

**4. FEASIBILITY STUDY FOR
PRIORITY PROJECTS**

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4.1 Selection of Priority Projects

4.1.1 Criteria for Selection

Economic Target;	EIRR is larger than that of Master Plan value of 14.6%
Financial Target;	The total cost is less than 800 Million Colons
	The construction period can be less than 5 years
Social Target;	The negative impact is small and acceptable, and positive impact (beneficial area) is large
Environment Target;	The negative environment impact is small
Technical Target;	No remarkable difficulty in engineering and construction

4.1.2 Selection Process

1) Structural Measures

A phased implementation with at first a small scaled project and the rest to cope with 10-year flood as second phase was studied, since the cost of the project covered by the Master Plan is high. As the first-phase project, river improvements to cope with 2-year flood, 5-year flood and 10-year flood were compared. The EIRRs are 18.1 %, 15.9 % and 15.2 % respectively. The 2-year flood was selected in view of the size of the project cost and efficiency of flood area reduction as compared in Fig. 4.1.

Thus, the Master Plan project is divided into the following projects.

San Miguel River Improvement, Lower Reach (River mouth - El Delirio)

Improvement to cope with 2-year flood

The Rest of Improvement to cope with 10-year flood

San Miguel River Improvement, Middle Reach (El Delirio - Aramuaca)

Improvement to cope with 2-year flood

The Rest of Improvement to cope with 10-year flood

San Miguel River Improvement, Reach around San Miguel City

(Aramuaca - Urbina Bridge)

Olomega Diversion / Retarding

Flood area reduction by each river improvement project against 10-year flood is summarized below:

Project	Flood Area Reduction
Lower Reach 1 (to cope with, 2-year flood)	26.6 km ² (25.9 %)
Middle Reach 1 including Olomega Diversion / Retarding (to cope with, 2-year flood)	53.9 km ² (51.8 %)
Sub-total	80.5 km ² (77.7 %)
Lower Reach 2, The rest (to cope with, 10-year flood)	15.2 km ² (14.6 %)
Middle Reach 2, The rest (to cope with, 10-year flood)	7.9 km ² (7.6 %)
Upper Reach (to cope with, 10-year flood)	0.4 km ² (0.3 %)
Total	104.0 km ² (100 %)

The rates of flood area reduction of the Lower and the Middle reaches river improvement projects are large and can cover 78 % of the Master Plan value. As shown in Table 4.1, socio-economic, environmental positive impacts of these projects are high while the negative impacts are low.

The River Improvement of the Lower and the Middle reaches and Floodwater Storage in Olomega to cope with 2-year flood are recommended to be priority projects of the structural measures.

2) Non-structural Measures

Non-structural Measure projects in the Master Plan are as follows;

Watershed Management

Watershed Management, Upper Basin (Reforestation)

Watershed Management, Middle Basin (Reforestation / Erosion Control)

Watershed Management, Lower Basin (Reforestation / Erosion Control)

Floodplain Management

Floodplain Management, Estuary Area

Floodplain Management, Jocotal Area

Floodplain Management, Olomega Area

Floodplain Management, San Miguel City Area

The selection of priority projects of non-structural measures was based on the following.

- Among the floodplain management projects, flood forecasting/warning, land use regulation and flood proofing for the areas of San Miguel City, Jocotal and Olomega and education to the residents are selected as priority projects considering the urgency of these.
- Among the watershed management projects, reforestation and erosion control for agricultural area protection have been planned mainly by MAG and partially conducted by CEL in the dam basin. Though these projects are desirable for flood control, main purposes are forestry, agriculture and preservation of nature. Thus, these projects were not selected as priority project for the Feasibility Study. The reforestation and erosion control projects, however, will be required for development and stability of the region. The projects should be started in early stage and continued steadily.

Selected priority projects for non-structural measures are as follows:

Floodplain Management, Jocotal Area

Floodplain Management, Olomega Area

Floodplain Management, San Miguel City Area

Main features of the Priority Projects are shown in Table 4.2. Fig. 4.2 shows the general layout of the Priority Project and Fig. 4.3 shows the area to be protected by the implementation of the Priority Project.

4.2 Outline of Priority Projects

4.2.1 Proposed structural Measure Project

River Improvement (from estuary to Aramuaca)

- Dredging / excavation : 7,444 x 10³ m³ (L = 70 km)
- Dike : 1,173 x 10³ m³ (L = 29 km)
- Revetment : 6,000 m
- Groundsill : 4 places, 229 m
- Bridge : 3 places
- Sluice : 1 place

Diversion / Retarding in L. Olomega

- Excavation / dredging : 591 x 10³ m³
- Diversion weir : 1 place
- Control gate : 1 place, effective span 20 m

The proposed flood control works to cope with 2-year flood are those related to the San Miguel River improvement and floodwater diversion / retarding in Olomega. The design discharge distribution and hydraulic design of the floodwater diversion / retarding are as shown in Figs. 4.4 and 4.5 respectively.

Proposed alignments , longitudinal profiles and typical cross sections of the rivers are shown in Figs 4.6, 4.7 and 4.8 respectively. Typical designs of the major proposed structures are shown in Fig. 4.2.

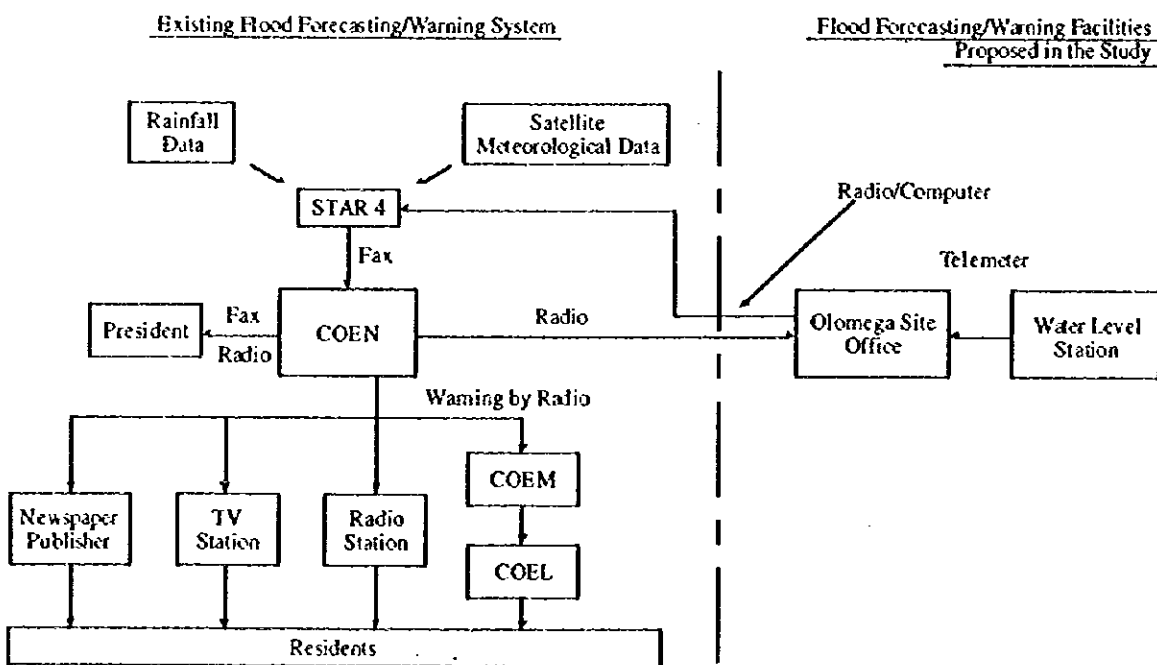
4.2.2 Proposed Non-structural Measure Project

(1) Flood Risk Map

The non-structural measure as Priority Projects is the floodplain management for the areas of San Miguel, Olomega and Jocotal, which includes flood forecasting/warning, land use regulation, flood proofing, and education to the residents.

1) Flood Forecasting / Warning Method

The flood forecasting/warning is proposed based on the following chart.



2) Land Use Regulation and Flood Proofing

Recommended floodplain management plan, by using the flood risk maps, is shown in Fig. 4.10. The areas are classified into three categories as follows;

- ① Areas expected to be not flooded by 10-year flood :
Can be developed for any purpose
- ② Areas not expected to be flooded by 2-year flood, but flooded by 10-year flood :
Can be developed for agricultural and for residential if flood proofing measures are taken
- ③ Areas expected to be flooded by 2-year flood :
Can be used only for low damage potential purposes

The MAG Central Office will undertake the land use regulation / flood proofing by using the flood risk maps prepared in this Study, until the San Miguel Project Office is constructed.

3) Education to the Residents

This is intended for the residents in the flood area under 10-year flood. The contents are briefing of the whole project, flood area as for with/without project, concept of land use regulation and flood proofing, method of flood forecasting/warning and evacuation. The education will be made by the San Miguel Project Office through representatives of the residents in COEL. It is proposed that the education will be made after completion of the detailed design and at the completion of the construction works for the structural measures.

4.3 Cost Estimate

The cost of the structural Priority Project, at the price level of December 1996, was estimated as summarized below:

Unit : Million Colons

Cost Item	L/C	F/C	Total
1. Construction	210.3	223.4	433.7
2. Land acquisition / Compensation	19.2	0	19.2
3. Administration	22.6	0	22.6
4. Engineering Services	25.1	42.8	67.9
5. Physical Contingency	27.7	26.6	54.3
(Sub-total)	(304.9)	(292.8)	(597.7)
6. Price Escalation	123.4	54.8	178.2
Total	428.3	347.6	775.9

Breakedown of the work quantities and the costs are shown in Tables 4.3 and 4.4.

The project cost for non-structural measures of 8.1 Million Colons including five water level stations, telemeter system and Lake Olomega site office is included in the above project cost.

The cost of Floodplain Management is estimated at Colons 8.1 Million for flood forecasting and warning system. This is closely related to the operation of Lake Olomega water level and the cost was included in the cost of structural measures. The cost of land use regulation and flood proofing is not included as it would be a separate project executed by the government by applying subsidy, etc.. The cost of education to the residents is included in the cost of administration in the structural measure costs.

4.4 Operation and Maintenance Plan

Operation and maintenance of the flood control facilities, after construction, will be conducted by MAG as described below:

- Operation and maintenance of the facilities, such as river banks, dikes, revetments, diversion structures, gauging stations, will be carried out by MAG.
- A project office of MAG in San Miguel is proposed for the management of the facilities.
- Olomega Site Office will operate and maintain the control gate

4.5 Organization and Institution

(1) Structural Measures

1) Organization in Construction Stage

The proposed organization for construction stage activities, which include the preparatory work, detailed design, tendering, land acquisition/compensation, construction supervision and coordination with the agencies concerned, consists of the following (refer to Fig 3.10) :

- Central Office of MAG and MOP in San Salvador
- Project Office in San Miguel
- Consultant(s)

2) Organization for Operation and Maintenance

Operation and maintenance of the project facilities will be made by the MAG Project Office in San Miguel including the Olomega Site Office provided during the construction stage. The facilities will be river channel, river banks, revetments, dikes, ground sills, diversion structures, telemetering equipment, etc.

(2) Non-structural Measures

Organization and institution for the Floodplain Management are almost same as the existing ones. MAG is the executing agency for the projects, with the assistance of the local governments, NGOs and the residents, for all stages of planning, execution and management. For the floodplain management, COEN will be responsible for the emergency activities including flood forecasting (by STAR 4), warning, flood fighting, etc.

