urban area, and their depth and discharge capacity are clearly indicated. The inventory shows that except for one deep well with a depth of 91.5 m in Palo, depth of the others is from several meters to 40 m at the most. The discharge capacity is as small as 0.1~ 5 l/s in most of the wells excluding two wells in Tacloban City with a yield of 33 l/s. Quality wise, the water is not that suitable as drinking water because it has a high content of iron and manganese and also contaminated with bacteria to some degree. In the water quality tests conducted for seven wells in Tacloban City during the field survey, the presence of bacteria was confirmed in four wells. At present the LMWD has a 12 m deep well in Tolosa, which is basically considered as an emergency facility to pump water when the operation of a treatment plant is stopped.

Table 14 Number of Wells in the Project Area

Source	Tacloban	Palo	Tanauan	Tolosa	Dagami	Pastrana	Total
1990 Census	2,759	1,196	4,805	2,277	3,398	1,529	15,964
Well Inventory	54	15	26	20	18	8	141

(Source: Feasibility Study on Detailed Design - Leyte Metro Water District, October 1991)

2.3.3 Water Quality and Water Quality Control

(1) Raw Water of the Tingib Treatment Plant

When the Tingib Treatment Plant was constructed in 1979, the water source of Binahaan River was protected by thick forest and that maintained a good water quality. Turbidity of the raw water was generally low and though it went up temporarily after a rainfall, used to come down in a matter of a few hours. It was about ten years ago that high turbidity in the river water became significant and this well coincided with the period when land development and road construction activities were started in the upstream catchment of Binahaan river for geothermal power development.

The rainy season and the dry season are not clearly distinct in the project area where rains are experienced every month of the year with an average monthly rainfall of 120-300 mm. As the turbidity of the raw water increases if there is a large rainfall, it is compelled to stop intake of water under the prevailing condition of the treatment facilities. According to the records of the LMWD since March 1991, operation of the treatment plant had been stopped at least once a month and in the month of October 1992 the duration of discontinued operation had reached a maximum of 22 days with an aggregated 383 hours. On the average, operation is stopped for 6 days or 72 hours per month. Even during the field survey, the intake was closed for about two weeks due to continuous rains. When the operation of the treatment plant is suspended for prolonged periods, obviously it will not only affect the civil life seriously but also cause great damage to the industrial activities in the metropolitan area of Tacloban City which is the capital of the province. During such times complaints rushed from the citizens and the LMWD was forced to operate the treatment plant in an overloaded condition and supply the water even though its turbidity was far exceeding the standard value. According to the results of water quality tests (see Annex) conducted between 16th to 28th February 1993 during the field survey, though a turbidity of over 100 degrees, a pH value of 7.4 and an alkalinity of 6 mg/l were observed in the raw water during the rainy period, conditions appeared to stabilize close to a turbidity of 10 degrees, a pH value of 7.5~8, an alkalinity of 60~72 mg/l and an electric conductivity of 250 µs/cm on resuming clear weather.

According to the data of water quality tests conducted by the LMWD in the past and those performed during the field survey (see Annex), the water quality is goodi except for the problem of turbidity. The organic content of the water is somewhat high as a result of the organic substances permeating from the surrounding coconut plantations and the primeval forest, and the iron content and the manganese content are also high owing to geological characteristics. However, the water can sufficiently satisfy the drinking water standards if subjected to chemical flocculation treatment.

(2) Raw Water of the Dagami Treatment Plant

The results of water quality tests conducted during the field survey with raw water samples from Hitognob River and Hiabangan River, which serve as the water sources of the Dagami Treatment Plant, are shown in Table 15. Although the water may become somewhat turbid during the rains, as evident from these data, it is of such a high purity that it turns clear within a few hours.

Table 15 Result of Water Quality Tests of Raw Water of Dagami

Source (River)	Sampling Date	EC (µs/cm)	pH	Turbidity (degree)	Alkalinity (mg/l)	T.Hardness (mg/l)	Residue (mg/l)	Iron (mg/l)
Hiabangan	Feb. 12,1993	48	7.2	<1	12.5	12	61	0.4
Hitognob	Feb. 16,1993	48	7.3	<1	12.5	29	87	<0.1

(3) Water Supplied in the Service Area

According to the results of water quality tests conducted during the field survey with the water supplied in Tacloban City (see Table 16), residual chlorine in the order of 0.2~0.4 mg/l has been detected and the treated water is considered to be safe although the turbidity has been over 10 degrees in some cases. The LMWD pays sufficient attention to the disinfection of water with chlorine, considering the fact that the transmission pipelines passes through an area infected with Schistosomiasis, and therefore there is the possibility of groundwater and Schistosomiasis entering into the water pipes when the negative pressure is generated in the pipes during the suspension of water supply.

Table 16 Results of Water Quality Tests of the Treated Water Supplied in Tacloban City

Sampling Date	Temperature (degree)	EC (μs/cm)	pH	Turbidity (degree)	Alkalinity (mg/l)	Chloride ions (mg/l)	Residual chlorine (mg/l)
Feb.17, 1993	25.0	290	---	---	---	---	0.4
Feb.19, 1993	25.5	280	7.6	---	---	---	0.4
Feb.20, 1993	26.0	298	7.8	18	61.5	7.6	0.25
Feb.24, 1993	25.0	264	7.9	---	---	---	0.2
Mar. 1, 1993	24.0	260	7.3	25	6.6	---	0.2

(4) Private Wells in the Urban Area

A large number of private wells are still being used within and outside the service area of the LMWD including Tacloban City. Especially in the prevailing situation where the water supply is frequently suspended, wells are also an important source of water for the inhabitants. During the field survey, water quality tests were conducted for seven private shallow wells (locations as shown in Fig. 10) in the city and the results are shown in Table 17. Coliforms and other general bacteria were detected from four wells out of the seven posing many problems about the suitability as drinking water.

Table 17 Results of Water Quality Tests of Private Wells (Feb. 1993)

Sampling Place	Temperature (degree)	EC (μs/cm)	pH	Turbidity (degree)	Alkalinity (mg/l)	Chloride ions (mg/l)	Biological reaction
1. J.C.Salano	28.0	755	7.2	4	24.0	87.4	positive
2. Sto.Nino Church	27.0	410	7.1	<1	85.8	19.5	negative
3. Bgy. 26	28.0	590	7.3	1	97.4	34.7	positive
4. Anido's Residence	27.5	570	6.8	1	175.6	32.0	positive
5. PTC drug store	28.5	560	7.8	2	133.2	29.7	negative
6. Sta. Cruz Street	27.5	570	7.1	3	180.0	19.8	positive
7. Bgy. 51.A	27.0	845	7.1	<1	234.1	49.0	negative

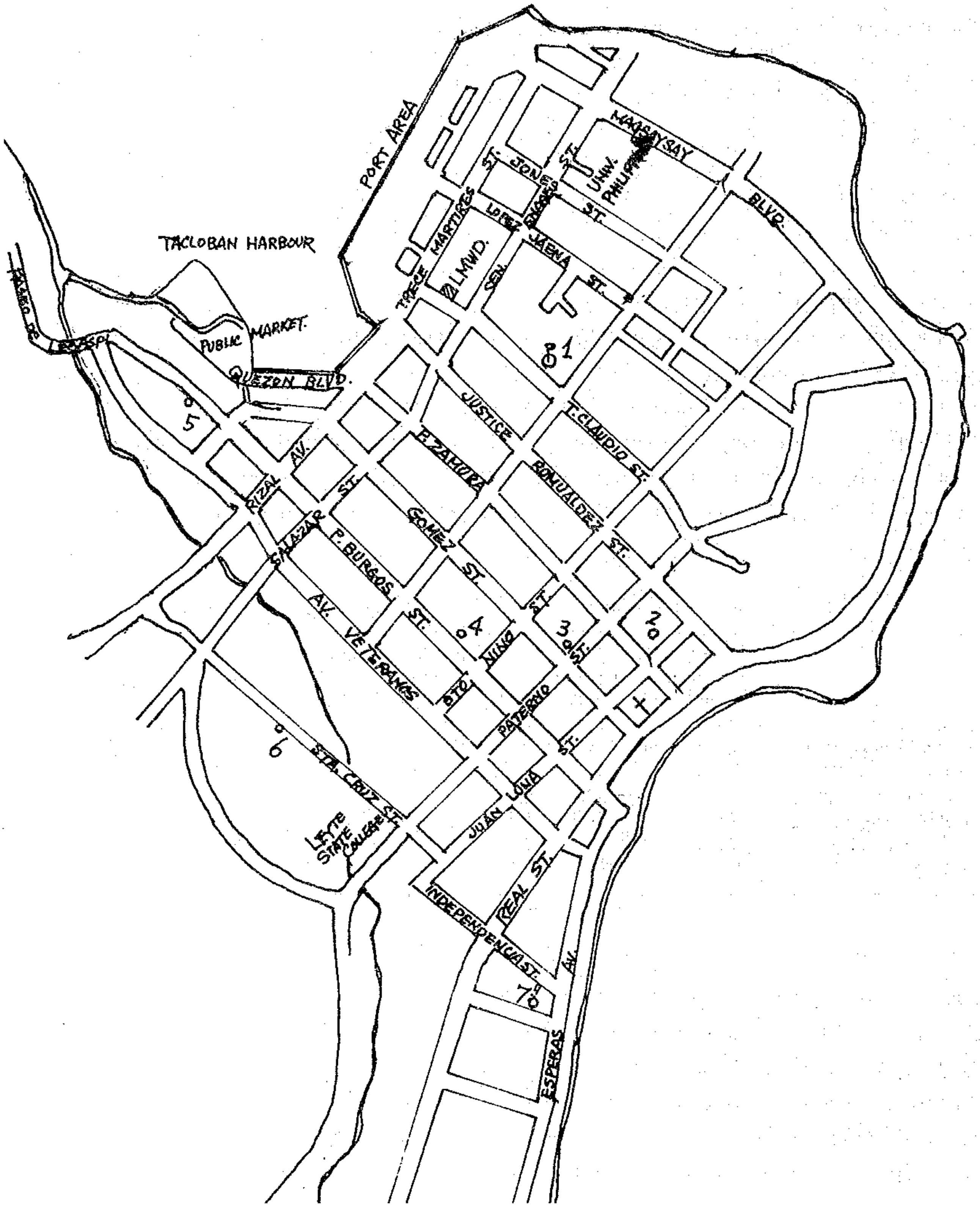


Fig. 10 Location of Private Wells Tested for Water Quality in Tacloban City

2.4 Background and Outline of the Request

2.4.1 Background of the Request

The facilities of the LMWD water supply system which serves Tacloban City and the five municipalities of Pastrana, Dagami, Palo, Tanauan and Tolosa were severely damaged by Typhoon Uring which struck Leyte Island in November 1991. While about 80,000 people in the water district were compelled to depend on shallow wells and springs for their water needs, their daily life and industrial and economic activities in this area were also disrupted and the sanitary conditions began to deteriorate with the spreading of diseases as a result of consuming unsafe water. Under these circumstances, some rehabilitation efforts had been taken by the LMWD in association with the LWUA as urgent measures, for example, construction of river dikes, rehabilitation and restoration of intake facilities etc., but they were far too small to put back the water district to its previous capacity and therefore drastic rehabilitation program has become essential.

The Government of Philippines is confronted with frequent natural disasters such as earthquakes, volcanic eruptions etc. and has only a very stringent national budget to recover from the present disaster. Therefore it prepared an emergency plan aimed at the rehabilitation of the water supply system and the construction of relevant facilities that need urgent attention and requested the Government of Japan in May 1992 for grant aid to implement this plan.

In response to this request, the Japan International Cooperation Agency (JICA) dispatched a study team to the Philippines in November 1992. The study team after confirming the contents of the request, also studied on the planning and organizational arrangements of the Philippine side for the implementation of the project, and carried out field surveys. Based on the above, some of the items in the original request pertaining to the scope etc., were amended and agreed upon after discussions with the executing agency responsible on the Philippine side.

2.4.2 Contents of the Request

The contents of the request made by the Government of Philippines are as follows;

1. Objective of the Project

   The objective of the project is to rehabilitate the water supply system in Leyte Metro Water District (LMWD) damaged by Typhoon Uring in 1991 in order to restore the system to its previous capacity.

2. Contents of the Original Request

   The contents of the original request are shown in Table 18.

After clarification with the Government of the Philippines during the Preliminary Study, these were amended to suit the present conditions of the project area as follows.

(1) Rehabilitation of the intake facilities

Rehabilitation of the Dagami System ; The intake weirs (Hiabangan, Hitognob) are located in steep terrain and there are no access roads and this makes construction work difficult. Moreover, as the water resources in the catchment is very small and cannot be relied upon in the future, this system will be abandoned in principle. However an equivalent volume of water

Table 18 Contents of the Request

Facility/ies	Extent of Damage	Original Request
1. Hitognob Dam	The intake wall was totally covered with boulders, silt, forest materials. A portion of the raw water conveyance pipeline was washed away.	Rehabilitation of the raw water conveyance pipeline washed away.
2. Hiabangan Dam	The concrete dam structure was overturned due to high pressure from run-off water. Approximately 500 m of the raw water conveyance pipeline was washed away.	Reconstruction of the intake dam and a part of the raw water conveyance pipeline.
3. Tingib Treatment Plant	The treatment plant was overrun by a flash flood and was totally covered with heavy silt. Damage of the slow sand filter units.	Construction of the sedimentation tanks with a larger capacity. Introduction of coagulation and flocculation processes.
4. Dagami Treatment Plant	The plant is still capable of supplying water although the row water intake dams were damaged.	Introduction of coagulation and flocculation process to the sedimentation tanks.
5. Mini Hydropower System		Construction of mini hydropower system to use the available hydraulic head between Hitognob and Hiabangan intakes and Dagami Treatment Plant. The excess hydraulic head between the Dagami treatment plant and the highest service area of Dagami may be also useful to generate electric power.

as that was supplied before the disaster (estimated to be about 15% of the entire LMWD) will be supplied from the Tingib System. Accordingly, transmission of treated water from the Dagami Treatment Plant to the areas such as Tacloban will also be abandoned, but the water supply to the nearby Dagami Town will be maintained through self efforts of the LMWD. The temporary pipeline (PVC ø 250 mm) presently installed from the temporary intake as an emergency measure is not properly laid, and moreover, the pipe material has deteriorated in quality. Therefore only the procurement of spare parts for the piping materials required for the rehabilitation of this pipeline will be considered.

(2) Rehabilitation of the purification facilities

(i) Dagami Treatment Plant is not affected by the typhoon. Moreover as further strengthening of the Dagami system is not required as mentioned above, this will be excluded from the present project.

(ii) As the existing facilities of the Tingib Treatment Plant are located within the riverbed they are vulnerable to flood damages. Therefore shifting of these facilities to a higher location will be considered. Plant capacity will include the capacity of Dagami Treatment Plant. In order to convey raw water by gravity flow, it is judged appropriate to shift the location of the new intake 1.5~2.0 km upstream of the existing intake.

(3) Construction of the transmission pipeline

Although the transmission pipeline (Dagami - Palo section) which is a part of the Dagami System will be excluded from the present project for the reasons mentioned above, a new transmission pipeline will be required for the Tingib System with the expansion of Tingib Treatment Plant. Two alternative routes are proposed as follows for this pipeline;

Route A : Tingib~Pastrana~Palo (same route as of the existing pipeline)
Route B : Tingib~Pastrana~Santa Fe~Palo

(4) Construction of mini hydropower facilities will not be taken into consideration for assistance under the present project as it is not directly related to typhoon damages.

2.5 Outline of the Project Area

2.5.1 Project Area

The Project Area consists of Tacloban City and the five municipalities of Palo, Tanauan, Tolosa, Dagami and Pastrana in the north east part of Leyte Island which are presently served by the Leyte Metro Water District (LMWD), and the catchment areas of Binahaan, Hiabangan and Hitognob rivers where the water intakes and treatment facilities are located.

2.5.2 Natural Conditions

(1) Topography

Leyte Province is one of the six provinces in the Eastern Visayan Region, which covers the northern 70 % of Leyte Island, and is composed of two cities and 41 municipalities. A mountain range that runs in the north-south direction through the central part of Leyte Province divides the province in to two areas, one to the east and other to the west, where the language and climate differ. This central mountain range which is formed by high peaks rising over 1,000 m above sea level is characterized by deeply incised valleys and a large number of water falls. Although there is natural forest cover deep in the hills, since recent years some parts of the central hills are being developed in connection with geothermal power development and denudation of forest has been gradually increasing as a result of development activities. Coconut plantations extend over the gentle slopes at the foot of the hills.

The east part of Leyte Province is composed of fans and lowlands extending from the foot of the eastern slope of Leyte Central Mountain Range up to the coastal line from Leyte Gulf to the Bay of San Pedro and San Pablo. This region is further divided in to the Central Basin (about 400 km^2) which is the catchment area of the Central Mountains and to Tacloban Basin (about 25 km^2) which is the catchment area of Palo - Babatongon Hills west of Tacloban. Of these two basins falling within the LMWD considered under this project, Tacloban City is located within the Tacloban Basin whereas the five municipalities are located within the Central Basin. A number of small hillocks are scattered over Tacloban, Tanauan and Tolosa areas and the two distribution tanks of the LMWD are installed on such hillocks. In the inland part of the project area there are two vast expanses of swampy zones, one about 30 km^2 in area and located about 4 km north of Santa Fe, and the other about 10 km^2 in area and located in Cogon, midway between Palo and Dagami. Tingib and Dagami treatment plants are located at the foot of Central Mountains which form the water source of Binahaan River, Hitognob River and Hiabangan River. Binahaan-Quilot River and Dapdap-Palo River, the two largest rivers in Leyte Island, run through the project area and enters Leyte Gulf at Tanauan and the Bay of St.

Pedro and San Pablo at Palo respectively. In addition there are many other rivers and streams through the project area including those flow only during the rainy season.

(2) Geology

The basic topography of the Philippine Islands is considered to have been formed as a result of repeated tectonic activities. The Philippine Fault which extends from Luzon Island through Leyte Island to Mindanao Island was formed during the Tertiary Period. Leyte Island is inferred to be a product of magmatic and tectonic movements and upheavals of the Philippine Sea Plate.

Cretaceous volcanic rocks generated by these plate action are observed within the Project area and these are overlain by intercalated shale, sandstone, chert and other sedimentary rocks. Intrusion of serpentinized peridotite and associated gabbro have occurred during the Paleocene to Eocene time. These basement rocks are unconformably overlain by Early to Middle Miocene San Ricardo Formation which consists of conglomerate, sandstone, shale, lime stone and intercalated volcanic flows. Dikes of andesitic composition have intruded this formation at a later stage. The San Ricardo Formation occupies the low ridge along the western side of Tacloban City and extends up north to the vicinity of Cabalawan. The Upper Miocene to Pliocene Bagahupi Formation which overlies the San Ricardo Formation unconformably is composed of conglomerate, sandstone and marly, tuffaceous shale beds. The Pliocene to Quarternary Dolores Formation covers the slopes of volcanic cones, and its general development in a radial pattern is evident particularly along the eastern slope of Mt. Lobi at Dagami Burauen area. This formation is composed mainly of pyroclastic rocks and the Quarternary Volcanics that occur within the Central Highlands are mainly of andesite. Alluvial and beach deposits consist of clay, silt, sand and gravel with some boulders at the upstream area. The geologic map of the project area is shown in Fig. 11.

