This hydraulic bore rushed towards the sea washing out bridges and houses; hence, flood duration was so short at 30 min to one hour.

3.3 Urban Drainage

3.3.1 Drainage System

Iloilo City

Urban areas of Iloilo composed of one city and five municipalities; namely, La Paz, Jaro, Molo, Mandurriao and Arevalo, are traversed by two main rivers and their tributaries. These watercourses constitute the nine (9) drainage basins and subbasins delineated in Fig. 3.24.

Stormwater collection and drainage systems have been constructed only in densely urbanized districts of the city proper at the right bank of the Iloilo river estuary and at the Jaro-La Paz area between Mandurriao River and the Jaro mainstream. Primary and secondary drainage channels are estimated to be approx. 55,900 m. Since the drainage pipes were installed several decades ago, functional damage is found in many places; even complete blockage due to soil or garbage sediments and structural collapse.

In addition to the confined drainage system, the major drainage problem in the urban area is the inadequate drainage capacity of primary channels. The following table shows the flow capacity of the three primary channels lying in serious inundation areas.

Item No.	Primary Channel	Drainage Area (km^2)	Flow Capacity (m^3/s)	Average Capacity (m^3/s)
1.	Ingore Creek	8.02	2 - 70	15
2.	Bo. Obrero Creek			
	- Downstream	3.89	10 - 90	30
	- Upstream	1.20	1 - 3	1
3.	Rizal Creek	0.50	4 - 230	4

Cebu City

The urban area of Cebu is traversed by five rivers, several creeks and drainage mains. These waterways constitute the basis for the formation of some 20 drainage basins and subbasins. The drainage basins are delineated in Fig. 3.25.

The existing urban stormwater drainage systems including collection facilities of inlets and gutters are found only in densely populated districts of the city, which are bounded approximately on the north by Subang Daku River, on the south by Kinalumsan River and confined within 2 to 4 km wide from the coastline.

The existing collection and drainage systems serving the combined functions of sewage and stormwater collection were constructed on the basis of the Drainage Master Plan in the 1950's. Lengths of the primary and secondary drainage including parts of the five rivers within the urban drainage area are estimated to be approx. 82,900 m.

One of the significant causes to urban drainage problems is the inadequate drainage capacity of primary channels and drainage mains, as well as the confined service area of the drainage system. The drainage capacity of primary channels and drainage mains lying in serious inundation areas are evaluated as shown below.

Item No.	Primary Channel	Drainage Area (km^2)	Flow Capacity (m^3/s)	Average Capacity (m^3/s)
1.	Mabolo Creek	2.78	2 - 40	8
2.	Lahug Tributary	0.65	1 - 50	9
3.	Tinago Creek	1.10	1 - 26	4
4.	Pahina Central	1.00	1 - 7	6
5.	Calamba	0.79	2 - 3	2
6.	Sta. Teresita	3.80	2 - 3	3
7.	Basak-San Nicolas	0.67	1 - 2	1
8.	Sto. Niño Creek	5.11	1 - 10	2
9.	Brgy. Inayawan	1.29	2 - 4	4

Ormoc City

The urban area of Ormoc City is divided into two; the city proper of 0.93 km^2 surrounded by Anilao River, Malbasag River, Hermosila Drive and the coastal line, and the new residential area of 2.68 km^2 adjoining the city proper, as shown in Fig. 3.26.

The city proper is densely urbanized being the commercial and residential center of Ormoc City, and the urban stormwater collection and drainage systems are well developed. The existing system is hydrologically divided into four (4) drainage areas within the city proper which drain independently into the sea or the rivers, and the new residential area is divided into four (4) drainage areas which drain directly into Malbasag River, Anilao River, Lotao Creek and Ormoc Bay.

The existing systems have been constructed on the basis of the drainage improvement plan prepared by the City Engineering Office. Various types of drainage facilities such as RC-U-type with cover, RC pipe, open channel, RC box culvert were adopted for the systems. The total length of the primary and secondary channels/pipes is estimated at 16,500 m.

To assess the existing drainage systems, the discharge capacity of the Lotao and City Proper creeks functioning as primary drainage channels in the urban area is calculated as shown below.

Item No.	Primary Drainage Channel	Drainage Area (km^2)	Flow Capacity (m^3/s)	Average Capacity (m^3/s)
1.	Lotao Creek			
	- Downstream	1.03	1.0 - 10.0	10
	- Upstream	0.44	0.5 - 1.0	1
2.	City Proper Creek	0.32	1.0 - 18.0	4

Tacloban City

The drainage area of Tacloban City covering 22.95 km^2 is divided into ten (10) drainage areas where stormwater is drained into the sea through rivers, primary drainage channels, and mains. The drainage areas are delineated in Fig. 3.27.

The existing urban stormwater collection and drainage system is only in the most densely built-up area being the city commercial center which is bounded on the west by Mangonbangon River and on the south by Langhas-Lirang Creek. The rest of the urban area depends largely on natural overland drain to the nearest recipients of the watercourses and the sea.

The existing pipe drainage systems in the city proper have been constructed in 1975 based on the drainage master plan in 1954 by the City Engineering Office. The total length of drainage pipes is nearly 5.3 km and open channel is 2.4 km. Reinforced concrete pipes ranging in size from 400 mm to 1,400 mm and open channels are commonly used as drainage systems.

Due to inadequate drainage capacity as well as the confined coverage of the drainage system, the urban area suffers from frequent inundation. As shown in the table below, the drainage capacity of primary channels, where five major inundation areas are located, is obviously small compared to the expected design discharge.

Item No.	Primary Channel	Drainage Area (km^2)	Flow Capacity (m^3/s)	Average Capacity (m^3/s)
1.	Naga-Naga	1.21	1.0 - 4	2
2.	Langhas-Lirang	4.38	1.0 - 9	3
3.	Pleasantville	1.25	1.0 - 10	1
4.	Sagkahan	0.14	0.4 - 10	1
5.	Burayan Tributary	1.41	0.1 - 2	2

To solve inundation problems, the Tacloban City Drainage Master Plan was prepared in 1987 which proposed improvement of the watercourses and construction of drainage mains. Due to budgetary constraints, however, only some drainage pipe improvement works have been implemented up to the present.

3.3.2 Stormwater Inundation

Iloilo

The flood-prone areas in the urban area of Iloilo City experience regular inundation brought about by the inadequate drainage systems. The DPWH District Engineering Office has identified habitual inundation areas at some 11 places with 100 ha in total area, as shown in Fig. 3.28. The major inundation areas and conditions are as follows:

Item		Inundation Condition		
No.	Flood Area	Area (ha)	Depth (m)	Duration (hrs)
1.	City Proper-Molo (5 places)	53.8	0.1 - 0.3	1 - 2
2.	Jaro-La Paz (4 places)	18.6	0.2 - 0.3	2
3.	Ingore Creek Upstream	42.4	0.3 - 1.0	2 - 12
Total		114.8	-	-

Cebu City

Habitual flood areas in Cebu City due to inadequate drainage systems were identified by the DPWH District Engineering Office in some 30 places with 90 ha in total, as shown in Fig. 3.29. The major inundation areas and conditions are given in the following table.

Item		Inundation Condition		
No.	Flood Area	Area (ha)	Depth (m)	Duration (hrs)
1.	Mabolo Creek	14.0	0.5	2
2.	Lahug Tributary	8.0	0.3 - 0.6	1 - 3
3.	Tinago Creek	7.2	0.3 - 0.5	1 - 2
4.	Sta. Teresita Creek	10.0	0.5 - 1.2	1 - 2
5.	Sto. Niño Creek	18.0	0.2 - 0.3	1
Total		57.2	-	-

Ormoc City

There are no serious drainage inundation problems in Ormoc, except partial water stagnation in some places due to inadequate drainage capacity as shown in Fig. 3.30. In the new residential areas adjoining north and west of the city proper, however, the urban drainage system has not been developed sufficiently to cope with the rapid urbanization. Frequent inundation problems in the area occur during the rainy season.

The major inundation areas due to inadequate drainage systems are as follows:

Item No.	Flood Area	Inundation Condition Area (ha)	Depth (m)	Duration (hrs)
1.	Gov't. Center	9.5	0.2 - 0.4	1
2.	Punta	6.8	0.2 - 0.4	24 - 48
3.	Lotao Creek	17.1	0.5 - 1.0	6 - 12
4.	Rizal Extension	4.1	0.2 - 0.4	2 - 6
Total		37.5	-	-

Tacloban City

Tacloban City is situated in the low-lying area along the coast varying from 0.5 m to 4 m above mean sea level. The city suffers from habitual inundation due to insufficient coverage of the drainage system and inadequate capacity of the existing watercourse, as shown in Fig. 3.31. Major inundation areas and conditions in the urban area are as follows:

Item No.	Flood Area	Inundation Condition Area (ha)	Depth (m)	Duration (hrs)
1.	Abucay River	16.6	0.3 - 0.5	5 - 6
2.	Naga-Naga Creek	7.8	0.3 - 1.0	2 - 4
3.	Mangonbangon River	40.0	0.3 - 1.0	2 - 72
4.	Langbas-Lirang Creek	24.4	0.2 - 1.0	2 - 24
5.	Old Sagkahan Creek	1.2	0.2 - 0.5	4 - 5
6.	Pleasantville Creek	18.2	0.5 - 0.8	12 - 24
7.	Burayan River	97.6	0.1 - 0.6	1 - 36
Total		205.8	-	-

3.4 Geology and Soil Mechanics

3.4.1 Topography and Geology of Study Area

Iloilo

Jaro and Iloilo rivers are bounded by a mountainous range running from west to north. The hilly area in Iloilo City has a gentle slope where an alluvial plain widely extends. The main regional geomorphology in Iloilo is summarized as follows:

(1) **Mountainous Area**

The area is characterized as Panpnan Basalt Formation basin located in the upper stream of Aganan and Tigum rivers, the major tributaries of Jaro River. The elevation of the area is approximately 500 m to 1,000 m and Mt. Inaman is the highest peak in the Jaro river basin (1,380 m). The physiography of the area shows a rugged and irregular structure of the outcropped formation consisting of metamorphic and igneous rocks. The drainage texture pattern in the area is dendritic and very dense.

(2) Hilly Area

The area extends in the middle stream of Aganan and Tigum rivers at an elevation of 50 m to 400 m with a smooth relief. An irregular drainage texture pattern reflecting the structure of the Sedimentary Rocks of Panlupan, Lagdo and Sewaragan Formation. Along Tigum River, especially from Maasin to Sta. Barbara, remnants of river terraces composed of Cabatuan Formation of the Quaternary and Apdo Formation of the Tertiary are still visible.

(3) Alluvial Plain

The alluvial plain is evidenced by a very flat morphology with a regular seaward slope. The alluvial plain is widely observed in Iloilo City, and it is a broad structure trending southwest to northeast.

Recent alluvial deposits which mainly consists of river and coastal deposits of Holocene cover this wide plain in Iloilo City. The basement rock of this alluvial plain is Cabatuan Formation composed of sandstone, siltstone and mudstone.

Two (2) sedimentary basins, Jaro and Iloilo, are confirmed by the analysis. Surface soil of Iloilo City is mainly cohesive soil of clay or silt. Marine deposits are distributed only at the Iloilo sedimentary basin.

Based on the geological field reconnaissance and data, a geological map is provided as shown in Fig. 3.32.

