Part – D

DAM AND RELATED FACILITY ENGINEERING

Part – D DAM AND RELATED FACILITY ENGINEERING

Table of Contents

LIST OF TABLES

LIST OF FIGURES

Part – D DAM AND RELATED FACILITY ENGINEERING

D1 Study Works Carried Out in First Stage I Field Investigation

D1.1 General

The field investigation works for the dam and related facility engineering were carried out for the period from the end of April to the middle of July. During the first stage field investigation, the following investigation works have been done in collaboration with the counterpart personnel of NWRB and NPC:

- Data collection
- Field reconnaissance
- Preparation of inventory of proposed reservoir type schemes
- Planning of new dams for water supply to Metro Cebu and Davao city

The above field activities are explained hereinafter.

D1.2 Data Collection

D1.2.1 Topographic and Geological Maps

On the commencement of the field investigation, a complete set of 1 to 250,000 scaled topographic maps which cover the whole Philippines were attempted to be procured from the National Mapping and Resources Authority (NAMRIA) so as to identify the locations of existing and proposed major dams. However, the Study Team could not procure all the necessary maps from the mapping agency during the 1st investigation, since some of them were out of stock thereat.

As stated in the Inception Report of the Study, the three major cities, namely Metro Manila, Metro Cebu and Davao city, were considered to cause the water shortage by the study target year of 2025 with respect to the municipal and industrial water. In the present study stage, hence, a focus was placed on these three areas in carrying out the dam planning including identification of new dam sites. In addition to the aforesaid topographic maps collected almost with a nation-wide coverage, the Study Team attempted to gather 1 to 50,000 scaled topographic maps as well as geological maps to be utilized for planning of new dam sites for the basins concerned with the municipal water supply to Metro Manila, Metro Cebu and Dabao city.

Unfortunately, the 1 to 50,000 scaled topographic map of the northern part of Metro Manila, which shows the Angat and Ipo dams could not be obtained from NAMRIA. Besides, the Study Team could not obtain the geological map of the Dabao river basin.

D1.2.2 Previous Study Reports on Water Resources Development Plan

In the course of the data and information collection from the concerned governmental agencies, it was found out that the majority of the water resources development plans in the country had been formulated for the purpose of the hydroelectric development under NPC and/or for the multipurpose development to date. Hence, the previous study reports were collected from NPC as much as possible.

The reports kept in NPC's office were not well arranged in the storage room, being in disorder, due to the past fire accident. Consequently, it took a rather long time to find out the previous reports on the proposed reservoir type hydroelectric development projects, which have an essential linkage with the dam planning in this study. The previous dam plans were arranged by project on formatted sheets with respect to their main features, which constitute a part of the "Data Base" to be established in the Study. Since the Study Team could not collect all the reports required to clarify the features of major dams contemplated in the previous study, the data collection on the previous reports need to be carried on in the successive 2nd stage field investigation scheduled to start in early November 1997.

D1.2.3 Data on Cost and Construction Plan

The data on construction cost and construction planning were collected from the concerned project offices such as the Agno flood control project office and SWIM project office under DPWH. These cost data are going to be used to estimate the project cost and establish the construction plan for the selected water resources development projects.

D1.3 Field Reconnaissance

Out of the aforesaid three major cities where the constraint of water demand and water supply is likely take place in the future, the water supply situation and new water resources development plans for Metro Manila were examined in depth through the previous studies by JICA, WB and ADB in relation to the municipal water supply as well as water reallocation of the Angat dam. Accordingly, the field reconnaissance for the proposed and newly identified dam sites was conducted in relation to water supply to Metro Cebu and Dabao.

The field reconnaissance to Cebu was performed in the end of May 1997. The following field works were carried out during the stay in Cebu:

- Discussion with and data/information collection at the Metro Cebu Water District (MCWD) concerning the present situation of water supply and prospective water resources development plans for water supply to Metro Cebu,

- Inspection of existing dams in and around the Metro Cebu area inclusive of the Buhisan dam and reservoir to confirm the present situation thereof,

- Reconnaissance of the on-going and proposed project sites for water supply to Metro Cebu, which include the Mananga I project site, Mananga II dam site and Lusaran dam site

- Data and information collection at the Water Resources Center (WRC) of the University of San Carlos, who installed and operates several rain gages in and around the Mananga and Lusaran (Balamban) river basins since 1977.

The multi-disciplinary experts proceeded to Davao together with counterpart in the middle of June 1997 in order to conduct the field reconnaissance in the Davao river basin as well as to gather the data and information relevant to the Study from the regional offices concerned. With regard to the dam and related facility engineering, the main purposes of the site reconnaissance were as follows:

- to discuss about the present situation and future plan of water supply system with the in-charge of the Davao Water District,

- to inspect the Davao river as well as the new dam sites thereon identified at a map study level through the present investigation stage, and

- to inspect the existing water resources facilities in the Davao river basin, which include the hydropower station with an installed capacity of 3.4 MW on the Talomo river.

Owing to unexpected much delay of the scheduled flight from Manila to Davao, however, the Study Team could not reconnoiter the Davao river basin satisfactorily. On the other hand, the Study Team has obtained a lot of useful information on the water resources for municipal water supply to Davao city from the regional offices of the concerned agencies in Dabao. In particular, it was confirmed through the site reconnaissance that there are many springs around the Mt. Talomo, feeding the Talomo river, Lira Dao river and many small streams, which are one of the promising water resources to be developed for water supply to Dabao.

D1.4 Dam Planning and Other Works Carried Out

Concerning the dam and other related facility engineering, the following study works have been conducted during the 1st field investigation in addition to the aforesaid data collection and field reconnaissance;

- to confirm and plot the location of each reservoir dam scheme, both for existing and proposed ones, on the 1 to 250,000 scaled topographic maps, which were procured by the Study Team on the commencement of the study works,

- to check the main project features of each scheme and to prepare an inventory of planned dam-reservoir type schemes, which constitute not only a part of the data base, but also the essential data for the formulation of the water resources development plan for each water resources region,

- to work out new reservoir type dam schemes at a map study level for the area where the dam schemes are hardly contemplated in the previous studies in spite of the water shortage being expected against the water demand in the future (i.e. Davao river basin), and

to prepare the small scale dam schemes at a map study level for the water supply to Metro Cebu to meet the future municipal and industrial water demand in the service area of MCWD.

D2 Dams in the Philippines

D2.1 Large Scale Dams Identified in the Philippines

In the Philippines, many dam sites have been identified so far as listed in the "Survey/Inventory on Water Impounding Reservoirs" (hereinafter refereed to as "the Survey/Inventory"), which was compiled by the National Water Resources Council (Original organization of the National Water Resources Board (NWRB)) in April 1978. The total number of the dams listed in the Survey/Inventory amounts to 864. However, it indicates only the location, catchment area, dam height, concerned governmental agencies and main purposes of those dams. Other features, such as inflow data, reservoir storage capacity, dependable discharges, etc., are not exhibited therein.

Besides, the Survey/Inventory lists the various scale of dams with a dam height of less than 5 m to more than 200 m and a catchment area of 5 km^2 to more than 1000 km^2. Thus, it appears that all the dam sites for the entire Philippines, which could be identified based on the available topographic maps at that time, are presented in the Survey/Inventory. Of those dams, at present, the smaller scale dams of not more than 30 m in dam height and not more than 30 km^2 in catchment area are categorized into and dealt with in conjunction with the small water impounding management (SWIM) project as described in the succeeding "Part H : Surface Water Resources Planning" of this Supporting Report. In view of the categorization, only the larger scale dams were picked out from those listed in the Survey/Inventory in order to make a new list of identified dams.

Since most of the dams selected for the SWIM project has a dimension of not more than 30 m in dam height as well as of not more than 30 km^2 in catchment area, the dams with larger dimensions than those in dam height and catchment area are categorized into the large scale dams in the Philippines. These dams are listed in Table D-1 and their locations are shown by water resources region in Figures D-1 to D-12. In these Table and Figures, the names of respective dams are same with those used in the Survey/Inventory. Of theses dams identified in the past, some dams have already been developed or examined at a study level of feasibility or pre-feasibility for the purpose of hydropower development or multipurpose development. As a result, a total of 364 dams are entitled to be larger scale dams in the entire Philippines. They are classified by the water resources basin and dam height as shown below:

Number of Large Scale Dams Identified by Region and Dam Height

Region No.	Land Area (km^2)	Dam Height (m)				Density on Dam Nos.
		DH<100	100<DH<200	200<DH	Total	
	(1)				(2)	=(2)/(1) x 1000
I	14,400	30	25	7	62	4.31
II	34,500	20	33	2	55	1.59
III	23,600	27	17	2	46	1.95
IV	46,500	23	17	0	40	0.86
V	17,600	8	3	0	11	0.63
VI	20,200	8	19	1	28	1.39
VII	14,900	3	6	0	9	0.60
VIII	20,400	20	5	0	25	1.23
IX	20,600	8	9	0	17	0.83
X	24,300	11	22	0	33	1.36
XI	24,900	6	8	0	14	0.56
XII	31,900	9	13	2	24	0.75
Total	293,800	173	177	14	364	1.24

DH : Dam height.

As seen in a table above, a comparatively lot of large scale dam sites are identified in Water Resources Region I.

D2.2 Dam Projects Formulated in Previous Studies

Out of the identified dams, a limited number of dams were realized as the multipurpose dam project to date. In addition, some dams are proposed to be developed as the multipurpose dam projects or mainly for the hydropower development. Concerning the proposed dam projects which have been planned at a study level of feasibility or pre-feasibility, the data and information were collected mainly from NPC. These dam schemes distribute almost in the major rivers of the Philippines. The data collected from NPC with respect to the proposed major dam schemes are as follows:

- List of existing and proposed hydropower projects of NPC, which contain 122 schemes in total, consisting of 57 reservoir type schemes and 65 run-of-river type ones, (hereinafter referred to as the NPC's list),

- Proposed Hydroelectric Projects (Proposed Hydel), which summarizes the project features of 34 schemes based on the feasibility and pre-feasibility study reports, and

- Feasibility study and pre-feasibility study reports on each of the proposed hydropower development projects.

Beside these, there are numerous number of small scale dams mainly for irrigation use and water shed management, which are existing, under construction and to be developed by the various agencies. They are called SWIM (Small Water Impounding Management) under DPWH, SWIP (Small Water Impounding Project) under Bureau of Soils and Water Management and SRIP (Small Reservoir Impounding Project) under NIA. These smaller scale dams are outlined in the succeeding "Part-H : Surface Water Resources Planning" of this Supporting Report..

With reference to data and information presented in such reports and documents as the Proposed Hydel, NPC's data, Survey/Inventory, reports on feasibility and pre-feasibility study of the respective water resources development projects, main features of about 60 reservoir type dam schemes were checked up and tabulated on data sheets of the "Inventory of Planned Dam-Reservoir Type Scheme" in the course of construction of Database in the first stage field investigation..

Concerning the previous studies on the reservoir type schemes, it has to be noted that some dam schemes have been formulated using an extraordinary high annual mean specific runoff of 10 m^3/sec/100 km^2 to 20 m^3/sec/100 km^2. Annual mean specific runoff of 10 m^3/sec/100 km^2 could be realized, only if annual basin rainfall exceeds 6,000 mm. In general, such a river basin blessed with abundant rainfall could not be found out in the Philippines according to the available rainfall record. This assertion would be endorsed by the procedure of hydrological analysis made in the ADB's Report, Draft Final Report on Small Scale Technical Assistance : Water Resources Management (Anagat Reservoir). In the Report, the 18 years' river run-off data of the Angat river before the year 1963, which corresponds to the long-term mean discharge of 73.2 m^3/sec or specific discharge of 12.9 m^3/sec/100 km^2, were not be adopted for the reservoir operation study.

D3 Dams Planned in Connection with Water Supply to Metro Manila, Metro Cebu and Davao City

D3.1 Dams for Water Supply to Metro Manila

D3.1.1 Previous Studies on the Angat Dam

The Angat dam consisting of rockfill type dam with a catchment area of 568 km^2, which was commissioned in 1967, the sole reservoir type dam that supplies surface water to the Metro Manila. At present, about 30 m^3/s is supplied to the Metro Manila (MWSS has now the water right of 37 m^3/s from the Angat reservoir.). NIA has a water right of 36 m^3/s from the Angat dam.

To date, a lot of studies have been carried out in connection with the augmentation of water supply to Metro Manila. These studies propose diversion of water from the neighboring basins into the Angat dam and reallocation of water released from the Angat dam into water supply to metro Manila by means of development of new reservoir schemes for irrigation water supply to the Angat-Massim River Irrigation System (AMRIS) located Metro Manila, enhancement of irrigation efficiency of the AMRIS, development of groundwater for irrigation water supply and improved reservoir operation of the Angat dam. These previous studies are as follows:

- Balintingon Reservoir Multipurpose Project - Feasibility Study (1997)
- Feasibility Study of AMRIS O&M Improvement Project - JICA (1983)
- Angat Water Supply Optimization Project (AWSOP) (1987)
- Umiray-Angat Transbasin Project (UATP) Study (1992)
- Water Resources Development Project (WRDP) Study - WB (1994)
- Water Resources Management (Angat Reservoir) Study - ADB (1996)

In the aforesaid ADB's report, the inflow into the Angat reservoir after 1986 was computed for the water balance study by the reservoir operation so that the mean annual inflow for 23 years from the year 1968 through 1990 was estimated to be 59.2 m^3/sec, which is equivalent to 10.4 $m^3/sec/100\ km^2$. After it was verified that the inflow into the reservoir which was estimated in the feasibility study was excessive, and water demand for municipal use and irrigation increased, power generation at the Angat dam has been not only strictly restricted to the operation mode in harmony with the water demand, but also often stopped as the reservoir water level dropped down below the minimum operation level (MOL) of 180 m.

D3.1.2 Reservoir Type Dams Planned in the WRDP's Study

Figure D-13 schematically shows the locations of four (4) reservoir type dams, for which a pre-feasibility study was carried out in the WRDP under the World Bank. These four dams purpose to supply water the AMIS in order to reallocate the water of the Angat dam to Metro Manila. These are the Bayabas, Massim, Salapangan and Garlang dams. Consequently, the WRDP's study recommended that the former two dams be proceeded to the next feasibility study.

D3.1.3 Umiray-Angat Transbasin Project

To cope with the water shortage under the aforesaid situations, the runoff of the Umiray river basin, which is adjacent to the Angat river basin and flows northward to the Philippine Sea, is planned to be diverted into the Angat reservoir. At present, the trans-basin tunnel connecting

the Umiray basin and the Angat dam is under construction. The Umiray diversion weir sites cover a catchment area of 160 km^2 in total and annual mean runoff at weir sites is estimated at 15.6 m^3/sec based on the estimation of annual basin rainfall of about 5,000 mm. The transbasin diversion tunnel is designed to be of free flow type and circular cross section of 4.3 m in diameter. The total tunnel length is 13.1 km with a gradient of 1.48 m/km and its flow capacity is 30 m^3/sec.

D3.2 Dams Planned for Water Supply to Metro Cebu

D3.2.1 General

Cebu island is of a strip-shape land with consecutive high mountain range lying in the middle part throughout the island. Metro Cebu is located in southern and middle part of the island. Due to the geographical conditions of the island, in general, most of the rivers in the island which originate from the mountain range are characterized by the comparatively short river length.

Although at present the municipal and industrial water supply for Metro Cebu relies on groundwater resource, it is anticipated that the development of surface water will need to be accelerated to meet the future water demand due to the issue of water quality on groundwater as well as the limited quantity of groundwater resources newly exploitable. From such a point of view, the new dam sites were attempted to be identified in the neighboring basins of the Metro Cebu in the present study stage.

Figure D-14 shows the existing dam and proposed dam sites in the previous studies which are located in the neighboring basins. As well, the new dam sites identified in the present study are illustrated in the Figure. Their catchment areas are summarized in Table D-2. As seen in the Table, the catchment areas of these dams are as small as less than 100 km^2.

D3.2.2 Existing and Proposed Dam Projects for Water Supply to Metro Cebu

The existing and proposed dam projects for water supply to Metro Cebu which includes the project under construction are listed below:

- Buhisan dam
- Malubog dam
- Manang phase I dam (underground type)
- Mananga phase II dam

The Buhisan is the only one dam that supplies surface water to Metro Cebu. The dam is of concrete double arch type with a height of 26 m, occupying a very small catchment area of 6 km^2. Thus, it is similar to that in the SWIM project. The dam and reservoir was completed in 1910 with a storage capacity of 500,000 m^3. Since then, the dredging works of sediments deposited in the reservoir have been conducted periodically by MCWD to maintain and restore the reservoir function. At present, the sediment volume of 30,000 m^3 to 40,000 m^3 deposited in the reservoir bottom is discharged downstream every year through a sand drain pipe in order that the reservoir storage volume of 263,000 m^3 can be kept constantly. The water supply from the Buhisan dam is now limited only in the rainy season and its amount is as small as about 4,000 m^3/day.

The Malubog dam is a privately owned dam located on the Malubog 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 Manang phase II dam, it appears that the dam heightening plan is one of the promising water resources plans to augment the water supply to the Metro Cebu.

The Mananga project phase I 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 comprise a 7.5 m high underground dam, infiltration fields in the upstream river bed of the dam and 15 deep wells. A 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.

The Mananga phase II project is contemplated to be developed at a location of about 4 km upstream of the weir site of the Mananga project phase I on the Mananga river. The main component of the project is a 90 m high roller compacted concrete type dam. However, a catchment area at the dam site is as small as 68 km^2 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 those records. According to the analysis results, the mean annual basin rainfall of project area is 1,770 mm and the annual mean river discharge at the dam site was estimated at 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 run-off 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 the 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.

The Lusaran dam has been studied and proposed for a further augmentation of water supply to Metro Cebu. The initial study on the dam project was carried out in 1997, before the installation of rain gages in the basin. The dam is planned to be of rockfill type with a height of 100 m. A 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 a specific runoff of 3.06 m^3/sec/100 km^2. The water supply capacity of the Lusaran dam is estimated at 1.85 m^3/sec or 160,000 m^3/day.

D3.2.3 New Dam Schemes Identified

In general, the geological formation of Cebu Island consists of limestone. On the other hand, a belt of Malubog Formation covers the south-eastern hilly areas of the boundary of the Mananga and Lusaran basins where the Buhisan dam was constructed. There are several small rivers running south-eastward in the nearby basins of the Metro Cebu. On these small rivers, the prospective dam sites with a catchment area of 5.4 km^2 to 20.5 km^2 were identified based on the 1 to 50,000 topographic maps. These new dam sites are tabulated in Table D-2

and their reservoir storage curves are illustrated in Figure D-15.

The preliminary dam planning was made for those new dam sites. A concrete gravity type dam with a height of 45 m to 60 m was planned for each dam site in order to develop the dependable discharge between 8,000 m^3/day and 15,000 m^3/day. They are tentatively named Cebu A to Cebu F_0 as summarized in Table D-2 and compiled in the Inventory of Planned Dam-Reservoir Type Scheme. The Cebu B is same as the Buhisan dam. Further, Upper Cot-Cot (CA=9.3 km^2, H=60 m, capacity=16,000 m^3/day) and Upper Lusaran (as an alternative for Lusaran dam, CA=40 km^2, H=60 m, capacity=15,000 m^3/day) were formulated at a map study level based on the 1 to 50,000 scaled topographic and geological maps.

In addition to the aforesaid new dam development plans, heightening of the existing Malubog dam is conceivable as one of the promising alternative plans.

D3.3 Dams Planned for Water Supply to Davao City

The Davao river basin is categorized into one of the major rivers basins of the Philippines. However, there are no proposed water resources schemes in the basin. Thus, the Davao river basin is regarded as virgin basin in view of the water resources development. The Water District of Davao city is planning to develop the surface water for the municipal water supply thereto, although at present it mostly relies on groundwater lifted by deep wells. Taking those circumstances into consideration, the new multipurpose dam projects were identified and examined based on the 1 to 50,000 scaled topographic maps.

The Survey/Inventory lists two dams (Calinan #1 and #2) located in the Davao river basin. There are no river runoff records on the Davao river. While, a long-term rainfall records at Davao city for the period from 1961 to 1995 are available. As a matter of course, the rainfall at Davao city dose not represent the basin average rainfall of the Davao river basin. For instance, although a flooding hit the Davao city on July 9, 1995 according to the "Damages Caused by Major Natural Disasters by Department of National Defense", the rainfall at Davao city was recorded to be nearly zero on that date. Nevertheless, the rainfall records at Davao city are useful for examining the condition of the basin rainfall in the Davao river basin, especially lower half of the basin. The mean annual rainfall at Davao city for 35 years from 1961 to 1995 is 1,750 mm. Though it is expected the the basin rainfall on the upper half of the basin would be much higher than the lower half of the basin, some reservoir type dam schemes on the Davao river were preliminarily formulated based on the 1 to 50,000 scaled topographic maps and the rainfall records at Davao city concerning the conservative estimate of the dependable discharge.

