CHAPTER VI

WATER RESOURCES DEVELOPMENT PLANS FOR SELECTED MAJOR CITIES

VI WATER RESOURCES DEVELOPMENT PLANS FOR SELECTED MAJOR CITIES

6.1 General

It was envisaged in the early stage of this study that the shortage of municipal and industrial water would become serious in the future at the three major cities in the Philippines, namely Metro Manila, Metro Cebu and Davao City. From such a viewpoint, the surface water development plans for municipal water supply to Metro Manila, Metro Cebu and Davao City were preliminarily examined in the first study stage.

In the course of the Study, other water-constrained cities which require the urgent expansion of the water supply capacities were selected and examined with respect to the future water supply development projects. As a result, the six (6) cities, namely Baguio, Iloilo, Bacolod, Angeles, Zamboanga and Cagayan de Oro were additionally examined in the present study stage with respect to the water supply and demand balance and necessity of new surface water development to meet the water demand until the year 2025. Besides, the water resources development scenarios for Metro Manila and Metro Cebu are drawn up by combining the existing development plans and those newly identified through this master plan study.

In principle, the surface water resources development plans are examined and formulated for the cities where the water demand in the year 2025 is forecasted to exceed the exploitable groundwater amount in and around the city area. The new surface water development plans are worked out in the present study even in case that the exploitable groundwater amount is by far over the total demand in the year 2025, on the other hand, provided that the promising potentials of surface water resources are identified in the past study.

6.2 Selection of Major Cities from Viewpoint of Future Water-Constraint

For the purpose of selecting the major cities where the constraint in water demand and supply balance is likely to take place in near future, the following factors were adopted to assess the extent:

i) Present groundwater extraction volume
ii) Type of water sources
iii) Population (value in deviation square for the provinces
iv) Population density
v) Ratio of groundwater potential to present water demand
vi) Ratio of groundwater potential to present water demand

In the Philippines, the municipal water supply relies on groundwater service as long as it is exploitable. In case of ii) above, the use of surface water implies the insufficient ground water potential in view of quantity and/or quality to meet the water demand in service area of the water district.

As for each of the above factors, the rating standards were set up as shown in Table b-1. The rating standards give the higher points with increase of extent of the water-constraint. The major cities and municipalities which are provided with the Level-III water supply system are rated in accordance with the rating standards. After then, the total point was calculated for each of those cities and municipalities. The results of the evaluation are shown in Table 6-2 which lists the cities in order of the scored total point. As seen from the Table, the following nine (9) cities are foreseen to encounter significant water-constraint in the near future:

i) Metro Manila
ii) Metro Cebu
iii) Davao City
iv) Baguio City
v) Angeles City
vi) Bacolod City
vii) Iloilo City
viii) Cagayan De Oro City
ix) Zamboanga City

6.3 Water Demand Forecast for Selected 9 Major Cities

The water demand projection for the nine cities selected above was carried out dividing the demand largely into two sectoral demands, namely the municipal and industrial demands. The procedures and methodologies applied to the sectoral water demand forecast are explained in the following paragraphs.

(i) Municipal Water Demand

In estimation of municipal water demand, population served and water demand component according to usage were determined with reference mainly to the collected data from the concerned WDs. However, unit water consumption and NRW ratio were based on the Design Criteria Standard of LWUA, relevant reports and others.

(ii) Industrial Water Demand

Industrial water demand in high economic growth for each city was estimated principally in the same manner with that used for the regional projection, which is explained in the foregoing Section 4.3.

The results of the water demand forecast for the selected 9 cities are shown in Table 6-3 and summarized below:

Water Demand for Selected 9 Major Cities

Year	Metro Manila	Metro Cebu	Davao City	Baguio City	Angeles City	Bacolod City	Iloilo City	Cagayan De Oro City	Zamboanga City
(1) Water Demand in 1995 (MCM)	1,068	59	50	12	11	37	9	29	28
(2) Water Demand in 2025 (MCM)	2,883	342	153	87	31	111	47	98	203
Ratio ((2)/(1))	2.7	5.8	3.1	7.3	2.8	3.0	5.2	3.4	7.3

As seen above, the water demands of the major cities in 2025 are projected to increase to 2 to 3 times of those in 1995, except for Metro Cebu, Baguio, Iloilo and Zamboanga cities in which the considerably high increase of water demand is expected to take place until 2025 because of the high increase of population and service coverage ratio of the public water supply system. Besides, the high growth of industrial water demand is projected in Zamboanga City.

6.4 Estimate of Exploitable Groundwater

6.4.1 *Estimate of Exploitable Groundwater and Future Requirement of Groundwater Supply*

In order to clarify the necessity of new surface water development in the selected 9 Cities, the exploitable groundwater amounts were estimated based on the data and information collected during the field investigation. The procedures and methodologies applied to the estimate are explained in detail in Part-C of the Supporting Report. Concerning the major cities for which the detailed analysis on groundwater potentials was carried out in the previous studies, the exploitable groundwater amounts estimated are adopted in this study. These are Metro Manila, Metro Cebu, Baguio, Metro Iloilo and Davao cities.

Concerning cities other than the above five cities, the exploitable groundwater amounts were estimated by means of two different methods. One is to apply the conventional formulae including the Darcy's formula in case that the hydrogeological data such as the pumping test records and transmissivity values of existing wells are available. The other is to estimate the exploitable groundwater amount from annual rainfall assuming the recharge ratio thereto as well as the recharge area, provided that there are no available data and information for estimating it. Consequently, the exploitable groundwater amounts for the selected major cities were derived as follows:

Exploitable Groundwater for Selected Major Cities

(Unit: MCM/year)

Metro Manila	Metro Cebu	Davao City	Baguio City	Angeles City	Bacolod City	Iloilo City	Cagayan De Oro City	Zamboanga City
191.0	60.1	84.4	14.5	137.3	103.3	79.9	34.3	53.8

6.4.2 Future Requirement of Groundwater Supply

In harmony with the exploitable groundwater amount, the groundwater resources development plans were formulated in consideration of existing BOT schemes and on-going development projects. Besides, the problems on groundwater which include water quality, water level lower and saline water intrusion were considered in preparing the development plans. The development thus formulated are summarized in Table 6-4 and explained below.

(1) Metro Manila

The future demand of municipal water in ex-MWSS service area needs to be met by surface water due to over exploitation of groundwater. It is recommended that the new issuance of the water rights for groundwater extraction be strictly controlled by NWRB.

(2) Metro Cebu

The MCWD stopped developing groundwater exclusively in areas where infiltration wells were available to provide recharge with river water as shown in Figure 6-1. Therefore, the MCWD now plans to develop surface water under the projects such as Mananga Phase-II project in order to cope with the future demand.

(3) Baguio City

The BWD is now implementing the groundwater development and improvement project financed under AusAID (Australian Agency for International Development). According to the BWD, a total of 33 deepwells will be constructed or rehabilitated (existing) up to the year 2000. The total extraction capacity of groundwater would reach its maximum limit.

In addition, the BWD is proceeding to surface water source through a BOT scheme.

(4) Angeles City

a. Deepwell Development

The present maximum groundwater extraction capacity of deepwells was estimated at 51,196 m^3/day or 18.7 MCM/year. Although it is estimated that this capacity will be reduced by 1 % per year due to the deterioration of the existing facilities, the deepwells are expected to produce enough water to meet the projected demand until the year 2009. In Angeles City, groundwater is the only available water source. The result of the existing deepwell evaluation indicates that the shallower deepwell in 100 m deep alluvium fun aquifer is more productive and would be more economical in meeting the projected future demand.

b. Recommended Well Field

In consideration of the well field in the city proper and in the northern part of city, there are problems with regard to the availability of vacant land for deepwell construction and also regarding groundwater quality. Also from the viewpoint of the hydrogeological condition, the belt of spring eyes in the alluvium fan of about 80 to 90 m above sea level is suitable for the future well field. It is located in the area of the highway connecting Angeles City and the municipality of Porac as shown in Figure 6-2. The distance between Angeles City and Porac is approximately 25 km. Considering the minimum distance of 500 m between the neighboring two wells, a maximum of 50 deepwells could be constructed in the future.

c. Deepwell Structure and Production Capacity

The target aquifer for new groundwater development is the alluvium fan deposits with a depth of about 100 m. Based on the existing deepwells, the capacity is be estimated at 39 lps or 2,808 m^3/day by pumping for 20 hours.

d. Construction Cost

Additional 18 deepwells need to be constructed between 2010 and 2025. The cost was estimated at about 96.3 million pesos, inclusive of pump house, submersible pump, transmission pipeline and elevated reservoirs.

(5) Cagayan De Oro City

To meet the future water demand, it is essential to develop surface water for the reason of the limited groundwater potential in the city area.

(6) Zamboanga City

Groundwater in the Zamboanga city area is affected by saline water. Therefore, groundwater, to be diluted by surface water, needs to be developed until its maximum limit in term of quantity and quality. In this respect, desalination of groundwater or seawater might be one of the alternatives to meet the future demand. For future groundwater development, the detailed investigation needs to be carried out.

a. Recommended Well Field

There is no detailed geological map of Zamboanga City and its surround areas. If well fields would be set up in Zamboanga City and/or the municipality of Ayala, the available deepwell area is estimated at about 17.4 km^2, as shown in Figures 6-3 and 6-4. Assuming the distance of deepwell influence at 500 meters, about 60 deepwells could probably be constructed in the future.

b. Deepwell Structure and Production Capacity

The depth of the deepwells to be constructed in the future might be less than 100 m. Their production could be estimated at 1,000 m^3/day. Therefore, a total of 60,000 m^3/day could be available to develop the slightly saline fresh water.

c. Construction Cost

The estimated construction cost is ₱253.2 million, inclusive of reservoirs.

(7) Bacolod City

It is considered possible to exploit sufficient groundwater in the service area in order to meet the future water demand. The ADB report titled as Options for Systems Development; May 1997 recommended the development of two rivers. However, for a domestic water supply system, there is much merit regarding the development of groundwater. They are 1) no WTP is necessary, 2) water is transmitted directly from water source, 3) gravity distribution is available. Groundwater is therefore the preferred source to be developed for domestic water supply purposes.

a. Deepwell Development

For the future demand, it is promising to develop groundwater with deepwells. There are two options to expand the groundwater capacity. One is to expand the well field and the other is to tap a deeper aquifer within the same well field. The deeper aquifer would be in the same geological condition with the shallower aquifer and there might be no interference of the production water level between them.

b. Recommended Well Field

Technically, the plan to use a deeper aquifer is recommended for future groundwater development. Therefore, the new location of the well field is to be identified within the Bacolod City area. Provided that the service area expansion project is formally approved, the well field will be located as shown in Figure 6-5.

c. Deepwell Structure and Production Capacity

According the ADB report and data provided by BACIWA, the new deepwells to expand the well field would have a depth of 150 m or 200 m. The capacity is around 35 lps. For the alternative to tap a deep aquifer, the deepwells would be designed for 300 m or more. The capacity of such deepwells is estimated at 20 to 25 lps.

d. Construction Cost

In case of the well field expansion, the required construction cost until the year 2025 is estimated at ₱307.8 Million. While, in case of the deeper aquifer development, the construction cost is estimated at ₱558.8 Million by the year 2025.

(8) Metro Iloilo

The exploitable groundwater in Metro Iloilo area is sufficient for the future water demand until 2025.

a. Deepwell Development

The total groundwater withdrawal of about 20.1 MCM/year is equivalent to about 25 % of the estimated recoverable groundwater recharge of 79.9 MCM/year within the three river basins, of which only the Tigum is located within the MIWD service area. Consequently, groundwater could provide a significant source of potable water to satisfy a great part of MIWD's future water demand. Therefore, groundwater is selected as the water source for the expansion of the MIWD water supply system in the near future.

b. Recommended Well Field

From the hydrogeological point of view, the most advantageous location for a well field is as far downstream a river basin as possible, along the groundwater contour, to capture most of the groundwater flow generated by recharge in the upstream part of a river basin. However, the main constraint to do this in the MIWD area is the risk of saline water intrusion, which might be caused by the intensive withdrawal of water from deepwells located close to the coast.

The placement of production deepwells at a distance of about six to nine km from the coast in the Oton and San Jose well field emphasizes this point. Therefore, deepwell locations in further inland area will be sought to intercept the greatest part of groundwater flow without causing saline water intrusion as shown in Figure 6-6, which occurs as hydraulic gradient toward the sea is reversed.

c. Deepwell Structure and Production Capacity

In the plain, the water table aquifer consists of unconsolidated alluvium sediments, separated by a semi-confining layer from the main artesian aquifer, which consists of unconsolidated and consolidated sediments. In the upland area, the semi-confining layer is not present, i.e. the water table aquifer which consists of consolidated sediments extends over the entire thickness of the system. The thickness of the different aquifer layers is 140 m.

The capacity of the deepwells to be constructed to meet the future demand is estimated at 20 lps on average.

d. Construction Cost

Sixty-five (65) deepwells and reservoirs with a total capacity of 13,500 m^3 needs to be constructed by the year 2025. The total cost is estimated at ₱335.0 million.

(9) Davao City

Six (6) deepwells are now under construction by the PCWSP-III, which is financed by OECF. In consideration of the industrial water exploitation and water supply BOT schemes for Davao City, the WD had planned their demand and water sources availability until the year 2015. This BOT scheme examined supply surface water at a maximum

230,000 m^3/day (84.0 MCM/year).

6.4.3 Environmental Aspect of Groundwater Development

(1) Piezometric Condition

Metro Manila

For the last twenty years, groundwater storage, which is differential between exploitable value and exploitation, has been unbalanced. Presently, the water level of major aquifers has been lowered five to six meters every year and is now observed more than one hundred meters below sea level as shown in Figure 6-7.

Metro Cebu

The ADB report on groundwater assessment (1996) was provided through the MCWD's "Groundwater Elevation Map, Dec. 1996". Presently, well fields are located within an area three meters above sea level or higher water level zones. The static water levels of 12 deepwells were measured at below sea level, mostly in Mandaue City and Central Cebu City. These groundwater conditions are shown in Figure 6-8.

Zamboanga City

As for the Zamboanga City area, it is necessary to carry out the detailed groundwater investigation in the near future as there is no such information available to plan water resources management at present.

(2) Water Quality

Metro Manila

Saline water intrusion was reported to take place along the seashore belt of Manila Bay, which covers the area of Valenzuela to Cavite City. The groundwater quantity measured by electric conductivity is 3,000 ms/cm or more. Also saline connate water contamination was reported on the northern side of Laguna Bay. This saline water is seawater blockaded by marine deposits of the Tertiary period.

Metro Cebu

According to the MCWD's "Salinity Map, Dec. 1996", the well fields were located within an area of 50 mg/liter or less chloride-ion zones. The highest salinity deepwell was measured at 230 mg/liter in Central Cebu City. The salinity condition of the Cebu well field is shown in Figure 6-9.

Zamboanga City

Even if there was no exploitation of groundwater, seawater probably would have intruded into the seashore belt. Water quality monitoring should be implemented in order to study the requirement for a future desalination plant.

(3) Subsidence

Metro Manila

Ground subsidence has not been reported as yet in the ex-MWSS service areas. However, all the elements that may cause the ground surface to subside are present.

Metro Cebu

Ground subsidence has not been reported as yet in the MCWD area. However, all the elements that may cause the ground surface to subside are present in the area. These might be the lowering of the piezometric water level and the presence of compact clay layers above the aquifers. The implications are that the MCWD must obtain water rights for its long-range requirements from the NWRB and introduce a groundwater and subsidence monitoring and study program for the purpose of environmental impact assessment. These acquired rights must be protected from encroachment by other users.

6.5 Water Resources Development Plans for Municipal Water Supply to Major Cities

6.5.1 Metro Manila, Metro Cebu and Davao City

(1) Shortage of Municipal and Industrial Water in Metro Manila, Metro Cebu and Davao City

It was envisaged in the early stage of this study that the shortage of municipal and industrial water would become serious in the future at the three major cities in the Philippines, namely Metro Manila, Metro Cebu and Davao city.

The municipal and industrial water demand projection including examination on the availability of groundwater resources has clarified that the greater parts of the municipal and industrial water supply at those three cities would have to depend on the surface water in order to meet the future water demand as shown below:

Future Water Demand and That to be Covered by Surface Water in Metro Manila, Metro Cebu and Davao City

Major City/Item		1995	2000	2005	2010	2015	2020	2025
Metro Manila								
Total water demand (MCM/year)		1,068	1,351	1,596	1,928	2,262	2,468	2,883
Groundwater	(MCM/year)	103	102	121	182	263	388	579
Surface water	(MCM/year)	964	1,249	1,475	1,746	1,998	2,079	2,304
	(10^3 m^3/day)	2,641	3,422	4,041	4,784	5,474	5,696	6,313
	(m^3/sec)	30.6	39.6	46.8	55.4	63.4	65.9	73.1
Metro Cebu								
Total water demand (MCM/year)		59	77	115	175	222	279	342
Groundwater	(MCM/year)	46	58	63	64	68	73	82
Surface water	(MCM/year)	-	19	53	111	155	205	261
	(MCM/year)	-	52	144	304	424	562	714
	(m^3/sec)	-	0.6	1.7	3.5	4.9	6.5	8.3
Davao City								
Total water demand (MCM/year)		48	54	58	73	90	114	146
Groundwater	(MCM/year)	48	-	-	-	6	30	62
Surface water	(MCM/year)	-	54	58	73	84	84	84
	(10^3 m^3/day)	-	148	159	200	230	230	230
	(m^3/sec)	-	1.7	1.8	2.3	2.7	2.7	2.7

(2) Surface Water Sources for Metro Manila

In the service area of MWSS, the present groundwater production has exceeded the exploitable ground amount so that the saline water intrusion into groundwater tables is taking place, especially in some areas such as Cavite, Rizal and Pasig.

A large part of municipal and industrial water consumed in the Metro Manila district is now supplied from the surface water resources, mainly from the Angat dam/reservoir. Its amount has reached to 30 m^3/sec. It is estimated that, according to previous study results, the maximum water supply capacity of the Angat dam/reservoir to Metro Manila would be about 35 m^3/sec. Hence, the water demand of Metro Manila would exceed the supply capacity of the Angat dam/reservoir before the year 2000 although even now the habitual interruption of water supply has taken place in the urban area due to the extraordinary lowering of water level of the Angat reservoir. At present, the Umiray-Angat Transbasin project, which is to divert the streamflow of the Umiray river into the Angat reservoir, is under construction with finance of ADB. The project will be completed in 1999/2000. The project will develop the additional water of about 12 m^3/sec for municipal water supply to Metro Manila. The Angat dam and reservoir together with the Umiray Angat Transbasin project could meet the water demand of Metro Manila up to the year 2005.

The total municipal and industrial water demand in the Metro Manila district, which is to be supplied from the surface water, is estimated to reach about 73 m^3/sec in 2025. Thus it is needed to newly develop surface water resources of about 26 m^3/sec in the vicinity of Metro Manila in succession to the Umiray Angat Transbasin project.

The Manila Water Supply III Project was studied and formulated in 1979 in the course of the re-study of the Marikina River Project. The report identified and pre-qualified several alternative development schemes in the vicinity of Metro Manila as listed below:

(i) Marikina river basin (Wawa dam)
(ii) Kaliwa river basin (Laiban dam)
(iii) Kanan river basin (Kanan dam)
(iv) Umiray river basin (Umiray-Angat Transbasin, now under construction as aforesaid)
(v) Pampanga river basin (Ring dike around Candaba swamp)
(vi) Laguna de Bay
(vii) Others

The report recommended that the Laiban rockfill dam on the Kaliwa river be developed as the source of water supply for Metro Manila prior to the Umiray-Angat Transbasin project. The Kaliwa scheme, involves the Laiban rockfill dam with a height of 143 m. In the reservoir area, however, limestone formation is dominant. Thus, the Laiban dam seems to have a geological problem, although its technical viability needs to be verified through detailed geological investigation. The location of the Laiban dam is schematically shown in Figure 6-10 together with the existing and proposed water supply facilities for Metro Manila.

The report also suggested that the Kanan Dam should be developed as the second stage to the Kaliwa scheme and to be linked to the Laiban reservoir. However, since the Umiray-Angat Transbasin project has already been implemented, a promising alternative plan was considered for diverting the water exploited by the Kanan dam to the Angat reservoir through the Umiray river basin. Since the Umiray transbasin tunnel has a capacity to discharge about 30 m^3/sec, it is anticipated that about 18 m^3/sec could be augmented for water supply to Metro Manila with the Kanan dam. Otherwise, the water released from the Kanan dam is planned to be conveyed to Metro Manila through a small concrete weir to be constructed on the Kaliwa river instead of the Laiban dam.

In the WRDP, four (4) dam schemes were identified on the small tributaries of the Pampanga river as shown in Figure 6-11. Their sites are all located on the western hilly region of the watershed of the Angat dam. Out of the four small dams, two dams are recommended to be promising ones as a result of the prefeasibility study thereon in the WRDP. These two dams aim to supply irrigation water to Angat Maasim Rivers Irrigation System (AMRIS) in order to reallocate the water of the Angat reservoir to Metro Manila. The amount of available water from these dams is preliminarily estimated at about 5 m^3/sec. When these dams are realized, it is estimated that an additional mean discharge of about 5 m^3/sec can be reallocated to municipal water supply for metro Manila out of the total discharge released from the Angat reservoir.

Further, it is conceivable to tap the discharge of the Pampanga river after the Casecnan Transbasin project be realized. The Casecnan Transbasin project was formulated to enhance the water supply capacity of the existing Pantabangan dam and reservoir by diverting the discharge of about 35 m^3/sec from the Cagayan river basin.

From this examination, the following projects are taken up as the promising water supply projects to meet the future water demand in Metro Manila:

(i) Construction of two small dams in the tributary basins adjacent to the Angat basin, namely Massim dam and Bayabas dam, which were formulated through the previous WRDP study at a level of prefeasibility. The project is referred to as "the Massim and Bayabas Dam Project" in this study by combining these two dams into one project.

(ii) The Kanan-Umiray Transbasin Project (KUTP)

(iii) The Kanan-Cogeo Water Supply Project

(iv) The Pampanga Water Conveyance Project (PWCP)

Out of the four water supply projects, the latter three (3) water supply projects are newly contemplated through the present master plan study. The three development scenarios are worked out by combining the four water supply projects as well as the Laiban Dam Project (MWSP III) to meet the water demand in the year 2025 as shown in Figures 6-12 to 6-14. Out of the three development scenarios for water supply to Metro Manila, Scenario-1 shown in Figure 6-12 which includes the Kaliwa dam project and Kaliwa-Kanan Transbasin project is similar to the original development plan set up by MWSS in the past. While, the other two development scenarios are established in combination of the above new four projects preliminarily formulated in this study. It is common to these three development scenarios that the Agos river basin inclusive of the Kaliwa and Kanan tributaries of the Agos river is planned to be developed in succession to the completion of the Angat-Umiray transbasin project.

(3) Surface Water Source for Metro Cebu

The municipal and industrial water consumed in the Metro Cebu district is now almost all supplied from the groundwater sources. It amounts to about 1.7 m^3/sec. Although there is one surface water resource developed, Buhisan dam, its supply capacity is negligible at 0.05 m^3/s or 4,000 m^3/day. Exploitation of the groundwater in Metro Cebu district has been already taken beyond its limit.

The Mananga Phase I Project is now under construction on the Mananga river. The project aims to pump up the river-bed water in the aquifer through 15 deep wells. The project comprises a 7.5 m high underground dam, infiltration fields in the upstream river bed of the dam and 15 deep wells. The catchment area at the dam site is 80 km^2. According to the original development plan, water supply capacity of the project is estimated at 33,000 m^3/day or 0.38 m^3/sec. Supply capacity of the Mananga Phase I Project could meet the water demand by around the year 2000. Water demand of the district depending on the surface water will sharply increase after 2000.

For the time being, the Metro Cebu Water District (MWCD) is planning to develop water supply projects and desalination plants as listed below:

i) Mananga Phase II dam
ii) Lusaran Dam
iii) Bohol-Cebu Water Supply Project
iv) Installation of Desalination Plants

In the field investigation, a group of small dams on the southeastern hilly region along the watershed of the Mananga and Cotcot river basins were formulated at a map study level. However, the total supply capacity of the small dams is roughly estimated at 80,000 m^3/day or 0.9 m^3/sec as shown in Table 6-5. They are not so attractive schemes because of their small water supply capacities.

