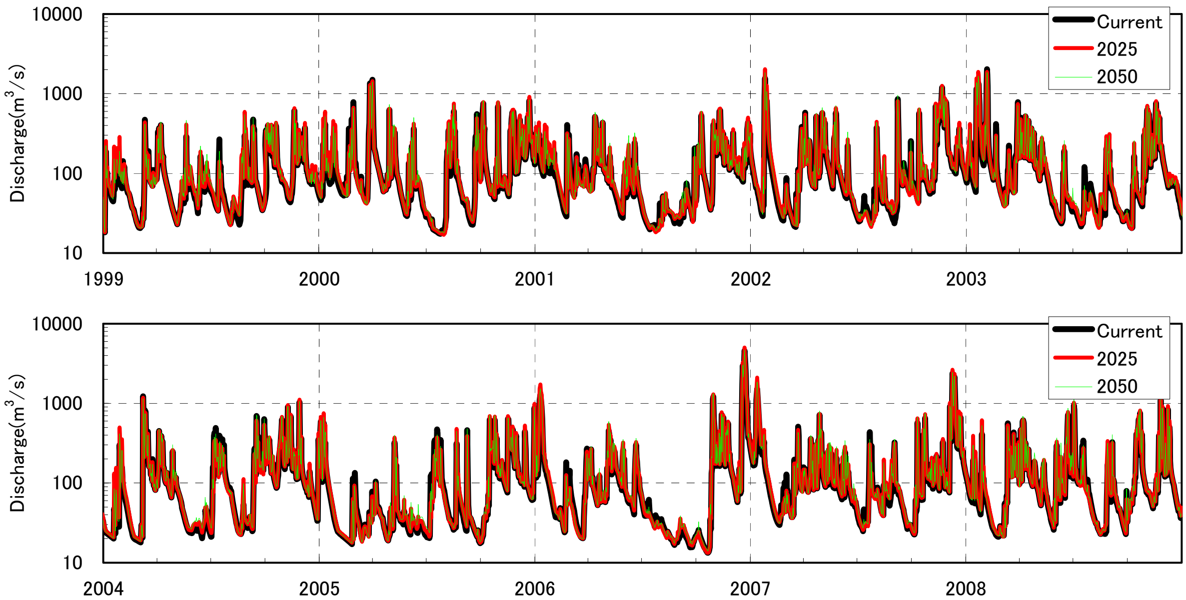


Figure 4.5.7 Temporal Plot of Simulated Daily Discharge at the River Mouth

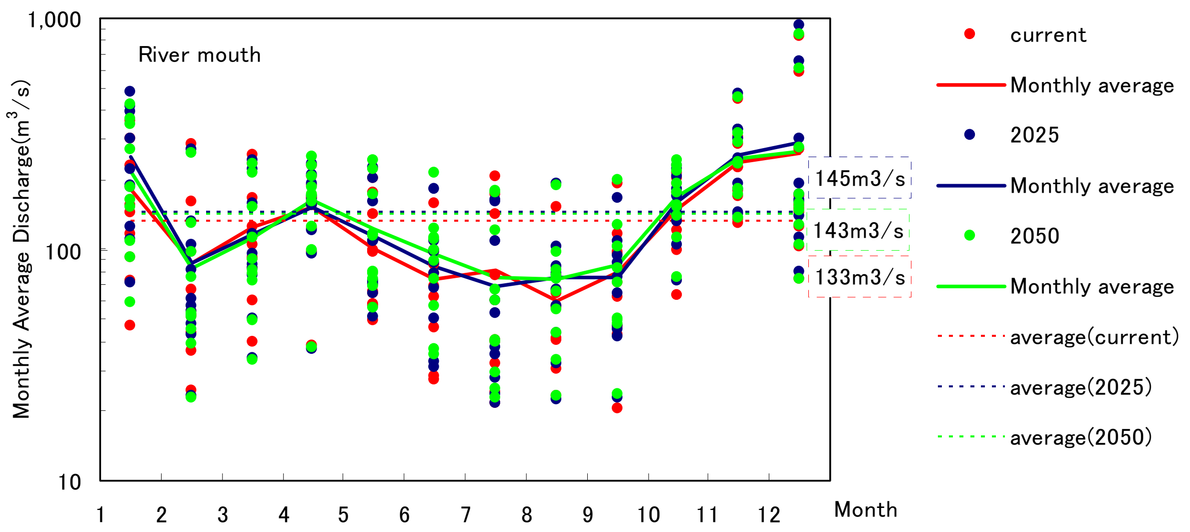


Figure 4.5.8 Average Monthly Discharge

Table 4.5.3 shows annual average, and maximum and minimum monthly discharge obtained from 10years simulation. Figures in the table indicate increase in annual mean discharge. They also indicate that hydrological extremes may magnify in the future; increase of maximum monthly discharge. However, as seen in **Table 3.4.6** and **Figure 3.4.6**, projected magnitude of the future precipitation and evapotranspiration increase/ decrease vary model to model, and uncertainties lie in river flow projected in this section. Therefore, river flow should be carefully monitored to cope with unforeseen changes.

Table 4.5.3 Annual Average, and Monthly Maximum and Minimum Discharge at the River Mouth obtained from 10 years Simulation

(m^3/s)

Annual Mean Discharge			Maximum Monthly Discharge			Minimum Monthly Discharge		
current	2025	2050	current	2025	2050	current	2025	2050
133	145	143	839	923	856	20	22	23

(3) Impact Assessment

(a) Flow Duration

The climate change impact was assessed by change in the number of days during which river discharge falls below environmental flow obtained under the current. 20 and 40% of annual average flow (AAF), which corresponds to “good” and “outstanding” flow defined in Tennant Method, were used as indexes for assessing the change in river flow regime.

Table 4.5.4 Environmental Flow Defined in Tennant Method

Narrative description of general condition of flow for maintaining aquatic habitat	Recommended flow regime (% of AAF)
Flushing or maximum	200
Optimum range	60-100
Outstanding	40
Excellent	30
Good	20
Fair or degrading	10
Poor or minimum	10
Severe degradation	<10

Figure 4.5.9 is flow duration curve developed based on 10year runoff simulation under the current and future condition. Horizontal axis of the figure indicates number of days which exceed specific discharge per year. Therefore, arrowed periods shown in the figure indicate number of days with discharge below 20 and 40 % of AAF. **Figure 4.5.10** is number of days with discharge below 20 and 40% of current AAF.

These figures tell us that the base flow is projected to slightly increase, and number of days with discharge below "good" and "outstanding" flow will also slightly decrease in the future. This could be an indication that there will be no severe negative impact by climate change to the river discharge volume of the Muar River at least.

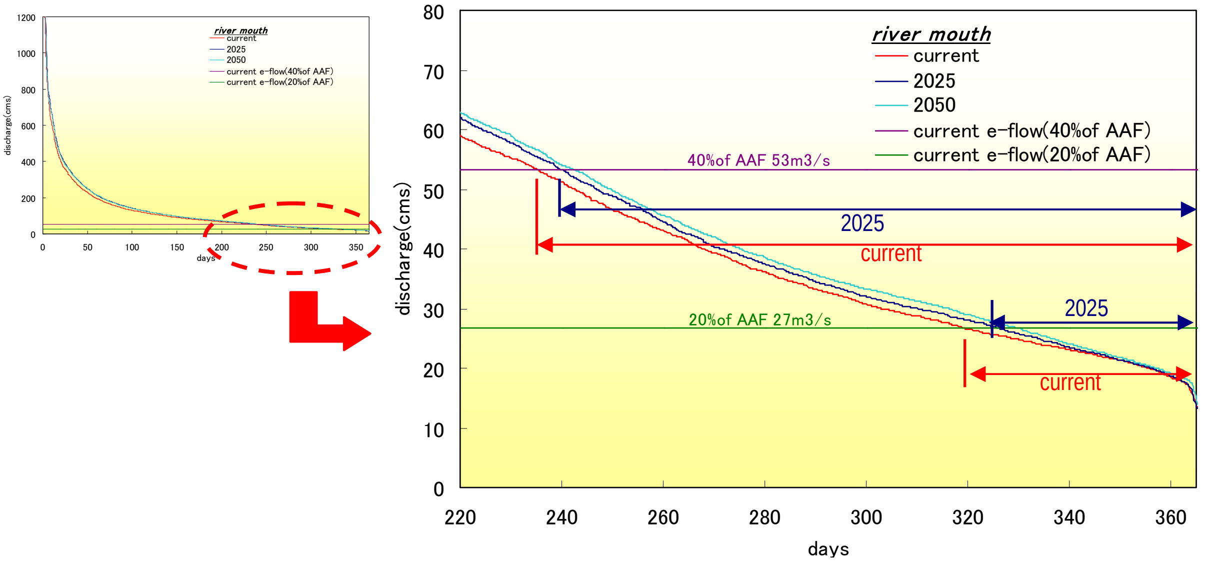


Figure 4.5.9 Flow Duration Curve

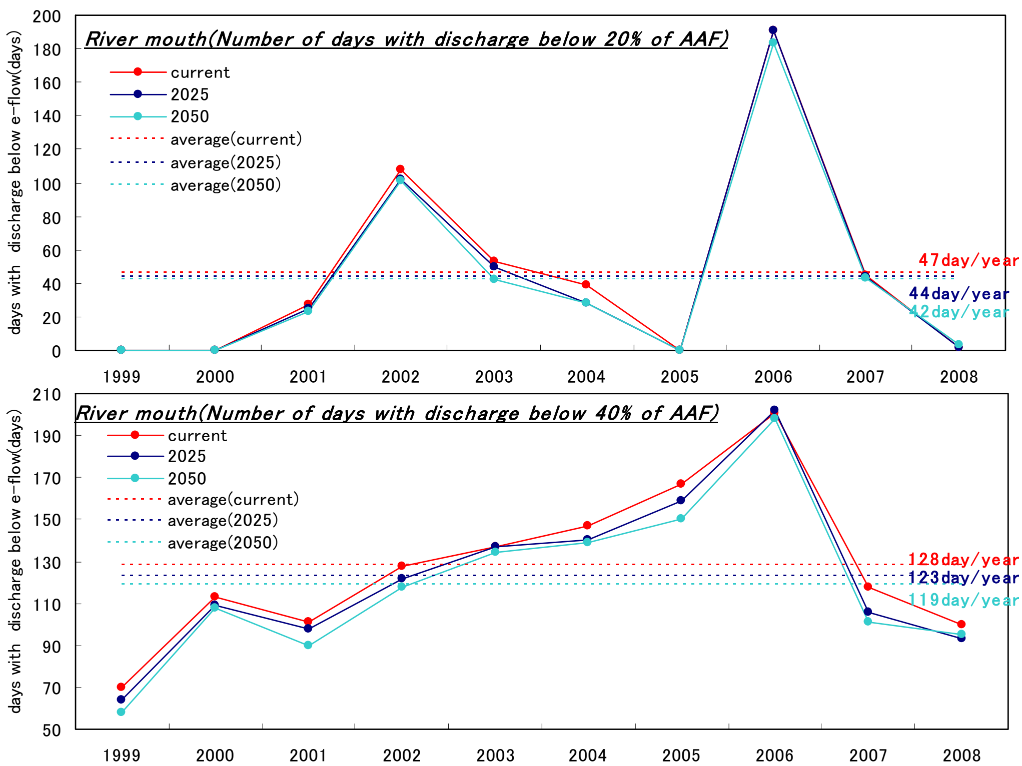


Figure 4.5.10 Number of Days with Discharge below "Good" Flow (Top panel) and "Outstanding" Flow (Bottom panel)

(b) Water Balance

Figure 4.5.11 shows annual water balance based on above simulation results. Diagram on the left shows annual water budget of Muar River Basin, and one on the right explains water budget in more detail.

As seen in the figure, amount of available water resources is projected to increase by 8% and 7% by 2025 and 2050 relative to current condition. The figure also tells us that total amount of water intake in Muar River Basin is small with 3 % of its natural discharge.

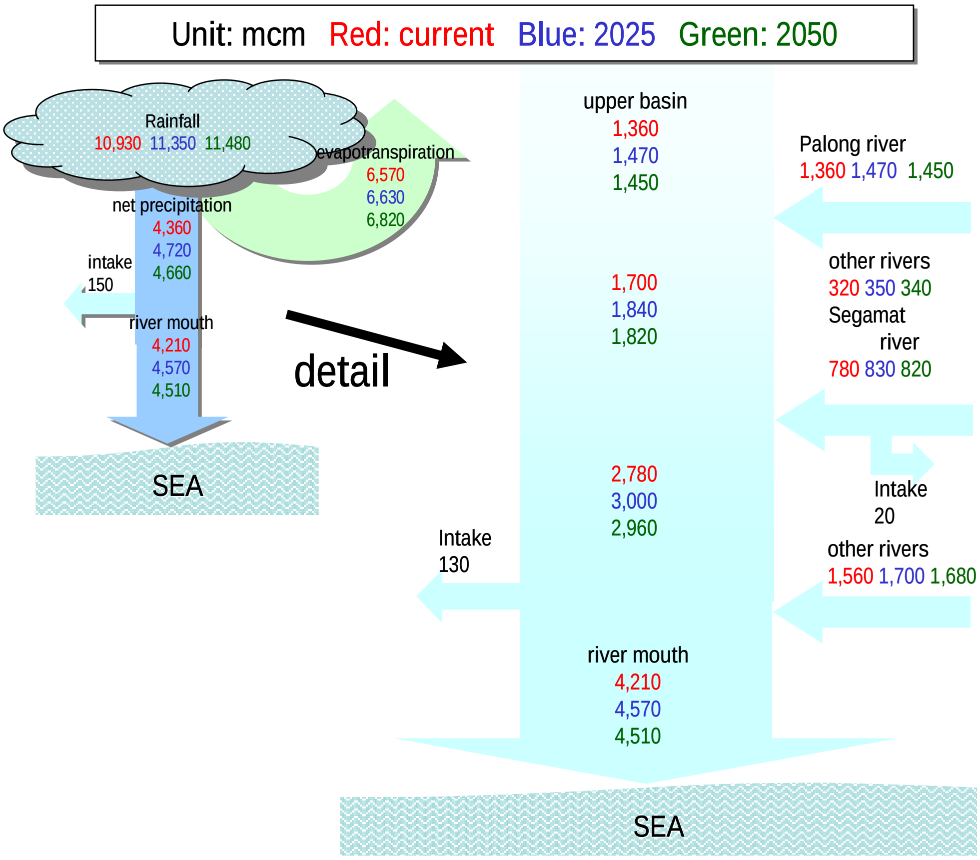


Figure 4.5.11 Annual Water Budget of Muar River Basin

CHAPTER 5 PREPARATION OF IRBM PLAN

5.1 Basic Conditions for Preparation of IRBM Plan

5.1.1 Objectives of IRBM Plan

The objective of the IRBM Plan is proposed as follows:

Objective: to provide a road map for realization of sustainable management of land and water in the Muar River Basin, focusing on water utilization, river environment and flood management.

5.1.2 Target Year of IRBM Plan

The planning term is a period within which projects and actions are planned so as to be implemented and completed. The target completion year is the end of the planning term.

Table 5.1.1 presents planning terms of past master plan studies on flood mitigation, water resources management and river basin management. Except for National Water Resources Study 2000-2050, the planning terms are between 15 and 18 years. Following the past practices, it is suggested that the planning term of the IRBM and IFM plans of the Preparatory Survey be 15 years from 2011 to 2025. In this way the proposed IRBM and IFM plans covers the planning terms of the 10^{th}, 11^{th} and 12^{th} Malaysia Plans.

Table 5.1.1 Planning Terms of Past Similar Studies

Name of Study	Planning term	Target completion year
National Water Resources Study, October 1982	18 years	2000
Comprehensive Management of Muda River Basin, December 1995	15 years	2010
National Water Resources Study 2000-2050, March 2000	50 years	2050
Sungai Langat Integrated River Bain Management Study, August 2005	15 years	2020
Master Plan Study on Flood Mitigation and River Management for Bernam River Basin, January 2005	16 years	2020

5.2 Identification of Issues for IRBM

5.2.1 Water Utilization

The Muar River Basin is also rich in water resources, although it is not as rich as the Pahang River Basin. The river water in the Muar River Basin has been utilized for a variety of activities, such as domestic and industrial water supply, irrigation supply, fishery, navigation, and so on, since old times as explained in **Section 2.5.**

Issues of water utilization in the Muar River Basin in relation to integrated river basin management (IRBM) can be summarized in **Table 5.2.1**.

Table 5.2.1 Summary of Major Water Utilization Issues in relation to IRBM

Subject	Issues	Responsible Agency	Major Governing Law
Institution	• Due to lack of inter-agency and inter-state coordination, the river basin management is far from integrated one.		
	• The river is improperly managed due to poor technical capacity of Land Office and poor legislative capacity of DID.	Land Office, DID	Land Code
Water Quantity management	• There is a possibility that surface water resources will be affected by Climate Change.	BKSA, DID	Waters Enactment
	• There are some districts in the Muar River Basin of which domestic and industry water supply facility capacities are insufficient to future water demands.	KeTTHA, JBA, SAINS, BKSA, SPAN, PAAB, DID	Waters Enactment NWRC Act SPAN Act

	• Environmental flow has been hardly considered in the water resources development plans.	BKSA, JPS, DOE	
	• There is no alternative water source to surface water.	JMG, BKSA, BAKAJ	Geological Survey Act
Water Supply Services	• Restructuring of water supply industry has been delayed.	KeTTHA, JBA, SAINS, BKSA, SPAN	NWRC Act SPAN Act
	• NRW rates are as high as 53.1 % in Negeri Sembilan State and 31.3 % in Johor State.	JBA, SAINS, PAAB	
Irrigation Water Supply	• Irrigation water supply is sometimes unstable due to insufficient maintenance of irrigation canals.	JPS	
Navigation	• Navigation is disturbed by garbage.		

(1) Institution

For the regulation of water utilization, various agencies in both Federal and State levels as shown in Table 5.2.2.

Table 5.2.2 Distribution of Authority for Water Utilization

	Responsible Agency	Relevant Legislative
Regulation of Water Services on:		
- Irrigation/Agriculture	DID	Irrigation Areas Act 1953
- Domestic/Industrial	SPAN, WAMCO and Operators	National Water Services Commission Act 2006, Water Services Industry Act 2006
- Hydropower	KeTTHA and TNB	Electricity Supply Act 1990
- Groundwater	JMG	Geological Survey Act 1974, National Land Code 1965
Regulation on Water Abstraction	BKSA	State Water Enactment
Regulation of River Activity:		
- Fishery/Aquaculture	DOFi	Fisheries Act 1985
- Inland Navigation	DOFi	The Merchant Shipping Ordinance 1952, The Port Authorities Act 1963
Permission of River Infrastructure	LO, DID and Local Authority	Waters Act 1920, Local Government Act 1976

SPAN: National Water Services Commission (*Suruhanjaya Perkhidmatan Air Negara*)
BKSA: State Water Regulatory Body (*Badan Kawalselia Air*) in Negeri Sembilan and Johor States
WSD: Water Supply Department
WAMCO: Water Asset Management Company
KeTTHA: Ministry of Energy, Green Technology and Water
TNB: Tenaga Nasional Berhad
JMG: Minerals and Geoscience Department
DOFi: Department of Fishery
LO: Land Office

Regulation of water services is responsible under several agencies, such as DID for irrigation, SPAN for domestic and industrial water supply and public sewerage services, KeTTHA for hydropower, and JMG for groundwater. Diversion and abstraction of water from rivers is prohibited except when licensed by State Water Regulatory Body (BKSA) in the state. Each agency plays a key role for regulation and monitoring of water use. However, due to the lack of inter-agency coordination, each above agency conducts the water regulation and management independently based on their own policies and strategies. Moreover, because the interstate coordination on river basin management among the concerned states in the river basin has not been well organized, the water allocation control from upstream to downstream has not been coordinated in the basin level.

Issuance of permission for land use including river area is under the jurisdiction of Land Office in state government. Land Office has District Land Office in each district, so, as a front line, it regulates and monitors the land and river use. On the other hand, DID does not have any jurisdiction on river use. Thus, it only gives advice to the Land Office from the technical point of view. It is pointed out that Land Office does not have sufficient technical staff for the proper river management. Moreover, it tends to regulate the land use without considering the environmental impact.

(2) Water Resources Quantity

As explained in **Section 1.7** and **Section 2.5**, the Muar River Basin is also so rich in surface water resources that a certain volume of the river water is transferred to Melaka State over the basin boundary. The annual total river runoff volume is 4,360 million m^3, while the present total water consumption from the river and its tributaries for domestic water supply and irrigation is as small as 150 million m^3. This means that only 3.4 % of the river water is being used for water supply and irrigation. The rest, 96.6 % flows freely into the sea, without being utilized.

Therefore, it can be said that the Muar River Basin still has a big potential as a water resource for future water uses. If the water resources of the Muar River Basin are examined very closely, however, there might be found some issues that will possibly affect the sustainable water utilization of the Muar River Basin in future. They are impacts of Climate Change, water resources development plans, environmental flow and alternative water resources, and are discussed below:

(a) Climate Change

It is generally said that climate change will make droughts severer. Although the long-term runoff analysis using average values of several GCMs and RCMs in this Preparatory Survey (refer to **Section 4.5**) incidentally happened to show no significant impact on low water discharges, a possibility of severer droughts can never be denied due to the so-called ‘uncertainty’ of Climate Change.

It might be seawater intrusion that more attention should be paid to. According to IPCC, sea level is projected to rise by 0.21 to 0.48 m at 2090 to 2099 relative to 1980-1999 under A1B scenario. By interpolation, the rise at 2025, the target year is estimated to be 0.12 m. Since there are so many intake facilities for water supply in the lower tidal stretches, sea water intrusion boosted by the sea water rise should be on the watch.

(b) Development Plan (Water Demand and Supply Balance)

As discussed in the above, the surface river water of the Muar River Basin is generally rich, and has a high potential for future developments. In order to ensure sufficient water supply, however, water source and supply facilities should be continuously developed so as to meet increasing demands. From this point of view, to confirm if the existing projects/plans will correctly respond to the future water demands, the future demands, the facility capacities and the actual water consumption volumes are compared as shown in **Figure 5.2.1** and **Figure 5.2.2**. **Figure 5.2.1** compares the total demand and the total supply capacity of the entire river basin, and **Figure 5.2.2** compares those of each district to look into the demand and supply balance at the district level.

These figures includes three kinds of water demands proposed in the National Water Resources Study 2000-2050 (those based on three different growth scenarios), the water supply capacity based on the existing projects/plans and the actual water consumption for the past 5 years 2004-2008. The 10-yearly staged supply capacity line was drawn by the JICA Study team to simplify the facility capacity that will increase with short steps. Details of this simplification and the used data for the two figures are presented in **Supporting Report Sector IV: Water Utilization.**

According to **Figure 5.2.1,** the water supply capacity will increase, covering all the three demands. The actual consumption volumes are on the low growth scenario demand line between 2004 and 2008.As far as the demand and supply balance at the basin level is concerned, it seems that there will be no problem if these projects/plans are implemented as planned.

If situation of each district is looked into, however, some problems can be found. **Figure 5.2.2** shows that the water supply capacity of Kuala Pilah was already almost caught up by the actual consumption at 2008, and that all the three demands of Tampin District are much less than the actual consumption. Therefore, the existing projects/plans of these districts are should be reviewed and modified. Fortunately "Review of National Water Resources Study 2000-2050" is now going on. It is expected that these discrepancies will be adjusted in the review.

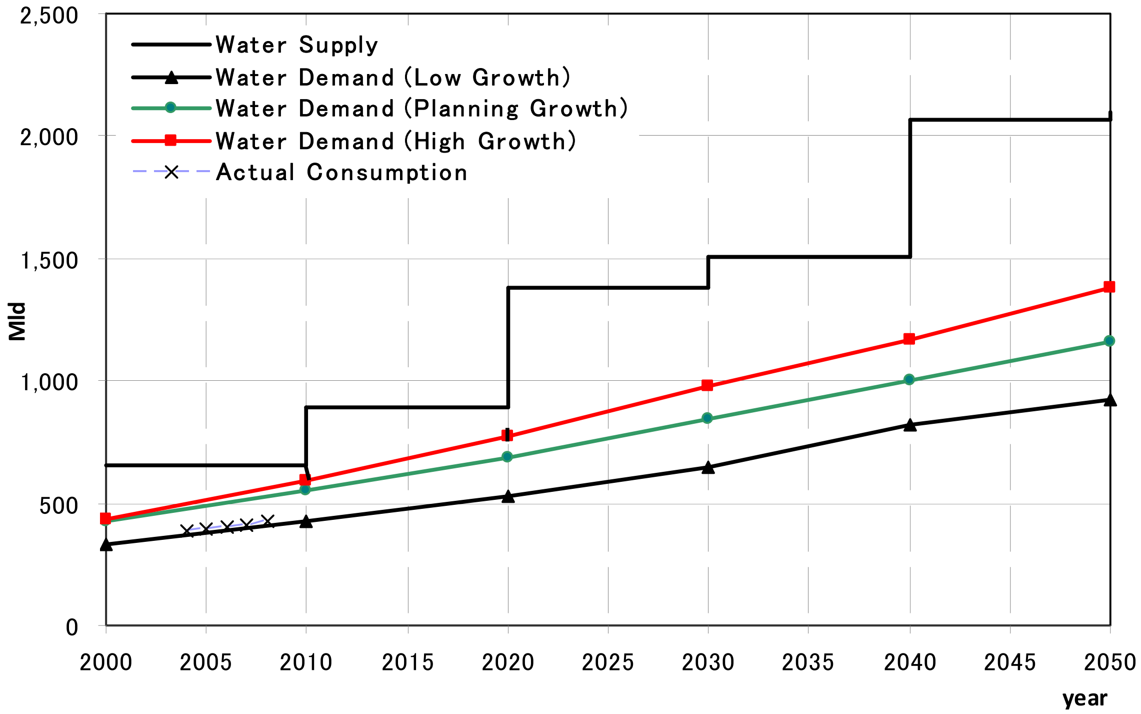


Figure 5.2.1 Comparison of Demand and Supply for Muar River Basin

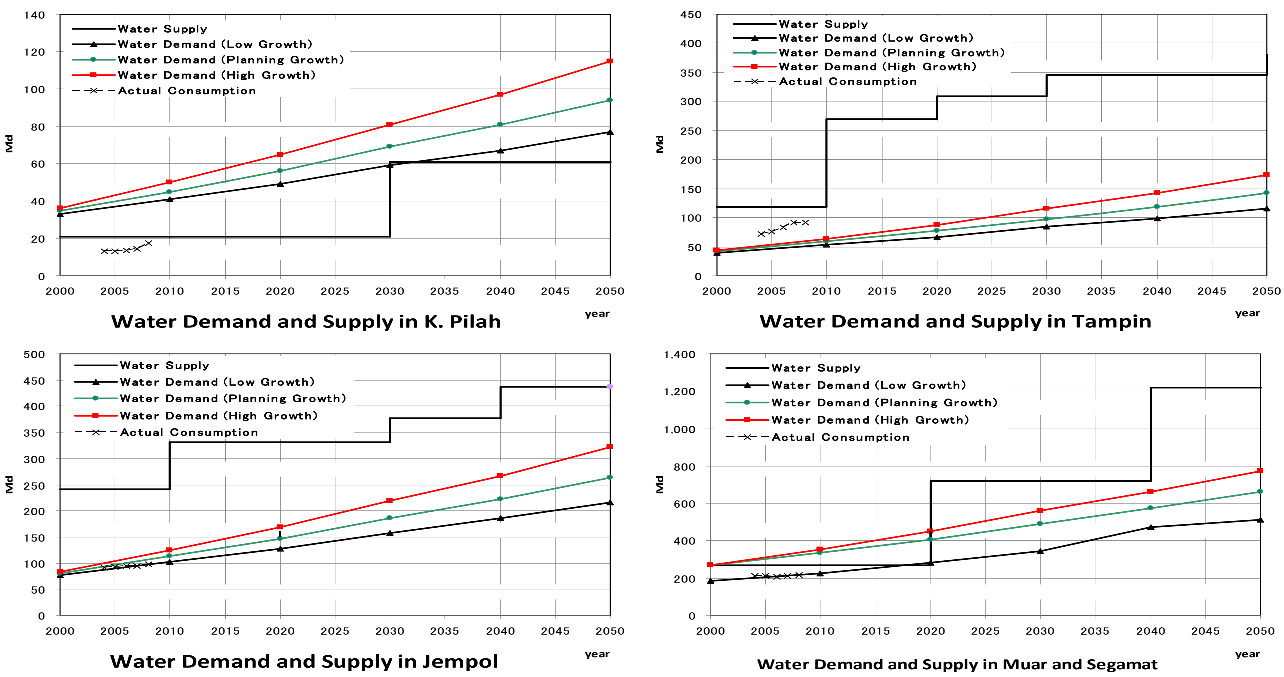


Figure 5.2.2 Comparison of Demand and Supply by District

(c) Environmental Flow

Environmental flow concept means enough water is left in our rivers, which is managed to ensure downstream environmental, social and economic benefits. When constructing a water flow -regulating structure like a dam or a barrage on a river, a certain flow (environmental flow) should be kept released downstream from the structure not to affect environmental, socio-economic conditions in the downstream. It is written in the **Subsection 3.5.4.3 of DID Manual Volume 2. River Management**, that it would be therefore desirable that minimum environmental flows for each river basin be specified that will allow and facilitate measures to be taken to avoid the decline of the valuable ecosystem.

In Malaysia, however, this environmental flow has not been necessarily specified for all river basins. There are several dams that do not release water downstream at all. They are Talang Dam in the Muar River Basin, Batu Dam in the Klang River Basin and Muda Dam in the Muda River Basin, for example. Certain lengths of the river courses below the dams, which used to be full of water, now are usually completely dry. These drastic environmental changes mush have given a significant impact on bio-diversity. There are many dam projects for water supply in the Muar River Basin, and it is definitely necessary to ensure sufficient environmental flow for the proposed dam projects.

(d) Alternative Water Resources

The Muar River Basin relies upon the river water almost 100% for its water resources for domestic and industry water supply and irrigation. Groundwater has been hardly developed. This might include a risk of stumbling into a water crisis in case of a contingency such as a water quality accident, heavy drought, etc. Recently, unscheduled water supply cut took place after closure of a water treatment plant due to high levels of ammonia in the water, and consequently over a million people were affected in several districts in the Klang Valley and in Putrajaya.

Although a few past surveys revealed that the groundwater potential of coastal alluvial deposits is limited due to predominantly clayey nature of the alluvium, the possibility of groundwater might be worth being investigated as an alternative water source to the river water for contingent uses during water quality accidents or for small users who are located beyond the reaches of the existing distribution systems or where there are constraints in capacities of existing mains serving these areas.

<Taps dry in four districts>

More than 1.2 million consumers in four districts, namely Petaling, Hulu Langat, Sepang and Kuala Langat District, have been hit by water supply disruptions after the Sungai Semenyih water treatment plant closed due to high levels of ammonia in water drawn from Sungai Kembong. The source of the contamination was traced to a "failed" retention wall at a sanitary landfill.
The plant was reopened after the ammonia content dropped to a safe level.

Source; "The Star, Wednesday 8 September 2010"

Dirty water: Syabas chief executive officer Datuk Ruslan Hassan showing a bottle of water taken from Sungai Kembong which contains high levels of ammonia.

(3) Water Supply Service Industry

(a) Restructuring of Water Service Industry

Reform of water supply and sewerage sectors is going on in Malaysia with the objective of creating an efficient and sustainable water service industry. With an amendment of the Federal Constitution and a creation of two acts, the Federal Government became to regulate the water and sewerage services industries in terms of licensing regulating services operators, while state governments retain the power to regulate water resources, water catchment areas and river basins. The water service industry will be privatized and integrated with the sewerage industry.

The reform is now at the final stage, although its transitional operation is already being implemented in some states under the regulation of SPAN. According to the 10th National Plan, the reform will be completed in the planning period, in which establishment of tariff-setting mechanism to allow full cost recovery will be completely phased in and water supply and sewerage services will be integrated, and initial efforts will be made to introduce integrated water and sewerage tariffs.

Negeri Sembilan State already migrated into the new regime in 2008 with SAINS, a semi-governmental corporation as water supply services operator, while Johor State migrated in 2009 with SAJH, a private company. SAINS will be fully privatized in the near future.

(b) Non Revenue Water

Non-Revenue Water (hereinafter referred to as NRW), which is defined as the difference between the measured supply and the metered and billed consumption is an operational issue for every water supply entities in Malaysia. NRW rate by state is presented in **Figure 5.2.3**, and those of foreign countries are also presented in **Figure 5.2.4** for reference.

The NRW rates of two states of Negeri Sembilan and Johor are 53.1 % and 31.3% respectively. That of Negeri Sembilan is the second highest in Malaysia. It is said that the economically ideal NRW rate is about 20%, and it is conceivable that these high NRW rates are one of the main financial constraints of the water supply operators. Tokyo of Japan is proud of its world-lowest NWR rate of 4.5% as an actual performance for the fiscal year of 2008.

States	NRW (%)			
	2005	2006	2007	2008
Johor	**35.50**	**32.46**	**31.20**	**31.30**
Kedah	43.80	45.00	41.70	44.90
Kelantan	40.00	44.40	48.40	49.30
Melaka	28.80	27.00	29.80	30.00
N. Sembilan	**53.00**	**60.10**	**53.80**	**53.10**
Pulau Pinang	19.40	18.60	16.80	16.90
Pahang	49.70	46.40	53.60	52.80
Perak	30.60	30.70	30.10	31.10
Perils	36.30	35.54	34.10	31.20
Sabah	57.20	57.00	56.30	55.70
Sarawak	24.70	32.00	30.50	29.40
Selangor	38.40	36.60	34.70	33.90
Terrengganu	34.70	31.50	38.50	38.00
WP. Labuan	24.00	36.00	35.90	33.10
National Average	37.70	37.70	37.10	37.00

Data source: Malaysia Water Industry Guide 2007, 2009

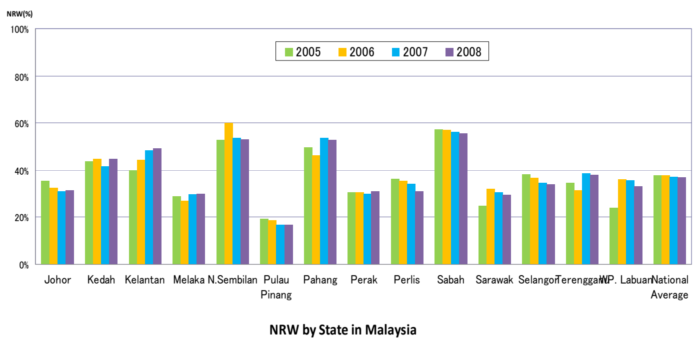
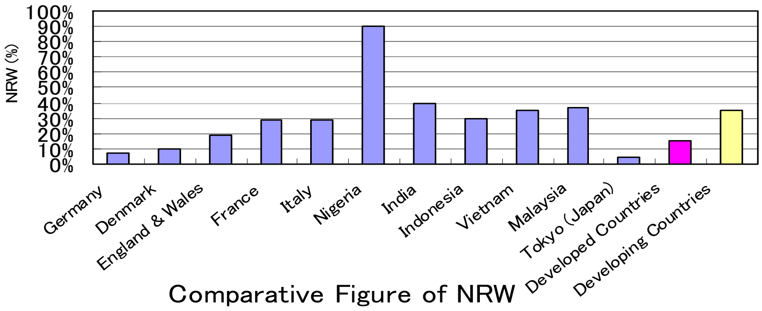


Figure 5.2.3 NRW Rate by State in Malaysia

Country	NRW (%)
Germany*1	7
Denmark*1	10
England & Wales*1	19
France*1	29
Italy*1	29
Nigeria*1	90
India*2	40
Indonesia*2	30
Vietnam*2	35
Malaysia*3	37
Tokyo (Japan)*4	4.5
Developed Countries*5	15
Developing Countries*5	35



Sources; *1: Wikipedia, *2 : Gloval Water Market (2008)
*3 : Malaysia Water Industry Guide (2009)
*4 : Bureau of Waterworks, Tokyo Metropolitan Government
*5 : Water Supply and Sanitation Sector Board Discussion Paper Series Paper No.10

Figure 5.2.4 NRW Rates of Foreign Countries

Causes of NRW can be classified into two major components, namely physical losses and non-physical losses. Physical loss is due to pipe leakages, leakage in the distribution system, overflows from reservoirs, fire-fighting usage. Non-physical loss is caused by unauthorized usage (illegal supplies and theft), inaccurate meter usage, billing system and meter reading error. Improvement of NRW rate makes sufficient contributions to water supply schemes, such as it can reduce source works scale properly. Therefore, all the water supply entities have committed to reduce and maintain NRW rate to an economic level. SAINS is taking the following actions to reduce the NRW rate in N. Sembilan State:

- Exchange of customer meters
- To control the activities of water stealing
- Planning for the NRW project affected areas
- Provide training to staff on the use of tools more effectively
- Planning a public awareness campaign for employees and the public
- Detection of active leakage
- Installation of Telemetry System
- Taking prompt remedial action on all leaks and burst pipes

(4) Irrigation Water

According to “the National Water Resources Study 2000-2050”, many of irrigation schemes have been abandoned because of a combination of (largely) social factors, lack of labour, etc., and these schemes are likely to converted to housing or high value crop cultivation in the long term.

Irrigation water supply is quite unstable because it entirely relies on unregulated run-of river flows. Moreover, water taken at intakes is led into paddy fields through canals, therefore, it is essential for irrigation activity to retain the function of canals. It is required to maintain those irrigation facilities in good condition.

(5) Navigation

In the Muar River Basin, navigation is mainly for river fishing and traffic for villagers. It is pointed out that boat navigation is sometimes disturbed by garbage including water hyacinths, dead palms and large branches.

5.2.2 Environment

In order to identify the major environmental issues in the Muar River Basin in relation to integrated river basin management, investigation on the existing environmental condition was carried out from September 2009 to December 2009. Based on the evaluation on the existing environmental conditions and discussions with the officials of various departments and agencies, a number of environmental issues have been identified. In order to reconfirm the appropriateness of those issues, consultations with various stakeholders have been carried out during the same period, for example Working Group Meetings, Stakeholders Meetings as well as direct consultations with agencies concerned. **Table 5.2.3** gives an overview of the potential environmental issues in the Muar River Basin in relation to integrated river basin management. Out of these issues several outstanding issues that require further actions, i.e. issues that either has not been addressed or the measures are inadequate are discussed as below:

Table 5.2.3 An Overview of Potential Environmental Issues

Potential issue	Possible causes	Responsible Agencies	Major governing law
Deterioration of water quality	Discharge of domestic wastewater	IWK.	▪ Water Services Industry Act 2006
	Discharge of industrial effluents	DOE.	▪ Environmental Quality Act 1974 [EQ (Industrial Effluent) Regulations 2009]
	Wastewater discharge from pig farms	DVS.	▪ -
	Wastewater discharge from wet markets	LA	▪ Local Government Act 1976 ▪ By-Laws
	Wastewater discharge from restaurants	LA	▪ Local Government Act 1976 ▪ By-Laws
	Wastewater discharge from hawkers	LA	▪ Local Government Act 1976 ▪ By-Laws
	Disposal of oil and grease from vehicle workshops	Licensed Operators.	▪ Local Government Act 1976 ▪ By-Laws ▪ Environmental Quality Act 1974 [EQ (Scheduled Wastes) Regulations 2005]
	Leakage of leachate from landfills/dumpsites	Alam Flora	▪ Solid Waste and Public Cleansing Management Act 2007
	Indiscriminate disposal of solid wastes into waterways	Alam Flora	▪ Solid Waste and Public Cleansing Management Act 2007
	Direct disposal of drinking water treatment sludge	-	▪ Environmental Quality Act 1974 [EQ (Scheduled Wastes) Regulations 2005
	Erosion at construction sites	LA, DOE	▪ Local Government Act 1976 ▪ By-Laws ▪ Environmental Quality Act 1974
	Erosion due to logging activities	Forestry Dept.	▪ National Forestry Act 1984
	Erosion due to agricultural activities	DOE.	▪ Environmental Quality Act 1974
	Sand dredging activities	Lands and Mines Office	▪ National Land Code
	Runoff of agrochemicals from plantations and smallholder farms	DOE	▪ Environmental Quality Act 1974
Loss of biodiversity	Large-scale agricultural development	JPBD.	▪ National Land Code ▪ Town and Country Planning Act 1976 ▪ Local Government Act 1976
	Logging activities	Forestry Dept.	▪ National Forestry Act 1984
Threats to ESAs and water resource	Developments within Environmental Sensitive Areas (ESAs) and water catchment areas	JPBD, Forestry Dept., LA, Lands and Mines Office	▪ Town and Country Planning Act 1976 ▪ Local Government Act 1976 ▪ National Land Code ▪ Water Resources Enactment 2007 ▪ National Forestry Act 1984

Note:
Special attention required.

(1) Discharge of Wastewater from Wet-Market

Wet-market is one of the main local level commercial facilities in Malaysia, including the Muar River Basin area. Almost all towns in the river basins are provided with wet-markets. These wet-markets are built and maintained by the respective Local Authorities and trading spaces are rented to local traders for selling of local produces like fresh vegetables, fishes, chicken meat, beef, pork, and so on. These wet-markets become a center of local level commercial activities in all sizes of towns. For example the following photo shows the external view of Labis wet-market that known as Pasar Labis (Labis Market).

Labis Market

Besides trading, there are many associating activities being carried out in the market, such as slaughtering of chicken, cleaning and preparation of meats and fishes. The issue is that the wastewater mixed with animal bloods, some intestines and feather from chicken slaughtering and fish preparation activities is being discharged into the drains without any treatment. Sungai Kedah Basin Management Plan shows that BOD value of the wastewater can be as high as 400 to 450 mg/l with discharge of as much as 100 m3/day. From the Structure Plans, there are a total of 43 towns in the Muar River Basin that being categorized as sub-regional center, major settlement center and minor settlement center. If each of these wet markets discharges 50 m3/day of wastewater with BOD value of 400 mg/l, the total BOD discharge into the environment in the Muar River Basin can be as much as 860 kg BOD/day. The following photos show how serious is the pollution load from Labis Market into the Labis River

Wastewater mixed with chicken intestines, blood and feather

Direct discharge of wastewater from wet market into the Labis River

(2) Runoff of Agrochemicals

Besides causing soil erosion, another main concern of agricultural activities is the runoff of agrochemicals such as fertilizers, herbicides, and pesticides into waterways. For large scale agricultural activities, they are partially monitored by the Department of Environment through the EIA requirements. However, for smallholder farms, the usage of agrochemicals depends very much on the awareness of the farmers (although the sale of pesticides is subject to the Pesticides Act 1974)

Figure 5.2.5 Some Locations of Concern

From the water quality monitoring data provided by the Department of Environment, out of the 173 river water samples collected at various locations and months, a total of 34 samples showed ammonical nitrogen contents within Classes III to V of NWQS. Among the rivers being monitored, ammonical nitrogen readings at Sg. Serom, Sg. Kelamah, Sg. Senarut, Sg. Spg. Loi and Sg. P. Menkuang are particularly high (see **Figure 5.2.5**).

(3) Disposal of Water Treatment Sludge

Drinking water treatment process involves various processes to treat raw water to potable water. In the treatment process, the backwash water together with the settled solids in the sedimentation tank forms residues are known as water treatment sludge. Thus water treatment sludge can be considered as a by-product of water treatment process. As alum and polyaluminium chloride (PACI) are commonly used as coagulants, it is expected that aluminium content in the residue is high. In a study initiated by the Malaysian Water Association (MWA) entitles *Study on Characteristic, Treatment and Disposal of Drinking Water Treatment Plant Residue,* sampling and laboratory tests were carried out for 16 randomly selected water treatment plants in Peninsular Malaysia, including two in the State of Pahang. Analyses revealed that aluminium content in the water treatment sludge can be as high as 79,200 mg/l. The value is very much higher than the Standard B of 15 mg/l level stipulated in the Environmental Quality (Industrial Effluent) Regulations 2009.

In Malaysia, water treatment sludge has been categorized as *Scheduled Waste* (category SW204) under the Environmental Quality (Scheduled Waste) Regulations 2005 that reads '*sludge containing one or several metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium*'. Under this Regulation, special method is required for the storage, transportation, treatment, and disposal of the water treatment sludge. Besides, if the discharge volume exceeds 60 m^3 per day, it is also subject to the requirements of the Environment Quality (Industrial Effluent) Regulations 2009. The said Regulations clearly stated that industrial effluent means *any waste in the form of liquid or wastewater generated from manufacturing process <u>including the treatment of water for water supply</u> or any activity occurring at any industrial processes.*

From the Working Group Meetings, it is confirmed that it has been an issue wherein the water treatment sludge containing high aluminium is not treated according to the *Schedule Waste* requirements. This is particularly true for the old plants whereby the residues are directly discharged into rivers. According to the Department of Environment, so far the Department has not made any strict enforcement on this matter, but the issue should be solved as soon as possible.

On the other hand, according to the abovementioned study, the original designs of most of the treatment plants are using conventional systems. Therefore, usually there are no provision for sludge treatment and disposal. This makes it very difficult to the operators to retrofit the residue treatment facilities. The said study further recommended that land, land application or monofill of dewatered sludge should be allowed as a means of disposal.

(4) Siltation Due to Sand Dredging Activities, Construction Activities and Large-scale Agricultural Developments

Based on the water quality monitoring results provided by the Department of Environment, out of 173 samplings at various along the Muar River and its tributaries in 2008, TSS contents of more than half (about 59%) of the total samples exceeded the DOE target water quality of NWQS Class II (National Water Quality Standards) (see **Table 5.2.4**). Furthermore, as high as 24% of the samples showed Class IV/V water quality, far exceeded the DOE target water quality.

Table 5.2.4 Distribution of TSS levels

TSS level	Class I (≤ 25mg/l)	Class II (≤ 50mg/l)	Class III (≤ 150mg/l)	Class IV/V (> 150mg/l)
Number of sample	25	46	61	41
Percentage	14%	27%	35%	24%

Source: Johor, N. Sembilan & Pahang Structure Plans

Figure 5.2.6 Existing agricultural areas in the Muar River Basin (2000)

There are many causes of high TSS content in river water. Site observation and discussion with Working Group members found that it is mainly due to large scale agricultural developments, sand dredging activities, large scale construction earthworks as well as natural riverbank erosion.

According to the Johor and Negeri Sembilan Structure Plans, the total agricultural areas in the Muar River Basin was about 3,900 km2 (about 64% of the total land area) in 2000, and it is expected that by the year 2020, it will increase to about 4,400 km2 (about 71% of the total land area). Due to removal of natural forest cover, these agricultural activities accelerated the erosion rate, particularly during earthwork phase of the development. Although erosion rate will be reduced after stabilization of the plantation, the erosion is still very high compared to the natural forest area. Past study (Sg. Langat IRBM Plan) shows that CP factor of agricultural land is as much as 20 times of forest area.

In 2009, there were 19 sand dredging operations in Mukim Gemas, Mukim Buloh Kasap and Mukim Pogoh. The approved operation areas range from 0.4 hectare to 1.6 hectares. None of them subject to EIA requirements.

Sand dredging is another activity that causes river siltation. Although sand dredging is important in maintaining or increasing the flow capacity of rivers, improper environmental management during dredging and washing operations may result in siltation of river. Sand dredging projects are licensed by the District Land Office, while DID is responsible to provide technical evaluation during licensing application stage and monitoring during operational stage. From the Working Group discussions, it is found that monitoring by DID has been ineffective as DID has no enforcement power in this respect. It is also noted that under the Environmental Quality Act, sand dredging projects involving an area of 50 hectares or more are required to prepare and submit an EIA Report to the Department of Environment for approval. However, it is found that most of the sand dredging operations are small scale far below the EIA requirements. As a result, no proper environmental management plan being implemented, and it is not within the jurisdiction of the Department of Environment to carry out any enforcement or environmental monitoring.

Construction activities are also contributing to the increase of TSS in the river, particularly during earthwork stage of the construction works. Although provision of silt trap and so on erosion control measures can reduce runoff of soil particles into waterways, increase of TSS is inevitable.

(5) Institution

Since the water quality issue is related to many sectors, such as water supply, sewerage, industrial effluence, livestock farming, etc., many institutions based on their jurisdiction act for regulation and management of water quality. However, especially, local authorities shall be responsible for the control of wastewater discharge from wet market, but in fact they do not have enough capability to take necessary countermeasures to fulfill the water quality standards and Environmental Quality Act, and to facilitate the wastewater treatment plants for ensuring the water quality.

The Land Office has authority on issuance of license for sand dredging in the river. For issuing the license, DID is responsible in providing technical advise on the proposed dredging methods, and, during operation stage, DID is in charge of monitoring the dredging activities. The function of DID is quite limited only to give technical advise to Land Office for licensing since DID has no legislative authority on it. Moreover, it is pointed out in the Working Group discussion that monitoring activity by DID is not effective since DID has no enforcement power.

5.2.3 Flood

(1) General

Based on discussions at the working group and stakeholder meetings, site reconnaissance and basic analyses, issues related to floods in the Muar River Basin may be summarized in **Table 5.2.5**. They are categorized to four subjects, flood damage, institution, data/information management and flood mitigation plans/projects.

Table 5.2.5 Issues for IRBM related to Flood

Subject	Issues	Responsible Agency	Major Governing Law	Plan/manual/ guidelines/Standard
Flood damage	The flow capacity of the main stream is very low.	DID		DID Manual
	The river banks are eroded during floods (Panchor).	DID, LO		DID Manual
	Railway facilities reduce the river flow capacity.	KTM		
	Some old facilities (bridges) should be replaced or maintained.	JKR		
	Siltation is significant in the Segamat River.	DID	Land Conservation Act	
	Segamat, Gemas, Labis and Panchor, Pagoh and Gemas towns are suffering from flooding.	DID		DID Manual
Institution	No opportunities are available for various sectors to discuss about IFM.	NRE, DID		
	There are illegal settlers inside the river zones.	DID	National Land Code	DID Manual
	Segamat Town is expanding over the low-lying area.	JPBD, LA	Town and country planning Act	
Data/information management	The format of the flood report changes every year.	DID		
	It is difficult to find at the DID headquarters data that were sent from district DIDs.	DID		
	Number of hydrological stations is insufficient.	DID		DID Manual
	Observed hydrological data are poor in reliability.	DID		DID Manual
Flood mitigation plans/projects	No authorized master plan is available.	DID		
	Priority for protection is unclear.	DID		
	Community residents are poor in understanding about flood hazard areas.	DID		
	There is no adaptation measure of Climate Change.	DID		
	No guidelines are available for evacuation activities after an automatic siren station sounds.	DID, LA		
	Upgrading of flood forecasting and warning system is necessary.	DID		DID Manual

(2) Description of Issues

(a) Flood Damages

Mainly due to the low capacity of the river channels, the Muar River and its tributaries often generated flooding. According to flood records, the Muar River Basin was hit twice by large floods in the last 40 years. The biggest one occurred in December 2006, and the second biggest one occurred between December 1970 and January 1971. Flood records of the two floods are summarized in **Table 5.2.6**.

Table 5.2.6 Summary of Flood Records for Muar River Basin

Item	1970/1971 Flood	December 2006 Flood
Inundation area (km^2)	380	600
Number of evacuees	50,000 (affected people)	Over 12,000
Number of causalities	No data	0
Flood damage	14.5 mil. USD	No data
3 day rainfall (mm)	242 mm	307 mm
3 day rainfall scale (ARI)	33 years	71 years
Inundation duration	Over 1 week	About 1.5 weeks

Source: "National Water Resources Study, 1982, JICA"
"National Register of River Basins, 2003"
Flood Reports, DID

Flood inundation areas during the 2006 flood are presented in Figure 5.2.7. It is observed that extensive flood inundation occurred along the main river and the major tributaries. The worst hit areas are Segamat, Bukit Kepong, Lenga, Panchor, Pagoh and Labis towns and their nearby villages in the State of Johor and Gemas Town in the State of Negeri Sembilan. Siltation in the the Segamat River is making the river channel shallow, and it is said that this siltation is one of the causes of the flood inundation of Segamat Town.

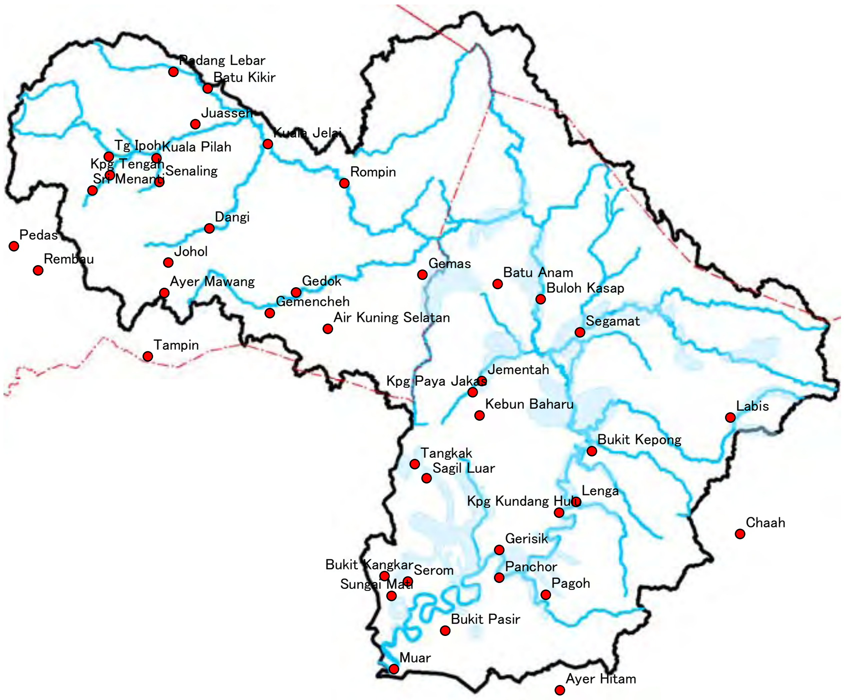


Figure 5.2.7 Flood Inundation Areas of 2006 Flood

Some old bridges with short spans and low girders form bottlenecks of the river courses. Abandoned ones left in the river channels are also obstacles to flood flow. They raise flood water to spill over the river banks.

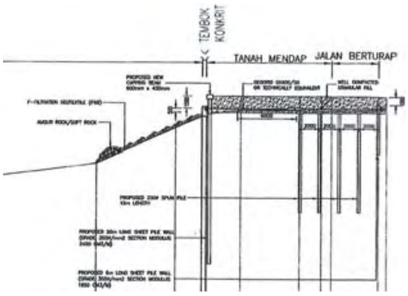

Abandoned old bridge on the Muar River at Kg. Kuning Patah


Railway Bridge on Gemas River

Figure 5.2.8 Bridges Hindering River Flow

The river bank of the Muar River failed at Kg. Panchor in April 2008. Immediately the related authorities (DID, JKR, Land Office, and Local Government, etc) arranged approximately RM 5 million for the urgent reconstruction. However, another bank erosion is already identified by DID Muar District Office. The Office is requesting the Central Government RM 5 million for the 10th Malaysia Plan (RMK-10).

River bank collapsed at the Night Market, Panchor on April, 2008



Structure design using anchored steel sheet pile wall

RM 4.9 million was spent for reconstruction.

Figure 5.2.9 River Bank Collapse and Reconstruction Work at Kg. Panchor

(b) Institution

Many agencies are involved in flood issues, but almost no opportunities were available for discussing about them. The recent creation of the river basin committees (the management committee, the technical committee and the taskforces of the two states are expected to provide such an opportunity. At the two stakeholder meetings in December 2009 and February 2010, where agencies of the two states (Johor and Negeri Sembilan) got together, the participants recognized, for the first time, flood issues of their neighbor state.

As stipulated by the Local Government Act 1976 (Act 171) and Street, Drainage and Building Act 1974 (Act 133), the local authority has legal jurisdiction to construct and maintain the drainage facilities in the urban areas. On the other hand, under the Ministerial Functions Act 1969 (Act 2), DID is entrusted with the responsibility for flood mitigation programs. Practically, DID has undertaken to construct and maintain the urban drainage as the local authority cannot ensure its technical and financial capability for the proper drainage management. Moreover, the responsibility between local authority and DID is overlapped due to the above conditions. For example, DID mainly manage the river system, but some rivers, especially small rivers have been maintained by the local authority.

Legal enforcement seems still insufficient. Gazetting of river reserve has not been conducted at all in Negeri Sembilan State. This has resulted in encroachment of river banks that should have functioned as buffer areas against flood and erosion and wildlife/riparian habitats.

The newly-developed urban area on the left bank of Segamat Town has been habitually suffering from flood inundation. The left bank area is much lower than the right bank where the old urban area is located, and it is obviously clear that the area is vulnerable to floods due to the topographical condition. Now a flood diversion project is about to be implemented for the protection of the urban area, but it is also regrettable to have allowed such an urban development with little consideration about flood vulnerability.

(c) Data/Information Management

Indispensable for effective integrated flood management is a comprehensive and effective river basin information management system that can be shared among the related agencies in the river basin. the Malaysian Government has initiated the development of a Geospatial Data Infrastructure

(MyGDI). The Malaysian Center for Geospatial Data Infrastructure (MaCGDI) under the Ministry of Natural Resources and Environment has the responsibility to coordinate the development and implementation activities of MyGDI. In addition, the Government, through DID, also has also started the development of a National River Basin Decision Support System (RB-DSS) to facilitate the integrated management of all river basins in the country. a web-based RB-IMS known as ‘River Basin Information System’ (RBIS) has been developed for trial run within the DID internet network, which in future will be opened to the public.

In a few years the above data/information management system making full use of ICT (Information and Communication Technology) will be put into practical use. On the other hand, however, efforts to enhance the quality of y raw data should be continued. It is often pointed out that the number of hydrological stations is insufficient and that the quality of the observed data is very low. Complaints from staff of district DIDs that the format of the flood report has been changed so often, and that data sent from the DID district offices have been often lost at the headquarters were also collected during the working group meetings and the stakeholder meetings.

(d) Flood Mitigation Plans/Projects

No authorized master plan is available for the Muar River Basin at present. This seems one of the reasons why no significant flood mitigation project for the Muar River basin has been implemented yet, and that priority for protection is unclear. However, a master plan study entitled “Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor” is being carried out by a local consultant firm, and it will conclude a flood mitigation master plan very soon, according to the officials concerned of DID. The JICA preparatory survey also once proposed a master plan, the draft IFM plan in the Interim Report, which should be modified by incorporating results of the local-made master plan. The JICA preparatory survey is taking into account impacts of Climate Change for the formulation of the IFM plan.

During the working group meetings and the stakeholder meetings, it is pointed out that community residents are poor in understanding about flood hazard areas, and that no guidelines are available for evacuation activities after an automatic siren station sounds. These issues should be also considered for planning the IFM plan. Fortunately no one killed in the 2006 flood in the Muar River Basin, but there are still threats of extraordinary floods that are amplified by Climate Change. Upgrading of the flood forecasting and warning system also seems necessary as one of the non-structural measures.

5.3 Core Issues and Problem Analysis

5.3.1 Identification of Core Issues

According to the discussions in **Section 5.2**, there are a variety of issues related to IRBM. If they are carefully categorized, most of them could be converged into four core issues. They might be:

- Weak Institutional Framework for IRBM/IFM,
- Insufficient Water Utilization,
- Deterioration of Water Quality, and
- Flood Damage.

5.3.2 Problem Analysis

In order to set up strategies and measures to fulfill the proposed IRBM policies, a problem analysis is made for each of the four core issues. In the problem analysis, issues that could be direct and indirect causes of the core issue are first selected by referring to discussions in Section 5.2. Then they are arranged in the form of "Problem Tree", based on the cause-effect relationship hierarchy among the issues.

Direct causes of the core issue, which are on the second level of the problem tree just behind the core issue, can be regarded as issues of strategy level. Causes of the lower levels could be regarded as issues at measure level.

(1) Institutional Setup

The issues on institutional setup were identified in each sector: water use, environment and flood. However, for the implementation of IRBM, the sector-based institutional issues shall be analyzed based on the integrated point of view. The problems as institutional setup for IRBM are summarized in **Figure 5.3.1**.

Figure 5.3.1 Problem Tree for Institutional Setup

(a) Insufficient coordination among relevant agencies

The first issue on the institutional framework for IRBM is the insufficient inter-agency and interstate coordination among the stakeholders. This issue is led by the sector-based policies and programs have been carried out by relevant institutions without considering the integration and coordination. The absence of integrated national water policy is one of the reasons to accelerate the sector-based approaches. During the course of JICA preparatory survey, the river basin committees were established to discuss on the issues in the river basin among the relevant federal and state government agencies.

The complicated mandates based on the various sectoral legislatives are also causing the insufficient coordination. Legislative jurisdiction on each sector related to IRBM can be seen in various laws as shown in **Chapter 2 of Part 1 Common Contexts.** Moreover, the existing Waters Act 1920 does not clearly stipulate the authorities and their functions for river management.

The federal DID has been making an effort to formulate the national water policy and law considering the effective implementation of IRBM in Malaysia.

(b) Inappropriate river management

As described above, the following targets need to be managed in the integrated way by the application of IRBM: the mitigation of flood damages, maintenance of river flow and conservation of river environment. For the implementation and achievement of IRBM in Muar River Basin, the relevant agencies for river management, environmental management and water management shall conduct their mandates as defined in the legislatives. In line with environmental management and water management, DOE and BKSA are primary agencies respectively. However, as mentioned before in this chapter, there is no institution authorized by the law to be a main agency for river management. Land Office has a legal jurisdiction to control lands and rivers but it does not have sufficient technical capacity. On the other hand, DID has been traditionally engaged in the river management without legal background. Therefore, a principal agency with legislative jurisdiction for the river management shall be defined in the legal documents. As a principle agency for river management, the following works shall be conducted properly.

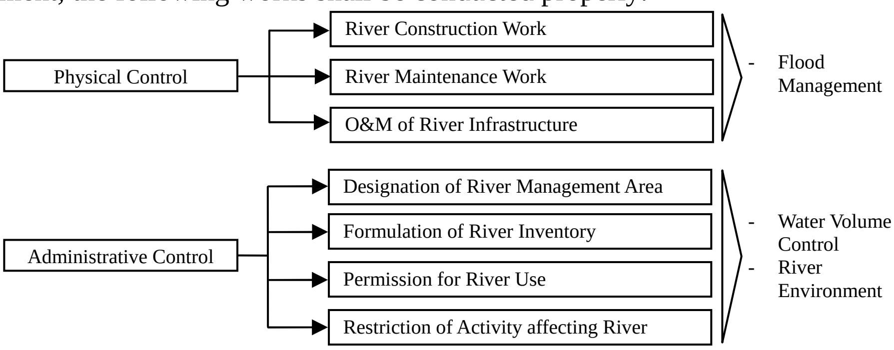


Figure 5.3.2 River Management Works

As for the physical control of the river, even though the Land Office has jurisdiction for the control of river, canal and siltation, it seems not to have sufficient technical capability to carry out proper river management. On the other hand, DID has technical capacity to conduct the physical works, but it does not have legislative jurisdiction for river management.

Moreover, the river management area is not defined due to the poor progress of gazetting of river reserve. River inventory seems not to be well organized. Since various institutions, such as DID, SPAN, KeTTHA, JMG, and BKSA have authority for the regulation of water related services and licensing, the water allocation control and monitoring in the river basin is not sufficiently coordinated. Activities affecting river environment such as river sand dredging is not well regulated due to the lack of technical capacity and incentive of Land Office and lack of legislative jurisdiction of DID for river management.

(c) Insufficient river information management

DID, as a secretariat, has developed the river basin information system named National River Basin Decision Support System (RB-DSS) to facilitate the integrated management of all river basins in Malaysia, consisting of three systems: River Basin Information Management System (RB-IMS), River Basin Geographical Information System (RB-GIS), and River Basin Simulation Modeling System (RB-SMS). A web-based RB-IMS known as "River Basin Information System (RBIS) has been developed for trial run within the DID internet network. The composition of RBIS is supposed to be information on institutions and legislatives for river management, socio-economic and environmental data in the river basin, budgetary information for river management projects/programs, etc. However, it is pointed out that the quality of raw data in terms of hydrological information is very low.

(2) Water Utilization

The Issues on the water utilization related to IRBM in the Muar River Basin are summarized in **Section 5.2.1**. **Figure 5.3.3** shows the "Problem Tree" for the water utilization in the Muar River Basin based on the abovementioned issues.

(a) Insufficient Water Resources

Insufficient Water Resources in the Muar River Basin mean possibility of drought by climate change impact, insufficient water resources development plans, insufficient environmental flow and non-existence of alternative water resources. The Muar River Basin has a possibility of drought by the evolution of climate change in the future. The actual consumption seems to have already reached the water supply capacity at Kuala Pilah District. The district is required to review their water supply plans on the basis of the results of "Review of National Water Resources Study 2000-2050". The environmental flow has not been considered as some dams do not release water downstream during normal times. It is required to determine the environmental flow for maintaining aquatic habitat and river functions in the Muar River Basin that has many dam projects. Groundwater is hardly utilized in the Muar River Basin probably due to the ample surface water, however, it is important to study groundwater potential as an alternative water resource against contingencies, such as a water crisis, a heavy drought or contamination in rivers.

(b) Improper Water Supply Service Operation

Improper Water Supply Service Operation means the delay of restructuring of water services industry, the discrepancy between the development plan and the water demand, and the prominent NRW rate. The reform of water service should be completed in the 10th National Plan period. N. Sembilan State already migrated into the new regime in 2008 and Johor State migrated in 2009. The states are required to migrate into new regime and establish tariff-setting mechanism to allow full cost recovery. Non-Revenue Water rate in the Muar River basin is assumed more than 30 % from the NRW rates of the two states as of the year 2008. This prominent NRW rate has a great influence on water supply scheme. It is therefore required to reduce it to the economically breakeven point (20%) as soon as possible.

(c) Insufficient Irrigation Water Supply

Insufficient Irrigation Water Supply means a situation being incapable of water abstraction or supplying water. Water supply is sometimes unstable due to insufficient maintenance of irrigation canal. It is required to maintain those irrigation facilities in good condition.

(d) Unsafe Navigation Management

Unsafe navigation management means a situation not being navigable for boats due to garbage including water hyacinths, dead palms and large branches. It is therefore required to maintain rivers properly in order to secure safe boat navigation.

Figure 5.3.3 Problem Tree for Water Utilization

(3) River Environment (Water Quality)

Section 5.2.2 above summarized the environmental issues related to integrated river basin management for the Muar River Basin. From **Table 5.2.3**, it is very clear that most of the issues are associated with the deterioration of (river) water quality. In order to address these water quality issues holistically, the following section undertakes problem analysis for the water quality issue.

Figure 5.3.4 overleaf presents the 'Problem Tree' of water quality issue in the Muar River Basin. The 'Problem Tree' was developed based on the issues summarized in Section 1.1.2 above. It elaborates the roots of water quality issue in the Muar River Basin. From left to right, the 'Problem Tree' identifies the main sources of water pollution (second column from left), then elaborate the possible causes of those water pollution sources at two to three levels (third to fifth columns from left). From the figure, is can be seen that there are four main water polluting sources i.e. wastewater discharge, solid waste disposal, erosion/siltation, and runoff of agrochemicals.

(a) Wastewater Discharge

Wastewater discharge includes domestic wastewater, industrial effluent, wastewater from commercial activities such as wet-markets, restaurants and hawker centers, used oil and grease from vehicle workshops, and leachate from dumpsites and landfills. As shown in the figure, most of these sources of wastewater have been addressed by various agencies concerned. The management of sewage discharge is under the jurisdiction of SPAN and IWK, discharge of industrial effluent is regulated by DOE, the control of wastewater discharge from commercial activities is under the responsibility of Local Authorities, while SWM is responsible to implement integrated waste management in both the States of Johor and Negeri Sembilan. Nevertheless, it must be highlighted here that wastewater discharge from wet-market and disposal of water treatment sludge are still the outstanding issues that must be addressed.

(b) Solidwaste Disposal

Solid waste disposal includes indiscriminate disposal of garbage (particularly into the rivers and waterways) and construction wastes. These issues are being handled by the Local Authorities and SWM.

(c) Erosion/Siltation

There are four main causes of Erosion/Siltation namely construction works (particularly those involving large scale land clearing and earthworks), logging activities, agricultural activities, and sand dredging activities. For the first three, to some extent, they are being managed by the Local Authorities, Forestry Department, and the Department of Environment (via EIA requirements) respectively. Although there is no large scale sand dredging operation, inadequate control of small scale operations may result in siltation as well as riverbank erosion.

(d) Runoff of Agrochemicals

Runoff of agrochemicals is another issue that must be addressed. Although there is no particular issue that drawn public concern, water quality monitoring data show that nutrient contents in the river are generally high.

(e) Inventory of Pollution Loads

One very important issue identified here is that an inventory of pollution loads for the Muar River Basin is not available. There are piece and parcels of information on various pollution sources that are kept by different agencies, but this information is not organized and difficult to be accessed but other agencies due to absence of a centralized database, and there is no single agency responsible for establishment and maintenance of this database. For example, DOE is keeping the database on industrial effluents, sewage discharge database is kept by IWK, information on individual septic tank is incomplete, partially kept by IWK and Local Authorities, and there is no complete database on runoffs from agricultural activities.

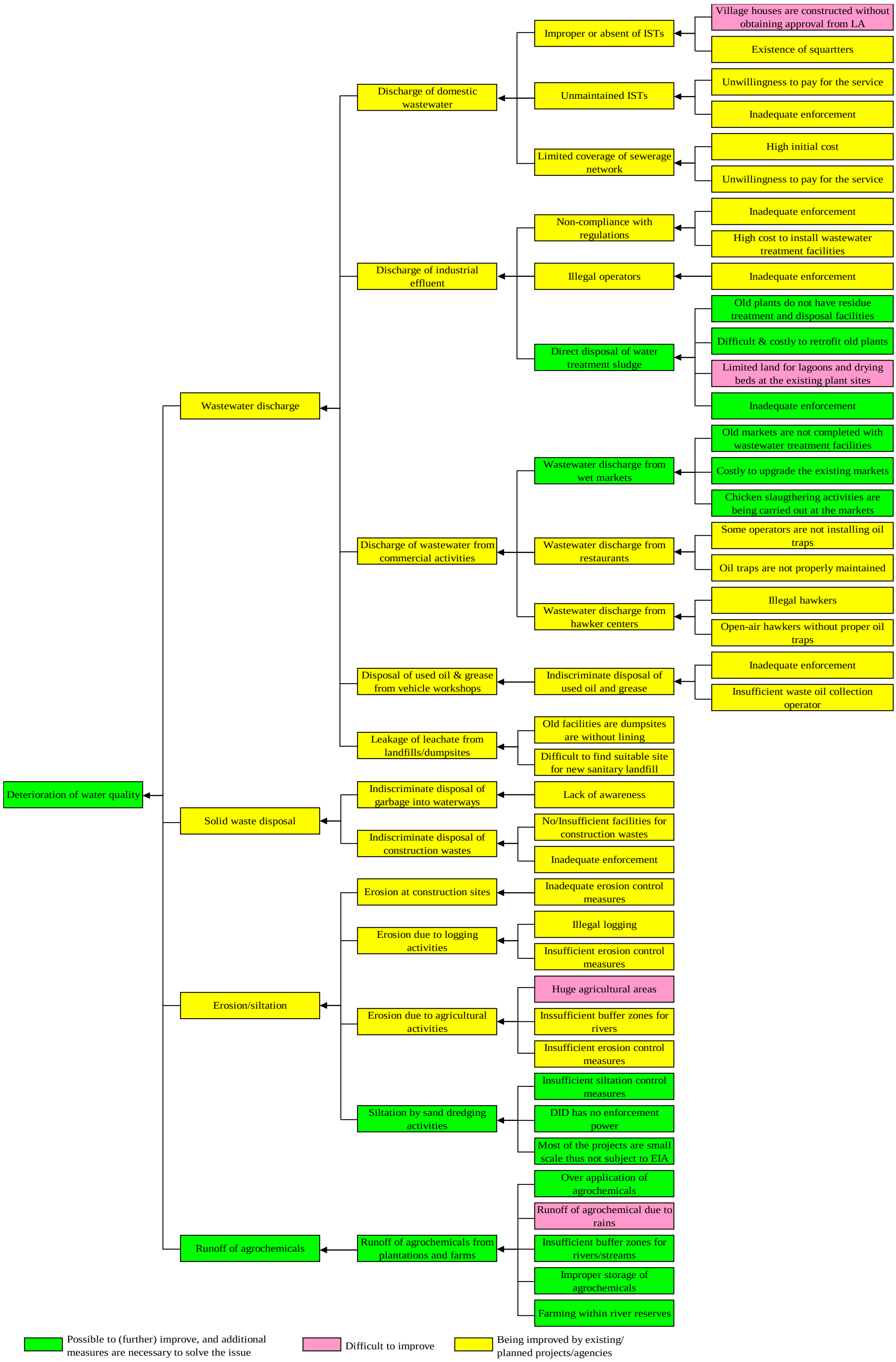


Figure 5.3.4 Problem Tree for Water Quality

(4) Floods

With the core issue "Flood causes damages", the problem analysis was made to make clear the structure of the issues, and finally to identify strategies and measures to improve the core issue. The problem tree is presented in **Figure 5.3.5**.

