6. SECTORIAL MASTER PLAN

6.1 Floodplain Management

6.1.1 Objectives of the Plan

In the rainy season, the Musi River flows down in the wide floodplains along the Musi mainstream and major tributaries in the middle and downstream areas. Floodplains are important for the water resources because they serve for flood and erosion control, help maintaining high water quality, and contribute to sustaining groundwater supplies. Most of the floodplains in the Basin are swamp/marsh and tidal swamp rice fields. (Refer to **Photo H6.1.1**) People's lives in these areas are those fit to the natural phenomena of river inundation.

Photo H6.1.1 Komering River Downstream

Topographically the portion of mountainous areas in the Musi River Basin is small, and it is rather difficult to find effective dam/reservoir sites to store water. Instead the basin has extensive natural retarding basins along the middle and lower reaches, serving for flood mitigation during rainy season and sustaining water supply during dry season for the lower basins including Palembang City.

If it is undertaken to protect the inundated areas from 100 years-flood, the channel capacity should be enlarged about 1.6 times of the present capacity. In addition, this enlargement has to be implemented for a stretch more than 100 km. Such a large channel works would not be practical and feasible because of huge investment cost, great number of settlement to be relocated and land acquisition. Furthermore, continuous diking system along the Musi River and riverbed dredging are not proposed.

On the contrary, the existing inundated areas and marshy lands are contributing much to the alleviation of flood and sediment disasters in the urban areas of Palembang City. The inundation also serves for detention of rain water as marsh and groundwater which could be used for irrigation and other water use in dry season.

At present, flood damage is not so serious, that is attributed to the floodplain's retarding function. Non structural measures should be used mainly as flood mitigation measures in the Musi River basin. Therefore, conservation of floodplain is very important as measures of flood mitigation and water resource.

The other issues of flood management in the Musi River Basin include riverbank erosion along the Musi mainstream and major tributaries and flush floods in the mountainous areas.

The objectives of the floodplain management in the Musi River Basin are to maintain the present river regime and to manage river properly.

6.1.2 Zoning and Land Use Control

Floodplain management commonly include flood damage mitigation (flood preparedness measures, emergency response measures, etc.), zoning and land use control plans, flood forecasting and warning, disaster management (disaster reduction, flood fighting, etc.), etc. In order to maintain water-retarding function in floodplains, zoning and land use control are commonly applied. Of these, measures that are realistic in the Musi River Basin are regulation of floodplain used in the middle and lower basins.

(1) Existing Regulations

There exist the following laws and regulations for floodplains to be protected and conserved.

- Law No. 11/1974 (Water Resources)
- Government Regulation No. 27/1991 (Swamps)
- Government Regulation No. 35/1991 (Rivers)
- Ministerial Regulation of Ministry of Public Works No. 63/PRT/1993 (River Channel, River Usage and Non-usage Areas, Old Unfunctional Rivers)
- Ministerial Letter of Home Affairs No. 179/1996 (Organization Guidelines of Basin Water Resources Management Unit (Balai PSDA))
- Presidential Letter No. 32/1990 (Protected Area Management)

Among others, the following are the declaration related to the floodplain management.

(a) Government Regulation No.27/1991 (Swamps)

In the Regulation, the followings are subject for conviction, namely, (i) to reclaim swamps and develop swamp reclamation channels without

permission, (ii) to dump solid or suspended contaminants in or surrounding the swamp reclamation system.

(b) Ministerial Regulation of Ministry of Public Works No.63/PRT/1993 (River Channel, River Usage and Non-usage Areas, Old Unfunctional Rivers)

Ministerial Regulation defines river borders and decrees details of their utilization. River borders may not be used for: dumping of garbage, solid and suspended wastes, developing permanent buildings, houses, and commercial facilities.

River borders: with dike is at least 3 m (in urban areas) or 5 m (outside urban areas). River border without dikes is 10-30 m (in urban areas) or 50-100 m (outside urban areas). Tidal-influenced river border is at least 100 m and functions as green-belt.

River borders may not be used for: dumping of garbage, soil and suspended wastes, development of permanent buildings, houses, and commercial facilities.

Land areas outside of authorized river areas may be used with permission from the government, users are subject to maintenance fee. Authorized river areas are (i) within 100 m from the river (for water retention areas), and (ii) floodplains. Authorized river areas may be used for certain usage with permission from the government.

(c) Presidential Letter No.32/1990 (Protected Area Management)

Protected areas mainly function to protect environment and its sustainability that cover natural resources, etc. Among others, "Water retention areas (with heavy rainfall) are included as protected areas.

(2) Zoning of the Floodplain Areas

As discussed above, existing laws and regulations already control the activities in the floodplains, thus needs is the actual zoning of floodplain areas in the Musi River Basin. There is no clear zoning of floodplain areas for this purpose. The Study Team identified floodplains in the middle and lower reaches of the Musi mainstream and major tributaries based on the existing 1/250,000 maps as shown in **Figure H6.1.1**.

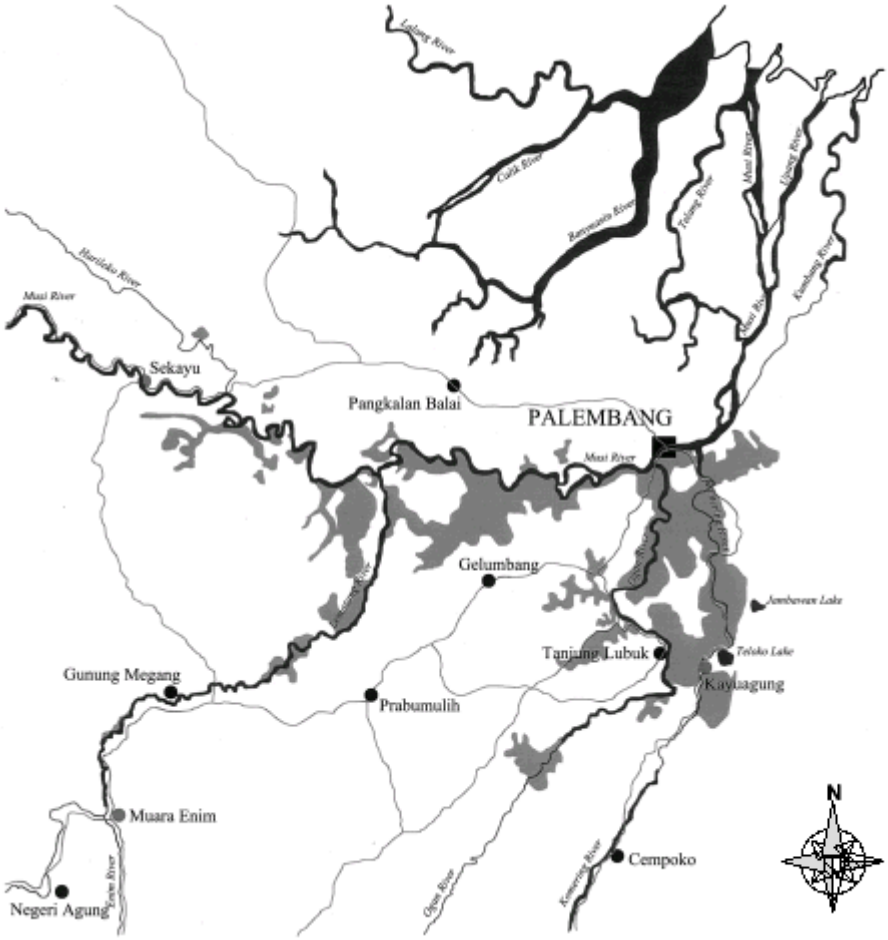


Figure H6.1.1 Identified Floodplain Areas

The total area of the identified floodplain is approximately 3,360km^2 and the breakdown by river basin is as shown in the **Table H6.1.1.**

Table H6.1.1 Floodplain Areas by River Basin

River	Area (km^2)	River	Area (km^2)
Musi	1,126	Semangus	-
Harileko	4	Lematang	299
Rawas	84	Ogan	432
Lakitan	68	Komering	1,350
Kelingi	-	Total	3,363

By using the land use data of the year of 2000 already compiled as the GIS database by this Study, land use types in the identified floodplains were confirmed as shown in **Table H6.1.2**. As shown in the table, land use in the floodplains is mainly swamp and tidal swamp rice field.

Table H6.1.2 Land Use of Identified Floodplains

Land Use Type	Area (km^2)
Swamp / Marsh	828
Tidal Swamp Rice Field (single crop)	1,819
Others	716
Total	3,363

(3) Evaluation of Effect of Flood Retardation

An attempt was made to evaluate the natural retardation effects of the inundation as follows:

- Discharge-duration under preset conditions: Discharge-duration curves are shown in **Figures H6.1.2** and **Figures H6.1.3** for Tebing Abang station of the Musi River at just downstream of the Lematang River confluence. Daily discharges in 1995, 1996 and 2001 are available for the study. According to the average curve, annual maximum daily discharge is 3,656m^3/s and the discharge-duration curve is almost linear on the log-normal coordinates expressed as:

  log Q = - 0.00232 D + 3.563

  where

  Q : Daily discharge (m^3/s)

  D : Ordinal number of daily discharge from the maximum

- Discharge-duration under no-inundation conditions: In order to evaluate the inundation effects, average discharge-duration curve under no-inundation conditions was estimated. The estimated curve is expressed as:

  log Q = - 0.00319 D + 3.628

  The following assumptions were introduced to work out the above curve:

  - Relationship of daily discharge (log Q) and ordinal number (D) was assumed to be linear.
  - Total volume of inundated water was estimated to be 1.7 billion m^3 at maximum for normal year, assuming inundated area (3,363 km^2) multiplied by assumed average inundated depth (0.5m).
  - Total period of inundation was assumed to be 12 months.

- Comparison of both curves: The discharge-duration curves under present and no-inundation conditions are shown in **Figure H6.1.4** in comparison. From the Figure the followings were clarified for the discharge duration in normal year:

- The annual maximum daily discharge of 3,656 m^3/s under the present condition would increase up to 4,040 m^3/s under no-inundation condition.
- The present 365-day (12 months) discharge of 584 m^3/s would decrease to 481 m^3/s if no inundation.
- The 125-day discharge would be the same for both conditions under present and no-inundation.