In order to meet the water demand after the year 2000, several schemes with supply capacity of more than 100,000 m^3/day or 1.2 m^3/sec each need to be developed. There are three prospective candidates for the purpose:

- Mananga Phase II dam
- Lusaran Dam
- Heightening of existing Malubog dam

The Mananga Phase II Project is contemplated to be developed at a location about 4 km upstream of the weir site of the Mananga Phase I Project on the Mananga river. The main component of the project is a 90 m high roller compacted concrete gravity type dam. However, the catchment area of 68 km^2 at the dam site is small in comparison with the large-scale dam. The WRC of the University of San Carlos installed several rain gages in and around the Mananga and Lusaran river basins in 1977. The hydrological analysis for the project was performed utilizing these records. It found the mean annual basin rainfall of project area to be 1,770 mm and the annual mean river discharge at the dam site to be 1.40 m^3/sec. The mean annual discharge is equivalent to the specific discharge of 2.06 m^3/sec/100 km^2, corresponding to a runoff coefficient of 36%. The sedimentation rate of 3,700 m^3/km^2/year was adopted for the Mananga Phase II reservoir with reference to the sediment measurement performed for the existing Malubog dam and reservoir located adjacent thereto. However, the dead storage capacity of the reservoir is only 7.4 million m^3, which corresponds to the sediment transport volume for about 30 years, assuming tentatively the horizontal deposition of sediment in the reservoir and a trap efficiency of 100%. The total water supply capacity of the Mananga Phase I and II projects are evaluated to be 123,000 m^3/day or 1.42 m^3/sec.

The Lusaran dam has been studied and proposed for further augmentation of water supply to the Metro Cebu. The initial study on the dam project was carried out in 1997, before the installation of rain gages in the basin. Updating of the hydrological analysis of the scheme needs to be performed in the future. The dam is planned to be of rockfill type dam with a height of 100 m. The catchment area at the dam site is 67 km^2. According to the rainfall record in the basin, the mean annual rainfall is 1,400 mm to 1,500 mm, which is slightly smaller than that of the Mananga basin. According to the principal features of the current study report, the mean annual runoff is 2.05 m^3/sec which is equivalent to 3.06

$m^3/sec/100\ km^2$. The water supply capacity of the Lusaran dam is estimated at 160,000 m^3/day or 1.85 m^3/sec.

The Malubog dam is a privately owned dam located on the Sapan Daku river. At present, the dam is being operated by the mining company, Atlas Consolidated Mining & Development Corporation, for its own use. The dam is of concrete gravity type with a height of 32 m. It covers a catchment area of 69 km^2. The Study Team got the information during the field reconnaissance that the mining company has an intention to supply municipal and industrial water to the Metro Cebu through MCWD in case the dam be heightened with a fund of MCWD. Since the catchment area of Malubog dam is almost same with that of the Mananga phase II dam, it appears that the dam heightening plan is one of the promising water resources development plans to augment the water supply to the Metro Cebu. But there are some problems to heighten the existing Malubog dam, that is, the left abutment ridge of the dam is not so massive and the geological formation of the ridge is the Cebu Formation consisting of limestone. Even if the problems were resolved, possible height of the dam would be about 60 m. About 100,000 m^3/day or 1.16 m^3/sec would be expected from the heightening of the existing Malubog dam. Besides, it is needed to clarify the water quality of the Sapan Baku river, since the river water might be adversely affected by the mining activities.

Even though the above three projects would be realized, the total water supply capacity would be 383,000 m3/day or 4.43 m3/sec. The water supply capacity would meet the water demand by the year 2015.

In addition to the above schemes, the Bohol-Cebu water supply project has been proposed. According to the original plan, about 130,000 m^3/day or 1.5 m^3/sec would be diverted from the Inabanga/Waig river basin on the Bohol island without any dam construction. There is one favorable dam site on the Inabanga/Waig river. That is the Tipolo dam, which is listed in the Survey/Inventory on Water Impounding Reservoirs. The catchment area at the Tipolo dam site is about 500 km^2 and annual basin rainfall is approximated to be around 1,400 mm. Thus, the annual mean runoff at the dam site is roughly estimated at about 8.9 m^3/sec. Though the geological formations at the dam site and reservoir area are not clarified at present, construction of about 60 m high concrete gravity dam or rockfill dam would be possible from the topographic configurations based on 1 to 50,000 scaled topographic maps. The vast reservoir area would be obtained realized in the upstream area. The location of the project is shown in Figure 6-15. Within a reasonable range, an active storage capacity of about 120 million m^3 could be usable. Firm discharge of about 4 m^3/sec would be available. If this firm discharge could be conveyed to Metro Cebu, municipal and industrial water demand of the Metro Cebu district would be secured until the year 2025.

If the Bohol-Cebu water supply project is impossible to implement for some reasons, a possible measure is to build the desalination plants along the coastal line of Metro Cebu. It is reported that the production cost of drinking water from saline water with the plants has lowered to about 1 to 2 US$/m^3 at present through development of new technology.

From this examination, the following water resources projects were studied in order to meet the future water demand in Metro Cebu:

(i) Mananga Phase II Dam Project
(ii) Lusaran Dam Project
(iii) Heightening of existing Malubog Dam
(iv) Bohol-Cebu Water Supply Project including Tipolo Dam Project

It is considered that installation of the desalination plan is an alternative to other three surface water development projects. In addition to the above water supply projects, the master plan study contemplates the following alternatives of those projects:

(v) Malubog-Mananga Transbasin Project (MMTP)
(vi) Lusaran-Pulanbato Transbasin Project (LPTP)

The location and main features of the above water supply projects are discussed in Section D 7.2 "New Water Supply Projects for Metro Cebu" of Part-D of Supporting Report and their locations are illustrated in the corresponding figures in the Part-C. These transbasin projects aim at the augmentation of the originally proposed Mananga Phase II dam and Lusaran dam projects. The three (3) development scenarios are worked out by combining the aforesaid projects as shown in Figures 6-16 to 6-18. Out of those three development scenarios for the Metro Cebu water supply, the Scenario-1 shown in Figure 6-16 is similar to that originally contemplated by the MWCD.

(4) Surface Water Source for Davao City
Municipal and industrial water of Davao city is now supplied from groundwater sources. Main sources of the groundwater for the Davao city are the aquifer of the skirts of Mt. Apo and Mt. Talomo, where more than 30 deep wells have been provided. Only small amount of surface water, 36 litters/sec, is now withdrawn from the Malagos creek, which is a small right tributary of the Davao river. Its intake site is located about 36 km distant from the city.

The Davao City Water District (DCWD) now intends to alter the water resources from groundwater to surface water owing to the fear of contamination of groundwater by pesticide used in the extensive banana and coconut plantations on the skirts of Mt. Talomo and along the Davao river. The sites proposed for the surface water sources are Talomo river and Tamugan river. The Talomo river originates from Mt. Talomo and running in parallel with the Davao river. The Tamugan river is a large right-side tributary of the Davao river. The intake site on the Tamugan river is far from the Davao city, more than 40 km apart. Both the Talomo and Tamugan rivers run on the steep slope of the skirts of Mt. Talomo. DCWD made up their minds to lay a long waterway for water supply to the city. The minimum discharge of the Davao river upstream of the confluence with the Tamugan river is estimated to be over the water demand of Davao city in 2025, which is estimated to be more or less 3 m^3/sec. The water supply project is going to be implemented in a form of BOT.

Main stream of the Davao river from the downstream of the junction of the Tamugan meanders on the plains, where vast plantations are developed. The lower Davao river itself could not be a source for the municipal and industrial water supply to the city.

Municipal and industrial water demand of Davao city is not so big, that is, more or less 3 m^3/sec in the year 2025, though it is a serious problem for DCWD to secure it.

The Davao river is big and is categorized into one of the major rivers of the Philippines. The Davao river should be developed not only for water supply for Davao city, but for multi-purpose schemes including flood control, power generation, municipal water supply and irrigation water supply.

In the Davao river basin, on the other hand, there are some dam sites suitable for large dam construction. The Survey/Inventory on Water Impounding Reservoirs lists two dam schemes on the Davao river, namely Calinan #1 and #2, as shown in Figure 6-19. In the Davao river basin, however, there are some other sites suitable for large dam construction. Although the geological conditions of the dam foundation and reservoir area should be scrutinized in the successive study stages, Davao I, II and IIIR (Calinan #2) dam schemes were formulated as shown in Table 6-5. Out of the three dams, it is expected that the Davao II dam project is developed as a multi-purpose dam.

From the aforesaid consideration, the following two scenarios were contemplated in relation to municipal water supply to Davao city:

i) Water Supply Project in a form of BOT
ii) Development of Davao II Dam Project

The above two development scenarios are depicted in Figures 6-20 and 6-21.

6.5.2 Other Major Cities Selected in View of Constrained Water Supply and Demand Balance

(1) Baguio City

Present Situation

Baguio city is located in the province of Benguet in the Cordillera Region, constituting the mountainous resort area situated north of Metro Manila. It is surrounded by the municipalities of the province. The Baguio Water District (BWD), that is a Government-owned corporation, is responsible for the municipal and industrial water supply to the people residing in its service area. BWD has made the continuous efforts to expand the water supply capacity through implementation of water supply development programs. However, it has not been able to cope with the rapidly expanding population in the service area. It is reported that of the total 21,500 service connection about 80 % are provided with potable water only for four (4) hours thrice a week.

At present, the population of Baguio city is projected to reach about 240 thousand people, increasing at an annual average rate of 4.4 %. Although the city and its surrounding areas suffered from severe damage in 1990 due to the large-scale earthquake, which hit the northern part of the Philippines, the rehabilitation program has been steadily progressed up to date. As a result, it is said that the present number of tourists has restored to the original level recorded before the occurrence of the earthquake. However, some of existing water supply facilities damaged by the earthquake have been left as they were. Based on the present situation of the tourism, it is foreseen that the water demand in the city would increase steadily from now on with the tourism, commercial and industrial development. Therefore, it is considered necessary to formulate the long-term water resources rehabilitation and development plan to cope with the future water demand in Baguio City.

Since no detailed data required to design dams and other facilities were available, the new surface water development plans to meet the future water demand was preliminarily worked out primarily based on the 1 to 50,000 scaled topographic maps.

Existing Rehabilitation and Development Plans of Surface Water Resources

In connection with municipal and industrial water supply to Baguio City, a lot of studies were carried out so far. Out of the water supply projects formulated through those studies, the following rehabilitation and development plans are on-going or intended to be implemented at earlier stage by the BWD in order to increase the water supply capacity for Baguio City:

i) Rehabilitation and expansion of existing water supply facilities including Stage I, Amliang and KM8 reservoir as well as St. Thomas rain basin
ii) Australian Aid Project including rehabilitation of distribution network in the city
iii) Bulk Water Supply Project in a form of BOT

In addition to the on-going and urgent projects above-mentioned, the following water resources development plans were formulated in relation to the municipal and industrial water supply to Baguio City:

iv) Wangal Dam Project
v) Water Conveyance Project from existing Ambuklao Reservoir

The aforesaid projects were explained hereunder and their locations are illustrated in the respective Figures in the Par-D of the Supporting Report.

Rehabilitation and Expansion of Existing Water Supply Facilities

The damaged water supply facilities have hampered the operation of the water supply facilities owned by BWD and brought about the present serious situation. BWD has a strong intention to rehabilitate existing water supply facilities in order to improve the present water supply condition in its service area. Thus, these plans are regarded as the urgent measures and the fundamental conditions to expand the water supply capacity, including rehabilitation of the following facilities:

a. Rehabilitation of Stage I, Amliang and Km8 Reservoir

At present, potable water for residential areas of Baguio city is supplied from Stage I intake and Amliang spring through KM8 reservoir. These two water intake sites lie on a tributary of the Bued river. The surface water off-taken at the Stage I weir site is being conveyed to KM 8 reservoir by gravity, while that taken from the Amliang spring is pumped up to the same. Owing to the earthquake in 1990, these intake facilities had been much deteriorated. Under the present condition, it is approximated that the Stage I and Amliang yield 5,400 m^3/day. It is expected that the maximum water production capacity of Stage I and Amliang would increase to 14,600 m^3/day after the completion of the rehabilitation works. The locations of the Stage I, Amilong and KM 8 are shown in Figure 6-22.

b. Rehabilitation of St. Thomas Rain Basin

The rain basin is located in the elevated area of Mount Kabuyao, north of the aforesaid Stage I and Amliang reservoir. The rain basin is covered by vinyl sheet to avoid seepage loss. At present, the vinyl sheet in the bottom portion is torn by uplift pressure of groundwater acting thereon. As long as the 1 to 50,000 scaled topographic map shows, a catchment area covered by the rain basin is as small as less than 1 km^2. According to the BWD office, however, the rain basin contributed to supply of portable water for the residential area not only in the wet season, but also in the dry season. Usually, the rain basin was easily filled up with rainwater in the wet season, enabling to supply portable water for the initial three months of the dry season. The location of the St. Thomas Rain Basin is shown in Figure 6-22.

c. Australian Aid Project (Exploitation of Groundwater)

The Australian aid project comprises construction of 22 wells and rehabilitation of existing 10 wells as well as installation of new distribution pipelines to reduce water loss in the service area of BWD. It is expected that the water supply capacity with groundwater will increase from 25,000 m^3/day to 68,000 m^3/day after the completion of the project. The project is scheduled to be completed in 2000 according to the original plan.

d. Bulk Water Supply Project

The bulk water supply project is now on-going under BWD as of the middle of December 1997. It is going to be implemented in a form of BOT and the BWD is to participate in the consortium. The BWD imposes the basic condition of the BOT as follows:

- Supply capacity : 50,000 m^3/day
- Water charge for initial 5 years : 22 pesos/m^3

In principle, the water exploited by the bulk water supply project is going to be supplied to the existing and planned industrial and commercial areas.

Wangal Dam Project

There exists a small-scale dam on the Wangal river, which was identified in the previous JICA's study. The dam site covers a small catchment area of about 5.5 km^2. The small-scale dam aims to supply irrigation water and domestic water for the La Trinidad City. The Wangal river originates from a watershed extending west of the La Trinidad City located adjacent to Baguio City northward.

The previous report estimates that the domestic water of about 1.824 million m^3/year or 13,000 m^3/day will be exploitable by means of constructing the small-scale dam. The main features of the Wangal dam are as follows:

- Catchment area at damsite : 5.5 (km^2)
- Mean inflow discharge : 0.483 (m^3/sec)
- Dam height : 37 (m)
- Full supply level of reservoir : 1,244 (El. m)
- Minimum operating level of reservoir : 1,222 (El. m)
- Effective storage volume : 2.52 (million m^3)

The Wangal dam project is very promising for the domestic water supply to Baguio City from the geographic position as well as lower water head to pump up for water supply. It is located comparatively near to the service area and the required length of water transmission pipeline is about 8 km in total. The water head to be lifted from the reservoir for water supply to Baguio City is as comparatively small as about 300 m. However, the Wangal dam project is associated with the social and technical issues:

- Resettlement of residents in the proposed reservoir area
- Geological issue such as limestone in the reservoir area.

Water Conveyance Project from Existing Ambuklao Reservoir (Tapping of Water from Ambuklao Dam for the Baguio City Water District)

The feasibility study for the Tapping of Water From Ambuklao Dam for the Baguio City Water District was completed by BECOM, a French Consultant, in July 1995. This project aims to supply the municipal and industrial water by pumping up water stored in the existing Ambuklao reservoir to the Baguio City area. The Ambuklao dam was originally developed for the purpose of hydroelectric power generation. It was commissioned in 1957. The main features of the existing dam are as follows:

- Catchment area at damsite : 686 (km^2)
- Mean inflow discharge : 30.0 (m^3/sec)
- Dam height : 129 (m)
- Full supply level of reservoir : 752.2 (m)

- Minimum operating level of reservoir : 694.0 (m)
- Installed capacity : 75 (MW)

In the project, raw water of the Ambuklao reservoir normally operated between 752.2 m (FSL) and 694 m (MOL) in the surface water level would be pumped up to an impounding reservoir planned to be provided at an elevation of 1,575 m in the Baguio city area. Potable water of 36.51 million m^3 or 100,000 m^3/day would be produced by the project. The main facilities involved in the water conveyance project are as follows:

- Intake structure with three pumps, each having a capacity of 1,800 kW, on right bank of the Ambuklao reservoir
- Water treatment plant on the "Dynamite Hill", located about 300 m distant from the Ambuklao reservoir: Capacity ; 1.00 m^3/sec
- Three booster-pumping stations along pipeline, each of which accommodates five identical pumps. Capacity of one unit for the first and second booster stations is 1,030 kW and 980 kW, respectively. The third station has the similar capacity to the second one.
- Two (2) balancing tanks, each with a capacity of 500 m^3, and impounding reservoir in Baguio city with a capacity of 5,000 m^3
- Transmission pipeline of 27,960 m in total, having a diameter of pipe of 700 and 800 mm

In the feasibility study, the present-day initial investment cost of the project was estimated at 1,270 million Pesos including cost for power facilities including power lines and sub-stations as well as land acquisition cost. The project will have a considerably high operation and maintenance cost attributed to high water head to be lifted, which amounts to about 900 m. The present-day annual O&M cost in 2020 when the project is projected to reach the full stage in terms of the sold water was estimated to be 384.22 million Pesos, which is equivalent to 30.0 % of the initial investment cost. As a result, the feasibility study reveals that the project does not meet the financial criteria of full recovery cost.

Surface Water Development Plan

Examination on the water supply projects found that the following projects will be realized sooner or later.

i) Australian Aid Project
ii) Rehabilitation of Amilang Spring, Stage I and St. Thomas Reservoir
iii) Bulk Water Supply Project in a form of BOT

In the course of the study, the contract of the Bulk Water Supply Project is awarded to the bidder who proposes to supply water of the Laboy river to Baguio City. Furthermore, the intake site is planned to be located adjacent to the existing Laboy bridge. The Study Team was also planning to develop the Laboy river for the purpose of municipal water supply to Baguio City. Since there are no promising surface water resources in and around the Baguio City except for the Laboy river basin, BWD's decision is considered to be reasonable.

After the successful bidder for the BOT schemes was notified, the Study Team contemplated the intensive development of the Laboy river to suffice the water demand of Baguio City in the year 2025. Consequently, it is proposed that the Aboy river water will be utilized effectively for the Bulk Water supply Project and the following two new projects identified in this study:

i) Laboy Dam Project
ii) Laboy Weir and Ponds Project

In case of i) above, however, it is estimated as a result of the water balance study that it could not suffice the water demand of Baguio City until the year 2025. Therefore, the water of existing Ambuklao would need to be pumped up to the Laboy weir site. The two development scenarios for the water supply to Baguio City taking the hydrologic condition into account as shown in Figures 6-23 and 6-24.

(2) Zamboanga City

The municipal water for Zamboanga City is now supplied from the Tumaga river by utilizing the existing intake weir without any seasonal regulation. The maximum intake discharge is small at about 1.0 m^3/sec. On the other hand, the exploitable groundwater is estimated to be about 58.8 MCM/year, which is insufficient for meeting the water demand in the year 2025. The Zamboanga Water District is planning to collect the additional surface water from the nearby small streams, but it is considered that the surface water thereon would not meet the water demand until the year 2025. Therefore, the reservoir type dam project on the Tumaga river has been formulated to meet the water demand of Zamboanga City. It is estimated that the municipal water of about 3.0 m^3/sec could be supplied to the City by providing a reservoir type dam. The development scenario for the municipal water supply to Zamboanga City is depicted in Figure 6-25.

(3) Cagayan De Oro City

The Cagayan De Oro Water District is planning to develop the Cagayan De Oro river in a form of BOT for the municipal water supply. It is informed that the Bulanog-Batang hydroelectric project situated on the upstream reach of the Cagayan De Oro river is to be implemented by NPC. The water source of the BOT project relies on the Cagayan de Oro river whose streamflow is to be seasonally regulated by the upstream reservoir type dam project. The development scenario for the municipal water supply to Cagayan De Oro City is depicted in Figure 6-26.

(4) Angeles, Iloilo and Bacolod Cities

Concerning the cities of Angeles, Iloilo and Bacolod, it is forecasted that the municipal water demand could be sufficed by groundwater resources until the year 2025 as shown in Figures 6-27 to 6-29. Thus, any necessity of surface water development in these cities would not take place until the year 2025.

On the other hand, in case of the Bacolod City, another alternative would be to develop the Bago dam as a multi-purpose project. In the past, the storage type dam project was formulated as a single-purpose dam project for hydropower generation. It is considered that the project needs to be reformulated as the multi-purpose dam project for hydropower and municipal and irrigation water supply. The alternative development scenario for the municipal water supply to Bacolod City is shown in Figure 6-30.

6.6 Preliminary Cost Estimate and Construction Plan

6.6.1 Preliminary Facility Plan

The preliminary facility plans were prepared based on 1 to 50,000 scaled topographic maps for the water supply projects, which are newly proposed in this study. As mentioned above, the majority of water resources development projects had been examined at a study level of prefeasibility or feasibility or definite design. Concerning the projects that are examined in the previous studies, therefore, the preliminary structural plan was not performed in this study.

With regard to municipal water supply to Metro Manila, the following four projects are proposed as the alternative projects in this study:

i) Kanan-Umiray Transbasin Project
ii) Massim Dam and Bayabas Dam
iii) Kaliwa-Cogeo Water Supply Project
iv) Pampanga-Novaliches Water Supply Project

The facility plans of the above projects are depicted in Figures 6-31 to 6-34 and the main features of the proposed structures involved therein are tabulated in Table 6-6.

To cope with the significantly increasing water demands of Metro Cebu, the following projects are preliminarily formulated as the alternative water supply projects in this study:

v) Bohol-Cebu Water Supply Project
vi) Malubog-Mananga Transbasin Project (MMTP)
vii) Lusalan-Pulambato Transbasin Project (LPTP)

Figures 6-35 to 6-37 illustrate the preliminary facilities plans of the above water supply projects and Table 6-7 shows the main features of those water supply projects.

As mentioned above, Baguio city is now in the most critical condition with respect to the water supply and demand balance. To solve the aggravated situation, the following new water supply projects are identified in the Laboy river basin, a tributary basin of the Aguno, in this study:

i) Laboy Dam Water Supply Project

ii) Laboy Weir and Pond Project

These two water supply projects require pumping facilities. Figures 6-38 to 6-43 illustrate the preliminary facilities plans of the above water supply projects and Table 6-8 shows the main features of those water supply projects.

6.6.2 Preliminary Cost Estimate

The preliminary cost estimate was made applying the following procedures:

i) With respect to the dam projects for which the construction costs were estimated through more detailed study in the past, the construction costs were derived by means of escalating the previous estimate with the procedures described in the successive Section 6.7.

ii) The construction costs of the water supply facilities and hydropower facilities, the construction costs were estimated based on the cost formulae prepared with reference to the cost data in the previous studies. Concerning the dam, the dam volume was quantified based on 1 to 50,000 scaled topographic maps and then the construction cost was derived through the application of the cost formula for dam.

iii) Regarding the work items which are not covered by I) and ii) above, the unit price method was used to estimate the construction cost, that is, the constrcution costs were estimated by multiplying the work quantities by unit prices. The work quantities were measures based on 1 to 50,000 scaled topographic maps. While, the unit price was determined with reference to those adopted in the on-going projects.

The construction costs estimated through the above procedures are summarized in Table 6-9. The detail bread-down of the construction costs for the respective work items are compiled in Part-D of Supporting Report.

6.6.3 Construction Schedule

The preliminary construction schedules for the respective water supply projects were set up taking into account the work quantities involved as depicted in Figures 6-44 to 6-54. As seen in those Figures, it is estimated that the total construction period of those projects would be 6 to 7 years, including the period for detailed design.

6.7 Economic Evaluation for Priority Schemes

6.7.1 Basic Conditions

In this master plan study, the economic evaluation was carried out for the proposed water supply projects for the major cities, for which the preliminary design and cost estimate were carried out at a master plan study level. Concerning the storage type dam projects planned to meet the future water demand on a basis of major river basin, it is noted that a prefeasibility and/or feasibility study was made in the previous studies. The following basic conditions were adopted for the economic evaluation of the proposed water supply projects:

(i) All the proposed facilities are completed before the year 2025 and the period for economic evaluation includes the implementation period of construction and project life. The evaluation period is taken at 50 years considering the durable life of the proposed civil structures and those adopted in other similar projects in the Philippines.