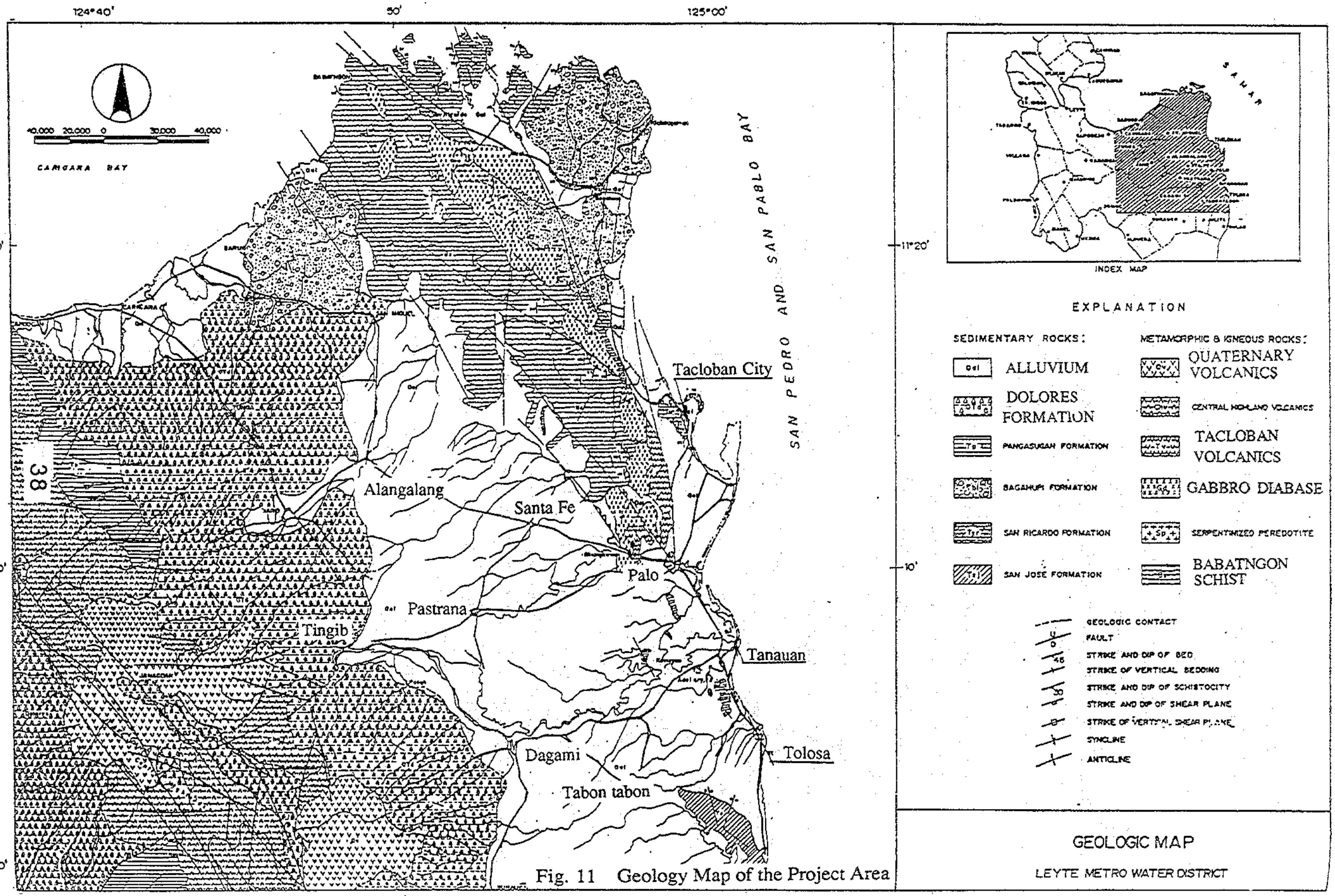


Fig. 11 Geology Map of the Project Area

(3) Climate

The climate of the Philippines, though not the same throughout the country due to diversified geographical features, can be said to be broadly representing a rainy season between July and October, a dry season between December and May and a period of variable climate in June and November. Climatically, the Philippines can be broadly classified into four types of regions as follows;

Type I: The regions where the dry season (November~April) and the wet season (May~October) are distinct; the west part of Luzon Island and the west part of Visayan Islands.

Type II: The regions where there is no distinct dry season but a pronounced maximum rainfall from November to January; South eastern coastal areas of Luzon Island, entire Samar Island, eastern half of Leyte Island and eastern part of Mindanao Island.

Type III: The regions where there is a short dry spell from November to April but without a distinct rainy season; Central part of Luzon Island, western part and central coastal part of Mindanao Island.

Type IV: The regions without a distinct dry season and pronounced maximum rainfall; Eastern plains of Luzon Island, coastal areas of Visayan Islands and central part of Mindanao Island.

The project area falls under Type II of the above classification. Although there is no distinct dry season nor a wet season, rainfall is relatively small from April to August and significantly high from November to February. According to the climatological data obtained from Tacloban City Recording Station, the average annual rainfall of the past 43 years is about 2,263 mm. Throughout the year, the climate is warm and humid, and the temperature varies from 26.0 ^{O}C to 28.2 ^{O}C with an annual average of 27.3 ^{O}C whereas the humidity varies from 84% to 89% with an average of 86%. The rainfall distribution in Leyte Island is shown in Fig. 12 and the monthly rainfall in Tacloban City is shown in Fig. 13.

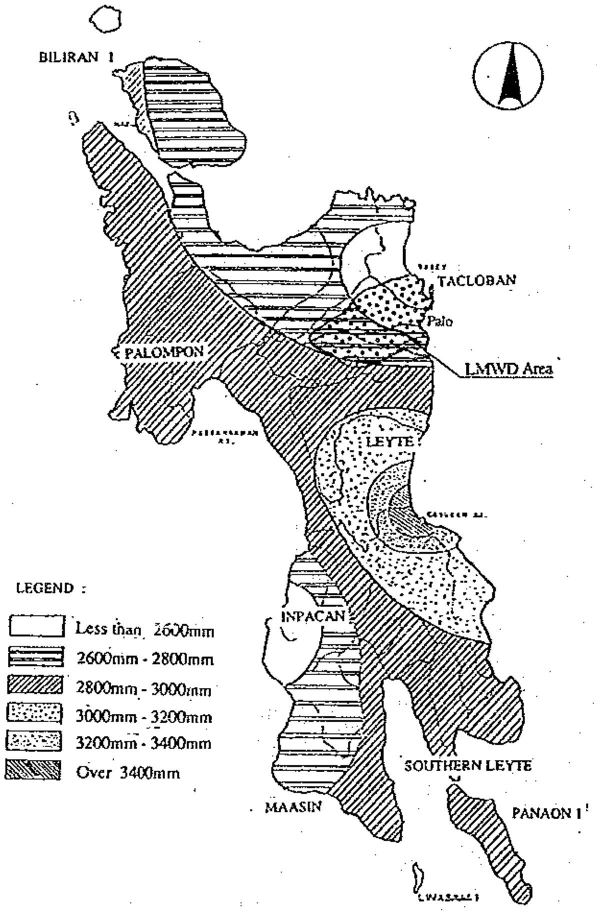
(4) Population

According to the national census of 1990, the population within the Project Area is as shown in Table 19. The total population in the Project Area (the city and 5 municipalities) presently served by the LMWD is 264,494 and covers 18% of the population in the entire Leyte Province. About 66% of this population live in the urban area. Within the Project Area, Tacloban City has the highest population which covers 52% of the entire Project Area. The average annual rate of population growth in the Project Area during the 10 year period from 1980 to 1990 was 2.39%. The population at the beginning of year 1991, therefore, is estimated to be approximately 270,800.

Table 19 Population of the Project Area

Name of Municipality	Area (ha)	Population Total	Urban	Rural	Growth Rate	Number of Households	Persons per Household
Tacloban	10,900	136,891	136,891	------	2.93	24,897	5.5
Palo	6,760	38,100	16,205	21,895	2.04	7,111	5.3
Pastrana	7,930	12,565	2,202	10,363	1.47	2,419	5.2
Tanauan	6,810	38,033	13,520	24,513	1.91	7,696	4.9
Tolosa	3,710	13,299	2,890	10,409	2.04	2,558	5.2
Dagami	16,000	25,606	3,921	21,685	1.52	5,007	5.1
Total	50,760	264,494	175,629	88,865	2.39	49,688	5.3
Tabontabon	2,390	7,183	2,388	4,795	1.05	1,436	5.0
Santa Fe	8,190	12,119	783	11,336	2.22	2,374	5.1
Alangalang	15,050	33,375	7,094	26,281	1.26	6,504	5.1
Total	76,390	317,171	185,894	131,277	2.22	60,002	5.3
Leyte Province	388,595	1,485,8282	485,817	1,000,011	2.23	287,872	5.2

Source: 1990 Census of Population and Housing



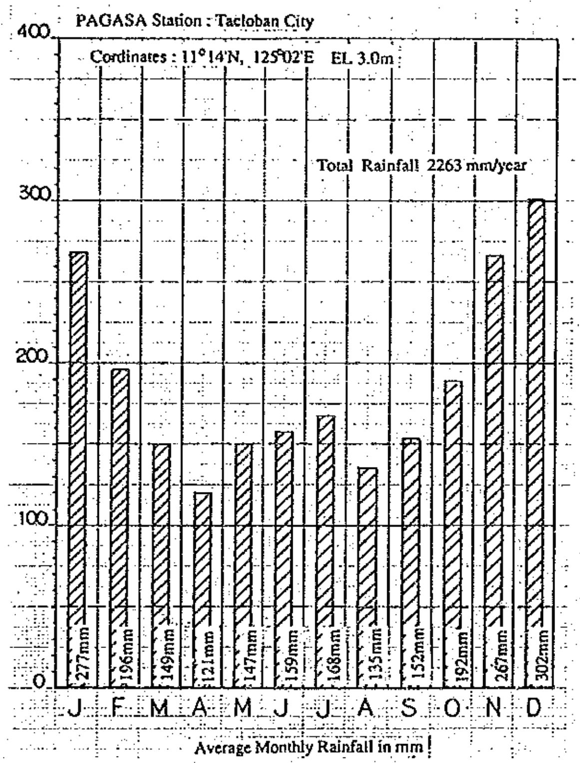


Fig. 12 Rainfall Distribution in Leyte Island Fig. 13. Average Monthly Rainfall in Tacloban

2.5.3 Social Environment

(1) Transport

Roads are the only mode of transport in the inland area of Leyte Island. About 40% of the 997 km of National Highways, which are the arterial roads, are concrete paved and well maintained thereby facilitating the transportation of people and goods. Also, there are 447 km of provincial roads and 1,552 km of Barangay roads, which are not paved, linking the interior and remote areas to the mainstream of transport. Since the adjacent island Samar is connected by San Juanico Bridge which is constructed over the San Juanico Strait, communication between Leyte and Metro Manila is relatively convenient on road using the Japan-Philippine Friendship Highway and the ferry which connects the southern tip of Luzon Island and Samar Island. Air routes and naval routes are also developed and there are two to three flights a day between Tacloban and Manila. Cebu Island is also linked by air. Tacloban Port has a total length 64 m and 6.7 m water depth. It can accomodate inter- inland vessels and ocean-going ships. Irrespective of the country of origin, about 11 to 14 vessels call this harbour on a monthly average.

(2) Communication

Telecommunication system through telephones is operated by the East Visayan Telecommunication Company (EVTELCO) in the region centering Tacloban, Palo, Tanauan, Abuyon, Caligara and Brauen areas. As of 1990 there were 3,471 connections indicating a low distribution rate of only 1.75 telephones for every 100 persons. International calls are possible through Manila but communication conditions are not so good. LMWD has introduced its own wireless communications system between the Main Office in Tacloban City and the treatment plants at Tingib, Dagami, etc. to enhance efficiency of its activities.

(3) Electricity

All the electrical power needs of Leyte Province are provided by the Tongonan Geothermal Plant. Whereas the Philippine National Oil Company (PNOC) develops wells for geothermal steam, the National Power Corporation (NPC) furnishes power generators and power distribution facilities, and the electricity is supplied by six electrical power companies in Leyte Province. The Tongonan Geothermal Plant presently has a total power generation capacity of 112.5 MW whereas the total power demand in the area served by the six companies is 68.52 MW. The excess power produced is transmitted to Samar Island. In Leyte Province, electricity supply coverage has reached 100% at municipality level and 60% at Barangay level. Further, there is a plan to develop a total of 752.5 MW of electricity and supply to Cebu and Metro Manila areas.

In the Projet area, the areas of jurisdiction of the electric power companies are distributed with Tanauan, Tolosa and Dagami coming under LEYECO I, Tacloban, Palo under LEYECO II and Pastrana, Santa Fe, Alangalang under LEYECO III. Although electricity is already supplied to Tingib village, there is no power distribution to the existing treatment plant which is about 800 m away from the village. Despite of the rich power generation capacity Leyte Province has, electricity supply is often interrupted due to poor functioning of the power distribution facilities and therefore the major facilities such as factories, banks, hotels, etc., have their own power generation equipment.

(4) Health and sanitation

As the major medical facilities in Leyte Province, there are 17 public hospitals and eight municipal hospitals with a total capacity of 1,278 beds which amounts to the availability of one bed per every 1,162 persons. Taclóban City has five hospitals with a bed capacity of 512. Each municipality has a health clinic. The proportion of medical and paramedical personnel and major medical facilities to the population is shown in Table 20. The Provincial Hospital in Palo has special laboratory for treatment of schistosomiasis.

Table 20 Health Manpower to Population Ratio in 1989

Health Manpower / Center	Ratio
Physicians	1 : 8,120
Nurses	1 : 4,464
Midwives	1 : 4,385
Dentists	1 : 38,436
Main Health Centers	1 : 24,534

Source: Major Development Programs and Project-Leyte, 1986-1992

(5) Industry

The main industry in Leyte Province is agriculture. About 74% of the total area of Leyte Province is farmlands and 76% of this area is cultivated with coconuts, rice and sugar cane. Mineral exploration is another major industry and limestone, bentonite, copper, phosphorous etc., are produced at Isabel. Other than the mineral related industries, there are coconut oil purifying plants and soft drink breweries in Tacloban and Tanauan. The various offices of provincial administration, banks, commercial and information business etc., are gathered in Tacloban which is the center of administrative and economic activities of the region. A Regional Industrial Center (RIC) which is planned 10 km north of Tacloban as the nucleus of industrial development in the Eastern Visayan Region will commence operations in the near future. The RIC plans to attract industries related to processing of coconut, which is a major product of this region, and timber, rootcrops, garments etc.

CHAPTER 3. OUTLINE OF THE PROJECT

3.1 Objective of the Project

The objective of the Project is to rehabilitate quickly the damaged water supply facilities of the LMWD that were affected by the typhoon and put the water supply capacity of the LMWD back to the previous level before the typhoon.

3.2 Review of the Contents of the Request

3.2.1 Review of the Contents of Project Facilities

Field survey for this study was conducted premised on the project contents which had been agreed upon with the Philippine side at the time of Preliminary Study as described in Section 2.4 of this report. The contents agreed upon during the Preliminary Study are summarized here under the following three items.

(i) Rehabilitation of the Dagami System

It is difficult to carry out the construction works for the rehabilitation of the intake weir and the conveyance pipelines because access to the site of these facilities is obstructed by steep terrain and moreover, as there is no maintenance road. Besides, there are many problems concerning the transmission pipeline from the Dagami to Palo, and when compared with the investment required for the replacement of this pipeline, the capacity of its water source is too small and hence it is judged that future development cannot be anticipated. Therefore, the Dagami System will be excluded from the items for rehabilitation under the Project, and instead, an amount equivalent to its previous capacity (about 15 % of the total capacity of the Project) will be added to the capacity of the Tingib System. As the intake weir and conveyance pipeline have already been rehabilitated temporarily by the LMWD with its own efforts. As the treatment plant was not damaged by the typhoon, Dagami System is now put back to operation though not fully restored. Under above circumstances, this system will not be totally abandoned but will be considered as an exclusive water supply facility for Dagami village, and therefore only the procurement of piping materials required for the rehabilitation of the deteriorated PVC pipeline will be considered.

(ii) Rehabilitation of the Tingib System

The treatment plant and the transmission pipeline of the Tingib System from the plant to

Palo will be rehabilitated based on the capacity mentioned in (i) above. As the treatment plant at its present location is vulnerable to recurring floods, it is necessary to shift the plant to a new site at a higher elevation on a hillock nearby. Moreover, as the present slow sand filter system in the existing plant cannot cope with the quality of the raw water drawn from Binahaan River which has a high turbidity, it has been proposed to adopt a new treatment system with rapid sand filters. Further, a new intake facility is to be constructed about 1.5~2.0 km upstream and the raw water will be delivered to the plant through a new conveyance pipeline. Two alternative routes have been proposed for the new transmission pipeline from the plant to Palo that becomes necessary with the increased capacity of the plant with one of them along the same route as the existing ø 600 mm pipeline and the other through Santa Fe which will be included in the future water supply project.

(iii) Capacity of the Facilities in the Project

By estimating the treatment capacity of the facilities to be rehabilitated in the Project based on a supply demand of about 14,500 m3/day and a total leakage rate of 62 % from the system, it had been considered that the required treatment capacity would be more than 38,000 m3/day.

As a result of the field survey conducted at this basic design stage, several new facts were revealed as follows.

(1) Leakage Rate and Water Supply Volume

What was considered as leakage at the time of the Preliminary Study was discovered to be actually the unmetered water including the water supplied from the public faucets and to some villages along the transmission pipelines without metering, as well as the actual leakage and water stolen. Further, it was found that the leakage rate estimated at 62 % should correctly be the ratio of unaccounted water amounting to 40 % as estimated from the comparison of the volume transmitted and the volume supplied (billed) for one month in September 1991 made by the LMWD, or in other words, the ratio of billed water was 60 %. On the other hand, the daily average of the volume of water supplied (billed) by the LMWD estimated from the water supply records up to the typhoon in 1991 is 15,545 m^3, and by dividing this by the billed water ratio (60 %) obtained above, the volume of water transmitted is determined as 25,900 m^3/day. Therefore, the planned capacity of the facilities was reduced to about two-thirds of the initial estimate. By the way, the daily average of the volume of (billed) water estimated from the water supply records for one year in 1989 was 14,172 m^3/day, where as the daily average of the volume of water transmitted was 23,620 m^3/day.