Proposed organization chart is shown in Fig. 4.11.

4.6 Project Evaluation

(1) Economic Evaluation

- 1) The direct benefit of the flood control project is an economic difference in flood damage between without-project and with-project situations, that is to say, reduction in flood damage to assets including building, household effects, livestock, agricultural crops, infrastructure and other facilities, as well as damage to socio-economic activities. For instance, flood area by 10-year flood will be reduced by 8,100 ha by the project. And in the area still flooded, duration and depth of flooding will be reduced.

The direct economic benefit, average annual flood damage reduction, is estimated at Colons 105.4 Million.

2) Economic Cost

For the purpose of the economic evaluation, the project cost is converted into the economic cost which excludes portions of inflation and transfer payments such as taxes and duties. Besides these exclusion portions, the economic cost is estimated taking shadow prices into account. The shadow prices are based on the standard conversion rate (SCR) and the opportunity costs of items such as land acquisition and wage of unskilled labor.

The economic cost of the Project is estimated at Colons 540.1 Million for the construction cost and Colons 2.15 Million/year for O/M cost.

3) Economic Evaluation (Table 4.5)

EIRR = 18.1 %

NPV = Colons 161 Million (for the discount rate of 12 %)

B / C = 1.49 (for the discount rate of 12 %)

Assuming that the increase in cost by 10 % and decrease in benefit by 10 % due to unexpected causes, EIRR is still 14.6 % with higher than the opportunity cost of capital 12 %. The project is economically feasible, and not sensitive to increase in cost and decrease in benefit.

(2) Financial Aspects

Assuming that a loan, for 75 % of the project cost with an annual interest rate of 6 %, from an international funding agency for the Project, the maximum amount of annual repayment is estimated at US\$17.86 Million. This is less than 3 % of the present total debt service of the State, and no difficulty of the repayment is expected.

(3) Environmental Impact Assessment (EIA)

As assessed in Table 3.4, negative impacts of the Project are land acquisition of 676 ha., compensation of 20 houses, disturbance of the communities during construction, etc. Positive impacts are improvement of ecology in Lake Jocotal, stabilization of fishery production in Lake Olomega (fishery related people of about 10,000), improvement in sanitation in the flood prone areas, etc. The positive impact is high while the negative impacts is low.

(4) Socio-economic Effects

- Enhancement of regional development and stability of the region
- Increase in employment opportunity by the project works
- Improvement of environment for socio-economic activities in the communities

(5) Overall Evaluation

The Project is economically viable and indispensable for development and stability of the region. Negative social and environment impact is low.

4.7 Implementation Schedule

The implementation schedule of the project was proposed as follows;

- (1) The project is completed by the year 2005.
- (2) One year for fund procurement and two years for detail design and tendering are allocated.
- (3) The construction term is five years.
- (4) The work for floodwater storage in Lake Olomega shall be completed prior to the river improvement works of the upstream reaches.
- (5) For other reaches of the San Miguel River, river improvement works shall be implemented, in principle, from the downstream toward the upstream to avoid the effects on the flooding downstream area.
- (6) Flood forecasting and warning system are installed so that it is applicable when the structures are completed.

Implementation Schedule for Priority Project

Description		1998	1999	2000	2001	2002	2003	2004	2005
Structural Measures	1. Loan Process	█							
	2. Detailed Design		█						
	3. Land Acquisition			█	█	█	█	█	
	4. Tendering			█	█	█	█	█	
	5. Construction to cope with 2-year flood			█	█	█	█	█	█
Non-structural Measures (Floodplain Management)	1. Land Use Regulation/Flood Proofing	█							
	2. Flood Forecasting/Warning			█	█	█	█	█	█
	3. Education to the residents			█	█	█	█	█	█

Table 4.1 PRIORITY COMPARISON OF THE PROJECTS

Project Name	Cost (\$ Million)	Reduction of Flood Area by 10-year Flood (Population Saved)	Socio-economic Impact	Environmental Impact		Project Execution and Management	Financial Aspect	Selection
				Improvement of Ecology in Lake Jocotal	Improvement of Ecology in Lake Jocotal			
San Miguel River Improvement, Lower Reach 1 (to cope with 2-year flood)	376	37.3 km ² (9,700 in 1996/17,100 in 2020)	(+) Increase in land development potential (+) Flood damage reduction (-) Land acquisition/compensation	high high low	(+) Improvement of Ecology in Lake Jocotal	F/S is required for project implementation and urgent	Project cost is medium size and possible to implement	high Yes
San Miguel River Improvement, Lower Reach 2 (rest of M/P projects)	141	17.1 km ² (700 / 1,300)	(+) Increase in land development potential Flood damage reduction	medium medium	(+) Improvement of Ecology in Lake Jocotal	F/S is required Construction of Phase 1 and 2 will take long period	Cost of Phase 1 and 2 is high	low No
San Miguel River Improvement, Middle Reach 1 and 2, Storage in Olomega (2 years flood)	314	42.7 km ² (8,500 / 15,100)	(+) Increase in land development potential (-) Effects on flooding in the downstream (-) Land acquisition/compensation	high medium low	(+) Stabilization of fishery in Olomega	F/S is required and urgent	Project cost is medium size and possible to implement	high Yes
San Miguel River Improvement, Middle Reach 2 (rest of M/P projects)	157	2.7 km ² (5,000 / 7,000)	(+) Increase in land development potential (-) Effects on flooding in the downstream	low low	(+) Stabilization of fishery in Olomega	F/S is required	Cost of Phase 1 and 2 is high	low No
San Miguel River Improvement, Upper Reach	60	6.0 km ² (1,300 / 2,400)	(+) Smooth urban development (-) Effects on flooding in the downstream (-) Land acquisition/compensation	medium low low		F/S is required	Cost is high compared with the effect	low No
Floodplain Management, Near San Miguel City	-	-	(+) Smooth urban development (+) Flood damage reduction	high high		Study is urgently needed because of rapid development	Low cost	high Yes
Floodplain Management, Olomega Area and Jocotal Area	5.6	-	(+) Flood damage reduction (-) Contribution to solution of lake problem	high high	(+) Improvement of Ecology in the lakes	Closely related with the river improvement	Low cost	high Yes
Floodplain Management, Estuary Area	-	-	(+) Smooth development (-) Flood damage reduction	medium medium		Can be executed without F/S	Low cost	high No
Watershed Management, Upper Basin	68	Small	(+) Effects on flood control and water resources (+) Increase in forestry production	high high	(+) Improvement of river water environment	Land owners are related studied and executed by MAG Not pure flood control	Cost is moderate size Project cost would be the government an land owners	medium low No
Watershed Management, Middle Basin	50	Small	(+) Effects on flood control and water resources (-) Increase in forestry and agricultural production	medium high	(+) Improvement of river water environment	Land owners are related studied and executed by MAG Not pure flood control	Cost is moderate size Project cost would be the government an land owners	medium low No
Watershed Management, Lower Basin	90	Small	(+) Effects on flood control and water resources (+) Increase in forestry and agricultural production	medium high	(+) Improvement of river water environment	Land owners are related studied and executed by MAG Not pure flood control	Cost is moderate size Project cost would be the government an land owners	medium low No

Note: high, medium, low in column means priority

Table 4.2 PRINCIPAL FEATURES OF PRIORITY PROJECT

RIVER IMPROVEMENT

Project Cost(₱ million): (Including price escalation)		775.9
Construction Works	Construction Period	5 years from 2001 to 2005
	Excavation(m³):	8,035,000
	Embankment(m³):	1,173,000
	Revetment(m³):	6,000
	Ground sill(site)	4
	Weir/gate(site):	2
	Sluice(site):	1
	Bridge(site):	3
Reduction of Flooded Area: for 10-yr. flood (km²)	San Miguel:	0.0
	Olomega:	53.9
	Jocotal:	13.0
	Usulután:	13.6
	Total:	80.5
Beneficiary in the Protected Area: for 10-yr. flood in 2020 (persons)	San Miguel:	0
	Olomega:	24,400
	Jocotal:	5,900
	Usulután:	6,100
	Total:	36,400
Social Impact	Positive Impact:	- To enable effective land use and development of the basin, - To ensure the people's livelihood in the basin, - To ensure stable fishery in lakes of Olomega and Jocotal, - To create employment opportunities during construction, and - To improve sanitary conditions.
	Negative Impact: - Land acquisition: - House comp.:	676 ha 20 houses
Environmental Impact		- Disturbance of communities during construction - Mitigation of inflow of polluted and sediment contained water of the San Miguel River - Stabilization of water level in lakes of Olomega and Jocotal
Economic Viability: EIRR (%)		18.1

FLOODPLAIN MANAGEMENT

Jocotal Area	Land use regulation, flood proofing and flood forecasting/warning to mitigate damage in non-dike reaches
Olomega Area	
Near S. Miguel City	Land use regulation to mitigate damage in urban area
Project Cost	- Office and equipment: ₱ 8,100,000 - Operation and maintenance: ₱ 720,000/yr.

Table 4.3 QUANTITY OF WORKS FOR PRIORITY PROJECT

From		To		Stretch code	Length dX(km)	Excavation (m ³)	Embankment(m ³)	Land (1,000m ²)	House (nos)
Location	Station	Location	Station						
LOWER REACHES									
River mouth	SR0	Santa Rita R.	SR21+0.20k		10.00				
Santa Rita R.	SR21+0.20k	End of farm land	SM1	L1-1	0.86	0	0	0	0
End of farm land	SM1	Cerro El Encantado	SM7	L1-2	2.65	146,900	0	299	1
Cerro El Encantado	SM7	Limon R.	SM13	L1-3	3.36	77,600	239,300	429	0
Limon R.	SM13	Ereguatquin R.	SM30+0.05k	L2	9.33	207,300	286,200	845	3
Ereguatquin R.	SM30+0.05k	Vado Marin Br.(old)	SM58	L3	15.51	213,000	0	1,067	11
Vado Marin Br.(old)	SM58	Jocotal Drainage	SM63	L4-1	2.17	824,100	0	191	0
Jocotal Drainage	SM63	Brazo de S.M.	SM79+0.15k	L4-2	6.30	1,597,600	0	711	0
Brazo de S.M.	SM79+0.15k	Chilanguera R.	SM91+0.32k	L4-3	4.37	1,220,900	0	526	0
Chilanguera R.	SM91+0.32k	La Canoa	SM95+0.38k	L4-4	2.42	263,100	0	267	0
La Canoa	SM95+0.38k	El Delirio	SM103	L4-5	6.74	0	0	0	0
					Sub-total	4,550,500	505,500	4,335	15
MIDDLE REACHES									
El Delirio	SM103	Omega D./S.M.R.	SM104+0.14k	M1	0.71	80,800	0	62	0
Omega D./S.M.R.	SM104+0.14k	Start of COC/G.Sill	SM113	M2-1	5.36	0	0	0	0
Omega D./S.M.R.	SM104+0.14k	End of COC	OL1+0.80k	O1-1	0.85	167,900	0	96	0
End of COC	OL1+0.80k	Start of COC/G.Sill	SM113	COC	2.10	556,500	0	289	0
Start of COC/G.Sill	SM113	WL drop	SM117	M2-2	2.39	320,100	0	184	0
WL drop	SM117	Pelota R.	SM120+0.26k	M2-3	2.05	216,700	103,400	171	0
Pelota R.	SM120+0.26k	L. Aramuaca	SM135	M3	10.47	775,000	427,400	654	3
L. Aramuaca	SM135	Moscoso Br.	SM157	M4	13.10	0	0	0	0
Moscoso Br.	SM157	Taisihuat R.	SM165+0.17k	M5	4.25	0	0	0	0
Taisihuat R.	SM165+0.17k	Urbina Br.	SM170+0.06k	M6-1	2.23	0	0	0	0
					Sub-total	2,117,000	530,800	1,456	3
OLOMEGA DRAINAGE									
End of Drainage	OL1+0.80k	Pelota R.	OL6+0.10k	O1-2	4.11	468,700	0	351	0
Pelota R.	OL6+0.10k	Omega Outlet	OL6+0.30k	O2	0.20	91,700	0	18	0
Omega Outlet	OL6+0.30k	Lake Olomega	W0+0.95k	W0	0.95	30,400	0	50	0
					Sub-total	590,800	0	419	0
OLOMEGA DIVERSION CHANNEL									
Omega D.	OL6+0.10k	Diversion weir	PL2+0.44k	P1	1.53	0	0	0	0
Diversion weir	W1+0/PL2+0.4	San Miguel R.	SM120+0.26k	P2	3.21	688,900	98,600	126	0
Lake Olomega	W1-1.10k	W1+0/PL2+0.44k	W1-0.00k	W1	1.10	88,000	37,600	423	2
					Sub-total	776,900	136,200	549	2
					Grand total	8,035,200	1,172,500	6,759	20