The location of dam sites identified in the present study as well as those listed in the Survey/Inventory are depicted in Figure D-16 and their main features are listed in Table D-2. The resrvoir storage curves of the alternative dam sites I, II and IIIR are illustrated in Figure D-17. The dam schemes listed in the Table occupy the comparatively large catchment area of more than 130 km^2. It is recommended that these dam schemes be developed as the multipurpose dam project which includes municipal water supply, hydropower generation, irrigation water supply if those demands exist in the downstream areas and/or the neighboring basins.

Out of the candidate dam schemes in the Davao river basin, Davao I, II and III_R (Calinan #2) schemes were formulated and listed in the Inventory of Planned Dam-Reservoir Type Scheme.

D4 Design Criteria of Dam and its Appurtenant Structures Adopted in the Philippines

D4.1 Design Criteria of Large Dam

In the Philippines, most of the large scale dam projects have been planed under NPC and NIA. However, no standardized design criteria for dam and its appurtenant structures are established so far. According to the Engineers of NPC, in general, the large scale dams in the country have been planned and designed in accordance with the USBR's standard.

D4.2 Design Criteria of Small Dam in SWIM Project

The SWIM projects have been implemented under a lot of governmental agencies such as DPWH, NIA, BSWM. To coordinate those SWIM projects, the derailed design tools in detailed design stage, which incorporate the design criteria for dam and its appurtenant structures for SWIM project were prepared under DPWH in September 1991.

Most of the dams of SWIM projects are designed to be of fill type dam. The major design and planning criteria of the SWIM projects are as follows:

(1) Magnitude of design flood for river diversion works

The magnitude of design flood for diversion facilities is adopted to be in a range of 5 to 10-year probable flood, depending on the extent of potential damage to the downstream area, damages to embankment and delay of construction.

(2) Magnitude of design floods for dam and spillway

In case of dam of not more than 15 m in height, at least 25-year probable flood is adopted, while concerning dam higher than 15 m at least 100-year probable flood is taken. The spillway is designed for the peak discharge of outflow which is derived through the flood routing analysis of reservoir based on the inflow hydrograph of the design flood, taking into consideration the regulation effect of the reservoir.

(3) Flood surcharge (Maximum water level)

The flood surcharge space in the reservoir is considered for the design flood so that the maximum surcharge height comes to a difference between maximum and normal full water level. The maximum water level on the condition of occurrence of the design flood is estimated by means of the flood routing analysis.

(4) Freeboard

The dam crest elevation is determined to be a sum of the maximum water level and minimum freeboard, which includes an allowance for wave height and other conditions likely to take place during the flood. The freeboard is adopted to be at least 1.0 m and 1.5 m for dams of less than 15 m and exceeding 15 m in height, respectively.

(5) Sediment deposit level in reservoir

The reservoir sediment level is determined on the condition that at least the sediment inflow for 25 years and 50 years be accumulated in the reservoir in case of dams of less than 15 m and exceeding 15 m in height, respectively, assuming the horizontal deposit therein.

(6) Dam crest width

The minimum dam crest width is determined to be 20 % of dam height plus 3 m taking into account the requirement for construction as well as its permanent use as road after completion

of dam.

(7) Embankment slope

Concerning dam of less than 15 m in height, the dam embankment slopes are determined based on the standard values derived from the "Design of Small Dams, USBR" without any stability analysis. In case of homogeneous earthfill dams, the upstream and downstream slopes are in a range of 1.5 to 4.0 and 2.0 to 2.5, respectively, depending on soil classification of embankment materials used for dam body. As well, those slopes in zoned earthfill dam range between 2.0 and 3.0. On the other hand, with regard to dam higher than 15 m, the dam embankment slopes are determined based on the results of stability analysis. The dam stability analysis is made applying the empirical "Slip Circle method".

(8) Seismic coefficient

The minimum seismic coefficient for dam design is determined by region based on seismic zone map prepared by DPWH and ASEP in 1968, in which the country is divided into three zones, namely strong seismic zone, medium seismic zone and weak seismic zone. The seismic map is shown in Figure D-18. Their minimum seismic coefficients are 0.15, 0.12 and 0.05, respectively.

(9) *Minimum safety factor of dam against sliding*

The required minimum safety factors for dam stability are set up for the various combination of loads to act on dam body as summarized below:

Required Minimum requirement for dam safety

Case	Reservoir Water Level or Condition	Design Seismic Factor (%)	Load Combination	Required Safety Factor
1-A	Reservoir is empty (just after completion of dam)	0	W, U	Fs>1.5
1-B	- do -	50	W, U	Fs>1.2
2-A	Normal full water level	0	W, P, U	Fs>1.5
2-B	- do -	100	W, P, U, I	Fs>1.2
3-A	Rapid draw-down	0	W, P, U	Fs>1.5
3-B	- do -	50	W, P, U, I	Fs>1.2

Notes : W ; weight of dam body, P ; static water pressure due to reservoir water
U ; pore pressure, I ; internal force on dam body due to earthquake

D5 Existing Water Supply Facilities

D5.1 Water Supply System for Metro Manila

The water supply facilities for Metro Manila as well as the existing and proposed major water resources are schematically shown in Figure D-19. At present, the water released from the auxiliary 4 turbines of hydropower stations of the Angat dam is off-taked at existing Ipo dam by MWSS for the raw water supply to Manila. Originally, MWSS has the water right of 22 m^3/sec with respect to the water released for the hydropower generation. Under the Angat Water Supply Optimization Project (AWSOP), on the other hand, the additional water right of 15 m3/sec was granted to MWSS on the condition that the water in excess of irrigation water requirement is available. For the purpose, an auxiliary unit of No. 5 was additionally installed, but MWSS has not suffice the additional water so far.

At the Ipo dam, the Angat river water is conveyed to the Bicti headwork through the following three tunnels:

Existing Tunnel Connecting Reservoir and Treatment Plan for Manila Water Supply

No.	Existing Tunnel	Year of Completion	Dimension of tunnel (Cross Section)	Design Flow capacity (mld)	Design Flow capacity (m^3/sec)
1	Tunnel No.1	1939	2.04 m x 2.19 m	760	8.796
2	Tunnel No.2	1969	3.0 m (horseshoe)	1,890	21.875
3	Tunnel No.3	1992	4.2 m (horseshoe)	2,000	23.148
Total				4,650	53.819

As seen a table above, the existing tunnels have a total flow capacity of 53.8 m^3/sec. The raw water collected at Bicti is transmitted to the La Mesa treatment plant at La Mesa and Balara treatment plant through the Novaliches reservoir. The capacity of existing water treatment plants are summarized below:

Existing Water Treatment Capacity for Manila Water Supply

No.	Water Treatment Plants	Design Flow capacity (mld)	Design Flow capacity (m^3/sec)
1	Balara TP1	470	8.796
2	Balara TP2	1,130	21.875
3	La Mesa TP1	1,500	
4	La Mesa TP2	900	23.148
Total		4,000	53.819

D5.2 Water Supply System for Metro Cebu

The plan of water supply facilities for Metro Cebu was schematically shown in Figure D-20. The plan was made assuming that the proposed Mananga Phase II and Lusaran dams be completed to meet the water demand in the Metro Cebu in the year 2025. In the next field investigation stage, the more detailed water supply facilities plan will be worked out based on the optimum water resources development plan to meet the water demand for Metro Cebu.

D5.3 Construction Cost Data

The data and information on cost data including unit prices of major civil construction works and the prices of construction materials and equipment have been collected from the following on-going project offices:

- Agusan River Flood Control Project Office
- Lacson CIP project in Davao city
- Lubogan CIP project in Davao city

In the present study stage, the unit prices of major civil construction works were estimated with reference to those provided from the above project offices as well as those presented used for cost estimate of the Massim and Bayabas dams in the WRDP's report whose studies were carried out at a level of prefeasibility study. The unit prices thus estimated preliminarily are summarized in Table D-4.

D6 Selection of Candidate Dam Schemes

D6.1 Overview of Dam Schemes Identified and Proposed in Previous Studies

In the second stage field investigation, the Study Team collected topographic maps at a scale of 1 to 50,000 for the areas where the proposed water resources facilities are situated. The topographic maps were used to measure the catchment area, storage capacity and surface area of reservoir and work quantities of the proposed facilities. The areas for which the topographic maps were collected included those of the Abra River basin, Baguio City, Angat Reservoir, Bicol River basin, Panay Island, Negros Island, Davao City, Pulangi Dam and the Buayan Malungun River basin. In order to plan the alignment of the proposed waterway, the topographic maps at a scale of 1 to 50,000 were also collected for Metro Manila and its surrounding areas.

Most of dams proposed in this study are the ones which have been studied by the agencies concerned with the water resources development. Accordingly, the previous study reports furnished the Study Team with various valuable information for the plan formulation. The Study Team gathered the existing reports and examined the data and information therein in succession to the first stage field investigation. The reports were gathered mainly from the libraries of NPC and NIA. In addition, the reports on the previous nation-wide and basin-wide studies as well as pre-feasibility and feasibility study reports on large-scale storage dams which were carried out under JICA and other international financial agencies were referred to in preparing the dam inventory. They are the Master Plan Study on the Cagayan River Basin Water Resources Development, Panay River Basin-Wide Flood Control Study, Hydropower Potential Study in Luzon Island and pre-feasibility and feasibility studies on major dams. The various data and information on hydrology, geology, dimentions of main structures and project cost that were presented therein were arranged and examined to be availed for the preliminary design of new dam schemes newly proposed in this study in order to meet the future water demand in the basin. As a result of the examination, the project costs estimated in the previous studies were assessed to be almost in an adequate range to be applied to the present master plan study. After then, those project costs are modified with the conversion factor to adjust to the present-day price level.

On the other hand, those dams were planned and preliminarily designed on the basis of the specific topographic, hydrologic and geologic conditions. Consequently, main features of dam and its appursent structures designed differ scheme by scheme due to the different design criteria and values adopted therefor. However, the overview of the available study reports clarified the following general features.

In case of the existing and proposed dam projects in the mountainous areas of eastern part of Region II, III and IV, the average annual runoff estimated in the previous study usually give remarkably high specific discharge expressed in $m^3/sec/100\ km^2$ as shown in Table D-5. The area receives world noted high annual precipitation of 4,000 to 6,000 mm due to geographic rainfall caused by the northeast monsoon during the period from October to March. While during the period from May to October the area again receives the rainfall caused by the tropical depression or frequently by typhoon. The existing Angat dam was designed so that the average annual inflow of 75.8 m^3/sec or the specific discharge of 13.4 $m^3/sec/100\ km^2$ would take place on the basis of the discharge data recorded for the period from 1946 to 1961. On the other hand, the average runoff at the dam site decreased to 59.2 m^3/sec for the period from 1968 to 1990, which is equivalent to the specific discharge of 10.4 $m^3/sec/100\ km^2$. The reservoir water level has recovered to the designed high water level every year and even spill-out of excess water from the dam has occurred in every flood season inspite of the average withdrawal of more than 50 m^3/sec from reservoir. Taking account of the evaporation from

the reservoir surface, the high specific discharge may be attested.

The dams in Region V are designed expecting the average annual inflow equivalent to the specific discharge of about 3.0 m^3/sec/100 km^2 for the catchment areas of less than 500 km^2. The average annual inflow of the dams in Region VII are the smallest, the specific discharges thereof being about 2.0 m^3/sec/100 km^2 for the catchment areas of 100 km^2 or less. Since these dams are located in the driest area of the country, it appears that the runoff data applied and the tendencies are acceptable.

With regard to other dams with catchment areas of 100 to 1,400 km^2, the specific discharges are derived to be mostly between 5.0 and 7.0 m^3/sec/100 km^2, exhibiting the general tendency that it decreases with catchment area. The average runoff adopted for planning of those dams are judged to be acceptable.

The rehabilitation study on Ambuklao dam carried out the surveys in the reservoir. The study concluded that the average annual denudation rate for the catchment was as high as 6.0 mm for the period from the completion year of 1957 to 1986. NIA and NPC carried out the study on the sedimentation in the Magat reservoir in 1996. As a result, the high average annual denudation rate of 4.6 mm was derived through the study. The high value might reflect the effect of the earthquake which occurred in 1990. Besides, the study on the silting in the reservoir of Malubogu dam in Cebu island worked out a high denudation rate of 3.7 mm. The deforestation of those catchment would be the main course of such high sediment yields. It is noted that the comparative large storage capacities are liable to trap the larger quantity of suspended sediment to be deposited in reservoir.

In the Philippines, most of the existing and proposed dams are rock fill type. The embankment materials have been obtained from the quarry sites located in the vicinity of the dam sites. The excavation works for the foundations of dam and spillway have provided a part of embankment materials. The slopes of the upstream and downstream surfaces of Ambuklao dam are as steep as 1: 1.75 to 2.00. Angat dam has steeper slope of 1.00:1.400 at the uppermost portion of the slope of 13m in height. That of lower portion is 1.00:2.40. Those steep slope afforded smaller embankment volumes as compared with dams in Japan. Both dams have experienced the earthquake occurred in 1985 and 1990 which brought about serious damages to the structures constructed in the vicinity of the dams. However, no structural damage or defect in the dams has been reported until now. The slender dams could attest their stabilities against the seismic load.

As a result of the aforesaid rapid assessment, it is judged that most of the proposed dams are able to be adopted in the master plan as the candidates for the water resources developing schemes. The existing, proposed and promising dams are tabulated in Table D-5 and their locations are shown in Figures D-21 to D-31.

D6.2 Main Features of Selected Candidate Dam Schemes

Large dams to be proposed for the development of water resources in each water resources region and for water supply to major cities are listed in Table D-5. The locations thereof are illustrated in Figures D-21 to D-31. The candidate dams comprise 1) existing dams, 2) proposed dam of which feasibility or pre-feasibility study has been done so far, and 3) proposed dam of map study level.

In Region I, the candidates proposed are four (4) rockfill dams, mostly located in the Abra

river basin. Among those proposed, Palsiguan dam has a possibility to be a concrete gravity type dam after more detailed geologic surveys. There is a possibility that the geologic conditions of the proposed Binongan dam site does not allow to construct a high dam. In that case, the scheme should be changed to propose a concrete weir instead.

In Region II, the candidates proposed are ten (10) dams, out of which two (2) dams are situated in the Abulug River basin and eight (8) dams in the Cagayan river basin. The geologic formation of the proposed Gened damsite is composed of andesite as a whole so that the 175 m high concrete arch dam is proposed. The foundation of the proposed Diduyon dam is andesite and the preferable dam type is concrete gravity. The Study Team judged that an earthfill dam is preferable for the proposed Siffu No. 1 dam, since it is considered difficult to find a quarry site for rock materials in the vicinity of the proposed damsite. In case of the rest of the candidate proposed rest schemes, the rockfill type dams is selected. The Government of the Philippines has once abandoned Chico No. 4 dam because of the social difficulty. However, it is retained as one of the candidate schemes because there is still a slight possibility for the scheme to be realized if the purpose of the dam is changed from hydroelectric generation to water supply for municipal water and irrigation.

The number of candidates in Region III is sixteen (16), the largest one among the 12 Regions. In relation to municipal water supply to Metro Manila, two large-scale dams are proposed in the previous WRDP's study. These are the Bayabas and Massim dam schemes which are located in the Angat River basin. The average inflow to the proposed Bayabas dam was derived to be the extraordinary large figure of 13.6 m^3/s for the catchment area of 50 km^2. It was revised referring to the average inflow to the proposed Maasim dam with a catchment area of 54 km^2, which is presented in the

The candidates in Region IV are the existing Caliraya dam and the proposed Kanan and Laiban dams. The purpose of the Caliraya dam is hydropower generation. It is provided with the pumed storage type hydropower station with an installed capacity of 300 MW. The geologic formation of Kanan dam is composed of andesite and a concrete gravity type dam with a height of 158 m is proposed on the Kanan River, tributary of the Agos river, in the past Hydropower Potential Study in Luzon Island. In this study, the rockfill type dam is contemplated to be installed at the sam loaction in consideration of the uncertain geologic condition. The geology of the proposed Laiban dam on the Kaliva River is composed of limestone. It is foreseen that leakage from the reservoir and dam foundation would take place with a high possibility after construction of the proposed high dam, taking the geological condition of the dam site into consideration. In this study, accordingly, a concrete weir is proposed instead of the high dam with a reservoir. The tapped water therefrom is going to be conveyed to a reservoir planned at Cogeo through the tunnel for the purpose of municipal water supply to Metro Manila.

There are two (2) candidates in Region V, the proposed Talisay and Sipocot dams. Both dams are located in the Bicol river basin. The proposed dam type is rockfill type for both dams.

The proposed 52.4 m high Panay concrete gravity dam on the Panay river has a reservoir with a storage capacity of 96 million m^3. The dam is the sole candidate in Panay island, which is proposed to develop the water resources in the island which belongs to Water Resources Region VI. The proposed Bago and Ilog No. 1 dams are the candidates in Negros Island. Both of the proposed dams are rockfill type and are expected contribute to the augmentation of the water resources in Negros Island.

In Region VII, six (6) dams are proposed mainly to suffice the water demand in Metro Cebu.

The five (5) dams are located in Cebu Island and one (1) in Bohol Island. Since most of the rivers in Cebu Island are short in river course length and steep in riverbed slope, the dam site that can create a large reservoir storage is not identifiable in the neighborhood of the city. While, Tipolo dam with a height of 60 m, which is proposed on the Inabanga river in Bohol island, has a comparatively large storage volume of 210 million m^3. The rockfill dam type is selected for the Tipolo dam. The Bohol-Cebu Water Supply Project contemplates that a part of the streamflow to be regulated by the reservoir is conveyed to Metro Cebu across the strait between both islands.

In Region VIII, no surface water resources development is proposed.

The proposed Tumaga dam is the only candidate to develop the water resources in the Region IX. The proposed dam is rockfill type with the height of 86 m and storage capacity of 44 million m^3.

Bulanog-Batang dam is proposed to develop surface water in the vicinity of Cagayan de Oro City to cope with the rapid increase of municipal water demand in the city. The rockfill dam with a height of 130 m would create a storage capacity of 102 x $10^6 m^3$. The dam is the only candidate in Region X.

In the Davao river basin, three (3) dams are proposed identified for the multi-purposes including municipal water supply to Davao City. The rockfill type dam is recommendable for all of three (3) dams. Dimuloc dam is situated on the Buayan-Malungan river. The dam with a height of 120 m generate the reservoir with a storage capacity of 293 x $10^6 m^3$.

The proposed Pulangi III and Cabilan dams on the Mindanao river are the candidates in Region XII. Pulangi III rockfill dam with a medium height of 90 m would provide a reservoir with a large storage capacity of 1,200 million m^3.

D7 Preliminary Design for New Water Supply Projects

The preliminary design was carried out for water resources facilities and water supply facilities, which were newly contemplated in this study for the purpose of water supply to major cities including Baguio City, Metro Manila, Metro Cebu. Concerning some of the Selected major cities, several alternative structures for the water resources development and water supply for the major cities are contemplated and preliminarily designed as the candidate scheme.

D7.1 New Water Supply Projects for Metro Manila

D7.1.1 General

For the water supply for Metro Manila, the conceivable candidates are the following five (5) schemes;

1) Kanan-Umiray Transbasin Project (KUTP)
2) Maasim and Bayabas Dam Project
3) Kaliwa Water Conveyance Project
4) Pampanga Water Conveyance Project

The above water supply projects to cope with the future water demand in Metro Manila were prelimarily formulated through this study. On the other hand, the Kaliwa-Kanan water supply project inclusive of the construction of the Laiban dam is illustrated in Figure D-32.

The main features of those schemes are presented in Table D-6 and their locations in Figure D-33. The main features thereof are explained hereunder.

D7.1.2 Kanan-Umiray Transbasin Project (KUTP)

The proposed Kanan dam site is located 17 km north from the confluence of the Kanan river and the Kaliwa river, both of which are a tributary of the Agos river. The purpose of this Project is to divert 18 m^3/sec of water from the Kanan river through the proposed connecting tunnel to the Umiray river in the upstream of Agos river basin. The diverted water is planned to be again diverted to the existing Angat dam through the trans-basin tunnel, which is under construction under Umiray-Angat Transbasin Project. The inlet of connecting (conveyance) tunnel is proposed at a location of 2 km upstream from the proposed Kanan dam site. The concrete-lined tunnel is designed to have a length of approximately 14 km and a diameter of 3.2 m.