(ii) Project benefit is estimated in accordance with the increasing water demand up to 2025.

(iii) The following currency exchange rates in July 1997 are adopted:

US$1.00 = 27.6679 Pesos

1.00 Peso=4.165 yen

The following matters were taken into consideration in determining the currency exchange rates;

a. The latest year of price index for domestic construction materials is 1997. Then, basic year for present price for domestic construction materials was set up at 1997.

b. The year of currency exchange rate for foreign currency portion must coincide with the one for local currency portion. Then, currency exchange rate was adopted for July 1997 as the middle month of the year.

6.7.2 Economic Benefit

(1) Water Resources Development Plan

Public Water Supply

For municipal and industrial water as public water, water supply plans do not contain construction cost of distribution system. then the benefit corresponding to construction cost for distribution system should be deducted from total benefit accrued from the water supply project. The total benefit of each water supply project was estimated based the affordability to pay. This affordability to pay was derived from water consumption per household by taking account of water leakage and water tariff for each water district except Metro Manila. MWSS was privatized in 1997 so that at present the water supply systems of the service area are being operated by the two companies, namely, Maynilad Water Services, Inc. and Manila Water Co. Inc.

On the other hand, new water tariff rates imposed by these two companies are extremely lower than the previous water tariff rates. It appears that these water rates do not necessaily reflect the appropriate market price of public water. It is predicted that their water tariff rates will be raised at least five times in the future taking into consideration that : i) it deems that the two companies could not maintain this low level of rates because their financial situation is already in deficits, ii) the five times of new water tariff rates is executable because the old water tariff rates of MWSS is around four to five times of the new rates. It is considered that the water rates corresponding to five times of present water tariff rates would be affordable for water consumers of Metro Manila.

As for Metro Cebu and Baguio City, the water tariff rates of water districts are not categorized into those for municipal water and industrial water. In this study, the weighted affordability to pay was estimated in consideration of the weight of water demand of municipal and industry for each area. The weighted affordability to pay at a price level of July 1997 is estimated for each of Metro Manila, Metro Cebe and Baguio City as follows;

- Metro Manila	:	8.2 Peso/m^3 (0.296US$/$m^3$)
- Metro Cebu	:	15.9 Peso/m^3 (0.575 US$/$m^3$)
- Baguio City	:	13.5 Peso/m^3 (0.488 US$/$m^3$)

<u>Irrigation Water Supply</u>

The benefit for irrigation project is estimated based on the unit economic value of irrigation benefit expressed in Pesos per hectare, which is standardized with reference to those estimated and adopted in the previous irrigation projects in Philippines. In case of the existing rainfed irrigation area, the benefit for irrigation water supply is derived to be the difference of net values of rice between "with project" and "without project", which are derived by deducing market prices of production cost from farm gate. Concerning the new irrigation area, the annual benefit is derived deducting the annual cost for cultivation land from farm gate price of the products. In the economic evaluation, the Kanan-Umilay Transbasin project is expected to develop new irrigation areas in the downstream low-land area of about 20,000 ha with the surplus water in excess of the diverted water for municipal water supply to Metro Manila. The annual net irrigation benefits at a price level of July 1997 are measured based on the following standardized unit values:

- Annual gross benefit : US$ 979/ha
- Annual production cost : US$ 772/ha
- Economoic capital investment cost for irrigation project : US$2,958/ha
- Annual O & M cost for irrigation facilities : US$29.58/ha (1% of investment cost)

(2) Hydropower Generation

It is difficult to estimate directly the economic benefit of the hydropower project. In general, the economic benefit is estimated by means of the "alternative facility cost method", in which the economic benefit is replaced by the economic cost of the most competitive alternative thermal plant, because the cost of alternative facility will be saved when the project will be implemented. Thus, the economic benefit of hydropower project is composed of initial investment cost and annual O&M cost of the selected thermal power plant, whose unit costs are represented by kW value and kWh values, respectively.

In this study, a hypothetical diesel plant is selected as the most competitive alternative thermal plant to hydropower plant. Based on the data gathered from NPC on the constrction and O&M costs of diesel power plant, the kW and kWh values (capacity value or energy value) and KW value (power value) are determined to be 1,098.2 US$/kW and 0.0403 US$/kWh, respectively.

6.7.3 Economic Cost

Conversion to US$ Equivalent by Escalation Factor

The financial project costs of the proposed projects were converted to US$ equivalent by price escalation factor in accordance with the following procedure:

(i) The financial cost into foreign and local currency portions. Their ratios are simply assumed to 40 % of local currency portion and 60 % of foreign currency portion.

(ii) The local currency portion was converted to constant price in July 1997 with the escalation factor, which is derived to be a weighted average of the following three kinds of indices in the Philippines in consideration of their relative weightnesses:

Index concerned with constr4uction cost	Weighness
- Wholesale price index of construction materials	: 75 %
- Wholesale price of machinery and transport equipment	: 10 %
- Average wages of construction workers	: 15 %

(iii) The present-day project cost of local currency portion escalated to the price level of July 1997 using the annual escalation factors was converted to US$ equivalent with the aforesaid currency exchange rate.

(iv) The foreign currency portion was escalated to the price level of July 1997 converted into US$ equivalent using inflation indices of manufactured exporters (MUV) by G-5 developed countries, which include France, Germany, Japan, UK and USA. After then, the amount was converted into US$ applying the currency exchange rate .

The price escalation factors for local currency portion and foreign currency portion are shown in Tables 6-10 and 6-11.

Basic Assumptions

The present-day project costs of the proposed projects in this study were converted into economic costs by applying the following procedures and assumptions:

(i) The present-day project cost, which excludes price contingency, is estimated at a price level of July 1997.

(ii) The transfer payments are deducted from the financial cost. The items of transfer items are considered to be taxes like VAT (Value Added Tax), sales taxes and payment which are imposed on construction materials and equipment, usually including government subsidy and contractor profit. In this study, it is simply assumed that approximately 20 % of the project cost is equivalent to the transfer payment.

(iii) It is generally accepted that the economic cost of land acquisition is replaced by the land production foregone which would bring about after completion of the project. For instance, the benefit accrued from the reservoir area which is submerged due to creation thereof would be able to be counted as one of the production foregone in case of the dam project. The data to estimate it are not sufficiently available, however, it is assumed that about 50 % of land acquisition cost is equivalent to the economic cost of the land acquisition cost.

6.7.4 Economic Evaluation

Economic evaluation was carried out for each of the newly proposed projects with those procedures and assumptions. The economic viability of those projects were assessed in terms of an internal of rate return (IRR). The cash flow tables for calculating the IRR values are presented in Tables 6-12 to 6-20. The estimated IRR values for the proposed projects are summarized below:

Estimate Economic Internal Rate of Return (EIRR)

(i) Water Supply Project for Metro Manila

Name of Project	1.Kanan-Umiray Transbasin	2. Massim and Bayabas Dam	3. Kaliwa-Cogeo Water Supply	4. Pampanga-Novaliches Water Supply
EIRR	19.7	14.9	13.4	8.2

(ii) Water Supply Project for Metro Cebu

Name of Project	1.Malubog-Mananga Transbasin	2. Lusaran-Pulanbato Transbasin	3. Bohol-Cebu Water Supply
EIRR	12.9	12.5	11.1

(iii) Water Supply Project for Baguio

Name of Project	1.Laboy Dam	2. Laboy Weir and Ponds
EIRR	10.7	3.6

As for most of the proposed water supply projects, as seen in a table above, the IRR values are derived to be more than 12 %. On the other hand, it is noted that the IRR values of the water supply projects for Baguio City become smaller in comparison of those for other cities due to the high operation and maintenance cost, which is attributed mainly to the high electricity cost required for pumping-up of water.

6.8 Proposed Action Plans

It is proposed that the following studies are to be performed in relation to the municipal water supply to Metro Manila, Metro Cebu and Baguio City:

6.8.1 Municipal Water Supply for Metro Manila

The following studies are recommended to be carried out in the successive stage with respect to the water supply to Metro Manila:

- Master plan study on the Agos river basin
- Feasibility study on the priority project(s) selected through the master plan study
- Feasibility study on the Maasim and Bayabas Dam Project

It is generally accepted that the additional municipal water would have to rely on the supply from the Agos river basin consisting two main tributaries, namely, the Kanan and Kaliwa basins, after the completion of the Umiray-Angat transbasin project.

Until now, several reservoir type dam projects were identified in the Kanan and Kaliwa river basins and examined at different study levels. However, no reliable streamflow data are available on the Kaliwa and Kanan rivers, while there exists a stream gauging station on the Agos river. It is strongly recommended to install a stream gauging station on each of these tributaries as soon as possible so as to enable the accurate estimate of their hydrological condition in the proposed master plan stage. In addition, the detailed geological investigation including core drilling at the proposed dam sites on those tributaries needs to be performed in the master plan stage of the next study in order to select the most favorable dam site from the technical aspect. Especially, limestone zone spreads over the reservoir area of the Laiban dam on the Kaliwa dam, which are prioritized for the purpose water supply to Metro Manila in the past study. This implies that the significant seepage might occur after completion of the Laiban dam. Hence, its technical viability needs to be verified through the geological investigation.

It is expected that the Maasim and Bayabas dams, which are originally identified and examined at a level of prefeasibility study for the purpose of irrigation water supply to the downstream paddy fields of the Angat dam, contribute to the augmentation of the municipal water supply capacity of the Angat dam. Therefore, it is recommended that a feasibility study on those dams be carried out in one package.

6.8.2 Municipal Water Supply for Metro Cebu

Field investigations attempted to identify the reservoir type dams on the rivers that drain the comparatively large areas in and around the Metro Cebu area. Consequently, it was found that there are no reservoir type dams with a catchment area of more than 100 km^2 and that most of those identified occupy small catchment areas. In addition, the annual rainfall in these catchments is not in general over 2,000 mm. Thus, the surface water resources in and around the Metro Cebu area are very limited because of its topographic condition as well as climatic condition.

As mentioned above, the present groundwater production exceeded its exploitable capacity. Accordingly, the new water source to meet the rapidly increasing water demand would have to be dependent on surface water sources in the neighboring small river basins. In this respect, it is recommended to carry out the following studies in the successive stage:

- Master plan study on municipal water supply to Metro Cebu, which includes carrying out the prefeasibility study on the specific water supply projects taken up in this master plan. These include:

  a) Lusaran dam project (Update the previous feasibility study)
  b) Malubog-Mananga transbasin project (MMTP)
  c) Lusaran-Pulanbato Transbasin project (LPTP)
  d) Bohol-Cebu Water Supply

- Feasibility study on the priority project(s) selected through the master plan study

6.8.3 Municipal Water Supply for Baguio City

At present, Baguio City suffers from the most aggravated situation in terms of water supply as explained in Subsection 6.5.2. The Baguio City area spreads over a western divide of the Agno river basin with an altitude of 1,000 m to 1,500 m. Although some rivers originate from the city area, they flow down with steep river bed slopes. Due to the topographic condition, the pumping facilities are unexceptionally required to be installed to covey water from downstream intake site on those rivers to the city area, in case that the river water is intended to be utilized for the municipal water supply purpose. Owing to the topographic condition, it is foreseen that the unit water production cost comes to considerably high.

Taking into consideration the high cost required for exploitation of surface water, it might be preferred that the groundwater in the Baguio Water District be developed to the maximum extent and/or the surplus groundwater in the other neighboring Water Districts be supplied to Baguio City, if any. According to the latest information, on the other hand, the groundwater production in wells dug under the on-going project dose not reach the initially expected level. Judging from the present circumstance, it is recommended to carry out the comprehensive study covering the neighboring municipalities such as La Trinidad City where the comparatively large groundwater resources are considered to be still exploitable. In the comprehensive master plan, it is recommended to perform the field investigation and survey on the rehabilitation projects such as Amliang spring, Stage I and St. Thomas Rain Basin so as to examine the necessity of urgent implementation thereof.

It is recommended to carry out the following studies:

- Master plan study on water supply to Baguio City
- Feasibility study on priority project(s) selected through the master plan study
- Examination of urgent rehabilitation projects

Table 6-1 RATING STANDARD FOR SELECTING MAJOR CITIES WITH WATER-CONSTRAINT IN FUTURE

(1) Present groundwater extraction volume

Point	Sphere	Percentage of WD
4	10 MCM/year or more	2.0 %
3	5 MCM/year or more and less than 10 MCM/year	2.5 %
2	3 MCM/year or more and less than 5 MCM/year	1.7 %
1	less than 3 MCM/year	93.8 %

(2) Type of water sources

Point	Sphere	Percentage of WD
4	Only SW was developed	3.5 %
3	SW/GW were developed, & SW was larger than GW	3.7 %
2	SW/GW were developed, & GW was larger than SW	1.5 %
1	Only GW was developed	91.3 %

(3) Population (value in deviation square for the province)

Point	Sphere	Percentage of WD
4	10 or more	0.7 %
3	5 or more & less than 10	1.0 %
2	2 or more & less than 5	8.7 %
1	less than 2	89.6 %

(4) Population density

Point	Sphere	Percentage of WD
2.0	10 or more	0.5 %
1.5	5 or more & less than 10	1.2 %
1.0	2 or more & less than 5	6.0 %
0.5	less than 2	92.3 %

(5) Ratio of groundwater potential to present water demand

Point	Sphere	Percentage of WD
2.0	10% or more	0.5 %
1.5	5% or more & less than 10%	1.5 %
1.0	1% or more & less than 5%	9.5 %
0.5	less than 1%	88.6 %

(6) Ratio of groundwater potential to future water demand

Point	Sphere	Percentage of WD
2.0	10% or more	2.2 %
1.5	5% or more & less than 10%	1.2 %
1.0	1% or more & less than 5%	8.5 %
0.5	less than 1%	88.1 %

Table 6-2 SELECTION OF MAJOR WATER DISTRICTS

WRR	Province	Water District	DW (MCM/year)	P-1	SP (MCM/year)	Q:GW (MCM/year)	Q:SW (MCM/year)	P-2	Q:WD (MCM/year)	S/Area (sq. km)	Pop/S (Persons)	Rainfall (mm/year)	Potential (MCM/year)	Cons.'95 (%)	P-5	Cons.'25	P-6	CWC (lpcd)	Pop.'95 capita	P/sqdev (%)	P-3	PD/sqdev (%)	P-4	Coverage (%)	Total P
4	Metro Manila	MWSS	26.88	4	0.00	26.88	949.10	3	975.98	656.0	7,291,480	1,651	1,057.3	2.59%	1.0	2.59%	1.0	366.72	11,425,000	-	4	-	2.0	65.82%	15.0
7	Cebu	Metro Cebu WD	51.97	4	0.00	51.97	0.67	2	52.64	489.3	300,000	1,585	775.5	6.70%	1.5	6.70%	1.5	480.73	1,157,470	11.016	4	2.393	1.0	25.92%	14.0
3	Pampanga	Angeles City WD	19.05	4	0.00	19.05	0.00	1	19.05	60.3	92,710	1,692	102.0	18.67%	2.0	67.68%	2.0	563.05	234,010	2.147	2	2.992	1.0	39.62%	12.0
10	Misamis Oriental	Cagayan de Oro City WD	26.72	4	1.91	28.63	0.00	1	28.63	412.8	365,100	1,535	633.6	4.52%	1.0	7.14%	1.5	214.83	428,310	9.962	3	2.414	1.0	85.24%	11.5
9	Zamboanga del Sur	Zamboanga City WD	15.49	4	0.00	15.49	8.73	2	24.21	1,414.6	321,000	1,705	2,411.9	0.64%	0.5	0.64%	0.5	206.66	511,140	12.012	4	0.785	0.5	62.80%	11.5
1	Benguet	Baguio City WD	8.24	3	2.54	10.77	0.00	1	10.77	48.9	172,000	3,714	181.6	5.93%	1.5	13.15%	2.0	171.63	226,880	4.874	2	8.276	1.5	75.81%	11.0
11	Davao del Sur	Davao City WD	37.91	4	0.00	37.91	9.86	2	47.76	2,211.3	793,970	2,104	4,652.6	0.81%	0.5	0.81%	0.5	164.81	1,006,840	8.567	3	0.399	0.5	78.86%	10.5
6	Negros Occidental	Bacolod City WD	16.09	4	0.70	16.78	0.00	1	16.78	156.1	130,460	2,757	430.4	3.90%	1.0	9.98%	1.5	352.56	402,350	4.289	2	4.981	1.0	32.42%	10.5
6	Iloilo	Metro Iloilo WD	5.86	3	1.67	7.54	0.00	1	7.54	407.6	113,830	2,357	960.2	0.78%	0.5	2.77%	1.0	181.41	472,590	7.413	3	10.766	2.0	24.09%	10.5
4	Batangas	Batangas City WD	11.83	4	0.00	11.83	0.00	1	11.83	283.0	76,270	1,453	411.2	2.88%	1.0	8.45%	1.5	424.95	211,880	3.343	2	0.203	0.5	36.00%	10.0
4	Cavite	Dasmarinas WD	6.04	3	0.20	6.24	0.00	1	6.24	50.4	151,000	1,526	76.9	8.12%	1.5	20.44%	2.0	113.29	262,410	2.748	2	0.844	0.5	57.54%	10.0
3	Pangasinan	Dagupan City WD	5.35	3	0.00	5.35	0.00	1	5.35	37.2	93,190	1,691	62.9	8.50%	1.5	10.44%	2.0	157.17	126,210	1.781	1	4.588	1.0	73.84%	9.5
8	Leyte	Leyte Metro WD	0.00	1	0.00	0.00	9.51	4	9.51	531.5	177,130	2,282	1,212.9	0.00%	0.5	0.00%	0.5	147.12	314,080	3.761	2	4.431	1.0	56.40%	9.0
4	Laguna	San Pedro WD	2.41	1	0.00	2.41	0.00	1	2.41	22.1	43,840	1,608	35.5	6.79%	1.5	63.66%	2.0	150.80	189,330	2.482	2	6.342	1.5	23.16%	9.0
6	Capiz	Roxas City WD	0.00	1	0.00	0.00	2.34	4	2.34	218.4	45,000	2,572	561.7	0.00%	0.5	0.00%	0.5	142.58	157,840	2.232	2	2.515	1.0	28.51%	9.0
3	Nueva Ecija	Cabanatuan City WD	8.22	3	0.00	8.22	0.00	1	8.22	192.7	151,070	1,738	334.9	2.45%	1.0	1.36%	1.0	149.04	201,030	3.272	2	1.650	0.5	75.15%	8.5
4	Batangas	Lipa City WD	7.01	3	0.31	7.32	0.00	1	7.32	267.9	120,590	1,453	389.3	1.88%	1.0	3.67%	1.0	166.22	222,390	2.647	2	0.365	0.5	54.22%	8.5
3	Pampanga	San Fernando WD	5.44	3	0.00	5.44	0.00	1	5.44	81.2	107,700	1,692	137.4	3.96%	1.0	10.19%	2.0	138.35	193,030	1.596	1	1.445	0.5	55.79%	8.5
4	Laguna	Calamba WD	4.79	2	0.60	5.39	0.00	1	5.39	144.8	74,510	1,608	232.8	2.32%	1.0	14.74%	2.0	198.28	218,950	3.027	2	0.296	0.5	34.03%	8.5
9	Sulu	Jolo Mainland WD	0.00	1	4.45	4.45	0.00	1	4.45	13.5	32,410	1,758	23.7	18.74%	2.0	29.98%	2.0	375.87	76,950	1.583	1	8.273	1.5	42.12%	8.5
12	Lanao del Sur	Marawi City WD	1.66	1	0.00	1.66	0.00	1	1.66	22.6	18,000	1,752	39.6	4.20%	1.0	28.18%	2.0	252.94	114,390	4.605	2	7.233	1.5	15.74%	8.5
10	Surigao del Norte	Metro Surigao WD	0.05	1	0.11	0.16	1.13	3	1.29	245.3	44,550	2,842	697.1	0.02%	0.5	0.02%	0.5	79.19	104,910	5.643	3	1.258	0.5	42.46%	8.5
8	Western Samar	Calbayog City WD	0.00	1	0.00	0.00	0.28	4	0.28	903.0	9,160	2,874	2,595.2	0.00%	0.5	0.00%	0.5	82.86	129,220	4.700	2	-0.104	0.5	7.09%	8.5
3	Tarlac	Tarlac WD	6.50	3	0.00	6.50	0.00	1	6.50	856.5	60,200	1,504	1,288.2	0.50%	0.5	1.06%	1.0	295.68	230,460	3.386	2	-0.558	0.5	26.12%	8.0
5	Camarines Sur	Metro Naga WD	4.31	2	0.96	5.27	0.00	1	5.27	129.5	71,090	2,091	270.8	1.94%	1.0	3.43%	1.0	202.97	162,650	2.297	2	3.050	1.0	43.71%	8.0
8	Western Samar	Catbalogan WD	0.08	1	0.00	0.08	0.57	3	0.65	187.5	18,000	2,874	538.9	0.01%	0.5	0.01%	0.5	98.67	91,810	2.367	2	2.990	1.0	19.61%	8.0
4	Quezon	Quezon Mtero WD	0.00	1	29.57	29.57	0.00	1	29.57	557.8	105,720	2,079	1,159.7	2.55%	1.0	4.19%	1.0	766.17	291,800	3.739	2	7.602	1.5	36.23%	7.5
3	Bataan	Balanga WD	5.33	3	0.00	5.33	0.00	1	5.33	165.6	33,430	2,041	338.0	1.58%	1.0	3.64%	1.0	437.18	60,910	0.487	1	-0.278	0.5	54.88%	7.5
3	Bataan	Mariveles WD	5.04	3	0.00	5.04	0.00	1	5.04	153.9	56,330	2,041	314.1	1.61%	1.0	2.77%	1.0	245.32	76,630	0.871	1	-0.023	0.5	73.51%	7.5
4	Palawan	Pto. Princesa City WD	1.15	1	0.09	1.24	2.48	3	3.72	1,295.0	33,210	1,576	2,040.9	0.06%	0.5	0.06%	0.5	306.68	129,580	3.855	2	0.105	0.5	25.63%	7.5
11	Surigao del Sur	Bislig WD	0.00	1	1.00	1.00	1.31	3	2.31	331.8	44,590	3,759	1,247.2	0.08%	0.5	0.08%	0.5	142.07	103,670	3.180	2	1.774	0.5	43.01%	7.5
10	Bukidnon	Malaybalay WD	0.00	1	0.00	0.00	1.82	4	1.82	835.2	26,520	2,318	1,936.0	0.00%	0.5	0.00%	0.5	188.46	112,280	1.627	1	-0.187	0.5	23.62%	7.5
3	Zambales	Masinloc WD	0.00	1	0.00	0.00	0.89	4	0.89	256.0	12,620	2,029	519.4	0.00%	0.5	0.00%	0.5	192.24	34,940	-0.141	1	-0.476	0.5	36.12%	7.5
4	Oriental Mindoro	Puamalavan WD	0.00	1	0.00	0.00	0.75	4	0.75	277.3	10,140	1,734	480.8	0.00%	0.5	0.00%	0.5	202.47	65,900	0.624	1	0.444	0.5	15.39%	7.5
11	Surigao del Sur	Tandag WD	0.00	1	0.00	0.00	0.43	4	0.43	316.2	11,300	3,759	1,188.6	0.00%	0.5	0.00%	0.5	104.87	39,220	0.581	1	0.102	0.5	28.81%	7.5
4	Quezon	Tagkawayan WD	0.00	1	0.00	0.00	0.34	4	0.34	647.0	7,800	2,079	1,345.1	0.00%	0.5	0.00%	0.5	118.97	40,870	0.090	1	-0.791	0.5	19.08%	7.5
4	Romblon	San Agustin WD	0.00	1	0.00	0.00	0.22	4	0.22	122.4	2,720	1,527	186.9	0.00%	0.5	0.00%	0.5	223.90	20,160	0.401	1	-0.177	0.5	13.49%	7.5
6	Iloilo	Miagao WD	0.00	1	0.00	0.00	0.22	4	0.22	132.9	2,400	2,357	313.2	0.00%	0.5	0.00%	0.5	249.67	52,280	0.315	1	-0.226	0.5	4.59%	7.5
9	Zamboanga del Norte	Dapitan City WD	0.00	1	0.00	0.00	0.19	4	0.19	215.0	2,530	1,893	407.0	0.00%	0.5	0.00%	0.5	204.74	63,000	1.207	1	0.695	0.5	4.02%	7.5
11	Surigao del Sur	Lingig WD	0.00	1	0.00	0.00	0.07	4	0.07	256.9	2,100	3,759	965.7	0.00%	0.5	0.00%	0.5	95.24	23,480	-0.530	1	-0.191	0.5	8.94%	7.5
8	Western Samar	Basey WD	0.00	1	0.00	0.00	0.05	4	0.05	520.1	2,370	2,874	1,494.8	0.00%	0.5	0.00%	0.5	52.32	40,110	0.770	1	-0.518	0.5	5.91%	7.5
6	Iloilo	Ajuy WD	0.00	1	0.00	0.00	0.02	4	0.02	193.4	2,370	2,357	455.8	0.00%	0.5	0.00%	0.5	28.27	38,420	-0.034	1	-0.608	0.5	6.17%	7.5
12	Maguindanao	Cotabato City WD	2.56	1	2.56	5.12	0.00	1	5.12	176.0	103,530	1,449	255.0	2.01%	1.0	2.50%	1.0	135.43	146,780	2.447	2	2.750	1.0	70.53%	7.0
1	Ilocos Norte	Ilocos Norte WD	3.85	2	0.64	4.49	0.00	1	4.49	891.8	67,120	2,771	2,471.2	0.18%	0.5	0.20%	0.5	183.27	187,900	3.210	2	2.546	1.0	35.72%	7.0
7	Negros Oriental	Dumaguete City WD	0.67	1	0.00	0.67	2.96	3	3.63	55.8	71,250	1,573	87.8	0.77%	0.5	0.77%	0.5	139.76	92,640	1.259	1	4.970	1.0	76.91%	7.0
5	Albay	Legaspi City WD	3.69	2	1.13	4.82	0.00	1	4.82	153.7	39,870	2,296	352.9	1.37%	1.0	1.37%	1.0	331.40	141,660	1.536	1	1.244	0.5	28.14%	6.5
3	Bulacan	Baliuag WD	4.06	2	0.00	4.06	0.00	1	4.06	45.0	34,640	2,409	108.4	3.74%	1.0	3.74%	1.0	320.73	103,050	0.386	1	0.671	0.5	33.61%	6.5
1	La Union	Metro La Union WD	2.22	1	0.16	2.37	1.08	2	3.46	504.1	65,340	2,515	1,267.8	0.19%	0.5	0.19%	0.5	144.90	222,050	2.078	2	0.752	0.5	29.43%	6.5
10	Agusan del Norte	Butuan City WD	3.06	2	0.00	3.06	0.00	1	3.06	526.3	80,790	2,304	1,212.6	0.25%	0.5	0.25%	0.5	103.94	247,070	4.763	2	0.890	0.5	32.70%	6.5
4	Cavite	Gen. M. Alvarez WD	1.58	1	0.00	1.58	0.00	1	1.58	13.3	21,230	1,526	20.3	7.77%	1.5	7.77%	1.5	203.49	86,820	0.240	1	1.312	0.5	24.45%	6.5
5	Catanduanes	Virac WD	0.00	1	0.20	0.20	1.01	3	1.21	157.4	25,000	2,671	420.4	0.05%	0.5	0.05%	0.5	132.68	49,910	1.712	1	1.139	0.5	50.09%	6.5
5	Camarines Norte	Paracale WD	0.24	1	0.00	0.24	0.97	3	1.20	194.8	6,090	3,358	654.1	0.04%	0.5	0.04%	0.5	542.06	43,820	0.198	1	-0.232	0.5	13.90%	6.5
4	Gov. Camins, Zambo	Infanta-Gen.Nakar WD	0.00	1	0.31	0.31	0.83	3	1.14	1,477.9	4,040	2,079	3,072.6	0.01%	0.5	0.01%	0.5	769.80	60,890	0.060	1	-0.022	0.5	6.63%	6.5
8	Leyte	Mtero Carigara WD	0.00	1	0.35	0.35	0.61	3	0.96	397.0	18,100	2,282	906.0	0.04%	0.5	0.04%	0.5	144.96	101,390	0.204	1	0.461	0.5	17.85%	6.5
1	Benguet	La Trinidad WD	0.15	1	0.08	0.23	0.36	3	0.59	61.4	18,680	3,214	228.0	0.10%	0.5	0.10%	0.5	86.08	63,000	0.633	1	1.055	0.5	29.61%	6.5

