7.5 Mechanical/Electrical Facilities and Instrumentation

As described in Section 7.2, some modifications were implemented in the existing Balara Plant in 1981. Various mechanical and electrical equipment and instrumentation were installed prior to this. These facilities have varying operational conditions and locations depending on the existing treatment processes.

The present staff of the Plant has been trying to maintain the existing facilities in good operating condition. These endeavors, however, are limited due to the existing budgetary constraints. For example, most of the equipment had installed a stand-by unit, but at present, all are already damaged. Although it is possible to operate the Plant without a stand-by unit, the Plant will be deficient when the main operating equipment breaks down.

Generally, equipment in the Plant should be repaired or replaced, regularly (annually) with the corresponding maintenance plans. However, since 1981, major repairs/replacements have not been carried out. Due to these, the Plant has deteriorated and will require immediate and major rehabilitation.

7.5.1 Mechanical Facilities

Mechanical facilities installed in the Balara Plant are described below and shown in Appendix E "Mechanical Equipment List", Supporting Report.

(1) Plant No. 1

The major mechanical equipment in Plant No. 1 are the rapid mixing and flocculation facilities, Accelators and filtration facilities.

The rapid mixers and twelve flocculators in Sedimentation Basin No. 1 & No. 2 were installed respectively in 1981, however at present, they are deteriorated. The shafts of the rapid mixer has been revolving eccentrically due to the length of shaft and the rapid stream flowing in the channel. Four flocculators out of the twenty four units have

no motor due to burn-out as a result of voltage fluctuations. Actual operating conditions are shown in Fig. 7.5.1. Although flocculators have variable speed gears, they are not properly adjusted to make good flocculation by reducing mixing speed gradually.

In the Accelator, most of the parts are original except for the motors and variable speed gears which were replaced in 1981. The original parts such as reduction gears and worm reduction gears are worn-out but the submersible steel structure is not heavily deteriorated and can still be utilized after some minor repairs.

Filtration facilities, except for the civil structures and main piping were rehabilitated in 1981.

The flow control equipment, as shown in Fig. 7.5.2, which is comparatively fragile and complicated, is located at the basement of the Filter Building where the atmosphere is very humid. Because of these conditions the said equipment had easily deteriorated as well as the air compressors and hydraulic control equipment.

Pumping facilities in Plant No. 1 consist of washwater pumps and recovery water pumps. All these pumps manufactured in the 1940's had been installed at their existing locations since 1981. They have at present, extensive leakages at their bearings and it is considered that they have lost their original designed efficiencies.

(2) Plant No. 2

The major mechanical equipment in Plant No. 2 are the flocculation and filtration facilities.

Flocculators' parts have been replaced (sprocket wheels, chains, paddles, etc.) since their construction in 1965/67. The entire flocculators are now deteriorated, particularly the driving units and bearings (gland packings) which have excessive leakages. Actual operating conditions of flocculators are shown in Fig. 7.5.3.

Filtration facilities, as shown in Fig. 7.5.4, have the same condi-

tions as the facilities in Plant No. 1

Washwater pumps in Plant No. 2 were installed in 1967 and one of the motors of the three pumps has been removed. The other two pumps have heavy bearing leakages at the bearings. Meanwhile, the recovery water pumps which were installed in 1981 are frequently not in operation.

(3) Chemical/Chlorination Facilities

Chemical/chlorination facilities are comparatively fragile and they easily encounter breakdowns than the other facilities.

There were originally six alum feeders or Rotodips, but one stand-by unit of Rotodip has already been removed and its parts had been transferred to the other Rotodips as replacement. Alum feeders are easily prone to mechanical trouble since alum is acidic which easily corrodes the metal parts of the feeder. PVC lining was applied for their tanks, and the water wheels were replaced with new PVC ones. At present, speed controllers are repaired every week.

Polymer dosing facilities consist of four mixing tanks with a corresponding mixer and five polymer feeders or plunger pumps which includes one stand-by pump. At present, the stand-by pump is out of order and the motor was removed, while the other four pumps are in continuous operation. However, these pumps can hardly adjust dosing quantity and therefore cannot quickly respond to the requirements of the sanitary engineer in charge of the Plant operation. The tanks and mixers are still in proper operating conditions.

Chlorination facilities faces possible corrosion due to hydrochloric acid produced by moisture and leaked chlorine gas. Metal parts of evaporators, chlorinators and steel pipes are already corroded. The evaporators cannot operate at its original maximum capacity while the chlorinators are not able to adjust the chlorine dosage properly. Moreover, booster pumps have excessive water leakages at their bearings and one of the three installed pumps have no motor.

7.5.2 Electrical Facilities and Instrumentation

Electrical facilities and instrumentation installed in the Balara Plant are described and shown in Appendix F "Electrical Equipment List" and Appendix G "Instrumention List", Supporting Report.

(1) Substation

The Balara Treatment Plant receives its electrical supply from the 34.5 kV distribution line of the Manila Electric Company (Meralco) through a metering device installed by Meralco in the Plant. Overhead distribution lines (approx. 1,200 m) are laid to supply electricity to three substations in the Plant. (Refer to Fig. 7.5.5)

The overhead distribution lines have some difficult points of maintenance owing to the lack of isolation devices at the point of tapping.

Also, the lines are installed on wooden poles which are deteriorated and inclined.

MWSS electricians carry out the regular maintenance work while Meralco's sister company conducts maintenance and repairs as requested by MWSS.

The three substations in the Plant have the following capacities:

- o No. 1 S/S: Transformer --- 3 phase, 34.5 kV/2.4 kV
  3750/4687 kVA X 1
  for Booster Pump Station
  Transformer --- 1 phase, 34.5 kV/480V, 167 kVA X 3
  for Plant No. 2

- o No. 2 S/S: Transformer --- 1 phase, 34.5 kV/480V, 100 kVA X 3

- o No. 3 S/S: Transformer --- 1 phase, 34.5 kV/480V, 250 kVA X 3
  for Plant No. 1
  Transformer --- 1 phase, 34.5 kV/480V, 167 kVA X 3
  for staff quarters

Capacitors for improvement of power factors are installed at No. 1 Substation and Wash Water Pump House for Plant No. 1 and maintain their power factor at more than 90% while at same time, they maintain the factor for the whole Plant at more than 85% which is the contract standard with Meralco.

All installations of these three substations are in conformity with the Philippine Electrical Code (PEC).

(2) Diesel Engine Generator

Diesel engine generators are installed as follows:

Wash water pump house No. 1: 625 kVA X 1 unit
Booster pump house : 750 kVA X 3 units

These generators are still operational.

(3) Low Voltage Distribution Lines

Low voltage electricity is distributed from three substations to treatment facilities by overhead lines, except for the Booster Pump Station.

Although low voltage distribution lines in Plant No. 1 was rehabilitated by replacing wooden poles in 1981, these lines at present are not properly maintained. The lines also have large voltage fluctuations and voltage imbalance among three phases at the Motor Control Center (MCC) in Plant No. 1.

(4) Control Facilities

Treatment facilities in Plant No. 1 and No. 2 are supplied with electricity at their main switch box, distribution panel (DP)/Motor Control Center (MCC) through low voltage overhead lines.

Most of DP/MCC are installed near their loads and with enough maintenance spaces. However, they have been deteriorating due to corrosion

brought about by high humidity and temperature and suffer from shortage of spare parts.

Electrical houses for Settling Basins No. 1 & No. 2 are not spacious enough for maintenance purposes. MCC of flocculators in Plant No. 2, also has a very narrow space near the locker room in the Filter Building. These conditions are not appropriate from the viewpoint of safety.

All facilities are controlled by manual operation at the MCC or line switch near the equipment. The line switches do not have any overcurrent protection device for motors.

(5) Instrumentation and Supervision Systems

Operation of the Plant is controlled by a sanitary engineer (3-shifts) and the engineer mainly controls the production (water quantity) of the Plant. As for water quality, chemists (3-shifts) assists the engineer in chemical dosing procedures.

Basically, instrument information such as, flow and water level which are required for proper control of the Plant, is indicated, integrated and recorded at the sanitary engineer's desk in the Filter Buildings both in Plants No. 1 and No. 2. Meanwhile, operational information such as stop operation, trouble etc., is not indicated.

The instrument information, however, is not monitored at the sanitary engineer's desk due to damages on the instrumentation system caused by lightning in 1984 and voltage fluctuations.

Therefore, at present, the operator takes the manometer readings of the venturi tube on aqueducts and relays the flow to the engineer by telephone. At the same time, the engineer informs the operators at the reservoir as to the opening of gates at the intake tower for control of water inflow to the Plant.

(6) Lightning Protection Equipment

There are two kinds of lightning protection, one is to protect the Plant from direct lightning while the other is a protection from electric inductions occurring on cables caused by lightning and surges due to operation of switches.

In comparison to other areas, frequent occurrence of lightning is evident in the Balara area. Due to this, some electrical facilities and instrumentations in the Plant have been damaged, namely, the ground wire of 34.5 kV overhead distribution line, lightning arresters in substations and the surge absorbers at the service point of low voltage distribution lines.

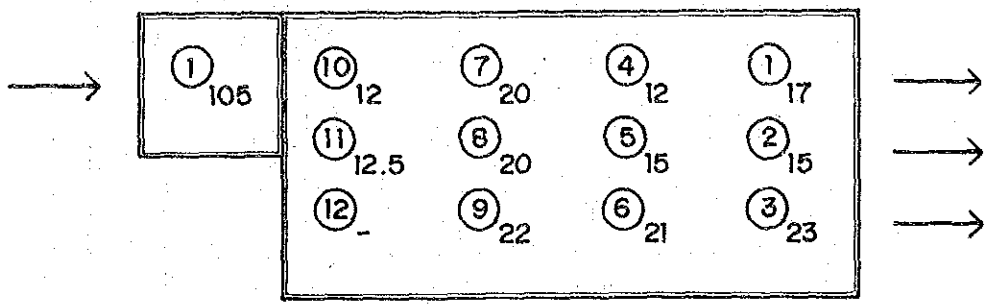
(7) Others

There is a very limited quantity of instruments and tools used for maintenance of electrical facilities and instrumentation in the Plant and this directly contributes to the lack of proper maintenance of the facilities. As a result, maintenance of electrical equipment and instrumentation is limited to visual inspection and regular cleaning.

SEDIMENTATION BASIN NO. 1

REVOLUTION (UNIT : RPM)

	RAPID MIXER - 1	FLOCCULATOR - 12
DESIGN :	104	13.2 - 34.2
ACTUAL :		



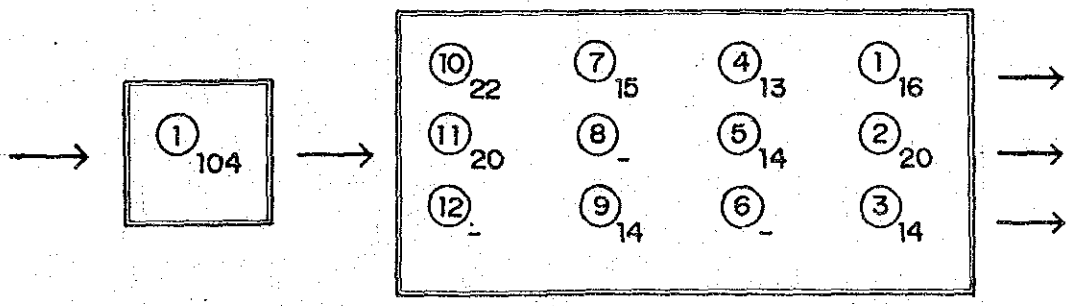
PERIPHERAL SPEED (UNIT : M / SEC)

DESIGN :	4.5	0.6 - 1.5
ACTUAL :	4.5	0.53 - 1.0

SEDIMENTATION BASIN NO. 2

REVOLUTION (UNIT : RPM)

	RAPID MIXER - 1	FLOCCULATOR - 12
DESIGN :	104	13.7 - 34.2
ACTUAL :		



PERIPHERAL SPEED (UNIT : M/SEC)

DESIGN :	45	0.6 - 1.5
ACTUAL :	4.5	0.57 - 0.97

Fig. 7.5.1
OPERATING CONDITION OF FLOCCULATORS IN PLANT NO.1

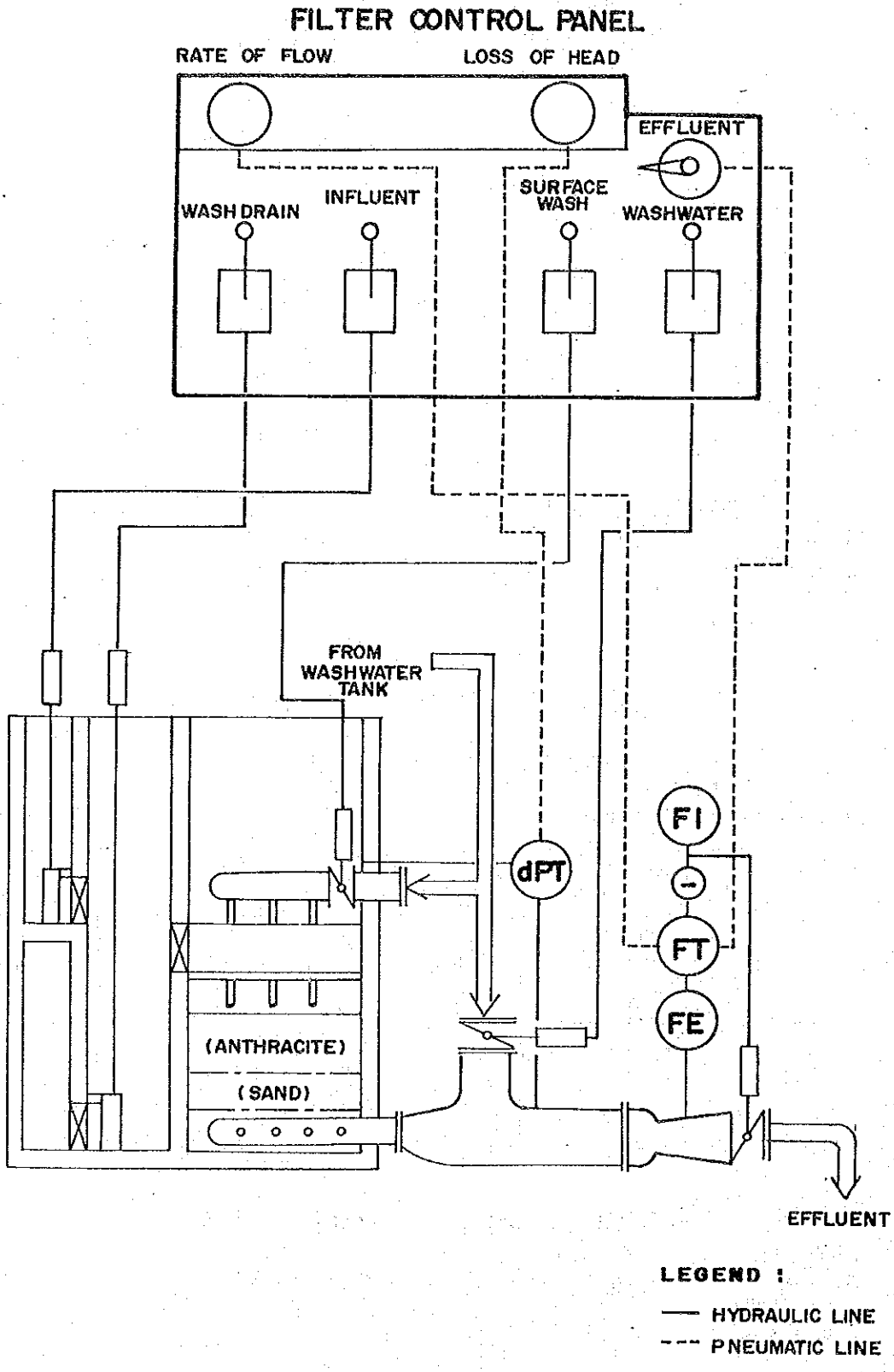
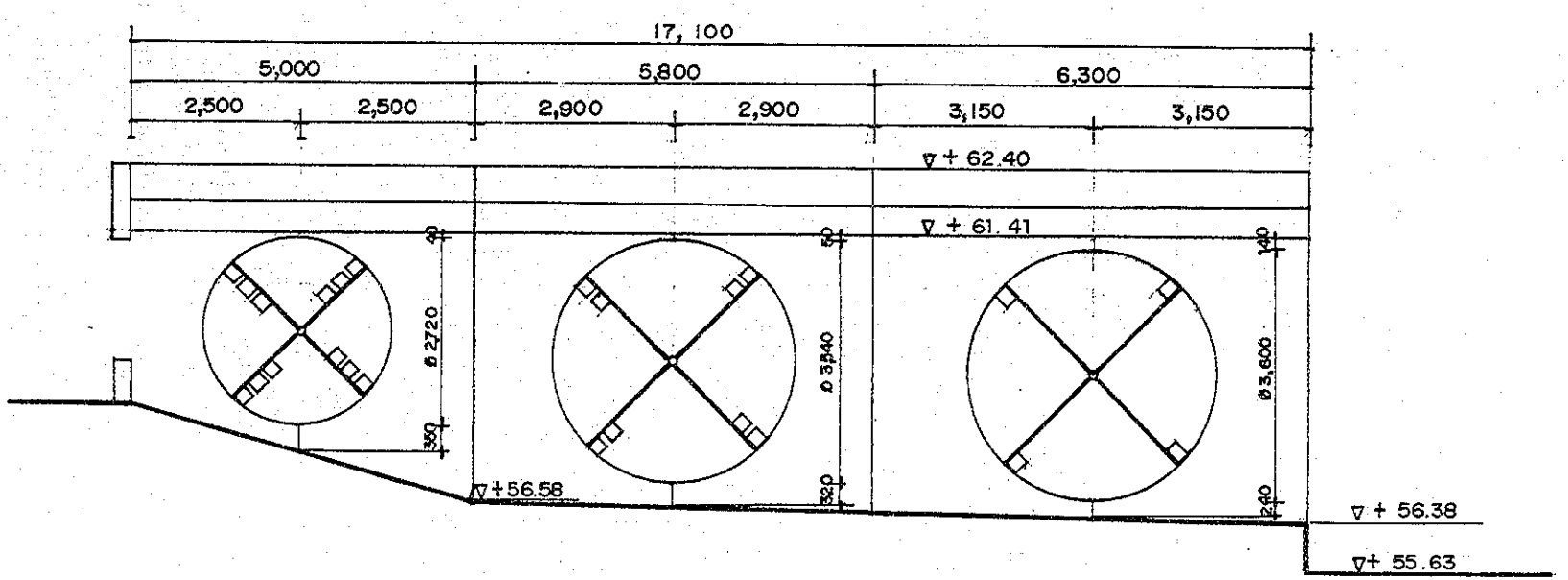