The rockfill type of dam is recommended for this project, although more detailed geologic study is necessary in the final decision. Out of the total discharge of 40 m^3/s, 18 m^3/s is to be shared and be diverted from the proposed Kanan dam to Umiray river for the water supply to Metro Manila.

Table D-6 and Figures D-34 and D-35 present the detail features of the scheme.

D7.1.3 Maasim and Bayabas Dam Project

The Maasim dam is located on the Maasim river, a tributary of Pampanga river, approximately 23 km east-southeast from San Luis and 9 km west-northwest from Angat. A

Pre-feasibility study on the Maasim dam was carried out by IBRD in 1994, substantially for the purpose of augmenting the water supply capacity for Metro Manila. The water released from the proposed Maasim dam is join to the Pampanga River at the 19 km downstream from the proposed site. The increased water of the Pampanga river is planned to be tapped for the purpose of irrigation water supply, thereby enabling the allocation of irrigation water supplied by existing Angat dam. As a result of the realization of Massim dam, thus, it is expected that the municipal water supply to Metro Manila from the Angat dam can be augmented. Table D-6 and Figures D-33 and D-35 present the detail features of the scheme.

The Bayabas dam is located on the Bayabas river, a tributary of Angat river, 6 km northeast from the Angat dam or 6 km upstream from the confluence with the Bayabas river and Angat river. A pre-feasibility study on the Bayabas dam was performed by IBRD in 1994, as well as the case in the aforesaid Massin dam, for the purpose of the augmentation of water supply for Metro Manila. The water released from the proposed Bayabas dam is to flow down to join to the Angat river. Table D-6 and Figures D-33 and D-35 present the detail features of the scheme.

It is expected that the additional water of about 5 m^3/sec can be allocated to municipal water supply for Metro Manila from the Angat reservoir after the completion of the Massim and Bayabas dams.

D7.1.4 Kaliwa Water Conveyance Project (KWCP)

The existing study report on the Manila Water Supply Project III (MWSP III) recommended that the Laiban rockfill dam (Kaliwa Dam) on the Kaliwa river be developed as the source of water supply for Metro Manila prior to the Umiray-Angat Transbasin Project (UATP). The highlight of the Kaliwa scheme, however, is the Laiban rockfill dam with a height of 143 m. The limestone formation is dominant in the reservoir area of the proposed dam. Besides, it seems to have the geological problems, although the technical viability needs to be verified through the detailed geological investigation. Therefore, the Kaliwa - Cogeo Water Supply Project proposes to construct a gated weir at the same location as that of the Laiban dam. The othe water supply facilities involved in the project are desanding basin, a water conveyance tunnel, a water treatment plant, pumping facilities, related structures of water supply pipe line and regulating reservoir. The proposed gated weir is located 20 km northeast from Tanay located adjacent to Laguna de Bay.

Water to be diverted by the proposed gated weir will be conveyed through a connecting tunnel to the proposed water treatment plant in Pantay located at 14.7 km downstream of the gated weir site. The water from treated by the water treatment plant is going to be conveyed to the regulating reservoir at Cogeo, located 11 km northwest from proposed water treatment plant, through water supply pipe line. Then, water will be distributed to the service area of MWSS from this proposed regulating reservoir.

Table D-6 and Figures D-33 and D-34 present the detail features of this project.

D7.1.5 Pampanga Water Conveyance Project (PWCP)

The proposed Pampanga Water Supply Project is composed of a gated weir, a desanding basin, pumping facilities, water supply pipe line and other relevant structures. The proposed gated weir is located about 1km north-northeast from San Luis and San Isidro. In the first stage field investigation, the Study Team conducted the field reconnaissance to select the route of

proposed water supply pipe line and location of the proposed gated weir on the Pampanga river. Consequently, the weir site is selected at the location near Apalit on the Pampanga river. However, the alcohol plant is being operated upstream of proposed gated weir site so that the gated weir site was shifted finally to the upstream location.

The water tapped from the Pampanga river is to be conveyed to the existing Novaliches reservoir and water treatment plant located approximately 65 km southeast of the proposed gated weir site (Intake site) through the proposed pipe line and the related structures.

Table D-6 shows the main features of the proposed project and the general alignment is depicted in Figure D-35.

D7.2 New Water Supply Projects for Metro Cebu

D7.2.1 General

To meet the future water demand in Metro Cebu, the following four (4) candidate schemes are conceivable:

1) Inabanga-Mactan Water Supply Project (Bohol-Cebu Water Supply Project Including Tipolo Dam Project)
2) Malubog-Mananga Transbasin Project (MMTP)
3) Lusaran-Pulambato Transbasin Project (LPTP)

Each of the above projects is discussed as follows;

D7.2.2 Malubog-Mananga Transbasin Project (MMTP)

The proposed Malubog dam is proposed aiming at supply water for Cebu City. The proposed Malubog dam is located on the Sapanodaku, river approximately 22 km west-northwest of Metro Cebu or about 8 km east-southeast of Toledo City. The water stored in the Malubog reservoir is planned to be divert to the proposed Mananga-II reservoir which is planned as a cascade plan from the proposed Malubog dam. Thus, the MMTP aims to expand the water supply capacity of the Mananga dam by conveying streamflow of the Malubog basin into the Mananga reservoir. On the other hand, it has to be noted that a feasibility study on the Mananga Phase II project including the Mananga dam is carried out. In this study, the MMTP is contemplated as the alternative plan of the Mananga Phase II project. It is recommended that the detailed investigation or the MMTP be carried out in the subsequent study, especially in order to clarify the geological conditions of the Malubog dam site as well as the water quality of the river which might be polluted by the past mining activities in the basin.

In the MMTP, a 10.5 km long transbasin tunnel with a diameter of 2.0 m is planned to be constructed to connect those two reservoirs. In addition to the municipal water supply to Metro Cebu, the MMTP aims at the hydropower generation. Two power stations are contemplated to be provided in the MMTP. One is layed out at the outlet portion of the transbasin tunnel, which will generate power utilizing the discharge conveyed from the Malbog reservoir. The other will be situated just downstream of the Mananga Phase II dam. It is estimated that these power stations would have an installed capacity of 2.1 MW and 2.8 MW, respectively. Thus, this study contemplates to develop the MMTP as the multi-purpose dam project. It is anticipated that the water supply capacity of the MMTP would be about 1.75 times that of the Mananga Phase II Project. Besides, it seems very harness to effectively

utilize the streamflow of the Malubog river basin for water supply to Metro Cebu due to the geographical condition, unless these two dams are connected by the transbasin tunnel. The proposed Mananga Phase II Dam is to regulate the water conveyed from the proposed Malubog dam to supply water for Metro Cebu. The proposed Mananga Dam is located approximately 79 km west-northwest of Cebu City.

The existing Mananga Phase I Dam is located downstream of the proposed Mananga Phase II Dam. This existing dam is an underground type dam.

The total discharge of 2.82m^3/s, 1.43 m^3/s from the Malubog dam and 1.39 m^3/s from the Mananga river basin, will be conveyed to the proposed Tisa water treatment plant in the Buhisan river basin by a pipe line. The proposed Tisa water treatment plant is located 2 km southeast of the proposed Mananga Phase II Dam or 4 km west of Metro Cebu. The treated water will be distributed to the service areas of the Metro Cebu Water District (MCWD)

Table D-6 and Figures D-36 and D-37 present the main features of the MMTP.

D7.2.3 Lusaran - Pulambato Transbasin Project (LPTP)

Lusaran - Pulambato Water Supply Project is the combined project of the proposed Lusaran Dam and proposed Pulambato Dam.

Lusaran dam is proposed to be a rockfill type dam located in the northern part of the Balamban river basin approximately 22 km from Metro Cebu. The proposed Pulambato dam and reservoir are located approximately 9.9 km south-southeast of the proposed Lusaran reservoir, discharges 2.05 m^3/sec of water. The proposed Lusaran power station generates the electric of 2,200 kW (Normal) and 8,500 kW (Peak) harnessing a head of approximately 130 m between Lusaran dam and Pulambato dam.

Further, another power station is proposed to be provided just downstream of proposed Pulambato dam site that will generates 1,000 Kw using the tailwater from the Lusaran power station. The tailwater from the Lusaran power station is to be regulated by the proposed Pulambato reservoir. Then, water will be conveyed by pipeline to the proposed Talamban water treatment plant located approximately 3.5 km northeast of the proposed Pulambato reservoir or approximately 9 km north-northeast of Metro Cebu.

Table D-6 and Figures D-36 and D-37 show the main features of the scheme.

D7.2.4 Inabanga-Mactan Water Supply Project (Bohol-Cebu Water Supply Project including Tipolo Dam Project)

This project is planned to convey the water of 1.6 m^3/sec from the Inabanga river in the Bohol Island to the proposed water treatment plant facilities in the Mactan Island constituting a part of Metro Cebu. The pipeline needs to run across the approximately 31 km long Cebu Strait between the Bohol and Mactan Islands. Thus, the project require the installation of marine pipelines which are to be laid out on sea bottom of Cebu Strait. The gated weir is proposed to be provided on the Inabanga river at a location of 12.5 km upstream from the river mouth. The proposed project involves the construction of a gated weir, desanding basin, intake pond, pumping station, water supply pipe line, water treatment plant, regulating reservoir and other related structures. In the second stage of the project, Tipolo Dam is planned to be constructed on the Inabanga river in order to augment the water supply capacity. The proposed Tipolo

Dam is located approximately 10.5 km upstream from the proposed Inabanga gated weir. Tipolo Dam is designed to be of rockfill type dam taking account of the prevailing geological condition in Bohol Island. A power station with an installed capacity of 2,400 kW is proposed at the downstream location of the dam. In the second stage, thus, the tailwater released from Tipolo power station is planned to be off-taken at the downstream weir site.

Table D-6 and Figures D-36 and D-38 present the detail features of the project.

D7.3 New Water Supply Projects for Baguio City

D7.3.1 General

The recommended water source of Baguio City water supply is the Laboy river located approximately 8 km southeast of the Baguio City.

The gated weir scheme is a candidate and the proposed site is located approximately 15 km east-northeast from Baguio City. A dam scheme is the other candidate and the proposed site is located approximately 12.5 km northeast of Baguio City. The proposed water treatment plant is located east-southeast about 8 km and 10 km from the proposed sites of the two candidate schemes. Treated water from the water treatment plant will be sent to the regulating reservoir for water supply to Baguio City.

Table D-6 and Figures D-39 to D-44 present the detail features of the candidate schemes.

D7.3.2 Laboy Dam Project

The proposed dam is located approximately 14 km west-northwest of Baguio City. This project is composed of a rockfill dam, one (1) pumping station, four (4) booster stations, water conveyance pipe line, water treatment plant and regulating reservoir. Table D-6 and Figures D-40 and D-42 present the details of the project.

D7.3.3 Laboy Weir and Pond Project

The proposed weir is located approximately 16 km west-northwest of Baguio City. This project is composed of a gated weir, a desanding basin, one pumping station, three booster stations, water conveyance pipe line, water treatment plant and regulating reservoir. Table D-6 and Figures D-41, D-43 and D-44 present the details of the project.

In the latter part of the second stage field investigation, the JICA Study Team was informed that the intake structure of BOT-based water supply project for Baguio City was planned to be provided on at the downstream reach of the proposed dam site. Therefore, the water resources development plan for the Laboy basin, which aims the municipal water supply to Baguio City, was contemplated in consideration of the BOT scheme industrial purposes of Baguio City.

If a proposed rockfill dam is constructed at the upstream of the BOT scheme, it could regulate and supply enough water for domestic and industrial purpose. Thus, the rockfill dam scheme has an advantage over the gated weir scheme because of the storage volume and the regulating capability. Figures D-39 illustrates the layout plan of project.

D7.4 New Water Supply Projects for Other Major Cities

The preliminary design was carried out for Bacolod City, Cagayan de Oro City and Davao City.

The proposed Bago multipurpose dam would be an alternative to supply municipal water to Bacolod City in the future. The proposed Bago dam is located on the Bago river near the town of Murcia, 25 km southeast of Bacolod City, the capital of Negros Occidental.

Regarding the cities of Cagayan De Oro and Zamboanga, surface water development which aim at municipal water supply are contemplated as shown in Figures D-45 to D-47.

D8 Preliminary Cost Estimate

D8.1 Methodology and Procedure Applied

The basic assumptions and conditions employed for the cost estimates for the master plan study are set forth with reference to those adopted in the Agno River Flood Control Project (Phase II), Pinatubo Hazard Urgent Mitigation Project and other similar on-going projects.

The unit price data as well as data and information on construction materials and equipment were collected the following sources during the field investigation:

(1) Lacson CIP Project in the around of Davao City (Region XI)
-Unit price of the civil construction works and construction equipment

(2) Lubogan CIP Project in and around Davao City (Region XI)
-Unit price of the civil construction works and construction equipment

(3) Data source; Cost estimate report for Maasim dam and reservoir
-Unit price of the civil construction works and construction equipment

(4) Data source; Cost estimate report for Bayabas dam and reservoir
-Unit price of the civil construction works and construction equipment

(5) Agno River Flood Control Project (Phase II)
-Unit price of the civil construction works and construction equipment

The location of the concrete aggregates or plants was selected at the nearby area of the proposed project site considering the scale of the structure.

The construction cost consists of costs of the civil works, land acquisition and compensation, administration cost of executive agency, cost of engineering services and contingency. The project costs were estimated on the basis of the following procedures and assumption:

1) The cost estimate is carried out at the price level on July 1997. The exchange rate of 1 US$ = 27.7 Pesos in July 1997 is applied to estimate the cost.

2) All the construction works are executed by contracting system, and the civil works are carried out by the contractor.

3) All equipment and their spare parts required for the works are provided by the contractor.

4) The cost required for civil works consist of cost for preparatory works, main civil works, architectural works, mechanical works and miscellaneous works. In case that the total project costs had bean adequately estimated in the previous studies, they were escalated with the adjustment factors to derive their present-day construction costs. The adjustment factors used for the purpose are obtained through the examination of the historical price escalation data as discussed in Part-A of this Supporting Report. With regard the projects identified newly or new construction works proposed in this study, their construction costs were estimated with the cost formulae shown in Figure D-48. As for the construction works to which those formulae are not applicable, the quantity calculation therefor is made on a 1 to 50,000 scaled topographic maps. After

then, the quantities are priced by multiplying them by their unit prices, which are determined with reference to those in the similar projects in the Philippines.

5) The unit price applied includes costs for the materials, plan and equipment including the spare parts, operators, technician, labors and contractor's overhead, profit and the local taxes.

6) The costs for preparatory and other works are assumed to be 10% and 5% of the cost of main civil works, respectively.

7) The cost for land acquisition and compensation of house, paddy field and plantation are estimated based on the 1 to 50,000 scaled topographic maps.

8) The engineering services and administration costs are assumed to be 6% and 5% of the sum of the costs for the civil works and land acquisition and compensation, respectively.

9) The physical contingency is assumed to be 10% of the sum of all above costs.

10) The construction cost is further divided into foreign and local currency portions to enable conversion of the financial cost into the economic cost.

11) For estimating of the unit prices for the civil works, the unit price of labor wages, materials and equipment expenses, which are currently applied to the similar projects in the Philippines, are utilized in this study.

12) The annual operation and maintenance cost of each project is approximated as follows;
- 0.5% of the total construction cost for civil works.
- 2% of the total installation cost for the hydro-mechanical equipment.

D8.2 Preliminary Cost Estimate

The preliminary cost estimate was carried out for the proposed water supply project for Metro Manila, Metro Cebu and Baguio City. The proposed water supply projects for those major cities are as follows:

1) Candidate schemes for the Metro Manila
- Kanan-Umiray Transbasin Project (KUTP)
- Maasim and Bayabas Dam Project
- Kaliwa-Cogeo Water Supply Project (KCWSP)
- Pampanga Water Conveyance Project (PWCP)

2) Candidate schemes for the Metro Cebu water supply
- Malubog-Mananga Transbasin Project
- Bohol-Cebu Water Supply Project including Tipolo Dam Project
- Lusalan- Plambato Water Supply Project

3) Candidate schemes of the Baguio City water supply
- Laboy Dam Water Supply Scheme
- Laboy Weir Water Supply Scheme

The estimated project costs are summarized in the Tables D-8 and D-9.

The detailed Bill of Quantities for the aforesaid water supply projects for major cities are tabulated in Tables D-11 to D-21, respectively.

D8.3 Construction Schedule

The preliminary construction schedules for the respective water supply projects were set up taking into account the work quantities involved therein as depicted in Figures D-49 to D-55. As seen in those Figures, it is estimated that the total construction period of those projects would to be 6 to 7 years, including the period for the detailed design.

D9 Operation and Maintenance Plan

The specific operation and maintenance plan for each facility proposed under the current master plan should be prepared in the course of its feasibility study and further in its detailed design stage, because the nature and content of the operation and maintenance plans for some specific facilities are sensitive to the local natural conditions, purpose and scale of the components of the schemes. The operation and maintenance plan for each specific facility is one component of the comprehensive water resources management plan.

Here, instead of preparing the operation and maintenance plan for the specific facilities, the items to be incorporated in the water resources management plan are listed below:

Watershed management
- Restriction of land use in the catchment area
- Conservation of forests
- Restriction of deforestation
- Restriction of slash-and-burn agriculture
- Promotion of reforestation
- Promotion of sand arresting and/or erosion control works in the upper reaches of the basin

Discharge management
- Flood discharge
- River maintenance flow
- Diversion intakes
- Sediment discharge
- Velocity control of fish way

Environmental preservation of water quality
- Proper slag management of mining operation
- Control of factory wastes
- Preparation/extension of sewerage system

Improvement of old facilities
- Improvement/innovation of old/damaged facilities

For the existing five (5) large dams in Luzon Island, the flood forecast and warning systems which consist of several telemetered rain gauges control in and around the dam watershed, telemetered reservoir water level gauges and a control system have been provided and effectively utilized for the management of the dam operation. These existing systems, however, are provided to function literally for floods. In the future, some significant river basins of the Philippines may be managed under the integrated manner, not only for flood control, but also for water allocation in the droughts. To realize such an advanced water management system, the following monitoring systems should be successively introduced in the dam schemes proposed under the current master plan:

i) Rain gauge telemetering system not only for the catchment of the dam, but also for the downstream plants
ii) Water level gauge telemetering system not only for the reservoir water level, but also at some strategic points of the river course
iii) Water quality monitoring telemeters

iv) Simulation system such as
- Rainfall prediction system for typhoons
- Short time rainfall prediction system
- Flood prediction system
- Low water level simulation system (inflow and outflow calculations for the reservoir)
- Integrated operation of multi-reservoirs.