Table 6-3 MUNICIPAL AND INDUSTRIAL WATER DEMAND FOR SELECTED MAJOR CITIES

(1/9) Metro Manila (Unit;MCM/year)

	Municipal (MWSS)	Industrial (Private)	Total
1995	976.0	91.5	1,067.5
2000	1,259.0	91.7	1,350.7
2005	1,480.0	115.9	1,595.9
2010	1,746.0	182.0	1,928.0
2015	1,993.0	268.5	2,261.5
2020	2,074.0	393.5	2,467.5
2025	2,299.0	584.2	2,883.2

(2/9) Metro Cebu (Unit;MCM/year)

	Municipal (MCWD)	Industrial (Private)	Total
1995	40.8	18.2	59.1
2000	58.9	18.3	77.2
2005	92.9	22.5	115.4
2010	151.2	23.4	174.6
2015	194.8	27.6	222.4
2020	245.3	33.3	278.6
2025	300.6	41.6	342.3

(3/9) Davao City (Unit;MCM/year)

	Municipal (DCWD)	Industrial (Private)	Total
1995	48.7	1.6	50.2
2000	54.2	1.5	55.7
2005	58.2	1.8	60.0
2010	72.9	2.5	75.4
2015	90.4	3.3	93.7
2020	113.5	4.5	118.0
2025	146.3	6.2	152.5

(4/9) Baguio City (Unit;MCM/year)

	Municipal (BWD)	Industrial (Private)	Total
1996	12.0	-	12.0
2000	29.4	-	29.4
2005	37.8	-	37.8
2010	50.0	-	50.0
2015	61.1	-	61.1
2020	73.7	-	73.7
2025	87.3	-	87.3

(5/9) Angeles City (Unit;MCM/year)

	Municipal (AWD)	Industrial (Private)	Total
1995	11.1	0.0	11.1
2000	13.0	0.1	13.1
2005	14.7	0.5	15.2
2010	16.5	0.6	17.1
2015	20.2	0.6	20.8
2020	24.3	0.6	24.9
2025	30.6	0.6	31.3

(6/9) Bacolodo City (Unit;MCM/year)

	Municipal (Bacolodo	Industrial (Private)	Total
1995	16.1	20.5	36.6
2000	22.0	20.9	42.9
2005	31.9	28.9	60.8
2010	40.5	32.1	72.6
2015	49.5	34.8	84.3
2020	59.4	36.9	96.3
2025	72.3	38.4	110.7

(7/9) Metro Iloilo (Unit;MCM/year)

	Municipal (MIWD)	Industrial (Private)	Total
1995	7.5	1.5	9.0
2000	28.7	1.5	30.2
2005	31.7	1.8	33.5
2010	33.2	2.0	35.2
2015	37.1	2.1	39.1
2020	40.9	2.2	43.1
2025	44.4	2.2	46.6

(8/9) Cagayan de Oro City (Unit;MCM/year)

	Municipal (CCWD)	Industrial (Private)	Total
1995	28.7	0.5	29.2
2000	47.1	0.5	47.6
2005	58.0	0.6	58.6
2010	72.6	0.6	73.3
2015	84.7	0.9	85.6
2020	93.4	1.3	94.7
2025	96.4	1.9	98.3

(9/9) Zamboanga City (Unit;MCM/year)

	Municipal (ZCWD)	Industrial (Private)	Total
1995	24.2	3.2	27.5
2000	38.5	9.0	47.5
2005	54.7	17.5	72.2
2010	74.4	22.5	96.9
2015	97.9	29.3	127.1
2020	123.7	39.6	163.3
2025	148.0	55.0	203.0

Table 6-4 EXPLOITABLE GROUNDWATER AMOUNT FOR MAJOR CITIES

Service Area	Water Use	Service Level	Source	1995	2000	2005	2010	2015	2020	2025	Remarks
Ex-MWSS:	Municipal	Level III	Demand	976.0	1,259.0	1,480.0	1,746.0	1,993.0	2,074.0	2,299.0	
[illegible]			GW	27.0	25.0	20.0	15.0	10.0	10.0	10.0	no Rehabilitation
[illegible]			SW	949.0	1,234.0	1,460.0	1,731.0	1,983.0	2,064.0	2,289.0	
[illegible]	Industrial	Private	Demand	91.5	91.7	115.9	182.0	268.5	393.5	584.2	
[illegible]	(High GDP)		GW	76.4	76.6	100.8	166.9	253.4	378.4	569.1	Max 181 MCM/year
[illegible]			SW	15.1	15.1	15.1	15.1	15.1	15.1	15.1	Recycle
[illegible]	Total		Demand	1,067.5	1,350.7	1,595.9	1,928.0	2,261.5	2,467.5	2,883.2	
[illegible]			GW	103.4	101.6	120.8	181.9	263.4	388.4	579.1	GPL: 141 MCM/year
			SW	964.1	1,249.1	1,475.1	1,746.1	1,998.1	2,079.1	2,304.1	
Metro Cebu WD	Municipal	Level-III	Demand	40.8	58.9	92.9	151.2	194.8	245.3	300.6	
			GW	40.8	52.9	52.9	52.9	52.9	52.9	52.9	
			SW	0.0	6.0	40.0	98.3	141.9	192.4	247.7	
	Industrial	Private	Demand	18.2	18.3	22.5	23.4	27.6	33.3	41.6	
	(High GDP)		GW	5.5	5.5	9.8	10.7	14.9	20.6	28.9	Max 7.2 MCM/year
			SW	12.7	12.7	12.7	12.7	12.7	12.7	12.7	Recycle
	Total		Demand	59.1	77.2	115.4	174.6	222.4	278.6	342.3	
			GW	46.3	58.4	62.7	63.5	67.7	73.4	81.8	GPL: 60.1 MCM/year
			SW	12.7	18.8	52.7	111.0	154.7	205.2	260.5	
Angeles City WD	Municipal	Level-III	Demand	11.1	13.0	14.7	16.5	20.2	24.3	30.6	
			GW	11.1	13.0	14.7	16.5	20.2	24.3	30.6	Capa.=13.6 MCM/year
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(year 2025)
	Industrial	Private	Demand	0.0	0.1	0.5	0.6	0.6	0.6	0.6	
	(High GDP)		GW	0.0	0.1	0.5	0.6	0.6	0.6	0.6	
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Total		Demand	11.1	13.1	15.2	17.1	20.8	24.9	31.3	
			GW	11.1	13.1	15.2	17.1	20.8	24.9	31.3	GPL: 137 MCM/year
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Cagayan de Oro City WD	Municipal	Level III	Demand	28.7	47.1	58.0	72.6	84.7	93.4	96.4	
			GW	28.7	33.8	33.7	33.7	33.4	33.0	32.4	Capa.=34.0 MCM/year
		(BOT=36.5)	SW	0.0	13.3	24.3	39.0	51.3	60.4	64.0	
	Industrial	Private	Demand	0.5	0.5	0.6	0.6	0.9	1.3	1.9	
	(High GDP)		GW	0.5	0.5	0.6	0.6	0.9	1.3	1.9	
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Total		Demand	29.2	47.6	58.6	73.3	85.6	94.7	98.3	
			GW	29.2	34.3	34.3	34.3	34.3	34.3	34.3	GPL: 34.3 MCM/year
			SW	0.0	13.3	24.3	39.0	51.3	60.4	64.0	
Zamboanga City WD	Municipal	Level-III	Demand	24.2	38.5	54.7	74.4	97.9	123.7	148.0	
			GW	1.0	4.3	20.5	40.2	63.6	89.5	113.8	Desalination
			SW	23.3	34.2	34.2	34.2	34.2	34.2	34.2	(diluted water)
	Industrial	Private	Demand	3.2	9.0	17.5	22.5	29.3	39.6	55.0	
	(High GDP)		GW	1.0	6.8	15.2	20.2	27.0	37.3	52.8	Recycle
			SW	2.2	2.2	2.2	2.2	2.2	2.2	2.2	
	Total		Demand	27.5	47.5	72.2	96.9	127.1	163.3	203.0	
			GW	2.0	11.1	35.8	60.4	90.7	126.8	166.5	GPL: 53.8 MCM/year
			SW	25.5	36.5	36.5	36.5	36.5	36.5	36.5	
Baguio City WD	Municipal	Level III	Demand	12.0	29.4	37.8	50.0	61.1	73.7	87.3	
		(Aus: 2.57)	GW	12.0	14.5	14.5	14.5	14.5	14.5	14.5	
		(BOT=38.3)	SW	0.0	14.9	23.3	35.6	46.6	59.2	72.9	
	Industrial	Private	Demand	0.0	0.0	0.0	0.0	0.0	0.0	0.0	supplied by BWD
	(High GDP)		GW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Total		Demand	12.0	29.4	37.8	50.0	61.1	73.7	87.3	
			GW	12.0	14.5	14.5	14.5	14.5	14.5	14.5	GPL: 14.5 MCM/year
	Gov. Camins, Zambo. City		SW	0.0	14.9	23.3	35.6	46.6	59.2	72.9	
Bacolod City WD	Municipal	Level-III	Demand	16.1	22.0	31.9	40.5	49.5	59.4	72.3	
		(add; 9.9)	GW	16.1	22.0	31.9	40.5	49.5	59.4	72.3	deeper aquifer
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Bago River ?
	Industrial	Private	Demand	20.5	20.9	28.9	32.1	34.8	36.9	38.4	
	(High GDP)		GW	20.5	20.9	28.9	32.1	34.8	36.9	38.4	Recycle
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Total		Demand	36.6	42.9	60.8	72.6	84.3	96.3	110.7	
			GW	36.6	42.9	60.8	72.6	84.3	96.3	110.7	GPL: 103.3 MCM/year
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Metro Iloilo WD	Municipal	Level-III	Demand	7.5	28.7	31.7	33.2	37.1	40.9	44.4	
			GW	0.2	21.3	24.3	25.9	29.7	33.6	37.1	
			SW	7.3	7.3	7.3	7.3	7.3	7.3	7.3	
	Industrial	Private	Demand	1.5	1.5	1.8	2.0	2.1	2.2	2.2	
	(High GDP)		GW	0.9	0.9	1.2	1.4	1.5	1.6	1.6	
			SW	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
	Total		Demand	9.0	30.2	33.5	35.2	39.1	43.1	46.6	
			GW	1.1	22.2	25.6	27.3	31.2	35.2	38.7	GPL: 79.9 MCM/year
			SW	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
Davao City WD	Municipal	Level-III	Demand	48.7	54.2	58.2	72.9	90.4	113.5	146.3	
		(add: 8.0)	GW	48.7	0.0	0.0	0.0	6.4	29.6	62.4	
		(BOT=84.0)	SW	0.0	54.2	58.2	72.9	84.0	84.0	84.0	
	Industrial	Private	Demand	1.6	1.5	1.8	2.5	3.3	4.5	6.2	
	(High GDP)		GW	1.6	1.5	1.8	2.5	3.3	4.5	6.2	
			SW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Total		Demand	50.2	55.7	60.0	75.4	93.7	118.0	152.5	
			GW	50.2	1.5	1.8	2.5	9.7	34.1	68.6	GPL: 84.4 MCM/year
			SW	0.0	54.2	58.2	72.9	84.0	84.0	84.0	

Table 6-5 LIST OF THE ALTERNATIVE DAM SITE FOR WATER SUPPLY TO METRO CEBU AND DAVAO CITY

Alternative Site	Catchment Area (km^2)	Proposed Dam Type (m)	Proposed Height (m)	Proposed Crest Length (m)	Effective Volume ($x 10^6 m^3$)	Dead Volume ($x 10^6 m^3$)	Supply Capacity (m^3/day)
For CEBU							
Cebu B (Buhisan Dam) (Existing on 1910)	5.9	Concrete Double Arch	26	-	0.26	-	4.000
Malubog Dam	70.0	Rockfill	65	520	47.00	21.0	123.600
Mananga II Dam	68.0	Rockfill	90	240	41.0	7.0	120.400
Lusaran Dam	67.0	Rockfill	100	315	116.0	10.0	36.000
Cebu Fo (Pulambato Dam	21.0	Rockfill	55	300	2.0	1.0	177.400
Tipolo Dam	500.0	Rockfill	60	300	120.0	90.0	259.000
						Total	720.400
For DAVAO							
Davao I	367	Rockfill	75	400	150	180	
Davao II	820	Rockfill	112	350	264	172	
Davao IIIR	163	Rockfill	132	430	56	55	

Table 6-6 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO MANILA (1/3)

Item Number Name of City/ Project/ Structure	Conditions
Metro Manila	
1 - 1 Kanan-Umiray Transbasin Project (KUTP Scenario-2)	
(Kanan Dam)	
- Type of Dam	: Rockfill (2,200,000m^3)
- Height of Dam	: 157.7m
- Length of Dam	: 430m
- Crest Elevation	: 317.7m
- Storage Volume	: 1,526 x 10^{6}m^3(gross)
(Diversion Tunnel)	
- Type of Tunnel	: Pressure
- length of Tunnel	: 1,000m
- Diameter of Tunnel	: 5m
(Intake Shaft)	
- Diameter of Shaft	: 3.5m
- Height of Shaft	: 60m
- **(Surge Tank)**	
- Diameter	: 20m
- Height	: 55m
(Hi-pressure Tunnel)	
- Diameter	: 3m
- Length	: 170m
(Powerhouse)	
- Generating Capacity	: 90,000kW
- Number of Unit	: 2nos
(Water Conveyance Tunnel)	
- Design Discharge	: 18m^3/sec
- Type of Tunnel	: Circular
- Diameter of Tunnel	: 3.2m
- Length of Tunnel	: 14km
(Inspection Tunnel)	
- Width and Height	: 2.5m(w) x 2.0m(h)
- Length	: 40m
(Follow Jet Valve)	
- Design discharge	: 18m^3/sec
- Diameter	: 2m
- Numbers	: 1nos
(Access Road)	
- Length	25,000m

Item Number Name of City/ Project/ Structure	Conditions
Metro Manila	
1 - 2 Kanan-Umiray Transbasin Project (KUTP Scenario-3)	
(Kanan Dam)	
- Type of Dam	: Rockfill (2,200,000m^3)
- Height of Dam	: 157.7m
- Length of Dam	: 430m
- Crest Elevation	: 317.7m
- Storage Volume	: 1,526 x 10^{6}m^3 (Gross)
Diversion Tunnel(Hi-pressure Tunnel)	
- Type of Tunnel	: Pressure
- Length of Tunnel	: 800m
- Diameter of Tunnel	: 5m to 3.5m
(Inteke Gate Shaft)	
- Type	: Vertical Shaft
- Height of Gate	: 3.5m
- Width of Gate	: 3.5m
- Design Discharge	: 17m^3/sec
(Power Station)	
- Generating capacity	: 21,000kW
- Number of Unit	: 1
Water Conveyance Tunnel to Umiray	
- Design Discharge	: 18m^3/sec
- Diameter	3.2m
- Numbers	: 1
- Length	: 14km
Water Conveyance Tunnel(Headrace tunnel)	
- Type of Tunnel	: Pressure
- Diameter of Tunnel	: 2m
- Design Discharge	: 5m^3/sec
- Length of Tunnel	: 20km
(Surge Tank)	
- Height of Shaft	: 60
- Diameter of Shaft	: 15m
(Hi-pressure Tunnel)	
- Length of Tunnel	: 120m
- Diameter of Tunnel	: 3m to 2m
(Kanan- Kaliwa Power Station)	
- Generating Capacity	3,900kW
- Number of Unit	: 1
(Access Road)	
- Length	50,000m

Table 6.6 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO MANILA (2/3)

Item Number Name of City/ Project/ Structure	Conditions
Metro Manila	
2 - 1 Maasim Dam Project	
(Maasim Dam)	
- Type of Dam	: Rockfill (2,402,400m^3)
- Height of Dam	: 52m
- Length of Dam	: 1,400m
- Crest Elevation	: 87m
- Storage Volume	: 100 x $10^6 m^3$ (Active)
- Design Discharge	: 3.05 m^3/sec
(Diversion Tunnel)	
- Type	: Pressure
- Diameter	: 5.0m
- Length	: 300m
(Hi-pressure Tunnel)	
- Diameter	: 1.2m
- Length	: 300m
(Powerhouse)	
- Installed Capacity	: 4,500kW
(Access Road)	
- Length	: 3,000m
2 - 2 Bayabas Dam Project	
(Bayabas Dam)	
- Type of Dam	: Rockfill (8,500,000m^3)
- Height of Dam	: 107m
- Length of Dam	: 620m
- Crest Elevation	: 197m
- Storage Volume	: 148 x $10^6 m^3$ (Active)
- Design Discharge	: 1.95 m^3/sec
(Diversion Tunnel)	
- Type	: Pressure
- Diameter	: 5.0m
- Length	: 500m
(Hi-pressure Tunnel)	
- Diameter	: 1.0m
- Length	: 550m
(Powerhouse)	
- Installed Capacity	: 7,600kW
(Access Road)	
- Length	: 5,000m

Item Number Name of City/ Project/ Structure	Conditions
3 Kaliwa-Cogeo Water Supply Project	
(Kaliwa Gated weir)	
- Type of Weir	: Concrete Gated Weir
- Height of Weir	: 35m
- Length of Weir	: 350m
- Crest Elevation	: 212m
(Intake)	
- Design Discharge	: 7.5m^3/sec
- Height of inlet	: 2.6m
- Width of Inlet	: 2.6m
(Water Conveyance Tunnel)	
- Type of Tunnel	: Non-pressure
- Length of Tunnel	: 14km
- Diameter of Tunnel	: 2.6m
(Water Pond)	
- Width of Pond	: 180m
- Height of Pond	: 180m
- Depth of Pond	: 10m
(Desanding Basin)	
- Width of Basin	: 10m
- Depth of Basin	: 5m(means)
- Length of Basin	: 70m
(Main Pumping Station)	
- Pump Capacity	: 13,800kW
- Numbers	: 3
(Booster Station)	
- Numbers	: 4
(Water Supply Pipe Line)	
- Length of Pipe Line	: 11km
- Diameter of Pipe Line	: 1.2m
(Water Treatment Plant)	
- Storage Volume	: 216,000m^3 (7.5m^3/sec x 8^{hrs})
(Regulating reservoir)	
- Storage Volume	: 650,000m^3/day
(Access Road)	
- Length	: 2,000m

Table 6-6 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO MANILA (3/3)

Item Number Name of City/ Project/ Structure	Conditions	Item Number Name of City/ Project/ Structure	Conditions

Metro Manila

4 Pampanga-Novaliches Transbasin Project

(Gated weir)

- Type : Concrete Gated Weir (11,500m^3)
- Height of Weir : 10m
- Length of Weir : 300m
- Crest Elevation : 18m

(Intake)

- Design Discharge : 7.5m^3/sec
- Dimension : 3.6$m^{(w)}$ x 3$m^{(h)}$ x2^{Lane}

(desanding Basin)

- Width of Basin : 10m
- Depth of Basin : 5m (means)
- Length of Basin : 70m

(Main Pumping Station)

- Pump capacity : 9,200kW
- Numbers : 3

(Booster Station)

- Numbers : 15

(Water Supply Pipe Line, Water Treatment Plant and Reservoir)

- Length of Pipe Line : 65km
- Diameter of Pipe Line : 1.8m
- Storage Volume of WTP : 216,000m^3 (7.5m^3/sec x 8^{hrs})
- Reservoir (to be extended or newly construction)

(Access Road)

- Length : 5,000m

Table 6-7 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO CEBU (1/3)

Item Number Name of City/ Project/ Structure	Conditions	Item Number Name of City/ Project/ Structure	Conditions

Metro Cebu

1 - 1 Bohol-Cebu Water Supply Project

(Inabangan-I Gated Weir)
- Type of Weir : Concrete Gated Weir ($30,800m^3$)
- Height of Dam : 10m
- Length of Dam : 150m
- Crest Elevation : 18m