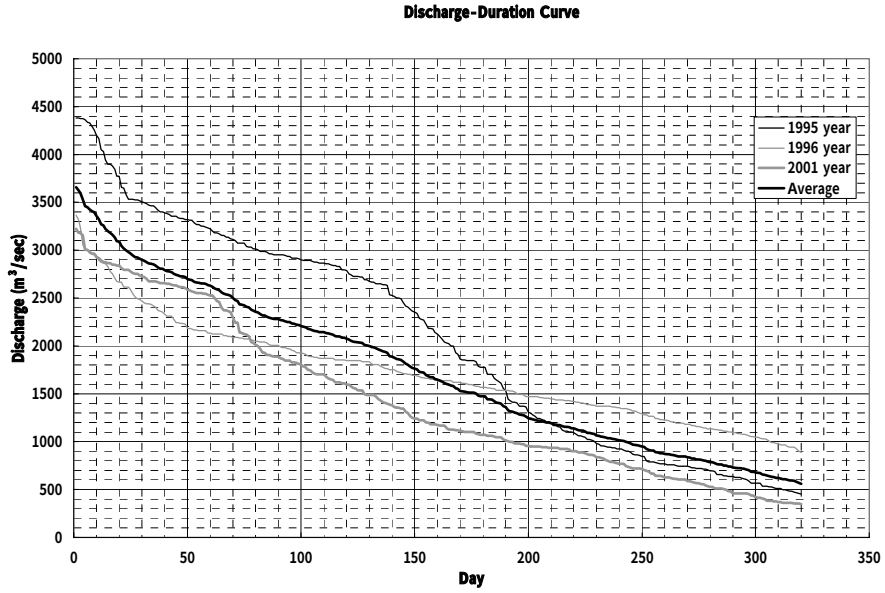


Figure H6.1.2 Discharge Duration Curve of Tebing Abang

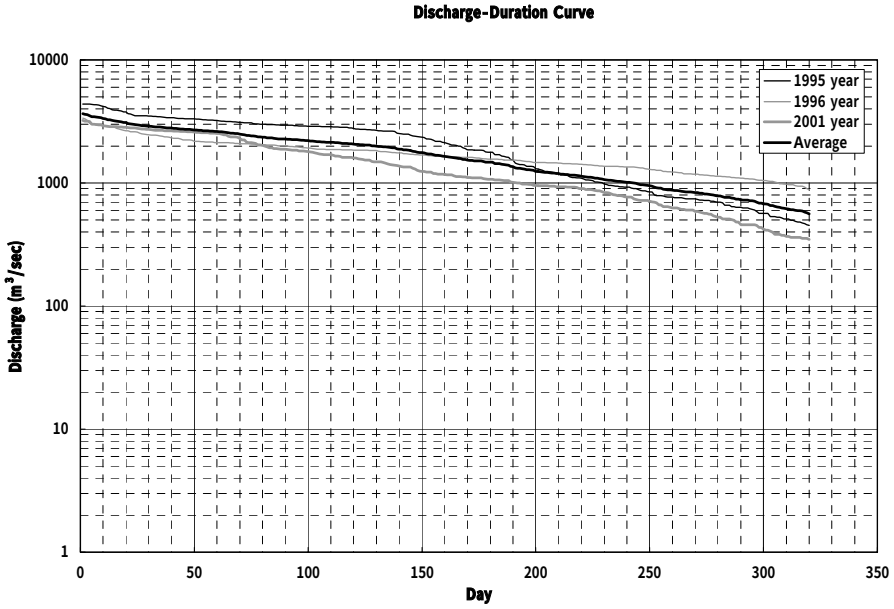


Figure H6.1.3 Discharge Duration Curve (One Sided Log) of Tebing Abang

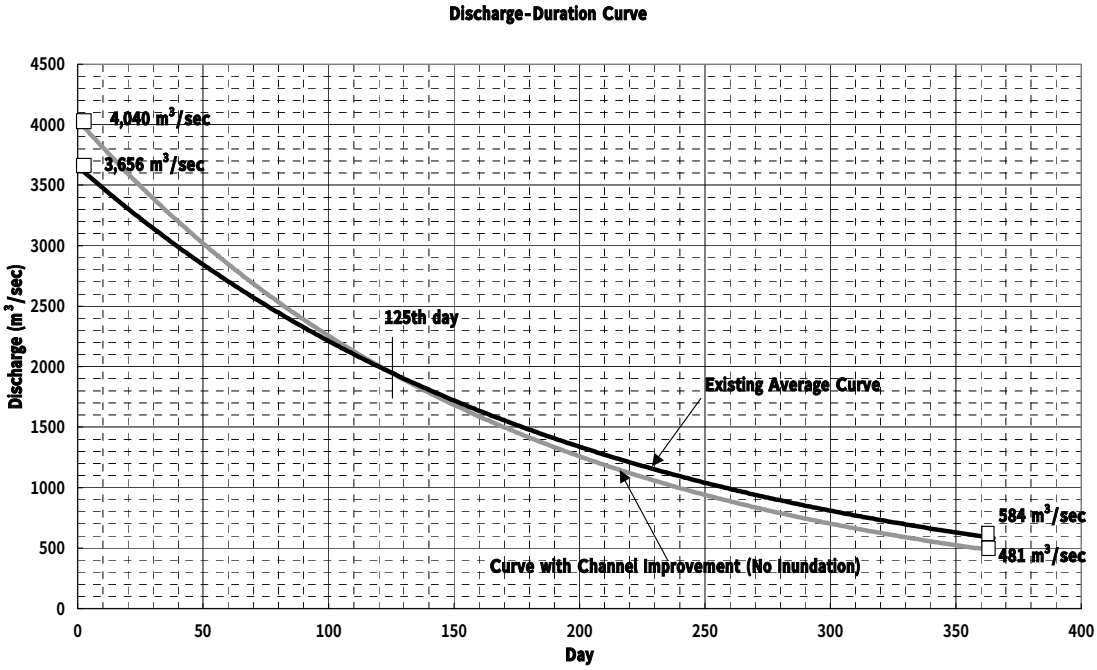


Figure H6.1.4 Discharge Duration Curve with Channel Improvement (No Inundation)

(4) Zoning and Land Use Control Program (Program 2-1)

The floodplains needed for the land use control were proposed by the Study Team. Confirmation of the area and zoning shall be conducted.

Confirmation of the Land Use Control Area (Program 2-1-1)

Land use control area proposed by the Study Team is 1/250,000 topographic map basis as shown in **Figure H6.1.4**. Detailed study (with remote sensing methods) for the confirmation of the necessary land use control area shall be conducted.

The primary objective of remote sensing methods for mapping flood-prone areas is to provide with a practical and cost-effective way to identify following items of floodplain.

- Where the floodplain and flood-prone areas are.
- How often the floodplain will be covered by water.
- How long the floodplain will be covered by water.
- At what time of year flooding can be expected.

With remote sensing methods, the extent of floodplains and flood-prone areas can be approximated at small to intermediate map scales (up to 1:50,000) over entire river basins. The repeat cycle of the LANDSAT system is greater than 15 days, it is not always possible to collect imagery during peak flooding stages. However, data for a period of one month or more including flood event commonly reveal the extent of the flooded area, due to reflectance differences between the inundated and non-inundated areas.

Most satellite coverage for a single full scene extends over a large area (usually more than 33,000km^2).

Zoning of the Area (Program 2-1-2)

After the confirmation of the area, zoning shall be conducted in the spatial plan of the relevant Kabupaten and Kotamadya.

Execution (Program 2-1-3)

Land use control shall be executed. Periodical patrol for the proper land use shall be conducted.

Implementation schedule and cost of this program is described in **8. IMPLEMENTATION, COST ESTIMATES AND PROJECT EVALUAITON**.

Examples of projects of floodplain management (allowing flooding and inundation, regulating and guiding land use, and flood-proofing of structures) and described in Annex H6.2.6.

6.1.3 Flood Forecasting and Warning

As another measure of floodplain management, flood forecasting and warning can be applied in the area where flush floods occur. Detailed information is not available for the flush flood in mountain areas, and more study is needed to identify what is needed. Dinas PU Pengairan of South Sumatra Province identified the following possibility of flood forecasting and warning system introduction.

(1) Flood Forecasting and Warning Program (Program 2-2)

Since not much information is available for the flush flood in the mountainous areas, inventory survey should be conducted. Inventory should be conducted based on the proposal of **Table H6.1.3**. Warning system against flush flood is established by use of automatic rain gage and GSM-digital mobile phone. That system is economical than use of Argos Satellite System or INMARSAT Satellite System. Flood Forecasting and warning system is shown in **Figure H6.1.5**.

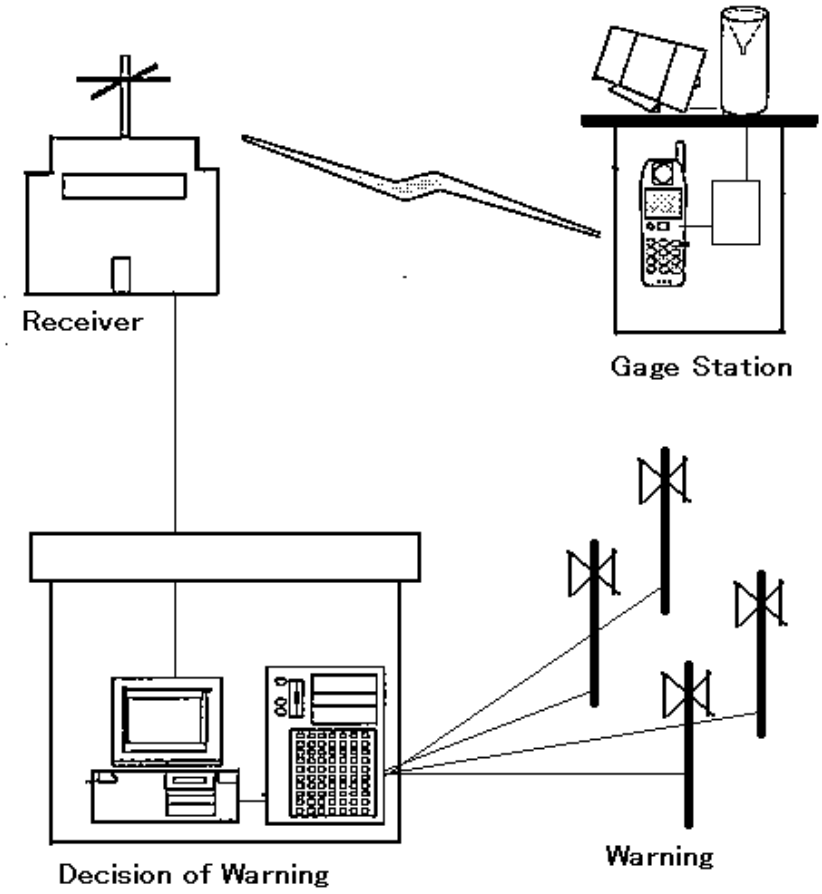


Figure H6.1.5 Illustrated Flood Forecasting and Warning System

Table H6.1.3 Possible Location for Flood Forecasting and Warning System

	Gage Location	Receiver (Dinas PU District)	Decision of Warning (Dinas PU District)	Control (Dinas PU Province)
OKU	Muaradua Kisam	Muaradua	Baturaja	Palembang
	Pulau Beringin	Muaradua	Baturaja	Palembang
	Pasar Banding Agung	Muaradua	Baturaja	Palembang
	Pengandonan		Baturaja	Palembang
Lahat				
	Tebing Tinggi		Lahat	Palembang
	Padang Tepung	Pagar Alam	Lahat	Palembang
	Pendopo	Pagar Alam	Lahat	Palembang
	Tanjung Sakti	Pagar Alam	Lahat	Palembang
	Kota Agung		Lahat	Palembang
MURA				
	Surulangun	Muara Rupit	Lubuk Linggau	Palembang
	Muara Kelingi		Lubuk Linggau	Palembang
	Muara Lakitan		Lubuk Linggau	Palembang

(2) Implementation Schedule

Implementation schedule of flood forecasting and warning system is shown in **Figure H6.1.6**.