(2) Capacity of the Existing Facilities Before the Typhoon

It was concluded that the original treatment capacity of the existing treatment facilities of the LMWD was 22,000 m^3/day at the Tingib System and 4,000 m^3/day at the Dagami System with 26,000 m^3/day in total. These figures well tally with the estimated volume of 25,900 m^3/day transmitted before the typhoon. It was presumed that the pipelines of the Tingib System are maintained in good condition without a large leakage, and the present transmission capacity is 22,000 m^3/day. The bases for the above presumptions are as follows.

(i) Treatment capacity of the Tingib System

(a) Capacity of the existing slow sand filter

The standard rate of filtration for a slow sand filter is specified as 4~5 m/day (Design Criteria for Water Works Facilities - JWWA). Accordingly, the filtration capacity is estimated from the area of the existing filter;

Filter area : 1,525 m^2/bed x 3 beds = 4,575 m^2

Filtration capacity : 4,575 m^2 x 4~5 m/day = 18,300 ~ 22,875 m^3/day.

(b) Measured value of actual flow

The LMWD, by installing flowmeters, has measured the volume of water delivered from the existing facilities under normal conditions of operation during the month of September 1991. According to these records which show a total volume of 666,060 m^3/month, the average daily flow is estimated as,

666,060 m^3/month /30 days/month = 22,202 m^3/day.

(c) Flow capacity of the existing pipeline

After determining the discharge capacity of the ø 600 mm transmission pipeline of the Tingib System, the treatment capacity is evaluated by balancing the treatment and delivery capacities. The assumptions made in calculating the discharge capacity calculations are as follows;

i) Length of pipeline :

31 km from the Tingib Treatment Plant to Utap Hill Reservoir in Tacloban City

ii) Difference in elevation :

Tingib Treatment Plant (El. 100 m) - Utap Hill Reservoir (El. 38 m) = 62 m

iii) Hydraulic gradient :

62.0 m x 0.9/31,000 m = 0.0018 (Considering lowering of flow capacity due to scaling in the pipes, the hydraulic head is reduced by 10%)

Therefore, the discharge in the pipeline determined from the above parameters using Hazen William's formula is ; $Q = 0.27853 \times 110 \times 0.60^{2.63} \times 0.0018^{0.54} =$ 0.263 m^3/sec.

or $Q = 0.26$ m^3/sec x 86,400 sec/day = 22,464 m^3/day

Considering i), ii) and iii) above, the supply capacity of the Tingib System is taken as $Q =$ 22,000 m^3/day.

(ii) Treatment capacity of the Dagami System

Dagami System does not have a filter basin but only a lateral flow type sedimentation tank where sedimentation is not by forced settling by chemical injection but natural. Moreover, since the turbidity is low, and does not require special treatment, its treatment capacity cannot be determined from the capacity of the sedimentation tank. Therefore its treatment capacity is estimated based on available data and flow measurements.

(a) Intake volume from the dam

According to the data available with LMWD, intake capacity in the dry season at the two intake dams of the Dagami System are;

Hiabangan Dam:	34.7 l/sec
Hitognob Dam :	12.0 l/sec
Total	46.7 l/sec (46.7 l/sec x 86400 sec/day /1000 l/m^3= 4,034 m^3/day)

(b) Records of flow measurements

According to the flow measurements made in September 1991 the discharge in the transmission pipeline is 46.48 l/sec. Then the daily volume,converted (46.48 l/sec x 86,400 sec/day/1000 l/m^3) is 4,016 m^3/day.

(c) Results of measurements made during the present study

The following results were obtained from the flow measurements conducted by the Basic Design Study Team on 12th February 1993 at the inlet channel of the treatment plant.

Area of cross section of the channel	: 0.39 m^2
Velocity measured	: 0.157 m/sec
Inflow: 0.39 m^2 x 0.157 m/sec	= 0.061 m^3/sec.

This when converted (0.061 m^3/sec x 86,400 sec/day) is 5,290 m^3/day.

(d) Discharge capacity of the existing transmission pipeline

The discharge capacity of the existing transmission pipeline from Dagami to Tacloban is estimated as follows;

i) Length of pipeline :

ø 300 mm - 4.9 km, ø 250 mm - 25.1 km. When 4.9 km of ø300 mm pipeline is converted as ø250 mm pipeline ; 4.9/2.43 = 2.016 (say 2.1 km). Therefore the total converted length (2.1 km + 25.1 km) is 27.2 km.

ii) Difference in elevation :

130 m. (Elevation at Dagami Treatment Plant : 150 m - Assumed water head required at the terminal point in Tacloban City : 20 m)

iii) Hydraulic gradient : 130 m / 27,200 m = 0.0048

Therefore, the discharge in the pipeline determined from the above parameters using Hazen William's formula is;

$$Q = 0.27853 \times 110 \times 0.25^{2.63} \times 0.0048^{0.54} = 0.045\ m^3/sec.$$

or $Q = 0.045$ m3/sec x 86,400 sec/day = 3,890 m^3/day

Considering i), ii) and iii) above, the transmission capacity of the Dagami System is taken as Q = 4,000 m^3/day.

The figure of 26,000 m^3/day estimated above as the total capacity of the facilities before the typhoon is judged to be appropriate, even when considering the volume of water supplied and the billed water ratio discussed in (1) above.

(3) Consideration on the utility value of the Dagami System

The Basic Design Study Team reached the same conclusions as those delivered from the Preliminary Study with regards to the rehabilitation policy of the Tingib system. But with regards to the Dagami System the it makes the following observations based on the reconnaissance of the intake, conveyance, treatment, and transmission facilities.

(i) Of the two intake facilities in the Dagami System, Hitognob Dam is rehabilitated almost to the previous condition before the typhoon as the damage to this structure was small. However, at the Hiabangan Dam the intake structure was completely destroyed and water is now drawn from a tentative intake installed downstream. This tentative intake, at the present location, may be vulnerable to damage due to a change in the river course caused by a future flood. But, for its simplicity in structure, reconstruction of the intake even in such an event can be easily managed with the technical capacity of the LMWD. Irrespective of such circumstances, more than one year has passed since the installation of the intake and during this period no conspicuous drop in water level has been observed at the treatment plant. Therefore it is judged that functioning of the intake has been sufficiently reliable.

(ii) The Dagami System is an economically favorable system that uses the water from a stream as the source which is so clean that it can be supplied without any special treatment with chemicals other than disinfection by chlorination and without any equipment operated by electric power. Moreover, as there are other potential water sources (streams) available in the vicinity besides Binahaan and Hitognob rivers, prospects for future development are well anticipated. The LMWD has a strong intention to maintain the Dagami System even in the future, and also the desire to reconstruct the destroyed Hiabangan Dam.

(iii) There are many problems in the existing transmission pipelines of the Dagami System due to leakage and pilferage, and the required volume of water cannot be transmitted to service area beyond Dagami. If a transmission pipeline is constructed along a new route instead of the existing one, it will be possible to use the water in the Dagami System effectively and at low cost while it will also contribute to reduce water losses in the entire LMWD system. The LMWD had proposed a similar plan in the past identifying a substitute route from Dagami to Tanauan.

As the scope of the facilities for improvement the Basic Design Study Team, based on the above conditions, formulated the following two plans including the concept proposed during the Preliminary Study considering the possibilities of utilizing the Dagami System.

Case 1: This plan is to exclude the Dagami System from the scope of major facilities of the LMWD proposed in the Preliminary Study, and instead to supply the required quantity (26,000 m^3/day) of water from the Tingib System.

Case 2: In this plan, in order to effectively utilize the economical water source of the Dagami System, a new pipeline will be constructed to substitute the existing pipeline which cannot be properly maintained and presently leads to severe leakage of water. Accordingly, the capacity of the planned facilities of the Tingib Treatment Plant will be reduced to (22,000 m^3/day).

3.2.2 Comparative Study of the Planned Facilities

The outline of the major facilities planned in the above two cases is shown in Table 21.

Table 21 Comparison of Alternatives of the Proposed System

Facility	Case 1	Case 2	Remarks
1. Tingib System			
(1) Capacity of proposed treatment plant (m3/day)	26,000	22,000	
Type	Rapid gravity sand filter	- ditto -	
Location	2.6 km upstream of the existing facility	- ditto -	
(2) Proposed intake Discharge (m3/day)	28,600	24,200	110% of (1)
(3) Proposed conveyance line			
Length (km)	2.6	- ditto -	
Size of pipe (mm)	ø 700	ø 600	
(4) Rehabilitation of existing transmission pipeline	replacement of air-valves	- ditto -	
(5) Proposed transmission pipeline			
Capacity (m3/day)	4,000		excess over existing capacity
Length (km)	24.5	- none -	
Size of pipe (mm)	ø 300		
2. Dagami System			
Proposed transmission pipeline	- none -	ø 250 mm, 14.2 km	

With regards the new conveyance pipeline of the Tingib System in Case 1 shown in Table 21 two alternative routes has been suggested during the Preliminary Study; one being the same route as that of the existing conveyance pipeline and the other route leading to Palo via Santa Fe with its direction changed northwards after Pastrana. Convenience of the execution of works, construction cost, future development potential and ease of maintenance and operation, etc., of the two routes were studied in comparison and as a result, the latter route was judged to be superior.

The following review is done in order to compare the level of improvements necessary in the two cases with a view to assess the benefits and impact of the two cases, by grasping the water supply and delivery conditions before and after the typhoon in 1991.

(1) Conditions of water supply and delivery before the typhoon

According to the water supply data of the LMWD, the billed water ratio at present is 60 %. Further, according to the data from measurements made for the transmission pipeline of the Dagami System, the volume of water delivered to Palo through the urban area of Dagami is merely 29 % of the volume of water transmitted from the plant. Considering these facts as the basic conditions and based on the following assumptions derived from the existing data, it is examined how the total volume of 26,000 m^3/day of water delivered from the two existing plants is distributed in the entire present service area.

Assumptions:

1) Service population in the area: Estimated based on 1990 data considering a population growth rate of 2.39 %.
2) Water consumption per capita: 138 lpcd (Records of 1991)
3) Water supplied other than domestic water: 4,900 m^3/day of water other than domestic water that had been actually supplied in 1991 was distributed according to the population of each area.
4) Leakage in the service area: Assumed as 31 % uniformly in all the areas.
5) Leakage from transmission pipelines:

Tingib route: Volume of unmetered water supplied along the transmission pipeline is assumed to be 5 % of the volume transmitted.

Dagami route: Combined volume of leakage and pilferage is assumed as 2,240 m^3/day based on the past records of actual flow measurements which show that only 29% of the water transmitted has reached Palo.

The status of distribution of water supply before the typhoon in 1991 is shown in Table 22 and illustrated in Fig. 14.

Table 22 Condition of Water Distribution in 1991 before Typhoon

Area	Service population a (persons)	Domestic use b (m^3/day)	Other uses c (m^3/day))	Sub Total d=b+c (m^3/day)	Supply volume e=d/0.69	Transmission loss f (m^3/day)		Total g=e+f (m^3/day)
Tacloban	55,900	7,710	3,530	11,240	16,290	---		16,290
Palo	12,000	1,660	750	2,410	3,490	---		3,490
Tanauan	5,300	730	330	1,060	1,540	---		1,540
Tolosa	700	100	40	140	200	---		200
Pastrana	1,900	260	120	380	550	1,100	*	1,650
Dagami	2,000	280	130	410	590	2,240	**	2,830
Total	77,800	10,740	4,900	15,640	22,660	3,340		26,000
Santa Fe	1,910***	260	---	260	380	---		380

where : b (m^3/day) = a (persons) x 0. 138 (m3/capita/day)
Other uses = government, commercial, industrial, bulk (m^3/day)
e = supply volume to the service area (m^3/day)
f = water loss from transmission line (m^3/day)
* = water loss between Tingib and Palo (m^3/day)
** = water loss between Dagami and Palo (m^3/day)
*** = estimated population in 1995 (persons)

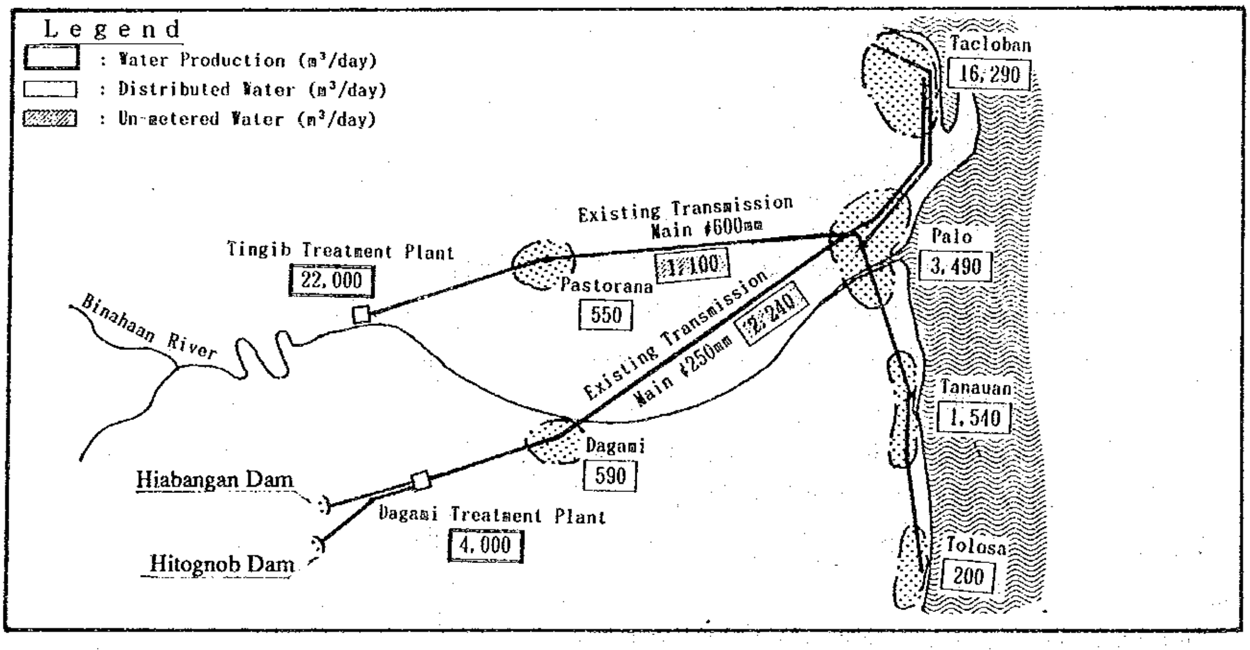


Fig. 14 Condition of Water Distribution in 1991 before Typhoon

(2) Conditions of water supply and delivery after the typhoon

As described in Section 2.3.2 in this report tthe billed water supply volume after the typhoon is 13,000 m^3/day. Based on this, the volume of treated water produced is estimated at 21,600 m^3/day as shown in Table 23.

Table 23 Condition of Water Distribution after Typhoon

Service population a (persons)	Domestic use b (m^3/day)	Other uses c (m^3/day))	Sub Total (m^3/day) d=b+c	Supply volume (m^3/day) e=d/0.69	Transmission loss (m^3/day) f=gx0.13	Total (m^3/day) g=e+f
58,700	8,100	4,900	13,000	18,840	2,810	21,650

(3) Proposed Transmission and distribution conditions in Case 1

In Case 1, transmission pipelines on the Dagami route after passing Dagami are to be abandoned and this system is to function as a water supply facility exclusively for the Dagami Municipality. Moreover, by constructing a new transmission pipeline in the Tingib System, Santa Fe Municipality will be newly added to the service area. Making the assumptions conforming to (1) above, the supply volume and the population benefited etc, in this case are estimated as follows based on 1991 data. Therefore, the water distribution in Case 1 is estimated as in Fig. 15.

i) Total volume transmitted	: 26,590 m^3/day	
ii) Volume delivered to service area	: 24,140 m^3/day	= 22,660+1,100+380(Santa Fe)
iii) Volume supplied in excess	: 2,450 m^3/day	= 26,590-24,140
iv) Increase in the population benefited	: 12,250	= (2,450 x 0.69)/0.138
v) Total service population	: 91,960	= 77,800+1,910 (Santa Fe)+12,250
vi) Billed water supply volume	: 17,600 m^3/day	= 91,960 x 0.138+4,900

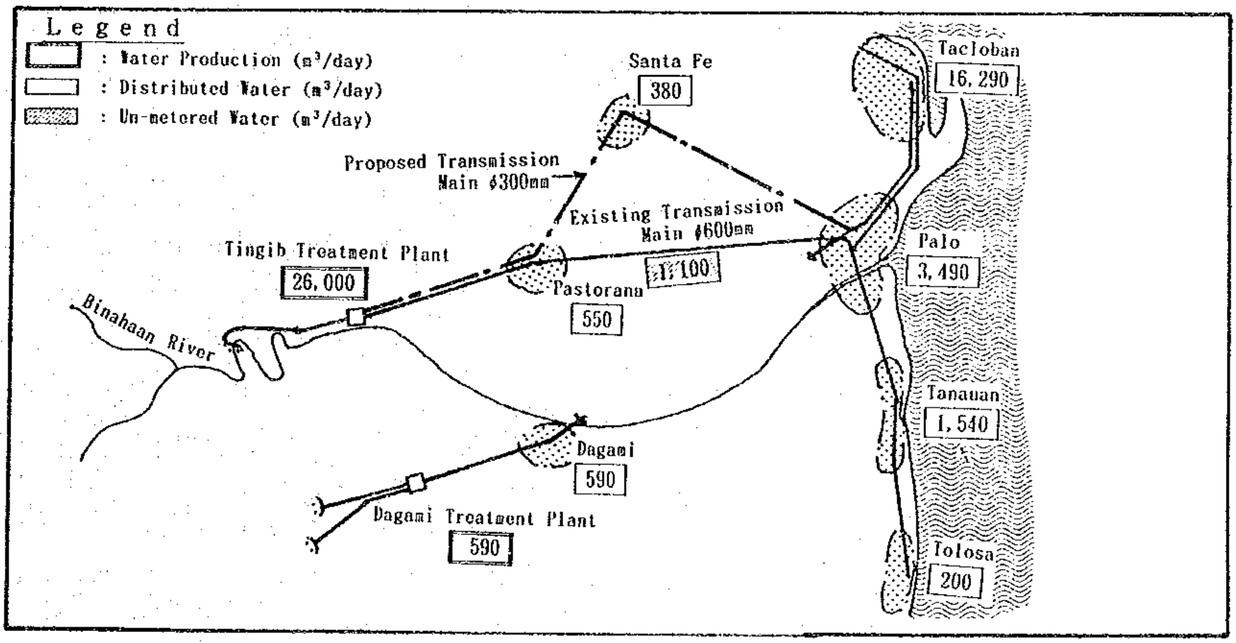


Fig. 15 Condition of Proposed Water Distribution in Case 1

(4) Proposed Transmission and distribution conditions in Case 2

Similarly as in Case 1, the transmission and distribution conditions are assessed for Case 2 as follows. The results of the analysis are illustrated in Fig. 16.