<u>Cebu</u>

Cebu City is formed by five (5) rivers, Bulacao, Kinalumsan, Guadalupe, Lahug and Subang Daku, which flow in parallel from the mountainous area toward the coastal area. These rivers show trends of flow from northwest to southeast with steep slope. Alluvial plains extend along the coastline of Cebu City. The main regional geomorphology in Cebu is summarized as follows.

(1) Mountainous Area

Five (5) major formations of Cretaceous to Oligo-Miocene of Tertiary (Mananga, Cebu, Maludog, Bulacao and Maingit) are mainly exposed at elevations of about 300 m to 700 m. The headwaters of the Guadalupe River is the highest in the five (5) river basins. The area of the headwaters is covered by the formation of Mananga group and Bulacao andesite. The physiography of the area shows a rugged and irregular structure of the formation consisting of sedimentary and volcanic rocks. Many dendritic drainage texture patterns are observed in this area.

(2) Hilly Area

The midstream of the five (5) related rivers are located at the hilly area with elevation of about 100 m to 300 m. Relatively moderate structures are observed in the area. The area is formed by the Carcar Formation of limestone. Maingit Formation and Bulacao Andesite are observed at both sides of the valley and the riverbed downstream of Buhisan Dam. Smooth and simple drainage texture patterns are observed in each river basin due to the massive formation of the area.

(3) Alluvial Plain

The alluvial plain is distributed along the coastline of Cebu City as a narrow belt following a southwest-northeast trend. Along Guadalupe and Linao rivers, the alluvium plain is well extended up to the north of Guadalupe Church. River deposits have accumulated more than in other rivers, which is an evidence of higher elevation than other alluvial plain areas. In general, the plain is characterized by a flat morphology with a regular sea-warded slope.

Most of the soils in the alluvial plain originated from sedimentary materials of shale, sandstone, conglomerate, limestone and volcanic rock, and coastal detritus deposits. Distribution of sedimentary materials are strongly related to elevation and the steep-sloped landform of the area.

The basement rock of the alluvial plain is Carcar Formation of Pleistocene limestone. The expected thickness is approximately 10 m to 20 m at the northern part, and 5 m to 10 m at the southern part. Alluvial deposits, classified as upper layer of Carcar Formation, mostly consist of sand, gravel, silt, and clay.

The study area is classified under three (3) major soil formations. In the high mountainous area, Baguio Clay Loam is distributed, may be as a surface soil of Mananga Group.

The depth to the basement rock is generally more than 20 m. Several cohesive soil layers with a relatively low N-value are widely observed as the uppermost 10-m depth from the ground surface except the reclamation area.

Based on the geological field reconnaissance and data, a geological map is provided as shown in Fig. 3.33.

Ormoc City

Anilao and Malbasag rivers flow in parallel at Ormoc City from the southwest toward the river mouth. The two rivers mostly flow on the moderate dipping pyroclastic deposits of the hilly area, from the mountainous area which is composed mainly of young volcanic rocks to the alluvial plain at Ormoc City. The main regional geomorphology in Ormoc is summarized as follows:

(1) Mountainous Area

The area is characterized by late Pleistocene volcanic lahar. The area has its elevation from 400 m to 800 m, and Mt. Bonao is the highest peak at elevation of 812 m. The formation is mainly composed of late Pliocene volcanic rock. Therefore, rugged and irregular structures of the drainage texture pattern are observed.

(2) Hilly Area

The upper and middle reaches of Anilao and Malbasag rivers lie on this hilly area. The formation is characterized with Plio-Pleistocene pyroclastics deposits composed of thick accumulations of lahar having moderate dipping. The elevation of the area is 30 m to 400 m, and simple relief drainage texture patterns are observed. However, the valley which has been formed with erosion by river flow is generally deep and steep. It shows that the area has a young history of area topographic evolution.

(3) Alluvial Plain

Alluvial deposits originating from river deposits consist of sand, gravel, silt and clay in the study area are located only at a limited area of Ormoc City Proper and along the downstream river bank of Anilao-Malbasag River. The depth to the basement rock of Dolores formation is 10 m to 20 m, in general.

Soil in the upstream, particularly along the valley having a very steep slope, are of a different soil material of young volcanic origin developed mainly from andesitic rocks. In general, these are loose, unstable and highly susceptible to erosion.

Based on the geological field reconnaissance and data, a geological map is provided as shown in Fig. 3.34.

Tacloban

The study area consists of the four (4) related drainage basin of Abucay, Mangonbangon, Langhas Lirang and Burayan. The flow of each channel is almost parallel, with south to north axis in the narrow alluvial plains of Tacloban City. A mountainous area is located west of the city and small scale hilly area is exposed at the center and east of Tacloban City. The main regional geomorphology in Tacloban is summarized as follows.

(1) Mountainous Area

The area is characterized as Tacloban Volcanic Formation located at the western side of the city, with an elevation of 50 m to 300 m. Mt. Naga-Naga is the highest peak with the elevation of 380 m. The physiography of the area is massive structure of volcanic rocks. Among the four related rivers, only the Mangonbangon River has its headwaters in the area.

(2) Hilly Area

There are two hilly areas in the city, composed of Tertiary sedimentary rocks. One is located west of Mangonbangon River, forming a narrow belt along the river and exposing Sanricardo Formation. The other one is located at a protuberance in San Pablo Bay at the eastern side of the city proper and exposes Bagahupi Formation.

(3) Alluvial Plain

The alluvial plain shows relatively flat morphology with very gentle sea-warded slope where all related rivers extend. The plain is narrow between the mountainous area and the hilly area, and it corresponds to a broad structure trending south to west.

The alluvial deposit in this area is narrowly distributed between the mountainous area and the hilly area where the whole reaches of the four drainage extend. The basement rock of the alluvial deposit is Tertiary sedimentary rocks of Bagahupi Formation and Sanricardo Formation. The deposit is composed mainly of unconsolidated clay, silt, sand and gravel derived from older rocks deposited along river channels, flood plains and river mouths.

Based on the geological field reconnaissance and data, a geological map is provided as shown in Fig. 3.35.

3.4.2 Geology and Soil Mechanics for Structures

Slit Dam Site

A total of three (3) slit dams, two (2) sabo dams in Anilao River and one (1) sabo dam in Malbasag River, is proposed at the midstream which is the boundary of the alluvial plain and hilly area. Proposed slit dam sites for each river are examined from topographical point of view to select the suitable area for the pocket of those drift-logs and boulders. The geological condition of each site is described as follows.

(1) Anilao Slit Dam-1 (Fig. 3.36)

The basement rock is pyroclastics of Dolores Formation consists of alternating beds of volcanic breccia at greater part, and volcanic sandstone at minor part. Profile A-A' is set along the proposed dam axis, where most of the narrow valley is situated.

Recent river unconsolidated deposit of sand and gravel is widely distributed along the right bank of the river. The thickness of deposit is thin at the proposed dam axis, rather thick downstream of Profile B-B'.

(2) Anilao Slit Dam-2 (Fig. 3.37)

The dam site is placed near the junction of a tributary of Anilao River. Geological condition both of lithology and facies is similar with the Anilao Dam-1 site. A major part of the basement rock is volcanic breccia of Dolores Formation including thin alternating beds of volcanic sandstone.

Since the layer of volcanic breccia in both river banks at Profile A-A' is much thicker than Profile B-B' and the depth to the volcanic sandstone which is estimated as less concretion rock than volcanic breccia is shallow at the proposed dam axis of Profile A-A', Profile A-A' is proposed for the dam axis.

(3) Malbasag Sabo Dam (Fig. 3.38)

The basement rock of the area is pyroclastics of Dolores Formation composed of only volcanic breccia. No volcanic sandstone is confirmed in this area.

Steep slope and massive volcanic breccia formation is observed at the left bank. In the right bank, however, a rather gentle slope of 18° inclination made of thick alluvium deposit (Qal) is observed. No outcrop of basement rock is found at the right bank of the area. Based on Borehole MRD-2, river terrace composed of volcanic breccia is confirmed at elevation 137 m. The facies of the volcanic breccia is similar to Anilao River.

Uniaxial compression strength of volcanic breccia which will be a dam foundation, shows a range from 280 to 320 kgf/cm^2. This value is considered as sufficient soundness for the construction of sabo dam.

Embankment Material

(1) Criteria for Material Selection

Generally, excavated soils from the existing river bank along the proposed river improvement site and floodway are planned to be used as embankment materials. The soil samples were examined to choose the suitable material for embankment, based on the following criteria.

(a)	Grain Size Distribution	:	within 15% to 70% of silt and clay content
(b)	Moisture Content	:	less than 50%
(c)	Specific Gravity	:	approximately 2.5
(d)	Soil Grading	:	refer to Table 3.3

(2) Evaluation for Embankment Materials

(a) Iloilo City

From the results of embankment material survey, it has been evaluated that most of the soil of the existing river bank along the Jaro River can be used for embankment material. The materials at the other sites are disqualified by the grain size distribution due to large proportion of more than 70% of silt and clay content except EJR-1 and EJR-2 of the Jaro River. However, all samples were classified as clay of Fine Soil (CL or CH) by the soil grading criteria and this kind of soil is available for embankment material with some countermeasures such as drying and soil stabilization.

(b) Ormoc City

From the results of embankment material survey, all samples at the proposed barrow pits except EAR-2 are qualified as embankment material.

However, the soil sampled at the existing river bank is a surface layer of sandy gravel (Acs) which is distributed from midstream to the hilly area. This layer is estimated to be not suitable for materials because of very high permeability.

Borrow area other than the existing river bank is recommended as shown as Fig. 3.39. Soil properties of these areas represented by EAR-3, EAR-1, EMR-2 and EMR-1 are judged as suitable for materials. The proposed borrow areas were also examined as to distance from the two (2) related rivers and land use condition of the area.

Soft Ground in Iloilo City

The alluvial plain of Iloilo City is characterized with relatively low bearing capacity of soft clay and unconsolidated loose sand. Fig. 3.40 shows the distribution of the soft layer which has a low bearing capacity of approximately less than 3 of N-value on average.

This is generally characterized as low land with less than 3 m elevation, and used mainly as fishpond. Low bearing capacity with large consolidation settlement of the clay layer and liquefaction susceptibility of the loose sand is expected in this area.

3.5 Socio-Economy

The Philippines administratively consists of 14 Regions, namely; National Capital Region (NCR), Cordillera Administrative Region (CAR), and Region 1 to Region 12. These regions are further divided into provinces, the provinces into cities/municipalities, and the cities/municipalities into barangays. As of 1988, there were 73 provinces, 60 cities, 1,532 municipalities and 40,904 barangays.

The four Selected Urban Centers (SUCs), Iloilo, Cebu, Ormoc and Tacloban, for the Master Plan are administratively located as follows:

Item No.	Name of City	Region Number	Name of Province	Number of Barangays	Land Area (km^2)
1.	Iloilo	VI	Iloilo	180	56.0
2.	Cebu	VII	Cebu	80	280.9
3.	Ormoc	VIII	Leyte	110	464.3
4.	Tacloban	VIII	Leyte	138	100.9

3.5.1 Population and Land Use

According to the 1990 census by National Statistics Office (NSO), the Philippines has a population of 60.6 million. This population increased by 12 million as compared to the 1980 census. During the 1970's, the average growth rate was 2.79% per annum. However, during the 1980's, it slowed down to 2.28% per annum.