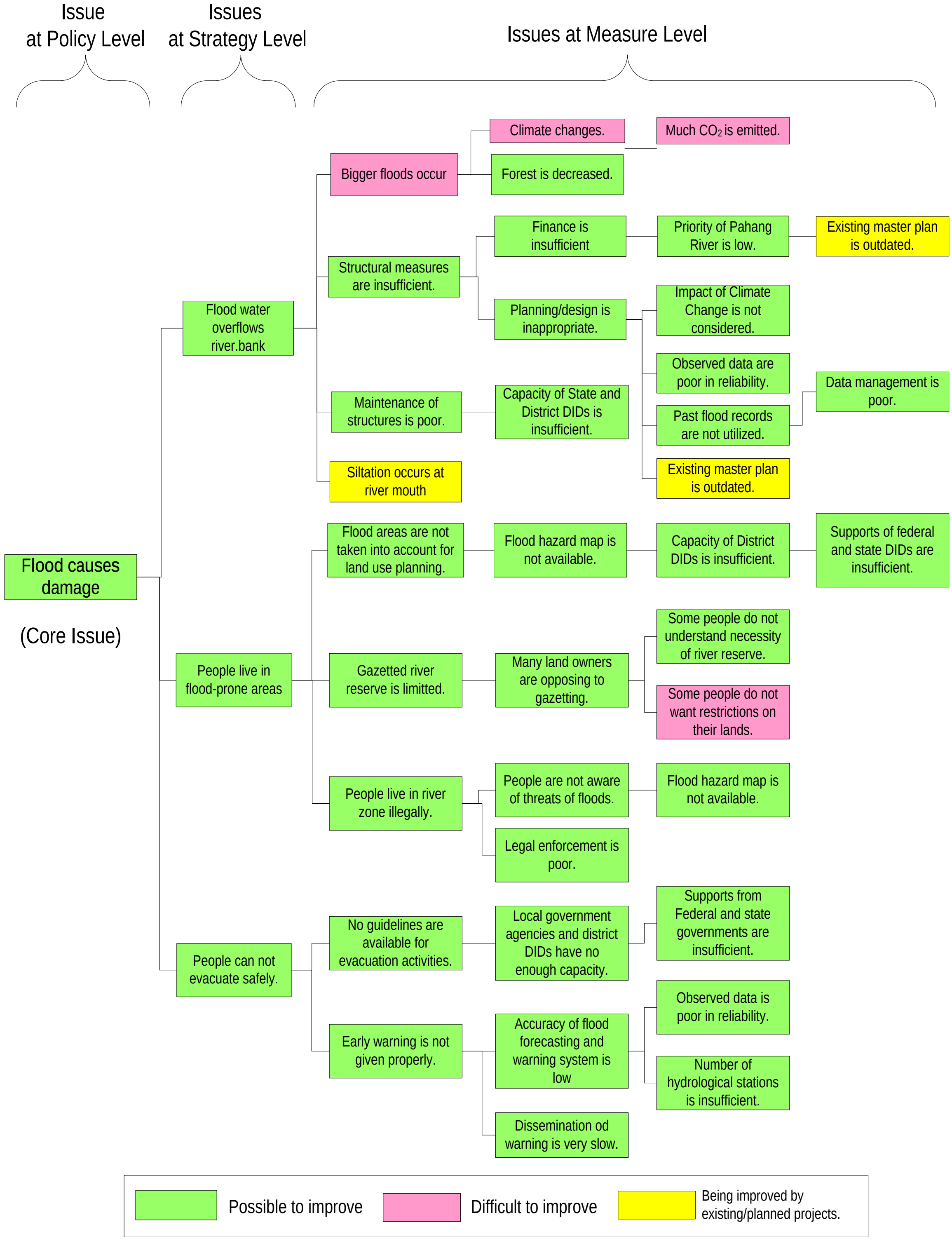


Figure 5.3.5 Problem Tree with Core Issue, "Flood Causes Damage"

Three direct causes of the core issue were conceived. They are “Flood water overflows river bank”, “People live in flood prone areas” and “People can not evacuate safely”.

(a) Causes of “Flood water overflows river bank”

The first direct cause, “Flood water overflows river bank” is physical one. Four secondary causes, “Bigger flood occurs”, “Structural measures are insufficient”, “Maintenance of structures is poor” and “Siltation occurs in river channels” are conceived.

As discussed in **Chapter 3**, more intensified rainfall is projected as an impact of the Climate Change, resulting in the occurrence of bigger floods. Efforts to reduce emission of greenhouse gases should be made, but it will be impossible to completely control impacts of Climate Change by the target year 2025 at least. Adaptation measures should be considered as this JICA survey proposes. In addition, decrease of forests by logging is another cause of increase of flood discharge. This is a cause of siltation in river channel, too.

Insufficiency of structural measures is further caused by insufficient finance for implementation and/or inappropriate planning/design. Low quality of observed hydrological data and poor data/information makes it difficult to elaborate appropriate plans/projects. Non-existence of an authorized master plan is also an indirect cause of the insufficient structural measures, although this issue will be solved if the IFM plan proposed in this JICA preparatory survey is accepted by the Malaysian Government.

Maintenance of constructed structures is generally responsibility of state or district DIDs, which need technical and financial supports from the federal DID.

(b) Causes of “People live in flood prone areas”

The second direct cause of the core issue, “People live in flood prone areas” is social one. Three secondary causes are conceived. They are “Flood areas are not taken into account for land use planning”, “Gazetted river reserve is limited” and “People live in river zone illegally”.

Non-availability of flood hazard maps seems a main cause of inappropriate land use planning. This is probably due to insufficient capacity of district DIDs. Poor legal enforcement by authorities allows people to live in river zones illegally. These people are generally not aware of threats of floods.

(c) Causes of “People live in flood prone areas”

The third direct cause, “People can not evacuate safely” is regarding people’s activities during floods. Although no one was killed by the 2006 flood fortunately, this issue should be dealt with very seriously.

Two secondary causes are conceived. They are “No guidelines are available for evacuation activities” and “Early warning is not given properly”. Local government authorities and district DIDs do not have enough capacity to prepare community-based flood management plan including guidelines for evacuation activities. Low accuracy of the present flood forecasting and warning system is based on poor quantity and quality of the hydrological data.

5.4 Federal and State Policies

5.4.1 Federal Policies

Federal policies related to IRBM are presented in the Five Year Malaysia Plan (FYMP) and the National Physical Plan (NPP).

(1) Five Year Malaysia Plan (FYMP)

In the 8th Malaysia Plan, covering 2001 - 2005, the integrated river basin approach was emphasized for the first time. This plan also encouraged state government to establish water management bodies such as LUAS to ensure proper planning, monitoring, enforcement and management of water resources on a river-basin basis.

The 9th Malaysia Plan (2006 – 2010) aims to concentrate the country's efforts on priority areas which ultimately leads to achieving Vision 2020 (Malaysia is a fully developed country by the year 2020. These priority areas encompass the nation's global competitiveness, human capital development, national integration, ethnic relations, distribution of income and wealth and the quality of life. Major policies related to IRBM highlighted in the 9th Malaysia Plan are presented in **Table 5.4.1**.

Table 5.4.1 Policies and Targets of the 9th Malaysia Plan

Sector	Policies and Targets
Water Supply	• Efforts are undertaken to conserve the quality and improve the quality of existing water resources as well as identify potential water resources. • The water demand and the water production for domestic and industrial use are expected to increase to 1,184 mld and 1,340 mld in 2010, respectively. • The efficiency of water supply is improved through NRW reduction programme with measures including strict enforcement against water theft, pipe and meter replacements, GIS mapping of distribution networks, rehabilitation of distribution systems and upgrading of existing WTPs as well as setting up of operation centers. The target NRW is 45% for Negeri Sembilan and 35% for Johor in 2010. • To increase accessibility to potable water in rural areas, priority will be given to states with low supply coverage such as Sabah, Sarawak, Pahang, Kelantan, Trengganu and Kedah. • The groundwater exploration and development programme is also undertaken to supply water to other water shortage areas and for irrigation. • IWRM (Integrated Water Resources Management) approach is promoted to achieve sustainable water resources development. • Non-structural measures to improve water supply services continue to be implemented including the promotion of wise use of water. • The SPAN is operationalised during the Plan period to regulate water supply and sewerage services in Penisular Malaysia. In addition WAMCO(Water Asset Management Company) is established to develop future water supply structures.
Sewerage	• Sewerage services continue to be expanded to ensure the quality of effluent discharged into receiving water bodies comply with environmental standards and safeguard public health. • Upgrading, rehabilitation, and refurbishment of existing sewerage treatment systems, which are in the catchments of public water supply systems continue to be given priority. • Awareness campaigns on the importance of managing wastewater and sewerage systems for maintaining cleanliness and protecting the environment as well as water resources is intensified.
Flood Mitigation	• Continuous efforts are undertaken to reduce flood hazards in the Klang Valley as well as other flood prone areas throughout the country with the implementation of both structural measures such as the construction of flood retention ponds, river improvement works and flood diversion as wellas nonstructural measures such as landuse control s and integrated flood forecasting, warning and response systems. • The Urban Stormwater Management Manual for Malaysia (MASMA) is extended to new development areas throughout the country.

The 10th Malaysia Plan (2011-2015) was tabled by the Prime Minister in Parliament in June 2010. In his speech it was stressed that the 10th Malaysia Plan is critical for the continuation of the national agenda to realize Vision 2020. The 10th Malaysia Plan targets the gross national income per capita to increase to RM 38,850 in 2015; and this requires the GDP to grow 6 % per annum.

Regarding policies related to IRBM, the IWRM approaches are continued to be encouraged in planning, managing, protecting and rehabilitating water resources. It is noted that the 10th Malaysia Plan committed that Malaysia would adopt a dual strategy in addressing climate change impacts, first adaptation strategies to protect economic growth and development factors from the climate change impacts. And second mitigation strategies to reduce emission of greenhouse gases. **Table 5.4.2** presents policies and strategies related to IRBM in the 10th Malaysia Plan.

Table 5.4.2 Policies and Strategies Related to IRBM in the 10th Malaysia Plan

Sector Policies	Strategies	Measures	Contents
Provide efficient public utilities and services (Public Utilities)	Manage water endowment and Supply	Develop a long-term strategy for water resource management to achieve water security	• Establish the National Water Resources Policy (NWRP). • Expand the implementation of IRBM approaches in planning, managing, protecting and rehabilitating water resources. • Provide RM 5 billion for flood mitigation.
		Continue efforts to restructure the water services industry	• Complete the migration of state water operators • Move towards full cost recovery • Drive efficiency in operations and capital expansion • Improve water services infrastructure • Integrate water and sewerage services
		Protect rivers from pollution	• Strengthen the enforcement on industrial effluents and sewage discharge in line with the revisions to the regulations under the Environmental Quality Act 1974. • Assess the total maximum daily load and carrying capacity of rivers for both points and non-point sources of pollution. • Revise the current Water Quality Index • Develop the National Marine Water Quality index to replace the current Marine Water Quality Criteria and Standards • Expand outreach and awareness programs
	Restructure Solid Waste Management	Provide support to local authorities	• Relive local authorities of solid waste management and public cleansing by privatization
		Deliver comprehensive and Sanitary services	• Stringently manage the performance of the three concessionaires
		Ensure waste is managed in a sustainable manner	• Promote 3R (the reduce, reuse, recycle)
Value the nation's environmental endowments (Environment)	Develop a climate resilient growth strategy	Protect the Nation from the Risks of Climate Change (Climate Adaptation)	• Develop a robust risk framework to assess and quantify the climate risk and prioritise measures to address those risks • Implement policy decision framework to ensure that future infrastructure investments are climate resilient • Enhance capacity in the field of climate prediction and modeling
		Reduce Malaysia's Carbon Footprint (Climate Mitigation)	• Create stronger incentives for investments in renewable energy (RE) • Promote energy efficiency to encourage productive use of energy; • Improve solid waste management; • Conserve forests • Reduce emissions to improve air quality.
	Enhance conservation of the nation's ecological assets	Enhance forest and wildlife conservation efforts	• Implement the Central Forest Spine of 4.32 million hectars in Peninsular Malaysia • Enhance regulations governing the trade of endangered fauna and flora • Link or integrate existing biodiversity inventory and databases. • Co-opting local communities in conservation efforts • Introduce the Access and Benefit Sharing framework
		Ensuring sustainable and safe utilisation of resources	• Co-opting local communities in conservation efforts • Establish a legal framework on access and benefit sharing

(2) National Structural Plan (NPP)

National Physical Plan (NPP) is a written statement of strategic policies on the physical development and conservation throughout the peninsular of Malaysia. The plan was approved by the National Physical Plan Council on April 26, 2006. The approval means, the plan needs to be a guideline for the physical planning and should be implemented at federal and states level throughout Peninsular Malaysia.

The NPP has a goal "The establishment of an efficient, equitable and sustainable national spatial framework to guide the overall development of the country towards achieving developed nation status by 2020" with following four objectives:

- To rationalise national spatial planning for economic efficiency and global competitiveness,
- To optimise utilisation of land and natural resources for sustainable development,
- To promote balanced regional development for national unity, and
- To secure spatial and environmental quality and diversity for a high quality of life.

The NPP contains a set of 36 policies. Out of them the following nine policies are related to IRBM:

Table 5.4.3 NPP Policies related to IRBM

Number	Policies
NPP 18	• Environmentally Sensitive Areas (ESA) shall be integrated in the planning and management of land use and natural resources to ensure sustainable development.
NPP 19	• A Central Forest Spine (CFS) shall be established to form the backbone of the Environmentally Sensitive Area network.
NPP 21	• Land development in the highlands shall be strictly controlled to safeguard human safety and environmental quality.
NPP 22	• All surface and ground water resources are strategic assets to be safeguarded and used optimally.
NPP 30	• The supply and projected demand for water by quantity and location should guide the planning of water resource areas.
NPP 31	• Ground water resources and recharge areas shall be identified and protected from activities that cause pollution and reduce yield.
NPP 32	• All urban settlements shall be serviced by a centralised sewerage treatment system.
NPP 33	• All urban settlements shall be serviced by an integrated network of solid waste disposal and/or recovery facilities.
NPP 34	• Land utilised for main drains, streams and rivers shall be designated as drainage or river reserves.

5.4.2 State Structural Plan 2020

The Structure Plan 2020 consists of written statement formulation of a State's policy and general proposals for the development and use of land in the State up to 2020. These policies are set within current state and national policies concerning the social and economic planning and development.

(1) Negeri Sembilan State

To achieve the goal to make the state to be a developed state that can be competitive, the state development strategy is to focus on improving the competitiveness of the economy to ensure rapidness and sustainability of economic growth. Policies related to IRBM are listed in **Table 5.4.4**.

Table 5.4.4 Policies related to IRBM for Negeri Sembilan State

Sector	Main policy	Sub policy	Policies
Land Use	**GT-DU4**		**Regulate and protect main agricultural areas.**
		GT-DS8	Gazette the land of second class agriculture in rural areas as the area of permanent agriculture.
		GT-DS9	Maintain the area of industrial plantation (oil plantation and rubber plantation) except for the area that is located outside the gazette area for development
		GT-DS10	Maintain the land of third agriculture except if there is concrete justification for development of that area
	GT-DU5		**Development of urban settlements are concentrated in the strategic growth nodes according to a clear hierarchy and special urban theme function:**
		GT-DS11	Development of economic central state region which is streamlined with the potential and resources provided.
		GT-DS12	Increase of environmental quality and service of semi-central region
		GT-DS13	Increase up to optimum level for the development of centre main local with its suitability
		GT-DS14	Decrease the gap of development between urban residential and small local centre
		GT-DS15	Improve integration planning and development of rural growth centre in direction to increase rural economic, quality of life and existence of sustainable and comfortable settlements.
		GT-DS16	All the indigenous settlements will be gazetted as a reserve land gradually with the agreement from State Government
Environment	**GT-DU6**		State government will practice sustainable development in planning with attention to the environmental protection and natural resource conservation.
		GT-DS17	Preserve of natural resources such as water, river basin, coastal area and biological resources.
		GT-DS18	Limit development within the sensitive area especially the area of high land, watershed, dam, water intake point, mangrove swamp and beach.
		GT-DS19	Conserve the sensitive area that had been disturbed and to control the development in order to achieve the balance between the usage of resources and environmental in direction of sustainable development.
		GT-DS20	Manage the water resource in a proper way in order to make sure that water resource in a good quality and enough for the use not only now but in the future also.
		GT-DS21	Practice the management of river basin in order to control the pollution so that the quality of river and sea could be preserved at the safe level for the various beneficial usage, following the standard of quality water that been set by environmental and health department.
		GT-DS22	Protect and conserve the biological resources and sensitive area (island, beach forest and land, coral, mangrove swamp, river estuary and many more) and to control the development so that the aesthetic value and quality of ecosystem could be maintained
Agriculture	**PT-DU2**		**Increase production of high quality food in environment-friendly manner.**
		PT-DS5	Improve production of high quality livestock animals in environmental-friendly manner.
Forestry	**PH-DU1**		**Preserve permanent reserve forest areas for continuous forest production revenue; protect life diversified forest, water and land; improve research and education; and make forest as economic resources and human well-being.**
		PH-DS1	Preserve existing permanent forest reserve area and gazette the government forest land as permanent forest reserve area
		PH-DS2	Make the Kenaboi Permanent Forest Reserve be A national eco tourism area and " Bio Valley Forest ".
		PH-DS3	Make Galla Permanent Forest Reserve as regional park and Tampin Permanent Forest Reserve as state park
		PH-DS4	Maintain the Pasir Panjang Permanent Forest Reserve as permanent forest reserve and recreational forest area.
		PH-DS5	Maintain permanent forest reserve area for sustainable forestry production and allowable for development of ‘ Estate Forest ‘ in the non productive forest and non-developed government land
Infrastructure and utilities	**KM-DU4**		**Provide adequate quality of economic and integrated infrastructure and utilities facilities in all district to accommodate the needs of community and planned development.**
		KM-DS 16	Effective, integrated and environmentally friendly management of irrigation & drainage systems will be established to reduce drainage problems.
		KM-DS 17	Enhance and Provide effective, economic and practical sewerage services by Centralized sewerage treatment systems.
		KM-DS 18	Integrated, economic and effective water resource development and management , in ensuring sufficient and quality water supply by gazette and preserve all water resources catchment area from development.
		KM-DS 20	All Domestic solid waste and wastes will be disposed at centralized landfill site provided and effectively managed and integrated without polluting the environment or affecting the society.

(2) Johor State

The Johor State Structure Plan has outlined a development vision for Johor by the year 2020 to be “A Developed, Sustainable and Glorious Johor (Johor Maju, Lestari dan Gemilang)” with following three achievement principles:

(1) To drive and generate the growing economic for a long term, comprehensive and balance.

(2) To manage the development and environment properly

(3) To increase the quality of life in every citizen by continuing the approach of holistic and balance

Policies related to IRBM, especially those on land use, infrastructure and utilities, and environment are listed in **Table 5.4.5**.

Table 5.4.5 Policies related to IRBM for Johor State

Sector	Code	Policies
Land use	LU-1.0	Direct urbanization development strategy based on scatter strategy focused on conurbation urban, main growth centre and corridor development.
	LU-2.0	Promote development in development limits area.
	LU-3.0	Protect all catchment areas in line with economic development and non contaminate recreation and tourism.
	LU-4.0	Preserve the forest reserve area and protect from any of development as part of CFS (Forest Central Spine) nation.
	LU-5.0	Give priority to the approach to 'infilling' area and potential areas in the current and new development that has been prescribed to the purpose of enhancing the quality and land use usage.
	LU-6.0	Create preservation areas for the purpose of eco - tourism activities based on sustainable development concept and strict application of guidelines.
	LU-7.0	Develop the contained area with the suitable development features that are environmental friendly development.
	LU-8.0	Concentrate the urbanization development in main development area.
	LU-9.0	Any form of development to the highland development will be controlled by the guidelines prescribed.
	LU-10.0	Settlement development is based on functional settlement hierarchy prescribed for each district until the year 2020.
	LU-11.0	Develop in rural settlement will be continued in planned and controlled as long as it can contribute to the prosperity and enhancement of images to the quality of community life with appropriate social facilities, economic, utilities and infrastructure.
Infrastructure and utilities	IU-1.0	The state government, local authorities and agencies should be responsible to ensure the provision of infrastructure and utilities that are available and complete for the current and future needs.
	IU-2.0	Develop and provide the comprehensive centralized water - based sewerage system in all urban and rural settlement that are economical and effective.
	IU-3.0	Increase level of service and quality for solid waste management system for creating healthy and harmonized community.
	IU-4.0	Provide comprehensive infrastructures for water supply, which is comprised of raw water resources, water treatment plant, and distribution of water, water pipe network and water tanks for the state of Johor to be more efficient, economic and sustainable.
	IU-5.0	Share water supply between state and nation in the optimum country development
	IU-6.0	Enhance distribution system and coverage of water supply in urban area and rural area for supporting the development of tourism, agriculture, industry, business and residential.
	IU-7.0	Plan and implement irrigation systems and flood control programs more effectively in urban areas and rural area and reduce risk of flooding and flash flood in the state of Johor.
	IU-8.0	Improving on monitoring, control and enforcement on area located in the sunken place (area tend to be flooded) should no be developed for residential, commercial and industrial use / activities.
Environment	EN-1.0	Plan, control and monitor land use activities comprehensively to minimize the negative effects on the environment
	EN-2.0	Ensure that all physical development activities be controlled tightly to control the quality of environment.
	EN-3.0	Monitor all urban areas and centre settlements closely to ensure the areas are free from pollution.
	EN-4.0	Control and monitor agricultural activities and livestock to minimize the negative impact on the environmental.
	EN-5.0	Control and monitor all industrial activities to minimize the negative effects level.
	EN-6.0	Make continuous efforts to overcome the river water problems, to improve the marine quality and to minimize the air and noise pollution comprehensively.
	EN-7.0	Make waste management system create more efficient, safe and friendly environment.
	EN-8.0	Monitor, control and plan the high risk activities area with more care to avoid aspects of pollution and accidents unsafe.
	EN-9.0	Ensure that the problem of flood / flood flash needs to be addressed immediately through more practical approach to planning and integrated plan
	EN-10.0	Preserving and protect sensitive environmentally areas (KSAS) and natural resources and fully prevent from interference of development.
	EN-11.0	Develop resources-contained in natural resources and integrate with prioritized aspects of conservation and preservation.
	EN-12.0	Ensure water will always be monitored and managed through more integrated plan to ensure the water will be clean, safe and sufficient for future need.
	EN-13.0	Preserving and manage river resources with integrated plan and always make sure the water is clean and free from any disaster risk.
	EN-15.0	Ensure the sustainable forest resource management to conserve biological diversity and to control excessive exploitation resources.
	EN-16.0	Monitor and control the exploitation of the mineral resources, minerals and rocks to ensure that they are sufficient for the future and not affect balance in natural environment.
	EN-17.0	Highland area and slopes are steep areas should be continued to be controlled and monitored to ensure that they always reserved.
	EN-18.0	Appropriate awareness courses and education will be applied and disseminated at all planning levels to ensure environment aspects always be preferred.
	EN-19.0	Give priority and enhance the use of modern technology for controlling and monitoring environmental quality.
	EN-20.0	Hold a relation and cooperation among the regional in the handling issue related environmental and natural resource management.
	EN-21.0	Enforcement and implementation the related acts and the environment regulatory especially 127 act, will be further tightened.

5.5 Proposed Policies, Strategies, Measures and Projects/Actions

5.5.1 Proposed Policies

Proposed policies can be obtained by transforming each of the four core issues into a positive statement. Moreover, special attention is paid to the wording of the policies, so that broad implications covering almost all the significant issues discussed in **Section 5.2** could be included in the policies. The core issues and their corresponding policies are presented in **Table 5.5.1**. All the policies are in line with the federal and state policies.

Table 5.5.1 Core Issues and Proposed Policies

No.	Core Issue	Proposed Policies
1	Weak institutional framework	Strengthen Institutional Setup
2	Insufficient Water Utilization	Ensure Sustainable Water Utilization
3	Deterioration of water Quality	Create a Sustainable and Pleasant River Environment
4	Flood damage.	Build a Resilient Society to Floods

5.5.2 Strengthen Institutional Setup

Based on the above problems analysis, the strategy and measures for strengthening the institutional setup are proposed as shown in **Table 5.5.2**.

Table 5.5.2 Proposed Strategies and Measures for Strengthen Institutional Setup

Policy	Strategies	Measures	Project/Action	Lead Institution	Remarks
Strengthen Institutional Setup	I-1 Establish Coordination Framework	I-1.1 Enhance RBC	- Enhance RBC - Determinate mandate, member & activities	RBC	RBC was established in JICA preparatory survey
		I-1.2 Formulate National Water Policy & Nation Water Resources Law	-	EPU, DID, State Authority	Study is under progress
	I-2 Implement Proper River Management	I-2.1 Authorize River Management Agency	I-2.1.1: Establish Water Resources Department (WRD) I-2.1.2: Establish River Basin Management Office (RBMO)	DID, BKSA, Land Office	
		I-2.2 Determinate River Management Area	- Proceed gazetting of River Reserve	Land Office, DID	
	I-3 Integrate River Basin Information	I-3.1 Establish Integrated Information System for River Basin Management	- Coordinate among Stakeholders on Data Sharing - Integrate River Basin Database	All Relevant Agencies	
				DID, MaCGDI	DID: RBIS MaCGDI: MyGDI

In order to achieve the above policy, the following strategies are recommended:

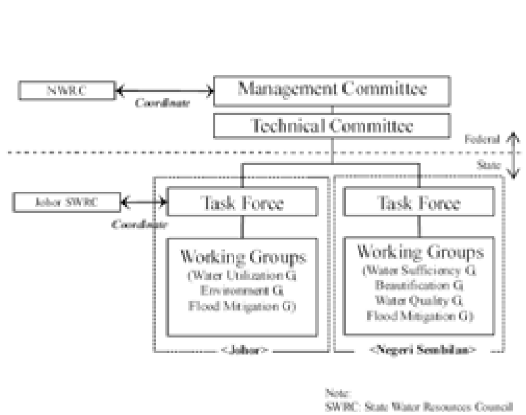
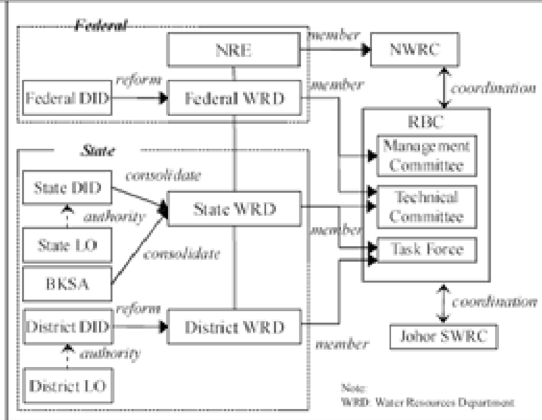
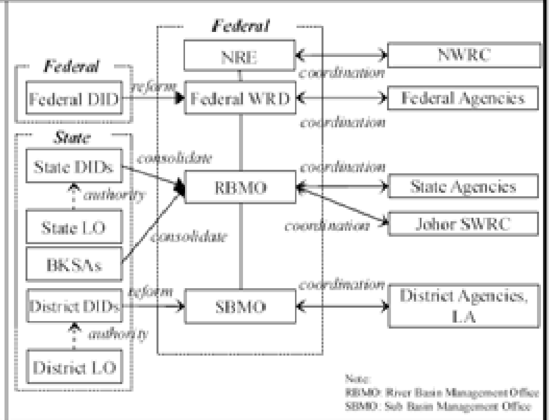
Strategy I-1: Establishment of Coordination Framework

Strategy I-2: Implementation of Proper River Management

Strategy I-3: Integration of River Basin Information

As for the Strategy I-1 and I-2, three types of institutional arrangements are proposed. The proposed institutions are summarized in **Table 5.5.3**.

Table 5.5.3 Summary of Proposed Institutional Arrangements

	River Basin Committee	Water Resources Department (consolication with State DID and BKSA in state boundary)	River Basin Management Office (consolication with State DID and BKSA in river basin)
Structure			
Type	Committee	Department in Federa and State Levels	River Basin Organization in Federal Level
Purpose	Coordination among Relevant Agencies	Establishment of Primary Agency for River Management	Establishment of River Basin Management Agency
Time Frame	Short-Term	Middle-Term	Long-Term
Main Function	- to act as discussion platform among relevant agencies - to approve and implement IRBM plans - to formulate and approve on IRBM	- to act as river management agency - to take initiatives for planning and implementation of IRBM - to encourage RBC members to be involved in IRBM	- to be established in river basin unit - to act as river basin management agency in federal level - to formulate and implement IRBM plans - to coordiate among related agencies for IRBM implementation
Advantage	- to make consensus building among members - to eccelerate integration of policies projects for IRBM - to promote enforcement of legislatives	- to integrate the authorities for river management into solo apex agency for the smooth implementation of IRBM - no need to amend the Federal Constitution	- to regulate river basin based on hydrological boudanry - to authorize the apex agency initiating the IRBM - to optimize the effectiveness, efficiency, fairness and neutrality on river basin management - to accelerate the implementation of IRBM
Disadvantage	- to decline activity gradually and to be dormant - to be stymied by the lack of ownership - to cause the slow decision making	- to regulate river basin based on state administrative boundary - to be concerned that Land Office has hesitation to transfer its authorities and EPU and/or BKSA objects to be consolidated with State DID	- to modify budget allocation procedures - to be concerned that Land Office has hesitation to transfer its authorities and EPU and/or BKSA objects to be consolidated with State DID - need to amend the Ninth Schedule of the Federarl Constitution

(1) STRATEGY I-1: Establishment of Coordination Framework

To achieve the implementation of IRBM in Malaysia, it is necessary to establish the institutional coordination framework with involvement of all relevant stakeholders in both federal and state agencies.

(a) Measure I-1.1: Enhancement of River Basin Committee in Muar River Basin

Current measures being implemented:

- National Water Resources Council (NWRC) was established in 1998 as a platform to discuss on the water resources management matters among federal and state water-related government agencies.
- In July 2003, NWRC accepted to implement Integrated River Basin Management in Malaysia and realized the necessity to prepare river basin management plans for all 189 river basins in the country.
- In Johor State, the State Water Resources Council was established as a coordination body among state agencies and between federal and state government.
- For the targeted river basins in the Preparatory Survey, River Basin Committee (RBC) was formulated to be composed of Management Committee and Technical Committee of the federal level and Task Forces and Working Groups of the state level.

Lead implementing agency:

- River Basin Committee (RBC)

Proposed action:

Various agencies have been involved in the river and water management, and these existing agencies have specified mandates in water resources and river management. Therefore, iIn order to optimize their expertise and to minimize the overlap and duplication of their mandates, the establishment of coordination scheme is proposed for the full utilization of their expertise. As for the coordination in the river basin, the River Basin Committee (RBC) has been established. Since the river basin is shared by more than two states, the Federal government can intervene in accordance with the Federal Constitution. Based on the structure of current RBC, the following structure of RBC is proposed (see in **Figure 5.5.1**).

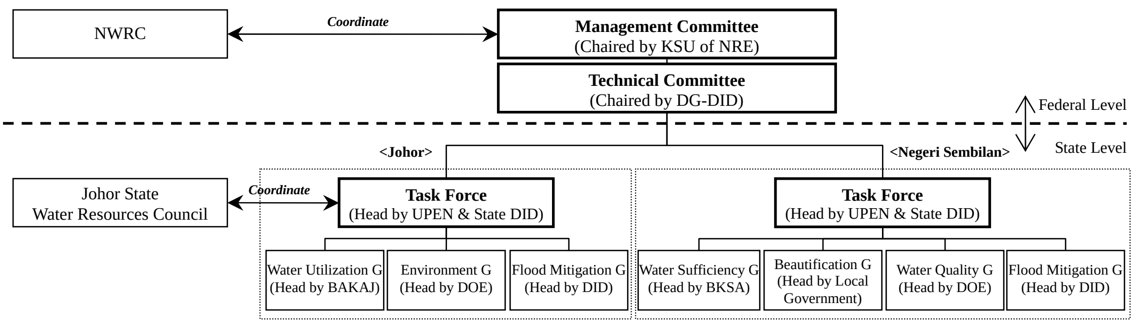


Figure 5.5.1 Proposed Structure of RBC in Muar River Basin

Under this scheme, the Management Committee will coordinate with NWRC and the Task Force will coordinate with and report to the State Watetr Resources Council in Johor state. The members of Managemnet Committee, Technical Committee and Task Force are almost same as the present member structure. However, several underlined agencies are proposed to be added.

Table 5.5.4 Proposed Members of RBC

	Member
Management Committee	***Federal Level***: NRE (Chairman), DID (Secretariat), MOF, EPU, NSC, KeTTHA, MAAI, MHLG, MOW, MOH, DOE, HAHRIM, MMD, FD ***State***: State Secretaries in Negeri Sembilan and Johor
Technical Committee	***Federal Level***: DID (Chairman), River Division, DID (Secretariat), NRE, MAAI, NAHRIM, MaCGDI, DSP, EPU ***State Level***: UPEN (Johor, Pahang, Negeri Sembilan, Melaka), NSC (Johor, Negeri Sembilan), DID (Johor, Negeri Sembilan), DOE (Johor, Negeri Sembilan), FD (Johor, Negeri Sembilan), PERHILITAN (Johor, Negeri Sembilan), DLM (Johor, Negeri Sembilan), DMG (Johor, Negeri Sembilan), TCPD (Johor, Negeri Sembilan), DOA (Johor, Negeri Sembilan), DOFi (Johor, Negeri Sembilan), DOH (Johor, Negeri Sembilan), MD (Johor), SSD (south branch), BKSA (Johor, Negeri Sembilan, Melaka), SPAN (south branch)
Task Force	***State Level***: UEPN (Johor, Negeri Sembilan), DID (Johor, Negeri Sembilan), DOE (Johor, Negeri Sembilan), FD (Johor, Negeri Sembilan), DLM (Johor, Negeri Sembilan), DMG (Johor, Negeri Sembilan), TCPD (Johor, Negeri Sembilan), DOE (Johor, Negeri Sembilan), DOFi (Johor, Negeri Sembilan), DOH (Johor, Negeri Sembilan), MD (Johor), SSD (south branch), BKSA (Johor, Negeri Sembilan, Melaka), SPAN (south branch) ***District Level***: District Officer (Johor, Negeri Sembilan), District Council (Johor, Negeri Sembilan), District NSC (Johor, Negeri Sembilan), District Land Office (Johor, Negeri Sembilan)

Note: MOW: Ministry of Works, DSP: Department of Survey and Mapping, PERHILITAN: Department of Wildlife and National Parks, MD: Marine Department

In accordance with flood management, NSC in federal, state and district levels are proposed to be participated. Other members are also primary agencies for IRBM in Muar River Basin.

In considering the necessary functions of RBC based on the review of the existing water management frameworks in Malaysia shown in **Box 1**, it is identified that they carry out the following functions.

- Advisory Function: to advise the State Authority on the management and use of water resources
- Coordination Function: to conduct inter-agency coordination in the state for the management and utilization of water resources
- Planning Function: to formulate and develop the policy, guideline, standard and procedure pertaining to the management, utilization and conservation of water resources
- Regulatory Function: to regulate and control the water use for the sustainable water management and protection of river environment in an integrated manner
- Investigation and Implementation Function: to undertake the research activities and to implement the IRBM projects for the effective management and use of water resources

Based on the review of the existing river basin organizations in Malaysia and the discussions with the officials concerned of federal and state government, the following functions will be required as a coordination scheme. In principle, the Management Committee has an approval and coordination function, the Technical Committee executes the coordination and planning functions, and the Task Force carries out the regulatory and investigation and implementation functions.

Table 5.5.5 Proposed Main Functions of RBC

RBC	Proposed Main Function
Management Committee	- To act as a discussion platform on the implementation of IRBM in the river basin - To approve IRBM plans and the implementation of the proposed projects in IRBM plans for the effective and sustainable river basin management - To approve the policies on water use priorities and allocation, flood mitigation measures and river environment management - To approve the river basin information management plan, standard and guideline
Technical Committee	- To monitor and promote the implementation of IRBM projects pertaining the management, utilization of water resources and the conservation of river environment - To formulate the policies on water use priorities and allocation, flood mitigation measures and river environment management for the approval by the Management Committee - To establish the river basin information management plan, standard and guideline for the approval by the Management Committee
Task Force	- To report issues and projects discussed and conducted in RBC to State Water Resource Council in Johor state (Task Force in Johor state only) - To collect the required data for the river basin information database - To monitor all the activities with negative impacts on the river basin management and submit the monitoring reports to the Technical Committee - To adopt and implement the policies on water use priorities and allocation, flood mitigation measures and river environment management for the approval by Management Committee formulated by the Technical Committee - To submit the proposals on issues and solution methods for the implementation of IRBM to the Technical Committee - To draft the river basin information management plan, standard and guideline to be submitted to the Technical Committee - To enforce the relevant legislatives for the regulation of water management and use and the protection of river environment

BOX 1: Review of Existing River Basin Organizations in Malaysia

(1) Selangor Water Management Authority (LUAS)

Selangor Water Management Authority (LUAS) was established in 1999 under the Selangor Water Management Authority Enactment No. 2 in 1999 as a statutory body to ensure the water resources, river basin, coastal waters and environment in manageable and sustainable condition for the socio-economic development in the state. The main mandates of LUAS stipulated the Enactment are:

- To provide advice to the State Authority as to the policies, methods and measures
- To formulate, approval and implement management and development plans for water sources
- To regulate the issue of licenses and permits
- To coordinate multi agency relationship in the State and promote cooperation and coordination for multi functional uses of water sources

Several Technical Committees were set up in accordance with concerned issues such as River Basin Management Committee, Water Resources Emergency Committee, and so on. Moreover, under the Committee, three task forces in Selangor, Langat and Klang rivers were established consisting of relevant state agencies, local authorities, district land offices, and so on. The task forces play roles on monitoring of water quality, law enforcement, data development, etc.

(2) Kedah Water Resources Board (LUAN)

Kedah Water Resources Enactment became effective in 2008 and Kedah Water Resources Board (LUAN) is under the preparation of the establishment for the achievement of integrated management of water use, development and protection of water resources in Kedah state. LUAN is supposed to be chaired by Chief Minister with secretariat of Water Resources Director which consists of relevant state departments. The Board will have the following functions.

- To ensure, maintain and facilitate the integrated and sustainable management of water resources and the water environment of the State

- To promote and facilitate cooperation and coordination between different agencies for multi functional uses of water resources
- To divide the State into river basin districts, designate and determine their boundaries for proper management by River Basin Committees

Moreover, the Board will appoint the Water Resources Director as a main water regulator with the following funcions.

- To prepare river basin plans
- To ensure the flow and exchange of information on projects, plans and activities which has a bearing on integrated water resources management between the Board, relevant agencies and the private sector, and between the Board and Federal government

The Board will divide the state into the river basin districts and set up the River Basin Committee involving the District Officer. The main functions of River Basin Committee are:

- To investigate related matters affecting the management of river basin
- To assist the Water Resources Director in the preparation of a draft river basin plan and any other reports

River basins are hydrological units, so the boarder of the basins shall be determined based on the hydrological boundary, not on the administrative boundary. River basins are hydrological units, so LUAN intends to manage the river and water resources in the river basin unit.

(3) Sabah State Water Resources Council and State DID

As required in Sabah Water Resources Enactment No. 6 in 1998, Sabah State Water Resources Council was formulated in February 2006 consisting of major state departments. The main function stipulated in the Enactment are:

- To advise the Minister on the management and use of water resources
- To set priorities for, ensure the development of, recommend for approval and review catchment management plans developed for the improvement of the management of water resources

For the proper management of state’s water resources, Director of Water Resources shall be appointed by the Minister to undertake the following functions.

- To manage the State’s water resources
- To control issuance of license for water activities
- To protect river and shore reserve
- To coordinate administrative action for water resources management
- To be responsible for the establishment of water resources database

In Sabah state, the State Director of DID was appointed as Director of Water Resources to carry out the above functions for the management of the state’s water resources.

The advantages and disadvantages for the establishment of RBC are summarized in **Table 5.5.6**.

Table 5.5.6 Advantage and Disadvantage of RBC

	Description
Advantage	- To establish RBC based on concensus among relevant agencies without amendment of existing legislatives - To provide opportunity for the coordination among relevant agencies - To accelerate the integration of policies and projects targeting the implementation of IRBM in the river basin - To promote the enforcement of legislatives
Disadvantage	- To decline the activity gradually and to be dormant - To be stymied by the lack of ownership - To cause the slow decision making

Coordination scheme in the form of the RBC has various advantages. Based on the agreement among the relevant agencies without any amendment of existing laws, the RBC can be established. The RBC can provide a plenty of opportunities to the relevant agencies to discuss on, coordinate and integrate their policies and projects for the implementation of IRBM. On the other hand, it may decline its activities since, even though it is initially active, the members will be busy to take priority on their own tasks and become dormant. Moreover, RBC may be hampered by the lack of ownership on the RBC, and each member has the limited authority to make any decision.

IRBM is generally defined as a continuous process promoting the coordination of the development and management of water, land and related resources for the optimization of economic and social welfare. Thus, it is necessary to consider the ways to maximize the advantages and to minimize the disadvantages. In order to ensure and develop the functions of RBC and the implementation of IRBM in Muar River Basin sustainably, the following consideration shall be initiated by the RBC.

- Regular Coordination Meetings: regular coordination meetings shall be held in order to minimize the overlapping of the functions and projects of each agency and improve their efforts, to encourage the collection of the related data and dissemination and integration of these data efficiently, and to monitor activity for the identification of negative impacts and the enforcement of legal requirement.

- Acceleration of Stakeholder Participation: Stakeholders such as water users, government institutions and affected community residents shall be participated in IRBM process. However, none of the laws describes the necessity of the stakeholders' participation. Therefore, it needs to be stipulated in the water related legislatives to ensure the participation of the stakeholders.

Malaysia has a variety of experiences to formulate a committee as an inter-agency coordination mechanism. Therefore, in the context of the current legislative framework in Malaysia, a committee in the river basin is more recommendable and implementable scheme in Muar River Basin.

(b) Measure I-1.2: Formulation of National Water Policy and National Water Resources Law

<u>Current measures being implemented:</u>

- DID has conducted the comprehensive study on "Review Study of the National Water Resources Study (2000-2050) and Formulation of National Water Resources Policy" from October 2009 up to October 2010. The objectives of the Study are to review the National Water Resources Study (2000-2050) and to formulate a National Water Resources Policy and a National Water Resources Model Law. The Study mainly focuses on the arrangement of Federal and State Water Governance for the efficient and effective water resources management in Malaysia through the formulation of National Water Resources Policy, and on reconciliation of sectoral laws and regulations for the water resources development, management and regulation.

- In the water service sector, the regulatory scheme on water supply services and sewerage services has been drastically reformed by establishment of NWSC and acceleration of privatization of water operators. On the other hand, the integrated management for water resources and river basin such as river water, ground water, coastal water, etc. has not been achieved yet. This is partly due to the absence of national water resource management policy for the effective management of water resources.

Lead implementing agency:

- DID
- EPU
- State Authority

Proposed action:

- National Water Resources Policy shall consist of integrated water resources management and river basin management policies, strategies and measures in consideration with existing sectoral policies including land use plans, agricultural development plans, forest management plans, infrastructure development plans, and so on.
- The existing institutions shall be reviewed and the improvement of institutional arrangement and task demarcation shall be recommended.
- The existing sectoral laws and regulations shall be reviewed and improved, if necessary, especially Waters Act 1920 to ensure the promotion of IRBM implementation
- Because the water is a property of the State, it is important to involve the relevant state agencies to acknowledge the prepared National Water Resources Policy with approval of NWRC.

The above study will be completed in October 2010, so no special recommendation is not made on this matter.

(2) STRATEGY I-2: Implementation of Proper River Management

For the proper river management in terms of water quantity and quality control and flood management, the river system shall be managed and regulated in the river basin unit.

(a) Measure I-2.1: Authorization of River Management Agency

Current measures being implemented:

- Currently, the sector-based approach is adopted for river management.
- Since the land and river are properties of the state government within the state, Land Office is a main agency to regulate the use, development and management of land. Moreover, BKSA is responsible for the regulation of water abstraction in the state. However, especially for the river management, both Land Office and BKSA do not have sufficient technical capability. On the other hand, DID is not ensured to be an agency for river management with legal jurisdiction even though DID provides the technical services for the river management.
- River management is carried out based on the administrative boundary, not hydrological boundary. It means that no agency manages and regulates the river system from the upstream up to the downstream.

Lead implementing agency:

- DID
- BKSA (BAKAJ)
- Land Office

Proposed action:

The Muar River Basin is shared by more than two states and there is no agreement among the concerned states, so that the Federal Government can intervene in accordance with the Constitution and it is legally possible to set up an Act to enable the Federal Government to manage and control the targeted river basin under the federal jurisdiction. Moreover, as DID defines, IRBM is a sustainable management of land and water based on natural geographical boundaries, rather than administrative units. Therefore, the land and water resources need to be managed based on the unit of the river basin in the integrated manner. In order to manage the river basin appropriately for protecting flood disaster and securing the social welfare, all the authorities regarding the regulation of river and water become integrated into solo apex institution. For the formulation of a solo apex authority in Muar River Basin, the following alternatives can be proposed.

(i) I-2.1.1: Establishment of Federal and State Water Resources Department

DID can be considered as a candidated body of Water Resources Department (WRD). The necessary actions for the establishment of WRD will be:

- To define WRD as a river management agency in the water related legislatives
- To define the mandates of WRD
- To amend the relevant laws to integrate and transfer the jurisdictions on river and water management

Regarding the Ministers of the Federal Government Order 2009 under the Ministerial Functions Act 1969 (Act 2), the following functions are ensured to implement IRBM.

- Development of planning and management of river basins
- Development of planning and management of flood mitigation programmes

Based on the above Act, the authority of DID for the river management has been already endorsed. Moreover, since Federal DID is made up of the operational divisions with the proper mandates for the implementation of river and water resources management, the organization structure shall not be modified drastically to be Federal WRD.

On the other hand, State DID structure will be drastically changed. As pointed out, river management consists of physical control and administrative control. In line with the physical control, State DID has carried out traditionally, but administrative control, especially designation of river administrative area and permission of water use is under the jurisdiction of other agencies such as Land Office and State Water Regulatory Body (BKSA). In order to act as a river management agency, these jurisdictions shall be taken over by State DID. The proposed WRD framework is shown in **Figure 5.5.2.**

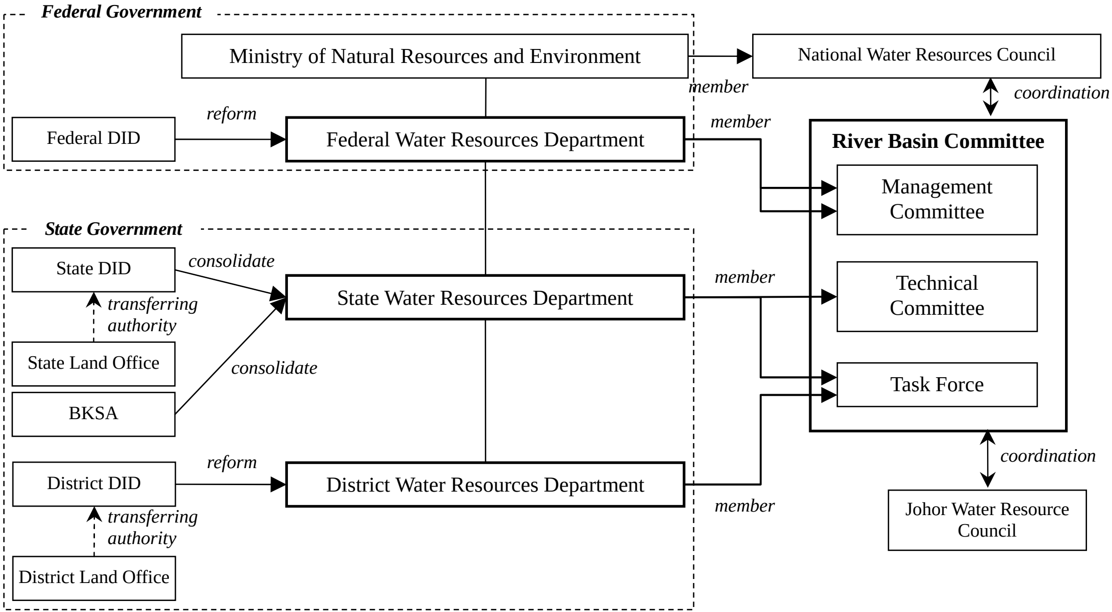


Figure 5.5.2 Proposed Framework of Water Resources Department

Federal WRD is mainly responsible for the policy formulation for IRBM, and State and District WRDs have operational functions to implement IRBM in the state, and the Director of State WRD shall be appointed as a licensing officer appointed by the State Secretary in Johor state and Water Resources Director in Negeri Sembilan state stipulated in each waters enacetment.

LUAS and LUAN have a coordination function among the relevant agencies in the states, but since they do not conduct the river works, WRD has different characteristics with them. On the other hand, this scheme is similar with one in Sabah state. The Director of Sabah State DID is appointed as the Director of Water Resources having the authorization on controlling licensing, implementation of river management works, and being responsible for water resources database establishment.

(ii) I-2.1.2: Establishment of River Basin Management Office

The establishment of River Basin Management Office (RBMO) as another alternative is proposed to formulate a solo apex river basin authority by restructuring the State DID into river basin level. Similar with State WRD, State DID can be a main body with the consolidation of BKSA and the transfer of authority on designation of river reserve to RBMO. State DID in each state in the river basin will be separated and integrated with other State DID into one RBMO. Moreover, District DID offices also need to be restructured and integrated into Sub-Basin Management Office (SBMO). RBMO and SBMO are a type of branch office directly administrated and controlled by Federal WRD. The proposed RBMO and SBMO framework is shown in **Figure 5.5.3**

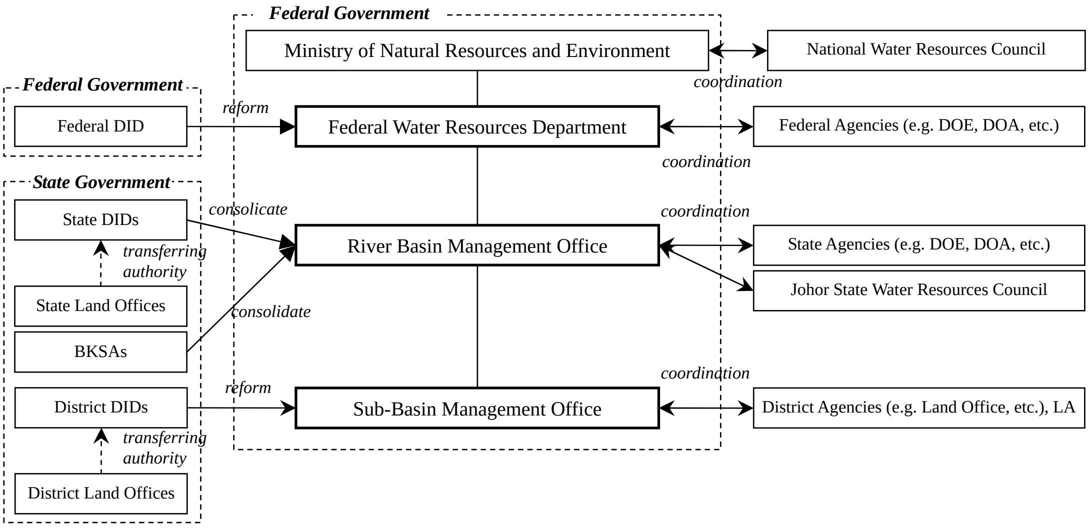


Figure 5.5.3 Proposed Framework of River Basin Management Office

Federal WRD is mainly responsible for the policy formulation for IRBM, and RBMO and SBMO have operational functions to implement IRBM in the river basin level. In this scheme, RBMO and SBMO are no more state agencies and will be federal agencies under the federal jurisdiction.

This framework is a quite new challenge in Malaysia since the institutional structure in Malaysia is organized based on the federal system, and jurisdiction of each institution is determined by the administrative unit. LUAS, LUAN and State DID can exercise their jurisdiction in their own state territories in principle. However, in this framework, federal institutions consisting of Federal WRD, RBMO and SBMO plan, develop, conduct and supervise the IRBM implementation.

The advantages and disadvantages for the establishment of RBC are summarized in **Table 5.5.7**.

Table 5.5.7 Advantages and Disadvantages of New Organizations

	Description
Advantages	
1) WRD	- To integrate the authorities for river management into solo apex agency for the smooth implementation of IRBM - No need to amend the Federal Constitution
2) RBMO	- To regulate river basin based on the hydrological boundary - To authorize the apex agency initiating the IRBM - To optimize the effectiveness, efficiency, fairness and neutrality on river basin management - To accelerate the implementation of IRBM
Disadvantages	
1) WRD	- To regulate river basin based on the state administrative boundary - To be concerned that Land Office has hesitation to transfer its authorities and EPU and/or BKSA objects to be consolidated with State DID
2) RBMO	- To modify budget allocation procedures - To be concerned that Land Office has hesitation to transfer their authorities and EPU and/or BKSA objects to be consolidated with State DID - -To amend the Ninth Schedule of the Federal Constitution and relevant laws

For the establishment of WRD, the existing legislatives do not need to be amended and the authority for river management can be clearly defined. The most remarkable feature of RBMO scheme is to achieve the river basin management based on the river hydrological boundary, not on the administrative boundary, which is a fundamental principle of IRBM. Through the implementation of this alternative, the authority on river and water management will be secured enabling to optimize the effectiveness, efficiency, fairness and neutrality on river basin management. Therefore, RBMO can drive the implementation of IRBM in Muar River Basin in cooperation and coordination with other relevant agencies.

However, WRD in the state will manage and regulate the river and water resources, so its jurisdiction will be constrained within the state boundary. On the other hand, RBMO scheme will enable to realize the integrated management of the river basin ideally. Furthermore, the process of the establishment of these schemes will stir up an argument between the Federal and State Government affecting the Federal-State relationship. In addition, for the establishment of RBMO as a federal agency, the amendment of Ninth Schedule of the Federal Constitution will be inevitably required to transfer the authority on rivers from the State Government to the Federal Government.

Thus, the achievement of this scheme will take time and further discussion will be necessary.

(b) Measure I-1.2.: Determination of River Administration Area

Current measures being implemented:

- According to the Waters Act 1920 and other relevant legislatives, the river management area is not clearly determined.
- As a river administrative area, the river corridor including the river reserve can be considered. If the land is gazetted as river reserve, DID has legal jurisdiction on the usage of land within the river reserve for public purposes such as flood mitigation, river channel improvement, etc. However, the gazetting of river reserve is not sufficiently progressed.
- In order to have required river bank widths effectively reserved, therefore, DID is about to start in the 10th Malaysia Plan gazetting of river reserve areas in accordance with Subsection 62 of the Land Code, while promoting immediate gazetting in the states that have no river reserve.
- In case of the gazetting by Subsection 62, the gazzeting notification is required to describe the reserved land and purposes for reserving, to designate the officer having the control of the land, and to be conclusive evidence that the land is reserved for a public purpose. DID could be the officer to control of the river reserve. As soon as next year DID will start land-surveying as a first step of this gazetting procedure.

Lead implementing agency:

- Land Office
- DID

Proposed action:

In order to implement the proper river management, river management area shall be designated in the legal jurisdiction and the defined river management area shall be administrated appropriately. For the achievement of river management, the following actions will be proposed.

(i) Defining River Management Area in the Legal Context

According to the section 62 of the National Land Code 1965 (Act 56), the reserved land is defined as a land for the time being reserved for a public purpose. This reserved land will be read in the context of river management, it is called river reserve, which can be gazetted as for the flood mitigation and other public purposes for the implementation of IRBM.

The considerable width of river corridor and river reserve is mentioned in the manual issued by DID and the establishment of river reserve is recommended to the State Authority. However, the legal jurisdiction on the establishment of river reserve is not under the DID, but the Land Office is a main regulatory body in the State Authority. Therefore, the river reserve shall be defined in the relevant laws as a river management area and the gazetting of river reserves shall be promoted.

(ii) Joint Monitoring for Enforcement

As mentioned above, the river corridor and the river reserve will be used not only for flood mitigation and river improvement but also for the other public purposes such as environmental protection, securing water quality and quantity, recreational purposes and so on. Regarding these issues, various agencies have legal jurisdiction and responsibilities. Therefore, based on the coordination by RBC, all the relevant agencies can jointly accelerate the gazetting of river reserve and monitor the condition of river reserve. Moreover, after the establishment of SWRD or RBMO, they will take initiatives to encourage the other agencies to conduct these proposed activities.

(iii) Improvement of Public Awareness for River Management

Since the river shall be administrated for the public purposes, it is necessary to accelerate the stakeholders' participation by raising their awareness. Public awareness improvement programs shall be considered, planned and developed carefully based on the characteristics of the stakeholders. For agricultural farmers, for example, the program needs to include the information not only on the agricultural policy and activities but also on the other relevant issues such as water pollution, river erosion, water use balance, flood mitigation effects, etc. Therefore, the public awareness improvement programs shall be planned, developed and conducted jointly with other agencies through RBC.

(3) STRATEGY I-1.3: Integration of River Basin Information

For the implementation of IRBM, the development and sharing of accurate information among all the relevant agencies is significant.

(a) Measure I-3.1: Establishment of Integrated Information System for River Basin Management

<u>Current measures being implemented:</u>

- The National Register of River Basins Study proposed to establish a National River Basin Decision Support System (RB-DSS) to facilitate the integrated management of all river basins in the country. RB-DSS consists of River Basin Information Management System (RB-IMS), River Basin Geographical Information System (RB-GIS), and River Basin Simulation Modeling System (RB-SMS).
- DID acts as a secretariat to develop, maintain and update the river basin database to provide the water-related data to all the agencies involving in the river basin management.
- A web-based RB-IMS called "River Basin Information System (RBIS)" has been developed as for the intranet network of DID as trial.
- The development of Geospatial Data Infrastructure (MyGDI) was initiated by the government and Malaysian Center for Geospatial Data Infrastructure (MaCGDI) under NRE is responsible

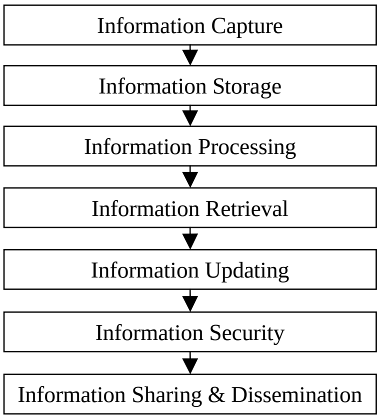
for the coordination, development and implementation of MyGDI as the clearinghouse of GIS database to the various agencies.

Lead implementing agency:

- DID
- MaCGDI
- All Relevant Agencies

Proposed action:

The objective of information management is to ensure that essential information is appropriately managed and disseminated to the stakeholders to support the transparent decision-making and to gain commitment and support for the decision made. The procedure for the river basin information management is summarized below:



Source: UNDP, *Integrated Water Resources Management for River Basin Organizations: Training Manual*, June 2008

Figure 5.5.4 Information Management Process

The contained data and data storage method shall be determined based on the necessity and issues for IRBM. The proposed captured data are listed in **Table 5.5.8**.

Table 5.5.8 Component of River Basin Information

Type	Component	Lead Agency
Administrative Data	- Administrative Boundary (state, district, sub-district, village)	- TCPD, Local Authority
	- Institution (relevant organization, legislative, guideline, manual, etc. related to river basin management)	- DID, Department of Local Authority, Local Authority
Social & Economic Data	- Land Use (Current and Future)	- TCPD, Land Office, Local Authority
	- Water Resource (surface, groundwater)	- BSKA, KeTTHA, DID, JBM
	- Water facilities	- JBA, SAINS, DID
	- Agriculture	- DOA
	- Fishery/Aquaculture	- DOFi
	- Livestock	- DVS
	- River Sand Dredging	- Land Office, DID
	- Flood/Drought Disaster Record	- DID, NSC
Environmental Data	- River Course	- DID
	- Hydrologic Data	- DID
	- Meteorological Data	- MMD
	- Topographic Data	- Dept. of Survey and Mapping, DID
	- Biodiversity	- DOE
	- Forest	- FD
	- Water Quality Monitoring Data	- DOE, MOH

As for the information storage, two major database so called “MyGDI and RBIS have been established by MaCGDI and DID respectively. However, the data contained in both databases are mutually related. Therefore, both database can be supportive tools each other and be considered to be integrated.

The stored information need to be processed from raw data for the dissemination to the stakeholders. In each database namely MyGDI and RBIS, these data will be retrieved and updated by MaCGDI and DID under the monitoring of the Technical Committee and Task Force regularly. The confidential data might be included, so the security of database shall be ensured.

It is necessary what information will be shared among the stakeholder and how to disseminate these shared information. In principle, these data are supportive for the decision-making and attractive for the acceleration of the stakeholders. Therefore, the contents and methods for the sharing and dissemination of the stored information shall be discussed and decided in the RBC.

The establishment of systematic river basin information management will enable the RBC to regulate and manage the water use, flood mitigation and river environment through the utilization of the database. However, in reality, due to the constrains of human resources and financial resources, the development of information management will be proceeded gradually. Moreover, the quality, format, procedure, etc. shall be standardized for the effective dissemination of the river basin information among the stakeholders.

In order to achieve the well-organized system on the river basin information management, the river basin information management plan, standard and guideline shall be established and approved by the Management Committee.

5.5.3 Ensure Sustainable Water Utilization

The policy of water utilization sector is to ensure sustainable water utilization. As repeated in the previous sections, the surface river water of the Muar River Basin is generally rich, and has a high potential for future development. There seems to be no issue on the surface. If closely examined, however, there are anticipated to appear very soon or already have appeared some negative issues such as impacts of Climate Change, imbalance of demand and supply capacity, negligence of environmental flow, Non Revenue Water (NRW), etc. The proposed policy aims to have the abundant water continuously and effectively utilized by the succeeding generations.

In order to achieve the above policy, three strategies are recommended:

Strategy W-1: Ensure Sufficient Water Resources

Strategy W-2: Ensure Sustainable Water Services Industry

Strategy W-3: Ensure Sufficient Irrigation Water

Strategy W-4: Ensure Safe Navigation

Under the three strategies, eight measures and their relevant proposed projects/actions are also proposed as shown in **Table 5.5.9**. Details of these measures and proposed projects/actions are described as below.

Table 5.5.9 Proposed Policy, Strategies and Measures

Policy	Strategies	Measures	Proposed Project/Action	Responsible Agencies	Remarks
Ensure sustainable water utilization	W-1: Ensure sufficient water resources	W-1.1: Monitor impact of Climate Change	W-1-1: Monitor impacts of Climate Change	BKSA, BAKAJ	
		W-1.2: Review water resources development plan		BKSA, BAKAJ, SAJH, SAINS, SPAN, PAAB, DID	Study is going on.
		W-1.3: Incorporate environmental flow with water resources development plan	W-1.3.1: Study on environmental flow	BKSA, BAKAJ, DID, DOE,	
		W-1.4: Establish response and coordination mechanism to droughts		BKSA, BAKAJ, DID etc.	Mechanism is available.
		W-1.5: Explore alternative water resources	W-1.3.2: Study on groundwater potential	BKSA, BAKAJ, JMG	
	W-2: Ensure sustainable water services industry	W-2.1: Complete restructuring of water services industry		SAINS, SAJH, SPAN, PAAB	Restructuring is going on.
		W-2.2 Reduce Non Revenue Water (NRW)	W-2.2.1: Reduce NRW	SAINS, SAJH, SPAN, PAAB	
	W-3: Ensure sufficient irrigation water	W-3.1 Manage irrigation facilities properly		DID	Efforts should be continuously made.
	W-4: Ensure safe navigation	W-4.1 Manage river course properly		DID, LA	Efforts should be continuously made.

(1) Strategy W-1: Ensure Sufficient Water Resources

(a) Measure W-1.1: Monitor Impact of Climate Change

Current measures being implemented:

- NAHRIM conducted a study on river flows of some river in Peninsular Malaysia including the Johor River in the “Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia”, Final Report, September 2006, NAHRIM.
- A long-term runoff analysis under impact of Climate Change was conducted under this Preparatory Survey.
- There is no specific monitoring on impacts of Climate Change in the Muar River after the above-studies.

Lead implementing agency:

- BKSA, BAKAJ

Proposed Project/ActionW-1.1.1: Monitoring Impact of Climate Change

It is generally said that climate change will make droughts severer. Although the long-term runoff analysis using average values of several GCMs and RCMs in this Preparatory Survey (refer to **Section 4.5**) incidentally happened to show no significant impact on low water discharges, a possibility of severer droughts can never be denied due to the so-called 'uncertainty' of Climate Change. Sea water intrusion by the sea water rise is also a concern. Therefore, it is proposed to monitor of the impacts of climate change, as follows:

(i) Review of IPCC

The Intergovernmental Plan on Climate Change (IPCC) is a scientific intergovernmental body tasked with evaluating the risk of climate change, and the panel was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP). IPCC publishes as assessment report every 4 or 5 years. The next 5th report is scheduled to be released in September 2013. The IPCC assessment report should be studied.

Monitoring Impacts of Climate Change

Carry out by	:	BKSA, BAKAJ
Duration	:	Every 5 years
Cost estimate	:	No significant additional cost
Coverage	:	Muar River Basin
Main scope	:	

- Review of IPCC
- Examination of Trend of Observed Rainfall Data
- Estimation of Impacts

(ii) Examination of Trends of Observed Rainfall Data

It is required to examine the trends of observed rainfall data of rainfall and river flow data in the Muar Basin.

(iii) Estimation of Impacts

Furthermore, it is also important to estimate the long-term runoff discharge in the Muar River Basin based on projection data by institutes worldwide with reference to **Section 4.5**.

(iv) Monitoring of Sea Water Intrusion

There are many intake facilities along the tidal stretch of the Muar River. It is required to monitor the sea water intrusion by measuring salinity regularly during high tides in dry season.

(b) Measure W-1.2: Review Water Resources Development Plan

Current measures being implemented:

- The Government of Malaysia made a decision to review "the National Water Resources Study 2000 – 2050" and DID is entrusted with the responsibility to carry out a study entitled "Review of the National Water Resources Study (2000 – 2050) and Formulation of National Water Resources Policy"

Lead implementing agency:

- BKSA, BAKAJ, SAINS, SAJH, SPAN, PAAB, DID

General Recommendations:

- The development of water supply investments has been carried out by Johor State and N. Sembilan State respectively in line with "the National Water Resources Study 2000 – 2050" that was published in 2000. As discussed in **Section 5.2**, it deemed that the actual consumption has already reached the water supply capacity at Kuala Pilah District.

- Fortunately, now the Review of the National Water Resources Study (2000 – 2050) is going on. The JICA Study Team hopes that the water resources development plan will be closely reviewed in due consideration of the above-said district-level issue.

(c) Measure W-1.3: Incorporate Environmental Flow with Water Resources Development Plan

Current measures being implemented:

- According to 'DID Manual Volume 2 River Management', the objective of environmental flow is to provide a flow regime that adequate in terms of quantity, quality and timing for sustaining the health of the rivers and other aquatic ecosystems. The environmental flow management strategies are also directed at two main types of management responses to the potential and extent of altered flow regimes as below:
  - A proactive response, intended to maintain the hydrological regimes of undeveloped rivers as close as possible to the unregulated condition, or at least to offer some level of protection of natural river flows and ecosystem characteristics.
  - A reactive response, intended to restore certain characteristics of the pre-regulation flow regime and ecosystem in developed rivers with modified/regulated flow regimes.
- For the Muar River no environmental flow has not been officially determined yet at present. According to personnel concerned, however, recently constructed dams are required to release a sort of compensation flow, although no water release as compensation flow during normal times have not been considered for old dams at all. This compensation flow seems to be dependent on each dam's judgment and condition, and it also seems to be unclear how to set up the flow amount.

Lead implementing agency:

- BKSA, DID, DOE

Proposed Project/ActionW-1.3.1: Study on Environmental Flow

Environmental flow is the amount of water needed in rivers to maintain healthy ecosystems. It is recommended to determine the environmental flow at several reference points in the Muar River Basin. Then the environmental flow should be incorporated into the water resources development plan, as flows:

(i) Site Survey

To grasp the situation in the Muar River, site survey is required focusing on river use, aquatic fauna and flora, water quality, river flow, and river works, etc. Several reference sites for environmental flow will be selected through this site survey.

(ii) Data Collection

Data collection of river flow data, river cross sections, width of water surface, etc., needs to be carried out.

(iii) Literature Study on Methodologies

Literature study on methodologies for determining environmental flow will be carried

Study on Environmental Flow

Carry out by	:	BKSA, BAKAJ, DID, DOE
Duration	:	2 years
Cost estimate	:	RM 1-2 million
Coverage	:	Muar River Basin
Main scope	:	

- Site Survey
- Data Collection
- Literature Study on Methodologies
- Determination of Environmental Flow at several reference points

out to select a suitable method for the Muar River Basin. According to the DID Manual, many methods are introduced as shown in **Table 5.5.10**. And, "Review of the National Water Resources Study (2000 – 2050) and Formulation of National Water Resources Policy" is also dealing with environmental flow. Therefore, results of this study will be informative in the method selection.

Table 5.5.10 Summary of Environmental Flow Methods

Organization	Categorization of Methods	Sub-category	Example
IUCN(Dyson et al. 2003)	Methods		Hydrological (e.g. Q95 Index) Ecological (e.g. Tennant Method)
		Desk-top Analysis	Hydrological (e.g. Richter Method) Hydraulic (e.g. Wetted Perimeter Method) Ecological
		Functional Analysis	BBM, Expert Panel Assessment Method, Benchmarking Methodology
		Habitat Modelling	PHABSIM
	Approaches		Expert Team Approach, Stakeholder Approach (expert and non expert)
	Frameworks		IFIM, DRIFT
World Bank (Brown & King, 2003)	Prescriptive approaches	Hydrological Index Methods	Tennant Method
		Hydraulic Rating Methods	Wetted Perimeter Method
		Expert Panels	
		Holistic Approach	BBM
	Interactive approaches		IFIM DRIFT
IWMI (Tarme, 2003)	Hydrological Index Methods		Tennant Method
	Hydraulic Rating Methods		Wetted Perimeter Method
	Habitat Simulation Methodologies		IFIM
	Holistic Methodologies		BBM DRIFT Expert Panel Benchmarking Methodology

Source; DID Manual

(iv) Determination of Environmental Flow at several Reference Points

The environmental flow will be determined using by the suitable method at the abovementioned reference points in the Muar River Basin. It is recommended to determine the environmental flow with careful consideration, and to make effort to ensure it for fish and functions of the river channels in the Muar River Basin. Moreover, it is strongly required to eliminate non-flow areas, which can be seen downstream of old dams.

(d) Measure W-1.4: Establish Response and Coordination Mechanism to Drought

Current measures being implemented:

- Mainly due to impacts of Climate Change, the risk of droughts is expected to increase. However, the Muar River Basin has no experience to response to droughts.

- Half of the Malaysian territory was affected during droughts in 1982-1983 and 1997-1998. After these severe droughts, 'Drought Disaster Administration Operation Regulations' were drawn up with some countermeasures.

- According to the Drought Disaster Administration Operation Regulations, Department of Meteorology, DID and JMG are the main agencies that have the authority to determine and release the warning regarding drought. **Table 5.5.11** explains about the warning stages for drought. These departments are also responsible to release and provide information regarding the drought to water users in accordance with the Information Release System shown below. All management agencies gather to 'Disaster Operation Control Center' to decide regarding the response to drought effects.

Table 5.5.11 Warning Stage for Drought in Malaysia

Stage	Remarks
Alert	A condition where weather activity change from normal to no rainfall and can cause difference in river water level. At this stage, final preparations are made.
Warning	A condition where continuous decrement of rainfall rate that caused decrement in main rivers water level. At this stage, preparations are done and ready to take action immediately.
Emergency	Start action

- JMG and DID announce early warning to National Safety Council and other agencies related when the situation reach alert level continuously until the termination level.

- Immediately after the announcement, National Safety Council activates the Management and Disaster Assistance Committee based on the drought level Stage 1 (district level), Stage 2 (state level) or Stage 3 (federal level), of which details are described in **Table 5.5.12**.

Table 5.5.12 Drought Levels

Level	Contents
1 (District)	Drought occurred in 1 or more area in a district . So, the rescue mission will be executed by the district management.
2 (State)	Drought occurred in 2 or more districts in a state. So, the rescue mission will be executed by the state management. Federal management team that is participated by the skeletal staff will be activated as well to observe the development and are preparing to help whenever needed.
3 (federal)	Drought occurred in 1 state or more, depending on the drought level. So, the federal management will be in action to give assistance.

Lead implementing agency:

- BKSA, BAKAJ, SAINS, SAHJ, DID, Department of Meteorology, JMG

- Mainly due to impacts of Climate Change, the risk of droughts is expected to increase. However, the Muar River Basin has no experience to response to droughts.

General Recommendations:

- There has ever not been reported any serious drought in the Muar River basin. Consequently, the Muar River Basin fortunately has not made use of the above-said response and coordination mechanism during droughts, namely the Muar River Basin has no experience. Any special project or any special action is not proposed here, however, it is strongly required to execute a kind of simulation every year before dry season for the emergent response and the coordination procedures during droughts.

(e) Measure W-1.5: Explore Alternative Water Resources

Current measures being implemented:

- Currently, there are no specific designated alternative water resources to river water in the Muar River Basin because of ample river water.

Lead implementing agency:

- BKSA, BAKAJ, JMG

Proposed Project/ActionW-1.5.1: Study on Groundwater Potential

Groundwater in the Muar River Basin has been hardly developed. It is recommended that the groundwater be explored as an alternative water resource to prepare for any contingency. Thus, the following study is proposed for this purpose, as follows:

(i) Literature Study

All available information and various types of maps, such as topographic maps, geologic maps, aerial photographs, study reports, and data of water use and hydro-geology concerning the Muar River basin are collected and analyzed. Based on the literature study, target study areas are determined.

(ii) Field Reconnaissance

Field Reconnaissance is carried out to complement the Literature Study at the target areas. A fact-finding survey is also carried out to grasp the situation of water use from residents.

(iii) Observation

Observation is carried out collate qualitative and quantitative information of the hydrological conditions. It entails rainfall data, evaporation dada, river flows, well water level and water quality.

Understanding of groundwater and surface water conditions and the interaction based on existing data can help guide hydro-geologic modeling and aspects of the more detailed investigations.

(iv) Drilling and Pumping Test

Exploration drilling and pumping test is conducted to provide detailed information on groundwater conditions. Understanding of groundwater and surface water conditions and their interaction based on the test data help hydro-geological modeling.

(v) Analysis

Groundwater availability is analyzed by using the hydro-geological simulation model.

(vi) Selection of Groundwater Development Areas

Groundwater development areas are selected based on the above analysis.

(vii) Settlement on Groundwater Development Plan

The main goal with this groundwater development is to supply water of a good quality certainly at least cost in case of a contingency. Consequently, it is required that groundwater development plan, including abstraction points, the number of wells, distribution of water pipes etc., is settled.

Study on Groundwater Potential		
Carry out by	:	BKSA, BAKAJ, JMG
Duration	:	2 years
Cost estimate	:	RM 3-4 million
Coverage	:	Muar River Basin
Main scope	:	

- Literature Study
- Field Reconnaissance
- Observation
- Detailed Survey
- Analysis of Study Results
- Selection of Groundwater Development Areas
- Settlement of Groundwater Development Plan

(2) Strategy W-2: Ensure Sustainable Water Services Industry

(a) Measure W-2.1: Complete Restructuring of Water Services Industry

Current measures being implemented:

- Water Services reform requires a new industry model that can transform the industry to a long-term sustainable operating model. With an amendment of the Federal Constitution and creation of two acts, the Federal Government became to regulate the water and sewerage services industries in terms of licensing regulating services operators, while state governments retain the power to regulate water resources, water catchment areas and river basins. The water services industry will be privatized and integrated with the sewerage industry.
- Restructuring of the water service industry, covering water supply and sewage services, began during 8th Malaysian Plan period with the objective of creating and efficient and sustainable water services industry.
- Negeri Sembilan State has migrated into the new regime in 2008, and SAINS as semi-government corporation as a water supply operator. Johor State has migrated into the scheme in 2009 with SAJH, the private company.

