- noise and vibration problem caused by construction work in the crowded areas;
- effect on the river water quality and on the ecological conditions caused by the excavation work;
- spoils generated by excavation work, which would disperse as dust or cause offensive odor;
- impacts on the transport of goods and services to/from the city caused by a disruption of the traffic for construction work in the crowded areas of commercial and industrial districts;

Relocation of squatters from the Mangonbangon river banks may prove difficult, as gleaned from a recent experience of the city government.

2.2 EIA for Urgent Plan

Future Environment without the Project

Without the implementation of the Urgent Plan the environmental conditions at the sites are expected to remain as same as the present or to be deteriorate. The flood prone areas in the selected urban areas will continue to be subjected to flooding during the rainy season. Probable damages without the Plan are estimated as follows:

Area	Project Site	Affected Population (persons)	Area Inundated (km^2)	Value of Damageable Property (mil. pesos)
Iloilo	Jaro River Basin	98,003	28.0	751.1
	Iloilo River Basin	18,128	6.0	373.5
	Drainage Rehabilitation Area	2,997	0.6	16.4
Ormoc	Anilao & Malbasag River Basin	21,570	2.4	228.5
	Drainage Rehabilitation Area	346	0.1	2.5

Water quality in Iloilo and Ormoc cities will deteriorate especially at rivers and drainage channels where the basin is urbanized and densely populated. If the measures such as alignment of river/drainage will not be taken, garbage and sewage from the squatters along the channels will continue to deteriorate water quality.

If the measures such as revetment, retaining wall and drop will not be taken, channel erosion and siltation problems will increase.

If the flooding problems will not be settled, economic dislocations will continue to affect the areas and the regional economy will hardly grow. Furthermore, the value of properties in the areas will not increase due to the recurrent flooding damage.

Inhabitants in the areas will never be relieved of unsanitary health conditions caused by the recurrent inundation.

Prediction and Assessment of Impacts

(1) Iloilo

(a) Physico-chemical Aspects

(i) Surface Water

Garbage dumped in the river/drainage channels will be removed by the initial site clearing during the pre-construction stage. The work will be done during

dry season, therefore grabbing of garbage piled in the channels will not discharge water polluting load or will not deteriorate the water quality of the channels. On the contrary, the removal of garbage will improve the water quality of the channels in a long-term sense.

Excavation and dredging will increase the turbidity of channels during the construction stage.

Hydraulic conditions will be dramatically improved by the Project, namely channel capacity will be expanded. River/drainage water will be diverted or will flow the channel without overflow.

(ii) Ground Water

Seawater will intrude to about one kilometer above the mouth of Jaro Floodway during spring tide and salinity of ground water along the floodway will increase. However, there exists a small river running almost parallel to the proposed Jaro Floodway, and the intrusion of seawater is already affecting the salinity of ground water along the river. As for La Paz Floodway, the area along the proposed course is utilized for fishponds. Saline water is used for fishponds and the ground water around the fishponds also has high salinity.

Seawater will intrude to almost the same distance above the mouth of Jaro River as the present, because channel deepening proposed in the Plan is rather limited. As for Iloilo River and Mandurriao River, seawater is intruding deeply into the middle reach.

Therefore, the Plan will not affect the ground water quality in these areas.

(iii) Topography

Jaro Floodway will divert the stormwater and carry it into the Iloilo Strait only during the flooding time. River flow will also carry the sediment into the strait. The waterway excavated on the seabed from the mouth of the floodway to 2 km offshore will take the sediment to the center of the strait where there exists a strong tidal current. Most of the discharged sediment will be dispersed by the current. On the other hand, littoral currents will carry the remaining sediment and will make the waterway shallower during ordinary time. However, the sediment deposited in or around the waterway will be easily flushed away by the next flood. Therefore, it is considered that the coastal topography will not change.

As for the La Paz Floodway, the conditions are the same as the Jaro Floodway. The proposed discharge of Jaro River is the same as the present one. Therefore, the coastal topography will not change.

River improvement will protect the riverbeds and riverbanks from erosion, and will reduce the sediment yield. Therefore, the topographical changes caused by channel erosion and sedimentation will be reduced.

(iv) Air, Noise and Offensive Odor

Air quality will be affected in the construction stage because of the emission of exhaust gases from various construction equipment and facilities and the production of dust from the spoil. Unwanted noise and vibration caused by the construction equipment will be experienced.

An optimum construction work schedule will be considered not to concentrate the equipment on a certain point close to the houses. Basically, construction work will not be carried out at night or on official holidays such as Sundays

and national holidays, therefore, the construction works will never seriously disturb the residents. If dust will be blown off from the earthwork sites, the borrow pits or spoil banks, a water tanker will be used to sprinkle water on those sites.

(b) Ecological Aspects

(i) Terrestrial Species

Corn, coconut, bamboo, banana, and fruit trees along the river bank will be displaced by the dikes on a limited scale. However, the soil stabilizing effect of the flood control structures will be favorable for future cultivation of such species after the Plan is implemented.

(ii) Aquatic Species

It was noted previously that the deposition process supplies the substrate for the developing mangrove community of the river mouth. On the other hand, the proposed construction of Jaro Floodway, with its discharge of silt, might contribute to the delta formation. However, at the mouth of Jaro Floodway a little sedimentation is the most probable scenario. Judging from the fact that the newly formed delta is now being colonized by mangrove species at the Jaro River, mangrove will rather grow than diminish. A similar situation is likewise expected at the mouth of La Paz Floodway.

Most of the sediment discharged from the proposed floodways will be dispersed by the strong tidal current in the Iloilo Strait, and will never affect the coral reef in Guimaras Island.

The relocation of squatters currently living along the rivers to suitable resettlement sites may improve overall water quality after the Plan is completed, possibly improving diversity and productivity conditions of the aquatic coastal and marine ecosystem.

(c) Aesthetic Aspects

A significant factor that might affect the physical appearance of both the land and water systems will be the manner in which the spoil from the river/drainage channel widening and deepening will be utilized. The spoil will be utilized for embankment and surplus spoil will be dumped into the spoil banks near the construction site or the borrow pit excavated for the embankment materials.

Newly constructed floodways will not seriously affect the view of the area since earth dike along the floodways will be covered by sodding.

No significant degree of negative impact is anticipated on the aesthetic character of the affected terrestrial and aquatic ecosystem. Rather, it is likely that river bank stabilization, as a result of flood control works will facilitate the adoption of practical beautification measures such as approach steps to the waterfront, low water channel and tree planting along the river banks.

(d) Socio-economic Aspects

Since the Plan will eventually alleviate the flooding problem, damage to inhabitants, private properties, infrastructure, crops, livestock and fisheries are expected to be significantly reduced. Jaro District, in particular, is expected to be spared from habitual inundation. Agricultural areas with valuable crops will also be protected from flooding. Furthermore, beneficial impacts such as

appreciation of land values in the existing flood-prone areas will be realized as a result of reduction of flood damage on persons and properties.

In the construction stage, dump trucks will haul a large amount of construction materials and spoils. This might increase a traffic volume of the road. However, these traffic generated by construction works will scarcely run on the trunk roads in the area, because both borrow lands for earth material and spoil banks for disposal will be provided near the construction sites. Therefore, the traffic for construction work will never affect the transport of goods and services in the city.

A socio-economic study (using a questionnaire survey form) was conducted among a population of 128 households that will be directly affected by the proposed project. The study focused on the residents that are located along the alignment of the flood control works. Its main purpose is to gather data on community perceptions about the project.

According to the socio-economic questionnaire survey, around 54% of the inhabitants stated that the Project will improve the quality of life in a community, while 44% anticipate that conditions will be more peaceful, safe and convenient as a result of the Project. Only 3% indicated that it will have no effect. As for a question about the negative impacts, a slight majority of the respondents stated that there are no negative effects, with 29% still uncertain about the effects of the Project.

The relocation of squatters still constitutes a significant socio-economic impact as evidenced by these perceptions. This is also aggravated by the fact that more than 50% of the respondents to the questionnaire survey have been staying in their present location for more than 15 years. This lends a relatively permanent character to these communities which is further reflected in established social relationships and lifestyles. However, majority (65 %) of the respondents recognize that the riverbank is a dangerous area, and majority (72%) expressed willingness to relocate provided that the relocation site is within the immediate vicinity or in other accessible parts of the city.

Socio-economic effects associated with the Project include generation of short-term employment opportunities to unemployed semi-skilled and unskilled labors in the city, increase of economic activities as a result of increased demand for goods and services among these temporary workers, and influx of migrant construction workers and their families which may lead to proliferation of squatters in the vicinity of the flood control works.

(2) Ormoc

(a) Physico-chemical Aspects

(i) Surface Water

Construction work, especially excavation work will affect the water quality of the rivers. Therefore an appropriate works and a necessary control of works will be adopted referring to the monitoring results in order to avoid water pollution during the construction stage.

Hydraulic conditions will be dramatically improved by the Project, namely channel capacity will be expanded. River/drainage water will be diverted or will flow the channel without overflow.

(ii) Topography

River improvement will protect the riverbeds and riverbanks from erosion, and will reduce the sediment yield. Therefore, the topographical changes caused by channel erosion and sedimentation will be reduced.

(iii) Air, Noise and Offensive Odor

Air quality will be affected both during the pre-construction and construction stages because of the emission of gases from construction equipment and production of dust. Noise and vibration will also be experienced.

An optimum construction work schedule will be considered not to concentrate the equipment on a certain point close to the houses. Basically, construction work will not be carried out at night or on official holidays such as Sundays and national holidays, therefore, the construction works will never seriously disturb the residents. If dust will be blown off from the earthwork sites, the borrow lands or the spoil banks, a water tanker will be used to sprinkle water on those sites.