i)	Total volume transmitted	: 26,000 m^3/day	
ii)	Volume delivered to service area	: 23,760 m^3/day	= 22,660+1,100
iii)	Volume supplied in excess	: 2,240 m^3/day	= 26,000-23,760
iv)	Increase in the population benefited	: 11,200	= (2,240 x 0.69)/0.138
v)	Total service population	: 89,000	= 77,800+11,200
vi)	Billed water supply volume	: 17,200 m^3/day	= 89,000 x 0.138+4,900

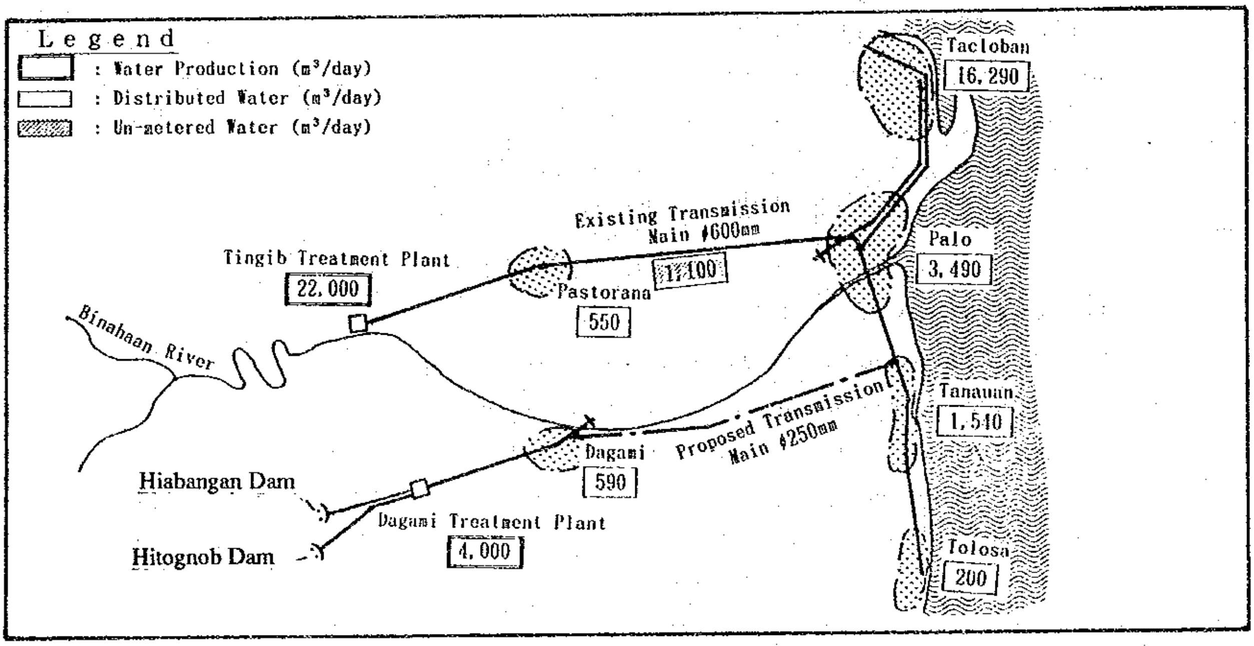


Fig. 16 Condition of Proposed Water Distribution in Case 2

(5) Conclusion

Comparison of the four cases based on the above analysis is summarized in Table 24. As evident from the Table 24, in both proposed cases, Case 1 and Case 2, an improvement in the billed water ratio and the population benefited etc, can be recognized when compared with the case of existing facilities. This is attributed to the decrease of leakage and pilferage due to the abolition of the existing transmission pipelines of the Dagami System. Comparison of the two cases shows that in Case 1 the population benefited will be about 3,000 persons (4 % of the population benefited before the typhoon) more than in Case 2 and moreover, Case 1 has the advantage of supplying water to the Santa Fe Municipality which is located along the transmission pipeline. However, the both billed water ratio are same and comparison of the construction costs shows that Case 1 is 30 % higher than Case 2 and the operation and maintenance cost is also 20 % higher in Case 1. This indicates that benefits in Case 1 will be small compared to the investment and moreover, it is difficult to say whether the facilities are economical in scale from the point of operation and maintenance. Accordingly, it was decided to adopt Case 2 in the planning of the Project and accordingly, the design of the details such as type etc. of the facilities, will be implemented as described in Chapter 5 - Basic Design.

Table 24 Comparison of Contents among Existing Condition and Alternatives

Items	Unit	Before Typhoon	After Typhoon	- Proposed facility - Case 1	Case 2
Production capacity	(m3/day)	26,000	21,600	26,590	26,000
- Tingib Plant		22,000	17,600	26,000	22,000
- Dagami Plant		4,000	4,000	590	4,000
Supply volume	(m3/day)	15,640	13,000	17,600	17,200
Billed water ratio	(%)	60	60	66	66
Supply ratio	(%)	60	50	66	66
Population benefited	(persons)	77,800	58,700	91,960	89,000
Population in LMWD	(persons)	270,800	270,800	283,200	270,800
Benefited population ratio	(%)	29	22	33	33
Ratio of construction costs		---	---	1.3	1.0
Ratio of operation and maintenance cost		---	---	1.2	1.0
Evaluation		---	---	Fair	Good

where : Billed water ratio (%) = Supply volume (m3/day) / Production capacity (m3/day)
Supply ratio (%) = Supply volume (m3/day) / Original production capacity (m3/day)
Service area Case 1 = Tacloban, Palo, Tanauan, Tolosa, Pastrana, Dagami, Santa Fe
Service area Case 2 = Tacloban, Palo, Tanauan, Tolosa, Pastrana, Dagami

3.2.3 Propriety and Necessity of the Project

Tacloban City which has a population of about 140,000 is the capital of Leyte Province and the commercial and industrial center of Eastern Visayas Region that includes Leyte Province. The water supply facilities of the LMWD which serve Tacloban City and the five adjoining municipalities were badly damaged by Typhoon Uring that struck the islands in November 1991. In spite of the devoted restoration efforts of the LMWD staff, the support from the LWUA and moreover the financial assistance from the central government etc., the treatment facilities have so far not recovered fully in their functions. Furthermore, the high turbidity of the raw water far exceeds the treatment capacity of the existing facilities, and as a result, suspension of water supply is frequent in the service area. Therefore, difficulties are confronted not only in the urban activities of the capital, but also in the daily activities of the people and the sanitary conditions.

By the implementation of the Project, not only the production capacity will be restored to the previous level of 26,000 m3/day, from the present 21,600 m3/day (now reduced to 83% of the capacity before the typhoon) but also the 13,000 m3/day of the present billed water volume (50% of the total production capacity) will increase to 17,200 m3/day (66% of the total production capacity). These are atrributed by the realization of continuous operation not affected by the high turbidity of raw water from the Tingib River and by the replaciement of the Dagami transmission pipeline which now has many problems with regards to leakage and pilferage of water. Therefore, it is expected that the population benefited by the water service will increase to 89,000 from the 77,800 before the typhoon and from the present 58,700.

Moreover, while the living standards of the inhabitants and the urban activities will be largely improved, the project will also contribute to enhance healthy operation and administration of the LMWD. Therefore, it is judged that the necessity of the Project is indisputable and moreover, the Project is appropriate as a Grant Aid Project.

3.2.4 Implementation and Operation Plan

Income and expenditure of the LMWD in 1991 and 1992 based on the data obtained during the field survey are as shown in Table 25.

Table 25 Financial Condition of LMWD (Unit : 1,000 Pesos)

Year		1991	1992
a. Revenue:			
	Water sales	21,623	30,994
	Other incomes	1,430	2,894
	Interest revenue	57	157
	Sub total	23,110	34,045
b. Expenditure:			
	Operating expenses	10,760	13,577
	Maintenance expenses	4,175	3,515
	Depreciation	1,873	1,873
	Sub total	16,809	18,966
c. Net income before paying tax and interest		6,302	15,079
	Taxes	4	14
	Interest on Loan (LWUA)	8,581	8,158
d. Net income		-2,283	6,906

Since the typhoon struck in the early part of November 1991, the water supply was in a poor condition through the year 1992. As 90 % of the income of the LMWD is covered by water charges, delays in the restoration of the damaged facilities directly affect the financial situation. The income from water charges improved in 1992 because the water rates were raised by

20~30 % from January 1992. Moreover, the operation cost increased because substantial investment was made in 1992 to rehabilitate the typhoon damaged facilities. Further, as a sum of more than 8 million Pesos is refunded to the LWUA every year as liabilities, under the present conditions it is impossible for the LMWD to develop any new projects. The LMWD plans to embark on a future project for the improvement of facilities with its target as year 2000, first of all, only after implementing the rehabilitation of the facilities damaged by the typhoon, and after resolving the unstable financial condition. Therefore, the LMWD expects a great deal in the realization of the rehabilitation project requested this time. Under the present circumstances, however, it is a fact that the LMWD has no specific plans with respect to implementation arrangements and budgetary arrangements as it has no experience in operating a rapid sand filter type treatment plant that is to be introduced in this project. The LMWD intends to revise the water rates in consideration of the increase in operation costs that will follow with the adoption of new facilities, but the details of this revision will be worked out in cooperation with the LWUA after the outline of the Project is determined.

3.2.5 Outline of the Facilities and Equipment Requested

The request of the Government of the Philippines is for the rehabilitation of the functions of the water supply facilities that were damaged by the typhoon. However, it became clear from the Preliminary Study and the Basic Design Study that the restoration alone of the facilities to the previous condition will not solve the problems in the project area. Therefore, in this project, it became necessary to restore the original capacity not only by the rehabilitation of the existing facilities but also by the construction of new facilities. The major facts and problems considered in the Preliminary Study and the Basic Design Study are listed below.

1. Frequently there are situations when the existing slow sand filter type treatment plant cannot cope with the problem of high turbidity of raw water from Binahaan River which is the main water source of the LMWD.
2. The existing treatment plant has been constructed within the river basin, and it is vulnerable to a recurring typhoon disaster.
3. The maintenance and operation of the existing transmission pipelines of the Tingib System is in good condition and there is no large leakage and pilferage from the pipeline, although the function of the air valves has deteriorated significantly.
4. The water quality of the water source of the Dagami System is so high that it is possible to provide an economical water supply that does not require any special treatment. Therefore there are many advantages in using this water source. The LMWD has a strong intention to continue the use of this source even in the future.
5. The intake facility of the Dagami System has some unstable factors, but there will be no

problem about the future maintenance of this structure, because it can be easily maintained and repaired within the technical capacity of the LMWD.

Thus, it was determined that a rapid sand filter type treatment plant should be newly constructed in the Tingib System along with the relevant intake facilities and conveyance pipelines. On the other hand, it was decided that a new transmission pipeline should be constructed for the Dagami System to facilitate effective use of the existing water source. Accordingly, construction and rehabilitation of the facilities were planned and the equipment and materials to be supplied were selected as shown in Table 26.

Table 26 Contents of the Facility and Equipment of the Project

Facilities and Equipment	Numbers	Necessity/Propriety
1. Intake / Conveyance facilities		
Intake weir	1 unit	to supply raw water to proposed treatment plant through conveyance line in gravity flow condition
Settling tank	2 basins	to remove small sand particles in raw water and to reduce the load to operation of treatment plant
Conveyance pipeline	2.48 km	to convey raw water to treatment plant
Maintenance road	2.60 km	to approach the intake site and conveyance pipeline for operation and maintenance
2. Treatment facilities		
Flocculation-sedimentation basin	2 basins	to form flocs of suspended matter in raw water and to remove it in sedimentation process
Rapid sand filter	8 basins	to remove suspended particles and fine flocks which could not be removed in settling tank
Clear water reservoir	1 tank	to adjust the operational imbalance, to store for emergency use and to do maintenance and repair etc.
Chemical feeding facility	1 set	to mix flocculent of aluminum sulphate and slaked lime and to add in raw water, to inject disinfectant
Transformer facilities	2 units	Transformer 13.2KV/7.62KV/220V
Generator	1 set	to provide standby power during interruptions of power service by LEYECO II
Buildings	1 set	to provide an rooms of operation, laboratory, staff office and to keep equipment in its inside
Transmission pipeline	420 m	to connect the new treatment plant and the existing Tingib transmission pipe line
3. Transmission facilities		
Replacement of the air valves	1 set	to rehabilitate the function of existing Tingib pipeline
Dagami System pipeline	14.2 km	to substitute the function of existing pipe line which is to be abandoned due to high leaking
4. Procurement of equipment and materials		
Water quality testing equipment	1 set	to monitor of quality of raw water and purified water
4 WD Vehicle	1 unit	to use operation, maintenance and monitoring work
PVC pipes	1 set	to increase reliability of Dagami system by providing spare parts for Conveyance line of Dagami

3.3 Project Description

3.3.1 Executing Agency and Operation System

The executing agency in the Philippine side responsible during the design and construction stage of the Project is the LWUA. The facilities, after the completion of their construction, will be transferred to the administration of the LMWD, the organization responsible for the water supply works in the Project Area, under whose responsibility the facilities will be operated and maintained. At present, the LMWD administers the water supply facilities in Tacloban City and the five municipalities of Pastrana, Dagami, Palo, Tanauan and Tolosa. The LMWD is an independent organization which basically adopts a self supporting system, but it is closely related to the LWUA in administration and operation.

The LMWD requests assistance from the LWUA for the planning the project. The LWUA is responsible for planning, design and construction works, and furnishes the funds necessary for for the implementation of the project. After completion, the facilities are transferred to the administration of the LMWD who will be responsible for the operation and maintenance. Even thereafter, the LWUA makes continued efforts to improve the institutional management of LMWD to a sound condition by providing know how on the operation and maintenance of the facilities and guidance to facilitate smooth repayment of loans.

The LMWD is managed by a General Manager under the direction of a Board of seven Directors. The organization is broadly divided into the three departments of Technical, Administrative and Commercial, each of which is managed by an Assistant General Manager. The Technical Service Department is further divided into of the three divisions of Engineering, Maintenance & Repairs, and Production whose activities are performed by the support staff. The Administrative Service Department is divided into the two divisions of Finance and Personnel, and the Commercial Service Department is divided into the divisions of Customer Service and Customer Accounting. Among other posts under the General Manager are a Technical Assistant and Public Relations Officers etc. As of February 1993, a total staff of 158 is employed under the General Manager. The organization of the LMWD is illustrated in Fig. 17. The tentatively planed operation and maintenance system of the new treatment plant is shown in Fig. 18.

At present the Production Division of the Technical Service Department is in charge of the operation of the existing treatment plant, and even after the completion of the Project, this division will be in charge of the operation of the facilities. The present Head of this division, who not only has wide experience, having been engaged in the operation of the existing treatment plant for many years, but also has participated in a training program on treatment technology held in Thailand and possesses basic knowledge in the operation of a rapid sand filter type treatment facilities and is therefore competent to be the responsible officer in charge of the treatment plant. Also in the other departments there are engineers and technical personnel who are conversant with the mechanical and electrical equipment in water supply facilities. Therefore, in setting up the future operational system after the completion of construction of the facilities in this project, it will be most appropriate to choose the technical staff from among such personnel currently employed without recruiting from outside.

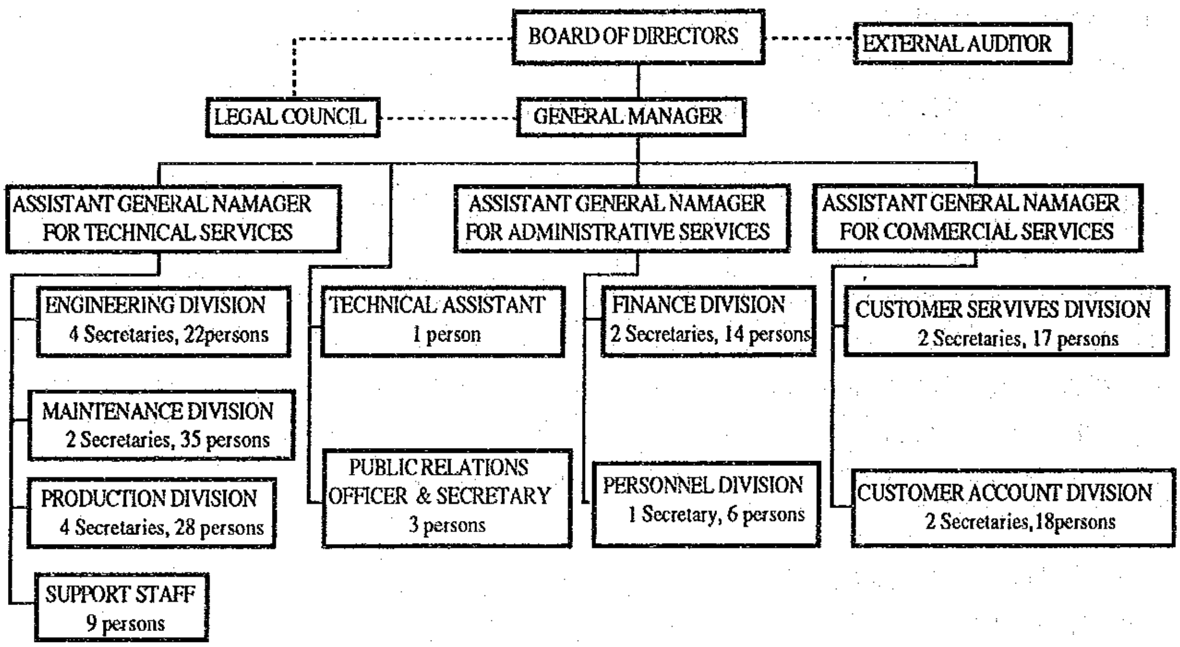


Fig. 17 Organization of the LMWD

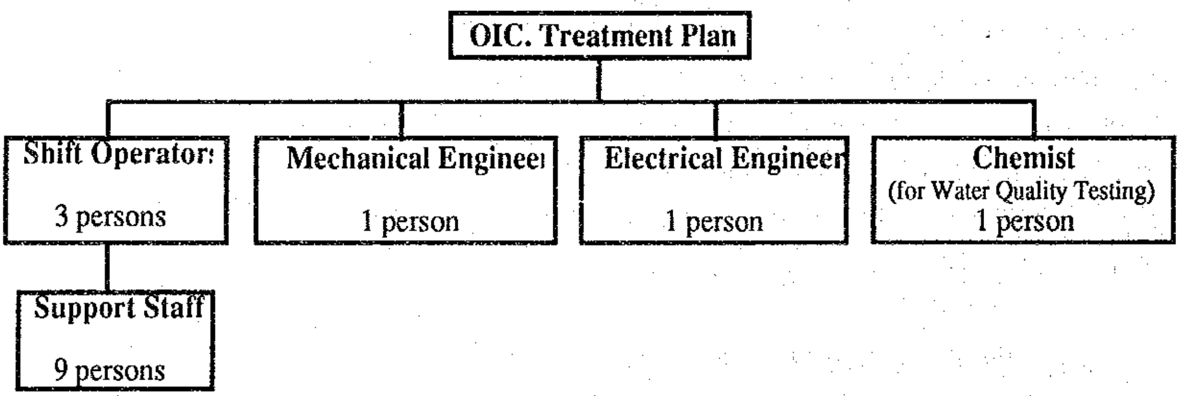


Fig. 18 Proposed Staffing of the Treatment Plant

3.3.2 Location and Conditions of the Project Site

The Project facilities consist of intake facilities, conveyance facilities, treatment facilities and transmission facilities. Their locations and topographical characteristics are described below.