Part – D

Tables

Table D-1 LIST OF LARGE SCALE DAMS IDENTIFIED IN THE PHILIPPINES (1/5)

NO.	SITE	RIVER	PROVINCE	COORDINATES OF DAMSITE N. LAT.	E. LONG	D.A. Sq. Km.	D.H. (M)	PURPOSE I	P	FC	M&I	ETC.	AGENCY
REGION I													
1	BULU	BULU	ILOCOS NORTE	18-31-08	120-50-52	165	220	X	X				NIA
2	VINTAR # 1		ILOCOS NORTE	18-21-52	120-46-54	55.8	80	X	X	X		X	
3	DADAUR	BANBAN RIVER	ILOCOS NORTE	18-28-24	12-43 47	39.62	60	X	X	X		X	
4	VINTAR #2	VINTAR	ILOCOS NORTE	18-31-55	120-44-24	139	160	X	X				NIA
5	SULBEC	PASUQUIN	ILOCOS NORTE	18-20-54	120-38-15	39.87	30	X		X		X	
6	TAMDAGAN	TAMDAGAN	ILOCOS NORTE	18-17-57	120-46-02	248	160	X	X	X		X	NIA
7	SOLSONA #1	CURA	ILOCOS NORTE	18 09-10	120-50-57	67	90	X	X	X		X	NIA
8	SOLSONA #2	LABUGAON	ILOCOS NORTE	18-06-45	120-50-23	101	110	X	X	X		X	NIA
9	SOLSONA #3	SOLSONA	ILOCOS NORTE	18 04-55	120-49-04	49	90	X	X	X		X	NIA
10	DINGRAS	MADONGAN	ILOCOS NORTE	18-00-29	120-45-39	154	120	X	X	X		X	NIA
11	SO. SACRITAN		ILOCOS NORTE	17-53-51	120-36-38	31.71	45	X		X		X	
12	STO. NIÑO	PAPA	ILOCOS NORTE	17-57-46	120-43-46	51	90	X	X	X		X	NIA
13	NUEVA ERA	BANGA	ILOCOS NORTE	17-53-37	120-44-52	52	160	X	X	X		X	NIA
14	NAGREBCAN	TIBANGRAN	ILOCOS NORTE	17-53 47	120-31-51	72	120	X	X	X		X	NIA
15	PALSIGUAN	PALSIGUAN	ILOCOS NORTE	17-49 45	120-43-47	153	180	X	X	X		X	NIA
16	BANUCAL	LANCUAS	ILOCOS SUR	17-17-24	120-33-03	55	140	X	X	X		X	NIA
17	BUGUI	STA. MARIA	ILOCOS SUR	17-14-33	120-32-42	34	120	X	X	X		X	NIA
18	BUAYA	BUAYA	ILOCOS SUR	17-08-27	120-33-38	110	160	X	X	X		X	NIA
19	UP. BUCNIT	ABRA #1	ILOCOS SUR	17-03-30	120-44 45	525	130	X	X	X		X	NPC
20	BUCNIT	ABRA	ILOCOS SUR	17-05-18	120-44-00	563	190	X	X			X	NIA
21	SUAGAYAN	DAGMAN	ILOCOS SUR	17-06-45	120-40-02	27.94	60	X	X	X		X	
22	NAMITPIT	NAMITPIT	ILOCOS SUR	17-05-30	120-41-05	74.49	60	X	X	X		X	
23	SUYSUYAN	BALASIAN	ILOCOS SUR	17-07-30	120-44-20	164.43	120	X	X	X		X	
24	LOBONG	CHICO # 1	ILOCOS SUR	16-58 47	120-31-10	211	200	X	X	X		X	NIA
25	USO	CHICO #2	ILOCOS SUR	16-58-26	120-32-17	150.74	150	X	X	X		X	NIA
26	TIBUNEC	BAKLIN	ILOCOS SUR	16-52-30	120-32-52	241	190	X	X	X		X	NIA
27	DAYAPAN	MALAYA	ILOCOS SUR	16-55-10	120-41-12	214.83	40	X	X	X		X	
28	LUYA	AMBURAYAN	ILOCOS SUR	16-47-40	120-32-30	610	205	X	X	X		X	NIA
29	AGAGRAO	AGAGRAO	ILOCOS SUR	17-22-30	120-33-24	75	150	X	X	X		X	NIA
30	BANOANG	ABRA	ILOCOS SUR	17-33-30	120-28-18	4742.1	150	X	X		X	X	NIA
31	AMLUAGAN	DAMANIT	ABRA	17-18-35	120-43-00	148.71	100	X	X			X	
32	KUMANGA	DITONG	ABRA	17-11-10	120-43-24	99.39	140	X	X	X		X	
33	BOYAN	IKMIN	ABRA	17-24 47	120-46-35	256.52	60	X	X	X		X	
34	MABUNGTAT	MANIKBEL R.	ABRA	17-28-26	120-20-52	40.51	80	X	X	X		X	
35	CALLABAN	MANIKBEL R.	ABRA	17-27-31	120-46-50	66.28	80	X	X	X		X	
36	UPPER MAGUYEPYE	BUCLOC R.	ABRA	17-26-50	120-47-07	216.79	60	X	X	X		X	
37	BUCLOC	SULDEN CR.	ABRA	17-26-34	120-52-04	147.39	50	X	X	X		X	
38	TOQUENG	IKMIN	ABRA	17-22-46	120-49-53	185.4	50	X	X	X		X	
39	DANAC	IKMIN	ABRA	17-23-05	120-53-38	117.78	50	X	X	X		X	
40	DAGUIOMAN	BUCLOC	ABRA	17-27-25	120-55-00	97.76	60	X	X	X		X	
41	TAPING #1	BAAY R.	ABRA	17-33-55	120-46-50	147.41	200	X	X	X		X	
42	SUBUSOG	ABAS	ABRA	17-30-54	120-46-25	46.09	40	X	X	X		X	
43	PAGANAO	MALANAS R.	ABRA	17-39-50	120-49-14	200.38	120	X	X	X		X	
44	LICUAN	KAWAYAN	ABRA	17-37-00	120-54-00	123.8	60	X	X	X		X	
45	TAPING #2	LINGAS	ABRA	17-35-24	120-47-25	68.23	80	X	X	X		X	
46	KAPUALAN	KAWAYAN	ABRA	17-37-39	120-57-23	62.68	80	X	X	X		X	
47	OMAGIT	MALAPAAO R.	ABRA	17-36-14	120-33-05	42	60	X	X	X		X	
48	PALANG		ABRA	17-34-03	120-30-29	34.6	30	X		X		X	
49	ARAB	SINALANG	ABRA	17-30-59	120-37-15	123.93	30	X		X		X	
50	BANGUED	MALAPAAO	ABRA	17-43-20	120-33-54	60.51	80	X	X	X		X	
51	BANDI	SAQUET-SOOT R.	ABRA	17-43-10	120-38-40	117.94	100	X	X	X		X	
52	LANGIDEN	MALAPAAO	ABRA	17-40-50	120-32-30	93.45	80	X	X	X		X	
53	TINEG #3	TINEG	ABRA	17-47-20	120-57-35	309.55	80	X	X	X		X	
54	ALAOA	BINONGAN	ABRA	17-45-22	120-52-20	492	210	X	X	X		X	
55	TINEG #1	TINEG	ABRA	17-48-30	120-52-00	419.05	200	X	X	X		X	
56	TINEG #2	TINEG	ABRA	17-47-00	120-47-00	982	200	X	X	X		X	NIA
57	ABUALAN		ABRA	17-42-55	120-46-39	77.06	120	X	X	X		X	
58	NAGLIBACAN	ANAYAN	ABRA	17-51-30	120-53-00	171.87	140	X	X	X		X	
59	DUPLAS	DUPLAS R.	LA UNION	16-49 08	120-29-38	30.39	60	X	X	X		X	
60	DRISSOR	CABASITAN R.	LA UNION	16-39-28	120-26-08	31.26	60	X	X	X		X	
61	RIZAL	GALIANO	LA UNION	16-22-40	120-26-00	126.37	140	X	X	X		X	
62	BAGULIN	NAGUILIAN	LA UNION	16-36-53	120-27-15	319.08	100	X	X	X		X	
REGION II													
63	SISIRITAN	ABULOG	KALINGA-APAYA	18-09-42	121-21-00	1951	45	X	X	X		X	NPC
64	BUBULAYAN	ABULOG	KALINGA-APAYA	18-06-18	121-18-18	1679	70	X	X	X		X	NPC
65	GENED	ABULOG	KALINGA-APAYA	18-05-18	121-15-36	1661	160	X	X	X		X	NPC
66	BULU	ABULOG	KALINGA-APAYA	18-02-30	121-13-00	1609	140	X	X	X		X	NPC
67	NABABALAYAN	APAYAO	KALINGA-APAYA	18-02-00	121-08-00	1050	70	X	X	X		X	NPC
68	DIBAGAT	APAYAO	KALINGA-APAYA	18-05-20	121-06-00	832	70	X	X	X		X	NPC
69	AGBULU	APAYAO	KALINGA-APAYA	18-08-20	121-05-00	769	115	X	X	X		X	NPC
70	AOAN	APAYAO	KALINGA-APAYA	18-15-30	120-00-20	147	100	X	X	X		X	NPC
71	PINUKPUK	SALTAN #1	KALINGA-APAYA	17-37-06	121-23-52	817.4	80	X	X	X		X	NPC
72	ADAGA	SALTAN #2	KALINGA-APAYA	17-30-15	121-16-20	353.8	125		X	X		X	NPC
73	SALTAN #4	SALTAN #4	KALINGA-APAYA	17-30-30	121-11-00	204.4	185		X	X		X	NPC
74	SALTAN #5	SALTAN #5	KALINGA-APAYA	17-30-04	121-07-00	145.8	210		X	X		X	NPC
75	NANENG	TANUDAN	KALINGA-APAYA	17-23-15	121-16-41	385	195		X	X		X	NPC
76	MT. BOLANTOT	PASIL	KALINGA-APAYA	17-23-15	121-09-30	250	114	X	X	X		X	NPC

Data Source : The Survey/Inventry by the National Water Resources Council, April 1978

Table D-1 LIST OF LARGE SCALE DAMS IDENTIFIED IN THE PHILIPPINES (2/5)

NO	SITE	RIVER	PROVINCE	COORDINATES OF DAMSITE N.LAT.	E.LONG	D.A. Sq. Km.	D. H. (M)	PURPOSE I	P	FC	M&I	ETC.	AGENCY
REGION II													
77	BANATAO	MALLIG #2	KALINGA-APAYA	17-18-06	121-28-55	345.1	110	X	X	X		X	NPC
78	BASAO	CHICO #3	KALINGA-APAYA	17-14-32	121-07-30	920	64	X	X	X		X	NPC
79	TOMIANGAN	CHICO # 4	KALINGA-APAYA	17-23-38	121-13-37	1408	160	X	X	X		X	NPC
80	BONTOC	CHICO #1	MT. PROVINCE	17-04-18	120-56-30	371	160	X	X	X		X	NPC
81	SADANGA	CHICO #2	MT. PROVINCE	17-08-53	121-03-08	720	160	X	X	X		X	NPC
82	TAOTAO	TAOTAO	MT. PROVINCE	16-57-16	121-33-02	387	30	X		X		X	NPC
83	TABUK	MALLIG # 1	MT. PROVINCE	17-16-20	121-32-06	563	30	X	X	X		X	NPC
84	NATONIN	SIFFU #1	MT. PROVINCE	17-08-00	121-30-10	414	100		X	X		X	NPC
85	PASTOR	SIFFU #2	MT. PROVINCE	17-05-53	121-20-18	359	140		X	X		X	NPC
86	ALIMIT # 1	ALIMIT	IFUGAO	16-46-20	121-16-30	513	220		X	X		X	NPC
87	ALIMIT #2	ALIMIT	IFUGAO	16-54-00	121-16-22	426	120		X	X		X	NPC
88	IBUOAB	IBULAO	IFUGAO	16-44-36	121-10-00	526.4	120		X	X		X	NPC
89	CAPISAYAN	DUMMON	CAGAYAN	18-03-06	121-51-15	195.2	55	X	X	X		X	NPC
90	ZINUNDUNGAN	ZINUNDUNGAN	CAGAYAN	17-59-45	121-27-28	152	60		X	X		X	NPC
91	MATALAG	MATALAG	CAGAYAN	17-49-53	121-24-17	642.9	130		X	X		X	NPC
92	BANTAY	PARET	CAGAYAN	17-55-00	121-49-00	735	75	X	X	X		X	NPC
93	DABBA	PINACANAOAN DE TI	CAGAYAN	17-42-05	121-50-05	452	160	X	X	X		X	NPC
94	ZIMIGUI	ZIMIGUI	CAGAYAN	18-24-45	121-18-06	317.85	100	X	X	X			
95	STA. ANA	PALAWIG	CAGAYAN	18-22-55	122-12-06	100.03	90	X	X	X			
96	STA. FILOMENA	NAGABARON	CAGAYAN	18-00-30	121-04-10	65.74	40	X	X				
97	SAN PABLO	PINACANAOAN	ISABELA	17-28-12	121-49-40	209.8	110		X	X		X	NPC
98	TUMAUINI # 1	PINACANAOAN	ISABELA	17-18-25	121-57-38	165	150	X	X	X		X	NPC
99	MARIANO	PINACANAOAN DE TI	ISABELA	16-41-36	122-04-00	1226.1	100	X	X	X		X	NPC
100	CATALANGAN	CATALANGAN	ISABELA	16-59-24	122-04-05	286.1	115	X	X	X		X	NPC
101	MARIANO	DISABUNGAN	ISABELA	16-51-56	122-08-35	180.6	45	X	X	X		X	NPC
102	MADELLA	DABUBU	ISABELA	16-22-09	121-48-12	138.5	80		X	X		X	NPC
103	OSCARIS	MAGAT	ISABELA	16-47-53	121-22-32	4143	105	X	X	X		X	NIA
104	BALLASANG	ABUAN	ISABELA	17-05-05	122-03-03	493	142	X	X				NPC
105	DIVISORIA	CALUMANGAN	ISABELA	17-01-40	122-11-10	77.79	120	X	X	X		X	
106	PALANAN	PINACANAOAN	ISABELA	16-55-15	122-23-50	365	65	X	X	X		X	NIA
107	MADELLA	DIBULUAN	QUIRINO	16-25-56	121-50-40	192.8	150	X	X	X		X	NPC
108	MADELLA	CAGAYAN #1	QUIRINO	16-22-07	121-44-06	2316.8	50		X				NPC
109	PINARIPAD	ADDALAM	QUIRINO	16-27-56	121-34-50	849.1	85	X	X			X	NPC
110	MADELLA	TABOYONG	QUIRINO	16-01-04	121-27-33	128.1	95		X				NPC
111	MADELLA	DIDUYON	QUIRINO	16-35-58	121-26-47	485	110		X				NPC
112	DAKGAN	CASECNAN	QUIRINO	16-03-04	121-27-31	820	110	X	X	X		X	NPC & NIA
113	CABINGATAN	CONWAP	QUIRINO	16-13-32	121-37-31	1473	135	X	X	X		X	NIA
114	GADENG	CASECNAN	NUEVA VIZCAYA	16-01-30	121-20-54	565	150	X	X	X		X	NPC & NIA
115	BARAT	MATUNO	NUEVA VIZCAYA	16-24-40	121-03-20	583	170	X	X	X		X	NPC & NIA
116	STA. CRUZ	STA. CRUZ	NUEVA VIZCAYA	16-22-00	121-02-00	269	75	X	X	X		X	NPC
117	KAGIPSIPAN	CASICNAN	NUEVA VIZCAYA	16-01-29	121-22-43	609.7	160		X			X	NIA
REGION III													
118	ANGAT	ANGAT	BULACAN	14-54-55	121-10-06	568	131	X	X	X	X	X	NPC
119	STA. MARIA	STA. MARIA	BULACAN	14-50-16	121-05-25	34.1	40	X	X	X		X	CLVCA
120	BAGONG	BAYABAS	BULACAN	14-57-34	121-04-26	63.4	100	X	X	X		X	CLVCA
121	BALACAG	BALACAG	BULACAN			40	75	X	X	X		X	NIA
122	SALAPANGAN	SALAPANGAN	BULACAN	15-01-56	121-00-35	52.4	30	X		X		X	CLVCA
123	MAASIM	MAASIM	BULACAN	15-00-37	121-00-30	48	30	X		X			CLVCA
124	BARDIAS # 1	BULU	BULACAN	15-14-36	121-02-30	44	30	X		X		X	CLVCA
125	MT. BISCAL	BULU	BULACAN	15-13-59	121-06-00	45	97	X	X	X		X	CLVCA
126	MADLUM	MADLUM	BULACAN	15-11-27	121-06-06	76	80	X	X	X		X	CLVCA
127	SAN ROQUE	AGNO	PANGASINAN	16-07-54	120-41-00	1221	200	X	X		X	X	NPC
128	KALIPLIP	TOBOY	PANGASINAN	16-08-20	120-38-30	74	103	X	X	X		X	NPC
129	LUBAS	TOBOY	PANGASINAN	16-05-42	120-39-55	89	120	X	X	X		X	NPC
130	BAYAOAS	BAYAOAS	PANGASINAN	15-49-11	120-13-37	63	92	X	X	X		X	NIA
131	PILA	PILA	PANGASINAN	15-44-37	120-14-58	156.47	131	X	X	X		X	NIA
132	BALINTINGON	SUMACBAO	NUEVA ECIJA	15-18-01	121-07-19	236.9	140	X	X	X	X	X	CLVCA
133	LUBINGAN	LUBINGAN	NUEVA ECIJA	15-41-00	121-19-00	134	215	X	X	X		X	CLVCA
134	ANTIPAS	ANTIPAS	NUEVA ECIJA	15-31-40	121-15-10	38	80	X		X		X	CLVCA
135	BUGNAM	BUGNAM	NUEVA ECIJA	15-26-53	121-16-22	39	77	X		X		X	NIA
136	UPPER CORONEL	CORONEL	NUEVA ECIJA	15-25-30	121-21-30	68	60	X		X		X	CLVCA
137	CABU	TALICTIC	NUEVA ECIJA	15-27-18	121-07-00	71	100	X	X	X		X	NIA
138	PAPAYA	CHICO	NUEVA ECIJA	15-21-39	121-10-26	124	86	X	X	X		X	NIA
139	MARINAT	MARINAT	NUEVA ECIJA	15-33-32	121-08-38	44	50	X	X	X		X	CLVCA
140	KALAANAN	DIGMALA	NUEVA ECIJA	15-30-35	121-12-05	89	94	X	X	X		X	NIA
141	CANAAN	BANCO	NUEVA ECIJA	15-41-49	121-10-18	71	31	X		X		X	NIA
142	UP MARINGALO	MARINGALO	NUEVA ECIJA	15-59-16	120-59-30	38	40	X		X		X	NIA
143	PANTABANGAN	PAMPANGA	NUEVA ECIJA	16-40-00	121-06-35	845	110.5	X	X	X	X	X	NIA
144	MARINGALO	TALAVERA	NUEVA ECIJA	15-56-23	120-00-35	52	54	X		X		X	NIA
145	AMBUKLAO	AGNO	BENGUET	16-28-42	120-44-45	684	129		X	X		X	NPC
146	BINGA	AGNO	BENGUET	16-25-10	120-43-29	936	107		X	X		X	NPC
147	TEB-BO	AGNO	BENGUET	16-17-04	120-44-26	1020	100	X	X	X		X	NPC
148	TAYUM	AGNO	BENGUET	16-14-58	120-43-00	1148	184	X	X	X		X	NPC
149	BUCAU	BUCAU	ZAMBALES	15-15-25	120-16-00	34	160	X	X	X		X	CLVCA
150	MARELLA	MARELLA	ZAMBALES	15-02-27	120-17-21	75	80	X	X	X		X	CLVCA
151	MAPANUEPE	MAPANUEPE	ZAMBALES	14-58-30	120-18-00	32	30	X	X	X		X	CLVCA
152	CANDELARIA	MAMBORAW, TAPOS	ZAMBALES	15-14-47	120-14-20	64.36	160	X		X			FSDC
153	CAMILING # 2	CAMILING	TARLAC	15-32-52	120-18-32	228.7	136	X	X	X		X	NIA

Data Source : The Survey/Inventry by the National Water Resources Council,April 1978

Table D-1 LIST OF LARGE SCALE DAMS IDENTIFIED IN THE PHILIPPINES (3/5)