(b) Ecological Aspects

(i) Terrestrial Species

Initial site clearing operation will destroy and displace many lifeforms, specially along the river banks. However, the existing species could be reestablished in the immediate vicinity outside the Project site. Ipomoea sp. (kangkong) will be disrupted but it will regain its habitat within a short time after the construction.

(ii) Aquatic Species

Channel erosion is expected to be reduced by the river improvement, therefore, the adverse effects on aquatic ecosystem will be reduced.

(c) Aesthetic Aspects

A significant factor that might affect the physical appearance of both the land and water systems will be the manner in which the spoil from the river/drainage channel widening and deepening will be utilized. The spoil will be utilized for embankment and surplus spoil will be dumped into the borrow pit excavated for the embankment materials.

No significant degree of negative impact is anticipated on the aesthetic character. Rather, it is likely that river bank stabilization, as a result of flood control works will facilitate the adoption of practical beautification measures such as approach steps to the waterfront, low water channel, utilization of natural materials for the structures and tree planting along the river banks.

(d) Socio-economic Aspects

The major socio-economic impacts of the proposed Project are viewed as positive or beneficial in nature. The Project is expected to bring significant reduction in flood damage to inhabitants, private properties, infrastructure, crops, livestock and fisheries.

In the construction stage, dump trucks will haul a large amount of construction materials and spoils. This might increase a traffic volume of the road. However, these traffic generated by construction works will scarcely run on the trunk roads in the area, because both borrow lands for earth material and spoil banks for disposal will be provided near the construction sites. Therefore, the

traffic for construction work will never affect the transport of goods and services in the city.

A socio-economic study (using a questionnaire survey form) was conducted among a population of 47 households that will be directly affected by the proposed project. The study was carried out in the same manner as the study in Iloilo City.

Around 63% of the inhabitants interviewed said that the Project will promote safety and protection for the community while 20% expect that the Project will improve their living conditions. Based on the answers to the perception questionnaire survey, the positive and beneficial effects of the Project outweigh its negative impacts. Majority (74%) of the respondents stated that there will be no negative effects.

3. MITIGATION MEASURES

On the basis of the prediction and assessment of possible impacts, mitigation measures against serious or major impacts are proposed as follows:

3.1 Pre-Construction Stage

During the pre-construction stage, the main concern would be on right-of-way acquisition. As for the proper compensation of private lands that will be displaced, an acceptable basis for land value assessment will be mutually agreed upon between the project proponent and the property owners. As for the relocation and resettlement of squatters, the local government, in coordination with the National Housing Authority and other institutions, will provide relocation or resettlement sites with basic services and facilities and access to employment and livelihood opportunities sufficient to meet the basic needs of the affected families.

3.2 Construction Stage

(1) Spoil (Excavated Soil)

Excavated soils will be basically used for embankment, and surplus soils will be dumped into spoil banks provided near the construction site. If the excavated soils are not suitable for embankment, materials will be taken from the borrow pit near the construction site. Thus, not only dumping sites but also borrow lands are very close to the project site, therefore, traffic problems will not be caused by transporting trucks.

The spoil bank for excavation work in Iloilo City is proposed nearby the construction site. As for construction of Jaro Floodway, four spoil banks of 31.5 ha are proposed along the floodway which are used for rice paddies or open spaces at present.

(2) Dredging

Dredging work will be conducted only in Iloilo City, at the river mouths of the proposed floodways and the channel of Mandurriao River. There are two ways for disposal of dredged material. One is to use a cutter suction pump dredger which discharge the dredged material by pipe into the spoil bank and the other is to use a grab dredger for dumping the dredged material into the sea.

Spoil bank is proposed at the left side junction of Iloilo River and Mandurriao River of about 50 ha. Sedimentation pond is attached to the spoil bank to remove silt or pollutant. Therefore, the effluent of treated water will never pollute the river water.

Dredge material near the mouth of floodway is directly transported to a barge, and the barge is taken to the spoil area designated by the PPA which is located between the Iloilo river mouth and the mouth of Jaro Floodway. The dredged material will not cause any harmful impacts, because this spoil area faces Iloilo Strait and the dumped material will be easily dispersed by the strong tidal current.

(3) Monitoring

During the construction period, monitoring for water quality (turbidity) will be periodically carried out to ensure the mitigation measures.

3.3 Operation Stage

(1) Drops

Aside from the function from the hydraulic requirement, drops are expected to have the following functions from the viewpoint of environmental protection:

- effect of aeration to reserve water quality;
- provide a variety of water flow; and
- improvement of a river scenery.

Natural stones will be used for the main structure of the drops. A drop is divided into three steps to accelerate aeration and to give variety to the river flow.

(2) Low Water Channel

A low water channel for maintenance flow is proposed for river water use such as washing, and bathing. Meandering like a natural stream is given to the improvement alignment and river banks of low water channel with a gentle slope is fixed with log piles or boulders. The floodwater channel is sodded with grass or covered with boulders.

(3) Maintenance Road along a River

Maintenance roads are provided along both banks or on the earth dike, which can be used for strolling along the rivers. If there is a space behind the road, tree shall be planted for improvement of the scenery.

(4) Approach Steps to Waterfront

The river water is used by the inhabitants near the river for domestic purposes. Therefore, approach steps to the waterfront are provided on the earth dike/retaining wall to ease access to the river. Additionally, these steps will also help people become intimate with rivers.

(5) Consideration for Structural Design

Natural construction materials such as wood or stone/boulder are used for the structures as much as possible to provide a refreshing view.

(6) Drainage Channel

The drainage channels in the Project areas perform the combined functions of sewage mainly in the dry season and stormwater collection in the rainy season. Stagnant wastewater in the uneven bed of an open channel spreads nasty smell in the vicinity. To minimize these unhealthy and unfavorable environmental situations, an exclusive drainage maintenance ditch is proposed in the middle of the channel bed.

TABLES

Table 1.1 Classification of Water Use

[Fresh Surface Waters (rivers, lakes, reservoirs, etc.)]

Classification		Beneficial Use
Class AA	-	Public Water Supply Class I: This class is intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines.
Class A	-	Public Water Supply Class II: For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration and disinfection) in order to meet the NSDW.
Class B	-	Recreational Water Class I: For primary contact recreation such as bathing, swimming, skin diving, etc. (particularly those designated for tourism purposes).
Class C	-	Fishery Water: For the propagation and growth of fish and other aquatic resources
	-	Recreational Water Class II: Boating, etc.
	-	Industrial Water Supply Class I: For manufacturing processes after treatment
Class D	-	For agriculture, irrigation, livestock watering, etc.
	-	Industrial Water Supply Class II: Cooling, etc.
	-	Other inland waters, by their quality, belong to this classification

[General Provision on Water Classification]

Classification of a water body according to a particular designated use or uses does not preclude use of the water for other purposes those are lower in classification provided that such use does not prejudice the quality required for such waters.

Water classifications are arranged in the order of the degree of protection required, with Class AA having generally the most stringent water quality, respectively, for fresh surface waters; and Class D water has the least stringent water quality for fresh surface waters, respectively. The main objective of the water quality criteria is to maintain the minimum conditions necessary to assure the suitability of water for its designated use or classification. All reclassification of water shall be adopted, only after public notice and hearing and upon affirmative findings by the DENR Regional Office concerned that:

- The proposed reclassification will establish the present and future most beneficial use of the waters;
- Such a reclassification is clearly in the public interest, and
- The proposed designated use is attainable, upon consideration of environmental, technological, social, economic and institutional factors.

For purposes of classification or reclassification the following minimum water quality parameters are to be considered:

DO , pH , (BOD) , Total Coliform Organisms

Table 1.2 Water Quality Criteria for Conventional and Other Pollutants Contributing to Aesthetics and Oxygen Demand for Fresh Waters

Parameter	Unit	Class AA	Class A	Class B	Class C	Class D b)
Color	PCU	15	50	c)	c)	c)
Temperature d) (max. rise in °C)	^{0}C rise	-	3	3	3	3
pH (range)		6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-9.0
Dissolved Oxygen	% satu.	70	70	70	60	40
(minimum) e)	mg/l	5.0	5.0	5.0	5.0	3.0
BOD_5 (5-day, 20^{0}C)	mg/l	1	5	5	7 (10)	10 (15)
Total Suspended Solids	mg/l	25	50	f)	g)	h)
Total Dissolved Solids	mg/l	500 i)	1,000 i)	-	-	1,000 i)
Surfactant (MBAS)	mg/l	nil	0.2 (0.5)	0.3 (0.5)	0.5	-
Oil/Grease (Petroleum Ether Extract)	mg/l	nil	1	1	2	5
Nitrate as Nitrogen	mg/l	1.0	10	nr	10 j)	-
Phosphate as Phosphorus	mg/l	nil	0.1 k)	0.2 k)	0.4 k)	-
Phenolic Substances as Phenols	mg/l	nil	0.002	0.005 l)	0.02 l)	-
Total Coliforms	MPN/100ml	50 m)	1,000 m)	1,000 m)	5,000 m)	-
Fecal Coliforms	MPN/100ml	20 m)	100 m)	200 m)	-	-
Chloride as Cl	mg/l	250	250	-	350	-
Copper	mg/l	1.0	1.0	-	0.05 o)	-

Source: DENR Administrative Order No.34

Notes :

a) Except as otherwise indicated, the numerical limits in Table 1.2 and 1.3 are yearly average values. Values enclosed in parentheses are maximum values.

b) For irrigation purposes, SAR (Sodium Adsorption Ratio) should have a minimum value of 8 and a maximum value not to exceed 18. Boron should not exceed 0.75 mg/l.