(1) Intake Facilities

Binahaan River which is the water source for the Project is the largest river in the Leyte Island. It originates from Lake Danao in the Leyte Central Mountains and flows down through steep hills to join with Hiloctogan River at a point about 3 km upstream of the existing treatment plant and thereafter flows through the alluvial fan and lowlands that start from the vicinity of Tingib, and ultimately falls into the Leyte Gulf near Tanauan. The average gradient of the river bed is about 1/40 in the mountainous area down to the confluence with Hiloctogan River and about 1/120 between the confluence and the existing treatment plant in Tingib. In the stretch from the mountainous area to a point about 2 km upstream of the existing treatment plant, the riverbed is relatively narrow and the river route is stable and defined without much variations in water routes, and where the river meanders rapidly, riverbanks form precipices with rugged rocks exposed here and there. In the downstream of this, the river-bed is wide and the flow becomes sluggish while the meandering becomes gentle. In a flood, the river overflows leaving many traces of the changes in water routes. The river-bed is covered with sand, gravel and pebbles over which rolling stones about the size of a foot ball are scattered.

In selecting a site for the intake, attention was paid to a location from which the water can be conveyed to the plant under gravity, where the river channel is narrow with a stable water route that does not change so often over a long period, and which secures a wide catchment area. As a result of the field survey, the site was selected at a point about 1.5 km downstream of the confluence of Binahaan River and Hiloctogan River, or about 2.6 km upstream of the existing treatment plant. Right bank of the river at the site of the proposed intake weir is a precipice which rises about 10 m high above the riverbed and sandstone is found exposed in some parts. On the left bank is a stable flat ground about 5 m above the riverbed, and this forms an ideal topography for locating the intake channel and the settling tank.The altitude of the riverbed at this site is 128.6 m, and the catchment area above this point is 103 km^2.

(2) Conveyance Facilities

A conveyance pipeline with a total length of 2,480 m will be installed to convey the raw water from the settling tank to the treatment plant. From the intake weir, water will be drawn towards the left bank, and the conveyance facility will be installed on the left bank along Binahaan River. However, as it is difficult to construct an open channel for this purpose due to heavy undulations in topography, a pipeline is adopted throughout the entire route. The land is generally flat for about 50 m from the settling tank, but thereafter, as there is a ridge formed by the meandering of the river which protrudes high in the downstream stretch of about 400 m, the pipeline will be installed by excavating this ridge to facilitate gravity flow in the pipeline. Further, over a stretch of about 400 m in the midway of the pipeline route, the left bank of the river makes a steep precipice and above this is a high land. In this section, the main flow route of the river is close to the left bank, and to install the pipeline in the land away from the river basin which will not be affected by a flood, it will be necessary to excavate the high land (involving a maximum excavation depth of about 15.0 m. Further, within this section, as there are two streams flowing into Binahaan River from the left bank, it is also necessary to provide an aqueduct and an inverted siphon across the streams.

Thereafter, the route of the pipeline enters the river basin. For a length of about 130 m, the flood periphery plain intrudes largely into the left bank from the main stream and the left bank forms a near vertical precipice which rises to an altitude as high as 150 m at its top. As it is impossible to excavate the high land on the left bank to install the pipeline, and moreover since this section is not directly affected by the floods, the pipeline will be laid on a high embankment (about 10 m) built on the flood periphery plain. In the downstream stretch of about 1.0 km up to the existing treatment plant, the pipeline will be laid along the maintenance road which is already constructed by the LMWD for the construction of an intake on Maitom Creek. The longitudinal profile of the planned conveyance pipeline is shown in Fig. 19.

(3) Treatment Facilities

The site of the proposed treatment facilities is situated inland about 150 m from the intake of the existing treatment plant within a private land which is a coconut plantation. This site is about 7 m higher in elevation than the existing treatment plant and located on a river terrace which is gradually sloping from an altitude of 107 m to 105 m. About 100 m further inland is a high land with an altitude of about 120 m. The site selected is a safe location which was not affected by the floods accompanied by the typhoon in 1991.

(4) Transmission Facilities

The transmission pipeline of the Dagami System planned under the Project will be laid, throughout its entire route, along roads designated as trunk roads. There are 1.2~1.5 m shoulders on both sides of the 6 m wide concrete pavement of these roads. The pipelines will be installed within the shoulders and excavations within the paved parts will be avoided as far as possible. The DPWH which is responsible for the administration of these roads has already approved the installation of the pipelines within the shoulders, and further, it has basically agreed with regards to the method of annexing the pipeline on to the bridges at five locations along its route extending to a total length of about 14 km.

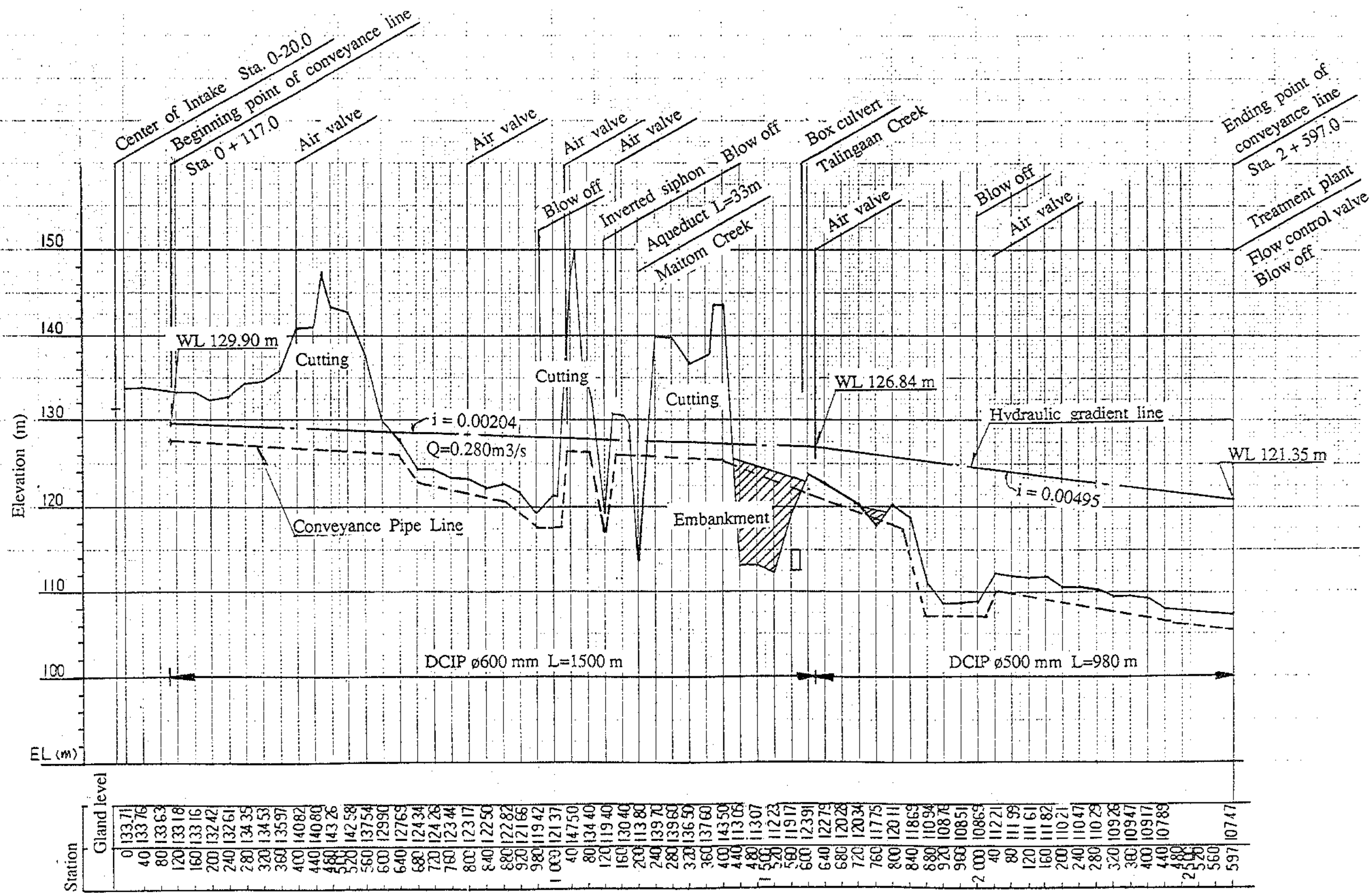


Fig. 19 Longitudinal Profile of the Proposed Conveyance Pipeline

3.3.3 Maintenance and Operation Plan

(1) General concept

The existing treatment plant has no particularly complicated operations but adopts a simple method of operation by observing the turbidity of the river and suspending intake only when the turbidity is high, and replacing the surface material in the filter bed once or twice a month. But in the facilities now planned in this project, continued treatment operations become possible even when the turbidity is high, but this will require higher skills in operation when compared to the existing facilities. Therefore, it is desirable that the engineers who will be in charge of the operation have undergone technical training and possess general knowledge of the water supply facilities. The LMWD has been engaged in the improvement of the water supply facilities for a long time, and the skills of the technical staff are placed at a relatively high level. It will be possible to operate the facilities without any difficulty by selecting competent personnel from among the present technical staff of about 100 and providing them with training for a specified period.

The LMWD is considering to raise water rates recognizing that an increase in the maintenance and operation cost is inevitable with the realization of this project. The LMWD is very enthusiastic about the introduction of rapid sand filter type new treatment facilities. While maintaining a close relationship of cooperation with the LWUA, the LMWD considers participating in the training programs conducted in the Philippines by the LWUA. Therefore, it is judged that the LMWD will be able to establish a system that enables satisfactory operation also after the completion of the Project.

(2) Operational costs of the proposed facilities and revenue

After completion of construction, the LMWD will operate all the new facilities. The LMWD will then have to spend a higher operation cost than in the past. At the same time, it is also expected that an increase in the income will be derived from the increased quantity of water supplied. Therefore, analysis of expenditure and revenue in the operation of new system is very important for the improvements in the future administration of the LMWD.

The cost of operation of the facilities under the Project and the increased income due to increased volume of water supply are estimated as follows;

i) Electricity cost

The electricity charges are determined based on the category of industrial contract and consist of a basic charge and a monthly charge. The equipment furnished in the treatment plant are as described in Table 27. Accordingly the contract amount of electricity is calculated as 120 KW including some allowance.

The monthly electricity cost ;

Basic charge	: 120 KW x 15 Pesos/KW	= 1,800 Pesos
Monthly charge	: 549.9 KWH x 30 days x 4.1593 Pesos	= 68.616 Pesos
Total monthly cost	:	70,416 Pesos/month

Table 27 Consumption of Electrical Power

Item	Unit Power (KW)	Quantity	Operation time (hours)	Power (KWh)
1. Sedimentation basin				
Sludge discharge pumps	3.7	4	1.0	15.0
2. Rapid sand filter				
Surface wash pump	30.0	1	1.0	30.0
Vacuum pump	2.2	1	1.0	2.2
Vacuum compressor	1.5	1	1.0	1.0
Humidifier	0.3	1	24.0	7.5
3. Chemical feeding facilities				
Alum agitator	2.2	1	1.0	2.2
Alum dosing pumps	0.2	2	24.0	9.6
Lime agitator	2.2	1	24.0	52.8
Lime solution transfer pump	3.7	1	24.0	88.8
Bag filter	0.8	1	3.0	2.4
4. Disinfection facilities				
Chlorinator	0.10	1	24.0	2.4
Water pressure pump	1.50	1	24.0	36.0
Service water pump	3.70	1	5.0	18.5
5. Illumination, laboratory etc.,	20.0	1	14.0	280.0
Total				549.9

ii) Chemical injection cost

a. Injection of aluminum sulfate

Average injection rate : 40 ppm - 970 Kg/day x 25 days/month = 24,250 Kg/month

Unit price of aluminum sulfate : 7 Pesos/Kg

Monthly cost : 24,250 Kg/month x 7 Pesos/Kg = 169,750 Peso/month

b. Injection of slaked lime

Average injection rate : 10 ppm or 242 Kg/day x 25 days/month = 6,050 Kg/month

Unit price of slaked lime : 15 Pesos/Kg

Monthly cost : 6,050 Kg/month x 15 Peso/Kg = 90,750 Peso/month

c. Injection of chlorine

Average injection rate : 2 ppm or 44 Kg/day x 30 days /month = 1,320 Kg/month

Unit price of chlorine : 79 Pesos/Kg

Monthly cost : 1,320 Kg/month x 79 Pesos/Kg = 104,280 Pesos/month

As the same amount of chlorine is used even now, the additional cost of chemical injection is calculated as the cost of injecting the two kinds of chemical namely, aluminum sulfate and slaked lime. Thus, the increase in chemical injection cost will be (169,750+90,750) = 260,500 Pesos/month.

iii) Personnel cost

The key technical personnel of the operation staff for the proposed facilities are to be selected from among the present staff with the addition of 9 support staff. Therefore the increase of personnel cost is estimated as follows;

Personnel cost : 3,000 Pesos/person.month x 9 persons= 27,000 Pesos/month.

iv) Increase of annual operation cost

Thus, the increased amount of the annual operation cost is as follows:

Electricity cost	70,400	Pesos/month	
Chemical cost	260,500	Pesos/month	
Personnel cost	27,000	Pesos/month	
Total	357,900	Pesos/month	x 12 months = 4,294,800 Pesos/year

As described above, a cost increase of about 4.3 million Pesos/year is estimated for the operation of the facilities under the Project. On the other hand, the completion of the Project will enable a stable water supply, uninterrupted even during the rainy season, and a drastic improvement in the quality of the water supplied through the faucets in the service area. It is also expected that the ratio of accounted water will improve from current 60 % to 66 % as a result of decreased leakage and pilferage of water. This means that the quantity of billed water, which was about 13,000 m^3/day in 1992, is expected to be improved to about 17,200 m^3/day. Therefore the increase in the billed water quantity will be 4,200 m^3/day.

The water charges were increased in January 1992 and the average of the water charges in the LMWD is estimated at 6.4 Pesos/m^3 by dividing the total annual revenue of about 31 million Pesos by the annual water supply volume of 4.8 million m^3 (billed water). By multiplying the expected increase in the billed water quantity of 4,200 m^3/day by this average water charge of 6.4 Pesos/m^3, the expected increase in the annual revenue is calculated to be about 9.8 million Pesos ; 4,200 m^3/day x 365 days/year x 6.8 Pesos/m^3 = 9,811,200 Pesos/year.

The difference between the increased revenue estimated above and the increased expenditure show a balance of about 5.5 million Peso/year. However this is on the presumption that 17,200 m^3 of metered water is supplied daily and for this, it is necessary that the LMWD of its own must improve and expand the present water supply facilities.

The LMWD has recorded a considerable financial deficit due to the damage caused by the typhoon in 1991. According to the financial records of 1992, the LMWD has just managed to recover this deficit after the water charges were raised in that year, but the management has not yet been fully stabilized. However, if this project is implemented, it can be anticipated that not only the water supply service is going to be improved but also the financial conditions of the LMWD.

Therefore, it is judged that the LMWD will have sufficient capability to manage operation and maintenance of the new system after its completion.

3.4 Necessity of Technical Cooperation

The executing agency on the Philippine side for this Project is the LWUA, but the LMWD will be responsible for the operation and maintenance of the facilities after their completion. The LMWD has operated the existing slow sand filter type treatment plant for about 14 years and it fully understands the fundamentals of the water treatment system. However, as the LMWD has no experience in the operation of treatment facilities of the type introduced under the Project which involve chemical treatment, flocculation and sedimentation and rapid sand filtration, it is necessary to provide sufficient training to the technical personnel in the initial period after completion of the facilities. On the other hand, the LWUA which is responsible for the administration of water supply works in the whole country centering around the local cities has up to now administrated 560 Water Districts and among these LWUA has wide experience also in rapid sand filter type treatment plants.

After the completion of the facilities, the LMWD will operate and maintain them under the guidance of the LWUA. The LWUA is prepared to provide training to the LMWD at national level if considered necessary. However, even the LWUA has only limited experience in the operation of the rapid sand filter type treatment system adopted in the Project. In order to facilitate smooth implementation of this project and operation thereafter, it is however desirable, to train in Japan a few engineers of the LMWD and LWUA selected in advance and get them acquainted with the operation of similar facilities. Further, it would make the project more effective, if Japanese experts could provide on-the-job training, on the operation methods to meet variations in raw water quality, to the LMWD staff during the initial stages after completion of the new facilities.

3.5 Basic Policy of Cooperation

Based on the above studies, and by assessing the effectiveness and feasibility of the project and the capability of the Philippine side to implement the project, etc., it was confirmed that the impact of this project is in compliance with the Grant Aid Program. Hence it is concluded that the Project is appropriate for implementation with the Grant Aid from Japan. Therefore, presuming that the project will be implemented under the Japan's Grant Aid Program, the basic design is conducted in the following chapters. However, as already mentioned under the review of the contents of the project, it was found appropriate to change a part of the requested components of the project.

CHAPTER 4. BASIC DESIGN

4.1 Basic Design Policy

(1) Consideration of natural conditions

Leyte Island, where the project area is situated, belongs to the tropical monsoon climatic zone and receives high rainfall exceeding 2000 mm per year. Further, the dry and wet seasons are not distinct and rains are experienced during every month of the year. Damage due to strong winds and rains are often experienced with the passage of typhoons during the months from October to December.