Lead implementing agency:

- SAHJ, SAINS

General Recommendations:

During the 10th Malaysian Plan period, restructuring efforts will enter into its final phase as shown in **Table 5.5.13**. Any special project or any special action is not necessary to propose, however, both N. Sembilan State and Johor are being expected to complete the restructuring shown below within 10th Malaysian Plan period to ensure sufficient water use in the Muar River Basin.

(i) Completing Migration of Water Operators

Full migration will be completed during the 10th Malaysian Plan period. Upon migration, the water operators will have to comply with the provisions of the Water Services Industry Act, 2006 and will be regulated by the National Water Services Commission or Suruhanjaya Perkhidmatan Air Negara (SPAN).

(ii) Moving towards full cost recovery

Tariffs in 2009 covered only 78% of operating expenditure in Malaysia. To address this problem, the Government will phase in a tariff-setting mechanism that allows full recovery of costs to encourage sustained investments in upgrading and rehabilitating water treatment plants and distribution systems. It is essential that Johor State and N. Sembilan State act promptly according to this movement respectively, however, it is necessary to protect the poor.

(iii) Driving efficiency in operations and capital expansion

Water operators will be required to provide detailed 30-year business plans and 3-year operational plans. These plans will be the basis for a roadmap towards full cost recovery and will allow Pengurusan Aset Air Berhad (PAAB) to plan long term capital expenditure funding. SPAN will regulate and monitor the performance of water operators based on the plans, linking tariff increases to efficiency gains in operations and capital expenditure.

(iv) Integrating water and sewerage services

Restructuring of sewerage services will be implemented by parcelling out the operations of centralised sewerage services to the respective state water operating companies.

When completed, the industry will move towards implementing an integrated tariff for both water and sewerage services. Both Johor State and N. Sembilan State are required to follow this movement.

Table 5.5.13 Restructuring Schedule of Water Services Industry

Malaysian Plan	Contents
8th 2001-05	**Stabilization** • Privatisation and corporatisation of state water authorities • Planning for restructuring of water services industry
9th 2006-10	**Consolidation** • Operationalisation of National Water Services Commission (SPAN) • Enforcement of Water Services Industry Act (WSIA), 2006 • Pengurusan Aset Air Berhad (PAAB) takes over existing water assets from state at negotiated values and is responsible for implementing water infrastructure development • State water operators are asset-light and focus on service provision
10th 2011-15	**Moving towards efficiency in operations and management** • Tariff-setting mechanism to allow full cost recovery to be completely phased in by 2013 • Integration of water supply and sewerage services • Initial efforts towards the introduction of integrated water and sewerage tariffs

Source: 10th Malaysian Plan

(b) Measure W-2.2: Reduce Non-Revenue Water

Current measures being implemented:

- NRW is a significant issue for the water industry in Malaysia. The NRW rates of Negeri Sembilan State and Johor State are 53.1 % and 31.3% respectively, about 15% higher than the national average of 37%. Both JBA and SAINS have been making efforts to reduce NRW, but no significant effect has been reported.

Lead implementing agency:

- JBA, SAINS, SPAN, PAAB

Proposed Project/ActionW-2.2.1: Reduction of NRW

The current NRW rate in the Muar River basin is assumed at about 30 %, and this prominent NRW rate brings unreasonable water abstraction and water treatment plant capacities and increase in the financial expenditure. According to a book entitled 'THE WATER TABLET; MALAYSIAN WATER REFORMS' the economical breakeven point is around 20 % as shown in **Figure 5.5.5**. Therefore, a project to reduce NRW is proposed as follows.

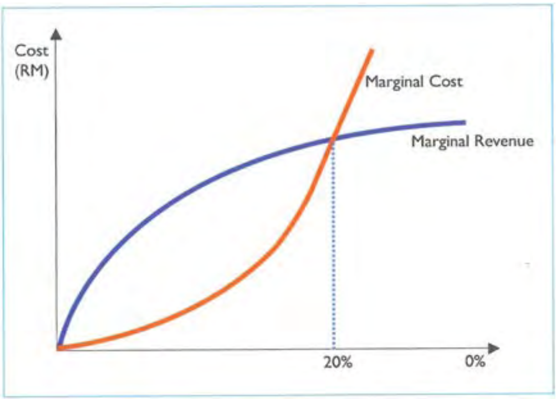
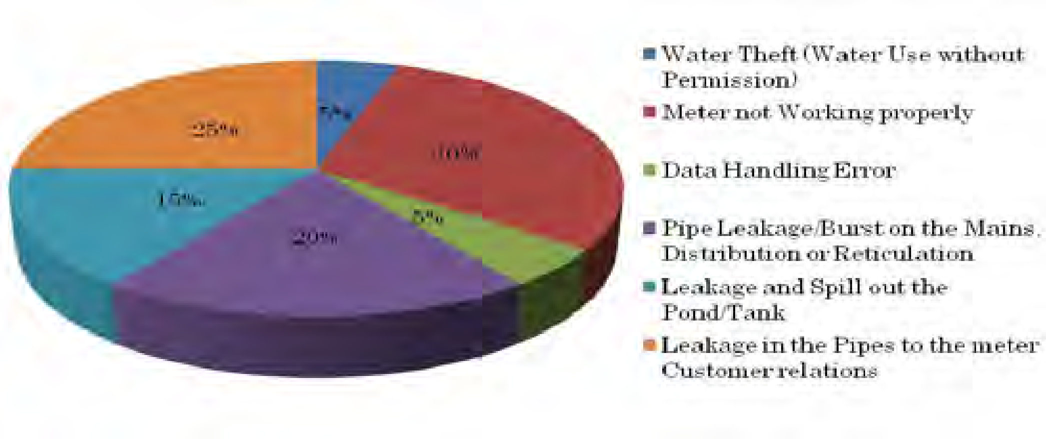


Figure 5.5.5 Economical Breakeven Point for NRW

(i) Analysis of Main Cause of NRW

Figure 5.5.6 shows the cause of NRW in N. Sembilan State. It can be seen from this figure that pipe leakage and meter troubles are the main causes of NRW. This seems to be a common consensus to all water operators in the world. Thus, it is required to analyze the main causes of NRW in the Muar River Basin firstly, and to grasp points/areas of outbreaks.



Source; SAINS

Figure 5.5.6 Cause of NRW

(ii) Pipe Repair/Replacement

Reduce NRW	
Carry out by	: SAJH, SAINS, SPAN, PAAB
Duration	: Every year
Cost estimate	: No significant additional cost
Coverage	: Muar River Basin
Main scope	:

- Analysis of Main Cause of NRW
- Pipe Repair/Replacement
- Meter Repair/Replacement

As the abovementioned, the pipe leakage is supposed to be one of the main causes of NRW commonly. The length of leakage time has a big influence on the leakage volume, so repairs or replacement should be conducted as soon as possible. The pipe leakage is generally classified into two types by its form as 'Surface Leakage' flows out on the ground and 'Underground Leakage' leaks out underground without appearing on the surface. 'Surface Leakage' is quite easy to find out, however, 'Underground Leakage' is not so easy to identify the source of leak because of its form. Tokyo Metropolitan Government, Japan has achieved the low leakage rate of 3.1 % in 2008. The Leakage investigation methods or special equipment being used in the 'Bureau of Waterworks, Tokyo Metropolitan Government' are mainly four methods and 2 special equipment. They are introduced in the following box as a good practice:

Box-1; **Leakage Investigation Methods/Equipments**

I. Minimum Night Flow Measurement Method

The minimum night flow measurement is a method that pays attention to the time period when there is no water usage in a block (Unoccupied hour), as shown in Figure-1. First, gate valves surrounding the block to be investigated are closed and the water from other blocks is shut down. Then the water is sent into the block through minimum flow measuring equipment set in the block water meter and the flow rate is measured. The minimum flow rate measured during the vacant period is considered to be the leakage. High precision portable minimum flow measuring equipment* as shown in Photo-1 is used in the measurement.

* This equipment was developed jointly by the Bureau and private industry.

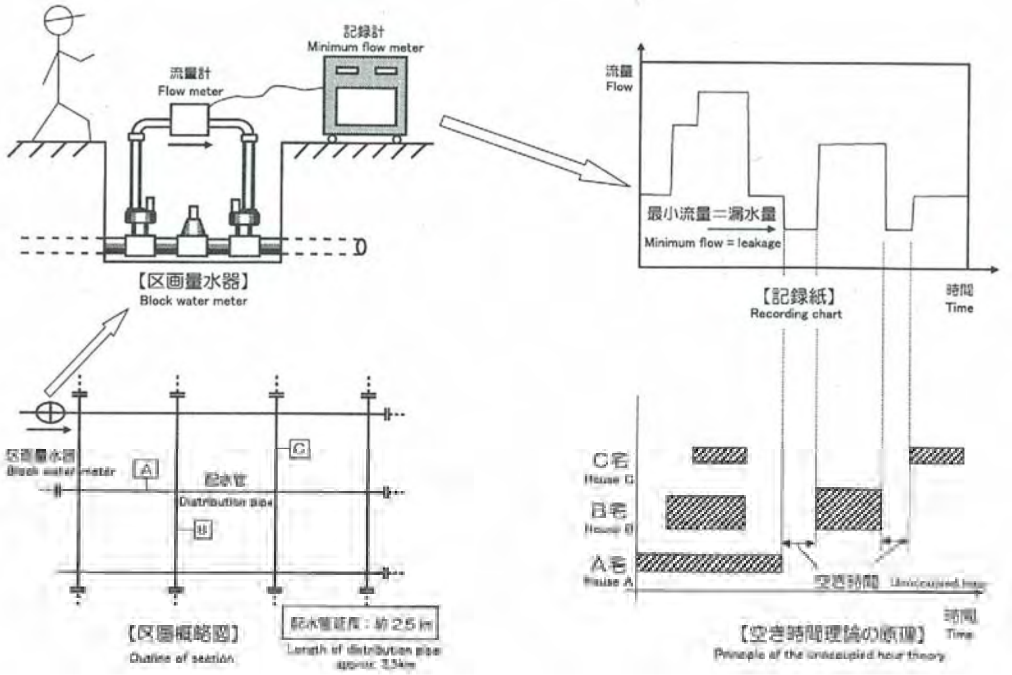


Figure-1 Theory of Minimum Night Flow Measurement Method

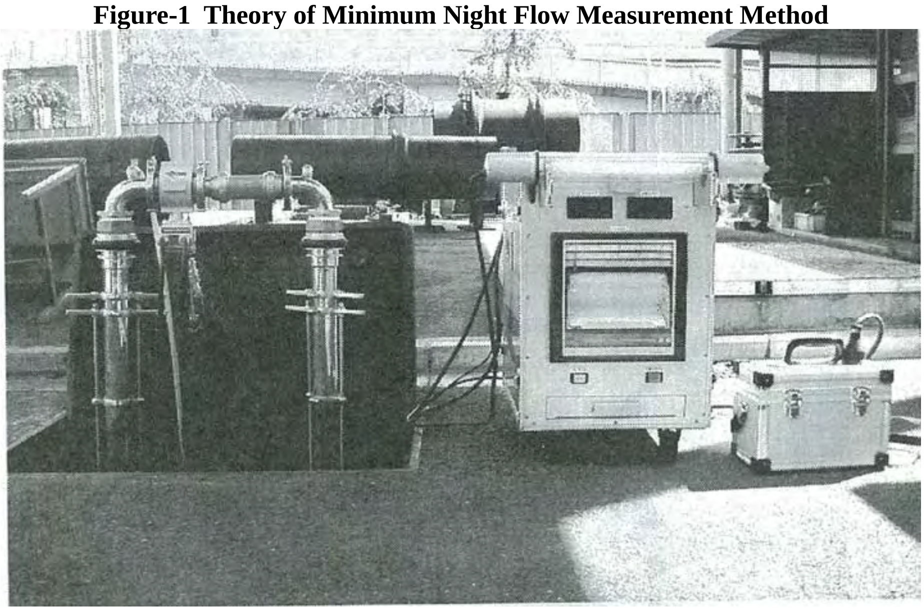


Photo-1 Portable Minimum Flow Meter

II. Acoustic Method

In the acoustic method, the leak sound is detected by an acoustic rod or an electronic leakage detector. The metal tip of the acoustic rod is pressed against the water meter, gate valve of fire hydrant. Acoustic Rods and an Electronic Leakage Detector are shown in Photo-2. An inspector then presses an ear against a vibration diaphragm set at the other end of the rod, and listens for transmitted sound of the leakage as shown in Figure-2. The acoustic rod can only tell whether the leakage is occurring in the neighborhood, but it is difficult to detect the position of leakage. Using an electronic leakage detector, a pickup to convert the leak sound into an electrical signal is placed on the ground, and the sound transmitted through the ground is amplified and heard through headphones. As the pickup is moved in order, the leak sound is heard most strongly directly above the point of leakage and thus the position of leakage can be detected.

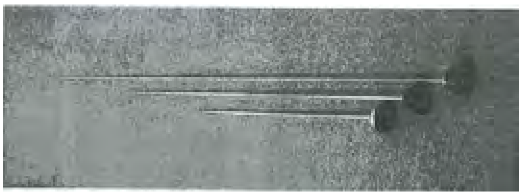


Photo-2 Acoustic Rod

Photo-3 Electric Leakage Detector

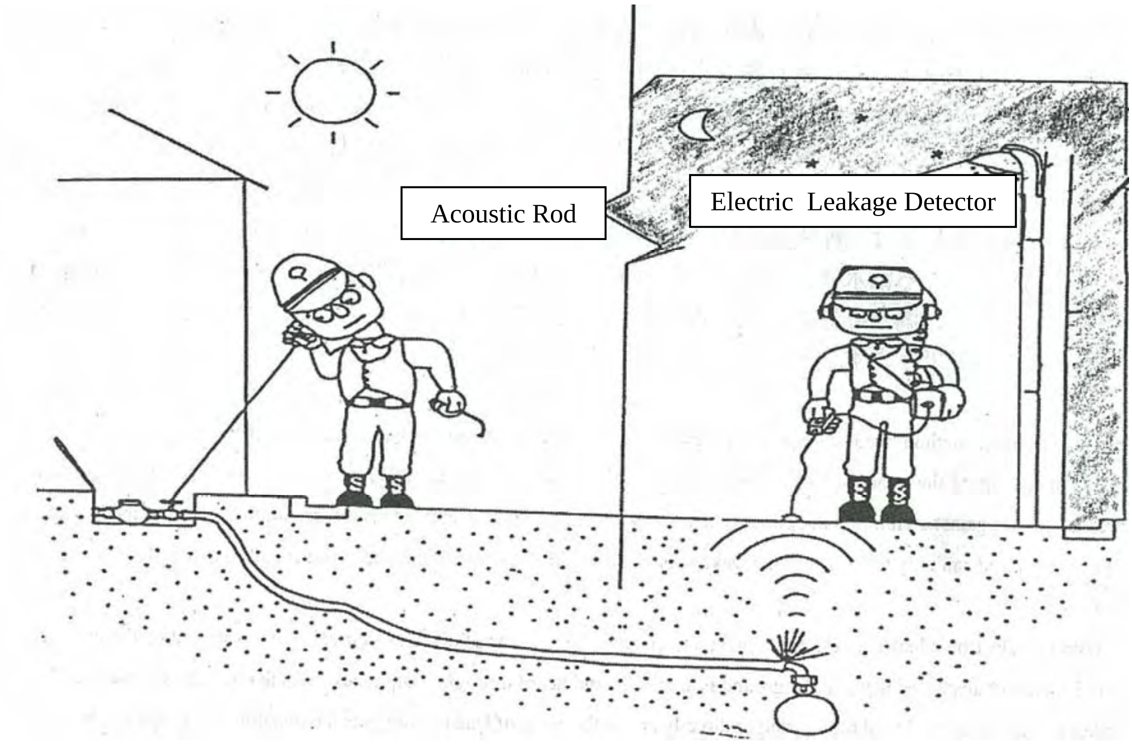


Figure-2 Acoustic Method

III. Correlation Method

In the correlation method, the position of leakage is detected by using a correlation type leakage detector (a combination of correlation analyzer, sensor, amplifier, wireless transmitter, etc. as shown in Photo-3). First the sensor is placed on either side of the expected point of leakage in the pipeline and the time lag of leakage sound reaching the two sensors is obtained by the correlation analyzer. The position of leakage is calculated by the time lag, distance between sensors, and velocity of leaking sound transmitting through the pipe as shown in Figure-3. The correlation type leakage detector* has the excellent characteristic of being largely unaffected by traffic noise or laying depth of the pipe.

* This detector was developed jointly by the Bureau and private industry.

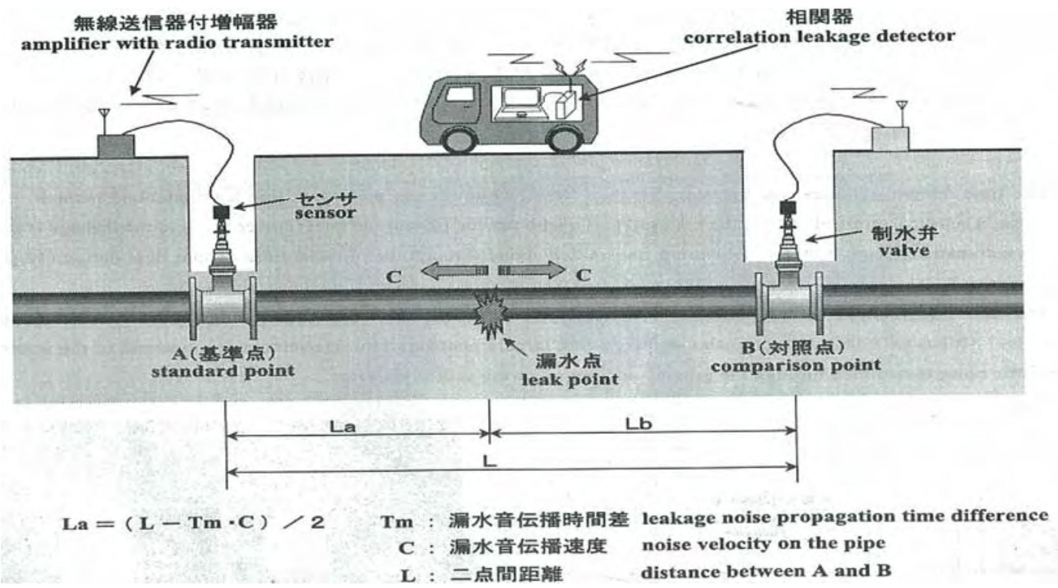


Figure-3 Theory of the Correlation Method

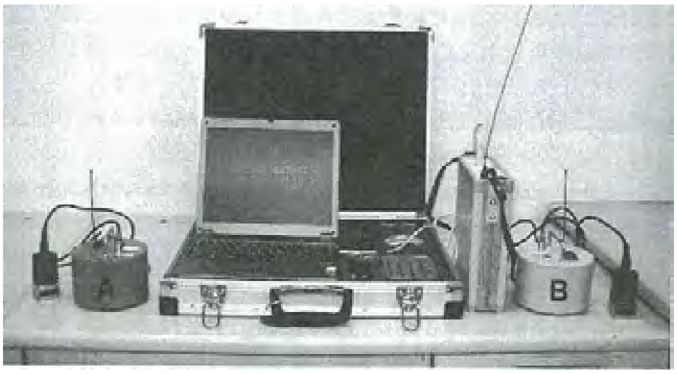


Photo-4 Correlation Type Leakage Detector

IV.Time Interval Type Leakage Detector

The time integral type leakage detector detects a leakage by utilizing the character that leaking sound persists. In this detector, sensor is pressed against the exposed part of the service pipe in the water meter box and the leakage is detected by an automatic leakage detector, measuring transmitted sound through the pipeline for certain time period (10 seconds to 3 minutes). The time integral type leakage detector* shown in Figure-4 has excellent characteristics such as being largely unaffected by intermittent usage sound of the waterworks or traffic noise transmitted through the ground, and not requiring skill to operate.

* This detector was developed jointly by the Bureau and private industry.

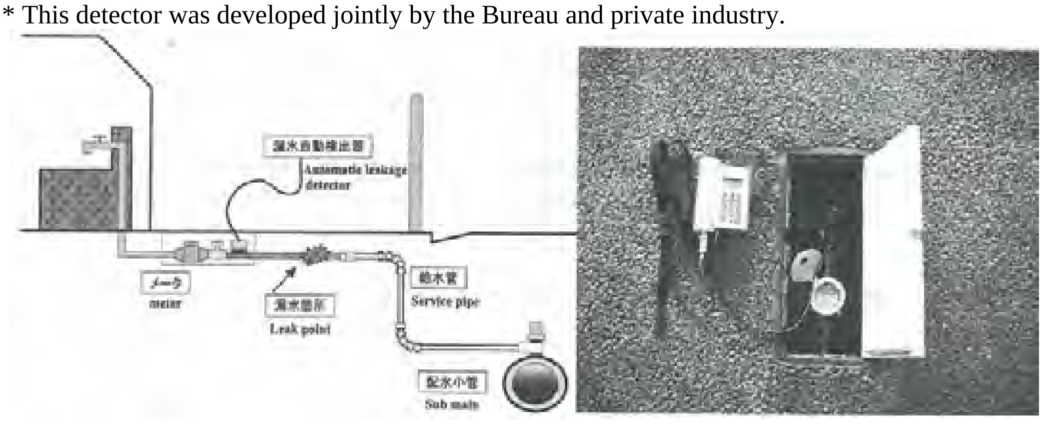


Figure-4 Time Integral Type Leakage Detector

V. Transmission-type Leakage Detector

The transmission-type leakage detector* is used for a leakage investigation in a pipe, where Chemically inert helium gas mixed with water or air is injected into, by detecting the helium gas leaked from the pipe and seeped through the ground as shown in Figure-5. This type of method allows to detect very small amount of leakage or leakage in bigger pipes such as main distribution pipes buried deep underground since it is not based on the leak sound as the acoustic leakage sound detection method or the correlative leak detection method.

* ; This detector was developed jointly by the Bureau and private industry.

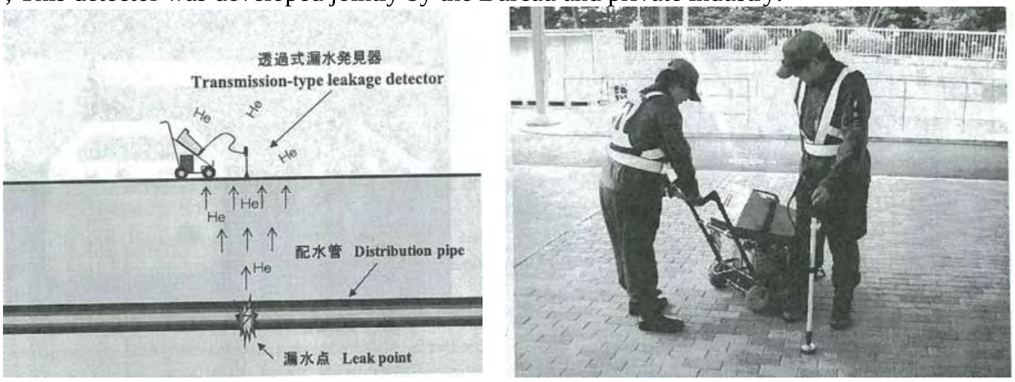


Figure-5 Transmission-Type Leakage Detector

VI. Other Methods

Leakage investigation requires not only the technology to identify the leakage but also those to detect the position of laid or to test water quality to determine whether leaking water is tap water. Metal Pipe Detector, Nonmetal Pipe Detector and Water Hammer Generator are used to detect the pipe location. Metal Pipe Detector and Water Hammer Generator are shown in Photo-4. To test whether it is the tap water or not, simple methods using a thermometer, residual chlorine meter, pH meter and electrical conductivity measuring equipment, or more precise methods of detecting trihalomethane and others are applied.

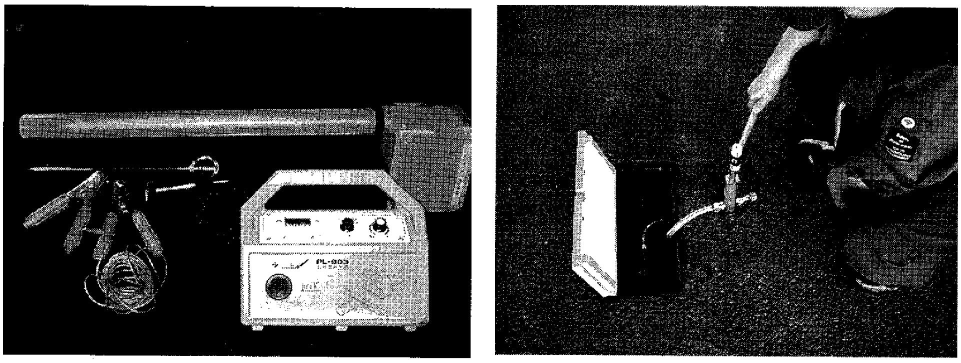


Photo-5 Metal Pipe Detector (left) and Water Hammer Generator (right)

Source: Bureau of Waterworks, Tokyo Metropolitan Government

(iii) Meter Repair/Replacement

Meter troubles are also one of the main causes of NRW. Generally, the meter troubles are classified into 2 types, inaccuracy of meters and reading error. It is required that defective meters should be repaired or replaced.

There are 889,000 and 217,000 meters in Johor and Negeri Sembilan States respectively as of 2008. Out of them, 107,000 (12%) and 74,000 (34%) meters are 8 years or older respectively, while the national average is 35%.

It is essential to maintain properly meters and renew them periodically because aged meters are apt to get into trouble. Moreover, on the occasion of renewal, the new model of meter should be carried out taking the accuracy of meters by type into consideration. **Table 5.5.14** shows the meter accuracy for reference.

Table 5.5.14 Indicative Examples of Meter Accuracy

Equipment/Method	Approximate Accuracy range
Electromagnetic Flow Measures	<0.15- 0.5 %
Ultrasonic Flow Meters	0.5 - 1 %
Insertion Meters	<2 %
Mechanical Meters	1.0 - 2 %
Venturi Meter	0.5 - 3 %
Meas. Weirs in open channels	10 - 50 %
Volume calculated with pump curves	10 - 50 %

Note: Actual meter accuracy will depend on many factors (like flow profile, calibration, meter installation, maintenance) and has to be verified case by case.
Source; World Bank Institute, 2007

(iv) Reading Error

Meter Readers are required to make accurate reading. Especially simple errors such as misreading of decimal positions should be avoided. Therefore, it is important to train the meter readers and to keep them motivated. For this purpose, awareness program for education and training is necessary to develop and maintain capacities of them.

(3) Strategy W-3: Ensure Sufficient Irrigation Water

(a) Measure W-3.1: Manage Irrigation Facilities Properly

Current measures being implemented:

- Water Supply for irrigation is being carried out by DID in the Muar River Basin. Irrigation Water is taken at intakes and is led into paddy fields through canals.

Lead implementing agency:

- DID

General Recommendations:

- As the above-mentioned, DID is maintaining the irrigation water supply facilities to ensure the irrigation water. Therefore, any special project or any special action is not proposed in this study. However, it is necessary that DID should continuously manage the irrigation water supply facilities properly so as not to interfere with irrigation. Moreover, it is required to make further efforts to ensure the irrigation water taking the climate change into consideration in the future.

(4) Strategy W-4: Ensure Safe Navigation

(a) Measure W-4.1: Manage River Course Properly

Current measures being implemented:

- Navigation activities, such as inland fishing boats and traffic boats, are widely seen in the Muar River Basin.

- As the above-mentioned, the Muar River is utilized mainly for fishing boats and traffic by villagers for daily activities including going to and coming back from school, commuting and shopping. By the way, there are a lot of garbage, such as water hyacinths, dead palms, semi-submerged large branches in the Muar River Basin. It is pointed out that some boats operators and passengers have experienced dangerous situations due to these garbage. DID has a role to maintain the river-course in the Muar River Basin.

Lead implementing agency:

- DID, LA

General Recommendations:

- Any special project or any special action is not proposed in this survey. However, it is important that DID should continuously manage river-course properly in cooperation with LA so as to ensure safe navigation.

5.5.4 Create a Sustainable and Pleasant River Environment

The policy of environment sector is to create a sustainable and pleasant river environment. 'River environment' here refers to the natural environment of the whole river basin that includes river channel itself as well as the catchment area. 'Sustainable' means that it is necessary to protect the natural biodiversity, water catchment capacity as well as the cultural heritage of the river basin while appropriately making use of the natural resources for economic purposes such as timber extraction, eco-tourism development, mining, plantation, etc. 'Pleasant river environment' means that it is necessary to create a scenic river view and riverfront that harmonize with the urban development, townscape as well as local culture and history. On a whole, the policy aims to promote the protection of natural environment of the river basin, with sustainable exploration of natural resources and appropriate landscaping of riverfront at selected locations of urban centers.

In order to achieve the above policy, the following strategies are recommended:

Strategy E-1: Reduce Pollution Load to Ensure Achievement of at Least NWQS Class II River Water Quality

Strategy E-2: Maintain the natural biodiversity of the river basin

Strategy E-3: Protect the catchment areas for water intake to avoid contamination and depletion of water resource

Strategy E-4: Make use of river as an asset for townscape and recreational activities

The above strategies and the respective measures and their components are discussed in this subsection, and are summarized in **Table 5.5.15.** Further to the proposed strategies, measures, and general recommendations, this section presents proposed specific projects/actions that deemed to be important and urgent to be implemented. When reading this section, it is recommended that it should be read together with the same section of the Volume 3 Pahang River Basin. This is because there are a lot of common issues between these two river basins. Also, when the proposed project is similar in both river basins, the implementing agency may choose to pilot at one of the river basins or one of the three States involved. So, when implementing the projects/actions, close coordination among the related agencies at Federal level and State level agencies in Pahang, Negeri Sembilan and Johor is needed, so as to avoid any duplication of work.

Table 5.5.15 Proposed IRBM Strategies and Measures towards Creating a Sustainable and Pleasant River Environment

Policy	Strategies	Measures	Components of Measures	Proposed projects/actions	Responsible Agencies	Remarks
Creating a Sustainable and Pleasant River Environment	E-1: Reduce pollution load to ensure achievement of at least NWQS Class II water quality.	E-1.1 Reduce wastewater discharge	Provision of sewerage services for treatment of domestic wastewater.		SPAN, IWK	Being implemented
			Strict control of industrial effluent to ensure compliance with the Environmental Quality (Industrial Effluent) Regulations 2009.	**E-1.1.1: Capacity development for establishment of a mechanism for developing and maintaining pollution load inventory.** **E-1.1.2: Study on drinking water treatment sludge in Malaysia**	DOE	**The issue of water treatment sludge needs to be solved.**
			Control of wastewater discharge from livestock farms (particularly pig farms).	-	DVS	Being implemented.
			Control of wastewater from commercial activities such as wet-markets, restaurants and food stalls.	**E-1.1.3: Feasibility study and pilot project for wastewater treatment system for wet-markets**	LA	**Measure on wet market is still inadequate.**
			Collection and treatment of all used oil and grease from vehicle workshops.	-	DOE, LA	Being implemented.
			Treatment of leachate from dumpsites/landfills.	-	SWM (N.S.), Alam Flora (Pahang)	Being implemented.
		E-1.2: Implement integrated waste management by reducing waste as source, increasing recycling rate and ensuring efficient and clean disposal.	Prohibit indiscriminate disposal of solid waste (including construction wastes).	-	LA, SWM (N.S.), Alam Flora (Pahang)	Being implemented.
		E-1.3: Minimize siltation of river by reducing erosion at source and controlling runoff of eroded soil particles into rivers.	Control siltation by construction activities.	-	LA, DOE	Being implemented.
			Control siltation by logging activities.	-	Forestry Dept, DOE	Being implemented.
			Control siltation by agricultural activities.	-	DOE	Being implemented.
			Control siltation by sand dredging activities.		PTG, DID, DOE	Being implemented.
		E-1.4: Minimize runoff of agrochemicals into rivers.		**E-1.4-1 Monitoring of agrochemicals**	DOA, LA, DOE	**Further improvement is necessary**
	E-2: Maintain the natural biodiversity of Basin.	E-2.1: Control large scale agricultural development		-	JPBD, DOE	Being implemented.
		E-2.2: Control logging activities		-	Forestry Dept., DOE	Being implemented.
		E-2.3: Proper planning and management of Environmental Sensitive Areas.			JPBD, LA, DOE, PERHILITAN, Forestry Dept., BKSA	Being implemented.
	E-3: Protect the catchment areas for water intake to avoid contamination and reduction of water resource.	E-3.1: Proper management of all catchment areas for water intake.				
	E-4: Make use of river as an asset for townscape and recreational activities.	E-4.1 Integrate rivers into the townscape and recreational facilities.		-	JPBD, LA	Being implemented

(1) Strategy E-1: Reduce Pollution Load to Ensure Achievement of at least NWQS Class II River Water Quality

In order to create a sustainable and pleasant river environment, firstly it is necessary to ensure clean water. This strategy aims to control pollution at source by reducing pollution load from various sources of pollution.

(a) Measure E-1.1: Reduce Pollution Load from Wastewater Discharge

(i) Provision of Sewerage Services for Treatment of Domestic Wastewater

Sewage generally refers to any liquid waste or wastewater discharge containing human, animal, domestic or putrescible matter in suspension or solution (Environmental Quality (Sewage) Regulations 2009). It is one of the main pollution loads from urban activities. Generally, organic loading from raw sewage is around 250 mg/l BOD per population equivalent per day (Malaysian Sewerage Industry Guidelines, 2009). As one of the measures to reduce wastewater discharge, it is necessary to provide sewerage services for collection and treatment of all domestic wastewater (mainly from dwelling houses) before discharging into waterways.

Current measures being implemented:

- Indah Water Konsortium Sdn Bhd (IWK), a wholly-owned company of the Minister of Finance Incorporated, is responsible (since 1994) for operating and maintaining the public sewage treatment plants and network of underground sewerage pipelines. The main scope of service of IWK includes:

- Operation and maintenance of public sewage treatment plants that built by developers and handed over to the Government (SPAN):
  - Refurbishing and upgrading of existing sewage treatment plants; and
  - Planning and building new sewerage infrastructure.

- In order to ensure systematic implementation of sewerage services, IWK has prepared (or in the progress of preparing) Sewerage Catchment Strategies (which means the sewerage service master plans) for all Districts.

- On the other hand, for premises with individual septic tanks (ISTs), under the Water Services Industry Act 2006, premise owner is responsible for the maintenance of the septic tank. In this respect, it is under the National Water Service Commission (SPAN) requirement that all premise owners with ISTs must desludge their ISTs at least once in every two years. The desludging work must be done by licensed contractors such as IWK.

Lead implementing agency:

SPAN, IWK

General Recommendations:

- The present effort of IWK in providing, maintaining and refurbishing sewerage services should be continued.

- As all the individual houses (including village houses) and housing schemes less than 30 units are still using ISTs, it is important to ensure that all houses with ISTs are maintaining their ISTs properly based on SPAN's requirement of desludging at least once in every two years. Also, it is also vital to ensure that all the individual houses and village houses are provided with ISTs that compliance with the design requirements of SPAN as per the Malaysian Sewerage Industry Guidelines: Septic Tanks.

Proposed Project/ActionE-1.1.1: Capacity Development for Pollution Load Inventory

One of the prerequisites of effective water quality management it to ensure comprehensive management of pollution sources. Pollution sources can generally be divided into point sources such as industrial discharges and non-point sources like runoff of agrochemicals. As part of pollution source management, it is necessary to understand the pollution load from each pollution source into the rivers.

As elaborated in the earlier section of the present report, DOE is the lead agency in water quality management in Malaysia (besides Sabah and Sarawak). DOE has three main roles in this respect, i.e. safeguarding the river water quality (the environment), monitoring of the water quality status and environmental education. Despite that DOE has the function of safeguarding the river water quality, the mandate of DOE is very limited. Although the control of point sources such as industrial effluents and sewage is under the jurisdiction of DOE, the Department does not have authority in regulating pollution loads from non-point sources such as agricultural activities, aquaculture, small-scale construction activities, mining and quarrying, as well as a number of point sources, such as the pollution loads from wet-markets, food stalls and individual septic tanks. Furthermore, although DOE is undertaking monitoring of river water quality, the Department does not have any authority in controlling of river water quality for example setting target water quality according to its intended uses, and direct control and enforcement on all pollution loads into the rivers.

In view of the above, in order to promote integrated water quality management, it is deemed necessary for DOE to compile a pollution load inventory. It must be emphasized that the inventory should not static information, but more importantly, it should be a database that will be updated on a regular basis, and be used as a tool in water quality management, including the routine monitoring and enforcement as well as a tool to support decision making in development planning. Hence, instead of an integrated water management plan study that DOE has carried out for several river basins throughout the country, a capacity development project is recommended here. As the problem of unavailability of a centralized database for pollution load is not only happened in the Muar River Basin, but all the river basins throughout the country, it is deemed that by merely conducting a study to establish an inventory is not a long-term solution to the problem. Instead, it is necessary to strengthen the capacity of DOE as a one-stop agency responsible to establish and maintain a centralized pollution load database for each river basin.

Capacity Development for Establishment of a Mechanism for Developing and Maintaining Pollution Load Inventory

Carry out by : DOE, Negeri Sembilan and Johor
Duration : 2 years
Cost estimate : RM 2-4 million
Coverage : Muarg River Basin
Main scope :

- Analysis of the existing situation of pollution load information management system.
- Establishment of a framework for pollution load inventory database.
- Establishment a mechanism for data collection and maintenance.

The outline of the abovementioned capacity development project is presented in the box on the right. The gist of this proposed project is not on the database itself but the ‘mechanism’ to establish the inventory database, to maintain it and to use it as a tool to support decision making in development planning. So the main component of the project would be to establish a new function or task within the existing organization setup of DOE. The project should deal with the DOE Negeri Sembilan and/or DOE Johor as a whole, and the project may use the Muar River Basin as a case study. It must be highlighted here that same recommendation has been made for the Pahang River Basin (see Part 3 of this report), so as mentioned above, coordination among DOE Negeri Sembilan, Johor and Pahang is necessary in the implementation of the action plan. These State DOEs may either pilot the project at one of the three State DOEs or may also undertake the project concurrently at all the three States.

- The first task is to understand the existing situation of pollution load information management. Basically it is to answer the question of ‘who has what?’. This will firstly necessary to identify all the pollution sources then to find out the agency responsible for each pollution source, and whether a complete database is available.

- After understanding the existing situation, next step would be to work out a complete framework of a centralized pollution load inventory database. This framework will serve the basis for the subsequent work to establish a mechanism for data collection and database maintenance by DOE.

- The third component would need to work very closely with the DOE Negeri Sembilan and DOE Johor, to understand the existing organization setup of the Department and its strengths and weaknesses in setting up of a centralized database for pollution load inventory. Close coordination with the DOE is necessary to make use of the existing resources to take a new task as the centralized agency to keep and maintain the pollution load inventory database.

(This is a common recommendation for both the Muar and Pahang River Basins. Close coordination between the implementing agencies of these two river basins is necessary)

Proposed Project/ActionE-1.1.2: Detailed study on drinking water treatment sludge in Malaysia

One of the by-products of water treatment process is the water treatment sludge (residue). It is normally from the sludge drawn from sedimentation tanks, wash water from filter backwash, and tank drainage. As Alum and polyaluminium chloride (PACI) are commonly used as coagulants in drinking water treatment, aluminium content in the water treatment sludge is generally high. Presently, old plants are discharging the water treatment sludge directly into the rivers, while some new plants are using mechanical dewatering machines to dewater the sludge then disposing the dewatered sludge within the plant sites or landfills.

> Environment Quality (Scheduled Waste) Regulations 2005:
>
> Schedule Waste SW204 refers to *sludge containing one or several metals including chromium, copper, nickel, zinc, lead, cadmium, aluminium, tin, vanadium and beryllium*'
>
> Environmental Quality (Industrial Effluent) Regulations 2009:
>
> Industrial effluent refers to *any waste in the form of liquid or wastewater generated from manufacturing process including the treatment of water for water supply or any activity occurring at any industrial processes.*

Water treatment sludge is categorized as a 'Scheduled Waste' under the Environment Quality (Scheduled Waste) Regulations 2005. Also, the discharge of wastewater from water treatment process, that containing also the water treatment sludge, can also be subject to the requirements of the Environment Quality (Industrial Effluent) Regulations 2009.

So far the Department of Environment has not fully enforced the Scheduled Waste requirements on the drinking water sludge. If the Regulation were fully enforced, all water treatment plant operators will not be allowed to discharge the sludge directly into rivers, and the dewatered residues will have to be sent to Schedule Waste treatment facilities at Bukit Nenas, Negeri Sembilan. The issue is that it will entail in requirement for retrofitting of all old plants for sludge treatment. This will not only significantly increase the water treatment cost but will very soon fill up the Scheduled Waste treatment facilities at Bukit Nenas. The increased cost will eventually transferred to all users. Considering this problem, the Malaysian Water Association (MWA) initiated a preliminary study that entitles Study on Characteristic, Treatment and Disposal of Drinking Water Treatment Plant Residue. The said study recommended the exclusion the water treatment sludge from the Schedule Waste category and to allow landfill or land application of dewatered residues. However, the study stressed that direct discharge shall not be permissible.

Considering the above issue, it is recommended a detailed study on the characteristics, treatment and disposal of water treatment sludge should be carried out. Since this is a national issue, it is deemed that the said study should be undertaken by the Water Supply Division, KeTTHA. As this issue is not only occurring in the Muar River Basin, the study should cover all the major river basins and States in Malaysia. It is expected that the study will take about one to two years to complete. The proposed scopes of study are as follows:

- An inventory of all drinking water treatment plants in Malaysia, including their exact location (e.g. water intake river), water treatment capacity, sludge volume, treatment and disposal methods, and land availability.

- Sludge characteristics and the potential environmental impacts. Sampling of water treatment sludge for laboratory analysis is necessary so as to ascertain its potential environmental impacts. Although it is not necessary to take samples from all treatment plants, it is recommended that all States should be covered, and sampling should be made for all types of treatment methodologies.

Study on Drinking Water Treatment Sludge in Malaysia

Carry out by	:	Water Supply Division, KeTTHA
Duration	:	1-2 years
Cost estimate	:	RM 2-4 million
Coverage	:	Drinking water treatment plants in Malaysia
Main scope	:	

- ■ Existing condition of treatment plants
- ■ Sludge characteristics and environmental impacts
- ■ Treatment and disposal technologies and options
- ■ International practice
- ■ Cost and socio-economic impacts of Scheduled Waste requirement
- ■ Necessity to revise the Schedule Waste requirement
- ■ Proposed solution

- A desk review of existing available sludge treatment and disposal technologies, options and their costs should be done.

- A desk review of international practice in water treatment sludge treatment and disposal should be carried out.

- Based on the above, an evaluation should be done to reconsider the necessity of Scheduled Waste requirement on water treatment sludge. It is also important to assess the impacts on both the water treatment operators and the public is the Scheduled Waste requirement is fully enforced or otherwise.

- The study should come out with solutions for the issue mentioned above.

It must be noted that this water treatment sludge issue is a common issue throughout the country, it is thus recommended that the above study should be a nationwide study. In this report, although this recommendation is presented in both the Pahang and Muar River Basins, it is recommended the study should be carried by the Federal Government agency so as to cover both river basins.

(This is a common recommendation for both the Muar and Pahang River Basins. Close coordination between the implementing agencies of these two river basins is necessary)

(ii) Strict Control of Industrial Effluent to Ensure Compliance with the Environmental Quality (Industrial Effluent) Regulations 2009

Industrial effluent means liquid water or wastewater produced by reasons of the production processes taking place at any industrial premises (Environmental Quality (Industrial Effluent) Regulations 2009). The control of industrial effluent is mainly governed by the Environmental

Quality Act 1974, specifically the Environmental Quality (Industrial Effluents) Regulations 2009. The agency in regulating industrial effluent is the Department of Environment (DOE).

The Environmental Quality (Industrial Effluents) Regulations 2009 stipulates that construction of any premises that may result in a new or altered source of discharge of industrial effluent or mixed effluent must notify the Director General of DOE in writing. It is also stipulated that discharge must comply with either Standard A or Standard B of effluent conditions as specified under the Fifth Schedule of the abovementioned Regulations.

Current measures being implemented:

- DOE is strictly enforcing the abovementioned Environmental Quality (Industrial Effluents) Regulations 2009. Due to some changes in this new Regulation, such as notification to DOE for new source or alteration of discharge, self monitoring and requirement on competent person, DOE is initiating various workshops and training courses to the industries to ensure fulfillment of the said Regulation.

- Besides the abovementioned Regulation, there are a number of other Regulations, Rules and Orders that strictly enforced by DOE to prevent pollution of inland waters.

Lead implementing agency:

DOE

General Recommendations:

- Drinking water treatment sludge, which is categorized as 'Scheduled Waste' under the Environmental Quality (Scheduled Wastes) Regulations 2005, is being discharged/disposed directly into the rivers without any treatment (except the new treatment plants with sludge treatment facilities). According to the officials of DOE, so far the Department has not made any strict enforcement on this matter, but the issue should be solved as soon as possible. It is thus deemed that a detailed study on the impacts, treatments and disposal of drinking water treatment sludge is necessary.

- DOE shall continue to carry out strict enforcement on discharge of industrial effluent as mentioned above.

(iii) Control of Wastewater Discharge from Livestock Farms

Wastewater discharge from livestock farms, particularly pig farms, is another potential source of river water pollution. Hence, it is important to control the discharge of wastewaters from these livestock farms. This strategy thus aims to promote proper control and proper treatment of wastewater from livestock farms, particularly pig farms.

Current measures being implemented:

- For the State of Pahang, according to the Pahang Department of Veterinary Services (DVS), the State Government intends to stop all pig farming in the State. Presently the State Government has stopped the issuance of pig farming licenses in the State and in the progress of eliminating all the existing pig farms.

- In Negeri Sembilan, the State Government is in the progress of relocating all the individual pig farms to the centralized pig farm area (PFA) at Bukit Pelanduk, Port Dickson. According to DVS Negeri Sembilan, so far only one pig farm in Tampin yet to be relocated to the PFA. The PFA at Bukit Pelanduk is equipped with proper wastewater treatment facilities.

Lead implementing agency:

Department of Veterinary Services

General Recommendations:

- Regular enforcement to avoid any illegal operation of pig farming.

(iv) Control of Wastewater from Commercial Activities such as Wet-Markets, Restaurants and Food Stalls

Discharges from commercial activities such as wet-markets, restaurants and food stalls are also among the significant sources of pollution load to the Pahang and Muar River Basins. Wet-market is the place where chicken slaughtering and fish preparation works are being carried out. Normally wastewater mixed with chicken bloods and debris of intestines and feathers are being discharged into the adjacent drains or rivers without any treatment. Wastewater from restaurants and food stalls also contains high organic pollutants with food and oil debris. Without proper measure, it may result in pollution of rivers and waterways. Hence, this strategy promotes proper control and treatment of wastewaters from commercial activities, particularly wet-markets, restaurants and food stalls.

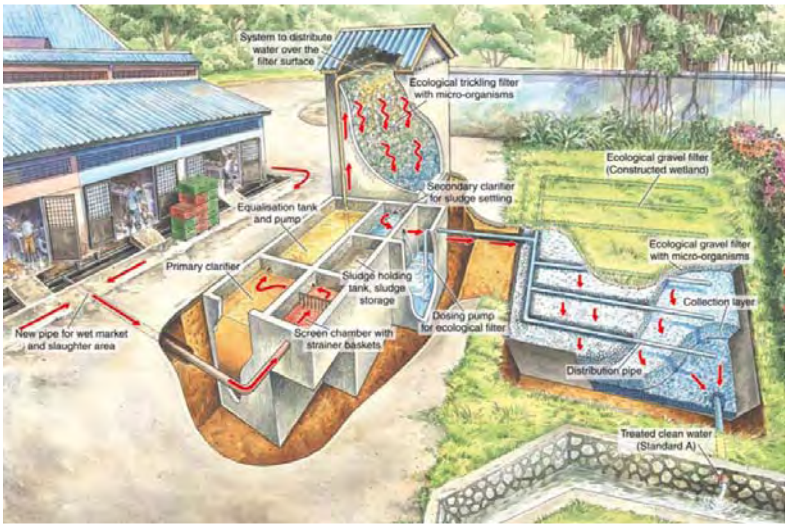
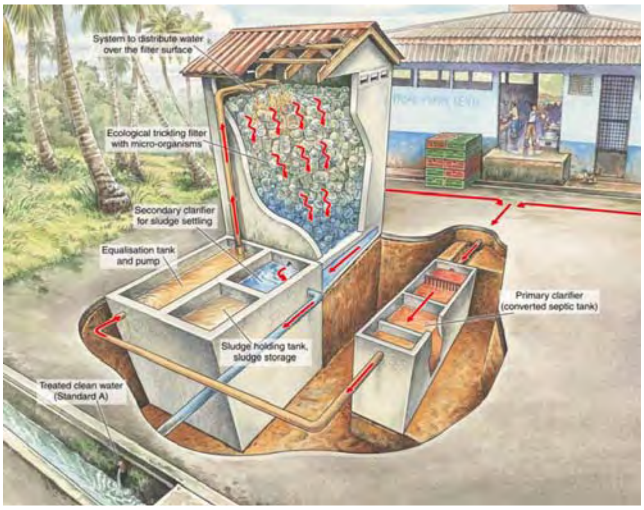
Current measures being implemented:

- For the control of wastewater discharge from restaurants and food stalls, Local Authorities have imposed strict conditions to all licensed restaurants and hawker centers to install individual FOG traps (fat, oil and grease traps) at all discharge points. Although there may be some none-compliances and inappropriate maintenance of the FOG traps (information from Working Group Meeting), the Local Authorities are in the progress of addressing this wastewater issue.

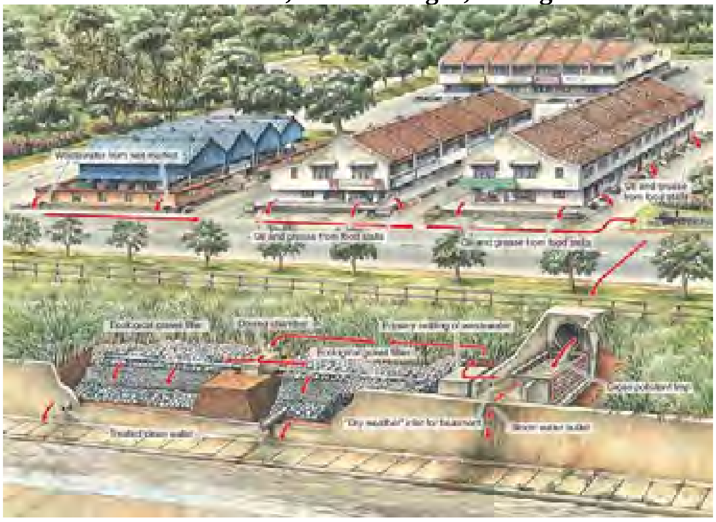
- Concerning wet-market, discussion during Working Group Meeting found that most of the wet-markets are discharging wastewater into the adjacent waterways without any treatment. However, certain Local Authorities have taken measures to address the issue. For example, it is found that the Temerloh Market is equipped with wastewater treatment plant that operated by IWK. On a whole, due to budget constraints, there is no immediate plan to install wastewater treatment plants to all wet-markets.

- DID is taking the lead in undertaking studies and implementing wastewater treatment pilot projects. In conjunction with the studies for the Sungai Kedah and Sungai Selangor River Basin Management Plans in 2007, DID has implemented several demo projects for wastewater treatments systems for wet-markets, slaughter house and restaurants in both river basins, in collaboration with DANIDA, as shown in **Table 5.5.16** and **Table 5.5.17**.

Table 5.5.16 An Overview of the Existing Wastewater Treatment Pilot Projects Implemented by DID

Biological and ecological treatment of wastewater from wet-market at Pasar Besar Alor Star, Kedah  Design concept    External view Ecological trickling filter Screen chamber	Design capacity: 39 kgBOD/day (1600 chicken slaughtered/day) Design efficiency: >95% BOD removal Actual efficiency: ≈ 98% BOD removal Discharge BOD = 16 mg/l (based on sampling on 7 Dec 2009) Filter media: Plastic pieces with open media Fulltime worker: 1 Construction duration: ≈ One year Construction cost: ≈ RM400,000 Maintenance cost: ≈ RM40,000/year
Biological treatment of wastewater from wet-market at Pasar Pokok Sena, Kedah  Design concept    External view Screen chamber Chicken slaughtering activity	Design capacity: 39 kgBOD/day (1600 chicken slaughtered/day) Design efficiency: >95% BOD removal Actual efficiency: ≈ 98% BOD removal Discharge BOD = 45 mg/l (based on sampling on 8 Dec 2009) Filter media: Plastic pieces with open media Fulltime worker: 1 Construction duration: ≈ One year Construction cost: ≈ RM330,000 Maintenance cost: ≈ RM30,000/year

Ecological treatment of polluted storm water from wet-market and restaurants at Bukit Sentosa, Hulu Selangor, Selangor



Design concept

Gravel filter

Dosing chamber

Distribution pipe

Design capacity:
12.7 kgBOD/day (650 chicken slaughtered/day + 3 restaurants)

Design efficiency:
>83% BOD removal

Actual efficiency:
≈ Yet to monitor

Filter media:
Gravel

Fulltime worker: 1

Construction duration:
≈ One year

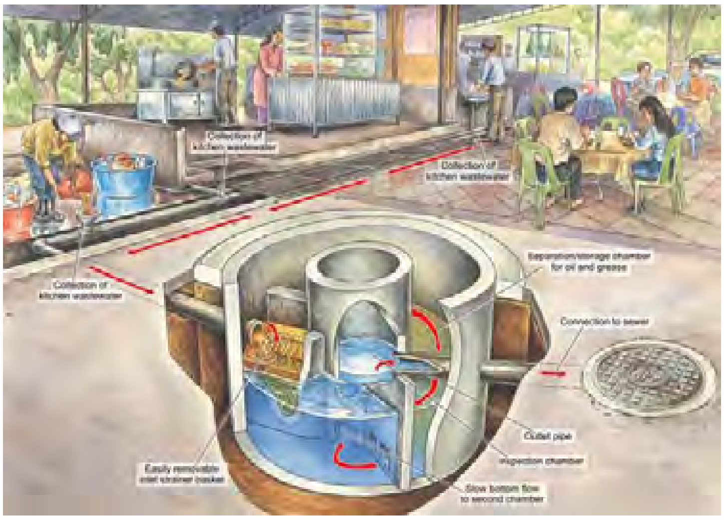
Construction cost:
≈ RM800,000

Maintenance cost:
≈ Still not known

Source: Saving Water, Cleaning Water: Eight Demonstration Projects (2007) and discussions with DID officials in May 2010.

Table 5.5.17 DID's Pilit Project for FOG Trap at the Medan Selara Teratai Food-Court in Alor Star, Kedah

FOG trap for the Medan Selara Teratai food-court in Alor Star, Kedah



Design concept

External view

Internal view

Discharge outlet

Inner diameter: 1.8 m

Water depth: 0.6 m

Total depth: 2.0-2.6 m

Trap volume: 1450 liters

Capacity: 6.9 m^3/day (≈ 435 seats)

Construction cost:
≈ RM40,000

Maintenance cost:
≈ RM2,400/year

Source: Saving Water, Cleaning Water: Eight Demonstration Projects (2007) and discussions with DID officials in May 2010.

Lead implementing agency:

Local Authorities

General Recommendations:

- There are two issues concerning wastewater from restaurants and food stalls. Firstly, in the original design of all shophouses and restaurants, wastewater from sinks is discharged into sewer pipes that connected to sewage treatment plant. However, when the restaurant operators renovate the shophouses into restaurants, all the additional sinks for individual food stalls within the shophouses are discharging wastewater directly into the roadside drains. Secondly, for those restaurants that discharging wastewater from sinks into sewer lines, the main problem is the high oil content in the wastewater that can clog the sewer lines.

- In order to overcome the above issues, firstly, the Local Authorities need to carry out strict enforcement to prohibit direct disposal of wastewater from restaurants and food stalls into the drains, but into sewer pipes. Secondly, as wastewater from restaurants and food stalls contain oil and grease that may clog the sewer pipes, Local Authorities need to carry out strict enforcement on installation of FOG traps for all discharge outlets of restaurants and food stalls. The design guideline for FOG trap is contained in the Malaysian Sewerage Industry Guidelines published by SPAN. Thirdly, it is extremely important that all FOG traps should be regularly maintained so as to ensure its effectiveness in screening oil and grease.

- For the wastewater from wet markets, since its treatment is not within the scope of service of IWK, all Local Authorities should be responsible to built wastewater treatment plants for all wet-markets to ensure discharge water quality in compliance with Standard A or Standard B.

Proposed Project/Action E-1.1.3: Feasibility study and pilot project for wastewater treatment system for wet-markets

It is recommended that a feasibility study to improve the above wastewater treatment systems for small scale wet markets. It should also be considered to have further pilot test for the improved system in the Muar River Basin. If eventually the above systems proven to be effective, the same systems may be implemented at the existing and future wet-markets in the Muar River Basin.

(This is a common recommendation for both the Muar and Pahang River Basins. Close coordination between the implementing agencies of these two river basins is necessary)

Feasibility study and pilot project for wastewater treatment system for small scale wet-markets

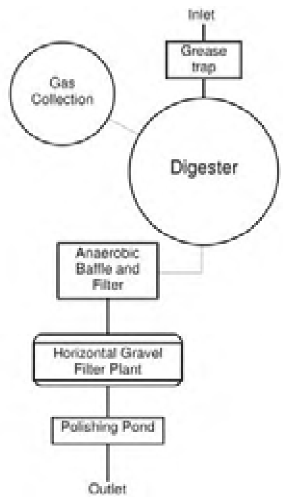
Carry out by	:	Department of Local Government
Duration	:	1-1.5 years
Cost estimate	:	RM 1-2 million
Target area	:	Any small scale rural wet-market
Technology	:	DEWATS or any other similar system
Main scope	:	

■ Selection of a target wet-market.
■ Review of available low cost technologies.
■ Feasibility study.
■ Pilot project.

Please refer to http://www.borda-net.org for further information on DEWATS.

‘Decentralized Wastewater Treatment System (DEWATS)’

As an alternative, DID or Local Authorities in the Muar River Basin may also consider to pilot test some other possible technology options. One of the technology options would be the ‘Decentralized Wastewater Treatment System’, or DEWATS, developed by the Bremen Overseas Research and Development Association (BORDA), Germany. DEWATS is a low cost and low maintenance wastewater treatment system that designed to eliminate grease, solids, organic pollutants, etc. It is suitable for treatment of wastewater from wet-markets where chicken slaughtering activities are being carried out, with discharge of diluted blood, fat and suspended solids. The system is suitable for organic wastewater flows of 1-1,000 m3 per day. Its low initial and maintenance costs have made it a competitive option for many developing countries. Presently there are more than 250 DEWATS plants being constructed and under operation in several developing countries, including the Philippines and Lao DPR. It is reported that in 2006, a DEWATS treatment plant was constructed for a slaughtering house in the Valenzuela City of the Phillippines, with treatment capacity of 10 m3/day. The construction cost was only about PhP500,000 (±RM36,000) with monthly operation cost of about PhP2,000 (±RM140). It is reported also that the system is able to reduce BOD/COD up to 90%. (BORDA)



Digester, anaerobic baffled reactor (ABR), and anaerobic

Planted gravel filter (PFG)

Source: BORDA

(v) Collection and Treatment of All Used Oil Grease from Vehicle Workshop

Vehicle workshop is one of the main commercial activities in all sizes of towns. It is operating at various places, including the conventional shophouses, light industrial estates or at individual premises (including some dwelling houses). There are various environmental issues concerning these vehicle workshops, such as noise, solid wastes and used oil and grease. From the perspective of IRBM, the disposal of used oil and grease is deemed to be the main issue. Direct disposal of these used oil and grease will pose serious pollution to both surface and ground water. Hence, this strategy aims to promote proper storage, treatment and disposal, or reuse of used oil and grease from vehicle workshops.

Current measures being implemented:

- The Local Authorities as well as DOE are taking strict enforcement measure to prevent any indiscriminate disposal of used oil and grease by the vehicle workshop operators. On the other hand, it is understand that the used oil and grease are being sold for recycling. The recycling companies are periodically collecting the used oil and grease from vehicle workshops.

Lead implementing agency:

Local Authorities

General Recommendations:

- The Local Authorities/DOE should carry out enforcement to ensure that used oil and grease are proper stored within the licensed vehicle workshop premises. The method of storage should comply with Section 9 of the Environmental Quality (Scheduled Wastes) Regulations 2005. Among the important points are that the used oil and grease should be stored in durable containers to prevent spillage or leakage, the containers should always be closed during storage, and the area of storage should be adequately built to prevent any possible spillage. Concerning this, when issuing business licenses, the Local Authorities may need to provide guidelines on storage and disposal of used oil and grease to all vehicle workshop operators. The Local Authority should consult with DOE for any technical requirements on handling of used oil and grease.

- DOE needs to carry out necessary enforcement to ensure that the contractors collecting used oil and greased are licensed under the Subsection 18(1A) of the Environmental Quality Act 1974, and processing of used oil and grease for recycling purpose must be carried out at 'prescribed premises' under the Environmental Quality (Prescribed Premises) (Scheduled Wastes Treatment and Disposal Facilities) Order 1989.

(vi) Control of Leachate from Dumpsites/Landfills

'Leachate' means liquid that has percolated through solid waste and has been extracted or dissolved, or suspended materials from the solid waste, or liquid discharged or released from a solid waste transfer station or landfill (Environmental Quality (Control of Pollution from Solid Waste Transfer Station and Landfill) Regulations 2009). Seepage of leachate will cause pollution to both surface and ground water. As not all the solid waste disposal sites in the Pahang and Muar River Basins are properly built sanitary landfill, but still in the form of 'dumpsite', it is necessary to take action to stop and prevent pollution by leachate.

Current measures being implemented:

- The Government has realised the problems concerning solid waste management in Malaysia. In 2007, the Solid Waste and Public Cleansing Management Act 2007 was passed by the Government, and the Department of National Solid Waste Management (under the Ministry of Housing and Local Government) was established to address the solid waste management issues in Peninsular Malaysia.

- In order to improve the solid waste management, the solid waste management function of the Local Authorities has been privatised. In Pahang, solid waste management service has been privatised to Alam Flora Sdn Bhd ('Alam Flora'), whereas SWM Environment Sdn Bhd ('SWM') is responsible for the solid waste management in Negeri Sembilan and Johor. Both Alam Flora and SWM have taken necessary measures not only on the collection of garbage, but also transportation, transfer and disposal. Hence, these companies are presently in the progress of improving the solid waste disposal facilities in the Pahang and Muar River Basins, including addressing issues concerning leachate as mentioned above.

Lead implementing agency:

Alam Flora (Pahang), SWM (Negeri Sembilan)

General Recommendations:

- All the existing open dumpsites should be closed as soon as possible, and replaced with environmentally friendly methods such as sanitary landfills and incinerators (subject to feasibility studies).

- All sanitary landfills should not be overloaded and should be properly maintained.

(b) Measure E-1.2: Implement Integrated Waste Management by Reducing Waste at Source, Increasing Recycling Rate and Ensuring Efficient and Clean Disposal

Solid waste is another potential source of river water pollution. It is related to Measure E-1.1(vi) above. Improper solid waste management and enforcement may result in indiscriminate disposal of solid wastes, which eventually may result in deterioration of surface and groundwater quality. This measure thus promotes the implementation of integrated waste management by reducing waste generation at source, reducing the volume of solid wastes through recycling of wastes, and ensuring efficient and clean disposal such as sanitary landfills and incinerators (subject to feasibility studies).

Current measures being implemented:

- As mentioned above (see Measure E-1.1(vi)), the Government has passed the Solid Waste and Public Cleansing Management Act 2007 and has established the Department of National Solid Waste Management to address the solid waste management issues in Peninsular Malaysia. In the Pahang and Muar River Basins, it has been privatised to Alam Flora (for the State of Pahang) and SWM (for the States of Negeri Sembilan and Johor) to improve the solid waste management.

Lead implementing agency:

Alam Flora (Pahang), SWM (Negeri Sembilan) and Local Authorities (during transition period, as well as for enforcement and awareness programs)

General Recommendations:

- The first step of good waste management practice is to reduce waste generation at source. For this purpose, it is necessary to inculcate environmental awareness of the general public so as to reduce wastage, increase reuse and recycling.

- In order to reduce the volume of solid wastes, measures should be taken to recycle as much as possible. This will not only require the necessary recycling facilities but also proper waste separation. Hence, it requires involvement and commitments from all parties, i.e. the public, waste management companies (Alam Flora and SWM) and recycling companies.

- Illegal waste dumping, particularly the disposal of construction wastes, is another issue that must be addressed. Site visit revealed that there are some spots of illegal dumping (construction wastes and domestic wastes). In order to address this issue, it is deemed strict enforcement by the Local Authorities is extremely important. Besides, the public should be cooperative in reporting the incidence of illegal dumping. This, again, relies on public awareness education.

- Improper disposal of solid wastes at markets (particularly wet-markets) also poses threat to the river water quality. Despite that solid waste collection centers are available at all the markets, indiscriminate disposal of solid wastes into the drains and around the solid waste collection centers is commonly seen at most of the markets. Besides, leakage of leachate from the organic wastes at the waste collection center also may result in pollution of both surface and ground water. Hence, garbage traps should be installed at all drainage outlets of markets and regular maintenance should be carried out. Besides, all markets should be provided with enclosed solid waste collection centers to avoid spillage of solid wastes and seepage of leachate into the ground.

- From the above recommendations, it can be seen that in order to improve the solid waste management, it requires not only commitments from the waste management concessionaires and the Local Authorities, but also cooperation from the public. Hence, environmental awareness of the general public should be heightened. For this purpose, close cooperation among the Local Authorities, Alam Flora, SWM, DOE and other agencies is extremely important, in conducting various environmental awareness program through various social activities, schools, medias and so on.

(c) Measure E-1.3: Minimize Siltation of River by Reducing Erosion at Source and Controlling Runoff of Eroded Soil Particles into Rivers

There are many causes of high TSS content in river water. Site observation and discussion with Working Group members found that the main potential contributing activities are large scale construction (earthwork) activities, large scale agricultural developments, sand dredging activities as well as logging activities. The following sub-sections address these issues.

(i) Control Siltation from Construction Activities

Large scale construction works, particularly earthworks, are inevitably resulting in soil erosion. The eroded soil particles flow into the adjacent waterways and eventually discharge into the rivers. This will increase the TSS and turbidity of the river water. Water quality monitoring from DOE showed that TSS is one of the main water quality issues for the Pahang and Muar River Basins. This measure thus promotes control of erosion at construction site (preventive measure) and control of runoff of eroded soil particles from construction site into waterways (curative measure).

Current measures being implemented:

- DID has developed the Urban Stormwater Management Manual (MASMA) to serve as a guideline to the contractors in various aspects of construction works, including erosion control.
- Approval from the Local Authorities is required for all construction works. The Local Authorities are regulating various soil erosion control requirements, including the implementation of MASMA.
- All large scale construction works, such as housing development covering an area of 50 hectares or more, construction of expressways, national highways, new townships, etc. (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987) are subject to EIA approval by DOE. With this, the contractors will need to comply with all the recommendations contained in the approved EIA reports, including various erosion control measures. Also, the project proponents are normally required to submit periodic environmental monitoring reports to DOE.

Lead implementing agency:

- Local Authorities (approval of construction works and its subsequent enforcement)
- Department of Environment (EIA requirements on large scale projects)
- DID (technical aspects of soil erosion control)

General Recommendations:

- Present efforts by the above agencies should be continued.
- Monitoring and enforcement by the Local Authorities and DOE should be strengthened.

(ii) Control Siltation from Logging Activities

Some parts of the Pahang River Basin are under logging activities. Similar to construction works mentioned above, logging activities will, to some extent, result in soil erosion and siltation of rivers. This measure aims to promote control of siltation caused by logging activities.

Current measures being implemented:

- Logging activities are strictly controlled by the Forestry Department. Generally the controls are on two aspects, firstly through the limitation of logging activities by controlling the logging licenses, and secondly through the control of logging operations by enforcing strict logging operation rules including measures on erosion control.

- All the large scale logging operations (≥500 ha.), logging within water catchment areas or adjacent to state or national parks are subject to EIA approval by DOE (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 for full detail). With this, the logging companies will need to comply with all the recommendations contained in the approved EIA reports, which includes various erosion control measures. Also, the logging companies are normally required to submit periodic environmental monitoring reports to DOE.

Lead implementing agency:

- Forestry Department (licensing and enforcement)
- Department of Environment (EIA requirements on large scale projects)

General Recommendations:

- Monitoring and enforcement by the Forestry Department and DOE should be strengthened to regulate the licensed logging operation and to stop/prevent illegal logging operations. During the Stakeholders Meeting, it was reported that there are some illegal logging activities at some parts of the Basin. However, official of the Forestry Department highlighted that actions have been taken to address this issue.

(iii) Control Siltation from Agricultural Activities

About 28% (over 8,000 km^2) of the total area of the Pahang River Basin and 64% (close to 4,000 km^2) of the Muar River Basin are under agricultural use. Due to removal of natural forest cover, these agricultural activities accelerate the erosion rate, particularly during earthwork phase of the development. Although erosion rate will be reduced after stabilization of the plantation, the erosion rate is still very high compared to the natural forest area. Past study (Sg. Langat IRBM Plan) revealed that the erosion rate of agricultural land is as much as 20 times of forest area. This measure aims to promote control of siltation caused from agricultural activities.

Current measures being implemented:

- The National Physical Plan, Pahang, Negeri Sembilan and Johor Structure Plans and all relevant Local Plans are providing land use zone plans to guide the land developments, including agricultural developments, within the Pahang and Muar River Basins.

- All the large scale agricultural developments (>500 ha.) are subject to EIA approval by DOE (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 for full detail). With this, the planters will need to comply with all the recommendations contained in the approved EIA reports, which includes various erosion control measures. Also, the logging companies are normally required to submit periodic environmental monitoring reports to DOE.

Lead implementing agency:

- JPBD and Local Authorities (on land use planning and control)
- UPEN and PTG (on approval of agricultural developments)
- Department of Environment (EIA requirements on large scale plantations)
- DOA (on agricultural practice)

General Recommendations:

- For those plantations subject to EIA requirements, DOE should implement strict enforcement to ensure that all recommendations in the EIA reports are fulfilled.
- For smallholders agriculture activities, DOA should implement more training and awareness programs to improve the farming practice, including erosion control.
- Land Offices should strengthen the enforcement on agricultural activities within river reserves.

(iv) Control Siltation from Sand Dredging Activities

Sand dredging is another activity that causes river siltation. Although sand dredging is important in maintaining or increasing the flow capacity of rivers, improper environmental management during dredging and washing operations may result in siltation of river. It is thus vital to control the sand dredging activities so as to minimize siltation of river water.

Current measures being implemented:

- The control of sand dredging operation is implemented mainly through the licensing method. All sand dredging operations require licenses from the District Land Office (approval by EXCO).
- With respect to concerns on potential siltation of river water and riverbank erosion, DID is responsible to provide technical advice to the Land Office during the evaluation of sand dredging license application.
- Besides, all large scale sand dredging projects involving an area of 50 hectares or more are subject to EIA requirements (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 for full detail). The operators are required to comply with all the recommendations contained in the approved EIA reports, which includes various erosion control measures. Also, the operators are normally required to submit periodic environmental monitoring reports to DOE.

Lead implementing agency:

- State EXCO (approval of sand dredging license application)
- District Land Office (issuance of licenses and enforcement)
- DID (technical advice)
- Department of Environment (EIA requirements on large scale projects)

General Recommendations:

- Land Offices should strengthen the enforcement on sand dredging activities to ensure that the terms and conditions set in the licenses are strictly adhered to.

- For those projects subject to EIA requirements, DOE should implement strict enforcement to ensure that all recommendations in the EIA reports are fulfilled.

(d) Measure E-1.4: Minimize Runoff of Agrochemicals into Rivers

One of the main environmental impacts of agricultural activities is the runoff of agrochemicals such as fertilizer, herbicides and pesticides into waterways. Water quality monitoring by DOE revealed that Sg. Batu and Anak Sg. Lepar of the Pahang River Basin, and Sg. Serom, Sg. Kelamah, Sg. Senarut, Sg. Spg. Loi and Sg. P. Menkuang of the Muar River Basin are possibly receiving high volume of agrochemical runoffs from the adjacent plantations. Also, agrochemical pollution at Cameron Highlands has drawn concerns from various parties. Hence, it is important to implement various measures to minimize runoffs of agrochemicals into rivers and other waterways.

Current measures being implemented:

- All the large scale agricultural developments (>500 ha.) are subject to EIA approval by DOE (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 for full detail). With this, the planters will need to comply with all the recommendations contained in the approved EIA reports, which includes various agrochemical management measures.

- As application of agrochemicals is inevitable, the Department of Agriculture (DOA) is carrying out various training courses and awareness programs concerning agriculture management and agrochemical management as well as environmental awareness.

- DOA is continuously undertaking various researches on agricultural management, which directly or indirectly will contribute to the control of agrochemical usage in agricultural activities.

- For areas facing agrochemical pollution problem (e.g. Cameron Highlands), Land Office and other related authorities are carrying out necessary enforcement on farming within river reserves, improper storage of agrochemicals, etc.

- As one of the measures to reduce runoff of agrochemicals into rivers, all the plantations are required to conserve river reserves within the plantation area as per the guideline recommended in the DID Manual. This requirement is particularly strict for those plantations subject to EIA requirements.

Lead implementing agency:

- DOA (training and awareness programs and research)
- Department of Environment (EIA requirements on large scale plantation)
- DID (river reserve requirements)

General Recommendations:

- Water quality monitoring and enforcement should be strengthened.

Proposed Project/Action E-1.4.1: Monitoring of agrochemical 'hotspots'

It is very difficult to control and monitor the application of agrochemicals as there is no legal restriction on this matter. Although the Pesticides Act is in force, the Act gives more provisions on the sales of pesticides and pesticide content in food, rather than its application. Although there is water quality standard for rivers (NWQS), there is no legal control on agrochemical application.

As agrochemicals (pesticides, herbicides and fertilizers) application is necessary in agricultural activities, it is impossible to stop its usage. Hence, the only way is to minimize its usage, and to ensure sufficient river reserves to avoid runoff of agrochemicals into rivers. For large scale plantation, normally it is recommended to adopt integrated pest management concept to reduce pesticide usage. For these large scale plantations that subject to EIA requirements (>500 hectares), they may be periodically monitored by the Department of Environment. However, for smallholder farms, it is very much depending on the awareness of the farmers. On this matter, the Department of Agriculture is conducting awareness and education programs for farmers.

