Japan International Cooperation Agency

National Water Resources Board
The Republic of The Philippines

The Study on Water Resources Development for Metro Manila in the Republic of the Philippines

Final Report

Volume IV
Feasibility Study
Main Report

March 2003

Nippon Koei Co., Ltd.

NJS Consultants

List of Volumes

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The cost estimate is based on the price level and exchange rate of June 2002.

The exchange rate is:

US$1.00 = PHP52.0 = ¥120.0

PREFACE

In response to a request from the Government of the Republic of the Philippines, the Government of Japan decided to conduct the Study on Water Resources Development for Metro Manila in the Republic of the Philippines and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched the study team headed by Mr. Michito Kato of Nippon Koei, Co., LTD. (consisting of Nippon Koei, Co., LTD. and NJS Consultants) to the Philippines, three times between March 2001 and February 2003. In addition, JICA set up the advisory committee headed by Mr. Takuji Oikawa, Director, Ikeda Dams and Canal Integrated Office, Water Resources Development Pubilic Corporation between March 2001 and March 2003.

The team held discussions with the officials concerned of the Government of the Republic of the Philippines, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the Study.

2003 March

Takao Kawakami
President
Japan International Cooperation Agency

March 2003

Mr. Takao Kawakami
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

Letter of Transmittal

It is a great pleasure that we submit herewith the Final Report of the "Study on Water Resources Development for Metro Manila in the Republic of the Philippines".

The main objective of the Study was placed on the formulation of water supply development plan for the Metro Manila and its vicinity for meeting the water demand up to the year 2025. The Study prepared in its Phase I a master plan for the water resources development in the Agos River Basin and the associated water conveyance facilities, and successively in the Phase II a feasibility study for the priority project selected from the master plan. The Report presents the outcomes of the master plan and feasibility study.

We hope that this Report will be helpful for the realization of the project proposed in this Study. We believe that the successful undertaking of the proposed project would assure stable water supply in the Metro Manila area in the long term and thus contribute to the further socio-economic development in the region.

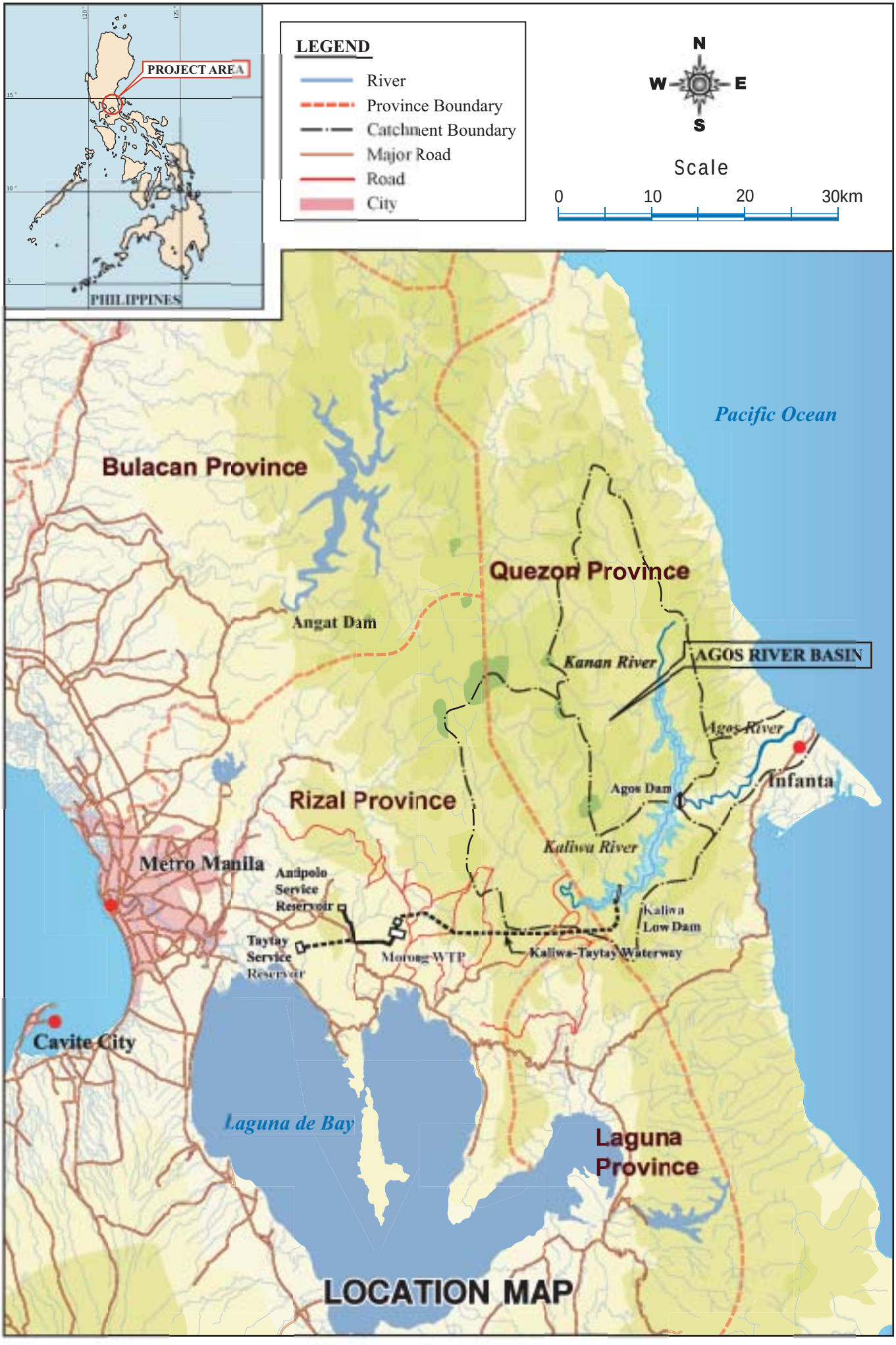
We wish to express our sincere gratitude to the personnel concerned of your Agency for the guidance and support given throughout the Study period. Our deep gratitude is also expressed to the National Water Resources Board and other concerned authorities of the Government of the Republic of the Philippines, JICA Philippines Office and the Embassy of Japan in the Philippines for their close cooperation and assistance extended during the course of the Study.

Very truly yours,

M. Kato

Michito Kato
Team Leader

The Study on Water Resources
Development for Metro Manila
in the Republic of the Philippines


PROJECT AREA
PHILIPPINES
LEGEND
River
Province Boundary
Catchment Boundary
Major Road
Road
City
N
W
E
S
Scale
0
10
20
30km
Pacific Ocean
Bulacan Province
Quezon Province
Angat Dam
Kanan River
AGOS RIVER BASIN
Agos River
Infanta
Agos Dam
Rizal Province
Kaliwa River
Metro Manila
Antipolo Service Reservoir
Kaliwa Low Dam
Taytay Service Reservoir
Morong WTP
Kaliwa-Taytay Waterway
Cavite City
Laguna de Bay
Laguna Province
LOCATION MAP

The Study on Water Resources Development
for Metro Manila in the Republic of the Philippines

VOLUME IV FEASIBILITY STUDY - MAIN REPORT

SUMMARY

Project for Feasibility Study: (Chapter I)

1. With the consent of the Steering Committee at a meeting held on January 16, 2002, the projects proposed as Development Scenario B were agreed for the feasibility study (F/S). The proposed projects consist of Kaliwa Low Dam and Agos Dam as water sources and Kaliwa-Taytay Waterway as water conveyance facility. The F/S also examined the viability of two hydropower schemes: Agos power scheme and Lagundi (Abuyod in M/P) power scheme.

Topographic Survey: (Chapter II)

2. Topographic maps produced during this Study are of 1:5,000 scale covering the whole project area and 1:2,000 scale for six (6) major structure sites and pipeline route. On account of inability of aerial-photo shooting for the whole area due to unfavorable weather prevailed in the dry season of 2002, the partial areas had to be mapped using the existing photos available from NAMRIA (1995-2000) or using the existing maps prepared in the earlier studies (1980-1992).