Fig. 7.5.2
FILTER CONTROL SYSTEM
IN PLANT NO.1



ACTUAL	1ST	2ND	3RD
REVOLUTION (RPM)	2.83	2.12	2.12
PERIPHERAL VELOCITY (M/SEC)	0.4	039	0.4

Fig. 7.5.3
ACTUAL OPERATING CONDITION OF FLOCCULATOR IN PLANT NO.2

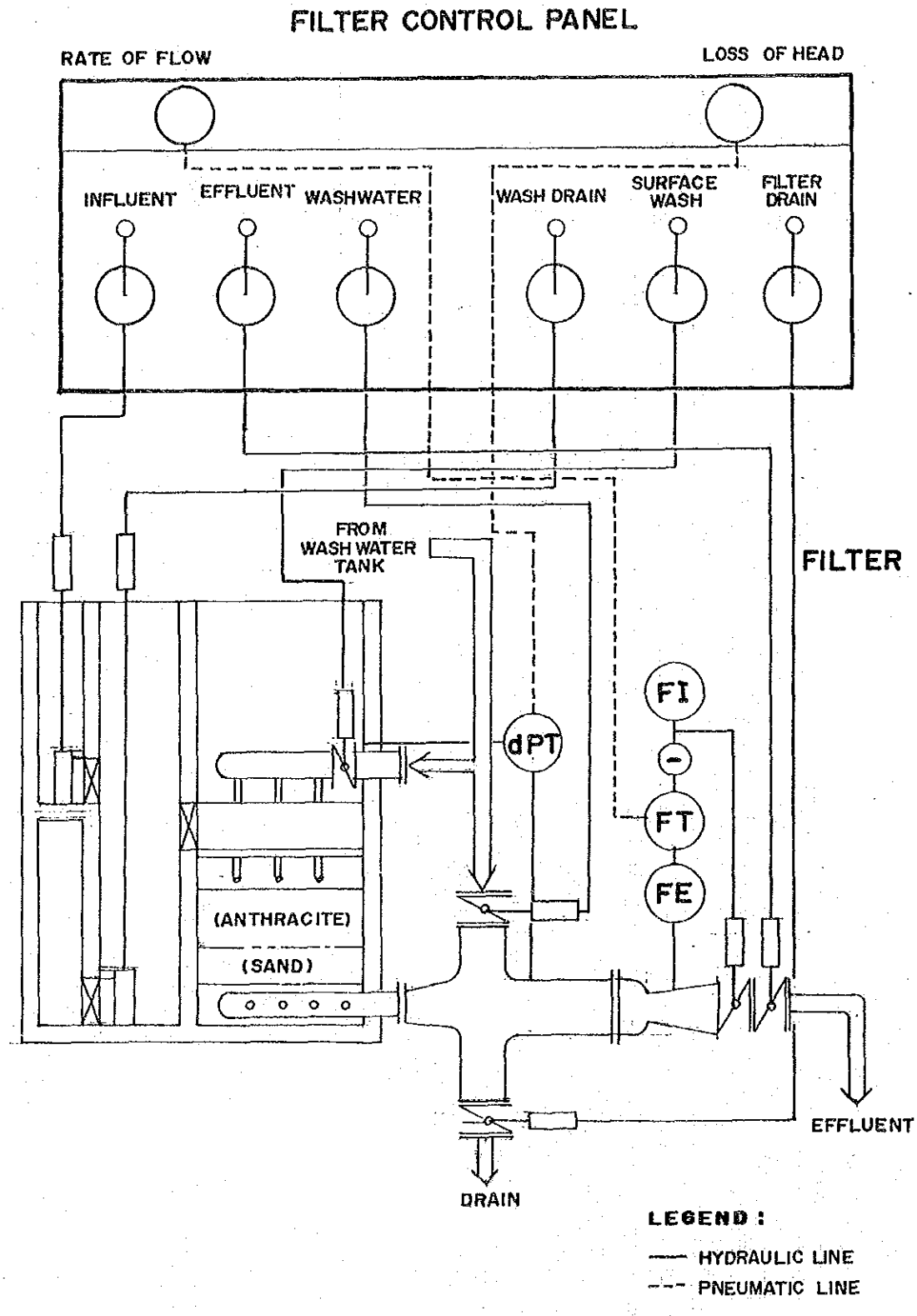


Fig. 7.5.4
FILTER CONTROL SYSTEM
IN PLANT NO.2

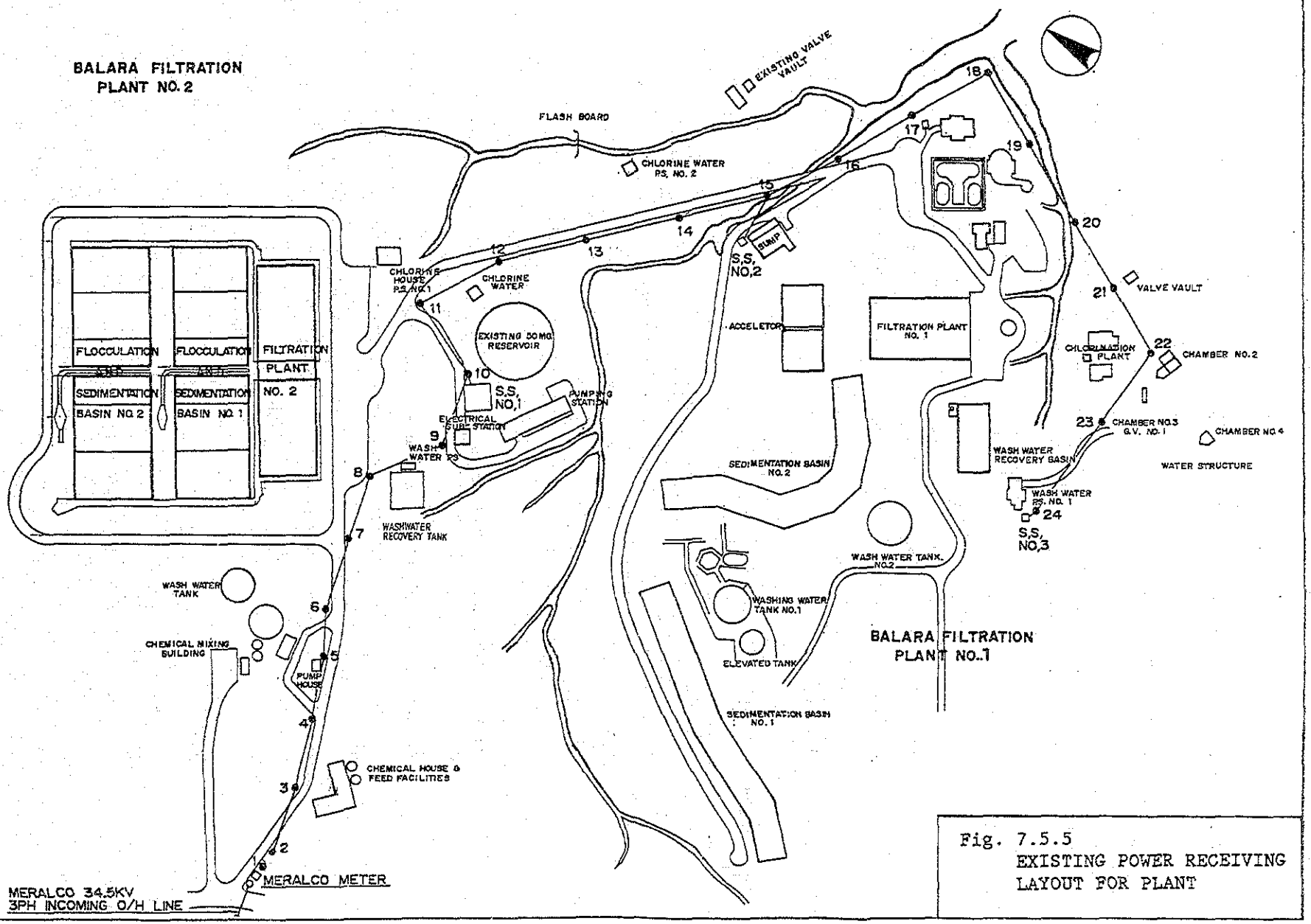


Fig. 7.5.5
EXISTING POWER RECEIVING LAYOUT FOR PLANT

7.6 Chemical Dosage and Chlorination

7.6.1 Quality of Chemicals

In the Balara Plant, the following chemicals are ordinarily used throughout the year:

(1) Alum

Water soluble alumina (Al_2O_3)- not less than 8.0%
Specific gravity at room temperature - 1.32-1.35
Total water soluble iron - not to exceed 0.75%
Suspended matter - not to exceed 0.2%

(2) Polymer (Cationic)

Appearance - colorless, viscous liquid
Solubility - soluble in water in all proportions
Specific gravity - 1.03
Viscosity - minimum 35 cps. at 25 °C
pH - slightly acidic

(3) Polymer (Anionic or Non-Ionic)

Appearance - colorless, viscous liquid
Solubility - soluble in water in all proportions
pH - not lower than 6.5
Free acrylamide monomer - not to exceed 0.05%
Specific gravity - not less than 1.03

(4) Chlorine

Liquid chlorine
pureness - not less than 99.5%

7.6.2 Determination of Dosage

Optimization of chemical dose is undertaken through Jar Test that is conducted three times a day by the Process Quality Control Unit to maintain the treated water quality as set forth by the National Standards for Drinking Water of the Department of Health.

The Jar Test procedure applied at present is shown in Table 7.6.1 below:

TABLE 7.6.1 JAR TEST PROCEDURE

PROCESS	ROTATION (rpm)	DURATION (min)
Rapid Mixing	100	1
Flocculation	60	10
	30	10
	15	10
Sedimentation	N/A	30

Jar Test results and recommendations are then transmitted to the Balara Treatment Plant Division for implementation.

7.6.3 Method of Dosing

(1) Alum

Liquid Alum is delivered by tank lorry and unloaded in measuring tanks and is transferred to the alum concrete storage tank which consists of five compartments with lining. Alum is fed to the Roto-dips at the Chemical House by gravity.

In the Chemical House, six Rotodips including one stand-by unit measure alum dosage by proportioning feed method controlled by Pelton wheels. Dosing points of five Rotodips are as follows.

a. Rapid mixer at Sedimentation Basin No. 1 in Plant No. 1
b. Rapid mixer at Sedimentation Basin No. 2 in Plant No. 1

c. Accelators in Plant No. 1
d. Parshall Flume (North) in Plant No. 2
e. Parshall Flume (South) in Plant No. 2

The Rotodip doses alum to two Accelators then two rotameters are installed near Accelators to deliver a uniform flow to each Accelator.

(2) Polymer

Polymer, both cationic and anionic, is supplied in drums and stored at the Chemical House.

Polymer facilities consist of four mixing tanks with a mixer each and five plunger pumps which include one stand-by unit. During usage, polymer is at first manually transferred to a measuring tank with wheels for measurement of quantity for one mixing tank. Then, the polymer is poured into a mixing tank which is filled with water for dilution.

Four plunger pumps supply diluted polymer to the following dosing points.

a. Rapid mixer at Sedimentation Basin No. 1 & No. 2 in Plant No. 1
b. Accelators in Plant No. 1
c. Parshall Flume/Flocculation Basin (North) in Plant No. 2
d. Parshall Flume/Flocculation Basin (South) in Plant No. 2

Same as Alum dosing, rapid mixer at Sedimentation Basin No. 1 & No. 2 and Accelators in Plant No. 1, two rotameters are installed to deliver a uniform flow to each unit of basin and Accelator respectively.

(3) Chlorine

Chlorine is supplied in 1-ton cylinders and stored at the Chlorination House. Chlorination facilities consist of two evaporators, four chlorinators, three booster pumps, etc. Liquid chlorine is heated and gasified by the evaporator then supplied to the chlorinator.

Chlorine gas is measured by the chlorinator and it is dissolved with water supplied by the booster pump, using an injector in the chlorinator. The chlorine gas solution is controlled by rotameters and valves in the house.

Dosing points of chlorine gas solution are as follows:

1) Pre-Chlorination

a. Aqueduct No. 1 near Chemical house for Plant No. 1
b. Receiving well of Accelators in Plant No. 1
c. Receiving well in Plant No. 2

2) Intermediate-Chlorination

a. Inflow Channel to Filter Building in Plant No. 1
b. Inflow Channel to Filter Building (East wing) in Plant No. 2
c. Inflow Channel to Filter Building (West wing) in Plant No. 2

3) Post-Chlorination

a. Effluent aqueduct from Plant No. 1
b. Effluent aqueduct (84") from Plant No. 2
c. Effluent aqueduct (72") from Plant No. 2

7.6.4 Actual Dosage

Amount of chemicals like alum, chlorine, cationic, and anionic polymer, consumed in 1990 are shown in Table 7.6.2.

Dosage of alum and cationic polymer was extremely increased in July, August, and September during the rainy season when the raw water turbidity increases, while dosage of chlorine and anionic polymer was not varied much.

TABLE 7.6.2 CHEMICALS CONSUMED & VOLUME OF WATER TREATED BY MONTH JANUARY - DECEMBER, 1990

MONTH	VOLUME WATER TREATED (TCH)	CHEMICAL CONSUMPTION (H.T.)				DOSE (mg/l)			
		ALUM	CHLORINE	CATIONIC	ANIONIC	ALUM	CHLORINE	CATIONIC	ANIONIC
January	42,752.50	537.931	40.424	0.592	0.169	6.29	0.94	*0.03	*0.03
February	37,939.70	348.018	37.1645	0.245	0.137	4.59	0.98	*0.03	*0.03
March	42,085.00	413.561	41.694	0.186	-	4.91	0.99	*0.03	-
April	40,086.90	402.618	39.47	-	-	5.01	0.95	-	-
May	40,595.30	443.135	41.303	0.028	-	5.48	1.02	*0.03	-
June	40,363.20	957.051	50.457	1.729	-	11.86	1.25	0.04	-
July	44,556.50	1938.805	61.95	5.253	0.471	21.75	1.39	0.012	*0.03
August	46,134.20	2316.431	60.227	2.938	0.959	25.1	1.30	0.06	*0.03
September	47,430.00	2012.364	55.971	1.603	1.338	21.21	1.18	0.03	0.03
October	47,899.10	936.415	45.644	0.472	1.360	9.77	0.95	*0.03	0.03
November	46,457.10	533.362	59.336	0.342	3.606	5.74	1.28	*0.03	0.08
December	46,714.00	659.860	60.941	1.134	1.585	7.06	1.30	*0.03	*0.03
TOTAL	523,013.50	11499.571	594.581	14.822	9.625	128.77	13.56	0.46	0.29
AVERAGE	43,584.45	958.297	49.548	1.235	0.802	10.73	1.13	0.07	*0.03
MAXIMUM	47,899.10	2316.431	61.95	5.253	3.606	25.1	1.39	0.12	0.08
MINIMUM	37,939.70	348.018	37.1645	0.028	0.137	4.59	0.94	0.03	0.03

* Only a portion of the total volume was treated.

7.7 Hydraulic Conditions

The combination of the raw water transmission system and the Balara water treatment system is schematically shown in Fig. 4.1.1.

Plant No. 1 receives the raw water from Aqueduct No. 1 and No. 2 which has a combined capacity of 470,000 m^3/d with a horseshoe cross-section of dimensions 1.70 X 2.03 m.

Plant No. 2 receives the raw water from Aqueduct No. 3 with a capacity of 1,140,000 m^3/d. Its tunnel portion cross section is horseshoe-shaped measuring 2.70 X 2.90 m. All of the raw water transmission systems depend upon the gravity system, and pumping stations are only employed in the distribution system as a supplement for the higher elevation areas being served by the Balara Water Supply System.

To maximize the use of the gravity system to meet the water demand several sluice gates are installed at the intake tower in the La Mesa Dam to control effluent from the reservoir. Effluent control is conducted by manipulating the opening of the sluice gates based on the measured values of the venturi meters.

The raw water taken by the Balara Plant is treated as it undergoes several processes as hydraulically shown in Figs. 7.7.1 and 7.7.2 which include coagulation, flocculation, sedimentation, and filtration.

The following shows the operation features and problems of the Plant from the viewpoint of hydraulics.

Coagulation and flocculation processes employed in Plant No. 1 is by mechanical mixing which controls energy input to the raw water .

While in Plant No. 2 a hydraulic rapid mixing structure, the parshall flume, is used. The degree of turbulence in the hydraulic mixer is measured by the loss of head and is dependent on the flow rate. As inflow rate changes, energy input to the raw water changes accordingly.

Problems such as lack of energy input could occur in cases of decreased flow rate, as water demand in Metro Manila is projected to increase uniformly.

The sedimentation process employed in both Plant No. 1 and No. 2 is plain sedimentation in which detention time ranges from 1.61 to 2.81 hours. The necessary detention time is theoretically chosen in connection with surface loading which ranges from 22.95 to 52 mm/min by the settling velocity of particles in raw water. According to the actual operations record on turbidity removal, detention time and surface loading could be within the allowable range even if they deviate from normal standards. However, the weir loading rate of more than 5,000 $m^3/m/d$ for the weir installed at the end of sedimentation is too high to withdraw settled water properly. A floc carry over can be detected and it is described in 7.8.

The designed filtration process is a system of constant-rate filtration using a rate-controller installed at the effluent line. At present, due to superannuation of rate controllers, filter beds are operated as declining-rate filtration system. Washwater drains through washwater trough, washwater gullet, washwater drain sluice gate, and washwater drainage channel. Hydraulic capacity of a series of washwater drain system of Plant No. 2 is observed to be insufficient so that washwater troughs are submerged and not functional during backwash.

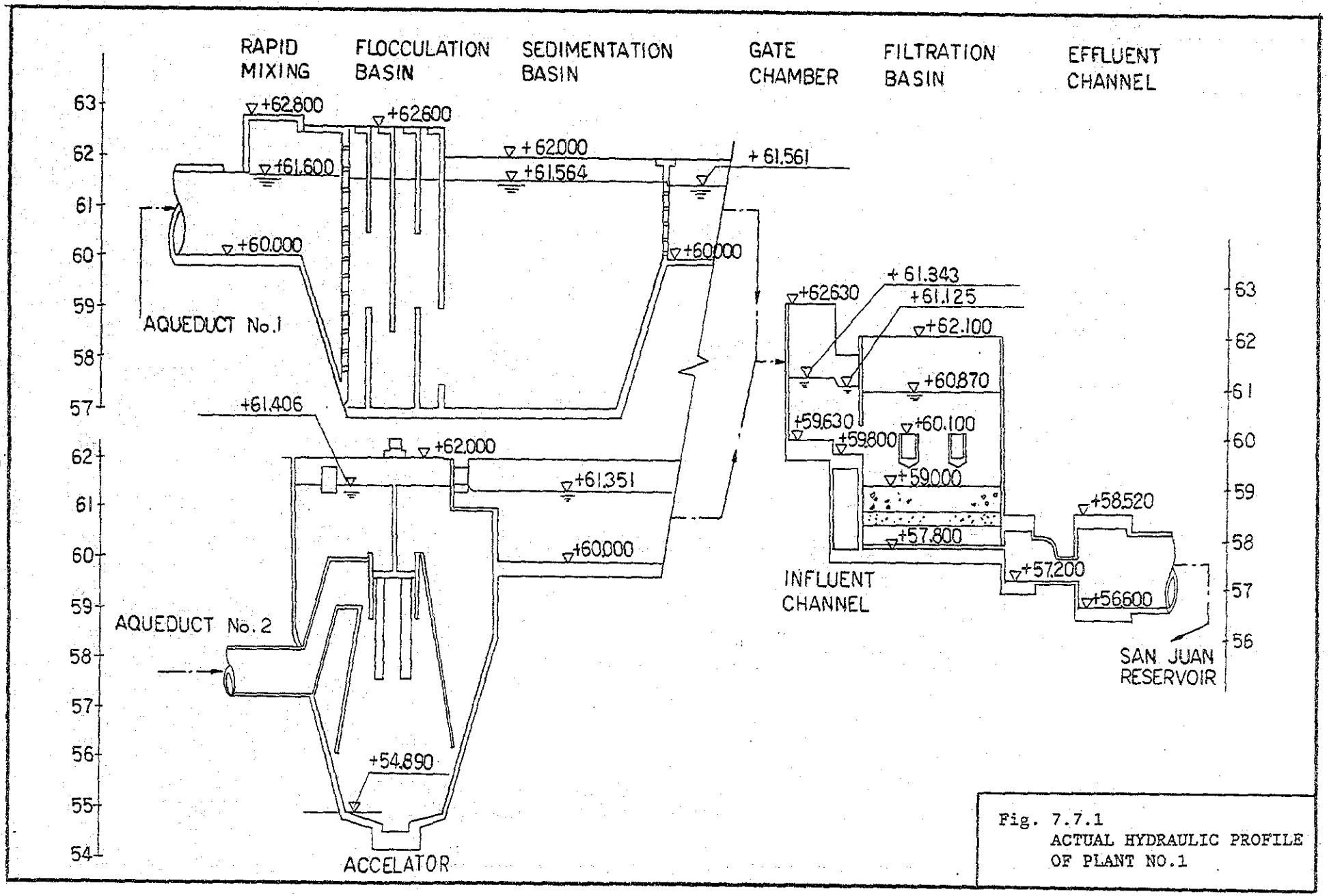


Fig. 7.7.1
ACTUAL HYDRAULIC PROFILE OF PLANT NO.1

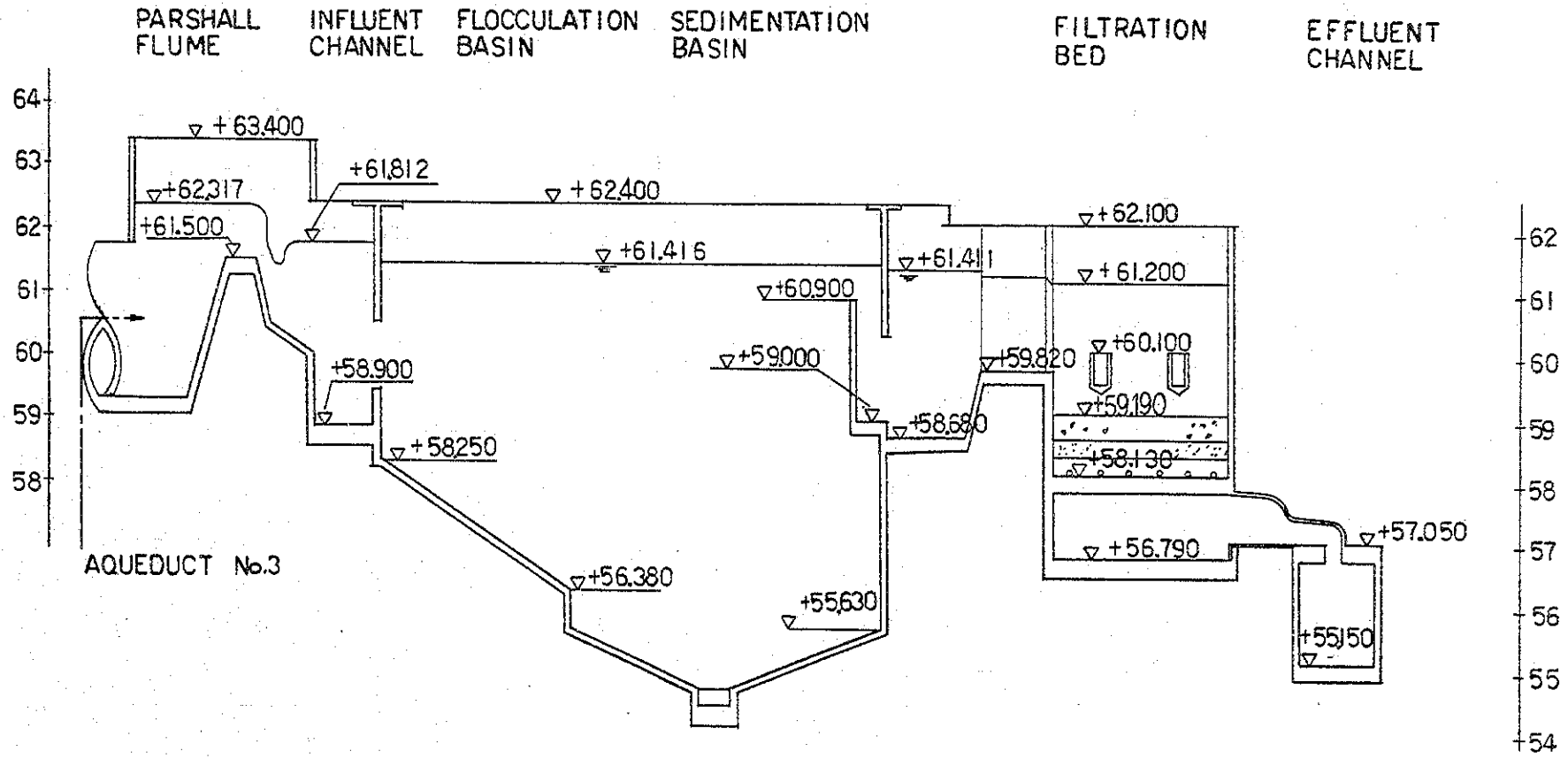


Fig. 7.7.2
ACTUAL HYDRAULIC PROFILE OF PLANT NO.2

7.8 Water Quality

7.8.1 Water Quality Standard

The National Standards for Drinking Water, 1978, prepared by the Ministry of Health, prescribes the maximum permissible level of the parameters that affect the quality of drinking water. The standard includes requirements for bacteriological, physical, chemical, radioactive, and biological aspects and the sampling methods and frequency. The analytical methods on the other hand are prescribed in "The Manual of Standard Methods for the Analysis of Air and Water", Vol.2, 1978, prepared by the Human Settlements Commission. Permissible limits on the physical, chemical and radiological aspects of water quality is shown in Table 7.8.1. Residual chlorine is regulated in chapter I Introduction, Item 2 Adequacy of Treatment of the standard to maintain not less than 0.1 mg/l at the furthest point of distribution system.