In the above four SUCs, the census population figures were 307,600 in Iloilo, 604,600 in Cebu, 129,200 in Ormoc and 136,400 in Tacloban, as shown in Table 3.4. Their growth rates in the 1980's were 2.31%, 2.22%, 2.10% and 2.90%, respectively. Except Cebu City, the growth rates of the cities exceeded their respective provincial rates.

Their population density were 55 persons/ha in Iloilo, 22 persons/ha in Cebu, 3 persons/ha in Ormoc and 14 persons/ha in Tacloban as shown in the table. In the census report, Ormoc City's territory is classified into both urban and rural areas. The population is recorded at 14,833 in the urban area and 114,623 in the rural area. Having territories of 145 ha and 46,285 ha respectively, their densities were 102 persons/ha and 2 persons/ha. Likewise, the Cebu City Government classifies the barangays making up Cebu City into urban and rural areas. According to this classification, the population density is 113 persons/ha in urban and 3 persons/ha in rural areas.

In the four cities the average family sizes were 5.43 in Iloilo, 5.32 in Cebu, 5.20 in Ormoc and 5.50 in Tacloban. In total, the average family size for the four cities was 5.36. This figure was slightly higher than the national average of 5.32.

The present land use in the four cities was not clear. Thus, the JICA Study Team and the Local Counterpart Team tried to identify the land use by referring to available maps such as topographical maps and aerophotos. The land use map of Iloilo City was delineated by using the topographic map which was drawn as the survey results of JICA in 1994. Table 3.5 shows the present land use in the four cities, which was identified using the above identification procedure.

Iloilo and Ormoc cities seem to include fairly ample green space covering the entire administrative territory. On the contrary, Cebu and Tacloban cities appear to be moderately urbanized compared to the other two cities, but this may be due to the mapped area covering only the urban Barangay classes designated by the city governments or the urban core.

3.5.2 Economic Profiles and Infrastructures

Gross Domestic Product

Gross Domestic Product (GDP) in the Philippines was 1,466 billion pesos in 1993, broken down into: 318 billion pesos in the agricultural sector, 483 billion pesos in the industrial sector and 666 billion pesos in the service sector. Per capita GDP was 22,596 pesos, equivalent to approximately US$829.

Gross Regional Domestic Product (GRDP) of the respective regions in 1993 was 104.7 billion pesos or 7.1% of GDP in Region VI, 94.3 billion pesos or 6.4% in Region VII, and 36.9 billion pesos or 2.5% in Region VIII. Value Added (VA) rates of major economic sectors to GRDP in their respective regions were summarized as follows:

(Unit: %)

Item	Philippines	Region VI	Region VII	Region VIII
Agriculture	21.7	33.2	15.3	34.9
Industry	32.9	23.3	30.6	30.5
Services	45.4	43.5	54.1	34.6
Total	100.0	100.0	100.0	100.0

Per capita GRDPs in 1993 were 18,459 pesos (approximately US$678) in Region VI, 19,436 pesos (US$713) in Region VII and 11,806 pesos (US$433) in Region VIII. Region VII recorded the highest per capita GRDP among the three, accounting for 86% of the national per capita GDP.

Average annual growth of both GRDPs and per capita GRDPs of the regions during nine years between 1985 and 1993 was summarized as follows:

(Unit: %)

Item	Philippines	Region VI	Region VII	Region VIII
Agriculture	2.17	3.26	3.41	- 0.24
Industry	2.89	1.60	2.17	0.59
Services	3.94	4.21	4.63	2.09
G(R)DP	3.15	3.25	4.66	2.05
Per capita GRDP	0.80	1.47	1.71	- 0.08

Region VI and VII grew at a rate higher than the entire country. Region VIII, on the other hand, recorded negative and much lower growth rates compared to the national figure, with the disparity increasing in recent years.

Economic Profiles

(1) Agriculture

The major crops in the three provinces are palay (rice), coconut, corn, sugar cane, banana and pineapple in order of production value. Considering only cultivated areas, the salient features of crop production in the three provinces are summarized as follows:

(a) Iloilo Province mainly produces palay, utilizing 216,800 ha in 1993 crop year for palay production. This land area is notably more than the combined areas for palay production in the other two provinces.

(b) Cebu Province mainly produces corn, devoting 120,200 ha in 1991 and 73,000 ha in 1993 for corn production. Although this production area is now smaller than that of Leyte Province, the areas used in corn production were still one of the most important crops in the province.

(c) In Leyte Province, the cultivated areas are evenly utilized not only for palay production but also for various crops such as corn, coconut and pineapple.

In the fishing industry, brackish water fishpond is one of the most vulnerable facilities to flood disaster. In 1993, the Philippines produced 234,700 tons of fish from brackish water fishponds. Of the national production figure, 16,700 tons or 7.1% is produced in Iloilo Province. Prawn and milkfish accounted for the bulk of brackish water products. The other two provinces do not yield as much brackish water fishpond products.

The livestock and poultry industry has received an important position in the agricultural sector of the national economy in recent years. In fact, its VA share increased from 3.1% in 1985 to 4.5% in 1993. In the three regions, the same trend may be observed during the same period. VAs of the industry were 6.2% of GRDP in Region VI, 5.8% in Region VII and 5.8% in Region VIII in 1993.

(2) Manufacturing

Within the industrial sector, the manufacturing subsector contributes the largest share to the national economy, accounting for 23.8% of GDP in 1993. It played an important role in the regional economy in the three regions as well. The manufacturing subsector accounts for 17.6% in Region VI, 22.0% in Region VII and 25.1% in Region VIII. In particular, Cebu City in Region VII is promoting to introduce foreign industries as a major part of its industrialization policy. Manufacturing establishments have recently increased in these years not only in industrial complexes such as the Export Processing Zone but also within Cebu City itself.

In Iloilo City, there were 525 manufacturing establishments as of 1992, according to "Socio-economic Profile" of the City. Since management characteristics of manufacturing establishments in the city are not available, the regional indices were applied to the city. The assets holding conditions as of the end of 1989. The following table summarizes the conditions for large scale manufacturers as average asset holdings.

(Unit: %)

Item	Large and Medium Scale*
Value Added Rate (%)	31.80
Ratio of Fixed Assets to Value Added	0.73
Ratio of Inventory Stock to Value Added	0.29

* Establishments with average total employment of 10 and more.

(3) Trading

Within the services sector, the trading (or commercial) subsector is considered the most popular and plentiful industry in the national economy, accounting for 14.2% of GDP in 1993. In the three regions, shops and stores perform an important role and are scattered all over the territories. The trading subsector accounted for 18.6% in Region VI, 26.6% in Region VII and 5.7% in Region VIII in 1993.

In Iloilo City, there were 4,500 wholesale and retail trading establishments as of 1992. Since management characteristics of trading establishments in the city are not available, the regional data was applied to the city. The assets holding conditions as of the end of 1989. The following table summarizes the conditions for wholesale and retail trading establishments as average asset holdings.

(Unit: %)

Item	Wholesale Trade	Retail Trade
Value Added Rate (%)	8.60	12.40
Ratio of Fixed Assets to Value Added	0.18	0.50
Ratio of Inventory Stock to Value Added	0.62	2.33

<u>Infrastructure</u>

(1) Educational Facility

Educational facilities comprise pre-school, elementary, secondary and tertiary schools. They were distributed in the regions concerned as follows:

Level	Region VI	Region VII	Region VIII
Pre-School	89	228	89
Elementary	3,061	2,635	3,061
Secondary	358	373	358
Tertiary	113	112	113

On the average, the rate of elementary schools to population was 5.6 facilities per 10,000 people in the country.

(2) Medical Facility

Medical facilities consist of hospitals, barangay health stations and rural health units. They were distributed in the regions concerned as follows:

Level	Region VI	Region VII	Region VIII
Hospital	80	90	73
Barangay Health Center	1,271	948	600
Rural Health Unit	164	200	164

In terms of bed capacity of hospitals, only Region VII among the three regions exceeded the national average of 1.30 beds per 1,000 people, indicating that the medical facilities available in Iloilo and Leyte provinces appeared backward as compared to the national average.

(3) Road System

As of 1991, the existing road network was 154,300 km in the country. In regions, there were 13,400 km of roads in Region VI, 9,400 km in Region VII and 8,700 km in Region VIII. The road densities in the regions, i.e., the total length of road to the total land area, were 953 m/km^2, 887 m/km^2 and 1,038 m/km^2, respectively, all of which were more dense than the national average of 514 m/km^2.

(4) Water Supply System

The system of waterworks is classified into three levels, namely; (a) Level 1, indicating a service level by a point source and no distribution system; (b) Level 2, indicating a communal faucet system; and (c) Level 3, referring to a piped system connected to individual houses. In total, the coverage of households served by these three levels was 35.8% throughout the country. In the three regions, these were 35.4% in Region VI, 36.7% in Region VII, and 56.7% in Region VIII.

(5) Electrification

While the electrification coverage in the municipal level was almost sufficient, individual connection levels were still considered backward. In the three regions, the ratio served remained at less than 40%, falling way below the national average of 52%.

(6) **Communications**

Telephone service penetration in the three Regions was quite backward from expected levels. Telephone density, i.e., the number of connections per 100 persons, was 0.62 in Region VI, 0.93 in Region VII and 0.08 in Region VIII. These figures were much smaller than 1.47 which represented the country and way below the density in NCR which is 8.31.

Housing Conditions

Based on the 1980 census, there were 68,719 housing units in Iloilo Province, 165,875 units in Cebu Province and 56,699 units in Leyte Province. Their building structures are classified into three types in general: (a) Type 1 is made of strong materials such as concrete and iron; (b) Type 2 is made of usual materials such as wood and asbestos; and (c) Type 3 is made of light materials such as cogon, nipa and bamboo. The distribution of the above dwelling units as to building structure is shown in Table 3.6.

The average age of dwelling units was 13 years in Iloilo, 14 years in Cebu and 12 years in Leyte. In all provinces, Type 2 dwelling units were the oldest among the three types, averaging more than 15 years old.

Regarding the floor area of housing units, Table 3.7 shows the distribution of units by housing type such as single house and duplex. The average floor area of all housing types was 56 m^2 in Iloilo City, 51 m^2 in Cebu City and 46 m^2 in Tacloban City. Most houses in flood-prone areas install a floor against habitual inundation. Having three or four steps to the floor level, the houses would install at least 50 cm higher floor than the ground level.

Living conditions may be derived sketchily from family income and expenditure. As regards average family income, the regional annual averages in the regions and provinces concerned were much lower than the national average of 65,186 pesos in 1991, ranging from 57% to 73% of the national family income. This disparity between national and regional figures, though, was not so much as that found in the per capita GDP.

The national annual family income of urban people was 89,571 pesos on average, which was almost 20% more than that of the entire people. In Iloilo and Cebu cities, however, the average income were 112,954 pesos and 78,009 pesos, exceeding the national average income of urban areas.

3.5.3 Socio-Economic Projection

Medium-Term Development Plans

Medium-Term Philippine Development Plan for 1993-1998 presents the national economic development policies to support the long-term goals of poverty alleviation and improved income and wealth distribution. The major macro-economic objectives in the medium-term plan are: (a) a sustained and broad growth of output and employment; (b) price stability; and (c) a sound balance of payments position.