Table 4.4 COST FOR PRIORITY PROJECT

Items	Unit		Quantity	Amount(£ million)		
	Unit	Cost(£)		Total	L.C.	F.C.
1. Construction works						
1.1 Channel works				366.9	167.5	199.4
Earth excavation(1)	m ³	45	3,977,000	179.0	73.4	105.6
Earth excavation(2)	m ³	20	3,906,000	78.1	32.0	46.1
Rock excavation	m ³	173	152,000	26.3	10.8	15.5
Embankment	m ³	42	1,173,000	49.3	20.2	29.1
Revcment	m	5,700	6,000	34.2	31.1	3.1
1.2 Structure works				24.7	18.8	5.9
Diversion weir	l.s.			10.5	9.0	1.5
Control gate	l.s.			9.4	5.8	3.6
Drainage sluice				0.6	0.4	0.2
Type-A	nos	426,000	0	0.0	0.0	0.0
Type-B	nos	586,000	1	0.6	0.4	0.2
Type-C	nos	754,000	0	0.0	0.0	0.0
Ground sill	m	18,269	229	4.2	3.6	0.6
1.3 Appurtenant works				42.1	24.0	18.1
Intake gate(Type-B)	nos	586,000	1	0.6	0.4	0.2
Bridge				33.0	17.2	15.8
Bridge(105m)	nos	13,400,000	1	13.4	7.0	6.4
Bridge(90m)	nos	12,600,000	1	12.6	6.6	6.0
Bridge(40m)	nos	7,000,000	1	7.0	3.6	3.4
Rural road	m	160	2,640	0.4	0.4	0.0
Telemetering system	l.s.			8.1	6.1	2.0
(Sub-total : 1.1+1.2+1.3)				433.7	210.3	223.4
2. Land and house				19.2	19.2	0.0
Land acquisit.(1)	10 ³ m ²	2,150	728	1.6	1.6	0.0
Land acquisit.(2)	10 ³ m ²	5,720	845	4.8	4.8	0.0
Land acquisit.(3)	10 ³ m ²	2,570	1,067	2.7	2.7	0.0
Land acquisit.(4)	10 ³ m ²	720	1,695	1.2	1.2	0.0
Land acquisit.(5)	10 ³ m ²	3,580	2,424	8.7	8.7	0.0
Land acquisit.(6)	10 ³ m ²	7,150	0	0.0	0.0	0.0
House compensat.	house	12,000	20	0.2	0.2	0.0
3. Administration	l.s.	-		22.6	22.6	0.0
4. Engineering service	l.s.	-		67.9	25.1	42.8
5. Physical contingency	l.s.	-		54.3	27.7	26.6
(Sub-total : 1+2+3+4+5)				597.7	304.9	292.8
6. Price contingency	l.s.	-		178.2	123.4	54.8
Total				775.9	428.3	347.6

Table 4.5 ECONOMIC ANALYSIS OF PRIORITY PROJECT

Priority Project-Alt.I (O+J+U)				Unit : Cols. Million		
Year	Economic Cost			Economic Benefit (B)	Net Benefit (B)-(C)	
	Construction	OM	Total (C)			
1	1999	21.45	0.00	21.45	0.00	-21.45
2	2000	9.99	0.00	9.99	0.00	-9.99
3	2001	103.46	0.00	103.46	0.00	-103.46
4	2002	103.46	0.43	103.89	21.08	-82.81
5	2003	103.46	0.86	104.32	42.17	-62.15
6	2004	99.19	1.29	100.48	63.25	-37.23
7	2005	99.14	1.72	100.86	84.34	-16.52
8	2006	0.00	2.15	2.15	105.42	103.27
9	2007	0.00	2.15	2.15	105.42	103.27
10	2008	0.00	2.15	2.15	105.42	103.27
11	2009	0.00	2.15	2.15	105.42	103.27
12	2010	0.00	2.15	2.15	105.42	103.27
13	2011	0.00	2.15	2.15	105.42	103.27
14	2012	0.00	2.15	2.15	105.42	103.27
15	2013	0.00	2.15	2.15	105.42	103.27
16	2014	0.00	2.15	2.15	105.42	103.27
17	2015	0.00	2.15	2.15	105.42	103.27
18	2016	0.00	2.15	2.15	105.42	103.27
19	2017	0.00	2.15	2.15	105.42	103.27
20	2018	0.00	2.15	2.15	105.42	103.27
21	2019	0.00	2.15	2.15	105.42	103.27
22	2020	0.00	2.15	2.15	105.42	103.27
23	2021	0.00	2.15	2.15	105.42	103.27
24	2022	0.00	2.15	2.15	105.42	103.27
25	2023	0.00	2.15	2.15	105.42	103.27
26	2024	0.00	2.15	2.15	105.42	103.27
27	2025	0.00	2.15	2.15	105.42	103.27
28	2026	0.00	2.15	2.15	105.42	103.27
29	2027	0.00	2.15	2.15	105.42	103.27
30	2028	0.00	2.15	2.15	105.42	103.27
31	2029	0.00	2.15	2.15	105.42	103.27
32	2030	0.00	2.15	2.15	105.42	103.27
33	2031	0.00	2.15	2.15	105.42	103.27
34	2032	0.00	2.15	2.15	105.42	103.27
35	2033	0.00	2.15	2.15	105.42	103.27
36	2034	0.00	2.15	2.15	105.42	103.27
37	2035	0.00	2.15	2.15	105.42	103.27
38	2036	0.00	0.00	0.00	0.00	0.00
39	2037	0.00	0.00	0.00	0.00	0.00
40	2038	0.00	0.00	0.00	0.00	0.00
41	2039	0.00	0.00	0.00	0.00	0.00
42	2040	0.00	0.00	0.00	0.00	0.00
Total		540.15	68.80	608.95	3,373.44	2,764.49

EIRR (%)					18.11
Discount Rate (%)	B/C	PV(Cols. Million)		NPV (Cols. Million)	
		Cost	Benefit		
20	0.90	241.50	218.32	-23.18	
15	1.21	292.16	352.29	60.13	
12	1.49	330.34	491.65	161.31	
10	1.75	360.10	629.53	269.44	
5	2.87	456.22	1,309.23	853.01	

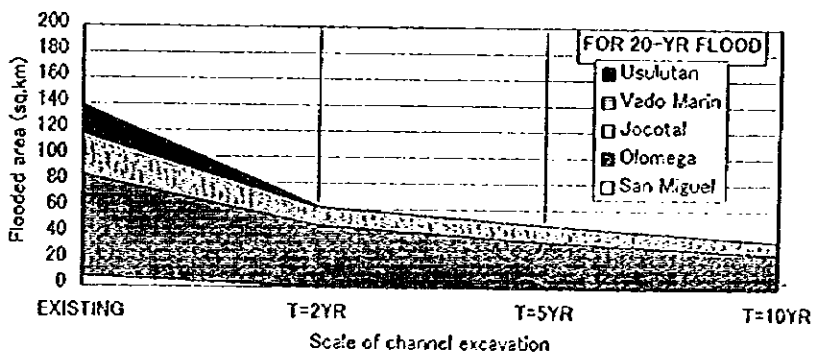
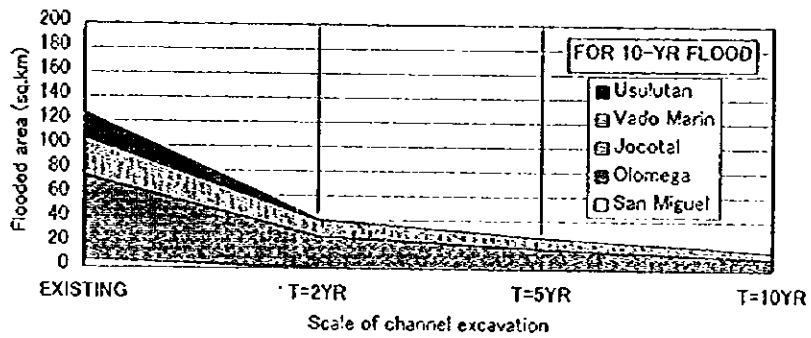
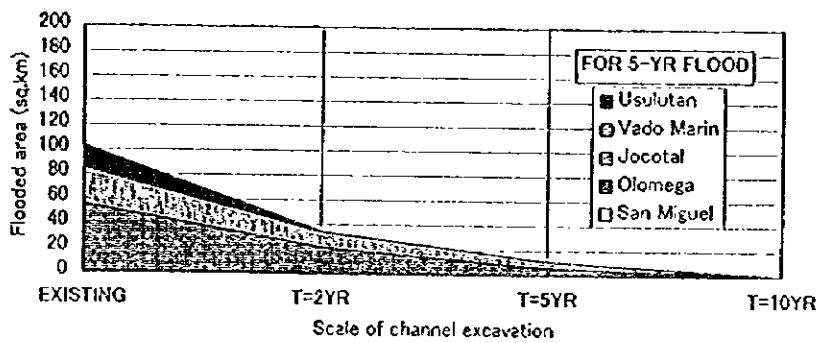
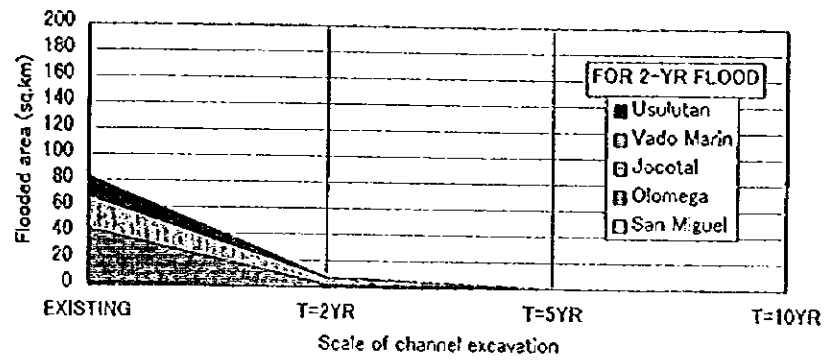