c) No abnormal discoloration from unnatural causes

d) The allowable temperature increase over the average ambient temperature for each month. This rise shall be based on the average of the maximum daily temperature readings recorded at the site but upstream of the mixing zone over a period of one (1) month.

e) Sampling taken between 9:00 AM and 4:00 PM

f) Not more than 30% increase

g) Not more than 30 mg/l increase

h) Not more than 60 mg/l increase

i) Do not apply if natural background is higher in concentration. The latter will prevail and will be used as baseline.

j) Applicable only to lakes, reservoirs, and similarly impounded water.

k) When applied to lakes or reservoirs, the Phosphate as P concentration should not exceed an average of 0.05 mg/l nor a maximum of 0.1 mg/l.

l) Not present in concentrations to affect fish flavor/taste

m) These values refer to the geometric mean of the most probable number of Coliform organism during a 3-month period and that the limit indicated shall not be exceeded in 20 percent of the samples taken during the same period.

n) For spawning areas for Chanoschanos and other similar species

o) Limit is in terms of dissolved copper

nil Extremely low concentration and not detectable by existing equipment

\- means the standard of these substances are not considered necessary for the present time, considering the stage of the country's development and DENR capabilities, equipment and resources.

nr means No recommendation made

Table 1.3 Water Quality Criteria for Toxic and Other Deleterious Substances in Fresh Waters (for the Protection of Public Health)

Parameter	Unit	Class AA	Class A	Class B	Class C	Class D
Arsenic i)	mg/l	0.05	0.05	0.05	0.05	0.1
Cadmium i)	mg/l	0.01	0.01	0.01	0.01	0.05
Chromium i) (hexavalent)	mg/l	0.05	0.05	0.05	0.05	0.1
Cyanide	mg/l	0.05	0.05	0.05	0.05	-
Lead i)	mg/l	0.05	0.05	0.05	0.05	0.5
Total Mercury i)	mg/l	0.002	0.002	0.002	0.002	0.002
Organophosphate	mg/l	nil	nil	nil	nil	nil
Aldrin	mg/l	0.001	0.001	-	-	-
DDT	mg/l	0.05	0.05	-	-	-
Dieldrin	mg/l	0.001	0.001	-	-	-
Heptachlor	mg/l	nil	nil	-	-	-
Lindane	mg/l	0.004	0.004	-	-	-
Toxaphene	mg/l	0.005	0.005	-	-	-
Methoxychlor	mg/l	0.10	0.10	-	-	-
Chlordane	mg/l	0.003	0.003	-	-	-
Endrin	mg/l	nil	nil	-	-	-
PCB	mg/l	0.001	0.001	-	-	-

Source: DENR Administrative Order No.34

Table 1.4 Characteristics of River Basins in Environmentally Critical Area

ITEM	RIVER BASIN											
	ILOILO		CEBU					ORMOC		TACLOBAN		
	Ilo	Jar	Bul	Kin	Gua	Lah	Sub	Ani	Mal	Abu	Mn	Bur
National Parks												
Watershed Reserves		O		O								
Wildlife Preserve												
Sanctuaries												
Potential Tourist Spots												
Habitat for any Endangered or Threatened Species of Indigenous Philippine Wildlife (flora & fauna)		O		O	O	O	O	O	O	O		
Unique Historical, Archaeological or Scientific Interest												
Areas Traditionally Occupied by Cultural Communities or Tribes												
Areas Frequently Visited and/or Hard-hit by Natural Calamities		O			O	O		O	O			
Areas with Critical Slopes			O	O	O	O	O	O	O			
Prime Agricultural Lands	O	O						O	O			
Recharge Areas of Aquifers			O	O	O	O	O	O	O			
Water Bodies		O										
Mangrove Areas		O								O		
Coral Reefs												

Note : Ilo : Iloilo Jar : Jaro Bul : Bulacao
Kin : Kinalumsan Gua : Guadalupe Lah : Lahug
Sub : Subang Daku Ani : Anilao Mal : Malbasag
Abu : Abucay Man : Mangonbangon Bur : Burayan

Table 1.5 Results of Water Quality Survey of Rivers in Iloilo City

Sampling Location	Point Point	Sampling Period	Color (PCU)	pH	Water-Temp. (°C)	DO (mg/l)	DO (%satur.)	BOD_5 (mg/l)	T-SS (mg/l)	T-DS (mg/l)	Total Coliform (MPN/100ml)	Chloride (mg/l)	Phenols (mg/l)
JARO Middle Reach	River Center	(1)	150	6.9	27.5	5.8	73	4.3	204	364	$22x10^4$	11	0.013
		(2)	75	7.2	28.0	6.5	84	5.7	66	454	$30x10^3$	18	0.004
		(3)	12	6.8	28.5	5.8	75	2	17	921	$80x10^2$	134	0.006
	Bank Side	(1)	100	7.0	27.5	5.6	71	1.8	230	398	$17x10^4$	11	0.017
		(2)	75	7.3	28.0	6.7	86	6.3	100	482	$23x10^3$	18	0.005
		(3)	12	7.0	28.5	5.5	71	1	20	627	$23x10^2$	20	0.007
JARO Lower Reach	River Center	(1)	150	7.0	28.4	-	-	7.3	210	483	$13x10^5$	27	0.015
		(2)	50	7.1	29.0	5.5	72	5.8	102	541	$24x10^4$	11	0.004
		(3)	25	7.1	29	-	-	1	15	875	$50x10^2$	138	0.010
	Bank Side	(1)	150	7.0	28.5	-	-	6.2	204	459	$17x10^5$	27	0.012
		(2)	50	7.1	29	5.8	76	2.5	88	455	$30x10^3$	10	0.007
		(3)	50	7.1	29	-	-	2	13	649	$30x10^2$	20	0.011
ILOILO Middle Reach	River Center	(1)	75	6.9	28.0	-	-	5.9	32	13,857	$13x10^3$	4,000	0.003
		(2)	40	7.1	27.5	-	-	9.5	31	9,211	$50x10^2$	3,500	ND<0.001
		(3)	12	6.9	28.1	-	-	2	18	28,605	500	16,895	ND<0.001
	Bank Side	(1)	50	6.9	28.0	-	-	7.3	22	9,833	$50x10^3$	3,950	0.003
		(2)	50	7.1	27.5	-	-	7.3	29	9,328	$30x10^2$	3,750	ND<0.001
		(3)	50	6.9	28.0	-	-	13	29	10,934	$50x10^2$	5,498	ND<0.001
ILOILO Lower Reach	River Center	(1)	15	7.1	28.7	-	-	5.4	52	43,367	$90x10^2$	13,550	0.001
		(2)	5	7.4	28.2	5.3	68	7.9	33	44,516	$50x10^2$	18,350	0.005
		(3)	50	7.1	28.4	-	-	5	31	11,173	$30x10^2$	5,598	0.003
	Bank Side	(1)	10	7.1	28.3	-	-	7.1	60	44,167	$24x10^3$	15,300	0.002
		(2)	5	7.4	28.2	5.3	68	6.5	71	43,756	$50x10^3$	17,350	0.004
		(3)	25	7.1	28.5	-	-	7	23	34,171	$30x10^2$	18,394	0.005

Note: 1. Sampling Period (1) : June 19, 1994; (2) : July 19, 1994; (3) : August 15, 1994
2. T-SS : Total Suspended Solids; T-DS : Total Dissolved Solids; Chloride : Chloride as Cl; Phenols : Phenolic Substances as Phenols

Table 1.6 Results of Water Quality Survey of Rivers in Ormoc City

Sampling Location	Point	Sampling Period	Color (PCU)	pH	Water-Temp. (°C)	DO (mg/l)	DO (%satur.)	BOD_5 (mg/l)	T-SS (mg/l)	T-DS (mg/l)	Total Coliform (MPN/100ml)	Chloride (mg/l)	Phenols (mg/l)
ANILAO	River Center	(1)	15	6.9	28.0	6.6	85	4.8	10	163	-	1	ND<0.001
		(2)	10	6.9	28.1	7.9	100	5.5	18	169	$17x10^4$	1.5	0.004
Middle Reach		(3)	12	6.9	28.3	6.8	88	1	9	196	$50x10^4$	1	0.003
	Bank Side	(1)	15	7.0	28.0	6.4	82	4.9	7	167	-	1.5	0.007
		(2)	10	6.8	28.2	7.3	94	8.5	14	181	$13x10^4$	1.8	0.002
		(3)	10	6.9	28.2	6.5	84	1	7	198	$30x10^3$	1	0.002
ANILAO	River Center	(1)	30	6.9	29.0	4.7	61	9.0	11	1,010	-	440	ND<0.001
		(2)	15	7.0	28.9	5.9	77	9	21	1,409	$14x10^4$	600	0.002
Lower Reach		(3)	25	7.2	29.1	4.8	63	1	16	736	$24x10^5$	264	0.004
	Bank Side	(1)	30	7.0	29.0	4.9	64	9.8	22	2,089	-	912	ND<0.001
		(2)	15	6.8	29.0	5.9	77	9.8	11	1,449	$50x10^4$	675	0.007
		(3)	10	7.2	29.0	4.6	60	3	10	1,237	$50x10^4$	700	0.008
MALBASAG	River Center	(1)	20	6.9	27.2	5.7	72	5.3	8	210	-	0.8	ND<0.001
		(2)	10	6.7	27.0	5.6	71	4.5	20	245	$13x10^4$	2	ND<0.001
Middle Reach		(3)	10	6.9	27.3	5.7	72	2	14	204	$50x10^3$	1	ND<0.001
	Bank Side	(1)	30	6.9	27.1	5.4	68	8.8	8	223	-	1.5	ND<0.001
		(2)	10	6.8	27.0	5.4	68	6.5	19	249	$14x10^4$	2	ND<0.001
		(3)	10	6.9	27.5	5.8	74	1	10	215	$24x10^3$	1	ND<0.001
MALBASAG	River Center	(1)	40	6.8	28.5	4.9	64	8.0	10	311	-	62	ND<0.001
		(2)	15	6.8	28.3	5.2	67	8.5	6	274	$13x10^4$	30	ND<0.001
Lower Reach		(3)	5	6.9	28.5	4.4	57	1	12	148	$11x10^4$	2	ND<0.001
	Bank Side	(1)	40	6.8	28.5	4.6	60	17.4	10	331	-	93	ND<0.001
		(2)	15	6.7	28.3	5.4	70	6.5	20	257	$24x10^4$	24	ND<0.001
		(3)	10	7.0	28.5	4.3	56	1	15	210	$50x10^4$	2	ND<0.001