(Intake and desanding Basin)
- Design Discharge : 1st Stage = $1.5m^3$/sec
- Width of Basin : 5m
- Depth of Basin : 5m (means)
- Length of Basin : 40m

(Water Treatment Plant)
- Storage Volume 1st S : $130,000m^3$/day

(Main Pumping Station)
- Pump Capacity : 1,300kW
- Design discharge : 1.5m3/sec (1st: $1.5m^3$/sec, 2nd: $3.01m^3$/sec Total = 4.51m3/sec)
- Numbers : 3

(Water Conveyance Pipe Line)
- Length of Pipe Line : 31.5km
- Diameter of Pipe Line : 1.4m
- Numbers(Lane) : 1

(Regulating reservoir)

Storage Volume : $300,000m^3$

(Access Road))
- Length : 4,000m

1 - 2 Tipolo Dam Project

(Tipolo Dam)
- Type of Dam : Rockfill ($694,000m^3$)
- Height of Dam : 40m
- Length of Dam : 300m
- Crest Elevation : 80m
- Storage Volume : $210 \times 10^6m^3$ (Gross)

(Diversion Tunnel)
- Type of Tunnel : Pressure
- Length of Tunnel : 100m
- Diameter of Tunnel : 5m

(Intake)
- Design Discharge 2nd Stage : $3.01\ m^3$/sec
- Height : 1.5m
- Width : 1.6m

(Hi-pressure Tunnel)
- Length of Conduit : 70m
- Diameter : 2.1m

(Power Station)
- Generating Capacity : 11,000kW
- Number of Unit : 1

(Water Treatment Plant)

<Extension>
- Storage Volume 2nd Stage : $259,000m^3$/day

(Main Pumping Station)
- Pump Capacity : 2,600kW
- Numbers : 3

(Access Road))
- Length : 12,000m

Metro Cebu

2. Malubog-Mananga Transbasin project (MMTP)

2 - 1 Malubog Dam Project

Malubog Dam(Main)
- Type of Dam : Rockfill ($3,411,200m^3$)
- Height of Dam : 65m
- Length of Dam : 520m
- Crest Elevation : 185m
- Storage Volume : $81 \times 10^6m^3$ (Gross)

(Saddle Dam)
- Type of Dam : Rockfill ($312,000m^3$)
- Height of Dam : 10m (means)
- Length of Dam : 1,500m
- Crest Elevation : 185m
- Storage Volume : $81 \times 10^6m^3$ (Gross)

(Diversion Tunnel)
- Type of Tunnel : Pressure
- Length of Tunnel : 100m
- Diameter of Tunnel : 5m

(Intake)
- Design Discharge : $1.43m^3$/sec
- Height : 1.3m
- Width : 1.5m

Item Number Name of City/ Project/ Structure	Conditions	Item Number Name of City/ Project/ Structure	Conditions
Hi-pressure Tunnel (Water Conveyance Tunnel)		**(desanding Basin)**	
- Type of Tunnel	: Pressure	- Width of Basin	: 6m
- Length of Tunnel	: 10.5km	- Depth of Basin	: 5m (means)
- Diameter of Tunnel	: 2m	- Length of Basin	: 30m
(Inspection tunnel)		**(Water Treatment Plant)**	
- Height and Width	: 2.5m[H] x 2m[W]	- Storage Volume	: 244,000m^3/day
- Length	: 40m	**(Pump Station)**	
(Powerhouse)		- Pump Capacity	: 800kW
- Installed Capacity	: 2,100kW	- Numbers (nos)	: 3
(Access Road))		**(Regulating Reservoir)**	
- Length	: 7,000m	- Storage Volume	: 300,000m^3
		(Access Road))	
2 - 2 Mananga Dam Project		- Length	: 5,000m
- **(Mananga Dam)**			
- Type of Dam	: Rockfill (2,956,800m^3)	**3. Lusalan-Pulambato Water Supply Project (LPTP)**	
- Height of Dam	: 90m		
- Length of Dam	: 240m	**3 - 1 Lusaran Dam project**	
- Crest Elevation	: 160m		
Storage Volume	: 48.2 x 10^{6}m^3 (Gross)	**(Lusalan Dam)**	
- **(Diversion Tunnel)**		- Type of Dam	: Rockfill (4,233,400m^3)
- Type of Tunnel	: Pressure	- Height of Dam	: 100m
- Length of Tunnel	: 170m	- Length of Dam	: 300m
- Diameter of Tunnel	: 5m	- Crest Elevation	: 235m
(Intake)		- Storage Volume	: 126 x 10^{6}m^3 (Gross)
- Design Discharge (1.39m3/sec)	: 2.82m^3/sec	**(Diversion Tunnel)**	
(1.43m^3/sec + 1.3m^3/sec9 = 2.82m^3/sec)		- Type of Tunnel	: Pressure
- Height	: 1.7m	- Diameter of Tunnel	: 5m
- Width	: 2.5m	- Length of Tunnel	: 500m
(Hi-pressure Tunnel and Water Conveyance Tunnel)		**(Intake)**	
- Type of Tunnel	: Pressure	- Type	: Inclined Type
- Length of Tunnel	: 3.5km	- Design Discharge	Normal : 2.05m^3/sec
- Diameter of Tunnel	: 2m		Peak : 8.2m^3/sec
(Intake weir)		**(Headrace Tunnel)**	
- Type of Dam	: Concrete Gravity	- Type of Tunnel	: Non-pressure
- Height of Dam	: 5m	- Diameter	: 2.4m
(Powerhouse)		- Length of Tunnel	: 10km
- Installed Capacity	: 2,800kW	**(Surge Tnak)**	
- Number of Unit	: 2nos	- Height of Shaft	: 100m
(Concrete Weir)		- Diameter of Shaft	: 15m
- Type	: Cocrete Gravity	**(Hi-pressure Tunnel)**	
- Height	: 5m	- Diameter	: 2.0m
- Length	: 50m	- Length	: 550m

Table 6-7 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO CEBU (3/3)

Item Number Name of City/ Project/ Structure	Conditions	Item Number Name of City/ Project/ Structure	Conditions
(Power Station)		**(Water Treatment Plant)**	
· Type of Powerhouse	: Open-air Type	· Storage Volume	: 213,400m^3/day
· Generating Capacity(6hour Peal	: 4,200kW	**(Main Pumping Station)**	
· Number of Unit	: 1	· Pump Capacity	: 600kW
(Access Road))		· Numbers	: 3
· Length	: 8,000m	**(Booster Station)**	
		· Numbers	: 1
3 - 2 Pulambato Dam Project		**(Water Supply Pipe Line)**	
		· Length of Pipe Line	: 3.8km
· **(Pulambato Dam)**		· Diameter of Pipe Line	: 1m
· Type of Dam	: Rockfill (1,274,200m^3)	· Numbers(Lane)	: 1
· Height of Dam	: 55m	**(Regulating reservoir)**	
· Length of Dam	: 300m	· Storage Volume	: 300,000m^3
· Crest Elevation	: 100m	**(Access Road))**	
Storage Volume	: 5.6 x $10^6 m^3$ (Gross)	· Length	: 8,000m
· **(Diversion Tunnel)**			
· Type of Tunnel	: Pressure		
· Diameter of Tunnel	: 5m		
· Length of Tunnel	: 130m		
· **(Intake)**			
· Type	: Pressure Type		
· Design Discharge(0.416m3/sec	: 2.47m^3/sec (Total)		
· Height	: 1.5m		
Width	: 2.5m		
(Hi-pressure Tunnel)			
· Diameter	: 2m		
· Length	: 100m		
(Power Station)			
· Type	: Open-air Type		
· Installed Capacity (12hour Pea	: 1,600kW		
· Number of Unit	: 1		
· **(Intake weir)**			
· Type of Dam	: Concrete Gated Weir (700m^3)		
· Height of Dam	: 10m		
· Length of Dam	: 80m		
(Desanding Basin)			
· Width of Basin	: 6m		
· Depth of Basin	: 5m(mean)		
· Length of Basin	: 30m		

Table 6-8 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR BAGUIO CITY

Item Number Name of City/ Project/ Structure	Conditions	Item Number Name of City/ Project/ Structure	Conditions

Baguio City

1. Laboy Dam Water Supply Project

(Rockfill Dam)		**(Intake)**	: 0.83m^3/sec (mean)
- Type of Dam	: Rockfill (5,290,000m^3)	- Design Discharge	: 2.5m^3/sec (Max)
- Height of Dam	: 75m	- Height of Inlet	: 1.5m
- Length of Dam	: 500m	- Width of Inlet	: 2.5m
- Crest Elevation	: 826m	**(Desanding Basin)**	
- Storage Volume	: 8.6 x 10^{6}m^3 (Gross)	- Width of Basin	: 6m
(Diversion Tunnel)		- Depth of Basin	: 5m (mean)
- Type of Tunnel	: Pressure	- Length of Basin	: 30m
- length of Tunnel	: 370m	- **(Main Pumping Station)**	
- Diameter of Tunnel	: 5m	Pump capacity	: 7,200kW
(Intake)		Numbers	: 3
- Design Discharge	: 2.5m^3/sec	**(Booster Station)**	
- Height	: 1.5m	- Numbers	: 3
- Width	: 2.5m	- **(Water Supply Pipe Line)**	
(Main Pumping Station)		- Length of Pipe Line	: 6.3km
- Installed Capacity	: 20,300kW	- Diameter of Pipe Line	: 0.9m
- Pump Numbers	: 3	Numbers(Lane)	: 1
(Booster Station)		**(Water Treatment Plant)**	: 72,000m^3/day (Min.)
- Numbers	: 4	- Storage Volume	: 216,000m^3/day (Max.)
- **(Water Supply Pipe Line)**		**(Regulating reservoir)**	
- Length of Pipe Line	: 10.3km	- Storage Volume	: 11,000,000m^3
- Diameter of Pipe Line	: 1.1m	**(Access Road))**	
- Numbers(Lane)	: 1	- Length	: 4,000m
(Water Treatment Plant)			
- Storage Volume	: 216,000m^3/day		
(Regulating reservoir)			
- Storage Volume	: 72,000m^3		
(Access Road))			
- Length	: 8,000m		

Baguio City

2. Laboy Weir and Pond Water Supply Project

(Gated Weir)	
- Type of Dam	: Concrete Gated Weir (16,900m^3)
- Height of Dam	: 10m
- Length of Dam	: 300m
- Crest Elevation	: 910m

Table 6-9 SUMMARY OF TOTAL COSTS OF WATER SUPPLY PROJECT FOR MAJOR CITIES

Metro Manila	(Unit: US$)
1. Kanan- Umiray Transbasin Project (KUTP)	
(1 - 1) KUTP (Scenario-2)	253,024,508
(1 - 2) KUTP (Scenario-3)	383,403,019
(2 - 1) Maasim Dam Project	42,871,037
(2 - 2) Bayabas Dam Project	121,977,929
2. Maasim Bayabas Project	164,848,966
3. Kaliwa-Cogeo Water Supply Project	275,620,173
4. Pampanga Water Conveyance Project	396,897,311

Metro Cebu	(Unit: US$)
(1 - 1) Malubog Dam Project	99,583,161
(1 - 2) Mananga-II Dam Project	122,377,573
1. Malubog-Mananga-II Transbasin Project (MMTP)	221,960,734
(2 - 1) Lusaran Dam Project	95,557,859
(2 - 2) Pulambato Dam Project	97,504,773
2. Lusaran-Pulambato Transbasin Project (LPTP)	193,062,632
(3 - 1) Bohol-Cebu Water Supply Project	187,671,275
(3 - 2) Tipolo Dam Project	229,834,650
3. Bohol-Mactan Water Supply Project including Tipolo Dam Project	417,505,925

Baguio City	(Unit: US$)
1. Laboy Dam Water Supply Project	180,866,931
2. Laboy Weir Water Supply Project	151,841,073

Table 6-10 PRICE ESCALATION FACTOR OF CONSTRUCTION MATERIALS FOR FOREIGN CURRENCY PORTION

Year	Index of Unit Value of Manufactured Exports (MUV) *1) (1990=100.0)	Price Escalation Factor in US$ Equivalent for Foreign Currency Portion (1998=1.000)
1976	45.83	2.394
1977	50.34	2.179
1978	57.94	1.893
1979	65.62	1.672
1980	71.97	1.524
1981	72.26	1.518
1982	71.15	1.542
1983	69.53	1.578
1984	68.05	1.612
1985	68.60	1.599
1986	80.87	1.356
1987	88.84	1.235
1988	95.31	1.151
1989	94.65	1.159
1990	100.00	1.097
1991	102.23	1.073
1992	106.64	1.029
1993	106.33	1.032
1994	110.21	0.995
1995	119.20	0.920
1996	114.20	0.961
1997	109.70	1.000

Note : *1) is inflation indices for manufactured exports from G-5 countries.

Data Source: "Commodity Markets and the Developing Countries", A World Bank Business

Table 6-11 PRICE ESCALATION FACTOR OF CONSTRUCTION MATERILAS FOR LOCAL CURRENCY PORTION

Year	Price Escalation Factor in US$ Equivalent for Local Currency Portion	US$ to Peso Rate Escalation Factor	Weighted Average Price Escalation Factor in Peso Equivalent for Local Currency Portion	Weighted Average Price Index (1998=100)			
				Wholesale Price of Construction Materials	Wholesale Price of Machinery & Transport Equipment	Average Wage of Construction Workers	Total
	[(A)x(B)]	(A)	[(B)=1/(F)]	(C)	(D)	(E)	[(F)=(C)+(D)+(E)]
1996	1.883	0.269	7.002	0.117	0.015	0.010	0.143
1977	1.737	0.268	6.493	0.127	0.016	0.011	0.154
1978	1.581	0.266	5.940	0.137	0.018	0.014	0.168
1979	1.297	0.267	4.862	0.171	0.020	0.015	0.206
1980	1.159	0.271	4.269	0.198	0.022	0.014	0.234
1981	1.137	0.286	3.981	0.209	0.025	0.018	0.251
1982	1.181	0.309	3.827	0.212	0.028	0.022	0.261
1983	1.358	0.402	3.382	0.234	0.031	0.030	0.296
1984	1.212	0.604	2.009	0.398	0.049	0.051	0.498
1985	1.249	0.673	1.858	0.416	0.063	0.060	0.538
1986	1.482	0.737	2.011	0.391	0.066	0.040	0.497
1987	1.493	0.743	2.008	0.391	0.070	0.036	0.498
1988	1.429	0.762	1.875	0.411	0.076	0.046	0.533
1989	1.296	0.786	1.650	0.474	0.080	0.053	0.606
1990	1.304	0.879	1.484	0.523	0.088	0.064	0.674
1991	1.284	0.993	1.293	0.606	0.095	0.072	0.773
1992	1.146	0.922	1.242	0.628	0.097	0.080	0.805
1993	1.207	0.980	1.232	0.635	0.099	0.078	0.812
1994	1.104	0.955	1.156	0.666	0.099	0.100	0.865
1995	1.066	0.966	1.104	0.691	0.099	0.115	0.906
1996	0.985	0.948	1.039	0.731	0.100	0.132	0.962
1997	1.000	1.000	1.000	0.750	0.100	0.150	1.000

Data Source : Annual Report, The Consumer Price Index in The Philippines, 1995, NSO

Table 6-12 CASH FLOW OF PROJECT BENEFIT AND COST FOR KANAN-UMIRAY TRANSBASIN PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation (Annual Net Benefit)	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	18.40		18.40					0.0	
-6	18.40		18.40					0.0	
-5	73.61		73.61					0.0	
-4	73.61		73.61					0.0	
-3	92.02		92.02					-13.0	-13.02
-2	55.21		55.21	49.42				-26.0	23.39
-1	36.81		36.81	49.42				-26.0	23.39
1		2.91	2.91		7.94	2.58	100.93	5.5	116.96
2		2.91	2.91		7.94	2.58	100.93	5.5	116.96
3		2.91	2.91		7.94	2.58	100.93	5.5	116.96
4		2.91	2.91		7.94	2.58	100.93	5.5	116.96
5		2.91	2.91		7.94	2.58	100.93	5.5	116.96
6		2.91	2.91		7.94	2.58	100.93	5.5	116.96
7		2.91	2.91		7.94	2.58	100.93	5.5	116.96
8		2.91	2.91		7.94	2.58	100.93	5.5	116.96
9		2.91	2.91		7.94	2.58	100.93	5.5	116.96
10		2.91	2.91		7.94	2.58	100.93	5.5	116.96
11		2.91	2.91		7.94	2.58	100.93	5.5	116.96
12		2.91	2.91		7.94	2.58	100.93	5.5	116.96
13		2.91	2.91		7.94	2.58	100.93	5.5	116.96
14		2.91	2.91		7.94	2.58	100.93	5.5	116.96
15		2.91	2.91		7.94	2.58	100.93	5.5	116.96
16		2.91	2.91		7.94	2.58	100.93	5.5	116.96
17		2.91	2.91		7.94	2.58	100.93	5.5	116.96
18		2.91	2.91		7.94	2.58	100.93	5.5	116.96
19		2.91	2.91		7.94	2.58	100.93	5.5	116.96
20		2.91	2.91		7.94	2.58	100.93	5.5	116.96
21		2.91	2.91		7.94	2.58	100.93	5.5	116.96
22		2.91	2.91		7.94	2.58	100.93	5.5	116.96
23		2.91	2.91		7.94	2.58	100.93	5.5	116.96
24	33.13	2.91	36.04	44.48	7.94	2.58	100.93	5.8	161.69
25	33.13	2.91	36.04	44.48	7.94	2.58	100.93	5.8	161.69
26		2.91	2.91		7.94	2.58	100.93	5.5	116.96
27		2.91	2.91		7.94	2.58	100.93	5.5	116.96
28		2.91	2.91		7.94	2.58	100.93	5.5	116.96
29		2.91	2.91		7.94	2.58	100.93	5.5	116.96
30		2.91	2.91		7.94	2.58	100.93	5.5	116.96
31		2.91	2.91		7.94	2.58	100.93	5.5	116.96
32		2.91	2.91		7.94	2.58	100.93	5.5	116.96
33		2.91	2.91		7.94	2.58	100.93	5.5	116.96
34		2.91	2.91		7.94	2.58	100.93	5.5	116.96
35		2.91	2.91		7.94	2.58	100.93	5.5	116.96
36		2.91	2.91		7.94	2.58	100.93	5.5	116.96
37		2.91	2.91		7.94	2.58	100.93	5.5	116.96
38		2.91	2.91		7.94	2.58	100.93	5.5	116.96
39		2.91	2.91		7.94	2.58	100.93	5.5	116.96
40		2.91	2.91		7.94	2.58	100.93	5.5	116.96
41		2.91	2.91		7.94	2.58	100.93	5.5	116.96
42		2.91	2.91		7.94	2.58	100.93	5.5	116.96
43		2.91	2.91		7.94	2.58	100.93	5.5	116.96

IRR= 19.7%

Table 6-13 CASH FLOW OF PROJECT BENEFIT AND COST FOR MAASIM AND BAYABAS DAM PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	4.75		4.75						0.00
-6	4.75		4.75						0.00
-5	31.65		31.65						0.00
-4	47.48		47.48						0.00
-3	31.65		31.65						0.00
-2	22.16		22.16	4.17					4.17
-1	15.83		15.83	4.17					4.17
1		1.25	1.25		0.67	0.22	33.65	0.00	34.53
2		1.25	1.25		0.67	0.22	33.65	0.00	34.53
3		1.25	1.25		0.67	0.22	33.65	0.00	34.53
4		1.25	1.25		0.67	0.22	33.65	0.00	34.53
5		1.25	1.25		0.67	0.22	33.65	0.00	34.53
6		1.25	1.25		0.67	0.22	33.65	0.00	34.53
7		1.25	1.25		0.67	0.22	33.65	0.00	34.53
8		1.25	1.25		0.67	0.22	33.65	0.00	34.53
9		1.25	1.25		0.67	0.22	33.65	0.00	34.53
10		1.25	1.25		0.67	0.22	33.65	0.00	34.53
11		1.25	1.25		0.67	0.22	33.65	0.00	34.53
12		1.25	1.25		0.67	0.22	33.65	0.00	34.53
13		1.25	1.25		0.67	0.22	33.65	0.00	34.53
14		1.25	1.25		0.67	0.22	33.65	0.00	34.53
15		1.25	1.25		0.67	0.22	33.65	0.00	34.53
16		1.25	1.25		0.67	0.22	33.65	0.00	34.53
17		1.25	1.25		0.67	0.22	33.65	0.00	34.53
18		1.25	1.25		0.67	0.22	33.65	0.00	34.53
19		1.25	1.25		0.67	0.22	33.65	0.00	34.53
20		1.25	1.25		0.67	0.22	33.65	0.00	34.53
21		1.25	1.25		0.67	0.22	33.65	0.00	34.53
22		1.25	1.25		0.67	0.22	33.65	0.00	34.53
23		1.25	1.25		0.67	0.22	33.65	0.00	34.53
24	14.24	1.25	15.50	3.76	0.67	0.22	33.65	0.00	38.29
25	14.24	1.25	15.50	3.76	0.67	0.22	33.65	0.00	38.29
26		1.25	1.25		0.67	0.22	33.65	0.00	34.53
27		1.25	1.25		0.67	0.22	33.65	0.00	34.53
28		1.25	1.25		0.67	0.22	33.65	0.00	34.53
29		1.25	1.25		0.67	0.22	33.65	0.00	34.53
30		1.25	1.25		0.67	0.22	33.65	0.00	34.53
31		1.25	1.25		0.67	0.22	33.65	0.00	34.53
32		1.25	1.25		0.67	0.22	33.65	0.00	34.53
33		1.25	1.25		0.67	0.22	33.65	0.00	34.53
34		1.25	1.25		0.67	0.22	33.65	0.00	34.53
35		1.25	1.25		0.67	0.22	33.65	0.00	34.53
36		1.25	1.25		0.67	0.22	33.65	0.00	34.53
37		1.25	1.25		0.67	0.22	33.65	0.00	34.53
38		1.25	1.25		0.67	0.22	33.65	0.00	34.53
39		1.25	1.25		0.67	0.22	33.65	0.00	34.53
40		1.25	1.25		0.67	0.22	33.65	0.00	34.53
41		1.25	1.25		0.67	0.22	33.65	0.00	34.53
42		1.25	1.25		0.67	0.22	33.65	0.00	34.53
43		1.25	1.25		0.67	0.22	33.65	0.00	34.53

IRR= 14.9%

Table 6-14 CASHFLOW OF ECONOMIC BENEFIT AND COST FOR KALIWA-COGEO WATER SUPPLY PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	7.94		7.94						0.00
-6	7.94		7.94						0.00
-5	33.07		33.07						0.00
-4	39.69		39.69						0.00
-3	59.53		59.53						0.00
-2	59.53		59.53	0.00					0.00
-1	56.89		56.89	0.00					0.00
1		2.09	2.09		0.00	0.00	49.01	0.00	49.01
2		2.09	2.09		0.00	0.00	49.01	0.00	49.01
3		2.09	2.09		0.00	0.00	49.01	0.00	49.01
4		2.09	2.09		0.00	0.00	49.01	0.00	49.01
5		2.09	2.09		0.00	0.00	49.01	0.00	49.01
6		2.09	2.09		0.00	0.00	49.01	0.00	49.01
7		2.09	2.09		0.00	0.00	49.01	0.00	49.01
8		2.09	2.09		0.00	0.00	49.01	0.00	49.01
9		2.09	2.09		0.00	0.00	49.01	0.00	49.01
10		2.09	2.09		0.00	0.00	49.01	0.00	49.01
11		2.09	2.09		0.00	0.00	49.01	0.00	49.01
12		2.09	2.09		0.00	0.00	49.01	0.00	49.01
13		2.09	2.09		0.00	0.00	49.01	0.00	49.01
14		2.09	2.09		0.00	0.00	49.01	0.00	49.01
15		2.09	2.09		0.00	0.00	49.01	0.00	49.01
16		2.09	2.09		0.00	0.00	49.01	0.00	49.01
17		2.09	2.09		0.00	0.00	49.01	0.00	49.01
18		2.09	2.09		0.00	0.00	49.01	0.00	49.01
19		2.09	2.09		0.00	0.00	49.01	0.00	49.01
20		2.09	2.09		0.00	0.00	49.01	0.00	49.01
21		2.09	2.09		0.00	0.00	49.01	0.00	49.01
22		2.09	2.09		0.00	0.00	49.01	0.00	49.01
23		2.09	2.09		0.00	0.00	49.01	0.00	49.01
24	23.81	2.09	25.91	0.00	0.00	0.00	49.01	0.00	49.01
25	23.81	2.09	25.91	0.00	0.00	0.00	49.01	0.00	49.01
26		2.09	2.09		0.00	0.00	49.01	0.00	49.01
27		2.09	2.09		0.00	0.00	49.01	0.00	49.01
28		2.09	2.09		0.00	0.00	49.01	0.00	49.01
29		2.09	2.09		0.00	0.00	49.01	0.00	49.01
30		2.09	2.09		0.00	0.00	49.01	0.00	49.01
31		2.09	2.09		0.00	0.00	49.01	0.00	49.01
32		2.09	2.09		0.00	0.00	49.01	0.00	49.01
33		2.09	2.09		0.00	0.00	49.01	0.00	49.01
34		2.09	2.09		0.00	0.00	49.01	0.00	49.01
35		2.09	2.09		0.00	0.00	49.01	0.00	49.01
36		2.09	2.09		0.00	0.00	49.01	0.00	49.01
37		2.09	2.09		0.00	0.00	49.01	0.00	49.01
38		2.09	2.09		0.00	0.00	49.01	0.00	49.01
39		2.09	2.09		0.00	0.00	49.01	0.00	49.01
40		2.09	2.09		0.00	0.00	49.01	0.00	49.01
41		2.09	2.09		0.00	0.00	49.01	0.00	49.01
42		2.09	2.09		0.00	0.00	49.01	0.00	49.01
43		2.09	2.09		0.00	0.00	49.01	0.00	49.01