The objective of this project is to rehabilitate the water supply facilities that were damaged, affected by the floods of Binahaan River accompanied by Typhoon Uring in November 1991. Therefore, it is necessary that the facilities that will be constructed under the Project must be sufficiently safe against future floods. Moreover, considering the poor performance of the existing slow sand filter system of the treatment plant which can not cope with the quality of raw water drawn from Binahaan River which has the tendency to increase in turbidity after every rain, a rapid sand filter system will be adopted together with a flocculation and sedimentation system. The site of the existing treatment plant is located at a relatively upstream position within the river catchment. However, as topographical characteristics, the riverbed there is as wide as 400 m and the water routes are not definite. A location ideal for the intake is found about 2.6 km upstream of the site of the treatment plant, and there, the river channel is narrow and the water route is defined and stable. Further, it is possible to convey the water by gravity from this point to the treatment plant. As the treatment plant is located at a sufficiently high elevation so that delivery of water to the service area is possible by gravity flow, an economical arrangement will be adopted in the design of the proposed treatment system which will make use of the gravity flow as much as possible thereby minimizing the energy needs.

(2) Consideration of social conditions

Tacloban city which is within the Project area is the capital of Leyte Province. In the national plan of the Philippines, regional development and industrial promotion are placed as the major policies, and in this respect Tacloban City is placed as the nucleus not only of Leyte Province but the East Visayas Region as a whole. However, due to inadequate functioning of water supply facilities affected by the typhoon disaster, not only the regional development but also the maintenance of the lives of the people has been hindered and the public demand for urgent improvement of this situation is growing. Even if the damaged facilities are simply restored to the original condition it will not be possible to realize stable water supply as already mentioned above in (1) consideration of natural conditions. Therefore, a flocculation-sedimentation-rapid sand filtration type of treatment system, although this is something which has not been so far experienced by the LMWD, will be introduced in the treatment plant which is the main component of the proposed facilities, due consideration will be given to construct a system that could be managed easily with the available local technical level without any problems. Moreover, condition of local electricity supply is very poor and power is often interrupted. Therefore, emergency power generation equipment will be installed to ensure an upgraded level of service from the new facilities through stable operation of the treatment plant.

Further, several small scale buildings for offices, operation control rooms ,water quality laboratory, etc., will be built at the water treatment plant. The structure of these buildings will be adopted, as far as possible, so as to maximize the use local materials.

(3) Considerations on construction conditions etc.,

In the Philippines although most of the basic construction materials such as sand, cement, steel etc, could be easily procured locally, most of the major machinery and equipment have to be imported. With regards to pipeline materials, there are steel pipes, which are mortar-lined on both inner and outer surfaces, developed and manufactured in the Philippines and used practically in almost all the local pipeline works. However, there are several technical problems can be pointed out with regards to their use in this Project.

i) The mortar lining inside the steel pipes is to prevent rusting and corrosion of the pipe. But this not only has a negative effect on the flexibility of the pipe which is the biggest advantage of steel pipes, but also makes the pipes heavy thus lowering the convenience in handling and construction efficiency.

ii) Due to shocks during transport and handling at the worksites, the steel pipes often deforms and the mortar lining cracks and peels off. In smaller diameter pipes repairs inside the pipe is impossible and even in the larger diameter pipes where men can get in, it is not possible to carry out reliable repairs. Particularly, the deformations in steel pipes develop often at the joints at the ends of the pipe and repairs are usually attempted, for example, by beating the deformed section with hammer. But the shocks due to such hammering cause cracking and peeling off of the mortar lining to progress also in to the adjacent parts.

iii) Joints of the pipes are butt welded at the site, but the inside treatment of the joints with mortar filling etc., after the welding is not that reliable. Moreover, it is essential to secure skilled welders experienced in pipe joint welding and this may lead to prolongation of the construction period. Further, if the treatment at the joints is not adequate, rusting and corrosion will progress and become the main cause of leakage.

iv) Sufficient production facilities are available with the steel pipe manufacturers in the Philippines, but the electrical power shortages in the metro area where the factories are located have become a major bottle neck in the production process. However, there is no sign that this situation will be improved in the near future. Therefore, considering the production capacity of the local manufacturers, it is extremely doubtful whether supplying of a large quantity of pipes required in this project will be possible in a very short time.

For these reasons, the major machinery and equipment and materials that will be used in this project will be presumed to be mainly of Japanese manufacture. Concerning piping material which is to be used for the construction of conveyance pipeline and transmission pipeline, ductile cast iron pipe (DCIP) procured in Japan is selected on the basis of its excellent properties that is long life period, economical construction cost and, high reliability on safety against pressures, water tightness, flexibility of joints, and workability (see Annex).

(4) Capabilities of the local organizations implementing water supply services

The facilities under this Project, after their completion, will be handed over to the LMWD and thereafter they will be operated and maintained by the LMWD. Since the operation of existing facilities began in 1979, LMWD has 14 years of experience in the operation of slow sand filter type treatment plant. The existing facilities are of a type that require neither complicated operations nor power. However, LMWD has well recognized that the existing facilities cannot cope with the quality of the raw water which has a high turbidity. Therefore, the concerned personnel of the LMWD have shown keen interest on the rapid sand filter system that will be introduced in this project and they have already acquired understanding on the fundamental system operations. In the new system, as additional costs will be incurred due to the addition of chemicals and operation of equipment etc. which were not required earlier, LMWD is considering necessary changes in the future water rates structure.

In the facilities introduced under this project, it is aimed to construct a system which will require minimum use of equipment, by taking the full advantage of natural difference in the elevation. By doing so, operational costs of the facilities could be reduced to a minimum.

(5) Consideration of the components and service level of the facilities
The major facilities that will be constructed under this project are to substitute the existing Tingib Treatment Plant and the design capacity of these facilities is decided based on the assessment of the capacity of existing facilities prior to the typhoon. The proposed water treatment facilities will be constructed on a higher location nearby so that these facilities will not be affected by the floods of the river. The intake structure will be located at a point 2.6 km upstream of the treatment plant by constructing a weir across Binahaan River and a conveyance pipeline will be laid between the intake and the treatment plant to deliver the raw water by gravity. A pipeline will be laid from the treatment plant to connect with the nearest existing

transmission pipeline so that the treated water could be supplied to the service area using the existing transmission pipeline.

In the existing system, there is the Dagami System besides the Tingib System. The former is a very economical system that uses as its source, stream water which is so clean that it can be supplied after minimal treatment with only disinfection. However, effective service of water supply to the lower areas cannot be expected due to several problems such as damage to the transmission pipes, leakage, increased incidence of pilferage of water, and the difficult natural conditions that prevent proper maintenance and management. Therefore, by constructing a new pipeline to substitute the existing transmission pipeline of the Dagami System, maximum utilization of this economical and favorable water source will be aimed at under this project. Moreover, attention will be given to the sustenance of the impact of this project. For this, replacement of the air valves in the existing transmission pipeline of the Tingib System not only as a measure against leakage but also to improve maintenance functions and supplying of spare parts for the PVC piping that is temporary laid on the transmission pipeline from the water source to the treatment plant of the Dagami System will also be considered.

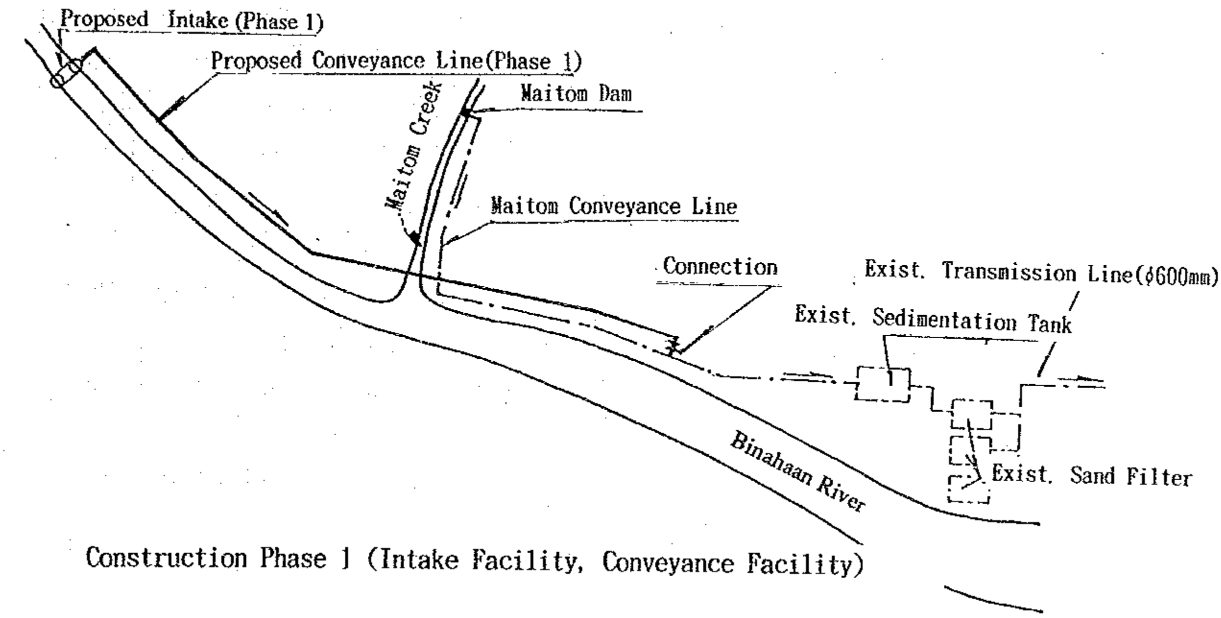
(6) Considerations on the duration of construction
As the work involved in the construction of facilities that will be implemented under the Project is large in volume and diversified, considerable difficulties are expected to be faced in the work schedule if the works are to be implemented within one year. Therefore the entire project will be implemented in two phases. However, in order to make the most of the spirit of grant aid assistance, attention is paid to see that effect of assistance are generated in each phase. Development of facilities in each phase are given in Table 28.

Table 28 Phasing of Construction Works

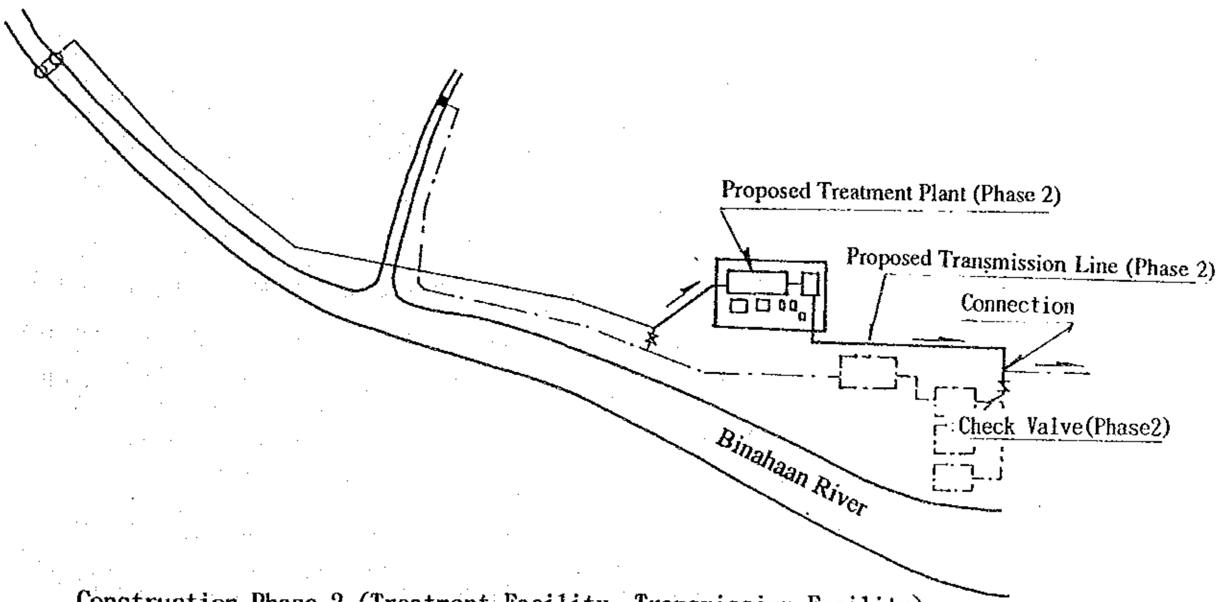
------- Phase I -------	------- Phase II -------
Intake facilities (Tingib System) Conveyance facilities (Tingib System) Replacement of air valves in the existing transmission facilities (Tingib System)	Treatment facilities (Tingib System) Transmission facilities (Dagami System) Procurement of equipment and materials (Pipes, Vehicle, etc)

The intake weir across Binahaan River, the sedimentation basin and the raw water conveyance pipeline will be constructed in Phase I and the raw water will be delivered to the existing Tingib Treatment Plant. With this arrangement, as water with a reduced turbid load can be delivered to the existing facilities after removal of silt from the raw water, it will be possible to assure adequate intake volume thereby making quantitative improvement in the water supply.

The raw water conveyance pipeline that is to be constructed in Phase I will be tentatively terminated before the proposed treatment plant and will be connected to the conveyance pipeline from Maitom Creek which is now under construction. The phased construction program of the Tingib treatment Plant is illustrated in Fig. 20. High turbidity in the raw water will be tackled in Phase II after the construction of the treatment plant. Moreover, with the laying of transmission pipeline of the Dagami System in Phase II a significant reduction in leakage and stealing of water will be anticipated.



Construction Phase 1 (Intake Facility, Conveyance Facility)



Construction Phase 2 (Treatment Facility, Transmission Facility)

Fig. 20 Phased Construction of Tingib System

4.2 Design Criteria

4.2.1 Design Standards

Although there are design standards relevant to water supply facilities which have been set up by the LWUA, the organization responsible for the implementation of this project, these standards deal mostly with the laying of pipelines and basically follows the design standards of the U.S.A. As only a few standards are available relevant to the planning of treatment facilities in this project, consent of the Philippine side was obtained to use the Japanese standards in principle. However, with regards to the electrical power supply facilities, the Philippines Standards for the Installation of Electrical Power Supply Facilities will be used as there are differences in the voltages used and the systems of power transmission in the two countries. The standards that will be used in this Basic Design are given below;

1. Design Criteria for Water Works Facilities - reviewed by the Ministry of Health and Welfare and published by the Japan Water Works Association (JWWA).
2. Building Basic Structure Design Standards and Interpretation - published by Japan Building Association
3. Concrete Standard Manual - published by the Japan Society of Civil Engineering
4. Technical Standards Manual - reviewed by LWUA
5. JIS, JEM and other standards etc.,

4.2.2 Capacity of the Proposed Facilities

The capacities of the facilities proposed in this basic design are as follows;

(1) Tingib Treatment Facilities
As analyzed in "section 3.2.1-(2) Capacity of the existing facilities before the typhoon" of this report, the capacity of Tingib Treatment Plant is 22,000 m^3/day. The intake facilities of this system has a capacity of 24,200 m^3/day taking in to consideration a water loss of 10% in the treatment processes of sedimentation, filtration etc.

(2) Dagami Treatment Facilities
Water treatment capacity of Dagami System is 4,000 m^3/day as analyzed in section 3.2.1-(2).

Hence a total water treatment capacity of 26,000 m^3/day can be assured to the service area from the two treatment plants at Tingib and Dagami.

4.3 Basic Design

This basic design covers the construction works related to the intake facilities, the water conveyance facilities, the water treatment facilities, the pipelines connecting with transmission facilities which will be newly laid and the existing transmission facilities that will be rehabilitated in the Tingib System, the transmission facilities that will be newly constructed in the Dagami System and the equipment and materials that will be supplied. The results of the Basic Design carried out in this Chapter are summarized in Table 29.

Table 29 List of Facilities and Equipment of the Project

Facility and Equipment	Quantity	Type and Specifications
1. Intake / Conveyance facilities		
Intake	1 facility	Concrete fixed weir with bar screen, length 85 m
Settling tank	2 basins	Reinforced concrete structure width 4.0 m x length 20.0 m x e.depth 1.2 m x 2 lanes
Conveyance pipeline	2.48 km	Ductile cast iron pipe T-4 type, 600 mm, L= 1500 m Ductile cast iron pipe T-3 type, 500 mm, L= 980 m
Maintenance road	2.60 km	3.5 m width, gravel paved
2. Treatment facilities		
Flocculation basin	2 basins	Reinforced concrete rectangular structure, a system of combined detoured vertical and horizontal flow
Sedimentation tank	2 basins	Reinforced concrete rectangular structure, lateral flow type
Rapid sand filter	8 basins	Reinforced concrete structure, natural balancing self-backwashing type with filter bed surface washing device
Clear water reservoir	1 tank	Reinforced concrete structure
Chemical feeding facilities	1 set	Reinforced concrete tanks for dissolving and mixing of alum and slaked lime
Disinfectant injection facilities	1 set	Wet chlorine doser
Transformer equipment	1 set	13.2KV/7.62KV/220V, phase 2 lines/3 phase 3 lines
Generator	1 set	Diesel engine, 100 KVA, 130 Ps
Buildings	1 set	Administrative building (240 m^2), chemical feeding room (320 m^2), disinfectant injection room (65 m^2), Generator room (50 m^2)
Transmission pipeline	1 set	Ductile cast iron pipe T-3 type, ø 500 mm, L= 420 m
3. Transmission facilities		
Replacement of air valves	1 set	ø 75 mm 22 nos, new installation ø75 mm 3 locations
Dagami transmission pipeline	14.2 km	Ductile cast iron pipe T-3 type, 250 mm
4. Procurement of equipment and materials		
Water quality testing equipment	1 set	Jar Test and other simple water quality tests
4 WD Vehicle	1 unit	Pick-up type
PVC pipes	1 set	PVC pipe ø 250 mm 200 m, PVC pipe ø 200 mm 30 m

4.3.1 Intake Facilities

(1) Objective of construction

The existing intake is constructed in a dug pond within the river basin approximately 400 m upstream of the existing slow sand filter. Although a diversion dike has been constructed after the devastation by the typhoon of 1991 to protect the intake, due to poor reliability of this dike, the intake structure is not absolutely free from the risks of floods. At this location the riverbed of Binahaan river is about 400 m wide and as the water routes change during floods, it is difficult to maintain a stable intake without adequate river control. Moreover, under this project, as the new treatment plant will be constructed at a location 7 m higher in elevation than the existing treatment plant, it will not be possible to draw water from the existing intake under gravity flow. Therefore in order to ensure a stable intake in the future, the new intake facilities will be constructed at an upstream location along Binahaan River where the main flow route of the river is defined and stable so that the water can be drawn by gravity flow.

(2) Type

As the general types of intake facilities adopted in rivers, there are the intake weirs, intake towers, intake gates and collection galleries etc. Upstream of Tingib, Binahaan River becomes a torrent with a very steep riverbed gradient and its discharge varies very much. The large volume of silt and gravel carried down by the floods, significant changes in the riverbed etc., indicate the unstable condition of river flow. Intake gates and silt removal gates cannot be installed within the river course as they are likely to be damaged by rolling stones during torrents. Therefore in this project, a Tyrolean type intake, namely, a fixed weir with a bottom intake type intake structure installed with bar screens, which also makes the operation of the gate simple, is judged to be most appropriate for the new facilities.