Note: 1. Sampling Period (1) : June 21, 1994; (2) : July 20, 1994; (3) : August 15, 1994
2. T-SS : Total Suspended Solids; T-DS : Total Dissolved Solids; Chloride : Chloride as Cl; Phenols : Phenolic Substances as Phenols

Table 2.1 Environmental Interaction Matrix for the Flood Control Plan in Iloilo

MAJOR ACTIVITIES (which may cause IMPACTS)		ENVIRONMENTAL FACTORS													
		Physico-Chemical				Ecological			Socio-Economic						
Project Stage	Activities	Surface Water	Ground Water	Topography	Air, Noise & Offensive Odor	Terrestrial Species	Aquatic Species	Aesthetic Aspects	Economic Activities	Land Use	Demography & Manpower	Transportation	Housing & Community Infrastructure	Health & Social Services	Life Style & Community
Pre-Construction	Right-of-Way Acquisition								-	--			---		---
	Initial Site Clearing					-		-							
Construction	Labor Mobilization								+		-		-	-	-
	Channel Improvement	--			---	-	--	--	+ -	-	+	-	-	--	
	Floodways		-		-	-	-	--	+ -	--	+	-	-	--	
	Replacement (Bridge, etc.)	--			--		--	--	+ --		+	--	-		--
	Drainage Channel Improvement	-			---		-	--	+ --	-	+	-	-	-	
	Drainage Diversion		-		---	-		--	+ --	--	+	--	-		
Operation	River Channel	+++		+ -	++	+	+	+++	+++	+++ -		++	+++	+++	++
	Floodway	+++	-	-		-	-	--	+++	+++ ---		++ -	+++	+++	++ --
	Drainage	+++	-	-	+++		+	+++	+++	+++ --		++	+++	+++	++

Note: + : Positive (Beneficial) Impact - : Negative (Adverse) Impact

Impact Categories:
+ or - : Possible but Minor Impact
++ or -- : Minor to Moderate Impact
+++ or --- : Moderate to Major Impact

Table 2.2 Environmental Interaction Matrix for the Flood Control Plan in Cebu

MAJOR ACTIVITIES (which may cause IMPACTS)		ENVIRONMENTAL FACTORS													
		Physico-Chemical				Ecological			Socio-Economic						
Project Stage	Activities	Surface Water	Ground Water	Topography	Air, Noise & Offensive Odor	Terrestrial Species	Aquatic Species	Aesthetic Aspects	Economic Activities	Land Use	Demography & Manpower	Transportation	Housing & Community Infrastructure	Health & Social Services	Life Style & Community
Pre-Construction	Right-of-Way Acquisition								--	---			---		---
	Initial Site Clearing					-									
Construction	Labor Mobilization								+		-		-	-	-
	Channel Improvement	-			---	-	-	-	+ -	-	+	--	--	--	
	Replacement (Bridge, etc.)	-			---		-	-	+ --		+	--	-		-
	Drainage Channel Improvement	-			---			-	+ --	-	+	--	--	--	
Operation	River Channel	+++		+ -	+++	+	+	+++	+++	+++ -		++	+++	+++	++
	Drainage	+++	--		+++			+++	+++	+++ --		+++	+++	+++	+++

Note: + : Positive (Beneficial) Impact - : Negative (Adverse) Impact

Impact Categories:
+ or - : Possible but Minor Impact
++ or -- : Minor to Moderate Impact
+++ or --- : Moderate to Major Impact

Table 2.3 Environmental Interaction Matrix for the Flood Control Plan in Ormoc

MAJOR ACTIVITIES (which may cause IMPACTS)		ENVIRONMENTAL FACTORS													
		Physico-Chemical				Ecological			Socio-Economic						
Project Stage	Activities	Surface Water	Ground Water	Topography	Air, Noise & Offensive Odor	Terrestrial Species	Aquatic Species	Aesthetic Aspects	Economic Activities	Land Use	Demography & Manpower	Transportation	Housing & Community Infrastructure	Health & Social Services	Life Style & Community
Pre-Construction	Right-of-Way Acquisition								-	--			---		--
	Initial Site Clearing					-		-							
Construction	Labor Mobilization								+		--		-	-	--
	Channel Improvement	--			--	--	-	--	+ -	-	+	-	-	-	
	Slit Dam					--	-	--	+	-	+				
	Replacement (Bridge, etc.)	--			--		-	--	+ --		+	--	-		--
	Drainage Channel Improvement				--		-	-	+ -	-	+	-	-	-	
Operation	River Channel	+++		++ -		++	+	+++	+++	+++ -		+	+++	++	++
	Drainage	+++	-	-	++		+	++	+++	+++ --		++	+++	+++	++

Note: + : Positive (Beneficial) Impact - : Negative (Adverse) Impact

Impact Categories:
+ or - : Possible but Minor Impact
++ or -- : Minor to Moderate Impact
+++ or --- : Moderate to Major Impact

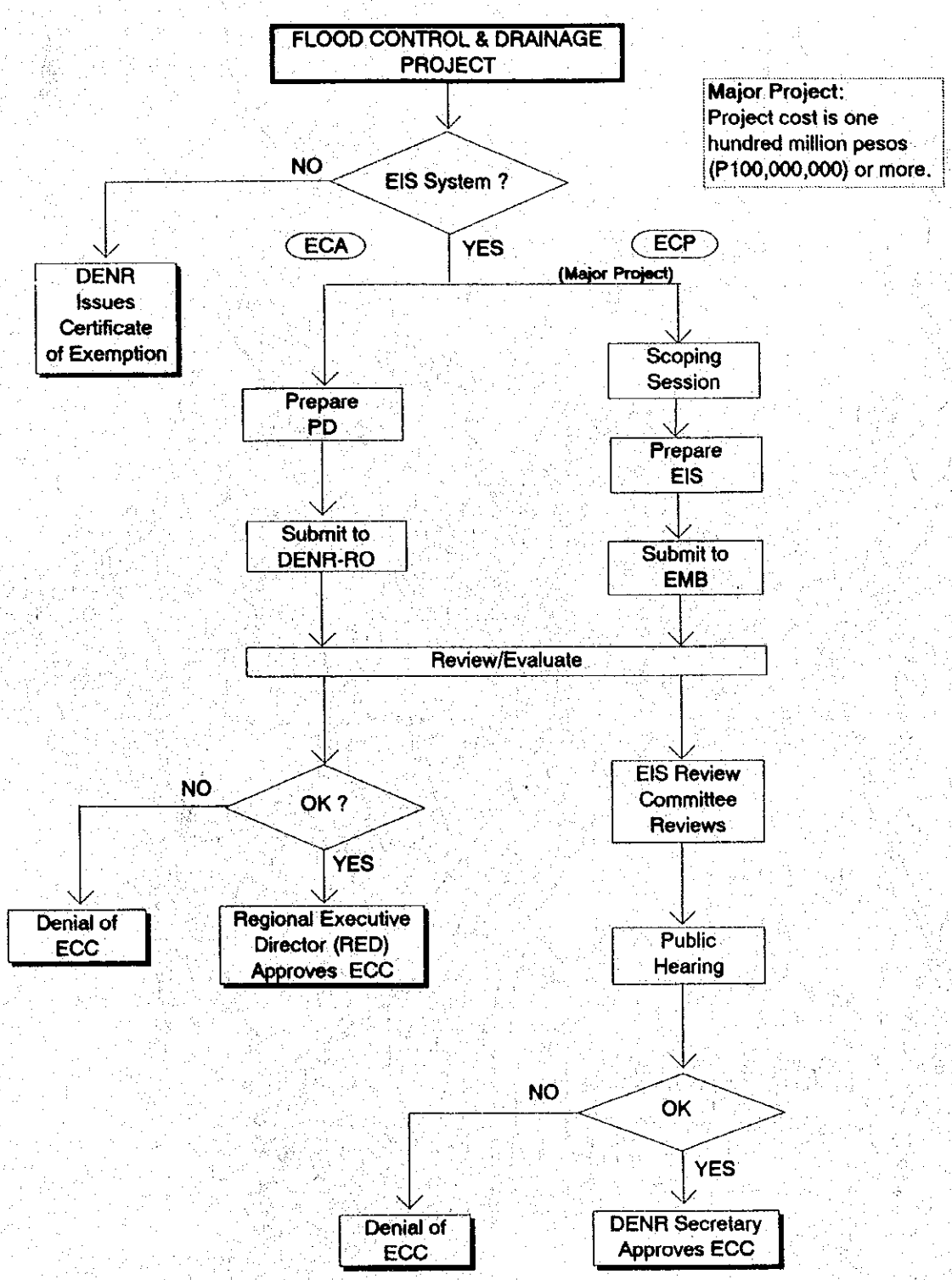
Table 2.4 Environmental Interaction Matrix for the Flood Control Plan in Tacloban