IRR= 13.4%

Table 6-15 CASHFLOW OF ECONOMIC BENEFIT AND COST FOR PAMPANGA-NOVALICHES WATER SUPPLY PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	11.43		11.43						0.00
-6	11.43		11.43						0.00
-5	47.63		47.63						0.00
-4	57.15		57.15						0.00
-3	85.73		85.73						0.00
-2	85.73		85.73	0.00					0.00
-1	81.92		81.92	0.00					0.00
1		3.01	3.01		0.00	0.00	42.06	0.00	42.06
2		3.01	3.01		0.00	0.00	42.06	0.00	42.06
3		3.01	3.01		0.00	0.00	42.06	0.00	42.06
4		3.01	3.01		0.00	0.00	42.06	0.00	42.06
5		3.01	3.01		0.00	0.00	42.06	0.00	42.06
6		3.01	3.01		0.00	0.00	42.06	0.00	42.06
7		3.01	3.01		0.00	0.00	42.06	0.00	42.06
8		3.01	3.01		0.00	0.00	42.06	0.00	42.06
9		3.01	3.01		0.00	0.00	42.06	0.00	42.06
10		3.01	3.01		0.00	0.00	42.06	0.00	42.06
11		3.01	3.01		0.00	0.00	42.06	0.00	42.06
12		3.01	3.01		0.00	0.00	42.06	0.00	42.06
13		3.01	3.01		0.00	0.00	42.06	0.00	42.06
14		3.01	3.01		0.00	0.00	42.06	0.00	42.06
15		3.01	3.01		0.00	0.00	42.06	0.00	42.06
16		3.01	3.01		0.00	0.00	42.06	0.00	42.06
17		3.01	3.01		0.00	0.00	42.06	0.00	42.06
18		3.01	3.01		0.00	0.00	42.06	0.00	42.06
19		3.01	3.01		0.00	0.00	42.06	0.00	42.06
20		3.01	3.01		0.00	0.00	42.06	0.00	42.06
21		3.01	3.01		0.00	0.00	42.06	0.00	42.06
22		3.01	3.01		0.00	0.00	42.06	0.00	42.06
23		3.01	3.01		0.00	0.00	42.06	0.00	42.06
24	34.29	3.01	37.30	0.00	0.00	0.00	42.06	0.00	42.06
25	34.29	3.01	37.30	0.00	0.00	0.00	42.06	0.00	42.06
26		3.01	3.01		0.00	0.00	42.06	0.00	42.06
27		3.01	3.01		0.00	0.00	42.06	0.00	42.06
28		3.01	3.01		0.00	0.00	42.06	0.00	42.06
29		3.01	3.01		0.00	0.00	42.06	0.00	42.06
30		3.01	3.01		0.00	0.00	42.06	0.00	42.06
31		3.01	3.01		0.00	0.00	42.06	0.00	42.06
32		3.01	3.01		0.00	0.00	42.06	0.00	42.06
33		3.01	3.01		0.00	0.00	42.06	0.00	42.06
34		3.01	3.01		0.00	0.00	42.06	0.00	42.06
35		3.01	3.01		0.00	0.00	42.06	0.00	42.06
36		3.01	3.01		0.00	0.00	42.06	0.00	42.06
37		3.01	3.01		0.00	0.00	42.06	0.00	42.06
38		3.01	3.01		0.00	0.00	42.06	0.00	42.06
39		3.01	3.01		0.00	0.00	42.06	0.00	42.06
40		3.01	3.01		0.00	0.00	42.06	0.00	42.06
41		3.01	3.01		0.00	0.00	42.06	0.00	42.06
42		3.01	3.01		0.00	0.00	42.06	0.00	42.06
43		3.01	3.01		0.00	0.00	42.06	0.00	42.06

IRR= 8.2%

Table 6-16 **CASH FLOW OF PROJECT BENEFIT AND COST FOR MALUBOG-MANANGA TRANSBASIN PROJECT**

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	6.37		6.37						0.00
-6	6.37		6.37						0.00
-5	26.54		26.54						0.00
-4	31.85		31.85						0.00
-3	47.78		47.78						0.00
-2	47.78		47.78	2.69					2.69
-1	45.65		45.65	2.69					2.69
1		1.68	1.68		0.68	0.14	35.78	0.00	36.60
2		1.68	1.68		0.68	0.14	35.78	0.00	36.60
3		1.68	1.68		0.68	0.14	35.78	0.00	36.60
4		1.68	1.68		0.68	0.14	35.78	0.00	36.60
5		1.68	1.68		0.68	0.14	35.78	0.00	36.60
6		1.68	1.68		0.68	0.14	35.78	0.00	36.60
7		1.68	1.68		0.68	0.14	35.78	0.00	36.60
8		1.68	1.68		0.68	0.14	35.78	0.00	36.60
9		1.68	1.68		0.68	0.14	35.78	0.00	36.60
10		1.68	1.68		0.68	0.14	35.78	0.00	36.60
11		1.68	1.68		0.68	0.14	35.78	0.00	36.60
12		1.68	1.68		0.68	0.14	35.78	0.00	36.60
13		1.68	1.68		0.68	0.14	35.78	0.00	36.60
14		1.68	1.68		0.68	0.14	35.78	0.00	36.60
15		1.68	1.68		0.68	0.14	35.78	0.00	36.60
16		1.68	1.68		0.68	0.14	35.78	0.00	36.60
17		1.68	1.68		0.68	0.14	35.78	0.00	36.60
18		1.68	1.68		0.68	0.14	35.78	0.00	36.60
19		1.68	1.68		0.68	0.14	35.78	0.00	36.60
20		1.68	1.68		0.68	0.14	35.78	0.00	36.60
21		1.68	1.68		0.68	0.14	35.78	0.00	36.60
22		1.68	1.68		0.68	0.14	35.78	0.00	36.60
23		1.68	1.68		0.68	0.14	35.78	0.00	36.60
24	19.11	1.68	20.79	2.42	0.68	0.14	35.78	0.00	39.02
25	19.11	1.68	20.79	2.42	0.68	0.14	35.78	0.00	39.02
26		1.68	1.68		0.68	0.14	35.78	0.00	36.60
27		1.68	1.68		0.68	0.14	35.78	0.00	36.60
28		1.68	1.68		0.68	0.14	35.78	0.00	36.60
29		1.68	1.68		0.68	0.14	35.78	0.00	36.60
30		1.68	1.68		0.68	0.14	35.78	0.00	36.60
31		1.68	1.68		0.68	0.14	35.78	0.00	36.60
32		1.68	1.68		0.68	0.14	35.78	0.00	36.60
33		1.68	1.68		0.68	0.14	35.78	0.00	36.60
34		1.68	1.68		0.68	0.14	35.78	0.00	36.60
35		1.68	1.68		0.68	0.14	35.78	0.00	36.60
36		1.68	1.68		0.68	0.14	35.78	0.00	36.60
37		1.68	1.68		0.68	0.14	35.78	0.00	36.60
38		1.68	1.68		0.68	0.14	35.78	0.00	36.60
39		1.68	1.68		0.68	0.14	35.78	0.00	36.60
40		1.68	1.68		0.68	0.14	35.78	0.00	36.60
41		1.68	1.68		0.68	0.14	35.78	0.00	36.60
42		1.68	1.68		0.68	0.14	35.78	0.00	36.60
43		1.68	1.68		0.68	0.14	35.78	0.00	36.60

IRR= 12.9%

Table 6-17 CASH FLOW OF PROJECT BENEFIT AND COST FOR LUSARAN-PULANBATO TRANSBASIN PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	4.63		4.63						0.00
-6	4.63		4.63						0.00
-5	27.80		27.80						0.00
-4	55.60		55.60						0.00
-3	46.33		46.33						0.00
-2	27.80		27.80	3.18					3.18
-1	18.53		18.53	3.18					3.18
1		1.47	1.47		0.65	0.17	31.35	0.00	32.17
2		1.47	1.47		0.65	0.17	31.35	0.00	32.17
3		1.47	1.47		0.65	0.17	31.35	0.00	32.17
4		1.47	1.47		0.65	0.17	31.35	0.00	32.17
5		1.47	1.47		0.65	0.17	31.35	0.00	32.17
6		1.47	1.47		0.65	0.17	31.35	0.00	32.17
7		1.47	1.47		0.65	0.17	31.35	0.00	32.17
8		1.47	1.47		0.65	0.17	31.35	0.00	32.17
9		1.47	1.47		0.65	0.17	31.35	0.00	32.17
10		1.47	1.47		0.65	0.17	31.35	0.00	32.17
11		1.47	1.47		0.65	0.17	31.35	0.00	32.17
12		1.47	1.47		0.65	0.17	31.35	0.00	32.17
13		1.47	1.47		0.65	0.17	31.35	0.00	32.17
14		1.47	1.47		0.65	0.17	31.35	0.00	32.17
15		1.47	1.47		0.65	0.17	31.35	0.00	32.17
16		1.47	1.47		0.65	0.17	31.35	0.00	32.17
17		1.47	1.47		0.65	0.17	31.35	0.00	32.17
18		1.47	1.47		0.65	0.17	31.35	0.00	32.17
19		1.47	1.47		0.65	0.17	31.35	0.00	32.17
20		1.47	1.47		0.65	0.17	31.35	0.00	32.17
21		1.47	1.47		0.65	0.17	31.35	0.00	32.17
22		1.47	1.47		0.65	0.17	31.35	0.00	32.17
23		1.47	1.47		0.65	0.17	31.35	0.00	32.17
24	16.68	1.47	18.15	2.87	0.65	0.17	31.35	0.00	35.04
25	16.68	1.47	18.15	2.87	0.65	0.17	31.35	0.00	35.04
26		1.47	1.47		0.65	0.17	31.35	0.00	32.17
27		1.47	1.47		0.65	0.17	31.35	0.00	32.17
28		1.47	1.47		0.65	0.17	31.35	0.00	32.17
29		1.47	1.47		0.65	0.17	31.35	0.00	32.17
30		1.47	1.47		0.65	0.17	31.35	0.00	32.17
31		1.47	1.47		0.65	0.17	31.35	0.00	32.17
32		1.47	1.47		0.65	0.17	31.35	0.00	32.17
33		1.47	1.47		0.65	0.17	31.35	0.00	32.17
34		1.47	1.47		0.65	0.17	31.35	0.00	32.17
35		1.47	1.47		0.65	0.17	31.35	0.00	32.17
36		1.47	1.47		0.65	0.17	31.35	0.00	32.17
37		1.47	1.47		0.65	0.17	31.35	0.00	32.17
38		1.47	1.47		0.65	0.17	31.35	0.00	32.17
39		1.47	1.47		0.65	0.17	31.35	0.00	32.17
40		1.47	1.47		0.65	0.17	31.35	0.00	32.17
41		1.47	1.47		0.65	0.17	31.35	0.00	32.17
42		1.47	1.47		0.65	0.17	31.35	0.00	32.17
43		1.47	1.47		0.65	0.17	31.35	0.00	32.17

IRR= 12.5%

Table 6-18 **CASH FLOW OF PROJECT BENEFIT AND COST FOR BOHOL-CEBU WATER SUPPLY PROJECT**

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (*Alternative Thermal Cost*)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	5.40		5.40						0.00
-6	5.40		5.40						0.00
-5	22.52		22.52						0.00
-4	27.02		27.02						0.00
-3	40.54		40.54						0.00
-2	40.54		40.54						0.00
-1	38.74		38.74						0.00
1		1.42	1.42				21.27	0.00	21.27
2		1.42	1.42				21.27	0.00	21.27
3	6.90	1.42	8.32				21.27	0.00	21.27
4	6.90	1.42	8.32				21.27	0.00	21.27
5	28.73	1.42	30.15				21.27	0.00	21.27
6	34.48	1.42	35.90				21.27	0.00	21.27
7	51.71	1.42	53.14				21.27	0.00	21.27
8	51.71	1.42	53.14	6.04			21.27	0.00	27.31
9	49.41	1.42	50.84	6.04			63.77	0.00	69.81
10		3.02	3.02		0.97	0.32	63.77	0.00	65.05
11		3.02	3.02		0.97	0.32	63.77	0.00	65.05
12		3.02	3.02		0.97	0.32	63.77	0.00	65.05
13		3.02	3.02		0.97	0.32	63.77	0.00	65.05
14		3.02	3.02		0.97	0.32	63.77	0.00	65.05
15		3.02	3.02		0.97	0.32	63.77	0.00	65.05
16		3.02	3.02		0.97	0.32	63.77	0.00	65.05
17		3.02	3.02		0.97	0.32	63.77	0.00	65.05
18		3.02	3.02		0.97	0.32	63.77	0.00	65.05
19		3.02	3.02		0.97	0.32	63.77	0.00	65.05
20		3.02	3.02		0.97	0.32	63.77	0.00	65.05
21		3.02	3.02		0.97	0.32	63.77	0.00	65.05
22		3.02	3.02		0.97	0.32	63.77	0.00	65.05
23		3.02	3.02		0.97	0.32	63.77	0.00	65.05
24	16.21	3.02	19.24	5.44	0.97	0.32	63.77	0.00	70.49
25	16.21	3.02	19.24	5.44	0.97	0.32	63.77	0.00	70.49
26		3.02	3.02		0.97	0.32	63.77	0.00	65.05
27		3.02	3.02		0.97	0.32	63.77	0.00	65.05
28	34.42	3.02	37.44		0.97	0.32	63.77	0.00	65.05
29	34.42	3.02	37.44		0.97	0.32	63.77	0.00	65.05
30		3.02	3.02		0.97	0.32	63.77	0.00	65.05
31		3.02	3.02		0.97	0.32	63.77	0.00	65.05
32		3.02	3.02		0.97	0.32	63.77	0.00	65.05
33		3.02	3.02		0.97	0.32	63.77	0.00	65.05
34		3.02	3.02		0.97	0.32	63.77	0.00	65.05
35		3.02	3.02		0.97	0.32	63.77	0.00	65.05
36		3.02	3.02		0.97	0.32	63.77	0.00	65.05
37		3.02	3.02		0.97	0.32	63.77	0.00	65.05
38		3.02	3.02		0.97	0.32	63.77	0.00	65.05
39		3.02	3.02		0.97	0.32	63.77	0.00	65.05
40		3.02	3.02		0.97	0.32	63.77	0.00	65.05
41		3.02	3.02		0.97	0.32	63.77	0.00	65.05
42		3.02	3.02		0.97	0.32	63.77	0.00	65.05
43		3.02	3.02		0.97	0.32	63.77	0.00	65.05

IRR= 11.1%

Table 6-19 CASH FLOW OF PROJECT BENEFIT AND COST FOR LABOY DAM PROJECT

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	3.47		3.47						0.00
-6	3.47		3.47						0.00
-5	17.36		17.36						0.00
-4	21.70		21.70						0.00
-3	30.39		30.39						0.00
-2	52.09		52.09	0.00					0.00
-1	45.14		45.14	0.00					0.00
1		7.99	7.99		0.00	0.00	30.76	0.00	30.76
2		7.99	7.99		0.00	0.00	30.76	0.00	30.76
3		7.99	7.99		0.00	0.00	30.76	0.00	30.76
4		7.99	7.99		0.00	0.00	30.76	0.00	30.76
5		7.99	7.99		0.00	0.00	30.76	0.00	30.76
6		7.99	7.99		0.00	0.00	30.76	0.00	30.76
7		7.99	7.99		0.00	0.00	30.76	0.00	30.76
8		7.99	7.99		0.00	0.00	30.76	0.00	30.76
9		7.99	7.99		0.00	0.00	30.76	0.00	30.76
10		7.99	7.99		0.00	0.00	30.76	0.00	30.76
11		7.99	7.99		0.00	0.00	30.76	0.00	30.76
12		7.99	7.99		0.00	0.00	30.76	0.00	30.76
13		7.99	7.99		0.00	0.00	30.76	0.00	30.76
14		7.99	7.99		0.00	0.00	30.76	0.00	30.76
15		7.99	7.99		0.00	0.00	30.76	0.00	30.76
16		7.99	7.99		0.00	0.00	30.76	0.00	30.76
17		7.99	7.99		0.00	0.00	30.76	0.00	30.76
18		7.99	7.99		0.00	0.00	30.76	0.00	30.76
19		7.99	7.99		0.00	0.00	30.76	0.00	30.76
20		7.99	7.99		0.00	0.00	30.76	0.00	30.76
21		7.99	7.99		0.00	0.00	30.76	0.00	30.76
22		7.99	7.99		0.00	0.00	30.76	0.00	30.76
23		7.99	7.99		0.00	0.00	30.76	0.00	30.76
24	15.63	7.99	23.62	0.00	0.00	0.00	30.76	0.00	30.76
25	15.63	7.99	23.62	0.00	0.00	0.00	30.76	0.00	30.76
26		7.99	7.99		0.00	0.00	30.76	0.00	30.76
27		7.99	7.99		0.00	0.00	30.76	0.00	30.76
28		7.99	7.99		0.00	0.00	30.76	0.00	30.76
29		7.99	7.99		0.00	0.00	30.76	0.00	30.76
30		7.99	7.99		0.00	0.00	30.76	0.00	30.76
31		7.99	7.99		0.00	0.00	30.76	0.00	30.76
32		7.99	7.99		0.00	0.00	30.76	0.00	30.76
33		7.99	7.99		0.00	0.00	30.76	0.00	30.76
34		7.99	7.99		0.00	0.00	30.76	0.00	30.76
35		7.99	7.99		0.00	0.00	30.76	0.00	30.76
36		7.99	7.99		0.00	0.00	30.76	0.00	30.76
37		7.99	7.99		0.00	0.00	30.76	0.00	30.76
38		7.99	7.99		0.00	0.00	30.76	0.00	30.76
39		7.99	7.99		0.00	0.00	30.76	0.00	30.76
40		7.99	7.99		0.00	0.00	30.76	0.00	30.76
41		7.99	7.99		0.00	0.00	30.76	0.00	30.76
42		7.99	7.99		0.00	0.00	30.76	0.00	30.76
43		7.99	7.99		0.00	0.00	30.76	0.00	30.76

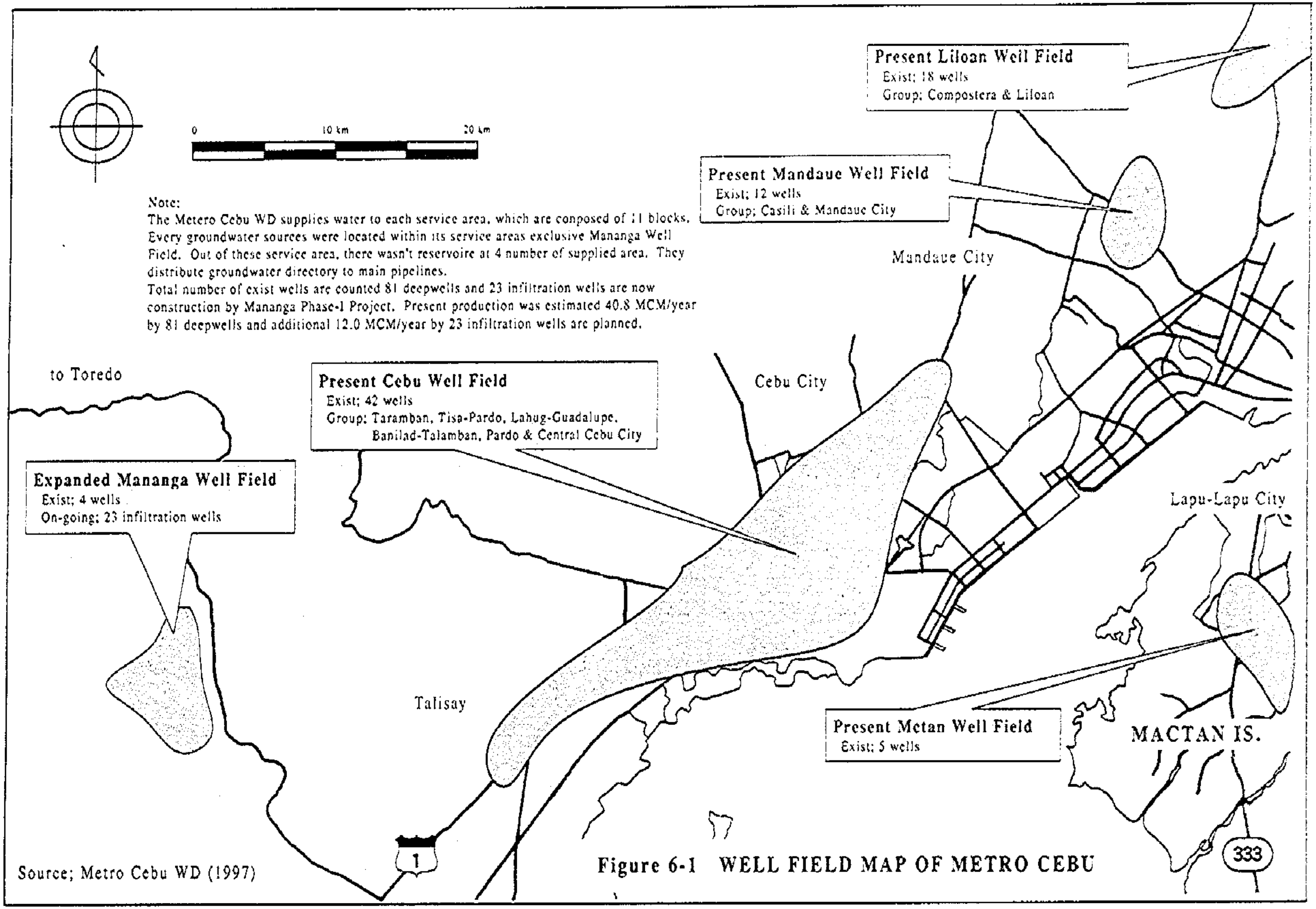
IRR= 10.7%

Table 6-20 **CASH FLOW OF PROJECT BENEFIT AND COST FOR LABOY WEIR AND PONDS PROJECT**

(Unit : Million US$)