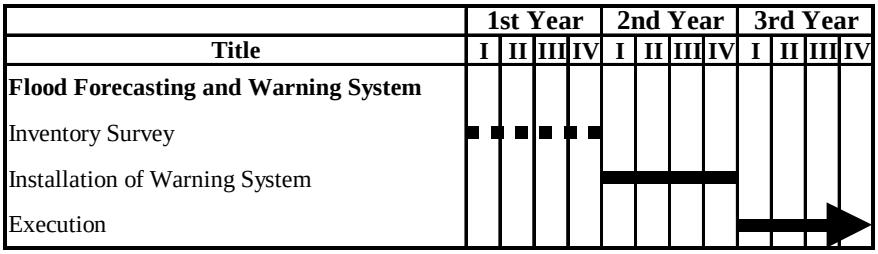


Figure H6.1.6 Implementation Schedule of Flood Forecasting and Warning System

(3) Cost

Cost of flood forecasting and warning system is shown in **Table H6.1.4**.

Table H6.1.4 Cost of Flood Forecasting and Warning System

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp.million
1	**Gage Station**				**4,440**
	Gage Station	location	370,000,000	12	4,440
2	**Data Analysis System**				**780**
	Data Analysis System	system	260,000,000	3	780
3	**Warning Instrument**				**90**
	Warning Instrument	location	7,500,000	12	90
4	**Communication Charge**				**2**
	Communication Charge	year	2,000,000	1	2
5	**Indirect Costs**				**531**
	Physical Contingency	l.s.	-		531
	GRAND TOTAL		**(Rp.million)**		**5,843**
			(US$ million eq.)		**0.647**
			(Yen million eq.)		**78.9**

6.1.4 Sustainable River Channel Management

(1) Sustainable River Channel Management Program (Program 2-3)

Bank erosions occur in the Musi mainstream and major tributaries. Riverbank protection works are presently conducted by Dinas PU Pengairan of each Kabupaten using APBD. The works include gabion revetment, concrete revetment, gabion jetty, bamboo net jetty, etc. and designing and construction technique are already well established. Thus the sustainable channel management shall be carried out under the present system continuously. Bank protection works are identified for future implementation listed in **Table H6.1.5**.

In addition to the works, Dinas PU Pengairan of South Sumatra Province, with the cooperation of other Provinces, is recommended to prepare local regulation concept of river corridor management. The concept will include guidelines of river areas and their utilization, and will be formulated based on study on flood water level, flood discharge, river morphology, landside, catchment area, etc. under with/without dike conditions in both rural/urban areas.

Table H6.1.5 Bank Protection Works identified for the Future Implementation

No.	Location	Length (m)	Bank
Musi River			
A	**MUBA**		
1	Epil	600	Left
2	Bailangu	650	Left
3	Sekayu	400	Left
4	Sukarame	240	Left
5	Rantau Panjang	230	Left
6	Karang Anyar	420	Left
7	Karang Waru	400	Left
8	Bumiayu	640	Left
9	Ulak Paceh	900	Left
10	Tanjung Durian	400	Left
11	Napal	450	Left
12	Rantau Kasih	360	Left
13	Karang Ringin	500	Left
14	Ulak Teberau	430	Left
15	Kasmaran	270	Left
16	Toman	220	Left
17	Babat	300	Left
B	**MURA**		
1	Sungai Pinang	580	Left
C	**LAHAT**		
1	Tebing Tinggi	870	Left
Harileko River			
A	**MUBA**		
1	Teluk	600	Left
2	Epil	400	Right
3	Muara Teladan	100	Right
Rawas River			
A	**MURA**		
1	Muara Rawas	240	Right
2	Ulak Macang	660	Right
3	Dusun Pau	500	Right
4	Tebing Tinggi	420	Right/Left
5	Batu Kucing	830	Right/Left
6	Balam	770	Right
7	Tanjung Raja	640	Right/Left
8	Bingin Teluk	1880	Right
9	Mandi Angin	870	Right
10	Alai	900	Right
11	Biaro	980	Right/Left
12	Karang Dapo	850	Left
13	Rantau Kadam	740	Right
14	Pantai	800	Right
15	Lubuk Umbai	900	Right
16	Muara Rupit	250	Right/Left
17	Lesung Batu	600	Right/Left
18	Kertadewa	800	Right

No.	Location	Length (m)	Bank
Lematang River			
A	**LAHAT**		
1	Prabu Menang	380	Right
2	Kebur	480	Left
3	Banjar Sari	450	Right
4	Lahat	280	Left
B	**MUARA ENIM**		
5	Sungai Rotan	960	Right
6	Sukarami	670	Right
7	Kuripan	700	Left
8	Belimbing	400	Left
9	Teluk Lubuk	400	Left
10	Beruge	870	Left
11	Tanjung	740	Right
12	Tanjung Muning	680	Right
13	Perjito	740	Right
14	Pinang Belarik	700	Right
15	Gunung Megang Luar	680	Left
Ogan River			
A	**OKI**		
1	Tanjung Raja	580	Left
2	Sri Jabo	700	Right
3	Sungai Pinang	420	Left
4	Embacang	460	Left
5	Lubuk Keliat	400	Left
6	Kalampadu	380	Left
7	Sukacinta	480	Left
8	Seri Kembang	520	Left
B	**OKU**		
9	Kuang Anyar	450	Left
10	Suka Pindah	380	Left
11	Munggu	270	Left
12	Kedaton	260	Left
13	Bunglai	180	Left
14	Peninjauan	370	Left
15	Belatung	360	Left
16	Lubuk Batang	870	Left
17	Terusan	400	Left
18	Tanjung Kemala	230	Left
19	Baturaja	980	Right/Left
20	Pusar	300	Left
21	Kedaton	450	Left
22	Tubohan	870	Left
23	Gunung Liwat	450	Left
24	Sukarame	420	Left
25	Gunung Meraksa	600	Left
Komering River			
A	**OKU**		
1	Rasuan	580	Right
2	Pulau Negara	600	Left
3	Matas	720	Left
4	Damarpura	960	Left
5	Muara Dua	860	Right/Left

(2) Implementation Schedule

Implementation schedule of sustainable channel management program is shown in **Figure H6.1.7**.

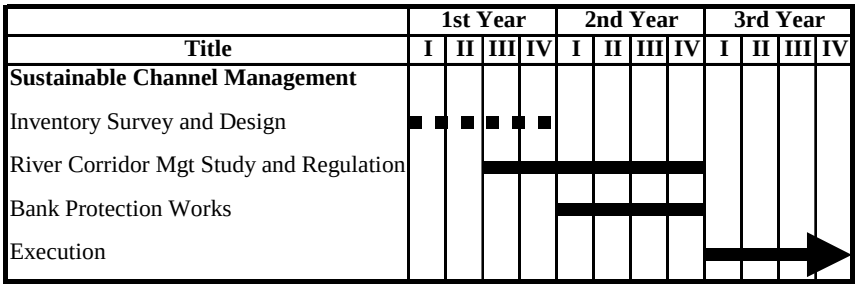


Figure H6.1.7 Implementation Schedule of Sustainable Channel Management Program

(3) Cost

Cost of sustainable channel management program is shown in **Table H6.1.6**.

Table H6.1.6 Cost of Sustainable Channel Management Program

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp. Million)
1	**Bank Protection Works**				**150,000**
	Bank Protection Works	m	3,000,000	50,000	150,000
2	**Indirect Costs**				**48,000**
	Administration Cost	l.s.	-		7,500
	Eng. Service Cost	l.s.	-		22,500
	Physical Contingency	l.s.	-		18,000
3	**River Corridor Management**				**440**
	Study and Regulation	l.s.	-		400
	Physical Contingency	l.s.	-		40
GRAND TOTAL			**(Rp. million)**		**198,440**
			(US$ million eq.)		**21.963**
			(Yen million eq.)		**2,679.8**

6.2 Urban Water Environment Improvement

6.2.1 Objectives

Urban areas scattered in the Musi River Basin have various living environment problems. Especially, deterioration of water environment is one of the major issues for the comprehensive water management of the Musi River Basin. This problem is distinguished and serious in Palembang whose population is approximately 1.5 million and shares nearly one fourth of the basin's population of 6.3 million. It is reported that the number of persons treated for waterborne or water-related diseases in Palembang Municipality amounted to 102,343 (1986). Cause and effect of the urban water environment problem is summarized as **Figure H6.2.1**.

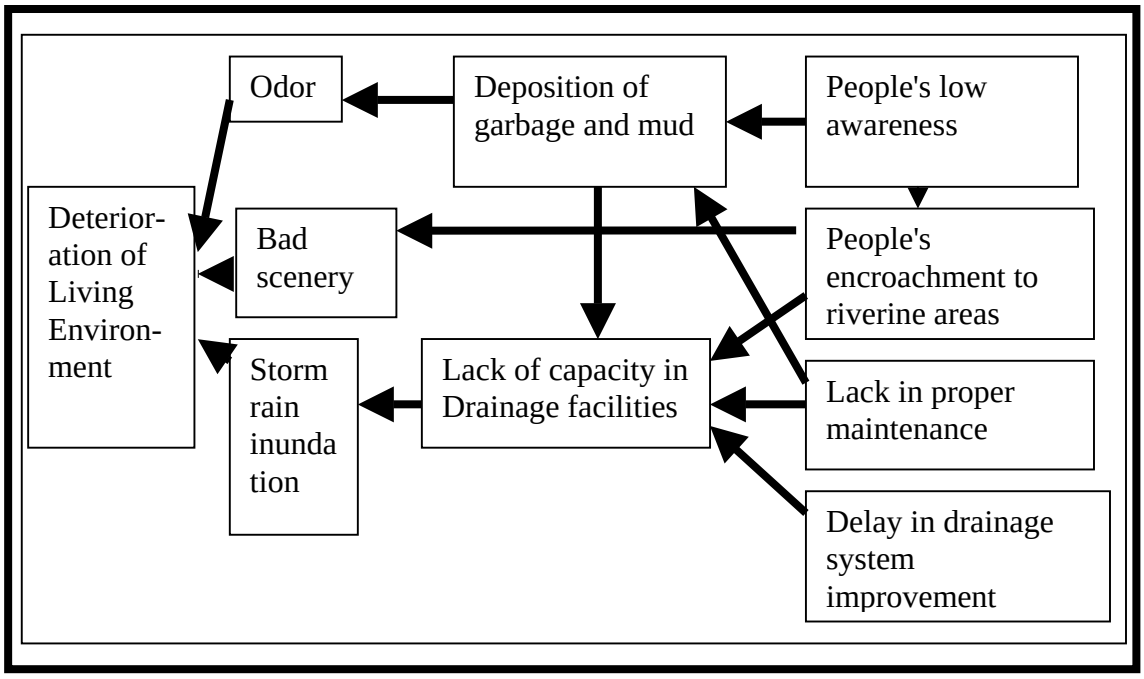


Figure 6.2.1 Causes and Effects of the Urban Water Environment Problem

The objective of the urban water environmental improvement (Component 4 of the Master Plan for Musi River Basin Comprehensive Water Management) is to solve these urban water environmental problems in Palembang as a pilot city with the following programs.

6.2.2 Community Drainage Management Program

For the improvement of urban environment, involvement of the community is indispensable. Though improvement or new construction of infrastructure will be needed, improved environment can be achieved with the people's willingness. The following program is proposed as the start of the urban environment improvement.

Community Drainage Management Program (Program 4-1)

(1) Objective and Leading Agency

The objective of the program is to realize better water environment in the community level through the following activities. Leading institution is Dinas KIMPRASWIL of Palembang Municipality. Relevant community organizations is NGOs, schools, etc.