Hydrological Investigation: (Chapter II and IV)

3. As a part of hydrological survey, spot discharge measurement was carried out at eight points on the Kaliwa River. The objective was to investigate the distribution of flows in limestone areas, through which the Study had intended to assess the possibility of water loss in the Daraitan limestone area situated at the upstream part of the planned Agos Reservoir. The results showed that water once infiltrating into the limestone mass returns back at the downstream reach. This suggests that there is no possibility for the loss of reservoir water leaking to the outside of the basin. (See also Para.6 below).

Geological Investigation: (Chapter IV)

4. Seismicity and Active Fault

   The project area is situated within a zone of active tectonics represented by the Philippine Fault (Philippine Fault Zone: PFZ) and the Valley Fault System. Particularly, the Agos damsite is located only 7-8 km distant from the Philippine Fault Zone (Infanta Fault). Therefore, high seismic risk should be taken into account in the preparation of design. The peak acceleration at a100-year probability is assessed at 0.58g.

   To confirm the distribution and certainty of active faults, photographic analysis was conducted in an area of 10 km radius around the Agos damsite. As a result, it was

found that "active fault that would need careful attention" does not exist nearby the Agos damsite.

5. Agos Damsite Geology

The foundation of the proposed Agos damsite is generally hard and impervious, which was assessed suitable for the foundation of a fill type dam. Nevertheless, the following were identified in the investigation:

(a) Thick riverbed deposit of 30 to 40 m in depth

(b) Existence of landslide blocks on the abutments

(c) Distribution of low velocity zones running perpendicular to the dam axis

Preliminary design of the dam in this Study has duly taken into account the above aspects.

6. Water Leakage from Daraitan Limestone in the Agos Reservoir Area

As stated above (Para.3), the possibility of water leakage from Daraitan limestone mass towards south was one of the subjects to be investigated. The investigation by two core-drillings and two lines of electric prospecting revealed that the problem of leakage from the limestone mass would possibly be negligible judging from the following facts:

(a) Towards the south, the permeable limestone mass wedges out around the Makmira village at the 3-km southern point from the Kaliwa River.

(b) Groundwater level seems shallow around Makmira to Santiago village area, represented by constant surface flows observed at streams in the vicinity.

(c) No loss of the river water flow was observed in the sections of limestone area, according to the result of spot discharge measurement (Para.3 above)

7. Waterway Geology

The field investigation identified the following problems for the waterway construction: (See Figure 7.1 for the layout of waterway)

(a) Tunnel No.1 will encounter a major fault designated as an 'assumed active fault' by PHILVOLCS (2000) at the point of 25 km from the intake (see Figure 4.9). Thus, the tunnel is aligned to cross the fault at right angle so as to decrease the length of tunneling in the fault zone.

(b) Tunnel No.2 is laid out beneath the Antipolo plateau. In the 1.3-3.3 km section, there is a possibility of encountering the Guadalupe Formation, which is supposed to be a confined aquifer supplying water to the deep wells in Antipolo. In the next stage, detailed geotechnical investigations will be required to confirm the geological condition for tunneling and evaluate the influence to the wells.

(c) Valve House No.2 at Teresa and partial area of Antipolo Pump Station are proposed in the low-flat area possibly formed by alluvial deposits such as soft clay, silt or sand materials. Pile foundation is recommended for the proposed structures.

(d) Partial sections of the pipeline route (37 % of the total length) pass through the alluvial deposit area. During the construction of this pipeline section, excavation with sheet-pile walling will be required.

Formulation of Optimum Development Plan: (Chapter VI)

8. Development Scale of Agos Dam (FSL of Agos Dam/Reservoir)

The optimum development scale of Agos Dam was examined by comparing six alternative full supply level (FSL) plans varying from El. 145 m to 195 m. The comparison study based on a 'unit water cost' showed that the unit water cost is generally lesser at higher FSLs, with the least-cost case being FSL 185 m.

On the other hand, however, topographic map indicates that the FSL higher than EL.159 m would submerge the residential area of Barangay Daraitan where about 500 households exist. Barangay Daraitan is the core village in the vicinity and its submergence would bring about a large social problem to the extent hampering the smooth implementation of the project. From this social aspect, the highest practical FSL of the Agos Reservoir was regarded to be EL. 159 m.

9. Selection of Dam Axis

Two alternative dam axes were examined in the Study: an upstream axis and a downstream axis (See Figure 4.5). Geological investigation revealed that the downstream axis would require extra costs for removal of landslide blocks lying between the two dam axes. Cost comparison indicated that the upstream site is less costly by US$ 44 million equivalent. Therefore, the upstream axis was selected as the preferable dam axis for the Agos Dam.

10 Selection of Dam Type

Two dam types, concrete face rockfill dam (CFRD) and earth core rockfill dam (ECRD), are retained as possible dam type for the Agos Dam. Comparing the two, the CFRD type was selected taking account of less cost requirement (by US$ 27 million) and other technical advantages.

11. Economic Diameter of Tunnel No.1 of Kaliwa-Taytay Waterway

The diameter of Waterway Tunnel No.1, which connects an intake structure at Kaliwa Low damsite and Valve House No.1 at water treatment plant site, is one of important factors dominating the project cost due to its long distance (27.5 km long). Through an economic comparison study, a diameter of 3.5m was selected as the economical diameter of Tunnel No.1

12. Hydropower Development

(1) Agos Power Scheme

Comparison of four (4) alternative development plans was based on economic evaluation. Economic benefit was taken from alternative thermal power cost. The result is summarized below:

Comparison of Economic Viability of Agos Power Scheme

Alternative	Installed Capacity (MW)	Construction Cost (US$ Mil.)	Present Worth at Discount Rate of 12 % (US$ Mil.)			EIRR (%)
			Cost (C)	Benefit (B)	B-C	
A	103.4	159.0	120.9	120.0	-0.9	11.8
B	77.5	139.4	98.6	98.6	-7.3	10.3
C	51.5	81.2	68.8	68.8	6.3	14.6
D	25.6	58.5	40.1	40.1	-4.9	9.6

As indicated in the table above, Alternative Plan C was evaluated to be most attractive from the national economic development viewpoint. A preliminary financial analysis also revealed that the Plan C would be most viable. Thus, the Agos hydropower scheme is proposed to be 51.5 MW in installed capacity.

(2) Lagundi Power Scheme

For the given conditions of plant discharge (34.7 m^3/sec average for water supply) and available head between the Agos Reservoir and the Lagundi powerhouse site, the power output of the scheme was calculated to be 10.61 MW in installed capacity. The viability of the scheme was evaluated through a financial analysis in the context that the scheme is proposed as a BOT scheme. The analysis revealed that the FIRR is only 5.3 %, which would not be a level of justifying as a BOT project. Hence, the scheme was ruled out from further study. Accordingly, the waterway is aligned so as to connect the Tunnel No.1 directly to Valve House No.1 at the water treatment plant.

Preliminary Design of the Proposed Project: (Chapter VII and VIII)

13. Water Source Development (Chapter VII and VIII)

(1) Kaliwa Low Dam

Kaliwa Low Dam, to be built under the first stage (Stage 1), will serve as an intake dam facility in the initial period of the project operation. It is virtually a temporary structure with a life of three years until it is submerged by the Agos Reservoir that will be built in the second stage (Stage 2-1). The dam will be constructed with random fill materials produced from the excavation of the intake and waterway tunnel. The layout plan and structural design of the Kaliwa Low Dam are shown in Figure 7.2.