As of September 1994, the Medium-Term Plan is still under discussion in the Government. Therefore, the proposed figures as the aggregate targets in the plan are not concrete, which would be essential to project the future socio-economic frame for the current study. In this study, however, the targets are applied to project the future framework, although they are still tentative. The targets of GNP and GRDP during the period are proposed as follows:

Item	1993	1994	1995	1996	1997	1998	Average
GNP *	759.8	809.2	869.9	939.5	1,019.4	1,121.3	-
Annual Growth Rate (%)	4.5	6.5	7.5	8.0	8.5	10.0	7.5
Per Capita GNP **	11.4	11.9	12.4	13.1	13.9	14.9	-
Annual Growth Rate (%)	2.0	3.9	4.8	5.4	6.0	7.6	4.9
GRDP Growth Rate (%)							
Region VI	2.8	6.7	7.1	7.7	8.1	9.6	7.0
Region VII	5.1	7.6	9.8	10.6	10.9	12.8	9.4
Region VIII	3.2	4.2	4.9	6.7	6.8	8.0	5.6

* Million pesos at 1993 constant prices.
** Thousand pesos at 1993 constant prices.

The above average growth rates are considerably high as compared with the real growth rates in the past. Incidentally, the average growth rates between 1985 and 1993 were 3.2% for the whole country, 3.3% in Region VI, 3.7% in Region VII and 2.1% in Region VIII.

In addition to the Medium-Term Plan, the Government is preparing to proclaim the "National Physical Framework Plan for 1993 to 2022" as a long-term development plan. It proposes a rational land use and physical framework for the country to promote a major agri-industrial economy in the coming century. However, it does not present any macro-economic targets or goals for the proposed terms.

Among the four Cities, Tacloban and Ormoc cities have prepared their city development plans for 1993-1998 consistent with the medium-term development plans of the country and the region. These plans cover development projects on the overall public sectors such as education, health and physical infrastructures.

Land Use Plans

For the Master Plan Study, a land use plan is one of the most fundamental tools. The land use plan shows not only the state of land utilization at a certain time but also reflecting the urban development policy in the area, currently in effect. Therefore, it has to be formulated reasonably in accordance with the regional economic growth.

Land use plans of the four cities have been released by the respective city governments. Table 3.8 shows the areas classified by land use categories, which were measured with the land use plan maps. The plans, however, are not demarcated and do not reflect the city development plans. The city development plans do not mention the relationship between the development projects and the land use maps. Compared with the present land use, the land use plans could not be realized within the plan period. The proposed land use, therefore, should be considered simply to depict the desirable features in the cities taking urban problems and environment into account. The land use plans are the ones which could be realized in the future, approximately by the end of the target year.

Population Projection

The NSO provides population projections for the country and for its subdivisions down to municipal level during the period 1980 to 2030 in the publication called "Philippine Population Projection 1980-2010." These projections, however, do not incorporate the results of the 1990 census. Although the agency is making the new projections reflecting the results, so far the new one has not been released yet.

In this study, the future population is projected on the basis of the NSO projection, taking the 1990 census into account. The following table shows the projected population up to the year 2020 in the four cities.

(Unit: Thousand)

City	1990	2000	2010	2020
Iloilo	308	353	387	415
Cebu	610	742	851	946
Tacloban	136	158	177	194
Ormoc	129	150	168	183

GRDP Projection

The long-term projection of GRDP is indispensable for formulating the future framework of the socio-economic structure in the project sites. The Medium-Term Development Plan present the official GRDP projections to the year 1998. After that, no projection scenarios are suggested in any of the development plans. Therefore, GRDP in the future is estimated on the following assumptions.

(a) Till the year 1998, GRDPs of the respective regions will increase at the growth rates predicted in the Medium-term Development Plans.

(b) Between 1998 and 2000, GRDPs will grow at two-thirds of the above rates.

(c) Beyond the year 2000, GRDPs will grow at a half of the rates applied in the above item (a).

By 2020, GRDPs in the respective regions are projected at 1985 constant prices as follows:

Item	GRDP (Billion Pesos)	Per Capita GRDP (1,000 Pesos)
Region VI	155 (3.1)	20.8 (2.3)
Region VII	206 (4.4)	33.0 (3.2)
Region VIII	44 (2.5)	10.4 (1.8)

Note: Figures in parentheses indicate the rate of increase for 1990

3.5.4 Assessment of Asset

Structure of Flood Damage

This structure of damage losses is illustrated in Fig. 3.41. Taking this structure into consideration, the flood damage is estimated by the following items below.

(a) Direct damage, which is divided into the five items, as follows:

- Dwelling units which include the building itself and the indoor movable or household effects in it.
- Industrial establishments consisting of factory building, machinery, equipment for production, inventory stock such as finished products, works-in- process, raw materials and goods for resale and expected profit through production.
- Trading establishments including store, furniture, equipment, inventory stock such as merchandise and materials for sale, and expected profit through damageable inventory of stock.
- Palay production consisting of accumulated production cost and expected net income. Irrigation facilities are considered to be a kind of physical infrastructure.
- Inland fishery production represented by prawn farm consisting of accumulated production cost expected net income.

(b) **Infrastructure damage, both social and physical, is assumed to be 35% of the above direct damage, as derived from similar studies and past flood damage records.**

(c) Indirect damage comprises (i) opportunity losses of business and/or production activities and (ii) emergency activities. Business losses take into account only the affected establishments in the manufacturing and trading sectors while damage due to emergency activities and operation losses are based on the government flood damage reports. However, due to the ambiguity of data, the amount of indirect damage is assumed to be the same 10% of the direct damage.

Damageable Assets and Their Values

The flood prone area is demarcated by the JICA Study Team. The target areas of the four cities are 5,675 ha in Iloilo, 3,456 ha in Cebu, 1,900 ha in Tacloban and 313 ha in Ormoc. A mesh block of 250 m interval squares is super-imposed on the map of the target area, each square representing 6.25 ha. The inventory of respective damageable assets is discussed in the following sections.

(1) Housing Units

The number of dwelling units in the flood prone areas is enumerated by mesh block on the basis of the 1990 census by Barangay. The total number of housing units in the target areas of the four Cities is estimated as shown in Table 3.9. They are estimated at: 55,299 in Iloilo, 80,234 in Cebu, 22,697 in Tacloban and 4,701 in Ormoc in 1994.

According to Table 3.10, unit construction cost (pesos per m^2) of a new house for one-family ranges as follows: 3,750 pesos for Type I (reinforce concrete structure), 3,050 pesos for Type II (semi-concrete structure) and 2,200 or 1,450 pesos for Type III and 650 pesos for Type IV. The average floor area is 54 m^2, referring to Table 3.7. Then, the new dwelling unit costs 203,000 pesos for Type I, 165,000 pesos for Type II, 119,000 or 78,000 pesos for Type III, and 35,000 pesos for Type IV. According to the 1980 census, the average age of dwelling units is 13 years as seen in Table 3.6. Supposing that a dwelling unit is maintained under condition of average maintenance, its depreciated value might be 31% for Type I, 44% for Type II, 70% for Type III and 85% for Type IV, according to the depreciation table of the city assessor in Iloilo City. Accordingly, the average market value is estimated at 141,000 pesos for Type I, 92,000 pesos for Type II, 36,000 or 23,000 pesos for Type III and 5,300 pesos for Type IV.

In this study, therefore, the market value of dwelling unit is assumed to be 100,000 pesos. This value is almost the same value of Type II of 92,000 pesos.

The indoor movable or household effects are assumed to be a half of a value of dwelling unit. Namely, they are estimated at 50,000 pesos. Incidentally, average annual family expenditure in Iloilo City is 102,000 in 1991. This value of household effects is almost equal to a half of the annual expenditure and to the total amount of five years expenses for damageable materials of about 10,000 pesos.

Assessed values of damageable assets in other three cities are estimated as the same as those in Iloilo City, because of data availability. Thus, the average present value of a dwelling unit is assumed to be 100,000 pesos and that of household effects is 50,000 pesos.

(2) Agricultural Production

(a) Crop Production

As major corps in Provinces are discussed in Economic Profile, Iloilo is specialized for palay production, Cebu for corn and Leyte for several crops. In Iloilo City particularly, most of palay fields are irrigated as far as field survey is investigated. Regarding crop cultivation lands in the target areas estimated in Table 3.9, Iloilo and Tacloban Cities include comparatively ample crop fields in the target areas: 2,088 ha in Iloilo and 739 ha in Tacloban. Cebu and Ormoc Cities, however, do not have much crop fields: 116 ha in Cebu and 38 ha in Ormoc only. Thus, cultivated crop in the target areas is assumed to be represented by palay.

The degree of crop damage varies from month to month, depending on the cropping stage and timing of flood occurrence. Therefore, the annual average damage value of crop per hectare is estimated as an aggregate of expected net income and accumulated expenditure for production expenditure until the time when flood occurs. In that case, flood frequency and planted area cultivated in each month have to be taken into account as well. It is expressed by the following formula:

$$DV = \sum_{i=Jan}^{Dec.} CA_i \cdot FF_i \cdot (AC_i \cdot PC_i + NI)$$

where;

DV	:	damageable value (Pesos/ha)
CA	:	cultivated area (%)
FF	:	flood frequency (%)
AC	:	accumulated cost (%)
PC	:	production cost (Pesos/ha)
NI	:	net income (Pesos/ha)

Applying economic values into the above formula, damageable value of palay is estimated at 10,100 pesos per hectare in economic terms, as shown in Table 3.11.

(b) Inland Fishery Production

In the four Cities, inland fishery is identified only in Iloilo City. As seen in Table 3.9, there are fishponds having the total area of 326 ha. They produce mostly prawn and milkfish. In the Study, prawn is assumed as a representative species for fishery production

The damageable value of fishery production is estimated through the same procedure as crop production mentioned in the previous part. The value is estimated at 22,100 pesos per hectare.

(3) Manufacturing Industry

The existing number of manufacturing establishments was 525 in Iloilo City in 1992, according to Socio-Economic Profile 1992, Iloilo City . However, the number of manufacturing establishments and their distribution in the flood prone area is not clear because the manufacturing establishments are not identified on the topographic maps. Thus, the number is estimated to apply the unit rate of as 1.6 establishments for every 1,000 urban people in built-up areas, referring to the conditions in Iloilo City in 1992, i.e., 525 establishments per 316 thousand of estimated urban people in 1992. 525 manufacturing establishments in Iloilo City are considered as belonging to large or medium scale establishments. In this Study, the indices and ratio of large scale establishments will be applied to estimate fixed assets and inventory stock.

Once this assumption (1.6 establishments per 1,000 urban people) is applied to the regional level, 3,080 manufacturing establishments might be counted in Region VI in 1990 because of 1,926 thousand of urban population at the 1990 census. Ninety percent (90%) of VA by manufacturing sector is assumed to be produced more by medium scale establishments, so an average VA of an establishment could be estimated at 4.97 million pesos per establishment, because VA of manufacturing sector of Region VI in 1992 was 17,025 million pesos for 3,080 manufacturing establishments.

The ratio of fixed assets to VA was 0.73, so the average value of fixed assets holdings of an establishment was estimated at 3.60 million pesos. Since this value includes land for the factory, the damageable value of fixed assets is 3.53 million pesos. In the same manner, since the ratio of inventory stock to VA is 0.29, the inventory stock of the factory is estimated at 1.44 million pesos. These values are re-evaluated as 4.17 million for fixed assets and 1.70 million pesos for inventory stock at 1994 current prices, since the inflation for two years is estimated at 18% according to Economic Indicators, April 1994, NSCB . The fixed assets are divided into 470 thousand pesos for building and 3.70 million pesos for machinery and equipment.