(3) The design intake volume and quality of water

Allowing a volume equivalent to 10% of the design daily treatment capacity as the water loss accounted for the water requirements in the treatment operations etc., the design intake volume is determined at 0.280 m^3/sec as follows;

Design treatment capacity = 22,000 m^3/day

Design intake volume = 22,000 m^3/day x 1.1 = 24,200 m^3/day (0.280 m^3/sec)

(4) Design flood discharge

The 30 year probability design flood discharge is determined as 1,300 m^3/sec (unit discharge 12.6 $m^3/sec/km^2$) after studying two methods, namely: method of calculating from the rainfall in the catchment using the rational formula; method of calculating from the unit discharge of design flood discharge at the NIA Intake Weir located 800 m downstream of the existing treatment plant. The design flood level is taken as 3.0 m above the crest of the proposed weir.

(5) Structure of the intake facilities

a. Intake weir

Structurally, the intake weir is planned as a concrete fixed ogee type weir. The elevation of the crest of weir is decided at El.131.22 m, taking in to consideration of the silt removal arrangement in the intake channel and the backwater effect. In order to guide a stable water route, the level of crest where the bar screen is installed is lowered by 20 cm to El. 131.02 m. The elevation of the downstream apron is taken as El. 128.60 m to coincide with the minimum riverbed level at the weir site.

Fixed weir : Total length = 85.0 m, width = 6.22 m, height = 2.62 m
Downstream apron : Total length = 9.0 m
Downstream riverbed protection works : Total length = 22.0 m

b. Water collecting channel

The water collecting channel adopted is of the bar screen-bottom intake (Tyrolean) type, and the bar screen is installed on the slope of the weir in an inclined position so that the gravel and rocks trapped on the screen can naturally flow down the weir. To facilitate convenient maintenance of the screen, it will be made of stainless steel and with a removable structure. Sufficient allowance is made in the installation width of the screen for factors such as blocking of screen and changes in the water route of the river.

Collecting channel : Total length= 20.0 m, width=0.80 m, bed slope= 1/20,
Screen : Total length= 12.0 m, width=0.92 m, inclination= 30^{o}
Screen bar : Stainless pipes ø 3 inch

c. Sand scoring channel

In this river, when the discharge increases, the sand and silt content in the river water also increases. The sand and gravel particles etc., smaller in size than the screen mesh size of 40 mm enter the water collecting channel through the bar screen. The larger and heavier of the suspended particles are allowed to settle and flushed downstream of the weir through a sand removing channel. This channel, which is provided in front of the intake gate, has a total length of 45 m, from the collecting channel to the lower end of downstream apron of the weir. The sand removing channel is designed with a bed slope of 1/100 to ensure that a rapid flow, with a velocity greater than the critical friction velocity of the particles to be removed, could be maintained within the channel. The discharge from the channel is controlled by a steel made flush out gate installed after the diversion on the intake channel.

d. Intake channel

An intake channel with a total length of 97 m will be installed to connect the water collecting channel and the settling tank. With the bottom of intake channel placed 1 m above the bottom of the sand scoring channel in order to prevent entry of silt etc. in to the intake channel from the sand scoring channel, the structure is arranged in such a way that both intake of water and removal of solids could be done at the same time. The intake volume will be controlled by a steel intake gate at the entrance of the intake channel.

e. Settling tank

A settling tank will be constructed downstream of the intake gate to remove sand particles below 0.1 mm in size so that they will not affect the treatment process. From the point of maintenance and management it is desirable to locate the settling tank close to the intake gate. However, as it is not possible to gain sufficient drop between the intake point and the river bed at a location nearby, the settling tank will be constructed at a location about 95 m downstream of the weir axis, taking into consideration of the effective depth of settling tank and gravity drainage in to the river. The sand deposited at the bottom of the tank is removed by collecting it manually and opening a drainage valve and therefore no mechanical equipment is required. Outline of the settling tank is given below;

Structure	: Reinforced concrete (RC) structure with two lanes
Settling basins	: width (W) 4.0 m x effective length (L) 20.0 m x depth (D)1.5 m (effective D 1.2 m, sediment D 0.3 m)
Effective volume	: 192 m^3 (retention period 11 min)
Flow speed within the tank	: 2.9 cm/sec
Surface load	: 10.5 cm/min

4.3.2 Raw Water Conveyance Facilities

(1) Conveyance Pipeline

Construction items of the conveyance pipeline which will convey raw water from the intake to the treatment plant under gravity flow is outlined below;

Pipeline	: DCIP - T-type Class 4, ø 600 mm, L =1,500 m DCIP - T-type Class 3, ø 500 mm, L = 980 m
Air valves	: ø 75 mm - 5 locations
Sludge withdrawals	: ø 300 mm - 3 locations
Aqueducts	: Steel pipe beam type, ø 600 mm, L 25.0 m - 1 location
Siphons	: DCIP ø600 mm, concrete lined - 1 location.

(2) Maintenance road

In order to facilitate maintenance of intake facilities and conveyance pipeline, a 3.5 m wide gravel paved maintenance road will be constructed along the conveyance pipeline connecting the treatment plant and the intake.

4.3.3 Treatment Facilities

Raw water, after the suspended fine sand has been removed in the settling tank that will be constructed near the intake weir, enters the treatment plant through the conveyance pipeline. The treatment facilities must function reliably responding to the fluctuations in the turbidity throughout the various unit processes such as chemical mixing, flocculation, sediment separation, sludge concentration and sludge removal. The system from the flocculation tank to the the sedimentation basin is divided in to two series, so that one of them could be operated at a time and it will not be necessary to stop production during the maintenance operations such as cleaning and repairs. Moreover, introduction of powered equipment such as motors, pumps, etc., and other complicated machinery and equipment is minimized in order to prevent future breakdowns of the facilities and to make the operation and maintenance of the facilities as simple as possible.

(1) Water receiving well

Inflow of raw water received at the treatment plant, after regulated in this water receiving well, is measured in the flow-measurement chamber using a notch weir. The inflow is controlled using a ø 500 mm butterfly valve installed on the conveyance pipeline just before the entrance of the water receiving well.

Type : RC structure, W 3.0 m x L 2.5 m x D 3.3 m (effective D 3.0m)
Volume : 49.5 m^3 (retention period 3.2 min)
Flow measurement device : notch weir with flow measuring scale, W 2.0 m
Flow control valve : butterfly valve ø 500 mm.

(2) Chemical mixing basin

The very minute turbid particles that are suspended in the raw water do not settle easily without treatment. Therefore, flocculent is added to the raw water to coagulate the suspended matter in to flocs so that settling of the turbid particles becomes easier. Chemicals used for flocculation are broadly divided into coagulants and alkaline agents. Normally, aluminum sulfate alone is used considering the convenience of treatment and economy. The alkalinity of raw water is comparatively high (about 70 mg/l) when the turbidity is low, but has a tendency to drop to about 10 mg/l when the turbidity is high (about 120 units). Therefore it is necessary to adjust the alkalinity to a suitable pH level by adding slaked lime. For the formation of flocs, rapid mixing of the coagulants is necessary, and therefore, addition of the chemical to a large volume of raw water should be done as quickly as possible and moreover the mixing should be done evenly. In this project, motor driven mixers will not used for the mixing of chemicals, but a system is adopted wherein the raw water that passes the notch weir is made to fall in several steps using the natural water head and the chemical is allowed to get mixed rapidly in a hydraulic jump action.

Type : RC structure, cascade type stepped channel, W 3.0 m x L 9.0 m

Volume : 17.1 m^3 (retention period 1.0 min)

Coagulant : aluminum sulfate

Alkali : Slaked lime

(3) Flocculation Basin

By the rapid mixing of coagulant, hydrolysis begins in the raw water and the flocculation of suspended matter takes place. Considering the convenience of operation and maintenance, mixing is done in a system where the energy of raw water itself is used; raw water as it flows through the basin is affected by the baffle walls and detours vertically and horizontally during which the flocculation takes place. After the flocs are sufficiently formed in the basin, the water is send in to the sedimentation tank. Specifications of the basin are given below;

Type : RC rectangular structure, two basins - a system of combined detoured flow in vertical and horizontal directions

Dimensions : W 11.05 m x L 12.45 m x D 5.5 m (effective 4.0~4.9 m)

Effective volume : 445 m^3/ basin (Retention time : 53 min)

(4) Lateral flow type sedimentation tank

When the chemically treated water, after completion of mixing for the formation of flocs is sent in to the sedimentation tank and allowed flow very slowly, the flocs formed will settle and separate from the water almost completely. After the flocs are separated, the supernatant water is collected in to a collecting trough installed at the end of the settling tank and sent in to the filtration basin. The flocs separated from the supernatant water and settled down to the bottom of the sedimentation tank will accumulate and concentrate as sludge. Since major part of the sludge accumulates near the inlet of the settling basin, it is removed at appropriate times through a sludge disposal valve installed in that part of the basin depending on the concentration of sludge accumulated. Moreover it is possible to remove sludge from any part of the basin by a submersible pump which is fitted to a movable bridge installed above the basin. Specifications of the sedimentation basin are given below;

Type : RC structure, Lateral flow type rectangular tanks - two basins

Dimensions : Sedimentation tank - W11.0 m x L 40.0 m x effective D3.6~4.0 m

Collecting trough : W 11.0 m x L 8.0 m x D 3.0~4.2 m (effective D 2.4~3.6 m)

Volume of the tank : 1936 m^3/ tank

Retention time : 3.8 hrs

Mean flow speed within the tank : 0.2 m/min

Sludge pumps: Submersible pumps Two pumps/tank

Sludge removal facilities: Sludge disposal pipe with sludge valve.

(5) Gravity type rapid sand filter

After most of the turbid matter contained in the raw water has been removed in the sedimentation tank by settling as flocs, the supernatant water flows in to a gravity type rapid sand filter. The fine flocs which could not be removed in the settling tank are removed completely by entrapping them in the sand layers of the filter. Thereafter, the filtered water which is collected in a clear water reservoir after disinfection by chlorination, is delivered to the service area. Rapid sand filter can be operated regularly without being influenced by the variations and the level of turbidity of raw water, and moreover, rapid sand filtration is an effective treatment process for the removal of impurities such as organic matter. The LMWD has 14 years of experience in the operation of slow sand filters at the Tingib treatment plant in spite of the many difficulties faced due to high turbidity load in the raw water which had been an excessive burden on the existing filter. For the proposed rapid sand filter, a natural balancing self backwashing type filter, which is an energy saving type of filter, is adopted. Its operation is considered to be not so difficult once experience is accumulated through on the job training with respect to the essential points.Unlike the conventional type of rapid sand filters which employ back-washing pumps and require much labour to operate a large number of valves, this system is considered most appropriate for this project because it needs a very few machinery for operation. The specifications of the proposed rapid sand filter are given below;

Type	: Natural balancing self backwashing type with filter bed surface washing device
Filter area	: 219.04 m^2 (27.38 x 8 beds)
Rate of filtration	: 110 m/day (normal condition when all beds are in operation)
	126 m/day (with one bed being back-washed)
	147 m/day (with one bed being stopped and one bed being backwashed)
Filter sand bed	: Effective diameter 0.6 mm, thickness 600 mm
Gravel bed	: Effective diameter 2~20 mm, thickness 200 mm
Bottom water collecting device	: Perforated block floor type
Filter cleaning system	: Self cleaning system with surface washing
Pumps for filter bed surface washing	: Submersible pump - 1 unit
Control panel	: 1 unit for the pump operation

(6) Clear water reservoir

The purified water will be stored in the clear water reservoir in order to adjust the imbalance between the volume of water filtered after treatment and the volume of water transmitted from the plant to the service area, and also to provide for necessary inspections, maintenance and repairs etc., of the facilities during which the operations may have to be suspended.

Structure	: RC tank with volume 2187.5 m^3
Tank dimensions	: W 25.0 m x L 35.0 m x effective D 2.5 m
Retention period	: 2.4 hours

Flowmeter	: Analog type - one set
Outflow control valve	: Butterfly valve

(7) Facilities for dissolving and injection of coagulants

Within these facilities, space is provided for the storage of aluminum sulfate and slaked lime. Space is provided adjacent to the chemical chamber also to store approximately one months requirement of aluminum sulfate (in crystal form) and slaked lime, both packed in bags. The specifications of the facilities are as follows.

a. Facilities for injection of aluminum sulfate

A 30% solution is prepared using sulfate crystals ;

Design dosage	: for pH adjustment	35 mg/l (normal), 45 mg/l (max.)	
	for coagulation	25 mg/l (normal), 50 mg/l (max.)	
Consumption	: for pH adjustment	847 kg/day (normal), 1,089 kg/day (max.)	
	for coagulation	605 kg/day (normal), 1,210 kg/day (max.)	
	total	1,452 kg/day (normal), 2,299 kg/day (max.)	

Solution tank ;

Type	: RC structure x 4 number of tanks with volume 11.09 m3/tank
Tank dimensions	: W 2.2 m x L 3.6 m x D 2.0 m (effective D 1.4 m)
Retention period	: 1.5 day/tank (normal)
Accessories	: mixers - 4 units

Injection pump ;

Type	: Hydraulic diaphragm pump
Specifications	: 2.4 l/min x 10 kg/cm^2 x 0.2 kw
Number	: for pH adjustment 2 units (inclusive of 1 stand-by)
	for coagulation 2 units (inclusive of 1 stand-by)

b. Facilities for injection of slaked lime

A 10% solution is prepared using powdered slaked lime.

Design dosage	: 15 mg/l (normal), 30 mg/l (max.)
Consumption	: 363 kg/day(normal),726 kg/day (max.)

Solution tank ;

Type	: RC structure x 2 number of tanks with volume 6.8 m^3/tank
Tank dimensions	: W 2.2 m x L 2.2 m x D 2.0 m (effective D 1.4 m)
Retention period	: 1.0 day/tank (normal)
Accessories	: mixers - 2 units

Injection pump ;

Type	: Centrifugal slurry pump x 2 units (inclusive of 1 stand-by)

Specifications : 50 l/min x 10 m x 3.7 kw
Hoppers : capacity: 2.0 m^3- 2 units
Bag filter : Dry exhaust blower type-1 unit

c. Others
Control panel : 1 set
Water tank (for plant premises): One tank - W 4.0 m x L 3.0 m x D 2.0 m
Hoist cranes : 2 sets

(8) Facilities for injection of disinfectant

It is very important that the water supplied should be free from pathogenic contamination and sanitarily safe. As it is impossible to remove completely all the bacteria present in the water only by the sedimentation and filtration processes, the bacteria are killed by adding a disinfectant to the filtered water to make it sanitarily safe. Liquid chlorine, which is already used in the existing system will be used as the disinfectant. The specifications of the facilities are as follows;

Storage facilities : Liquid chlorine cylinders 1 ton , 4 (inclusive of 3 spare) cylinders
Injection device : Wet chlorine doser 1 unit (2 kg/hr)
Dosage : 2 mg/l
Consumption : 44 kg/day
Chlorine gas anti-diffusion pit with counter agents and absorbents
Control panel : 1 set

(9) Drainage facilities

Facilities are provided for the drainage of the excess water from the water receiving well, the sludge from the sedimentation tank and the backwash water from the rapid sand filter etc. Using ø 600 mm concrete pipes for the drainage pipeline, waste water will be discharged in to the drain of the existing facilities.

(10) Administrative building

An administrative building for the operation and management of the treatment plant is provided. This building will house, in addition to an operation room installed with an operation monitoring and control panel, a water quality testing laboratory, staff offices, meeting room and accommodation facilities.

Structure : RC single storied building
Dimensions : frontage 20.0 m x W 12.0 m x 1 building
Operation monitoring and control panel : 1 set
Equipment for water quality testing laboratory : 1 set

(11) Electrical power facilities

1) Power receiving and transformer facilities

The extension of hightension power distribution line by the LEYECO III from Tingib village to the site of the proposed treatment plant is expected to be completed before commencing the construction of the treatment plant. Accordingly, electricity to the facilities of the treatment plant will be supplied by installing a transformer sub station within the premises. The substation will be located at the southern end of the premises as an outdoor installation. Facilities of the substation will consist of receiving unit, transformer, breakers, lightning arresters and meters. The power demand of the treatment facilities has been calculated as 120 kw as shown in Table 30, and the specifications of the power receiving and transformer facilities are as given below;

Transformer : 60 KW (72 KVA), 60 cycles- 2 units
Primary voltage = 13.2 KV/7.62 KV, V phase
Secondary voltage = 220V, 3 phase

Table 30 Electrical Capacity of the Equipment

Item	Unit Capacity (KW)	Quantity	Total Capacity (KW)
1. Electric motor			
Alum agitator	2.20	4	8.80
Alum dosing pump	0.20	2	0.40
Lime agitator	2.20	2	4.40
Lime solution transfer pump	3.70	1	3.70
Lime solution rotary valve	0.40	2	0.80
Sludge discharge pump	3.70	2	7.40
Water pressure pump	1.50	1	1.50
Surface wash pump	30.00	1	30.00
Vacuum pump	2.20	1	2.20
Vacuum compressor	1.50	1	1.50
Humidifier	0.31	1	0.31
Bag filter	0.75	1	0.75
Service water pump	3.70	1	3.70
Chlorinator	0.10	1	0.10
Sub Total			65.56
Efficiency : 85%, load factor : 90%, (65.56 x 0.9/0.85) =			69.41
2. Others			
for Illumination in the buildings, laboratory equipment, outlets etc,			50.00
3. Total			119.41
Required capacity (say)			120.00

2) Power distribution facilities

Power drawn from the secondary of the transformer will be supplied to the central switchboard and the control panel installed in the administrative building through an underground cable. Power will be distributed from this control panel to the various facilities such as motors, instruments, illumination and lightning arresters etc. A power control panel will be installed for power distribution to the motors.

3) Emergency power generators

A power generator will be provided to take care of emergencies during power interruptions. Capacity of the generator is taken as the minimum capacity required for producing the designed volume of purified water. As the operation of filter bed surface washing pumps and sludge disposal pumps in the sedimentation tank is considered to be not necessary during such emergencies, the emergency power requirement is estimated at 60 KW as follows;

Motors	: (65.56-37.40) x 0.9/0.85	= 29.82
Others	:	= 30.00
Total	: 29.82 + 30.00	= 59.82 (say 60 KW)

Specifications of the generator facilities are given below;

Generator	: 3 Phase alternative current generator
Output	: 60 KW (100 KVA)
Voltage	: 220V x 3 phase x 60Hz
Prime mover	: Diesel engine, manual operation

(12) Other facilities

The following are the other facilities necessary within the premises of the treatment plant.