(2) Agos Dam

Agos Dam will function as a permanent water source of the project. The crest level of Agos Dam is set at El. 165.2 m securing a required freeboard of 6.2 m above FSL to ensure the dam to be safe against the design flood (1.2 times 200-year probable flood) and the probable maximum flood (PMF). The dam height is 165 m above the foundation rock at the plinth. The dam embankment is designed to have a slope of 1V:1.5H for both the upstream and downstream slopes (V: Vertical, H: Horizontal). The upstream surface is covered with face slab concrete with a plinth structure at the bottom. Preliminary design of the Agos Dam is shown in Figures 8.1 and 8.2.

14. Agos Hydropower Station (Chapter VIII)

The facilities for the Agos power station, comprising a power intake, a headrace-penstock tunnel and a powerhouse with tailrace, will be constructed on the left bank. The total length of the power waterway will be 755 m from the power intake to the powerhouse. The powerhouse will accommodate two units of generating equipment. The installed capacity will be 51.5 MW and the maximum plant discharge 55.4 m^3/sec. Annual energy production will be 318.2 GWh. Preliminary design of the power waterway and powerhouse is shown in Figure 8.6.

The generated power will be sent to the existing Dolores Substation in Taytay and partly to a Quezelco Substation in Infanta.

15. Water Treatment and Conveyance Facilities (Chapter VII and VIII)

Waterway is laid out between Kaliwa Low Dam and Taytay Service Reservoir for a total length of about 38 km. Figure 7.1 shows the general plan and profile of the waterway.

(1) Waterway Intake

A waterway intake will be adjacent to the Kaliwa Low Dam. The structure will consist of two intakes: one for each waterway (See Figure 7.2). The first intake will be constructed with full facilities under the first stage (Stage 1), while the second intake will be constructed partially under the Stage 1 and completed under the Stage 2-2. Each intake will have a capacity of 21.0 m^3/sec for meeting the maximum water conveyance requirement of 1,820 MLD (1,500 MLDx1.21).

(2) Tunnel No.1

Tunnel No.1 is designed to convey the water from the intake to a water treatment plant. The tunnel route is 27.5 km long and the tunnel will have a circular section of 3.5-m diameter. Of the two lines of tunnels, one will be constructed under the Stage 1 project and the second under the Stage 2-2 project.

At the downstream end of the tunnels, Valve House No.1 is to be provided to accommodate five regulating valves including one standby unit for controlling the flow into the water treatment plant.

(3) Morong Water Treatment Plant

A water treatment plant (WTP) will be built at Barangay Lagundi, Morong. The net area of the plant yard is about 96 ha (640 m x 1,500 m). The production capacity of the WTP is 3,640 MLD at the ultimate stage. The WTP will have four units of plant facilities, each 910 MLD in production capacity. They are installed one by one in four stages in accordance with the increase of water demand. The general layout plan and hydraulic profile of the WTP are shown in Figures 7.5 and 7.6, respectively.

(4) Transmission Pipelines

Water treated at the WTP is further conveyed by pipelines to service reservoirs at Taytay and Antipolo (see Figure 7.1). The pipelines comprise two trunk lines to Taytay (Pipeline No.1) and two branch lines to Antipolo (Pipeline No.2).

The two lines of Pipeline No.1 are laid out between the WTP and the portal of Tunnel No.2 for a length of 4.9 km (1st line at Stage 1 and 2nd line at Stage 2-2). The pipeline is divided into two sections: 4.0 km long pipeline of 3.4 m diameter (Pipeline No.1-1) from WTP to Valve House No.2 and 0.9 km long pipeline of 3.3 m diameter (Pipeline No.1-2) from the Valve House No.2 to the Tunnel No.2 portal.

The two lines of Pipeline No.2, 1.6 m in diameter, are installed for water transmission to the Antipolo (1st line at Stage 1 and 2nd line at Stage 2-2). The total length is 4.1 km between the Valve House No.2 and Antipolo Service Reservoir.

The pipeline between the Antipolo Pump Station and Antipolo Service Reservoir would be subject to water hammer phenomena in the case of sudden shut-down of the pumps. To prevent the occurrence of hazardous negative pressure inside the pipe, a surge tank is planned to be provided at the midway point of the pipeline.

(5) Tunnel No.2

Two lines of 5.3 km long Tunnel No.2, 3.3 m in internal diameter, are aligned to connect the Pipeline No.1-2 and Taytay Service Reservoir. The tunnel passes through the Antipolo plateau where many deep wells exist. Since the groundwater level is higher than the tunnel inner water head, there is a concern for lowering of groundwater level even after the completion of the tunnel if excessive intrusion of water into the tunnel takes place. Hence, the tunnel is designed to be steel-lined in the sections where such concern is observed.

(6) Antipolo Pump Station and Service Reservoir

The service area of Antipolo City is situated at a high altitude, generally higher than EL.200 m. This necessitates the pump-up of water by installing a pump station. A service reservoir is planned at a highest point (EL.260m) in the northern part of Antipolo City so that water could be distributed by gravity to the service area.

In order to meet the supply requirement towards 2025 (680 MLD), Antipolo Pump Station is planned to have 10 units of pumps (including two standby units), each 59 m^3/min (0.99 m^3/sec or 85 MLD) in capacity, at the ultimate stage (Stage 2-2). Storage capacity of the Antipolo Service Reservoir is 180,000 m^3 with six units of reservoir tanks, each having 30,000-m^3 capacity. Both the pumps and reservoirs are installed in three stages towards 2025.

(7) Taytay Service Reservoir

The majority of treated water conveyed from the Morong WTP is delivered to the Taytay Service Reservoir which is a main facility to distribute water to the main service areas of the proposed project; i.e., south-western part (Cavite area), southern part (Muntinlupa area) and south-eastern part (towns in Rizal Province). This reservoir is the off-take point for delivering water to the two Concessionaires. Another off-take point is the Antipolo Service Reservoir mentioned above.

Storage capacity of the Taytay Service Reservoir is 720,000 m^3 with four units of reservoir tanks, each having 180,000-m^3 capacity. HWL and LWL of the service

reservoir are set at EL. 72 m and 66 m by NAMRIA datum (EL.82 m and 76 m by MWSS datum), respectively, taking account of the altitudes of the service area ranging between EL.5 and 50 m by NAMRIA datum.

Environmental Impact Assessment: (Chapter V)

16. Anticipated Environmental Impacts

Varying degrees of physical and biological impacts are expected to occur as a result of the development project. Major issues identified in the course of the EIA study are:

i) Impact on rare and endangered flora and faunal species both terrestrial and aquatic due to inundation;

ii) Need of watershed management in the Kaliwa River Basin to reduce sediment deposit in the proposed reservoir;

iii) Reduction of sediment release, which may cause lowering of the downstream river bed level and change of shape of lower alluvial plains/delta and coastal lines especially the sand dunes in the Agos River estuary;

iv) Reduction of river flow in the lower Agos due to water supply for Metro Manila, and

v) Need of monitoring for pollution of the reservoir water due to effluent from households and agro-industries in the upper Kaliwa River Basin.

17. Need for Protection of Natural Environments

(1) Protection of Ecosystems in the Kanan-Agos Watersheds

The Kanan-Agos River Watershed system in a recent biodiversity study is declared as a "biologically hot spot" area. To maintain the present level of diversity, proposed is the transplantation of threatened and rare plants species through collection of their germplasm, prior to the inundation of the reservoir.

Access to the forested areas would be greatly improved using mechanized watercraft on the reservoir surface. However, if usage is left uncontrolled, the general populace would encroach, possibly exposing precious forest products to wild extraction and poaching. This could be mitigated by deputation of Environment and Natural Resources Officers for Forest Protection (DENRO) or deputizing the local communities, e.g. Dumagats, to apprehend poachers.

(2) Continuation of the Kaliwa Watershed Rehabilitation and Management (KWRM) Project

The on-going KWRM project has drawn out a watershed development and management plan for the Kaliwa River Basin. One of its objectives is to formulate strategies to rehabilitate, manage and restore the productive and protective functions of the watershed. At present, however, the sustainability of the project is a problem. Funds are not sufficient to implement some of the

programs/sub-projects such as structural soil conservation, bamboo/balete riverbank stabilization and greenbelt, reforestation and enrichment planting, and agro-forestry.