Assessed values of damageable assets in the other three cities are estimated to be the same as those in Iloilo City, because of data availability regarding the number of manufacturing establishments.

(4) Trading Industry

The existing number of trading establishments was 4,500 in Iloilo City in 1992. This total number accounted for 57.0% of the total business establishments of 7,890 in the city. In the same procedure mentioned in the previous section, the number of trading establishments is estimated to apply the unit of 13.9 establishments for every 1,000 people, referring to the data (4,500 establishments per 324 thousand of estimated total people in 1992) in Iloilo City. As a result, the number of trading establishments in target areas is enumerated at 4,228 in Iloilo, 5,911 in Cebu, 1,735 in Tacloban and 340 in Ormoc as shown in Table 3.9.

Applying this assumption to regional level, 77,500 trading establishments might be existing in Region VI in 1992 because the regional population is estimated at 5.58 million in 1992. Since VA of trading sector was 18,131 million pesos in 1992, an average VA is estimated at 234,000 pesos per establishment. On the other hand, the ratio of fixed assets to VA for retail trading sector is 0.50, so the average value of fixed assets holdings of an establishments is estimated at 117,000 pesos. Since this value included site where the store is located, the damageable value of fixed assets is 83,000 pesos excluding land value. In the same manner, the inventory stock of the store is estimated at 545,000 pesos, since the ratio of inventory stock to VA is 2.33.

Considering the inflation between 1992 and 1994, the damageable fixed assets are re-evaluated at 98,000 pesos and inventory stock, 643,000 pesos. The fixed assets are furthermore divided into 54,000 pesos for building and 44,000 pesos for equipment.

Assessed values of damageable assets in other three cities are assumed as the same as those in Iloilo City, because of data availability.

Distribution of Damageable Assets

Distribution of damageable assets is worked out in the form of grid information. A mesh block is 250 m interval squares, as mentioned before. The inventory of damageable assets in every square is read or estimated on the basis of the aforesaid land use map, topographic map, administrative boundary map and socio-economic information.

Regarding dwelling units, the distribution is figured out through the following procedure. The dwelling units in a barangay are assumed to be distributed equally all over the Barangay area excluding agricultural land and/or green spaces. This connotes that the population density in the barangay is assumed to be equal. In case that a grid is divided into two or more barangays, the population in the mesh block would be aggregated to the total of portions in respective barangays. The number of dwelling units is assumed to be the same as the household number which is estimated as a quotient of population divided by family size. Finally, the number of dwelling units by mesh block is counted up in the entire target areas. Fig. 3.42 to 3.49 show the distribution of dwelling units in mesh block maps of Iloilo, Cebu and Ormoc.

Manufacturing establishments are not always distributed in densely inhabited areas such as city proper and/or urban core. They would rather be established surrounding areas of urban core. Thus, their distribution is assumed as one manufacturing establishment in a grid for population density of between 500 and 100 persons per a grid.

Trading firms are basically established in densely inhabited areas. They would be established not only in city proper and/or urban core but also in rural areas. Thus, they are assumed to be distributed as one store for every 75 persons in a grid having a density of more than 100 persons per mesh block.

The distribution of agricultural lands such as palay field and fishpond are figured out on the basis of land use map. In principle, there are no buildings such as dwelling units and industrial establishments in agricultural lands.

Probable Flood Damage

Flood damage is calculated as a product of damageable property and damage rate. The damage rate for assets vulnerable to flood is determined with inundation depth. Since standard flood damage rates of buildings and other properties are not available in the Philippines, the damage rates which developed by the Ministry of Construction in Japan are tentatively substituted for the standard damage rates conceivable in the Philippines. Table 3.12 shows the standard flood damage rate by type of damageable assets and by inundation level.

Flood damage of infrastructure is estimated as 35% of the above direct damage. Indirect losses is also estimated at 10% of the direct damages including infrastructure damages.

By means of the aforesaid procedure, flood damages by different scales are simulated based on the result of area-depth analysis, unit values of damageable properties and damage rate. The results of respective rivers in Iloilo, Cebu and Ormoc cities are summarized in the table below.

(Unit: Million Pesos in Economic Terms)

City/	Return Period (Year)					
River	2	5	10	20	50	100
Iloilo City	389	583	837	1,125	1,378	1,591
Jaro River	290	405	558	751	921	1,041
Iloilo River	99	178	279	374	457	550
Cebu City	356	597	752	1,016	1,325	1,515
Bulacao River	44	74	83	94	102	108
Kinalumsan River	65	123	180	277	331	355
Guadalupe River	80	159	213	333	441	518
Lahug River	96	144	168	186	291	365
Subang Daku River	71	97	108	126	160	169
Ormoc City	106	186	205	229	252	262

In the same manner, flood damages of poor drainage areas in Iloilo, Cebu, Ormoc and Tacloban are summarized in the table below.

(Unit: Million Pesos in Economic Terms)

City	Return Period (Year)			
	1	2	3	5
Iloilo City	14	15	16	16
Cebu City	118	167	167	168
Ormoc City	2	2	2	3
Tacloban City	78	98	102	107

3.5.5 River Administration

General Policy

Republic Act No. 7160, Art 26 states that "Public works and infrastructure projects and other facilities, programs, and services funded by the National Government under the annual General Appropriations Act, other special laws, and pertinent executive orders, and those wholly or partially funded from foreign sources, are not covered by the devolution of basics and facilities under...". The devolution has been proceeding since budgetary year 1992 and implementing year 1993 from the National Government to Local Government Units (LGUs) to enable them to perform specific functions and responsibilities.

The National Government is responsible for managing of twelve (12) major river basins and Metro Manila, and implementing projects funded by foreign sources. Therefore, construction works at other river basins and drainage are controlled by the LGU.

Administration for Medium and Small River Basin

Except for the 12 major river basins and Metro Manila, administration of river basins fall under the LGU's responsibilities. LGU include barangay, municipality, province and city. Each construction and maintenance activity involving infrastructure facilities, including medium/small river basins and urban drainage, is basically funded by the LGU.

Flood control works are acted upon by request from the local government and the necessity is investigated and reported by the local engineer. The operation and maintenance will also be served by the LGU.

Administration for Urban Drainage

The basic idea of budgeting for rivers is the same at LGUs, with distinctions being made by type of road. If the drainage channel is along a national road, management is under the national office; otherwise, it shall be managed by the LGU.

3.5.6 Organization and Activity

Organizational Setup for Flood Control Works

Flood control work at the national level is initiated by a request from the local government and/or the district office of DPWH concerned. An investigation on the necessity of the project is carried out and reported by the district engineer. If the project is recognized to be necessary, the request form is filled in by the district engineer and sent to the regional office with a proposal and design. Through the evaluation by the DPWH regional office and the finalization by the regional director, the request is forwarded to the Regional Development Council (RDC) and the Central Office and incorporated in the national budget. Based on the budgetary requests from all regional offices, the programming division of the DPWH central office summarizes all request forms and arranges the budget for each regional office.

<u>Compensation Works for Flood Control Project</u>

Since a project may be funded by the national government or foreign sources, the supervision of flood control works is undertaken by the DPWH regional office. In order to implement the flood control project, compensation for house evacuation and land acquisition is one of the main problems to deal with. There are two types of compensation processing methods available: one for private house owners and another for squatters. Their standard procedures are summarized in Fig. 3.45 to 3.47.

<u>Operation and Maintenance of River</u>

If infrastructure projects are constructed with financial assistance from foreign funds, the maintenance and operation works shall be undertaken by the project management office (PMO), DPWH until the end of implementation. After completion of the project, the basic services and facilities are turned over to the LGU. The LGU shall be responsible for a set of services and facilities in accordance with the established national guidelines and standards (refer to Fig. 3.48 and 3.49).

The maintenance work is mostly carried out by the regional office s maintenance division, regional equipment services and construction division except in some special cases.

3.6 Environment

3.6.1 Environmental Policy

<u>EIS System</u>

The EIS System refers to the entire process of organization, administration and procedure institutionalized for the purpose of assessing the significance of the effects of physical developments on the quality of the environment.

Environmental Impact Assessment (EIA) is done during the feasibility stage of the project cycle where inputs from the study can really help in shaping a particular project to be both environmentally sound and economically viable. It should be started as early as possible and in parallel with other studies so that the environmental consequences of the project can be taken into account from the earliest planning stage. Recommendations can also easily be implemented without considerable change in plans and increase capital outlay.

(1) Projects Covered by EIS System

The following Environmentally Critical Projects and Areas fall under the scope of the EIS system. Proponents are required to apply for ECC before these projects can be implemented.

(a) Environmentally Critical Project

(i) Heavy Industries

(ii) Resources Extractive Industries

(iii) Infrastructure Projects

- Major dams
- Major power plants
- Major reclamation projects
- Major roads and bridges

The Department of Public Works and Highways (DPWH) is preparing a Department Order (DO) to revise Ministry Order (MO) No. 72 proclaiming certain areas and types of projects as environmentally critical and within the scope of the EIS system. New guidelines proposed in the draft DO are to supplement other infrastructure projects as the projects covered by the EIS system in consonance with the Memorandum of Agreement (MOA) entered into by and between the Department of Environment and Natural Resources (DENR) and DPWH dated 26 June 1992. The supplemented projects include development, construction and maintenance of national roads, bridges and major flood control infrastructure projects. Major flood control project refers to any large scale activity which will involve river control works, channel widening, dredging and embankment and urban drainage works including cross drainage of diversion highway. The project cost of this type of project shall be at least one hundred million pesos (₱100,000,000) or more. The DO is expected to be signed and to take effect within 1994. Therefore, it is desirable that the projects proposed in this study should follow the EIS procedure.

(b) Environmentally Critical Areas

(i) All areas declared by law as national parks, watershed reserves, wildlife preserve and sanctuaries.

(ii) Areas set aside as aesthetic potential tourist spots.

(iii) Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna).

(iv) Areas of unique historical, archaeological or scientific interests.

(v) Areas traditionally occupied by cultural communities or tribes.

(vi) Areas frequently visited and/or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity, etc.).

(vii) Areas with critical slopes.

(viii) Areas classified as prime agricultural lands.

(ix) Recharge areas of aquifers.

(x) Water bodies characterized by one or any combination of the following conditions:

- tapped for domestic purposes;
- within the controlled and/or protected areas declared by appropriate authorities; and
- which support wildlife and fishery activities.

(xi) Mangrove areas characterized by one or any combination of the following conditions:

- with primary pristine and dense young growth;
- adjoining mouth of major river systems;
- near or adjacent to traditional productive fry or fishing grounds;
- which act as natural buffers against shore erosion, strong winds and storm floods; and
- on which people are dependent for their livelihood.

(xii) Coral reefs characterized by one or any combination of the following conditions:

- with 50% and above live coral cover;
- spawning and nursery grounds for fish; and
- which act as natural breakwater of coastlines.

Processes in the EIS System

The following procedures for the EIS system are conducted according to the procedures for the EIS shown in Fig. 3.50.

(1) The Pre-Study Phase

(a) Pre-screening

Prior to any project implementation, project proponents (PP) are to coordinate with the Environmental Management Bureau (EMB) or the nearest DENR Regional Office (DENR-RO) to initially determine if the proposed project falls under the purview of the EIS System.

(b) Scoping

For projects identified that would need an EIS, scoping sessions with DENR will follow. Scoping is a stage in the process where the information requirements for the EIS is established. This stage is considered to be important as it can provide to the proponent a clear direction for the environmental impact assessment work.

