4. SURABAYA WATER QUALITY REQUIREMENTS FOR INDUSTRIAL WASTEWATER

Water quality requirements for industrial wastewater.
(the figures inserted constitute the maximum value).

Physics

Maximum water temperature	30° C
Maximum size flotable particles	3 mm

Chemical

Aluminium (Al)	10 ppm
Arsen (As)	1 ppm
Barium (Ba)	1 ppm
Ferro (Fe)	4 ppm
Chrom (Cr (6))	0.1 ppm
Cadmium (Cd)	1 ppm
Nickel (Ni)	2 ppm
Silver (Ag)	0.1 ppm
Quicksilver (Hg)	0.1 ppm
Zinc (Zn)	4 ppm
Copper (Cu)	1 ppm
Lead (Pb)	1 ppm
Ammonia (NH_3)	1,5 ppm
Chloride (Cl_2)	0.06 ppm
Fluoride (F)	2 ppm
Nitrite (ion-No_2)	1 ppm
Phosphate (ion-PO_4)	0.3 ppm
Sulphate (ion-S)	0.1 ppm
pH	6.5-8.5
Reaction with methyl blue	negative
Manganese	1 ppm

Specific characteristics

BOD (20^{o} C, 5 days)	30	ppm	
COD	80	ppm	
COD	90	ppm	$KMNO_4$

Organic substance

Hydro-carbon/mineral oils	10	ppm
Oil and fats	10	ppm
Phenols	0.1	ppm
Sianide (CN)	0.1	

Surabaya, February 13, 1978.

TEAM PENGENDALIAN PENCEMARAN LINGKUNGAN HIDUP
PROPINSI DAERAH TINGKAT I JAWA TIMUR

Attachment 3. Quality of Water from Water Bodies

Table referred to in Article 2 of Republic of Indonesia Health Minister No. 173/Men.Kes/Per/VIII/77 concerning the control of Water Pollution of Water Bodies for Various Utilization that Relate to Public Health.

List 1

QUALITY OF WATER FROM WATER BODIES

CLASS A, B AND C

No.	Parameter	Unit	Min. Per-mis-sible	Maximum		Remarks
				Desire-able	Permis-sible	
I.	CHEMICAL					
	A. Inorganic Chemicals					
1.	Arsenic	mg/l		nil	0,05	as As
2.	Barium	mg/l		nil	0,05	as Ba
3.	Total Iron	mg/l		nil	1,0	as Fe
4.	Boron	mg/l		nil	1,0	as B
5.	Chromium	mg/l		nil	0,05	as Cr valency 6
6.	Chromium	mg/l		nil	0,5	as Cr valency 3
7.	Cadmium	mg/l		nil	0,01	as Cd
8.	Cobalt	mg/l		nil	1,0	as Co
9.	Manganese	mg/l		nil	0,5	as Mn
10.	Nickel	mg/l			0,1	as Ni
11.	Silver	mg/l		nil	0,05	as Ag
12.	Mercury	mg/l			0,005	as Hg
13.	Selenium	mg/l		nil	0,01	as Se
14.	Zinc	mg/l		nil	1,0	as Zn
15.	Copper	mg/l		nil	1,0	as Cu
16.	Lead	mg/l		nil	0,05	as Pb
17.	Ammonia	mg/l		0,01	0,5	as N
18.	Chloride	mg/l		25	600	as ion Cl

/Cont'd. 19 .../5-

List 1 (Cont'd)