Figure 4.1 RELATIONSHIP BETWEEN PROJECT SCALE AND FLOOD AREA

Proposed Priority Project

Dike and Excavation Length

Area	Dike Length(km)	Excavation Length(km)
Lower Reach	12.7	46.1
Middle Reach	12.5	18.6
Omega Drainage	0.0	5.3
Omega Diversion	4.3	4.3
Total	29.5	74.3

Proposed Project Works

ITEM	AMOUNT
1. Structural Measures	
Earth Excavation	7,853,000 m ³
Rock Excavation	132,000 m ³
Embankment	1,173,000 m ³
Revetment	6,000 m
Diversion Weir	1 place
Control Gate	1 place
Drainage Sluice	1 place
Ground Sill	229 m
Intake Gate	1 place
Bridge	3 places
Rural Road	2,640 m
Land Acquisition	6.76 km ²
Compensation	20 hours
2. Non-structural Measures	
Automatic Water Level Station	5 places
Telemetering System	1 unit
Floodplain Management	3 places

Legend

- San Miguel River
- Catchment Boundary
- Maximum Flooded Area
- Dike
- Channel Excavation
- Revetment
- Omega Diversion Weir
- Omega Conton Gate
- Automatic Water Level Station
- New Omega Site Office
- Area for Floodplain Management
- Bridge
- Ground Sill
- Drainage Sluice
- Intake Gate

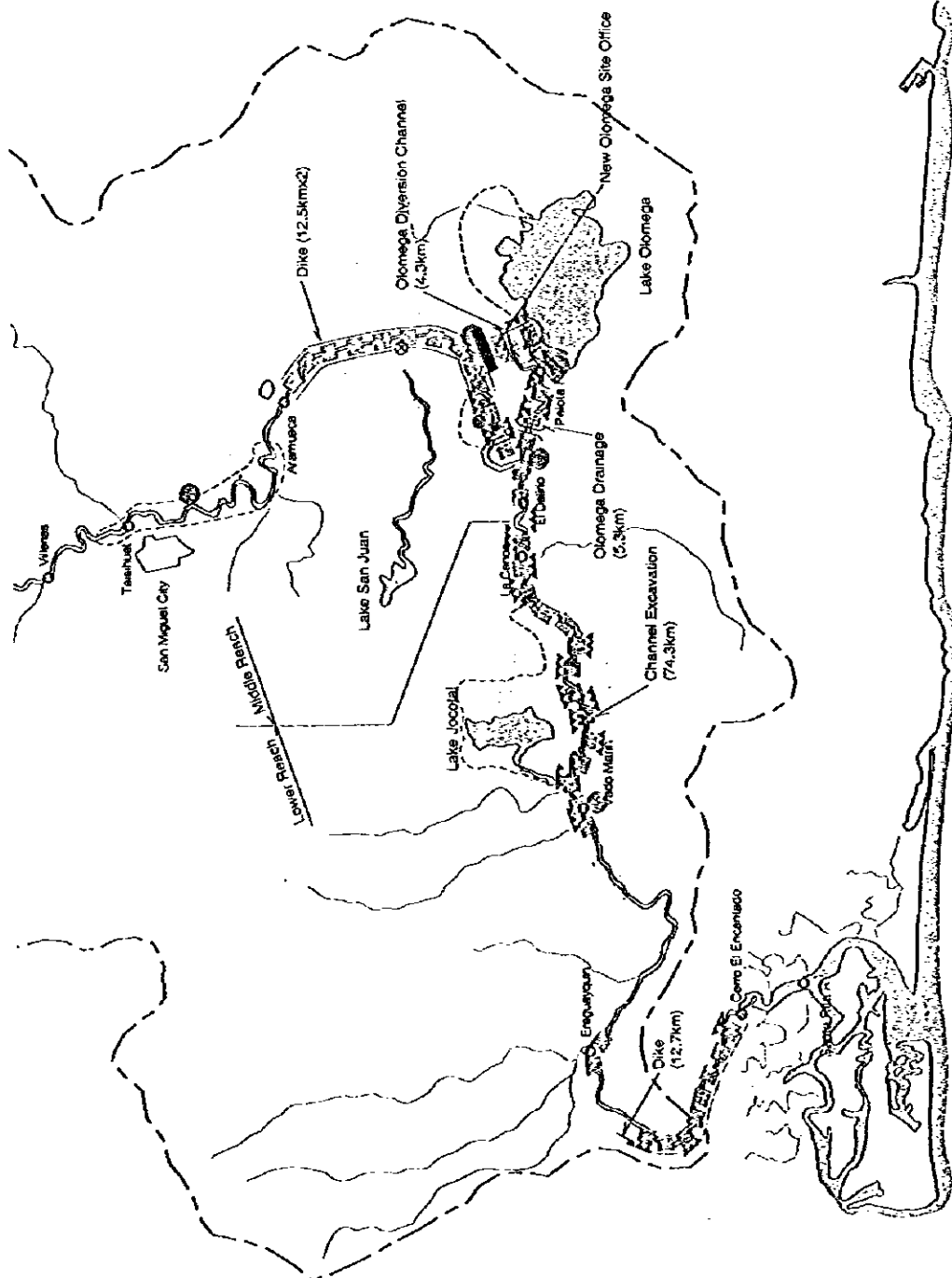
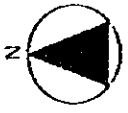


Figure 4.2 PROPOSED PRIORITY PROJECT

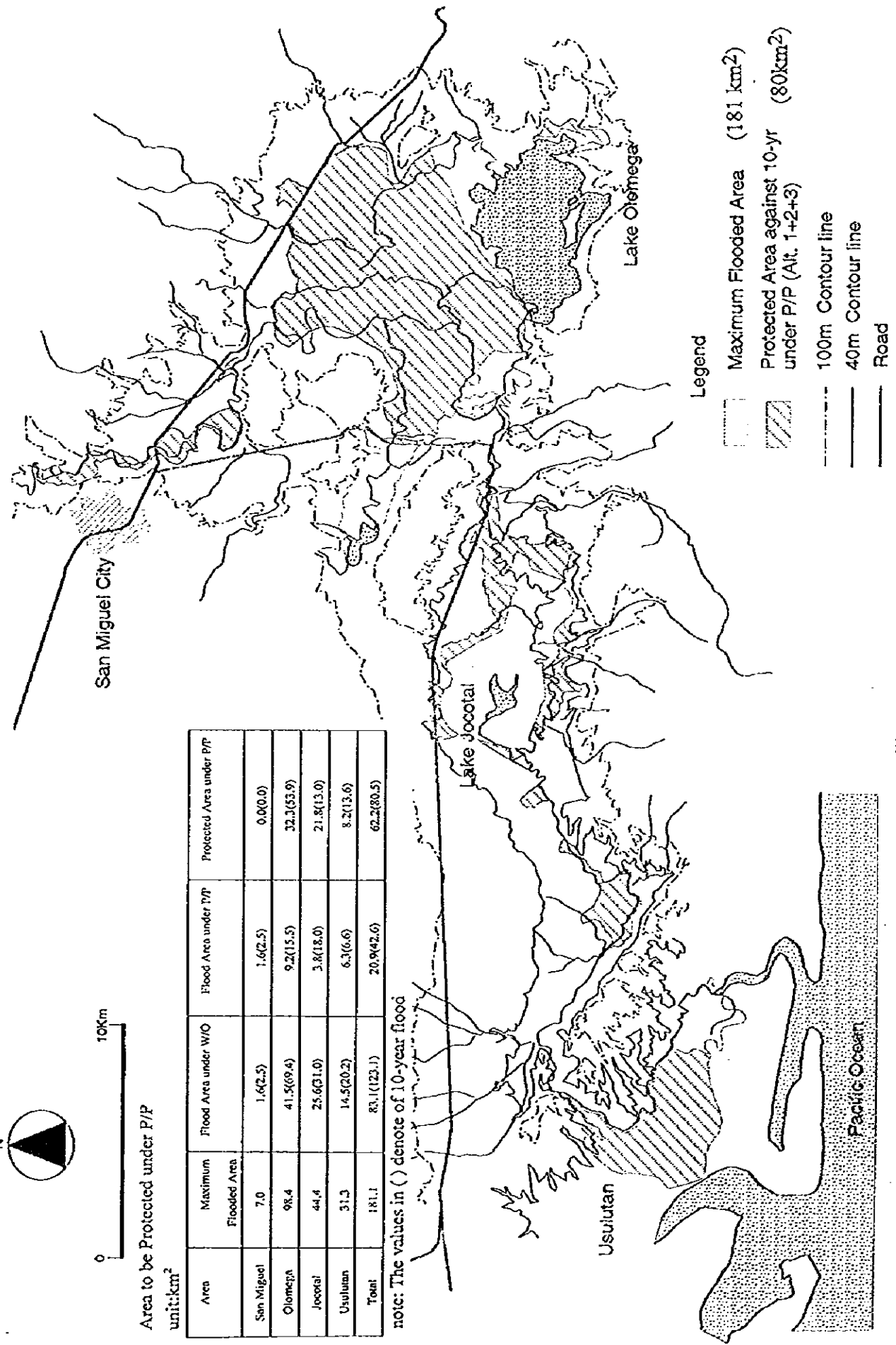


0 10Km

Area to be Protected under P/P
unit:km²

Area	Maximum Flooded Area	Flood Area under W/O	Flood Area under P/P	Protected Area under P/P
San Miguel	7.0	1.6(2.5)	1.6(2.5)	0.0(0.0)
Olemeqa	98.4	41.5(69.4)	9.2(15.5)	32.3(63.9)
Jocotal	44.4	25.6(31.0)	3.8(18.0)	21.8(13.0)
Usulután	31.3	14.5(20.2)	6.3(6.6)	8.2(13.6)
Total	181.1	83.1(123.1)	20.9(42.6)	62.2(80.5)