(2) Activities

(a) Choose one drainage area: Chosen area is recommended to have strong, existing community organization.

(b) Preparation meeting with key persons in community

(c) 1st meeting with the community: objectives, free discussion

(d) 2nd meeting: trip to good example.

(e) 3rd meeting: PCM list up project components, decide on future vision. Project components may include following actions.

- Storage and gathering of house garbage for prevention of odor
- Removal of plants and garbage, and dredging of the bottom mud in watercourse (tertiary drainage channel and tertiary to the house drainage level) every 4 months, for smoother water flow and to control the odor. Collected garbage and mud should be treated appropriately for dumping
- Setting a public sign for prevention of garbage dumping to appeal the public about the community's effort
- Holding inter-neighbourhood meeting to understand different needs and perception about one drainage (inland, riverside)
- Hygienic and public moral education to children at schools.

(f) Commencement of the project

(g) Evaluation meetings in every 2 months.

(h) Final meeting for the model project

(i) Summarize and share the obtained know-how for future phase. Formulate project terms for the following standard implementation.

(3) Standard Implementation

Follow the project procedure learned from the model project, two or three projects in one two-year term are recommended to conduct. By the year 2020, eight implementations, 19 drainage systems, may be covered by the improvement project.

In the standard implementation, it is important to include a visit to the community that already experienced the project, so that participants in the new project can directly communicate with the people who already experienced the difficulties and rewards of the improvement work.

Implementation schedule and cost of this program is described in **8. IMPLEMENTATION, COST ESTIMATES AND PROJECT EVALUAITON**.

6.2.3 Riverine Areas Conservation Program

Boundary of river area (right-of-way) and conservation of the area are declared in Ministerial Regulation of Ministry of Public Works No.63/PRT/1993. The boundary of the river area is not clear in everywhere. River areas in the urban cities are sometimes not controlled and the environmental condition is worst with illegally built houses and dumping of garbage, etc. Conservation of river area is important for urban environment improvement.

Riverine Areas Conservation Program (Program 4-2)

(1) Objective and Leading Agencies

The objective of the program is to conserve the river function of floodwater retention in wet season and to allow smooth flow of the water to avoid inundation in the city.

Palembang Municipality BAPPEDA, in cooperation with Provincial BAPPEDA, and the Municipality social workers shall be the leading institutions.

(2) Activities

Three years for preparation of local land use ordinance, and regular budget for monitoring and implementation of the ordinance afterward shall be considered.

Palembang Municipality is recommended to prepare local land use regulation and enforce it. The regulation must include the following guidelines.

- Recognition of the river area. A map shall be prepared that shows each structures outside of the riverbank or outer-most linear structure like roads. Scale of the map shall be 1:2,500 to 1:5,000.
- Prohibition of landfill in the river area shall be declared in the land use ordinance. Existing landfill is recommended to be removed by the owner of the structure.
- Limitation of architectural structure type in the river area shall be declared. The houses in the river area must be built on pillars tall enough to allow free flow of water in the wet season. Proposed team organization is shown in **Table H6.2.1.**

Table H6.2.1 Proposed Team Organization

Item	Detail Item	Municipality			Province
		BAPPEDA		Social Workers	BAPPEDA
		Map Operators	City Planners		
River area identification	Preparation of preliminary river area map	5			
	On-site survey	1	4	1	
	River area map improvement	2			
	Identification of location with problems		4	1	
	Preparation of river area ordinance		2		1
River area conservation	Information meeting with communities		4	4	1
	Monitoring of construction activities		2	1	
	Enforcement of order of recovery at problematic sites		2	1	

(3) Guiding Principles

Houses in the river area of the Musi River have been used as affordable housing in Palembang City. Although these houses may interrupt the flow of the water in the river, it will be socially difficult to remove the houses in a short time period. The City government is recommended to implement land use regulation on the river area to control the style of construction work to minimize impact on the river flow. Recommended stilt house with approach road is shown in **Photo H6.2.1**.

The experiment of Palembang City shall be applied to other large cities and towns on major tributaries, such as Muararupit, Muarabeliti, Lubuklinggau, Lahat, and Baturaja.

Photo H6.2.1 Stilt House with Approach Road

(4) Target area

Target area is the area along the Musi, Ogan, and Komering rivers in Palembang City. The total length of the rivers within the city limit is approximately 22.5 km. According to the Land Use Regulation of Palembang City, the river area is designated as the area within 15 meters from the top of the riverbank. Therefore, the target area is estimated to be 0.675 km^2 (or 67.5 ha).

The house density in the above area is assumed to be 13,333 house/km^2 (or 133 house/ha). Thus, the number of houses within the target area is estimated to be 9,000 houses (households).

(5) Implementation Schedule

Implementation schedule of riverine areas conservation program is shown in **Figure H6.2.2**.

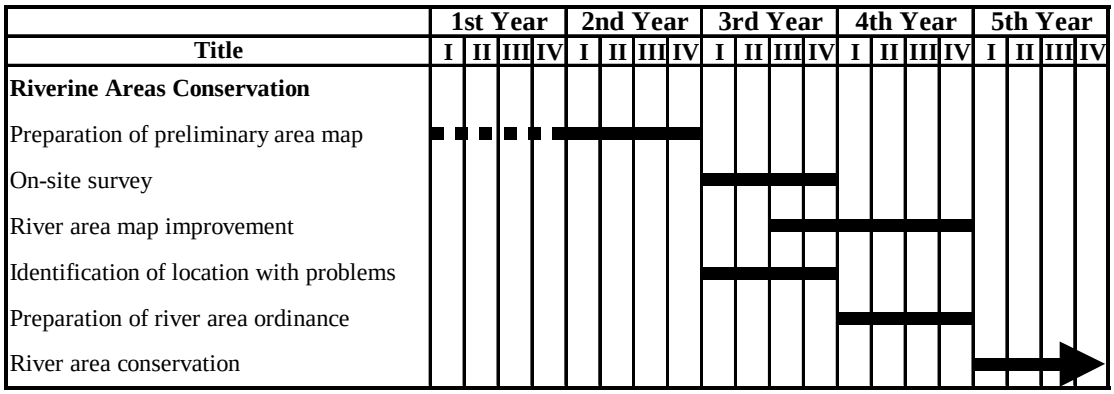


Figure H6.2.2 Implementation Schedule of Riverine Areas Conservation Program

(6) Cost

Project cost should include mapping of the river area. Personnel cost for monitoring land use and advising to the house owners may be covered by regular budget (not by project budget).

Cost of riverine area conservation program is shown in **Table H6.2.2**.

Table H6.2.2 Cost of Riverine Areas Conservation Program

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp.million)
1	**Inventory of Present Condition**				**86**
	Interpreting and analyzing of air photograph(1:60,000)	100,000 ha	11,980,000	7	84
	Making river area map (1:5,000, 3km x 4km, by manual)	sheet	270,000	6	2
2	**Community participation meeting**				**5**
	Community participation meeting	man	25,000	200	5
3	**Indirect Costs**				**9**
	Physical Contingency	l.s.	-		9
	GRAND TOTAL		**(Rp.million)**		**100**
			(US$ million eq.)		**0.011**
			(Yen million eq.)		**1.4**

6.2.4 Trunk Drainage Channels Rehabilitation Program

Maintenance of trunk drainage channels, primary and secondary channels, is under the responsibility of Dinas PU Pengairan of Kota Palembang. There are a total of 19 drainage systems in Palembang Municipality. Though the trunk channels have been improved in major drainage basins in the City center, deterioration of the facilities and deposition of mud are identified in almost all channels. Due to the lack of budget, proper maintenance for the existing drainage channels have not been conducted. Strengthening of the capability of the regular maintenance of the structures shall be a prerequisite to the new construction of the facilities.

Trunk Drainage Channels Rehabilitation Program (Program 4-3)

(1) Objective and Leading Agency

The objective is to establish the system for the drainage system rehabilitation. Drainage system improvement proposed in the **Program 4-4** can be implemented when such rehabilitation system is established and start functioning. Dinas PU Pengairan of Kota Palembang is the leading agency for this program.

(2) Activities

Rehabilitation program consists of excavation of garbage and mud and rehabilitation of trunk drainage channel (primary and secondary drainage channel). This program improves capacity of drainage channels and sanitary condition, and scenery in the city.

Implementation schedule and cost of this program is described in **8. IMPLEMENTATION, COST ESTIMATES AND PROJECT EVALUAITON**.

6.2.5 Drainage System Improvement Program

One of the water environment problems in urban area is storm water inundation. The present study identified that Palembang has this inundation problem. The detailed study has been conducted to minimize storm water inundation in Palembang.

(1) Capacity of Existing Drainage System

The drainage system in Palembang City is divided into 19 drainage systems as shown in **Annex H3.2.1**. Each system consists of structures, e.g. detention ponds, primary channels, secondary channels, and tertiary channels. The present flow capacities of the 19 drainage systems are studied.

As the boundary condition, high tide water level of the Musi River has been determined as follows: In the rainy season, the high water level of the Musi River is +1.8 m above mean sea level, and the mean water level is +1.05 m. Duration of higher water level than mean water level is about 12 hours. The average water level during the 12 hours was estimated at +1.6m above mean sea level, and this value was used for the downstream boundary water level.

The flow capacity of each drainage system was checked by non-uniform flow calculation. In this Study, the Team conducted longitudinal and cross-sectional survey for the channels except those of drainage system 1, 2, 3, 12, 13, 18 and 19. The result of the survey was used for the calculation. For the drainage systems where the survey was not conducted, longitudinal profile was obtained from the final report of ADB LOAN 1383 INO, and typical cross sections were applied. Capacities of the 19 drainage systems are shown in **Table H6.2.3**.

Table H6.2.3 Present Capacity of Major Drainage Channels

No.	Drainage System	Catchment Area (km^2)	Channel Capacity (m^3/s)
1	Gandus	23.9	14.6
2	Gasing	52.1	46.2
3	Lambidaro	50.5	14.7
4	Boang	8.7	23.7
5	Sekanak	11.4	20.0
6	Bendung	19.2	20.0
7	Lawang Kidul	2.3	7.3
8	Buah	10.4	8.1
9	Juaro	6.9	21.0
10	Batang	5.6	10.4
11	Selincah	4.8	1.8
12	Borang	71.2	67.6
13	SP. Nyiur	22.9	35.0
14	Sriguna	4.9	8.4
15	Aur	6.6	27.1
16	Kedukan	9.3	28.2
17	Jaka Baring	37.1	11.2
18	Kertapati	25.0	6.2
19	Keramasan	30.1	6.6

(2) Improvement Plan for the 19 Drainage Systems

The design scale for the drainage improvement of Palembang City has been determined at 15-years referring to the criteria for selection of the appropriate return period for drainage planning in Flood Control Manual (Volume 1, Project No. WSTCF 091/011).

Design hydrograph was determined for each drainage system based on the future land use in the target year 2020 (based on the development plan of the year 2009).

Shortage capacities of 19 drainage systems are estimated as excess volume of the design hydrograph against the present channel capacity. The excess volumes of each drainage system and applicable measures are tabulated in **Table H6.2.4**.