NO.	SITE	RIVER	PROVINCE	COORDINATES OF DAMSITE N. LAT.	E. LONG	D.A. Sq. Km.	D.H. (M)	PURPOSE I	P	IC	M&I	ETC	AGENCY
REGION III													
154	SULA	BULSA	TARLAC	15-27-22	120-22-27	289.6	39	X		X		X	NIA
155	BALOG-BALOG	BULSA	TARLAC	15-25-51	120-21-18	282	97	X	X	X	X	X	NIA
156	O'DONNEL	BANGAT	TARLAC	15-19-20	120-27-48	44.3	60	X		X		X	NIA
157	O'DONNEL #1	O'DONNELL	TARLAC	15-17-02	120-22-49	40.3	70	X		X		X	CLVCA
158	SAN NICOLAS	MARISILA	TARLAC	15-15-18	120-32-57	75.5	60	X		X		X	CLVCA
159	BAMBAN	MALAGO	TARLAC	15-14-03	120-28-16	35.5	30	X		X		X	CLVCA
160	DOLORES	BAMBAN	TARLAC	15-14-20	120-33-30	35	30	X	X	X		X	CLVCA
161	GUMAIN	GUMAIN	PAMPANGA	15-01-30	120-27-45	103	93	X	X	X		X	CLCVA
162	STA. ROSA	AMBAYAOAN	NUEVA VIZCAYA	16-12-24	120-46-05	256.4	151	X	X	X		X	NIA
163	MALUPA	MALUPA	QUEZON	15-44-40	121-21-30	202	100	X	X	X	X		NIA
REGION IV													
164	WAWA	MARIKINA	RIZAL	14-43-30	121-31-54	280	135		X	X	X	X	MWSS
165	CALIRAYA	CALIRAYA	LAGUNA	14-16-05	121-30-30	91.5	106		X			X	NPC
166	LOWER AGOS	AGOS	QUEZON	14-41-40	121-32-00	873	130		X				NPC
167	DARAITAN	KALIWA	QUEZON	14-36-00	121-26-10	340	106		X		X	X	MWSS
168	SANTA ROSA	AGOS	QUEZON	13-33-52	122-22-10	42.44	30	X		X		X	
169	PICSAAN	GUINTALINAN	QUEZON	13-41-30	122-25-35	54.75	50	X	X	X		X	
170	BINUNGA	BOAC	MARINDUQUE	13-23-57	121-55-23	153	140	X	X	X			NIA
171	MORENTE	BONGABONG	MINDORO	12-41-50	121-01-48	343.12	90	X	X	X			
172	BONGABONG	BONGABONG	MINDORO	12-44-17	121-20-18	149.27	70	X	X	X	X	X	
173	BANUTAN	BANUS	MINDORO	12-55-00	121-22-00	69.14	110	X	X	X		X	
174	MALUBAY	BALETE	MINDORO	12-57-50	121-20-50	109.78	130	X	X	X		X	
175	PAMBISAN	PULA	MINDORO	13-00-15	121-20-20	171.67	70	X	X	X		X	
176	TANGON	SALANGAN	MINDORO	13-06-37	120-47-12	93.87	70	X	X	X		X	
177	BANGIH MTS.	TANGUILAN	MINDORO	13-16-20	120-34-20	55.27	90	X	X	X		X	
178	LUMINTAO	LUMINTAO	MINDORO	12-40-30	121-07-40	231	140	X	X	X		X	NIA
179	AMNAY	AMNAY	MINDORO	13-01-00	120-56-30	227	123	X	X	X		X	NIA
180	PATRICK	PATRICK	MINDORO	12-53-40	120-58-10	212	108	X	X	X		X	NIA
181	PACLOLO	CAGARAY	MINDORO	12-23-50	121-11-50	401.13	90	X	X	X		X	
182	CABIRIAN	LABANGAN	MINDORO	12-28-10	121-07-00	165.3	50	X	X	X		X	
183	PITOGO	BUGSANGA	MINDORO	12-35-07	121-08-54	384.81	110	X	X	X		X	
184	SAN MARIANO	BAROC	MINDORO	12-37-20	121-24-02	82.99	70	X	X	X		X	
185	BATANGAN	MONGPONG	MINDORO	12-48-05	120-57-10	130	30	X		X		X	
186		BANSUD	MINDORO	12-52-14	121-22-21	56.25	90	X	X	X		X	
187	COGON	MARANGAS	PALAWAN	8-42-32	117-37-12	49.22	160	X	X	X		X	
188	FILANTROPIA	FILANTROPIA	PALAWAN	8-57-06	117-53-53	44	90	X	X	X	X	X	
189	QUEZON	KINLUNGAN	PALAWAN	9-05-48	117-48-10	38.49	70	X	X	X	X		
190	QUEZON	LAMAKAN	PALAWAN	9-06-10	117-52-33	166	90	X	X	X	X		
191	ABORLAN	PANANCAN	PALAWAN	9-17-58	118-21-06	36.64	130	X	X	X	X		
192	MALASGAO #1	MALASGAO I	PALAWAN	9-24-28	118-23-47	107.96	110	X	X	X	X		
193	INAGAWAN	INAGAWAN	PALAWAN	9-34-10	118-35-16	117.85	80	X	X	X	X		
194	IWAIBG	IWAIBG	PALAWAN	9-41-00	118-36-00	54.23	40	X	X	X	X		
195	BARRAQUI	ABORLAN	PALAWAN	9-28-18	118-28-00	40.67	40	X	X	X	X		
196	BATON BATON	BATON-BATON	PALAWAN	9-17-00	118-16-00	79.78	140	X	X	X	X		
197	APURAUAN	APURAUAN	PALAWAN	9-35-00	118-21-39	78.94	100	X	X	X	X		
198	BABUYAN	BABUYAN RIVER	PALAWAN	10-03-00	118-53-00	213.29	80	X	X	X	X		
199	CARAMAY	RIZAL RIVER	PALAWAN	10-16-12	119-10-42	129.33	120	X	X	X	X		
200	LANGOGAN	LANGOGAN	PALAWAN	10-03-00	119-06-36	198.17	90	X	X	X	X		
201	ROSARIO	MALAKINIEBLOG	BATANGAS	13-47-24	121-07-05	234.67	40		X	X		X	NPC
202	GEN. LUNA	LUNGOSO	QUEZON	13-44-50	122-13-50	30.47	40		X	X	X	X	
203	MONTALBAN # 2	PURAY	RIZAL	14-46-00	121-10-50	33.01	50		X	X	X	X	
REGION V													
204	TALISAY	ALBAY	ALBAY	13-13-00	123-28-00	146	80	X	X	X		X	BRBDP
205	PULANTUNA	PULANTUNA	CAMARINES SUR	13-52-01	122-54-50	288	90	X	X	X		X	BRBDP
206	CULALING	CULALING	CAMARINES SUR	13-47-00	122-54-00	101	45	X	X	X		X	BRBDP
207	SALVACION	MANAPOT	CAMARINES SUR	13-45-00	123-51-04	35.98	90	X	X	X		X	
208	LABO	LABO	CAMARINES SUR	14-04-45	122-44-00	62.58	110	X	X	X		X	
209	MALABAGO	TOYTOY	CATANDUANES	13-58-18	124-09-50	32.45	70	X	X	X		X	
210	SAGRADA	VIGA	CATANDUANES	13-50-10	124-16-00	39.11	110	X	X	X		X	
211	PAGSAGNAHAN	BATO	CATANDUANES	13-45-00	124-16-15	79.26	130	X	X	X		X	
212	MABARIW	NARANGASAN	MASBATE	12-14-58	122-25-50	33.73	30	X	X	X		X	
213	SIMBARAN	BITO	MASBATE	12-29-24	123-43-45	57.55	30	X	X	X		X	
214	PINAMALATICAN	BANADERO	MASBATE	12-18-02	123-30-06	53.04	30	X	X	X		X	
REGION VI													
215	PANGLANGANGAN	TIPULUAN	ANTIQUE	10-44-30	122-07-00	67.97	190	X	X	X		X	
216	VILLA SALOMAN	IPAYO	ANTIQUE	10-54-41	122-03-15	52.93	180	X	X	X		X	
217	SAN AGUSTIN	CANGARANAN	ANTIQUE	11-05-00	122-11-43	65.71	110	X	X	X		X	
218	IGROSO	PALIWAN	ANTIQUE	11-05-10	122-07-35	143.33	150	X	X	X		X	
219	PAN-AN	DALANAS	ANTIQUE	11-15-25	122-06-38	122.03	190	X	X	X		X	
220	CAMANSIHAN	BACONG	ANTIQUE	11-25-10	122-05-50	31.29	150	X	X	X		X	
221	RIZAL	MANINILA	ANTIQUE	10-55-47	122-11-22	114.85	170	X	X	X		X	
222	LUNA	MAOIT	ANTIQUE	10-46-34	122-04-50	108.47	150	X	X	X		X	
223	LIBACAO	AKLAN	AKLAN	11-24-20	122-17-10	251.88	90	X	X	X		X	
224	TALANGBAN	JINGBABAN	AKLAN	11-32-35	122-15-10	113.69	70	X	X	X		X	
225	MT. CAGUMAN	IBAJAY	AKLAN	11-41-10	122-11-05	117.34	170	X	X	X		X	
226	CATABANGAN	ULIAN	ILOILO	11-04-20	122-23-00	45.89	110	X	X	X		X	
227	DAP	ALIBUNAN	ILOILO	11-09-00	122-26-12	18.77	100	X	X	X		X	

Data Source : The Survey/Inventry by the National Water Resources Council, April 1978

Table D-1 LIST OF LARGE SCALE DAMS IDENTIFIED IN THE PHILIPPINES (4/5)

NO.	SITE	RIVER	PROVINCE	COORDINATES OF DAMSITE N. LAT.	E. LONG	D.A. Sq. Km.	D.H. (M)	PURPOSE I	P	IC	M&I	ETC.	AGENCY
REGION VI													
228	TIGUM	TIGUM	ILOILO	10-55-15	122-23-00	46.92	100	X	X	X		X	
229	CARUCUAN	TANIAN	ILOILO	10-44-50	122-14-30	78.59	100	X	X	X		X	
230	MAGALLON	BINALBAGAN	NEGROS OCC.	10-18 45	123-09-32	229.46	90	X	X	X		X	NPC
231	BAGO I	BAGO RIVER	NEGROS OCC.	10-33-05	123 09-18	435.45	115	X	X	X		X	NPC
232	BAGO II	BAGO RIVER	NEGROS OCC.	10-33-20	123-07-48	443.5	45	X	X	X		X	NPC
233	HILABANGAN #1	HILABANGAN	NEGROS OCC.	9-56 00	122-55-00	384.1	90	X	X	X		X	NIA
234	ILOG NO 2	ILOG	NEGROS OCC.	9 46-00	122-46-00	283.06	70	X	X	X		X	NIA
235	ILOG NO. 1	ILOG	NEGROS OCC.	9-52-00	122-51-00	1371	100	X	X	X		X	NIA
236	HILABANGAN #2	HILABANGAN	NEGROS OCC.	9-56-00	122-57-00	320.87	240	X	X	X		X	NIA
237	ISIO	ISIO	NEGROS OCC.	9-56 45	122-34 05	56.32	110	X	X	X		X	
238	DAPDAP HILL	BINULUG CREEK	NEGROS OCC.	9 44 30	122-31 00	161.67	70	X	X	X		X	
239	SIPALAY	CALATONG RIVER	NEGROS OCC.	9 46-58	122-29-15	73.01	90	X	X	X		X	
240	TABLAS	KANALUM	NEGROS OR.	9-27-00	122-47-25	31.29	130	X	X	X		X	
241	CATUMBAHAN	PAGATBAN	NEGROS OR.	9-28-20	122-43-25	361.4	170	X	X	X		X	
242	UGBO	AGANON	ILOILO	10-53-24	122-20-37	40.43	100	X	X	X		X	
REGION VII													
243	STA. CATALINA	CAUTAN	NEGROS OR.	9-18-48	122-55-00	62.58	150	X	X	X		X	
244	SIATON	NEGROS OR.	NEGROS OR.	9-09-15	123-01-40	180.96	130	X	X	X		X	
245	BAYAWAN #1	SICOPONG	NEGROS OR.	9-24-50	122-54-52	189.3	70	X	X	X		X	
246	MALUMINSAG	LIBERTAD	NEGROS OR.	10-03-00	123-12-32	225.8	130	X	X	X		X	
247	BIGA	PAGATBAN	NEGROS OR.	9-36-44	122-43-30	3649	190	X	X	X		X	
248	BAYAWAN # 2	BAYAWAN	NEGROS OR.	9-27-00	122-48-30	248 23	110	X	X	X		X	
249		SAPANG DAKU	CEBU	10-23-10	123-44-30	55.8	130	X	X	X		X	
250	MANTALUJAN	LANGUYON	CEBU	10 42-05	123-50-22	60.49	90	X	X	X		X	
251	DANAO CITY	LUYANG RIVER	CEBU	10-36-00	124-00-21	46.93	70		X				NPC
REGION VIII													
252	BURAWEN # 1	DAGUITAN	LEYTE	10-56-20	124-50-24	113.16	30		X	X			NPC
253	AMPARO	AMPARO	LEYTE	10-08-30	124-56-20	66	100	X	X	X		X	
254	CATMON	SALOG	LEYTE	10-22-50	124-55-40	79	60	X	X	X		X	
255	KAPODLUSAN	SALUG	LEYTE	10-25 45	124-50-20	43	90	X	X	X		X	
256	BOJO	SALUG	LEYTE	10-27-25	124 48-00	52.15	120	X	X	X		X	
257	GUINSANGAN	IBMBANGAN	LEYTE	10-22-20	125-06-40	47.69	110	X	X	X		X	
258	BUNTAY	BITO	LEYTE	10-44-25	124-54-50	67	90	X	X	X		X	
259	CABAGNON	BISAY	LEYTE	10-23-20	125-09-10	38	40	X	X	X		X	
260	ABUYOG	IBGASAAN	LEYTE	10-33-25	125-04-08	51	30	X	X	X		X	
261	DOLORES	DOLORES	SAMAR	12-08-37	125-11-00	278	80	X	X	X		X	NPC
262	GANDARA	GANDARA	SAMAR	11-59-10	124-55-18	272.2	160	X	X	X		X	NPC
263	MAWO # 1	MAWO	SAMAR	12-23-19	124-23-40	119.42	35	X	X				NPC
264	GANDARA	BLANCA	SAMAR	12-01-25	124-58-00	203.38	50	X	X	X		X	
265	SAN RUFINO	HAYIBAN	SAMAR	12-13-30	124-33-50	59.45	80	X	X	X		X	
266	GEN. LUNA	HIBUNAWAN	SAMAR	12-17-00	124 41-00	61.53	50	X	X	X		X	
267	MERADER	BUGKO	SAMAR	12-25-40	124 49-20	1043	60	X	X	X		X	
268	SOLONG	PAMBUKHAN	SAMAR	12-21-20	124-51-10	113.68	80	X	X	X		X	
269	TRUJILLO	GULGANTI	SAMAR	12-25-40	124-31-00	53.71	80	X	X	X		X	
270	IBPIL	HILINO CREEK	SAMAR	12-20-25	124-43-10	43.28	60	X	X	X		X	
271	PONOD	PATIKWA	SAMAR	12-20-30	124-33-25	39.11	5050	X	X	X		X	
272	POLAHONGON	LAYOG	SAMAR	10-31-40	124-58-18	44.54	50	X	X	X		X	
273	HIMAMARA		SAMAR	10-37-30	124-59-30	48.49	80	X	X	X		X	
274	MT. ASGAD	SOHOTAN	SAMAR	11-23-40	125-12-25	47.97	100	X	X	X		X	
275	CALBIGA	CALBIGA	SAMAR	11-35-20	125-04 40	263.35	60	X	X	X		X	
276	WRIGHT		SAMAR	11-54-30	125-13-00	144.45	50	X	X	X		X	
REGION IX													
277	GUMALARANG	GUMALARANG	BASILAN	6-37-12	121-59 00	84	73	X		X		X	NPC
278	PAGADIAN # 1	LABANGAN	ZAMBOANGA S	7-53-40	123-16-32	148	100	X	X	X		X	
279	PAGADIAN # 2	LABANGAN	ZAMBOANGA S	7-55-50	123-19-20	54	160	X	X	X		X	
280	MALAUGAS	SIBUGUEY	ZAMBOANGA S	7-53-20	123-04 40	148.62	100	X	X	X		X	
281	MOLAVE # 1	DIPOLO	ZAMBOANGA S	8-14-30	123-24-00	123.07	120	X	X	X		X	
282	MOLAVE #2	DIKAYO	ZAMBOANGA S	8-18-50	123-16-40	117.33	120	X	X	X		X	
283	PASONANCA	TUMAGA	ZAMBOANGA S	6-58-15	122-04-10	101	150	X	X	X		X	
284	TAGASILAY	VITALI	ZAMBOANGA S	7-18-00	122-14-00	113.68	80	X	X	X	X	X	
285	PIACAN	PIACAN	ZAMBOANGA N	7-31-35	122-10-12	53	90	X	X	X		X	
286	SIOCON #1	SIBUCO	ZAMBOANGA N	7-14-40	122-05-10	119.94	100	X	X	X		X	
287	PANGANURAN	PANGANURAN	ZAMBOANGA N	7-24-50	122-06-40	101.17	100	X	X	X		X	
288	ANUNGAN	ANUNAGN	ZAMBOANGA N	7-28-20	122-06-30	93.87	160	X	X	X		X	
289	SIRAGUAY	SIRAGUAY	ZAMBOANGA N	7-35-20	122-10-30	53.71	60	X	X	X		X	
290	LABASON	QUIPIT	ZAMBOANGA N	7-58-40	122-26-00	626.84	90	X	X	X		X	
291	SIOCON # 2	SIOCON	ZAMBOANGA N	7-45-50	122-11-00	45.89	89	X	X	X		X	
292	SIOCON # 3	LITOBAN	ZAMBOANGA N	7-42-50	122-14-20	262.83	80	X	X	X		X	
293	DISAKAN	DISAKAN	ZAMBOANGA N	8-28-00	123-03-35	107.95	80	X	X	X		X	
REGION IX													
294	ADGAOAN	ADGAOAN # 1	AGUSAN SUR	8-19-00	125-39-00	373	70	X	X	X		X	BPW
295	ADGAOAN	ADGAOAN # 2	AGUSAN SUR	8-24 00	125-30-00	249	120	X	X	X		X	BPW
296	ADGAOAN	ADGAOAN # 3	AGUSAN SUR	8-23-00	125-26-00	192	170	X	X	X		X	BPW
297	ANDANON	ANDANON	AGUSAN SUR	8-45-00	125-46-00	193	130	X	X	X	X	X	BPW
298	BAGUE	BAGUE #1	AGUSAN SUR	8-05-00	125-36-00	443	115	X	X	X		X	BPW
299	BAGUE	BAGUE #2	AGUSAN SUR	8-08-00	125-25-00	117	140	X	X	X		X	BPW
300	BUNAWAN	BUNAWAN	AGUSAN SUR	8-10-00	126-01-00	188	115	X	X	X		X	BPW

Data Source : The Survey/Inventry by the National Water Resources Council,April 1978

Table D-1 LIST OF LARGE SCALE DAMS IDENTIFIED IN THE PHILIPPINES (5/5)