No. of Year	Project Cost			Project Benefit					
				1. Hydropower (Alternative Thermal Cost)			2. Water Supply	3. Irrigation	Total
	Capital Cost	O&M Cost	Total	Capital Cost	Fuel Cost	O&M Cost			
-7	0.00		0.00						0.00
-6	3.23		3.23						0.00
-5	3.23		3.23						0.00
-4	19.36		19.36						0.00
-3	25.81		25.81						0.00
-2	38.72		38.72	0.00					0.00
-1	38.72		38.72	0.00					0.00
1		3.55	3.55		0.00	0.00	10.23	0.00	10.23
2		3.55	3.55		0.00	0.00	10.23	0.00	10.23
3		3.55	3.55		0.00	0.00	10.23	0.00	10.23
4		3.55	3.55		0.00	0.00	10.23	0.00	10.23
5		3.55	3.55		0.00	0.00	10.23	0.00	10.23
6		3.55	3.55		0.00	0.00	10.23	0.00	10.23
7		3.55	3.55		0.00	0.00	10.23	0.00	10.23
8		3.55	3.55		0.00	0.00	10.23	0.00	10.23
9		3.55	3.55		0.00	0.00	10.23	0.00	10.23
10		3.55	3.55		0.00	0.00	10.23	0.00	10.23
11		3.55	3.55		0.00	0.00	10.23	0.00	10.23
12		3.55	3.55		0.00	0.00	10.23	0.00	10.23
13		3.55	3.55		0.00	0.00	10.23	0.00	10.23
14		3.55	3.55		0.00	0.00	10.23	0.00	10.23
15		3.55	3.55		0.00	0.00	10.23	0.00	10.23
16		3.55	3.55		0.00	0.00	10.23	0.00	10.23
17		3.55	3.55		0.00	0.00	10.23	0.00	10.23
18		3.55	3.55		0.00	0.00	10.23	0.00	10.23
19		3.55	3.55		0.00	0.00	10.23	0.00	10.23
20		3.55	3.55		0.00	0.00	10.23	0.00	10.23
21		3.55	3.55		0.00	0.00	10.23	0.00	10.23
22		3.55	3.55		0.00	0.00	10.23	0.00	10.23
23		3.55	3.55		0.00	0.00	10.23	0.00	10.23
24	11.62	3.55	15.17	0.00	0.00	0.00	10.23	0.00	10.23
25	11.62	3.55	15.17	0.00	0.00	0.00	10.23	0.00	10.23
26		3.55	3.55		0.00	0.00	10.23	0.00	10.23
27		3.55	3.55		0.00	0.00	10.23	0.00	10.23
28		3.55	3.55		0.00	0.00	10.23	0.00	10.23
29		3.55	3.55		0.00	0.00	10.23	0.00	10.23
30		3.55	3.55		0.00	0.00	10.23	0.00	10.23
31		3.55	3.55		0.00	0.00	10.23	0.00	10.23
32		3.55	3.55		0.00	0.00	10.23	0.00	10.23
33		3.55	3.55		0.00	0.00	10.23	0.00	10.23
34		3.55	3.55		0.00	0.00	10.23	0.00	10.23
35		3.55	3.55		0.00	0.00	10.23	0.00	10.23
36		3.55	3.55		0.00	0.00	10.23	0.00	10.23
37		3.55	3.55		0.00	0.00	10.23	0.00	10.23
38		3.55	3.55		0.00	0.00	10.23	0.00	10.23
39		3.55	3.55		0.00	0.00	10.23	0.00	10.23
40		3.55	3.55		0.00	0.00	10.23	0.00	10.23
41		3.55	3.55		0.00	0.00	10.23	0.00	10.23
42		3.55	3.55		0.00	0.00	10.23	0.00	10.23
43		3.55	3.55		0.00	0.00	10.23	0.00	10.23

IRR= 3.6%



Source; Metro Cebu WD (1997)

Figure 6-1 WELL FIELD MAP OF METRO CEBU

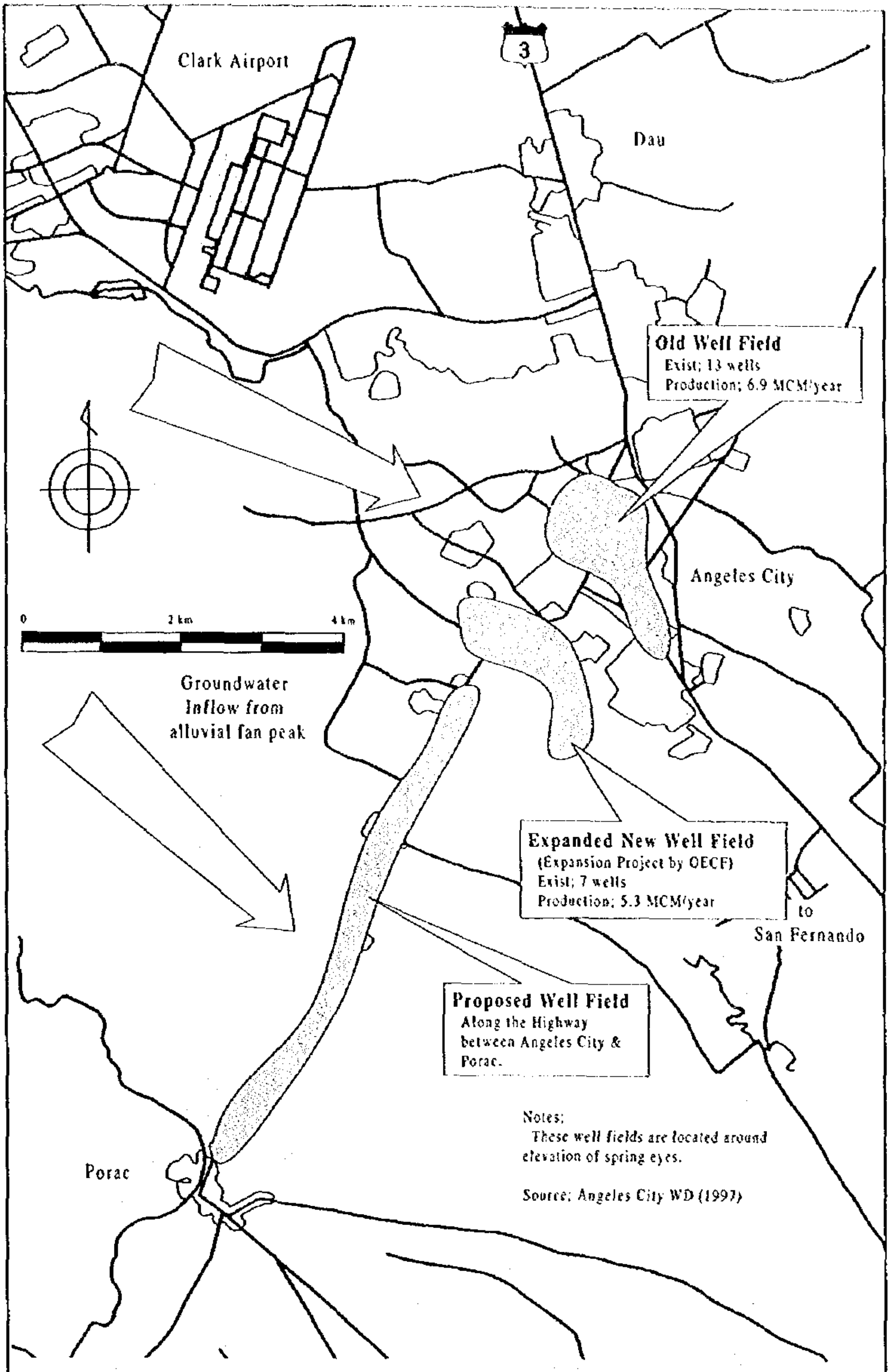
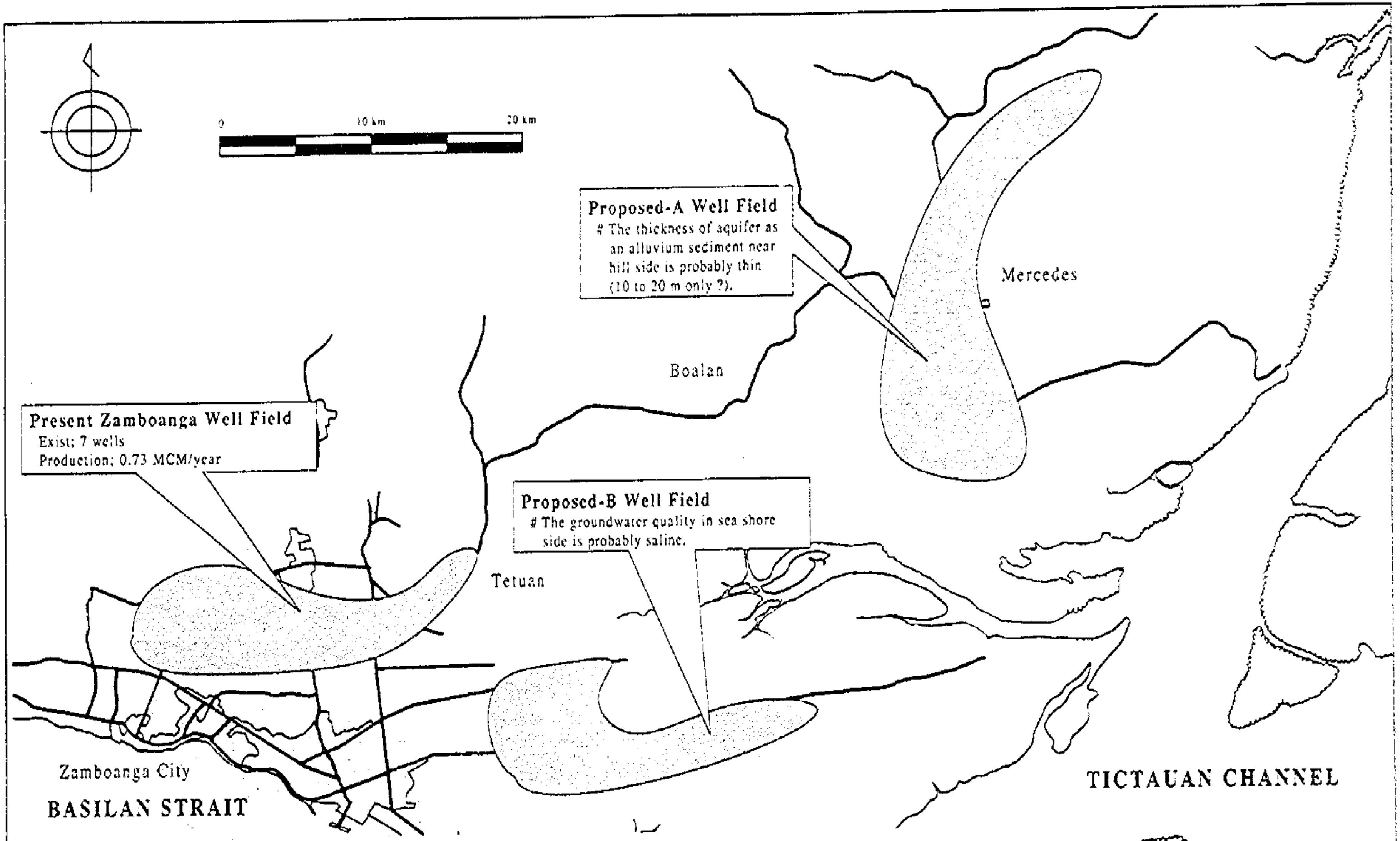
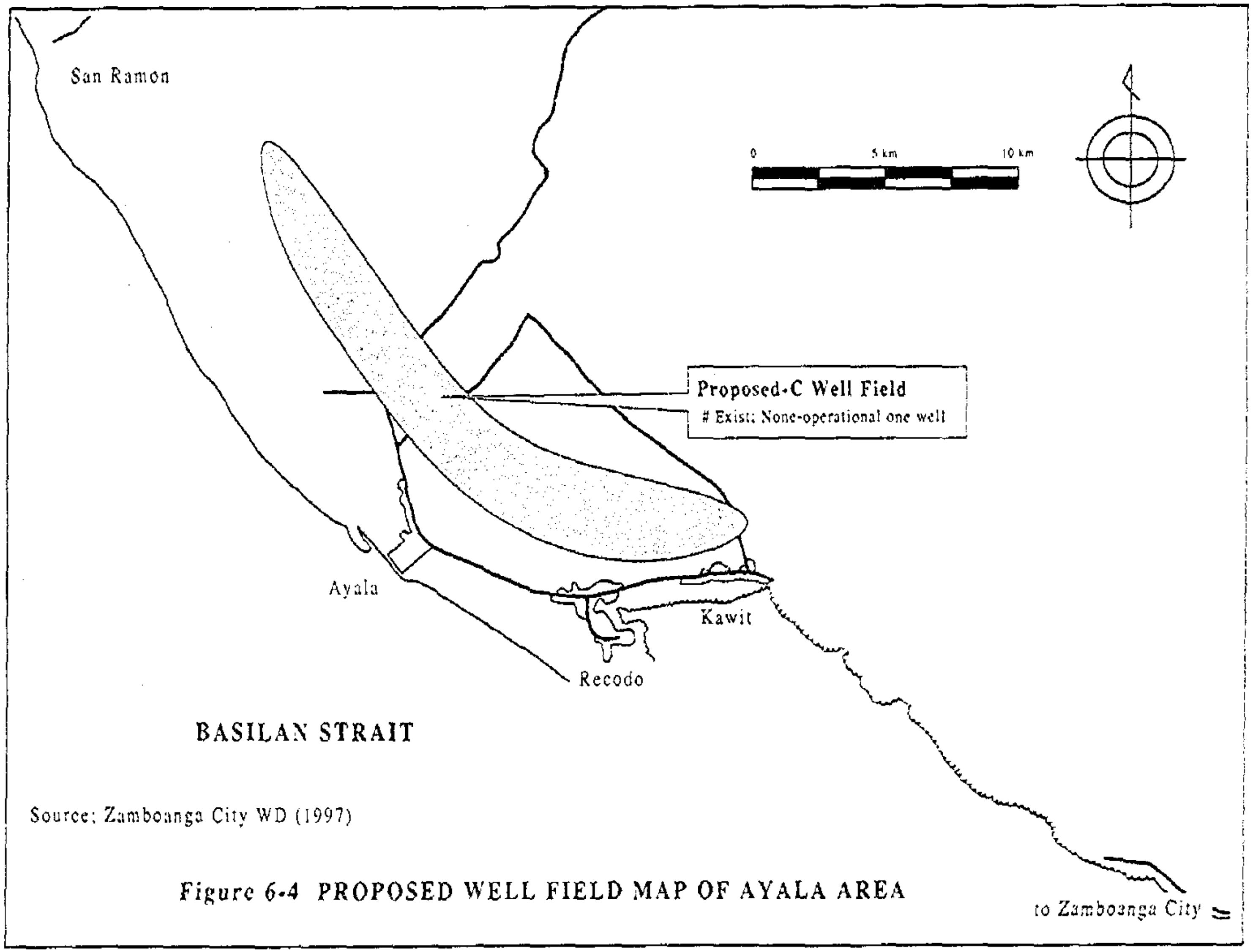


Figure 6-2 PROPOSED WELL FIELD MAP OF ANGELES CITY WD



Source: Zamboanga City WD (1997)

Figure 6-3 PROPOSED WELL FIELD MAP OF ZAMBOANGA CITY WD



Source: Zamboanga City WD (1997)