Table H6.2.4 Excess Volume and Applicable Measures

Drainage System	Excess volume (m^3)	Counter Measures
Gandus	125,000	Use swamp as detention pond
Gasing	96,000	Use swamp as detention pond
Lambidaro	38,000	Use swamp as detention pond
Boang	0	
Sekanak	2,000	Drainage channel improvement
Bendung	100,000	Drainage channel improvement
Lawang Kidul	3,000	Drainage channel improvement
Buah	104,000	Drainage channel improvement
Juaro	0	
Batang	0	
Selincah	69,000	Use swamp as detention pond
Borang	56,000	Use swamp as detention pond
SP. Nyiur	0	
Sriguna	2,000	Drainage channel improvement
Aur	0	
Kedukan	0	
Jaka Baring	0	
Kertapati	183,000	Use swamp as detention pond
Keramasan	474,000	Use swamp as detention pond

Capacity of drainage systems of 1, 2, 3, 5, 6, 7, 8, 11, 12, 14, 18 and 19 is not enough for the design hydrograph. In these drainage systems, however, 5, 7 and 14 drainage systems are not so serious. Many swamps are located in the drainage systems in the outer side of the City, namely, 1, 2, 3, 11, 12, 13, 18 and 19. These swamps can be expected as detention ponds, when they are conserved by existing city regulation. (In article 10 of Palembang City law as Swamp conservation, swamp reclamation can only be done for 50% of total development area in case the development area is 1,000 m^2 or more. Type of buildings that can be built on swamp area is kinds of stilted type buildings.)

According to the land use plan for 2009, drainage systems 1, 2 and 19 are agriculture and swamp area. Drainage system 3 is swamp-housing area. Drainage system 11 and 13 are industry and agriculture area. Drainage system 12 is housing, agriculture and swamp area. Drainage system 18 is industry, commerce and forest area. According to land use study, land use on 2020 is almost same as the plan on 2009. Therefore, the swamps can be used as measures of the drainage systems of 1, 2, 3, 11, 12, 13, 18 and 19 until 2020.

In drainage system 17, there are two existing ponds with a total area of 4 ha, and a 40 ha pond inclusive of areas and drainage systems are under construction for the sports center area. Therefore, no problem of drainage exists in drainage system 17. No serious problems can be found in drainage system 4, 9, 10, 15 and 16 as the systems' trunk channel capacities are still sufficient.

Conversely, drainage system 6 and 8 suffer serious problems because of the insufficiency of the systems' trunk channel capacities. Drainage system 6 area is of the commercial and residence area. There is no more space to widen the channel, and no large areas for detention pond are available. Dredging the channel bed and/or heightening the channel wall in low land area are considered to be the applicable way.

Many residence and a fertilizer factory are located in drainage system 8. There is no more space to widen the channel, but some areas to function as detention pond was identified. Dredging the channel bed and heightening the channel wall in low land area is also required.

In consideration of the above, drainage system 6 and 8 are selected as the proposed project areas for further study.

(4) Improvement Plan for Drainage System 6

Drainage system 6 is shown in **Annex H6.2.1**. Present channel alignment was not changed in the proposed plan. Design discharge distribution of Bendung channel for the design scale of 15-year return period is shown in **Figure H6.2.3**.

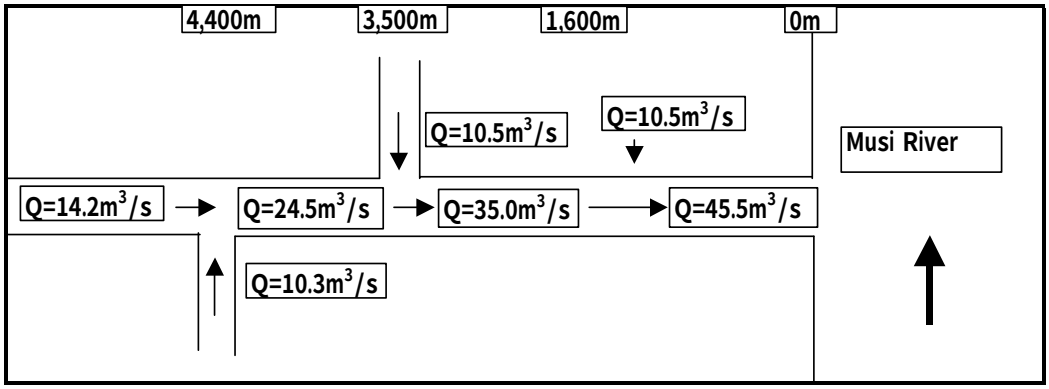


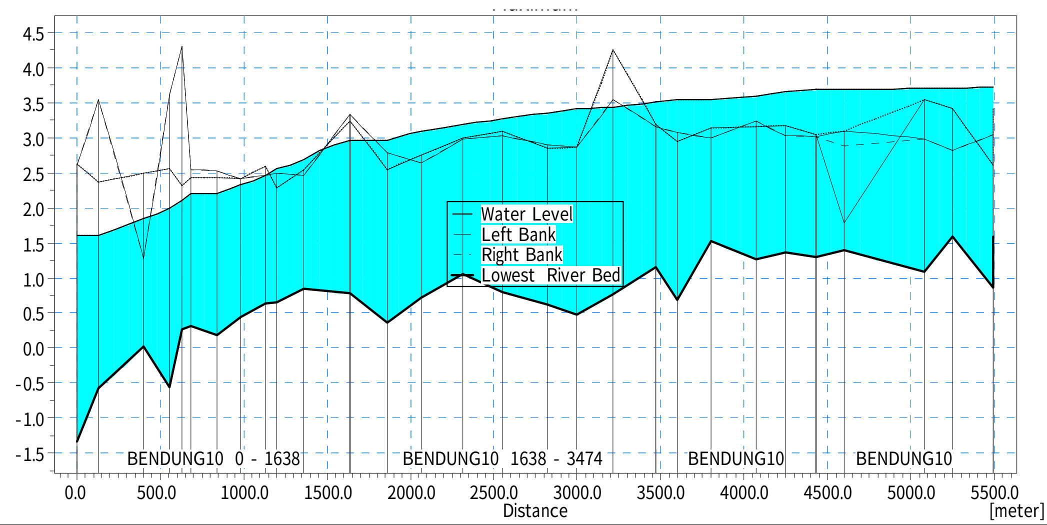
Figure H6.2.3 Design Discharge Distribution of Bendung Channel

(a) Alternative-1

In this alternative, no change in longitudinal profile is proposed. Channel wall heightening to the design high water level was proposed. The total length of channel wall heightening stretch is 14 km including branch channel. A concrete parapet wall is applied. Work volume is as follows:

- 0.5m heightening: 3,400m long, 1,190m^3 concrete volume
- 1.0m heightening: 11,200m long, 7,840m^3 concrete volume

One bridge should be raised. Drainage sluices should be installed at about 500m intervals in low ground level area. During high water level of this drainage channel, rainwater cannot drain into the channel at area along the channel because of high-level channel. Proposed profile is presented in **Figure H6.2.4.**

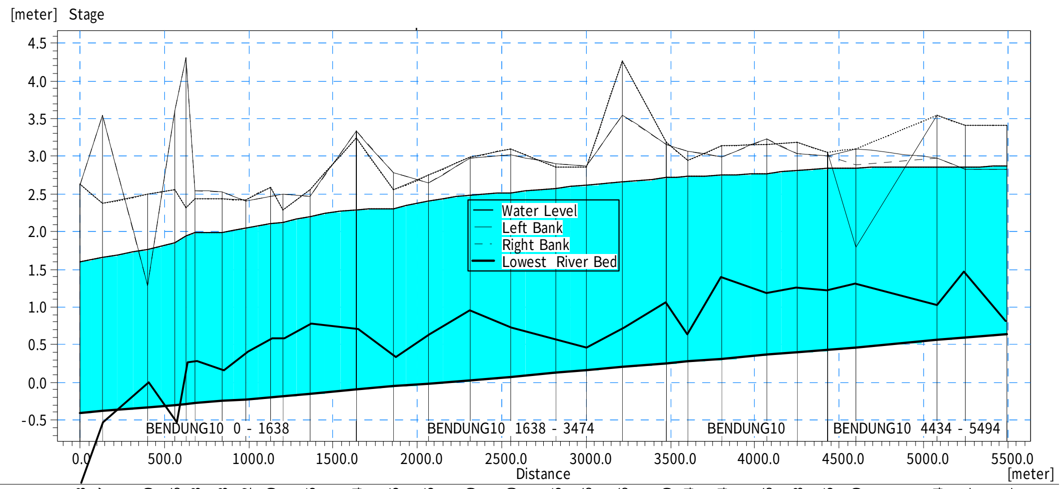


Left Bank	2.630	2.370	2.490	2.560	2.430	2.430	2.420	2.590	2.550	3.240	2.550	2.750	2.990	3.100	2.850	2.860	4.260	3.190	2.940	3.140	3.160	3.180	3.050	1.790	3.540	3.410	3.410
Right Bank	2.610	3.540	1.290	3.610	2.540	2.530	2.410	2.470	2.470	3.330	2.780	2.640	2.980	3.020	2.900	2.870	3.550	3.160	3.070	2.990	3.230	3.030	3.010	2.890	2.980	2.820	2.820
Lowest River Bed	-1.340	-0.580	0.020	-0.560	0.320	0.180	0.440	0.640	0.850	0.780	0.360	0.720	1.060	0.800	0.620	0.480	0.760	1.150	0.690	1.520	1.260	1.370	1.300	1.390	1.090	1.590	1.590

Figure H6.2.4 Proposed Profile for Alternative-1

(b) Alternative-2

Alternative-2 proposes excavation of channel bed by 1 m in average and smoothing of the longitudinal profile. Stone masonry protection works are employed to protect the existing revetment. Proposed profile for Alternative-2 presented in **Figure H6.2.5.**



Left Bank	2.63	2.37	2.49	2.56	2.43	2.43	2.42	2.59	2.55	3.24	2.55	2.75	2.99	3.10	2.85	2.86	4.26	3.19	2.94	3.14	3.16	3.18	3.05	1.79	3.54	3.41	3.41
Right Bank	2.61	3.54	1.29	3.61	2.54	2.53	2.41	2.47	2.47	3.33	2.78	2.64	2.98	3.02	2.90	2.87	3.55	3.16	3.07	2.99	3.23	3.03	3.01	2.89	2.98	2.82	2.82
Lowest River Bed	-0.41	-0.38	-0.33	-0.30	-0.28	-0.25	-0.22	-0.19	-0.15	-0.10	-0.05	-0.02	0.03	0.08	0.13	0.16	0.20	0.25	0.28	0.31	0.37	0.40	0.44	0.47	0.56	0.59	0.64
Distance	0	133	400	558	683	843	980	1128	1360	1638	1860	2066	2315	2553	2820	3000	3215	3474	3600	3800	4070	4250	4434	4598	5082	5250	5494

Water Level: 1.60 1.65 1.69 1.73 1.77 1.81 1.86 1.99 1.99 1.99 2.04 2.11 2.16 2.19 2.24 2.27 2.29 2.30 2.35 2.41 2.44 2.46 2.48 2.49 2.51 2.52 2.54 2.56 2.57 2.60 2.62 2.65 2.68 2.70 2.72 2.72 2.74 2.75 2.75 2.76 2.77 2.80 2.82 2.83 2.84 2.85 2.85 2.85 2.85 2.85 2.85 2.86 2.86 2.86 2.86 2.87 2.87

Figure H6.2.5 Proposed Profile for Alternative-2

An average depth of 1.0 m and the total length of 8,990 m including branch channel give the total dredging volume at 110,000m^3. Stone masonry works is about 32,400 m^3. Work item and quantity of Alternative-1 and 2 are shown in **Table H6.2.5**. Alternative-2 has finally been selected for the proposed plan.