The current KWRM project is scheduled to terminate in 2004. However, it is proposed that the similar activities would continue in the subsequent period until the watershed is restored to a fair environment. Collaboration with the KWRM project brings about a beneficial effect to the proposed project in terms of reducing the sediment yields and water turbidity.

(3) Measures for Mitigating Water Pollution

To mitigate water pollution in the Kaliwa River, changes in the existing land use in the watershed should be strictly regulated by land control development. Adequate wastewater treatment facilities must also be installed under a separate program especially for residential areas and agro-farms/industries located upstream of the proposed reservoir.

18. Proposed Protection Measures

For the needs identified above, the following protection measures are proposed to be included as a part of the project components:

Proposed Environmental Protection Measures

	Proposed Work	Source of Budget	Entrusted to
1	Protection of Eco-System:		
	(a) Transplantation of threatened and rare plants including the establishment of a nursery or genebank	Project construction cost	LGU, DENR
	(b) Re-vegetation for the areas affected by construction works, such as spoil banks, temporary facilities area	Project construction cost	LGU, DENR
	(c) Forest protection by deputizing Environment and Natural Resources Officers (DENRO) and/or local communities	A fund system*	LGU, DENR
	(d) Periodical wildlife census survey	A fund system*	DENR
2	Collaboration with KWRM Project		
	(a) Provision of subsidy to cover a part of the KWRM project cost	A fund system*	DENR
3	Measures for Mitigating Water Pollution		
	(a) Land use management and wastewater control	Coordination with concerned agencies	DENR, DILG, DOH
	(b) Promoting the installation of community-based and/or household wastewater treatment units	A fund system*	LGU, DILG, DENR

Note: * A preliminary idea is to establish a special fund for these purposes, e.g., 'Agos River Environmental Development Fund', which will be managed by donation of a part of water revenue accrued from the government project (GOVw in Para.25 hereinafter). The mechanism on fund administration is subject to further study when the idea is accepted by major stakeholders.

19. Relocation of Projected Affected Families

(1) Number of Project Affected Families (PAF)

An estimated 174 families will be directly affected by the dam/reservoir construction based on the census, inventory of losses and preliminary measurement survey results in EIA. Another 222 families will be affected by the construction of waterway facilities. Thus, the total number of PAFs is some 400 families.

(2) Public Perception on Relocation

As an initial activity in EIA, two methods were utilized to collect the general responses; focus group discussions (FGD, at 33 Sitios) and the socio-economic survey (SES, interview survey for 861 households). FGD was held with free participation of the people in the nearby area, including Indigenous People. In both activities, the majority of the affected people responded that they were not willing to move to another place to give way for the project (82% for the FGD and 51% for the SES).

The difference in obtained figures between the two surveys is presumably due to the different way of collecting the responses; i.e. peoples' opinion at FGD was collected in the presence of many participants sitting together at a place, while SES was conducted in a one-on-one basis with each respondent. It seems that relatively high percentage of the PAP's disagreement, at this project beginning stage, is a natural response from the people since they have not fully been informed of the detail of the project as well as the resettlement plan.

(3) Public Consultation

Public consultations were held at 3 places (General Nakar, Infanta and Daraitan) after the FGD and SES. People were invited to participate on free basis, where representatives from the LGUs were also present. In the public consultations, the issue on relocation of the PAP also drew varied reactions. While the general attitude of the participants was that of 'resigned acceptance', it was clear that the people would like to have "conditions" or "promised benefits" in place prior to the construction, a reflection of their attitude towards the government projects from their previous experiences.

(4) Workshop

Two workshops were held in the final stage of the Study (at Pililla in October 2002 and in Manila in February 2003), by inviting representatives of the LGUs and people's group. The participants expressed their general consent to the necessity of the proposed project, however, on a condition that the issues and concerns raised during the workshop and succeeding consultations should be given due considerations. Also asserted was a need that the people should be actively involved in the formulation of resettlement plans in the subsequent stages.

20. Proposed Resettlement Plan

The number of PAP as a result of the dam construction is considered significant, which requires the preparation of a full resettlement plan (RP). The requirement

of RP is to compensate those directly affected at replacement cost and institute a sustainable income restoration measure. The proposed RP contains project policy on entitlements of lands and other properties, resettlement and compensation methods, resettlement strategies, mitigation measures, grievance redressals, implementation arrangements and schedule, and cost estimates.

The cost relevant to the resettlement is estimated at PHP 1.3 billion (US$ 25 million equivalent). The estimated costs include the cost of losses/compensation assistance (affected land, houses and structures, communal/public structures, disturbance compensation, financial assistance), cost of resettlement site development, and cost of strategic communications.

21. Resettlement Sites

There are two resettlement sites identified: (See Figure 5.2)

(1) Resettlement Site No. 1 is situated in Barangay Magsaysay. The site is intended to house the PAPs from the same Barangay. In this way, social displacement and institutional adjustments are kept to a minimum. Located on the right bank of the Kaliwa River, the proposed site is planned along the shoreline of the reservoir of Agos Dam. Total land area of Resettlement Site No. 1 is 32 ha with land elevation ranging from 160 m to 275 m.

(2) Resettlement Site No. 2 is situated in Sitio Kiragpan in Barangay Pagsangahan. Located on the left bank of the Kaliwa River, the proposed site is also planned along the shoreline of the reservoir of Agos Dam. The site has relatively rolling terrain with elevation ranging from 160 m to 200 m. The total land area is 40 ha.

22. Impact to Coastlines of Infanta Peninsula (Chapter IV)

The Agos River Basin yields sediments of the order of 980,000 m^3 annually at present. The Agos Reservoir, after the completion, will trap almost 90 % of these sediment yields. The discharge of sediment loads is reduced to some 190,000 m^3 at the Agos River mouth (corresponding to about 10 % of the present yield). The reduction of sediment yield is presumed to give influence to the sediment environments of coastlines in the Infanta Peninsula.

A possible consequence may be the erosion of coastlines in the worst case, particularly along the coast south from the river mouth. A preliminary analysis in this Study has revealed that about 14,000 m^3 of sand is being transported annually southward from the river mouth along the shallow water zone of the coast, a quantity not considered excessive. Although the extent of coastal erosion is difficult to estimate accurately at the present stage (no sufficient data for a detailed analysis), it is not thought significant in view of a moderate quantity of sand transport as estimated above. Nevertheless, the condition of coastlines should be monitored for a period of decades by means of cross section survey and bathymetric survey along the coast.

Possible countermeasures, should the erosion take place, would be the provision of training work at the river mouth and a series of jetties along the coastlines. The estimated cost of such works is included as a part of O&M cost to reflect in the evaluation of the project.

Associated Works for Supporting Regional Socio-Economic Activities: (Chapter X)

23. The implementation of the proposed project, particularly Agos Dam, will bring about a certain extent of inconveniences to the people in the project area. For compensation to those inconveniences, the project will contain several works aiming at improvement of people's livelihood and enhancement of regional economic activities. The proposed works are shown in the table blow:

Associated Works Proposed for Regional Development

	Description	Objective
1	Bank erosion protection works at General Nakar and Infanta	Collaboration to solving the present difficulty in project affected area
2	Flood protection work at General Nakar	- do above -
3	Provision of river use facility at 21 places in the Agos downstream reach	For facilitating the people's river use (for change of water level regime)
4	Provision of access roads and footpaths along the perimeter of proposed Agos reservoir, including a permanent access road to Barangay Daraitan	For facilitating the people's traffic between the communities in the area
5	Flood protection bund at Barangay Daraitan	For prevention of flooding in low-lying area due to rise of flood water level
6	Establishment of a manpower training center either at Barangay Daraitan or new resettlement site	For supporting income restoration program for the relocated people
7	Establishment of a health center either at Barangay Daraitan or new resettlement site	For benefit to the relocated people

The cost of the above works, estimated at US$ 5.75 million equivalent, was included as a part of the construction cost of Agos Dam.