Figure 6-4 **PROPOSED WELL FIELD MAP OF AYALA AREA**

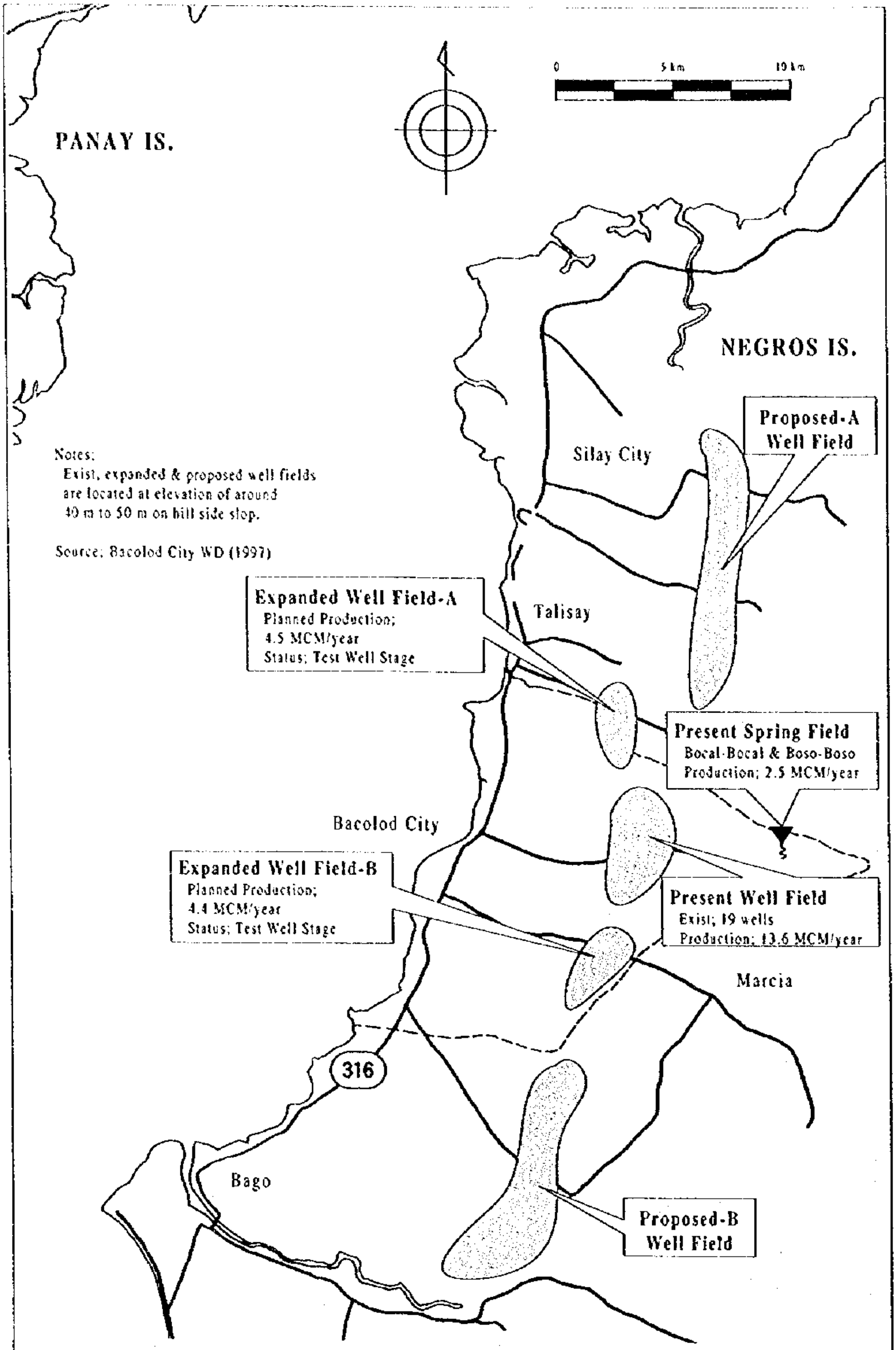


Figure 6-5 PROPOSED WELL FIELD MAP OF BACOLOD CITY WD

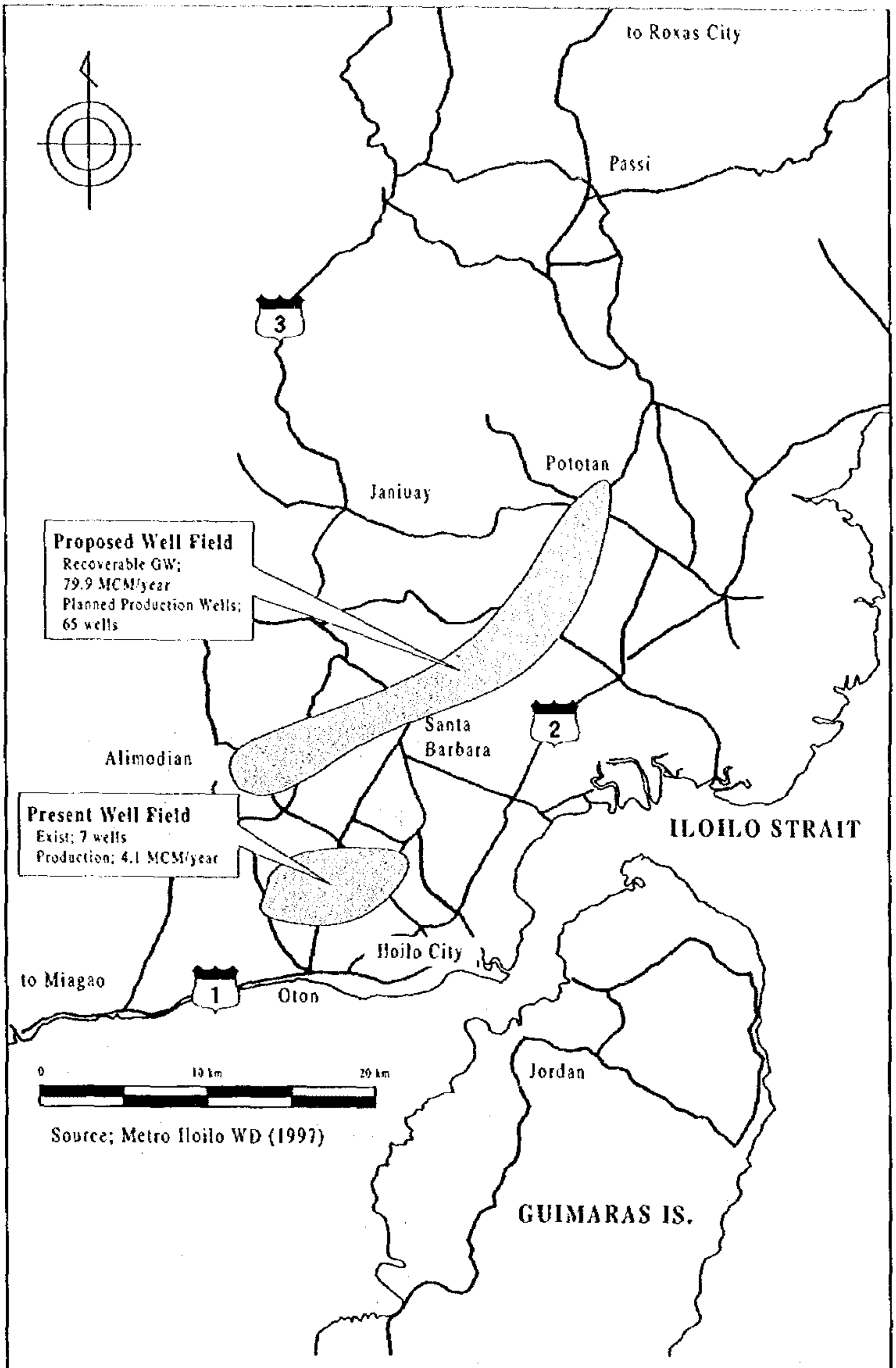


Figure 6-6 PROPOSED WELL FIELD MAP OF METRO ILOILO WD

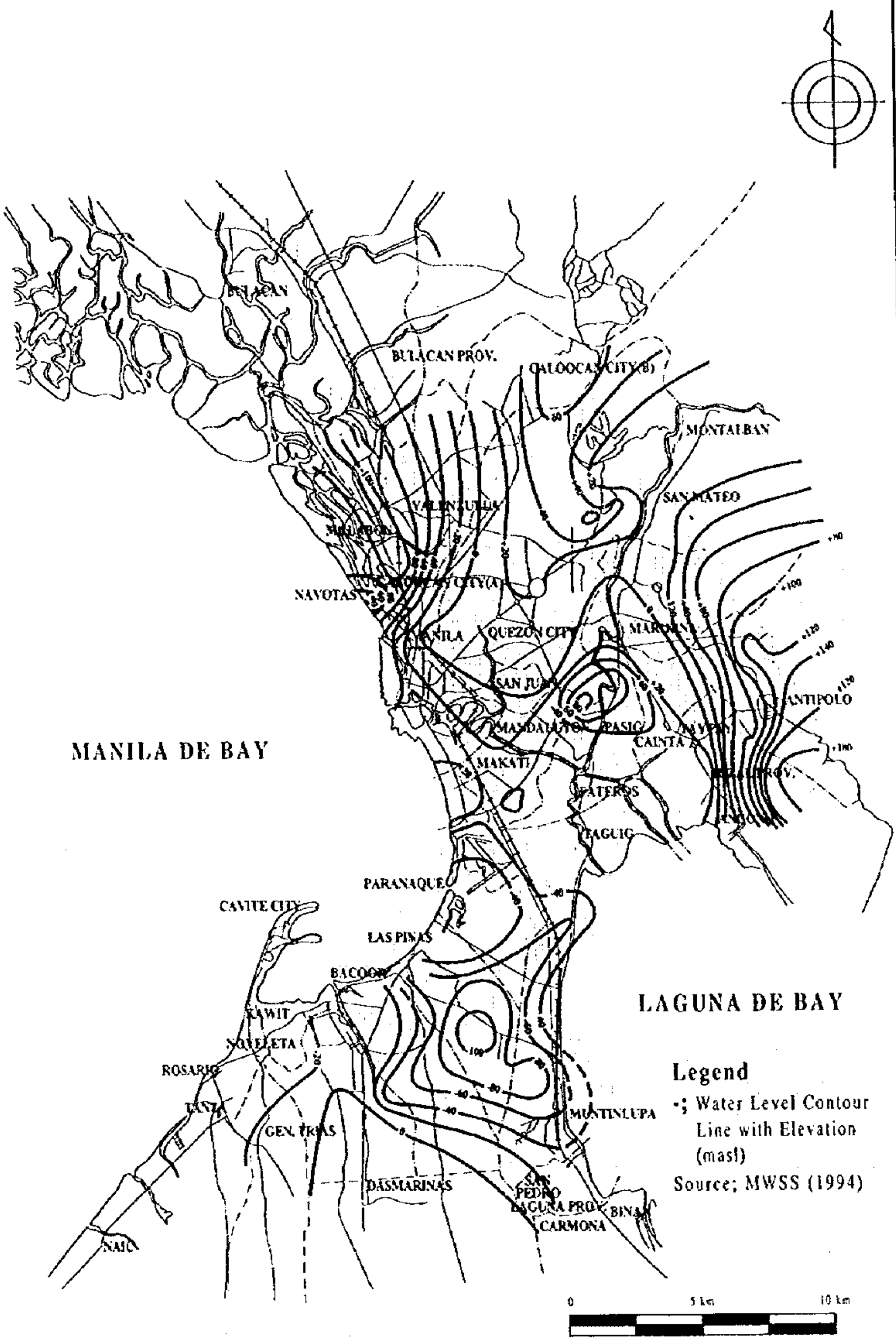


Figure 6-7 PIEZOMETRIC MAP OF METRO MANILA

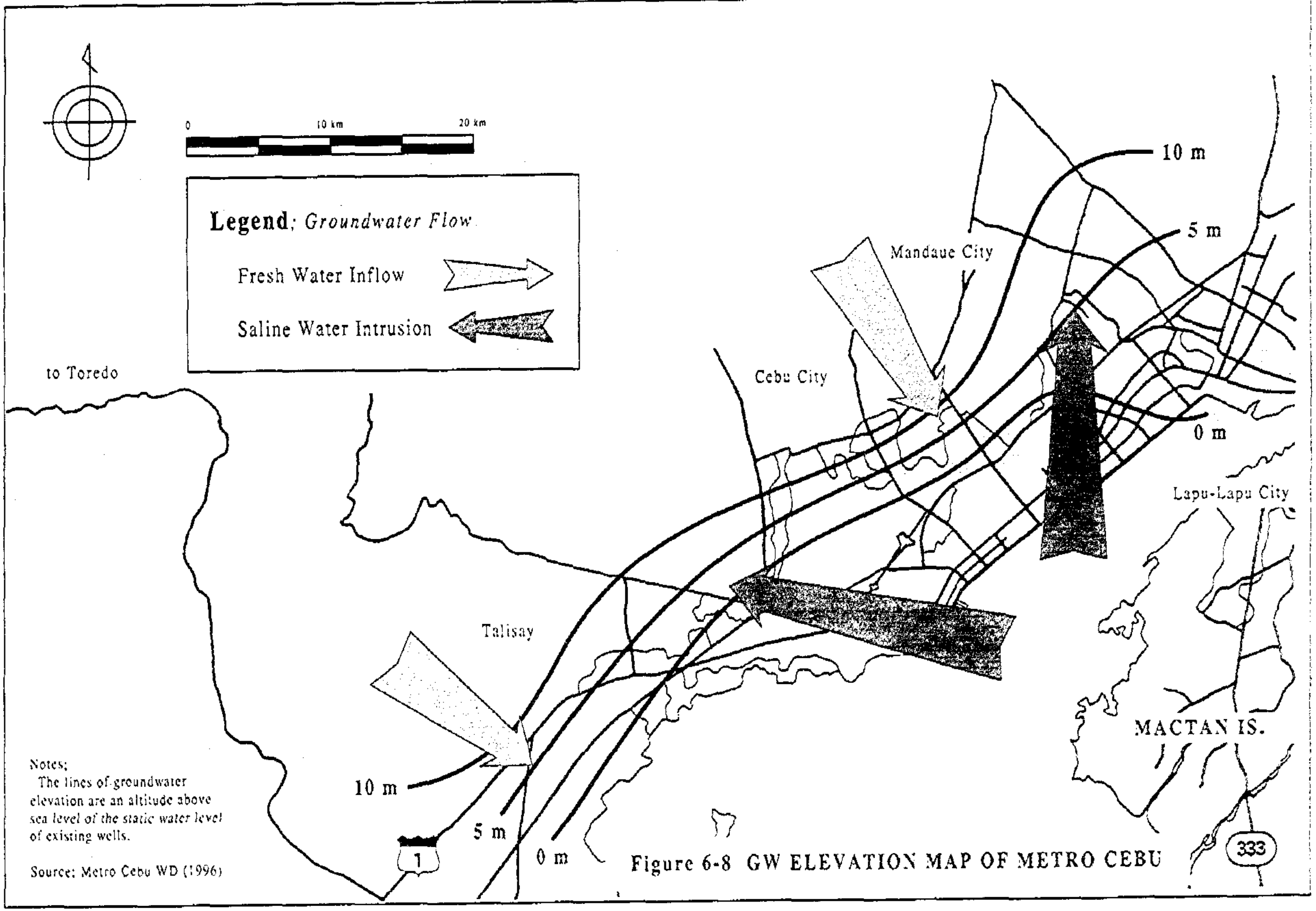


Figure 6-8 GW ELEVATION MAP OF METRO CEBU

Notes;
The lines of groundwater elevation are an altitude above sea level of the static water level of existing wells.

Source: Metro Cebu WD (1996)

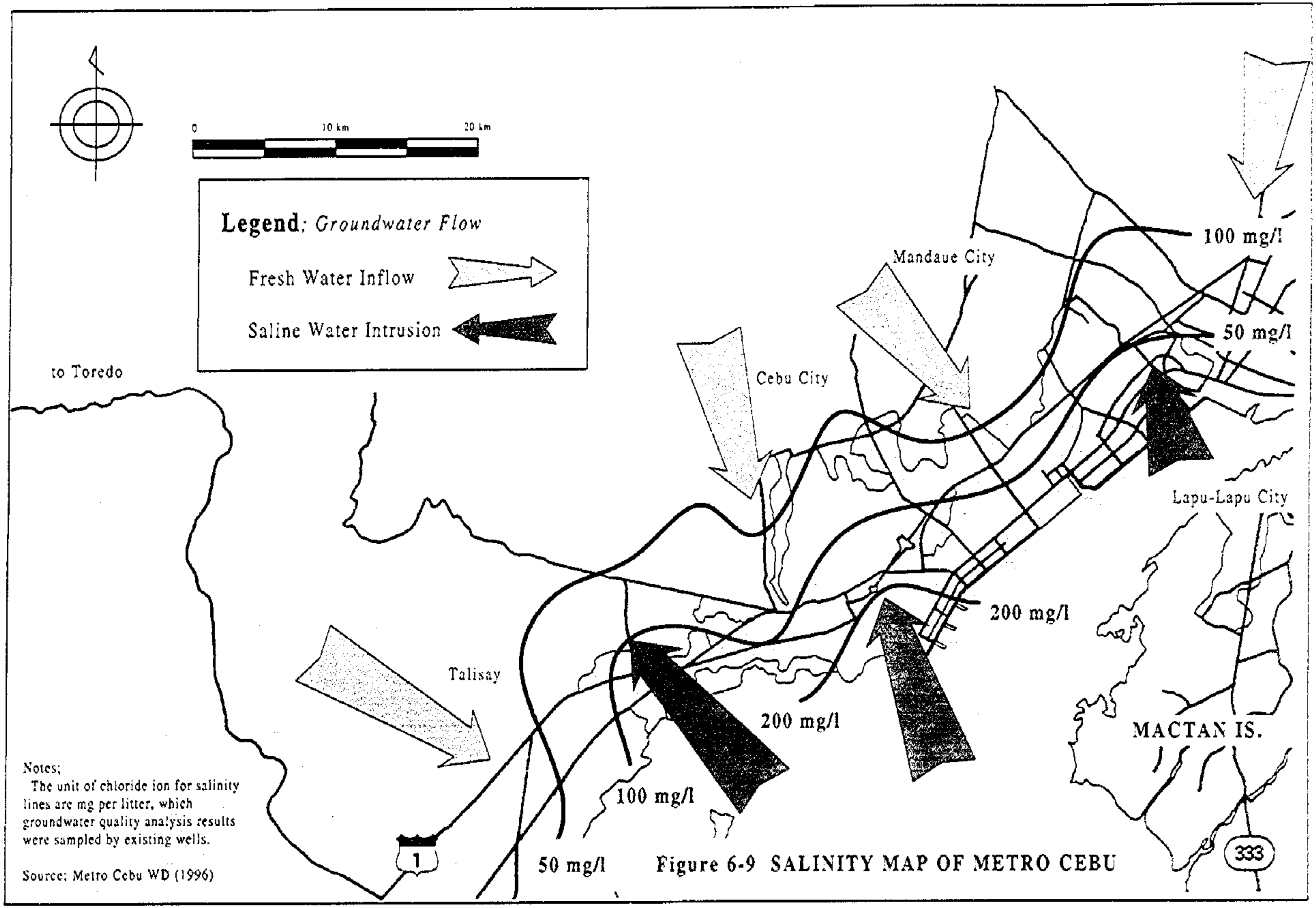


Figure 6-9 SALINITY MAP OF METRO CEBU

Notes;
The unit of chloride ion for salinity lines are mg per litter, which groundwater quality analysis results were sampled by existing wells.

Source; Metro Cebu WD (1996)

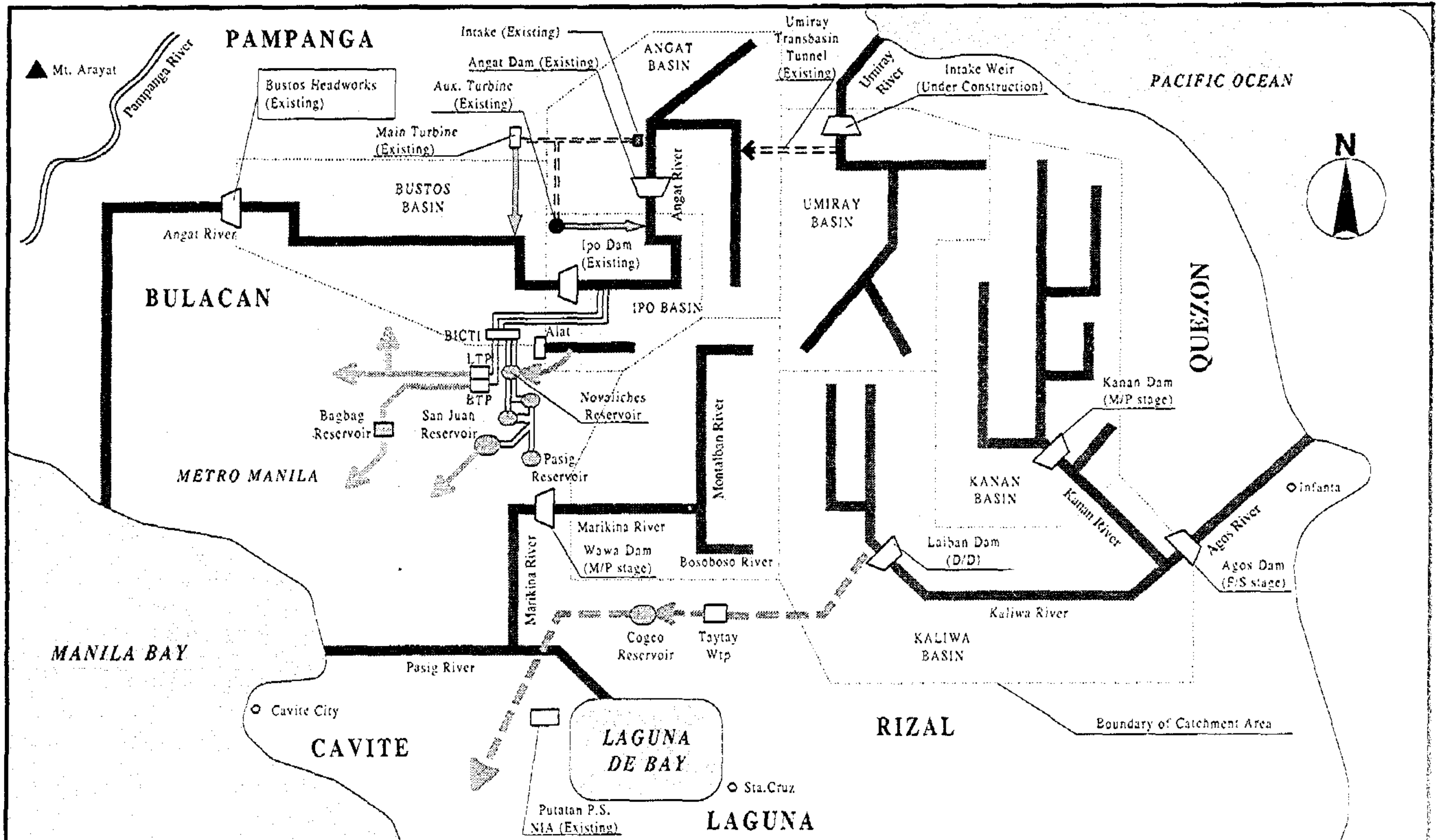


Figure 6-10 SCHEMATIC MAP OF DAM AND WATER SUPPLY FACILITY FOR METRO MANILA

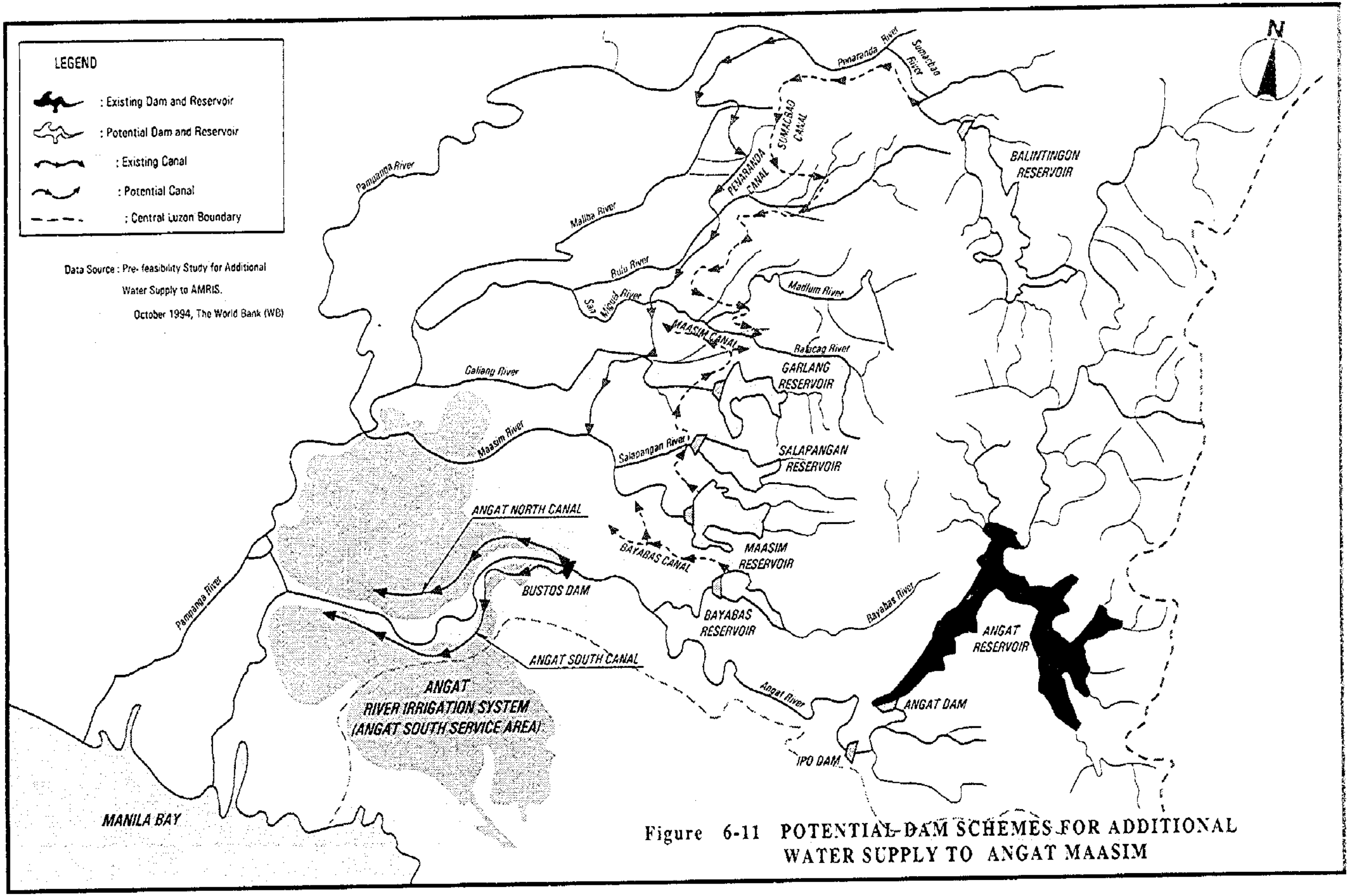
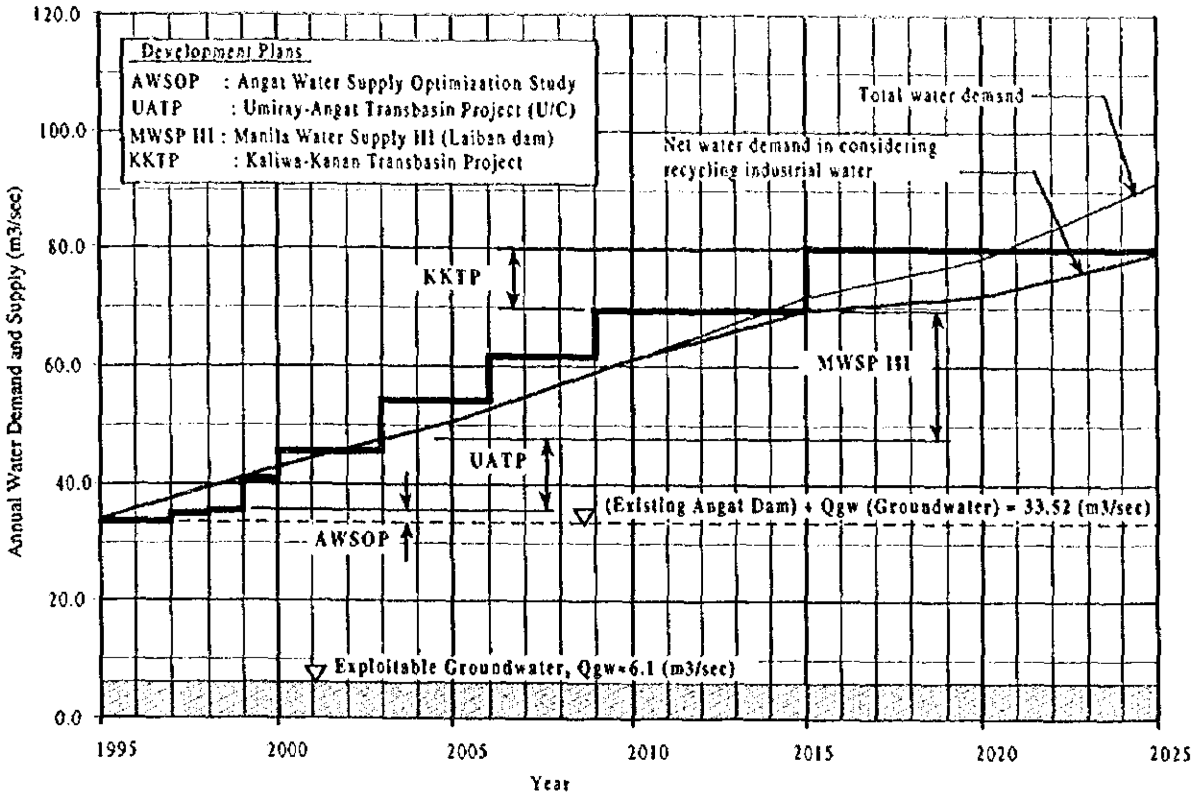
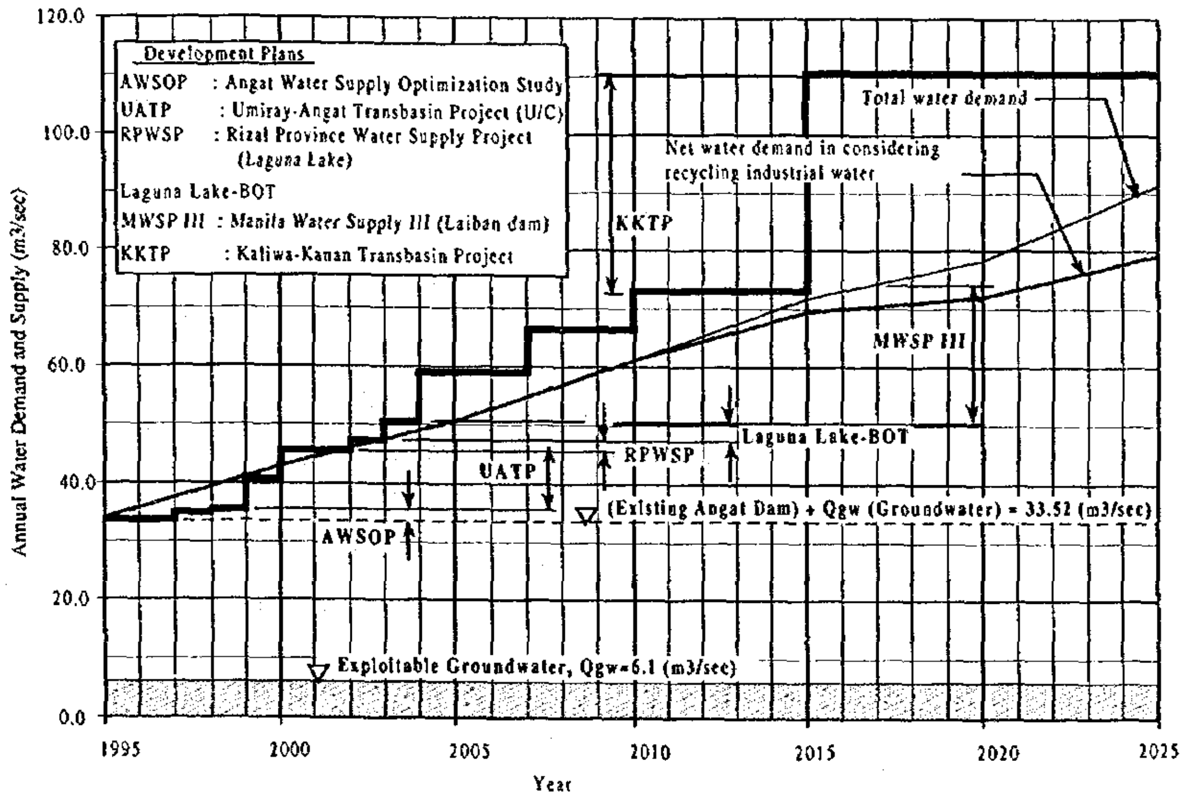


Figure 6-11 POTENTIAL DAM SCHEMES FOR ADDITIONAL WATER SUPPLY TO ANGAT MAASIM



Scenario-1 (1/2) : Development Plan Proposed in the Study on Water Supply and Sewerage Master Plan of Metro Manila (February 1996)



Scenario-1 (2/2) : Latest Development Plan Proposed by MWSS

Figure 6-12 IMPLEMENTATION PLAN OF WATER SUPPLY PROJECTS FOR METRO MANILA (SCENARIO-1)