MAJOR ACTIVITIES (which may cause IMPACTS)		ENVIRONMENTAL FACTORS													
		Physico-Chemical				Ecological			Socio-Economic						
Project Stage	Activities	Surface Water	Ground Water	Topography	Air, Noise & Offensive Odor	Terrestrial Species	Aquatic Species	Aesthetic Aspects	Economic Activities	Land Use	Demography & Manpower	Transportation	Housing & Community Infrastructure	Health & Social Services	Life Style & Community
Pre-Construction	Right-of-Way Acquisition								-	--			---		---
	Initial Site Clearing					-									
Construction	Labor Mobilization								+		--		-	-	--
	Replacement (Bridge, etc.)	-			--		-	--	+ --		+	--	-		--
	Drainage Channel Improvement	--			--		-	--	+ --	-	+	--	--	-	
Operation	Drainage	+++	-	-	++		+	+++	+++	+++ --		++	+++	+++	++

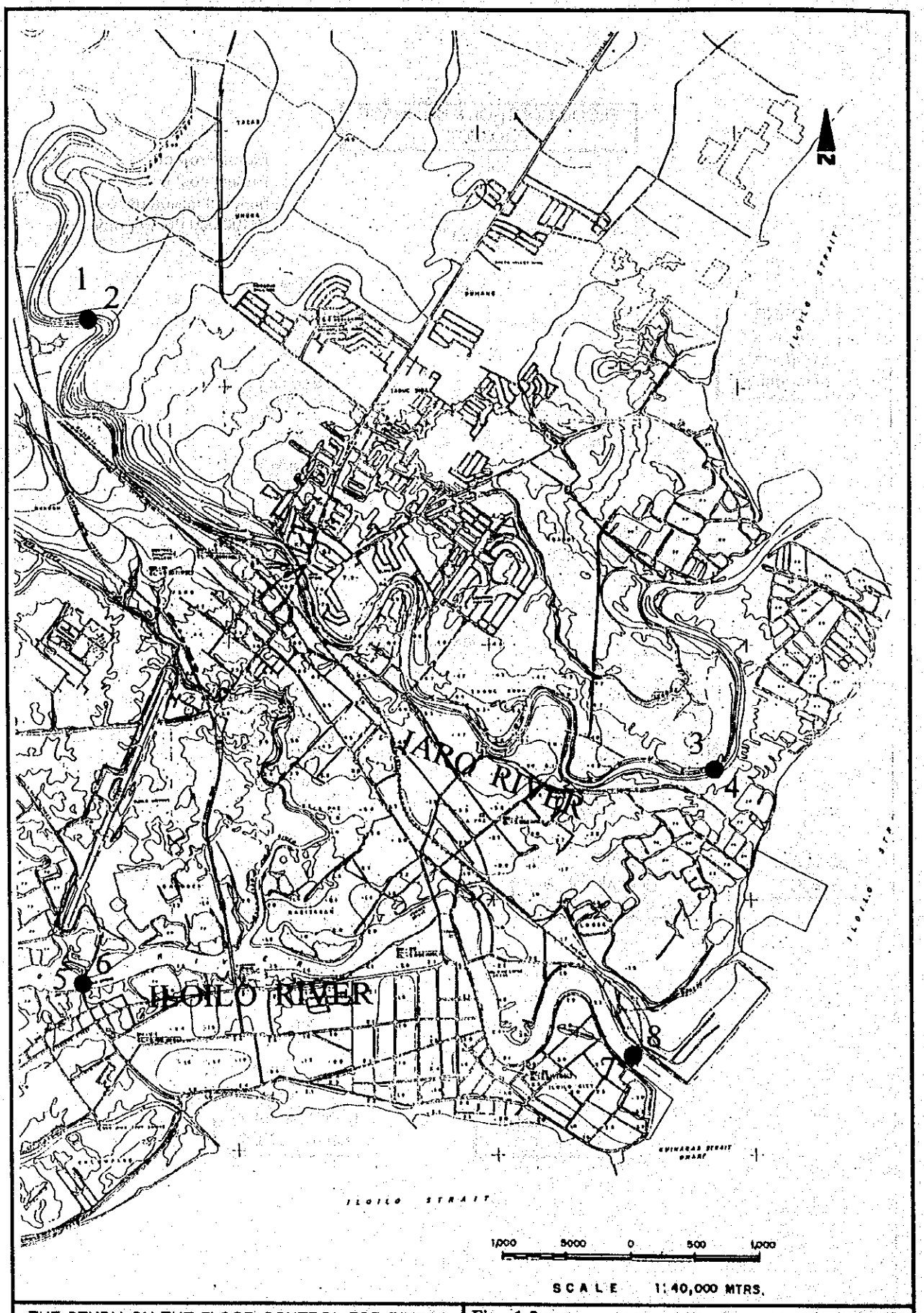
Note: + : Positive (Beneficial) Impact - : Negative (Adverse) Impact

Impact Categories:
+ or - : Possible but Minor Impact
++ or -- : Minor to Moderate Impact
+++ or --- : Moderate to Major Impact

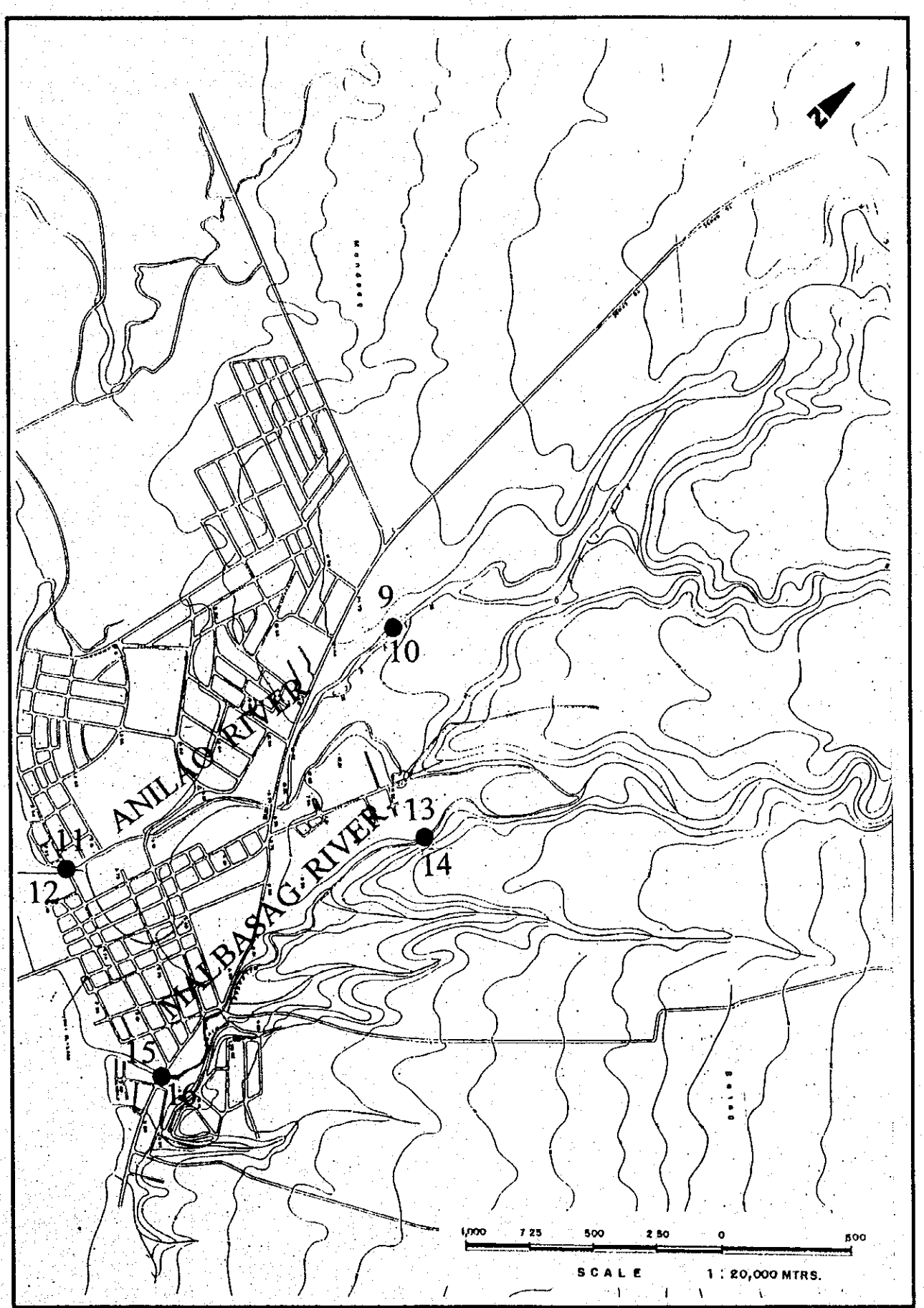
FIGURES



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.1 Conceptual Flow Chart of EIS System
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS	Fig. 1.2 Sampling Points of Water Quality Survey, Iloilo
JAPAN INTERNATIONAL COOPERATION AGENCY	



THE STUDY ON THE FLOOD CONTROL FOR RIVERS IN THE SELECTED URBAN CENTERS JAPAN INTERNATIONAL COOPERATION AGENCY	Fig. 1.3 Sampling Points of Water Quality Survey, Ormoc

SUPPORTING REPORT

ON

RIVER IMPROVEMENT PLAN

(6)

SUPPORTING REPORT
ON
RIVER IMPROVEMENT PLAN

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1. INTRODUCTION

This Supporting Report on River Improvement Plan presents the results of the study on flood control for the Master Plan and the Urgent Plan. The study area covered the basins of nine (9) rivers in selected urban centers; namely, Jaro, Iloilo (Iloilo City), Bulacao, Kinalumsan, Guadalupe, Lahug, Subang Daku (Cebu City), Anilao, and Malbasag (Ormoc City).