Through ASMA, the Department of Environment is conducting periodic water quality monitoring for 143 rivers throughout the country, including 39 monitoring stations within the Muar River Basin. There are a total of 33 monitoring parameters, including NH3-N, NO3 and PO4 that can indicate the possible fertilizer runoff into the rivers. However, there is no monitoring of pesticides and herbicides.

In order to ensure more efficient and effective enforcement, it is recommended that the Department of Environment should regularly monitor the water quality monitoring data to identify the agrochemical pollution 'hotspots'. Some commonly used pesticides/herbicides should be included in the monitoring parameters for the 'hotspot' rivers. When extraordinary high nutrient or pesticide/herbicide were detected, the Department of Environment should carry out joint operation with the relevant Land Office, Local Authority and other relevant agencies/authorities to identify any encroachment into river reserves, indiscriminate disposal of pesticide containers, and so on. For example, from the existing water quality monitoring results as well as discussions with various stakeholders, it is found that Sg. Kelamah, Sg. P. Menkuang, Sg. Serom, Sg. Senarut and Sg. Spg. Loi are possible to have more serious agrochemical pollutions.

(*This is a common recommendation for both the Pahang and Muar River Basins. Close coordination between the implementing agencies of these two river basins is necessary*)

Monitoring of agrochemical 'hotspots'

Carry out by	:	Department of Environment, Johor and Negeri Sembilan
Duration	:	Continuous
Target area	:	Entire Muar River Basin
Main scope	:	

- Include some common pesticides/herbicides in the monitoring parameters for locations with possible agrochemical pollution (for example the rivers indicated in the figure below).
- Identify agrochemical 'hotspots' by regular monitoring of water quality monitoring results from ASMA.
- Conduct joint enforcement with the Land Office, Local Authority and other relevant agencies/authorities when high agrochemical content is detected.

Example of common pesticides/herbicides:
Aldrin, alpha-BHC, beta-BHC, delta-BHC, lindane, 4,4-DDD, 4,4DDE, 4,4DDT, dieldrin, endosulfan I, endosulfan II, endosulfan sulphate, endrin aldehyde, heptachlor and heptachlor epoxide.

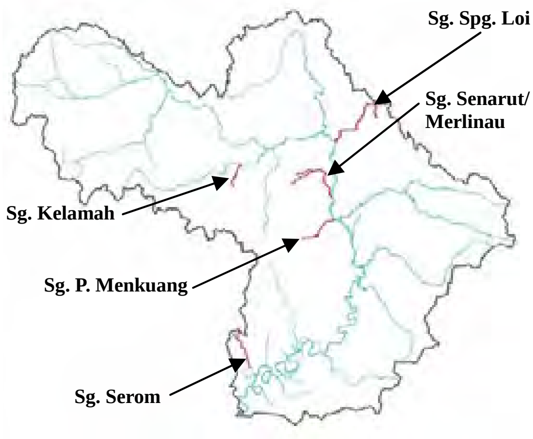


Figure 5.5.7 Potential 'Hotspots'

(2) STRATEGY E-2: Maintain Natural Biodiversity of Basin

Besides ensuring clean water, it is important to maintain the natural biodiversity of the river basin. For the case of Pahang River Basin, there are many areas of ecological importance, such as the Taman Negara, Tasik Bera (a RAMSAR site), Tasik Chini (Biosphere Reserve) and the Krau Wildlife Reserve. The following subsections present the necessary measures required to protect the natural biodiversity of the Pahang and Muar River Basins.

(a) Measure E-2.1: Control Large Scale Agricultural Development

Agricultural development, particularly large scale plantations, poses threats to the conservation of natural biodiversity of both the Pahang and Muar River Basins. As mentioned above, about 28% (over 8,000 km^2) of the total area of the Pahang River Basin and 64% (close to 4,000 km^2) is under agricultural use. Without proper control, these large scale plantations may result in significant loss of natural biodiversity. As the Pahang River Basin is an ecologically and environmentally very important region, it is extremely important to maintain the biodiversity of the region. In this respect, control of large scale agricultural developments is an important measure that must not be overlooked.

Current measures being implemented:

- The National Physical Plan, Pahang, Negeri Sembilan and Johor Structure Plans and all relevant Local Plans provide land use zone plans to guide the land developments, including agricultural developments.
- For the protection of natural environment, various guidelines and master plans are in place. For example the guidelines for development within Environmental Sensitive Areas (ESAs) and on highlands, Taman Negara Master Plan and so on. Besides, the Government has also identified various ecologically, environmentally and culturally important sites for conservation, for example the Taman Negara, Tasik Bera (a RAMSAR site), Tasik Chini (Biosphere Reserve), and the Krau Wildlife Reserve.
- All the large scale agricultural developments (≥500 ha.) are subject to EIA approval by DOE (see Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 for full detail). In the EIA reports, assessments are made on the potential environmental impacts of the proposed plantation and mitigating measures are proposed.

Lead implementing agency:

- JPBD and Local Authorities (on land use planning and control)
- UPEN and PTG (on approval of agricultural developments)
- Department of Environment (EIA requirements on large scale plantations)
- Forestry Department (forest conservation and management)
- Department of Wildlife and National Parks (PERHILITAN) (wildlife protection, national park management, etc.)

General Recommendations:

- Agricultural development should be controlled so as to ensure a balance between environmental protection and socio-economic development. Hence, when approving plantation projects, recommendations of the National Physical Plan, Structure Plans, and Local Plans should be adhered to.

- When preparing new Structure Plans and Local Plans, it is recommended that more consideration on the impacts of large scale plantations on natural biodiversity should be taken into account.

(b) Measure E-2.2: Control Logging Activities

Some parts of the Pahang River Basin are under logging activities. Similar to the agricultural activities mentioned above, uncontrolled logging activities may pose adverse impacts on the natural biodiversity of the Pahang River Basin. This measure thus promotes sustainable logging to avoid destroy of natural biodiversity.

Current measures being implemented:

- Refer to Measure E-1.3 (ii) above.

Lead implementing agency:

- Refer to Measure E-1.3 (ii) above.

General Recommendations:

- Refer to Measure E-1.3 (ii) above.

(c) Measure E-2.3: Proper Planning and Management of Environmental Sensitive Area

In the National Physical Plan, all the environmentally and ecologically important and sensitively areas are being demarcated as Environmental Sensitive Areas (ESAs). This includes areas such as protected areas, wetlands, water catchment areas, wildlife corridors and so on. In order to maintain/conserve the national biodiversity of both the Pahang and Muar River Basins, it is necessary to ensure proper management of these ESAs.

Current measures being implemented:

- Under the National Physical Plan, there are three ranks of ESA. The criteria for demarcation of ESA and the development control imposed on these areas are shown in **Table 1.6.2.** Further details on development control requirements are contained in the ESA development guidelines published by the Town and Country Planning Department.

Lead implementing agency:

- JPBD (demarcation of ESAs)
- Other agencies involving in environmental protection/management and development control include the Forestry Department, PERHILITAN, Local Authorities, DOE, District and Land Office, DID, etc.

General Recommendations:

- Measures for protection of ESAs should be clearly reflected in the relevant Structure Plans and Local Plans.
- The proposed Integrated ESA Management Plan recommended in the Pahang Structure Plan should be prepared.

(3) STRATEGY E-3: Protect the Catchment Areas for Water Intake to Avoid Contamination and Depletion of Water Resource

(a) Measure E-3.1: Proper Management of All Catchment Areas for Water Intake

A majority part of the Pahang and Muar River Basins is within catchment areas for raw water intake. In order to protect these water catchment areas from contamination due to pollution and depletion of water volume due to loss of natural forest, it is necessary to protect these water catchment areas.

Current measures being implemented:

- All the water catchment areas are categorized as ESAs under the National Physical Plan. Hence, the current measures are similar as mentioned in Measure E1.2.3 above.
- DOE is controlling the pollution load by restricting various sources of wastewater discharge such as industrial effluent, sewage discharge, etc. Generally, discharges into water catchment areas must comply with Standard A water quality (please refer to Environmental Quality (Sewage) Regulations 2009 and Environmental Quality (Industrial Effluent) Regulations 2009 for further details).
- Conservation of protected forests.

Lead implementing agency:

- JPBD (demarcation of ESAs)
- DOE (regulating the wastewater discharge requirements)
- Forestry Department (forest conservation/management)
- Other agencies involving in environmental protection/management and development control include the PERHILITAN, Local Authorities, District and Land Office, DID, etc.

General Recommendations:

- All water catchment areas should be gazetted.
- A detailed guideline for developments within water catchment area is necessary.

(4) STRATEGY E-4: Make Use of River as an Asset for Townscape and recreational Activities

River landscaping and riverfront development is part of the river corridor management. It is now widely recognized that rivers have many other values in addition to drainage and water supply uses. The DID Manual (March 2009) highlights that one of the objectives of river corridor management is for enhancement of opportunities for public outdoor recreation, education and scenic enjoyment, which is deemed very closely related to river landscaping and riverfront development. This strategy thus emphasizes on making use of river, regardless of its size, as an asset in townscape and development of recreational facilities.

(a) Measure E-4.1: Integrate rivers into the townscape and recreational facilities

In line with the above strategy, this measure promotes the integration of rivers and streams into the landscape plans of all urban centers. Rivers and stream should serve as one of the landscape elements in townscape. This will not only improve the aesthetics of towns but can also inculcate the awareness among the general public on the importance of rivers and to educate the people to love the rivers. Current measures being implemented:

Current measures being implemented:

- The general guidelines and concepts of river landscaping and riverfront development are contained in the Local Plan of each Local Authority area. The existing Local Plans in the Pahang and Muar River Basins has identified all the major existing riverfront recreational and landscape areas along the Pahang River and Muar River, and its tributaries, and proposals have also been made for new riverfront parks and upgrading of existing riverfront recreational spots.

Lead implementing agency:

Local Authorities

General Recommendations:

- Landscape plans proposed in the Local Plans should be adhered to.
- Landscape design should reflect the local natural environment, culture and history. At the same time, it should be environmental friendly and people friendly. Meaning that it should promote conservation of natural environment and biodiversity, and at the same time encourage people to appreciate the importance of river by providing leisure and recreational facilities along the riverbanks.
- When development, as far as possible, all streams should be excluded from development and be converted into landcape area. Anyway, unavoidable conversion of streams to drains should be carried out in such a way that the design of the drain (e.g. monsoon drain) should be as close to the natural stream as possible. While the existing conventional monsoon drains should be improved to include natural landscape as shown in the Supporting Report.
- As part of the efforts to inculcate the public awareness on the importance of keeping the river clean, social activities such as river cleaning campaign, fishing competition, kayaking, and so on should be organized by various organizations. For example, the 'Love Our Rivers' campaign of DID should be continued and further promoted.

5.5.5 Build a Resilient Society to Floods

The policy of flood sector is to build a resilient society to floods. This policy was created in accordance with the IFM concept that aims to make a shift from conventional flood management of 'controlling' floods to trying to achieve sustainable development of the basin while maximizing the net benefit from flood plains by appropriately 'managing' floods.

In order to achieve the above policy, three strategies are recommended:

Strategy F-1: Manage Flood Water

Strategy F-2: Create Flood-flexible Land Use

Strategy F-3: Ensure Safe Evacuation

Under the three strategies, eight measures are also proposed as shown in **Table 5.5.18**. Concrete components of these measures as proposed projects/actions are further described in the IFM Plan of **Chapter 6** or proposed commonly with the environment and institution sectors. Therefore, details of these measures and proposed projects and actions are omitted in this subsection.

Table 5.5.18 Proposed Policy, Strategies and Measures

Policy	Strategies	Measures	Proposed Project/Action	Responsible Agency	Remarks
Build a resilient society to floods	F-1: Manage flood water	F-1.1: Implement appropriate structural measures	Proposed in IFM Plan	DID	
		F-1.2: Upgrade data management procedures	Proposed in IFM Plan	DID	
		F-1.3: Monitor and review impacts of climate change	Proposed in IFM Plan	DID	
		F-1.4: Conserve forests	E-2.3: Proper planning and management of ESAs	JPBD, LA, DOE, PERHILITAN, Forestry Dept., BKSA	Common with Environment sector
	F-2: Create flood-flexible land use	F-2.1: Prepare flood hazard maps	Proposed in IFM Plan	DID, Local government agencies.	
		F-2.2: Promote gazetting of river reserve	I-2.2: Determination River Management Area (River Reserve)	DID, Land Office	Common with Institution sector
	F-3: Ensure safe evacuation	F-3.1: Upgrade flood forecasting and warning system	Proposed in IFM Plan	DID	
		F-3.2: Prepare community-based flood management plan	Proposed in IFM Plan	DID, Local government agencies	

5.6 Roadmap for Implementation of IRBM Plan

Table 5.6.1 summaries a roadmap for the implementation of the projects/actions specially recommended in the previous section. The table includes responsible agencies, approximate costs and time schedules of the projects/actions.

Table 5.6.1 Proposed Roadmap for IRBM for Muar River Basin

Sector	Project/Action	Main Agencies	Cost (RM million)	Schedule		
				10th MP	11th MP	12th MP
				2015	2020	2025
Institution Setup	I-1.1: Enhancement of River Basin Committee (RBC)	RBC		●		
	I-2.1.1: Establishment of Federal and State Water Resources Department (WRD)	NRE			●	
	I-2.1.2: Establishment of River Basin Management Office (RBMO)	NRE				●
	I-3.2: Establishment of integrated information system	DID, MaCGDI		●●●		
	I-2.2: Determination of river management area (River Reserve)	DID, Land Office		•••••••••	•••••••••	•••••••••
	Review and Updating of IRBM plan	RBC		●	●	●
Water Utilization	W-1.1.1: Monitoring of impact of climate change	BKSA, BAKAJ		●	●	●
	W-1.3.1: Study on environmental flow	BKSA, BAKAJ, DID, DOE	1-2	●●		
	W-1.4.1: Study on groundwater potential	BKSA, BAKAJ, JMG	3-4	●●		
	W-2.2.1: Reduction of Non-revenue Water (NRW)	SAJH, SAINS, SPAN, PAAB		•••••••••	•••••••••	•••••••••
Environment Management	E-1.1.1: Capacity development for establishment of a mechanism for developing and maintaining pollution load inventory	DOE	2-4	●●		
	E-1.1.2: Study on drinking water treatment sludge	Water Services Dept.	2-4	●●		
	E-1.1.3: Feasibility study and pilot project for wastewater treatment system for wet-markets	Dept. of local government	1-2	●●		
	E-1.4.1: Monitoring of agrochemicals	DOE		•••••••••	•••••••••	•••••••••
Flood Management	Implementation of structural measures of IFM plan (Refer to Table 5.6.1)	DID	530	•••••••••	•••••••••	•••••••••
	Implementation of non-structural measures of IFM plan (Refer to Table 5.6.1)	DID and others	17	•••••••••	•••••••••	•••••••••

In preparing the road map, followings were specially taken into consideration:

- I-1.1.1: Enhancement of the River Basin Committee (RBC), which is a coordinating framework for the implementation of IRBM, is the first thing to do.

- I-1.2.1: Establishment of Federal and State Water Resources Department (WRD) requires revision of related laws, and I-1.2.2: Establishment of River Basin Management Office further requires amendment of the ninth schedule of the federal constitution. To realize them, considerable times need to be spent for deliberation.

- Most of the proposed projects should be implemented in the first five years until 2015. Based on the project results, the IRBM plan should be reviewed and updated at least every five years. Depending upon the project outputs, if necessary, new projects/actions will be proposed for the next five years. In this way, as likened to an upward spiral process, the IRBM for the Muar River Basin will be continuously improved.

- Monitoring of impacts of Climate Change should be also made at least every four to five years in harmony with the release of the IPCC assessment report. The fifth assessment report will be published in September 2013.

CHAPTER 6 FORMULATION OF IFM PLAN

6.1 Introduction

6.1.1 Policy, Strategies and Measures

In **Chapter 5** flood issues in the Muar River Basin have been identified and analyzed very closely, and a policy for the flood sector, '**build a resilient society to floods'** was proposed in conclusion. This policy implies the **IFM concept** that aims to make a shift from conventional flood management of 'controlling' floods to trying to achieve sustainable development of the basin while maximizing the net benefit from flood plains by appropriately 'managing' floods. The policy is supported by following three strategies:

(1) F-1: Manage Flood Water

This strategy aims to minimize flood inundation mainly in urban areas by appropriate structural measures associated with non-structural measures. Almost no major flood mitigation structure has been provided, and structural measures are definitely insufficient in the Muar River Basin, even to protect important urban areas only. Appropriate structural measures, which should be planned and designed based on studies using reliable data, should be provided to the river basin.

Even if magnificent structural measures have been constructed through great efforts, all the efforts possibly come to nothing by impacts of Climate Change and/or devastation of the river basin. Adaptation to Climate Change and land use management should be considered jointly with the structural measures.

(2) F-2: Create Flood-flexible Land Use

"People live in flood prone area" is another problem. Disorderly land developments in flood plains increase flood damage potential as well as flood discharges. It is necessary to create land use that is flexible to floods.

For this purpose, flood hazard maps might be very effective. They are expected not only to raise awareness of people about floods, but also to serve as a reference when planning land use zoning. For more stringent management of river reserves, gazetting based on Subsection 62 of Land Code should be promoted.

(3) F-3: Ensure Safe Evacuation

To save human lives is the first priority of the IFM plan. Appropriate response to floods is also important to minimize flood damages. Flood forecasting and warning system with community-based flood management is a tool to lead people to safe places during floods.

6.1.2 Objective of IFM Plan

In this chapter, the above-said policy and strategies and measures are integrated into the IFM Plan that includes several specific projects/actions. The objective of the IFM Plan for the Muar River Basin is proposed as follows:

Objective: to provide a road map for building a resilient society to floods in the Muar River Basin.

6.2 Past and On-going Flood Mitigation Activities

6.2.1 Structural Measures

Since 1970s flood mitigation works have been implemented in the Muar River Basin. They were bund construction with hydraulic control structures and river channelization for tributaries and upgrading of drainage systems in urban centers, etc. However, they all aimed to deal with local flood problems, not to address the extensive inundation along the main river from a basin-wide perspective, although a few basin-wide studies had been conducted for the main river and the Segamat River.

Under these circumstances, the 2006 flood hit the Muar River Basin. Areas along the mid- and downstream stretches of the main river and along the major tributaries such as the Segamat River were submerged for one to three weeks.

Since the exceptional flood, substantial flood mitigation measures have been discussed among officials concerned. A master plan study on flood mitigation titled “Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor” by a local consultant firm started in 2008 and is still on-going as of September, 2010. In this study several flood mitigation options that are combinations of mitigation measures including a flood diversion, bypass channels, flood control dams, river improvement and a tidal barrage, etc. are being proposed and examined.

(1) Structure Measures until the 9th Malaysia Plan

The structure measures of flood mitigation adopted for the Muar River are mainly composed of bund construction and river channelization (widening and upgrading). The bunds and control structures were constructed for 4 tributaries (Temian River, Pergam River, Tanjung Selabu River and Tanjung Olak River) to prevent the tidal inflow into the drainage system in the 1970-1980. As the major project, the urban drainage upgrading, canalization and rehabilitation work has been implemented for Bandar Maharani of Muar from 6th to 9th MP.

The States DID of Johor and Negeri Sembilan have implemented construction, designing and planning on the structural measures related to the flood mitigation. Table 6.2.2 listed the past and ongoing activities related to the flood mitigation structures during the 9th MP. The Federal Government allocates approximately RM 71.9 millions for these projects.

Table 6.2.1 Flood Mitigation Projects related to the Muar River Basin

ID Number	Project Name	Allocated Budget (‘1000 RM)	State
15100-005-0006	Upgrading of bund and structure for coastal erosion	6,161	Johor
15200-001-0016	City drainage infrastructure rehabilitation	-	Johor
15200-001-0030	Rehabilitation of rivers	13,000	Johor
16700-008-0002	Flood mitigation plan of Muar River	6,000	Johor
16700-008-0008	Flood mitigation plan of Segamat River	7,710	Johor
16700-008-0014	Flood mitigation plan of Muar River (Bandar Maharani)	7,490	Johor
16700-008-0015	Flood mitigation research for Muar River basin	24,137	Johor
15200-001-0014	City drainage infrastructure rehabilitation	-	Negeri Sembilan
15200-001-0027	Rehabilitation of rivers	7,400	Negeri Sembilan
16700-007-0009	Flood mitigation plan Kuala Pilah district	-	Negeri Sembilan
	Total	71,898	

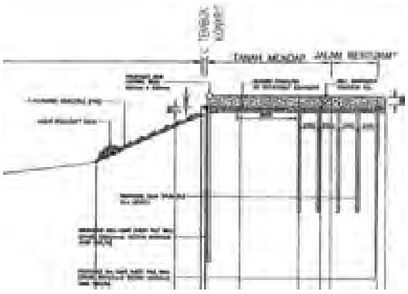
Source: DID

(2) Bank Protection Work

Against the bank failure at Kg. Panchor in April 2008, the related authorities (DID, JKR, Land Office, and Local Authority, etc) allocated approximately RM 5 million for urgent reconstruction. Another bank erosion has been already identified in the lower stretch of the Muar River by DID Muar District

Office. The Office is requesting the Federal Government RM 5 million for the 10th MP. **Figure 6.2.1** shows the bank protection works at Kg. Panchor.

Riverine collapsed at the Night Market, Panchor on April, 2008



Structure design using anchored steel sheet pile wall

Reconstructed riverine expended RM 4.9 million

Figure 6.2.1 Bank Protection Work at Kg. Panchor

(3) Segamat-Genuang Diversion

Among the proposed measures in the antecedent master plan study, a combination of the Segamat-Genuang diversion and the Genuang and Chodan river improvement that aims to solve flood inundation in the new town of Segamat on the left bank of the Segamat River is preferred by DID, which have already conducted detailed design of the diversion project. Locations and outlines of the diversion and the river improvement are presented in **Figure 6.2.2** and **Table 6.2.2**. According to officials concerned of DID, the diversion project was already determined to be implemented under the 10th Malaysia Plan (2011 to 2015).

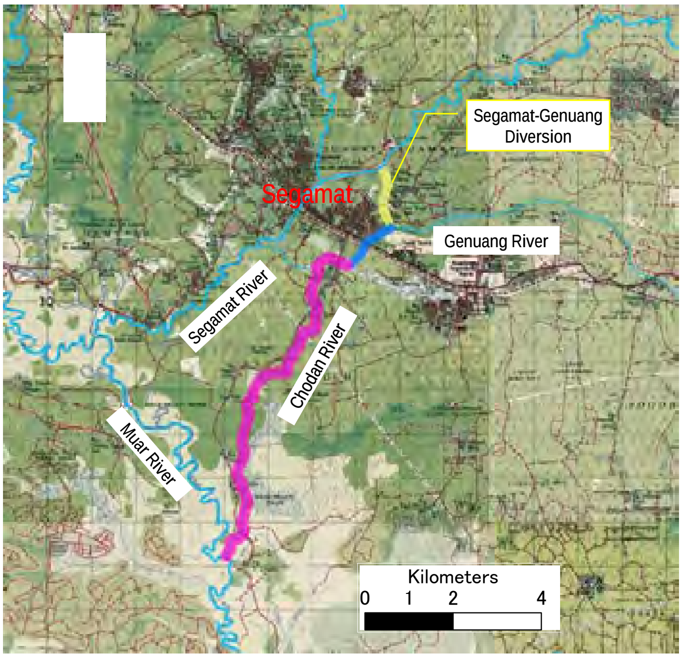


Figure 6.2.2 Segamat-Genuang Diversion

Table 6.2.2 Outlines of Proposed Diversion and River Improvement

Item		Contents
Purpose		To evacuate flood water from Segamat Town arising from overflowing of the Segamat River. (500 m3/s of 1,350m3/s of Segamat River is diverted to Genuang, Chodan then to Muar River.)
Design Scale		ARI of 100 years
Cost		RM 178 million
Major Works	Segamat-Genuang Diversion	Design Discharge = 500 m3/s, Length = 1.5km, 2 bridges
	Genuang River Improvement	Design Discharge = 640 m3/s, Length = 1.2km, 3 bridges
	Chodan River Improvement	Design Discharge = 640 m3/s, Length = 8.5km, 9 bridges

6.2.2 Non-Structural Measures

It might be said that in the Muar River Basin the existing non-structural measures have been more developed than the structural ones. It is probably because personnel concerned have endeavored to supplement the insufficient structural measures with less costly non-structural measures. This section describes following typical non-structural measures introduced in the Muar River Basin

- Flood Map/Flood Hazard Map
- Land Use Management
- Flood Forecasting and Warning System
- Flood Response
- Adaptation to Climate Change

(1) Flood Map/Flood Hazard Map

Flood maps/hazard maps are useful not only for recoding flood inundation, but also for raising flood-awareness of people, land use planning and evacuation activities. In 2003, DID completed the study on National Register of River Basins in Malaysia. This study aimed at updating of information on flood events from 1981 to 2001, preparation of flood maps and listing up for the flood mitigation projects for the 8th Malaysia Plan. Through this study, a flood map titled "Flood Map of Johor" in scale 1:400,000 and a detailed flood map of river in scale 1:50,000 were prepared. After the December 2006 - January 2007 flood, a flood map of this flood event was also prepared by DID as shown in **Figure 6.2.3**. These flood maps are too low in resolution to serve as a reference for the practical planning of land use zoning and evacuation. The scale of flood maps/hazard maps is recommended to be 1/10,000 or larger.

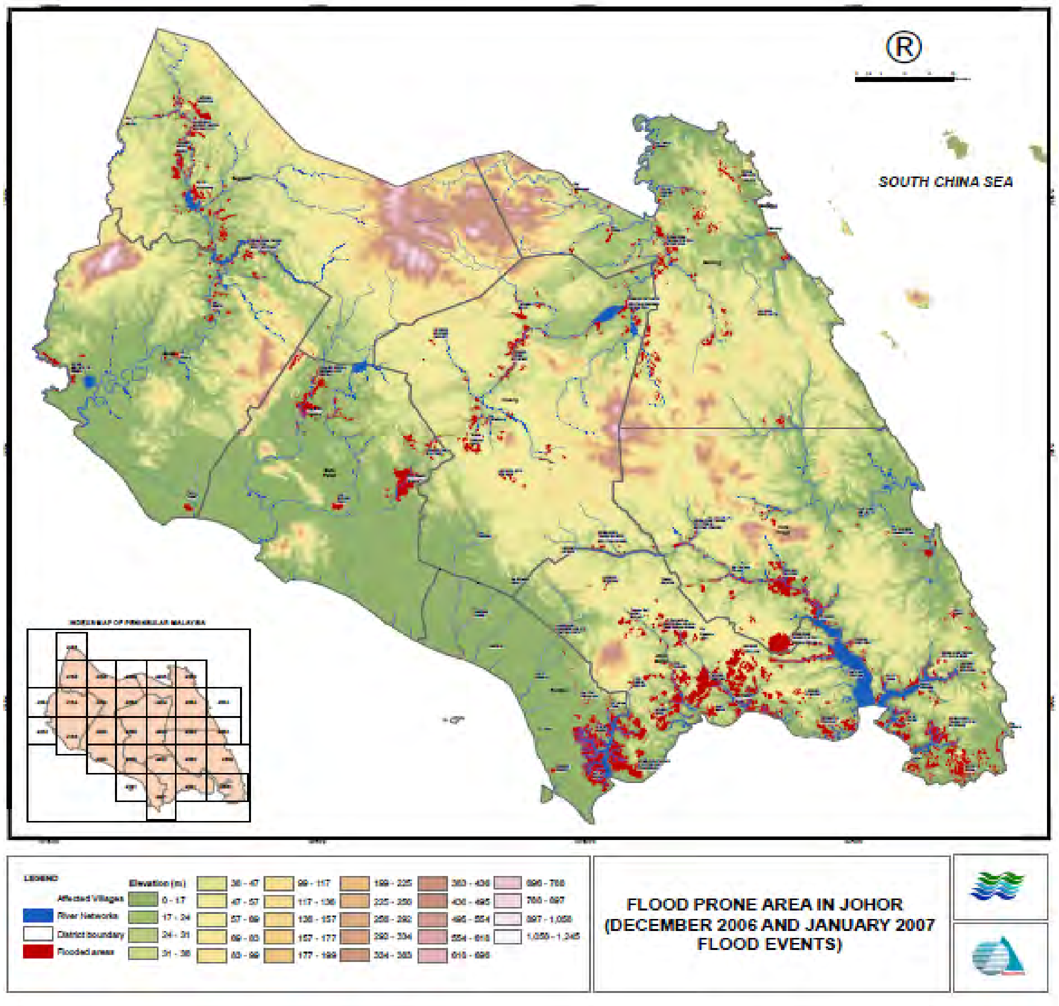


Figure 6.2.3 Flood Map in Johor State including Muar River (DID, 2007)

A flood hazard map is defined as a map that graphically provides information on inundation as well as on evacuation. Flood hazard map is useful to prevent loss of people's properties, and helps smooth evacuation from home to relief center before flood coming. DID is responsible for planning, preparing and dissemination about flood hazard mapping. According to information from DID, action plans for the formulation of flood hazard map were already made and flood hazard maps has been preparing for Damansara River located in the west of Kuala Lumpur. For the Muar River basin, however, no hazard map has been prepared.

(2) Land Use Management

(a) Land Use Zoning

The National Physical Plan, the State Structural Plans of States of Negeri Sembilan and Johor, and all the relevant Local Plans are providing land zone plans to guide the land development. According to the state structural plans, forest lands that occupy 33% (2,000 km^2) of the entire river basin at the year 2000 will decreased by 12% (700km^2) at 2020, mainly transformed to agricultural lands as discussed in **Section 2.7.2**.

A local plan that is prepared and gazetted by each of the local authorities provides detailed land use zoning information. The land use zoning usually includes land use categories of industry, infrastructure & utility, institution & public facility, freeland & recreation, business & services, agriculture, forest, etc., for each of which guidelines of allowable activities are described in the plan. Since all development activities are subject to the land use zoning, it is very important how the zoning is made. The local authorities hardly refer to flood maps/hazard maps when preparing the local plans at present, according to an interview to an official of a local authority.

(b) Regulation of Development Activities

To prevent disorderly development activities, many regulations are provided in Malaysia. **Table 6.2.3** shows how major development activities including construction works, logging activities and agricultural developments are regulated. Large scale developments such as housing developments of 50ha or over and agricultural developments of 500ha or over are also subject to EIA.

In addition, all the environmentally and ecologically important and sensitive areas have been demarcated as Environmental Sensitive Areas (ESAs) in the National Physical Plan, as described in **Section 1.6.1**. These includes areas such as protected areas, wetlands, water catchment areas, wildlife corridors and so on, which are to be protected in accordance with the ESA development guidelines developed by JPBD.

DID has developed the Urban Stormwater Management Manual for Malaysia (MASMA) in 2000. MASMA is a comprehensive manual for urban stormwater design, covering processes, control principles, works design and plan preparation, as well as maintenance requirements. It is noted that MASMA prescribes a developer installation of a detention pond to compensate the storage capacity to be lost by his development activity.

Table 6.2.3 Regulation of Development Activities

Activities	Regulation
Construction works (including housing)	• Approval of the local authority is required. • DID and Land Office, etc. participates in evaluation of the construction works as a technical advisor. • MASMA is enforced.
Logging	• Forestry Department regulate logging activities by licensing and enforcing logging rules.
Agricultural Developments	• JPBD and the local authority enforce land use control. • Approval of UPEN and PTG is necessary for agricultural developments. • DOA regulates on agricultural practices.

(c) River Reserve

In Johor State, 10 to 50m wide river reserve, depending the river width, has been gazetted in accordance with Subsection 13 of the Land Code, while no river reserve has been gazetted at all in Negeri Sembilan State.

According to an official of the River Management and Coastal Zone Division, DID, the gazetting by the Subsection 13 is not so effective because the river reserve areas and the regulators of activities in the river reserve areas are not legally clear. In order to have required river bank widths effectively reserved, therefore, DID is about to start in the 10th Malaysia Plan gazetting of river reserve areas in accordance with Subsection 62 of the Land Code, while promoting immediate gazetting by Subsection 13 for the states that have no river reserve.

In case of the gazetting by Subsection 62, the gazetting notification is required to describe the reserved land and purposes for reserving, to designate the officer having the control of the land, and to be conclusive evidence that the land is reserved for a public purpose. DID could be the officer to control of the river reserve. As soon as next year DID will start land-surveying as a first step of this gazetting procedure.

(3) Flood Forecasting and Warning System

(a) Infobanjir (Telemetry Flood Forecasting and Warning System)

Hydrology and Water Resources Division of DID developed a flood warning system or “Infobanjir” on the website in 2005. The hydrometric data is updated at regular intervals (hourly to daily) from over 300 remote telemetry units located at strategic points in Malaysia.

Once water level of a monitoring station reaches the alert level, DID begins to monitor closely the flood situation such as rainfall and water level. When it reaches the warning level, DID informs relevant flood control centers. When the river water level exceeds the critical level, forecast information is transmitted to the flood operation centers and other relevant agencies.

There are 15 water level monitoring stations and 31 rainfall gauging stations for the telemetry network of Infobanjir in Johor State. Of these, 7 water level monitoring stations including 1 station located in Negeri Sembilan State and 9 rainfall gauging stations (1 station in Negeri Sembilan State) are located in the Muar River Basin.

Table 6.2.4 Telemetry Network for Water Level and Rainfall (Infobanjir, Muar Basin)

Monitoring	No. of Stations	Johor State	Negeri Sembilan State
Water level	7	6	1
Rainfall	9	8	1

Source: Inforbajir on-line river level data and rainfall data

(b) Flood Forecasting

Flood forecasting is not conducted at all for the Muar River Basin at present.

(c) Warning System by Siren and Signboard

There are several food waning sirens installed by DID in flash flood areas of the Muar River Basin. The sirens ring automatically to warn neighbors of the flood event when water level reaches the critical levels. In addition to the sirens, there are several signboards in the basin. The signboards give information on the relationship between water levels in the upstream reference points and those at the signboard site. The numbers of the sirens and signboards is still insufficient.

Flood Warning Siren at Pago, Muar

Signboard at Kg. Tiong, Gemas, Tampin

Figure 6.2.4 Photos of Warning Siren

(4) Flood Response

For the disaster management in Malaysia, the Disaster Management and Relief Committee (DMRC) is set up in federal, state and district levels with secretariat by National Security Council (NSC). DMRC is a coordination mechanism consisting of relevant government institutions such as DID. For the flood management, NSC issued guidelines entitled "The Standard Procedures on Flood Relief Mechanism in 2001". According to the guidelines, main responsibilities of each relevant institution including DID for flood management are shown in **Table 6.2.5**.

Table 6.2.5 Responsibility of Relevant Institutions for Flood Management

Item	Responsibility	Responsible Institution
(1) Preparedness		
1) Evacuation Center	Identifying evacuation center	DSW
2) Storage of Basic Necessities	• Storing basic necessities • Identifying source of food supply	DSW
3) Helicopter Landing Spot	Ensuring helicopter landing spot	MRAF, RMP
4) Rescue Boat	• Preparing rescue boats • Preparing safety jackets	RMP, MRAF, MCDD, FRD, DO, LA
5) Clearing of Drainage System	**Clearing up drainage**	**DID**, PWD, LA
6) Flood Warning	Providing weather information	MMD
	Providing flood warning	**DID,** WA, TNB
	Setting up flood warning signboard	DID, PWD
7) Flood Risk Analysis	**Examining/analyzing flood risks**	**DID**, PWD, MGD, MACRES
(2) Flood Response		
1) Order and Control	Coordinating all activities at OSCP	RMP (federal), police officers (state & district)
2) Communication Tool	Preparing communication tools (telephone, fax, radio, walkie-talkie, etc.)	-
3) Reporting	Reporting current flood conditions	NSC
	Reporting flood event	**DID**
4) Evacuation of Victims	Assisting victims to move to evacuation center	police officers (state & district)
5) Set-up of Evacuation Center	Handling evacuation center (confirmation of victims, supply of food, commodities, medical goods, security of victims, etc.)	DSW, MCDD, RMP
6) Rescue	Searching and rescuing victims	police officers (state & district), FRD
7) Media Management	Disseminating information and media management	DOI

Note:
DSW: Department of Social Welfare, MRAF: Malaysian Royal Armed Forces, RMP: Royal Malaysian Police, MCDD: Malaysian Civil Defense Department, FRD: Fire and Rescue Department, LA: Local Authority, DO: District Officer, DID: Department of Irrigation and Drainage, PWD: Public Works Department, MMD: Malaysian Meteorological Department, WA: Water Authority, TNB: National Electric Company (Tenaga Nasional Berhad), MGD: Mineral and Geoscience Department, MACRES: Malaysian Center for Remote Censing, OSCP: On-Scene Control Post, DOI: Department of Inform

As community-based activities for the flood management, educational activities have been carried out in a form of seminar and training for both communities and DID officials. In principle, such seminar and training have been held once a year and twice a year respectively. Flood information including flood inundation areas, flood maps, monitoring, forecasting and warning system (equipment, communication systems, information flow for warning, etc.), and so on is provided to participants of the seminar and training.

On the other hand, simulation drills including evacuation drills with community participation has not been implemented in the Muar River Basin. However, implementation of a simulation drill is currently discussed between DID and NSC to strengthen flood-awareness among people.

(5) Adaptation to Climate Change

In Malaysia no adaptation measures to Climate Change have been undertaken yet. The 10th MP committed, for the first time, that Malaysia would adopt a dual strategy in addressing climate change impacts.

However, climate change projection has been conducted in Malaysia since about 5 years ago. Two institutes, NAHRIM and Malaysia Meteorological Department (MMD) developed Regional Climate Models (RCMs) for Peninsular Malaysia and Southeast Asia respectively. NAHRIM, jointly with University of California, developed Regional Hydroclimate Model of Peninsular Malaysia (RegHCM-PM) with horizontal resolution of 9km x 9km. MMD has developed a Regional Climate Model (RCM) as well with horizontal resolution of 50km x 50km, covering Southeast Asia including whole Malaysia utilizing Providing Regional Climate Impact Studies (PRECIS) model developed by Hadley Centre, UK.

NAHRIM also predicted change of monthly river runoff discharges of eight major rivers in Peninsular Malaysia, the Muda, Perak, Selangor, Klang, Johor, Pahang, Terengganu, and Kelantan Rivers. The result shows that the maximum monthly discharge of the Johor River at Rantau Panjan will increase and that the minimum monthly discharge of that will decrease on the other hand. This implies that extreme hydrologic phenomenon such as floods and droughts will take place more frequently and in an amplified manner in the future.

6.2.3 Maintenance of River and Drainage Structures

DID and local authorities undertake the following maintenance and rehabilitation works of river and drainage structures.

DID District Offices take efforts to mitigate and prevent flood damage in the Muar River Basin, such as installation of bank protection works, construction of the small bund along rivers, and drainage improvement. The dredging work of the Muar River belongs to Marine Department, the Ministry of Transportation. The maintenance work of DID Muar is increased regarding the emergency rehabilitation against the bank erosion that happened in 2008. DID Muar office have expended RM 5 million in the year of 2009. The maintenance work in the drainage directly connecting to the Muar River is decreased recently. **Table 6.2.6** lists the drainage structures maintained by DID Muar. RM600,000 was allocated for the maintenance cost during the 9th MP. Local Authority of Muar Town also has the maintenance work of some drainages and ditches.

Table 6.2.6 Drainage Structures maintained by DID Muar

No	Name of Stretch	Distance (m)	Completion Year	Maintenance Cost in RMK-9
1	PT. SUNGAI ABONG (PAKEJ 5A)	2300	1997	41,400
2	PT. SETONGKAT (PAKEJ 5B)	2950	1997	53,100
3	PT. OTHMAN (PAKEJ 4A)	580	1998	10,440

No	Name of Stretch	Distance (m)	Completion Year	Maintenance Cost in RMK-9
4	PT. TIRAM (PAKEJ 3A)	2450	1998	44,100
5	PT. BAKRI (PAKEJ 3B)	2900	1998	52,200
6	PT. BAKRI II (PAKEJ 3C)	2300	1998	41,400
7	PT. PDG. GOLF/PT.ABD.RAHMAN (PAKEJ 4B)	3000	1998	54,000
8	PT. SULAIMAN (PAKEJ 4C)	1150	1998	20,700
9	PT. SULAIMAN II (PAKEJ 4D)	225	1999	4,050
10	PT. BAKRI III (PAKEJ 3D)	240	1999	4,320
11	PT. SULTANAH (PAKEJ 4E)	490	1999	8,820
12	PT. TANJUNG AGAS I - BARAT	2700	2001	48,600
13	PT. TANJUNG AGAS II - TIMUR	2800	2001	50,400
14	PT. BAKRI IV (PAKEJ 3E)	1530	2001	27,540
15	PT. BETING (PAKEJ 6A)	980	2002	17,640
16	PT. PERUPOK	160	2002	2,800
17	PT. BAKRI V (PAKEJ 3F)	1620	2003	29,160
18	PT. BETING II (PAKEJ 6B)	1800	2004	32,400
19	PT. BAKRI VI (PAKEJ 3G)	1820	2004	32,760
20	PT. HJ. BAKRI (PAKEJ 4F)	1300	2005	23,400
	Total	33,295		599,230
	PT: Stretch			

Data Source: DID Muar

For DID Segamat District, excavation and cleaning works of tributaries are concentrated as the maintenance work as shown in **Table 6.2.7**, and the expenditure in 2009 reached to the amount of RM 554,000.

Table 6.2.7 Maintenance Work by DID Segamat in the Year 2009

No	Existing Maintenance Work	Length (m)
1	Downstream of Paya Merah River to Gatom River	3,000
2	Temanggau River	5,000
3	Beraal River	6,000
4	Sanglang River, Kg. Awat	3,000
6	Paya Merah River	5,000
7	Genuang River	6,000
8	Downstream of Segamat River	500
9	Branches of Muar River, Kg. Serdang	1,000
10	Branches of Penarah River, Kg. Paya Lebar	2,000
11	Branches of Muar River, Kg. Serdang	450
12	Branches of Tagal River along	2,000
13	Gerchang River at Desa Temu Jodoh area	2,000
14	Mados River at Kg. Tenang	2,000
15	Labis River at Gotam River downstream	-
16	Kenawar River at Pagoh	-
17	Upstream of Jenalin River	1,500
18	Chodan River (Beautification, Repairing)	400

Data Source: DID Segamat

6.3 Planning of Framework

6.3.1 Target Year of IFM Plan

The planning term of the IFM plan is the same as the IRBM plan. Namely the year, 2025 is the target completion year, and the IFM plan covers three 5-yearly Malaysia Plan (MP) periods, the 10^{th}, 11^{th} and 12^{th} MP periods.

6.3.2 Setting-up of Future Conditions

As the IFM plan is completed in 2025, it is elaborated under the physical and social conditions at 2025, of which population, land use and impact of Climate Change are assumed as presented in **Table 6.3.1**.

Table 6.3.1 Determination of Future Conditions at 2025

Item	Way of Determination	Remarks
Population	Population at2025 is projected under this survey.	Basin population increases by 17 % from 660,000 at 2010 to 770,000 at 2025.
Land use	Land use zone map of 2020 (Figure S.2.1) is substituted for that of 2025.	Build-up areas increases by 4.4% from 2.7% at 2000 from to 7.1% at 2025.
Impact of Climate Change	Increment of rainfall intensity and sea level rise is considered as described in Chapter 3.	100 year ARI 3 day rainfall increases by 20% from 339.7 mm to 407.6 mm. The sea level rise is 12 cm.

6.3.3 Design Scale of Structural Measures

DID Manual of flood mitigation management (Volume 1: Flood Management, Chapter 6: Flood Mitigation Guideline) suggests that the protection level of flood mitigation plans be basically at 100 years and 25 to 50 years of ARI (Average Recurrence Interval) for urban areas and rural areas respectively, although the definitions of the urban and rural areas are not clear. According to Chapter 10: Design Criteria and Design Consideration of the same manual, however, the design scale could be lower than the above-said ideal target levels in consideration of constraints in budget, socioeconomic condition, schedule and so on. In this Preparation Survey, therefore, the target protection level is provisionally set as Chapter 6 of the manual requires, but it could be lowered according to the local situations.

6.3.4 IFM Approach

According to the Volume 1: Flood Mitigation of the DID Manual, IFM (Integrated Flood Management) includes 7 components, (1) Ensure a participatory approach, (2) Integrate land and water management, (3) Manage the water cycle as a whole, (4) Adopt a best-mix of strategies, (5) Adopt integrated hazard management approaches, (6) Adopt environmental enhancement, (7) Introducing national flood management policy. The IFM plan considers all the components, and makes much of three items, (1) Ensure a participatory approach, (2) Integrate land and water management and (4) Adopt a best-mix of strategies in particular.

As a part of the participatory approach, the stakeholder meeting and the steering committee meeting have been held three times and four times respectively in the course of the Preparatory Survey. The JICA Study Team collected opinions and data regarding flood issues and feedbacks on the planning from the participants.

The integrated management of land and water is very important for the Muar River Basin. The IFM plan should aim to mitigate flood damage for all the flood inundation areas. However, the flood inundation of the Muar River is too extensive to manage, similar to the Pahang River. Efficiency of large-scale structural measures that aim to deal with the extensive flood may be very low because the flood inundation areas are less developed and less populated. It might be avoidable that the IFM plan has to accept inundation in agriculture and forest areas and to concentrate structural measures more in urban areas. Appropriate flood management made of a best mix of structural and non-structural measures should be applied to build a resilient society to floods.

6.4 Proposed Measures for IFM Plan

6.4.1 Conceivable Structural Measures

As explained in **Section 6.2,** there is an antecedent master plan study. This study that is entitled "Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor" and is conducted by a local consultant firm started in 2008 and is still on-going.

As written in the Inception Report of this Preparatory Survey, the JICA Study Team was waiting for final results of the antecedent study that was to be ready by October 2009. The objectives of the master plan are almost the same as those of this IFM plan, only except that the JICA IFM plan considers impacts of climate change but the master plan study does not. To avoid inconsistency with the antecedent study, The JICA Study Team was supposed to review measures proposed in the master plan and add some more measures only if necessary mainly to adapt to the impacts of climate change.

However, the study is being delayed and needs some more time to produce a final result. As the deadline for the Interim Report for this Preparatory Survey, in which the JICA Study Team should have included an IFM plan, was coming nearer, the JICA Study Team decided in January 2010 to give up waiting for the final result of the master plan study and to elaborate an IFM plan based on its interim results.

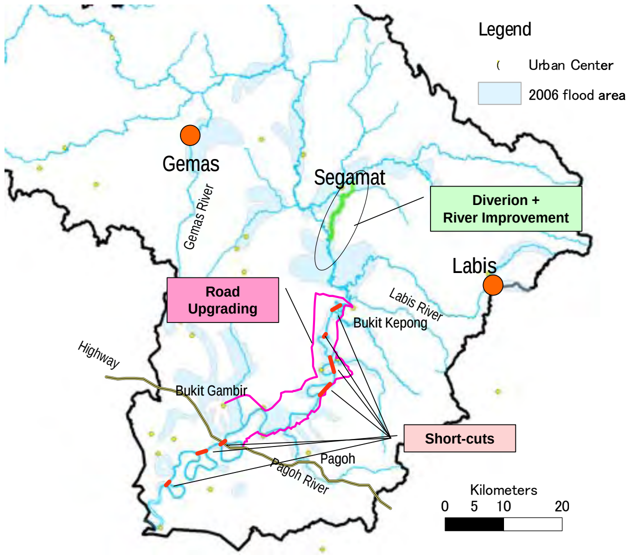


Figure 6.4.1 Location of Conceivable Measures

Conceivable structural measures are selected as presented in **Table 6.4.1,** taking into consideration the interim results of the antecedent master plan study as of the end of January 2010. The location of the proposed measures is also presented in **Figure 6.4.1**.

Table 6.4.1 Conceivable Structural Measures for Muar River Basin

Project	Contents	Remarks
Segamat-Genuang Diversion and River Improvement of Genuang and Chodan Rivers	1.5 km Diversion Channel, + 1.2 km River Improvement for Genuang River and + 8.5 km River Improvement for Chodan River	To be implemented in 10th Malaysia Plan
Short-cuts of river loops (Bypass channels)	7 candidate sites are identified between the river mouth and Bukit Kepong..	
Road Upgrading	RaisingHeightening and strengthening of main roads to prevent traffic communication cuts during floods	
Protection of Urban Centers	Labis and Gemas Towns are identified as candidate urban centers.	

(1) Segamat-Genuang Diversion and River Improvement of Genuang and Chodan Rivers

The Segamat-Genuang Diversion and the River Improvement of Genuang and Chodan Rivers are a package that should be implemented together. Since DID has already determined to implement it in the coming 10th Malaysia Plan, this survey considers that this package work will be implemented within an earliest stage of the planning term from 2011 to 2025.

As pointed out in **Section 5.2.3**, however, this package work may results only in transfer of harmful flood inundation from Segamat Area to the downstream if it is solely implemented without any offset works in the downstream to absorb the harmful additional discharge. This survey firstly assesses the impact of the diversion and the river improvement, and proposes appropriate offset works, based on the flood simulation.

(2) Short-cut Channels (Bypasses of River Loops)

The Muar River meanders remarkably in the lowest 110 km stretch, and 7 sites for short-cut of river loops are identified based on the interim results of the antecedent master plan study and site reconnaissance. By short-cutting, the river channel becomes shorter and steeper, resulting in lowering of the flood water level. Locations and outlines of the seven short-cut channels are given in **Figure 6.4.2** and **Table 6.4.2** respectively.

Figure 6.4.2 Location of Short-cut Channels

Table 6.4.2 List of Short-cut Channels

No.	Name	Length of Channel (km)			% of Shortening	Main Land Use	Number of House Relocation	Cost (10^6 RM)	Remarks
		Original Loop	Short-cut Channel	Difference					
1	Sungai Sendok	8.1	1.2	6.9	85%	Orchard, Rubber	10	45	Once a tidal barrage was proposed.
2	Belemang	14.5	1.6	12.9	89%	Rubber	5	83	
3	Tg. Olak	10.1	0.9	9.2	91%	Oil Palm	0	90	North-South Highway is crossed.
4	KundangLiang Batu	6.8	2.2	4.6	67%	Rubber	5	27	
5	PenchuLenga	7.7	2.3	5.4	70%	Rubber	0	26	
6	Bt. Serampang	1.2	0.4	0.8	67%	Oil Palm	0	5	
7	Bt. Kepong	3.6	1.6	2.0	56%	Permanent Livestock farm	0	14	
		52.0	10.2	41.8	80%		20	290	

The first three short-cut channels seem very effective because they can shorten the original loops very efficiently, by more than 80%, although. No.1 and No.2 require house relocation. If all the short-cuts are implemented, the Muar River will be shortened by as much as 41.8 km.

It is noted that these short-cuts might be able to offset the adverse impact of the diversion and the river improvement in the upstream. This survey examines the possibility of the shot-cut channels as the offset work of the upstream works as well as the measure to mitigate the flood inundation in the downstream stretches. The effectiveness is verified by flood simulation and economic analysis.

Adverse impacts of the short-cuts, especially on the river morphology and the environment, are concerns of DID on the other hand. The artificial change of the river course may cause local scoring and sedimentation near the short-cut channels. Sea water intrusion is also anticipated. To avoid rapid evolution of these impacts, step-wised implementation might be recommended, Monitoring these impacts and applying necessary mitigation measures, the short-cuts should be step-wisely implemented from the downstream if these measures are adopted.

(3) Road Upgrading

Road upgrading is to raise and strengthen main roads to prevent road communication cuts even during floods. To secure road communication during floods is very important to facilitate evacuation and relief activities in the flood inundation areas that are submerged for one to three weeks. According to the Flood Mitigation Division of DID, a total about 75 km of the existing roads on the both banks of the lower Muar River are proposed to be upgraded.

A possibility to use the upgraded roads as river bunds by providing hydraulic control structures at the river and drainage crossings has been also discussed among officials concerned. If this is realized, flood inundation water will be confined between the left and right bund roads. Within this area, however, thousands of people are now living. Huge social impacts are anticipated.

(4) Protection of Urban Centers

The antecedent master plan study is focusing on the flood mitigation for the flood inundation areas along the lower Muar River and the Segamat Town. However, it is true that the other areas are also suffering from flood damages. Pagoh, Labis, and Gemas Towns have been often named as flood-vulnerable urban centers during the stakeholder meeting on December 10, 2009 and the meetings of the Flood Mitigation WGs of Johor and Negeri Sembilan.

Informed by the WGs, the JICA Study Team conducted site reconnaissance and found that these three urban centers were damaged during the 2006 flood by overflow from the tributaries, the Pagoh River, the Labis River and the Gemas River respectively. As the overflow of the Pagoh River was caused by the backwater from the Muar River, the flood problem of Pagoh Town can be mitigated if the water level of the Muar River is lowered by the implementation of the short-cuts. For the two towns, Labis and Gemas, ring bunds and drainage facilities seem effective, although further study is necessary.

6.4.2 Flood Simulation and Economic Analysis on Structural Measures

By the flood simulation and the economic analysis, the adverse effects of the diversion package (The Segamat-Genuang Diversion and the River Improvement of Genuang and Chodan Rivers) and the effectiveness of the short-cuts are examined. **Figure 6.4.3** and **Table 6.4.3** give results of the simulated water levels and a summary of the flood simulation and the economic analysis, respectively. The number of the study cases are nine, and Case-01 is without measures, Case-02 is with the diversion package only, Case-1 is with Case-02 and the lowest shortcut (Sungai Sendok), Case-2 is with Case-1 and the second lowest short-cut (Belemang), Case-3 is with Case-2 + the third lowest short-cut (Tg. Olak) and so on. The reason why the short-cuts are added from the downstream, is to follow the principle that river works should be implemented from the downstream to the upstream. **Table 6.4.3** includes results of the economic analysis. The benefit that is expressed as reduction of flood damages by the measures was calculated to further estimate economic indicators, Benefit Cost Ratio (B/C), Net Present Value (NPV = B-C) and Economic Internal Rate of Return (EIRR) under the condition that the implantation schedule is as presented in **Table 6.5.1**.

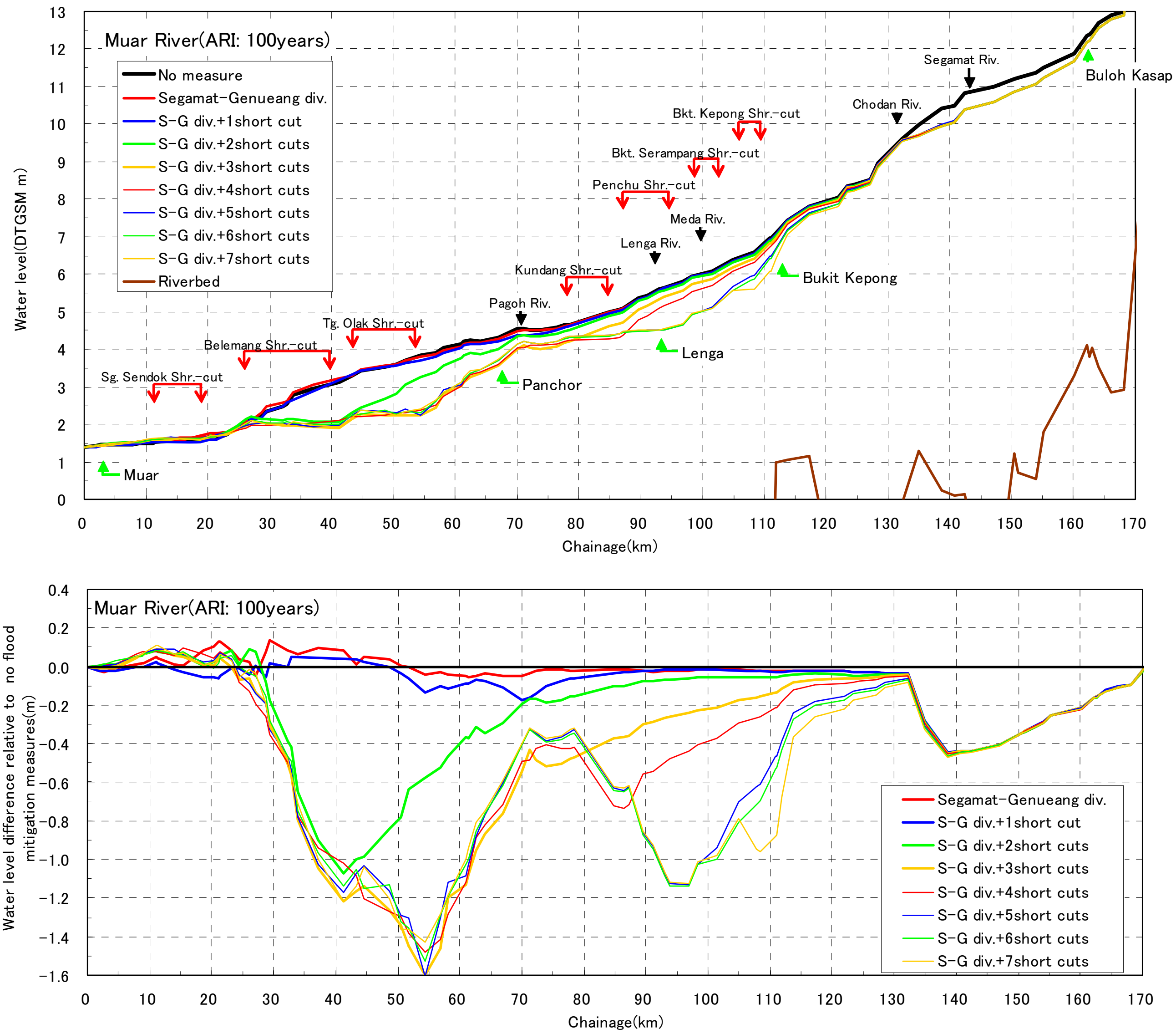


Figure 6.4.3 Simulated Water Levels for 100-year ARI Flood under 2025 Condition

Table 6.4.3 Results of Flood Simulation and Economic Analysis

Case	River Water Level of 100-year ARI Flood						Cost (10^6 RM)	NPV (10^6 RM) Benefit/year (10^6 RM/year)	EIRRB /C	B/CB-C (10^6 RM)
	Bandar Segamat	Bukit Kepong	Lenga	Panchor	Kg. Belemang	Muar				
011. Without measuresDiversion + River improvement of Genuang and Chodan	12.06	6.95	5.59	4.31	2.32	1.45	n/a	n/a	n/a	n/a
02. Diversion + River improvement of Genuang and Chodan	10.72	6.92	5.57	4.26	2.47	1.42	178	n/a	n/a	n/a
12. 021+ Sungai Sendok Short-cut	10.72	6.92	5.57	4.20	2.35	1.42	223	9	10.5%	1.05
23. 12+ Belemang Short-cut	10.72	6.89	5.52	4.02	2.15	1.46	306	12	10.5%	1.05
34. 23+ Tg. Olak Short-cut	10.72	6.81	5.33	3.55	2.04	1.44	396	1	10.1%	1.01
45. 34+ KundangLiang Batu Short-cut	10.72	6.73	5.10	3.59	1.97	1.46	423	-10	9.6%	0.96
56. 45+ PenchuLenga Sho Shortrt-cut	10.72	6.48	4.52	3.70	2.00	1.45	449	-11	9.6%	0.96
67. 56+ Bukit Serampang Short-cut	10.72	6.42	4.51	3.69	2.04	1.46	454	-11	9.5%	0.96
78. 67+ Bukit Kepong Short-cut	10.72	6.07	4.53	3.72	2.01	1.45	468	-13	9.5%	0.95

Discount rate for estimation of B/C and B-C: is 10 %

(1) Adverse Effect of Diversion Package Work

As seen in the **Figure 6.4.3**, water level rise is observed between 10 km and 50 km in chainage. The maximum rise is about 15 cm at 30 km chainage, near Kg. Belemang.

(2) Effectiveness of Short-cuts

It is observed in **Figure 6.4.3**, the short-cuts can absorb the above adverse effect to some extents. As shown in **Table 6.4.10**, the water rise is decreased, and the water level rising portion becomes shorter and moves downstream, for example between chainage 5 km and 25 or 27 km in the cases 2 to 7. Fortunately kampongs adjacent to the lower stretch between 5 and 27 km in chainage are situated on the grounds higher than the 100 year ARI water levels. Therefore, it can be said that the adverse effect of the diversion package can be minimized if the two lowest short-cuts are implemented at least.

Table 6.4.4 Results of Flood Simulation and Economic Analysis

Case	Water Level Rise Portion Relative to no-measure case	Maximum Water Level Rise (cm)
01. Diversion + River improvement of Genuang and Chodan	10 to 50 km in chainage	15
1. 1+ Sungai Sendok Short-cut	30 to 50 km in chainage	5
2. 2+ Belemang Short-cut	5 to 27 km in chainage	9
3. 3+ Tg. Olak Short-cut	5 to 25 km in chainage	9
3. 4+ Kundang Short-cut	5 to 25 km in chainage	10
5. 5+ Penchu Short-cut	5 to 25 km in chainage	9
6. 6+ Bukit Serampang Short-cut	5 to 25 km in chainage	9
7. 7+ Bukit Kepong Short-cut	5 to 25 km in chainage	11

The effectiveness of the short-cuts to reduce the water levels are remarkable. If all the short-cuts are implemented, water levels between 25 km and 130 km are lowered by 1.6m at the maximum.

The results of the economic analysis show that all the cases have B/C of about 1. Although B/C of Cases 4 to 7 is slightly lower than 1, all the cases could be applicable.

6.4.3 Draft Master Plan by the Antecedent Master Plan Study

In June 2010, the antecedent master plan study, 'Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor' produced its draft master plan report at last. In the draft report, a draft master plan that propose a combination of several components including the above-said diversion, bypass channels, retention ponds, bunds, tributary improvement, flood mitigation dams, a tidal barrage, etc. These structures are proposed to be implemented in three stages, namely Stage-I (Short Term), Stage-II (Mid Term) and Stage-III (Long Term), although their periods are not specified, as summarized in **Table 6.4.6**. The location of the proposed components is presented in **Figure 6.4.4**. Unfortunately, details of these measures such as design scale, dimensions, cost, economic effectiveness, environmental issues have not been provided in the draft master plan report. In the draft master plan, following allied measures are also proposed to complement the structural measures:

Table 6.4.5 Proposed Allied Measures

Category	Item
River Conservancy Plan	Controls on land use conservation
	Controls on development in the flood plain
	Erosion and sedimentation controls from earthworks sites
River Corridor Management Plan	Zoning of land in the corridor to limit future adverse effects
	Re-vegetation in the riparian strip, where practicable
	Initiatives to promote improved riverfront amenity and visual values
Non-structural Measures	Preparing flood hazard delineations
	Implementation of a flood forecasting /warning system
	Public education initiatives

Table 6.4.6 Components of Proposed Draft Master Plan

Stage	Measure/Project	Effectiveness Level	Target Area	Remarks
Stage I (Short-Term)	Segamat project	Water level is reduced by 1.2m	Segamat	Segamat-Genuang Diversion and, Channel improvement (Genuang-Chodan)
	Lower By-passes	Water level is reduced by 1.1m	Lower Muar	Belemang and Olak by-passes
	Retention pond	Water level is reduced by 0.1 to 0.25m	Lower Muar	Around Tebiang Tinggi and Chodan
	Road heightening/Flood proofing	Flood level and extent is reduced	Lower Muar	-
	All measures of Stage I	Affected buildings and Flood Area are reduced by 72% and 26% respectively in 100 year flood		
Stage II (Mid-Term)	Upper by-passes with bridge heightening	Water level is reduced by 1.4m	Segamat	Kundang Ulu, Penchu, Serampang, and Bt Kepong
	Tributary improvement	Water level is reduced by 0.3m	Middle Muar	Pagoh, Labis, Ring, Meda, Sepang Loi, Merlimau, Jementah, kapeh, Lenga, and Segamat River
Stage III (Long-Term)	Two dams	Flood level reduction in the order of 0.3m	Middle and Lower Muar	Kapeh Dam and Palong Dam
	Barrage	Prevention of inundation by high tide	Lower Muar	Sendok River

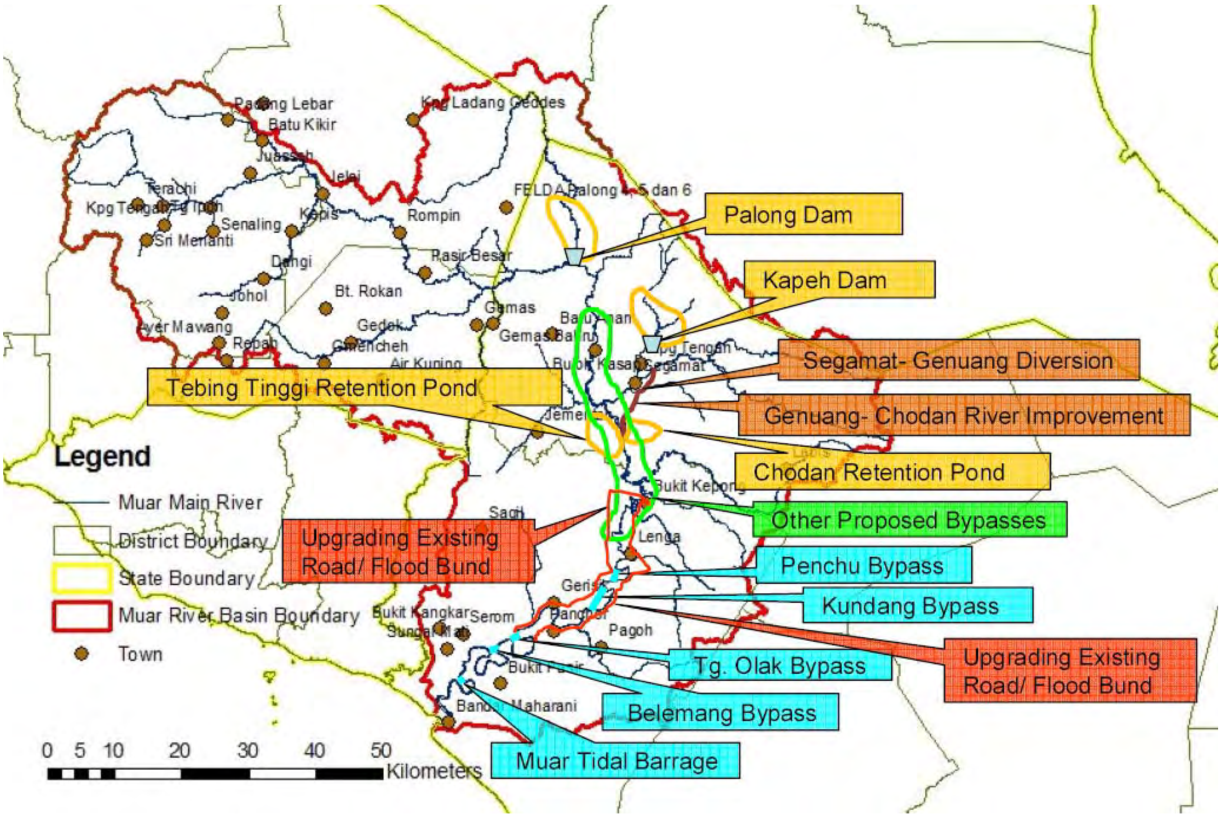


Figure 6.4.4 Location of Draft Master Plan Components

6.4.4 Non-Structural Measures

As discussed in **Section 6.2.2**, the existing non-structural measures have been already developed to some extent. Institutional frameworks for implementing them have been also generally established. Therefore, the JICA Study Team firstly recommend that efforts should be continued to enforce or operate the existing non-structural measures effectively. In addition, the Team also specially proposes to implement three projects in **Table 6.4.7** that aim to strengthen the existing non-structural measures. Details of the proposed projects are described below:

Table 6.4.7 Proposed Specific Non-structural Measure Projects

Project	Contents
Capacity Development of District DIDs and Local Government agencies for Flood Management	Capacity development of District DIDs and local government agencies (Flood Management and Disaster Committee for flood) for flood management, especially preparation and dissemination of hazard maps.
Improvement of Flood Forecasting and Warning System	Strengthening of Flood Forecasting and Warning System with additional telemetry stations for the Muar River Basin
Updating of Projection of Impact of Climate Change	Updating of projection of impact of climate change based on IPCC's assessment reports.

(1) Capacity Development

Local government agencies (members of Disaster Management and Relief Committee for flood) are responsible for the security of the people at the local level. In fact they shoulder activities of warning, evacuation, flood fighting and rescue during floods. Moreover, they are involved in land use planning at the local level. Therefore, to strengthen the capacity of the local government agencies is a key for building flood-resistible communities. Their DID partner at the level of district, District DIDs should be also strengthened, especially for the preparation and dissemination of hazard maps. The capacity development project may be summarized as shown in **Table 6.4.8**.

Table 6.4.8 Summary of Capacity Development Project

Item	Contents
Objective	To build the capacity of District DIDs and local government agencies (members of Disaster Management and Relief Committee for flood) in the Muar River Basin for flood management
Outputs	• District DIDs and the local government agencies can elaborate flood hazard maps. • District DIDs and Local government agencies can elaborate flood management plans. • The elaborated hazard maps and the flood management plans are published. • Training, simulation drills are implemented
Cost	RM 1 million x 5 districts = RM 5 Million
Implementing Agency	DID and local government agencies

In order to achieve the objectives and outputs for the capacity development for flood management, the following activities should be carried out (see **Table 6.4.9**).

Table 6.4.9 Proposed Programs and Activities for Capacity Development Project

Program	Activities	Relevant Institution
Elaboration of Flood Hazard Map	• To collect data/information on flood inundation and damages (flood area, flood level, etc.) on the past major flood • To prepare baseline map • To confirm evacuation routes and location of evacuation center • To elaborate flood hazard map • To make manual for preparation of flood hazard map • To hold workshops for explaining prepared flood hazard map to the residents and for collecting comments from the participants • To revise prepared flood hazard map based on the above comments	• DID • NSC • DO • LA

Program	Activities	Relevant Institution
Elaboration of Flood Management Plan	• To collect data/information on current conditions of flood management facilities (flood monitoring, forecasting and warning systems, evacuation route, evacuation center, transportation for evacuation and rescue, etc.) • To review tasks and responsibility on flood monitoring, forecasting and warning among relevant institutions • To elaborate action plan for flood management (plan on installation of flood monitoring, forecasting and warning systems, establishment and procurement of flood warning signboard, evacuation center, evacuation transportation (helicopter, boat, car), plan of educational and training program, etc.) • To hold workshops for explaining prepared flood management plan to the residents and for collecting comments from the participants • To revise prepared flood management plan based on the above comments	• DID • NSC • DO • LA
Training and Simulation Drill	<Trainings> • To conduct on-the-job training (OJT) of engineers through the elaboration of flood hazard map and flood management plan • To train maintenance staff of flood monitoring, forecasting and warning systems (telemetry system, rainfall gauge, etc.) • To strengthen the institutions concerning with monitoring and forecasting (definition of responsibility) <Simulation Drill> • To coordinate among the institutions concerning with simulation drills • To prepare evacuation materials (evacuation posters, etc.) • To formulate the program/scenario of simulation drills • To implement the simulation drills by using prepared flood hazard map • To review and evaluate the results of simulation drills • To strengthen the institutions concerning with simulation drills (definition of responsibility)	• DID • NSC • DSW • MMD • PWD • MRAF • RMP • MCDD • FRD • DO • LA

Note:
DID: Department of Irrigation and Drainage, NSC: National Security Council, DSW: Department of Social Welfare, MMD: Malaysian Meteorological Department, PWD: Public Works Department, MRAF: Malaysian Royal Armed Forces, RMP: Royal Malaysian Police, MCDD: Malaysian Civil Defense Department, FRD: Fire and Rescue Department, DO: District Officer, LA: Local Authority

(2) Improvement of Flood Forecasting and Warning System

The Muar River Basin has been incorporated to the national flood forecasting and warning system called "Infobanjir". However, the number of the existing telemetry stations in the river basin (9 rainfall stations and 7 water level stations) is very small compared with the size of the river basin of 6,140 km^2. It is proposed to increase the number of the stations as shown in **Table 6.4.10** and Figure 6.4.5, referring to the recommendation by WMO that the density of rainfall stations in mountainous areas be 250 km^2/station or less. With this addition, the rainfall station density will become 180km^2/station, including those of the rainfall and water level stations.

Table 6.4.10 Proposed Number of Telemetry Stations

Stations	Numbers	Remarks
Rainfall Stations	21 (9)	
Water level stations	13 (7)	Each of the water level stations are proposed to upgrade to rainfall and water level station.
Total	34 (16)	

Numbers in parentheses are ones of existing stations

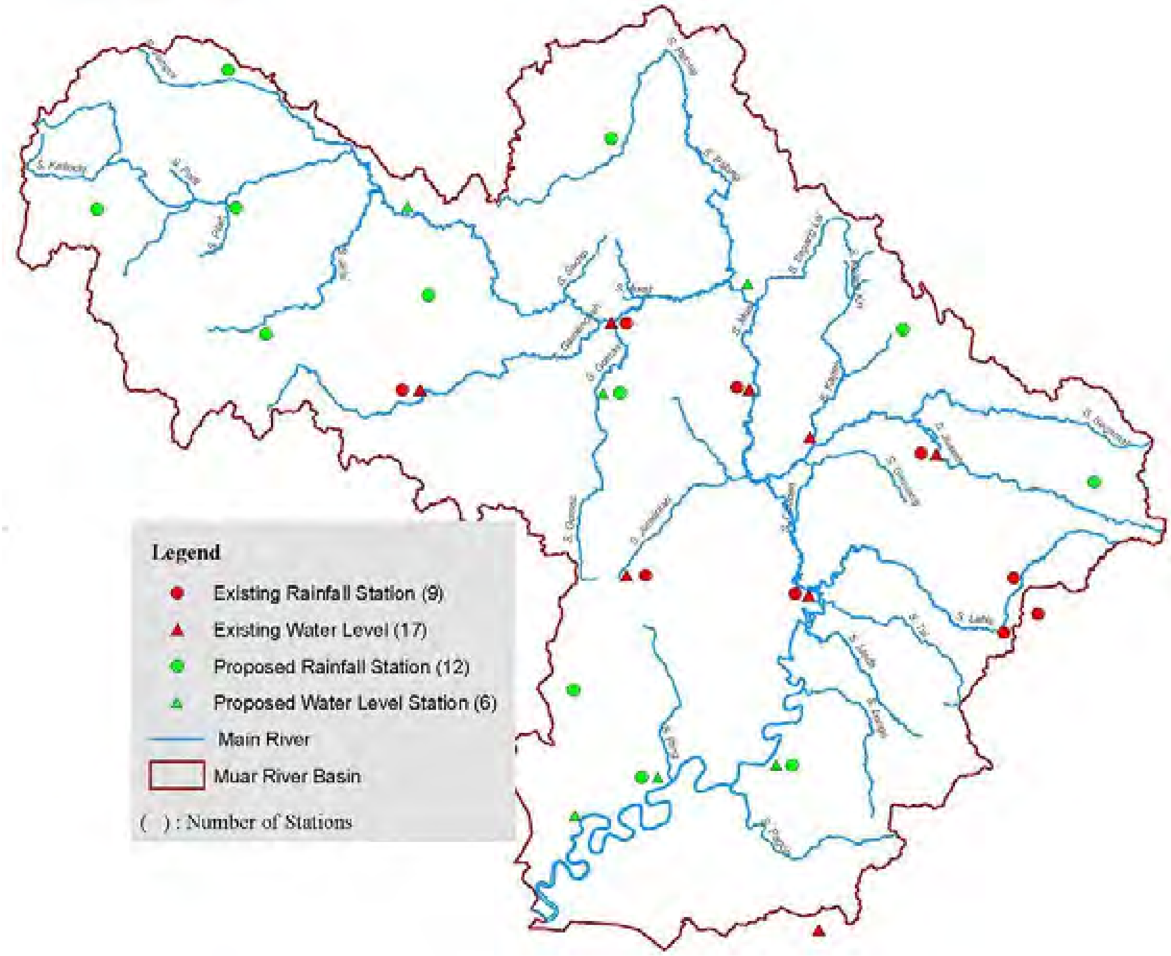


Figure 6.4.5 Proposed Telemetry Stations (Rainfall & Water level)

The project cost is RM 10.9 million, as shown in **Table 6.4.11**.