7.8.2 Water Quality Analysis

Water quality analysis in relation to the Balara Water Supply System is conducted by two sections namely, the Process Quality Unit (PQU) and the Water Research Analysis Section.

The PQU which is under the control of the Water Sources and Treatment Department is responsible for monitoring water quality from water sources at Angat, Ipo, Bicti, and La Mesa specifically water quality as it passes through different stages from raw water, treated water (water treated after coagulation and flocculation), influent water (water after sedimentation), filtered water, and finished water (filtered water after chlorination).

The Water Research Analysis Section which is under the control of the Central Laboratory Division monitors and safeguards the quality of supplied water in accordance with the aforementioned National Standards for Drinking Water, 1978. Sampling of supplied water is undertaken by other affiliated sections namely: the Field Survey and the Sampling Section.

The Plant Laboratory which belongs to the PQU is located in the Filtration Building of Plant No.2. Essential laboratory equipment for water quality processes are found in this laboratory. Complex analytical equipment like gas chromatography and atomic absorption spectrophotometer are available at the Central Laboratory since they conduct studies and experiments to recommend economical and optimum operation of water quality control such as jar test proceedings, availability of new chemicals, and optimization of chemical application.

The working conditions of these laboratory equipment are described in Table 7.8.2 and 7.8.3. Since most of these equipment are quite old, spare parts are not available. Replacement of the equipment and provision of consumable supplies is highly recommended.

7.8.3 Water Quality Control

(1) Process Water Quality Control

Table 7.8.4 and 7.8.5 shows the results of the latest water turbidity test which was recorded by the Plant Laboratory of PQU of Plant No. 1 and No. 2 from April to October 1991. Turbidity of finished water exceeds the drinking water standard of 5 mg/l when raw water is very turbid specifically when raw water turbidity is beyond 40 mg/l during rainy season.

In addition, as shown in Table 7.8.5 typical problems could be pointed out in water quality between inflow water before the weir which is sampled at the end of sedimentation basin and inflow water after the weir which is sampled just after the sedimentation basin before the inlet to the filter beds. Turbidity in inflow water after the weir is higher than that of inflow water before the weir. This means that settled solids are stirred-up again and then carried over to the filter beds. These phenomena could be related to the performance of the overflow weir where weir loading rate is more than 5,000 $m^3/m/d$ and extremely deviates from the standard of 300-500 $m^3/m/d$.

Problems of the sedimentation basins in Plant No. 1 are similar to

Plant No. 2 as shown in the monitoring results presentedas Figs.7.8.1 and 7.8.2.

Referring to Appendix J, Supporting Report, monitoring process water of the Balara Plant was conducted by the Study Team from 20th September to 22nd October 1991 considering on the pH, conductivity, alkalinity, and turbidity. Results revealed that pH, conductivity, and alkalinity were fair since pH values ranged from 6.4 to 7.3, conductivity ranged from 115 to 150 μs/cm, and alkalinity ranged from 45 to 60 mg/l. From 0.24 mg/l of theoretical reduction ratio of alkalinity by unit alum dosage and desirable residual alkalinity of 20 mg/l in filtered water, 25 mg/l of alkalinity is available at least in the worst case. Thus, the raw water is of desirable quality after undergoing the existing water treatment process in the Balara Plant. These findings are supported by the data prepared by the PQU during January to December in 1990 as shown in Table 7.8.6.

(2) Service Water Quality Control

In order to study the water quality of the Balara Water Supply System in which some 111 representative sampling points were indicated to be zero in residual chlorine (as reported in the "PRELIMINARY ENGINEERING REPORT WATER DISTRIBUTION SYSTEM; VOL. 1 - TEXT", in November, 1989 on the ANGAT WATER SUPPLY OPTIMIZATION PROJECT), an analysis of the residual chlorine in the distribution lines was conducted. The area being served solely by the Balara Plant was isolated and divided into four districts for the sake of convenience as shown in Fig. 7.8.5. Sampling points were identified on the basis of its proximity to the trunk main as shown in Fig. 7.8.4. This was done to prevent the distributed water contaminated through the service pipings from being sampled, otherwise, unreliable test results will be obtained. Other test results were also conducted,namely, coliform test(test paper), turbidity test (Turbidimeter), conductivity (conductivity meter) and pH (pH meter).

As shown in Table 7.8.7, residual chlorine was sufficiently detected to be ranging from an average of 0.20 to 0.7 in all parts of the study area. This is stressed further depending on the proximity of

the sampling point from the trunk main where high residual chlorine levels were monitored. However there are some service pipelines which have been monitored to contain only traces of residual chlorine. Such a situation occasionally occurs due to changes in the distribution pressure. Almost all of the trace level of residual chlorine was monitored in areas where there is low water pressure and the service pipelines are antiquated, specifically the Makati and Manila areas. In Marikina and Pasig, where numerous construction developments are taking place, some areas were observed to be low in residual chlorine due to the shortage of water supply.

Also it has been noted that power interruptions in the Balara plant drastically affects the residual chlorine concentration in the distribution lines. Booster pumps for the chlorinators are inoperational during power failures. At such time, residual chlorine was detected to be zero at areas near the Plant.

Further, sample collection procedure from faucets demand special attention. It could cause wrong results especially in turbidity, color, and residual chlorine if the faucet is not allowed to flush any stagnant water from the service line. The flushing time needs usually 2 to 5 min., when the water temperature begins to drop and sample collection could be allowed. Thus, zero chlorine could be monitored in November, 1989 on the ANGAT WATER SUPPLY OPTIMIZATION PROJECT.

Accordingly, it is evident that chlorination itself is carried out perfectly through the trunk main, a marked improvement as compared to 1989, which is connected to a direct benefit derived from the "Manila Water Supply Rehabilitation Projects I and II ".

Table 7.8.1 WATER QUALITY STANDARD ON PHYSICAL CHEMICAL AND RADIOLOGICAL REQUIREMENTS

Parameter	Maximum Permissible level*
Turbidity	5 units
Color	5 units (s) **
Odor	Unobjectionable
Threshold odor number	Not more than 3
Taste	Unobjectionable
Total Solids	500 (s)
pH	6.5 - 8.5
Phenolic substances	0.001
Radioactive Substances	
Gross Alpha	3 pCi/l
Gross Beta	30 pCi/l
Trace Elements	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Copper	1.0
Cyanide	0.05
Fluoride	0.6
Iron	1.0 (s)
Lead	0.05
Manganese	0.5 (s)
Mercury	0.002
Selenium	0.01
Zinc	5.0 (s)
Organic Chemicals	
Synthetic	
Detergents (MBAS)	0.5
Oil & Grease	Nil
Persistent Pesticides	
Aldrin	0.001
DDT	0.05
Dieldrin	0.001
Chlordane	0.003
Endrin	0.0002
Heptachlor	0.0001
Lindane	0.004
Toxaphane	0.005
Methoxychlor	0.1
2,4-D	0.1
2,4,5-T	0.01
PCB	Nil
Other Chemicals	
Calcium	75
Chloride	200 (s)
Magnesium	50 (s)
Nitrate (NO_3)	30
Sulfate	200 (s)
Hydrogen sulfide	0.05 (S)

* All units are in mg/l unless, otherwise stated.
** (S)- Secondary standards; Compliance with the standard and analysis are not obligatory.

TABLE 7.8.2 EXISTING CONDITIONS OF PLANT LABORATORY EQUIPMENT

No.	EQUIPMENT NAME	Q'ty	Remarks
1.	Turbidimeter	1	working, but has to be regulated
2.	pH meter	1	working
3.	Taylor Water Analyzer	1	working, but inaccurate, obsolete
4.	Jar Tester	1	working
5.	Analytical Balance	1	inaccurate, obsolete
6.	Muffle Furnace	1	out of order
7.	BOD Incubator	1	working, obsolete
8.	Spectornic 20	1	working, obsolete
9.	Microscope	1	working
10.	Quebec Colony Counter	1	working, obsolete
11.	Gravity meter	1	working, partly damaged
12.	Refrigerator	1	working
13.	Airconditioner	1	out of order
14.	Autoclave	1	working, obsolete
15.	Incubator 37°C & 45°C	2	working, obsolete
16.	Fume Hood	1	out of order
17.	Distilling Apparatus	1	working, obsolete

(Note) Articles for consumption like glassware and chemical reagents are excluded.

TABLE 7.8.3 EXISTING CONDITIONS OF CENTRAL LABORATORY EQUIPMENT

No.	Equipment Name	Q'ty	Remarks
1.	Autoclave	3	2 units working, 1 unit out of order
2.	Incubator 37°C & 45°C	2	working
3.	BOD Incubator at 25°C	1	working
4.	Spectornic 20	1	working
5.	Atomic Absorption Spectrophotometer	1	out of order
6.	Flame Photometer	1	working
7.	Gas Chromatograph	1	working
8.	Muffle Furnace	2	1 unit working, 1 unit out of order
9.	pH meter	2	working, obsolete
10.	HACH Calorimeter	1	working
11.	Analytical Balance	2	working but has to be regulated, obsolete
12.	Top loading Balance	2	working
13.	Water Bath	1	working
14.	Multi Heater for Reflex COD Analysis	1	working
15.	Hot Air Sterilizer	2	working
16.	Dry Oven	2	1 unit working, 1 unit out of order
17.	Microscope	2	working
18.	Refrigerator	1	working
19.	Freezer	1	working
20.	Vacuum Pressure Pump	1	working
21.	Fume Hood	2	working
22.	Hot Plate	1	working
23.	Magnetic Stirrer	3	working
24.	Stirrer Hot Plate	1	working
25.	Quebec Colony Counter	1	working, obsolete
26.	Bacticinerator	1	working
27.	Distilling Apparatus	2	1 unit working, 1 unit out of order
28.	Centrifuge	1	working
29.	Turbidimeter	1	working but inaccurate, obsolete
30.	Jar Tester	1	working
31.	Tecator Aquatec Flow Analysis	1	under repair
32.	UV-VIS Spectronic 1001	2	working
33.	Conductivity Meter	1	working
34.	Taylor Water Analyzer	1	working but inaccurate, obsolete
35.	Dessicating Cabinet	1	working
36.	Water Sampler	2	working, obsolete
37.	DPD Chlorine Comparison Kit	3	working but inaccurate, obsolete
38.	Thermometer	3	working but inaccurate, not for analytical use
39.	Culture Medicine Bottle	-	working
40.	Water Sampling Bottle	-	working

(Notes) : Articles for consumption like glassware and chemical reagents are excluded.

TABLE 7.8.4 WATER TURBIDITY (mg/l) IN PLANT NO. 1

PERIOD IN 1991	RAW WATER	TREATED WATER	INFLOW WATER	FILTERED WATER	FINISHED WATER
April	9.69	-	5.11	2.36	3.40
May	11.21	5.35	5.59	1.98	3.42
June	33.25	12.34	7.41	3.36	3.92
July	73.47	18.47	15.73	5.46	5.63
August	50.80	18.80	14.54	6.22	6.33
September	42.07	10.57	8.76	5.00	5.21
October	13.05	6.65	6.84	3.03	3.50

Source: Plant Laboratory of PQU

TABLE 7.8.5 WATER TURBIDITY (mg/l) IN PLANT NO. 2

PERIOD IN 1991	RAW WATER	TREATED WATER	INFLOW WATER 1	INFLOW WATER 2	FILTERED WATER	FINISHED WATER
April	10.51	-	5.74	6.78	3.31	3.26
May	10.61	9.08	6.04	7.17	2.83	3.02
June	27.91	25.75	7.28	9.23	3.54	3.50
July	54.06	50.63	6.94	14.78	4.98	5.14
August	52.15	49.63	14.81	22.90	6.75	5.56
September	37.64	37.18	8.82	9.84	5.64	4.18
October	12.13	10.65	7.70	8.75	3.72	4.27

Source: Plant Laboratory of PQU

TABLE 7.8.6 PHYSICAL AND CHEMICAL ANALYSIS DATA OF BALARA RAW, TREATED, INFLUENT, FILTERED AND FINISHED WATER FROM JAN., 1990 TO DEC., 1990

	Water Samples	pH	Acidity mg/l	Free CO_2 mg/l	Alkalinity mg/l	Bicarbonates mg/l	Hardness mg/l	Chlorides mg/l	Iron mg/l	Residual Chlorine mg/l
AVERAGE	Raw	7.45	6.43	5.66	51.22	62.49	53.49	7.74	0.12	
	Treated	7.17	9.27	8.16	51.40	62.71	52.62	7.50		
	Influent	7.20	8.70	7.66	51.07	62.31	50.82	7.38		
	Filtered	7.19	5.58	4.91	48.60	59.29	51.36	7.45		
	Finished	7.05	8.18	7.20	48.38	59.02	50.22	7.59	0.08	0.53
MAXIMUM	Raw	7.48	12.40	10.91	57.00	69.54	69.00	8.50	0.18	
	Treated	7.19	13.20	11.61	57.40	70.03	62.00	8.35		
	Influent	7.45	12.10	10.64	56.00	68.32	62.00	8.18		
	Filtered	7.41	11.80	10.38	53.00	64.66	64.00	8.45		
	Finished	7.30	10.60	9.32	54.68	66.71	60.00	8.39	0.10	0.66
MINIMUM	Raw	7.31	6.40	5.63	46.00	56.12	45.67	7.52	0.08	
	Treated	6.74	6.40	5.63	46.39	56.60	45.28	5.84		
	Influent	6.94	6.30	5.54	45.28	55.24	40.09	6.10		
	Filtered	6.95	6.30	5.54	43.08	52.56	42.22	6.47		
	Finished	6.95	6.60	5.81	41.61	50.76	41.17	6.61	0.06	0.38

TABLE 7.8.7 SUMMARY OF WATER QUALITY ANALYSIS DISTRIBUTED IN BALARA SERVICE AREA

ITEM No.	District		Temp. (°C)	Res. Chlorine (mg/l)	Turbidity (NTU)	pH	Conductivity (uS/cm)	Coliform (Count/ml)
1	Quezon city	MAX	31.5	1.3	9.4	7.24	164.6	15
		MIN	26.4	0.0	1.3	6.30	119.3	ND
		AVE	28.4	0.4	4.1	6.82	135.5	<1
2	San Juan - Mandaluyong	MAX	29.5	1.2	9.9	7.16	150.2	ND
		MIN	26.0	0.0	1.5	6.51	118.8	ND
		AVE	27.5	0.5	4.4	6.82	132.5	ND
3	Manila	MAX	31.4	1.2	6.6	7.02	154.0	ND
		MIN	26.8	0.0	1.9	6.50	123.1	ND
		AVE	27.7	0.2	4.0	6.77	135.8	ND
4	Makati	MAX	30.0	1.3	19.0	7.23	153.7	ND
		MIN	26.3	0.1	1.9	6.30	123.3	ND
		AVE	27.6	0.7	4.7	6.83	134.9	ND