(2) The Study Phase

(a) Site Characterization and Prediction of Impacts

Once the study is scooped, the proponent shall now proceed with the EIS by collecting the necessary data information and predicting the project impacts. The main activities at this stage are Impact Identification and Impact Prediction .

(b) Evaluation of Impacts and Proposal of Alternatives

The identified impacts are compared with pre-defined acceptability criteria or existing environmental standards. The key activity at this stage is the evaluation of the significance of impacts, that is, judgment about which impacts found in the study are considered important and therefore needs to be mitigated.

(c) Identification and Assessment of Mitigation Measures

On the basis of the evaluation of impact, the corresponding mitigation measures are then identified and assessed. This stage also involve re-evaluation of impacts to determine whether the measures lead to acceptable levels of the impacts.

(d) Preparation of the Environmental Impact Statement (EIS)

Having determined the impacts and the corresponding mitigating measures, the next stage involves the preparation of the Environmental Impact Statement (EIS).

Scoping Session

For the above-mentioned purpose, DPWH, as a proponent of the Project, held the scoping sessions on June 21 in Ormoc City and on June 24 in Iloilo City. The JICA Study Team assisted the Counterpart Team of DPWH with the preparation for the sessions and also participated in both sessions as an observer. Some opinions expressed in the sessions have been fully considered and reflected in the Study.

3.6.2 Existing Environmental Conditions

Judging from the results of the field reconnaissance, the data/information obtained and the results of the preliminary environmental survey, environmental profiles of the selected urban centers and the river basins in the areas are described as follows, and also are characterized by the items defined in "Environmentally Critical Areas (ECA)" as shown in Table 3.13.

Iloilo

(1) Physico-chemical Aspects

(a) Surface Water

Iloilo City is situated on a river delta. Flooding has been a perennial problem especially in the Jaro area near the banks of the Jaro River and other low areas within the city proper. Iloilo River has no recorded flooding.

(b) **River Water Quality**

Jaro river is regularly monitored at four sampling stations; Ticud Bridge, Ungka Pumping Station, Aganan Bridge (Pavia) and Maasin Dam, to check its water quality and extent of pollution. The upper reach of the river is still within the Class "A" water quality, except for the Total Suspended Solids (T-SS) concentration which is slightly above the standard. Some stations at the lower reach classified as Class "B" are not within Class "B" water quality, however, all of them conform with Class "C" water standard. The station downstream of the piggery farms has a slight increase in BOD.

Iloilo River is classified as Class "C" and is regularly monitored at three sampling stations; Parola Bridge, Quirino Bridge and Carpenter's Bridge, to check its water quality and extent of pollution. The monitoring results show that the river still conforms with the water quality standard of Class "C". There are many ships anchoring along the riverside of Iloilo River, but some of them are scrapped ships. The same is the recipient of domestic wastes from Iloilo City sewage drainage system and from industries such as piggeries and poultry farms, a slaughterhouse, a power plant, a beverage and a coconut oil factory.

Water quality survey was carried out in the Study to evaluate the existing environmental condition of the Jaro and Iloilo rivers. River water samples were taken from center and bank side of the channel in the middle and the lower reach of each river. Sampling was carried out three times; once in each month of June to August in 1994. The water quality parameters were analyzed using the designated standard methods.

Results of the survey are shown in Table 3.14. In the middle reach of Jaro River, BOD fluctuates a little and shows the values of Class A to C, though DO satisfies a water quality criteria of Class AA. This shows that river water in the middle reach is not so polluted with organic substance such as sewage. T-SS and Total Coliform show higher concentration than water quality criteria. Phenol is detected with a level of Class B or C, which shows river water seems to be slightly polluted with industrial wastewater. In the lower reach of Jaro River, river water seems to be affected by the effluents from the urban area, therefore, DO shows lower concentration corresponding to Class A than that of the middle reach, and BOD shows higher concentration corresponding to Class A to D. T-SS and Total Coliform show higher concentration than water quality criteria, especially, Total Coliform is higher than that of the middle reach. Phenol is detected with a level of Class B or C as shown in the middle reach.

As for Iloilo River, BOD shows a higher concentration of the level of Class C or D than that of Jaro River in the Middle reach. On the contrary, T-SS and Total Coliform are lower than those of Jaro River. High values of T-DS and Chloride seem to show an effect of seawater intrusion. Phenol is detected with a level of Class A or B, which shows river water seems to be slightly polluted with industrial wastewater even if it is less polluted than Jaro River. In the lower reach, BOD, T-SS and Total Coliform show almost the same concentration as those of the middle reach. T-DS and Chloride are higher than those of the middle reach, which shows an effect of seawater intrusion. Phenol is also detected with a level of Class A or B in the lower reach.

(c) Ground Water

Iloilo City has a relatively constant ground water level. Based on ground water quality studies, the water is highly mineralized and does not meet the criteria set by the Philippine National Standard for Drinking Water.

(d) Oceanography

The Iloilo Strait is one of the most important bodies of water bounding Iloilo City.

(2) Ecological Aspects

(a) Terrestrial Species

No significant vegetation is observed along the lower reach of Iloilo River except for a few Avicennia sp. and members of Rhizoporaceae family in the vicinity of the Molo Bridge.

No wildlife is observed in the vicinities of the lower reaches of the Iloilo and Jaro rivers since the areas are highly urbanized.

The grassland/openland is the dominant vegetation at the lower and the middle portions of the watershed. The vegetation is mostly cogon and Themeda.

(b) Aquatic Species

Iloilo River and Jaro River flow out into the water body surrounding Guimaras Island known as Iloilo Strait. Extensive coral reef used to cover the southwestern part of the island. Currently, the coral cover is very sparse and fish catch has dramatically declined according to a fisherman informant. No commercial fishing activity is observed in the Iloilo Strait.

In Bo. Jinactacan where Jaro River exits to Iloilo Strait, the extensive juvenile growth of mangrove tree species belonging to the family Rhizoporaceae and genus Avicennia is observed. Young forest covers an area of approximately 65 hectares of the advancing delta formation on both sides of the river mouth. At the site of the proposed La Paz Floodway, adjacent to the sea, young mangrove tree species grow in the small inter-tidal area.

(3) Socio-economic Aspects

(a) Land Use

Areas along the river sides are used extensively as fish/prawn ponds. Salt beds are also found alongside the river, especially near the mouth. Fish traps dot the main river body. Almost all basin is the cultivated land for rice paddies.

(b) Housing

Significant residential development has occurred and subdivisions have proliferated in the various districts of Iloilo City to meet the growing housing demand. In the urban area of Iloilo City, squatters are found in the river channel. According to the data of Iloilo City, 242 households or population of 996 persons were estimated as squatters.

(c) Garbage Disposal

The city utilizes an open dump system for its solid wastes.

(d) Toilet Facilities

A considerable number of households do not have toilet facilities (6.8%). Without these facilities, this portion of the population tend to use the natural waterways and tributaries of the rivers.

(e) Health and Social Services

Bronchitis, diarrhea and pneumonia are the three major causes of morbidity. Diarrhea may be due to the lack of safe drinking water and the living near and being exposed to polluted waters in the waterways.

Cebu

(1) Physico-chemical Aspects

(a) Surface Water

Cebu City and the five related river basins are characterized with evenly distributed rainfall throughout the year. Having a prevailing impervious clay loam soil cover, lack of forest cover, steepness of topography, and rather small rainfall, the rivers in Cebu City are characterized by a regime with no sustained base flow and extremely sharp flood peaks. The major causes of floods are overbank flow, stagnant water at several spots due to inadequate drainage and obstruction of solid waste and tidal floods in low -lying areas.

(b) River Water Quality

According to the existing water quality data measured at several points of the rivers of Lahug, Guadalupe and Subang Daku, DO level (5.4 mg/l) at Busay of Lahug River passed the standard for Class "C" waters but those for Guadalupe and Subang Daku failed. All the rivers, however, do not pass the standard for the coliform count as well as BOD concentration indicating that these rivers are unfit even for irrigation or aquaculture use. Concentration of heavy metals was also detected in the three rivers.

(c) Ground Water

Groundwater is the main source of potable water in Cebu City. It is being extracted from several hundred wells. The capacity and recharge possibilities of this aquifer are limited. Wells in these areas are therefore experiencing increasing salinization and contamination problems.

(d) Oceanography

Cebu City is bounded to the south by the Cebu Strait. At present, Cebu Strait is heavily polluted. Pollution arise from the industrial sewage discharged by the different factories and refineries along the coast. Fishing in the strait has ceased because of the pollution and pressures of industrialization.

(2) Ecological Aspects

(a) Terrestrial Species

Vegetation in the upper stream basin of Guadalupe River is mainly comprised of shrubs, bamboo and mangoes, and that in the upper stream basin of Subang

Daku River is grassy. Vegetation in the upper stream of Lahug River seems to be comparatively thick.

(b) Aquatic Species

The lower stream basin of Bulacao River is muddy plain and a mangrove swamp is slightly found around the river mouth. The coastline is a coral reef, however, it has been seriously damaged by man's activities.

(3) Socio-economic Aspects

(a) Land Use

A big portion of the watershed divide separating the Bulacao River catchment area from the Kinalumsan River watershed is currently being developed into a big residential area. An area of about 300 ha has been cleared and is already being developed and more portions are still being excavated. The basin of Linao River which is a tributary of the Kinalumsan river system has been developed for housing, however, there must be some problems in the drainage system and the river is often flooded. The upper stream basin of Subang Daku River has been developed for a residential zone for upper income group.

(b) Housing

Squatter shanties abound especially along the waterways. Housing in Cebu is increasingly getting to be difficult due to limited availability of units and high rental rates.

(c) Toilet Facilities

A considerable number of households do not have toilet facilities (10.2%). The households account largely for those who use natural waterways and tributaries of the rivers included in the Study area for human waste disposal.

(d) Garbage Disposal

Although the city government provides garbage collection services for much of the city, some members of the community still insist on throwing their domestic wastes into the rivers and tributaries which are accessible to them.

(e) Health Status

Diarrhea may be due to the lack of safe drinking water and living near and being exposed to polluted waters in the waterways.

Ormoc

(1) Physico-chemical Aspects

(a) Surface Water

Anilao and Malbasag river basins in Ormoc City are characterized with evenly distributed rainfall throughout the year. Though the river basins are very steep, the base flows are rather big for their catchment area due to rich springs in the upper stream areas. On the other hand, river flood flow is quite fast and sharp as evidenced by the flood on November 5, 1991.

(b) River Water Quality

Water quality survey was carried out to evaluate the existing environmental condition of Anilao and Malbasag rivers. River water samples were taken from center and bank side of the channel in the middle and the lower reach of each river. Sampling was carried out three times; once each month of June to August in 1994. The same water quality parameters were analyzed using the same methods as those of the survey in Iloilo

Results of the survey are shown in Table 3.15. In the middle reach of Anilao River, BOD and DO satisfy a water quality criteria of Class A. This shows that river water in the middle reach is not so polluted with organic substances such as sewage. Total Coliform shows rather high concentration, however the content of Fecal Coliform seems to be low, judging from concentration of BOD. BOD in the lower reach satisfies only the level of Class D. Total Coliform shows as high concentration as that of the middle reach. Phenol is detected with a level of Class AA not only in the middle reach but also in the lower reach, which shows river water seems to be slightly polluted with industrial wastewater. T-SS is rather low in both reaches.