Table 6.4.11 Project Cost for Integrated Flood Forecasting and Warning System

Components	Qty	Cost(1,000 RM)	Remarks
1.RTU (Rainfall)	21 units	2,940	
2.RTU (RF+WL)	13	2,470	RF:Rainfall,WL:Water level
3.Control Center	1	1,500	
4.Hardware	Lump sum	140	
5.Software	Lump sum	700	
6.Development system	Lump sum	3,100	Including preliminary cot
Total		10,850	

Note: Unit price is estimated based on Klang Valley Project

(3) Monitoring of Impacts of Climate Change

Observed temperatures, rainfall and tide levels should be examined at least every five years to assess check impacts of Climate Change, as described in **Section 3.2**.

IPCC publishes its assessment report on climate change every 4 or 5 years. It is proposed to update the projection of the impact of Climate Change for the Muar River Basin by using the newest projection results of the GCMs and RCMs that the assessment report is based on. If any RCM projection covering the Muar River Basin is available, the projection data also can be used. If significant differences from the impact projection of this Survey are found, the design of the proposed measures should be modified.

6.5 Implementation of IFM Plan

6.5.1 Implementation Program

The IFM Plan is formulated as a combination of the proposed structural and non-structural measures, and a tentative implementation program is proposed in **Table 6.5.1**. In addition to the diversion package, the road upgrading and the protection of the two urban centers are also tentatively included although further studies are necessary. The short-cuts will be implemented in two phases to avoid rapid evolution of adverse impacts and to secure a certain period for monitoring.

Since the antecedent master plan study, 'Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor' is still on-going, all the components proposed in the study have not been incorporated in this IFM plan. The JICA Study Team recommend that DID finalize the master plan in due consideration of the recommendations by the Preparatory Survey.

Table 6.5.1 Tentative Implementation Program of IFM Plan

Structural/ Nonstructural	Project	Cost (10^6 RM)	10th MP 2011–2015	11th MP 2015–2020	12th MP 2020–2025
Structural	Segamat-Genuang Diversion and River Improvement for Genuang and Chodan	178			
	Sungai Sendok Short-cut	45			
	Belemang Short-cut	83			
	Olak Short-cut	90			
	Kundang Short-cut	27			
	Penchu Short-cut	26			
	Bkt. Serampang Short-cut	5			
	Bkt. Kepong Short-cut	14			
	Road Upgrading	n/a			
	Flood Mitigation Project for Labis Town	n/a			
	Flood Mitigation Project for Gemas Town	62*			
Non-structural	Capacity Development of District DIDs and Local Government Agencies for Flood Management	5			
	Flood Forecasting and Warning System Project	11			
	Updating of Projection of Impact of Climate Change	1			
	Total	547	373	32	142

* : Estimated in the feasibility study.

The total cost is RM 547 million, which is allocated over three 5-yearly MP periods. The average cost per single 5-yearly MP period is about RM 182 million, which is 2.5 times more than RM 72 million of the total budget in the 9th MP period for flood mitigation works in the Muar River Basin as shown in **Table 6.2.2**.

6.5.2 Organization for Implementation

Figure 6.5.1 is a proposed organization chart for the implementation of the IFM Plan. The federal DID is the primary implementing agency, supported by the two state DIDs of Negeri Sembilan and johor.

Many other related agencies, especially local government agencies will be involved in the implementation of the IFM plan. To facilitate the collaboration with these agencies, intervention of the river basin committees is very important. Fortunately, each of the two states of Johor and Negeri Sembilan has its task force, which is chaired by UPEN and has members from the district governments. The task forces are expected to make coordination with these agencies.

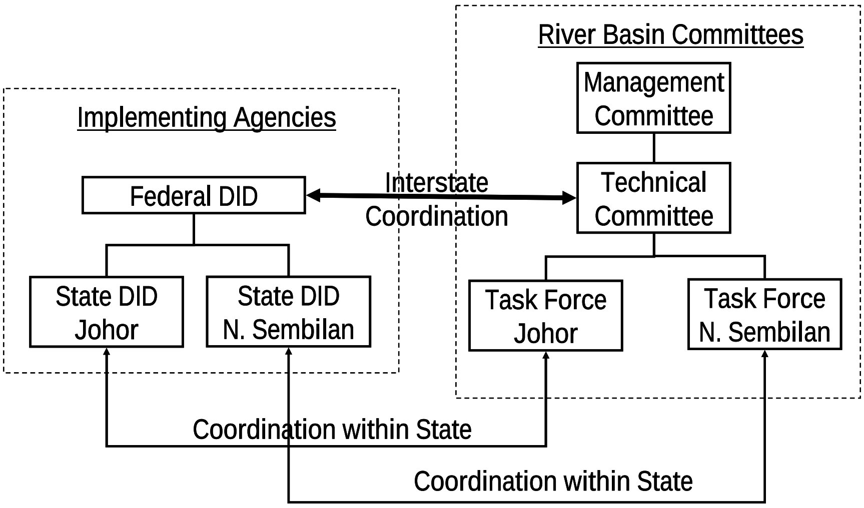


Figure 6.5.1 Organization for Implementation

6.6 Environmental and Social Considerations

In order to predict and evaluate potential environmental impacts of proposed projects, Initial Environmental Examination (IEE) has been carried out. The target projects for IEE are two projects, namely short-cut channels and flood mitigation projects for Labis and Gemas Towns as shown in **Table 6.6.1**.

The IEE was carried out based on the existing data, which are mainly obtained from DID, DOE and other organizations as well as field reconnaissance. The methodology used is based on the Japan Bank of International Cooperation Guideline for Environmental and Social Considerations (JBIC guidelines, July 2009).

Table 6.6.1 Proposed Flood Mitigation Project in the Muar River Basin

	Project	Project Component
I	Short-cut Channels (Sg. Sendok, Belemang, Tg. Olak, Kundang, Penchu, Bkt. Serampang and Bkt. Kepong)	Construction of Short-cut
II	Flood Mitigation Project for Labis and Gemas Towns	Construction of Ring Bund

6.6.1 Necessity of IEE

It is necessary to carry out IEE in the early stage of a project plan. The main steps of IEE are as follows:

- To classify the project based on the JICA guideline;
- To confirm the necessary EIA procedures based on the above classification,;
- To evaluate the necessary policies to prevent, minimize, mitigate environment impacts.

The following subsections outline the EIA procedures in Malaysia and classification according to the Japan Bank of International Cooperation Guideline for Environmental and Social Considerations (JBIC guideline July 2009).

(1) EIA Procedure in Malaysia

(a) Environmental related Law and Regulations

The main environmental law of Malaysia is the Environmental Quality Act 1974 (EQA). The provisions of EIA requirement is under Section 34A of the said Act and it is further stipulated in the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987.

The DOE was established in 1975 as the executing agency of the above Act. Concerning EIA requirements, the DOE has published a Handbook of Environmental Impact Assessment Guidelines (DOE, 1987).

(b) Environmental Impact Assessment (EIA)

In Malaysia, EIA Screening process is conducted at the very early stage of the proposed project in order to determine whether the project is subject to the EIA requirements. This process is deemed similar to the abovementioned project classification.

With respect to EIA requirements, development projects in Malaysia can be classified into three (3) categories in accordance with Malaysian Environmental Quality Act 1974 (see **Table 6.6.2**).

Table 6.6.2 Project Classification in Malaysia

Classification	Description
EIA is not required	Projects categorized in this category are not necessary to conduct EIA Study. However, depends on the nature of the project, it may me necessary to fullfil the environmental requirements under the EQA and its Order, Rules and Regulations.
Preliminary EIA is required	Projects that classified as “Prescribed Activities” under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987.
Detailed EIA is required	Projects that classified as “Prescribed Activities” under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987 and that expected to results in significant impacts to the environment. The DOE has listed the types of project that require Detailed EIA in the ‘Enviornmental Impact Assessment (EIA) – Procedure and Requirements in Malaysia’ (DOE, 2007).

For those projects subject to EIA requirements, the project proponents are required to undertake an EIA or Detailed EIA study. Approval of the EIA/Detailed EIA report from DOE is necessary before commencement of the project.

(c) Land Acquisition, Resettlement and Compensation

The main legal provisions related to land acquisition, resettlement and compensation in Malaysia are as follows.

- The Federal Constitution
- The National Land Code 1965 (Act 56) & its Regulations
- Land ordinance (Saba State)

Basically, Land Offices are implementing all necessary procedures for land acquisition, resettlement and compensation. Although DID is not directly involved in these procedures, Land Offices submit the resettlement, land acquisition and compensation plans to DID Headquarter for evaluation and approval.

For the evaluation of asset value and compensation, it is under the jurisdiction of the Valuation and Property Services Department (JPPH) that operates branch offices in all districts. According to the interview the officials of DID Segamat, normally stakeholder meetings will be held by the Land Office as part of the activities in the resettlement, land acquisition and compensation process.

In the case that an EIA/Detailed EIA study is required, the land acquisition, resettlement and compensation plan should be included in the EIA/Detailed EIA Report.

(d) EIA Procedure of JICA Study

The objective of the JBIC guidelines is to encourage recipient governments to take in account appropriate and adequate environmental and social considerations before project implementation.

On the other hand, under the JBIC Guideline, classification of projects is should be carried out. The projects shall be classified according to the level of potential environmental impacts. Depends on the classification, submission of an environmental review report to the recipient country may be necessary. **Table 6.6.3** shows the project classification under the JBIC Guidelines.

Table 6.6.3 Project Classification and Environmental Review

Category Classification	Description	Environmental Review
Category A	Projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society.	EIA report and Environmental approval certification about subjected project by the partner country government. JICA shall carry out environmental review after submission of EIA report and approval certificates from the partner country.
Category B	Projects are classified as Category B if their potential adverse impacts on the environmental and society are less significant than those of Category A projects. Generally, they are site-specific and in most cases normal mitigation measures can be designed more readily.	EIA report and Environmental approval certification about the subject project are not compulsory. An environmental review shall be carried out based on the information provided by the partner country.
Category C	Projects are classified as Category C if they are likely to have minimum or little adverse impacts on the environmental and society.	The environmental review after screening is omitted.
Category FI	A subproject is not specified before loan determination. The project is expected to have some adverse environmental impacts.	It is necessary to determine the necessary environmental and social considerations for the project.

6.6.2 Scoping (Preliminary Scoping)

(1) Proposed Project subject to Preliminary Scoping

Table 6.6.1 lists down the proposed projects where a preliminary scoping has been carried out under this survey.

(2) Project Classification and its Rationales

The results of the preliminary scoping by IEE are shown in **Table 6.6.5**. Project classification was carried out based on "The Japan Bank of International Cooperation Guideline for Environmental and Social Environmental Considerations (July 2009).

Table 6.6.4 shows the classification of each of the proposed projects. The conclusion is that the both projects are categorized "B", and that EIA report and Environmental approval certification about the projects are not indispensable according to the JBIC's Guidelines.

Table 6.6.4 Project Classification Results

	Name of Project	Environmental Category (JBIC)	Project Component	Reason
I	Short-cut Channels (Sg. Sendok, Belemang, Tg. Olak, Kundang, Penchu, Bkt. Serampang and Bkt. Kepong)	B	Construction of Short-cut	A small number of involuntary resettlements and some adverse environmental impacts are expected.
II	Flood Mitigation Projects for Labis and Gemas Towns	B	Construction of Ring Bund	Some adverse environmental impacts are expected.

Table 6.6.5 Scoping of Proposed Project in the Muar River Basin

	Impact	Project Overall Rating	Muar I	Muar II	Brief Description
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.					
1	Process of EIA and Environmental related approval	**-**	-	-	No commencement of any EIA procedure so far. It is necessary to judge whether implementation of EIA study is necessary or not.
2	Public Announcement	**-**	-	-	No announcement to residents and stakeholders so far.
3	Involuntary Resettlement/Land acquisition	**B**	B	C	In the Project "I", two(2) bypass, Belemang and Liang Bypass require a resettlement. However, maximum number of houses required resettlement is about 10 houses at each site. Project "II" is not sure whether involuntary resettlement is necessary or not.
4	Local economy such as employment and livelihoods, etc.	**C**	C	C	Land acquisition some of farm area may influence local economy and livelihood.
5	Land use and utilization of local resources	**B**	B	C	Accompany with resettlement and land acquisition, impact on existing land use can be considered.
6	Social institutions such as social infrastructure and local decision-making institutions	**B**	B	C	Dividing into sections of a village due to construction Bypass may influence social structure.
7	Existing social infrastructure and services	**B**	B	C	Dividing into sections of a village due to construction Bypass and Dam will influence social infrastructure and require a relocation of existing infrastructure.
8	The poor, indigenous and ethnic people	**C**	D	C	Confirmation of the residence of Orang Asli is an important factor to evaluate this impact. Project "II" site, living of Orang Asli is not sure.
9	Misdistribution of benefit and damage	**B**	B	C	Due to resettlement
10	Cultural heritage	**C**	D	C	There is no cultural heritage at each Project"I" site.
11	Local conflict of interests	**D**	D	C	Resettlement of Orang Asli may trigger a local conflict.
12	Water usage or Water Rights and Rights of Common	**C**	C	D	Construction Bypass may influence on water usage and water right.
13	Sanitation	**B**	B	D	Construction of bypass in the existing village may influence existing sanitation system.
14	Infectious diseases such as HIV/AIDS	**B**	B	B	A risk by influx of the construction person concerned can be considered.
15	Gender	**D**	D	D	-
16	Rights of children	**D**	D	D	-
Natural Environment					
17	Topography and geographical features	**B**	B	C	Geotopographical alteration can be considered.
18	Soil erosion	**B**	B	B	It is thought that earthwork for construction may accompany a soil erosion. Soil erosion along the new bypass and bund after construction phase should be avoided by an appropriate surface protection work.
19	Groundwater	**C**	C	D	It is assumed that construction of bypass may trigger an groundwater level fall. However, utilization of any wells is not identified vicinity of proposed bypass so far.
20	Hydrological Situation	**B**	B	B	Plus factor: Hydrological change triggers Flood mitigation.
21	(Mangroves, Coral reefs, Tidal flats, etc.) Coastal Zone	**D**	D	D	-
22	Flora, Fauna and Biodiversity	**B**	B	B	River flow change due to construction bypass will impact on flora, fauna and biodiversity. However, natural vegetation area is limited.
23	Meteorology	**D**	D	D	-
24	Landscape	**B**	B	B	Construction of bund in town area may influence landscape.
25	Global Warming	**D**	D	D	-
Pollution					
26	Air Pollution	**B**	B	B	It is expected that dust and an exhaust gas increase temporarily by use of the heavy industrial machine under construction. After construction does not generate the problem of air pollution.
27	Water Pollution	**B**	B	B	It is expected that the outflow of earth and sand increases temporarily with the digging work under construction. After construction sediment discharge from bypass should be avoided by suitable surface erosion protection. Moreover, contamination by the ou
28	Soil Contamination	**B**	B	B	Some contamination can be considered by the outflow of the oil and fat under construction etc.
29	Waste	**C**	C	C	Problem about disposal of the garbage and filth under construction may occur. Moreover, the suitable disposal of digging earth and sand is required.
30	Noise and Vibration	**B**	B	B	There is a possibility that noise and vibration occur somewhat by heavy industrial machine use under construction.
31	Ground Subsidence	**D**	D	D	-
32	Offensive Odor	**D**	D	D	-
33	Bottom sediment	**B**	B	D	There is a possibility that construction and use of bypass and reservoir may trigger a disturbance of bottom materials. However, there is no deteriorative factor of the bottom material's quality. Construction bund may not trigger bottom sediment disturba
34	Accidents	**B**	B	B	A risk of the traffic accident by the passing vehicle under construction can be considered. Moreover, it is necessary to perform suitable safety education and measures against accident in the construction phase.

I : Muar Shortcuts
II: Muar Gemas & Labis Ring Bunds

Rating:
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)
D: Impact can hardly be considered.

6.7 Selection of Project for Feasibility Study

Selection of high-priority projects that are subject to the feasibility studies is to be conducted in the second stage of this Preparatory Survey were discussed at the 2nd Steering Committee Meeting on February 9, 2010.

The JICA Study Team proposed the lowest two short-cut project for the feasibility study in consideration with its high effectiveness and necessity of simultaneous implementation with the Segamat-Genuang Diversion Project. However, considering that DID has already started the master plan study including the short-cut project ('Rancangan Tebatan Banjir Bagi Lembangan Sungai Muar, Johor'), it was suggested that the JICA Study Team focus on other areas where no study has been carried out. In conclusion, the flood mitigation project for Gemas Area (Gemas in Negeri Sembilan and Gemas Baru in Johor) was selected as the objective flood mitigation project for the Muar River Basin from the reasons as follows:

- Gemas Area was seriously damaged by the 2006 flood.
- Urban/Resettlement areas expand over the state boundary, covering Gemas Town in Tampin, Negeri Sembilan and Gemas Baru in Segamat, Johor. Therefore, this project will benefit the two states, and could be a good sample for IRBM.
- Gemas Area is an important point for railway transportation in Peninsular Malaysia. Gemas Railway Station is a terminal of the East Cost Line and a junction with the West Coast Line. Now "Electrified Double Track Project from Seremban to Gemas (SGEDT)" has commenced in 2008 with a project period of four years. Gemas Area will increase its importance in Peninsular Malaysia with this project.

Table 6.7.1 Project for Feasibility Study

Title of Project	Component	Structural/Non-structural
Gemas Flood Mitigation Project	Protection of Gemas areas (Gemas in Negeri Sembilan and Gemas Baru in Johor) by ring bunds with drainage pumps, bypass channel, etc.	Structural measure
	Non-structural measures to supplement the structural measures, including capacity development, flood forecasting and warning system, land use control, community-based flood management, etc.	Non-structural measure

CHAPTER 7 BASIC STUDIES FOR FEASIBILITY STUDY ON GEMAS FLOOD MITIGATION PROJECT

7.1 Introduction

The basic studies in this Chapter aim to 1) define basic conditions to plan and design Gemas Flood Mitigation Project, and 2) obtain necessary information and standards to evaluate technical feasibility and the economic and environmental viability of the projects. The description of the Gemas Flood Mitigation Project is summarized below:

7.1.1 Project Area

Based on the result of IFM Plan study and the discussion in the Steering Committee held on February 2010, Gemas Town and its surrounding area in Muar River Basin was selected as target area for feasibility as shown in **Figure 7.1.1**. The population and properties of Mukim Gemas in Segamat District and Tampin District are concentrated on Gemas Town (the Town divided into two districts by Gemas River which is the boundary between Tampin and Segamat District) and its surrounding area. The area is expected to expand by future urbanization along with development of railway and road system in and around Gemas Town.

Figure 7.1.1 Location of Target Area

7.1.2 Project Purpose and Project Components

The Proposed Gemas Town Flood Mitigation Project shall consist of structural measures, and non-structural measures including capacity development for flood management targeting DID District and other related local government agencies in Tampin and Segamat District. JICA study team will propose (1) structural measures with an optimum design scale to protect the towns from Gemas River-overflow and inland flood, and (2) non-structural measures to minimize the regional gap inflicted by the structural measures and to mitigate the damage by larger floods than the design scale of structural measures.

Table 7.1.1 Target Area for Feasibility Study

Item	Contents	Target Area
Structural Measure	Ring Bunds, Shortcut of river, Floodway, Pumping Station, Sluice Gate, Regulation Pond and so on would be designed to protect Gemas Town with the surrounding area from river overflows and inland floods	Gemas Town and its surrounding area
Non-Structural Measure	Capacity Development Projects, Preparation and utilization of flood hazard maps, Flood forecasting and warning, Land use management, etc.	Tampin and Segamat District

7.2 Project Area

7.2.1 Natural Condition

(1) Climate

There is no meteorological station in and around Gemas. Therefore, the climate condition of the Muar Basin is explained here. According to the climate data of meteorological stations in Muar River Basin, the region experiences maximum rainfalls around the months of November to December, while the driest months are June and July with the total yearly rainfall amount of 1,966 mm. In addition, mean maximum and minimum daily temperatures are around 32 °C and 33 °C respectively through the year, while mean relative humidity is generally around 80 - 90% with daily evaporation of about 3 mm. The climatic characteristics of Muar River Basin is summarized in **Table 7.2.1**.

Table 7.2.1 Climate Characteristics

Item	Value
Mean maximum temperature	32.0 °C - 33.0 °C
Mean minimum temperature	22.5 °C - 23.5 °C
Mean relative Humidity	86.5 % (Lower Basin) - 94 ℃ (Upper Basin)
Mean annual rainfall (mm)	1,600 mm (Upper Basin) – 2,200 mm (Lower Basin)
Mean no. of rain days	150 days (Negeri Sembilan side), 190 days (Johor side)

(2) Topography

Gemas Town, which is developed along the railway and principal road which runs through the center of Gemas Town in the east - west direction as shown in **Figure 7.2.1**, is developed at the area with the range from 23 m to 50 m in height. Gemas River flows through Gemas Town from south to north passing under the bridge of the railway. And the river hold the low-lying area in the both bank the width of which doubles after crossing the bridge. The area wedged by black line around Gemas River in **Figure 7.2.1** indicates the low-lying area within 28 m in ground height.

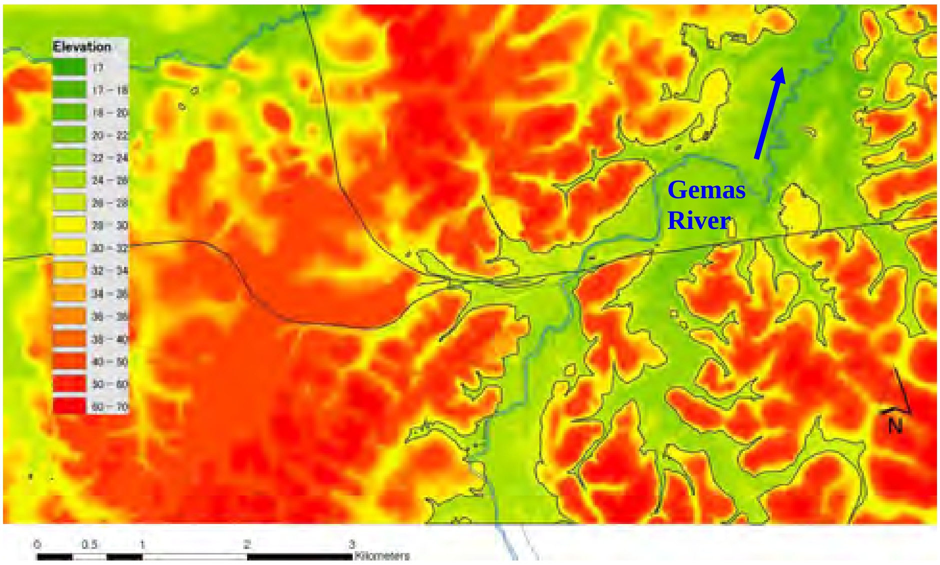


Figure 7.2.1 Topographic Map in the Target Area

(3) River Condition

Gemas River flows through Gemas Town from the south toward the northeast and joins the Muar River in 8 km distance from the town. Gemas Town suffered from relatively large river overflow flood from Gemas River in 1971, 1984 and 2007 year. According to the DID district officers, the water level of Gemas River is highly affected by the backwater of the Muar River because of its gentle slope of rivers. The features of the Gemas River are summarized in **Table 7.2.2**.

Table 7.2.2 Feature of Gemas River

Item	Characteristics
Catchment Area	242 km^2
Length	35 km
River Width	15m ～ 30m
Slope	1/2,000 (by town)
Water Level of 2007 Flood	About 28 m (70 year flood)

7.2.2 Socio Economic Condition

(1) Administrative Boundary and Condition of Target Area

Gemas Town is situated in the middle of Muar River basin, which is divided into two parts by the administrative boundary of Negeri Sembilan and Johor State. The left (green) part of the town is administrated by Tampin District and the right (blue) part belongs to Segamat District. The location of the towns and the administrative boundaries of Mukims and States are illustrated in **Figure 7.2.2**.

Figure 7.2.2 Boundaries of State and Town

(2) Infrastructure (Road and Railway)

The principal road (Route 1), which connects between capital city Kuala Lumpur after passing by district capital city Tampin and major city Johor Baru in the northwest and southeast direction, runs through the Gemas town in the south side. In addition, according to "Draft Local Plan in 2020, Tampin District" and "Draft Local Plan in 2020, Segamat District" issued by JPBD, the Gemas Bypass is planned to be constructed along the north boundary of Gemas Town. The both edges (west and north side) of bypass are connected to Route 1 in a suburb of the town.

In addition, the Malayan railway (KTM: Keretapi Tanah Melayu) delineates the south part of Gemas Town boundary. In Gemas station located at the center of Gemas town, the number of passenger was recorded about 77 thousand and the revenue is estimated RM 1.5 mil in 2009 (Jan. to Des). Gemas station is an important junction where east coast line is connected with west coast line. Under the present condition that the Government of Malaysia promotes to improve existing railway system and "Electrified Double Track project from Seremban to Gemas (SGEDT)" has commenced in January 2008 with the project period of 4 years. As of May 2010, the construction for double track is ongoing around Gemas station. Incidentally, after completed the project, operation speed of trains is 140 kilometers per hour and total distance of new railway alignment is approximately 98 km.

(3) Land Use

Current landuse condition of the Gemas Town is summarized in **Table 7.2.3**.

Table 7.2.3 Current Land Use

Category	Area (km^2)	%
Housing Area	0.75	12.2
Business Area	0.13	2.2
Industrial Area	0.11	1.8
Institution and Community Facility	0.49	7.9
Infrastructure and utility	0.11	1.8
Open and Recreation Space	0.10	1.6
Vacant land	1.67	27.1
Agricultural Land	1.49	24.1
Water Body	0.18	2.9
Road	1.15	18.6
Total	6.17	100.0

(4) Number of people

Based on satellite image as of 2008 and field investigation, 2,700 houses could be counted in Gemas Town. The Population of Gemas Town estimated from family size (4.67 person per household) and the number of houses is approximately 12,600 people. This was obtained by multiplying the number of houses by average family size.

7.2.3 Past Flood Event

Unfortunately, the information regarding the flood in the Gemas Town was insufficient to arrange detailed historical flood record. Especially, there is no available record to grasp the condition of floods of Gemas Bharu in Segamat district even if the latest 2006 flood. The Team, however, elaborated to define the flood area of 2006 flood in the target area as shown in **Figure 7.2.3** based on the flood report (2006, DID Tampin) and the result of field survey by the Team in the beginning of April 2010. The water level of inundation achieved at 28 m and the duration of inundation is 1 to 2 weeks in Gemas Town.

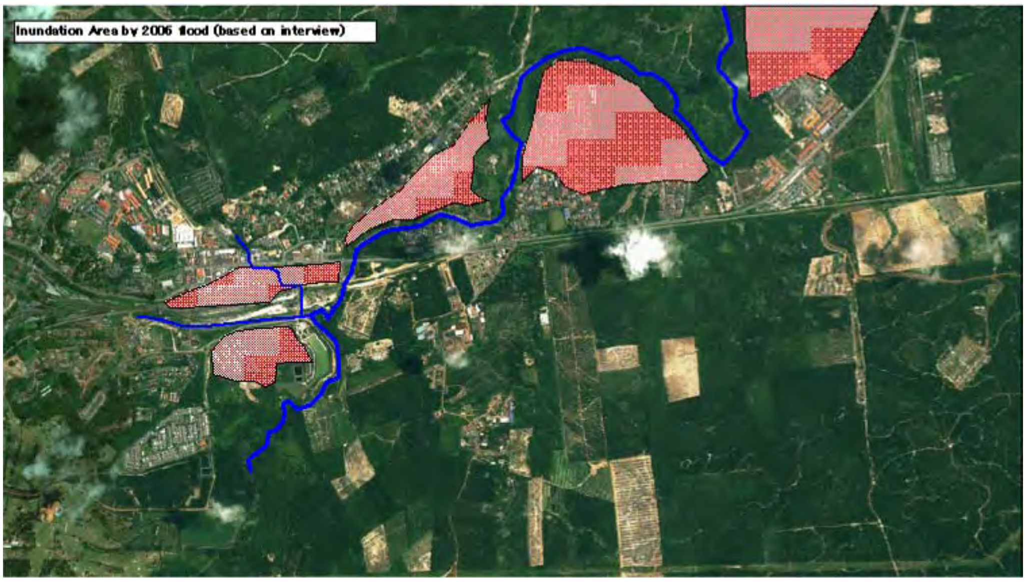


Figure 7.2.3 Inundation Area in Gemas Town

According to the flood report (2006, Tampin), the flood condition in December 2006 flood is summarized as follows:

(1) Flood in Tampin District

On December 18, 2006 the Tampin district was hit by incessant rains for 3 days and suffered from flooding in several areas of the district such as Mukim Keru, Mukim Gemencheh, Mukim Air Kuning and Mukim Gemas. The flood scale is larger than the latest relatively large flood in 1984 (19 years). Overflow of rivers, especially Keru River, Gemencheh River, Air Kuning River, Gemas River and Muar River, drastically increased the flood water depth in several areas of the Mukims.

(2) Flood in Mukim Gemas

The 2006 flood had hit Mukim Gemas at Felda Sg. Kelamah, Jelai 3 & 4, Kampung Londah, Kampung Bangkahulu, Kampung Ladang, Kampung Tiong, Taman Sg. Gemas and Gemas Town. There are paddy fields project under Londah Irrigation Scheme more than 100 acres and Bangkahulu Irrigation Scheme more than 130 acres that were totally destroyed.

At that time, main road such as Tampin-Gemas Road, road to Jelai, Londah-Pasir Besar road, Gemas Town road to Taman Sg. Gemas, Gemas Town road to Segamat were disconnected. In addition, overflow of Gemas River resulted in the flooding of the retention pond at Taman Sg. Gemas, and the number of evacuees in the Gemas Town and Taman Sg. Gemas reached 325.

7.3 Preparation of Ortho-map and River and Drainage Cross Section Survey

Survey had been carried out by the local survey company under the supervision of the JICA Study Team. Used map projection is the "Rectified Skew Orthomorphic Natural Origin in Malaysia", and used vertical datum is DTGSM (Peninsular Malaysia Geodetic Vertical Datum, determined from Tidal Observation at Port Kelang, 1984 - 1993). The detail of surveys is described as follows:

7.3.1 Objectives

The creation of ortho-map with 1m-interval contour lines and the cross section survey of Gemas River, its tributaries and drainage also were planned for the utilization of hydraulic analysis and the field survey. The map is utilized to mainly grasp the ground height and area for designing a scale and alignment of structural measures and to serve as input data for hydrological simulation model as DEM (Digital Elevation Model).

The result of cross section survey of Gemas River and its tributaries and drainages was used for the hydraulic and hydrological analysis. Mainly, flow capacity, flow velocity, water level, river discharge and flood inundation area are estimated by the hydraulic and hydrological simulation model which use cross-sections as its input.

(1) Preparation of Ortho-map

GeoEye-1 color satellite image of 0.5m resolution taken on August 17th, 2010 was used as basic image to prepare the ortho-image, and IFSAR (Interferometric Synthetic Aperture Radar) data of 5m spacing acquired in December 2008 were mainly used as DEM to make the ortho-image. (See Figure 7.3.1)

The ortho-map was prepared based on the ortho-image and 1m-interval contour lines. The 1m-interval contour lines were created by the IFSAR data and the LIDAR (Light Detection and Ranging) data of 1m spacing. Generally, best elevation accuracy of IFSAR data is thought around 0.5m and the accuracy of LIDAR data is thought around 10cm.

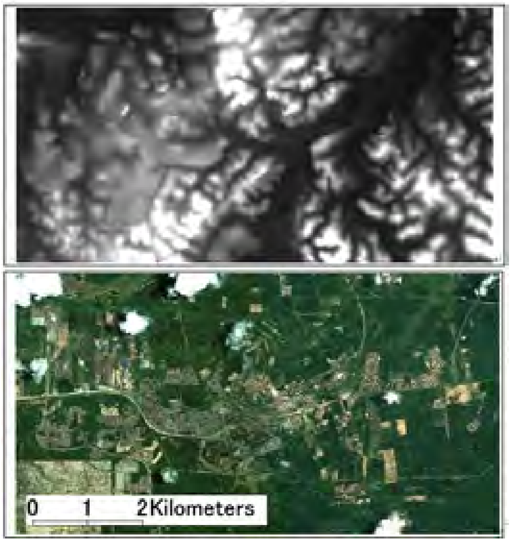


Figure 7.3.1 IFSAR Data (above) and Ortho Image (below)

However, our verification test for the IFSAR and LIDAR data in the two sites setting 31 check points respectively showed +1.26m (average) and -1.21m (only one test site) errors, respectively comparing with the elevation values by GPS (Global Positioning System) of Real Time Kinematic method (horizontal accuracy: 0.5cm+1ppm, vertical accuracy: 1cm+2ppm). Therefore, the IFSAR and LIDAR data were corrected by these error values. Moreover, the leveling survey by GPS of RTK method was carried out in the important area for flood analyses to improve the 1m-interval contour lines. The two test sites, the leveling points and the LIDAR DTM are shown in **Figure 7.3.2**.

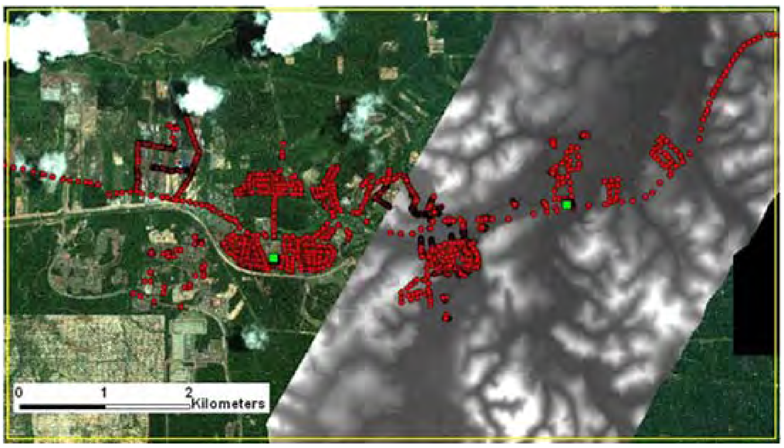


Figure 7.3.2 Two Test Sites (green), Leveling Points (red) and LIDAR DTM (gray)

The raw 1m-interval contour lines were automatically generated by the DTM (Digital Terrain Model) created using the IFSAR data, the LIDAR data and the leveling survey results including the river cross section survey results, and after manually error editing, the contour lines were finalized. Finally, the ortho-map was created putting the contour lines on the ortho-image. A sample part of the ortho-map is shown in **Figure 7.3.3**. Moreover, the land parcel data from Survey Department will be put on the ortho-map.

Figure 7.3.3 Sample Part of Ortho-map

(2) River and Drainage Cross Section Survey

The cross section survey was carried out for Gemas River (12 sections), its tributaries and drainage (8 sections). The cross section locations are shown in **Figure 7.3.4**. Methodrology of the Cross-Section survey is summarized in The sample of the cross section survey result is shown in **Figure 7.3.4**.

Figure 7.3.4 Cross Section Location (Gemas River: yellow, Tributaries & Drainage: red) and Sample of the Cross Section Survey Result

Table 7.3.1 Methodology of Cross Section Survey

Item	Contents
Setting of Survey Point	The coordinates (xyz) of each survey point were determined using DGPS (Differential GPS) with Starfire correction signal of sub-meter accuracy (RMSE).
Measurement Interval of Cross Section	Distance from each survey point was measured by using a leveling instrument and/or measuring tape at each measuring point where slope changes in degrees take place. Water depth of each point -was basically measured at 1 m interval. Distance and elevation error were planned with sub-meter accuracy.
Measurement of Water Level	At each cross section, water level was measured at one selected location along the surveyed line.
Measurement of Land Area	Topographical survey was carried out about 5m outside from the bank on both sides of the river and site scene digital photographs were taken for understanding the land situation on the both sides of the banks. If there are bridges, pipelines, or the other utilities crossing, their locations and sizes were measured approximately and digital photographs were taken.
Used Equipment	• DGPS system capable of achieving sub-meter accuracy (xyz) at open area • Measuring tape, staff, EDM (Electronic Distance Meter) and auto-level • Total Station Surveying System

The following results at each cross section site have been prepared: 1) Bathymetric and topographic profiles at a horizontal scale of 1/500 and vertical scale of 1/100 in A3 size, and DWG format data, 2)Typical diagram of the bridges in A3 size, and DWG format data, and 3) Digital topographic and bathymetric dataset by ASCII format.

7.4 Geological survey

7.4.1 Purpose of Survey

This Geological investigation is composed of core drilling with testing and laboratory tests. They shall be performed for the purpose to obtain geotechnical data on the soil layer conditions for the feasibility study on Gemas area in the Muar River Basin.

7.4.2 Feature of Silty Clay

Laboratory tests were conducted to comprehed feature of silty clay which deposit from surface to around GL.-12.0m. Feature of Silty Clay is showin in **Table 7.4.1** and **Figure 7.4.2**.

Table 7.4.1 Feature of the Silty Clay

Item	unit	GBH1	GBH2	GBH3	GBH4	GBH5	GBH6
Moisture content	%	13 - 26	9 - 18	7 - 27	21 - 27	21 - 25	13 - 26
Bulk Density	kg/m^3	1.541 - 1.632	1.384 - 1.529	1.378 – 1.793	1.814 - 1.872	1.488 - 1.871	1.279 - 2.000
Specific gravity	-	2.62 - 2.64	2.63 - 2.65	2.61 - 2.65	2.61 - 2.62	2.61 - 2.62	2.65
Permeability(K)	cm	$2.74x10^{-3}$	$2.48x10^{-3}$	$4.79x10^{-3}$	$3.38x10^{-3}$	$4.06x10^{-3}$	$4.63x10^{-4}$

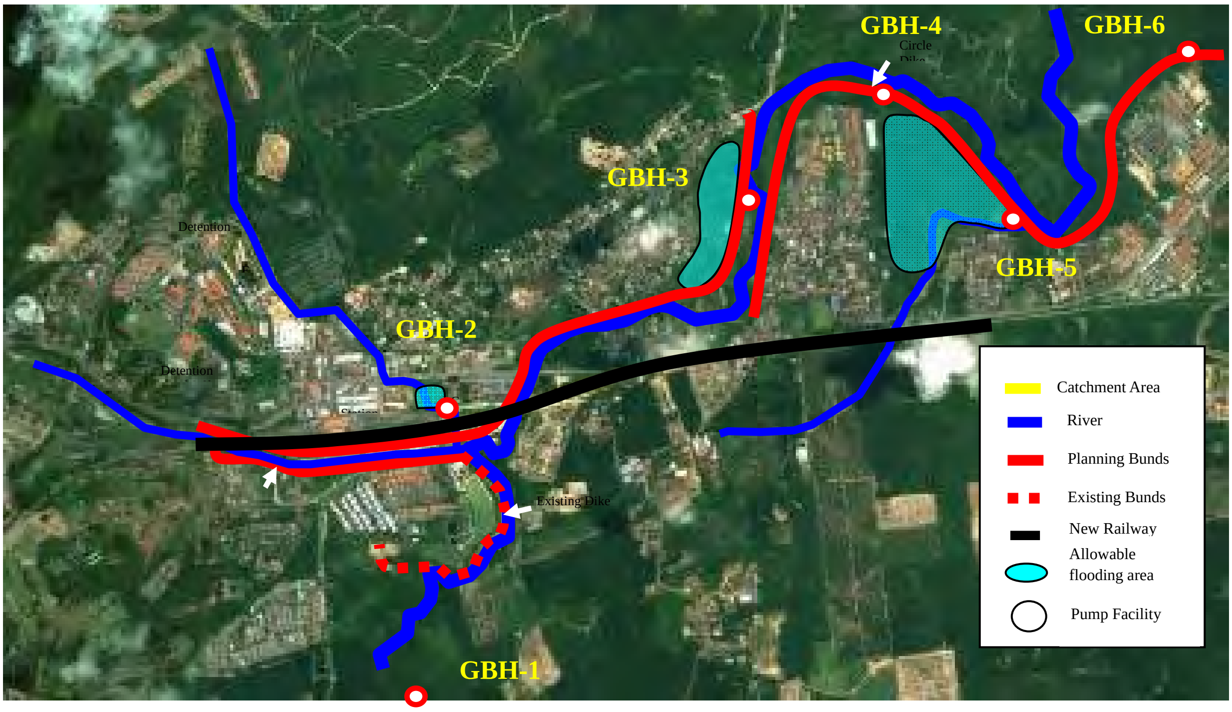


Figure 7.4.1 Boring Location

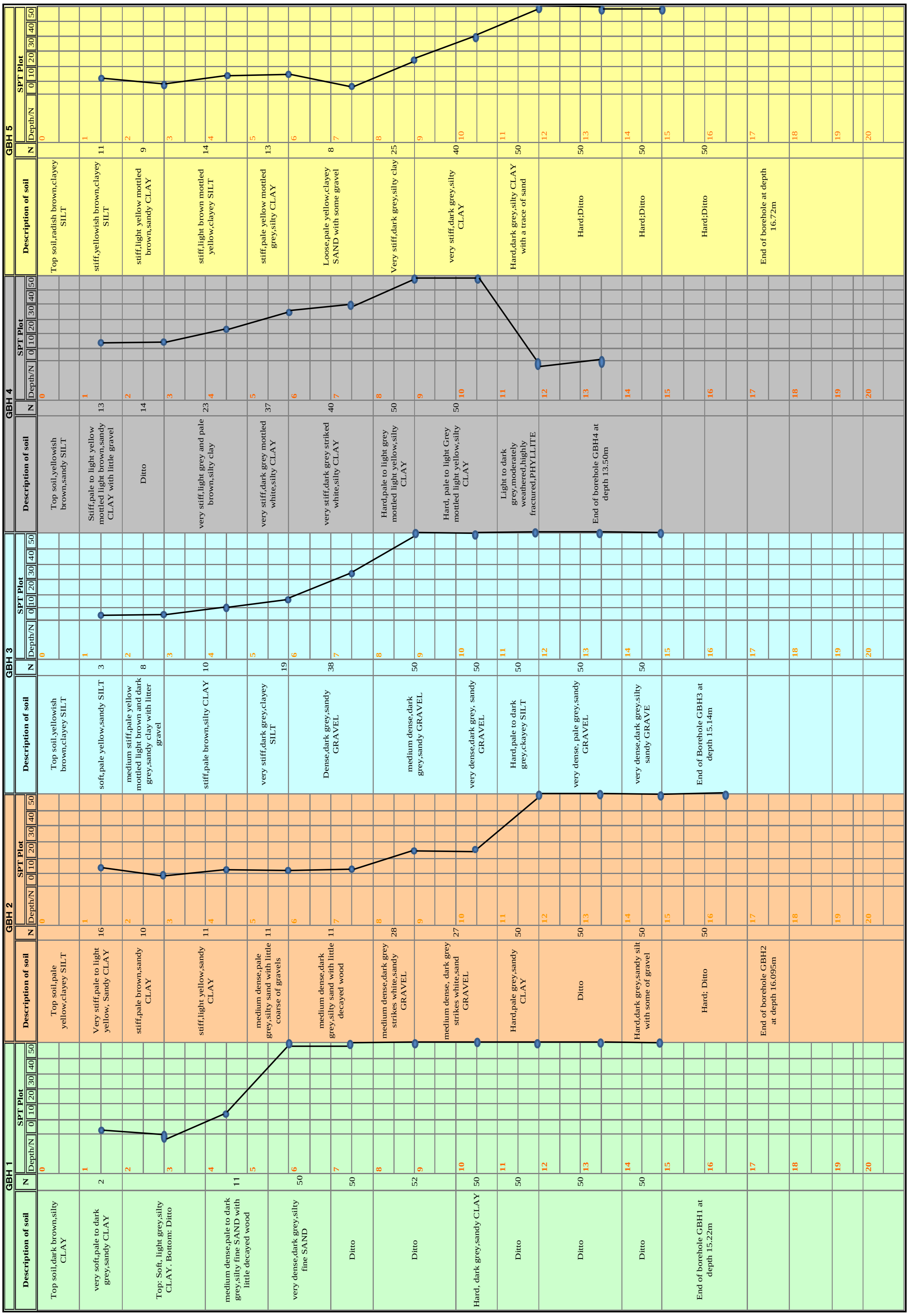


Figure 7.4.2 Borehole log of Gemas Area

7.5 Asset Survey

The study needs to evaluate economic impact of each alternative flood mitigation proposal. Hence asset survey was carried out to find out the asset value and flood damage in the flood prone area. The survey area is the area inundated by 2006/2007 flood around the Gemas Town. The coverage of this survey is shown in **Figure 7.5.1** and its background information is summarized in **Table 7.5.1**.

Figure 7.5.1 The Coverage of Survey Area in Gemas

Table 7.5.1 Survey Area

Basin	District	FS area	Area	Remarks
Muar River	Tampin District, Segamat District	Gemas Town	Under 27 m in ground height	Area inundated by 2006/2007 flood

(1) Target Property and Sampling Number

Asset and flood damage survey was carried on 3rd to 4th May 2010. The study area was divided into 6 survey zones around Gemas Town. The total number of samples was 111 samples for target area and the distribution of samples is shown in **Figure 7.5.2**. In each survey zones, respondents were picked up randomly. The detail is respondents and survey items summarized in **Table 7.5.2**.

Figure 7.5.2 The Number of Samples in Gemas

Table 7.5.2 Respondents and Survey Items

Target Property	House / Shop
Respondents	Over 18 years old
Survey Items	Conditions of House / Shop
	Items of Households
	Information by 2006 Flood
	Damage by 2006 Flood

(2) Survey Result

Assets in residence include home belongings such as interior equipment, furniture, kitchen equipment, electric appliances, bicycle, automobile and clothes as well as building. Assets in shop include its inventory if any as well as their home belongings. The main survey results on assets are shown in the following table.

Table 7.5.3 Main Survey Results on Assets in Gemas

	Household Building	Household Asset	Shop Building	Shop Asset	Shop Stock
Sample Number	48	105	50	28	28
Maximum	RM 150,000.00	RM 270,295.00	RM 400,000.00	RM 240,000.00	RM 600,000.00
Minimum	RM 1,000.00	RM 2,250.00	RM 1,000.00	RM 2,000.00	RM 0.00
Mean	RM 26,583.33	RM 54,594.63	RM 44,609.38	RM 45,232.14	RM 47,791.43

7.6 Hydraulic and Hydrological Studies

7.6.1 Flood Simulation

Gemas River Basin Model will be developed to conduct detail flood prediction of Gemas Town which is the target area of the feasibility study. Basic analysis and calculation conditions for flood simulation are described in this section.

(1) Rainfall Analysis

Gemas River confluence point in Muar River was selected as reference point for rainfall analysis. It is because its water level is the major factor which controls the water level along Gemas Town. Thus rainfall probability analysis was conducted with the data of spatial average 3 days rainfall upstream of this point. 40 years (1968-2007) data of gauging stations shown in **Figure 7.6.1** were used to obtain rainfall depth for various ARIs.

St. ID	Area(km^2) Whole Basin	Area(km^2) Reference Point
2127017	735	0
2225026	336	0
2326022	323	4
2424087	280	280
2426005	335	80
2428013	1249	0
2526001	1146	276
2623085	363	363
2722003	797	797
2724082	574	371

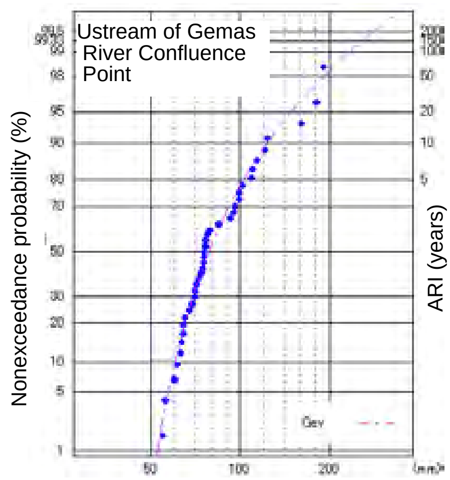
Figure 7.6.1 Thiessen Distribution and Area Represented by Each Station

Table 7.6.1 ARI of Observed 3 days Rainfall

Year	Whole Basin		Reference Point		Year	Whole Basin		Reference Point	
	Maximum Rainfall	ARI	Maximum Rainfall	ARI		Maximum Rainfall	ARI	Maximum Rainfall	ARI
1968	58.2	1.1	56.0	1.04	1988	92.1	2	75.8	1.8
1969	159.6	1.6	72.4	1.6	1989	125.2	4	74.8	1.8
1970	242.1	33	182.0	41	1990	83.3	1.7	67.3	1.5
1971	100.9	3	76.5	1.9	1991	108.1	3	70.4	1.5
1972	83.2	1.7	99.0	4	1992	153.1	8	85.0	3
1973	55.7	1.08	95.4	4	1993	64.6	1.4	68.8	1.6
1974	58.8	1.1	60.9	1.1	1994	95.7	2	59.8	1.1
1975	56.3	1.09	54.6	1.03	1995	113.6	3	101.3	5
1976	74.5	1.6	75.1	1.8	1996	*Not Available*			
1977	82.5	1.7	63.9	1.4	1997	54.9	1.07	63.7	1.4
1978	85.8	1.8	74.0	1.7	1998	75.2	1.7	121.6	9
1979	86.9	1.9	75.9	1.8	1999	86.7	1.9	96.3	4
1980	59.7	1.2	110.2	6	2000	63.1	1.2	99.9	5
1981	49.4	1.03	76.8	1.9	2001	123.1	4	75.1	1.8
1982	80.6	1.6	64.6	1.4	2002	148.9	7	109.6	6
1983	175.0	12	123.2	10	2003	114.8	4	70.0	1.7
1984	91.1	2	92.5	3	2004	74.7	1.6	64.0	1.4
1985	207.2	20	161.3	26	2005	87.4	1.9	70.9	1.5
1986	106.5	3	106.5	1.2	2006	306.9	71	191.9	50
1987	93.2	2	93.2	2	2007	134.2	5	113.6	7

* Hydrological year: July until June next year

3 days rainfalls for various return periods at the reference point are as in **Figure 7.6.2**.



General Extreme Value (GEV) distribution, Plotted on Log-Normal Probability Paper

ARI(yrs)	3 days Rainfall (mm)
200	283.0
150	260.9
100	232.7
80	218.7
50	191.9
30	166.8
20	149.3
10	123.8
5	102.5
2	78.3

Figure 7.6.2 3 days Rainfall for Various Return Periods at the Reference Point

(2) Outline of the Flood Simulation Model

Gemas River Basin Model was developed in order to conduct detail simulation for Gemas Town, the target area for the feasibility study. Basic structure of the model is same with the one developed in **Chapter 4** except it is with higher spatial resolution, and will use results of the Basin Model for its boundary condition. Detail of the flood simulation model could be found in **Chapter 4**. Relationship between Gemas River Model and Muar River Basin Model are shown in **Figure 7.6.3**.

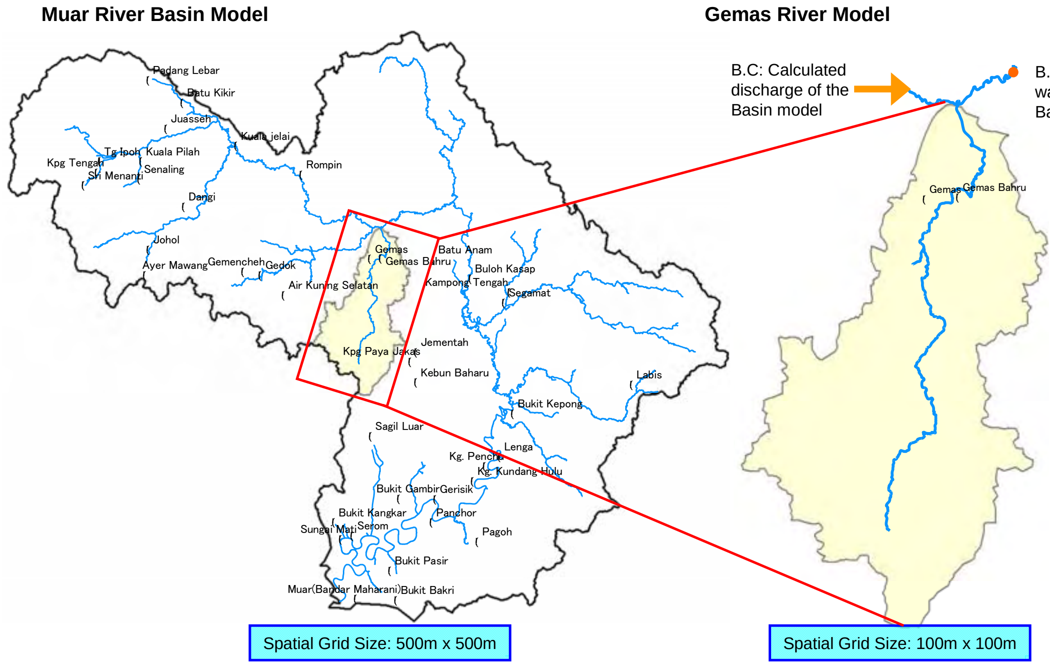


Figure 7.6.3 Schematic View of the Basin and River Model

Flood simulation was conducted under rainfall pattern of 2006 which caused the most severe flood in Muar River Basin in the last 40 years.

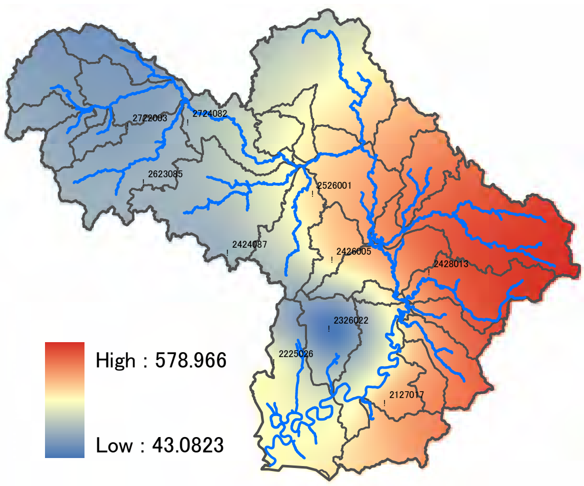


Figure 7.6.4 Rainfall Distribution of Dec. 2006 Flood Events

Enlargement ratio in **Table 7.6.2** will be multiplied to observed temporal rainfall data in order to adjust the observed 3 days rainfall depth to rainfall depth of target ARIs.

Table 7.6.2 Enlargement Ratio for Flood Simulation

	Return Period							Observed Rainfall depth upstream of the reference point
	2	5	10	20	30	50	100	
3 days rainfall(mm)	78.3	102.5	123.8	149.3	166.8	191.9	232.7	-
Enlargement Ratio	0.41	0.53	0.65	0.78	0.87	1.00	1.21	191.9(Dec. 2006)

Table 7.6.3 Model Parameters

	Catchment Area (km^2)	Runoff					Infiltration	
Runoff Model		Width (km)	Slope	Land Use		Roughness Coefficient	Initial Loss (mm)	Continuing Loss (mm/hr)
	242	20	0.002	Pervious (%)	65.9 (95.9)	0.1	30.0	0.4
				Impervious (%)	34.1 (4.1)	0.014	-	-
2D Flood Model	Spatial Resolution							
	100m x 100m							

Numbers in the parenthesis indicate proportion in the current condition

(3) Validation of the Model

The flood simulation model was verified by comparing actual and simulated inundation area of December 2006 flood which was the largest flood event in Gemas Town in the last 40years.

Figure 7.6.5 shows inundated residential area based interview survey and one developed based on the flood simulation result. Inundated area indicated by the simulation result covers the inundated residential area identified through interview survey, and it is appropriate to say the simulation result agrees well with the observed data.

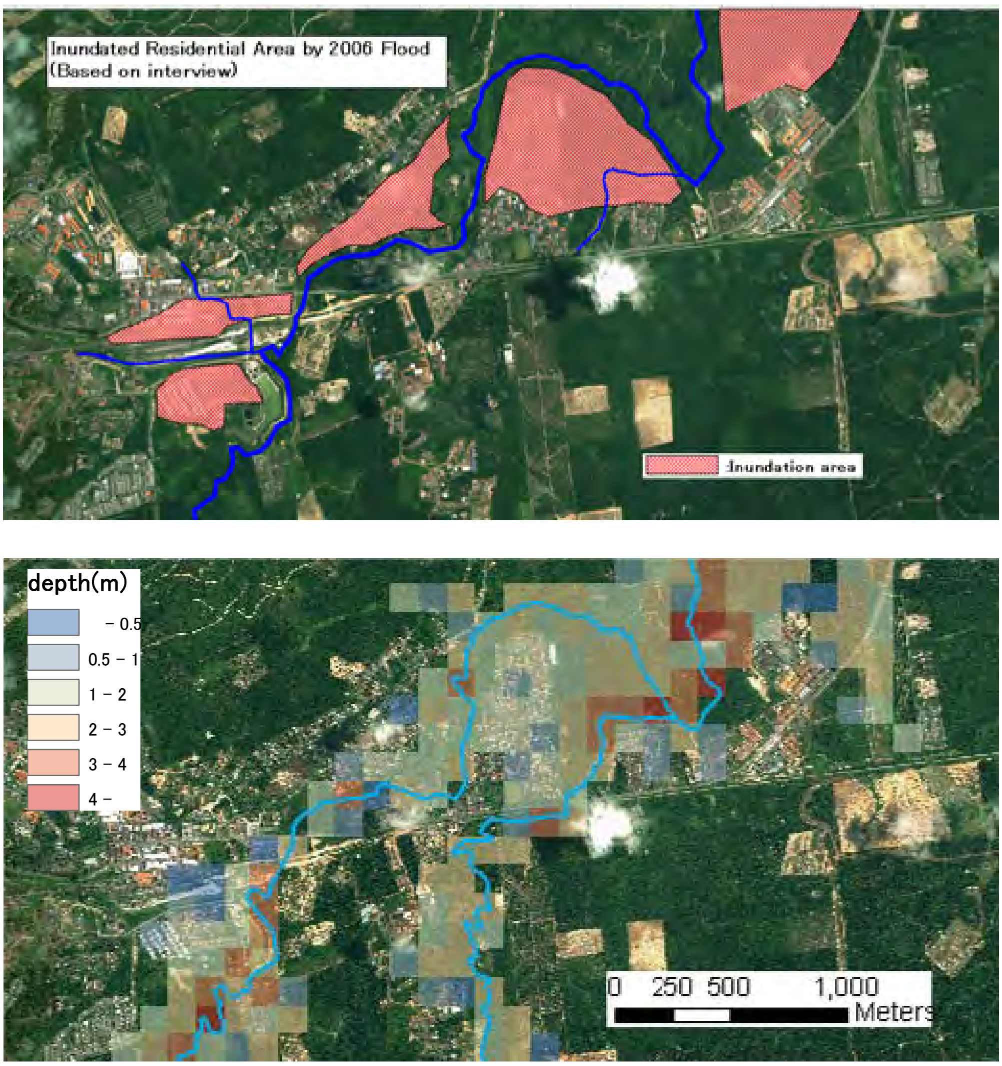


Figure 7.6.5 Model Verification: Flood Area
(Upper Panel: Inundated residential area based on interview, Lower Panel: Simulation result)

(4) Simulation Result

(a) Simulation Case

Flood simulation will be conducted under existence of two flood management alternatives, namely flood bund and flood bund with bypass channel, in addition to simulation without structural measures. Simulated cases are as listed in **Table 7.6.4**. Details of structural measures could be found in the next section.

Table 7.6.4 Simulation Cases

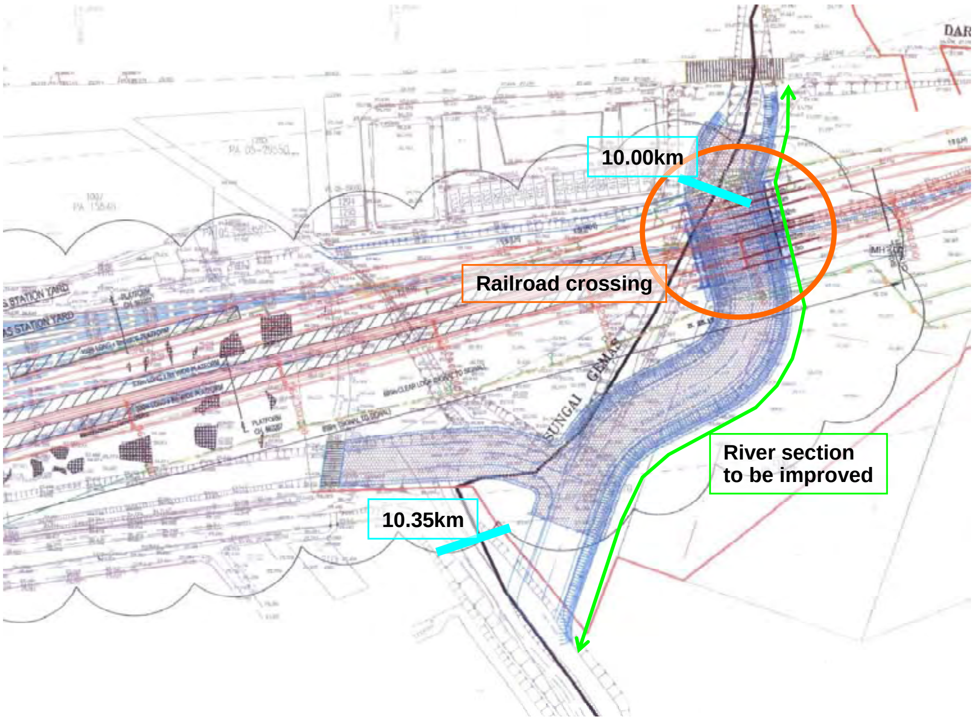
Alternatives		Land use Condition	Description
0. No structural measure		2025	Without any structural measures
Structural measure	1.Bunds	2025	Existence of flood protection bunds
	2.Bypass channel and bunds	2025	Existence of a bypass channel and flood protection bunds

Alternative1

Alternative2

Figure 7.6.6 Location Plan of Structural Measures

It should be noted that river section neighboring the railroad crossing will be improved as part of on going railroad construction to upgrade the current railroad to double-tracked one. This improvement will be considered as prerequisite condition in the flood simulation. Cross sections are shown in **Figure 7.6.7**.



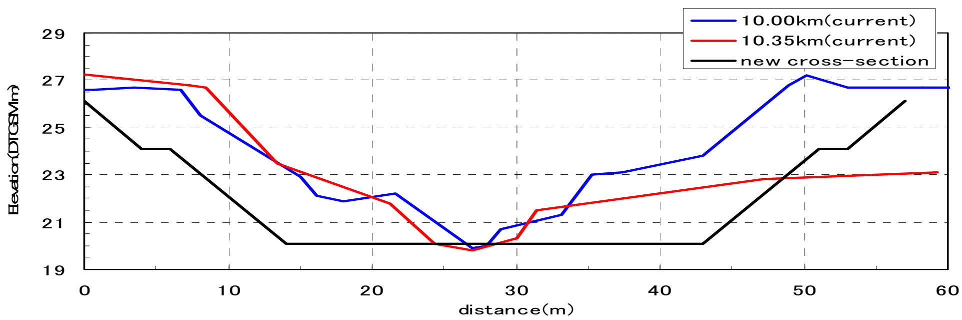


Figure 7.6.7 Improved and Current River Cross Sections

(b) Result

Table 7.6.5, **Figure 7.6.8** and **Figure 7.6.9** shows the simulation result. The result indicates river water level rise relative to no measures in and upstream of target protection area as a result of bund construction. This is due to decrease in flooding area which will be partially protected by bunds. The bypass channel could reduce the water level in the upstream of Gemas Town. No significant negative impact (water level rise) to downstream of the target area was predicted by structural measures.

Table 7.6.5 River Water Level of Gemas River

Cross section ID	ARI: 100years			ARI: 50years			ARI: 20years		
	Alt.0*	Alt.1*	Alt.2*	Alt.0*	Alt.1*	Alt.2*	Alt.0*	Alt.1*	Alt.2*
0.00km	21.78	21.78	21.78	21.20	21.20	21.22	20.52	20.50	20.51
2.00km	23.25	23.28	23.31	22.68	22.70	22.73	21.95	21.96	22.01
4.00km	24.76	24.80	24.84	24.18	24.20	24.25	23.47	23.49	23.55
7.84 km	25.29	25.32	-	24.81	24.82	-	24.28	24.29	-
8.23 km	25.57	25.87	-	25.11	25.36	-	24.59	24.74	-
8.68 km	25.71	26.05	-	25.26	25.54	-	24.73	24.90	-
9.09 km	26.04	26.40	-	25.57	25.88	-	25.02	25.20	-
9.49 km	26.20	26.58	-	25.72	26.04	-	25.16	25.34	-
9.89 km	26.49	26.81	-	25.98	26.25	-	25.37	25.52	-
10.00 km	26.51	26.83	-	26.00	26.26	-	25.38	25.53	-
10.35 km	26.60	26.90	-	26.07	26.32	-	25.45	25.59	-
10.68 km	26.98	27.47	-	26.45	26.79	-	25.82	25.96	-
10.95 km	27.22	27.93	-	26.68	27.20	-	26.06	26.33	-
11.55 km	27.67	28.30	-	27.14	27.68	-	26.44	26.67	-
11.82 km	27.82	28.40	27.53	27.30	27.74	26.80	26.58	26.79	27.53

** Numbers correspond to those in **Table 7.6.4***

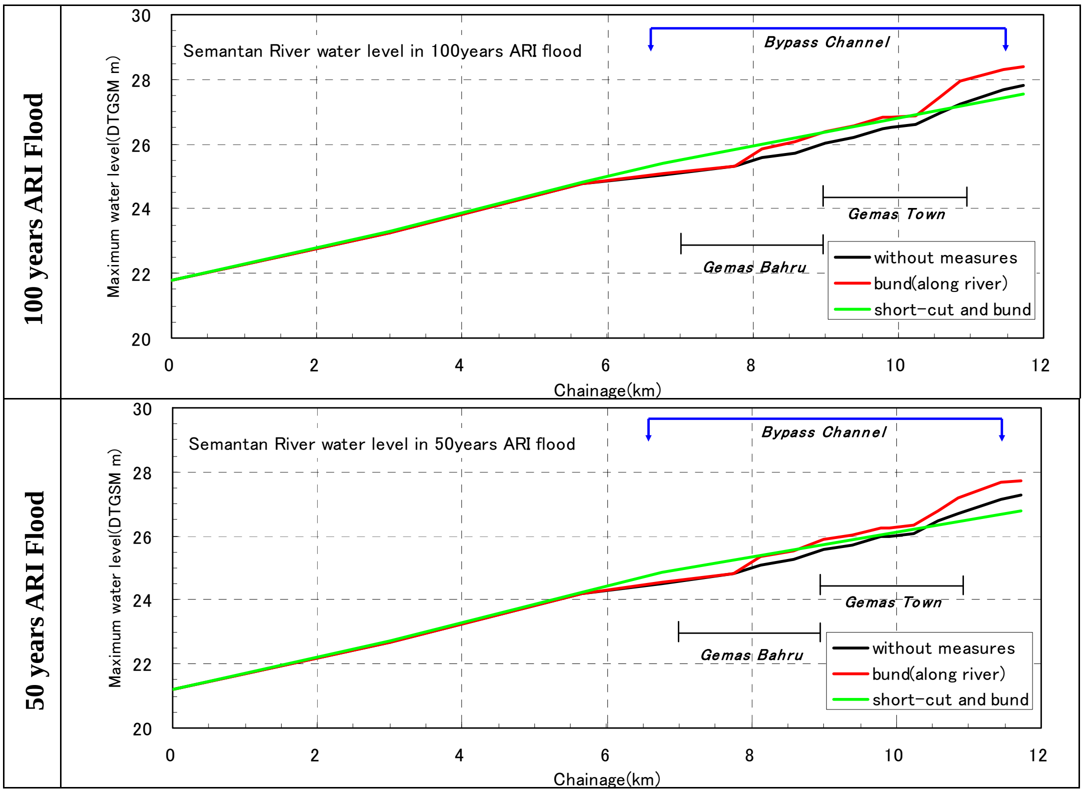
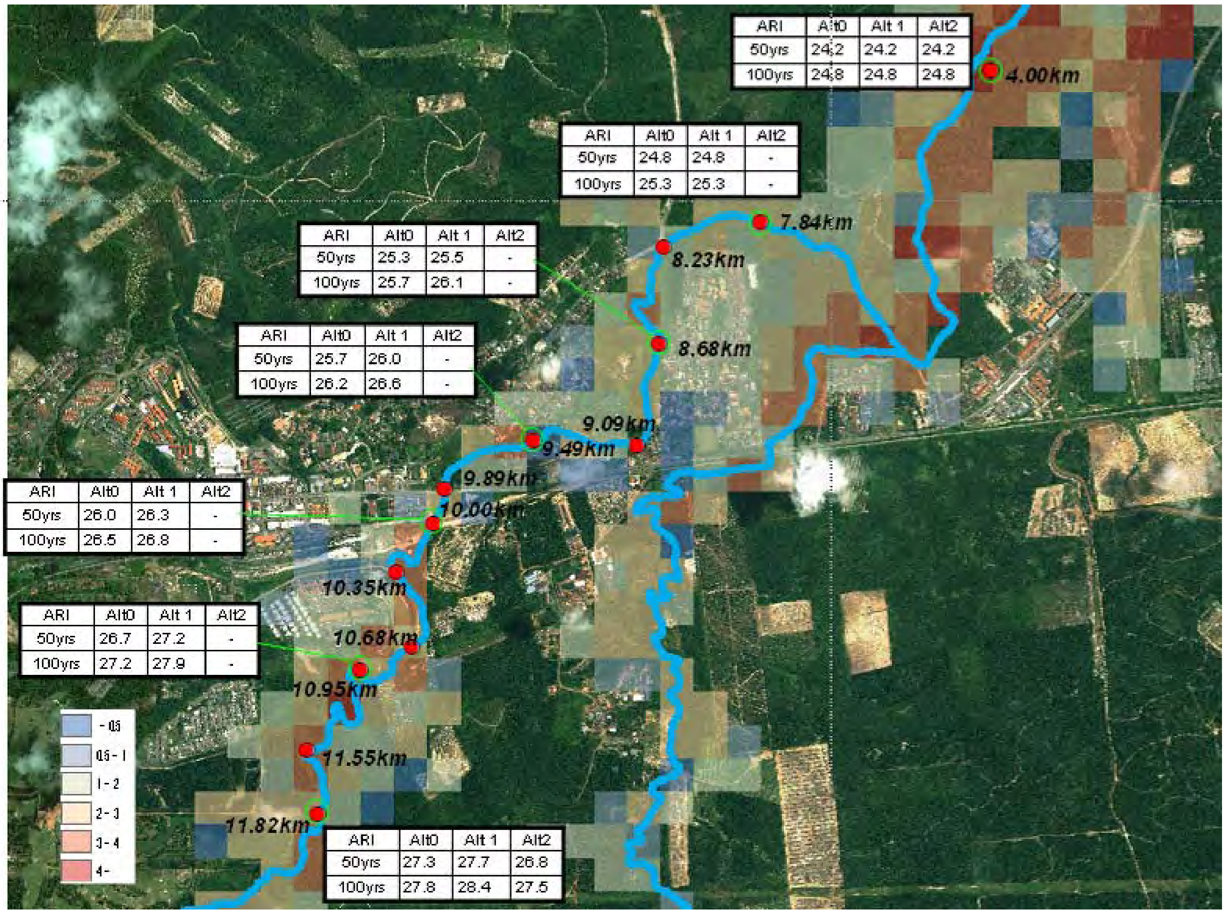


Figure 7.6.8 River Water Level with/ without Structural Measures



Numbers indicate river water level(DTGSM m)

Figure 7.6.9 Inundation Area by 50 years ARI Flood (No structure measures)

7.6.2 Stormwater Runoff Analysis

Stormwater runoff analysis will be conducted to estimate amount of peak discharge and flow volume from target protection area. The result will serve as basis for drainage system design to be proposed in the next section.

(1) Design Rainfall

The objective of the analysis is to estimate peak discharge and flow volume of stormwater during flood when river water is high. Therefore, 10days will be introduced as design rainfall duration which is actual inundation period of Gemas Town in 2006 flood derived based on interview survey. The ARI of design rainfall is 10years as described in the next the next section.

IDF curve of Segamat presented in the MASMA was introduced to obtain design rainfall depth, and observed rainfall data (1968-2007) of station 2526001 was utilized to extend the curve for rainfall with duration longer than 1000minutes (IDF curves presented in MSMA are applicable to rainfall event of duration within 1000minutes). Center concentrated rainfall pattern was introduced for design temporal rainfall pattern. IDF curve and design temporal rainfall are shown in **Figure 7.6.10** and **Figure 7.6.11**.