In addition to the above, a drainage improvement work for Infanta town was also examined in the Study. The work will be mobilized as a separate project since it is not directly related to the proposed Agos Dam project (no adverse effect by the dam). The cost is estimated roughly to be US$ 2.4 million.

The detailed features of the proposed works are described in Chapter X.

Project Implementation Cost: (Chapter IX)

24. The project will be implemented in three stages. The estimated cost is summarized below:

Estimated Project Cost

(Unit: Million US$ equivalent)

Stage	Package	Main Works	F.C. Portion	L.C. Portion	Total
1	GOVw	Kaliwa Low Dam and 1st Waterway	166.1	86.0	252.1
	BOTw	WTP #1 Unit and 1st Waterway from WTP to S/R	177.8	80.5	258.3
		Sub-total	343.9	166.5	510.4
2-1	GOVw	Agos Dam	292.6	210.6	503.2
	BOTw	WTP #2 Unit	59.0	32.3	91.3
	BOTa	Agos Power Station	67.3	13.5	80.8
		Sub-total	418.9	256.4	675.3
2-2	GOVw	Kaliwa-Lagundi 2nd Waterway	125.8	50.5	176.3
	BOTw	WTP #3 and #4 Units	245.2	123.3	368.5
		Sub-total	371.0	173.8	544.8
	Project Cost at 2002 Price (*)		1,133.8	596.7	1,730.5
	Price Contingency		351.8	287.9	639.7
	Taxes		113.4	59.7	173.1
	Total Project Cost (Fund requirement excluding IDC)		1,599.0	944.3	2,543.3

Note: (*) Base construction cost at 2002 price + Engineering Services + Administration Cost + Physical Contingency

Abbreviation

GOVw: Government project for water supply development (See Para.26 below)
BOTw: BOT project for water supply development (Ditto)
BOTa: BOT project for Agos Hydropower Development (Ditto)
LDC: Interest during Construction

Implementation Program: (Chapter XI)

25. Implementation Schedule

The earliest attainable completion schedule of the Stage-1 project is deemed to be Year 2013. Figure 11.6 shows the proposed implementation schedule of overall project covering Stages 1 to 2-2.

Figure 11.7 shows the balance of water demand and supply capacity in the case of commissioning of the proposed project in Year 2013. The demand-supply scenario shown in Figure 11.7 was worked out with the following consideration:

(1) The proposed Kaliwa-Agos project will meet the day peak demand of 3,640 MLD, out of the total demand growth of 4,360 MLD arising between the present (4,090 MLD) and Year 2025 (8,450 MLD).

(2) MWSS proposes to implement two interim schemes: a 50 MLD Project at Wawa River and a 300 MLD Project on a performance-based target scheme (one of the candidate water sources is the Laguna Lake). This Study further proposes that, to fill the demand-supply gap remaining till the Kaliwa-Agos project is on stream in Year 2013, an additional interim scheme of at least 350-400 MLD should be commissioned in the earliest attainable year. The water demand after Year 2014 can be met by the supply from the Kaliwa-Agos project, except for the gap still remaining during 2014-2016.

(3) The proposed schedule assumes that 4 units of water treatment plant (WTP #1 - #4) will be commissioned at 3-year interval. This schedule is almost similar to that contemplated in the M/P.

26. Procurement of the Project

The whole project is planned to comprise the following three (3) schemes:

1) A government scheme for dam and tunnel construction (hereinafter referred to as GOVw),
2) BOT scheme for the construction of water treatment plant and transmission facilities (BOTw), and
3) Another BOT scheme for hydropower development at Agos Dam (BOTa)

The reasons for proposing the GOVw as a government project are twofold:

(a) Construction of Agos Dam (165 m high) and Tunnel No.1 (27.5 km long) involves a variety of technical risks and requires a large investment cost, both of which would be large burdens to BOT proponents.
(b) In view of the high importance of a supply of cheap water to the consumers, the least costly approach is to utilize the ODA soft loans of low interest rate and longer repayment period, which could minimize the annual repayment amount and accordingly contribute to minimizing the water cost.

It is assumed in this Study that the water produced by the GOVw scheme will be handed over at the entrance of the water treatment plant to the joint venture company of BOTw with full-cost-recovery basis without any return to the government.

The water will then be treated by the BOTw joint venture company and transferred to the existing Concessionaires at the exit of the service reservoir to be built by the Project. The BOTw is implemented with full-cost-recovery basis plus the return that can be considered reasonable by the responsible government agency (MWSS) and is high enough to attract BOT proponents as well.

27. Financial Procurement for the Implementation

(1) GOVw Scheme

For the GOVw scheme, the ODA loan of foreign government's assistance is assumed taking the advantages of long-term repayment period and the concessional interest rate. Its repayment period is usually around 20-30 years including a grace period of 5-10 years. The domestic currency portion is also desirably to be financed as far as possible through ODA financial facilities as well.

The DFI (development financing institutes) loan with concessional terms and conditions is also assumed to supplement the ODA fund.

The remaining requirement for local funding is to be raised by the government with such fund for which the Project will not be responsible in terms of either principal repayment or interest payment. When the significant importance of the Project as

water supply to Metro Manila is recognized, it is not deemed hard for the government to obtain inter-agency consensus for appropriating the Project.

(2) BOT Schemes (BOTw and BOTa)

Joint venture companies (JVC) will be established under BOT bases. Member companies of JVC are required to contribute to the share of the equity capital of the JVC. The total equity capital is assumed in this Study at 35% of the total fund requirement of each BOT scheme. The remaining 65% will be financed by either concessional loans of DFI or commercial loans of city banks.

The concession period is assumed to be 25 years for BOTw and BOTa schemes starting from the operation of projects to the transfer of project facilities. The JVC is expected to repay all the debt and secure an appropriate return to its investment before the end of the concession period.

28. Implementation Framework

(1) Executing Agency

The Steering Committee meeting held on August 21, 2001 agreed that MWSS will handle the implementation of the water resources development of the Agos River Basin. Following this conclusion, the MWSS will take the role of the Executing Agency.

(2) Inter-Agency Coordination Committee

In order to assist and coordinate the roles and duties of the MWSS, an "Inter-Agency Coordinating Committee for the Agos River Basin Project (ICCARBP)" will be organized. The Committee will be composed of the representatives of MWSS, NEDA, DPWH, DENR, DILG, DOE/NPC, NWRB, NIA, and Provinces of Quezon and Rizal, with MWSS as the chair agency. Figure 11.1 shows the proposed organizational chart of the Committee.

The ICCARBP will be terminated upon the completion of construction works of the Project and its powers and functions inherited by the Agos River Basin Committee (ARBC, see below) after necessary modification.

29. Organization Structures after the Completion of the Project

(1) Agos River Basin Committee (ARBC)

After the completion of construction works, the ICCARBP will be reorganized into the Agos River Basin Committee (ARBC). The ARBC will be composed of the same water-related agencies as those of the ICCARBP except that the chair agency will be changed from MWSS to NWRB. The NWRB as the chair agency of the ARBC will be responsible for all the areas of development and management activities of the Agos River Basin through the power/function delegation mechanism as shown in Figure 11.4.

Although NWRB is responsible for all the areas of development and management activities of the Agos River Basin, daily routine operational works in every area of development/management works are to be within the responsibility of each

executing agency. In other words, all the sector-specified operations in this proposed organizational framework are delegated from NWRB as the chair agency of ARBC to each responsible agency.

(2) River Basin Authority (RBA)

The ARBC proposed above is an organization that is to be upgraded to the River Basin Authority (RBA) when the idea currently contemplated by NEDA and relevant agencies is realized. Finally, the RBA is expected to become an organ under the umbrella of Water Resources Authority of the Philippines (WRAP) when the WRAP is established.