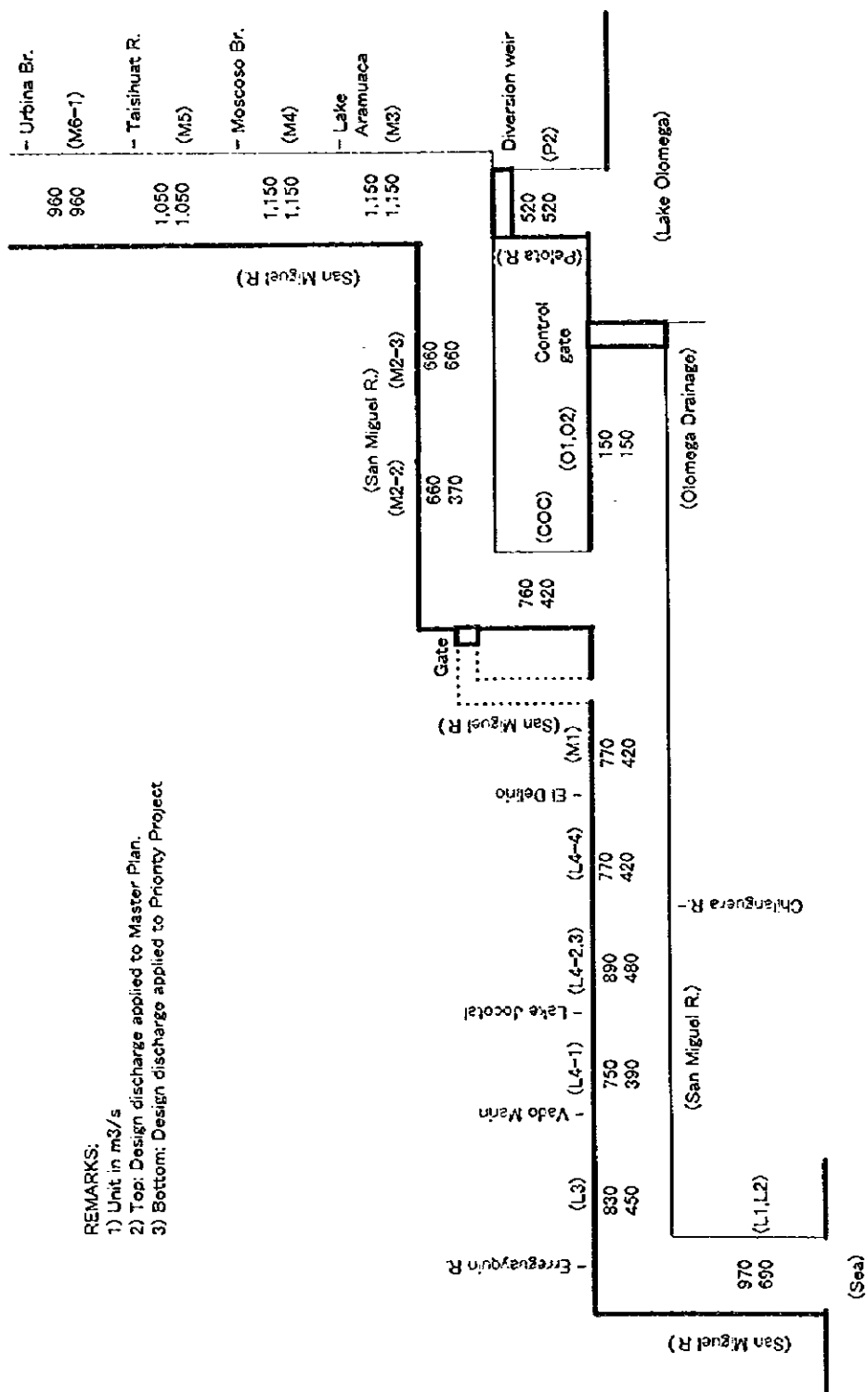
note: The values in () denote of 10-year flood



Legend

- Maximum Flooded Area (181 km²)
- Protected Area against 10-yr under P/P (Alt. 1+2+3) (80km²)
- 100m Contour line
- 40m Contour line
- Road

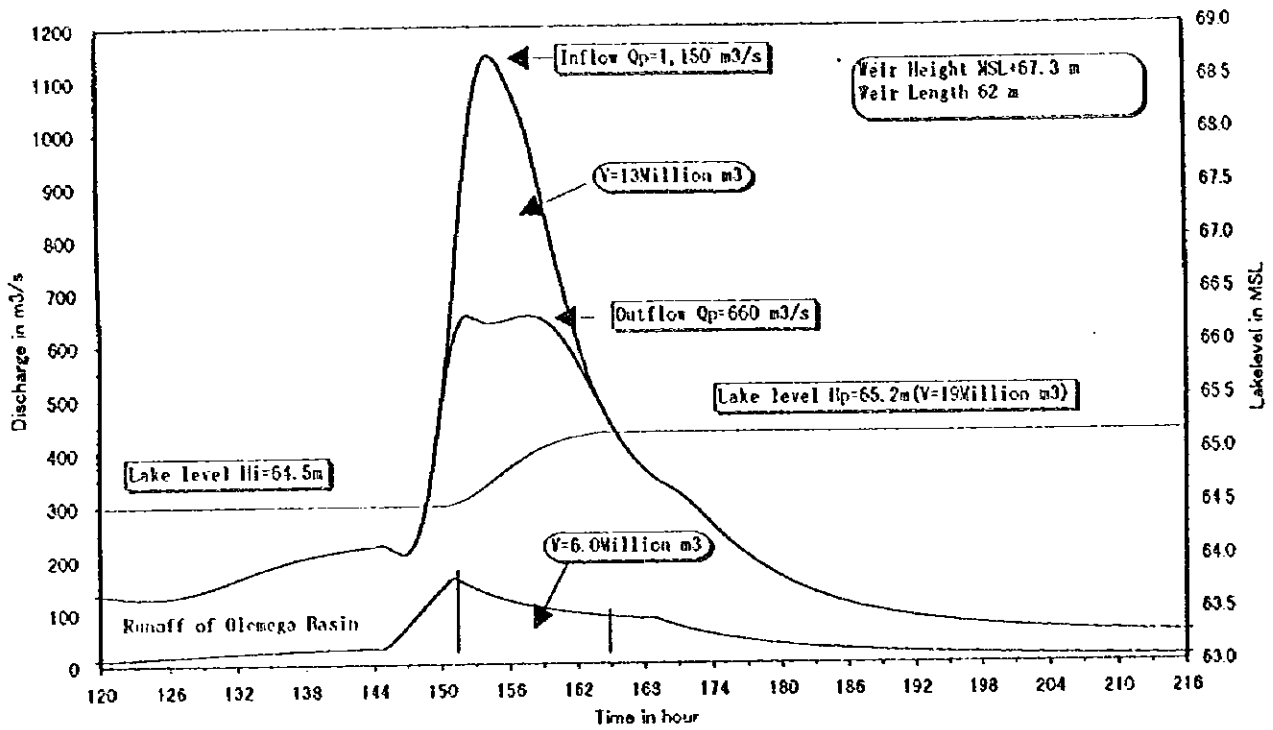
Figure 4.3 AREA TO BE PROTECTED BY PRIORITY PROJECT



REMARKS:
 1) Unit in m³/s
 2) Top: Design discharge applied to Master Plan.
 3) Bottom: Design discharge applied to Priority Project