Internal drainage facilities

Internal roads

Fencing and entrance gate

4.3.4 Transmission Facilities

(1) Transmission facilities of the Tingib System

Although the existing Tingib transmission pipeline itself is not necessarily a large rehabilitation work, it is necessary to provide a connection from the new water treatment plant to the existing transmission pipeline and a back-flow valve to prevent water flowing in to the existing plant from the new plant which is at a higher elevation. Moreover, to restore the functions of the existing transmission pipeline, replacement of the air valves is also included under the project.

Construction of connecting pipeline	: DCIP, T type Class 3, ø 500 mm, L 420 m
Installation of back-flow valves	: 600 mm, 1 location
Replacement of air valves	: ø 75 mm, 22 locations
Installation of air valves	: ø 75 mm, 3 locations

(2) Transmission facilities of the Dagami System

A new transmission pipeline will be laid from Dagami to Pastrana along the trunk road. Construction outline is as follows;

Transmission pipeline : DCIP, T type, Class 3, ø 250 mm, L 14,200 m

Pressure reducing valve : at Dagami Town and community supply points along the route, ø 100 mm- 2 sets.

Connection with existing pipeline : starting point - Dagami; existing ø 300 mm CIP
terminal -Tanauang; existing ø 300 mm steel pipes

Air valves	: ø 50 mm - 25 locations
Sludge pipes	: ø 150 mm - 14 locations
Gate valves	: ø 250 mm - 15 locations
Pipeline crossings	: ø 250 mm, 4 locations (annexed to the existing bridges).

4.3.5 Procurement of Equipment and Materials

Spare parts for the raw water conveyance pipeline from the intake to the treatment plant of the Dagami System, water quality testing equipment essential for the operation and management of the Tingib System and a vehicle for management and supervision purposes are considered as the equipment and materials to be procured under the project.

(i) Spare parts for the raw water conveyance pipeline of the Dagami System
PVC pipes: ø 250 mm length 200 m, ø 200 mm length 30 m, and fittings

(ii) Water quality testing equipment for the Tingib Treatment Plant
It is planned to equip the water quality testing laboratory with the testing equipment that are considered necessary on a routine basis. The following are the water quality tests taken in to consideration; Moreover, supply of testing chemicals adequate for two years consumption, or for 2,400 times at the rate of 3 times a day, has also been considered.
Turbidity; Colour; Conductivity; Total Alkalinity; Total Hardness; Chloride Ions; $KClO_3$ Consumption; Residual Chlorine; Total Colonies; Coliforms; Jar Test.
Testing equipment include a water bath (30°C) used for simple field measurements of total colonies and coliforms, and a small distiller.

(iii) Vehicle for management and supervision purposes (4WD pick-up type) - 1 unit.

4.3.6 Basic Design Drawings

The following basic design drawings are annexed to this report.

1. General Location Map
2. General Plan of Proposed Tingib System
3. Plan of Intake Facility
4. Settling Tank of the Intake Facilities
5. Plan and Profile of Tingib Conveyance Pipeline
6. Typical Section of Pipeline and Maintenance Road
7. General Plan of the Tingib Treatment Plant
8. Layout of Treatment Facilities
9. Hydraulic Profile of Treatment Facilities
10. General structure of Treatment plant
11. Plan of Rapid Sand Filter
12. Section of Rapid Sand Filter
13. Administrative Building
14. Coagulents Chemicals Injection House
15. Disinfectant Injection House
16. Emergency Power Generator
17. Single Line Diagram of Electrical Facility

4.4 Implementation Planning

4.4.1 Project Execution System

This project is composed of (i) construction works of intake, conveyance, treatment and transmission facilities, (ii) design and construction supervision by the consultants and (iii) works which are the responsibility of the Republic of the Philippines. Of these, (i) and (ii) are covered by the Grant Aid. The system for project implementation in the case of construction of facilities under the Grant Aid program is as shown in Fig. 21. First of all, after the conclusion of the Exchange of Notes between the Government of the Philippines and the Government of Japan, an agreement for consulting services shall be concluded. After the detailed design and tender documents are completed, tendering shall be done by the consultant on behalf of the client to select a contractor. After the contractor is selected, a contract shall be signed and the construction works shall be commenced immediately.

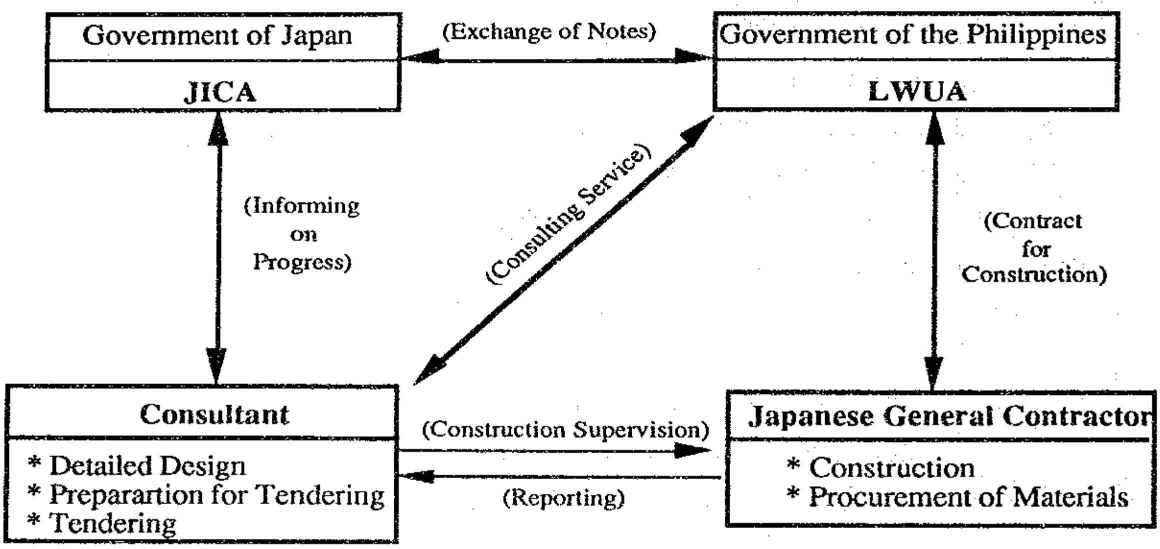


Fig. 21 Project Implementation System

(1) System for Project Implementation

The Local Water Utilities Administration (LWUA) is the agency responsible for the implementation of this project on the Republic of Philippines side. LWUA is a public corporation which coordinates all water supply works in the urban and rural areas in the Philippines except for the Metro Manila region. It provides financial and technical assistance for investigations, planning, design and construction execution of development and improvement projects in these water supply works. LWUA is composed of 4 services namely;

Administration, Financial, Institutional Development and Engineering Services. The Engineering Services through its Department (Area 3) will be in charge of the practical operations of this project. The said department is composed of the Planning Division, Design Division and Construction Division. The LWUA, after concluding the Exchange of Notes for Grant Aid between the Government of Japan, shall in cooperation with other relevant agencies in the Philippines take action on matters such as banking arrangements, tax exemption for equipment and materials to be imported. After the completion of the project, operation, maintenance and management of the water supply system will be taken over by the Leyte Metro Water District (LMWD) which is directly in charge of the project area.

(2) The Consultant

The Consultant shall be a Japanese consulting firm. A Contract for Consulting Services should be entered in to between the Consultant and the LWUA immediately after concluding the Exchange of Notes between the two governments for Grant Aid for this project.

(3) The Contractor

The Contractor shall be a Japanese general contractor. The Contractor shall procure the equipment and materials and execute the construction works as specified in the contract. The procured equipment and materials must be delivered to the construction site. Construction works will be executed under the supervision of the Consultant. After completion of the works, necessary tests runs, adjustments and operational guidance etc., shall be conducted and upon confirming that the completed facilities are in perfect order, the facilities shall be handed over to the Philippine side. Moreover, in order to enhance the impact of this project, the test runs, adjustments etc., will be carried out in the presence of technical personnel of the LWUA and LMWD.

4.4.2 Division of Responsibilities for the Execution of Works

Division of responsibilities in executing the works is outlined below.

(1) Responsibilities of the Philippine side

The work items which are the responsibility of Philippine side and the conveniences that should be offered by the Philippine side for smooth implementation of the project are listed below;

1) Acquisition of land necessary for the project.
2) Land preparation and affiliated works
   i) Intake facilities and conveyance facilities:
      Clearing of vegetation and roots, land preparation
   ii) Treatment facilities and transmission facilities:

- Clearing of vegetation and roots, land preparation (including the storage yard for construction materials)
- Drains outside the plant
- Vegetation and turfing

3) Works related to utilities:
Installation of power line to the project site
4) Conclusion of smooth banking arrangements, payment arrangements thereafter and payment of various commissions and fees.
5) Taking necessary measures for exemption of custom duty, internal taxes and other levies on equipment and materials and services provided under the project.
6) Handling of procedures for smooth custom clearance of equipment and materials that are to be imported for the project.
7) Extending of necessary assistance and conveniences for smooth immigration and emigration procedures and visas to the Japanese personnel who offer services on the Project.
8) Attending to all procedures with respect to legal obligations, such as making applications and obtaining approvals, permissions etc., under the internal laws and regulations of the Philippine Law applicable to the project.
9) Securing of budgetary requirements for the operation and maintenance of the facilities after the completion of this project.

(2) Responsibilities of the Japanese side

The responsibilities of the Japanese side are the construction of facilities, delivery of equipment and materials necessary for these facilities, installation of equipment, and conducting test runs, tests and adjustments and providing guidance on operation.

1) Intake facilities: Intake weir, Sand removing channel, Intake channel, Settling tank, and other affiliated facilities
2) Conveyance facilities: Conveyance pipeline, Maintenance road and other affiliated facilities.
3) Treatment facilities: Water receiving well, Chemical mixing basin, Flocculation basin, Sedimentation tank, Rapid sand filter, Clear water reservoir, Facilities for dissolving and injection of coagulants, Facilities for injection of disinfectant, Drainage facilities, Administrative building, Electrical power facilities, and other affiliated facilities.
4) Transmission facilities:
Tingib System- Installation of connecting pipeline, Installation of back-flow valves, Replacement of air valves,
Dagami System- Construction of transmission pipeline, Installation of pressure reducing valves and other affiliated facilities.

5) Supply of equipment and materials: PVC pipes, Equipment for water quality testing laboratory, Vehicle for management and supervision purposes (4WD).

4.4.3 Construction Conditions and Matters that Require Attention

(1) As competent contractors are available in the Philippines, skilled labour can be procured mainly from Manila and Leyte although ordinary labour could be obtained locally. Moreover, as the work sites of the intake facilities, conveyance facilities and treatment facilities are located in the hilly region away from the human settlements, it will be necessary to provide simple temporary accommodation facilities for these workers.

(2) There are construction machinery leasing firms in Manila and as it is possible to lease out the general construction machinery from them, only the special machinery will be taken from Japan.

(3) Climatically, the dry season and the rainy season are not clearly distinct in the project area where rains are being experienced throughout the year as a characteristic feature. However, the tendency is that rainfall is relatively small during the months of April to August, but high from October to February. Therefore, in the planning of the construction work schedule, attention must be paid so that the construction works of the intake facilities within Binahaan River basin will be executed avoiding the October - February period when the river flow is heavy. Moreover even during the remaining months, preparedness is necessary with suitable disaster prevention and emergency response measures, for example, by arranging cofferdams, sandbags and drainage pumps etc., to meet any unexpected situations.

(4) Water from Binahaan River is presently being extracted as the raw water for the existing treatment plant. Therefore, adequate precautions must be taken so that river water will not be polluted with mud and spoil from the excavation works for the conveyance pipeline. Where the water routes of the river are close to the work site, these should be diverted.

(5) In the Tingib System, as the topography along the conveyance pipeline is hilly, it is necessary to construct an access road prior to the construction of the pipeline.

4.4.4 Construction Supervision Plan

After the signing of the Exchange of Notes between the two governments, the LWUA will enter into a contract with a consultant whose duties are divided in to detailed design and construction supervision. Outline of these duties are given below;

(1) Detailed design

(i) Field studies

The various criteria necessary for the detailed design will be confirmed through field studies by supplementing the information and data already collected during the basic design stage on climate, hydrology, geology, construction materials, labour, construction methods etc.

(ii) Detailed design

Detailed designs, detailed cost estimates of construction works and construction schedule will be prepared prior to the preparation of the tender documents.

(iii) Tendering

Preparation of tender documents, assistance in prequalification of tenderers, attendance in witness during tendering, evaluation of tendering and assistance in negotiations with contractors and in the conclusion of construction contract are the duties of the Consultant at the tendering stage.

(2) Construction Supervision

(i) Supervision services

Deliberations among the relevant parties prior to commencement of work, obtaining approval of the design drawings, inspection of equipment and materials prior to shipment, field supervision of construction works, supervision of installation of equipment, preparation of progress reports during construction period, issuing of works completion certificate and payment certificates, commissioning of completed works etc., are the duties of the Consultant under supervision services.

(ii) Duties upon completion of the works

The Consultant will perform the duties such as, issuing of works completion certificate, handing over procedures, preparation of final report, attending to work completion procedures.

(iii) Operation and maintenance

The consultant will prepare the maintenance and management plans and manuals for operation and maintenance of intake facilities, electrical power receiving and transforming facilities, water treatment facilities etc.,

4.4.5 Planning of the Procurement of Equipment and Materials

The equipment and materials required for this project shall be basically the materials and products of Japan or the Philippines. Further, the procurement of equipment and materials shall be done by a Japanese Contractor under the supervision of a Japanese Consultant. A list of the equipment and materials required for this project is given in Table 31.

Table 31 List of Equipment and Material

Structure	Type	Quantity	
1. Intake facilities			
Bar screen	3" dia steel pipe	1	set
Intake gate	Sluice gate 1.2 m x 1.0 m	1	unit
Scouring sluice gate	Sluice gate 1.2 m x 1.0 m	1	unit
Gate in settling tank	Sluice gate 0.8 m x 0.8 m	1	set
Sheet piles	U-II Type	1	set
Gabion nets	# 10 mm x 150 mm x 150 mm mesh	1	set
2. Conveyance facilities			
Pipes	DCIP 600 mm, T-4 Type	1500	m
Pipes	DCIP 500 mm, T-3 Type	980	m
Air valves	75 mm	1	set
Blow-off valves	300 mm	1	set
Aqueducts	SP 600 mm	1	set
3. Treatment facilities			
Water receiving well			
Control valve	Butterfly, 500 mm	1	set
Blow-off valve	300 mm	1	set
Measuring weir	2 m width	1	set
Baffle wall		1	set
Flocculation basin			
Baffle wall		1	set
Blow-off		1	set
Sedimentation basin			
Trough		6	units
Sludge discharge pump		4	units
Traveling bridges		2	units
Baffle wall		1	set
Rapid sand filter			
Surface wash pumps		2	units
Surface wash pipes		1	set
Backwash water channel		1	set
Under drain		1	set
Solenoid valve box		1	unit
Vacuum pumps		2	units
Vacuum tanks		1	unit
Compressors		2	units
Humidifier		1	unit
Service water pumps		2	units
Service water supply tank		1	unit
Effluent weirs		2	units
Pipes and fittings		1	set
Drain valve		1	set
Clear water reservoir			
Flow meter	Totalizer & momentary flow indicator, 500 mm	1	unit
Control valve	Butterfly, 500 mm	1	unit
Transmission pipeline			
Pipes	DCIP 500 mm, T-3 Type	420	m
Check valve	600 mm	1	set

4. Chemicals feeding facilities			
Aluminum dosing pumps	2.4 l/min x 10 m	4	units
Aluminum agitators	propeller type, 11 m3	4	units
Lime solution transfer pumps	50 l/min x 10 m	2	units
Lime agitators	propeller type	2	units
Bag filter		1	unit
Lime solution measuring tank		1	unit
Hoist cranes and rails		2	units
5. Disinfection facilities			
Chlorinator		1	set
Chlorine cylinders	1 ton	3	units
Hoist crane and rail		1	unit
6. Electrical facilities			
Transformer equipment	60 KW (75 KVA), 60 Hz	2	units
Diesel generator	130 PS, 100 KVA, 220V x 60 Hz	1	unit
Instrumentation system, Control panel		1	set
7. Transmission facilities			
Pipes	DCIP 250 mm, T-3 Type	14.15	km
Air valves (Dagami)	50 mm	1	set
Air valves (Tingib)	75 mm	1	set
Blow-off valves	150 mm	1	set
Sluice valves	250 mm	1	set
Pressure reducing valves	100 mm	1	set
8. Procurement of equipment and materials			
Conveyance pipeline	PVC pipes 250 mm	200	m
	PVC pipes 200 mm	30	m
Water quality testing equipment		1	set
Vehicle	4 WD Pickup type	1	unit

4.4.6 Project Implementation Schedule

This project involves construction of the necessary new water supply facilities starting with the intake facilities and through the conveyance and treatment facilities up to the transmission facilities. Hence, the types of work items are many, and moreover, the work quantities are very large. Therefore it is considered that a period of about two years would be required for the implementation of this project. Accordingly, it is desirable to divide the entire works in to two phases. In order to generate the impact of the project independently in each phase, the works will be divided as follows; stabilization of the intake in the Tingib system is aimed at in Phase I, whereas, improvements in the quality of treated water and connection to the existing transmission pipelines of the Tingib System and enhancement of water supply efficiency in the Dagami System are targeted in the Phase II.

Phase I

1) Tingib System

(i) Construction of intake facilities (Intake weir, Sand removing channel, Intake channel, Settling tank, and other affiliated facilities)

(ii) Construction of conveyance facilities (Conveyance pipeline, Maintenance road and connection to existing treatment plant)

(iii) Rehabilitation of transmission facilities (Replacement of air valves)

Phase II

1) Tingib System

(i) Construction of treatment facilities (Water receiving well, Chemical mixing basin, Flocculation basin, Sedimentation tank, Rapid filter, Clear water reservoir, Chemical dosing facilities, Drainage facilities, Administrative building, Electrical power receiving and transforming facilities, Emergency power generating facilities and other affiliated facilities).

(ii) Construction of transmission facilities (Laying of pipeline connecting with the existing transmission pipeline, Installation of back-flow valves)

2) Dagami System

(i) Construction of transmission facilities

3) Procurement of equipment and materials

(i) Procurement of PVC pipes for the Dagami Conveyance Pipeline

(ii) Procurement of equipment for water quality testing laboratory of the Tingib Treatment Plant

(iii) Procurement of (4WD) vehicle for management and supervision purposes.

4) Test runs, testing, adjustments and guidance on operation and management of the facilities

The project implementation schedule is shown in Fig. 22.

In Phase I, 3.5 months will be required for the detailed designs and tendering procedures whereas 12 months would be necessary for the construction works including fabrication and transportation of equipment and materials. In Phase II, 3 months will be required for the detailed designs and tendering procedures whereas 12 months would be necessary for the construction works including fabrication and transportation of equipment and materials.