NO.	SITE	RIVER	PROVINCE	COORDINATES OF DAMSITE N. LAT.	E. LONG	D.A. Sq. Km.	D. H. (M)	PURPOSE I	P	FC	MAI	FTC	AGENCY
REGION X													
301	BUSILAO	BUSILAO	AGUSAN SUR	8-38-00	125-32-00	272	100	X	X	X	X	X	BPW
302	CASAPA	CASAPA	AGUSAN SUR	8-10-00	125-43-00	714	110	X	X	X	X	X	BPW
303	CAYAWAN	CAYAWAN	AGUSAN SUR	8-16-00	125-40-00	333	75	X	X	X		X	BPW
304	PROSPERIDAD	GIBONG	AGUSAN SUR	8-37-30	125-55-10	414	85	X	X	X	X	X	NPC
305	KASILAYAN	KASILAYAN	AGUSAN SUR	8-26-00	125-38-00	107	80	X	X	X		X	BPW
306	LIBANG	LIBANG	AGUSAN SUR	8-34-00	125-35-00	241	100	X	X	X		X	BPW
307	MAASAM	MAASAM #1	AGUSAN SUR	8-29-00	125-36-00	361	85	X	X	X		X	BPW
308	MAASAM	MAASAM #2	AGUSAN SUR	8-28-00	125-25-00	184	175	X	X	X		X	BPW
309	OJOT	OJOT	AGUSAN SUR	8-40-00	125-32-00	467	100	X	X	X	X	X	BPW
310	WAWA	WAWA	AGUSAN SUR	8-18-00	125-42-00	391	160	X	X	X	X	X	BPW
311	BUGABUS	BUGABUS	AGUSAN NORTE	8-48-0	125-33-00	184	120	X	X	X		X	BPW
312	BUTUAN CITY	BUGABOS	AGUSAN NORTE	8-48-30	125-33-10	257.62	80	X	X	X		X	
313	MANLUKUP	AGUSAN #1	DAVAO NORTE	7-32-00	126-06-00	336	120	X	X	X		X	BPW
314	SABAKI	AGUSAN #2	DAVAO NORTE	7-26-00	126-08-00	284	160	X	X	X		X	BPW
315	IHAOAN	IHAOAN	DAVAO NORTE	8-0-00	125-49-00	318	60	X	X	X		X	BPW
316	LAGUM	LAGUM	DAVAO NORTE	7-57-00	125-55-00	95	50	X	X	X		X	BPW
317	SIMULAO	SIMULAO	DAVAO NORTE	7-59-00	126-12-00	261	130	X	X	X		X	BPW
318	UMASA	UMASA CREEK	DAVAO NORTE	7-59-00	125-54-00	99	35	X	X	X		X	BPW
319	TALAKAG	CAGAYAN NO. 1	BUKIDNON	8-14-20	124-34-25	762.43	195	X	X	X		X	NPC
320	MALUKO	TAGLOAN III	BUKIDNON	8-23-40	124-56-49	567.9	181	X	X	X		X	NPC
321	KALAPIONGAN	TAGOLOAN IV-A	BUKIDNON	8-29-37	124-50-21	1311.04	130	X	X	X		X	NPC
322	STA. ANA	TAGOLOAN IV	BUKIDNON	8-32-11	124-47-00	1404.91	70	X	X	X		X	NPC
323	NICDAO	BUBUNAUAN	BUKIDNON	8-23-20	124-37-54	224.24	150	X	X	X		X	
324	MAMBURAYA	CAGAYAN NO. 2	MISAMIS OR.	8-19-34	124-36-14	893.32	110	X	X	X		X	NPC
325	CAGAYAN DE ORO	CAGAYAN NO. 3	MISAMIS OR.	8-24-23	124-37-26	1132.17	75	X	X	X		X	NPC
326	CLAVERIA	MALITBOG	MISAMIS OR.	8-35-42	124-57-15	34.41	170	X	X	X		X	
REGION XI													
327	LINGDAN	HIJO	DAVAO NORTE	7-25-00	125-57-56	299.58	100	X	X	X		X	
328	MABANTAO	SIMONG	DAVAO NORTE	7-40-32	125-35-45	110.41	90	X	X	X		X	
329	JAGUMITAN	KAPALONG	DAVAO NORTE	7-51-10	125-37-20	162.5	120	X	X	X		X	
330	MAGTUGA	LANGITANG	DAVAO NORTE	7-53-27	125-32-27	73.01	130	X	X	X		X	
331	CALINAN #1	DAVAO	DAVAO SUR	7-16-00	125-23-50	1603.61	90	X	X	X		X	
332	CALINAN # 2	SUWANAN	DAVAO SUR	7-16-35	125-18-50	152.5	160	X	X	X		X	
333	TAGLANDASA	SUMLOG	DAVAO OR.	7-03-10	126-05-35	219.55	90	X	X	X		X	
334	TAGUGPO	BITANAGAN	DAVAO OR.	7-02-01	126-06-37	26.68	190	X	X	X		X	
335	ANIBONGAN	CASAUMAN	DAVAO OR.	7-11-35	126-27-20	362.44	120	X	X	X		X	
336	QUINONOAN	QUINONOAN	DAVAO OR.	7-06-10	126-27-00	108.47	160	X	X	X		X	
337	MADRID # 1	TARACAN	SURIGAO S.	9-12-40	125-53-51	55	90	X	X	X		X	
338	MADRID # 2	CARACAN	SURIGAO S	9-15-35	125-54-15	237.5	70	X	X	X		X	NPC
339	MADRID # 3	EYAMIO	SURIGAO S	9-17-10	125-54 30	73.75	80	X	X	X		X	
340	LUN GRANDE	BIG LUN	COTABATO S	6-02-50	125-39-30	299.58	130	X	X	X		X	
REGION XII													
341	MULETA NO. 2	MULETA NO. 2	BUKIDNON	7-33-00	124-54 00	517	180	X	X	X		X	BPW
342	MARAMAG	PULANGI #3	BUKIDNON	7-38-16	125-03-13	3,633	115	X	X	X		X	NPC
343	LUMBAYAO	PULANGI # 4	BUKIDNON	7-57-00	125-16-00	1,126	115	X	X	X	X	X	NPC
344	PULANGI	PULANGI # 6	BUKIDNON	8-21-00	125-14 00	326	100	X	X	X	X	X	NPC
345	PULANGI NO. 5	PULANGI # 5	BUKIDNON	8-10-00	125-19-00	737	110	X	X	X	X	X	NPC
346	KATUDAN	LIBUNGAN	NORTH COTABAT	7-23-00	124-33-00	367	80	X	X	X		X	NIA
347	KITUBUD	MALADUGAO # 1	NORTH COTABAT	7-16-00	124 43-00	1342	70	X	X	X	X	X	NPC
348	GATA	MALADUGAO # 2	NORTH COTABAT	7-29-00	124 47-00	1068	180	X	X	X	X	X	NPC
349	MULUETA	MULUETA # 1	NORTH COTABAT	7-23-00	124-55-00	1126	110	X	X	X		X	NPC
350	MALITUBOG	MALITUBOG # 1	NORTH COTABAT	7-15-00	124-39-00	551	65	X	X	X		X	NPC
351	MT. BABOY	MALITUBOG #2	NORTH COTABAT	7-21-00	124-39-00	473	130	X	X	X		X	NPC
352	DATU SANTILLA	PULANGI #1	NORTH COTABAT	7-20-18	124-54-48	5216	35		X	X		X	NPC
353	BALATUKAN	PULANGI # 2	NORTH COTABAT	7-23-24	125-01-49	4,652	105	X	X	X		X	NPC
354	LAKE SEBU	LANON	SOUTH COTABAT	6-14-00	124-44-00	88	55	X		X		X	NPC
355	BATDAN	CABILANAN # 1	MAGUINDANAO	6-38-00	124-22-00	568	200	X	X	X		X	BPW
356	PENAS	CABILANAN # 2	MAGUINDANAO	8-33 00	124-25 00	514	150	X	X	X		X	BPW
357	TIUBANGAN	MAGANOY # 1	MAGUINDANAO	6-48-00	124-24 00	981	355	X	X	X		X	NPC
358	MT. SULATAN	MAGANOY # 2	MAGUINDANAO	6-36-00	124-21-00	309	190	X	X	X		X	NPC
359	LAGUILAYAN	MAGANOY #3	MAGUINDANAO	6-31-00	124-22-00	317	170	X	X	X		X	NPC
360	TRAN	TRAN	SULTAN KUDARA	6-45-30	124-05-30	793.33	110	X	X	X		X	NIA
361	SAGUIARAN	AGUS II	LANAO DEL SUR	8-02-00	124-16-00	1768.76	31		X			X	NPC
362	KALANGANAN	AGUS III-A	LANAO DEL N.	8-05-06	124-14 45	1844.18	50		X			X	NPC
363	MATAMPAY	AGUS IV	LANAO NORTE	8-07-00	124-14-00	1872	32		X	X		X	NPC
364	LINAMON	AGUS VII	LANAO NORTE	8-11-24	124-09-48	2000.84	43		X			X	NPC

Data Source : The Survey/Inventry by the National Water Resources Council,April 1978

Table D-2 LIST OF THE ALTERNATIVE DAM SITE FOR WATER SUPPLY TO METRO CEBU AND DAVAO

Alternative Site Name	Catchment Area (km^2)	Proposed Dam Type (m)	Proposed Height (m)	Proposed Crest Length (m)	Effective Volume ($\times 10^6 m^3$)	Dead Volume ($\times 10^6 m^3$)	Location
For CEBU							
Cebu A	5.4	Concrete Gravity	60.0	400.0	2.0	2.1	Located on the Bulacao River near the Toong
Cebu B (Buhisan Dam)	5.9	oncrete Double Ar	26.0	-	0.26	-	The Buhisan Dam has been constructed. (Existing Water Supply Facility)
Cebu C	8.3	Concrete Gravity	55.0	300.0	2.0	2.7	Located on the Guadalupe River near the Sapan Daku
Cebu D1	2.1	-	-	-	-		Located on the Guadalupe River near the Katunasan
Cebu D2	1.5	-	-	-	-		Located on the Lahug River near the Katunasan
Cebu E	5.8	Concrete Gravity	45.0	300.0	1.7	2.0	Located on the Butuanon River near the San Jose
Cebu Fo	20.5	Concrete Gravity	55.0	300.0	2.4	3.2	Located on the Butuanon River near the Pulangbato
Upper Cotcot	9.3	Concrete Gravity	60.0	300.0	2.7	2.9	Located on the Cotcot River near the Cambinocod
Upper Lusaran	40.0	Concrete Gravity	60.0	250.0	2.5	6.0	Located on the Cotcot River near the Adlaon
For DAVAO							
Davao I	367.0	Rockfil	75.0	400.0	150.0	180.0	Located on the Davao River near the Panganan
Davao II	820.0	Rockfil	112.0	350.0	56.0	55.0	Located on the Davao River near the Malikong- kong
Davao IIIM	962.0	-	-				Located on the Davao River near the Binoayan
Davao IIIR	163.0	Rockfil	132.0	400.0	56.0	55.0	Located on the Suwawan River near the Kibangay
Davao IV	1,322.0	-	-				Located on the Davao River near the Tamugang

TABLE D-3 LIST OF EXISTING AND PROPOSED WATER SUPPLY FACILITIES FOR METRO MANILA

	Name of the Facilities	Condition / Stages	Name of the River	Location of the Site	Classification of the Structure
1.	Angat dam	Existing	Angat River	Norzagaray, Bulacan	Rockfill Dam
2.	Ipo Dam	Existing	Angat River	Norzagaray, Bulacan	Concrete Gravity Dam
3.	Bustos Headworks	Existing	Angat River	Bustos, Bulacan	Concrete Weir
4.	BICTI (LPT, BTP)	Existing	-	Bulacan	Concrete Structure
5.	Wawa Dam	Master Plan Study	Marikina River	Montalban Rizal	Concrete Gravity Dam
6.	Umiray Transbasin Tunnel	Under construction	Umiray River	Umiray Basin	Concrete Tunnel
7.	Umiray Intake Weir	Under construction	Umiray River	Umiray Basin	Run-Off River Type of Concrete Weir
8.	Kanan Dam	Master Plan Study	Kanan River	Quezon Province	Rockfill Dam
9.	Agos Dam	Feasibility study (F/S)	Agos River	Quezon Province	-
10.	Laiban Dam	Detailed Design (D/D)	Agos River	Laiban, Tanay	-
11.	Taytay WTP	-	-	Taytay, Rizal	Concrete Structure
12.	Cogeo Reservoir	Existing	-	Cogeo, Rizal	Reservoir
13.	Putatan P.S	Existing	Laguna de Bay	Rizal	Concrete Structure

Table D-4 SUMMARY OF CONSTRUCTION COST DATA COLLECTED

Work Items		Unit	Project Name: Lacson CIP Project Unit Price (RP pesos)	Lubogan CIP Project Unit Price (RP pesos)	Proprosed Maasim Dam & Reservoir Unit Price (RP pesos)	Proprosed Bayabas Dam & Reservoir Unit Price (RP pesos)	ARFCP (Phase II) Unit Price (RP pesos)
1.	Earth Works						
1.1	Open Air Excavation						
001/	Clearing and Grubbing	ha	-	-	20,000.0	20,000.0	59,600.0
002/	Excavation common	cu.m	128.7	126.0	59.0	59.0	81.3
003/	Excavation rock	cu.m	-	-	165.0	100.0	-
1.2	Embankment Works						
001/	Coffer dam	cu.m	164.7	130.0	91.0	60.0	-
002/	Core materials	cu.m			60.0	104.0	-
003/	Filter materials	cu.m			238.0	238.0	-
004/	Random fill materials	cu.m			91.0	60.0	-
005/	Boulder riprap	cu.m	924.7	-	160.0	250.0	-
006/	Gravel Blanket	cu.m	469.2	-	-	-	-
007/	Slope protection/ rock toe	cu.m	322.0	-	322.0	-	-
1.3	Backfill Works						
001/	Structure backfill	cu.m	74.5	69.2	80.0	80.0	66.1
002/	Filter materials in sand	cu.m	203.0	-	203.0	220.0	256.2
003/	Filter materials in gravel	cu.m	238.0	-	238.0	-	256.2
004/	Compaction	cu.m	125.2	116.3	-	-	-
1.4	Concrete Works						
001/	2,400 psi plain concrete	cu.m	2,946.9	-	-	-	-
002/	2,400 psi reinforced concrete	cu.m	3,637.6	-	-	-	2,395.6
003/	3,000 psi reinforced concrete	cu.m	5,676.4	5,176.0	6,664.0	6,664.0	2,555.1
004/	Concrete pipe, 18" dia.	m	1,508.2	-	-	-	-
005/	Concrete pipe, 24" dia.	m	1,698.3	-	-	-	-
006/	Concrete pipe, 30" dia.	m	2,402.6	-	-	-	-
007/	Concrete hallow blocks	sq.m		54.8	-	-	-
1.5	Finishing Works						
001/	Plastering	sq.m	198.6	128.9	-	-	-
1.6	Miscellaneous Works						
001/	Gravel bedding	cu.m	-	-	238.0	238.0	295.7
002/	Gabion	cu.m	-	-	2,000.0	2,000.0	-
003/	masonry	sq.m	-	186.0	-	-	1,102.2
1.7	Metal Works						
001/	Steel pipe, 25mm	m	650.0	-	-	-	

Note: ARFCP means Aguno River Flood Control Project (Phase II)

Table D-5 DAMS ADOPTED AS THE CANDIDATES FOR WATER RESOURCES DEVELOPMENT SCHEMES (1/2)

No	WRR	Name of Dam	River System	Dam				Reservoir									Hydroelectric power		Irrigation	Cost	Consultant/Agency	Status
				CA (km^2)	Type	Height (m)	Crest Length (m)	Volume ($10^6 m^3$)	FWL (EL.m)	HWL (EL.m)	LWL (EL.m)	Tail WL (EL.m)	F/C Space ($10^6 m^3$)	Gross ($10^6 m^3$)	Active ($10^6 m^3$)	Dead ($10^6 m^3$)	Area (km^2)	(MW)	(GWh)	(ha)	(US$ 10^6)		
1	I	Cura-Tina-Gasgas	Laoag	233	Rockfill	85.0	254	1.5	188	178	140	-	-	34	33	1	1.6	6	24	6,600	140	Asiatic	F/S
2	I	Palsiguan/Nueva	Abra/Laoag	153	rockfill/Conc. gra	143.5	480	9.1	-	335	275	-	-	232	189	43	5	36	160	12,400	716	JICA	F/S
3	I	Binongan/Tineg	Abra	683	Rockfill/Conc. Weir	112.0	375	3.4	383	380	350	-	9	121	79	42	4	175	718	-	468	Shawinigan/ADB	F/S
4	I	Supo	Abra	1,293	Rockfill	138.0	440	6.6	325	320	280	-	300	1,332	832	300	32	120	340	-	368	NK/JICA	Master Plan
5	II	Agbulu	Abulug/Apayao	773	Rockfill	233.0	610	22.1	373	370	310	136	-	3,424	2,164	1,260	49	360	1,479	-	994	ELC	F/S
6	II	Gened	Abulug/Apayao	1,661	Conc. Arch	175.0	472	2.0	-	180	160	-	-	2,800	1,200	1,600	63	600	1,632	-	892	New JEC	D/D
7	II	Bantay	Cagayan	742	Earthfill	64.0	320	2.0	67	62	45	-	354	1,646	1,278	368	105	40	68	-	188	NK/JICA	Master Plan
8	II	Chico IV	Cagayan	1,410	Rockfill	160.0	890	17.8	-	451	411	-	-	740	430	310	14	360	955	-	758	Lahmeyer	D/D
9	II	Abuan	Cagayan	487	Rockfill	100.0		2.6	136	131	110	-	-	250	124	126	-	60	172	610	159	Lahmeyer/NK	F/S
10	II	Mallig II	Cagayan	362+1,951	Rockfill	84.0	300	2.6	183.5	180	160	-	112	1,037	545	-	41	-	-	-	99	NK/JICA	Master Plan
11	II	Siffu I	Cagayan	656	Earthfill	58.0	240	1.7	115.5	106	97	-	115	314	93	-	19	5.4	41	-	67	NK/JICA	Master Plan
12	II	Magat	Cagayan/Magat	4,143	Rock/Gm	114.0	2,925		197	193	158	-	210	1,254	969	210	17	300	991	104,600	-	Bu.Recla US	Existing(1983)
13	II	Matuno	Cagayan/Magat	593	Rockfill	147.0	580	10.0	525	520	480	-	-	137	97	40	-	180	528	13,600	668	NK/JICA	F/S
14	II	Addalam A	Cagayan/Addalam	849	RCC	60.0									32			45	102				F/S
15	II	Ilaguen B	Cagayan/Ilaguen		RCC										31			46	102				F/S
16	II	Didoyon	Cagayan	477	Conc. Gravity	111.0	375	1.2	-	648	620	162	-	570	454	125	-	352	957	-	664	New JEC	F/S
17	III	Maikong	Amburayan	100	Rockfill	147.0	400	9.5	-	900	885	-	-	102	26	76	1.9	-	-	-	400	JICA	Map Study
18	III	Amburayan	Amburayan	135	Rockfill	137.0	400	8.0	-	760	720	-	-	104	64	40	2.1	-	-	-	400	JICA	Map Study
19	III	Roloc II	Agno	396	Rockfill	177.0	570	20.0	-	1,030	1,015	870	-	280	64	216	4.6	36	66	-	614	JICA	Map Study
20	III	Mount Caoa	Agno	390	Rockfill	142.0	400	9.0	-	880	860	750	-	120	46	74	2.8	40	73	-	326	JICA	Map Study
21	III	Ambuklao	Agno	612	Rockfill	129.0	452	5.8	-	752	694	574	-	327	258	69	-	75	300	-	-	Harza	Existing(1956)
22	III	Binga	Agno	854	Rockfill	107.4	215	1.9	-	575	555	417	-	91	33	58	-	100	516	-	-	Harza	Existing(1960)
23	III	Lahoy II	Agno/Laboy	48.6	Rockfill	75.0	500	5.3		818	811			13.9	3.0	10.9	0.5	-	-	-		JICA	Map Study
24	III	Tebbo	Agno	1,072	Rockfill	142.0	320	9.0	-	415	395	280	-	285	110	175	6.6	120	219	-	267	JICA	Map Study
25	III	San Roque	Agno	1,235	Rockfill	200.0	1,130	38.5	290	280	225	-	140	850	530	140	13	345	1,030	87,000	1,050	ELC	On-Going
26	III	Mabini	Balincaguin	225	Rockfill	88.5	530	4.1	65	93	38			345	240	105	15			11,500			F/S
27	III	Balog-Balog	Agno/Tarlac	283	Rockfill	113.5	1,400	11.8	241	238	190	-	45	625	575	50	18	33	98	44,350	292	ELC	F/S
28	III	Pantabangan	Pampanga	853	Earthfill	107.0	1,615	12.0	230	221	177	128	-	2,310	1,903	337	-	100	230	102,000	-	USAID/IBRD	Existing(1977)
29	III	Abaca (Casecnan)	Cagayan/Pampanga	590	Rockfill	107.0	500	6.2	499	490	473	-	-	130	58	72	-	270	495	-	652	ELC/IBRD	On-going
30	III	Conwap (Casecnan)	Cagayan/Pampanga	1,150	Rockfill	168.5	913	19.4	394	390	375	-	-	1,207	321	888	-	-	442	66,500	591	ELC/IBRD	On-going
31	III	Angat	Pampanga/Angat	568	Rockfill	131.0	568	7.1	219	217	180	-	-	1,075	850	225	23	218	398	30,000	-	Harza/IBRD	Existing(1967)
32	III	Umiray-Angat	Umiray/Angat	160	Concrete Weir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	C.Lotu/ADB	On-going
33	III	Balimbingan	Pampanga/Sumacbao	228	Rockfill	128.0	490	8.4						559	463	96	14	40	132	18,800			F/S
34	III	Bayabas	Pampanga	50	Rockfill	107.0	620	-	191	187	120	-	48	-	148	-	4.8	-	-	-	-	ELC/Asiatic/World Bank	Pre-F/S
35	III	Maasim	Pampanga	54	Rockfill	52.0	1,400	-	82	80	55	-	10	-	100	-	9.0	-	-	-	-	ELC/Asiatic/World Bank	Pre-F/S
36	IV	Laiban	Agos/Kaliwa	276	Rockfill	141.0	588	9.7	278	270	235	134	-	-	472	-	20	21		-	1,104	Electrowatt	D/D
37	IV	Kanan	Agos/Kanan	286	Rockfill	157.7	430	2.0	-	316	267	-	-	1,526	1,137	389	40	-	-	-	245	JICA	Map Study
38	IV	Caliraya	Caliraya	92	Earthfill	42.0			-	-	-	-	-	-	-	-	-	300		-	-		Existing(1947)
39	V	Sipocot	Bicol/Sipocot	447	Rockfill	64.0	600	2.3	60	57	35	-	150	1,270	870	400	52	30	55	18,000	133	JICA	Map Study
40	V	Talisay	Bicol/Talisay	100	Rockfill	58.0	400	1.2	90	85	70	-	125	315	231	84	25	4.4	8	3,000	50	JICA	Map Study
41	VI	Panay	Panay	239	Con. Gravity	52.4	160	-	75	65	57	-	-	96	31	-	-	7	31	-	40	NK/JICA	F/S
42	VI	Jalaur	Jalaur	109	Arch	145.0	405			221	156.7			370	337	33	10	20	58	22,000		ELC/NK	D/D
43	VI	Bago	Bago	402	Rockfill	125.0	605	5.3	-	300	255	-	-	-	64	-	-	183	497	-	267	Shawinigan/ADB	F/S
44	VI	Ilog No.1	Ilog-Hilabangan	1,389	Rockfill	81.0	750	5.0	80	75	55	-	110	650	370	280	25	52	95	24,000	237	JICA	F/S
45	VII	Buhisan	Buhisan	5.9	Conc Arch	26.0	-	-	-	-	-	-	-	-	0.26	-	-	-	-	-	-		Existing(1910)
46	VII	Malubog	Sapang Daku	70	Rockfill	65.0	520	-	-	180	162	-	-	81	47	21	3	-	-	-	148	JICA	Map Study
47	VII	Mananga II	Mananga	68	Rockfill	90.0	240	0.5	161	154	110	-	-	48	41	7	1.5	-	-	-	130	Electrowatt/ADB	F/S
48	VII	Lusaran	Balamban	67	Rockfill	100.0	315	3.2	232	228	163	-	-	126	116	10	-	-	-	-	83	Camp Dresser/Mckee	D/D
49	VII	Cebu F_5(Palambato)	Butuanon	23	Rockfill	55.0	300	-	98	95	85	-	1	6	2	1	0.3	-	-	-	82	JICA	Map Study
50	VII	Tipolo	Inabanga	500	Con. Gravity	60.0	-	-	-	75	65	-	-	210	120	90	15	-	-	-	159	JICA	Map Study
51	IX	Pasonoca	Tumaga	101	Rockfill	86.0	-	-	-	109	95	-	-	-	13.7	30.3	1.3	-	-	-	-	JICA	Map Study
52	X	Bulanog-Batang	Cagayan de Oro	533	RCC	126.0	-	1.4	-	475	460	-	-	-	28.3	-	-	132	290	-	-	ELC	D/D
53	XI	Davao I	Davao	367	Rockfill	90.0	450	4.0	455	450	430	380	125	740	405	135	26	36	66	-	189	JICA	Map Study
54	XI	Davao II	Davao	820	Rockfill	112.0	350	5.0	385	380	360	285	-	436	224	212	14	100	180	-	265	JICA	Map Study
55	XI	Davao III	Davao	163	Rockfill	132.0	430	7.5	-	465	445	-	-	111	56	55	3.5	24	44	-	268	JICA	Map Study
56	XI	Dumuloc	Bunyan-Malungon	99	Rockfill	120.0	430	6.0	384	380	350	-	45	293	193	100	9	-	-	-	200	JICA	Map Study

Note: 1) The runoff of Bayabas dam is estimated refering the runoff of the adjacent Maasim dam in proportion to the catchment area.