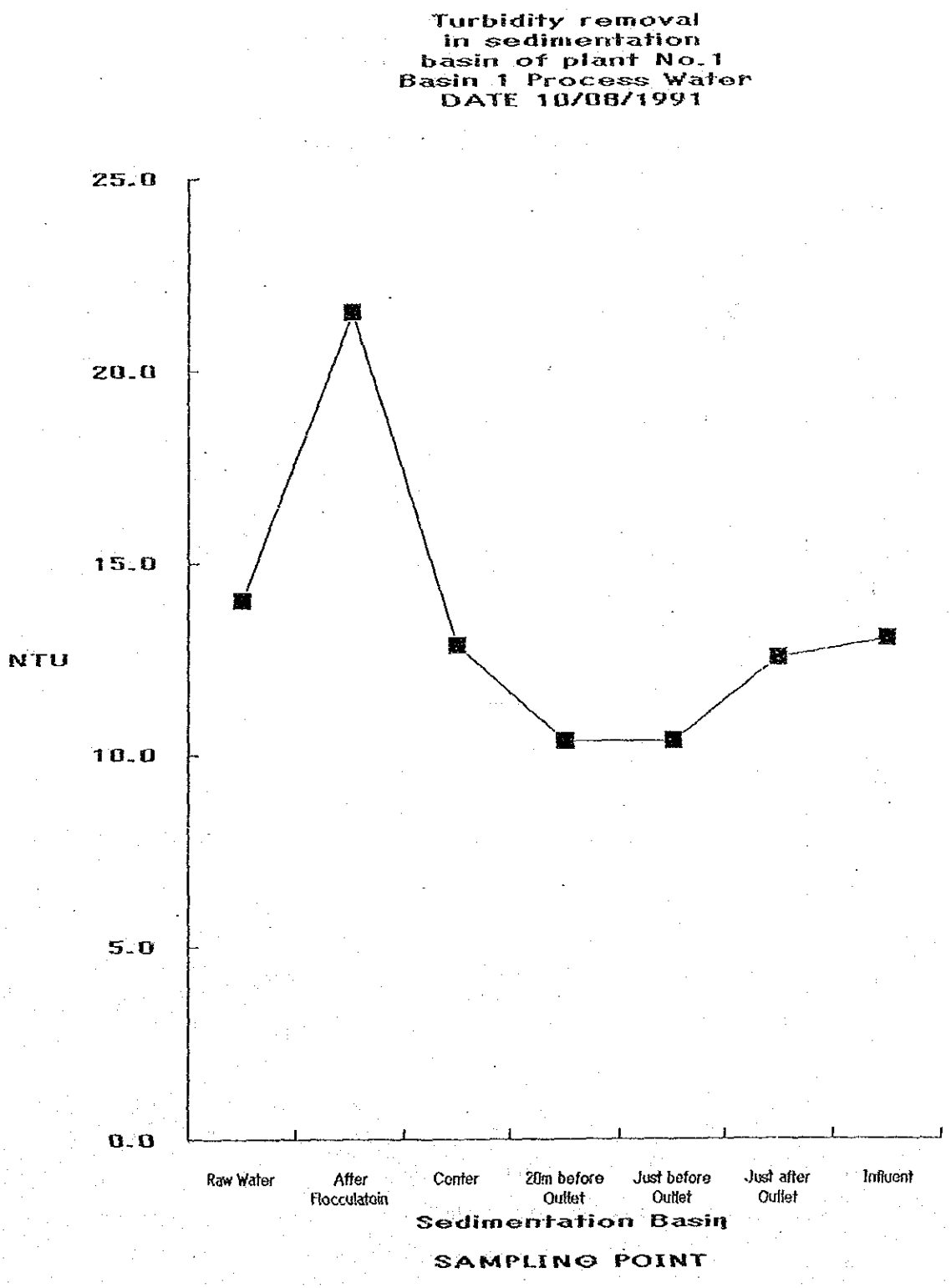


Fig.7.8.1
TURBIDITY IN SEDIMENTATION BASIN IN PLANT NO.1

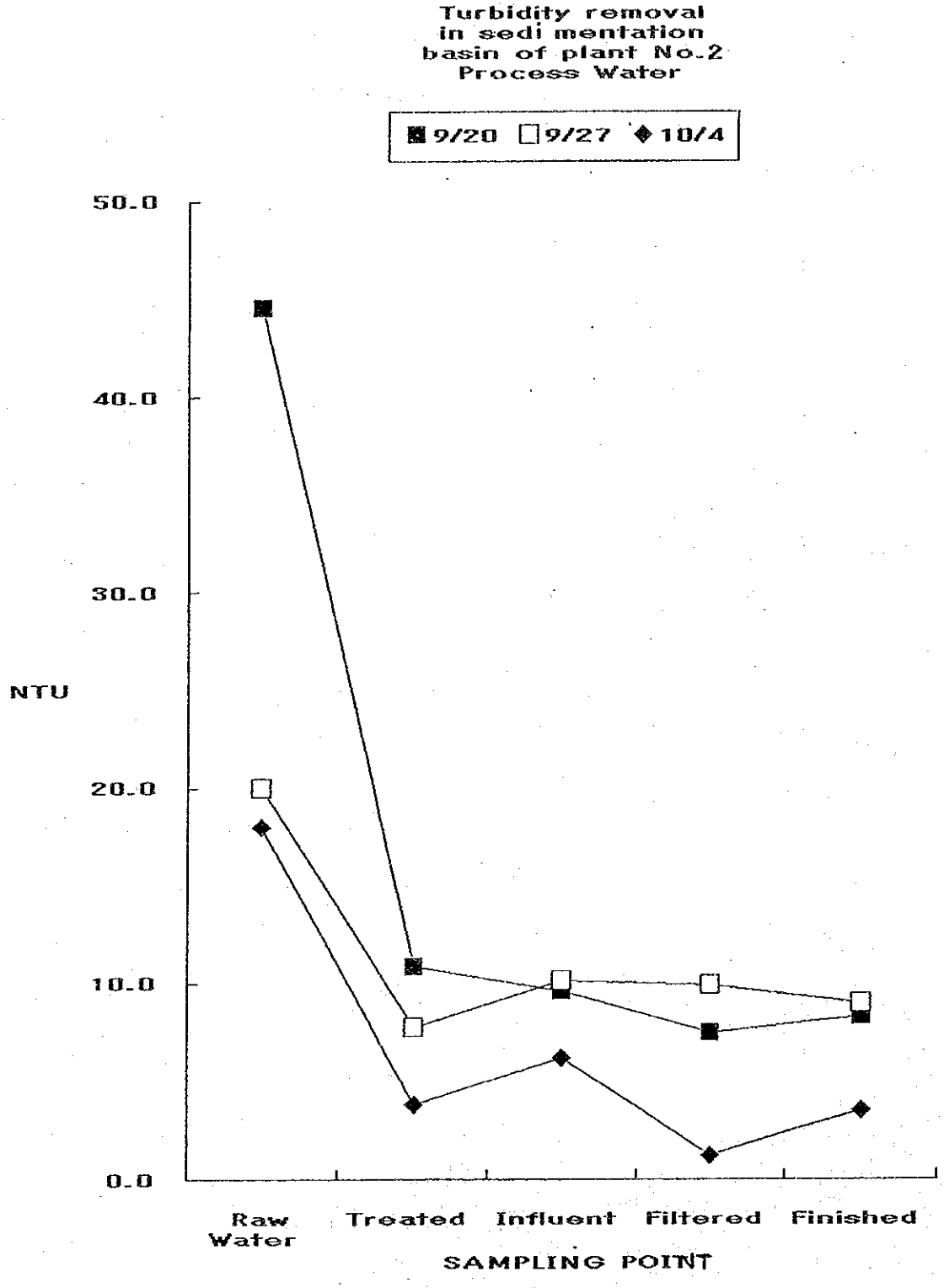


Fig.7.8.2
TURBIDITY IN SEDIMENTATION BASIN IN PLANT NO.2

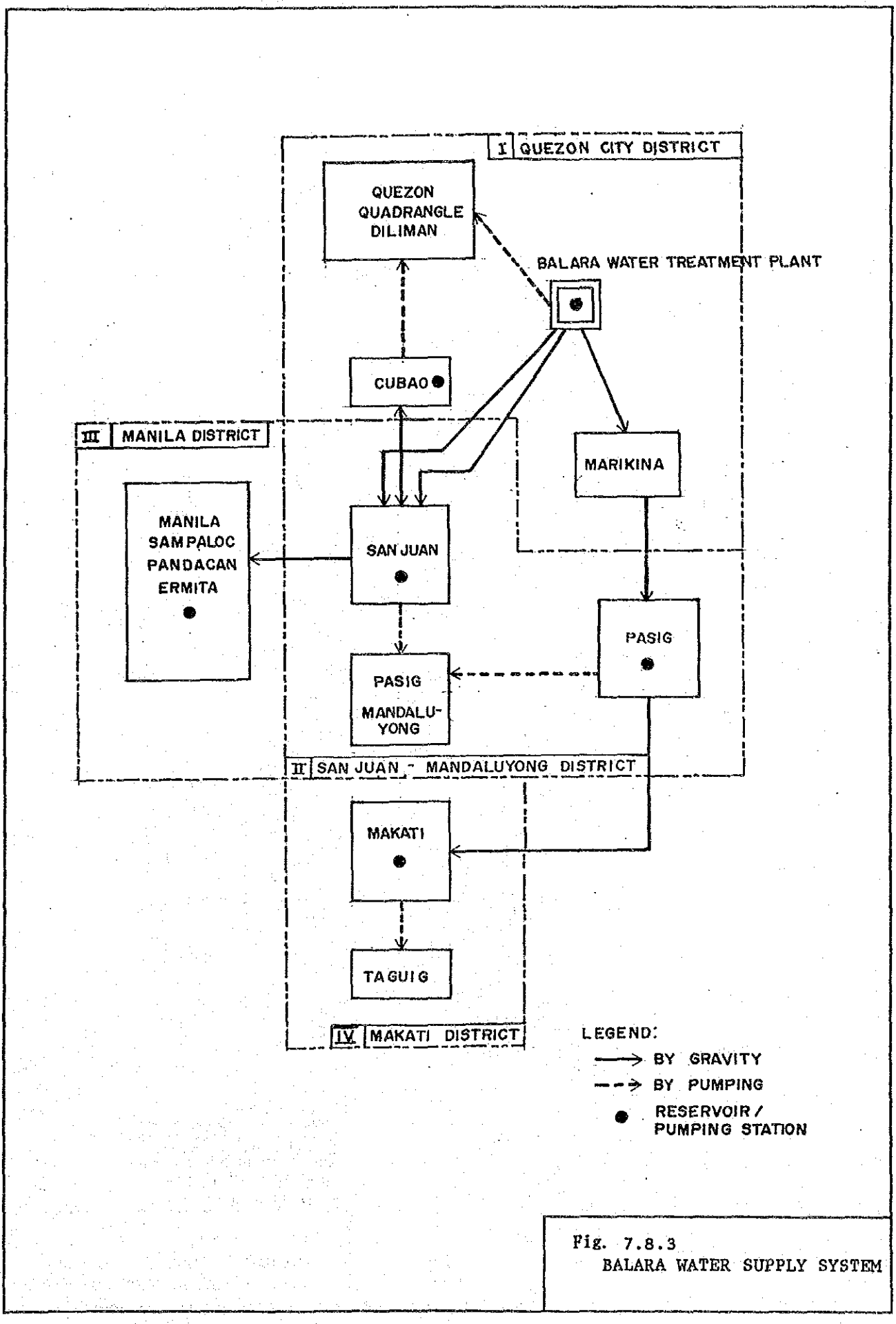


Fig. 7.8.3
BALARA WATER SUPPLY SYSTEM

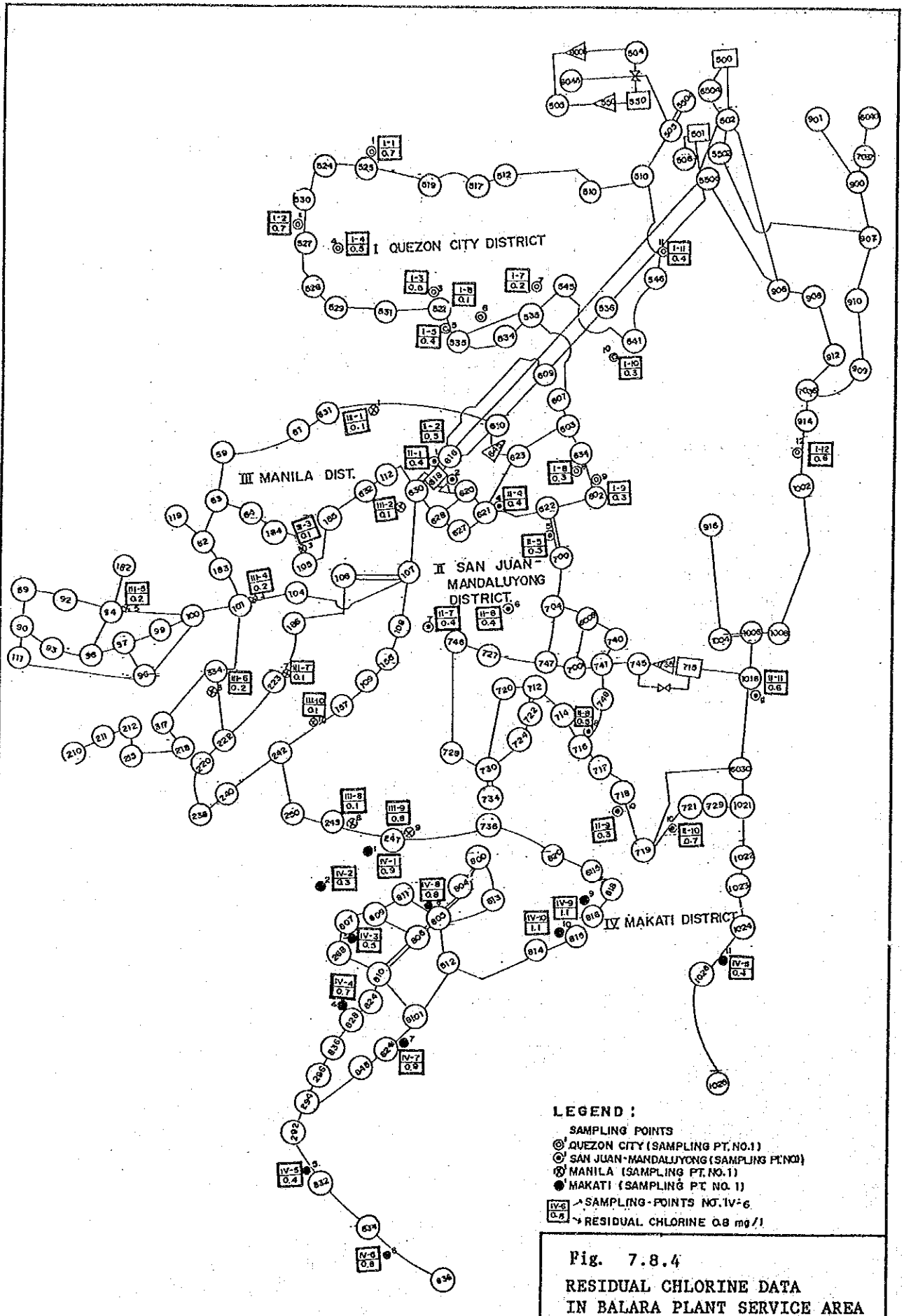


Fig. 7.8.4
RESIDUAL CHLORINE DATA
IN BALARA PLANT SERVICE AREA

7.9 Operation and Maintenance Cost.

The O & M costs for the last five years of the Balara Plant is summarized in Table 7.9.1

Table 7.9.1 O & M IN LAST 5 YEARS 1986-1990

Section/Items	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990
Chemical Treatment Section					
Chemicals	28,133,894.00	19,656,836.04	19,656,836.04	34,697,447.63	33,894,146.40
Official Supplies & Materials	49,252.13	64,626.78	64,626.78	64,447.46	72,348.87
Personnel	1,159,971.00	1,178,789.49	1,198,789.49	1,754,867.31	1,963,245.27
Filter Plant Operation Section					
Office Supplies & Materials	3,000.00	3,500.00	3,000.00	3,000.00	24,873.33
Personnel	1,372,984.87	1,517,701.56	2,073,128.79	2,522,386.66	3,466,171.94
Instrument Field Service Section					
Materials	231,689.75	220,990.01	400,815.91	393,762.31	212,821.08
Personnel	197,460.61	191,031.97	188,144.35	199,912.19	189,477.55
Treatment Plants Mechanical &					
Electrical Section					
Prevention Maintenance	115,872.19	353,575.98	180,555.61	59,914.51	150,100.95
General Repair	1,895,083.88	703,163.85	1,840,850.73	1,730,207.61	1,318,326.78
Personnel	348,872.64	438,834.61	481,533.82	576,283.65	702,808.40
Electricity	1,973,275.40	2,143,463.00	1,973,275.40	5,333,564.21	6,329,952.62
TOTAL	37,481,356.47	26,472,513.29	28,061,556.92	47,335,793.54	48,323,273.19

In addition, the composition ratio of total repair expenses (material of the Instrument Field Service Section, prevention maintenance and general repair of the TP Mechanical & Electrical Section) indicates only 3.5% for all the ratio appears very low, comparing with that one ranging 15% to 20% of Tokyo Metropolitan Government Waterworks Bureau%.

Taking into consideration the diference of personnel expenses, welfare expenses and etc., the value of the ratio becomes lower, which seems that repair expenses for all budgets are not given proper attention and priority.

The volume produced in the Balara Plant for distribution from 1986 to 1990 are shown in Table 7.9.2.

Table 7.9.2 TOTAL VOLUME PRODUCED IN THE BALARA PLANT (Unit:ML)

Year	Filter 1	Filter 2	Total	(Corrected)
1986	166,691.0	390,486.5	557,177.5	534,397.4
1987	163,482.2	379,589.5	543,071.7	521,429.7
1988	152,854.3	375,745.3	528,599.6	509,568.0
1989	151,461.8	378,676.9	530,138.7	511,068.7
1990	160,931.4	362.945.6	523,837.0	504,032.88

Source : Balara Treatment Plant Division (BTPD)

The corrected figures are the total volumes of filtered water sent to distribution and were obtained after deducting the losses during filtration process wherein the factor of 0.9782 was used.

Power Consumption for the last five years is referred as follows:

Year	POWER CONSUMPTION (kWh)
1986	3,443,555.00
1987	3,740,548.67
1988	3,273,107.89
1989	9,307,580.03
1990	13,458,063.00

Source : BTPD

7.10 Summary of Findings

The following are findings and recommendations relating to the processes of the Balara Plant.

7.10.1 Findings

(1) Plant No.1

1) Raw Water Conveyance

Four out of the five units of sluice gates are not functioning due to worn-out sluice gate guides.

2) Rapid Mixing

Although two units of rapid mixers are operational at present, frequency and cost of maintenance are increasing due to superannuation. The shafts has been revolving eccentrically due to the length of shaft and the rapid stream flowing in the channel.

3) Flocculation

Although most of the flocculators are operational at present, frequency and cost of maintenance are also increasing due to superannuation. Four flocculators out of the twenty four units have no motor due to burn-out. Frequency and cost of maintenance for the equipment, especially drive units, are increasing due to superannuation.

4) Sedimentation

Weir loading rate is calculated to be over 6,000 $m^3/m/d$ which extremely deviates from the 300 to 500 $m^3/m/d$ standard. Accordingly, flocs being carried over to filters are observed and filter run may be shortened.

Sludge discharge is not functioning due to insufficient hydraulic gradient between the sedimentation basin No. 1/No. 2 and the dis-

charge creek inside the premises of the Plant due to accumulation of discharged sludge.

5) Accelators

Two units of rotor mixing units are operational at present, frequency and cost of maintenance for the reduction gears and worm gears, which are installed in 1958, are increasing due to superannuation. Submersible steel structures are partly corroded. Also, the sludge blow-off system, which bears an essential role in maintaining a stable slurry concentration is out of order.

6) Filtration

Most of the equipment such as rate of flow control system for filtration, rate of flow control system for surface wash and backwash, sheets of influent and drain sluice gate, pumps and air compressors for hydraulic control, and air compressors for pneumatic instrumentation are superannuated.

The existing surface wash system is ineffective especially during initial operation due to the angle of the perforations of the surface wash pipe to the anthracite level.

The results of grain size analysis show that sand is still useful. However, specifications of anthracite, such as size and specific gravity deviate from the designed values. Depth of filter media is also not in accordance with the designed values.

7) Washwater and Recovery Pump

These second hand pumps had been transferred to the present locations in 1981, some pumps , however, were not very suitable for the usage. Efficiency of pump is low compared to the designed value due to superannuation and apparent leakage at the pump bearings.

The pump houses are also superannuated, and this affects maintenance conditions.

Recovery water is returned to the sedimentation No. 2 in which treatment effects are most likely to be worse than that of No. 1 due to the unstable current caused by the curved section of the Sedimentation basin.

(2) Plant No.2

1) Rapid mixing

At present the parshall flume is working effectively as a hydraulic rapid mixer, however, due to worn-out of flow indicators, accurate measurement cannot be conducted.

2) Flocculation

Several units of flocculators are not functioning due to the defective driving gears , chain and severe water leakages at the driving shafts. Even for the operating units of flocculators, frequency and cost of maintenance are increasing due to superannuation. Metal parts are corroded and rotation is not smooth. Short-circuiting might occur in the tank due to the installation level of flocculators and baffle walls.

3) Sedimentation

Some cracks on the foundation of the headstocks of the influent sluice gates are apparent. In addition , shaft supports of the drain sluice gate are corroded. Weir loading rate of the existing weir of each sedimentation basin is calculated to be 5000 $m^3/m/d$, extremely deviating from the 300 to 500 $m^3/m/d$ standard. Carrying over of particles which were stirred up after settling, were also observed in the basin.

4) Filtration

Most of the items related to the control of the filtration system such as the control units, flow control systems for filtration, surface wash and backwash, sheets of inlet and drain sluice gate,

pumps and air compressors for hydraulic control, and air compressors for pneumatic instrumentation are all superannuated.

Washwater troughs are not functioning due to submergence during backwash, caused by a series of hydraulic problems such as the opening size of wash drain sluice gates and available hydraulic gradient through drainage channel.

5) Washwater Pump

One of three washwater pumps has no motor due to burn-out. Although the remaining pumps are operational at present, frequency and cost of maintenance are increasing due to superannuation.

The pump house is also decrepit, thus affecting maintenance conditions.

6) Washwater Recovery

Washwater from filters in Plant No.2 is discharged to creeks, then, it is stored and introduced to Washwater Recovery Pumps by flush boards on the creeks. At present, water is not returned to the Accelators thereby affecting their stable operation.

(3) Chemical/Chlorine Facilities

Mechanical parts controlling the rotational speed of alum feeders and polymer feeders are so superannuated that the actual dosing amount is not consistent.

According to the actual dose test made by the Study Team, accuracy of dose amount of polymer is not consistent.

Although chlorination facilities including chlorinators, evaporators, chlorine leak detectors, exhaust fan, chlorine booster pumps and dosing pipelines are operational at present, frequency of maintenance and cost are increasing due to superannuation.

The existing chlorine storage house can store chlorine for only one week's use, and therefore needs further expansion.

(4) Laboratory Equipment

Almost all of the equipment used at the plant laboratory are obsolete. Some equipment which requires a degree of accuracy are utilized even without any calibration.

(5) Electrical Facilities

1) Substation

The overhead distribution lines have difficult points of maintenance owing to the lack of isolation devices at the point of tapping. Also, the existing lines are installed on wooden poles which are mostly deteriorated and hazardously inclined.

2) Diesel Engine Generator

During power interruptions (brown-outs) the booster pumps of the chlorinators are inoperational, cutting-off the supply of chlorine to the distribution pipeline for the entire duration of the brown-out.

3) Low Voltage Distribution Lines

Although low voltage distribution lines in Plant No.1 was rehabilitated by replacing wooden poles in 1981, these lines at present are not properly maintained. The lines have large voltage fluctuations and voltage imbalance among three phases at Motor Control Center (MCC) in Plant No.1 Filter Building were recorded.

4) Control Facilities

Most of DP/MCC are installed near their loads and with enough maintenance spaces. However, they have been deteriorating due to corrosion brought about by high humidity and temperature and suffer from shortage of spare parts.

Houses for control facilities at Settling Basins No. 1 & No. 2 are not spacious enough for maintenance purposes. MCC of flocculators in Plant No. 2, also has a very narrow space near the locker room in the Filter Building. These conditions are not appropriate from the viewpoint of safety.

5) Instrumentation & Supervision Systems

Instrument information is not monitored by the sanitary engineer due to damages on the instrumentation system caused by lightning in 1984 and voltage fluctuations. At present, the operator takes the manometer readings of the venturi tube on aqueducts and relays the flow to the engineer by telephone. At the same time, the engineer informs the operators at the reservoir as to the opening of gates at the intake for water inflow control to the plant.

6) Lightning Protection Equipment

In comparison to other areas, frequent occurrence of lightning is evident in the Balara area. Due to this, some electrical and instrumentation facilities in the Plant have been damaged, namely, the ground wire of 34.5 kV overhead distribution line, lightning arresters in substations and the surge absorbers at service points of low voltage distribution lines.

7) Others

There is a very limited quantity of instruments and tools used for maintenance in the Plant and this directly contributes to the lack of proper maintenance of the facilities. As a result, maintenance of electrical equipment and instrumentation is limited to visual inspection and regular cleaning.

7.10.2 Recommendation on Operation and Maintenance for Pre-Rehabilitation

The objectives of a public water supply system is to supply a stable amount of safe water according to the drinking water standard at a reasonable price. To achieve these objectives, water quality control

should be conducted carefully and with certainty in the existing Balara Treatment Plant.

The following shows the findings and recommendations to further improve water quality control at the existing Balara Plant.

(1) Confirmation of Treated Amount of Water in Plant No. 1

Confirmation of treated water amount in Plant No. 1 is recommended to obtain fair water quality control using a flow measurement device at the effluent channel after the sedimentation basin No. 1 and No. 2 and the Accelators.

Unless actual flow rate of the treatment process is obtained, all efforts starting with the coagulation process will be useless. Every step for the process water quality control should be based on the actual inflow including the determination of production amount, filtration rate, chemical dose, and other rates that are measured.

In Plant No. 2 raw water is taken solely from Aqueduct No. 3. Inflow rate detected by the Venturi meter installed at Aqueduct No. 3 should be applied in the same manner as described in Plant No. 1

Regular calibration of flow measurement devices is also recommended by comparing the total inflow rate and effluent rate. If some errors are detected, further inquiry should focus on problems such as mechanical, electrical and/or instrumentation failure during the flow measurement.

(2) Rotation Speed of Flocculators in Plant No. 1

Flocculation is the gentle mixing phase that follows the rapid dispersion of coagulant by the rapid mixer/hydraulic jump. Its purpose is to accelerate the rate of particle collisions, causing the agglomeration of electronically destabilized colloidal particles into settleable and filterable sizes.

The general design criteria for a basic rectangular flocculation tank

are as follows:

Energy input	: G x t = 1 X 10^4 to 1 X 10^5 or G = 10 to 70 sec^{-1}
Detention time	: 20 - 30 min
Water depth	: 3 - 4.5 m
Flocculation stages	: Two to six stages (commonly three to four)
Max flow Velocity (Vertical shaft)	: First stage 2.5 m/sec First stage 0.6 m/sec

The existing facilities have been set as follows:

	NO. 1	NO. 2
Energy input:		
G X t	22,700	16,200
G	12.6-33.5	14.3-33.5
Detention time :	20.2 (17) min	
Flocculation stages:	4 stages	
Max. flow velocity :	0.52-1.0 m/sec	0.57-0.97 m/sec

It is recommended to arrange the rotation speeds of flocculators as follows:

	Revolution	G
1st	34 rpm	60.8 sec^{-1}
2nd	27 rpm	43.5 sec^{-1}
3rd	20 rpm	21.5 sec^{-1}
4th	14 rpm	15.4 sec^{-1}

The expected G X t is 37,600.