The main objectives of the study on river improvement plan are as follows:

(1) To grasp the existing channel conditions and river structures of the nine (9) rivers through field investigation and data collection;

(2) To propose an optimum Master Plan of river improvement through comparison among alternative plans;

(3) To propose the Urgent Plan of river improvement; and

(4) To prepare a preliminary design of the related structures.

2. EXISTING CONDITION OF RIVERS

2.1 River Channel

Iloilo City

(1) Jaro River

The upstream channel of Jaro River, i.e., Tigum River, shows a braided configuration on the alluvial fan with a wide flood area at the section of Maasin to Sta. Barbara, where the average riverbed gradient is 1/400. During floods, the flow section along this stretch may have a width ranging from 300 m to 1.0 km. The low water channel is narrow and shallow. The flood-prone area spreading along the river course is partly utilized as farmland during the dry season.

The lower stretch of the Tigum and Jaro rivers from Sta. Barbara to La Paz is a single cross section channel, 5 to 8 m deep and 40 to 80 m wide at the top of the bank. Along this stretch, a natural levee is found at both banks. The natural levee has a height of 1.0 to 1.5 m and a width of 20 to 50 m, formed by recurrent overflows since ancient times. The gradient of the riverbed gradually becomes gentle from 1/850 to 1/1,500.

The lower reaches of Jaro River from La Paz to the river mouth show a gentle gradient of 1/5,000, a river width of 80 to 120 m and a water depth of 3 m. It merges with the Iloilo Strait with some meandering.

Fig. 2.1 shows changes of the river mouth of Jaro River as reflected in the topographic map of 1953 and aerial photographs of 1980 and 1987. The river course on the deltaic area has been gradually shifting in these 30 years, while that in the upper reach has been stable since 1953. On the other hand, the sandbars at the river mouth are gradually expanding to the Iloilo Strait. The notable expansion of sandbars between 1980 to 1987 was caused by artificial factors such as the expansion of fishponds in the Iloilo Strait and sand mining along the river by construction works.

Aganan River, the biggest tributary of Jaro River, joins with the mainstream at the 15.78 km point. The river channel from the confluence to San Miguel is a single cross section with a width ranging from 40 to 60 m and a depth from 4 to 6 m. The gradient of the riverbed is constant at 1/850. In the upper portion of this stretch, the river channel becomes braided with a wide floodplain of 300 to 500 m in width and a steep riverbed of 1/350. Longitudinal profiles are shown in Fig. 2.2 and channel dimensions are given in Table 2.1

(2) Iloilo River

Along the river stretch of 3 km from the river mouth, the right bank is used as a wharf at the Port of Iloilo. The Philippine Ports Authority (PPA) has been conducting dredging works along the stretch every year. The river width ranges from 150 to 190 m and the water depth is from 6 to 8 m.

The main stream of Iloilo River has a constant riverbed gradient of 1/4,000. However, the channel width gradually becomes narrower upward from 150 m at the confluence with Mandurriao River, the first tributary, down to 55 m at the confluence with the Carahauan Brook, the second tributary, and 10 m at the end of the main stream. Mandurriao River has a small channel of about 5 m wide and 1 to 3 m deep, and a gradient of 1/500 to 1/800.

Longitudinal profiles are shown in Fig. 2.3 and channel dimensions are given in Table 2.2

Cebu City

The five (5) objective rivers in Cebu City; namely, Bulacao, Kinalumsan, Guadalupe, Lahug and Subang Daku from the west are classified as rivers of rapid flow with steep gradient and narrow width.

(1) Bulacao River (Table 2.3 and Fig. 2.4)

The river channel of Bulacao River at the 0.0 km to 1.5 km stretch having a 5 to 10 m of river width is provided with concrete walls, 2 m high. The riverbed gradient of 1/220 at the river mouth is steep compared with other rivers in Cebu City. Along the stretch from 1.50 to 2.65 km, the channel is unlined and has a depth of 2 to 3 m, a width of 10 to 30 m and a river gradient of 1/140.

The upper portion shows a mountain stream with a steep riverbed. The width of the channel in this portion is 20 to 30 m and the depth is 7 to 10 m.

(2) Kinalumsan River (Table 2.4 and Fig. 2.5)

The Slum Improvement and Rehabilitation Project (SIRP) provided concrete dikes along both banks of Kinalumsan River at the river mouth to the 0.5 km point. The river section of this stretch is 12 m wide and 2 to 3 m deep, with a river gradient of 1/700.

From the boundary of the SIRP area to the 1.2 km point, the river channel has a width of about 10 m, a depth of 2.5 to 4 m and a river gradient of 1/200. It runs through a dense residential area. From the 1.45 km point, the confluence with Linao River, a tributary of Kinalumsan River, the river channel has a channel section of 5 to 10 m wide, 2 to 5 m deep and 1/120 river gradient with natural bank slope.

The river section upstream of 2.5 km is a valley-shaped channel with a width of 25 to 30 m, a gradient of 1/85 and a depth of more than 10 m.

(3) Guadalupe River (Table 2.5 and Fig. 2.6)

The channel at the river mouth has a width of 20 m and a depth of 2.5 m. From the 0.5 km to the 2.0 km point, through the urban area, it becomes narrower with a width of 6 to 10 m and a depth of 1.5 to 6.0 m. The river gradient gradually changes along this section from 1/400 to 1/200. From the 2.0 km to the 4.5 km point, the river sections have a width of 10 m, a depth of 12 m and a gradient of 1/130.

(4) Lahug River (Table 2.6 and Fig. 2.7)

A box culvert, 2.6 m high and 6 m wide, has been constructed at the river mouth for use as a wharf at the Port of Cebu.

The river channel in the city area from the river mouth up to the 5.0 km point has a rectangular section with a height of 2 m and a width ranging from 6 m to 10 m. The riverbed gradient gradually changes from 1/400 at the river mouth, 1/200 at the 2 km point, 1/130 at the 2.65 km point, and up to 1/80 at the 5 km point. The river stretches in the mountainous area, upstream of 5.0 km, become steeper than 1/50.

(5) Subang Daku River (Table 2.7 and Fig. 2.8)

The lower portion is connected to an artificial waterway with a width of 50 m in the reclamation area. This waterway is also connected to the diversion culvert of Lahug River.

The stretch from 0.54 km to the 3.0 km point is located in the town area, where the channel of 5 to 10 m wide and 1 m high is provided with a concrete wall used for house foundations. The riverbed gradient ranges from 1/600 to 1/300. At the 3.0 km point, the river gradient changes to 1/100 and the upstream of this point is a rectangular channel, 3 to 6 m wide and 2 m deep. The upper portion of the 5.5 km point forms a steep valley with a gradient of more than 1/50.

Ormoc City

As shown in Fig. 2.9, the river courses of Anilao and Malbasag had merged and changed remarkably in the flood-plains in the last two decades.

(1) Anilao River (Table 2.8 and Fig. 2.10)

The upstream section of the river forms a deep valley with a width of 10 to 20 m, a depth of 5 m to 15 m and a gradient steeper than 1/45. Before reaching the plain area, the main stream receives four (4) main tributaries deeply eroding the mountain slope.

In the downstream, Anilao River widens and forms a small flood-plain of approximately 200 m wide. This stretch has a riverbed gradient of 1/75. The channel section downstream of the Anilao Bridge has an average width of 60 m and a height of 2 to 3 m.

(2) Malbasag River (Table 2.9 and Fig. 2.11)

The channel section forms a deep valley in the mountain area and a flood-plain in the middle reach. The river flows into the Ormoc Bay at a steep gradient of 1/150.

2.2 Flow Capacity

Flow capacity of the objective rivers is estimated on the basis of the results of river survey conducted in the study. The non-uniform flow analysis is employed for the sub-critical flow and the uniform flow calculation (Manning s Formula), for super-critical flow, using the following roughness coefficients: The details of evaluation on the flow capacity are shown in Table 2.10:

River Name	Roughness Coefficient
Jaro River	0.035
Iloilo River	0.030
Mandurriao River	0.035
Rivers in Cebu City	0.040
Rivers in Ormoc City	0.040

For the initial condition of water level at the first section, the water level of the mean spring higher high water level (MSHHW) was employed. The flow capacity is evaluated as a non-damageable discharge taking the water level at the bank top/crown and with a vertical clearance of 1.0 m below the bridge superstructure.

Flow capacities of the nine (9) rivers are shown in Tables 2.1 to 2.9 and Figs. 2.12. They are summarized in the table below and in Fig. 2.13.

River Name	Stretch (km)	Flow Capacity (m^3/s) Average (Range)
Iloilo City		
(1) Jaro River		
- Main Channel	0.0 - 4.0	150 (90-250)
	4.0 - 10.0	400 (200-500)
	10.0 - 16.0	500 (400-550)
	16.0 -	300 (250-350)
- Tigum River		
- Aganan River		
(2) Iloilo River		
- Main Channel	0.0 - 3.5	more than 1,000
	3.5 - 5.0	500 (400-600)
	5.0 -	200 (100-300)
- Mandurriao	0.0 - 1.0	200 (100-300)
	1.0 - 2.0	60 (20-120)
	2.0 -	20 (15-100)
Cebu City		
(1) Bulacao River	0.0 - 1.0	5 (5 - 20)
	1.0 - 2.5	30 (15 - 50)
(2) Kinalumsan River	0.0 - 4.0	30 (30 - 200)
(3) Guadalupe River	0.0 - 1.5	20 (20 - 250)
	1.5 -	200 (200 - 600)
(4) Lahug River	0.0 - 1.0	7 (4 - 20)
	1.0 - 3.0	15 (10 - 35)
	3.0 -	> 100
(5) Subang Daku River	0.0 - 5.0	10 (5 - 80)
Ormoc City		
(1) Anilao River	0.0 - 0.8	250 (50-400)
	0.8 - 2.0	450 (400-800)
	2.0 -	200 (200-800)
(2) Malbasag River	0.0 - 1.4	40 (15-100)
	1.4 - 2.0	50 (40-300)
	2.0 -	more than 300

2.3 Existing River Structures

<u>Iloilo City</u> (Fig. 2.14)

(1) Jaro River

There are many existing river structures classified into four (4) categories, i.e., flood control structures, bridges, municipal water intake and irrigation system. All river structures along Jaro River are listed in Table 2.11.