Figure 4.4 DESIGN DISCHARGE DISTRIBUTION FOR P/P AND M/P

HYDROGRAPH AT OMEGA DIVERSION FOR 10-yr. FLOOD



HYDROGRAPH AT OMEGA DIVERSION FOR 2-yr. FLOOD

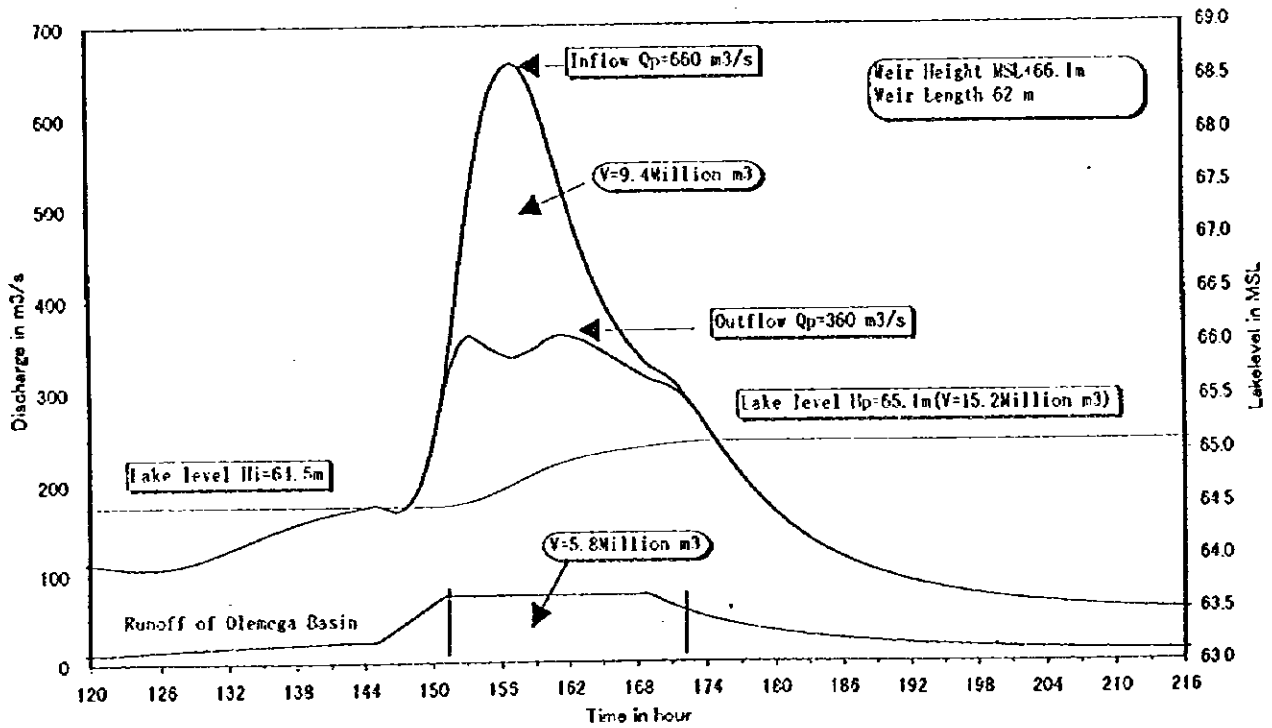


Figure 4.5

HYDROGRAPH OF LAKE OMEGA INFLOW

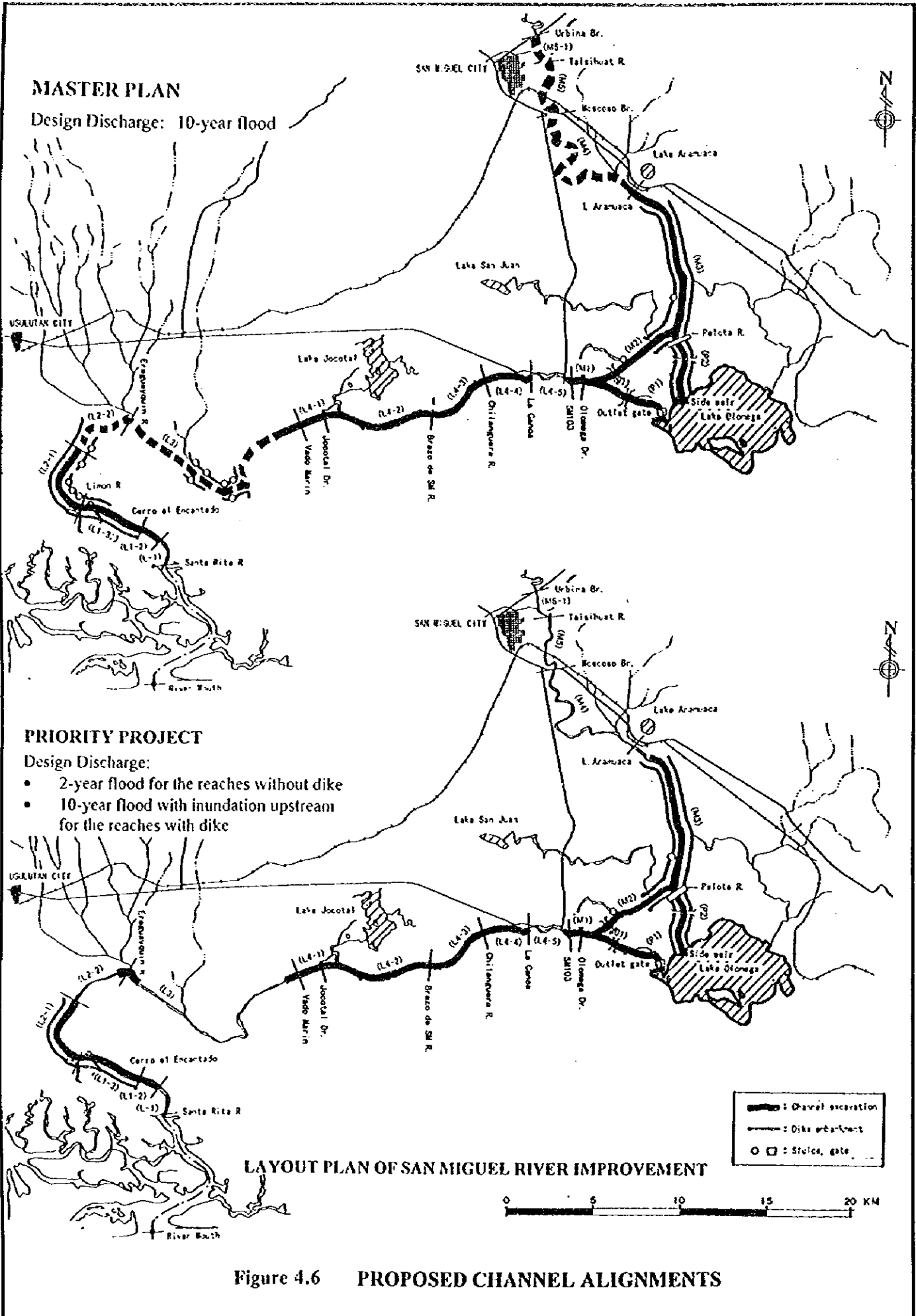


Figure 4.6 PROPOSED CHANNEL ALIGNMENTS

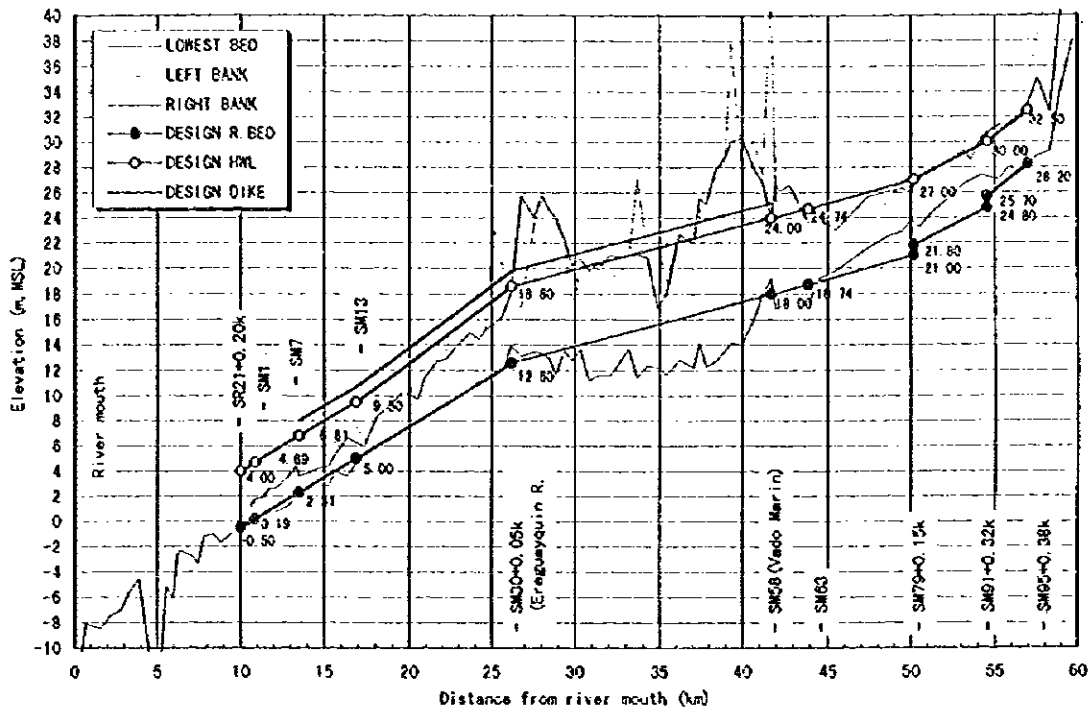


Figure M.4.3 DESIGN CHANNEL PROFILE(1/3): LOWER REACHES

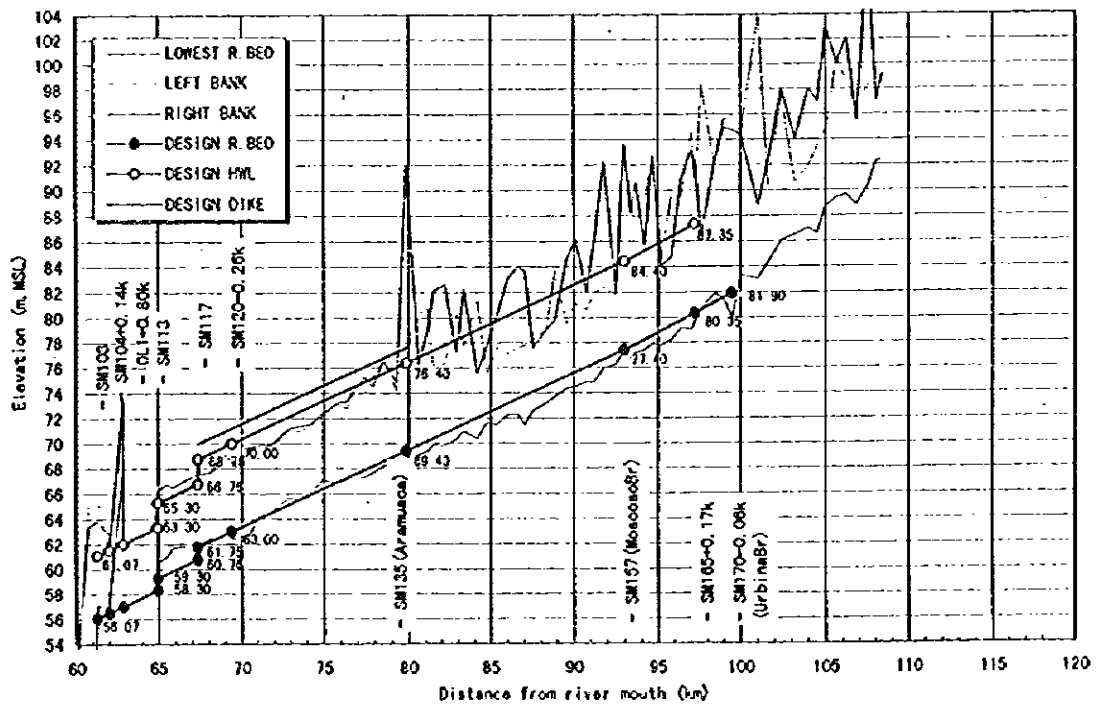


Figure 4.7(1/2) PROPOSED LONGITUDINAL PROFILE OF SAN MIGUEL RIVER : LOWER REACHES

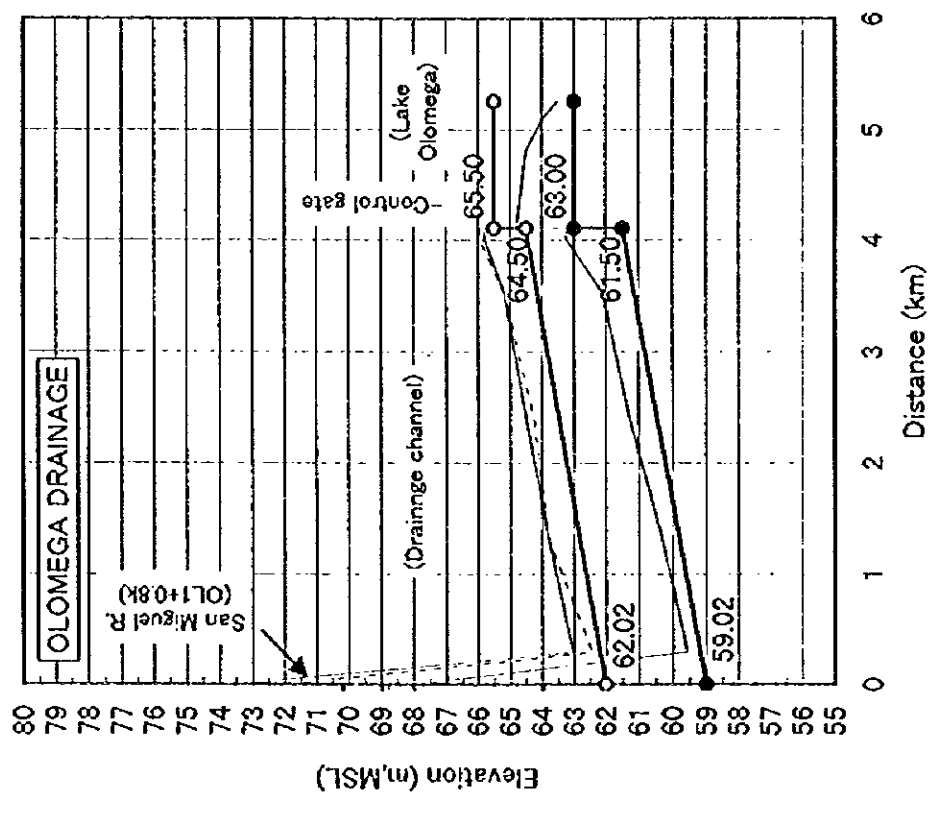
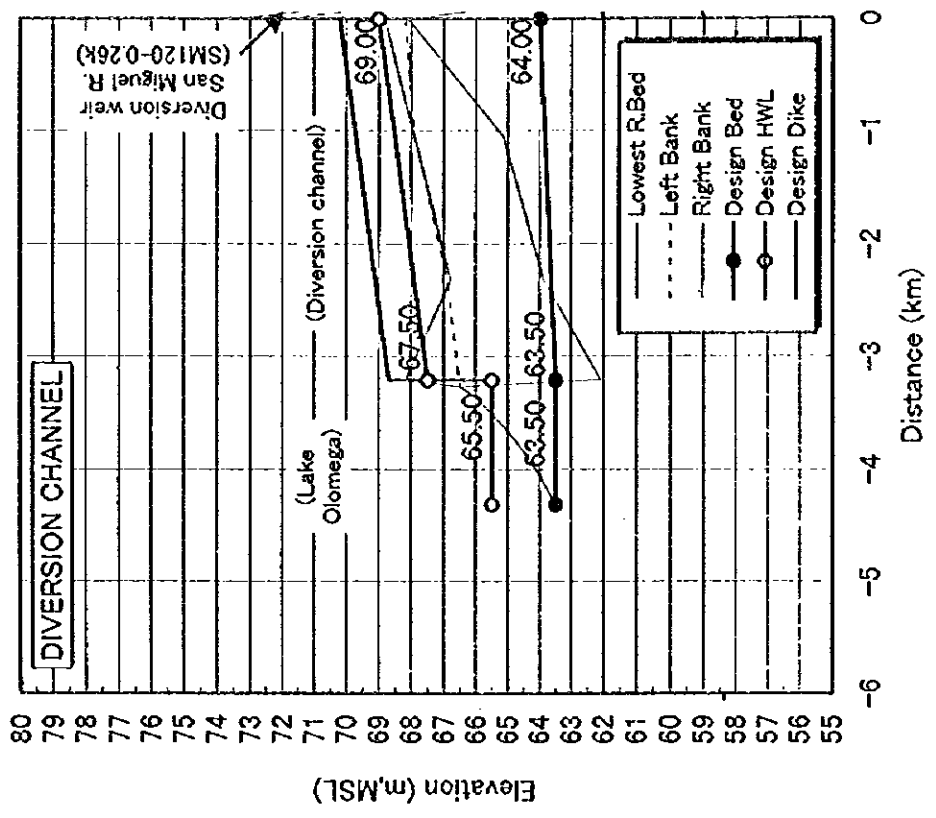