Table H6.2.5 Comparison of Works for Alternative-1 and 2

No	Work Item	Unit	Drainage System-6	
			Alternative-1	Alternative-2
			Q'ty	Q'ty
1	**Direct Works**			
	Bed excavation work	m^3		110,000
	Concrete wall	m^3	9,030	
	Protection of revetment	m^3		32,400
	Drainage sluice work			
	- DS type-(1m x 1m)	pcs	20	
	Bridge rising work			
	- Br. type- (w = 7.0 m)	l.s.	1	
	Drainage pump (0.15m3/s x 4)	l.s.	1	
	Miscellaneous work	l.s.	1	1
2	**Land Acquisition**			
	Residential Land	m^2	-	-
Cost	**(Rp.million)**		30,116	25,883
	(US$ million eq.)		3.3	2.9
	(Yen million eq.)		406.7	349.5

Planned longitudinal profile of channel bed and typical cross section are shown in **Annex H6.2.2.**

(5) Improvement Plan for Drainage System 8

Drainage System 8 is shown in **Annex H6.2.3**. Present channel alignment was not changed in the proposed plan. Design discharge distribution of Buah channel for the design scale of 15-year return period is shown in **Figure H6.2.6**.

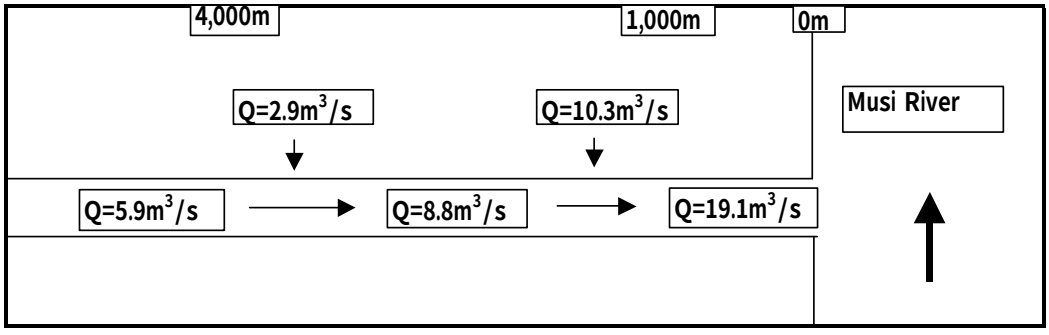


Figure H6.2.6 Design Discharge Distribution of Buah Channel

(a) Alternative-1

In this alternative, no change in longitudinal profile is proposed. Channel bed excavation at the mouth of the channel and the channel wall heightening to the design high water level was proposed. The total length of the channel wall heightening stretch is 9 km. A concrete parapet wall is applied. Proposed profile for Alternative-1 is in **Figure H6.2.7**.

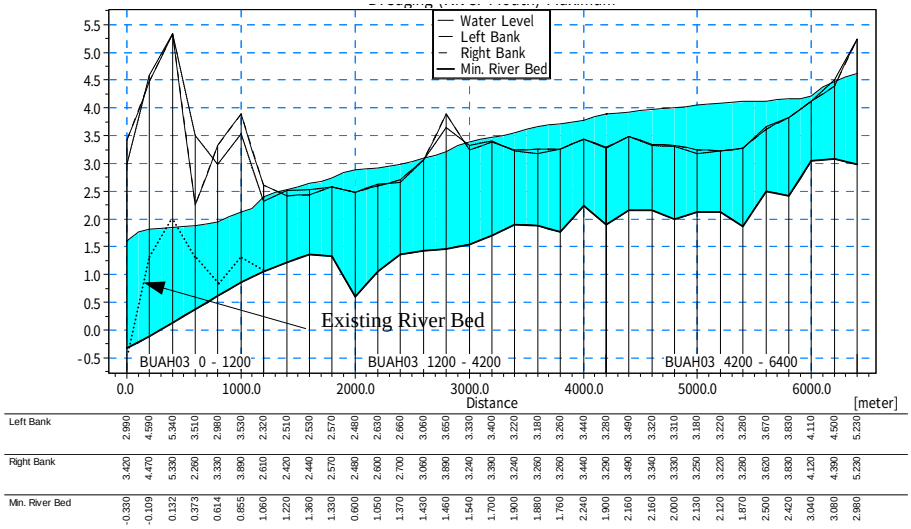


Figure H6.2.7 Proposed Profile for Alternative-1

Work volume of the concrete wall is as follows:

- 0.5m heightening: 6,200m long, 2,170m^3 concrete volume
- 1.0m heightening: 3,000m long, 2,100m^3 concrete volume
- Dredging along the 1,200m stretch from the channel mouth toward upstream is proposed. Dredging depth and volume is calculated at 1.0m and 13,200 m^3 respectively.

(b) Alternative-2

In this alternative, no change in longitudinal profile is proposed. Channel bed excavation at the mouth of the channel, introduction of detention pond, and the channel wall heightening to the design high water level were proposed.

Similar to the Alternative1, the Alternative 2 also proposes dredging works along the 1,200m reaches from the river mouth toward upstream.

- Dredging depth and volume are calculated at 1.0m and 13,200 m^3

Some areas located at 2-3 km and 3.5-4 km from the channel mouth toward upstream can be used for detention ponds. Detention ponds of a total of 4 ha are proposed to be newly established as follows:

- 2-3 km reaches: 2 ha
- 3-4 km reaches: 2 ha

High water level of channel is presented in **Figure H6.2.8**. Installation of detention ponds of 4 ha is effective against installation area of detention ponds, but is not so effective against upper reaches. High water level is still higher than the ground level of upper reaches. Channel wall heightening is needed.

- 0.5m heightening: 3,200m long, 1,120m^3 concrete volume
- 1.0m heightening: 2,400m long, 1,680m^3 concrete volume
- One bridge should be raised

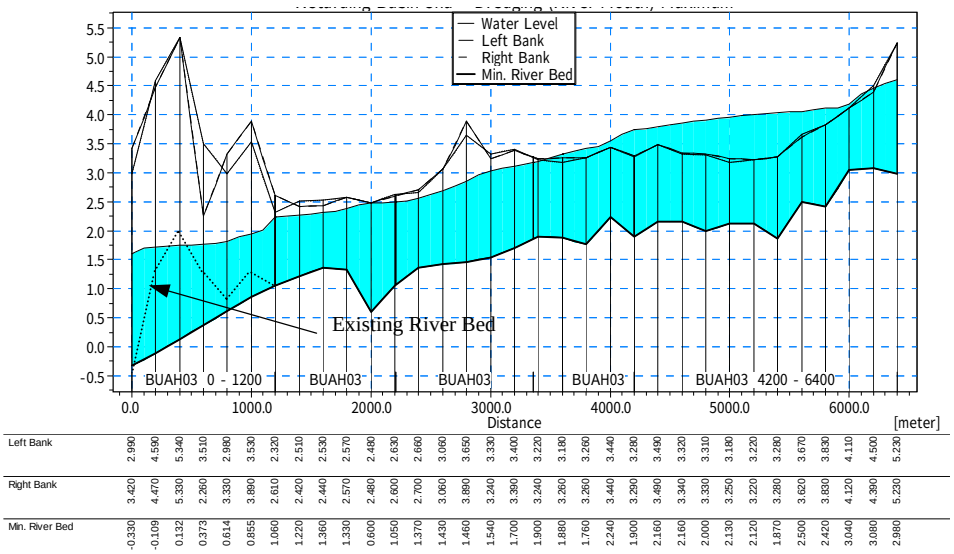


Figure H6.2.8 Proposed Profile for Alternative-2

(c) Alternative-3

In this alternative, channel bed excavation at the mouth of the channel, excavation of channel bed by 0.5 m in average and smoothing of the longitudinal profile, and channel wall heightening at critical location were proposed.

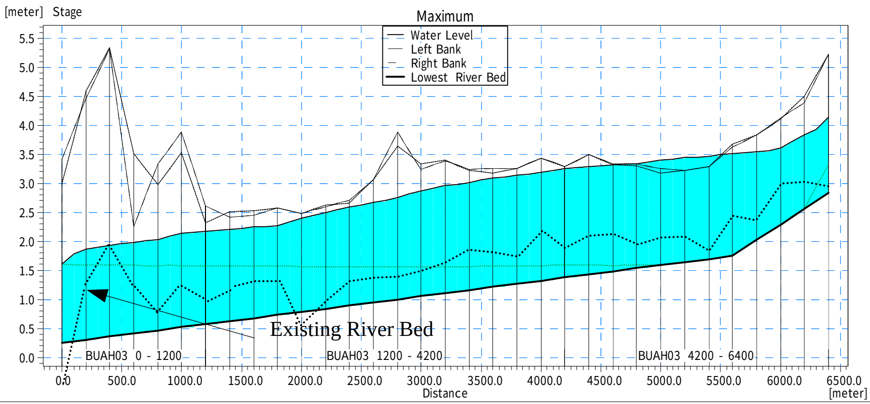
Similar to the Alternative1, the Alternative 2 also proposes dredging works along the 1,200m reaches from the river mouth toward upstream.

About channel bed excavation, 1m dredging is difficult because of narrow channel width (5m), and 0.5m dredging is possible.

Even with this channel mouth excavation and channel bed excavation, some stretches of the riverbank are not high enough to the design high water. Channel wall heightening was proposed at these critical points. Work volume is as follows:

- For 0.5 m depth of dredging and total length reaches of 6,400m from river mouth toward upstream, the dredging volume is turned out to be 25,000m^3.
- Stone masonry protection works are employed to protect the existing revetment. The works volume is about 6,800m^3.
- 0.5m heightening: 1,400m length, 420m^3 concrete volume

Proposed profile is shown in **Figure H6.2.9**.