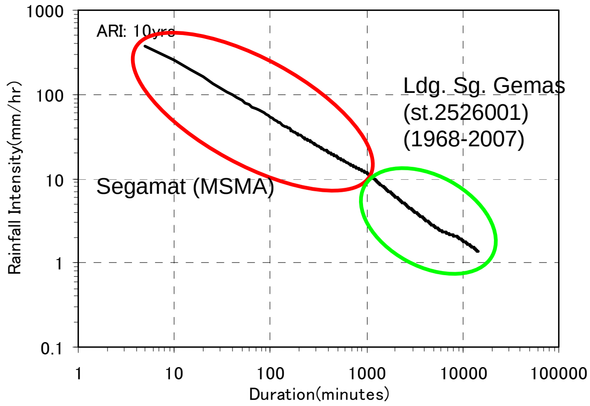


Figure 7.6.10 IDF Curve

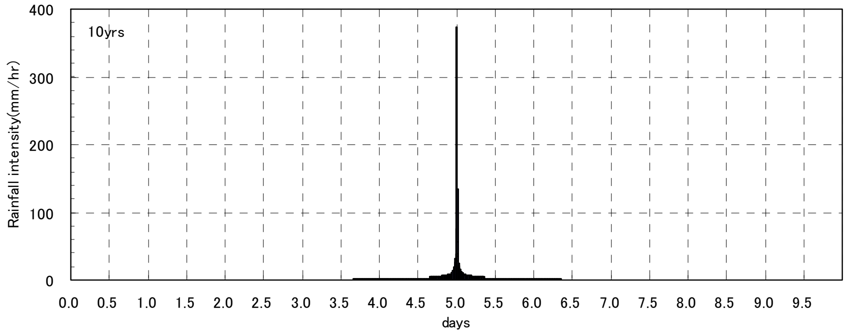


Figure 7.6.11 Design Temporal Rainfall

(2) Sub-basins and Their Characteristics

Target protection area was divided into 6 and 9 sub-basins respectively for alternative1 and alternative2 as shown in **Figure 7.6.6** and **Figure 7.6.12**, and their characteristics are as in **Table 7.6.6**. Flow concentration time of urbanized sub-basins with proportion of built up area exceeding 40% were obtained by sum of overland flow time and channel flow time described in the following equations.

Overland flow time (Friend's formula)

$$t_0 = \frac{107 n L_o^{\ 1/3}}{S^{1/2}}$$

where, t_o is overland sheet flow travel time(minutes), L_o is over land sheet flow path length(m), n is surface roughness and S is slope of overland surface(%).

Channel flow time

$$t_{ch} = \frac{L}{60V}$$

where, t_{ch} is travel time in the channel(minutes), L length of reach(m), V is average velocity(m/s). 1.5m/s was applied for channel velocity in the analysis.

Concentration time for sub-basins with low built up area proportion were estimated by Bransby-Williams' Equation expressed as:

$$t_c = \frac{F_c L}{A^{1/10} S^{1/5}}$$

where, t_c is time of concentration(minutes), F_c is conversion factor (58.5), L is length of path from catchment divide to outlet(km), A is catchment area(km^2) and S is slope of stream flow path(m/km).

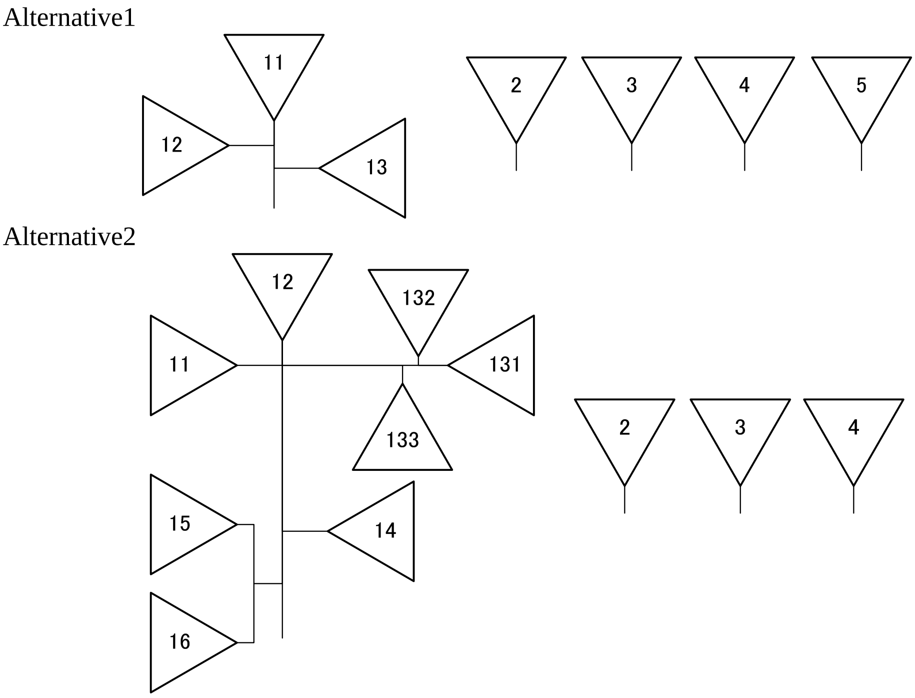


Figure 7.6.12 Schematic View of the Runoff Model

Table 7.6.6 Basin Characteristics

Alternative 1

Sub-basin	Area (km²)	Proportion of built up Area(%)	Chanel length (m)	Overland sheet flow path length(m)	Slope	Roughness coefficient	Overland flow time (min)	Channel flow time (min)	Time of Concentration (min)
	A	-	L	L_o	S	n	t_o	t_{ch}	t_c
11	0.63	5	1000	-	0.0300	-	-	-	31
12	0.07	57	200	150	0.0250	0.02	8	2	10
13	0.52	54	1000	260	0.0050	0,02	19	11	30
2	0.41	56	600	342	0.0250	0.02	9	7	16
3	0.37	51	800	231	0.0063	0.02	17	9	26
4	1.93	4	2700	-	0.0130	-	-	-	89
5	0.19	42	500	190	0.0100	0.02	12	6	18

Alternative 2

Sub-basin	Area (km²)	Proportion of built up Area(%)	Chanel length (m)	Overland sheet flow path length(m)	Slope	Roughness coefficient	Overland flow time (min)	Channel flow time (min)	Time of Concentration (min)
	A	-	L	L_o	S	n	t_o	t_{ch}	t_c
11	0.86	20	1200	-	0.0125	-	-	-	43
12	4.75	20	4000	-	0.0088	-	-	-	130
131	0.63	5	1000	-	0.0300	-	-	-	31
132	0.07	57	200	150	0.0250	0.02	8	2	10
133	0.52	54	1000	260	0.0050	0,02	19	11	30
14	0.41	56	600	342	0.0250	0.02	9	7	16
15	0.4	20	1200	-	0.0125	-	-	-	46
16	0.32	59	800	200	0.0063	0.02	16	9	25
2	0.62	11	900	-	0.0167	-	-	-	31
3	1.93	4	2700	-	0.0130	-	-	-	89
4	0.19	42	500	190	0.0100	0.02	12	6	18

(3) Hydrograph Method

Rational Method Hydrograph Method was applied to develop design hydrographs of each sub-basin. The formula is:

$$Q = \frac{CI_t A}{360}$$

where, Q is discharge(m^3/s), C is runoff coefficient, I_t is rainfall intensity over time of concentration(t_c) (mm/hr) and A is catchment area. Runoff coefficient was assumed to be function of rainfall intensity as show in **Figure 7.6.13** following MSMA.

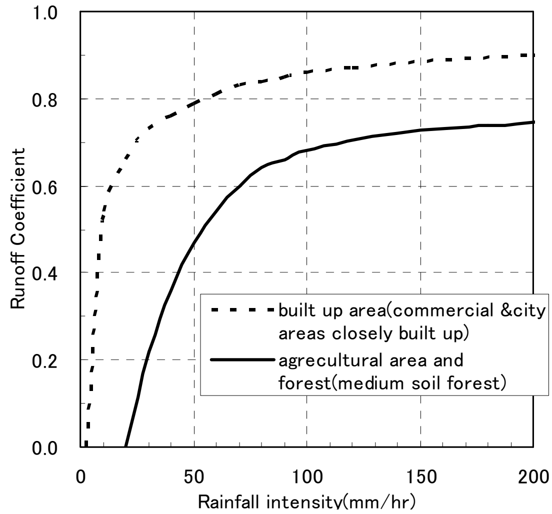


Figure 7.6.13 Runoff Coefficient

(4) Result of the Runoff Analysis

Figure 7.6.14 shows example of hydrographs obtained by Rational Method Hydrograph Method, and peak discharge and total runoff volume of each sub-basin are tabulated in **Table 7.6.7**.

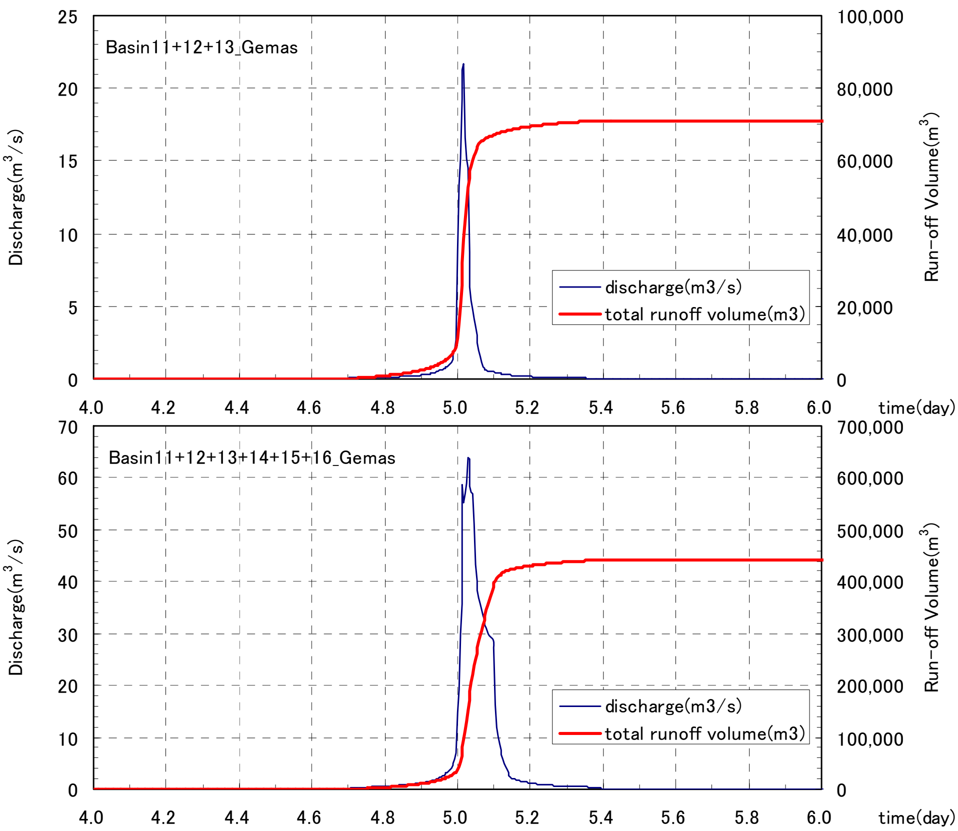


Figure 7.6.14 Examples of Stormwater Hydrograph
(Upper panel: Alternative1, Lower panel: Alternative2)

Table 7.6.7 Peak Discharge and Runoff Volume

<table>
<tr><th colspan="3">Alternative 1</th><th colspan="4">Alternative 2</th></tr>
<tr><th>Sub-basin</th><th>Peak discharge (m^3/s)</th><th>Runoff volume ($1000m^3$)</th><th colspan="2">Sub-basin</th><th>Peak discharge (m^3/s)</th><th>Runoff volume ($1000m^3$)</th></tr>
<tr><td>11</td><td>11.2</td><td>26.7</td><td colspan="2">11</td><td>12.3</td><td>45.0</td></tr>
<tr><td>12</td><td>3.5</td><td>5.4</td><td colspan="2">12</td><td>28.0</td><td>248.5</td></tr>
<tr><td>13</td><td>11.6</td><td>38.8</td><td rowspan="4">13</td><td>131</td><td>11.2</td><td>26.7</td></tr>
<tr><td rowspan="3">Total (11+12+13)</td><td rowspan="3">21.7</td><td rowspan="3">70.9</td><td>132</td><td>3.5</td><td>5.4</td></tr>
<tr><td>133</td><td>11.6</td><td>38.8</td></tr>
<tr><td>Total</td><td>21.7</td><td>70.9</td></tr>
<tr><td>2</td><td>15.0</td><td>31.1</td><td colspan="2">14</td><td>15.0</td><td>31.1</td></tr>
<tr><td>3</td><td>9.3</td><td>26.9</td><td colspan="2">15</td><td>5.7</td><td>20.9</td></tr>
<tr><td>4</td><td>14.4</td><td>80.7</td><td colspan="2">16</td><td>8.3</td><td>24.9</td></tr>
<tr><td>5</td><td>5.3</td><td>12.7</td><td colspan="2">Total (11+12+13+14+15+16)</td><td>64.0</td><td>441.4</td></tr>
<tr><td colspan="3" rowspan="3"></td><td colspan="2">2</td><td>11.3</td><td>28.8</td></tr>
<tr><td colspan="2">3</td><td>14.4</td><td>80.7</td></tr>
<tr><td colspan="2">4</td><td>5.3</td><td>12.7</td></tr>
</table>

7.7 Preliminary Design for Structural Measures

As a result of flood inundation simulation and the survey of past flood condition, it was decided that consideration should be made on protecting Gemas town and its residential areas, which are scattered along the Gemas River, from flood inundation by flood control facilities in the F/S study.

7.7.1 Design Criteria

Design criteria of flood control facility are explained as follows:

(1) Design Flood

Probable design floods for river water and inland water are determined as follows:

- River flood control : Return period 50-year flood
- Inland flood control: Return period 10-year flood

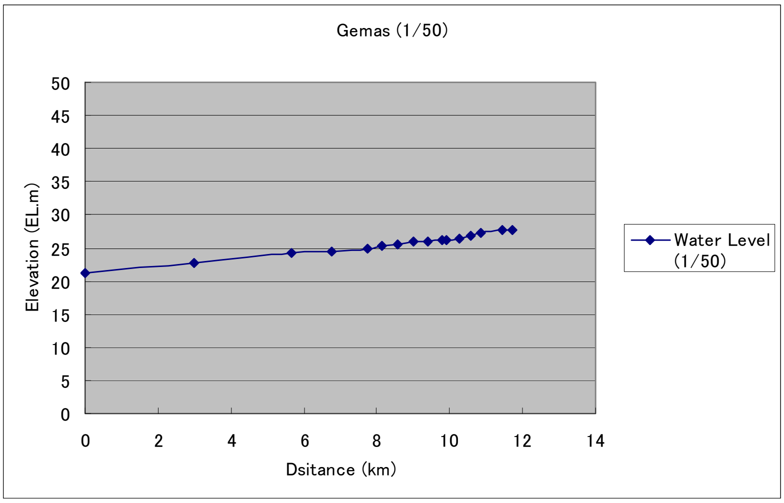
(2) Design Water Level

Design water level of the Gemas River in 50-year return period is analyzed and shown in **Table 7.7.1** (refer to **Figure 7.7.1**). The water level at the confluence of the Muar River was given as boundary condition of downstream end for flood simulation model, which is EL. 21.20m at maximum. In the river stretch of Gemas area, water level of 50-year flood varies approximately from EL. 24.53m to 26.25m. Bunds height is set with the 0.6m, as a freeboard, in addition to water level of 50 year flood.

Table 7.7.1 Water Level (50-year flood)

Location	Water Level (1/50)	Height of Bunds
Strech of Gemas Town	24.53 – 26.25	25.13 – 26.85

ID	Distance(km)	Water Level (1/50)	Water Level (1/100)	Section gradient (1/X)	Average gradient of WL (EL.m)	Design Height of Bunds (EL.m)
Gmas00000	0.00	21.199	21.780			21.80
Gmas00200	3.00	22.699	23.277	2,000		23.30
Gmas00400	5.65	24.199	24.798	1,767		24.80
Comp.-CS	6.77	24.533	25.076	3,349	3,349	25.13
Gemas00780	7.74	24.823	25.317	3,349		25.42
Gemas00820	8.13	25.359	25.865	728		25.96
Gemas00870	8.58	25.542	26.051	2,459		26.14
Gemas00910	8.99	25.883	26.400	1,202		26.48
Gemas00950	9.39	26.042	26.583	2,516		26.64
Gemas00990	9.79	26.252	26.811	1,905		26.85
Gemas01000	9.90	26.258	26.827	18,333	1,815	26.86
Gemas01040	10.25	26.317	26.897	5,932		26.92
Gemas01070	10.58	26.788	27.470	701		27.39
Gemas01100	10.85	27.204	27.928	649		27.80
Gemas01160	11.45	27.683	28.299	1,253		28.28
Gemas01180	11.72	27.739	28.395	4,821	1,229	28.34



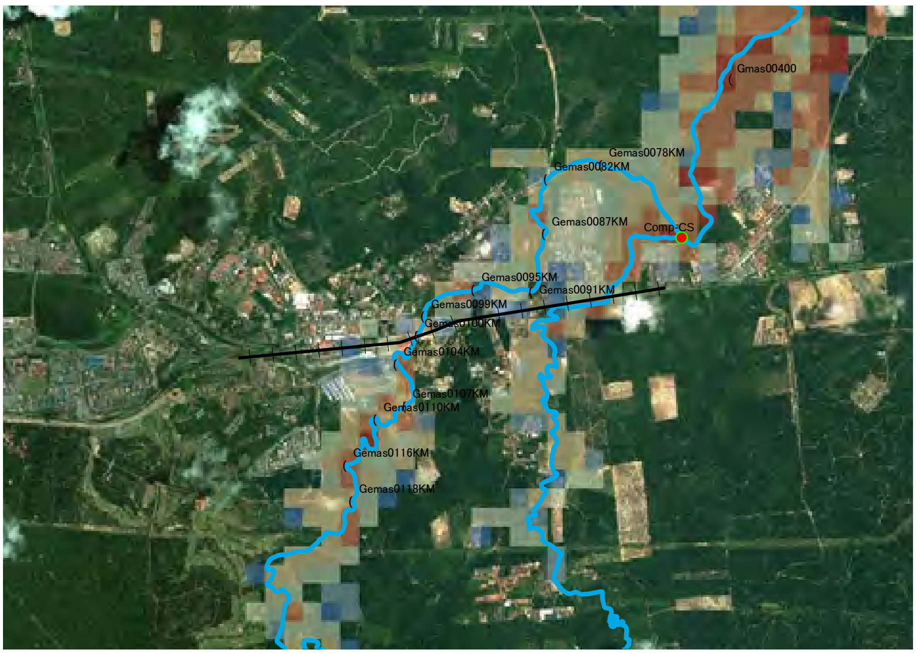


Figure 7.7.1 Design Water Level of Gemas Area

7.7.2 Proposed flood control facilities

Flood control facilities proposed in F/S study are listed in **Table 7.7.2**. Countermeasures were considered for both river flood of the Gemas River and inland flood. Countermeasures against river flood aim to preventing inundation from river overflow of the Gemas River and that against inland flood aim to control floods of tributaries whose catchment will be enclosed by bunds.

Table 7.7.2 Proposed Flood Control Facilities

Flood	Facilities	Purpose
River flood	Bunds	To prevent inundation from river flood
	Shortcut Channel	To detour around Gemas town
Inland flood	Retarding Basin	To store flood water to prevent inland flood
	Flood Regulation Pond	To store flood water and regulated drainage volume of Pump station
	Pump Station	To force to drain inland flood water to Gemas River
	Sluice Way	Natural drainage in case water level of Gemas River is lower than inland ground level
	River Gate	To control river flow diversion

(1) Bunds

(a) Shape of Bunds

Considering that the flooding of the Gemas River prolonged for 1 to 2 weeks, keeping high water level, it is proposed in this F/S study that the bunds has a gentle slope to resist collapse due to overflow and/or seepage.

The height of the bund is proposed to be approximately 4m or less and their width in conformity to Malaysian flood control standard. The bund slope adopted here is 1:3 so as to be resistant to seepage failure and circular slip. Freeboard is proposed to be more than 0.6m against the water level of 50-year return period flood.

Table 7.7.3 Basic Shape of Bund

Type of Bund	Ring bund
Width of Bund	5.0 m
Slope of Bund	River side 1:3.0, Inland side, 1:3.0
Freeboard	0.6 m

(b) River Reserve Area

Bunds will be located to keep approximately 30m distance from riverbank to secure river reserve area which is secure safety from river bank erosion and conserve river environment.

According to the DID manual, river reserve area should be kept 30m from riverbank to the end of bund foundation. The figure below shows the typical formation of the bund placement.

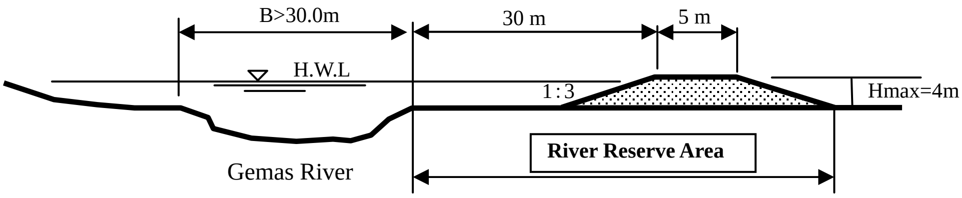


Figure 7.7.2 Schematic View of Bund

(2) Shortcut-Channel

Shortcut channel is proposed for Alternative-2 in order to bypass flood water from residential area. The shortcut channel is designed to have almost same capacity with the Gemas River. The figure below shows the dimension of shortcut channel.

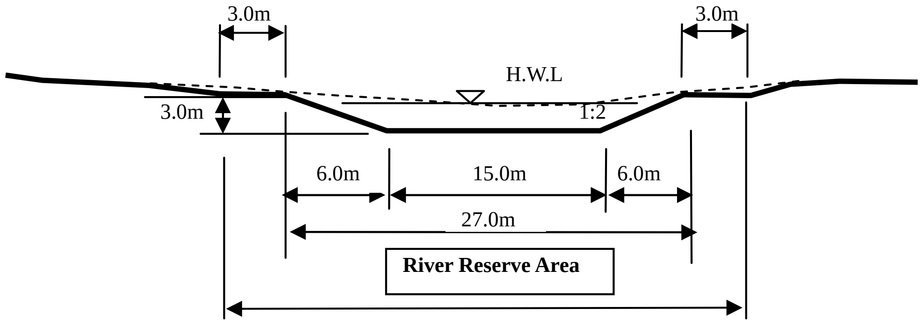


Figure 7.7.3 Schematic View of Shortcut Chanel

(3) Retarding Basin

Retarding basin whose capacity is to store inland flood discharge of 10-year return period is considered in inland areas. Area of retarding basins should be included in the Local Plan managed by Municipality Council as allowable flooding areas and should be regulated against land development which is likely to reduce storage capacity.

(4) Regulation Pond

Regulation pond is expected to store flood discharge of 10-year return period and is constructed aiming to reduce pump capacity. Land for regulation pond shall be acquired as flood control facility.

(5) Pump Station

Gemas River flood prolonged for about two weeks. On the other hand, duration of concentrated local rainfall lasted for one day, but it is expected to occur several times during flood of the Muar River. Pump Station is designed to drain stored water in the regulation pond within 24 hours considering preparation to next inland flood.

(6) Sluice Way

Sluice way is constructed to secure natural drainage function of tributary and to drain flood water from area surrounded by the bunds. Sluice way will be closed in case river water level is higher than inland ground water level.

(7) River Gate

River gate is the flood control facility constructed on the bunds, which separate outer water level and inland water level to prevent flooding to inland area.

7.7.3 Study Case for Structural Measures

Ring bunds and shortcut channel plans were examined as alternatives for flood control plans in Gemas area The plans for alternatives are explained in **8.1.2**.

7.7.4 Alternative 1

(1) Countermeasures against River Flood

(a) Bunds Alignment

Bunds are the core component of the flood control facilities in this study to mitigate flooding from the Gemas River. As for the type of bund, ring bunds are proposed. Bunds alignment is shown in **8.1.2** and the bund length are shown in **Table 7.7.4**. 3,656m length of bunds and 657m of RC wall are placed in Johor area and 928m of bunds and 1,060m of RC wall are placed in Negeri Sembilan Area.

Table 7.7.4 Proposed Bunds in Gemas Area

tructures	Location	Length	Remarks
Johor			
	GB1	852m	EL.27.0m
	GB2	655m	
	GB3A	118m	
	GB3	2,031m	
	RC wall-1	657m	
Sub total	Bunds	3,656m	
	RC wall	657m	
Negeri Sembilan			
	GB4	680m	EL.27.0m
	GB5	248m	
	RC wall-2	403m	
Sub total	Bunds	928m	
	RC wall	403m	
Total	Bunds	4,584m	
	RC wall	1,060m	
Ground total		5,644m	

(b) River Gate

In facility layout plan of Alternative 1, river gates are placed in the tributary to block back water from downstream. At normal time river gate is opened. Once water level of the river becomes higher than inland ground level, river gates will be closed.

Table 7.7.5 Dimension of River Gate

Location	Name	Dimension
Bund GB3A	GRG1	4nos x 3.5m x 5.0m

(2) Inland flood control measures

Inland flood control was studied to mitigate flooding from tributary of the Gemas River. Inland flood control facilities are comprised of regulation pond, pump station, sluice way and river gate. Flood discharge is stored at first regulation pond. And then when water level of the Gemas River is lower than inland ground level, drainage is conducted by gravity through sluice way or the river gate. When water level of the Gemas River become higher than inland ground level, gates of sluice way is closed to prevent back water intrusion. In the target area, pump station is planned to drain inland flood water within 24 hours.

(a) Retarding Basin and Regulation Pond

Table 7.7.6 shows the dimension of regulation pond. Five regulation ponds are planned in Negeri Sembilan area and one regulation pond is proposed in Johor Area.

Table 7.7.6 Retarding Basin and Regulation Pond

Area	Name of pond	Area of Ponds (ha)	Required Capacity(m^3)	High Water Level of Pond (EL.m)
Negeri Sembilan				
	Pond-1+Pond-2	1.263	22,494m^3	EL.25.0m
	Pond-3	0.798	5,364m^3	EL.30.0m
	Pond-4	3.84	26,745m^3	EL.32.0m
	Pond-5	1.749	31,143m^3	EL.23.5m
Total			85,746m^3	
Johor				
	Pond-6	3.059	24,933m^3	EL.22.5m
Ground Total			110,679m^3	

(b) Sluice Way

Location and dimension of the Sluice ways which will be placed in Negeri Sembilan and Johor areas are shown in **Table 7.7.7**.

Table 7.7.7 Dimension of Sluice way

Location	Location	Dimension
Neregi Sembilan	-	-
Johor	SG1(BundnGB1)	2nos x H1.5m x B1.5m
	SG2(Bund GB2)	2nos x H1.5m x B1.5m
	SG3(Bund GB3)	2nos x H1.5m x B1.5m
	SG4(Bund GB4)	2nos x H1.5m x B1.5m

(c) Pump station

Capacity of the pump stations is designed to drain 10-year flood volume which is stored in regulation ponds within 24 hours. One pump station in Negeri Sembilan is planned to be constructed at the outlet of tributaries with regulation pond to mitigate inundation around the town and Gemas station.

Table 7.7.8 Dimension of Pump Stations

Location	Basin	Catchment Area (km^2)	Length (m)	Peak Discharge (m^3/s)	Total Discharge Volume (m^3)	Pump Capacity (m^3/s)
Negeri Sembilan	12	1.31	2,000	14.68	74,655	Pump1 1.0 m^3/s

7.7.5 Alternative 2

(1) Countermeasures against River Flood

(a) Alignment of Bunds and Shortcut Channel

Bunds are constructed to block off backwater from downstream of the Gemas River. Shortcut channel is planned to bypass flood from upstream to downstream to mitigate flood in the town and Gemas station. Short cut channel is constructed in Johor area but it contributes to mitigate flood of areas in both Negeri Sembilan and Johor. Alignment is shown in **8.12**. Dimension of Bunds and Shortcut Channel are shown in **Table 7.7.9**. Total length of bunds is approximately 3,742m and that of shortcut channel is 2,756m.

Table 7.7.9 Length of Bunds

Structures	Location	Length	Elevation
Bunds	GB1	852m	EL.27.0m
	GB2	655m	
	GB3A	118m	
	GB3	1,517m	
	GB4	40m3	
	GB5	560m	
Total	Bunds	3,742m	
Shortcut channel		2,756m	

(b) River Gate

In facility layout plan of Alternative 2, river gates are constructed at the Gemas River and tributary to bypass river water, and to block back water from downstream. At normal time river gates are kept opened. Once water level of the river becomes higher than inland ground level, river gates are closed and all of the floodwater is diverted to the shortcut channel. Dimension of river gates are shown in **Table 7.7.10**.

Table 7.7.10 Dimension of River Gate

Location	Name	Dimension
Bund GB3A	GRG1	4nos x 3.5m x 5.0m
Bund GB3	GRG2	4nos x 3.5m x 5.0m
Bund GB5	GRG3	4nos x 3.5m x 5.0m

(2) Inland Flood Control

Flood control facilities against inland floods are one retarding basin in and around the Gemas River channel, Sluice Gates and one pump station.

(a) Retarding Basins

Retarding basins are planned in and around the Gemas River channel which id enclosed by bunds and shortcut channel. Dimension of retarding basins is shown in **Table 7.7.11**.

Table 7.7.11 Dimension of Retarding Basin

Area	Name of pond	Area of Pond (ha)	Required Capacity (m^3)	High Water Level of Pond (EL.m)
Retarding Basin	River area	30.20	436,218	EL.25.0m

(b) Sluice Way

Location and dimension of the Sluice ways which will be constructed in Negeri Sembilan and Johor areas are shown in **Table 7.7.12**.

Table 7.7.12 Dimension of Sluice way

Location	Location	Dimension
Neregi Sembilan	-	-
Johor	SG1(BundnGB1)	2nos×H1.5m×B1.5m
	SG2(Bund GB2)	2nos×H1.5m×B1.5m

(c) Pump Station

One Pump Station is constructed to drain inland flood water in the Gemas River.

Table 7.7.13 Scale of Pump Station

Location	River Name	Basin*	Catchment Area (km^2)	Length (m)	Peak Discharge (m^3/s)	Total Discharge Volume (m^3)	Pump Capacity (m^3/s)
Bunds GB3	Gemas	11,12,131,132,133,14,15,16	7.84	4,000	27.19	436,218	Pump1 5.1 m^3/s

* Stormwater Sub-basin could be found in **Figure 7.6.6**

7.7.6 Comparison between Alternative 1 and 2

Comparison of flood control facilities planned in Alternative 1 and 2 is shown in **Table 7.7.14**.

Table 7.7.14 Comparison of River Facility for Gemas

Flood control facility	Name	Unit	Alternative 1	Alternative 2
Bunds		nos	6	5
	GB1	m	852	859
	GB2	m	655	656
	GB3	m	2031	-
	GB2-3	m	-	1517
	GBA3	m	118	-
	GB4	m	680	-
	GB5	m	248	-
	GB6	m	-	560
	GB7	m	-	40
Total		m	4,584	3,742
Concrete levee	RCW1	m	403	-
	RCW2	m	657	-
Total		m	1,060	-
Shortcut channel	SCC	m		2,756
Regulation pond		nos	6	1
	POND1	m^3	22,494	-
	POND2	m^3		-
	POND3	m^3	5,364	-
	POND4	m^3	26,745	-
	POND5	m^3	31,143	-
	POND6	m^3	24,933	24,933
Total		m^3	110,679	24,933
Retarding basin		location	-	1
		m^3		436,218
Sluice way		location	4	2
River Gate		nos	1	3
Pump Station		nos	1	1
	Pump1	(m^3/s)	1.0	-
	Pump2	(m^3/s)	-	5.1

7.8 Cost Estimate for Structural Alternative Measures

7.8.1 Constitution and Conditions of Project cost

Cost of the proposed flood mitigation project is based on the preliminary designs of project components. The main items of the project costs are given as below:

- Construction base cost (Direct cost, Indirect cost, contingency)
- Compensation Cost（Land acquisition Cost, etc）
- Administration and Engineering cost
- Tax,etc

Project cost has been estimated under the following conditions.

(1) Condition of Construction Base Cost

Construction base cost is composed of direct cost estimated based on the work quantities multiplied by unit cost, and indirect cost which is estimated in percentage.

The estimation of the construction cost includes:

- Direct construction;
- Miscellaneous Works(indirect cost); and
- Contingency.

Details of work items considered under each of the above mentioned heads are described below:

(a) Direct Cost

Cost of all the project works is included under this head. The cost estimate of the works is based on the approximate bill of quantities and unit rates applied to the respective project work item.

The construction of the proposed alternatives for flood mitigation measures will involve various components of works such as construction of bunds, pump stations, sluice gates and detention ponds.

Construction cost for the various components of the proposed measures is estimated as the product of unit cost and corresponding work quality. Unit cost of a respective work item consists of cost for material, labor, equipment and contractor indirect costs, overhead and profit.

Direct Cost = $\sum$ (Unit Cost for a Payment Item x Work Quantity for a Payment Item).

The unit cost can be estimated based on the basic costs such as labor wage, unit prices of materials and equipment cost.

(b) Unit Rate

Unit rates developed/adopted for various items of works were applied to estimated quantities to derive the cost of works.

Cost estimation for the proposed alternatives for flood mitigation is carried out based on the preliminary designs, available market prices. Unit rates used in framing the project estimate are mainly based on those adopted for similar projects elsewhere in the region, keeping in view the site conditions generally related to availability of construction materials. For some of the items of works rates are obtained from the supplier/manufacturers. Consideration has been given to keep the rates to 2009 price level.

Construction costs of the proposed works are derived with reference to the following information and data:

- Recent DID contract and private sector contracts of relevant works carried out in Selangor;
- Cost structure of the other contract works in Peninsular Malaysia; and
- Labor, materials and equipment costs provided by the local contractors and suppliers.

(c) Indirect cost

The indirect cost on the project is an integral part of each estimate. Temporary works, Site expense and Mobilization & Demobilization are considered as the indirect cost.

(d) Contingencies

A provision of 5% of direct cost has been provided as contingencies to meet this requirement. The contingency is provided to cater for the costs involved due to unpredictable physical conditions during the implementation of urgent and important components of the projects.

(2) Construction Cost

Based on the above assumptions, the overall cost of the project was estimated for the optimum structural flood mitigation plan as RM 42.10 million which comprises RM 34.87 million as direct costs, RM 5.23 million as indirect cost and RM 2.00 million as contingencies. **Table 7.8.1** shows summary of construction cost under each of the three items.

Table 7.8.1 Construction Base Cost for the Proposed Structural Flood Mitigation Measures in Gemas Area

Detail Item	Cost (RM million)	Cost (RM million)
	Alt-1	Alt-2
Over all cost	42.10	57.55
Direct cost	34.87	47.66
Indirect cost	5.23	7.15
Contingency	2.00	2.74

(3) Land Acquisition Cost

These costs are estimated on the basis of actual market value obtained from the interview Survey in Gemas.

The study aimed to locate the proposed measures within the available government land and reserves. However, for most of the proposed measures, some land is to be acquired for the construction and land owners are to be compensated for the acquisition. Land acquisition costs form a major part of the total project costs and are notoriously difficult to estimate with accuracy. The price of the land varies enormously, depending on its location and development trends within the study areas.

The land values used are to represent the best estimated prices of market values RM 30 per m2 at agricultural land. Total land acquisition cost is given in **Table 7.8.2**, at RM9.82 millon in Gemas.

Table 7.8.2 Compensation Cost for the Proposed Structural Flood Mitigation Measures

Cost (RM million) Alt-1	Cost (RM million) Alt-2
9.82	6.15

(4) Administration, Investigation, Design and Construction Supervision Cost

Administration, investigation, designs and construction supervision cost is estimated in proportion to direct construction cost.

(a) Administration Cost

Administration Cost (Project Owner's Expense for management) of the Project is estimated at 7% of the total sum of construction cost and compensation cost.

(b) Engineering Service Cost

Engineering service cost is prepared for the detailed engineering design and construction supervision services at 5% and 11% respectively of construction base cost.

Table 7.8.3 Administration, Investigation, Design and Construction Supervision Cost

Item		Cost (RM million)	Cost (RM million)	Remarks
		Alt-1	Alt-2	
Administration Cost		3.63	4.46	7%of Sum of construction and compensation
Engineering Service Cost	Detailed Design	2.11	2.88	5% of construction cost
	Supervision	4.63	6.33	11% of construction cost
Total		10.37	13.67	

(5) Operation and Maintenance Cost

The operation and maintenance cost mainly consist of costs for Patrol/Inspection Work, Maintenance Work and Operation Work. These costs include facility maintenance cost, cost for the administrative and logistic support, cost for operation cost in case of flooding, cost for repair of the structures, and other miscellaneous expenses but exclusive for heavy damage due to calamities, such as huge flood. Maintenance is mainly for structural and geotechnical health assessment, repairs, rehabilitation, desilting, lawn moving, rubbish removal, etc. Annual maintenance costs are estimated based on fifty (50) years service life for each structure. The costs are estimated at 0.5% of the total construction cost for maintenance. The total maintenance cost for the next fifty (50) years service life is estimated at RM0.21 million, RM 0.27 million for Alternative 1 and 2 respectively as given in **Table 7.8.4**.

Table 7.8.4 Project Cost for the Proposed Structural Flood Mitigation Measures

Item	Detail Item	Cost (RM million)	Cost (RM million)
		Alt. 1	Alt. 2
Total Construction Base Cost	Over all cost	42.10	57.55
	Direct cost	34.87	47.66
	Indirect cost	5.23	7.15
	Contingency	2.00	2.74
Total Compensation Cost		9.82	6.15
Construction + Land Acquisition Cost		51.92	77.37
Administration Cost		3.63	4.46
Enigineering Cost		6.74	9.21
Summary of the Projet Cost		62.29	72.45
O & M Cost / year		0.21	0.27

7.9 Methodologies Economic Evaluation

7.9.1 Objective

A main objective of the economic evaluation here is to examine the efficiency of the project investment in structural measures from the viewpoint of the national economy, using cost-benefit analysis. Market prices are converted to economic ones where the influence of market distortion is removed, (so-called "shadow prices"). Opportunity costs are used for the costs of goods and services whose markets do not exist. Willingness-to-pay is used for benefits whose markets do not exist. An Internal Rate of Return (IRR) is used here as the indicator of the efficiency of a project investment. IRR is defined as the discount rate which makes the present value of the flow of costs incurred in the project the same as that of benefit, which makes the Net Present Value (NPV) 0 (zero) or makes B/C 1 (one), showing what percentage of profit the investment will be paid back with. IRR used in economic evaluation is called Economic Internal Rate of Return (EIRR).

7.9.2 Preconditions

The following preconditions are assumed in the economic evaluation. Additional preconditions will be clarified as necessary.

(1) Without-the-project and With-the-project

Without-the-project is the case where the structural measures are not implemented to mitigate the flood damage. With-the-project is the case where the structural measures are implemented to mitigate the flood damage. Other conditions which are NOT affected by the project are assumed to be kept as they are before the project is implemented, which does not mean that other conditions do not change but that they change as they changed before. By comparing the with-the-project and without-the-project, the additional costs and benefits incurred can be estimated to calculate an EIRR.

(2) Evaluation Period

The Evaluation period is from 2012 to 2065 (50 years after the completion of the construction). Its implementation schedule is as follows:

2012 Detailed design, 2013 -2015: Construction, 2016 - 2065: In-service.

(3) Standard Conversion Factor (SCF)

SCF is the ratio of the economic price value of all goods in an economy at their border price equivalent values to their domestic market price value. Prices of goods and services procured domestically are converted to economic ones by the SCF. This study employs an SCF of 0.85.

(4) Other Preconditions

Price level : Year of 2009

Social discount rate : 10%

7.9.3 Mesh Data

The flood prone area or the benefit area is divided into meshes (100 m by 100 m). Land use and assets in each mesh are identified and estimated by examining aerial photo of the area as well as inundation depth in each mesh is calculated with the simulation model. Future land use was decided by the Land Use Plan.

This mesh data is the basis of the benefit calculation of the project. The mesh data is summarized as follows:

Table 7.9.1 Summary of Mesh Data of Gemas in 2009

Number of Meshes	754
Population	12,600
Number of Houses	2,700
Number of Shops	900

7.9.4 Benefits

Benefits are the reduction of flood damages by comparing with-the-project and without-the-project. The benefits are calculated in the form of cash flow of each year during the evaluation period. This study includes the benefit of damage mitigation of the following items.

(1) Damage Reduction of Household and Shop Buildings, Assets and Stocks

Damages of household and shop buildings, assets and stocks depend on the inundation depth caused by the floods. The reduction of inundation depth contributes to the reduction of damages of such items. The following data is used for the relation between inundation depth and damage rate of items.

Table 7.9.2 Inundation Depth and Damage Rate

Inundation Depth (m)	Damage Rate			
	Household		Shop	
	Building	Assets	Building	Assets/Stocks
0.00 - 0.19	0.000	0.000	0.000	0.000
0.20 - 0.49	0.092	0.145	0.232	0.128
0.50 - 0.99	0.119	0.326	0.453	0.267
1.00 - 1.99	0.266	0.508	0.789	0.586
2.00 - 2.99	0.580	0.928	0.966	0.897
3.00 -	0.834	0.991	0.995	0.982

Source: *Economic Study Manual for River Works, 2005.* Ministry of Land, Infrastructure, Transport and Tourism, Japan

Average prices of the above items are shown in **7.5 Asset and Flood Damage Survey**. As buildings and assets are depreciated during they are used, their actual values are estimated at a half of their prices.

(2) Mitigation of Business Suspension

Damages due to business suspension caused by floods are estimated at 6% of the total damages of household and shop buildings and assets/stocks according to *Technical Criteria for River Works, 1997*, Ministry of Land, Infrastructure, Transport and Tourism, Japan.

(3) Damage Reduction on Public Facilities

Damages on public facilities such as roads, bridges, etc. by floods are estimated at 74.1% of the total damages of household and shop buildings and assets/stocks according to *Economic Study Manual for River Works, 2005*, Ministry of Land, Infrastructure, Transport and Tourism, Japan.

Table 7.9.3 Rate of Damages on Public Facilities to Damages on Non-Public Buildings/Assets

Facility Type	Roads	Bridges	Urban Facilities	Utilities	Total
Rate (%)	61.6	3.7	0.2	8.6	74.1

Source: *Economic Study Manual for River Works, 2005.* Ministry of Land, Infrastructure, Transport and Tourism, Japan

(4) Damage Reduction on Agricultural Products

Damages of agricultural products depend on the inundation depth and duration caused by the floods. The reduction of inundation depth and duration contributes to the reduction of damages of agricultural products. The damage mitigation of agricultural products by the project is very limited. Its value is around 0.1 percent of those of building, assets and stocks according to a preliminary examination so they were not in the detailed calculation.

(5) Damage Reduction on Livestock

The number of livestock kept by the households in the target area is very limited according to the asset survey of JICA Study Team so it is not included in the calculation.

7.9.5 Costs

Additional costs are included in the evaluation by comparing with-the-project and without-the-project. The costs are calculated in the form of cash flow of each year during the evaluation period. The following cost items are calculated:

(1) Construction, Replacement and Salvage Value

Construction cost includes costs of construction of the facilities, and equipment. Economic evaluation includes physical contingencies but excludes price escalations. Replacement costs of facilities and equipment are calculated at the end of their effective life-spans. Salvage value of construction, facility and equipment is added as a negative cost at the last year of the evaluation period.

(2) Operation and Maintenance

Operation and maintenance (O&M) costs for each year is included. Price escalation is not included. The value of O&M costs is usually estimated at a certain percent of the total construction cost. This study employs 0.5% for each year.

(3) Engineering Services

Engineering services cover that in the detailed design stage and that in the construction supervision stage. Both of them are usually estimated at certain percents of the total construction cost. This study employs 5% for the detailed design and 11% for the construction supervision.

(4) Land Acquisition and Local Administration for Construction

Although land acquisition cost and local administration cost for construction are not covered by the loan offered by Japanese ODA, they are included in the economic evaluation as long as the project displaces domestic sources to be used for other economic activities or they have opportunity costs. The value of local administration cost is usually estimated at a certain percent of the total of construction cost and land acquisition cost. This study employs 7%.

7.9.6 Calculation of Expected Annual Average of Damage Reduction

As the flood occurs stochastically, annual flow of benefit should be presented in the form of expected annual average of damage reduction, which is calculated as follows.

Table 7.9.4 Expected Annual Average of Damage Reduction

Occurrence Probability	Damage Value			Interval Average of Damage Reduction	Interval Provability	Annual Average Damage Reduction
	w/o Project	w/ Project	Damage Reduction			
1/1			D_0=0			
				$(D_0+D_1)/2$	1-(1/2)=0.500	$d_1=(D_0+D_1)/2$ x 0.67
1/2	L_1	L_2	$D_1=L_1-L_2$			
				$(D_1+D_2)/2$	(1/2)-(1/5)= 0.300	$d_2=(D_1+D_2)/2$ x 0.300
1/5	L_3	L_4	$D_2=L_3-L_4$			
				$(D_2+D_3)/2$	(1/5)-(1/10)= 0.100	$d_3=(D_2+D_3)/2$ x 0.100
1/10	L_5	L_6	$D3=L5-L6$			
				$(D_3+D_4)/2$	(1/10)-(1/20)= 0.050	$d_4=(D_3+D_4)/2$ x 0.050
1/20	L_7	L_8	$D_4=L_7-L_8$			
				$(D_4+D_5)/2$	(1/20)-(1/30)= 0.017	$d_5=(D_4+D_5)/2$ x 0.017
1/30	L_9	L_{10}	$D_5=L_9-L_{10}$			
				$(D_5+D_6)/2$	(1/30)-(1/50)= 0.013	$d_6=(D_5+D_6)/2$ x 0.013
1/50	L_{11}	L_{12}	$D_6=L_{11}-L_{12}$			
				$(D_6+D_7)/2$	(1/50)-(1/100) =0.010	$d_7=(D_6+D_7)/2$ x 0.010
1/100	L_{13}	L_{14}	$D_7=L_{13}-L_{14}$			
Expected Annual Average of Damage Reduction			$d_1+d_2+d_3+d_4+d_5+d_6+d_7$			

7.9.7 Calculation of EIRR, B/C and NPV

Finally, annual cash flow of costs and benefits (expected annual average of damage reduction, EAADR) are summarized as follows.

Table 7.9.5 Summary Table Form for Cost and Benefit of the Project

Year	Cost			Benefit	Net Benefit
	Construction	......	Cost Total	Total of EAADR	
1					
2					
......	......	......	......	......	......
49					
50					

EIRR, B/C and NPV are calculated based on the summary table mentioned above with using the following formulas.

EIRR (r) is defined as follows:

$$\sum_{i=1}^{n}\frac{B_i}{(1+r)^i}=\sum_{i=1}^{n}\frac{C_i}{(1+r)^i}$$

B/C is calculated as follows:

$$B/C=\sum_{i=1}^{n}\frac{B_i}{(1+r)^i}\Bigg/\sum_{i=1}^{n}\frac{C_i}{(1+r)^i}$$

NPV is calculated as follows:

$$NPV=\sum_{i=1}^{n}\frac{B_i}{(1+r)^i}-\sum_{i=1}^{n}\frac{C_i}{(1+r)^i}$$

where,
B_i: benefit in the ith year
C_i: cost in the ith year
r : EIRR or discount rate
n: number of evaluation years.

The project is considered as feasible or efficient from the viewpoint of the growth of the national economy when EIRR exceeds the discount rate, B/C exceeds 1 (one) or NPV exceeds 0 (zero).

CHAPTER 8 FEASIBILITY STUDY ON GEMAS FLOOD MITIGATION PROJECT

The feasibility study (hereinafter referred to as F/S) on Gemas Flood Mitigation Project selected in the IFM Plan is the main themes to be discussed as priority project in Chapter 8. F/S will be conducted on projects composed of structural measures and non-structural measures, and are combination of several components. The detailed objectives of the F/S on the project are as enumerated below:

- Objectives of the study on the structural components are addressed to clarify the technical, economical and environmental viability of alternatives with a combination of structural measures such as bunds, pump stations, detention ponds, allowable flooding areas and so on.

- Objectives of the study on the non-structural components basically covers to support legal arrangement and to complement for existing non-structural measures such as flood forecasting and warning system, evacuation system, management of landuse, etc.

8.1 Proposed Structural Measures

8.1.1 Design Concept

(1) Planning Frameworks

The planning and evaluation of structural measures are carried out in consideration of future conditions such as population, land use and property value of the target project completion year (2025). However, the Gemas Flood Mitigation Project shall be implemented in the RMK-10 (2011-2015) if funds permitted. In the Steering Committee Meeting on Inception Report held on 16th October 2009 and on Interim Report on 9th February 2010, participants agree that the project will be considered in the formulation of RMK-10 projects. The evaluation of the project is executed from the viewpoint as follows: 1) Cost effectiveness, 2) Impact to environment and 3) Extensibility to adapt to climate change.

(2) Basic Design Concept

According to agreed IFM Plan, the selected countermeasure is composed of two structural measures, namely, bunds to protect target area from river flooding and pumping stations associated with retarding water facilities to prevent flooding by inland water. Target protection area in this study is around Gemas town and its surrounding area where assets and population are concentrated. The design scale and concept for the structural measures are summarized in **Table 8.1.1**. The main design principles adopted are: (1) To protect town areas from overflow of flood water from rivers by construction of bunds and/or bypass/shortcut channel(s) based on 50 years ARI flood design level (refer to Subsection 8.1.2); and (2) To protect the town areas from inland floods caused by concentrated downpour by construction of sluice gates, pumping stations, detention ponds and so on based on 10 years ARI flood design level.

Table 8.1.1 Design Concept

Issues	Conceivable Countermeasure	Design Level
River Overflow Flood	Construction of Bunds, Bypass and Road Heightening	- Probability of Rainfall: 50-years ARI (in consideration of the DID manual, past flood mitigation plans and result of stakeholder meetings)
Inland Flood	A) Installment of Pumping Station and Sluice Gate B) Designation of Allowable Flooding Area and/ or Construction of Detention Pond for Pomp Operation	- Probability of Rainfall : 10-year ARI (in consideration of the present landuse condition, DID manual, past drainage project/Plan and result of stakeholder meetings)

(3) Approach for Integrated Flood Management

As stated in the IFM Plan stage, among the seven components of Flood Mitigation of the DID Manual on IFM (Integrated Flood Management), the JICA Study Team makes much of the first three items: (1) Ensure a participatory approach; (2) Integrate land and water management; and (3)Adopt a best-mix of strategies. As a part of the participatory approach, stakeholder meetings were held several times for the Muar River Basin to present progress and results of feasibility study as to tentative alternative plans for the structural and non-structural measurements. In addition, the team will recommend to integrated land and water management in consideration of the existing local plans and land use regulations. Moreover, the team will propose structural and non-structural measures which mitigate flood damage with less adverse impact to downstream retaining natural water retarding function.

(4) Adaptation to Climate change

In the feasibility study, our basic position is to design structural measures for flood management based on result of flood simulation under current climate condition. However, the climate change impact to flood (increase in water level and rainfall depth) will be assessed as well. In addition, the adaptation measures will be examined based on the magnitude of the impact and the cost efficiency of conceivable adaptation measures.

8.1.2 Study on Alternatives

(1) Definition of Target Area

The Gemas town, which is densely populated area in Mukim Gemas, was seriously inundated in 2006 Flood as shown **Figure 8.1.1**. Based on the inundation area and the result of flood simulation in Chapter 7, the target area was defined through discussions on the stakeholder meetings.

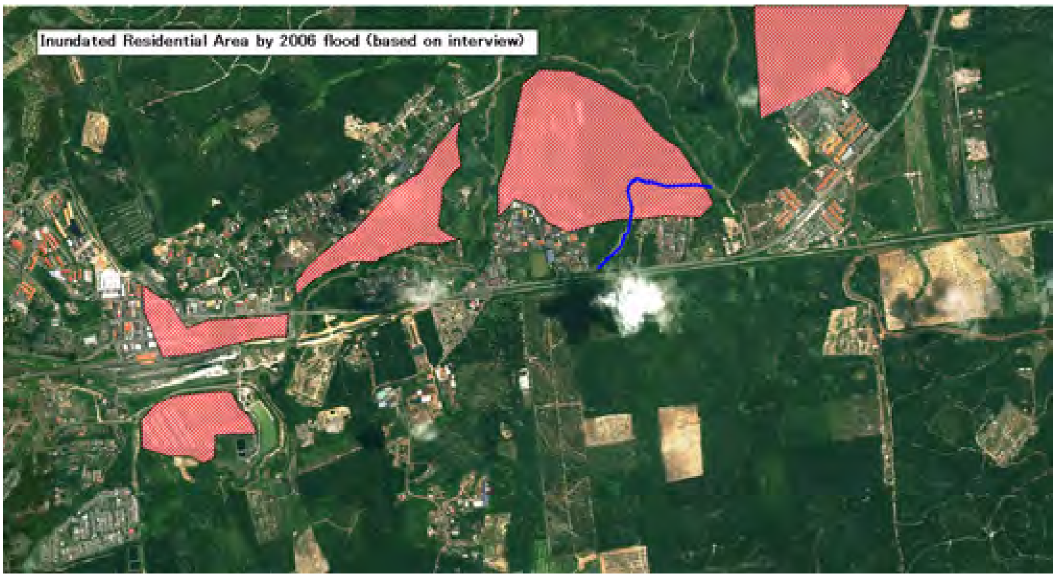


Figure 8.1.1 Inundation Condition in 2006 Flood (Based on interview)

(2) Selection of Structural Measures

As explained in IFM Plan in **Chapter 6**, the efficiency of large-scale structural measures that aim to protect only the Gemas town may be very low in consideration of the condition of the town. On the other hands, ring bunds with effective utilization of retarding effect of upper swampy, forest and farm land is considered as best structural measure in the target area because of less adverse effect to downstream of Muar River Basin compared with other structural measures and cost effectiveness.

For fundamental measures to reduce the flood water level of Gemas River, improvement of main channel of Muar River may be effective. However, as of August 2010, the Master Plan study by DID to improve Muar River is still ongoing and needs some more time to finalize as explained in **Chapter 6**. In addition, in the Master Plan, there is no examination to reduce the water level around Gemas River.

Under these circumstances, the measures of ring bunds are considered as appropriate flood control measure to build a resilient society in Gemas town.

(3) Setting of Design Scale

As mentioned in IFM Plan in **Chapter 6**, design scale had been often limited in Malaysia by constrains such as budgetary, environmental and social conditions. Especially, as for construction of bunds at the target area, stakeholders mentioned in the stakeholder meetings that the lower height of the bunds is, the more residents are relieved. The stakeholders preferred the JICA Study Team to design bunds with less than 4m in height.

Thus, the Study Team analyzed the relationship between design scale and bund height at Gemas town, drawing the alignment of bunds on the ortho-map (made by this preparatory survey). As a result of the works, the JICA Study Team confirmed the viability to protect Gemas town from the 50 year flood by construction of the bunds with height of 4m on average.

(4) Component of Alternatives

To protect Gemas town, two alternatives are proposed as summarized in **Table 8.1.2**. The basic concept of alternative-1 and alternative-2 is enumerated as follows:

Alternative-1: To protect the target area from Gemas River overflow flood by ring bunds. The collected water in regulation ponds is forced to drain through pumping stations that are placed at outlet of existing small rivers and channels, or is discharged through sluice gates after flood. In addition, flood walls are planned to construct the area where river reserve area or width of bunds can not be ensured.

Alternative-2: To protect the target area from Gemas River overflow flood by ring bunds and bypass channel. The runoff discharge inside the ring bunds is reserved in retarding basin. The reserved water in the retarding basin is forced to drain through the pumping stations to Gemas River. The flood water would make a detour around Gemas town of Negeri Sembilan through the by-pass channel by operating the three river gates.

Table 8.1.2 Component of Alternatives

Alternative		Alternative-1	Alternative-2
Basic Concept		Protect by ring bunds, flood walls	Protect by ring bunds and by-pass channels
Facilities	Against river flood	• Ring bunds(Length: 4584m) • Road heightening (Length: 1090m)	• Ring bunds (Length: 3742m) • By-pass channels (Length: 2,756m) • Flood wall (Length: 112m)
	Against inland flood	• 6 Regulation Pond: (Area=10.72 ha, Volume=0.1mil. m^3) • 1 Pump Stations with Regulation ponds (Total pump capacity: 1.0 m^3/s) • 4 Sluice ways • 1 River gate	• 1 Pump Stations without Regulation pond (Total pump capacity: 5.1 m^3/s) • 1 Retarding basin: (Area=30 ha, Volume 0.4 mil. m3 • 2 Sluice ways • 3 River gate

The plans of facility placement of flood control measures for alternative-1 and 2 are presented in **Figure 8.1.2** to **Figure 8.1.3**. Orange lines, blue shadow, gray line are indicated bunds, retarding basin or regulation pond, and heightening of road respectively.

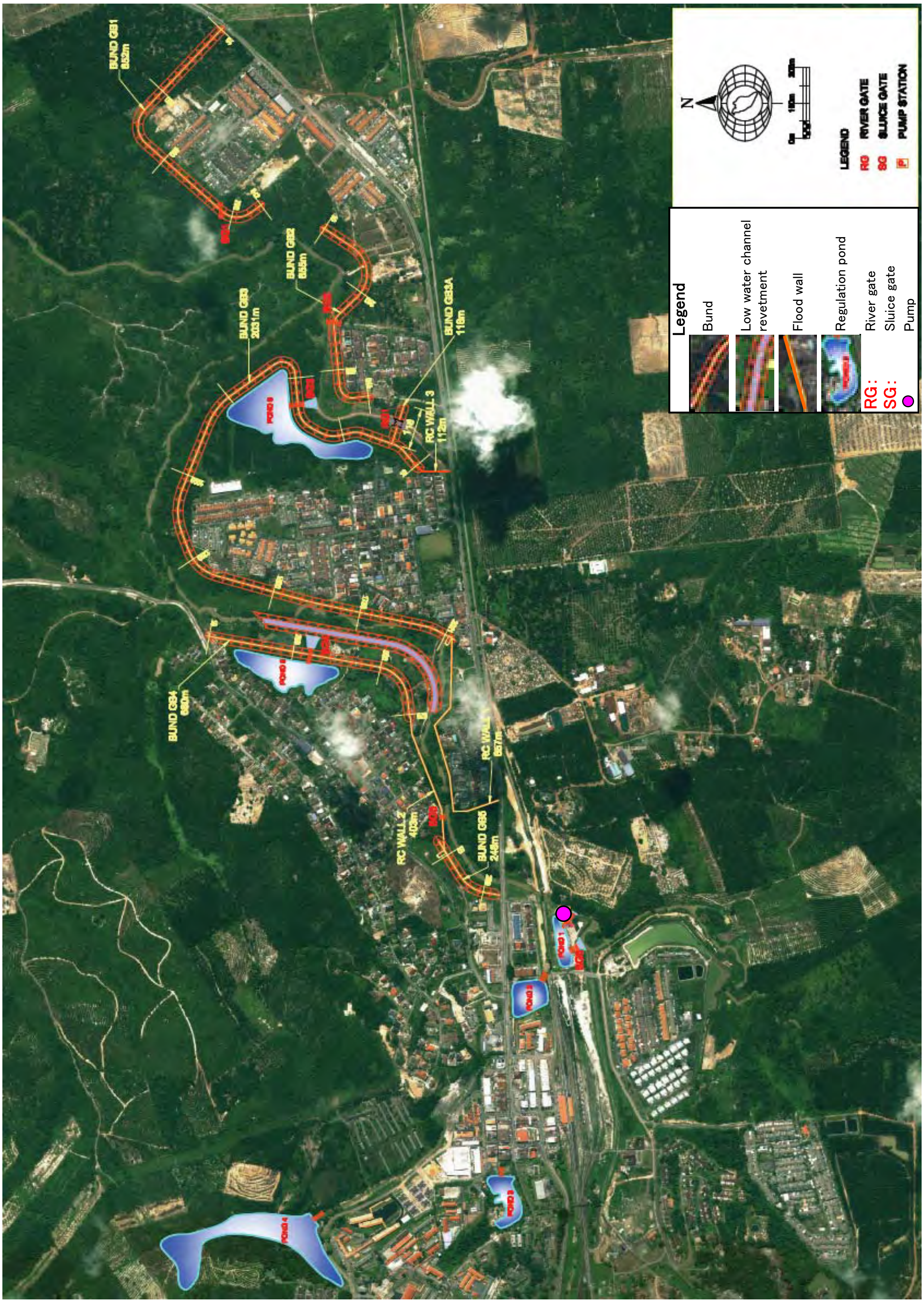


Figure 8.1.2 Plan of Structural Measures for Alternative-1

Figure 8.1.3 Plan of Structural Measures for Alternative-2

(5) Functions of Alternatives

The function of the flood control facilities which are installed and constructed in the alternatives are summarized in **Table 8.1.3**. The main purpose of the alternatives is to prevent flooding by river-overflow from Gemas River.

Table 8.1.3 Function of Flood Mitigation Measures in Alternatives

Purpose	Facilities	Alternative-1	Alternative-2
For flood from Gemas River (against 50 year flood)	Bunds	To prevent the overflow from Gemas River	Same as Alt-1
	Bypass channel	-	To divert the floodwater making a detour around a part of Gemas town
For inland flood (against 10 year inland flood)	Pump Station	To force to drain the inland water from the area enclosed in the constructed ring bunds. (The reserved water in regulation pond is drained.)	To force to drain the inland water from the retarding basin enclosed in the constructed river gates 1 and 3
	Regulation Pond	To store inland flood and discharge it after flood	-
	Retarding Basin	-	To store inland water in the river channel with low-lying area closured by Gate 1 and 3
	Sluice way and River Gate	To prevent inrush of floodwater of Gemas River toward the protected area by ring buns	Same as Alt-1

In addition, major advantages and disadvantages in construction phase and operation phase for both alternatives are summarized in **Table 8.1.4**.

Table 8.1.4 Advantage and Disadvantage in Alternatives

Phase	Item	Alternative-1	Alternative-2
Construction Phase	Advantage	• To shorten the bund length and to reduce construction cost by placing the bunds along the Gemas river to connect to hilly area	• Materials by excavation will be reused for the bunds construction. • Regulation pond will not be required because of placement of pump stations away from residential area and near the retarding basin
	Disadvantage	• Materials to built the bunds must be purchased. • 2 houses should be resettlement	• Construction cost will be high priced by install of River gate and excavation of short-cut channel. • 1 houses should be resettlement • Power Plant will be affected
Operation Phase	Advantage	• The bunds can be utilized as roads	• The bunds can be utilized as roads
	Disadvantage	• Amenity of river environment will be reduced due to the bunds being constructed near residential area	• Amenity of river environment will be reduced due to the bunds being constructed near residential area • The operation of River Gates might be complex.

(6) Land Acquisition and Regulation of Land Use

Land acquisition will be executed to acquire necessary land for construction of 1) regulation ponds, 2) bunds and 3) by-pass channel. The areas for the land acquisition in the alternatives are summarized in **Table 8.1.5**. The present condition of the area for retarding basin should be conserved by land use regulation.

Table 8.1.5 Areas for Land Acquisition

Item	Alt-1	Alt-2
Bunds and Flood wall(ha)	22	16
Regulation Pond (ha)	11	-
Retarding Basin (ha)	-	0
By-pass channel (ha)	-	16
Total (ha)	33	32
Total Cost (RM ‘000)	9,816	3,150

Incidentally, unit cost of land acquisition in Alternative-1 is higher than that of Alternative-2 because of difference in values between town area and agricultural land.

8.1.3 Selection of Optimum Plan

The alternative plans are evaluated from aspects such as economic, environmental and flexibility to cope with impact of climate change. The values and degree of criteria to evaluate are summarized in **Table 8.1.6**.

As a result of the evaluation described below, Alternative-1 is selected as an optimum plan to mitigate flood damage in the target area because Alternative-1 is superior to Alternative-1 from the economic point of view though both are at the same level for other criteria.

Table 8.1.6 Criteria for the Selection of Alternatives

Criteria			Alternative-1	Alternative-2
Economic Evaluation	Cost (including land acquisition)		51.9	59.3
	EIRR (%)		10.7	8.7
	B/C		1.09	0.86
	NPV (RM ’000)		3,755	-7,700
Environmental Evaluation	Social Condition	Affected House	2	1
		Land Acquisition (ha)	33 ha	32 ha
		Livelihood	No significant impact	No significant impact
	Natural Condition		No significant impact	No significant impact
Flexibility for Impact of Climate Change			Same Condition	

(1) Economic Evaluation

Alternative-1 is recommendable to be adopt as Gemas Flood Mitigation Project from an economic standpoint. According to the economic evaluation in **8.4.4**, Alternative-1 is deemed feasible. As for Alternative-2, EIRR, B/C and NPV do not reach the level of "feasible".

(2) Environmental Evaluation

It is difficult to judge superiority or inferiority from the environmental viewpoint on these two alternatives. As for the social and natural conditions, in fact, there is no significant difference between these two projects when seeing overall though there are some superiorities or inferiorities in each item. The detailed information on environment is summarized in **8.5**.

(3) Flexibility for Impact of Climate Change

It can be said that both projects have same level of flexibility to adapt to impact of climate change. The alignment of bunds is illustrated in **8.1.2**.

8.1.4 River Amenity and Landscaping

Primary role of bunds and ponds proposed in this study are to protect residential areas from flooding. However, another important function of flood structural measures is that they could also benefit residents when river water level is at normal condition.

Since slope gradient of bunds proposed in this study is gentle with 3:1 slope, they could be considered as an asset to landscaping and waterfront development. 3:1 slope is walkable which could provide an access to river waterside. River reserve could function as an open space for recreations and ponds could provide new waterfront for relaxation.

Current Gemas River bank, as seen in pictures below, is covered with deep riparian vegetation or difficult to access, and it is currently not used as recreation area.

Figure 8.1.4 Current Landscape of Gemas River Bank

Preliminary perspective drawings of the possible future riverbank landscaping are shown here. Figures aim to provide an image how water amenity oriented flood management structure measures could benefit residents at normal times.

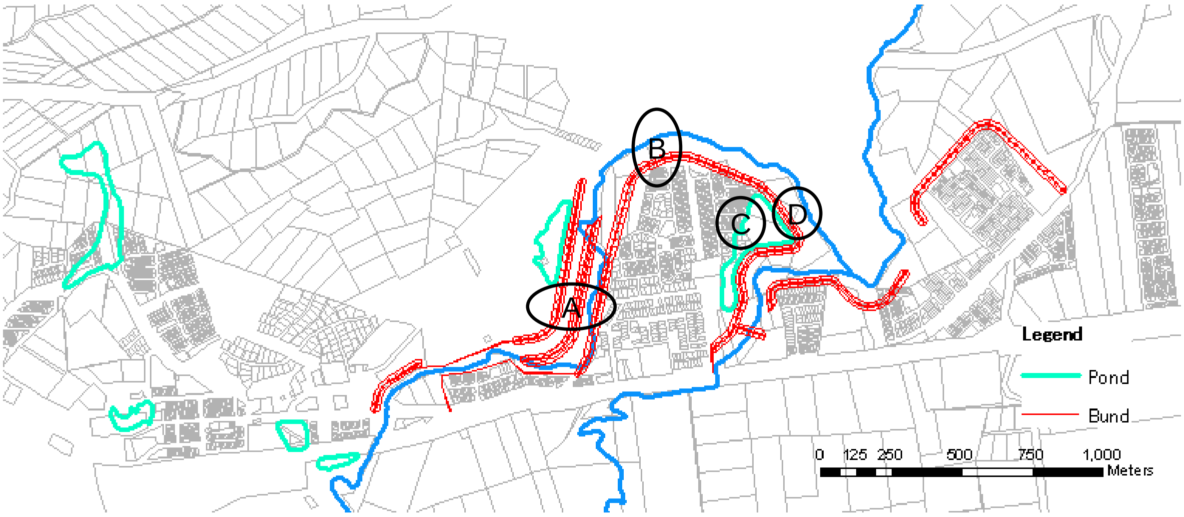
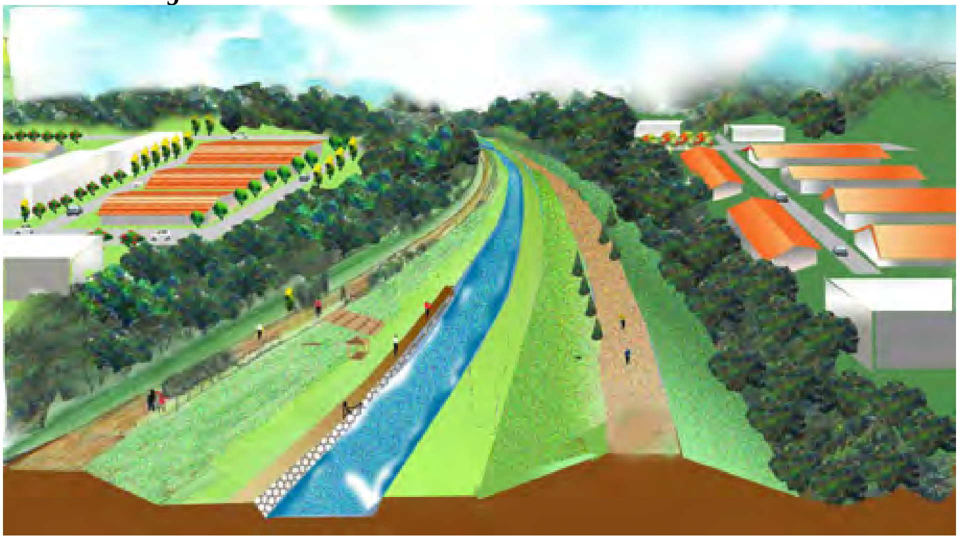


Figure 8.1.5 Locations of the Drawings

A: Bund along Gemas River



B: Bund along Gemas River

C: Pond and Bund along Gemas River

Figure 8.1.6(1) Preliminary Landscape Drawings

D: Outlet Channel from Pond and Sluice Gate

Figure 8.1.6(2) Preliminary Landscape Drawings

8.2 Proposed Non-Structural Measures

8.2.1 Existing Non-structural Measures in Gemas Area

Non-structural measures such as warning system and flood management are necessary to complement the limitation of structural measures such as bunds system. Through the data collection, an interview to the officers and residents in the project area, existing non-structural measures using in Gemas along Gemas River are shown as follows.

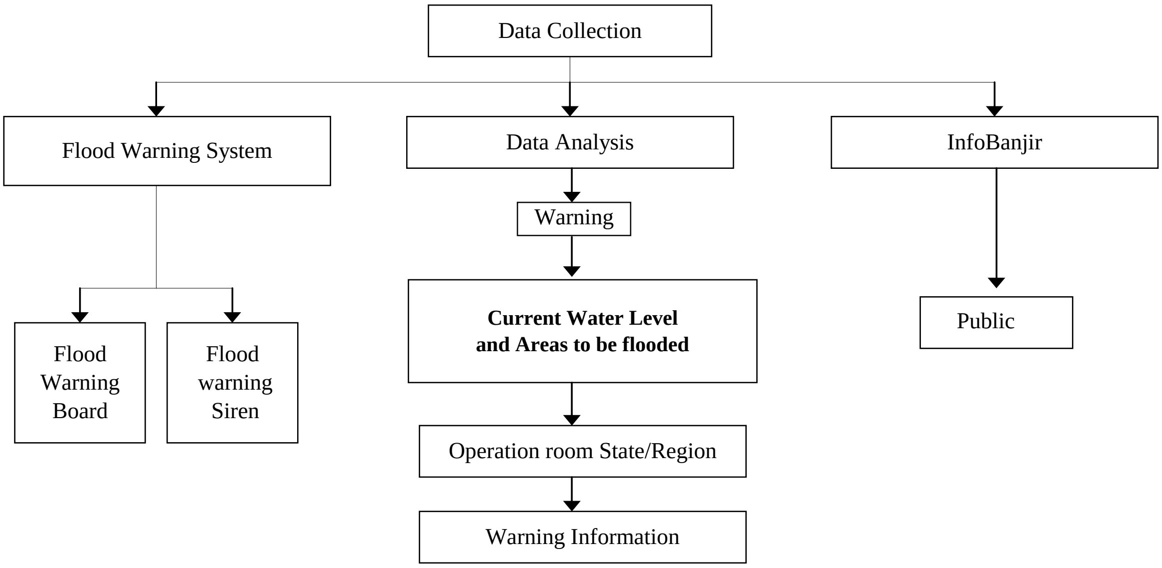
Table 8.2.1 Existing Non-Structural Measures in Gemas

No.	Existing Non-Structural Measures	Relevant Organizations/Agencies
1	Flood warning system	DID
2	Flood management and operation	National Security Council (MKN)
3	Flood maps	DID (JPS)
4	Flood proofing	-
5	Land use control	DTCP (JPBD), Local Authority

(1) Flood Warning System

Flood warning system is managed under the responsibility of DID. Current monitoring process and dissemination of flood forecasting and warning system by DID is shown in **Figure 8.2.1**. The flood forecasting system has been developed in Muar basin including Gemas River.

Data for rainfall and water level is analyzed and is sent to relevant authorities for preparation and warning on flood mitigation. The warning system or “infobanjir” on the website is in operation by DID and information on rainfall and water level is disseminated to the public.



Source) DID Hydrology Division

Figure 8.2.1 Monitoring Process and Dissemination of Flood Warning System

Two flood warning sirens are located at Kg. Tiong and Taman Sungai Gemas in Sub-district Gemas as shown in **Figure 8.2.2**. No flood warning system exists in Gemas Bharu in Sub-District Gemas Bharu.