Evaluation of the Proposed Project: (Chapter XII)

30. Framework of Economic Evaluation and Financial Analysis

The project is evaluated from the two different aspects, namely economic and financial aspects. Major differences are compared in the table below:

Framework of Economic Evaluation and Financial Analysis

Method	Point of view	Benefit and cost	Indicator	Criteria (target)
Economic evaluation	National economy	Cost: Economic cost Benefit: WtP, Cost of alternative thermal	EIRR	More than 12% (Opportunity cost of capital) More than 15% (NEDA criteria)
Financial analysis	Project company	Cost: Market price + Tax + inflation Benefit: Sales revenue of water and power	FIRR ROE WACC DSCR	Evaluation of financial indicators

Note: 1) WtP: Willingness to pay; 2) WACC: Weighted average cost of capital
3) DSCR: Debt service coverage ratio

Economic evaluation is undertaken to ascertain the economic viability of the Project from the point of view of the socio-economy as a whole. Financial analysis looks at the point of view of project companies, namely the joint venture companies of two BOT schemes in this Study.

In principle, evaluation is carried out for each individual scheme of GOVw, BOTw and BOTa. However, the economic evaluation is rendered for the integrated schemes of GOVw and BOTw as these two schemes are components of one identical water supply project supplying water to Metro Manila and they can function only when they are operated in combination.

31. Economic Evaluation

(1) Economic Cost and Benefit

Base costs estimated in preceding Para.24 are utilized for the project evaluation. The shadow pricing is applied for foreign exchange (by applying a standard conversion factor) and unskilled labor wage. The evaluation period is set at 50 years considering economic life of facilities and the replacement cost considered for metal and electrical works every 20 years.

Economic benefit of water supply is measured by willingness to pay (WtP) of consumers for water. The WtP is estimated at Pesos 38.9 per m^3 for billed water after taking into account the bottled water prevailing at markets. In addition, an external social benefit is estimated and incorporated by valuing the time of housewives freed up from carrying water.

The economic benefit of hydropower project is estimated based on the cost of alternative thermal power plant assuming that the said cost can be avoided in case hydropower plant is built by the Project.

(2) Assessment of EIRR

(i) Integrated Water Supply Scheme (GOVw and BOTw)

As the result of computation, an EIRR of 16.7% is derived for the integrated water supply project combining GOVw and BOTw schemes. The EIRR exceeds both opportunity cost of capital assumed at 12% in this Study and the EIRR criteria of 15% set by ICC of NEDA. Therefore, the Project is economically justified.

(ii) Hydropower Scheme (BOTa)

The EIRR of BOTa scheme is computed to be 14.4%. This assessed EIRR is slightly less than the criteria of ICC NEDA (15%), but sufficiently larger than the opportunity cost of capital (12%). The scheme is regarded economically justifiable taking also into account other intangible social benefits accrued from the project (See Chapter XII for detail of intangible benefits).

32. Financial Analysis

(1) Purpose of Financial Analysis

The purpose of financial analysis differs by each scheme.

(i) GOVw scheme:

The purpose of financial analysis of GOVw is to verify if the full-cost-recovery can be realized in implementing the GOVw scheme. It will be proved when no deficit is observed in the cash surplus stream of projected cashflow statement.

(ii) BOTw scheme:

The function of BOTw is to treat the raw water purchased from GOVw scheme and to sell the treated water to Concessionaires at the exit of service reservoirs. The buying price of raw water of GOVw at the entrance of WTP will be determined by the equalizing water rate (EWR) that makes the total cost stream of GOVw equal to its total revenue stream by discounting at the rate of 12%. The selling price of treated water at the exit of service reservoirs should be high enough for the BOTw company to gain appropriate profit. Finally, the selling price is required to meet the affordability-to-pay of consumers at the household level.

(iii) BOTa scheme:

The financial viability of BOTa hydropower scheme relies on the assumed selling price of electricity.

(2) Results of Financial Analysis

The financial analysis is based on an assumed financial procurement condition (see Chapter XII for detail) and concession period (25 years from the commencement of operation). The following results were derived:

(i) GOVw Scheme

Since it is assumed that no return is to be expected for GOVw scheme, the financial analysis of GOVw aims at ascertaining the possibility of loan repayment. According to the financial analysis, the projected cashflow statement proves that loan repayment is possible and also verifies that some cash surplus is generated from the initial stage of operation after rendering interest payment and principal repayment of loans.

(ii) BOTw Scheme

Regarding the selling price of treated water, it should be such value that covers not only full cost but also an appropriate profit to run the project company. The "appropriate" level of the profit, however, is obscure and arbitrary. The price of water will actually be determined in the agreement to be concluded between the Project Company and the distribution concessionaires. In this Study, however, the ROE of 15% is proposed taking into consideration long-term interest rates and yields of national bonds. Actually, the criteria that ROE should be greater than 15% was adopted in the Laiban dam study that is similar by nature to the present project.

The financial analysis of BOTw scheme was conducted by applying the water rate of 15.9 P/m^3 that corresponds to the ROE of 15%. The FIRR was derived at 17.6% and WACC (weighted average cost of capital) at 9.0%. The minimum DSCR (debt service coverage ratio) in the projected cashflow statement was 1.4 at the first year with gradual yearly improvement. Meanwhile, the necessary condition for a BOT project to be implementable is for the FIRR to be greater than WACC. This condition is satisfied as well. These financial indicators show the scheme's financial viability under the BOT basis assuming a ROE of 15%.

The above selling price of water of 15.9 P/m^3 at service reservoirs was examined for consumers' affordability-to-pay for water. In this examination, it was assumed that Angat water will be blended, monthly water consumption is 30 m^3 per family, NRW will be improved up to 30% in and after 2025, and inflation rate will be 3% per annum in average. On the basis of these assumptions, it was verified that the household expenditure for water would occupy 0.8% of total family income in 2025. Judging from the statistics that the share of total expenditures for electricity, fuel and water in 1997 was 5.5% toward monthly family income, the water rate of 15.9 P/m^3 is deemed to be within a range of affordability-to-pay of consumers.

(iii) BOTa Scheme

The financial analysis of BOTa scheme was made under the assumption of a power-selling price of 3.5 Peso/kWh (at 2002 prices). The resulted cashflow statement shows no deficit of cash surplus with minimum DSCR of 2.5 at the first year. The FIRR is derived at 25.6%, real ROE at 38.4% and WACC at 17.9%. These financial indices show the scheme's financial viability under BOT basis.

33. Summary of Results of Economic Evaluation and Financial Analysis

Analytical indices of economic evaluation and financial analysis of each scheme are summarized in the table below:

Summary of Economic Evaluation and Financial Analysis

Scheme	EIRR (%)	FIRR (%)	ROE (%)	WACC (%)	Min DSCR (Times)
GOVw	16.7	-	-	-	-
BOTw		17.6	15.0	9.0	1.2
BOTa	14.4	25.6	38.4	17.9	2.5

The Study also evaluated the economic and financial viability of the Stage 1 project alone. The results are presented in Chapter XII.

34. Evaluation from Technical and Socio-Environmental Aspects

The proposed projects need to pay attention to a variety of technical and socio-environmental issues mentioned in the preceding paragraphs. However, all of them are of technically solvable nature by proper design of facilities/structures and/or proper planning of preventive mitigation measures. Evaluation in this respect is described in Chapter XII.

Recommendation of Further Actions: (Chapter XIII)

35. Chapter XIII describes several items of further actions to be followed up by the Executing Agency (MWSS) in the subsequent stage. They are:

(a) Early decision of the implementation of the proposed project, in view of impending water demand growth in Metro Manila

(b) Commencement of the activities for mobilizing the project immediately after the decision of (a) above, initiated by dialogue with the project-affected people for solving the relocation issue at an early period

(c) Refinement of some technical aspects that could not have been fully detailed in this F/S stage, owing mainly to the limited quantities of field investigation works and the lack of existing data made available at the present stage. This action will be taken during the next detailed design stage.