As for Malbasag River, BOD and DO satisfy a water quality criteria of Class A in the middle reach. Total Coliform shows rather high concentration like that of Anilao River. In the lower reach, BOD only satisfies a water quality criteria of Class D, which shows the river water is affected by the effluent from the urban area. Total Coliform shows high concentration like that of the middle reach. T-SS is rather low in both reaches. However, Phenol is not detected in both reaches.

(c) Ground Water

The local water district extensively uses ground water for its commercial and domestic needs. The water source comes from two groups of springs located along Anilao and Malbasag rivers plus pipe production wells.

(2) Ecological Aspects

(a) Terrestrial Species

Banks of Anilao and Malbasag rivers are covered with small shrubs and grasses of several species. Significant species that contribute to the stability of the banks are cogon and talahib. Several trees like coconut, ipil-ipil, and ratiles also thrive here. Bananas, camoteng kahoy and papaya are cultivated along the river banks. Kangkong is abundant in the river and serves as a means of livelihood for residents of nearby areas.

No wildlife is observed around the project site since it has become urbanized.

(b) Aquatic Species

Part of Ormoc Bay where Anilao River discharges is characterized by shallow and muddy sea floor. Large quantities of coarse and fine particles are present, presumably carried to the sites by the flood during Typhoon Uring. The reef flats and occasional bands of sea-grass/algal beds are quite far from the area.

(3) Socio-economic Aspects

(a) Demography and Manpower

The areas washed out by the flood in 1991 are now generally clear of squatters as most of those whose houses were completely damaged have been relocated in various resettlement projects.

(b) Housing

The 1991 calamity aggravated the housing situation in the city. The floods affected a total of 39,691 households. It rendered 3,193 families totally homeless while 12,470 more had had their houses partially destroyed. Consequently, six resettlement areas covering a total of 18.5 ha were established for families whose houses were completely destroyed. A total of 1,935 housing units were targeted to be provided in these resettlement areas.

(c) Toilet Facilities

A significant number of households (39.2%) have no toilets at all. In some houses along the Anilao River, improvised toilets which extend to the river can be noted.

(d) Garbage Disposal

The city center has a garbage collection system with a dumpsite, however, those residing near rivers and drainage canals conveniently dump their solid wastes into them.

Tacloban

(1) Physico-chemical Aspects

(a) Surface Water

The Abucay River, a smaller river system lying on the northwestern side of the city watershed area, used to be an irrigation water source for some agricultural lands in Barangays Abucay and Naga-Naga. The river drains to the Anibong Bay which is situated west of the Panalaron Bay.

Mangonbangon River runs along the western side of the city proper, carries part of the city's runoff, wastewater and solid domestic wastes and drains to Panalaron Bay.

(b) Oceanography

Tacloban City is surrounded by four bodies of marine water, namely: the Anibong and Panalaron Bays to the north, and Cancabato and San Pedro Bays to the east. San Pedro Bay is characterized by strong currents and not used for commercial purposes.

(2) Ecological Aspects

(a) Terrestrial Species

None of the rare, threatened and endangered flora and fauna listed for Region VIII are present here.

(b) Aquatic Species

Near the mouth of Abucay River are remnants of both mangroves and littoral forest. The key mangrove species observed were mayapi and nipa.

(3) Socio-economic Aspects

(a) Housing

It is estimated that the number of households residing along the two-kilometer stretch of the Mangonbangon River embankment can be as high as 4,000. Most of these households are squatting on private and public lands and on the river right-of-way. The city government has opened three resettlement sites in the Tigbao and Palanog Districts, several kilometers away from the city.

(b) Toilet Facilities

There are some 2,404 households (10%) that have no toilets at all. Many of these households can be found in the esteros and near the seawall. In squatter settlements along the Mangonbangon River, improvised toilets extend to the river.

(c) Garbage Disposal

The city center has a garbage collection system with a dumpsite, however, most of those residing near rivers and drainage canals simply dump their solid waste into them. The clogging of Mangonbangon River near its mouth by garbage is one of the causes of flooding during the typhoon season.

(d) Health Status

Along the esteros, skin diseases among children, which are also caused by poor hygiene, are reported to be prevalent.

Tacloban is a Schistosomiasis endemic city. Caibaan, Marasbaras, Manlurip, Tagpuro, San Paglaum and Divisoria are positive barangays in the city. The river basin is considered as one of the breeding areas of Schistosomiasis

(e) Community

There are two organizations which draw most of their members from the urban poor in squatter areas. One is an organization of market vendors called NAGBENTA (Nagkaurosa nga Benders sa Tacloban) while the other is PAGMATA (Pagkakaisa ng mga Maralitang Taga-Lungsod ng Tacloban). The PAGMATA members were the frontliners in opposing the resettlement of the urban poor in Barangay 37 or the Seawall District. They will be a force to contend with in any relocation projects as they can easily mobilize the urban poor.

CHAPTER 4 MASTER PLAN

4.1 Planning Conditions

4.1.1 Project Scale

The project scale of the Master Plan is proposed taking the following conditions into account:

(1) The flood damage potential and flood control capacity of the river basins;

(2) The magnitude of recorded maximum floods in the river basins; and

(3) The project scale employed in existing and proposed flood control plans in the Philippines.

Rivers in the study area flow through cities; hence, damage inflicted by floods on assets and properties is enormous. Due to the topographic conditions, some rivers like those in Cebu and Ormoc could bring disastrous damage to life and properties due to flush floods.

There are no records on flood discharge in the respective rivers, therefore, the magnitude of recorded maximum floods was calculated by frequency analysis on daily rainfall at representative stations in the river basin. With 20 to 40 years of rainfall records for each rainfall station, maximum rainfall in the respective river basins was estimated to be around a 30-year return period, and maximum rainfall in Iloilo during the disastrous event on July 29, 1994 corresponded to nearly a 50-year return period.

For major river basins such as Cagayan, Agno and Pampanga, the project scale of 100 year return period has been adopted only for the framework plan of flood control. A project scale of 100-year return period has also been employed for the master plan of Pasig-Marikina River which flows through Metro Manila, although a 30-year return period was employed for Malabon River which flows in a low-lying and congested area.

Therefore, the project scale of the Master Plan for rivers in this Study is generally proposed at a 50-year return period for flood control in consideration that: (1) the objective rivers have only a small catchment area but they are located in regional urban centers; and, (2) the magnitude of past maximum floods as estimated by rainfall frequency analysis is 30-year to 50-year return period.

As for urban drainage, a higher scale of 5-year return period is applied to major drainage systems with drainage areas of more than 50 ha, while a lower scale of 3-year return period is adopted for those with less than 50 ha.

4.1.2 Target Year

The target year of the Master Plan is proposed, taking the following conditions into account which have to be consistent with the background and objective of the Study:

(1) The four cities selected for the Master Plan in the First Stage Study shall represent the 13 urban centers and all medium and small-scale rivers in the country which have flooding problems;

(2) Periods for implementation of flood control works for the respective rivers are different depending on scales and areas of flood problems, and the socio-economic and financial conditions, therefore, the target year shall be set at the farthest time possible for estimating physical conditions; and

(3) Flood control plans are parts of national and regional development plans; hence, the target year and purpose of the former shall be consistent with the latter.

The National Physical Framework Plan for 1993 to 2022 has been arranged by the government as a long term development plan in addition to the Medium-Term Regional Development Plans for 1993-1998 proposed by respective NEDA regional offices. In accordance with the aforementioned conditions, the year for completion of flood control works in the 13 urban centers (one urban center for each region except the National Capital Region) is assumed to be the year 2022. Therefore, the target year of the Master Plan of flood control for the four cities is proposed to be the year 2016, while that for the 13 urban centers is assumed to be the year 2022. The implementation plan is shown in Fig. 4.1.

4.1.3 Flood Control Measures

<u>River</u>

The following measures are proposed for the flood control plan of rivers:

(1) Jaro River

The flood control plan is a combination of river improvement works for 18.9 km of Jaro-Tigum River and 3.0 km for Aganan River and two floodways; 4.8 km of Jaro Floodway and 0.6 km of La Paz Floodway for the flood discharge of Jaro River to Iloilo Strait.

(2) Iloilo River

For the main stream of Iloilo River, channel improvement works for 6.5 km from the river mouth such as raising of river banks and dredging are employed to confine the design flood discharge and to protect river banks.

For Mandurriao River, the main tributary of Iloilo River, only channel improvement for 4.8 km from the confluence with Iloilo River is employed.

(3) Bulacao River

River improvement for 2.7 km is required to increase channel flow capacity.

(4) Kinalumsan River

River improvement for 4.0 km such as widening, excavation, diking and revetment works is required to increase flow capacity and stabilize flood flow.

(5) Guadalupe River

River improvement for 4.0 km is the optimum measure for flood control. Although a flood control dam at the upstream is proposed as an alternative flood control plan, this plan may have a higher cost and bring some social problems of right-of-way.

(6) Lahug River

River improvement for 5.0 km such as widening, excavation and revetment works is required to confine the flood in the river channel.

(7) Subang Daku River

River improvement for 5.5 km such as widening, excavation and revetment works is required to confine the design flood discharge.

(8) Anilao River

River improvement of 1.8 km in the lower reaches, emphasizing realignment of the river course is required. In addition, two (2) slit dams are provided to stop floating logs.

(9) Malbasag River

River improvement of 1.9 km 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.

Urban Drainage

Channel improvement such as widening and deepening the drainage channel excluding diking is basically adopted for all objective watercourses. Improvement works are planned to remove acute bends and constrictions, bottleneck culverts and bridges, squatter encroachment and clogging with sediment and garbage.

Embankment is, in principle, not adopted for drainage channel improvement since inundation water could be drained by gravity. Construction of pumping station is not also physically required.

Considering the ease of operation of drainage systems, the existing drainage channels to be improved are, principally, to remain as open watercourses, not to be enclosed by box culvert. As for the improvement of the four existing drainage mains in Cebu, however, the box culvert type of drain is proposed since they are to be located under the existing roads.

Non-Structural Measures

As described in the foregoing concerning the current conditions of riparian areas, flooding problems of the rivers are partly brought about by encroachment of houses, deposit of solid waste/garbage, as well as lack of proper maintenance on river channels. Therefore, non-structural measures such as land use regulation/zoning, afforestation and enforced maintenance works will be effective.

The non-structural measures required for the respective river basins are discussed below.

(1) Land Use Regulation/Zoning

This measure shall be employed for all rivers, especially riparian areas along river channels. Houses have been built on the river banks even inside river channels. All five rivers in Cebu City have a problem of encroachment on channels. Subdivisions to be developed in the upstream hilly area of Cebu City shall have to be screened through land use regulation.

A river code or structural standards is necessary to control and avoid the problem. Zoning regulations along river channels as issued for Anilao and Malbasag rivers in Ormoc City shall be enforced.

The middle reach of Tigum River in Iloilo is dendritic in shape and has a wide floodplain which is partly used for rice paddy. Through the hydrologic analysis in this Study, this middle reach has been identified to have a large flood retarding effect. Land use regulations will maintain the function of the middle reach as a retarding basin so as to reduce flood discharge to the downstream areas. The location of the proposed retarding basin is presented in Fig. 4.2.

(2) Afforestation

Watershed management has been practiced for the catchment area of Buhisan Dam on Kinalumsan River. The upstream areas of other rivers in Cebu City will require the same watershed management works including afforestation.