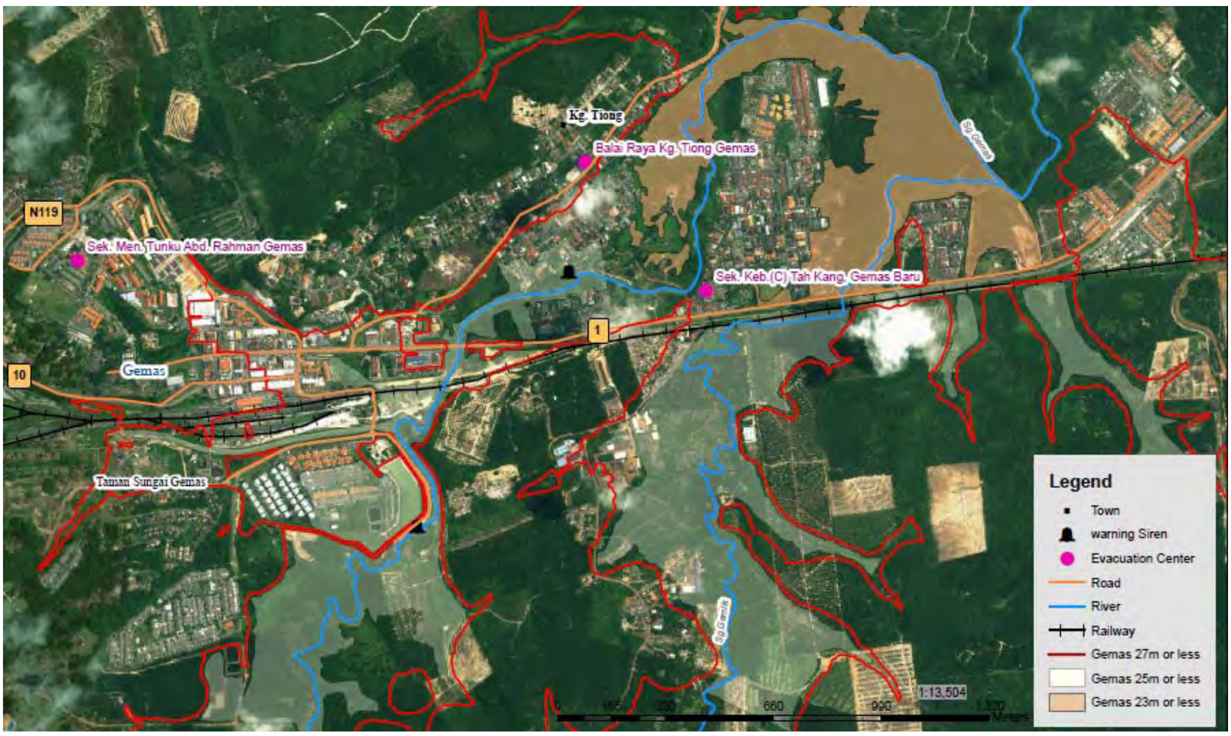


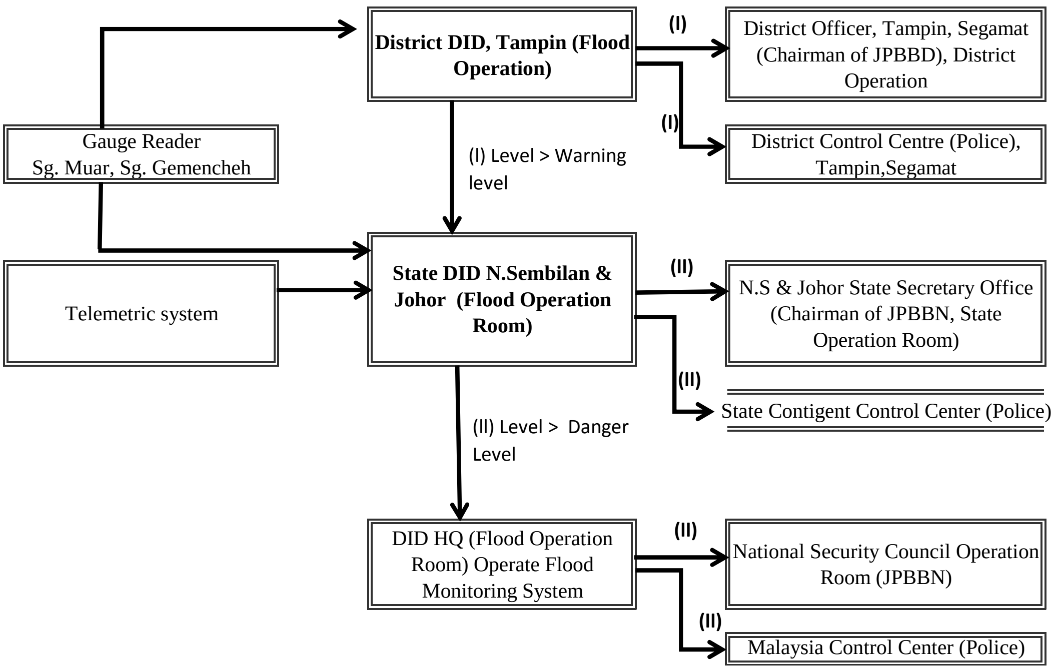
Figure 8.2.2 Location of Flood Warning Siren and Evacuation Center

This flood warning siren system is installed in flood prone area where flood forecasting or warning systems are not applicable due to short forecast lead time or some other reasons. If the water level rises to a defined water level, the siren will start its function and residents nearby can be alerted even at night.

Figure 8.2.3 Flood Warning Siren (Kg. Tiong and Taman Sg. Gemas)

In DID's flood warning service, the warning information on water level will be disseminated to State Operation Room of DID Negeri Sembilan (DID Johor), then, will send the information to Tampin (Segamat) District DID, State Operation Room (DMRC or JPBB) and contingent control center (Police). District DID Tampin (Segamat) will send to Tampin (Segamat) District Officer and District control center.

The communication and information flow on flood forecasting is shown below.



Notes: (I) river level >warning level
(II) river level >danger level
(III) Heavy rainfall advisory
DMRC Disaster Management and Relief Center (JPBB)
Information flow is arranged for Tampin based on the flow in DID Manual

Figure 8.2.4 Communication and Information Flow

The water level monitoring stations for the warning under operated by DID Tampin and DID Segamat are shown in **Table 8.2.2**. No water level station in Gemas.

Table 8.2.2 Flood Warning Water Level at the Monitoring Stations

No.	Name of Stations	River	Water Level(Normal)	Alert Level (Green)	Warning Level (Yellow)	Danger Level (Red)
1	Gemencheh	Gemencheh	22.31 m	22.00 m	24.00 m	26.00 m
2	Kg. Awat	Muar	16.46	17.60	18.95	19.95
3	Biloh Kasap	Muar	5.63	7.92	8.53	9.14

Source) Infobanjir web site

When water level of the monitoring station reaches the alert level, District DID begins to monitor closely the flood situation such as rainfall and water level. When it reaches warning level, DID informs the relevant flood operation rooms. When the river water level exceeds danger level, the forecast shall be transmitted to the flood operation rooms and other relevant agencies.

Communication system using SMS on flood information such as water level among engineers and technicians has been introduced by DID.

(2) Flood Management and Operation in Tampin District and Segamat District

(a) Guideline and Workshop for Community-based Disaster Management

Guideline for flood management and relief at District level is prepared under guidance of National Security Council (NSC, Majilis Keselmatan Negara, MKN) of State. Guideline is prepared at State (Negeri) level, District (Daerah) level and Sub-district (Mukim) level. Guidelines at Daerah (District) level are shown in **Figure 8.2.5**.

Guideline for Segamat (Daerah) District

Warning System for N. Sembilan State

Figure 8.2.5 Prepared Guideline for each Administration (State, District)

The composition of a guideline is the same at state, district and sub-district level. The contents of the Negeri Sembilan State guideline are:

- List of members for Disaster Management and Relief Committee (JPBB, Negeri);
- Address and phone number for offices of flood management during flood;
- List of evacuation center, forward base, food supply, land transportation;
- Sub-committee for risk management, Budget, evacuation center and food supply, medical transportation and communication. flood monitoring;
- Information flow among Federal, State, District level of DMRC (JPBB);

- List of kinds of foods for supply in evacuation center; and
- Report form for flood management (victims in evacuation center, foods supply).

An annual workshop for disaster management including floods at community level is held under arrangement of the State NSC in collaboration with related agencies. This workshop aims at establishing a community-based disaster management. The objectives of the workshop are listed below.

- Identify knowledge of the community about the types of the disasters and risks
- Identify the level of community awareness in the risk areas and prepare the risk maps
- Review the knowledge of the warning level for the local disaster
- Identify the level of community awareness for the safe places and plan for the evacuation
- Analyze community capacity for the disaster management before, during and after the disaster.

(b) Flood Management and Relief Activities in Tampin (Segamat) District

Flood management and relief activities in Tampin District will be done under Disaster Management and Operation Committee (DMRC, Jawatankuasa Pengurusan dan Bantuan Bencana, JPBB) chaired by Tampin District officer. District Police officer chief will be appointed as the commander and District Fire and Rescue chief will be appointed as the deputy commander.

DMRC consists of members from parliament member, state member, police chief, district officer, head of village, relevant officer from JPS, JKR, JBA. DMRC also consists of sub-committees, such as risk analysis sub-committee, practice and education sub-committee, and food supply committee. Before flood season coming, DMRC (JPBB) holds meetings for several times.

The command and control of the disaster relief operations is the responsibility of the Disaster Operation Control Center (DOCC, Pusat Kawasan Operasi Bencana, PKOB). This center is chaired by the district officer and placed in the police headquarters operation room in Tampin District. All information related to flooding shall be transferred to DOCC (PKOB). This center consists of public officer, police and military.

Same activities mentioned above have been done in Gemas Bharu in Segamat District.

There are no Forward Bases (Pangkalan Hadapan in Malay) in Gemas, while Forward Base for Gemas Bharu is located at Complex of District Office, Mukim Gemas. The functions of forward base are summarized as follows:

- Small operation room at the Mukim (sub-district) level
- Report and disseminate information related to flood disaster
- Transfer problems at the evacuation center to the forward base
- Storage of foods
- Vehicle stations during flood

The evacuation centers located in the project area are listed up as follows.

Table 8.2.3 List of Evacuation Center and its Seating Capacity in the Project Area

No.	Name of Center	Capacity (person)	Evacuated Kampung (Village)	Mukim (Sub-District)
1	Sek. Men. Tunku Abd. Rahman	300	Kg. Benggali	Mukim Gemas, N.S
		-	Kg. Kolam Air	
		-	Taman Sungai Gemas	
		-	Sekitar Gemas	
2	Balairaya Kg. Tiong	100	Kg. Baru Tiong	
	Sub-total (2 Centers)	**400**		
3	Sek. Keb. Tah Kang Gemas Baru	100	Kg. Gemas Baru	Mukim Gemas (Baharu), Johor
		-	Taman Gembira	
		-	Taman Wira	
		-	Taman Megah	
		-	Taman Sri Gemas	
		-	Taman Golden Hill	
		-	Taman Bintang	
	Sub-total (1 Centers)	**100**		
	Total (3 Centers)	**500**		Project Area

Source) List of evacuation center, DID Tampin, Guideline for Flood Management and Relief , (Segamat 2009/2010)

The number of evacuation center has a total of 3 places consists of two places in Gemas and one place in Gemas (Baharu). The number of seating capacity of the evacuation centers reaches 500 persons. These centers are shown in **Figure 8.2.6**.

As shown in Table, each Kampung (Village) already has designated evacuation centers in the guideline. The largest one is Sek. Men. Tunku Abd. Rahman Center with seating capacity of 300 persons.

Figure 8.2.6 Evacuation Center (Abd.Rahman, Kg.Tiong, Sek.G. Baru)

The health teams and medical teams are responsible for all victims during flood event are set up. Transportation facilities such as vehicles, trucks, buses, tractors and motor boats are prepared for each governmental office such as Public Work Office (JKR), Royal Malaysian Police (PDRM), Department of Civil Defense (JPA) and Municipal Office for each District.

Food supply will be secured three times a day by Department of Welfare. Personal hygiene such as tooth pastes, soaps and towels, and other requirements such as blankets, mats and batik clothes are also prepared. Seven suppliers in Gemas and are listed up showing with address and types of items for supply.

(c) Communication Flow from State Level to Evacuation Center

There are procedures for information from the State Flood Operation Center to the evacuation center located in Kampungs (villages). According to the guideline, communication flow is summarized as follows.

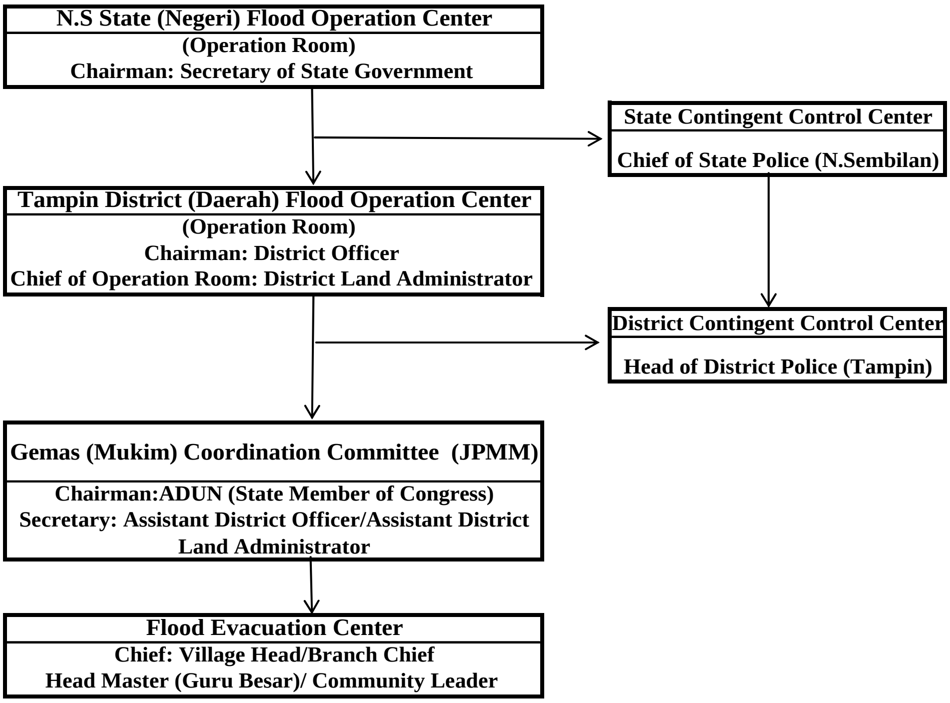


Figure 8.2.7 Communication Flow on Flood Management Information (Tampin)

(3) Flood Maps

The flood maps for Muar River were prepared by DID in 2000 and 2007 at Basin Level. Detailed flood maps of the scale 10,000 to 25,000 have not been developed in the project area, however, schematic flood maps have been prepared by DID Tampin and Segamat.

(4) Flood Proofing (Stilt House/ Raising House)

In order to prevent inundation to the dwelling at the time of a flood, stilt/raising houses are constructed along Muar River. By raising a floor, inundation can be prevented and family properties can be also protected. **Figure 8.2.8** shows a typical stilt house in Kg. Bukit Pasir along Muar River.

Figure 8.2.8 Stilt House along Muar River (Kg. Bukit Pasir)

According to interviews to residents, the water level of the flood has exceeded the floor level of stilt house about 50 cm in the 2006 flood event.

(5) Land use

In District Tampin, zoning plans are done based on the local district plan. The land use zoning plan, Tampin Local District Plan, are the guideline of development process that must be followed by land owners or developers to obtain planning permission or development order approved when submitted to Tampin Municipal Council Planning Authority.

There are many agricultural lands of palm trees and swampy areas along the Gemas River. These areas locate low land areas and play a role for retention function during flood.

8.2.2 Current Condition of the Project Area

Prior to the review on existing non-structural measures and measures to be adopted in the project area, the current features on administration, historical flood records and land characteristics are described as follows.

(1) Current Features of the Project Area

The Project area consists of two administrative areas, which are Mukim (Sub-district) Gemas (Tampin) and Mukim Gemas Bharu (Segamat). Two sub-districts have a population of 2,900.

(2) Historical Flood Water Level in Gemas

Several large floods have occurred in Tampin District. Based on the flood report prepared by DID Tampin, the record of water level in 2006 food event is ranked at the largest with estimated water level of 27m in elevation.

(3) Affected Areas and Number of Victims by 2006 Flood Events

(a) Affected Areas by 2006 Flood Event

The flood hit Mukim Gemas on 18th of December 2006. Gemas River overflowed from Taman Sungai Gemas. According to the flood report Year 2006, affected areas by flood are Taman Sg. Gemas, Gemas Town and Kg. Tiong in Gemas, and Kg. Gemas Bharu in Gemas Bharu.

Inundated House in December, 2006

Same Place as of August, 2010

Figure 8.2.9 Inundated House and it Current Condition (Taman Sg. Gemas)

(b) Number of Victims at Evacuation Center by 2006 Flood Event

The total number of evacuees during the flood event reached 325 persons. No data for evacuees in Gemas Bharu. No casualties are reported.

(4) Land Characteristics in Gemas

In Gemas, the low land areas spread along Gemas River. **Figure 8.2.10** shows areas with an elevation of 23m, 25m and 27m respectively.

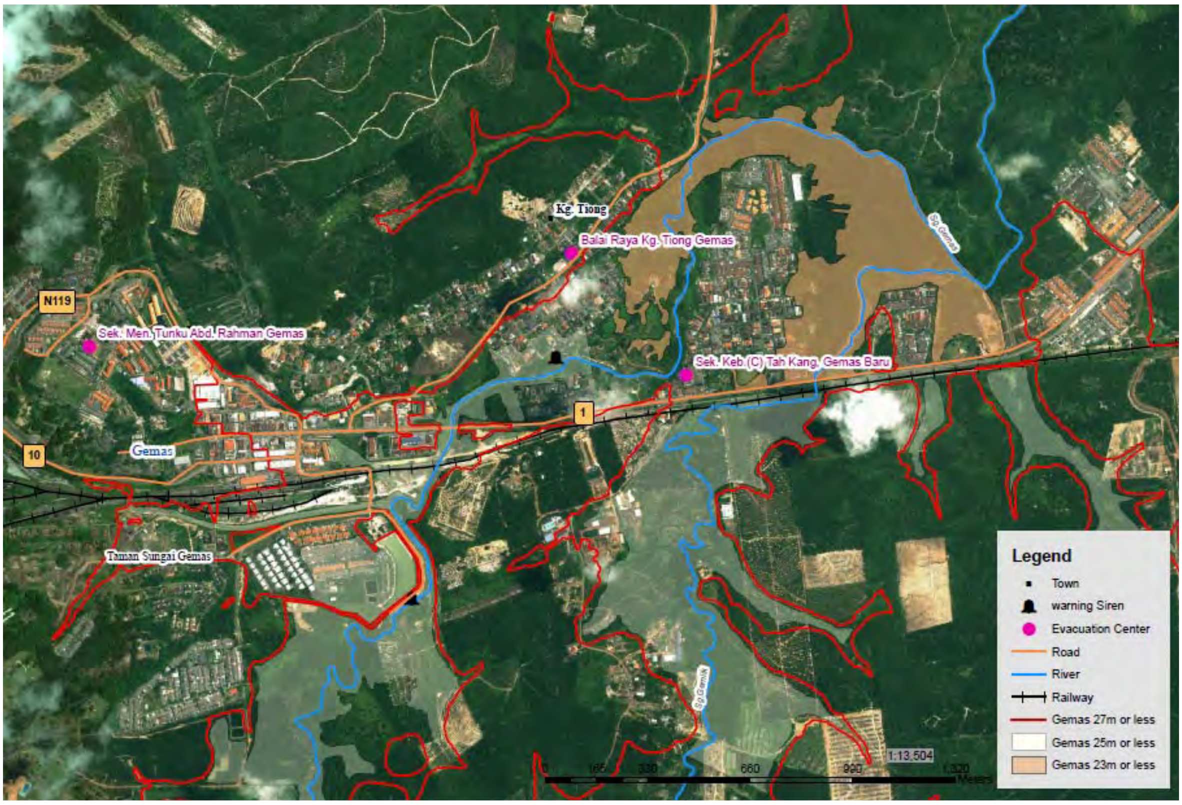


Figure 8.2.10 Areas with Elevation 23m, 25m and 27m and Evacuation Center

- According to Figure, the surrounded zones of contour line 23m in elevation spread from the downstream of the Kg. Tiong along Gemas River. These areas were affected by flood in 2006.
- Affected area, Taman Sungai Gemas, is located at 25m in elevation; and this area was inundated by 2006 flood due to the overflow at the left side of Gemas River.
- Contour line 27m in elevation equivalent to the estimated flood level in 2006 spreads over the project area except around the area of Gemas Station.
- Two evacuation centers are located out of area in elevation of 27m, however, evacuation center, Sek. Keb.(C) Tah Kang, Gemas Bharu, is located at elevation of 26m.
- From this figures shown above, land characteristics in Gemas are summarized as follows.
- Most of the developed areas such as institutions, public services and housing areas are located with an elevation of 27m. These areas will be a potential to be inundated at the level of 2006 flood.
- Taking into consideration the flood level in 2006, design water level should be set as 27m or more in elevation.
- It is recommendable that the evacuation center, Sek. Keb.(C) Tah Kang, Gemas Bharu located in the area of elevation 26m, will be transferred to the higher place which currently located.

8.2.3 Issues on the Non-structural Measures in Gemas

Taking into account the land characteristics, the characteristics of the historical floods and existing flood mitigation measures for non-structural measures are summarized as follows.

(1) Flood warning systems

- The sounding range of siren covers 700m to 1km depending on the wind condition. This range of siren should be identified in advance to assure that the sirens are useful for evacuation activities.
- There is no water level station in and around the project area. To improve monitoring system, water level monitoring station shall be installed.

(2) Flood management

- In accordance with a guideline, the flood management activities in Gemas/Gemas Bharu are done by relevant agencies, villages and local communities.
- In the flood in 2006, evacuees per day reached 325 persons at the maximum Gemas. It can be judged that it has sufficient seating capacity since this number is less than the seating capacity with 400 persons of the evacuation centers in Gemas. However, in case of larger flood, it will need to increase the seating capacity.
- According to the guideline for flood management, there is no forward base (Pengkalan Hadapan) in Gemas. This base has a function like small operation center at Mukim level during flood. To mitigate the flood damages, the forward base should be opened at Gemas Sub-District Office.

(3) Flood Maps/Hazard Maps

- Schematic flood map for each flood is prepared and shown in the flood report by DID.
- Preparation of detailed flood map or hazard map is recommended to minimize flood damages especially to eradicate loss of human lives.

(4) Flood proofing (Stilt Houses)

- Many people live near the River. They inherit their parents' house from generation to generation, and cannot move out due to economic circumstances and other reasons such easy accessibility for fishery.
- In inundation areas along the river, the construction of stilt house is recommendable for the flood mitigation.

(5) Land use and upgrading railway

- There are many agricultural lands of palm trees and swampy areas along the Gemas River. These areas locate in low land areas and function as retention area during flood.
- For mitigation of railway damage from the flood, upgrading of railway as well as relocation of Gemas Station is under implementation. With construction of a station, the new road, fly over, branching from the present Road No.1 and linking to on the south of a new station is under construction by KTM (Keratapi Tanah Melayu, Malaysian Railway). The elevation of this road is designed at 29m.

8.2.4 Proposed Non-structural Measures

(1) Project Components and Measures in Gemas

Non-structural measures will be designed to mitigate flood damages in Gemas area from floods larger than the design scale of structural measures. Advantages of the non-structural measures are summarized as follows.

- To bring about the early effect of flood mitigation with less cost of implementation as compared with the structural measures
- To contribute to a certain extent at every scales of flood
- To adapt the uncertain future climate change impact

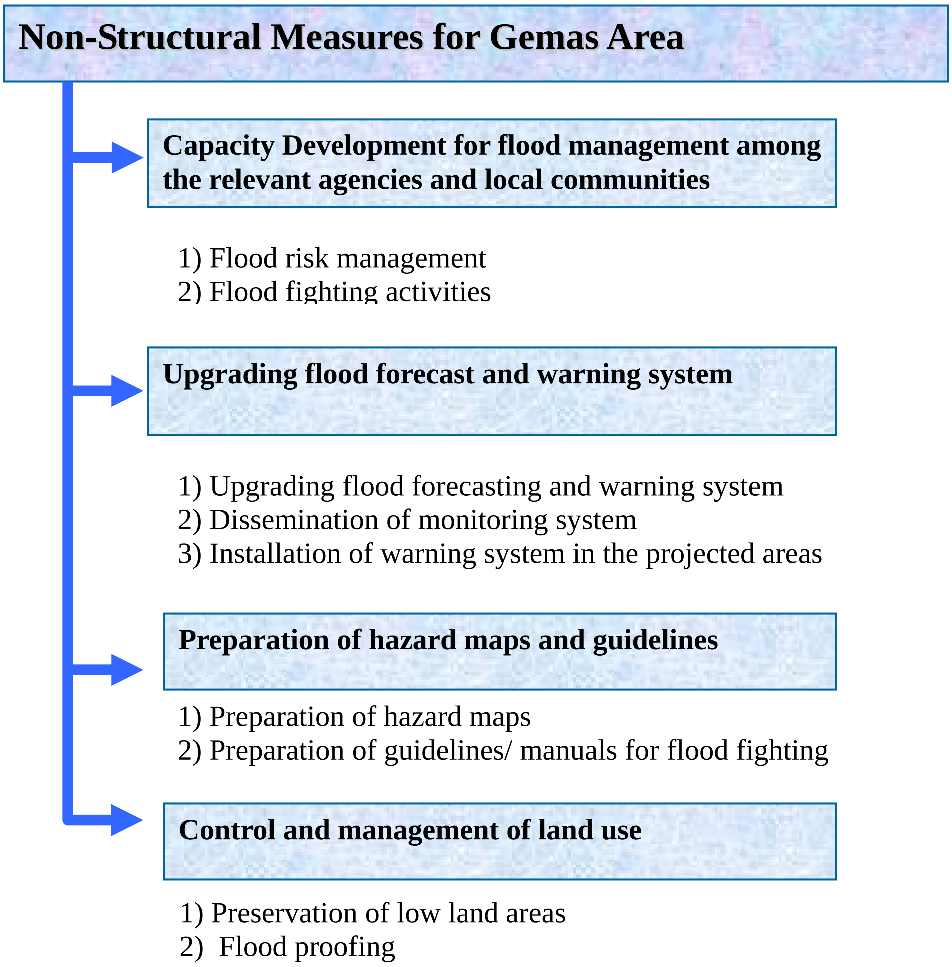


Figure 8.2.11 Project Components for Non-structural Measures in Gemas

Flood management with hazard maps and flood fighting activities will be the key measures, and through these activities, the capacity development among relevant authorities and communities shall be improved.

(2) Proposed Measures for the Project Components

Each measure for the component shall be examined in detail shown as follows.

(a) Flood risk management

Flood management activities in the Gemas area, since flood occur almost every year, are performed quite actively. Before flood season coming, DMRC (JPBB) holds meetings among relevant agencies on flood management for several times.

In accordance with the guideline, command and control of the disaster relief operations, DOCC (PKOB) and the evacuation center are prepared and identified. From the view point of flood mitigation, however, the followings shall be prepared.

- In Gemas, the total seating number of evacuation centers should be increase to 500 persons or more.
- For smooth flood management activities, Forward Base should be opened in at Gemas Sub-district Office.
- The evacuation center, Sek. Keb.(C) Tah Kang, Gemas Bharu located in the area of elevation 26m, will be transferred to the higher place which currently located.

(b) Flood fighting activities

The flood fighting activities are another non-structural measures to be adapted in Gemas area. In the proposed project, the bunds are planned along Gemas River.

In connection with the construction of bunds, the inspection and monitoring for them shall be required and the flood fighting activities shall be done depending on the water level during flood in Gemas River.

The characteristics of the flood fighting activities are shown as follows.

- As an emergency measure to minimize flooding damage, these activities have positive effect at small cost.
- The method for bund protection mainly uses soil, trees, and bamboo that are easily obtained on site.
- The main players in flood fighting activities through bund protection are not only municipalities and relevant offices but also residents living in the sites.

Source: Flood Fighting in Japan, Ministry of Land, Infrastructure, Transport and Tourism of Japan

Figure 8.2.12 Flood Fighting Activities in Japan

In Gemas area, the flood management activities at kampung level are well organized so these areas are suitable for activities on flood fighting.

(c) Upgrading flood warning system

In the project area, two warning sirens are installed. To avoid accidents such as no sounding during flood, appropriate inspection and checking of the sounding range shall be done before monsoon season. The installation of the warning siren is recommended in Gemas Bharu.

There is no water level station in and around the project area. To improve monitoring system, water level monitoring station shall be installed at the Gemas River Bridge located in Road No.1.

(d) Dissemination of flood information by utilization of monitoring system

As part of flood management activities, the monitoring is most important activity before and during flood. In Muar River, water level and rainfall at strategic points are on the web site, Inforbanjir, and updated at regular intervals (hourly to daily). Data is transmitted by various means depending on the most reliable system of telecommunication such as UHF, VHF, telephone or satellite.

The online rainfall data displayed through this website are useful indicators of potential flooding in Gemas. The online river level data at flood monitoring and warning stations provide online information on flooded areas. DID also provides the public with the most updated data on rainfall and water level.

This monitoring system shall be used for not only flood operation room, but also community-based flood activities at public level in monsoon season.

(e) Preparation of flood hazard maps

Whereas the structural measures are aimed at preventing and mitigating flooding, the flood hazard maps are based on the standing point that flooding will occur, and aims to minimize loss of life.

The purpose and befit for preparing flood hazard maps are summarized below.

- Local residents receive types of information on potential flood damage and become aware of the importance of flood management
- By using flood maps, when flood occurs, local residents are able to evacuate to the evacuation center
- Municipal council is able to smoothly accomplish the evacuation of local residents.
- Municipal council is able to serve for regulation of the land use by using flood maps.

The flood hazard maps were prepared for Gemas Area. In the map, location of the evacuation center, a total of 3 places, are shown in **Figure 8.2.13**. The major offices like community halls are shown on the map. The number of seating capacity of the evacuation centers reaches 500 persons.

According to the map, hazard areas are located along the Gemas River and Gemelik River.

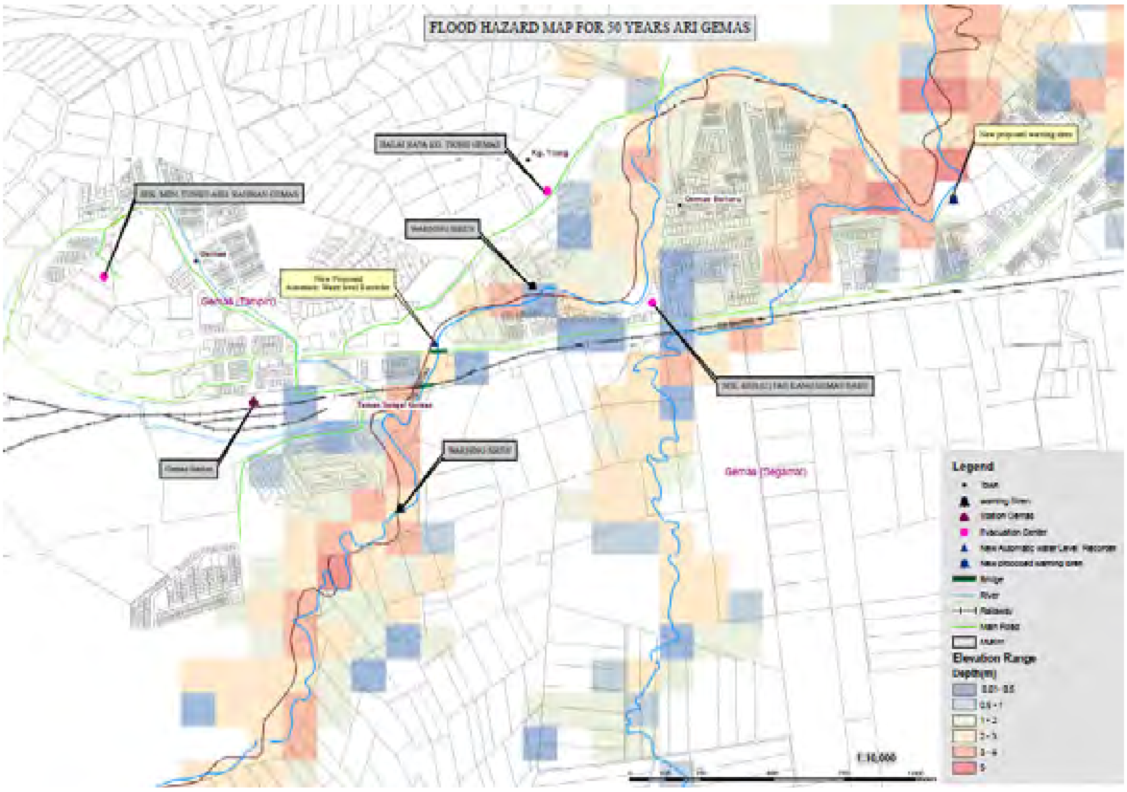


Figure 8.2.13 Flood Hazard Map in Gemas (by JICA)

Prepared hazard maps shall be shared among the local authorities and communities in Gemas. In order to make maximum use of the information, following activities should be done.

- For the sufficient information transfer, required number of copies of map should be printed, and those should be distributed to the relevant agencies for the flood management and residents in the project area.
- Thorough regular meetings held by DMRC (JPBB) before the monsoon season, an explanation for maps with the evacuation drills should be done.
- For upgrading the hazard maps, the study group shall be organized at the community or Kampung level and mutual identification on hazard areas, routes for evacuation center and submerged areas and roads shall be identified.
- DID shall need to improve the map based on opinion and the improving point from residents while performing the dissemination work of hazard maps.

(f) Flood proofing (Stilt houses)

In outside areas of the project, the stilt house is also recommended for the potential areas of flooding along the Gemas River.

Based on the historical flood level, design level for the construction of stilt house is recommended at the elevation of 27m.

(g) Preservation of low land areas for the retention of water

Measures that play the complementary role to the structural ones are also required for the non-structural measures. For example, as described in **8.2.3**, the low land areas spreads out along Gemas River. These areas have retention function and detention function at the time of a flood. In the future, when developed, there is a concern that these functions could be lost.

Regarding the town and land use planning, all the planning has to be approved by the State Council thorough the municipal council before gazetting. In the project area, these areas become the swamp areas or non-cultivated areas.

In structural measures, it is proposed to utilize the are as temporary regulating pond during flood. Therefore, the low land areas consisting of swamp area or non-cultivated areas should be defined as the agricultural areas or preservation areas in the Temerloh city planning in order to avoid development. After formulation of city plan with appropriate preserving areas for retention purpose, it shall be gazetted by Negeri Sembilan and Johor State Council.

The low land areas to be regulated by municipal council are shown in **Figure 8.2.14**.

Figure 8.2.14 Low Land Areas to be regulated by Municipal Council (Tampin, Segamat)

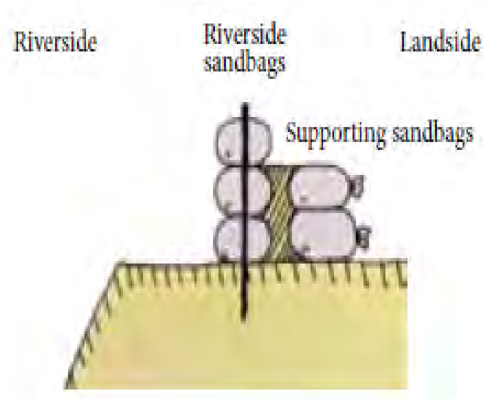
(h) Preparation of guideline and manual

In the proposed project, with the construction of bunds, the flood fighting activities shall be done by relevant authorities and local communities.

Referring to the DID manual and other references, the guideline for flood fighting activities shall be prepared with the following contents.

1) Purposes
2) Outline of the flood fighting system
3) Techniques for the bunds protection
4) Flood fighting drills
5) Organizations
6) Communication and information flow
7) Reports

Furthermore, the flood fighting drills based on these guidelines needs to be carried out in the sub-district level in Tampin (Segmat).



Source: Flood Fighting in Japan, Ministry of Land, Infrastructure, Transport and Tourism of Japan

Figure 8.2.15 Flood Fighting Drills and Sandbag Pilling Technique (in Japan)

Based on the above mentioned measures, proposed non-structural measures in Gemas are summarized as follows.

From a viewpoint of raising public awareness, the flood management activities including flood fighting activities and dissemination of flood maps at sub-district level are very important. Through these activities, the capacity on flood management shall be improved.

Table 8.2.4 Proposed Non-Structural Measures in Gemas

Project Components	No.	Non-Structural Measures	Organizations/Agencies
I. Capacity Development for flood management	1	Flood risk management 1) Forward base should be opened in Gemas 2) Seating capacity should be upgraded	National Security Council (MKN)
	2	Flood fighting activities along Gemas River	National Security Council (MKN)
II. Upgrading flood forecasting and warning system	3	Upgrading warning system by instillation of water level recorder at Gemas River Bridge	DID (JPS)
	4	Dissemination of flood information by utilization of monitoring system	DID (JPS)
III. Preparation of hazard maps and guidelines	5	Preparation of hazard maps and share the information among the local authorities and communities	DID (JPS)
	6	Preparation of guidelines/manuals for flood fighting activities	DID (JPS)
IV. Control and management of land use	7	Preservation of low land areas for the retention of water	DTCP, Local Authority
	8	Flood proofing by construction of stilt house	Local Authority

8.3 Adaptation to Climate Change

8.3.1 Concept for Adaptation Measures

Climate Change that accompanies global warning is now becoming a serious concern to be shared by all people in the world. The 4th Assessment Report that was published in 2007 by the Intergovernmental Panel on Climate Change (IPCC) shows impacts on water availability, flooding, natural resources and environment, endemic morbidity, etc. As for flooding of Asia region, especially in coastal and low-land areas, both frequencies and scales of floods are predicted to increase due to sea level rise, frequent heavy precipitation events.

In Peninsular Malaysia, NAHRIM conducted "Study of the Impact of Climate Change on the Hydrologic Regime and Water Resources of Peninsular Malaysia" between 2002 and 2006 to build up knowledge on this and in the area of climate change projection. According to NAHRIM, it is projected that floods will take place more frequently and in an amplified manner in the future.

To cope with these impacts, the IPCC report suggests that is as important to promote "adaptation" to climate change as to promote "mitigation" since climate change "mitigation" centered one reduction of greenhouse gases has limitations, and the climate change would continue over centuries even if "mitigation" were implemented. Malaysia also committed in the 10th Malaysia Plan to adopt a dual strategy in addressing climate change impacts: firstly, adaptation strategies to protect economic growth and development factors from the impact of climate change; and secondly, mitigation strategies to reduce of green house gases.

8.3.2 Necessity of Adaptation Measures

Before proposing of adaptation measures, flood risk by climate change at the target area is assessed on the condition without structural flood mitigation measures to reassure necessity of adaptation measures. To assess the flood risk based on the projection results on rainfall (see **Chapter 3**), flood inundation area and depth at Gemas town in 2025 is simulated by the flood simulation model (established in **Chapter 7**). The result of risk assessment would be utilized as basis to propose and to examine adaptation measures.

In addition, adaptation measures would be proposed taking care of uncertainly of impact. When planning adaptation measures, it is necessary to recognize uncertainty that always accompanies the projection of climate change impacts. The uncertainty is generally caused by 1) Limitation of meteorology, 2) Limitation of projection by GCMs, 3) Uncertainty of future GHG emission and 4) Opacity of effects of mitigation measures. In consideration of the uncertainly of impact, adaptation measures should be so flexible as to respond to the uncertainty of impacts of climate change.

Furthermore, based on basic direction of adaptation strategy summarized in the Report Volume 1 of the preparatory survey, the adaptation measures would be proposed.

8.3.3 Risk Assessment

As estimated in **Chapter 3**, 3days rainfall with ARI of 10-100 years is projected to increase by 10-30% at maximum by 2025 due to climate change. With this increase in rainfall, ARI of floods under current climate condition may decrease and severe rainfall event may occur more frequent. **Table 8.3.1** and **Figure 8.3.1** show how ARI may decrease and 3days rainfall increase in the future.

Table 8.3.1 Projected Relationship between ARI and 3days Rainfall Depth in 2025

3 days Rainfall(mm)		232.7	218.7	191.9	166.8	149.3	123.8
ARI (years)	Current Climate Condition	100	80	50	30	20	10
	2025 (Average increase)	71	56	35	21	14	7
	2025 (Maximum increase)	52	32	19	11	7	4

ARI (years)		100	80	50	30	20	10
3days Rainfall Depth (mm)	Current Climate Condition	232.7	218.7	191.9	166.8	149.3	123.8
	2025 (Average increase)	256.0 (10%)	240.6 (10%)	211.1 (10%)	183.5 (10%)	164.2 (10%)	136.2 (10%)
	2025 (Maximum increase)	279.2 (20%)	262.4 (20%)	230.3 (20%)	216.8 (30%)	194.1 (30%)	160.9 (30%)

Percentages the parenthesis indicate increase relative to current climate condition

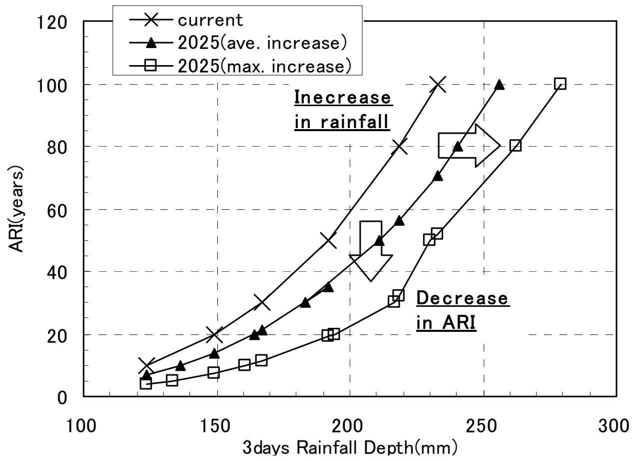


Figure 8.3.1 Projected Relationship between ARI and 3days Rainfall Depth in 2025

Hereinafter, preliminary flood risk assessment for respective zones in Gemas Town area as shown in **Figure 8.3.2** will be conducted under current and the future climate condition. Boundaries of 5zones were identified based on existing river, railroad and main road.

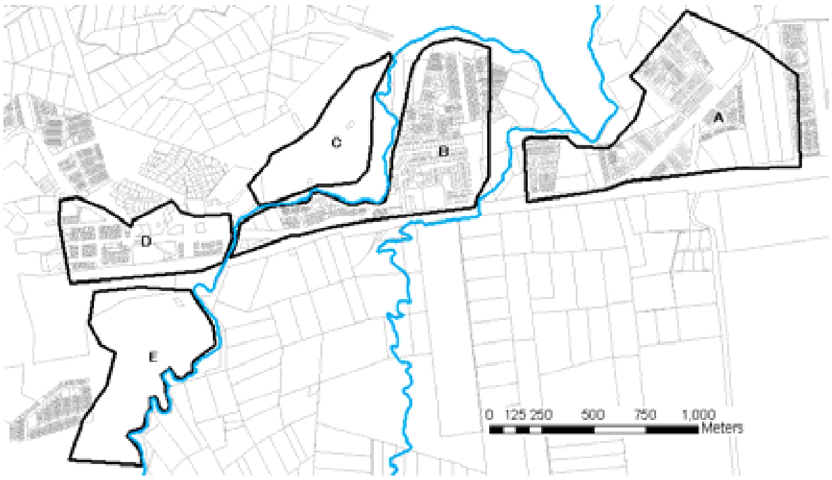


Figure 8.3.2 Zones for Risk Assessment

Characteristics of each zone are tabulated in **Table 8.3.2**.

Table 8.3.2 Characteristics of Each Zone

Zone	Area(km^2)	Number of houses*	Population**	Portion of one story houses***
A	0.62	355	1,658	0.7
B	0.44	391	1,826	0.8
C	0.20	114	532	0.9
D	0.25	188	878	0.0
E	0.33	122	570	1.0
Total	1.83	1,170	5,464	-

* Counted from ortho-image
** Population estimated assuming 4.67 person/ household
***Rough estimate based on field survey

(1) Flood Simulation

Flood simulation was conducted under current climate condition and condition under 10% and 20% increase in rainfall. **Figure 8.3.3** indicates Gemas River water level of flood with 50years ARI may rise by 20-50cm in 2025 due to increase in rainfall depth.

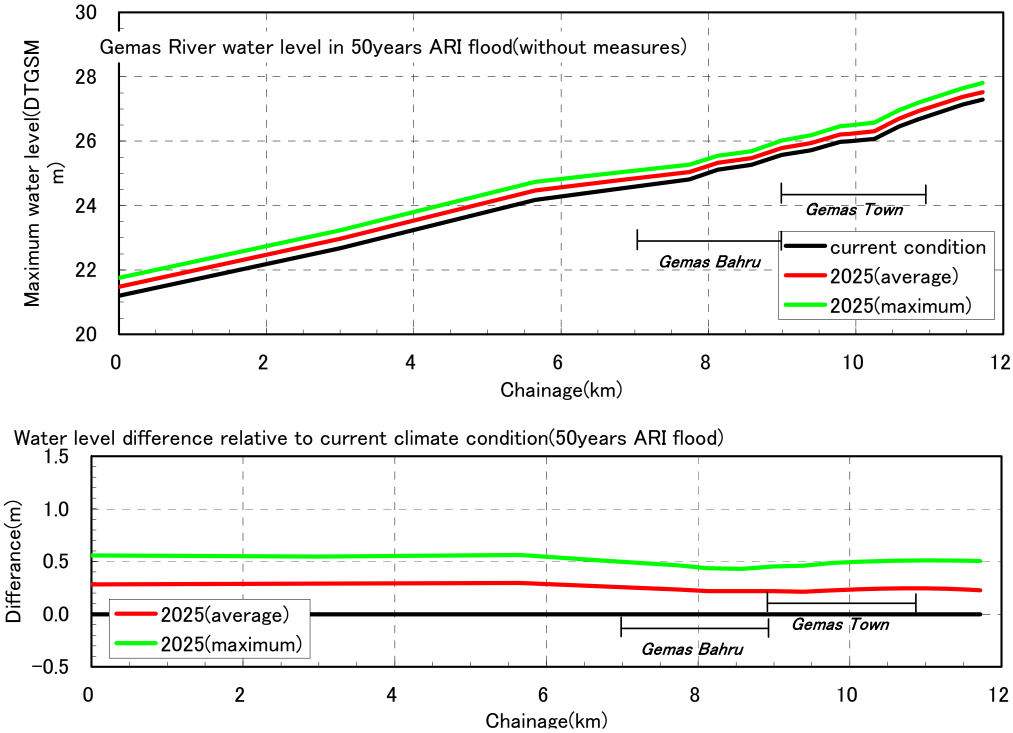


Figure 8.3.3 River Water Level of 50year ARI Flood under Current and 2025 Climate Condition (Upper Panel: River water level, Lower Panel: Water level difference relative to current climate condition)

Flooded area by 50years ARI flood is show in **Figure 8.3.4**.

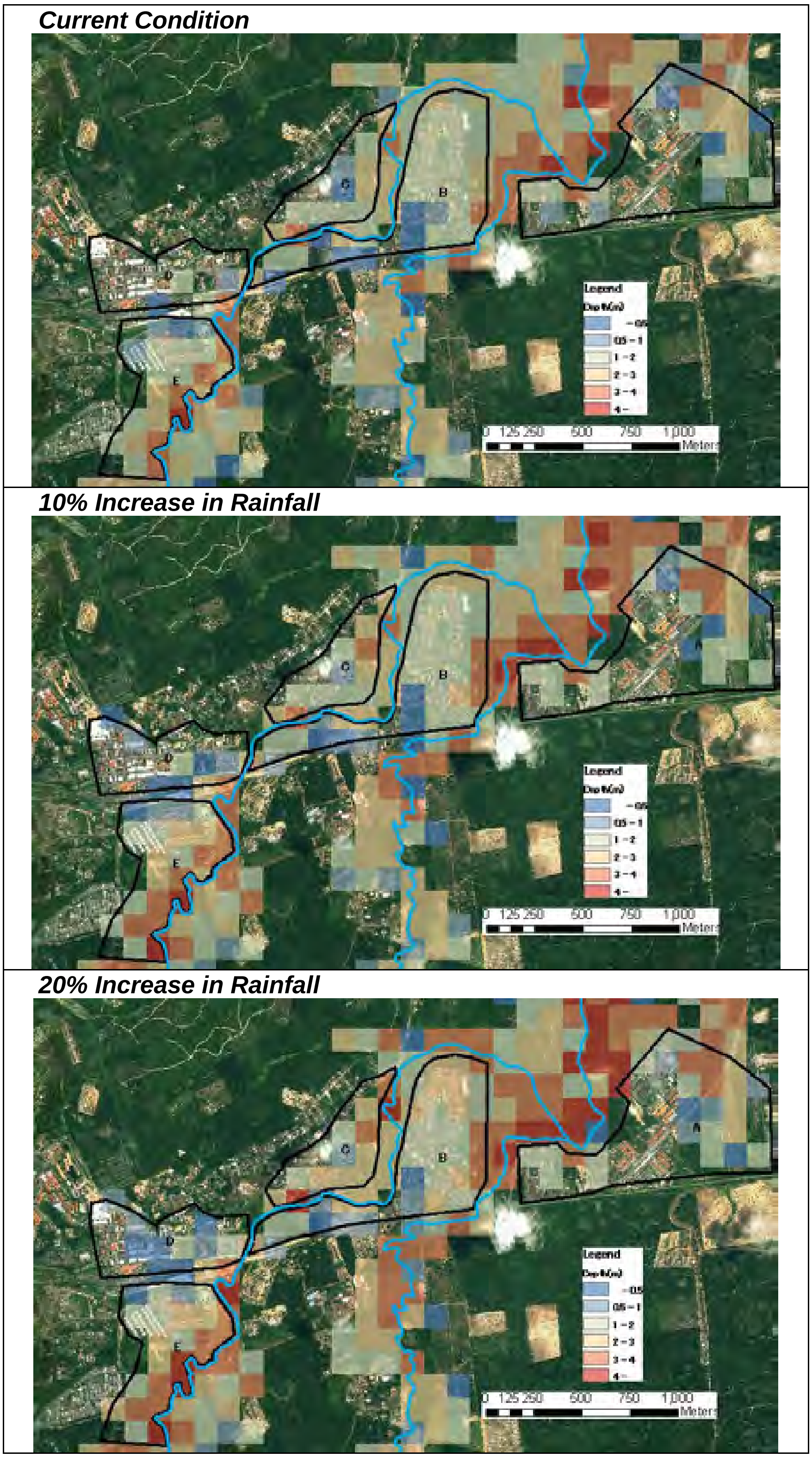


Figure 8.3.4 Flooded Area by 50years ARI Flood (Upper Panel: Current Condition, Middle Panel: 10% Increase in Rainfall, Lower Panel: 20% Increase in Rainfall)

(2) Risk Maps

Risk items which are assessed here are:

- Flooded area;
- Number of houses in flooded area;
- Potential number of people stranded; and
- Potential number of immediate fatalities.

Potential number of people stranded and immediate fatalities were estimated following method introduced by US Army Corp of Engineers[1]. Vertical zones are defined as **Figure 8.3.5** and the people in the *walk-away* zone are those who are able to evacuate without any rescue. It is assumed that all people exist in the highest habitable level of the building and those under the age of 65 years can climb to higher level such as roof or attic. Fatality rate of the people in *safe*, *compromised* and *chance* zone are 0.023%, 12% and 91.75% respectively. Number of stranded people is estimated by subtracting number of immediate fatalities from number of people who exist in area where water depth exceed two feet (61cm).

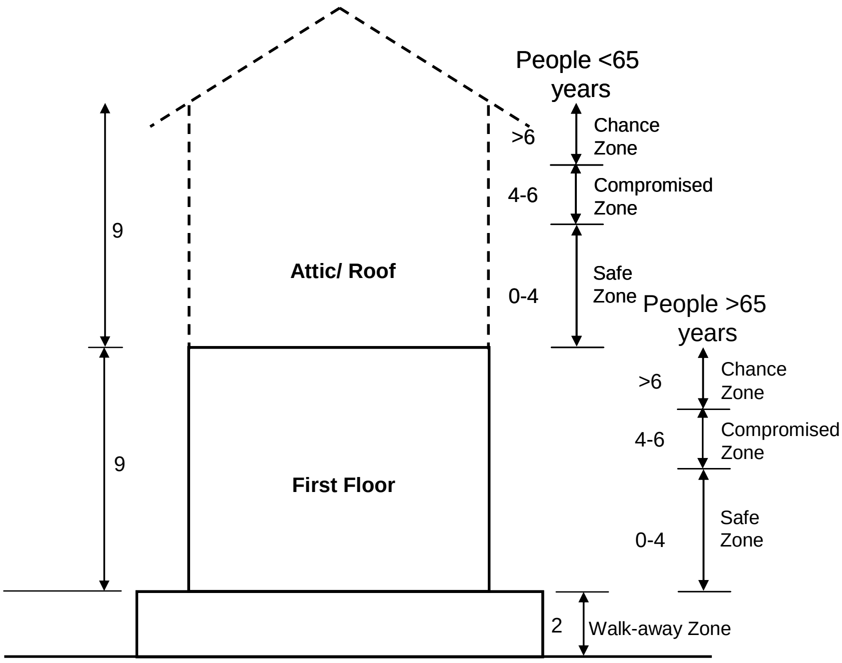


Figure 8.3.5 Building Submergence Criteria

Flooded area is defined here is area where water depth exceeding two feet (61cm).

Result of risk assessment for 50yreas ARI flood is tabulated in **Table 8.3.3** and risk maps are shown in **Figure 8.3.6**. It should be noted that "Stranded persons" and "Immediate fatalities" are estimation under absent of any prior evacuation, and household data used here are ones of current condition. The table indicates that life of 4 people are potentially at risk by 50years ARI flood under current climate condition if no structural and non-structural measures are to be put in place. This number could more than double by aggravated flood due to climate change. Potential number of stranded people who needs to be rescued is more than 2,600 and this may increase by 10-20% in the future. Figures in parenthesis are estimation under existence of prior evacuation at the rate of 80%. From these figures, it is also important to mention that prior evacuation could drastically reduce the number of people who are at

[1] "Estimating Loss of Life from Hurricane-Related Flooding in the Greater New Orleans Loss-of- Life Modeling Report" May 22, 2006

risk. Therefore, non-structural measures must be strengthened and emphasized to cope with future climate change and flood exceeding design level.

Table 8.3.3 Potential Flood Risk by 50years ARI Flood

	Zone	Flooded area(km^2)	Inundated houses	Stranded persons	Immediate fatalities
Current Climate Condition	A	0.23	55	257 (51)	0 (0)
	B	0.34	335	1,563 (312)	1 (0)
	C	0.13	51	238 (48)	0 (0)
	D	0.02	12	56 (11)	0 (0)
	E	0.27	115	534 (107)	3 (1)
	Total	0.99	568	2,647 (529)	4 (1)
10% Increase in Rainfall	A	0.25	83	387 (77)	0 (0)
	B	0.35	340	1,584 (317)	3 (1)
	C	0.13	51	237 (47)	1 (0)
	D	0.04	30	140 (28)	0 (0)
	E	0.28	121	558 (112)	7 (1)
	Total	1.05	625	2,907 (581)	11 (2)
20% Increase in Rainfall	A	0.29	105	490 (98)	1 (0)
	B	0.37	343	1,595 (319)	7 (1)
	C	0.15	75	349 (70)	2 (0)
	D	0.07	45	210 (42)	0 (0)
	E	0.28	121	553 (111)	13 (3)
	Total	1.16	689	3,196 (639)	23 (4)

Numbers in parenthesis are figures estimated assuming 80% for prior evacuation rate

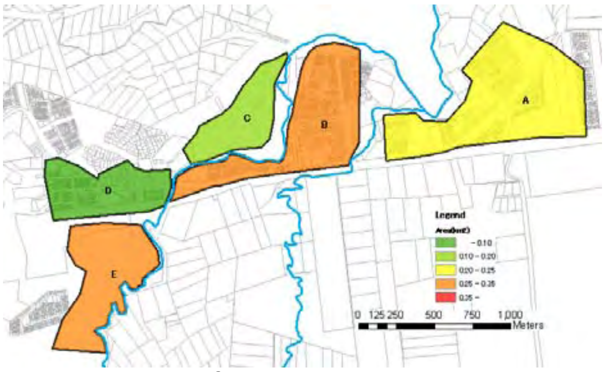
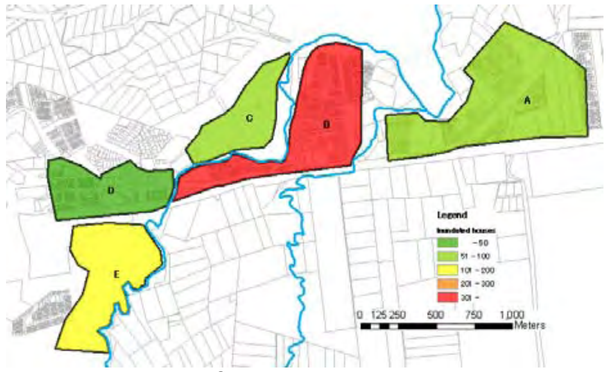
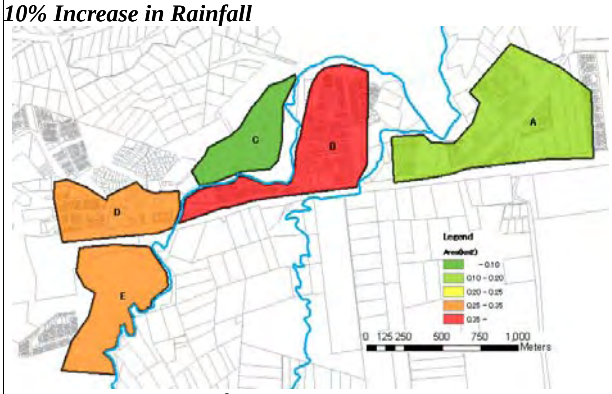
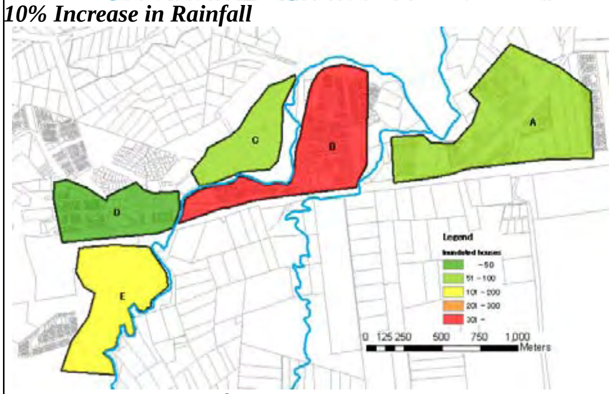
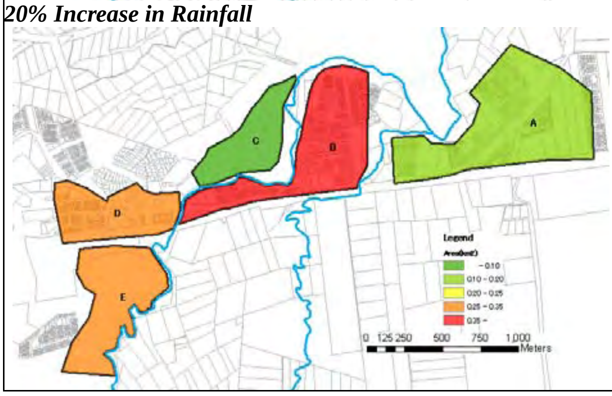
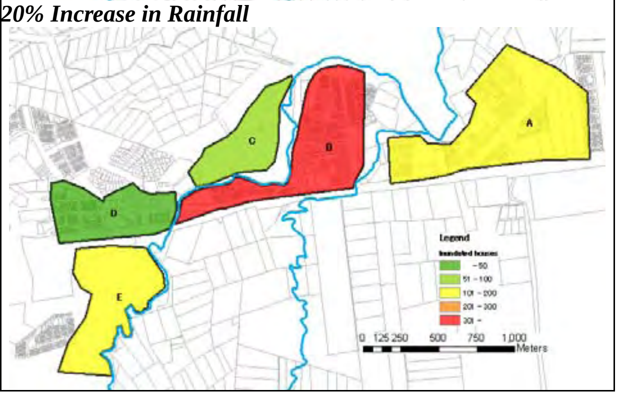
Flooded Area	Number of Inundated Houses
Current Condition 	*Current Condition* 
10% Increase in Rainfall 	*10% Increase in Rainfall* 
20% Increase in Rainfall 	*20% Increase in Rainfall* 

Figure 8.3.6(1) Flood Risk Maps of Gemas Town (Flooded Area and Number of Inundated Houses)

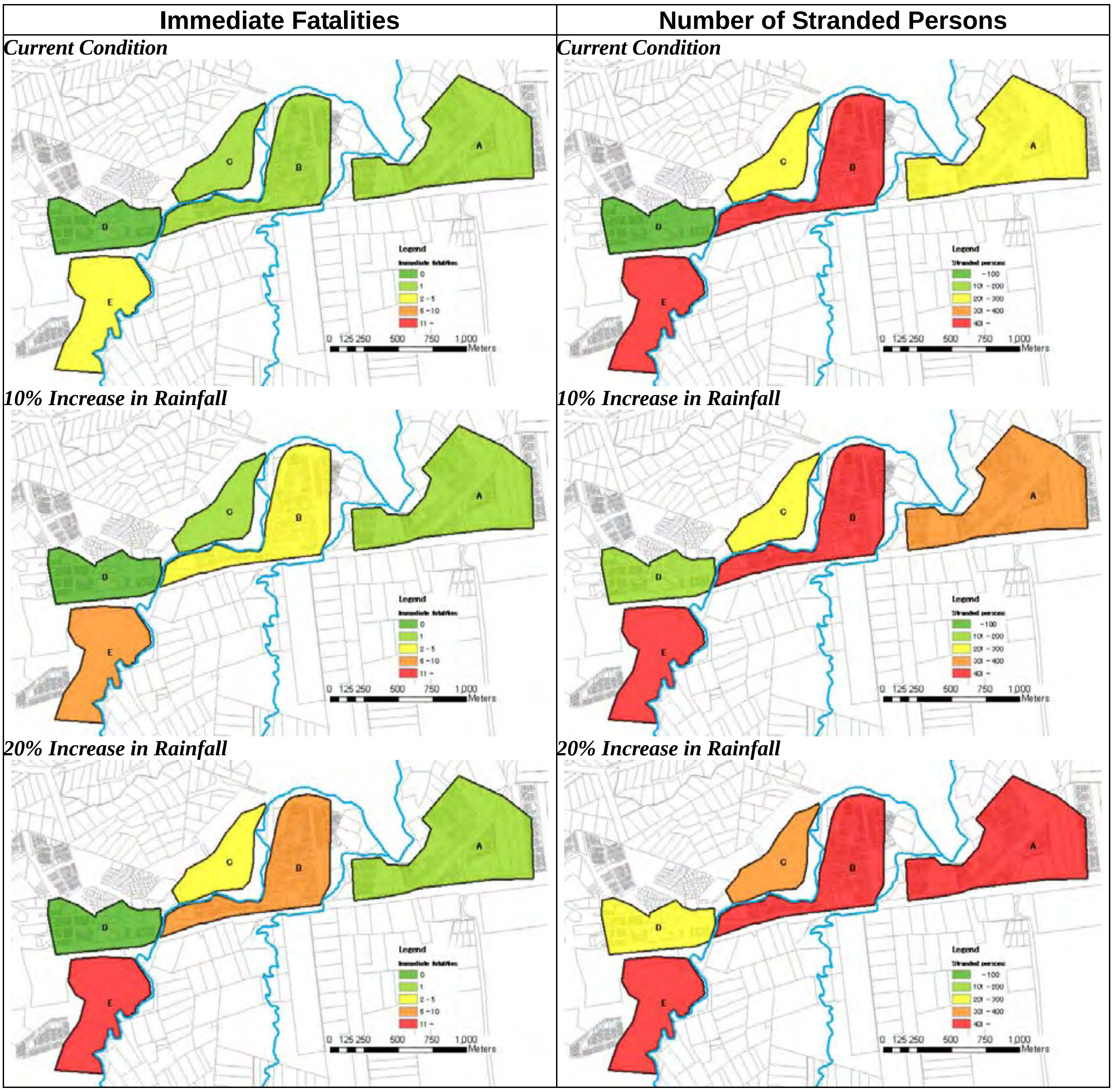


Figure 8.3.6(2) Flood Risk Maps of Gemas Town (Immediate Fatalities and Number of Stranded Persons)

(3) Impact on Stormwater Runoff

Stormwater Runoff could increase in the future due to climate change. As indicated in the **Table 8.3.4**, 10year ARI 1day rainfall depth could increase by 30% at maximum by 2025.

Table 8.3.4 Incremental Ratio of 1day Rainfall with ARI of 10years

ARI (years)	Period	RegHCM-PM	PRECIS	GCM Average	Average	Maximum	Proportion of models that show increase
10	2025	1.32	1.14	1.18	1.2	1.3	93%(14/15)
	2050	1.37	1.24	1.31	1.3	1.4	93%(14/15)
	2090	-	1.11	1.34	1.2	1.3	86%(12/14)

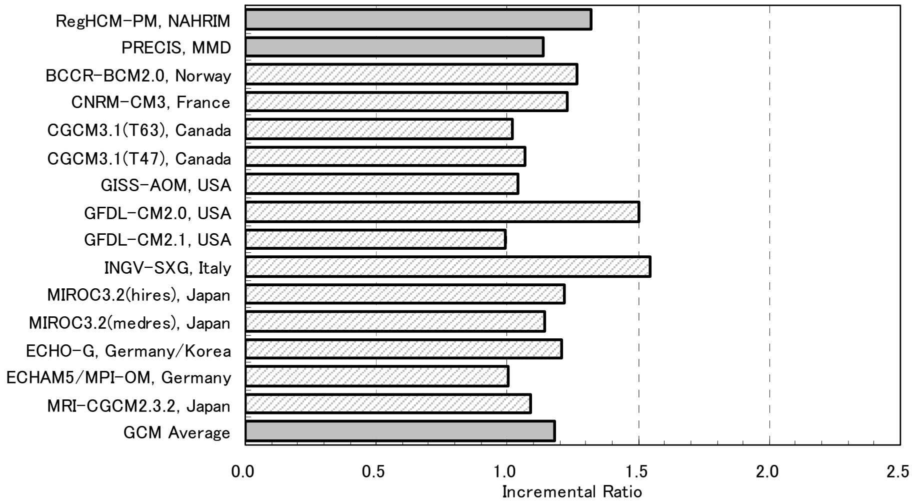


Figure 8.3.7 Incremental Ratio of 10years ARI 1 day Rainfall Depth (2025)

Possible increase in stormwater runoff was obtained using the runoff model developed in **Chapter7** (See the **7.6** for model detail). Peak discharge and total runoff volume of each sub-basin are tabulated in **Table 8.3.5** and the figures indicate approximately 30-50% increase in runoff volume.

Table 8.3.5 Peak Discharge and Runoff Volume under Future Climate Condition

Alternative 1						
Sub-basin	Peak discharge (m^3/s)			Runoff volume ($1,000m^3$)		
	Current	20% Increase	30% Increase	Current	20% Increase	30% Increase
11	11.2	14.9	16.7	26.7	36.5	41.5
12	3.5	4.4	4.8	5.4	7.1	8.0
13	11.6	14.8	16.3	38.8	51.6	58.2
Total (11+12+13)	21.7	28.6	31.9	70.9	95.3	107.7
2	15.0	19.0	20.9	31.1	41.4	46.6
3	9.3	11.8	13.1	26.9	35.8	40.3
4	14.4	19.5	22.0	80.7	110.3	125.3
5	5.3	6.9	7.7	12.7	16.9	19.1

Alternative 2							
Sub-basin		Peak discharge (m^3/s)			Runoff volume ($1,000m^3$)		
		Current	20% Increase	30% Increase	Current	20% Increase	30% Increase
11		12.3	16.1	17.9	45.0	60.7	68.8
12		28.0	37.3	41.9	248.5	335.5	339.9
13	131	11.2	14.9	16.7	26.7	36.5	41.5
	132	3.5	4.4	4.8	5.4	7.1	8.0
	133	11.6	14.8	16.3	38.8	51.6	58.2
	Total	21.7	28.6	31.9	70.9	95.3	107.7
14		15.0	19.0	20.9	31.1	41.4	46.6
15		5.7	7.5	8.3	20.9	28.3	32.0
16		8.3	10.5	11.6	24.9	33.1	37.3
Total (11+12+13+14+15+16)		64.0	84.6	97.2	441.4	594.3	672.3
2		11.3	15.1	16.8	28.8	39.1	44.3
3		14.4	19.5	22.0	80.7	110.3	125.3
4		5.3	6.9	7.7	12.7	16.9	19.1

**Volume under existence of proposed $1m^3/s$ drainage pump*

Table 8.3.6 shows comparison of proposed pond capacity and necessary runoff volume to be detained in order to avoid inundation in major residential areas. The figures in the table indicate proposed ponds are able to accommodate possible runoff increase as a result of climate change.

Table 8.3.6 Capacity of Proposed Ponds and Runoff Volume to be Detained

Sub-basin	Pond Capacity ($1,000m^3$)	Runoff Volume to be Detained ($1,000m^3$)		
		Current	20% Increase	30% Increase
11(131)*	64.6(below EL 32.0m)	26.7	36.5	41.5
12(132)*	11.8(below EL 31.0m)	5.4	7.1	8.0
13(133)*	35.8(below EL 25.5m)	22.5	30.5	34.7
2(14)*	50.5(below EL 24.0m)	31.1	41.4	46.6
3(16)*	57.3(below EL 23.0m)	26.9	35.8	40.3

**ID in alternative e2*

8.3.4 Proposed Adaptation Measures

As described in **8.3.3**, flood risk in the target area may increase in 2025 by the climate change impact if without countermeasures. Therefore, it is necessary to introduce adaptation measures to mitigate or prevent the increase of flood damage. The conceivable adaptation measures in the target area are explained as follows:

(1) Adaptation by Structural Measures

Adaptation measures are proposed considering a condition after implementation of optimum plan of structural measures. In the Gemas River basin, to protect the target area from river-overflow floods, it is necessary to take note of the condition that there are constrains to limit further installment of structural measures except construction of ring bunds as described in **8.1.2**. In this respect, range of choice in the target area is narrowed for selection of adaptation measures by structure, namely, enhancement of ring bunds and construction of on-site flood-retention pond. However, direct heightening of bunds corresponding to the water level rising by 25cm on average in 2025 can not be recognized as the best way, judging from the stakeholders opinion to keep beautification of landscape and not to increase flood risk in case of collapse of bunds.

Adaptations for these structural measures are as enumerated hereinafter.

(a) Enhancement of ring bunds

The adaptation by structural measures aims at strengthening the proposed dike body to prevent seepage failure due to increase of flood duration and to avoid collapse of dike by overtopping caused by future water rising of Gemas River. These measures are described in **Table 8.3.7**.

The selection of those measures should be carried out considering the stakeholders opinion, condition of river reserve area (woody, flat plain, existing of obstacles), hydrological condition, cost for construction and other constrains. The result of simple evaluation for these adaptation measures are also summarized in **Table 8.3.7**.

Table 8.3.7 Conceivable Adaptation Measures in Structural

Category	Contents	Evaluation	Remarks
Control of seepage to bund body (considering extension of flood duration)	Gentle slope of bunds	P	Proposed bunds: 1 to 3 slope
	Slope protection works of riverside slope by impermeable material	A	
	Enlargement bunds width	B	
	Installment of drainage structure at back slope toe	P	Proposed bunds contains
	Blanket works (Covering the high water bed)	B	
	Installment of sheet pile screen at riverside slope toe	B	
	Securement of river reserve area for future enlargement of bund	A	For enlargement of bunds
	Periodic inspection and monitoring	A	
Prevention of over-flow by water level rising	Heightening Dike	B	
	Installment of parapet at crown of dike	C	Not sustainable
	Securement of river reserve area	A	For enlargement of bunds

A: recommendable, B: recommendable but costly, P: including in proposed bunds, C: not recommendable

(b) Placement of Retention ponds

According to **8.3.3**, increased runoff volume of inland flood of Gemas town by the climate change impact can be absorbed by the proposed retarding basin. However, to keep this condition, the onsite flood retention pond should be constructed to cover retention capacity of land so as to offset the increment of inland flood runoff discharge induced by development of Gemas town and its surrounding area. As for the retention pond, land developers shall construct them in accordance with MASMA.

(2) Adaptation by Non-Structural Measures

At present, variety of non-structural measures and activities have been introduced and proposed in the target area as explained in **8.2**. All of those measures and activities have a capacity to be utilized as adaptation measures to the future climate change impact. Therefore, enhancement and enforcement of the existing and proposed measures are most effective way to adapt to climate change impact by non-structural measure. In addition, basin-wide land use control also necessary to prevent adverse alternation of discharge and sediment runoff in Gemas River Basin as mentioned in Volume 1 of this preparatory survey.

Under the circumstance, especially, 1) review of hazard map, 2) upgrading of evacuation system, are necessary as practical adaptation measures to follow further alteration by the impact in the target area. Those measures should be reviewed and modified when IPCC issued their Assessment Report. The contents of those adaptation measures are explained as follows:

(a) Revision of hazard map

According to the risk assessment, the inundation area in 2025 might increase 10 % to 20% compared with the present condition in the target area. This means that the hazard map, which is proposed in this study, should include the future condition in prospect of establishment of evacuation system. In addition, the hazard map should be reviewed and revised in accordance with the improvement of accuracy in RCM and the Assessment Repot by IPCC whenever it is made public. Responsible agencies are the designated agencies by the guideline “Standard Procedures on Flood Relief Mechanism in 2001” such as DID and related agencies.

(b) Upgrading of evacuation system

Based on the result of risk assessment, the immediate fatality in the target area might increase from 3 to 4 times compared with the present condition. In addition, the stranded people in 2025 might increase from 10 % to 20%. Thus, the flood evacuation system, which is totally managed by DMRC as a part of the flood risk management, should be modified whenever the hazard map is revised in consideration of the impact. The hazard map would contain important information for evacuees to grasp evacuation route, location of evacuation center, means of escape and evacuation time, etc. Those basic information should be reviewed corresponding to increase of flood area and depth by the impact.

In addition, to reduce such a flood risk, the responsible institutions identified by the guideline “Standard Procedures on Flood Relief Mechanism in 2001” should confirm preparedness conditions such as capacity of evacuation center, storage of basic necessities and facilities to maintain lifelines (helicopter landing spot, rescue boat and so on) in accordance with the guideline.

(3) Adaptation Measures around Target Area

In the outside of protected area by proposed structural measures, endorsement of land use control and further expansion of flood warning system is necessary to prevent increase of flood damage by climate change impact. However, in case of new construction of inhabitant area, the area with surrounding facilities such as road should be raised up to prevent inundation of the area and to secure lifeline considering the flood water level.

8.4 Implementation Plan

8.4.1 Project Cost

Project cost for Gemas Flood Mitigation project is shown in **Table 8.4.1**. The methodology to estimate the project costs are described in **Chapter 7**.

Table 8.4.1 Conceivable Adaptation Measures in Non-Structural

Item	Detail Item	Cost(RM million)	
		Alt. 1	Alt. 2
Total Construction Base Cost	Over all cost	42.10	57.55
	Direct cost	34.87	47.66
	Indirect cost	5.23	7.15
	Contingency	2.00	2.74
Total Compensation Cost		9.82	6.15
Construction + Land Acquisition Cost		51.92	77.37
Administration Cost		3.63	4.46
Enigineering Cost		6.74	9.21
Summary of the Projet Cost		62.29	72.45
O & M Cost / year		0.21	0.27

8.4.2 Implementation Schedule

(1) Basic Condition of Construction Schedule

The construction schedules will be prepared based on the working quantities for the each work item through the feasibility study. Each of the scheduled activities contains labors to be assigned and equipment resources considered with the most appropriate method to particular site conditions and requirement of the works.

Unit construction schedules for each work item has been analyzed and fixed in this section hereinafter.