(a) Flood Control

Concrete revetments have been constructed partially between La Paz and the confluence with Aganan River. The revetments with a total length of 2,965 m are provided mainly on the right bank at the meandering section of the river.

(b) Bridges

There are four (4) bridges with RC girders between La Paz and the confluence. The foundation piles of bridge piers are exposed due to degradation of the

riverbed caused by the collection of riverbed materials. At Jaro Bridge and Montola Bridge, reinforcement works of bridge foundations were conducted and completed in June 1993. Six (6) bridges along the upstream of the confluence were constructed. The left abutment of Tuburan Bridge had been washed out by floods and is now under repair. There are four (4) bridges on the major road along Aganan River.

(c) Municipal Water Intake

The intake structure of the Metro Iloilo Water District (MIWD) with a pump station and a weir of sandbags is located at the 13.4 km from the river mouth. At the upstream of the confluence, there are two intake structures: Maasin Dam constructed in 1928 with an intake capacity of 11,355 m^3/day, and an infiltration gallery and pump station in Sta. Barbara with a capacity of 3,785 to 5,678 m^3/day.

(d) Irrigation Systems

The project area has two (2) irrigation systems; namely, the Aganan River Irrigation System (ARIS) and the Sta. Barbara Irrigation System (SBIS). There are two (2) intake dams constructed upstream, one in Jaro River and the other in Aganan River.

(2) Iloilo River

The river structures along Iloilo River and Mandurriao River which is the first tributary of Iloilo River are summarized in Table 2.12.

The right bank at the river mouth of Iloilo River is utilized as a part of the wharf of the Port of Iloilo. In the port area along the river channel, concrete walls for the wharf are provided for 3 km from the river mouth.

There is no major flood control structure along the upstream of Iloilo River. Both river banks are mostly used for fishponds. Some footpaths between the river and fishponds are protected with dry masonry revetments.

Four (4) road bridges and one railway bridge are built across Iloilo River. Along Mandurriao River, a diversion road has been newly constructed with four (4) concrete bridges. In addition, there are two (2) other bridges on the way to Jaro.

Cebu City (Fig. 2.15)

(1) Bulacao River (Table 2.13)

Both banks of the river channel are provided with concrete or masonry revetments which are used for the foundation of private houses, but no flood control structures have been constructed.

Three (3) RC girder bridges were constructed at the point crossing the main roads on the river. At the 0.15 km point, a bridge on the waterway passing through the reclamation area is under construction. Further, several wooden or steel-made bridges are placed for private use.

(2) Kinalumsan River (Table 2.14)

Both banks of the river mouth area are reinforced by concrete dikes constructed under SIRP. Some revetments for house foundations have been constructed in the downstream area. Channel works have been provided to prevent bank erosion in the midstream stretches. Four (4) RC girder bridges have been constructed across the river.

The Buhisan Dam for municipal water supply is located 7 km from the river mouth, but the dam has been abandoned due to heavy siltation.

(3) Guadalupe River (Table 2.15)

Revetments are provided at the stretch from 1.55 km to 1.80 km, the meandering portion along Y. Rama Avenue, and the right bank of the stretch between Colon Bridge and Tupas Bridge. There are many rubble concrete foundations for private houses in the city proper; however, they are constructed only to protect houses and impede the smooth flow of the river.

At the 0.7 km point, a groundsill has been placed to prevent the degradation of the riverbed. There are seven (7) bridges located on the main road from Tupas Street to N. Escario Street.

(4) Lahug River (Table 2.16)

Concrete dikes and revetments have been provided from the 1 km point to 3 km point. There is a partition wall (separation concrete dike) at the confluence of the drainage channel, 3.9 km from the river mouth, which is a bending point of the river.

A diversion structure has been constructed at the 3.32 km from the river mouth to divert floods to Subang Daku River. The diversion structure is composed of a pipe culvert with a diameter of 1.8 m, and a broad-crested fixed weir with a crest length of 6 m and a width of 3 m. The outlet of the diversion culvert located in the Cebu Business Park which is under construction is connected to the drainage box culvert, 2.75 m wide and 2.85 m high.

At the river mouth, the river flows into the wharf of the Port of Cebu through a box culvert, 6 m wide and 2.5 m high.

(5) Subang Daku River (Table 2.17)

Both river banks in the city proper are provided with revetments for the foundation of private houses. However, revetments for flood control with the purpose of stabilizing the river course or preventing the scouring of bank are not provided.

There are four (4) bridges on the main street and many small-scale wooden or steel bridges for private use.

<u>Ormoc City</u> (Fig. 2.16)

(1) Anilao River (Table 2.18)

A concrete dike on the left bank and concrete revetments on the right bank were destroyed by the 1991 flood. At the upstream section of the Anilao Bridge, the bending point of the river course, gabion mattress type revetments were constructed in 1993 with financial assistance from ADB.

Reconstruction of the Anilao Bridge and repair of the Alegria Bridge were completed in 1992, but the Osmeña Bridge remains as a temporary spillway with four pipe culverts.

(2) Malbasag River (Table 2.19)

Concrete revetments in the city proper were partially damaged by the 1991 flood. At the 2.0 km point from the river mouth, concrete revetments were constructed with financial assistance from ADB.

The river water is used for municipal and irrigation water supply. For the municipal water supply, water tanks, water transmission pipes and intake galleries are provided

along the downstream of the intake weir located at the 3.5 km point. The irrigation channel is connected from Malbasag River at the 2.7 km point to Anilao River at the upstream of Anilao Bridge.

2.4 Related Plans

There are some projects and plans related to the objective river basins and drainage areas, as follows:

(1) Iloilo Commercial Port Complex Project

Extension of the Iloilo Commercial Port Complex at the outlet of the proposed La Paz floodway has been studied by the Philippine Ports Authority (PPA). There are three (3) alternative plans for the project, but the details of the plan have not been finalized. It is expected that the project will be started in 1996 and completed in 1999. The alignment of the La Paz Floodway does not affect any alternative plans.

(2) Scheme for Maintenance Dredging at RC-3 (Iloilo Port)

From the river mouth to STA. 2+400, maintenance dredging works have been carried out by the PPA for the Port of Iloilo. This dredging scheme is considered in the river improvement plan of Iloilo River. The scheme of the dredging works is shown below:

Stretch	Bottom Elevation (from MLLW)
River Mouth to STA. 0+800	EL. - 6.0 (EL. - 6.75 m)
STA. 0+800 to STA. 1+200	EL. - 5.0 (EL. - 5.75 m)
STA. 1+200 to STA. 1+800	EL. - 4.0 (EL. - 4.75 m)
STA. 1+800 to STA. 2+400	EL. - 3.0 (EL. - 3.75 m)

Note: Elevation in parentheses is above MSL.

(3) Iloilo River Rehabilitation Project

The Iloilo River Rehabilitation Project has been conducted by the Region VI Office, DPWH. The project is composed of construction of several bridges, dredging works and river environmental improvement works such as construction of promenade and green park along the river.

(4) Osmeña Extension Bridge on Anilao River

Osmeña Extension Bridge, washed out in the 1991 flood, is schedule to be reconstructed in 1994. The length of the bridge is 57 m which is shorter than the proposed bridge in this Study. Therefore, it is necessary to make the bridge longer in the actual construction.

(5) Rehabilitation of Concrete Dike along Malbasag River

The collapsed concrete dike at STA. 1+ 200 will be reconstructed by the Ormoc City Engineer s Office.

3. MASTER PLAN

3.1 Planning Conditions for Master Plan

3.1.1 Project Scale and Design Discharge

The project scale of the Master Plan for rivers is generally proposed to be a 50-year return period.

The design discharge corresponding to the design scale of each river is estimated at base points, as presented in the Supporting Report on Hydrology. The results of the hydrological study are summarized as follows:

City Name	River Name	Design Discharge (m^3/s)
Iloilo City	Jaro River	
	- Jaro River	1,400
	- Tigum River	600
	- Aganan River	800
	Iloilo River	
	- Lower Section *	600
	- Upper Section *	550
	Mandurriao River	70**
Cebu City	Bulacao River	220
	Kinalumsan River	220
	Guadalupe River	240
	Lahug River	120
	Subang Daku River	210
Ormoc City	Anilao River	610
	Malbasag River	330

* The Lower and Upper sections of Iloilo River merge at STA. 5+180, the confluence with Mandurriao River.

** Corresponding to a 20-year return period.

Based on the project scale proposed for river flood control plans, the design discharge of river improvement works is estimated from the river flood control measures described in Subsection 3.1.5, as presented in Fig. 3.1.

3.1.2 River Improvement Section

The river section to be improved are determined with the following conditions:

(a) Flow capacity of the existing river channel;

(b) Existing and future land use plans;

(c) Recorded flood area; and

(d) Topographic condition along the river channel.