(3) Enforced Maintenance

Most of the river channels are used as dumping sites for city dwellers' wastes and garbage. The wastes have accumulated in the channels, and channel flow capacity has been reduced in all rivers in Cebu City very much.

Enforced maintenance works to remove solid wastes and sediments from river and drainage channels will be effective to recover flow capacity and to restore a pleasant river environment.

4.2 Flood Control Plan

4.2.1 River Improvement

Based on the project scale proposed for the river flood control plan, estimates of design discharges of river improvement works were made as presented in Figs. 4.3 to 4.5. The estimates were derived from the river flood control measures described hereinafter.

<u>Iloilo City</u>

(1) Jaro River

To minimize land acquisition and house evacuation, a combination of river improvement works and two (2) floodways for the flood discharge of Jaro River to the Iloilo Strait is proposed. The river improvement stretch is from the river mouth up to the confluence with Aganan River. The optimum scale of the two floodways proposed were determined through cost comparison. The upper floodway, the Jaro Floodway, to divert the design discharge of 850 m^3/s, gives the minimum construction cost among the alternatives as shown in the table below:

Item No.	Diversion Discharge (m^3/s)		Project Cost (million pesos)		
	Mainstream	Floodway	Construction	Compensation	Total
1.	1,400	0	1,255	883	2,783
2.	1,000	400	1,154	699	2,422
3.	800	600	1,067	596	2,179
4.	550	850	912	453	1,795
5.	400	1,000	966	409	1,814

The alignment of improvement works is set to be along the existing river course. The alignment of Jaro Floodway is proposed to be located at the existing drainage channel in the low-land paddy fields. The alignment of La Paz Floodway is designed to assure a smooth flow and minimize impact against the proposed Iloilo Commercial Port Complex.

The design riverbed of Jaro River follows the average existing riverbed. That of the floodway is derived from the elevation at the diversion point, the outlets' sea bottom and the length of the floodway.

A single cross-section is employed for the river improvement works and floodways. A low water channel for the river maintenance flow is provided for Jaro River. The capacity of the low water channel corresponds to the specific discharge of $0.01\ m^3/s/km^2$ and the depth is set at 1.0 m.

Since the diversion point of Jaro Floodway is located near the confluence of the Aganan River and Tigum River, two fixed weirs for the existing river channel and floodway are provided for the stable diversion of flood.

The proposed alignment and typical cross sections are shown in Fig. 4.6 and the proposed longitudinal profiles are also given in Fig. 4.7. The related river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	26,700 m	Jaro River
Revetment	12,750 m	
Diversion Works	2 sites	Jaro & La Paz Floodways
Groundsill	3 sites	
Sluice with Slide Gate	2 sites	
Sluice with Flapgate	10 sites	
Invert Siphon	3 sites	Jaro Floodway
Bridge	2 sites	Reconstruction
Bridge	4 sites	New

(2) Iloilo River

River improvement works, composed mainly of dredging and construction of concrete and/or earth dike, are required. The channel alignment is planned along the existing river course. Both sides of the channel are set along the existing riverbanks.

The Philippine Ports Authority (PPA) has been conducting maintenance dredging works for Iloilo Port from the river mouth to STA. 2+400. Therefore, the design riverbed profile is planned along the existing riverbed and connected to PPA's dredging scheme.

In the urban area along Iloilo River, a concrete dike is employed to minimize land acquisition and house evacuation. Besides, earth dikes are provided at the fishpond area.

The proposed alignment and typical cross sections are shown in Fig. 4.8 and the proposed longitudinal profiles are also given in Fig 4.9. The related river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	3,430 m	For fishpond area
Concrete Dike	4,780 m	For urban area
Revetment	300 m	
Sluice with Flapgate	5 sites	
Bridge Protection Works	1,200 m^2	For 3 bridges

For Mandurriao River, the main tributary of Iloilo River, to minimize land acquisition and house evacuation, the channel alignment is set along the existing river course. The small meandering, however, is stretched from the hydraulic aspect.

The design riverbed elevation at the confluence of Iloilo River is employed as the elevation at the junction, which is 2 m deeper than the existing riverbed.

The proposed alignment and typical cross sections are shown in Fig. 4.10 and the proposed longitudinal profiles are also given in Fig 4.11. As for the related river structures, two (2) sluices with slide gates, two (2) sluices with flapgates and three (3) bridges shall be constructed or reconstructed.

Cebu City

(1) Bulacao River

River improvement is required only to increase flow capacity. The stretch for river improvement of Bulacao River is from the river mouth to Bulacao Bridge (STA. 2+650).

Since there is no big meandering on the existing river course, the channel alignment is planned along the existing river course. Since the land use along Bulacao River is mainly the paddy field, a channel of single cross-section without lining is employed.

The channel alignment and typical cross-section are shown in Fig. 4.12. The design riverbed is set at the average existing riverbed slope. The longitudinal profile is shown in Fig. 4.13. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,400 m	
Revetment	680 m	
Drop	8 sites	
Bridge	1 site	Reconstruction

(2) Kinalumsan River

River improvement is required only to increase flow capacity. The improvement stretch is 4 km from the river mouth to STA. 4+000.

The channel alignment is planned along the existing river course, but the bending point at STA. 1+400 is made smooth. Since land along Kinalumsan River is used mainly as residential area, a lined channel with a side slope of 1:0.5 is employed to minimize land acquisition.

The channel alignment and typical cross-section are shown in Fig. 4.14. The design riverbed is set along the average existing riverbed. Since the velocity along the upper stretch is more than 4 m/s, drops are provided along the stretch. The longitudinal profile is shown in Fig. 4.15. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	8,000 m	
Drop	9 sites	
Bridge	6 sites	Reconstruction

(3) Guadalupe River

River improvement comprises the main works of flood control for Guadalupe River. The stretch for river improvement is from the river mouth to STA. 4+000.

The channel alignment is planned along the existing river course. Since the land along Guadalupe River is used mainly as a high density residential area, revetment with a side slope of 1:0.5 is provided to minimize land acquisition.

The channel alignment and typical cross-section are shown in Fig. 4.16. The design riverbed is set along the average existing riverbed. Some drops are provided to reduce the flow velocity. The longitudinal profile is shown in Fig. 4.17. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	6,400 m	
Drop	3 sites	
Bridge	4 sites	Reconstruction

(4) Lahug River

River improvement is required only to increase flow capacity. The improvement stretch of Lahug River is proposed from the river mouth to STA. 5+000.

The channel alignment is planned along the existing river course. Since the riparian area of Lahug River is used mainly as residential area, revetment with a side slope of 1:0.5 is provided to minimize land acquisition.

The channel alignment and typical cross-section are shown in Fig. 4.18. The design riverbed is set along the average existing riverbed. Some drops are placed to reduce flow velocity. The longitudinal profile is shown in Fig. 4.19. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	8,000 m	
Drop	6 sites	
Bridge	10 sites	Reconstruction

(5) Subang Daku River

River improvement is required only to confine the design flood discharge. The improvement stretch of Subang Daku River is from the river mouth to STA. 5+540.

Channel alignment is planned along the existing river course, while a cut-off channel is adopted at the stretch between STA. 0+300 and STA. 1+590. The length of the cut-off channel is 500 m. Since the riparian area is used mainly as a residential area, revetment with a side slope of 1:0.5 is provided to minimize land acquisition.

The channel alignment and typical cross-section are shown in Fig. 4.20. The design riverbed is set along the average existing riverbed. Some drops are provided to reduce flow velocity. The longitudinal profile is shown in Fig. 4.21. The related river structures are as follows:

River Structure	Dimension/Site	Remarks
Retaining Wall	10,500 m	
Drop	2 sites	
Bridge	8 sites	Reconstruction

<u>Ormoc City</u>

(1) Anilao River

The channel alignment is basically set along the existing river course. A shortcut channel is proposed at the concave portion upstream of Anilao Bridge.

A single cross-section with a maintenance flow channel is employed for Anilao River. Both banks of the main channel are to be protected by revetment from bank erosion because the flow velocity is estimated at more than 3 m/s. The maintenance flow channel is designed to have a flow capacity of 20 m^3/s and a gentle bank slope of 1:5.0. Where the water velocity is estimated to be higher than 4 m/s at the upstream from STA. 0+800, drops are provided along the stretch to reduce water velocity.

In the disastrous flood of 1991, it was reported that the large quantity of floating logs which flowed down with debris increased the flood damage. To stop floating logs, two (2) slit dams are provided upstream of Anilao River.

The proposed alignment and typical cross sections are shown in Fig. 4.22 and the proposed longitudinal profiles are also given in Fig. 4.23. Other than the slit dams, river structures are provided as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,800 m	
Revetment	4,000 m	
Sluice with Flapgate	3 sites	
Drop	3 sites	
Bridge	3 sites	Osmeña Bridge is under construction.

(9) Malbasag River

The channel alignment is basically set along the existing river course, however, to avoid the small meandering in the proposed alignment, a shortcut channel is employed and a projecting ridge is to be removed.

A single cross-section with a maintenance flow channel is employed for Malbasag River. Both banks of the main channel are to be protected from bank erosion by revetment because the flow velocity is estimated to be higher than 3 m/s. At the lower reach from STA. 0+000 to STA. 1+000, a retaining wall is employed to minimize land acquisition and house evacuation. The maintenance flow channel is designed to have a flow capacity of 10 m^3/s and a gentle bank slope of 1:5.0. As countermeasure against floating logs, one (1) slit dam is also proposed upstream of the main river course.

The proposed alignment and typical cross sections are shown in Fig. 4.24 and the proposed longitudinal profiles are also given in Fig. 4.25. Other than one slit dam, the related river structures are as follows:

River Structure	Dimension/Site	Remarks
Earth Dike	1,250 m	
Retaining Wall	2,400 m	
Revetment	1,250 m	
Sluice	4 sites	
Drop	4 sites	
Bridge	2 sites	Reconstruction

4.2.2 Urban Drainage

A single trapezoidal-shaped section with slope protection is typically employed for under-urbanized areas, while a rectangular-shaped section formed by retaining facilities is employed for densely urbanized stretches in consideration of the difficulty of land acquisition and house evacuation/settlement.

The bank slope for a trapezoidal-shaped section takes three gradients, 1:0.5, 1:1 and 1:2, depending on the progress of urbanization. A summary of the cross-section types employed for the Master Plan is shown below.

Type	Shape	Bank Slope	Slope Protection	Land Use
I	Rectangular	Vertical	Retaining Wall	Dense Urban
II	Trapezoidal	1 : 0.5	Lining	Medium Urban
III	Trapezoidal	1 : 1	Lining	Scattered Urban
IV	Trapezoidal	1 : 2	Sodding	Open Space

The total length of drainage channels in the four cities is 38,630 m. The breakdown of improvement works is as follows:

City	Improvement Length (m)	Remarks
Iloilo City	10,020	3 channels
Cebu City	10,850	9 channels
Ormoc City	1,830	2 channels
Tacloban City	15,930	7 channels

The drainage alignments with typical cross-section and longitudinal profile are shown in Figs. 4.26 to 4.46.

City/Structure	Dimension/Site	Remarks
Iloilo City		
Revetment	17,000 m	21,300 m^2
Bridge	1,100 m^2	9 bridges
Cebu City		
Revetment	14,000 m	
Box Culvert	680 m	
Bridge	285 m^2	16 bridges
Ormoc City		
Revetment	3,000 m	
Bridge	174 m^2	10 bridges
Tacloban City		
Revetment	25,000 m	
Bridge	480 m^2	19 bridges