Distance	Left Bank	Right Bank	Lowest River Bed	Water Level
0	2.99	3.42	0.25	1.60
				1.78
200	4.59	4.47	0.30	1.86
				1.90
400	5.34	5.33	0.36	1.94
				1.96
600	3.51	2.26	0.41	1.99
				2.01
800	2.98	3.33	0.46	2.03
				2.10
1000	3.53	3.89	0.52	2.14
				2.15
1200	2.32	2.61	0.57	2.17
				2.19
1400	2.51	2.42	0.63	2.20
				2.23
1600	2.53	2.44	0.68	2.25
				2.26
1800	2.57	2.57	0.73	2.27
				2.34
2000	2.48	2.48	0.79	2.39
				2.45
2200	2.63	2.60	0.84	2.50
				2.54
2400	2.66	2.70	0.89	2.59
				2.63
2600	3.06	3.06	0.95	2.67
				2.70
2800	3.65	3.89	1.00	2.75
				2.82
3000	3.33	3.24	1.05	2.87
				2.92
3200	3.40	3.39	1.11	2.96
				2.99
3400	3.22	3.24	1.16	3.02
				3.06
3600	3.18	3.26	1.21	3.09
				3.11
3800	3.26	3.26	1.27	3.13
				3.16
4000	3.44	3.44	1.32	3.19
				3.22
4200	3.28	3.29	1.38	3.25
				3.27
4400	3.49	3.49	1.43	3.29
				3.31
4600	3.32	3.34	1.48	3.32
				3.33
4800	3.31	3.33	1.54	3.34
				3.37
5000	3.18	3.25	1.59	3.40
				3.42
5200	3.22	3.22	1.64	3.44
				3.46
5400	3.28	3.28	1.70	3.47
				3.49
5600	3.67	3.62	1.75	3.51
				3.52
5800	3.83	3.83	2.02	3.54
				3.56
6000	4.11	4.12	2.29	3.61
				3.73
6200	4.50	4.39	2.56	3.83
				3.94
6400	5.23	5.23	2.83	4.15

Fgure H6.2.9 Proposed Profile for Alternative-3

Work item and quantity of Alternative-1, 2 and 3 are compared in **Table H6.2.6**. Alternative-3 has been selected. Planned longitudinal profile of channel bed and typical cross section are shown in **Annex H6.2.4.**

Table H6.2.6 Comparison of Works for Alternative-1, 2 and 3

No	Work Item	Unit	Drainage System-8		
			Alternative-1	Alternative-2	Alternative-3
			Q'ty	Q'ty	Q'ty
1	**Direct Cost**				
	Bed excavation work	m^3	1,200	133,200	25,000
	Sodding of pond area	m^2		40,000	
	Concrete wall	m^3	4,270	2,800	420
	Protection of revetment	m^3			6,800
	Drainage sluice work				
	- DS type-(1m x 1m)	pcs	20	12	8
	Revetment of pond	m		1,600	
	Bridge rising work				
	- Br. type- (w = 7.0 m)	l.s.		1	
	Drainage pump (0.15m3/s x 4)	l.s.	1		
	Miscellaneous work	l.s.	1	1	1
2	**Land Acquisition**				
	Residential Land	m^2		40,000	
Cost	**(Rp.million)**		19,991	25,883	6,399
	(US$ million eq.)		2.2	2.9	0.7
	(Yen million eq.)		270.0	349.5	86.4

(6) Drainage System Improvement Program (Program 4-4)

The Study Team examined the present capacity, degree of inundation damage, and urgency of improvement of existing 19 drainage systems in Palembang Municipality. Two drainage systems, namely, Bendung Drainage System (System No.6) and the Buah Drainage System (System No.8), have finally been selected for early implementation.

Drainage improvement of Bendung Drainage system is as follows: The total stretch of the primary channels in the Bendung Drainage System is approximately 9 km. Alignment of the present channels has not been changed in the proposed plan. Longitudinal plan proposes average 1 m deep excavation and smoothing of the riverbed. Proposed cross section of the channel maintains the existing concrete wall and excavation/dredging is proposed in the riverbed. Stone masonry protection works are proposed to protect the existing concrete revetment

Drainage improvement of Buah Drainage System is as follows: The total stretch of the primary channel is about 6.4 km. Alignment of the present channels has not been changed in the proposed plan. Longitudinal plan proposes average 0.5 m riverbed excavation and smoothing. In the proposed section, concrete revetment is maintained as present condition and stone masonry protection works are proposed to protect it from sliding after the excavation.

(7) Implementation Schedule

Implementation schedule of drainage system improvement program is shown in **Figure H6.2.10**.

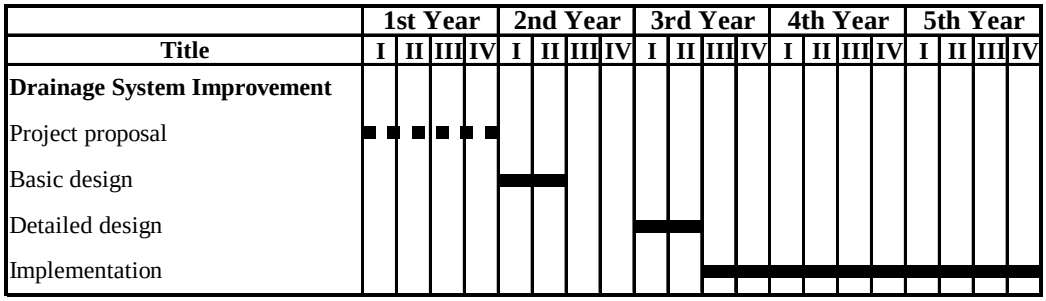


Figure H6.2.10 Implementation Schedule of Drainage System Improvement Program

(8) Cost

Cost of drainage system improvement program is shown in **Table H6.2.7**.

Table H6.2.7 Cost of Drainage System Improvement Program

No	Work Item	Unit	Unit Price (Rp.)	Drainage System-6		Drainage System-8	
				Q'ty	Amount (Rp.million)	Q'ty	Amount (Rp.million)
1	**Direct Cost**				**19,609**		**4,848**
	Excavation work	m^3	22,500	110,000	2,475	25,000	563
	Concrete work	m^3	700,000		0	420	294
	Protection of revetment	m^3	500,000	32,400	16,200	6,800	3,400
	Drainage sluice (1m x 1m)	pcs	45,000,000			8	360
	Miscellaneous work	l.s.			934		231
2	**Land Acquisition**				**0**		**0**
	Residential Land	m^2	75,000	0	0	0	0
3	**Indirect Costs**				**6,274**		**1,551**
	Administration Cost	l.s.	-		980		242
	Eng. Services Cost	l.s.	-		2,941		727
	Physical Contingency	l.s.	-		2,353		582
	GRAND TOTAL		**(Rp.million)**		**25,883**		**6,399**
			(US$ million eq.)		**2.9**		**0.7**
			(Yen million eq.)		**349.5**		**86.4**

(9) Economic Analysis

Results of economic analysis indicated that the project for Bendung System has rather low economic efficiency with EIRR of 11%. However, the project for Buah System has good economic efficiency with EIRR of 19.3%, which is by far higher than the opportunity cost of capital in Indonesia (12%), while implementation of both the projects also indicated sufficient economic efficiency

with EIRR of 12.6%. Economic analysis of this program is shown in the Table H6.2.8. Detail is described in Annex H6.2.5.

Table H6.2.8 Economic Analysis of Drainage System Improvement Program

Project	EIRR (%)	B/C ratio	NPV (Rp. million)
1. Bendung system	11.0	0.91	-1,389
2. Buah system	19.3	1.69	2,451
3. Both Bendung & Buah systems	12.6	1.06	1,062

7. SELECTION OF PRIORITY PROGRAMS

7.1 Criteria for Selection of Priority Programs

Various programs have been identified and proposed in order to achieve the objectives of each component. Since a lot of input of fund and human resources is necessary for the implementation of these programs, priority of each program should be judged, and the implementation plan in accordance with the priority has been prepared.

Priority in this Study has been decided based on the following categories:

- Prerequisite to the other programs
- Degree of seriousness
- Requirement of early start
- Economic feasibility, cost scale etc.

7.2 Priority Programs for Floodplain Management

As a result of study on the component of floodplain management in the previous chapter, the following three programs were developed:

- Land use and zoning program
- Flood forecasting and warning program
- Sustainable channel management program

Discussions were made to give priority on the above programs for their implementation as presented below.

Deterioration of the river regime will worsen the water deficit situation in the water balance in the Musi River Basin. Thus, the conservation of floodplains through zoning for land use control and building control, and the maintenance of the present river regime is a basin wide request. Furthermore, land use control and building control in the zoned area should be started as early as possible, since the uncontrolled development may progress due to the absence of the zone. Land use and zoning program should be given higher priority.

Flood forecasting and warning program needs more investigation at each site. Sustainable channel management program shall be conducted with the continuous and sustainable manner by Dinas PU Pengairan of South Sumatra. Thus the priority of these two programs in the comprehensive water management is judged low. Priority of floodplain management (Component 2 of the Master Plan for Musi River Basin Comprehensive Water Management) is shown in **Table H7.1.1**.

Table H7.1.1 Priority of Floodplain Management

	Programs of Floodplain Management	Prerequisite to Other Programs	Degree of Seriousness	Requirement of Early Start	Cost Scale	Total	Priority Order
1	Land Use and Zoning (Program 2-1)	5	3	5	5	18	1
2	Flood Forecasting and Warning (Program 2-2)	1	3	5	5	14	2
3	Sustainable Channel Management (Program 2-3)	1	3	5	3	12	3

Note) Score 5 (High Priority); 3 (Middle Priority); 1 (Low Priority)

Thus land use and zoning program (Program 2-1) was selected as priority project of floodplain management (Component 2).

7.3 Priority Programs for Urban Water Environment Improvement

As a result of study on the component of urban water environment improvement in the previous chapter, the following four programs were developed:

- Community drainage management program
- Riverine area conservation program
- Trunk drainage channel rehabilitation program
- Drainage system improvement program

Discussions were made to give priority on the above programs for their implementation as presented below.

Community drainage management program is high degree of seriousness and low cost scale. This program needs early start also.

Riverine area conservation program shall be conducted with the continuous and sustainable manner by Palembang Municipality.

Trunk drainage channel rehabilitation program shall be conducted with the continuous and sustainable manner by Palembang Municipality. This program is high degree of seriousness and needs early start.

Drainage system improvement program shall be conducted with the continuous and sustainable manner by Palembang Municipality.

Thus the priority of riverine area conservation program and drainage system improvement program in the comprehensive water management is judged low.

Priority of urban water environment (Component 4 of the Master Plan for Musi River Basin Comprehensive Water Management) is shown in **Table H7.2.1**.

Table H7.2.1 Priority of Urban Water Environment Improvement

	Programs of Urban Water Environment Improvement	Prerequisite to Other Programs	Degree of Seriousness	Requirement of Early Start	Cost Scale	Total	Priority Order
1	Community Drainage Management (Program 4-1)	3	5	5	5	18	1
2	Riverine Areas Conservation (Program 4-2)	1	3	3	5	12	3
3	Trunk Drainage Channels Rehabilitation (Program 4-3)	3	5	5	3	16	2
4	Drainage System Improvement (Program 4-4)	3	3	3	3	12	3

Note) Score 5 (High Priority); 3 (Middle Priority); 1 (Low Priority)

Thus two programs, community drainage management program (Program 4-1) and trunk drainage channels rehabilitation program (Program 4-3), were selected as priority projects of urban water environment improvement (Component 4).

8. IMPLEMENTATION, COST ESTIMATES AND PROJECT EVALUATION

8.1 Implementation Schedule

8.1.1 Land Use and Zoning Program

Implementation schedule of land use zoning program is shown in **Figure H8.1.1**.

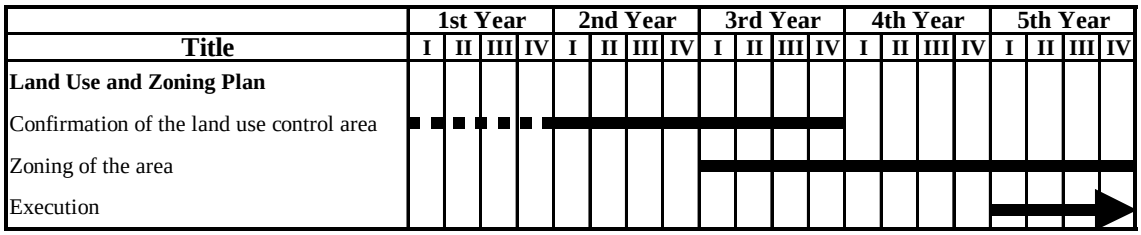


Figure H8.1.1 Implementation Schedule of Land Use and Zoning Program

8.1.2 Community Drainage Management Program

Implementation schedule of community drainage management program is shown in **Figure H8.1.2**.