The proposed improvement sections of rivers are as follows:

Iloilo City

(1) Jaro River

The overbank sections in the flood of July 29, 1994 have been reported to be the downstream of Tacos Bridge on Tigum River and Pavia Bridge on Aganan River. The overbank flood from Tigum River spread to the east into the watershed of Ingore Creek. On the other hand, the overbank flood from Aganan River ran into Mandurriao River and reached Iloilo River with over-spreading inundation.

Based on this flood condition, the river improvement stretch is delineated from the river mouth up to Tacos Bridge (STA. 18+860) on Tigum River and Pavia Bridge (STA. 3+000) on Aganan River to prevent the flood from the upstream of Jaro River.

(2) Iloilo River

The riverine area is urbanized from the river mouth to STA. 4+000 along the right bank and to Molo Bridge (STA. 6+500) along the left bank. The section from the river mouth to Molo Bridge is selected for the improvement plan of Iloilo River.

In the downstream of Mandurriao River, fishponds abound around the sections from the confluence to STA. 2+000. The riverine area along the river section lower than STA. 4+500 is used as residential areas and upper than STA. 4+500 are paddy fields. Therefore, the stretch from the river mouth to Dongon Bridge (STA. 4+800) is selected for the river improvement plan.

Cebu City

(1) Bulacao River

The proposed improvement section is from the river mouth to STA. 2+650 which is at the mountain foot. Land use along this section is still urban area mixed with agricultural land, although industrial development has been proposed.

(2) Kinalumsan River

The development of subdivisions along the river has made a rapid progress even in the mountain area. The improvement section is proposed up to the mountain foot (STA. 3+970).

(3) Guadalupe River

Since a high density residential area has been expanding from the river mouth to the mountain foot, river improvement works are proposed from the river mouth to the mountain foot (STA. 4+000).

(4) Lahug River

The channel flow capacity is evaluated to be less than the design discharge for the river section from the river mouth to STA. 4+500. On the other hand, there are revetments constructed for houses from the river mouth to STA. 5+000 and they shall be reconstructed for flood control. Therefore, the improvement section is set from the river mouth to STA. 5+000.

(5) Subang Daku River

The riverine area is fully urbanized from the river mouth to the mountain foot (STA. 5+540). This section is selected for the improvement plan.

Ormoc City

(1) Anilao River

The flood plain along the left bank from STA. 2+000 to the mountain foot is used for farm and pasture lands, while that along the right bank is hilly and hardly affected by floods. From these topographic conditions, the river improvement plan is made for the sections from the river mouth to the end of the flood-plain (STA. 2+000).

(2) Malbasag River

The river improvement plan is prepared for the stretch from the river mouth to the mountain foot. The improvement works will be connected to the concrete dike which was constructed by ADB in 1993 at the mountain foot.

3.1.3 River Improvement Measures

The following measures are proposed for the river improvement plan for rivers:

Iloilo City

(1) Jaro River

Proposed is a combination of river improvement works and two floodways; namely, Jaro Floodway and La Paz Floodway to carry the flood discharge of Jaro River to Iloilo Strait. The discharge to be diverted to the floodway has been determined through a comparative study (refer to Subsections 4.3.1 and 4.3.2), which proposes the design discharge of 850 m^3/s for Jaro Floodway and 400 m^3/s for La Paz Floodway.

(2) Iloilo River

For the Iloilo river main stream, river improvement works such as raising of river banks and dredging of riverbed are employed to confine the design flood discharge and to protect riverbanks. For Mandurriao River, channel improvement only is applicable.

Cebu City

(1) Bulacao River

River improvement such as widening and channel excavation is required to increase flow capacity.

(2) Kinalumsan River

River improvement such as widening, excavation, diking and revetment works is required to increase flow capacity and stabilize flood flow.

(3) Guadalupe River

River improvement is the optimum measure for flood control. Although a flood control dam at the upstream is proposed as an alternative flood control plan (refer to Subsection 3.3.4), the cost comparison shows that the construction cost of a dam is higher than river improvement works and the dam construction may bring some social problems of right-of-way.

(4) Lahug River

River improvement such as widening, excavation and revetment works is required to confine the flood in the river channel.

(5) Subang Daku River

River improvement such as widening, excavation, and revetment works is required to confine the design flood discharge.

Ormoc City

(1) Anilao River

River improvement in the lower reaches, emphasizing realignment of the river course is required. In addition, two (2) slit dams are to be provided to stop floating logs which were among the main causes of the disastrous flood in 1991.

(2) Malbasag River

River improvement in the lower reaches, emphasizing realignment of the river course is required. As in Anilao River, a slit dam is proposed to stop floating logs and debris flow.

3.1.4 Planning Criteria

The criteria for river improvement plan is prepared based on the Design Guideline, Criteria and Standards for Public Works and Highways (BOD, DPWH, Philippines) and the Technical Standard for Rivers and Sabo Facilities (Ministry of Construction, Japan). Following are the conditions applied to the river improvement plan.

Design High Water Level (DHWL)

The DHWL is set to be equal to or lower than the existing ground level except in the low-lying area so as not to create drainage problems inside the embankment.

The flood water level is calculated by non-uniform flow analysis, assuming that Manning s roughness coefficient of the improved river is smaller than the existing, as follows:

River Name	Roughness Coefficient	
	Existing	Improved
Jaro River	0.035	0.030
Iloilo River	0.030	0.030
Mandurriao River	0.035	0.030
Anilao River	0.040	0.035
Malbasag River	0.040	0.035

The mean spring higher high water level (MSHHW) is employed for the initial water level at the river mouth in the non-uniform analysis as given below.

City Name	MSHHW (EL. m)
Iloilo City	1.07
Cebu City	1.06
Ormoc City	1.15

Alignment of River Channel

River course alignment is proposed along the existing river channel to minimize land acquisition and house evacuation. The existing river course at the meandering portion shall be smoothened and widened. For the river sections with a sufficient width such as Iloilo

River, the river mouths of Jaro River and the downstream of Mandurriao River, the width is maintained and only dredging work is conducted to increase the flow capacity.

Longitudinal Profile

The design riverbed principally follows the existing average riverbed. The riverbed slope between the upper and lower stretches is set within the ratio of less than 1 : 2 to assure the stability of the river channel. For steep rivers such as those in Cebu and Ormoc City, drop structures are provided to reduce the flow velocity. The design riverbed slope between drops is set at 1/2 to 2/3 of the existing riverbed slope.

Cross Section

A single cross section channel is applied to all rivers in view of the following reasons:

(a) It is necessary to minimize land acquisition and house evacuation, especially in urbanized areas; and

(b) It is assumed that the compound cross section channel for small rivers like the rivers in Ormoc City is uneconomical.

The bank slope for embankment and excavated slope is designed at 1 : 2 and the surface of slope is protected from erosion by sodding in general. A retaining wall or a concrete wall, however, shall be employed along Iloilo River, rivers in Cebu City except Bulacao River, and the lower reach of Malbasag River to minimize land acquisition and house evacuation.

Planning Conditions for River Structures

Planning conditions for river structures are given below.

(1) Freeboard

The following freeboard corresponding to the design discharge are applied for the structural design:

Discharge (m^3/s)	Freeboard (m)
Less than 200	0.6
200 to 500	0.8
More than 500	1.0

For the river section where the DHWL is lower than the elevation of the existing bank, a freeboard of 0.6 m is employed for all design discharges. The clearance between the DHWL and the bottom of the lowest member of superstructures shall not be less than 1.0 m.

(2) Maximum Flow Velocity

The following conditions on the flow velocity are applied for the channel design:

(a) For flow velocity of less than 3 m/s, river banks shall not be lined;

(b) For flow velocity between 3 m/s and 4 m/s, river banks shall be lined; and

(c) For flow velocity more than 4 m/s, drops shall be provided to decrease flow velocity to less than 4 m/s.

Closure of River Mouth

The riverbed profile at the river mouth is classified into three (3) types as shown in Fig. 3.2. Type A is formed mainly by large scale rivers, Type B by medium scale and gentle stream

rivers, and Type C by small scale and rapid stream rivers. Among these shapes, the river with a problem of closure of river-mouth is Type B. The nine (9) rivers may be classified as follows:

Item No.	River Name	Type
1.	Jaro River	Type B
2.	Iloilo River	Type A
3.	Rivers in Cebu	Type C
4.	Rivers in Ormoc	Type C

The detailed analysis on river mouth condition with improvement works such as excavation and widening is shown in Annex 1. The analyses show that the proposed improvement works will not affect the existing river mouth condition. It is also concluded that closure of river mouth will not occur even under the existing condition.

3.1.5 Environmental Consideration on River Improvement Works

Inasmuch as a river contributes to environmental maintenance, provides water and functions as flood protection as well, many people, particularly those from urban areas, have come to realize the importance of caring for and preserving rivers. Therefore, environmental concerns are taken into consideration during the river planning stages.

Environmental requirements may be classified into two categories as given below:

(1) Maintenance of River Channel and Water Quality

To provide the amenity of river environment, the following items shall be included in this category:

(a) Water quality control
(b) Safe utilization of river
(c) Enjoyment of river scenery

The image perspective of the environmental design is shown in Fig. 3.3.

(2) Social Activity at River

To accelerate local/regional activity, the following items shall be considered:

(a) Water usage at riverside
(b) Flow usage
(c) Utilization of river space

In the planning and designing of rivers in this study, the following methods of river arrangement from the environmental aspect are employed considering the possibility of implementation and economical aspect in the Philippines:

(a) Drops

Aside from the function as hydraulic requirement, drops, which are to be provided along Anilao and Malbasag rivers, should have the following functions related to the environmental aspect:

- Effect of aeration to preserve water quality;
- Provide a variety of water flow; and
- Improvement of the river scenery.