(3) Regular Implementation of Sludge Removal from Sedimentation Basins

Regardless of the type of sedimentation basin used, four zones always exist, each with its own function. Every zone should be maintained according to their design. Especially the sludge zones which receives the settled solids and keeps them separate from other particles in the settling zone. Inconsistent sludge removal affects

severely the effluent quality from the sedimentation basins.

For example, stirring up of settled solids and carry-over to the effluent will develop, which results in the insufficient filter run and low productivity of the Plant. In fact, the Study Team observed a difference in the treated water quality between the two Accelator units after one of these accelators were cleaned up. The Accelator, which was cleaned, produced a much better quality of treated water than the other unit which was always kept in operation.

The following shows an example of the sludge production in Sedimentation No. 1 with a capacity of 140,000 m^3/d. Assuming that the turbidity is 16 mg/l and alum dose is 10.13 mg/l, the dry solids amount is obtained as follows:

$140,000\ m^3/d \times (16 + 10.13 \times 156/666) \times 10^{-3} = 2,600\ kg/d$

Assuming that sludge concentration will be 1% (10 kg/m^3), wet solids amount will be obtained as follows:

$2,600\ kg/d \times 1/10 = 260\ m^3/d$

Then, total accumulation of sludge in a month in the sedimentation basin No. 1 is obtained as follows:

$260\ m^3/d \times 30\ days = 15.25\ m \times 200\ m \times h$

$h = 260 \times 30/15/15.25/200$

$= 2.6\ m$

The 2.6 m of sludge accumulation in a month is sufficient to adversely affect the sedimentation process.

(4) Recovery Water to Sedimentation Basin No. 2 in Plant No. 1

Washwater from each filter in Plant No. 1 is as follows:

Volume : 1.026 m^3

Turbidity: Ave. 1,070

(Max. 3,500)
(Min. 50)

Meanwhile, the Basin No. 2 is introducing raw water.

Flow : 140,000 m^3/d
= 97.22 m^3/min

Turbidity: rainy season Ave. 35
dry season Ave. 8

If recover water is returned within one hour, mixed water is as follows:

Flow : 97.22 + 1,026/60 = 114.32 m^3/d (118%)

Turbidity : rainy season 190 (540%)
dry season 167 (2,088%)

In case of two hours return,

Flow : 97.22 + 1,026/120 = 105.77 m^3/d (109%)

Turbidity : rainy season 119 (339%)
dry season 94 (11,730%)

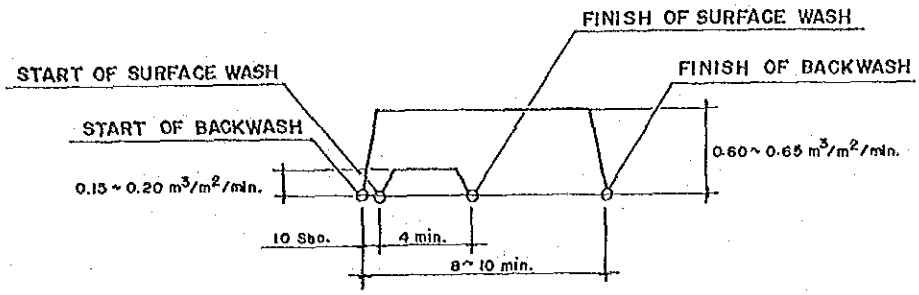
Therefore, it is recommended to return recovery water with a smaller capacity or in a longer period.

(5) Filter Washing Schedule

Washing is a critically important step in the filtration process, and inadequate washing causes the most operational problems associated with filtration such as mudball formation, turbidity break through the filter, etc.

For the filters to operate efficiently, the following procedures are recommended:

For Plant No. 1, washwater tank capacity is 1,026 m^3 and its minimum recovery time is calculated to be 44 min according to the pump discharge capacity. To maximize the performance of the filter facilities, figure below shows a typical washing operation schedule.

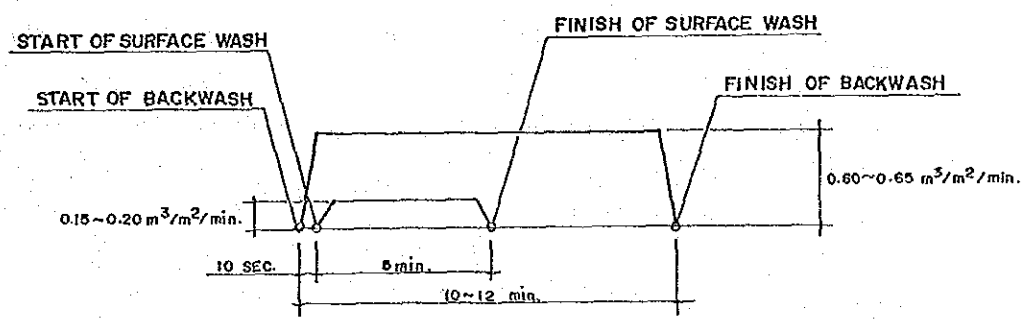


RECOMMENDED WASHING SCHEDULE FOR PLANT NO. 1

Combination of surface wash and backwash provides a violent scrubbing of the area between the anthracite and sand layers where most of the filtered materials are removed. Washing rate should be adjusted by the valves, after confirming of the rising ratio of water level. Backwash is then stopped when the wash water become clean.

For Plant No. 2, washwater tank capacity is 1,308 m^3 (X 2 tanks) and its recovery time is less than 1 hour.

Recommended washing schedule is described as shown below; Plant operation procedure should be the same as mentioned in Plant No. 1.



RECOMMENDED WASHING SCHEDULE FOR PLANT NO.2

The recommendations mentioned above are made on the basis that wash water tank is available in full capacity.

Likewise in Plant No. 2, during backwashing the collecting troughs are not functioning due to submergence caused by the insufficient hydraulic head between the top level of the troughs and the drain sluice gate. Wash rate should be adjusted in order that the collecting troughs will not be submerged. If the collecting troughs is

submerged, insufficient washing will occur especially at the other side of filter beds of the wash water gullet.

The existing perforations of surface washing pipes are designed horizontally, which could not release energy of the surface wash water to the filter media effectively. Surface wash is recommended especially just after 10 sec. of backwash started in order to maximize the energy input by the pressured wash water. In addition, it is very important to draw down the water level in the beds to the level of the surface wash pipings installed before starting the washing.

(6) Fill Up Anthracite

According to the investigation done by the Study Team, it was confirmed that some anthracite were lost during backwashing as shown in the attached results of filter media depth check. This may be unavoidable if surface wash is employed. Thus, filter media monitoring is recommended to be conducted regularly. Meanwhile, refilling up of anthracite to its designed thickness is highly recommended.

If the thickness of filter media does not meet the original design, washwater will be wasted and washing time will be extended.

Specification including effective size and specific gravity should be complied strictly with the designed values of 0.9 to 1.1 mm and 1.45 to 1.60, respectively.

(7) Chemical Dosage

In connection with the filtered water quality, turbidity is occasionally detected to be higher level than the National Standards for Drinking Water, 1978. That could result in not only overloading of the superannuated facilities and structural defects but also inconsistent operation of chemical dosage . At present, optimum chemical dosage are initiated by Jar Test by PQU, however it is not reflected immediately to the actual operation of chemical feeding facilities. Even after rehabilitation if optimum dosage will not be applied at the appropriate time, the improvement in water quality could not be

achieved, which should be one of the major objective for the rehabilitation. Chemical feeding facilities should strictly follow the Jar Test result. Accumulated Jar Test results should be also available to be able to take some measures if unexpected conditions would happen on the treatment process.

(8) Inspection and Maintenance

Management of water treatment plants involves two kinds of activities operation and maintenance. Operation is concerned with the production of the proper quality and quantity of water by controlling the facilities and equipment, while maintenance activities takes care of the facilities and equipment to ensure a reliable, stable and continuous operation, free from troubles and damages.It is recommended to inspect and maintain the facilities regularly.

(9) Others

Some minor items were observed during our study.

a. uneven chemical dosage at flocculation basin of Sedimentation Basins in Plant No. 1.
b. uneven quality of influent water to filter from Sedimentation Basins and Accelators.
c. opening of influent sluice gates at Sedimentation Basins in Plant No. 2 (hydraulic jump)
d. tightening of drive chains of flocculators in Plant No. 2
e. arrangement of chemical dosing pipes for easy calibration
f. cleaning of Rotometer
g. storage of chlorine gas cylinders

CHAPTER 8 ORGANIZATION AND INSTITUTION

8.1 Organization of MWSS

The principal objective of this chapter is to describe how MWSS is organized and to ensure that the completed rehabilitation work of the Balara Plant will be appropriately managed.

The water supply system for Metro Manila was established based on the assistance of Don Fransisco Carriedo's fund. At that time, the water system harnessed water from Santolan area on the Marikina river with pumps and the water was transmitted to a reservoir in San Juan and then conveyed to the Manila City through 650mm dia distribution pipeline by gravity. The system was strengthened gradually and in 1919 the organization was set up as Metropolitan Manila Water District by the Act No. 2832 and got responsible for the Manila City and the adjacent 14 municipalities. After World War II, in 1955, in order to accelerate the restoration for devastated facilities, the National Waterworks and Sewerage Authority (NWSA) was established. In 1971, NWSA was reorganized into two water-related organizations, namely MWSS and LWUA by the Act No. 6234, "An Act Creating the Metropolitan Waterworks and Sewerage System and Dissolving the National Waterworks and Sewerage Authority, for Other Purposes".

The organization of MWSS is shown in Fig. 8.1.1. The Board of Trustees is an organ for "decision-making" and is composed of ten members including Board Secretary. It is the rule that the Secretary of the Department of Public Works and Highways (DPWH) plays the role of ex-officio Chairman unless the President of the Philippines shall appoint another person as Chairman. And the Administrator of MWSS plays as the Vice-Chairman. According to the rule, the Undersecretary (for Construction) of Public Works and Highways is placed as the Administrator, unless another person shall be appointed designated by the President of the Philippines. Six members of the Board shall be appointed by the President and the one remainder is placed from the Government Corporate Council as a legal Adviser of the Board.

One Senior Deputy Administrator and six Deputy Administrators are

supporting the Administrator.

Number of MWSS employee is 8,962 persons as of August 31, 1991, of which 4,803 are permanent employees and the rest are casual employees. Table 8.1.1 shows the number of MWSS personnel by Department.

Table 8.1.1 NUMBER OF MWSS PERSONNEL BY DEPARTMENT AS OF AUGUST 31, 1991

EMPLOYMENT STATUS/DEPARTMENT	Total	Regular	Casual
Total Employees	8,962	4,803	4,159
Office of the Board of Trustees	13	13	0
(Sub Total)	13	13	0
Office of the Administrator		40	
Public Information		35	
Corplan Group		15	
MIS Group		4	
PMED		26	
System Development		17	
Computer Service center		124	
(Sub Total)	282	261	21
Engineering		26	
Planning & Programming		66	
Design		97	
Applied Res. & Quality Con.		34	
(Sub Total)	367	223	144
Construction Management		7	
MWSP II		15	
MWSP III		5	
MWSP		7	
MWSRP I		8	
MWSRP II		8	
Locally Founded		146	
(Sub Total)	2,988	196	2,792
Operations		6	
Water Sources & Treatment		260	
Water Distribution & Maint.		816	
Sewerage Systems		283	
Central Maintenance		212	
(Sub Total)	1,859	1,577	282

EMPLOYMENT STATUS/DEPARTMENT	Total	Regular	Casual
Customers Services		6	
North Sector		313	
East Sector		364	
South Sector		367	
West Sector		363	
Cavite-Muni Sector		300	
Big Accounts & Census Sector		125	
(Sub Total)	2,737	1,838	899
Finance		5	
Financial Control		71	
Accounting		141	
Treasury		161	
(Sub Total)	388	378	10
Administration		5	
Personnel Management		47	
Human Resource Dep.t		33	
Health & Safety		39	
Procurement		20	
Legal		28	
General Services		145	
(Sub Total)	328	317	11

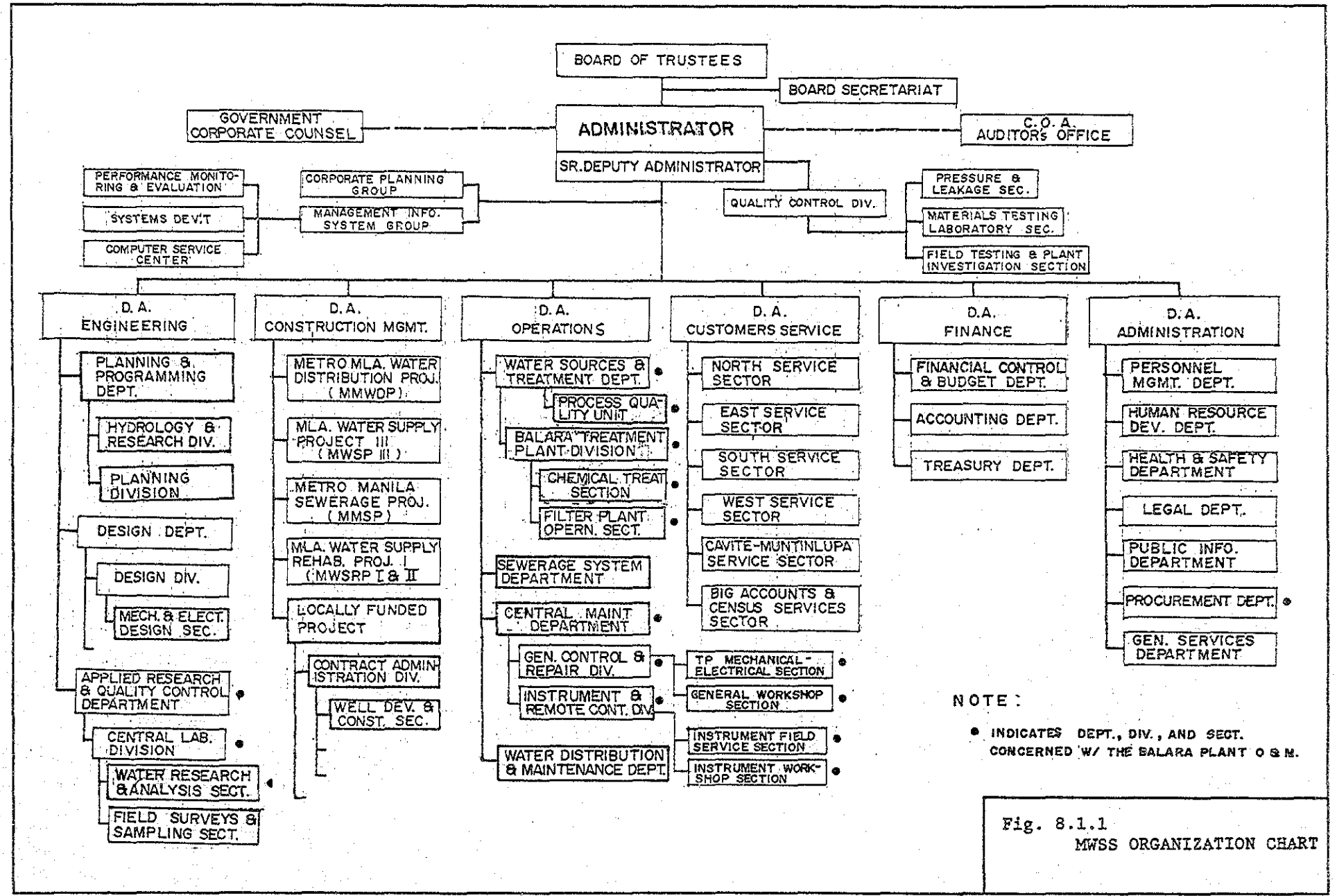


Fig. 8.1.1
MWSS ORGANIZATION CHART

8.2 Organization for the Balara Plant

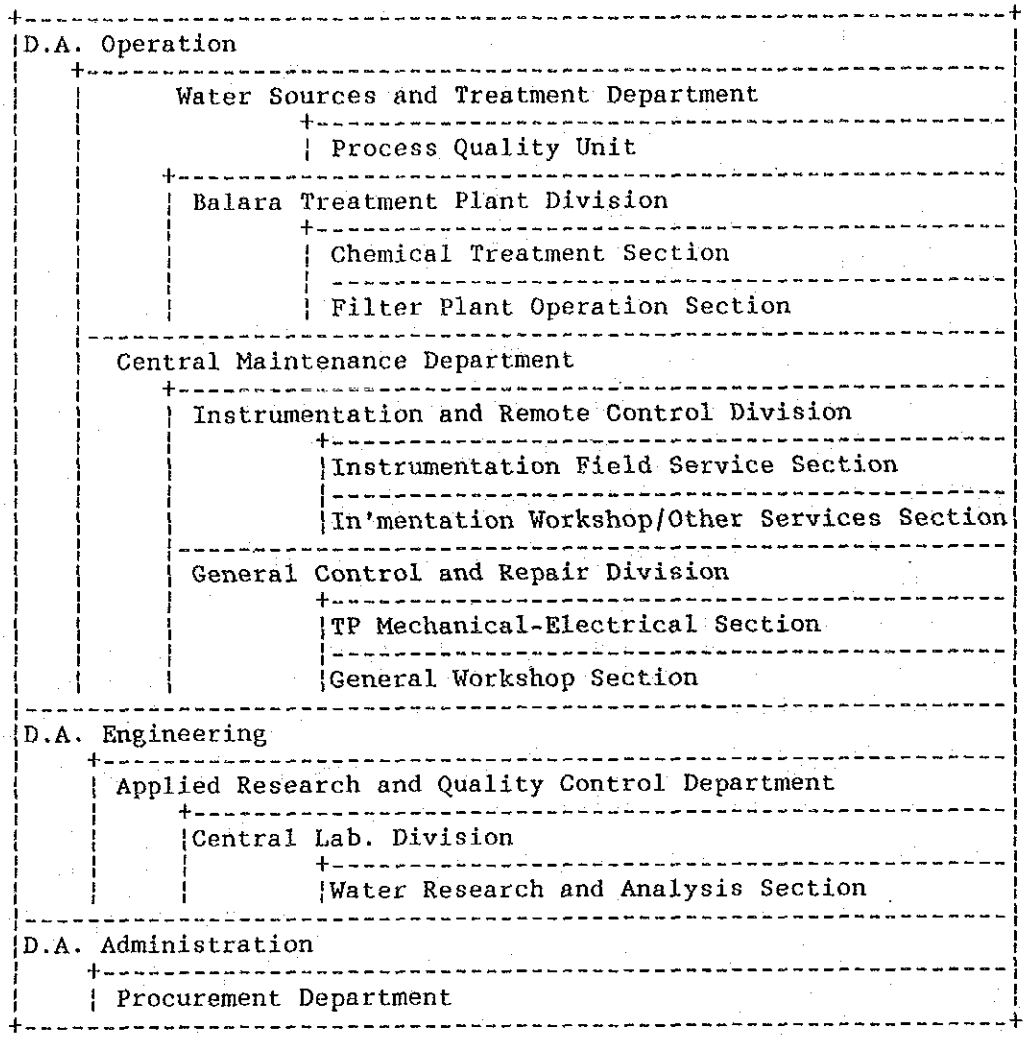
8.2.1 General Observation

In general, it is quite impressive that the existing treatment plant has been operated and maintained in a very professional manner by the concerned division staffs. The facilities were observed to be operated and maintained adequately despite the lack of spare parts, testing equipment, and malfunctioning of flocculators at Plant No. 2 and deficient instrumentation. The facilities and its premises are clean and overall housekeeping is always maintained at a high level.

The operation and maintenance of the Balara Plant, the La Mesa Plant, Distribution and Sewerage System is under the Deputy Administrator for Operations. (See Fig. 8.1.1 Organization Chart of MWSS). However, to operate and maintain the Balara Plant, two other Departments under the D.A. for Administration and the Applied Research and Quality Control Department under the D.A. for Engineering are concerned with the processing of purchase orders. Although at present, this complicated organizational set-up was observed to attain mutual cooperation, it will become more difficult once La Mesa No. 2 commences its operation.

8.2.2 Organizations and Duties

The following are the Deputy Administrators, Departments, Divisions and Sections concerned with the O & M of the Balara Plant.



Plant operations falls under the responsibility of the Water Sources and Treatment Department.

The duties of Chemical Treatment Section are:

- To plan, organize and control the optimum utilization of chemicals to ensure efficient water treatment process thereby maximizing production of potable water for the consuming public; and,
- to direct and control the plant operation and monitor minor repairs and maintenance of all chemical feeders, chlorination and other dosing equipment.

The main duty of the filter Plant Operation Section is:

- to operate filtration plants, pumping stations and storage reservoirs at San Juan.

The maintenance of equipment and the conduct of the water analysis in the Plant are separate activities. The maintenance of equipment is the responsibility of the Central Maintenance Department. Four sections under this Department are listed below. The duties of each section are as follows:

1) Instrumentation Field Service Section
- to repair, maintain and calibrate all treatment plant process instrumentation such as control, pneumatic, electric instruments, chemical and instrumentation control devices at the Balara Plant, La Mesa Plant, and at the different pumping stations.

2) Duties of Mechanical-Electrical Section
- to repair and conduct preventive maintenance action on treatment plants and water sources equipment/facilities within the system
- to recommend, perform, replace and modify existing treatment equipment facilities.

3) Instrumentation Workshop & Other Services Section
- to set up control or test methods and devices at the shop
- to record technical information
- to coordinate with Instrumentation Field Service Section and Maintenance Specialist Staff.

4) General Workshop Section
- to ensure the best use of machine tools according to the necessity of repair and technical modifications.
- to work closely with maintenance specialist staff and Field Mechanical and Electrical Section

Daily water analysis check in the Balara Plant is the responsibility of the Process quality unit (PQU) which is directly under the Water Sources and Treatment Department. Its duties are:

- to monitor water quality from the water sources at Angat, Ipo,

Bicti and La Mesa to the treated water of the Balara Plant and the La Mesa Plant in order to maintain the quality of treated water as set forth by the National Standards for Drinking water of the Department of Health.