(2) Work Quantity of Major Construction Work Items

The major construction work items are divided into following two (2) main work items: (1) Earth Works (i.e. Excavation and Embankment), (2) Concreting Works (Outlet structure and Pump station). The work items and their work volumes are as listed below:

Table 8.4.2 Major Construction Works for Gemas Site

Area	Item	Detail Item	Unit	Quantity
Gemas	Embankment		m^3	372,677
	RC Wall		m^3	1,060
	Regulation Pond-1	Excavation	m^3	12,630
		Outlet structure	nos	1
		Pump Station	nos	1
	Regulation Pond-2	Excavation	m^3	17,520
		Outlet structure	nos	1
	Regulation Pond-3	Excavation	m^3	4,000
		Outlet structure	nos	1
	Regulation Pond-4	Excavation	m^3	4,000
		Outlet structure	nos	1
	Regulation Pond-5	Excavation	m^3	52,500
		Outlet structure	nos	1
	Regulation Pond-6	Excavation	m^3	91,500
		Outlet structure	nos	1
	River Gate		nos	1
	Outlet Strructure		nos	2

(a) Climate Condition

The characteristic of climate at the project area is dominated by the rainy season from October to March and dry season for the rest of the months.

(b) Available Working Time

In determining the number of working days available for construction activities, the following factors are considered:

- Working day per week, Working hours per day
- Public Holiday
- Rainfall
- Type of Construction Activity

(i) Working Day per Week, Working Hours per Day

The normal workweek consisting of six (6) working days is adopted for developing all calendars in the sure track program. All construction schedules are based on an 8-hour per a working day.

(ii) Public Holiday

The following days are excluded from the working calendars as public holidays:

Table 8.4.3 Public Holiday

Holiday	Date
New Year's Day	January 1
Chinese new year	February 14-15
Prophet Muhammad's Burthday	February 26
Labor Day	May 1
Wesak Day	May 28
Birthday of DYMM SPB Yang Di-Pertuan Agong	June5
National Day	August 31
Hri Raya Puasa	September 2 days
Deepavali	November 5
Hari Raya Haji	November 17
Awal Muharam	December 5
Christmas Day	December 25
Sub-total of Public Holiday	14 days

In addition, an allowance is made for four (7) extra days on account of special events. Thus, total number of non-working days accounts for 21 days in this study.

(iii) Daily Rainfall and Annual Working Day

The time lost due to rainfall was based from the rainfall data and the number of rainy days. It is recognized that the effect of rain on different types of construction activities will vary.

Table 8.4.4 Average Rainy Days

Month	Average rainy days(2006-2009)
Jan	15
Feb	11
Mar	19
April	16
May	11
Jun	12
July	11
Aug	14
Sept	15
Oct	20
Nov	22
Dec	19
Total	185

In this Study, half of rainy days are assumed workable, accounting 92 days to be non working days.

Based on the previous construction plans under JICA or JBIC projects, the total number of working days available annually for different activities a established by incorporating all assessed time losses into the eight (8) items shown in the following table:

Table 8.4.5 Annual Working Day for Major Work Items

Work Item	Sunday	Public Holiday	Non workable Rainy at Weekday	Annual Working day
Embankment /Backfill	52	21	92	200
Concrete Work	52	21	92	200
Road Work	52	21	92	200

(c) Works Productivity

(i) Earth Works

The performance of the construction machine is assumed as listed in the following table taking the most suitable machine combination and the reuse of the excavation soil.

Based on the performance of the construction machine, the construction period of earthwork was estimated. Due to huge volume of earth work, critical paths are attributed to the construction schedule of earth work for the Project.

Table 8.4.6 Performance of Construction Machines in Earth Work

Item of Earth Work	Major Equipment	Performance Capacity	Remarks
Common Excavation	Bulldozer (32t)	146 m^3/hr	
Loading	Backhoe (1.0m^3)	104 m^3/hr	
Hauling	Dump Track (10t)	30.8 m^3/hr	Distance: 0.5 km.
	Dump Track (10t)	8.0 m^3/hr	Distance: 8 km.
	Dump Track (10t)	6.7 m^3/hr	Distance: 12 km.
Grading & Compaction	Bulldozer (21ft)	100 m^3/hr	Disposal site, Road work
Compaction of Embankment	Tamping Roller	55 m^3/hr	Road Work

(ii) Concrete Work and Revetment Work

Concrete works for pump station and outlet structure works are also main construction works other than earth work. The construction period of concrete of the small structure are estimated on the basis of the following assumptions:

Table 8.4.7 Performance of Main Construction Work

Item of Work	Daily Capacity	Remarks
Concrete Work	60 m^3/day/party	Depending on Concrete Pump

(3) Construction Schedule

In accordance with the program and strategy mentioned above, the entire construction period for the major work components of the optimum structural plan was assumed as shown in the following table.

Table 8.4.8 Construction Schedule for Gemas Flood Mitigation Project

Gemas

Working Item	unit	Qunatity
Mobilization & Preparaory Work	L.S	
(1)Embankment	m3	372,677
(2)RC Wall	m3	1,060
(3)Regulation Pond-1		
①Excavation	m3	12,630
②Outlet Structure	nos	1
③Pump Station	nos	1
(4)Regulation Pond-2		
①Excavation	m3	17,520
②Outlet Structure	nos	1
(5)Regulation Pond-3		
①Excavation	m3	4,000
②Outlet Structure	nos	1
(4)Regulation Pond-4		
①Excavation	m3	4,000
②Outlet Structure	nos	1
(5)Regulation Pond-5		
①Excavation	m3	52,500
②Outlet Structure	nos	1
(6)Regulation Pond-6		
①Excavation	m3	91,500
②Outlet Structure	nos	1
(7)River Gate	nos	1
(8)Drainage Structure		
(9)Site Clearance/Cleaning	L.S	
Demobilization	L.S	
Completion	L.S	☆

8.4.3 Organization for Project implementation

Many other related agencies, especially state government agencies will be involved in the implementation of the IFM plan. To facilitate the collaboration with these agencies, intervention of the proposed River Basin Committees as a coordination framework is very important.

(1) Structural Measure

Figure 8.4.1 is a proposed organization chart for the implementation of the IFM Plan. The Federal DID is the primary implementing agency, supported by the two State DIDs.

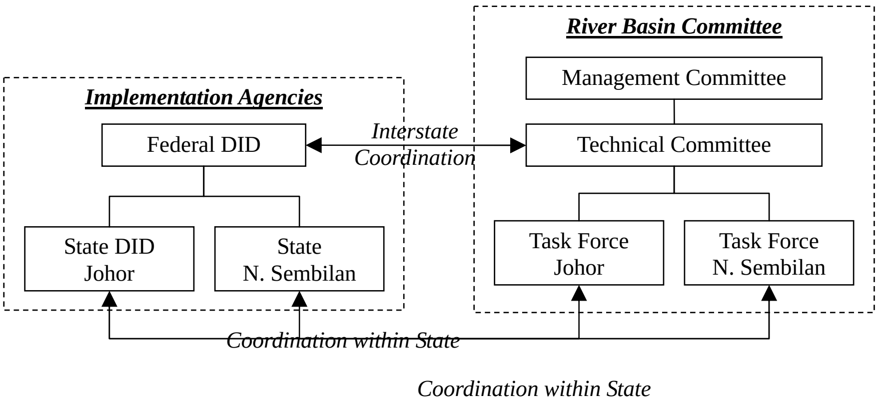


Figure 8.4.1 Organization for Implementation

Fortunately, each of the two states of Johor and Negeri Sembilan has its Task Force, which is chaired by UPENs and State DIDs and has members from the other state agencies and local authorities. The Task Forces are expected to make coordination with these agencies. In addition, interstate coordination will be conducted between Technical Committee and Federal DID.

The responsibilities for the implementation of the proposed projects in IFM plan are shown in **Table 8.4.9**.

Table 8.4.9 Responsibility on Implementation of Structural Measures

	Funding	Project Management		O&M
		Planning & Design	Construction Supervision	
MoF	X			
Federal DID	X	X	X	
State DID			X	X

- Funding Management: project funding is managed by Ministry of Finance and Federal DID. Ministry of Finance is a primary body to approve and monitor the use of project budget. As a implementation agency, Federal DID is responsible for the management of overall project budget during the project implementation.

- Project Management:
  - Planning and Design: planning and design of the proposed structural facilities are carried out under the responsibility of Federal DID based on the design criteria. For the flood management project, Flood Management Division will be a main implementation agency for IFM projects.
  - Construction Supervision: construction supervision consists of quality assurance and quality control, construction inspection and supervision, time control, cost control, health, safety and environmental management, and so on. The federal funded projects will be supervised by Federal DID, on the other hand, state funded projects will be supervised by State DID.

- Operation and Maintenance (O&M): the O&M is conducted by State and District DIDs. Flood control facilities such as pump stations, gate, etc. proposed as structural measures in IFM plan shall be operated properly referring to the proposed manuals as non-structural measures. According to DID Manual, the planned maintenance works are categorized as follows.
  - Preventive maintenance: to carry out at pre-determined intervals or corresponding to the prescribed criteria, all intended to reduce the probability of failure
  - Corrective maintenance: work is done knowing a fault has occurred to restore mechanically or electrically an installation to normal operation.
  - Immediate maintenance: this is necessitated by unforeseen breakdown or damage and the need to put it right immediately
  - Opportunity maintenance: work is done as and when possible within the limits of operational demand
  - Design-out maintenance: this is performed when other forms of maintenance are inappropriate.
  - Condition-based maintenance: this is work initiated by trends highlighted by routine or continuous monitoring of the condition of the mechanical/electrical installation, such as general performance of specific parameters.
  - Run-to-failure: this requires that the mechanical/electrical installation be safely and effectively run to destruction without serious loss of their services.

(2) Non-Structural Measure

As for the implementation organization of non-structural measures, the following agencies will be main implementation agencies.

Table 8.4.10 Responsibility on Implementation of Non-Structural Measures

Strategies	Measures	Implementation Agency
Capacity Development regarding Flood Management		District DMRC
Land Use Management	Regulation of Land Use for Farmland and Forest Areas	TCPD (Federal), Land Office (State)
	Encouraging Construction of Raising Houses	Local Authority
	Utilization of Flood Hazard Map on Regulation of Land Use	DID (Federal & State) TCPD (Federal)
Community-Based Flood Management	Upgrading Flood Forecasting & Warning System	DID (State)
	Enhancement of Flood Evacuation System in Community Level	District DMRC
	Flood Fighting	District DMRC
Strengthen Monitoring System	Upgrading of Inforbanjir System	DID (Federal)
	Upgrading of Communication System	DID (Federal)
Preparation of Hazard Map and Guidelines/ Manuals	Guideline for Monitoring and Inspection of Bunds	DID (Federal)
	Preparation & Utilization of Flood Hazard Maps	DID (Federal & State)
	Operation Manuals for Flood Control Facility	DID (Federal)
	Guideline for Flood Fighting Activities, Climate Change, etc.	DID (Federal)

- Capacity Development regarding Flood Management:
  - Some of the following proposed non-structural measures regarding the flood management are new challenging activities in Malaysia. Especially, preparation and utilization of flood hazard maps and implementation of community-based flood management are currently started, but so far have not been well organized. Therefore, for the acceleration of these activities, the capacity building programs shall be planned and conducted by District Disaster Management and Relief Committee (DMRC) involving the various flood related agencies.
- Land Use Management:
  - In accordance with land use regulation, Town and Country Planning Department (TCPD) has jurisdiction of land use planning in the form of national physical plan, structure plan and local plan, and Land Office is responsible to regulate the land use in each district. As proposed in the non-structural measures, land use shall be regulated in consideration with flood management.
  - In order to avoid the inundation of residence houses, it is recommended to raise the house for the resistance against flood damages. Local authorities has jurisdiction for the promotion of flood resistant houses.
  - The prepared flood hazard maps shall be utilized and disseminated for the effective land regulation driven by DID in cooperation with TCPD.
- Community-Based Flood Management:
  - The existing flood forecasting and warning system shall be upgraded and well maintained under the jurisdiction of State DID.

- Flood evacuation system contains a wide variety of activities to be carried out by several related agencies. Therefore, District DMRC will be a main body for the implementation of planned programs.
- Since the flood control facilities including bunds, pump stations, gage, etc. are proposed to be newly constructed in the targeted areas, the flood fighting activities shall be planned and conducted.
- Federal DID needs to develop and upgrade the flood information dissemination tool named "Infobanjir" system.
- In order to ensure the smooth information flow among the responsible agencies on flood responses, the communication tools shall be upgraded by Federal DID.

- Preparation of Guidelines/Manuals:
  - The preparation of flood hazard maps will be conducted by Federal DID, and the utilization and dissemination shall be promoted by State DID together with other relevant state agencies.
  - Before, during and after the flood disaster occurrence, the conditions and damages of bunds shall be inspected to secure the function of the bunds. Therefore, the manuals on the monitoring and inspection of bunds shall be formulated by Federal DID.
  - In order to minimize the flood disaster damages, the flood control facilities need to be operated based on the defined operational procedures. Thus, the operational manuals including the operational procedures shall be prepared by Federal DID.
  - For the smooth and effective flood fighting activities, guidelines for the planning, developing and implementing the flood fighting activities shall be formulated by Federal DID and disseminated to the relevant agencies through DMRCs.

8.4.4 Economic Evaluation and Financial Considerations

(1) Economic Evaluation

(a) Projection of Population and Number of Houses/Shops

The population of the target area in 2025 was projected by applying the weighted average of projected growth rates in Gemas Sub-district of Johor State and Gemas Sub-district of Negeri Sembilan State. The number of houses was estimated applying an average family size of the sub-districts. The number of shops was estimated using the average number of shops to households in the target area, which was obtained in the asset survey. Projection results are as follows:

Table 8.4.11 Projection of Population and Number of Houses/Shops of Gemas

	2009	2025
Population	12,600	17,700
Houses	2,700	3,800
Shops	900	1,300

Increased houses were distributed in the housing areas which was designated by the land use plan so that the population density does not exceeds the highest figure in 2009 and they were not allocated where the retarding ponds are planned.

(b) Economic Costs

Economic costs were estimated by applying the standard conversion factor to that in market prices. They are shown in the following Tables.

Table 8.4.12 Economic Cost (Alternative 1)

(Unit: RM '000)

Item	Economic Cost
Construction	
(a) Flood Protection Bund	14,935
(b) Flood Wall	3,590
(c) Ponds	8,809
(d) River Gate	8,452
Total	35,787
Land Acquisition Cost	8,344
Administration Cost	3,089
Engineering Services	5,726
Total Initial Cost	52,945
O&M (yearly)	179

Table 8.4.13 Economic Cost (Alternative 2)

(Unit: RM '000)

Item	Economic Cost
Construction	
(a) Flood Protection Bund	12,258
(b) Flood Wall	379
(c) Excavation Works	8,991
(d) Pumping Stations	3,750
(e) River Gate	22,786
(f) Sluice Gate	749
Total	48,914
Land Acquisition Cost	5,228
Administration Cost	3,790
Engineering Services	7,826
Total Initial Cost	65,758
O&M (yearly)	245

(c) Expected Annual Average of Damage Reduction

Annual flow of benefit was calculated in the form of expected annual average of damage reduction (EAADR). EAADRs were calculated for 2009 and 2025. Those between the two years were estimated by interpolation method and those after 2025 were flattened. Calculation results in 20025 are shown below:

Table 8.4.14 Expected Annual Average of Damage Reduction in 2025 (Alternative 1 & 2)

(Unit: RM)

Return Period	Flood Damage		Damage Reduction	Average Damage Reduction	Expectation	Benefit
	Without the Project	With the Project				
1	0	0	0			
				4,560,616	0.500	2,280,308
2	31,713,882	22,592,650	9,121,232			
				12,392,725	0.300	3,717,818
5	49,021,976	33,357,757	15,664,218			
				19,093,722	0.100	1,909,372
10	60,331,185	37,807,960	22,523,225			
				28,061,516	0.050	1,403,076
20	87,964,889	54,365,082	33,599,807			
				37,170,404	0.017	619,507
30	103,961,832	63,220,831	40,741,000			
				45,808,642	0.013	610,782
50	119,395,926	68,519,643	50,876,283			
				25,438,142	0.010	254,381
100	145,400,702	145,400,702	0			
Annual Average Benefit	10,795,244					

(d) Summary of Costs and Benefits

Calculated costs and benefits are summarized in the following tables, which are the basis of the EIRR, NPV and B/C calculation.

Table 8.4.15 Summary of Costs and Benefits in Economic Prices (Alternative 1)

(Unit: RM '000)

Year	Cost								Benefit	Net Benefit
	Const.	Land	Admin.	E/S	O&M	Replace	Salvage	Total		
2012				1,789				1,789	0	-1,789
2013	11,929	8,344	1,419	1,312				23,004	0	-23,004
2014	11,929		835	1,312				14,076	0	-14,076
2015	11,929		835	1,312				14,076	0	-14,076
2016					179			179	3,673	3,494
....	....	....	....	....	....	....	....	....	....	....
2064					179			179	9,176	8,997
2065					179		-5,777	-5,598	9,176	14,774
Total	35,787	8,344	3,089	5,726	8,947	23,107	-5,777	79,222	427,603	348,380

Table 8.4.16 Summary of Costs and Benefits in Economic Prices (Alternative 2)

(Unit: RM '000)

Year	Cost								Benefit	Net Benefit
	Const.	Land	Admin.	E/S	O&M	Replace	Salvage	Total		
2012				2,446				2,446	0	-2,446
2013	16,305	5,228	1,507	1,794				24,833	0	-24,833
2014	16,305		1,141	1,794				19,240	0	-19,240
2015	16,305		1,141	1,794				19,240	0	-19,240
2016					245			245	3,673	3,428
....	....	....	....	....	....	....	....	....	....	....
2064					245			245	9,176	8,931
2065					245		-12,355	-12,110	9,176	21,286
Total	48,914	5,228	3,790	7,826	12,229	49,420	-12,355	115,051	427,603	312,551

(e) EIRR, NPV and B/C of the Project, and their Sensitivity Analysis

Calculation results of EIRR, NPV and B/C of the project are shown below. In addition their sensitivity was checked either by increasing the costs or by decreasing the benefit from the base case.

Table 8.4.17 EIRR, B/C and NPV of the Project, and their Sensitivity (Alternative 1)

	Base Case	Cost 5% Up	Cost 10% Up	Benefit 5% Down	Benefit 10% Down
EIRR (%)	10.71	10.29	9.90	10.27	9.81
B/C	1.09	1.03	0.99	1.03	0.98
NPV (RM '000)	3,755	1,587	-580	1,400	-956

Note: 10% discount rate is applied to NPV and B/C calculations.

Table 8.4.18 EIRR, B/C and NPV of the Project, and their Sensitivity (Alternative 2)

	Base Case	Cost 5% Up	Cost 10% Up	Benefit 5% Down	Benefit 10% Down
EIRR (%)	8.72	8.32	7.95	8.30	7.87
B/C	0.86	0.82	0.78	0.82	0.77
NPV (RM '000)	-7,700	-10,441	-13,181	-10,056	-12,441

Note: 10% discount rate is applied to NPV and B/C calculations.

(f) Evaluation

[For Alternative 1] Although EIRR, B/C and NPV show that the project is not necessarily feasible when cost increases by 10% or benefit decreases by 10%, their negative impacts are limited because EIRRs, for example, are still more than 9.8%. In addition, it should be reminded that this calculation does not include the effects of the project, which are difficult to quantify in monetary terms. Considering these factors, the proposed project is deemed feasible, although in a certain extent.

[For Alternative 2] EIRR, B/C and NPV do not reach the level of "feasible" even for the base case. It should also be reminded that this calculation does not include the effects of the project, which are difficult to quantify in monetary terms. Considering these factors, the proposed project may be deemed feasible.

Above-mentioned positive effects of the project, which are difficult to quantify in monetary terms, can be itemized as follows.

- Contribution to the future economic development of the area as the reduction of concern about business suspension/damage
- Contribution to the increase of employment for the local people by construction works
- Improvement of sanitary conditions due to the mitigation of inundation which is one of the major reasons of water borne diseases
- Improvement of landscape, which contributes to the amenity of the area
- Improvement of awareness of the local people about floods and other disasters

(2) Financial Consideration

Here is to be examined the impact of the finance for the project (Alternative 1) on the fiscal conditions of the Federal and local governments. It is assumed that the investment cost (construction and engineering, excluding taxes) is financed by a soft loan of Japanese ODA scheme. Cost items of the project are shown below.

Table 8.4.19 Cost Items of Project (Alternative 1)

	Value (RM '000)	Initial Project Cost	Covered by Loan
Construction	42,102	√	√ (Excl. taxes)
Engineering	6,736	√	√ (Excl. taxes)
Land Acquisition	9,816	√	
Administration	3,634	√	
O&M (yearly)	211		

Terms and conditions of the soft loan are assumed as follows.

Table 8.4.20 Assumed Terms and Conditions of Loan

	Interest Rate (%)	Loan Period (year)	Grace Period (year)
Construction	1.70	25	7
Engineering	0.01	25	7

Note: It should be noted that the provision as well as the terms and conditions of loan for the proposed project have neither been officially decided nor announced by JICA. In addition, all the project costs of construction and engineering services are not necessarily covered by the Japanese ODA loan.

Taxes are assumed to be 10% of the price here. Repayment and interest payment of the loan were calculated as follows:

Table 8.4.21 Repayment and Interest Payment of Loan (Alternative 1)

(Unit: RM '000)

Year	Loan Disburse		Repayment		Interest Payment		Payment Total
	Const.	E/S	Const.	E/S	Const.	E/S	
2012		1,895					0
2013	12,631	1,389				0.19	0.19
2014	12,631	1,389			215	0.33	215.05
2015	12,631	1,389			429	0.47	429.91
2016					644	0.61	644.77
2017					644	0.61	644.77
2018					644	0.61	644.77
2019				105	644	0.61	750.02
2020			702	182	644	0.60	1,528.90
2021			1,403	260	632	0.58	2,295.84
2022			2,105	337	608	0.55	3,050.85
2023			2,105	337	573	0.52	3,015.02
2024			2,105	337	537	0.48	2,979.20
2025			2,105	337	501	0.45	2,943.38
2026			2,105	337	465	0.42	2,907.56
2027			2,105	337	429	0.38	2,871.74
2028			2,105	337	394	0.35	2,835.92
2029			2,105	337	358	0.32	2,800.10
2030			2,105	337	322	0.28	2,764.28
2031			2,105	337	286	0.25	2,728.46
2032			2,105	337	251	0.21	2,692.64
2033			2,105	337	215	0.18	2,656.82
2034			2,105	337	179	0.15	2,621.00
2035			2,105	337	143	0.11	2,585.18
2036			2,105	337	107	0.08	2,549.36
2037			2,105	232	72	0.05	2,408.28
2038			1,403	154	36	0.02	1,593.59
2039			702	77	12	0.01	790.82
Total	37,892	6,063	37,892	6,063	9,985	9.40	53,948.44

The maximum payment for the loan is RM 3.05 million in 2022. On the other hand, development expenditure for economic services and social services of the Federal Government in last five years are shown in the table below. Combined population share of Johor and Negeri Sembilan States amounts to 15.5% of Malaysia, and 15.5% of the average development expenditure for economic services and social services is RM 2,213 million in a year. Thus, RM 3.05 million is equivalent to only 0.14% of RM 2,213 million, which deems to have little impact on the financial condition.

Table 8.4.22 Federal Development Expenditure for Economic Services and Social Services

(Unit: RM Million)

Development Expenditure	2004	2005	2006	2007	2008	Average
Economic	2,881	2,482	3,999	3,842	4,184	3,478
Social	10,260	7,450	9,525	12,893	13,717	10,769
Total	13,141	9,932	13,524	16,735	17,901	14,247

Source: National Bank of Malaysia (NBM)

O&M budget of Segamat and Tampin District DIDs are shown in the table below. Yearly O&M cost for the project amounts to RM 211 thousand, which is equivalent to 11% of the total of the two District DID O&M budgets. Federal and State Governments will be required to consider the support District DIDs if the project is implemented.

Table 8.4.23 O&M Budget of Segamat and Tampin Districts' DIDs

(Unit: RM '000)

District	2006	2007	2008	2009	Average
Segamat	1,660	1,735	2,184	119	1,424
Tampin	525	490	571	521	527
Total	2,185	2,225	2,755	640	1,951

Source: Department of Irrigation and Drainage

8.5 Environmental and Social Condition

8.5.1 Introduction

Environmental law (Environmental Quality Act 1974) was enacted as an environmental-related law of Malaysia in 1974. Under this law, the regulation and orders of 33 environmental relations are enacted. Of these, in the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, a project (Activities), of which a duty of enforcement of EIA and preparation of an EIA report is imposed, is mentioned as "Prescribed Activities".

In accordance with Environmental Quality Act, proposed projects of this study do not come under the “Prescribed Activities” mentioned above. Therefore, it is not necessary to submit an EIA report for the projects. However, for the implementation of projects, a duty of planning and implementation of EMP (Environmental Management Plan) is imposed by DOE.

On the other hand, DID has a manual which consists of 11 volumes. DID stipulates in the volume No. 11 of the manual that construction contractors are required an implementation of environmental management, and occupational safety and health management during construction period in accordance with the Environmental Quality Act and the Occupational Safety and Health Act 1994.

From above situation, JICA Study Team carried out an Initial Environmental Examination (hereinafter referred to as IEE) in order to predict and evaluate the impact on social and natural environment around proposed project area caused by the implementation of proposed projects, and to obtain the basic data for environmental management plan which the Malaysia side will establish for project implementation.

Through this study, three (3) alternatives are proposed as a flood mitigation structural measure. IEE study for three (3) alternatives shown in the **Table 8.5.1** has carried out.

Table 8.5.1 Alternatives of Structural Measure for the Gemas Flood Mitigation Project

Project	Project Components
Alternative-1	Bund, Pump Station, Gate, Detention Pond
Alternative-2	Diversion Channel, Bund, Gate
Alternative-3	No Measure

8.5.2 Initial Environmental Evaluation (IEE)

(1) Objectives of IEE

The IEE study will include the following items of work:

- To identify the environmental elements, which would receive the adverse impacts by the implementation of the proposed projects;
- To assess the impacts on the environmental elements;

- To identify possible mitigation measures of the impacts where they exceed the allowable limit. Then, the optimum monitoring plans for the impact are identified; and
- To perform the category classification in accordance with the JICA guideline.

(2) Survey Items/ Contents of IEE Level Study

Survey items or contents of IEE are shown below.

(a) Arrangement of Existing Environmental Conditions of the Project Area.

The existing environmental conditions are adopted as the baseline for the environmental assessment of the proposed projects. The conditions is finalized by reviewing the other previous report, collecting necessary data, and interviewing with the concerned people/ organizations.

(b) Identification of Major Environmental items thorough Field Survey

The environmental elements to be assessed are identified by the two-dimensional matrix method. Those environmental elements cover three categorized elements of social and natural environments and public hazard, which are further subdivided into several elements, respectively, as enumerated below. The field survey was conducted to confirm those eenvironmental Elements.

- Social Environmental Element includes: (a) involuntary resettlement and land acquisition; (b) impact on livelihood and local economy; (c) change in land use; (d) social institution; (e) social service and infrastructure; (f) poverty, indigenous people and ethnic minority; (g) uneven distributed losses and benefits; (h) historical and archaeological site; (i) regional conflicts of interests; (j) water use; and (k) fishery.

- Natural Environmental Element includes: (a) topography and geology; (b) groundwater; (c) soil erosion; (d) river flow regime; (e) seashore; (f) fauna, flora and ecological diversity; (g) landscape; and (h) global warming.

- Public Hazardous Element includes: (a) air pollution; (b) water pollution; (c) soil pollution; (d) solid waste; (e) noise and vibration; (f) ground subsidence; and (j) odor.

The matrix is prepared for both construction and operation phases. The adverse impacts are evaluated in terms of: (1) magnitude/extent; (2) occurrence probability; and (3) duration. These are then scored from A to C; namely, (A) stands for large impact, (B) for medium impact, (C) for uncertain, and No Score for no or negligible impact. In this study, the following criteria are applied for A and B.

A: Magnitude/extent of the impact is large and it continues for a long time or it will not recover.

B: All impacts other than A. Even if the magnitude/extent of the impact is large, the impact is categorized as B when it is temporary and recovery is made in the near future.

(3) Result of IEE

(a) Existing Environmental Condition

Major existing environmental condition in the project area is described in **Table 8.5.2**.

Table 8.5.2 Major Environmental Setting in the Project Area (Gemas)

Items	Description	
Project Name	Flood Mitigation Measure	
Social Environment	Local Residents	Population of the Gemas area, population of Mukim is 13,634, population of city area is 2,306 in Gemas in Negeri Sembilan Stare, and 560 in Gemas Bahru in Johor State (Population and housing census of Malaysia 2000) Ethnic group in the Gemas area is mainly composed of Malays, Chinese and Indians. The population of the Malaysia is the largest in the Gemas in Negeri Sembilan State and Chinese in the Gemas Bahru in Johor State.
	Land Use	- Almost of the project area is composed of built-up area and agricultural land distributes partially along river. - On the other hand, planned diversion channel area is mainly composed of palm tree and rubber tree plantation.
	Economy / Transportation	- Malaysian National Railway KTM has the following two main lines. One is a railroad that starts from Kota Bharu, which located at east coast of Malaysia near border of Thailand, and it goes to southward in the inland of Malaysia. The other is a railroad that passes through the border of Thailand, then passes Kuala Lumpur and it goes to southward. These railroads join at the Gemas station. Then it passes through Johor Baharu where located at the southernmost in Malaysia, and reach to Singapore. - Total amount of passenger of the Gemas station was 76,967 in 2009. This amount was larger than 58,990 the total amount of passenger of the Gemas station. Moreover, total amount of revenue of the Gemas station was RM 1,483,411 in 2009. This amount was larger than RM 823,735 the total amount of revenue of the Gemas station. - The national road No.1 also passes through the Gemas town. From these, it is though that Gemas is a key point of rail and road transport.
Natural Environment	Topography/ Geology	- Topography around the Gemas Area is composed of flat land along the existing river. Left side of the Gemas River, 3 or 4 steps of flat lands distribute. Right side of the Gemas River, 1 or 2 steps of flat lands distribute. Residential areas are built on these flat planes. - Altitude of the highest flat plane in the project area is around 33m. - Geology around Gemas area is consisted of sedimentary rocks and metamorphic rocks which were formed in the Triassic period in the Mesozoic era. - Generally, ground surface of flat lands are weathered and becomes clayey soil.
	Surroundings of the River	Surroundings of the river around planned bund area generally flatlands are distributing.
	Valuable fauna and flora	There is no protected area, reserved area and national park in and around the proposed project area. From the result of IEE, there is no endangered and endemic fauna and flora in and around the proposed project area.
Pollution	Situation of occurrence of Air pollution, Water Contamination, Noise	- There is no source of the outbreak of air pollution. - The cause of existing water pollution is thought to be a sediment discharge due to soil erosion. Cause of the soil erosion is thought to be a slope failure along the river. Deference in elevation between river bed and surface of the lowest flat land is around 1m almost of the project area. - Main national highway passes through the Gemas town area, and it has become a source of the noise of a car etc. However, there is no source where generates remarkable loud noise.
	Response to above situation	There is no trace currently carried out at all in present condition.
Items deserving special mention	In the Gemas area, there are few existing data about existing flood. However, according to the flood report in 2006, by the flood in 2006, the damage caused by the inundation for one to two weeks occurred in the Gemas town. For the stabilized economical maintenance and development, an immediate countermeasure against a flood is required.	

(b) Scoping Results

Scoping results based on the IEE are shown in **Table 8.5.3, ,** which shows almost the same evaluation levels (Rating) for both Alternative-1 and Alternative-2 in each evaluation element.

Table 8.5.3 Scoping Results

	Impact	Rating		a Brief Description
		Alt-1	Alt-2	
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.				
1	Process of EIA and Environmental related approval	-	-	For this project, EIA is not required in accordance with Malaysian Law. However, appropriate Environmental Management Plan will need to be conducted during construction stage.
2	Public Announcement	-	-	In order to disseminate the plan of proposed project a stekeholder meeting was held on 25th August. The information disclosure for public is only this meeting until now.
3	Involuntary Resettlement	**B**	B	Relocation for Alt-1 Total 2 house and Alt-2 Total 1House are thought to be necessary.
4	Local economy such as employment and livelihoods, etc.	B	**B**	Impact on owner of agricultural land located at proposed bund and detention pond is considered.
5	Land use and utilization of local resources	B	**B**	Land use of a portion of Agricultural land is necesasry to change for construction bund and diversion channel.
6	Social institutions such as social infrastructure and local decision-making institutions	D	D	Impact can hardly considered.
7	Existing social infrastructure and services	B	D	An existing sub-power plant shoul be relocated in case of Alternative-1.
8	The poor, indigenous and ethnic people	D	D	Impact can hardly considered.
9	Misdistribution of benefit and damage	D	D	Impact can hardly considered.
10	Cultural heritage	D	D	Impact can hardly considered.
11	Local conflict of interests	D	D	Impact can hardly considered.
12	Water usage or Water Rights and Rights of Common	D	D	Impact can hardly considered.
13	Sanitation	D	D	Impact can hardly considered.
14	Infectious diseases such as HIV/AIDS	B	B	A risk by inflow of the construction person concerned can be considered.
15	Gender	D	D	Impact can hardly considered.
16	Rights of children	D	D	Impact can hardly considered.
Natural Environment				
17	Topography and geological features	B	**B**	Topographical alteration can be considered.
18	Soil erosion	B	B	Soil erosion on surface of bund and during construction work for diversion channel can be considered.
19	Groundwater	D	D	Impact can hardly considered.
20	Hydorological Situation	B+	B+	Plus impact by flood reduction can be considered.
21	(Mangroves, Coral reefs, Tidal flats, etc.) Coastasl Zone	D	D	Impact can hardly considered.
22	Flora, Fauna and Biodivesity	B	**B**	Almost all areas is mainly consist of built-up area and agriculturel land. Especially areas of proposed diversion channel are mainly consisted of agricultural land. Therefore, distribution of natural plant is thought to be rare. And there is no endangered
23	Meteorology	D	D	Impact can hardly considered.
24	Landscape	**B**	B	Construction of Bund 3m in height may slightly impact on landscape. In alternatives-1, a bund is built at the place near a residential area.
25	Global Warming	D	D	Impact can hardly considered.
Pollution				
26	Air Pollution	B	B	It is expected that dust and an exhaust gas increase temporarily by use of the heavy machine during construction. After construction does not generate the problem of air pollution.
27	Water Pollution	B	**B**	It is expected that the outflow of earth and soil (soil erosion) temporarily with the digging work during construction diversion channel and river channel.
28	Soil Contanmination	B	B	Some contamination can be considered by the outflow of the oil and fat during construction.
29	Waste	B	B	Problem about disposal of the garbage and filth during construction may occur. In case of Alternative-2, soil caused by excavation of diversion channel can utilize for construction bund.
30	Noise and Vibration	**B**	B	There is a possiblity that noise and vibration occur somewhat by heavy machine use during construction. In case of alternative-1, impact on residents may be larger than alternative-2.
31	Ground Subsidence	D	D	Impact can hardly considered.
32	Offensive Odor	D	D	Impact can hardly considered.
33	Bottom sediment	**B**	D	In case river channel improvement of Alternative-1, impact on botom sediment can be considered.
34	Accidents	B	B	A risk of the traffic accident by the passing vehicle under construction can be considered. Moreover, it is necessary to perform suitable safety education and measures against accident in the construction phase.

Rating:

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.)

D: Impact can hardly be considered.

Bold type in the table indicates larger impact compared to the other alternative for elements evaluated as B for both Alternative-1 and 2.

(c) Scoping Matrix

Detailed evaluation in each element is described in **Table 8.5.4**, which shows scoping matrix for both Alternative-1 and Alternative-2.

Table 8.5.4 Scoping Matrix

Name of Cooperation Project														
				Planning Phase		Construction Phase						Operation Phase		
	No.	Likely Impacts	Overall Rating	Land acquisition	Change of Land use plan, Control of various activities by regulations for the construction	Transportation of Construction Materials and Equipment	Deforestation	Alteration to ground by cut land, filling, drilling, tunnel, etc.	Operation of Construction Equipment and Vehicles	Construction of Bund, Diversion channel, Detention pond and other related facilities	Traffic Restriction in construction area	Change of River Flow	Appearance/ Occupancy of Bund and related building structures	Increasing influx of settlers
Social Environment: *Regarding the impacts on "Gender" and "Children's Right", might be related to all criteria of Social Environment.	1	Involuntary Resettlement/ Land Acquisition	B	B						B				
	2	Local economy such as employment and livelihood, etc.	B	B	B				B	B				
	3	Land use and utilization of local resources	B	B	B					B			B	
	4	Social institutions such as social infrastructure and local decision-making institutions	D											
	5	Existing social infrastructures and services	B							B	B		B	
	6	The poor, indigenous and ethnic people	D											
	7	Misdistribution of benefit and damage	D											
	8	Cultural heritage	D											
	9	Local conflict of interests	D											
	10	Water Usage or Water Rights and Rights of Common	D											
	11	Sanitation	D											
	12	Infectious diseases such as HIV/AIDS	B							B				
	13	Gender	D											
	14	Rights of Children	D											
Natural Environment	15	Topography and Geographical features	B					B		B				
	16	Soil Erosion	B							B		B	B	
	17	Groundwater	D											
	18	Hydrological Situation	B							B+			B+	
	19	Coastal Zone	D											
	20	Flora, Fauna and Biodiversity	B					B		B		B	B	
	21	Meteorology	D											
	22	Landscape	B							B			B	
	23	Global Warming	D											
Pollution	24	Air Pollution	B			B		B	B	B				
	25	Water Pollution	B					B	B	B			B	
	26	Soil Contamination	B					B	B	B				
	27	Waste	B					B	B	B				
	28	Noise and Vibration	B			B		B	B	B				
	29	Ground Subsidence	D											
	30	Offensive Odor	D											
	31	Bottom sediment	B								B			
	32	Accidents	B			B			B	B				

(d) Category Classification in accordance with the JICA Guideline

Based on the results of the IEE, proposed Temerloh flood mitigation project is classified as Category B since potential adverse impacts on the natural and social environment are not significant. For a project classified Category B, JICA will monitor whether suitable environmental and social considerations are executed as planned in EMP (Environmental Management Plan) during the project implementation period if the projects were implemented under the Japanese ODA loan.

(4) Estimated Environmental and Social Impact

Based on the results of IEE, it is considered that the impact on social and natural environment by implementation of proposed projects is not significant. However, in this section, the elements to be considered having a few impacts are descried.

(a) Impact on Social Environment

Based on the result of IEE, impact on social environment due to implementation of proposed projects is summarized in **Table 8.5.5.**

Table 8.5.5 Impact on Social Environment

Items	Description		
	Alternative-1	Alternative-2	Alternative-3
Involuntary Resettlement	Relocation of 2 houses is required. Large scale involuntary resettlement is not occurred.	Relocation of 1 house is required. Large scale involuntary resettlement is not occurred.	No impact
Local economy such as employment and livelihoods, etc.	Impact on agricultural land located at proposed components area can be considered. However, remarkable impact on local economy such as employment and livelihood, etc. can not be identified.		No impact
Land use and utilization of local resources	Land use of a portion of agricultural land is necessary to change by construction bund, river channel and regulation ponds. Total area of land acquisition is 32.27ha.(mainly categorized as housing area, but currently forest or agriculture land)	Land use of a portion of agricultural land is necessary to change by construction bund, diversion channel. Total area of land acquisition is 61.5ha. (mainly categorized as housing area, but currently forest or agriculture land)	No impact
Existing social infrastructure	Relocation of 1 of the sub-power plant is necessary.	Remarkable impact on existing infrastructure can not be considered.	No impact

(b) Impact on Natural Environment

Based on the result of IEE, impact on natural environment due to implementation of proposed projects is summarized in **Table 8.5.6.**

Table 8.5.6 Impact on Natural Environment

Items	Description		
	Alternative-1	Alternative-2	Alternative-3
Topography and geological features	Topographical alteration can be considered because of construction bund and regulation ponds.	Topographical alteration can be considered because of construction bund and diversion channel.	No impact
Soil Erosion	Soil erosion can be considered during and after construction bund, river improvement and regulation ponds.	Soil erosion can be considered during and after construction bund and diversion channel.	No impact
Hydrological Situation	Plus impact can be considered because of flood reduction.		
Flora, Fauna and Biodiversity	Absence of vegetation covers due to site cleaning activities prior to earthwork will impact on flora, fauna and biodiversity. However, existing visitation in the project area mostly consists of secondary vegetation, and endangered and endemic species do not distribute in the proposed area. Impact on flora, fauna and biodiversity is thought to be small.		
Landscape	It is considered that construction bund and flood wall with height 4 to 5m may have impact on landscape. In this alternative, a bund, flood wall and regulation ponds are constructed at the place near residential areas.	It is considered that construction bund with height 4 to 5m may impact landscape.	No impact

(c) Pollution

Based on the result of IEE, pollution due to implementation of proposed project is summarized in **Table 8.5.7.**

Table 8.5.7 Pollution due to implementation of proposed project

Items	Description		
	Alternative-1	Alternative-2	Alternavite-3
Air Pollution	It is considered that dust and exhaust gas increase temporary by use of the heavy machine and excavation work during construction phase.		No impact
Water Pollution	Water pollution due to soil erosion can be considered during and after construction bund, river improvement and regulation ponds. And an outflow of fats and oils during construction work may trigger water pollution. The cause of water pollution by proposed project implementation is mainly thought to be by soil erosion.	Water pollution due to soil erosion can be considered during and after construction bund and diversion channel. And an outflow of fats and oils during construction work may trigger water pollution. The cause of water pollution by proposed project implementation is mainly thought to be by soil erosion.	No impact
Soil contamination	Some soil contamination can be considered by an outflow of fats and oils during construction work.		No impact
Waste	A problem about disposal of garbage and filth during construction work can be considered In this alternative, soil generated by excavation of regulation ponds can utilize for construction bund.	A problem about disposal of garbage and filth during construction work can be considered In this alternative, soil generated by excavation of diversion channel can utilize for construction bund.	No impact
Noise and Vibration	There is a possibility of occurrence of noise and vibration by heavy machine use during construction work. Especially, during piling work accompany with construction pump station generating of a loud noise can be considered. In this alternative almost of construction works are carried out near residential area. Therefore impact by noise of Alternative-1 is larger than Alternative-2.	There is a possibility of occurrence of noise and vibration by heavy machine use during construction work. Especially, during piling work, generation of loud noise accompany a construction pump station can be considered.	No impact
Accident	A risk of the traffic accident by the passing vehicle during construction work can be considered. It is possible that a worker causes an accident during construction.		No impact

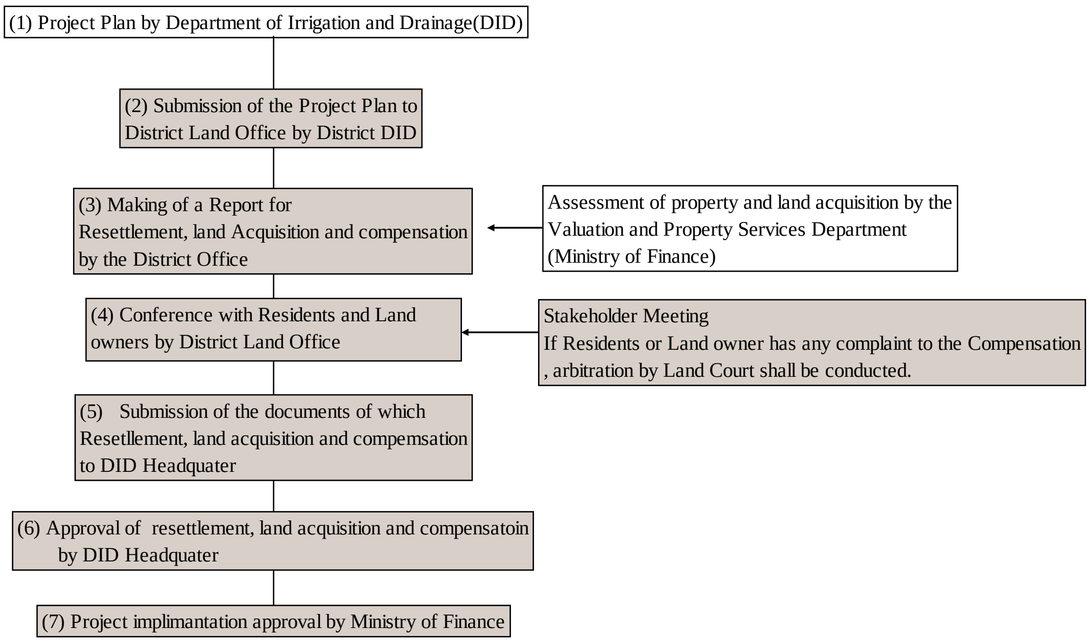
(d) Relation of the Plan for Resettlement of Malaysia and JBIC Guideline

There are following law and regulations related to involuntary resettlement/ land acquisition/ compensation in Malaysia:

- The Federal Constitution;
- The National land Code 1965 (Act 56 of 1965) & Regulations;
- Land Ordinance (Sabah); and
- The Land Acquisition Act 1960, Law of Malaysia Act 486.

In addition, Valuation and Property Services Department (JPPH) will carry out procedure of resettlement and land acquisition in conformity with The Land Acquisition Act 1960 and other related regulations.

Figure below shows a general procedure for involuntary resettlement/ land acquisition/ compensation for the existing DID project based on the result of interviews with DID.



Basically, District Land Office carries out all procedure regarding resettlement, land acquisition and compensation. Based on the development plan which DID drew up, a District Land Office, which has jurisdiction over the district, prepares the data and document which will serve as basis for compensation of a resettlement plan, the number of resettlement and acquired area, etc. and calculates property by the standard price based on the unit price prepared by JPPH.

Based on the data and documents prepared by a District Land Office, Valuation and Property Services Department (JPPH) assesses compensation (property) based on the standard price by the market value.

Unless affected person agree to the compensation plan by JPPH, approval of the project enforcement by Ministry of Finance is not given.

Moreover, in the case of resettlement, a monitoring will be carried out by the District Land Office on the affected person after the resettlement.

When affected person have agreed on a resettlement and compensation plan by executing above mentioned procedure, it is thought that there is almost no gap with the principles of the involuntary resettlement (the compensation for loss and support for those who receive the loss and influence of means of living) described in the JBIC Guideline.

On the other hand, in the case of existing development project implemented by DID, generally information disclosure about a development project to stakeholders or target residents in an early stage, such as master plan and feasibility study, is not a requirement. This is considered to be a cause that the procedure concerning resettlement and compensation takes a long period of time for the existing development project (DID officer said that generally it requires more than two (2) years).

From this, it is thought be necessary to have a consultation to DID for performing resettlement and compensation smoothly.

(5) Alternative-3 (Without Countermeasure)

A condition without structural measures can be thought as an alternative for this project. In this case, there is no impact on social and natural environment. Impact on human life by flood damage cannot be reduced, furthermore impacts on local economy and social environment due to the occurrence of flood inundation, sediment intrusion into houses and outflow of crops from a farmland will continue from now on at the time of flooding.

8.5.3 Discussion on Necessity of EIA with DID

Regarding a necessity of EIA, JICA Study Team had a discussion with DID.

In accordance with Environmental Quality Act, proposed projects of this study do not come under the “Prescribed Activities”. Therefore, it is not necessary to submit EIA (Environmental Impact Assessment) report. This means that it is not necessary to carry out EIA study.

In addition, JICA Study Team had a discussion in confirmation of above point at the meeting that was held on 4th August 2010. As a result of the discussion both Director of Flood Management Division of DID HQ and Deputy Director of River Basin Management and Coastal Zone Division of DID HQ concluded that EIA study is not required for the proposed projects. Similar projects has been implemented without EIA study until now.

8.5.4 Mitigation and Monitoring Plan

(1) Mitigation Plan

Adverse impacts on social environment due to implementation of each alternative were examined in the feasibility study so as to minimize the impact. In order to minimize the adverse impact on social environment due to construction of the bund and shortcut channel, examination was performed in the feasibility study. As a result, Alternative-1 and 2 were proposed.

Mitigation plan is required to minimize the adverse impact on social and natural environment, and impact by pollution due to proposed project implementation.

(a) Mitigation Plan for Social Environment

Mitigation measures for adverse impact on social environment are shown in **Table 8.5.8**.

Table 8.5.8 Mitigation Plan for the Impact on Social Environment

Items	Impact	Mitigation Plan
Involuntary Resettlement	Alternative-1 relocation of 2 houses is required. Alternative-2 relocation of 1 house is required. Large scale involuntary	Appropriate compensation for their property in accordance with the Land Acquisition Act 1960 (Act 486) & Rules and Orders, and land acquisition procedures by Valuation and Property Services Department (JPPH) should be conducted.

Items	Impact	Mitigation Plan
	resettlement is not occurred.	The target of compensation is property including land. JPPH carried out a detailed study of all losses that can be compensated. Basically District Land Office carries out all procedure/detailed survey regarding resettlement, land acquisition and compensation based on the development plan that drawn by DID. District Land Office calculates property by the standard price based on the market value of JPPH. Then JPPH assesses that.
Local economy such as employment and livelihood, etc	Remarkable impact on local economy such as employment and livelihood, etc. can not be identified.	For the affected palm and rubber tree plantation industry, appropriate compensation for their loss of livelihood in accordance with the compensation procedure by JPPH should be conducted.
Land use and utilization of local resources	A portion of agricultural land is necessary to change by construction bund, diversion channel and regulation ponds.	The impact on land use should be reduced by consideration of a design. Appropriate compensation for their loss of livelihood in accordance with the compensation procedure by JPPH should be conducted.
Existing social infrastructure	Relocation of the sub-power plant is necessary. Existing road that intersect the bund should be relocated.	Appropriate compensation and relocation of the facility should be conducted. A shifted road should be built. For construction of a shifted road etc., it is necessary to refer to the Road Traffic Ordinance 1987.

(b) Mitigation Plan for Natural Environment

Mitigation measures for adverse impact on Natural environment are shown in **Table 8.5.9.**

Table 8.5.9 Mitigation Plan for the Impact on Natural Environment

Items	Impact	Mitigation Plan
Topography and geological features	Topographical alteration can be considered because of construction bund, regulation ponds and diversion channel.	-
Soil Erosion	Soil erosion can be considered during and after construction bund, river improvement, regulation ponds and diversion channel.	Soil erosion and sediment discharge should be avoided by appropriate slope erosion protection, silt trap and sediment basin. Soil erosion and sediment discharge protection should be conducted in accordance with the Guidelines for the Prevention and Control Soil Erosion and Siltation in Malaysia in 1996. Caused by an implementation of a mitigation plan, pollution of river water due to soil erosion will decrease. As a result, sediment discharge and sedimentation at the lower reach area will reduce.
Flora, Fauna and Biodiversity	Absence of vegetation covers due to site cleaning activities prior to earthwork will impact on flora, fauna and biodiversity. However, existing vegetation in the project area mostly consists of secondary vegetation, and endangered and endemic species do not distribute in the proposed area. Impact on flora, fauna and biodiversity is thought to be small.	Vegetation on the bund slope should be performed after bund construction. In order to mitigate the impact on flora, fauna and biodiversity, it is necessary to refer to following acts. - Protection of Wild Life Act 1972 (Act76) - National Forestry Act 1984 (Act 313) - Fisheries Act 1985 (Act 317) and Regulations Caused by an implementation of a mitigation plan, sediment discharge from surface of bund due to rainfall etc. will decrease. Vegetation will also mitigate the impact on landscape.

Items	Impact	Mitigation Plan
Landscape	It is considered that construction bund and flood wall with height 4 to 5m may have impact on landscape. In case of Alternative-1, a bund, flood wall and regulation ponds are constructed at the place near residential areas.	The distance between a bund and a wall, and a house should be kept as much as possible. Vegetation (tree etc.) should be planted between a house and bund/flood wall, and on the bund slope and circumference of regulation ponds. In case of flood wall, a consideration in respect of a design is required. Specific regulations and orders for mitigate the impact on landscape does not exist. An implementation of a mitigation plan will mitigate a sense of oppression due to construction of bund.

(c) Mitigation Plan for the Pollution

Mitigation measures for adverse impact by pollution is shown in **Table 8.5.10**.

Table 8.5.10 Mitigation Plan for the Pollution

Items	Impact	Mitigation Plan
Air Pollution	It is considered that dust and an exhaust gas increase temporary by use of the heavy machine during construction work.	In order to avoid unusual discharge of the exhaust gas from construction vehicles etc., periodic check and maintenance of vehicles etc. are ensured, and condition is kept good. In order to mitigate the impact by air pollution, it is necessary to take following regulations into considerations. - Environmental Quality (Clean Air) Regulations 1978 - Environmental Quality (Control of Emission from Diesel Engines) Regulations 1995 - Environmental Quality (Control Emission drom Petrol Engines) Regulations 1995 - EHS Guideline (Environment, Health and Safety Guildeline, IFC 2007)
Water Pollution	Water pollution due to soil erosion can be considered during and after construction work bund and short-cut. And an outflow of fats and oils during construction work may trigger water pollution. The cause of water pollution by proposed project implementation is mainly thought to be by soil erosion	Soil erosion and sediment discharge should be avoided by appropriate slope erosion protection, silt trap and sediment basin. In order to mitigate the impact by water pollution due to soil erosion and sediment discharge, it is necessary to conduct a mitigation measure in accordance with the Guidelines for the Prevention and Control Soil Erosion and Siltation in Malaysia , in 1996 and refer to the National Water Quality Standards for Malaysia. Suitable measures should be taken in order to prevent leakage of the oil and fat from construction vehicles and a heavy industrial machine. Condition should be kept good. Specific regulations and orders for prevention of leakage do not exist. However, it is necessary to refer to the Environmental Quality (Water Pollution Control) Regulations 1998. However, it is necessary to refer to the following regulation and guideline - Environmental Quality (Water Pollution Control) Regulations 1998. - EHS Guideline (Environment, Health and Safety Guildeline, IFC 2007)
Soil contamination	Some soil contamination can be considered by an outflow of fats and oils during construction work.	In order to prevent leakage of the oil and fat from construction vehicles or a heavy industrial machine, while performing a suitable measure, a periodic check and maintenance are ensured and condition is kept good.

Items	Impact	Mitigation Plan
		Specific regulations and orders for prevention of soil contamination do not exist.
Waste	A problem about disposal of garbage and filth during construction work can be considered. In case of Alternative-1 and 2, soil generated by excavation of regulation ponds and diversion channel can utilize for construction bund.	A statute should be observed and it processes appropriately. In order to conduct appropriate process, it is necessary to refer to the Environmental Quality (Schedule Wastes) Regulations 2005.
Noise and Vibration	There is a possibility that noise and vibration occurrence by heavy machine use during construction work. Especially, during piling work accompany with construction pump station, generating of a loud noise can be considered. In case of Alternative-1, almost of construction works are carried out near residential area. Therefore impact by noise of Alternative-1 is larger than Alternative-2.	Environmental standards should be observed. Construction at night is not performed. Monitoring for the noise and vibration of public places (school etc.), in which people gathered, should be executed in order to identify the influence by the construction work. And suitable countermeasures should be taken when some of influences are observed. In order to mitigate impact due to noise and vibrations, it is necessary to refer to the following regulations and guide lines. - The planning guidelines for Environmental Noise Limits and Control - The planning guidelines for Vibration and Control in the Environment. - Guidelines for Noise labeling and Emission Limits of Outdoor Sources - Factory and Machinery (Noise Exposure) Regulations 1970(DOSH) - Environmental Quality (Motor Vehicles Noise) Regulations 1987 - EHS Guideline (Environment, Health and Safety Guildeline, IFC 2007)
Accident	A risk of the traffic accident by the passing vehicle during construction work can be considered. It is possible that a worker causes an accident during construction.	Safety education is performed to the construction workers concerned and a related vehicles user. A sign, a cautions signboard, etc. are installed in a suitable location. In order to mitigate accidents, it is necessary to refer to the Occupational Safety and Health Act 1994 (Act 514) Regulations and Orders.

(2) Monitoring Plan

(a) Outline

It is stipulated in the Environmental law in Malaysia (EQA), and the DID Manual which is established based on EQA that project proponent and construction contractor shall execute an occupational safety and health, and environmental monitoring during construction work.

The indicators for the establishment of environmental management plan applied to the proposed project are the “A Handbook of Environmental Impact Assessment Guideline” and the “Construction Management, DID Manual Volume 11” and other relevant environmental regulations and orders.

Above mentioned DID Manual (Volume 11) shows planning and implementation method and rule for formulation and implementation of environmental management plan and occupational safety and health plan in detail in conformity to the Environmental Quality Act, 1974 and Regulation (Act 127) , environmental guideline, and the Occupational Safety and Health Act 1994 (Act 514) Regulation and Orders.

State DID supervise federal/public works for a construction of flood mitigation measures.

On the other hand, DOE has governed the environmental administration of Malaysia. DOE give an approval to the Environmental Management Plan (EMP) which is formulated by construction contractor based on the DID Manual and other guideline etc. Then construction contractor carry out environmental monitoring in accordance with the EMP during construction work. DID supervises construction contractor's work.

In the environmental management plan of DOE and DID, the construction contractor is to submit a monitoring result to DID and DOE periodically. DOE checks the influence by a construction work in respect of environmental based on the submitted monitoring result. DOE requests necessary mitigation measure for the adversely influence that arises during construction work to DID who is project proponent and construction contractor if necessary. Moreover, DOE has the power to stop any project if they find that the adverse impact on environmental aspect exceeds an allowable limit or the project development is degrading the environment.

(b) Environmental Management Plan (EMP)

(i) Outline

The monitoring plan for items which may have impact on environment is formulated in an environmental management plan, and monitoring based on the plan will be carried out during a construction period.

For the proposed project, a construction contractor needs to formulate an environmental management plan based on the DID Manual and Malaysian laws, regulations and orders. However, even in such a case, unless approved by DOE, construction work cannot be started.

Moreover, an environmental management plan has the term of validity for two years after the date of approval of DOE. In case that, a construction work is not started within two years after approval of DOE, it is necessary to formulate a new environmental management plan and to get an approval from DOE again.

An environmental management plan consists of following contents.

- Environmental Monitoring Plan: Described are the monitoring method, location of monitoring and frequency of monitoring etc. for the items, which considered to influence on environment. It is necessary to carry out a sampling and monitoring of water quality, air quality and noise in advance in order to obtain the baseline data of present condition for formulation of the monitoring plan.

- Erosion and Sediment Control Plan (ESCP): The concrete plan for the prevention and mitigation of erosion and sediment discharge

- Best Management Practice (BMP): The administrative plans for carrying out the environmental management plan appropriately (enforcement organization, a budget, etc.)

- Occupational Safety and Health Management Plan: A plan to secure safety and health of workers during construction

(ii) Submission of monitoring results

The result of monitoring carried out in accordance with the environmental management plan must be submitted to DID and DOE from a construction contractor in the following frequency.

- Water quality and silt trap discharge monitoring results: to be submitted monthly

- Ambient air quality and Sound (Noise) monitoring results: to be submitted quarterly
- Environmental monitoring report: to be submitted quarterly

In addition, it is required that EIA study including formulation and implementation of EMP must be conducted by competent individuals who are registered with the DOE under the EIA Consultant Registration Scheme (Environmental Impact Assessment Procedure and Requirement in Malaysia; DOE).

(c) Monitoring plan for proposed project

(i) Monitoring Plan

For formulation and implementation of a monitoring plan for the proposed project, it is necessary to consider about the following points.

- Planning and enforcement of an environmental management plan based on the DID Manual in conformity to environmental law and environmental related guideline in Malaysia
- Proposed monitoring items

In this section, a monitoring plan for the impact on natural environment and pollution, which are required of monitoring, and submission of the monitoring results are described. Monitoring plan for the social environment is described as well.

This monitoring plan is developed based on the result of IEE and DID Manual. Therefore, for the project implementation, it is necessary to be re-examined based on new social environment.

Table 8.5.11 to **Table 8.5.13** shows the monitoring plan for this proposed project.

Table 8.5.11 Monitoring Plan for Impact on Social Environment

Items	Impact	Monitoring Plan
Involuntary Resettlement	Alternative-1 relocation of 2 houses and 1 restaurant is required. Alternative-2 relocation of 1 house is required. Large scale of involuntary resettlement will not occur.	There is no standard in particular that is in charge of monitoring implementation. Usually, there are cases where the district land office performs monitoring about the affected person.
Local economy such as employment and livelihood, etc	In case Alternative-2, some of impact on aquaculture can be considered during and after construction caused by water flow condition change.	Ditto

Table 8.5.12 Monitoring Plan for Impact on Natural Environment

Items	Impact	Monitoring Plan
Soil Erosion	Soil erosion and water quality deterioration due to soil erosion can be considered during and after construction bund, river improvement and regulation ponds.	It checks by water quality monitoring by referring to the following standards. TSS: 100 mg/L DO: 5.0- 7.0 mg/L

Table 8.5.13 Monitoring Plan for Impact on Pollution

Items	Impact	Monitoring Plan
Air Pollution	It is considered that dust and an exhaust gas increase temporary by use of the heavy machine during construction work.	It is necessary to carry out the check periodically whether periodical check and maintenance of vehicle etc. are implemented appropriately. It checks by air quality monitoring by referring to the following standards. Malaysian recommended Environmental Air Quality Limits of 260μ/m^{3}of TSP in 24 hours. Total Suspended Particulate(TSP): 260μ/m^3 Nitrogen Dioxide as NO_2 : 320μ/m^3 Sulphur Suixide as SO_2 : 105μ/m^3 EHS Guideline recommends following standard values which are based on the WHO Guideline. ・$PM_{2.5}$: 10μ/m^3 anual mean 25μ/m^3 24-hours mean ・PM_{10}: 20μ/m^3 anual mean 50μ/m^3 24-hours mean ・NO_2 : 40μ/m^3 annual mean 200μ/m^3 1-hour mean ・SO_2 : 20μ/m^3 24-hours mean 500μ/m^3 10minutes mean
Water Pollution	Water pollution due to soil erosion can be considered during and after construction work bund, river channel improvement and regulation ponds. And an outflow of fats and oils during construction work may trigger water pollution. The cause of water pollution by proposed project implementation is mainly thought to be by soil erosion.	It checks by water quality monitoring by referring to the following standards. pH (On-site) 6.5-9.0 Dissolved Oxygen (On-site) :5.0-7.0 mg/L COD: 25 mg/L BOD_5: 3mg/L Total Suspended Solids : 50 mg/L Oil and Grease : Not Detected Ammonical Nitrogen as NH3-N : 0.3 mg/L E-coli count : 400/ 100mL MPN EHS Guideline recommends following standard values (Note: Indicative value for Treated Sanitary Sewage Discharges) pH: 6.0-9.0 COD: 125 mg/L BOD: 30mg/L TSS: 50 mg/L Oil and Grease: 10 mg/L Total Nitrogen: 10 mg/L Total Phosphorus: 2 mg/L Total coliform bacteria : 400/ 100mL MPN
Noise and Vibration	There is a possibility that noise and vibration occurrence by heavy machine use during construction work. Especially, during piling work accompany with construction pump station, generating of a loud noise can be considered. In case of Alternative-1, almost of construction work are carried out near residential area.	It checks by monitoring for noise by referring to the following standards. EIA Approval Condition (Noise) 65 dB(A) for daytime 55 dB(A) for night-time EHS Guideline recommends following standard values for receptor(residential, institutional and educational) 55 dB(A): Daytime(07:00- 22:00) 45 dB(A): Nighttime(22:00- 07:00)

(ii) Monitoring Points and Frequency of the Monitoring

Figure 8.5.1 shows the monitoring points for Alternative-1 and **Figure 8.5.2** shows the monitoring position for Alternative-2.

Monitoring is divided into two categories. MPW is the monitoring for water quality and soil erosion, and MPN is the monitoring for noise and vibration. **Table 8.5.14** shows monitoring items of MPW and MPN respectively.

Table 8.5.14 Monitoring Items

Monitoring	Monitoring Items
MPW(Monitoring for Water Quality and Soil Erosion)	TSS, DO, pH, COD, BOD, NH_3-N, E-coliform
MPN(Monitoring for Noise and Vibration)	Noise, Vibration and Ambient air quality

Monitoring for a river (MPW) is considered to be carried out following points.

(1) Upper stream and down stream of the construction section

(2) Upper stream of the construction section of a tributary

(3) Lower reach of confluence of a tributary and main river

On the other hand, when the public facility, such as a school, in which persons gathers is located near the construction site, monitoring for noise and vibration is considered to be carried out. There is one of school near the construction site.

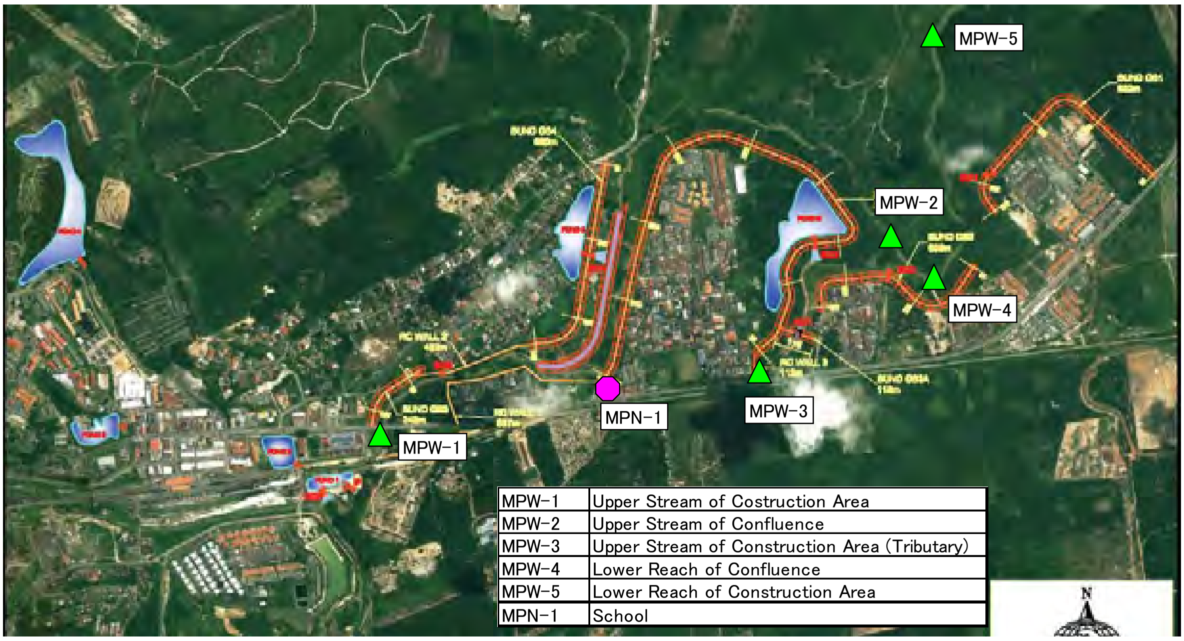


Figure 8.5.1 Proposed Monitoring Points (Alternative-1)

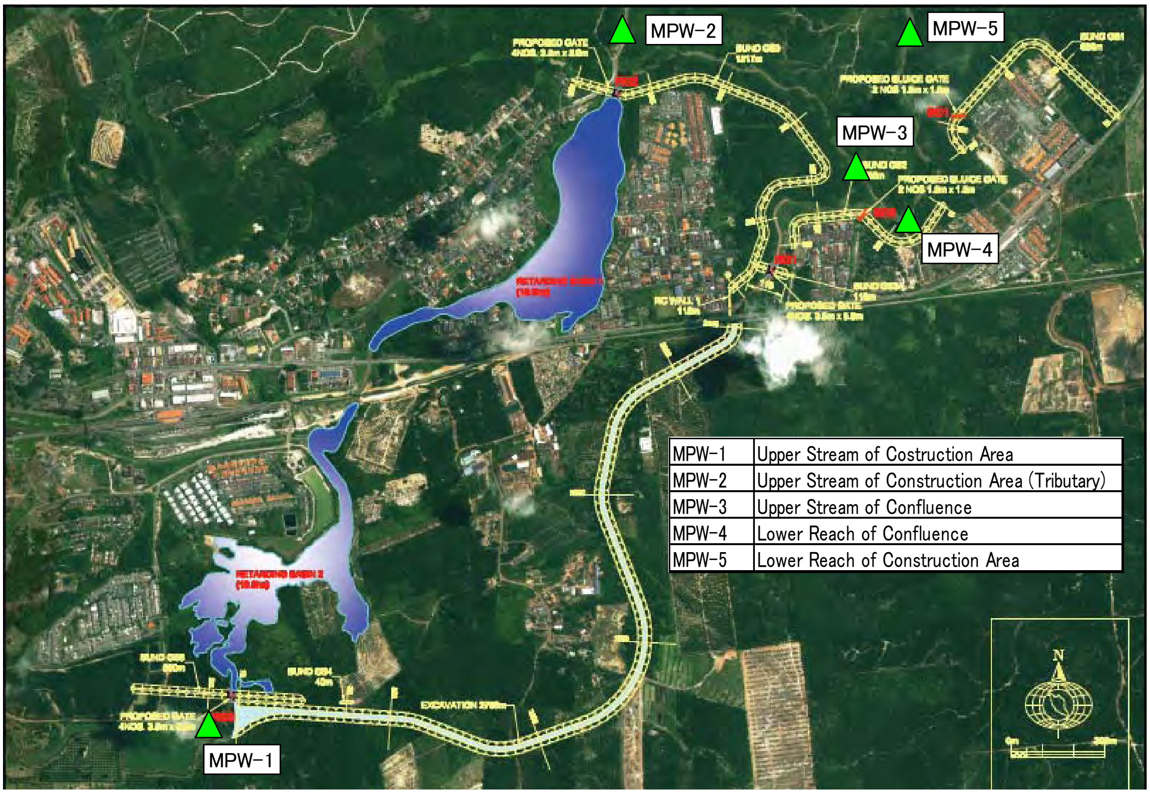


Figure 8.5.2 Proposed Monitoring Points (Alternative-2)

Frequency of implementation of the monitoring is shown in **Table 8.5.15**.

In this report, monitoring frequency is set up based on the DID manual.

Table 8.5.15 Proposed Frequency of Monitoring

Monitoring	Frequency
MPW (Monitoring for Water Quality and Soil Erosion)	Monthly
MPN (Monitoring for Noise and Vibration)	Quarterly

In addition, the monitoring plan needs to be established by construction contractor based on the discussion with DID at the time of establishment of the Environmental Management Plan in advance to construction work. Moreover, it is necessary to obtain approval from DOE.

8.6 Toward Project Implementation

8.6.1 Operation and Effect Monitoring Indicators

Since this project is a public project, it is very important to monitor the operation and effect of the project even after the completion of the construction works. Human lives and public and private property are main things to protect for the flood mitigation project. Therefore, reduction of the damage of the two items can be regarded as effects of the project, as shown in **Table 8.6.1**.

Table 8.6.1 Proposed Operation and Effect Monitoring Indicators

Indicator	unit	Value of indicator	
		Present (without project)	2025 (target)
Annual average flood damage amount caused by floods of 50-year or shorter ARI in the protected area.	RM/year	1.9 million	0
Number of immediate fatalities caused by floods of 50-year ARI in the protected area.	persons	4	0

The annual average damage amounts are quoted from a result of the economic analysis of Subsection 8.4.4. The number of immediate fatalities at 2010 is quoted from a simulation result of Subsection 8.3.3. At 2025, the target completion year of the IFM plan, no-damage and no-immediate-fatality should be accomplished in the event of a flood of 50-year or shorter ARI.

8.6.2 Consulting Services

For the project implementation, consulting services will be necessary. The consulting services are composed of the following works:

- Detailed Design
- Tender assistance
- Construction Supervision

Followings are detailed consulting services necessary in case the project is implemented under Japan’s ODA loan:

(1) Detailed Design

- Review the preliminary design conducted by the JICA preparatory study.
- Undertake supplemental topographic surveys and geo-technical investigation.
- Prepare proper project management and construction management plan for quality assurance of detailed design and construction supervision stages.
- Undertake all necessary engineering works for the detailed design.
- Prepare prequalification document for each package.
- Prepare drawings, specifications and bidding documents including evaluation criteria for each package.
- Prepare detailed designs of civi1 and building structures and mechanical and electrical equipment including structura1, hydraulics, capacity and other engineering computation and analysis

- Prepare construction plan and implementation program of the Project
- Prepare detailed conditions of contract, specifications, schedules and bills of quantities for carrying out the Project.
- Assist DID in obtaining approvals where necessary from local authorities, utility bodies, and other approving authorities in connection with the Project.
- Prepare engineering design report containing the description of the Project.

(2) Tender Assistance

- Review of the final design and the bidding documents if necessary, including preparation of final bidding documents for invitation of Contractors.
- Liaison with JICA for compliance with their requirements in respect of procedural aspects of bidding and related conditions.
- Invitation of shortlisted Contractors for each package and answering additional questions during bidding period.
- Evaluation of tender documents received including the evaluation report.
- Assistance during contract negotiations and establishment of Contractors contracts.
- Assistance on right-of-way and land acquisition, if necessary.

(3) Construction Supervision

- Advising the Client on the appointment of the resident site staff of the Contractor in accordance with the terms and provisions;
- Ensuring all construction and installation works are to the details and required standards as specified;
- Advising the Client on the necessity for the inspection and testing of materials and plant supplied under the contract and arranging for these to be carried out on his behalf as approved, where applicable;
- Implementation of the Action Log;
- Arranging and guiding regular progress meetings with the Contractor;
- Monitoring of progress and total costs with a view to completion within time and budget. The Client shall be advised, on a regular basis, on these matters. Progress Reports shall be submitted to the Client on a monthly basis;
- Planning, coordination and liaison as necessary, to minimize the impact of the works on other parties, such as the Client, nearby property owners, service authorities, the public, etc.;
- Issuing certificates for payment to Contractors with appropriate make-up sheets;
- Preparing reinforcement schedules and any further designs and drawings necessary for the information of the Contractors to enable them to carry out the works;

- Technical quality assurance should be provided according to ISO 9001 which has to be built in as general overhead expenditures.
- Advice on amendments/changes to the present construction works to optimize.
- Commissioning of the works and assisting the Client with respect to acceptance of the works;
- Establishing operating and maintenance procedures, if required.
- Delivering to the Client on completion of the works three sets of such records as are necessary for operation and maintenance including "as-built" drawings (with reinforcement details) and making arrangements through the Contractors for the supply of the associated documents, such as manufacturers' manuals, recommended maintenance schedules and list of spares required for proper maintenance;
- Assisting in settling disputes or differences, which may arise between the Client and Contractor except litigation and arbitration.
- Ensuring that health and safety procedures are respected by Contractors.
- Evaluation of shop drawing and instruct contractors to modify in case.
- Prepare the O&M manual.