Figure 4.7(2/2) PROPOSED LONGITUDINAL PROFILE OF SAN MIGUEL RIVER : MIDDLE REACHES

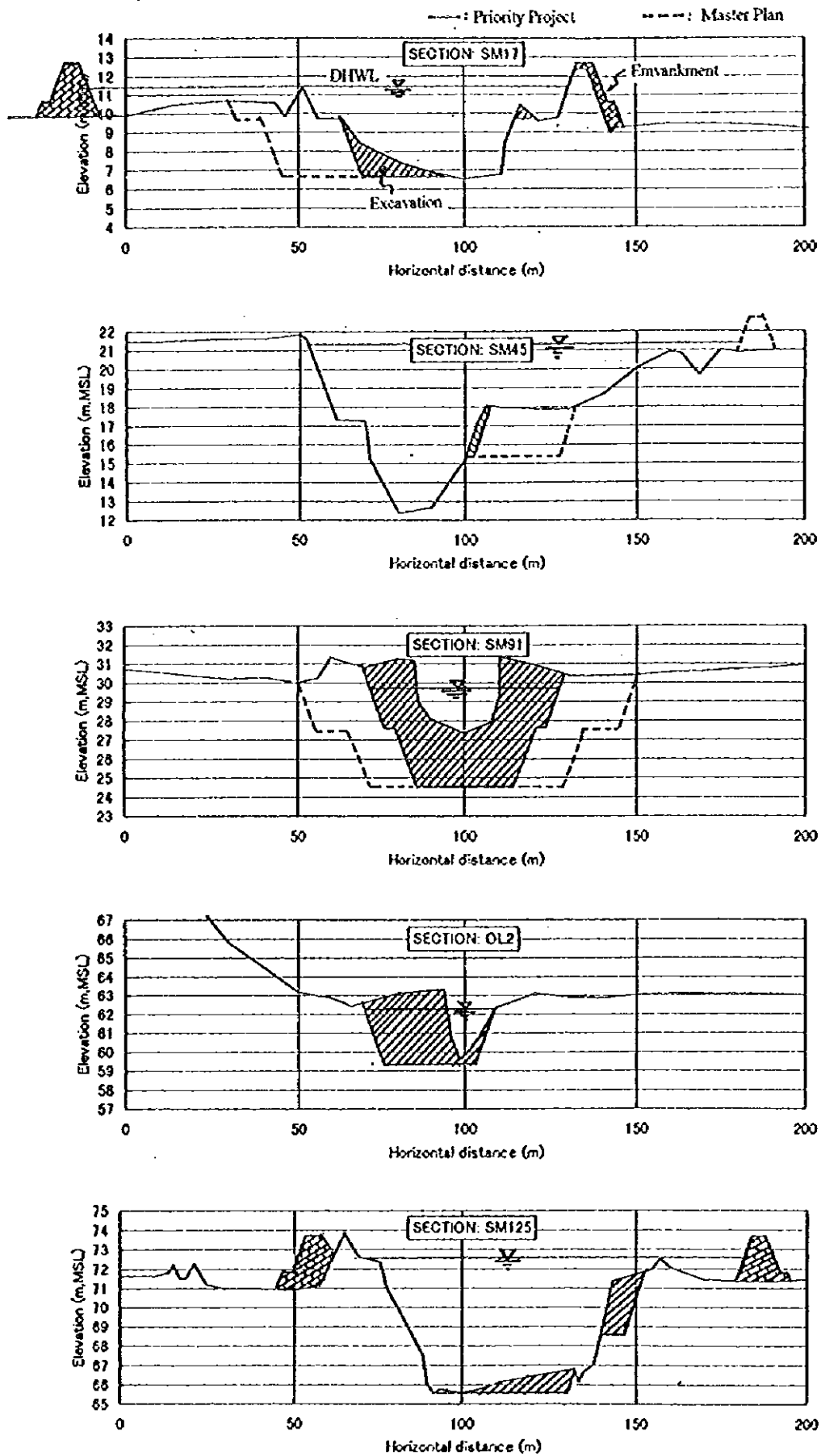


Figure 4.8

REPRESENTATIVE SECTIONS OF PROPOSED SAN MIGUEL RIVER

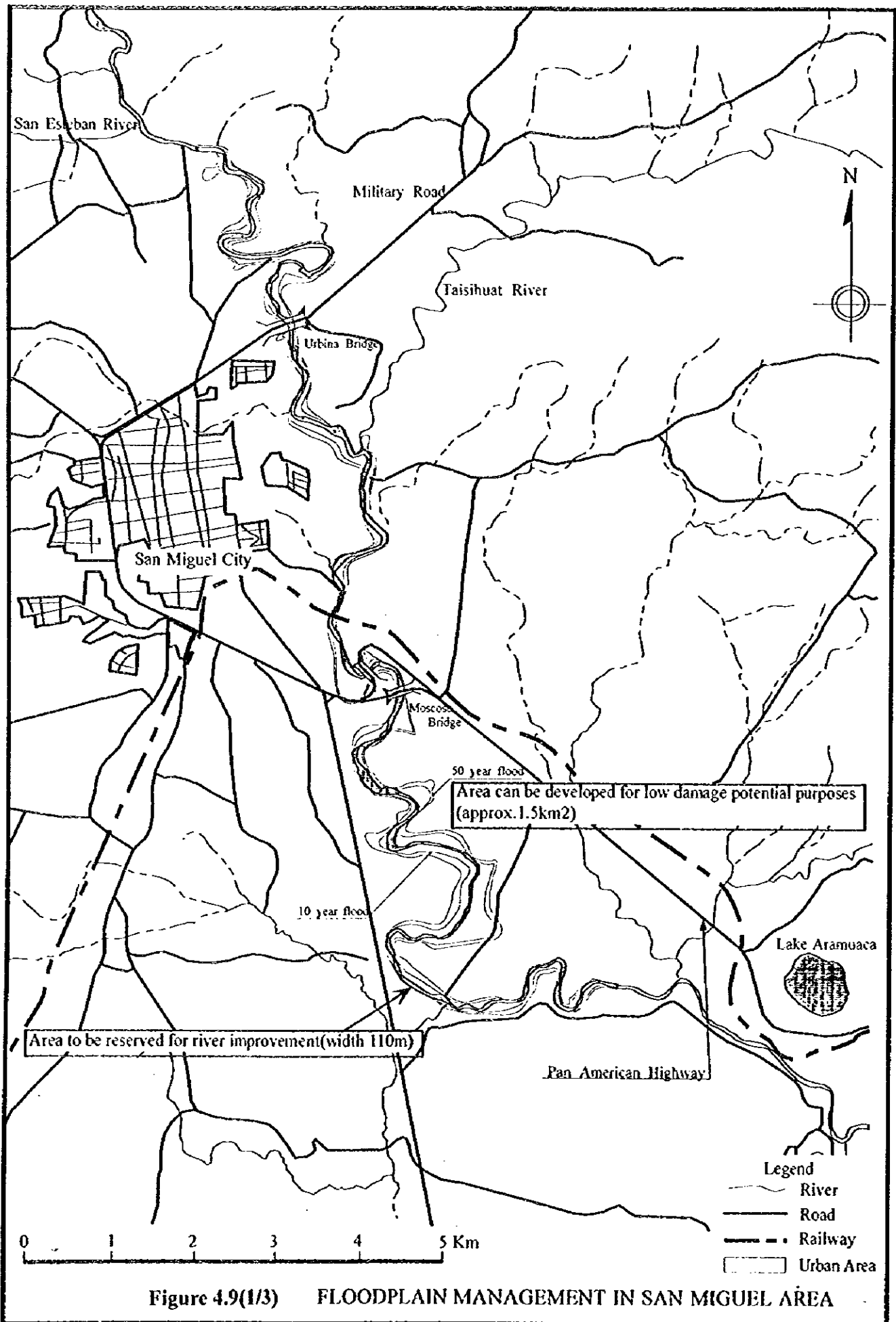


Figure 4.9(1/3) FLOODPLAIN MANAGEMENT IN SAN MIGUEL AREA

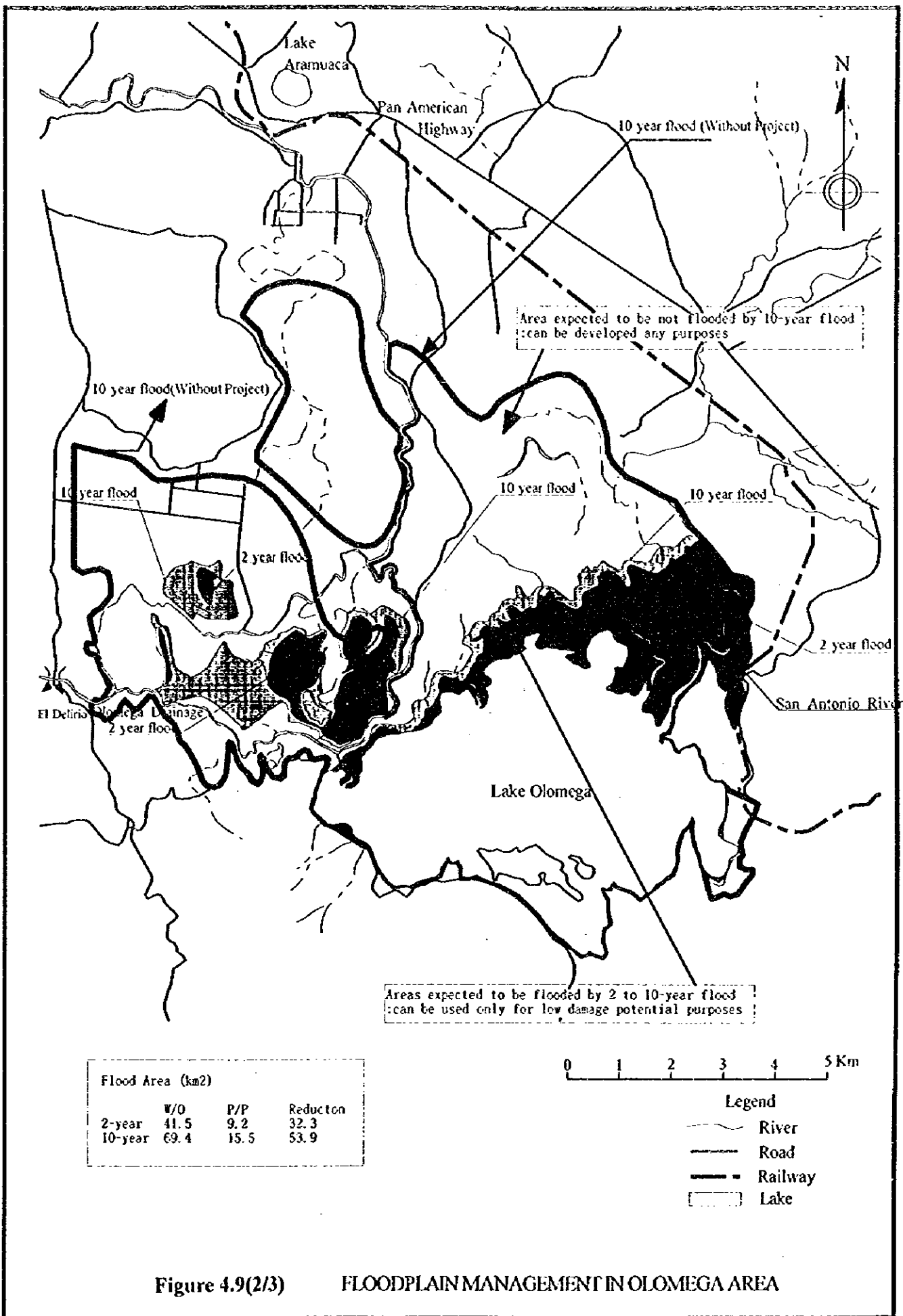
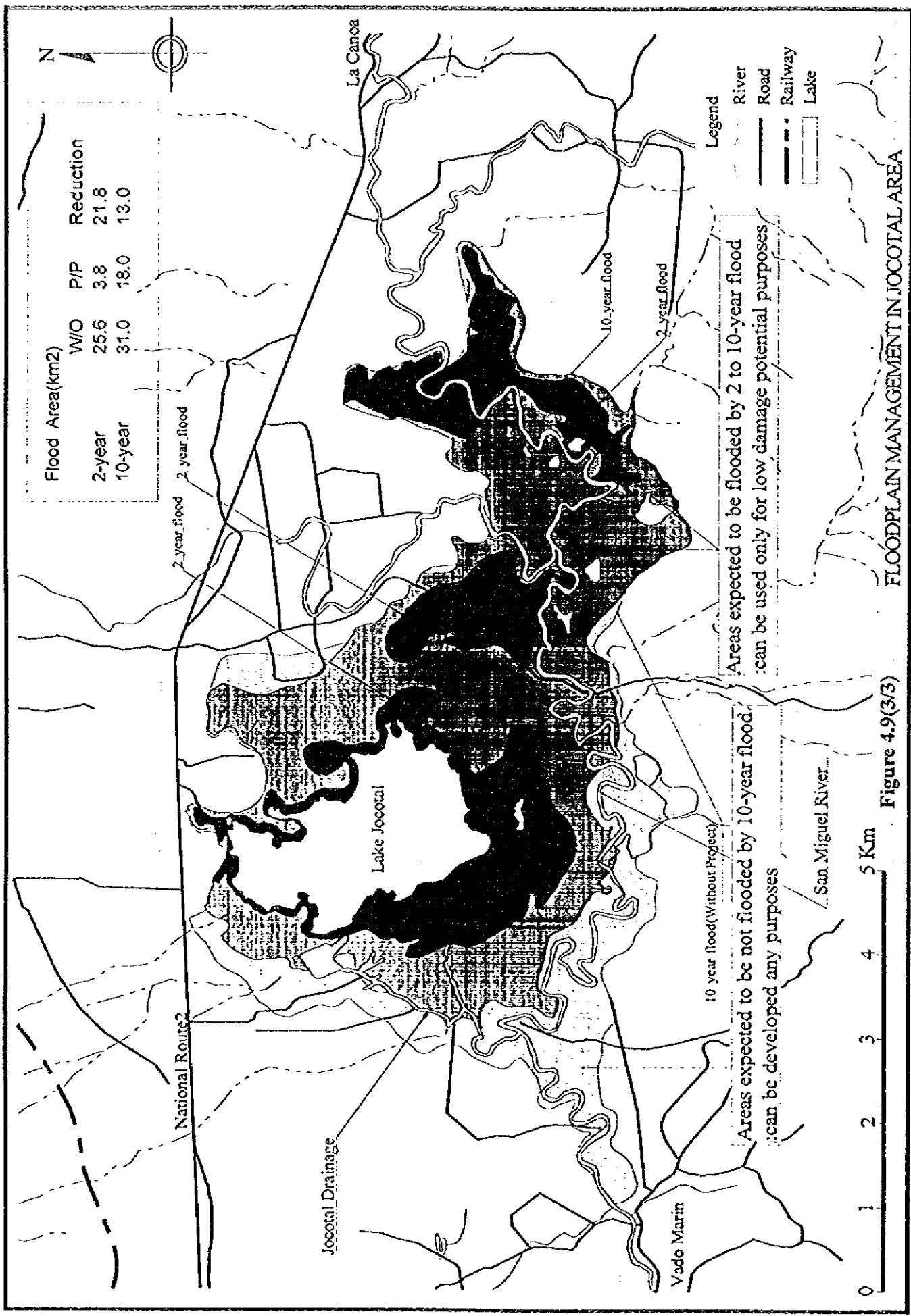


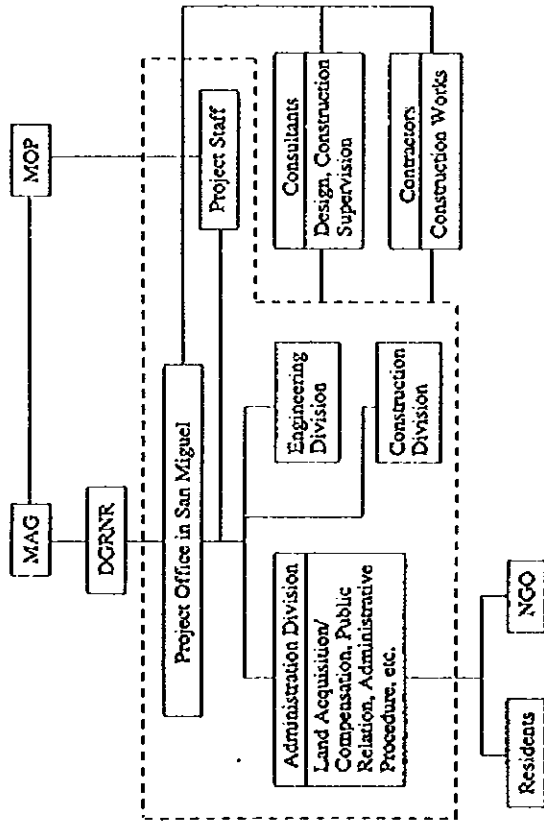
Figure 4.9(2/3)

FLOODPLAIN MANAGEMENT IN OLOMEGA AREA

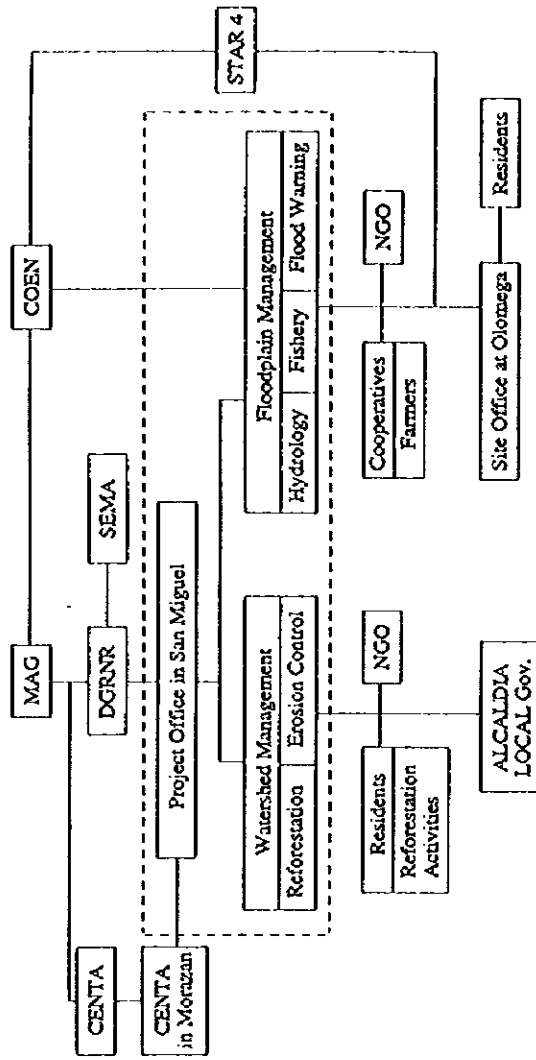


Proposed Organization for Structural Measures

(1) Design/Construction Stage



Proposed Organization for Nonstructural Measures



(2) Operation/Management Stage

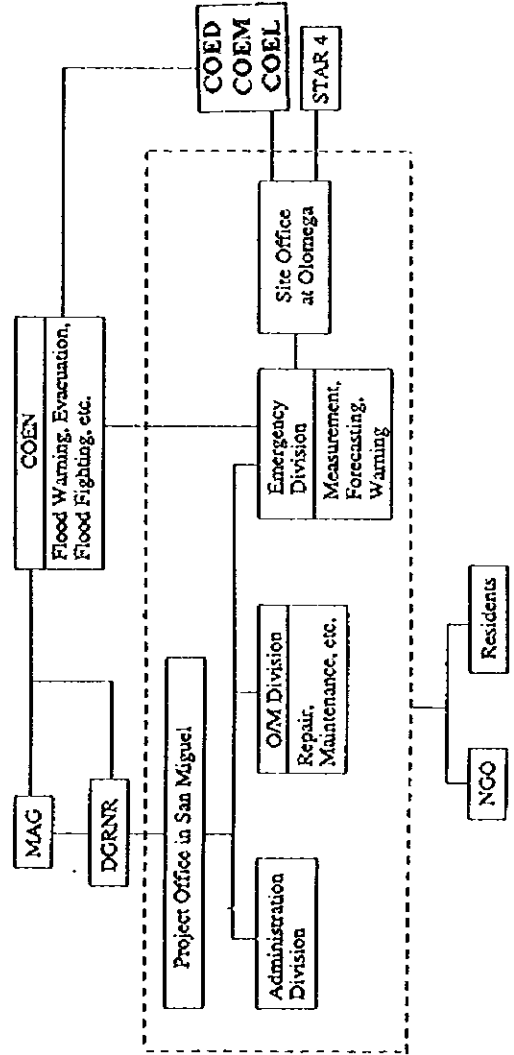


Figure 4.10 PROPOSED ORGANIZATION

5. CONCLUSION AND RECOMMENDATION

5. CONCLUSION AND RECOMMENDATION

- (1) The Priority Project of the structural measures is, from technical, economic, social and natural environmental viewpoints, justified. Immediate implementation of the Project is recommended for reduction in flood damage and smooth development of the region.**
- (2) The floodplain management, including land use regulation, flood forecasting/warning and education to the residents, for the flood prone areas of San Miguel City, Olomega and Jocotal is urgent and effective to reduce the potential flood damage. Immediate implementation of the project is recommended.**
- (3) Reforestation and erosion control have been studied and planned by the Government and should be applied to the San Miguel River Basin. The proposed watershed management is recommended to be implemented immediately for flood control / water resources development, increase in forestry / agricultural production, recovering of nature, etc.**

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