- to conduct raw water analysis three (3) times a day and check the turbidity on an hourly basis during the rainy season.
- to evaluate the supplied chemicals prior to acceptance and usage.

On the other hand, another section conducts water analysis in the MWSS distribution system. This is under the Central Laboratory Division, specifically, the Water Research and Analysis Section. Its other duties concerned with the Balara Plant are:

- to determine thru research and experimentation by jar tests, feasible and economic alternatives for water clarification and treatment and to evaluate bidden water chemicals.
- to evaluate monitored plant results and thereafter recommend to management the appropriate products for approval.
- to analyze, examine, evaluate water quality complaints by testing samples submitted by MWSS customers.

8.2.3 Staff Numbers

Staff numbers and the position are presented in Table 9.2.1.

Table 8.2.1 STAFF NUMBER AND POSITION*

1. CHEMICAL TREATMENT SECTION	1 - Utilities Services Chief
	1 - Supervision Chemist
	5 - Sr. Water Resources Facilities Technician
	16 - Water Resources Facilities Technician
2. FILTER PLANT OPERATION SECTION	1 - Utilities Servicers Chief
	1 - Supervision Water Utilities Mngt. Officer
	4 - Sr. Water Utilities Mngt. Officer
	1 - Plant Egpt. Operator B
	3 - Sr. Water Facilities Technician
	9 - Water Resources Facilities Technician
	11 - Plant Egpt. Operator A
	1 - Clerk-Processor A
3. INSTRUMENTATION FIELD SERVICES SECTION	1 - Utilities Services Chief
	1 - Utilities Services Officer A
	3 - Utilities Services Officer B
	4 - Instrumentation Technician A
	(40% of above personnel performs the Balara Plant Maintenance)
4. TREATMENT PLANTS MECHANICAL ELECTRICAL SECTION	1 - Utilities Services Chief
	1 - Supvg. Utilities Services Officer
	3 - Sr. Plant Mechanic
	1 - Sr. Plant Electrician
	1 - Water Maintenance Foreman
	1 - Property Officer B
	3 - Plant Mechanic A
	4 - Plant Electrician A
	3 - Sr. Water Maintenance A
	1 - Sr. Water Maintenance B
	1 - Driver Mechanic B
	(65% of above personnel performs the Balara Plant maintenance)
5. PROCESS-QUALITY UNIT	1 - Chief Chemist
	1 - Principal Chemise
	1 - Environmental Specialist
	1 - Sr. Water Resources Facilities Technician
	1 - Water Resources Facilities Technician
	1 - Clark/Processor A
	1 - Sr. Water Resources Facilities Technician
	2 - Plant Helper B
	1 - Driver
6. WATER RESEARCH & ANALYSIS SECTION	1 - Chief Chemist
	1 - Supervising Chemist
	3 - Senior Chemist
	1 - Sr. Environmental Specialist
	1 - Quality Control Inspector

	1 - Water Resource Technician
7. FIELD SURVEY & SAMPLING SECTION	1 - Principal Engineer B 1 - Principal Engineer C 2 - Supervising Engineer B 2 - Sr. Engineer B 3 - Engineering Assistant B 1 - Driver
8. INSTRUMENTATION WORKSHOP & OTHER SERVICES SECTION	1 - Utilities Services Chief 2 - Utilities Services Officer A 1 - Sr. Instrument Technician 1 - Sr. Plant Electrician 1 - Sr. Electronic Communication system Technician 1 - Supvg. Electronic Communication System Technician 1 - Sr. Instrument Technician 1 - Utilities Servicers Officer B (5% of above personnel perform the Balara Plant maintenance)
9. GENERAL WORKSHOP	22 - Personnel (5% of above personnel perform the Balara Plant maintenance)

* (Filled Position only)

8.2.4 Qualification of the Balara-related Staff

As mentioned previously it appears that the Plant has been operated and maintained in very professional manner by the concerned division staff.

According to the information from the Personnel Management Department, educational classification of the staff shows approximately 20% percent of college/university graduates and 80% of high school/locational graduates excluding the composition of the PQU & Central Labo.

As a conclusion the educational composition on the whole Balara - related staff are seasonal and in general it seems important to make on attractive working environment for the mechanical/electrical engineer in the plant.

8.2.5 Present Problems in O & M

Major Problems of the Balara Plant has had:

1) Inefficiency of procurement procedures
2) Low limit of allowable purchasing cost not requiring bidding

procedure

3) Budgetary constraints
4) Understaffed situation in some divisions
5) Lack of modern testing equipment
6) Obsolete repair equipment
7) Similar tasks of water analysis

(1) Inefficiency of the procurement procedure

One of the major problems which MWSS and the Balara Plant has been suffering from is the delay in procuring the necessary spare parts for defective equipment. In MWSS, numerous documents, paperworks and signatures are required for requisitions and purchases. The whole procedure often takes months, or even years in some cases, from the time of requisition application to the arrival of requested equipment and spare parts. The worst case on record took 5 years before requisition arrived.

On the other side, beside the red-tape like procedure, the following are the problems besetting the procurement procedures:

1) Lack of qualified bidders to participate in the bidding. Main cause seems to be different commercial practice between private sector and public sector such as payment method.

2) Inadequacy of submitted specification requirement.

3) The complaints of some losing bidders which takes months to resolve further delays the award to the winning bidder.

4) Procurement is a process entailing action from various departments in MWSS. The performance of each of the units involved in the process is critical to expeditious procurement of the equipment and supplies.

Anyway, as a result of this delay, majority of the malfunctioning equipment has remained at its deteriorated state. This problem concerning spare parts requisition has been a recurring problem in

the MWSS which has resulted in the following:

1) Decline in the quality of treated water which may result to the citizenry's disdain of the System.
2) Overloading to other downstream facilities
3) undesirable result occurs as when the requested spare parts has finally arrived, other parts has also broken down.
4) Some equipment have undergone modifications or has been phased out when the order was finally received.
5) Potential demoralization among the ranks of O & M personnel.

As references, due bidding process and the normal period regulated for public bidding and modified public bidding are attached to the end of this section as Table 8.2.2. and 8.2.3. While one example of the procurement which experienced delay is indicated in Table 8.2.4 as a chronological history. This case took one year and nine months from requisition order to the contract.

(2) Low limit of allowable purchasing cost not requiring bidding procedure.

Another major cause of delay in the procurement of necessary equipment and instrumentation is the current bidding system. Purchases which costs more than P3,000 pesos must be subject to bidding procedures. Since the limit is very low, the bidding system causes much of the procurement inefficiency, since the bidding requires a lot of time to prepare documents and other pertinent papers.

Table 8.2.2 PROCESS IN THE PROCUREMENT OF SUPPLIES, MATERIALS, EQUIPMENT AND GENERAL SERVICES (OSMEGS)
(PUBLIC BIDDING)

OFFICE/RESPONSIBLE PERSONNEL	ACTIVITY	TIME ALLOTED
PREPARATION OF BID DOCUMENTS:		5 Days
	- Confirms correctness of specifications, quantity, etc., determine mode of procurement and prepare bid documents including request for publication.	
INVITATION TO BIDS		15 Days
	- Publishes Invitations to Bids, sends invitation and issues bid documents to prospective bidders/suppliers.	
PRE-QUALIFICATION OF PROSPECTIVE BIDDERS:		14 Days
	- Reviews shop drawings, test samples submitted together with the pre-qualification documents, if required in the specifications.	
	- 7 Days from the deadline of the pre-qualification - pre-bid conference is conducted	
	- 7 Days from the conduct of pre-bid conference - opening of the bids	
	- Pre-qualifies prospective suppliers and submit results to the Administrator for approval.	
OPENING, EVALUATION & RECOMMENDATION FOR AWARDS OF BIDS:		7 Days
	- Open bids and abstract all offers received.	
	- Evaluate bids and submit its recommendation for award.	
	- Deliberates on the analysis of bids, and recommends award to the Adm.	
	- Reviews the recommendation and approves the awards.	
PREPARATION/PROCESSING/ FUNDING OF:		
A. LETTER ORDER		5 Days
B. CONTRACT		9 Days
	- Prepare Letter Order if amount is P500,000.00 below.	
	- Prepare Contract and other requirements, including contract review.	

	- Obligates Funds for Letter Order and for Contract; COA verification funds and approval of C.A.F.	
APPROVAL OF LETTER ORDER/ CONTRACT		4 Days
	- Approval of Letter Order/ Contract, Transmittal to the Board for notation of contract and Notice to Proceed if P500,000.00 or over but not exceeding P2 Million (Contracts exceeding P2 Million shall be approved by the Board of trustees	
SUPPLIER	- Review and sign contract	1 Day
RELEASING OF LETTER ORDER/ CONTRACT P2 MILLION & BELOW		1 Day
	- Release approved Letter Order to supplier concern.	
	- Release Notice to Proceed to Contractor after approval of the Administrator (P500,000.00 but not exceeding P2,000,000.00)	
	- Release Notice to Proceed to Contractor for contract amount exceeding P2 Million after approval of the Board.	
	- Transmit to OGCC of Contract review if Contract amount is ₱10,000,000.00 and over	
OGCC		10 Days
	- Review Contract if ₱10 Million over	
BOARD OF TRUSTEES		
	- For Notation of Contract if amount is more than ₱500,000.00	
	- For approval of Contract if amount is more than ₱2 Million.	

S U M M A R Y:

IF THE AMOUNT INVOLVED IS LESS THAN P500,000.00:	51 days
IF THE AMOUNT INVOLVED IS MORE THAN P500,000.00 BUT NOT EXCEEDING P2,000,000.00	55 days
IF THE AMOUNT INVOLVED IS MORE THAN ₱10 MILLION	65 days

Table 8.2.3 PROCESS IN THE PROCUREMENT OF SUPPLIES, MATERIALS, EQUIPMENT AND GENERAL SERVICES (OSMEGS)
(MODIFIED PUBLIC BIDDING)

OFFICE/RESPONSIBLE PERSONNEL	ACTIVITY	TIME ALLOTED
PREPARATION OF BID DOCUMENTS	- Confirms correctness of specifications, quantity, etc., determine mode of procurement and prepare bid documents.	4 DAYS
INVITATION TO BIDS (Publication of Invitation to Bids)		(5-7 DAYS)
	- Posts scheduled bidding at the bulletin boards within the office.	
	- 5 calendar days if amount of RO is P50,000.00 or less.	5 DAYS
	- 7 calendar days if amount of RO is more than P50,000.00 but less than P200,000.00.	7 DAYS
	- Invites prospective bidders thru telephone calls.	
	- Issues bid documents to prospective bidders/suppliers.	
	- Forwards copies of abstract forms & attachements to Bidding & Documentation Division (BDD) on the date of opening of bids	
OPENING, EVALUATION AND RECOMMENDATION FOR AWARDS:	- Open bids and abstract all offers received.	6 DAYS
	- Evaluate bids and submit its recommendation for award.	
	- Deliberates on the analysis of bids & recommends award to the Adm.	
	- Reviews the recommendation and approves the awards.	
PREPARATION/PROCESSING/ FUNDING OF:		
A. LETTER ORDER		
B. CONTRACT		
	- Prepare Letter Order if amount is P500,000.00 below.	4 DAYS
	- Prepare Contract and other requirements, including contract review.	8 DAYS
CERTIFY FUNDS AVAILABILITY	- Obligates Funds for Letter Order and for Contract; COA verification funds and approval of C.A.F.	

APPROVAL OF LETTER ORDER/ CONTRACT		
	- Approval of Letter Order/Contract. Transmittal to the Board for notation of contract and Notice to Proceed if P500,000.00 or over but not exceeding P2 Million shall be approved by the Brd. of Trustees	4 DAYS
SUPPLIER	- Review and sign contract	1 DAY
RELEASING OF LETTER ORDER/ CONTRACT P2 MILLION & BELOW		1 DAY
	- Release approved Letter Order to supplier concern.	
	- Release Notice to proceed to Contractor after approval of the Administrator (P500,000.00 but not exceeding P2,000,000.00).	
	- Release Notice to Proceed to Contractor for Contract amount exceeding P2 million after approval of the Board of Trustees.	
	- Transmit to OGCC of Contract review if Contract amount is P10 million and over.	
OGCC	- Review Contract if P10 million and over.	10 DAYS
BOARD OF TRUSTEES	- For Notation of Contract if amount is more than P500,000.00.	
	- For approval of Contract if amount is more than P2 million.	

S U M M A R Y:

If amount involved is less than P50,000.00	24 DAYS
If amount involved is more than P50,000.00 but not exceeding P500,000.00	26 DAYS
If amount involved is P500,000.00	40 DAYS

N O T E: The period of delivery was excluded in this computation which varies depending on the items.

Table 8.2.4 CHRONOLOGICAL HISTORY EXAMPLE FOR SPARE PARTS PROCUREMENT

PB-49-90 - SPARE PARTS FOR FOXBORO FLOW & LEVEL INDICATOR

May 10, 1990	:	RO Nos. 252091 dated 11/6/89 and 252093 dated 11/27/89was received by Procurement Department.
July 27, 1990	:	Bidding was published at Manila Times and Daily Inquirer. Opening of bids scheduled for August 24, 1990.
August 10, 1990	:	Opening was postponed for October 11, 1990 because pre-qualification was not completed due to non-submission of Inspection report by the end-user (requisitioner) as required in the pre-qualification of bidders.
August 15, 1990	:	Prepared Notice of Postponement.
September 13, 1990	:	Approved Notice of Postponement was received by Procurement Department.
September 18, 1990	:	Pre-qualification was completed and for approval of the Administrator. As of 9/28/90 pre-qual. statement was not yet approved and opening of bids was postponed for 11/15/90.
October 23, 1990	:	Approved Pre-qualification statement was received by Procurement Department.
November 15, 1990	:	Bidding was opened as scheduled, however, bidding was declared a failure because of the two (2) participating bidders, one (1) was disqualified outright because there was alterations in the delivery period required by MWSS leaving only one (1) participant.
November 26, 1990	:	Bidding was opened with two (2) participating bidders. One bidder was disqualified outright due to non-submission of Warranty Certificate.
December 14, 1990	:	Taken-up at P/PBAC-OSMEGS Committee meeting to resolve the matter on the submission of warranty certificates. The P/PBAC-OSMEGS recommended a negotiated purchase thru the Exclusive Distributor, Instrumentations, Inc. (please refer to Minutes of Meeting of the P/PRAC-OSMEGS Committee meeting held on 14 December 1990).
	:	Negotiations were conducted. Clarification on the specifications of items 8 & 11 was made to the end-user.
December 26, 1991	:	Official quotations of Instrumentations was received by the Procurement Department.

January 10, 1991	:	Taken-up at P/PBAC Committee meeting reagrding the prices offered by Instrumentations and Asia Network (the other bidder) (please refer to P/PBAC Minutes of Meeting of Ja. 10, 1991.
January 28, 1991	:	Official memo regarding the specifications of items 8 & 11 was sent to CMD (end-user).
February 14, 1991	:	Follow-up memo was sent to CMD.
February 22, 1991	:	Received reply of CMD.
February 25, 1991	:	P/PBAC-OSMEGS evaluation/recommendation for award was prepared.
March 13, 1991	:	Evaluation/recommendation was approved. Forwarded to Board Committee on Contracts...
March 26, 1991	:	Board Committee's recommendation was signed by the members.
April 5, 1991	:	Forwarded to Board of Trustees to be taken-up at MWSS Board Meeting.
April 11, 1991	:	Award was confirmed by the Board of Trustees.
April 12, 1991	:	NOA was received by Conrad Marayag. Performance Bond is to be submitted prior to preparation of Contract as required by Legal Dept.
April 17, 1991	:	Received Board Res. No. 79-91
May 10, 1991	:	Due to the urgency of the needs for the spare parts documents were forwarded to Legal Dept. for Contract preparation without the bond.
May 22, 1991	:	Performance Bond was filed by Contractor.
July 29, 1991	:	Approved Contract (NP-02-91) was received by the Procurement Department.
August 8, 1991	:	NTP was received by Conrad Marayag. Signed by Mr. Ruben Romero and returned to Procurement on October 3, 1991.

(3) Budgetary constraints

Another reason for the current procurement delay is the influence of the budget slash beginning from the year 1990 as prescribed by the Department of Budget (DBM). Due to this, the budget necessary to maintain the facilities was not obtained, reducing the budget to almost 50% per year.

(4) Understaffed situation in some Division

The Sections which are understaffed, due to unfilled position at present, are the Instrument Field services Section, Instrument Workshop/Other Services Section, Treatment Plant Mechanical and Electrical Section, Filter Plant Operation Section and Chemical Treatment Section.

The Instrumentation Field Services Section has only nine (9) people including the Section chief, but their responsibility covers the entire Balara Plant, La Mesa Plant No. 1, 14 booster pump and approximately 154 deep well pumping stations. Although the section has requested 10 more instrumentation technicians, no action has been taken to date. Furthermore, since all instrumentation of the Balara Plant will be functionally recovered after the rehabilitation work and taking into consideration the imminent operation of La Mesa No. 2 additional personnel will definitely be required in the near future.

At present, exemption to Administrative Order No. 177 is strongly requested, because of the existing situation wherein only 61% of the total division work load of 242 instruments per day can be maintained by the present number of available technicians from the two sections.

(5) Lack of Modern Testing Equipment/Obsolete Repair Equipment

Another problem is the lack of testing equipment/precision tools and modern repair equipment. The problem is directly related to problems (1) to (3). The testing equipment and precision tools are essential for preventive maintenance procedures in order to recover/maintain the vital treatment functions of the facilities. However, the

present situation seems to show that operation and maintenance is not getting much attention from the administration.

The difficulties encountered in preventive maintenance procedures and low efficiency in repair works which uses obsolete equipment has compounded existing problems.

(6) Similar tasks of Water Analysis

At present, there are three sections which are conducting water analysis in MWSS. The specific duties of each section has been mentioned in previous paragraphs. These Sections are the PQU, Water Research Analysis Sections of the Central Laboratory Division, and Chemical Treatment Sections, La Mesa Plant.

8.3 Institution

The establishment of MWSS, its purpose, function, organization and finance are prescribed in Republic Act No. 6234, "An Act Creating the Metropolitan Waterworks and Sewerage System and Dissolving the National Waterworks and Sewerage Authority ; and for the Other Purpose" which are approved by the President on June 19, 1971. The recapitulation is as follows:

(1) Jurisdiction

1) All supervision and control regarding water supply and sewerage service covering following areas

- 5 cities:
  Manila, Pasay, Quezon, Cavite, Caloocan

- 13 municipalities in Metro Manila:
  Las Pinas, Makati, Malabon, Mandaluyong, Marikina, Muntinlupa, Nabotas, Paranaque, Pasig, Pateros, San Juan, Taguig and Vallenzuela

- 14 municipalities in Rizal Province:

Angono, Antipolo, Baras, Binangonan, Cainta Cardona, Jala-Jala, Montalban, Morong, Pilila, San Mateo. Tanay, Taytay and Teresa

- 5 municipalities in Cavite Province:
  Bacoor, Imus, Kawit, Noveleta, and Rosario

(In addition to these five cities and thirty-two municipalities, "Lungsod Silangan" is legally included as a proposed supply area when the necessary time comes. Also, MWSS can annex one after another areas which are deemed as appropriate expansion areas of Metro Manila, by mutual agreement between the related national and local authorities, and under the approval of the President of the Philippines.)

(2) Principal duties and competence regarding Waterworks

1) Enactment of by laws

2) Construction, operation and maintenance of dams, reservoirs, aqueduct , tunnels, water treatment plans, distribution network, hydrants, pumping station, equipment and other waterworks facilities.

3) Regulation and control covering water supply and its demand, and prevention from the wastage of water.

4) Periodical fix of water tariff schedule,

5) Construction, operation and maintenance of artesian well and spring water resource as may be needed in its operation within its territory.

6) Conclusion of indebtedness and issuance of bond.

7) Approval, regulation and supervision regarding installation, operation and maintenance on waterworks and deep wells for commercial, industrial and governmental purposes.

8) Assistance for installation, operation and maintenance conducted within its jurisdictions

9) Approval and regulation of installation of private waterworks.

10) Monopolistic competence controlling testing, mounting, dismounting and remounting

11) Submission of annual report to the President and two Congresses.

12) Consideration to prevention of environmental pollution, effective utilization of national resources, and beautification of the facilities in connection with its projects.

(3) Board of Trustees

This is the Decision-making organ of MWSS, which has the competence to establish the policies and measures, to prepare the budget of receipts and expenditures and to decide personnel movement.

(4) Regulation regarding indebtedness and bonds

Issuance of obligation and bond requires the approval of the President under the agreement of the Secretary of Finance and the total amount of the obligation excluding interest shall not exceed three billions Pesos. Foreign loans shall be negotiated and concluded by the President and the total amount shall not exceed 600 million US dollars or equivalent.

(5) Assistance to local systems

In response to the request of the various local waterworks MWSS can assist them in terms of technical and management aspects, and MWSS may charge them 10 percent overhead charge in addition to the actual expenses.

8.4 Water-Related Regulations

Purposes of this section are to know the regulation system concerning organization, roles and MWSS performance and to grasp the principal legal requirements for the rehabilitation of the Balara Plant.

In connection with the above purposes, the following Act, Decree, Code and Standard were studied.

1) Republic Act No. 6234 "An act creating the Metropolitan Waterworks and Sewerage System and dissolving the National Waterworks and Sewerage Authority ; and for other purposes.

2) Presidential Decree No. 424 : "Creating a National Water Resources Council ,reconstituting its membership vesting the same with powers to coordinate and integrate water resources development, and providing funds therefore.