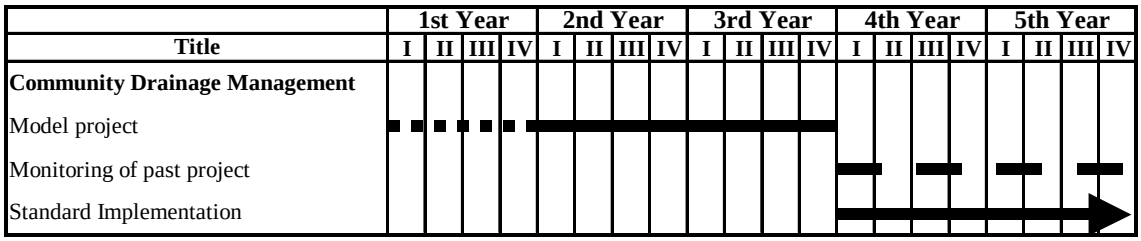


Figure H8.1.2 Implementation Schedule of Community Drainage Management Program

8.1.3 Trunk Drainage Channel Rehabilitation Program

Drainage system of central commercial area is carried out at beginning stage as model project. Implementation schedule of trunk drainage channel rehabilitation program is shown in **Figure H8.1.3**.

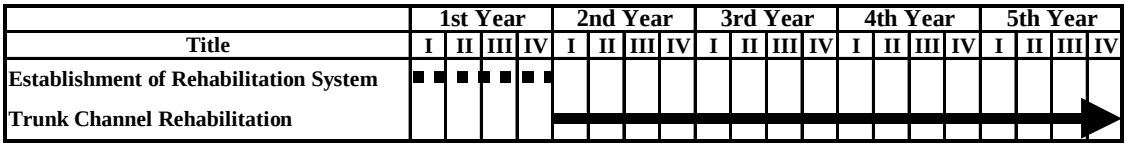


Figure H8.1.3 Implementation Schedule of Trunk Drainage Channel Rehabilitation Program

8.2 Cost Estimates

8.2.1 Land Use and Zoning Program

Program cost of land use and zoning program is shown **Table H8.2.1**.

Table H8.2.1 Cost of Land Use and Zoning Program

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp.million)
1	**Satellite data cost**				**36**
	Satellite data cost	data	9,000,000	4	36
2	**Satellite data processing cost**				**16**
	Satellite data processing cost	data	4,000,000	4	16
3	**Delineation of floodplain boundaries**				**15**
	Delineation of floodplain boundaries	l.s.	15,000,000	1	15
4	**Degitalization**				**4**
	Degitalization	l.s.	4,000,000	1	4
5	**Indirect Costs**				**7**
	Physical Contingency	l.s.	-		7
	GRAND TOTAL		**(Rp.million)**		**78**
			(US$ million eq.)		**0.009**
			(Yen million eq.)		**1.1**

8.2.2 Community Drainage Management Program

Program cost of community drainage management program is shown **Table H8.2.2**.

Table H8.2.2 Cost of Community Drainage Management Program

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp.million)
1	**Establishment of Model Project**				**400**
	Establishment of model project	l.s.	400,000,000	1	400
2	**Indirect Costs**				**40**
	Physical Contingency	l.s.	-		40
	GRAND TOTAL		**(Rp. million)**		**440**
			(US$ million eq.)		**0.049**
			(Yen million eq.)		**5.9**

8.2.3 Trunk Drainage Channel Rehabilitation Program

Excavation volume of sediment including garbage is estimated assuming that sediment depth is 0.3m in trunk channel of 19 drainage systems. Rehabilitation length of channel is estimated as 5 % of total length of primary drainage channel of 19 drainage systems.

Project cost of trunk drainage channel rehabilitation program is shown **Table H8.2.3**.

Table H8.2.3 Cost of Trunk Drainage Channel Rehabilitation Program

No	Work Item	Unit	Unit Price (Rp.)	Q'ty	Amount (Rp.million)
1	**Excavation of Sedimentation**				**7,875**
	Excavation of Sedimentation	m^3	22,500	350,000	7,875
2	**Rehabilitation of Channel**				**20,000**
	Rehabilitation of Channel	m	2,000,000	10,000	20,000
3	**Indirect Costs**				**5,620**
	Administration Cost	l.s.	-		1,394
	Eng. Services Cost	l.s.	-		1,181
	Physical Contingency	l.s.	-		3,045
	GRAND TOTAL	**(Rp. million)**			**33,495**
		(US$ million eq.)			**3.707**
		(Yen million eq.)			**452.3**

8.3 Project Evaluation

8.3.1 Land Use and Zoning Program

(1) Social Evaluation

Positive social impacts are expected to the people of the lower Musi River basin by implementing the Project.

The major positive impacts include: (i) conservation of existing water environment of the floodplain in the lower Musi River basin, (ii) conservation of existing water resource of the floodplain in the lower Musi River basin, and (iii) conservation of existing water quality of the floodplain in the lower Musi River basin. There is no negative impact against the society of the lower Musi River basin.

(2) Economic Evaluation

Implementation of the program may bring about various economic effects, they are nevertheless virtually impossible to value satisfactory in monetary terms.

- Flood condition in the downstream reaches will not be worsen by preventing wanton developments in the floodplain of the mid- and upstream reaches,
- Current agricultural practice in midstream, swamp, and tidal swamp areas can be maintained by conserving the current water conditions,
- Effective investment can be made by zoning the land use control,
- Various kind of pollution can be mitigated by separating housing, industrial, commercial, and agricultural areas by zoning, and

- Natural environment and landscape may be conserved in some area and people can enjoy the environment.

(3) Financial Evaluation

After the regional autonomy and financial decentralization, it will gradually be necessary to implement necessary programs by the local government fund (APBD). Development expenditure of Dinas PU Pengairan was Rp.38 billion in 2002. Out of this, allocation from APBD was Rp.9.7 billion.

The total cost of this program is estimated at Rp.78 million for 2 years. The annual required fund for implementation of the program is approximately Rp.39 million or 0.4% of the development expenditure from APBD of the Service (Dinas). Therefore, the cost will not be a burden on the finance of the department.

From the financial viewpoint, implementation of the program is possible with financial arrangement of the development budget of the department.

(4) Technical Evaluation

The works and activities proposed are lower in cost and shorter in realization of the effects. Technology proposed is able to be performed by the local government. There is no particular problem in technical matter.

(5) Environmental Evaluation

The program aims to conserve existing natural environments. Therefore, it is clear that there is no negative impact to natural environment.

8.3.2 Community Drainage Management Program

(1) Social Evaluation

Positive social impacts are expected to the community people by implementing the Project. The major positive impacts include: (i) improvement of water environment in the community, (ii) improvement of drainage capacities, (iii) strengthening of social solidarity, and (iv) improvement of sanitary conditions.

Through the implementation of the program, community people will improve their understanding on the drainage facilities, their functions and drainage works, which may reduce harmful activities to their facilities. In this manner, the organized people will finally be responsible to regular operations and maintenance of drainage facilities.

The collaborative activities by the organized people will strengthen social solidarity in the community, which will contribute to promote social morality and justice.

No negative impacts to the society are identified.

(2) Economic Evaluation

Implementation of the program may bring about various economic effects, they are nevertheless virtually impossible to value satisfactory in monetary terms.

- Flood damages to houses and household properties can be mitigated by smoother water flow and shorter inundation,
- Waterborne diseases of the children in flood prone areas, which was stated by many residents in the areas, can be mitigated and medical cost can be saved,
- Better drainage and cleaner living environment may avoid inconvenience of people's livelihood and ease people's mental stress caused by habitual inundation,
- Better drainage and shorter inundation may reduce the cost of emergency measures taken by local government for flood fighting and assisting affected people, and
- Community activity with residents participation may give incentive for people to keep the rivers and drainages clean and it may reduce river O&M cost of the local government.

(3) Financial Evaluation

Development expenditure of Palembang Municipality was Rp.100 billion in 2002.

The total cost of this program is estimated at Rp.440 million for 2 years. The annual required fund for implementation of the program is approximately Rp.220 million or 8% of the development expenditure for water resources sector of the Municipality. Therefore, the cost will not be a burden on the finance of the Municipality.

From the financial viewpoint, implementation of the program is possible with financial arrangement of the development budget of the municipality.

(4) Technical Evaluation

There is no particular problem in technical matter, since the program was prepared, in principle, so that the works and activities could be implemented using labours, materials, equipment and techniques available in the community.

(5) Environmental Evaluation

Since the program aims to create favourable urban water environment, it is clear that the program would bring good effects on water quality and odor environment in the drainage channels and rivers.

When local residents are instructed to store house garbages, and when garbage collection by the City does not function well, there is possibility that residents start burning the garbage in open spaces close to their house. Burning mixed garbage at low temperature may cause air pollution, including emission of black smoke, odor, and toxic substances. This negative effect can be prevented by providing sufficient resources (personnel and equipment) for the garbage collection section, so that the garbage can be frequently collected at all parts of the project areas.

8.3.3 Trunk Drainage Channel Rehabilitation Program

(1) Social Evaluation

Positive social impacts are expected to the people of urban area by the Project. The major positive impacts include: (i) improvement of urban water environment, and (ii) decrease of inundation. There is no negative impacts against the society.

(2) Economic Evaluation

Implementation of the program may bring about various economic effects. However, it is rather difficult to value the economic effect satisfactory in monetary terms at this stage. The effects include the following:

- Flood damages to houses and household properties can be mitigated by smoother water flow and shorter inundation,
- Waterborne diseases of the children in flood prone areas, which was stated by many residents in the areas, can be mitigated and medical cost can be saved,
- Better drainage and cleaner living environment may avoid inconvenience of people's livelihood and ease people's mental stress caused by habitual inundation, and
- Better drainage and shorter inundation may reduce the cost of emergency measures taken by local government for flood fighting and assisting affected people.

(3) Financial Evaluation

The total cost of this program is estimated at Rp.33,495 million for 10 years. The annual required fund for implementation of the program is approximately

Rp.3,350 million or 3% of the development expenditure of the Palembang Municipality. Though it is still slightly larger than regular expenditure of the Municipality for water resources sector (approx. Rp.2.7 billion), the cost will not be a burden on the finance of the Municipality.

From the financial viewpoint, implementation of the program is possible with financial arrangement of the development budget of the municipality.

(4) Technical Evaluation

Works of this program are mainly excavation of channel bed and rehabilitation of drainage facilities. The works are not so difficult and can be implemented by the local contractors. There is no particular problem in technical matter.

(5) Environmental Evaluation

This program would bring good effects on the urban environment along the channels.

When there are factories, workplaces, or mills that use toxic substances along the trunk drainage channels, the excavated mud and soil may be polluted by those chemicals by unintentional spill or by washing containers. There is possibility that if such polluted soils are disposed into rivers or on lowland, river and rain water may release toxics from the soil, and surface and ground water may then be contaminated. To avoid such contamination, it is important that the potential of contamination is carefully studied prior to the commencement of the project. When the possibility is reported, the disposal site of the excavated soil must be carefully selected to avoid contamination of drinking ground water and public water bodies that support fishery resources.