2) Map Study in the column of Status means that the scheme was formulated in this study on map study level

Table D-5 DAMS ADOPTED AS THE CANDIDATES FOR WATER RESOURCES DEVELOPMENT SCHEMES (2/2)

No	WRR	Name of Dam	River System	Dam				Reservoir								Hydroelectric power		Irrigation	Cost	Consultant/Agency	Status
				CA (km^2)	Type	Height (m)	Crest Length (m)	Volume ($10^6 m^3$)	FWL (EL.m)	HWL (EL.m)	LWL (EL.m)	Tail WL (EL.m)	F/C Space ($10^6 m^3$)	Gross ($10^6 m^3$)	Active ($10^6 m^3$)	Dead ($10^6 m^3$)	Area (km^2)	(MW)	(GWh)	(ha)	(US$ 10^6)		
57	XII	Agus I	Agus(Lake Lanao)	1,645	-										1,715			80	456				Existing(1992)
58	XII	Agus II	Agus		Earthfill	29.0												180	756				Existing(1979)
59	XII	Agus III	Agus	1,844	Rockfill	58.0				524	516				0.7			225	1,065			ELC -> Lavalin	F/S
60	XII	Agus IV	Agus		Rockfill	32.0									24			158	762				Existing(1985)
61	XII	Agus V	Agus		Conc.gravity													55	265				Existing(1977)
62	XII	Agus VI	Agus(Maria Cristina)		Rockfill	12.5				203					1.2			200	1,016				Existing(1983)
63	XII	Agus VII	Agus		Conc.gravity													54	274				
64	XII	Pulangi I	Mindanao/Pulangi	376	Rockfill	100.0				660	626				1,715			24	105			Sofreles	Pre-F/S
65	XII	Pulangi II	Mindanao/Pulangi	737	Rockfill	110.0				557	523				535			70	257			Sofreles	Pre-F/S
66	XII	Pulangi III	Mindanao/Pulangi	1,339	Rockfill	90.0	632	7.6	-	417	380	-	-	-	1,156	-	71	90	382	-		477 MERALCO	F/S
67	XII	Pulangi IV	Mindanao/Pulangi	3,633		115.0												255	1,012				Existing(1985)
68	XII	Pulangi V	Mindanao/Pulangi	4,952	Gravity	125.0	228			160	123				1,190			348	1,310			Sofreles	Pre-F/S
69	XII	Pulangi VI	Mindanao/Pulangi	5,216	Gravity	30.0	139											70	340			Sofreles	Pre-F/S
70	XII	Maganoy	Mindanao/Cabilanan	550	Earthfill	45.0	226		-	687	660	-	-	-	62	-	10	66	315	13,000		34 Asiatic	F/S

Table D-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 D-6 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO MANILA (2/3)

Item Number	Name of City/ Project/ Structure	Conditions	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 10^6m^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 10^6m^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

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

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

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 x 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 x 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 x 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

Table D-7 MAIN FEATURES OF WATER SUPPLY PROJECTS FOR METRO CEBU (2/3)

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

Table D-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)
- Type of Powerhouse : Open-air Type
- Generating Capacity(6hour Peal : 4,200kW
- Number of Unit : 1

(Access Road))
- Length : 8,000m

3 - 2 Pulambato Dam Project

- **(Pulambato Dam)**
- Type of Dam : Rockfill (1,274,200m^3)
- Height of Dam : 55m
- Length of Dam : 300m
- Crest Elevation : 100m

Storage Volume : 5.6 x $10^6 m^3$ (Gross)

- **(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

(Water Treatment Plant)
- Storage Volume : 213,400m^3/day

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

(Booster Station)
- Numbers : 1

(Water Supply Pipe Line)
- Length of Pipe Line : 3.8km
- Diameter of Pipe Line : 1m
- Numbers(Lane) : 1

(Regulating reservoir)
- Storage Volume : 300,000m^3

(Access Road))
- Length : 8,000m

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

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 D-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 D-10 TOTAL CONSTRUCTION COSTS OF WATER SUPPLY PROJECTS FOR MAJOR CITIES

(Unit : US $)

		Baguio City		Metro Manila						Metro Cebu					
		Dam Scheme	Weir Scheme	Pampanga Novaliches	Kanan-Umiray (Scenario-2)	Kanan-Umiray (Scenario-3)	Kaliwa Cogeo	Maasim Dam	Bayabas Dam	Malubogu Dam	Mananga-II Dam	Inabangan Dam	Tipolo Dam	Lusaran Pulambato	Pulambato Talanban
A .	Total Construction Cost	180,866,931	151,841,073	396,897,311	253,024,508	383,403,019	275,620,173	42,971,037	121,977,929	99,583,161	122,377,573	187,671,275	229,834,650	95,557,859	97,504,773
B .	Direct Cost	129,145,979	116,072,996	294,733,422	170,167,074	266,492,804	215,018,969	29,145,963	91,838,786	76,699,392	97,677,192	130,109,595	144,251,022	62,686,586	76,046,493
B . 1	Civil Work	106,651,430	97,018,192	126,809,414	167,125,035	264,255,222	181,236,710	28,634,991	91,327,814	75,033,420	85,007,538	55,421,289	64,893,444	61,918,857	63,511,802
B . 2	Architectural Work	13,357,344	13,690,744	24,098,151	860,244	1,720,488	24,096,534	510,972	510,972	510,972	12,574,944	9,199,806	12,791,694	683,991	11,235,516
B . 3	Mechanical Work	9,137,205	5,373,060	83,825,858	2,181,795	517,094	9,685,725	This cost is included in the dam cost	This cost is included in the dam cost	1,155,000	94,710	65,488,500	66,565,884	83,738	1,299,375
C .	Indirect Cost	51,720,953	35,768,078	162,163,889	82,857,434	116,910,215	60,601,204	13,725,074	30,139,144	22,883,769	24,700,381	57,561,680	85,583,628	32,871,273	21,458,280
C . 1	Land Acquisition	17,050,000	6,045,000	90,000,000	35,200,000	44,000,000	6,300,000	5,625,000	6,375,000	3,344,000	412,500	21,900,000	43,125,000	15,000,000	2,250,000
C . 2	Administration Cost	7,309,799	6,105,900	16,236,671	10,268,354	15,524,640	11,065,948	1,738,548	4,910,689	4,002,170	4,904,485	7,600,480	9,368,801	3,884,329	3,914,825
C . 3	Price Contingency	3,874,379	3,482,190	7,042,003	5,105,012	7,994,784	6,450,569	874,379	2,755,164	2,300,982	2,930,316	3,903,288	4,327,531	1,880,598	2,231,395
C . 4	Physical Contingency	15,738,016	13,170,609	34,801,210	22,074,044	33,401,223	23,883,549	3,738,389	10,587,964	8,634,654	10,592,449	16,351,336	20,107,235	8,345,151	8,449,271
C . 5	Engineering Services Cost	7,748,759	6,964,380	14,084,005	10,210,024	15,989,568	12,901,138	1,748,758	5,510,327	4,601,964	5,860,632	7,806,576	8,655,051	3,761,195	4,562,790

Table D-11 BILL OF QUANTITY FOR KANAN-KALIWA WATER CONVEYANCE PROJECT FOR METRO MANILA IN SCENARIO-2 (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
B .	Kanan and Umiray Water Conveyance Project (Scenario-2)				
	Grand Total				205,367,074
1 .	Land Acquisition	ha	4,000	8,800	35,200,000
2 .	Total of Direct Cost				170,167,074
2 . 1	Civil Works				167,125,035
2 . 1 . 1	Open-air excavation common in inlet, outlet and water supply facilities	m^3	250,000	4	1,000,000
2 . 1 . 2	Open-air excavation rock in inlet, outlet and water suppl facilities	m^3	78,000	10	780,000
2 . 1 . 3	Backfill in random materials	m^3	54,000	2	108,000
2 . 1 . 4	Rockfill dam	LS			18,800,000
2 . 1 . 5	Gate shaft	LS			350,200
2 . 1 . 6	Powerhouse(sub-structure)	LS			3,450,800
2 . 1 . 7	Powerhouse(Super-structure)	LS			3,810,000
2 . 1 . 8	Power equipment	LS			28,638,000
2 . 1 . 9	Tunnel concrete in water convayance	LS			67,318,000
2 . 1 .10	Diversion tunnel (Hi-pressure tunnel)	LS			9,392,000
2 . 1 .11	Open-air structural concrete in inlet, outlet and water suppl facilities	m^3	45,000	140	6,300,000
2 . 1 .12	Access road	m	25,000	150	3,750,000
2 . 1 .13	Preparatory Works (10% of Item 1.1.1 to 1.1.12)				14,469,700
2 . 1 .14	Others (5% of Item 1.1.1 to 1.1.13)				7,958,335

Table D-11 BILL OF QUANTITY FOR KANAN-KALIWA WATER CONVEYANCE PROJECT FOR METRO MANILA IN SCENARIO-2 (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				860,244
2 . 2 . 1	Control building (x1)	LS			700,000
2 . 2 . 2	Guardhouse (x2)	LS			44,800
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				74,480
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				40,964
2 . 3	Mechanical works				2,181,795
2 . 3 . 1	Steel Liner	LS			639,000
2 . 3 . 2	Outlet (Followjet valve x1)	LS			1,250,000
2 . 3 . 3	Preparatory Works (10% of Item 1.3.1 to 1.3.2)				188,900
2 . 3 . 4	Others (5% of Item 1.3.1 to 1.3.3)				103,895

Table D-12 BILL OF QUANTITY FOR KANAN-KALIWA WATER CONVEYANCE PROJECT FOR METRO MANILA IN SCENARIO-3 (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
B .	Kanan and Umiray Water Conveyance Project (Scenario-3)				
	Grand Total				310,492,804
1 .	Land Acquisition	ha	5,000	8,800	44,000,000
2 .	Total of Direct Cost				266,492,804
2 . 1	Civil Works				264,255,222
2 . 1 . 1	Open-air excavation common in inlet, outlet and water supply facilities	m^3	350,000	4	1,400,000
2 . 1 . 2	Open-air excavation rock in inlet, outlet and water suppl facilities	m^3	110,000	10	1,100,000
2 . 1 . 3	Backfill in random materials	m^3	80,000	2	160,000
2 . 1 . 4	Rockfill dam	LS	(2,200,000m^3)		19,800,000
2 . 1 . 5	Hi-pressure tunnel (Diversion tunnel)	LS	(800m)		10,877,000
2 . 1 . 6	Gate shaft	LS			350,200
2 . 1 . 7	Kanan powerhouse(sub-structure)	LS			2,279,000
2 . 1 . 8	Kanan powerhouse(Super-structure)	LS			1,228,000
2 . 1 . 9	Power equipment (Kanan)	LS			7,729,000
2 . 1 . 10	Tunnel concrete in water convayance (to Umiray pond)	LS	(14,000m)		67,318,000
2 . 1 . 11	Tunnel concrete in water convayance (to Kaliwa pond)	LS	(20,000m)		96,169,000
2 . 1 . 12	Kaliwa powerhouse(sub-structure)	LS			654,000
2 . 1 . 13	Kaliwa powerhouse(Super-structure)	LS			424,000

Table D-12 BILL OF QUANTITY FOR KANAN-KALIWA WATER CONVEYANCE PROJECT FOR METRO MANILA IN SCENARIO-3 (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 1 . 14	Power equipment (Kaliwa)	LS			2,004,200
2 . 1 . 15	Open-air structural concrete in inlet, outlet and water suppl facilities	m^3	70,000	140	9,800,000
2 . 1 . 16	Access road	m	50,000	150	7,500,000
2 . 1 . 17	Preparatory Works (10% of Item 1.1.1 to 1.1.16)				22,879,240
2 . 1 . 18	Others (5% of Item 1.1.1 to 1.1.17)				12,583,582
2 . 2	Architectural Works				1,720,488
2 . 2 . 1	Control building (x2)	LS			1,400,000
2 . 2 . 2	Guardhouse (x4)	LS			89,600
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				148,960
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				81,928
2 . 3	Mechanical works				517,094
2 . 3 . 1	Steel Liner (Kanan)	LS			323,100
2 . 3 . 2	Steel Liner (Kaliwa)	LS			124,600
2 . 3 . 3	Preparatory Works (10% of Item 1.3.1 to 1.3.2)				44,770
2 . 3 . 4	Others (5% of Item 1.3.1 to 1.3.3)				24,624

Table D-13 BILL OF QUANTITY FOR MAASIM AND BAYABAS DAM PROJECT FOR METRO MANILA (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
D .	Maasim Dam				
	Grand Total				34,770,963
1 .	Land Acquisition	ha	450	12,500	5,625,000
2 .	Total of Direct Cost				29,145,963
2 . 1	Civil Works				28,634,991
2 . 1 . 1	Open-air excavation common in slope protection and others	m^3	600	4	2,400
2 . 1 . 2	Open-air excavation rock in slope protection and others	m^3	300	10	3,000
2 . 1 . 3	Backfill in random materials	m^3	200	2	400
2 . 1 . 4	Rockfill dam (Including the related structure)	LS			21,621,600
2 . 1 . 5	Backfill concrete	m^3	100	70	7,000
2 . 1 . 6	Structural concrete in outdoor	m^3	250	140	35,000
2 . 1 . 7	Diversion tunnel (Including the related work items)	LS			2,672,800
2 . 1 . 8	Access road	m	3,000	150	450,000
2 . 1 . 9	Preparatory Works (10% of Item 1.1.1 to 1.1.8)				2,479,220
2 . 1 . 10	Others (5% of Item 1.1.1 to 1.1.9)				1,363,571
2 . 2	Architectural Works				510,972
2 . 2 . 1	Control building (x1)	LS			420,000
2 . 2 . 2	Guardhouse (x1)	LS			22,400
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				44,240
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				24,332

Table D-13 BILL OF QUANTITY FOR MAASIM AND BAYABAS DAM PROJECT FOR METRO MANILA (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
D .	Bayabas Dam				
	Grand Total				98,213,786
1 .	Land Acquisition	ha	170	37,500	6,375,000
2 .	*Total of Direct Cost*				91,838,786
2 . 1	Civil Works				91,327,814
2 . 1 . 1	Open-air excavation common in slope protection and others	m^3	1,100	4	4,400
2 . 1 . 2	Open-air excavation rock in slope protection and others	m^3	500	10	5,000
2 . 1 . 3	Backfill in random materials	m^3	400	7	2,800
2 . 1 . 4	Rockfill dam (Including the related structure)	LS			76,500,000
2 . 1 . 5	Backfill concrete	m^3	250	70	17,500
2 . 1 . 6	Structural concrete in outdoor	m^3	350	120	42,000
2 . 1 . 7	Diversion tunnel (Including the related work items)	LS			1,750,000
2 . 1 . 8	Access road	m	5,000	150	750,000
2 . 1 . 9	Preparatory Works (10% of Item 1.1.1 to 1.1.8)				7,907,170
2 . 1 . 10	Others (5% of Item 1.1.1 to 1.1.9)				4,348,944
2 . 2	Architectural Works				510,972
2 . 2 . 1	Control building (x1)	LS			420,000
2 . 2 . 2	Guardhouse (x1)	LS			22,400
2 . 2 . 3	Preparatory Works (15% of Item 1.2.1 to 1.2.2)				44,240
2 . 2 . 4	Others (10% of Item 1.2.1 to 1.2.3)				24,332

Table D-14 BILL OF QUANTITY FOR KALIWA-COGEO WATER SUPPLY PROJECT FOR METRO MANILA (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
C .	Between Kaliwa and Metro Manila				
	Grand Total				221,318,969
1 .	Land Acquisition	ha	21	300,000	6,300,000
2 .	Total of Direct Cost				215,018,969
2 . 1	Civil Works				181,236,710
2 . 1 . 1	Open-air excavation common in inlet, outlet, reservoir along pipe line	m^3	27,500	4	110,000
2 . 1 . 2	Open-air excavation rock in inlet, outlet, reservoir along pipe line	m^3	5,600	10	56,000
2 . 1 . 3	Backfill in random materials	m^3	300	2	600
2 . 1 . 4	Intake weir	LS			66,630,000
2 . 1 . 5	Water convayance tunnel	LS			41,672,000
2 . 1 . 6	Structural concrete for inlet, outlet, overflow spillway and saddle	m^3	1,400	140	196,000
2 . 1 . 7	Water treatment plant	LS			38,213,300
2 . 1 . 8	Asphalt water proofing	m^2	74,900	130	9,737,000
2 . 1 . 9	Access road	m	2,000	150	300,000
2 . 1 . 10	Preparatory Works (10% of Item 1.1.1 to 1.1.9)				15,691,490
2 . 1 . 11	Others (5% of Item 1.1.1 to 1.1.10)				8,630,320

Table D-14 BILL OF QUANTITY FOR KALIWA-COGEO WATER SUPPLY PROJECT FOR METRO MANILA (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				24,096,534
2 . 2 . 1	Pumping station	LS			20,736,000
2 . 2 . 2	Guardhouse (x2)	LS			44,800
2 . 2 . 3	Boosterhouse (x3)	LS			67,200
2 . 2 . 4	Valve house	LS			23,000
2 . 2 . 5	Preparatory Works (10% of Item 1.2.1 to 1.2.4)				2,078,080
2 . 2 . 6	Others (5% of Item 1.2.1 to 1.2.5)				1,147,454
2 . 3	Mechanical works				9,685,725
2 . 3 . 1	Pump (Main)	LS			1,365,000
2 . 3 . 2	Pump (Boost x3)	LS			1,233,000
2 . 3 . 3	Water supply pipe	m	11,000	590	6,490,000
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1 to 1.3.3)				136,500
2 . 3 . 5	Others (5% of Item 1.3.1 to 1.3.4)				461,225

Table D-15 BILL OF QUANTITY FOR PAMPANGA WATER CONVEYANCE PROJECT FOR METRO MANILA (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
A .	Between Pampanga and Novaliches (Direct Cost)				
	Grand Total				324,733,422
1 .	Land Acquisition	ha	300	300,000	90,000,000
2 .	Total of Direct Cost				234,733,422
2 . 1	Civil Works				126,809,414
2 . 1 . 1	Open-air excavation common in water supply pipe line and reservoir	m^3	6,800	4	27,200
2 . 1 . 2	Open-air excavation rock in water supply pipe line and reservoir	m^3	1,700	10	17,000
2 . 1 . 3	Backfill in random materials in water supply pipe line and reservoir	m^3	6,500	2	13,000
2 . 1 . 4	Gated weir	LS			9,367,000
2 . 1 . 6	Backfill concrete	m^3	150	70	10,500
2 . 1 . 7	Structural concrete for guide wall, apron, after bay, saddle, inlet pond and reservoir(spillway)	m^3	15,500	140	2,170,000
2 . 1 . 8	Water treatment plant	LS			97,437,000
2 . 1 . 9	Access road	m	5,000	150	750,000
2 . 1 .10	Preparatory Works (10% of Item 1.1.1 to 1.1.8)				10,979,170
2 . 1 .11	Others (5% of Item 1.1.1 to 1.1.9)				6,038,544