(d) Review of the issues raised at public consultations/workshops and decision on how to respond to the LGUs and people in the project area

PRINCIPAL FEATURES OF PROPOSED PROJECT (MAIN WORKS)

Objective of Project:				
- Water Supply	Supply of water to Metro Manila and its vicinity for meeting demand up to Year 2025			
- Hydropower	Supply of power to the existing Luzon grid and Quezelco grid (Infanta) by harnessing hydropower potential available at Agos Dam			
Development Scale:		Stage 1	Stage 2-1	Stage 2-2
- Water Supply (Accumulated)	Day average supply volume	550 MLD	1,500 MLD	3,000 MLD
	Day peak supply capacity	660 MLD	1,820 MLD	3,640 MLD
- Hydropower	Installed capacity		51.5 MW	

Description	Proposed Plan
Agos River Basin:	
Drainage area	
- at Agos damsite	860 km^2
- at river mouth	940 km^2
Mean annual rainfall (at Agos dam)	3,330 mm
Mean discharge	
- at Agos damsite	113.3 m^3/sec
- at river mouth (Banugao)	120.6 m^3/sec
Agos Reservoir:	
Full Supply Level (FSL)	EL.159 m
Minimum Operating Level (MOL)	EL.133 m
Gross storage capacity	886 x10^6m^3
Effective storage capacity	409 x10^6m^3
Reservoir area at FSL	19.1 km^2
Exploitable water	61.0 m3/sec
Agos Dam:	
Type	CFRD
Crest elevation	EL.165.2 m
Crest length	780 m
Height above foundation rock	165 m
Dam embankment volume	13.4 x10^6m^3
Spillway discharge capacity	
- Design flood	9,600 m^3/sec
- Probable maximum flood	17,100 m^3/sec
Kaliwa Low Dam:	
Type	Random fill
Operating water level	EL.125.0 m
Crest elevation	El.129.0 m
Height	36.0 m
Waterway Intake:	
Type	Inclined type
No. of intake mouth	2 nos.
Intake discharge (by 2 intakes)	42.0 m^3/sec
Tunnel No.1:	
Type	Pressure tunnel
No. of tunnels	2 lines
Discharge capacity (by 2 tunnels)	42.0 m^3/sec
Diameter	3.5 m, circular
Length	27.5 km

Description	Proposed Plan
Morong Water Treatment Plant:	
Type	Rapid filtering
Plant yard net area	96 ha
No. of plant units	4 units
Capacity (by 4 units)	910MLD/unit
Pipeline No.1:	
(WTP-Tunnel No.2)	
Type	Buried steel pipe
No. of pipelines	2 lines
Diameter	3.4 - 3.3 m
Length	4.9 km
Pipeline No.2:	
(Valve house-Antipolo SR)	
Type	Buried steel pipe
No. of pipelines	2 lines
Diameter	1.6 m
Length	4.1 km
Antipolo Pump Station:	
Type of Pumps	Multi. centrifugal
Plant yard net area	0.9 ha
No. of plant units	10 units
Capacity per pump unit	59m^3/min/unit
Antipolo Service Reservoir:	
Type	Concrete tank
Plant yard net area	6.5 ha
No. of reservoir tanks	6 tanks
Storage capacity per tank	30,000m^3/tank
Tunnel No.2:	
Type	Pressure tunnel
No. of tunnels	2 lines
Discharge capacity (by 2 tunnels)	42.0 m^3/sec
Diameter	3.3 m, circular
Length	5.4 km
Taytay Service Reservoir:	
Type	Concrete tank
Plant yard net area	20 ha
No. of reservoir tanks	4 tanks
Storage capacity per tank	180,000m^3/tank

Agos Damsite (Looking Upstream)

Agos Power House
Agos Dam
Kaliwa Low Dam
Proposed Relocation Sites
Intake
Antipolo Service Reservoir
Pump Station
Valve House No.2
Valve House No.1
Dolores Substation
Taytay Service Reservoir
Morong Water Treatment Plant
Tunnel
Marcos Highway
Antipolo
Taytay
Angono
Tanay
Phililla
Bay.Daraitan
General Nakar
Infanta
Polilo Strait
Lamon Bay
Laguna de Bay
Province of Quezon
Province of Rizal
Province of Laguna
Kaliwa River
Kanan River
Agos River
Limutan River
Lenatin River
121 20
121 25
121 30
121 35
121 40
14 50
14 45
14 40
14 35
14 30
N
W
E
S
SCALE 0 5 10km

Proposed Facilities in the Project Area

THE STUDY
ON
WATER RESOURCES DEVELOPMENT
FOR
METRO MANILA
IN
THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

VOLUME IV
PHASE 2: FEASIBILITY STUDY
MAIN REPORT

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ABBREVIATION

ACP	:	Asbestos Cement Pipe
ADB	:	Asian Development Bank
AMSL	:	Above Mean Sea Level
ANR	:	Assisted Natural Regeneration
ASEAN	:	Association of Southeast Asian Nations
AWLR	:	Automatic Water Level Recorder
AWSOP	:	Angat Water Supply Optimization Project
AWWA	:	American Waterworks Association
BIR	:	Bureau of Internal Revenue
BOD	:	Biochemical Oxygen Demand
BOO	:	Build Operate Own
BOT	:	Build-Operate-and-Transfer
BP	:	Bank Policy
BRS	:	Bureau of Research and Standards
BSWM	:	Bureau of Soils and Water Management
CA	:	Concession Agreement
CALABARZON	:	"Cavite, Laguna, Batangas, Rizal and Quezon Provinces"
CAPEX	:	Capital Expenditure
CARP	:	Comprehensive Agrarian Reform Program
CBFM	:	Community-Based Forestry Management
CD	:	Community Development
CDO	:	Cease and Desist Order
CENRO	:	Community Environment and Natural Resources Office
CERA	:	Currency Exchange Rate Adjustment
CFRD	:	Concrete Face Rockfill Dam
CO	:	Community Organization
COA	:	Commission On Audit
CPC	:	Certificate for Public Convenience
CPCN	:	Certificate for Public Conveniences and Necessity
CPI	:	Consumer's Price Index
DA	:	Department of Agriculture
DAO	:	DENR Administrative Order
DAR	:	Department of Agrarian Reform
DBCC	:	Development Budget Coordination Committee of NEDA
DECS	:	Department of Education, Culture and Sports
DENR	:	Department of Environment and Natural Resources
DFI	:	Development Financing Institutes
DILG	:	Department of Interior and Local Government
DMA	:	District Metering Area
DMS	:	Detailed Measurement Survey
DMZ	:	District Monitoring Zone
DO	:	Dissolved Oxygen
DOE	:	Department Energy
DOF	:	Department Of Finance
DOH	:	Department of Health
DPWH	:	Department of Public Works and Highways
DSCR	:	Debt Service Coverage Ratio
DSWD	:	Department of Social Welfare and Development