3) Philippines Water Code (Presidential Decree No. 1067)

4) National Standards for Drinking Water, 1978

5) Water Tariff Schedule (Latest)

These can be summarized as follows:

1) Republic Act No. 6234

This Act prescribes the establishment of MWSS and its organization and management. The promulgation was made in the year 1971. After then, the Act has been amended ten times and the latest is the one amended in 1987. The principal contents are regarding 1) policy, 2) jurisdiction, 3) capital stock, 4) attributes, powers and functions, 5) the Board of Trustees and to composition, powers and duties, 6) management for organization, 7) construction, repair, work and contracts, 8) audit, 9) review of rates, 10) abolition of NWSA; etc.

2) Presidential Decree No. 424

This Decree prescribes the creation of the National Water Resources Council which is vested the power to control water resource development. The promulgation was made in the year 1974. The purpose of the Decree is to coordinate and to integrate water-concerned projects in order to achieve an orderly and scientific development as well as optimum utilization and control of water resources to meet the present and future water needs of the country.

Practically, this Decree vests the National Water Resources Council the following function of regulatory and executory on overall national plans and programs;

1) Coordinate and integrate, on a sound and logical basis, water resources development activities,

2) Determine, adjudicate, and grant water rights amending,

3) Formulate and promulgate general criteria, methods and standards and furthermore rules and regulation and optimum utilization of water resources,

4) Review and approve water resources development plans and programs, and

5) Apprise and/or advise NEDA on matters pertaining to water resources development projects and programs.

(3) Philippines Water Code

This Code prescribes the regulations governing ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources. Waters, as used in this Code, refers to water under the ground, water above the ground, water in the atmosphere and the waters of the sea within the territorial jurisdiction of the Philippines. The promulgation was made in the year 1976 and

the regulatory agency is the National Water Resources Council established by the Act No.624.

The objectives of this Code are:

1) To establish the basic principles and framework relating to the appropriation, control and conservation of water resources to achieve the optimum development and rational utilization of these resources;

2) To extent of the rights and obligations of water users and owners including the protection and regulation of rights;

3) To adopt a basic law governing water resources and rights to land related thereto; and

4) To identify the administrative agencies which enforce this Code.

(4) National Standards for Drinking Water, 1978

This Standards prescribes drinking water quality standard, sampling methods and survey guidelines. The promulgation was made in the year 1963 and revised in 1978. The water quality (physical, chemical and radiological requirements) are presented in Table 7.8.1 in this Report and residual chlorine is provided that the concentration at the furthest point of the distribution system should be not less than 0.1 mg/l.

(5) Water Tariff Schedule

The latest water tariff schedule of MWSS effective December 12 1990 is presented in Table 8.4.1. In order to avoid the sharp impact on public the rate was risen gradually until May 1st 1990.

Table 8.4.1 WATER TARIFF SCHEDULE

Customer Type/ Consumption Volume	Effectivity Date: Up to 12/31/90	1991 Jan 1	1991 Feb 1	1991 Mar 1	1991 Apr 1	1991 May 1
RESIDENTIAL A						
First 10 Cu.m.	P16.00/Conn.	P16.50	P17.00	P17.50	P18.00	P18.50
Next 10 Cu.m.	2.15/Cu.m.	2.20	2.30	2.35	2.40	2.45
Next 10 Cu.m.	2.70/Cu.m.	2.80	2.90	3.00	3.10	3.20
Next 10 Cu.m.	3.75/Cu.m.	3.85	3.95	4.05	4.15	4.25
Next 10 Cu.m.	4.30/Cu.m.	4.45	4.60	4.75	4.90	5.05
Next 10 Cu.m.	4.85/Cu.m.	5.00	5.15	5.30	5.45	5.60
Next 20 Cu.m.	5.40/Cu.m.	5.60	5.75	5.90	6.10	6.30
Next 20 Cu.m.	5.95/Cu.m.	6.15	6.35	6.55	6.75	6.95
Over 100 Cu.m.	6.50/Cu.m.	6.70	6.90	7.10	7.30	7.50
RESIDENTIAL B						
First 10 Cu.m.	P21.00/Conn.	P21.50	P22.00	P23.00	P23.50	P24.00
Next 10 Cu.m.	2.65/Cu.m.	2.75	2.85	2.95	3.05	3.15
Next 10 Cu.m.	3.20/Cu.m.	3.30	3.40	3.50	3.60	3.70
Next 10 Cu.m.	3.85/Cu.m.	4.00	4.10	4.20	4.30	4.45
Next 10 Cu.m.	4.40/Cu.m.	4.55	4.70	4.85	5.00	5.15
Next 10 Cu.m.	4.95/Cu.m.	5.10	5.25	5.40	5.50	5.70
Next 20 Cu.m.	5.50/Cu.m.	5.70	5.90	6.10	6.30	6.50
Next 20 Cu.m.	6.05/Cu.m.	6.25	6.45	6.65	6.85	7.05
Over 100 Cu.m.	6.60/Cu.m.	6.80	7.00	7.20	7.40	7.60
COMMERCIAL						
First 25 Cu.m.	P175.00/Conn.	P181.25	186.25	191.25	196.25	202.50
Next 975 Cu.m.	7.00/Cu.m.	7.25	7.45	7.65	7.85	8.10
Over 1000 Cu.m.	7.30/Cu.m.	7.55	7.80	8.05	8.30	8.55
INDUSTRIAL						
First 25 Cu.m.	P192.50/Conn.	P198.75	203.75	210.00	216.25	222.50
Next 975 Cu.m.	7.70/Cu.m.	7.95	8.15	8.40	8.65	8.90
Over 1000 Cu.m.	9.10/Cu.m.	9.40	9.70	10.00	10.30	10.60
AVERAGE	4.73	4.88	5.03	5.18	5.33	5.48

Reference : Board Resolution No. 220-90
Prepared by: The Corporate Planning Group
Date : 12 December 1990

CHAPTER 9 REHABILITATION PLAN

9.1 Basic Principle of Rehabilitation Plan

The basic scope of the proposed rehabilitation plan is to recover the functional performance of the Balara Treatment Plant utilizing the existing structures to its maximum. The study will not include any rehabilitation of the distribution system, aqueducts and reservoirs. As mentioned in the previous sections of this study, majority of the rehabilitation plan involves the replacement of defective mechanical and electrical equipment and minor civil works. There were four objectives which were considered in the formulation of the basic principles of the Rehabilitation plan. These are as follows:

(1) Recovery of Treatment Capacity

The underlying intention of the proposed rehabilitation is to restore the efficient treatment capacity of the Plant to the 1981 level which is 1,600,000 m^3/day. MWSS records show that from 1989 to 1990 the actual production of the Plant varied from 1,364,900 m^3/day to 1,554,000 m^3/day. At present, the Plant approximately produces only 1,450,000 m^3/day which is relatively less than the designed capacity (1981 level). The insufficient production is directly related to the superannuated facilities of the Plant.

(2) Good Quality of Treated Water

Since most of the equipment are old, these are prone to frequent mechanical trouble which affects the smooth and continuous operation of the Plant. This does not only affect the total production output but also the quality of treated water. Proper dosage of chemicals is unattainable because of the use of defective dosing equipment, compounded further by the leakages in the dosing pipeline.

(3) Stable Plant Operation

The Rehabilitation plan also intends to maintain a stable operation of the Plant after its completed Rehabilitation. At present, the

operating equipment of the Plant have few stand-by units since most of them are already inoperative. The cost of frequently maintaining some of these superannuated equipment has exceeded acceptable levels. Also, the Rehabilitation intends to furnish only the mechanical and electrical equipment which is suitable to Philippine conditions. This is to further ensure the stable operation of the Plant by providing equipment which can respond adequately to the humid conditions prevailing in the Plant.

(4) Enhancement of O & M Procedures

Another aspect by which this Rehabilitation is to proceed taking into consideration the Operation and Maintenance procedures and the technical know-how governing them. Local Condition is also to be considered at the selection of the equipment to be installed for the project.

One of the actual modification items involved in this aspect is the plan to improve the efficiency of each treatment process. To specifically elaborate, by increasing the efficiency of the sedimentation process through the proposed Rehabilitation items intended for this purpose will reduce the load of work that will be conveyed to the filters, thereby maximizing the capability of each facility.

Secondly, when the proper, suitable equipment is installed, a certain degree of reliability is attained. For instance, in the chemical dosing facilities where the proper dosage of chemicals is critical, accurate measuring devices should always be functioning properly.

Lastly, vital information that is utilized in the overall operation of the Plant should have accurate instrumentation and measuring devices. A specific example which illustrates this idea is the proposed installation of flow meters to accurately measure inflow rate that is important in contributing to the overall operation of the Plant.

This section has enumerated the basic principles which has governed the proposed Rehabilitation plan. For purposes of clarity and defin-

ing the exact limits of the proposed rehabilitation, some of the facts have been often reiterated to achieve the aforementioned purpose.

9.2 Design Capacity

The design capacity is directly restricted by the raw water availability, the hydraulic conditions existing in the aqueducts, and the functional recovery of the Plant facilities. After recovering the function of the Plant thru the proposed rehabilitation project, the capacity will be set at the designed value of 1,600,000 m^3/d which was the original aim of the upgrading project that was implemented in 1981.

The availability of raw water sources has been discussed in the previous sections. As previously stated, the total combined capacity of the aqueducts is limited to 1,705,000 m^3/d taking into consideration the hydraulic performance and size, available head between the water level of the La Mesa Dam and the Plant.

At present, the potential raw water intake capacity, the capacity of the aqueducts, is 6.5% higher than the designed capacity of the treatment plant, which is a percentage difference that is appropriate to the designed capacity.

Design capacity applied in the modification project in 1981 was reported to be 1,600,000 m^3/d. However, the actual productivity of the Plant had a varying range of 1,364,900 m^3/d to 1,554,200 m^3/d from 1989 to 1990, as shown in Table 7.3.2. Average water production at present is approximately 1,450,000 m^3/d which deviates from the 1,600,000 m^3/d design capacity. Several causes are considered to explain the insufficient production:

- Inconsistent operation of the facilities including coagulant dosage, poor chemical mixing and coagulation, inadequate flocculation, insufficient backwash of the filter beds
- Overloading of the superannuated facilities
- Structural defects caused by the former upgrading scheme
- Low water level at Novaliches reservoir during dry season

o Water conservation

External causes were also identified. The transmission mains from the Balara Plant to the San Juan Reservoir which has a total capacity of 1,610,000 m^3/d, based on the report entitled, "REPORT ON OPTIMIZING THE OPERATION OF THE BALARA AND LA MESA WATER FILTRATION PLANTS" which is sufficient to cover the design capacity of the Plant, has not been used effectively in order to avoid leakage problems in the service systems.

9.3 Comparative Study of Alternative and Recommended Plan

The Balara Plant maintains its functions in much the same way since its modification in 1981. However, its superannuation will further accelerate because of the absence of suitable maintenance works due to lack of financial measures. As a result, the maximum production capacity is only 1,550,000 m^3/d which is less than the design capacity of 1,600,000 m^3/d.

In terms of the Rehabilitation Plan that includes mainly mechanical and electrical facilities, it is impractical to attend to the other alternatives technically in some levels. Actually, the implementation of the major rehabilitation scheme is directly related to various aspects, not only technical but also financial and other critical aspects.

Consequently, this study comes up with several levels of the Rehabilitation Plan ranging from the minimum replacement of equipment to the appropriate modernization of facilities involved with the improvement of technical and managerial aspects.

In the preparation, a series of steps were carried out to come up with an optimum level of rehabilitation plan, initiated by setting-up a selection plan of equipment.

The selection plan of equipment includes a possible equipment list that was chosen for every treatment process according to the following plans: Plan 1 provides rehabilitation works with the existing treatment process unaltered that is focused on the replacement of superannuated items for mechanical and electrical facilities. Plan 2 provides rehabilitation works with the existing plant capacity upgraded that is connected to reliable water quality control and O & M. Plan 3 provides rehabilitation works with the improvement on the treatment process including minor modification of the structure that is connected to the application of modernization of each process. This plan referring to Appendix M, Supporting Report provides a framework from which the Rehabilitation Plan is classified according to the technical and other related aspects.

Each possible equipment plan is further evaluated technically taking into consideration the construction plan, hydraulic constraints, water quality control and O & M. Then, the final classification of rehabilitation is formulated according to three levels as shown below:

(1) Level 1

Consists of the minimum replacement of equipment and resumption of the same existing conditions during the modification project in 1981. Necessary review of performance of equipment which will be replaced will be considered. In addition, replacement of vital facilities which are even operational at present such as chlorination facilities are included with Level 1 as a minimum replacement. This level is based on actual successfully managed performance of existing facilities as a whole, but items are limited to only urgent matters.

(2) Level 2

Consists of and in addition to Level 1, stable supply and safe quality of water to be achieved in connection with the improvement of water quality control and O & M. Rehabilitation items will be expanded which will not only involve the replacement of equipment as in Level 1, but also the improvement of process water quality control and the repair of existing structural defects, taking into consideration the actual O & M procedures and financial measures. In addition, the design of this rehabilitation plan is based on necessary and normally prevailing technology.

(3) Level 3

Consists of modernization and possible expansion in terms of water treatment process will be added to Level 2, provided that technical, financial, socio-economic, and environmental aspects are all satisfied.

As a result of the preparation of the Rehabilitation Plan, Table 9.3.1 itemizes the three levels of rehabilitation for each facility.

Based on Table 9.3.1 which compares the different levels of rehabilitation, the most appropriate level of rehabilitation which corresponds adequately to the existing hydraulic and physical conditions of the plant and the accompanying financial considerations is Level 2. This level involves the replacement of defective equipment and facility ; improvement of the process water quality procedures and repair of existing structural defects thus providing a complete approach to the solution of the urgent rehabilitation requirements of the Treatment Plant. As to the expected durability of Level 2, 15 years is assumed since the civil and architectural structures appear to last in the years ahead and normally equipment of the plant is to said to last approximately 15 years.

Level 1 which consists of minimum replacement of equipment and the resumption of existing conditions after the modification project in 1981, is more of short-term in approach. Although this level of rehabilitation will be comparatively lesser in cost and the actual construction will be easily implemented with minor inconveniences, the benefits derived will be superficial. In addition, the expected durability appears to be about 5 years as a whole because the components of Level 1 are minimal replacement as an urgent countermeasure.

Level No. 3 offers a rehabilitation scheme based on a long-term outlook. The scheme which involves the modernization and expansion of the treatment process will entail huge costs as compared to Level No. 1 and 2 which may not be within the existing financial conditions. However, this rehabilitation scheme will provide future generations with an advanced and much-better equipped Treatment Plant.

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (1/8)

PLANT NO. 1

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
1	Aqueduct No. 1 & No. 2	Replacement of headstocks (4 units)	0	0	0	
2	Rapid Mixing	Replacement of rapid mixers (2 units)	0	0	0	
		Construction of baffle walls	-	0	0	
		Replacement of rapid mixers to higher performance of rapid mixing	-	-	-	
3	Flocculation	Replacement of Flocculators (24 + 2 units)	0*	0	0	* Spare only (2 units)
		Replacement of flocculators to widen range of agitation	-	-	-	
		Reconstruction to baffled channel flocculation	-	-	-	
		Construction of control panel house (5 m X 3m X 2 houses)	-	0	0	
4	Sedimentation	Replacement of drain valves (basin-6 units) (channel-4 units)	-	0	0	
		Construction of collecting troughs with perforated baffle walls.	-	0	0	
		Construction of baffle walls in the basin No. 2 (L.S.)	-	0	0	
		Installation of inclined plates with sludge removal system.	-	-	-	
		Excavation of the sludge discharge creek.	0	0	0	
5	Accelators	Replacement of driving units. (2 units)	-	0	0	
		Replacement of sludge blow-off equipment (2	0	0	0	including quick-open valves.

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (2/8)

PLANT NO. 1

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		sets)				
		Repair of corroded steel members	-	0	0	
		Installation of inclined plates	-	-	-	
		Repair of operation house	0	0	0	
6	Filtration	Replacement of venturi tubes (10 units)	0	0	0	
		Replacement of sheets of inlet and drain penstocks (10 units each)	0	0	0	
		Replacement of pumps and air compressors for hydraulic control	-	0	0	
		Replacement of anthracite	0 *	0	0	* Supplement
		Improvement of surface wash system (10 basins)	-	0*	0**	* PVC ** PVC with nozzles
		Installation of surface wash pumps and pipes	-	-	0	
		Modification of filtration system from constant flow rate (the existing system) to variable declining rate.	-	-	-	
		Construction of surface wash pump room	-	-	0	
7	Washwater	Replacement of washwater pumps (3 units)*	0	0	0	* Pumps were manufactured in 1940's and deteriorated.
		Repair of pump house (L.S.)	0	0	0	
8	Washwater recovery	Replacement of washwater recovery pumps. (3 units)*	0	0	0	* Pumps were manufactured in 1950's
		Reconstruction of pump house (7m X 5m:L.S)	0	0	0	
		Change of washwater returning point (L.S.)	-	0	0	

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (3/8)

PLANT NO. 2

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
9	Rapid mixing (parshall flume)	Installation of rapid mixers	-	-	-	
10	Flocculation	Replacement of flocculators	0*	0	0	* Only driving unit chains, sprockets, and bearings
		Construction of baffle walls (L.S.)	0*	0	0	* replacement of wooden plates
		Change from the existing horizontal paddle type to vertical turbine type	-	-	-	
		Construction of control panel house (6m X 4m X 1 house)	-	0	0	
11	Sedimentation	Reinforcement of foundations of inflow headstocks. (24 units)	0	0	0	
		Construction of collecting troughs with perforated baffle walls.	-	0	0	
		Installation of inclined plates with sludge removal system.	-	-	-	
		Replacement of shaft support for drain penstock	0	0	0	
		Replacement of flushing pump (2 units)	0	0	0	
		Construction of flushing pump house	0	0	0	
12	Filtration	Replacement of sheets of inlet and drain penstocks (20 units each)	0	0	0	
		Replacement of pumps and air compressors for hydraulic control	-	0	0	
		Replacement of anthracite	0*	0	0	* Supplement

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (4/8)

PLANT NO. 2

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		Installation of surface wash pumps	-	-	0	
		Replacement of surface wash system (20 basins)	-	0*	0**	* PVC ** PVC with nozzles
		Improvement of washwater troughs	0	0	0	
		Construction of roof for basi No. 1, 2, 3, 4, 17, 18, 19, and 20.	-	-	0	
		Construction of surface wash pump house	-	-	0	
13	Washwater	Replacement of pumps (3 units)	0	0	0	* one motor is removed three pumps is deteriorated
		Repair of pump house (L.S.)	0	0	0	
14	Washwater recovery	Replacement of pumps (3 units)	-	0	0	
		Construction of washwater recovery storage tank and pumphouse (L.S.)	-	0	0	
		Change of washwater returning point (L.S.)	-	0	0	

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (5/8)

CHEMICAL/CHLORINATION/OTHERS

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
15	Chemical dosing (Alum)	Replacement of feeders (6 units)	0*	0	0	* Spare only (1 unit)
		Installation of calibration flow meter (L.S.)	-	-	0	
		Construction of elevated foundation for feeders	-	0	0	
16	Chemical dosing (Chlorine)	Replacement of chlorinators (4 units) Replacement of evaporators (2 units) Replacement of chlorine leak detectors (3 units) Replacement of exhaust fan (3 units) Replacement of hoist (1 unit) Replacement of chlorine booster pumps (3 units) Replacement of Dosing pipelines (3 lines)	0	0	0	
		Repair of roof	0	0	0	
		Expansion of chlorine storage house/generator room.	0	0	0	
		Installation of hoisting rail.	0	0	0	
17	Chemical dosing (Polymer)	Replacement of feeders (5 units)	0	0	0	
		Installation of calibration flow meter (L.S.)	-	-	0	
18	Laboratory Equipment	Replacement for Plant No. 2 and Central Lab.	0*	0	0	* partly

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Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (6/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
19	Power Receiving	Replacement of wooden poles for 34.5 kV O/H distribution line (24 pcs.)	0	-	-	
		Installation of new concrete poles (24 pcs)	-	0	0	
		Installation of new 34.5 kV switching station	-	0	0	
20	Low Voltage Main Service Line	Replacement of O/H wires	0	0	0	
		Establishment of improvable equipment for voltage fluctuation on low voltage power line	-	0	0	
21	Motor Control Panel Plant No. 1 - Settling Basin Nos. 1 & 2 - Accelator - Washwater pump - Recovery pump	Replacement	0 *	0	-	* except Plant No. 1 - Sedimentation Basin No. 1 & 2, Plant No. 2 - Recovery pump
	Plant No. 2 - Flocculation - Wahwater pump - Recovery pump	Modification of operation system	-	-	0	
22	Lighting Panel Plant No. 1 - Settling Bain Nos. 1 & 2 - Filter Building - Recovery pump	Replacement	-	-	-	
		Modification of interior devices and installation new meters on panel	-	0	0	
23	Distribution Panel Plant No. 1 - Washwater pump Plant No. 2 - Filter Building	Replacement	0	0	-	
		Modification of interior devices and installation new meters on panel	-	-	0	
24	Starter switch Booster Pump of Chlorination House	Replacement	0	0	0	
25	Flow Meter	Replacement Plant No. 1 - Accelator (2 units) - Surface wash - Wash water - Recovery water Plant No. 2 - Parshall Flume (2 units) - Surface Wash	0*	0	0	* Only Accelator and Parshall Flume

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (7/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		- Wash water - Recovery Water				
		Installation Plant No. 1 - Settling Basin Plant No. 2 - Effluent	0	0	0	
26	Level meter Plant No. 1 - Wash water Tank Plant No. 2 - Washwater Tank - Chemical Alum Tank	Replacement	0	0	0	
27	Instrumentation of filter beds	- Replacement of Filter No. 1 & No. 2 loss of head devices including modification (30 units)	0	0	0	
		- Replacement of Filter No. 1 & No. 2 rate of flow devices including modification (30 units)	0	0	0	
28	Instrument Panel	Replacement & installation of new instrument panel for supervision (2 panels)	0*	0	0	* Partly according to necessity
29	Interior lighting	Replacement	-	-	-	
		Replacement & improvement of illumination	-	0	-	
		Modification of lighting fixtures (by site condition)	-	-	0	
30	Street lighting	Replacement	-	0	-	
		Replacement & improvement of illumination	-	-	0	
31	Lightning Facilities	Replacement of existing surge absorber	-	-	-	
		Installation of new lightning protective devices including air terminals for building				

Table 9.3.1 COMPARISON OF ALTERNATIVE PLAN (8/8)

ELECTRICAL EQUIPMENT

ITEM	FACILITIES	ALTERNATIVES	LEVEL 1	LEVEL 2	LEVEL 3	REMARKS
		Replacement of existing surge absorber and installation of new lightning arrester for instrument devices & 34.5 kV O/H line.	-	-	-	
		Installation of new lightning rod devices for all bldg. in addition to above Alt.	0	0	0	
32	Generator for Chlorine House	Installation of Generator	0	0	0	
33	Testing Equipment	Procurement	0	0	0	

ALT-B1.WK1

9.4 Requirements for Rehabilitation

The following paragraphs discuss in detail for the requirements for the recommended Rehabilitation work (Level 2) to be implemented for each treatment facility.