Table D-15 BILL OF QUANTITY FOR PAMPANGA WATER CONVEYANCE PROJECT FOR METRO MANILA (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				24,098,151
2 . 2 . 1	*Pumping station*	LS			20,736,200
2 . 2 . 2	Boosterhouse	LS			105,000
2 . 2 . 3	Valvehouse	LS			23,000
2 . 2 . 4	Preparatory Works (10% of Item 1.2.1 to 1.2.3)				2,086,420
2 . 2 . 5	Others (5% of Item 1.2.1 to 1.2.4)				1,147,531
2 . 3	Mechanical works				83,825,858
2 . 3 . 1	Pump (for Main)	nos	1		888,000
2 . 3 . 2	*Pump (for Boost)*	nos	3		188,500
2 . 3 . 3	Water supply pipe (L=65,000m)	LS	65,000	1,100	71,500,000
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1 to 1.3.3)				7,257,650
2 . 3 . 5	Others (5% of Item 1.3.1 to 1.3.4)				3,991,708

Table D-16 BILL OF QUANTITY FOR BOHOL-CEBU WATER SUPPLY PROJECT FOR METRO CEBU: FIRST STAGE (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
C .	Between Inabangan and Mactan (crossing the sea)				
	Grand Total				152,009,595
1 .	Land Acquisition	ha	73	300,000	21,900,000
2 .	Total of Direct Cost				130,109,595
2 . 1	Civil Works				55,421,289
2 . 1 . 1	Open-air excavation common in inlet, desanding basin outlet, reservoir along pipe line	m^3	65,000	4	260,000
2 . 1 . 2	Open-air excavation rock in inlet, desanding basin, outlet, reservoir along pipe line	m^3	58,000	10	580,000
2 . 1 . 3	Backfill in random materials	m^3	5,600	2	11,200
2 . 1 . 4	Intake weir	LS			12,320,000
2 . 1 . 5	Open-air structural concrete in inlet, outlet, desanding basin, saddle and overflow spillway	m^3	45,600	120	5,472,000
2 . 1 . 6	Water treatment plant	LS			24,728,600
2 . 1 . 7	Asphalt water proofing	m^2	30,400	130	3,952,000
2 . 1 . 8	Filter materials in reservoir	m^3	10,000	6	60,000
2 . 1 . 9	Access road	m	4,000	150	600,000
2 . 1 . 10	Preparatory Works (10% of Item 1.1.1 to 1.1.9)				4,798,380
2 . 1 . 11	Others (5% of Item 1.1.1 to 1.1.10)				2,639,109

Table D-16 BILL OF QUANTITY FOR BOHOL-CEBU WATER SUPPLY PROJECT FOR METRO CEBU: FIRST STAGE (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				9,199,806
2 . 2 . 1	pumping station (Mechanical and GE is included)	LS			7,920,400
2 . 2 . 2	Guardhouse (x2)	LS	2		44,800
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				796,520
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				438,086
2 . 3	Mechanical works				65,488,500
2 . 3 . 1	Water supply pipe	m	31,500	1,800	56,700,000
2 . 3 . 2	Preparatory Works (10% of Item 1.3.1)				5,670,000
2 . 3 . 3	Others (5% of Item 1.3.1 to 1.3.2)				3,118,500

Table D-17 BILL OF QUANTITY FOR BOHOL-CEBU WATER SUPPLY PROJECT FOR METRO CEBU: SECOND STAGE (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
D .	Inabangan(Tipolo Dam)				
	Grand Total				187,376,022
1 .	Land Acquisition	ha	1,150	37,500	43,125,000
2 .	Total of Direct Cost				144,251,022
2 . 1	Civil Works				64,893,444
2 . 1 . 1	Open-air excavation common in inlet and outlet	m^3	5,600	4	22,400
2 . 1 . 2	Open-air excavation rock in inlet and outlet	m^3	2,400	10	24,000
2 . 1 . 3	Backfill in random materials	m^3	10,500	2	21,000
2 . 1 . 4	Diversion tunnel	LS			300,000
2 . 1 . 5	Rockfill dam	LS			6,246,000
2 . 1 . 6	Hi-pressure conduit (Penstock) Q=7.2m^3/s	LS			225,500
2 . 1 . 7	Powerhouse(sub-structure)	LS			376,000
2 . 1 . 8	Powerhouse(Super-structure)	LS			478,000
2 . 1 . 9	Power equipment	LS			1,720,000
2 . 1 . 10	Water treatment plant	LS			44,761,900
2 . 1 . 11	Open-air structural concrete	m^3	1,500	140	210,000
2 . 1 . 12	Access road	m	12,000	150	1,800,000
2 . 1 . 13	Preparatory Works (10% of Item 1.1.1 to 1.1.12)				5,618,480
2 . 1 . 14	Others (5% of Item 1.1.1 to 1.1.13)				3,090,164

Table D-17 BILL OF QUANTITY FOR BOHOL-CEBU WATER SUPPLY PROJECT FOR METRO CEBU: SECOND STAGE (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				12,791,694
2 . 2 . 1	Pumping station	LS			12,012,300
2 . 2 . 2	Control building (x1)	LS			630,000
2 . 2 . 3	Guardhouse (x2)	LS			44,800
2 . 2 . 4	Preparatory Works (10% of Item 1.2.1 to 1.2.3)				67,480
2 . 2 . 5	Others (5% of Item 1.2.1 to 1.2.4)				37,114
2 . 3	Mechanical works				66,565,884
2 . 3 . 2	Steel liner	LS			57,632,800
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1)				5,763,280
2 . 3 . 5	Others (5% of Item 1.3.1 to 1.3.2)				3,169,804

Table D-18 BILL OF QUANTITY FOR MALUBOG-MANANGA WATER CONVEYANCE PROJECT FOR METRO CEBU (1/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
A .	Between Malubog and Mananga-II (ALT-1/1)				
	Grand Total				80,043,392
1 .	Land Acquisition	ha	380	8,800	3,344,000
2 .	Total of Direct Cost				76,699,392
2 . 1	Civil Works				75,033,420
2 . 1 . 1	Open-air excavation common in inlet, outlet and water supply facilities	m^3	15,800	4	63,200
2 . 1 . 2	Open-air excavation rock in inlet, outlet and water suppl facilities	m^3	9,800	10	98,000
2 . 1 . 3	Backfill in random materials	m^3	1,500	2	3,000
2 . 1 . 4	Rockfilldam (Malubog)	LS			30,700,800
2 . 1 . 5	Saddle dam (Right and left abutment)	LS			10,600,000
2 . 1 . 6	Diversion Tunnel	LS			300,000
2 . 1 . 7	Water conveyance tunnel	LS			22,100,000
2 . 1 . 8	Open-air structural concrete in water supply intake, outlet , diversion tunnel and others	m^3	350	140	49,000
2 . 1 . 9	Access road	m	7,000	150	1,050,000
2 . 1 . 10	Preparatory Works (10% of Item 1.1.1 to 1.1.9)				6,496,400
2 . 1 . 11	Others (5% of Item 1.1.1 to 1.1.10)				3,573,020

Table D-18 BILL OF QUANTITY FOR MALUBOG-MANANGA WATER CONVEYANCE PROJECT FOR METRO CEBU (2/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				510,972
2 . 2 . 1	Control building (x1)	LS			420,000
2 . 2 . 2	Guardhouse (x1)	LS			22,400
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				44,240
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				24,332
2 . 3	Mechanical works				1,155,000
2 . 3 . 1	Outlet (Followjet valve)	LS	1		1,000,000
2 . 3 . 2	Preparatory Works (10% of Item 1.3.1)				100,000
2 . 3 . 3	Others (5% of Item 1.3.1 to 1.3.2)				55,000

Table D-18 BILL OF QUANTITY FOR MALUBOG-MANANGA WATER CONVEYANCE PROJECT FOR METRO CEBU (3/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
B .	Mananga-II				
	Grand Total				98,089,692
1 .	Land Acquisition	ha	33	12,500	412,500
2 .	Total of Direct Cost				97,677,192
2 . 1	Civil Works				85,007,538
2 . 1 . 1	Open-air excavation common	m^3	107,100	4	428,400
2 . 1 . 2	Open-air excavation rock in inlet, outlet and water suppl facilities	m^3	46,000	10	460,000
2 . 1 . 3	Backfill in random materials	m^3	15,000	2	30,000
2 . 1 . 4	Rockfill dam (Mananga)	LS			26,611,200
2 . 1 . 5	Powerhouse(sub-structure)	LS			396,800
2 . 1 . 6	Powerhouse(Super-structure)	LS			288,200
2 . 1 . 7	Power equipment	LS			1,110,000
2 . 1 . 8	Water treatment plant	LS			42,343,000
2 . 1 . 9	Diversion Tunnel	LS			510,000
2 . 1 . 10	Open-air structural concrete	m^3	4,800	140	672,000
2 . 1 . 11	Access road	m	5,000	150	750,000
2 . 1 . 12	Preparatory Works (10% of Item 1.1.1 to 1.1.11)				7,359,960
2 . 1 . 13	Others (5% of Item 1.1.1 to 1.1.12)				4,047,978

Table D-18 BILL OF QUANTITY FOR MALUBOG-MANANGA WATER CONVEYANCE PROJECT FOR METRO CEBU (4/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
					12,574,944
2 . 2	Architectural Works				11,553,000
2 . 2 . 1	Pumping station	LS			840,000
2 . 2 . 2	Control building (x1)	LS			44,800
2 . 2 . 3	Guardhouse (x2)	LS			38,480
2 . 2 . 4	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				48,664
2 . 2 . 5	Others (5% of Item 1.2.1 to 1.2.3)				
					94,710
2 . 3	Mechanical works				82,000
2 . 3 . 1	Steel Liner	LS			8,200
2 . 3 . 2	Preparatory Works (10% of Item 1.3.1 to 1.3.1)				4,510
2 . 3 . 3	Others (5% of Item 1.3.1 to 1.3.2)				

Table D-19 BILL OF QUANTITY FOR LUSARAN-PULAMBATO WATER CONVEYANCE PROJECT FOR METRO CEBU (1/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
E .	Between Lusalan and Pulambato Reservoir				
					77,686,586
	Grand Total				
1 .	Land Acquisition	ha	400	37,500	15,000,000
					62,686,586
2 .	Total of Direct Cost				
					61,918,857
2 . 1	Civil Works				
2 . 1 . 1	Open-air excavation common in regulating reservoir and along pipe lin	m^3	22,400	4	89,600
2 . 1 . 2	Open-air excavation rock in regulating reservoir and along pipe line	m^3	9,600	10	96,000
2 . 1 . 3	Backfill in random materials	m^3	1,500	2	3,000
2 . 1 . 4	Rockfill dam	LS			26,838,000
2 . 1 . 5	Diversion tunnel	LS			1,500,000
2 . 1 . 6	Intake structure (Pressure type)	LS			835,100
2 . 1 . 7	Headrace tunnel	LS			19,800,000
2 . 1 . 8	Surge tank	LS			590,500
2 . 1 . 9	Hi-pessure tunnel	LS			206,200
2 . 1 . 10	Powerhouse(sub-structure)	LS			390,500
2 . 1 . 11	Powerhouse(Super-structure)	LS			310,000
2 . 1 . 12	Power equipment	LS			1,344,900
2 . 1 . 13	Concrete in inspection tunnel (all classes)	m^3	200	68	13,600
2 . 1 . 14	Open-air structural concrete	m^3	2,800	140	392,000
2 . 1 . 15	Access road	m	8,000	150	1,200,000
2 . 1 . 16	Preparatory Works (10% of Item 1.1.1 to 1.1.15)				5,360,940
2 . 1 . 17	Others (5% of Item 1.1.1 to 1.1.16)				2,948,517

Table D-19 BILL OF QUANTITY FOR LUSARAN-PULAMBATO WATER CONVEYANCE PROJECT FOR METRO CEBU (2/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				683,991
2 . 2 . 2	Control building (x1)	LS			525,000
2 . 2 . 3	Guardhouse (x3)	LS			67,200
2 . 2 . 4	Preparatory Works (10% of Item 1.2.1 to 1.2.3)				59,220
2 . 2 . 5	Others (5% of Item 1.2.1 to 1.2.4)				32,571
2 . 3	Mechanical works				83,738
2 . 3 . 1	Steel liner	LS			72,500
2 . 3 . 2	Preparatory Works (10% of Item 1.3.1)				7,250
2 . 3 . 3	Others (5% of Item 1.3.1 to 1.3.2)				3,988

Table D-19 BILL OF QUANTITY FOR LUSARAN-PULAMBATO WATER CONVEYANCE PROJECT FOR METRO CEBU (3/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
F .	Between Pulambato and Talanban				
	Grand Total				78,296,493
1 .	Land Acquisition	ha	60	37,500	2,250,000
2 .	Total of Direct Cost				76,046,493
2 . 1	Civil Works				63,511,602
2 . 1 . 1	Open-air excavation common in inlet, outlet and water supply facilities	m^3	2,600	4	10,400
2 . 1 . 2	Open-air excavation rock in inlet, outlet and water suppl facilities	m^3	1,100	10	11,000
2 . 1 . 3	Backfill in random materials	m^3	4,600	2	9,200
2 . 1 . 4	Diversion tunnel	LS			455,000
2 . 1 . 5	Rockfill dam	LS			11,467,800
2 . 1 . 6	Concrete weir (desanding basin is included)	LS			1,310,000
2 . 1 . 7	Intake (pressure type)	LS			735,600
2 . 1 . 8	Hi-pressure conduit (Penstock)	LS			54,400
2 . 1 . 9	Powerhouse(Sub-structure)	LS			263,200
2 . 1 .10	Powerhouse(Super-structure)	LS			195,800
2 . 1 .11	Power equipment	LS			753,700
2 . 1 .12	Open-air structural concrete in inlet, outlet, desanding basin, saddle and	m^3	5,000	140	700,000
2 . 1 .13	Water treatment plant	LS			37,822,300
2 . 1 .14	Access road	m	8,000	150	1,200,000
2 . 1 .15	Preparatory Works (10% of Item 1.1.1 to 1.1.14)				5,498,840
2 . 1 .16	Others (5% of Item 1.1.1 to 1.1.15)				3,024,362

Table D-19 BILL OF QUANTITY FOR LUSARAN-PULAMBATO WATER CONVEYANCE PROJECT FOR METRO CEBU (4/4)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				11,235,516
2 . 2 . 1	*Pumping station*	LS			10,672,800
2 . 2 . 2	Control building (x1)	LS			420,000
2 . 2 . 3	Guardhouse (x3)	LS			67,200
2 . 2 . 4	Preparatory Works (10% of Item 1.2.1 to 1.2.3)				48,720
2 . 2 . 5	Others (5% of Item 1.2.1 to 1.2.4)				26,796
2 . 3	Mechanical works				1,299,375
2 . 3 . 3	Water supply pipe	*m*	2,500	450	1,125,000
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1 to 1.3.3)				112,500
2 . 3 . 5	*Others (5% of Item 1.3.1 to 1.3.4)*				61,875

Table D-20 BILL OF QUANTITY FOR LABOY DAM WATER SUPPLY PROJECT FOR BAGUIO CITY (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
B .	Between Laboy and Bagio (Rockfill Dam Scheme)				
	Grand Total				146,195,979
1 .	Land Acquisition	ha	110	155,000	17,050,000
2 .	Total of Direct Cost				129,145,979
2 . 1	Civil Works				106,651,430
2 . 1 . 1	Open-air excavation common in slope protection and others	m^3	1,400	4	5,600
2 . 1 . 2	Open-air excavation rock in slope protection and others	m^3	200	10	2,000
2 . 1 . 3	Backfill in random materials	m^3	2,400	2	4,800
2 . 1 . 4	Rockfill dam	LS			47,610,000
2 . 1 . 5	Backfill concrete	m^3	350	100	35,000
2 . 1 . 6	Open-air structural concrete in overflow spillway and saddle and other	m^3	2,500	140	350,000
2 . 1 . 7	Water treatment plant	LS			38,213,300
2 . 1 . 8	Asphalt water proofing	m^2	36,700	130	4,771,000
2 . 1 . 9	Filter materials in reservoir	m^3	18,400	8	147,200
2 . 1 . 10	Access road	m	8,000	150	1,200,000
2 . 1 . 11	Preparatory Works (10% of Item 1.1.1 to 1.1.10)				9,233,890
2 . 1 . 12	Others (5% of Item 1.1.1 to 1.1.11)				5,078,640

Table D-20 BILL OF QUANTITY FOR LABOY DAM WATER SUPPLY PROJECT FOR BAGUIO CITY (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				13,357,344
2 . 2 . 1	Control building (x1)	LS			630,000
2 . 2 . 2	Guardhouse (x2)	LS			44,800
2 . 2 . 3	Pumping House	LS			10,750,000
2 . 2 . 4	Boosthouse (x4)	LS			140,000
2 . 2 . 5	Preparatory Works (10% of Item 1.2.1 to 1.2.4)				1,156,480
2 . 2 . 6	Others (5% of Item 1.2.1 to 1.2.5)				636,064
2 . 3	Mechanical works				9,137,205
2 . 3 . 1	Pump (Main)	LS			1,235,000
2 . 3 . 2	Pump (Boost x4)	LS			2,247,000
2 . 3 . 3	Water Supply pipe	m	10,300	430	4,429,000
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1 to 1.3.3)				791,100
2 . 3 . 5	Others (5% of Item 1.3.1 to 1.3.4)				435,105

Table D-21 BILL OF QUANTITY FOR LABOY WEIR WATER SUPPLY PROJECT FOR BAGUIO CITY (1/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
A .	Between Laboy and Bagio (Weir Scheme)				
	Grand Total				122,117,996
1 .	Land Acquisition	ha	39	155,000	6,045,000
2 .	Total of Direct Cost				116,072,996
2 . 1	Civil Works				97,019,192
2 . 1 . 1	Open-air excavation common in reservoir, desanding basin along the pipe line	m^3	1,750,000	4	7,000,000
2 . 1 . 2	Open-air excavation rock in reservoir, desanding basin along the pipe line	m^3	285,000	10	2,850,000
2 . 1 . 3	Backfill in random materials	m^3	3,500	2	7,000
2 . 1 . 4	Intake weir (Gated weir)	LS			5,625,000
2 . 1 . 5	Open-air structural concrete in overflow spillway, desanding basin and saddle	m^3	1,600	140	224,000
2 . 1 . 6	Water treatment plant	LS			38,213,300
2 . 1 . 7	Asphalt water proofing	m^2	220,000	130	28,600,000
2 . 1 . 8	Filter materials in reservoir	m^3	110,000	8	880,000
2 . 1 . 9	Access road	m	4,000	150	600,000
2 . 1 . 10	Preparatory Works (10% of Item 1.1.1 to 1.1.9)				8,399,930
2 . 1 . 11	Others (5% of Item 1.1.1 to 1.1.10)				4,619,962

Table D-21 BILL OF QUANTITY FOR LABOY WEIR WATER SUPPLY PROJECT FOR BAGUIO CITY (2/2)

Item No.	Work Item	Unit	Quantity	Unit Price (US$)	Amount (US$)
2 . 2	Architectural Works				13,680,744
2 . 2 . 1	Pumping station	LS			10,750,000
2 . 2 . 2	Boosthouse (x3)	LS			1,050,000
2 . 2 . 2	Guardhouse (x2)	LS			44,800
2 . 2 . 3	Preparatory Works (10% of Item 1.2.1 to 1.2.2)				1,184,480
2 . 2 . 4	Others (5% of Item 1.2.1 to 1.2.3)				651,464
2 . 3	Mechanical works				5,373,060
2 . 3 . 1	Pump (Main)	LS			954,000
2 . 3 . 2	Pump (Boost x3)	LS			903,000
2 . 3 . 3	Water supply pipe	m	6,500	430	2,795,000
2 . 3 . 4	Preparatory Works (10% of Item 1.3.1 to 1.3.3)				465,200
2 . 3 . 5	Others (5% of Item 1.3.1 to 1.3.4)				255,860