DTI	:	Department of Trade and Industry
EA	:	Executing Agency
ECAs	:	Environmentally Critical Areas
ECC	:	Environmental Compliance Certificate
ECPs	:	Environmental Critical Projects
ECRD	:	Earth Core Rockfill Dam
EDCOP	:	Engineering and Development Corporations Of the Philippines
EIA	:	Environmental Impact Assessment
EIARC	:	EIA Review Committee
EIRR	:	Economic Internal Rate of Return
EIS	:	Environmental Impact Statement
ELC	:	ELC Electroconsult
EMB	:	Environmental Management Bureau
EMMP	:	Environmental Management and Monitoring Plan
EMP	:	Environmental Management Plan
EMS	:	Environmental Management System
EO	:	Executive Order
EPA	:	Extraordinary Price Adjustment
ERB	:	Energy Regulatory Board (of DOE)
EVAT	:	Expanded Value Added Tax
FC	:	Foreign Currency
FGD	:	Focus Group Discussion
FIRR	:	Financial Internal Rate of Return
FMB	:	Forest Management Bureau
F/S	:	Feasibility Study
FSL	:	Full Supply Level
G.S.	:	Gauging Station
GDP	:	Gross Domestic Products
GHD	:	Gutteridge Haskins and Davey Pty Ltd.
GI	:	Galvanized Iron
GNP	:	Gross National Products
GOCC	:	Government Owned and Controlled Corporations
GOJ	:	Government of Japan
GOP	:	Government of the Philippines
GRDP	:	Gross Regional Domestic Products
HP	:	Hydropower
HUDCC	:	Housing and Urban Development Coordinating Council
HWL	:	High Water Level
IAs	:	Implementing Agencies
IBRD	:	International Bank for Reconstruction and Development or the World Bank
ICC	:	Investment Coordination Committee of NEDA
ICCs	:	Indigenous Cultural Communities
IEC	:	Information-Education and Communications
IEE	:	Initial Environmental Examination
IICDA	:	Infanta Integrated Community Development Assistance
IOL	:	Inventory of Losses
IPs	:	Indigenous Peoples
IPRA	:	Indigenous People's Right Act
IRR	:	Implementing Rules and Regulations

IU	:	International Union for the Conservation of Nature and Natural Resources
JBIC	:	The Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency
JVC	:	Joint Venture Company
JWWA	:	Japan Waterworks Association
LC	:	Local Currency
LCB	:	Local Competitive Bidding
LFPR	:	Labor Force Participation Rate
LGU	:	Local Government Unit
LLDA	:	Laguna Lake Development Authority
Lpcd	:	Liter per capita per day
LPG	:	Liquefied Petroleum Gas
LTPDP	:	Long-term Philippines Development Plan
LWL	:	Low Water Level
LWUA	:	Local Water Utilities Administration
M/P	:	Master Plan Study
MARILAQUE	:	Manila-Rizal-Laguna-Quezon
MEMSI	:	"MADECOR Environmental Management Systems, Inc."
MENT	:	Multi-Partite Environment Monitoring Team
MERALCO	:	Manila Electric Company
MGB	:	Mines and Geosciences Bureau
MLD	:	Million Liter per Day
MMDA	:	Metro Manila Development Authority
MMT	:	Multi-partite Monitoring Team
MMUTIS	:	Metropolitan Manila Urban Transportation Information System
MOA	:	Memorandum of Agreement
MOL	:	Minimum Operation Level
MTPDP	:	Medium-Term Philippines Development Plan
MWCI	:	Manila Water Company Inc.
MWSI	:	Maynilad Water Services Inc.
MWSP	:	Manila Water Supply Project
MWSRP	:	Manila Water Supply Rehabilitation Project
MWSS	:	Metropolitan Waterworks and Sewerage System
NAMRIA	:	National Mapping and Resource Information Authority
NATM	:	New Austrian Tunneling Method
NCIP	:	National Commission on Indigenous Peoples
NCR	:	National Capital Region
NEDA	:	National Economic and Development Authority
NEPC	:	National Environmental Protection Council
NGO	:	Non-Government Organization
NGOs	:	Non-Government Organizations
NIA	:	National Irrigation Administration
NP Junction	:	Novaliches Portal Junction
NPC	:	National Power Corporation
NPCC	:	National Pollurion Control Commission
NRW	:	Non-Revenue Water
NSCB	:	National Statistical Coordination Board
NSDW	:	National Standard for Drinking Water
NSO	:	National Statistical Office
NTFW	:	Non-timber Forest Product

NTU	:	Nephelometric Turbidity Unit
NWDCC	:	National Water Data Coordinating Center (to be created)
NWRB	:	National Water Resources Board
NWRMP	:	National Water Resources Master Plan
O&M	:	Operation and Maintenance
ODA	:	Official Development Assistance
OP	:	Office of the President
PAC	:	Poly Aluminum Chloride
PAFs	:	Project Affected Families
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAMB	:	Protected Area Management Board
PAPs	:	Project Affected Persons
PD	:	Presidential Decree
PENRO	:	Provincial Environment and Natural Resources Officer
PFDA	:	Philipine Fisheries Development Authority
PHILVOLCS	:	Philippine Institute of Volcanology and Seismology
PHP	:	Philippine Peso
PMF	:	Probable Maximum Flood
PMP	:	Probable Maximum Precipitation
PNSDW	:	Philippine National Standards for Drinking Water
PO	:	People's Organization
PR	:	Public Relations
PROC	:	Proclamation
P/S	:	Power Station
PSY 2000	:	Philippine Statistical Yearbook 2000
PTFWRDM	:	Presidential Task Force on Water Resources Development and Management
PVC	:	Poly Vinyl Chloride
QUEZELCO	:	Quezon Electric Company
RA	:	Republic Act
RAP	:	Resetlement Action Plan
RBW	:	Receiving Body of Water
RBWA	:	River Basin and Watershed Authorities
RCCD	:	Roller Compacted Concrete Dam
REECS	:	"Resources, Environment and Economics Center for Studies"
RIZWADA	:	Rizal Water Districts Association
ROE	:	Return on Equity
ROW	:	Right Of Way
RPV	:	Pressure Reducing Valve
SAMAKA	:	Samahang Mahalin ang Kalikasan
SAMAKABAY	:	Samahang Magsasaka ng Bantay Bayan
SCP	:	Strategic Communications Plan
SEC	:	Securities and Exchange Commission
SES	:	Socio-Economic Survey
S.G.S.	:	Streamflow Gauging Station
SMBDSM	:	Samahan ng Magsasaka sa Bundok na Dahilig ng Sierra Madre, Inc.
SO2	:	Sulfur Oxides
STP	:	Sewerage Treatment Plant
SR	:	Service Reservoir
SRD	:	Social Resettlement Division

TBM	:	Tunnel Boring Machine
TCD	:	Tribal Community Development
TCU	:	True Color Unit
TDS	:	Total Dissolved Solids
TOR	:	Terms Of Referece
TRANSCO	:	National Transmission Company
TSS	:	Total Suspended Solids
UATP	:	Umiray-Angat Transbasin Project
UP	:	Univerdity of the Philippines
UPSARDFI	:	"UP Social Action and Research for Development Foundation, Inc."
WACC	:	Weighted Average Cost of Capital
WB	:	World Bank
WCS	:	Water Conveyance Schemes
WCT	:	Water Conveyance Tunnel
WD	:	Water District
WRAP	:	Water Resources Authority of the Philippines
WRDP	:	Water Resources Development Project
WTP	:	Water Treatment Plant
WtP	:	Willingness to Pay

Measurements

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer

Volume

cm^3	=	cubic centimeter
l	=	liter
kl	=	kiloliter
m^3	=	cubic meter

Weight

g	=	gram
kg	=	kilogram
ton	=	metric ton

Time

sec	=	second
min	=	minute
hr	=	hour
d	=	day
y	=	year

Energy

W	=	watt
kW	=	kilowatt
MW	=	Megawatt

Area

m^2	=	square meter
ha	=	hectare
km^2	=	square kilometer
cu m	=	cubic meter

Derived Measures

m/sec	=	meter per second
m^3/sec	=	cubic meter per second
kWh	=	kilowatt hour
MWh	=	megawatt hour
GWh	=	gigawatt hour
PPM	=	parts per million
kmph	=	kilometer per hour
MLD	=	million liter per day
mg/l	=	milligram per liter

Currency

PHP	=	Philippine Peso
¥	=	Japanese Yen
US$	=	US Dollar

Other Measure

%	=	percent
°	=	degree
°C	=	degree(s) Celsius
10^3	=	thousand
10^6	=	million
10^9	=	billion