(1) Rapid Mixing

The function of the rapid mixing system is to dispense the coagulant uniformly throughout the entire volume of raw water with maximum possible speed in order to ensure that the coagulation process is as effective as possible. If sufficient head loss is available for the rapid mixing, hydraulic mixer is preferable due to the negligible operating and maintenance costs. However, the existing rapid mixing is applied for mechanical agitation which permits no head loss due to the limited hydraulic capacity of aqueducts, sedimentation tanks, and filtration tanks. Therefore, replacement of equipment which is superannuated is urgently recommended. Furthermore, a pair of baffle walls before and after the mechanical mixer should be constructed to ensure the agitation from short-circuiting.

(2) Flocculation

Flocculation is a process of gentle and continuous agitation during which suspended particles in the coagulated water combines into larger masses so that they can be removed from the water. Due to the merits as mentioned in rapid mixing, availability of hydraulic flocculation is studied as an alternative. However, because of the limitation of hydraulic performance of the existing structures, replacement of mechanical flocculators is recommended. The mechanical system is not always defective, if operation and maintenance procedures would be followed perfectly, energy input to the treated water could be optimized according to the fluctuation of the raw water quality.

(3) Sedimentation

Sedimentation process provides for the settling and removal of heavi-

er and larger suspended particles from raw water which is promoted through coagulation by rapid mixing and flocculation. Plant No. 1 uses the process of plain sedimentation with a detention time of about 2.68 to 2.81 hours. After sedimentation, treated water is withdrawn to the filters. Weirs or perforated launders are the most common structures used for this purpose. However, the existing structure consists of weirs of which loading rate is calculated to be over 6,000 $m^3/m/d$ which extremely deviates from the standard of 300 to 500 $m^3/m/d$. Accordingly, floc carrying over to the filters are observed and filter run might be shortened, even in such cases the sedimentation process is still achieved. Construction of perforated launders with perforated baffle wall at the end of sedimentation process are recommended to prevent floc from carrying-over to the filters. Also, baffle walls should be constructed to improve the current in the sedimentation basin No. 2.

(4) Filtration

Filtration is a physical, chemical, and in some instances biological process for separating suspended solid that could not be removed in the sedimentation process by passage through a porous filter media. Therefore, the filter media plays an important role in the filters and should always be kept in good condition as provided for in the design.

The Study Team conducted grain size analysis as shown in Appendix A, Supporting Report, based on the results, anthracite deviates from the standard values in uniformity coefficient, effective size, and specific gravity. Sand deviates in specific gravity which is allowable. Other functions including solubility of hydrochloric acid, porosity, and dry weight reduction is found to be allowable. The anthracite should be arranged in its size, while sand is allowable according to the designed values.

The combination of backwash and surface wash, which remove the suspended materials that has been deposited in the filter bed during the filtration cycle, is another important process that is vital for the recovery of cycle of the filtration process. Based on actual inspec-

tion, both backwash and surface wash rate are kept in the reasonable range of; backwash rate is 0.6-0.65 $m^3/m^2/min$ and surface wash rate is 0.15-0.20 $m^3/m^2/min$. However, surface wash is not done occasionally during the high water consumption season during which higher priority is given to the continuous supply of water rather than the quality of supplied water. To improve this condition, washwater recovery facilities are considered. Further, available head for surface wash that is estimated to be approx. 10m might be improved if washwater recovery facilities are functioning. At least, the existing perforated surface washing pipe should be replaced to one which is designed reasonably.

Then Wash water drain troughs are not functional in submerged during backwash in Plant No. 2. That is caused by a series of hydraulic problems such as opening size of washwater drainage sluice gate and available hydraulic gradient through troughs and drainage channel. As a solution to the problem, a change in the size of drainage sluice gate and/or raising up of the top level of troughs are considered. Due to cost and construction problems, raising up of the top level of the troughs up to necessary level based on the hydraulic computations is preferable.

Although, changing of filter control systems will be studied in the alternative study, but there are still plenty of problems to be resolved with regards to cost and the construction period, during which water supply will be affected seriously. Replacement of the superannuated equipment is then preferable instead of changing the filter control systems.

(5) Chemicals

Chemicals used in the Balara Plant are alum as coagulant, polymers as coagulant aids and liquid chlorine as disinfectant. Almost all of them are handled carefully. However, without calibration, even the fluctuation of raw water inflow rate would occur. Additional installation of calibration system combined with metering pumps is highly recommended. Even after water production facilities are completed, a water quality control system should be in place.

(6) Electrical Facilities

The existing electrical facilities are operational at present, but they have some problems caused by superannuation and lack of protection devices.

Therefore, taking into consideration corrosion due to high humidity, damages due to shortage of spare parts and difficulties in maintenance due to narrow spaces, it is proposed that the motor control panel overcurrent protection be replaced, to replace overhead distribution lines, to install protection devices against voltage fluctuations, etc. Also, it is recommended that a diesel engine generator be installed in the Chlorine House.

(7) Instrumentation

Since flow rate is one of the most important parameters needed to operate the treatment plants, flow meters for influent, effluent, washwater, surface water and recovery water shall be replaced. In addition to the flowmeter, lightning protection devices are proposed.

9.5 Recommendations for Rehabilitation

Based on the aforementioned reasons, the following Table 9.5.1 shows the recommended rehabilitation Plan.

Fig. 9.5.1 shows the Location Plan of the Rehabilitation Items.

Table 9.5.1 RECOMMENDED REHABILITATION PLAN

PLANT NO.1

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
1	Aqueduct No.1 & No.2			
-1	Guide of Sluice Gates	4 units	Replacement	Manually Operated
2	Rapid Mixing			
-1	Rapid mixers	2 units	Replacement	Vertical constant speed
				Turbine : 1.0m dia
				Revolution: 82 rpm
				Motor : 5.5 kW
-2	Baffle walls	L.S.	Construction	
3	Flocculation			
-1	Flocculators	26 units	Replacement	Vertical variable speed
		(2 units		Turbine : 1.5m dia.
		for spare)		Revolution: 7.6 and 15.3
				Motor : 1.5 kW
-2	Control panel house	2 houses	Construction	5m x 3m
4	Sedimentation			
-1	Drain valves for Sedimentation Basin No.1 & NO.2	6 units	Replacement	Manual gate valve with sluice gate guide
		(basin)		Valve : 600mm dia.
				Spindle : approx. 5.7m
		4 units	Replacement	Manual gate valve with sluice gate guide
		(channel)		Valve : 250mm dia.
				Spindle : approx. 2.1m
-2	Collecting launders with perforated	20	Construction	Launder : 0.6m Wx0.485m Dx17.5m L
	baffle wall			
-3	Baffle walls	L.S.	Construction	Sedimentation basin No.2; 133m
-4	Sludge discharge creek	L.S.	Excavation	
5	Accelator			
	Driving units	2 units	Replacement	Variable speed reduction gear
				Revolution: 1.0 - 1.5 rpm
				Motor : more than 18.6 kW
-2	Sludge blow-off equipment	2 sets	Replacement	Pneumatic diaphragm value
				Valve : 150 mm dia.
				Acc. : Manual gate valve
				Air compressor
				Capacity : 165 l/min
				Pressure : 7kg/cm2
				Motor : 1.5 kW

PLANT NO.1 (CONTN'D)

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
				Manual Operated Quick Open Valve
				Valve : 250 mm dia.
				Spindle : approx. 8.0m
-3	Corroded steel members	L.S.	Repair	
-4	Operation house	L.S.	Repair	
6	Filtration			
-1	Sheets of inlet and drain sluice gates	10 units	Replacement	
-2	Pumps and air compressors for	2 units each	Replacement	End-suction, Centrifugal Pump
	hydraulic control			Capacity: 60 l/min
				Head : 60m
				Motor : 3.7 kW
				Air Compressor
				Capacity: 48 l/min
				Pressure: 7kg/cm2
				Motor : 0.4 kW
				Acc. : Control Unit
-3	Pneumatic control unit	2 units	Replacement	Air Compressor
				Capacity: 1,651 l/min
				Pressure: 7kg/cm2
				Motor : 1.5 kW
				Acc. : Air Dryer
-4	Anthracite	810 m^3	Replacement	e.s. 0.9-1.1mm
-5	Surface wash	L.S.	Improvement	pvc; perforated pipings
-6	Venturi tube	10 units	Replacement	
7	Washwater			
-1	Washwater pumps	3 units	Replacement	Horizontal Centrifugal pump
				Capacity: 3.7 m3/min.
				Head : 15m
				Motor : 18.5 kW
				Acc. : foot valve - 1 PC.
				gate valve - 2 pcs.
				check valve - 1 pc.
-2	Pump house	L.S.	Repair	
8	Washwater Recovery			
-1	Washwater pumps	3 units	Replacement	Horizontal wastewater pump
				Capacity: 3.7 m3/min
				Head : 13m
				Motor : 18.5 kW
				Acc. : foot valve - 1 pc.
				gate valve - 1 pc.
				: check valve - 1 pc.
-2	Pump house	L.S.	Reconstruction	8m X 5m
-3	Washwater returning points	L.S.	Change of point	

PLANT NO.2

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
10	Flocculation			
-1	Flocculators	12 units	Replacement	Horizontal fixed speed paddle
				paddle 1st 2nd 3nd
				Dia. 3.0m 4.0m 4.0m
				Plate 3x4x4 3x4x4 3x4x4
				Revolution 5.1 rpm 2.4 rpm 1.4 rpm
				Motor 7.5 kW
-2	Baffle walls	L.S.	Construction	
-3	Control panel house	L.S.	Construction	6m x 4m x 1 house
11	Sedimentation			
-1	Foundation of inflow sluice gate guide	24 units	Replacement	
-2	Launders with perforated baffle walls	108 units	Construction	Launder: 0.6M w X 0.42M d X 13.5M L
-3	Shaft support for drain sluice gate	12 sets	Replacement	
-4	Flushing pumps	2 units	Replacement	Horizontal Centrifugal
				Capacity: 0.8 m3/min
				Head : 20m
				Motor : 5.5 kW
				Acc. : gate valve - 2 pcs.
				check valve - 1 pc.
-5	Flushing pump house	L.S.	Construction	
12	Filtration			
-1	Sheets of influent and drain sluice gate	20 units each	Replacement	
-2	Pumps and air compressors for hydraulic control	2 units each	Replacement	Horizontal Centrifugal Pump
				Capacity: 150 l/min
				Head : 60m
				Motor : 5.5 kW
				Air Compressor
				Capacity: 48 l/min
				Pressure: 7kg/cm2
				Motor : 0.4 kW
-3	Anthracite	1,620 m^3	Replacement	e.s. : 0.9-1.1mm
-4	Surface wash	L.S.	Improvement (Replacement)	PVC perforated pipings
-5	Washwater troughs	L.S.	Improvement of drainage cap.	Raise up of the top level of troughs
13	Washwater			
-1	Washwater pumps	3 units	Replacement	Horizontal Centrifugal
				Capacity: 8.7 m3/min
				Head : 15m
				Motor : 45 kW
				Acc. : gate valve - 2 pcs.
-2	pump house	L.S.	Repair	check valve - 1 pc.

PLANT NO.2 (CONTN'D)

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
14	Washwater Recovery			
-1	Washwater recovery pumps	3 units	Replacement	Horizontal Centrifugal
				Capacity: 8.7 m3/min
				Head : 13m
				Motor : 45 kW
				Acc. : gate valve - 2 sets
				check valve - 1 set
-2	Washwater recovery storage tank and	L.S.	Construction	
	pumps house			
-3	Washwater returning point	L.S.	Change of point	

CHEMICAL/CHLORINE FACILITIES

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
15	Alum Dose			
-1	Feeders(Rotodip:p)	6 units	Replacement	Rotodip
				Capacity: 19-6,810 l/hr
				Motor : 0.2 kW
-2	Calibration flow meter	L.S.	Installation	
-3	Elevated foundation of feeders	6 sets	Construction	
16	Polymer Dose			
-1	Feeders	5 units	Replacement	Diaphragm pump
				Capacity: 0.2 - 7.2 l/min
				Pressure: 3 kg/cm2
				Motor : 0.4 kW
-2	Calibration flow meter	L.S.	Installation	
17	Chlorination			
-1	Chlorinators	4 units	Replacement	Net vacuum type
				Capacity: 150 kg/h
-2	Evaporators	2 units	Replacement	Electric immersion heater type
				Capacity: 300 kg/hr
-3	Chlorine leak detectors	3 units	Replacement	Wall mounted type
-4	Exhaust fan	3 units	Replacement	Wall mounted type
				Propeller: 600mm dia. x 4
				Motor : 0.75 kW
-5	Hoist	3 units	Replacement	Motorized hoisting block
				Capacity: 3 ton
-6	Chlorine booster pumps	3 units	Replacement	Horizontal centrifugal
				Capacity: 1.2 m3/min
				Head : 40m
				Motor : 15 kW
-7	Dosing pipings	3 units	Replacement	
-8	Roof	L.S.	Repair	
-9	Chlorine storage house	L.S.	Expansion	
-10	Hoisting rail	L.S.	Installation	

ELECTRICAL EQUIPMENT

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
19	Power Receiving			
-1	Poles and wires	24 pcs	Replacement &	34.5 kv overhead distribution lines
			Improvement	Concrete Pole
-2	Power Receiving Panel and Others	1 unit	Installation	Capacity 34.5 kv
				Switching station
20	Low Voltage Main Service Line			
-1	Overhead wires	L.S.	Replacement	Cable
-2	Low Voltage Power Line Improvement Equipment	6 units	Installation	100 V
21	Motor Control Panels	28 units	Replacement	Plant No. 1
				- Sed. basin no. 1 & 2
				- Accelerator
				- Washwater pump
				- Recovery pump
				Plant No. 2
				- Flocculation
				- Washwater pump
				- Recovery pump
22	Lightning Panel	2 units	Replacement &	Plant No. 1
			Modification	- Sed. basin no. 1 & 2
				- Filter Building
				- Recovery pump
23	Distribution Panel	2 units	Replacement	Plant No. 1 Washwater pump
				Plant No. 2 Filter Build.
24	Starter Switch for Chlorine Booster Pump	1 unit	Replacement	
25	Flow Meter			
-1	Flow Meter (1)	10 units	Replacement	Differential pressure type
				(Orifice or Venturi)
				Plant No. 1
				- Accelerator (2 units)
				- Surface wash
				- Recovery water
				Plant No. 2
				- Parshall Flume (2 units)
				(Float Type)
				- Surface wash
				- Washwater
				- Recovery water
	Flow Meter (2)	2 units	Installation	Differential pressure type
				Plant No. 1 Inf. of Sed. basin
				Plant No. 2 Effluent
26	Level Meter	7 units	Replacement	Plant No. 1
				- Washwater tank
				Plant No. 2
				- Washwater tank
				- Chemical alum tank

INSTRUMENTATION

NO.	DESCRIPTION	Q'TY	REHABILITATION	SPECIFICATION
27	Instrumentation of Filter beds			
-1	Loss of Head Devices	30 units	Replacement & Modification	Pressure gauge type Filter No.1 & No.2
-2	Rate of Flow Devices	30 units	Replacement & Modification	Differential pressure type Filter No.1 & No.2
28	Instrument Panel	1 unit	Replacement & Modification	
29	Interior Lighting	L.S.	Replacement & Improvement	
30	Street Lighting	L.S.	Replacement	
31	Lightning Facilities	L.S.	Installation & Modification	- Installation of new lightning protective devices including air terminals for building - Replacement of existing surge absorber - Installation of new instrument devices & 34.5 kv O/H line - Installation of new lightning rod devices for all bldg.
32	Generator for chlorination Equipment	1 unit	Installation	- Engine generator 50 KVA
33	Testing Equipment	L.S.	Procurement	

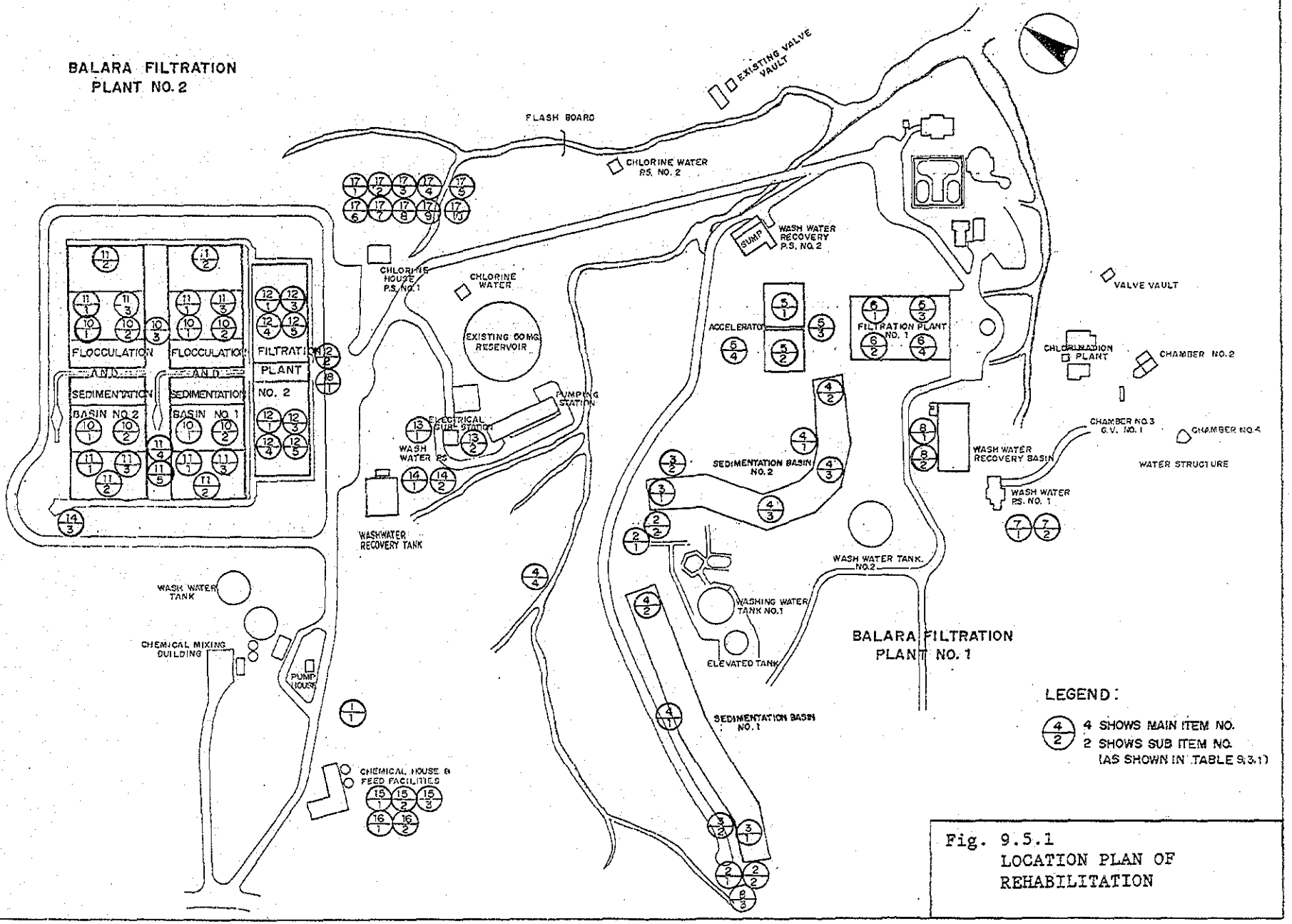

Fig. 9.5.1
LOCATION PLAN OF REHABILITATION

CHAPTER 10 ENVIRONMENTAL ASSESSMENT

10.1 Introduction

The environmental feasibility objectives are to identify the potential effects of the proposed project on environmental resources, and to identify any specific study needs for the detailed design stage. The objective will be to prepare a sustainable project which will not compromise the ability of future generations to meet their own needs.

The Environmental Management Bureau (EMB) with its Environmental Guidelines encourages the planner early in the planning process to be environmentally conscious to fully enhance the quality of the project. Guidelines consists principally of environmental check items to which close attention is to be given. The check items includes environmental pollution, natural resources and the human environment.

An organization of this environmental assessment consists of the following four sections:

1) Description of the Environmental Resources
2) Effects of the Project on Environmental Resources
3) Conclusion, and
4) Recommendations

10.2 Description of Environmental Resources

For purposes of environmental assessment, the study area was confined to the surrounding areas within the plant (Fig. 10.2.1). The area is located in the Balara area, West of Quezon City and bounded in the North by the Capital Hill Golf and Country Club, the Diliman residential area, a low population density area to the South, vast forests to the East and the MWSS Headquarter Buildings and the UP Campus to the West. Generally, the surrounding environs is a quiet and peaceful green area.