QUALITY OF WATER FROM WATER BODIES

CLASS A, B AND C

No.	Parameter	Unit	Min. Per-mis-sible	Maximum		Remarks
				Desire-able	Permis-sible	
19.	Free Chlorine	mg/l			nil	as Cl_2
20.	Fluoride	mg/l			1,5	as ion F
21.	Hardness	^oD	5	10		
22.	Nitrate and Nitrite	mg/l		nil	10	as N
23.	Sulphate	mg/l		50	400	as SO_4
24.	Sulfide	mg/l			nil	as S
25.	Uranyl	mg/l		nil	5	as ion uranyl
	B. Organic Chemical					
1.	Carbon Chloroform Extract	mg/l		0,04	0,5	
2.	Herbicides	mg/l		nil	0,1	
3.	Oil and Grease	mg/l		nil	nil	
4.	Phenol	mg/l		nil	0,002	
5.	Pesticides					
	a. Aldrin	mg/l		nil	0,017	
	b. Chlordane	mg/l		nil	0,003	
	c. D.D.T.	mg/l		nil	0,042	
	d. Dieldrin	mg/l		nil	0,017	
	e. Endrine	mg/l		nil	0,001	
	f. Heptachlor	mg/l		nil	0,018	
	g. Heptachlor epoxide	mg/l		nil	0,018	
	h. Lindane	mg/l		nil	0,056	
	i. Metoxy chlor	mg/l		nil	0,035	
	j. Organophosphate and Carbamate	mg/l		nil	0,100	
	k. Texaphene	mg/l		nil	0,005	
6.	Cyanide	mg/l		nil	0,1	as ion Cn
7.	M.B.A.S.	mg/l		nil	0,5	
II.	RADIOCTIVE					
1.	Gross beta	pCi/l		100	1.000	
2.	Radium - 226	pCi/l		1	3	
3.	Strontium - 90	pCi/l		2	10	

Table referred to in Article 2 of Repuplic of Indonesia Health Minister No. 173//Men.Kes/Per/VIII/77 concerning the control of Water Pollution of Water Bodies for Various Utilization that Relate to Public Health.

List 2

QUALITY OF WATER FROM WATER BODIES

No.	Parameter	Unit	Class A		Class B		Class C		Remarks
			Min. Per-mis-sible	Max. Per-mis-sible	Min. Per-mis-sible	Max. Per-mis-sible	Min. Per-mis-sible	Max. Per-mis-sible	
I.	PHYSICAL Temperature	^oC	-	Same Degree		Same Degree		Same Degree	
II.	CHEMICAL								
1.	Biological Oxygen Demand	mg/l		3		3		5	as O_2
2.	Dissolved Oxygen	mg/l	6		4		6		as O_2
3.	pH		6,5	8,5	6,5	8,5	6	9	
4.	Dissolved Solids	mg/l		1.000		2.000		2.000	
III.	Microbiological								
1.	Coliform	per 100 ml		10.000		1.000		20.000	
2.	Faecal coliform	per 100 ml		2.000		400		4.000	

Note : Class A ; Water body used for raw water
Class B ; Water body used for bathing and agriculture
Class C ; Water body used for land-fishery, pleasure and beauty

The Regulations from Ministry of Health, number 173/Men.Kes./Per./VIII/7

Table referred to in Article 6 clause (1) of Republic of Indonesia Health Minister No. 173/Men.Kes/Per/VIII/77 concerning the control of Water Pollution of Water Bodies for Various Utilization that Relate to Public Helath.

List 3

QUALITY OF DISCHARGES/OVERFLOWS/LEAKAGE FROM INDUSTRY, MINING AND HOUSEHOLDS

No.	Parameter	Unit	Min. Permissible	Ave. over 24 hrs.	Max. Permissible	Remarks
I.	PHYSICAL					
1.	Temperature	°C			30	(which will be
2.	Floatable Solids	mg/l			nil	retained on a
3.	Settleable Solids	mg/l			1,0	3 mm sieve.
II.	CHEMICAL					
	A. Inorganic Chemical					
1.	Total Aluminium	mg/l			10	as Al
2.	Total Arsenic	mg/l			1	as As
3.	Barium	mg/l			1	as Ba
4.	Total Iron	mg/l			1	as Fe
5.	Chromium	mg/l			0,2	as Cr valeray 6
6.	Total Cadmium	mg/l			1	as Cd
7.	Total Nickel	mg/l			2	as Ni
8.	Total Silver	mg/l			0,1	as Ag
9.	Total Mercury	mg/l			0,1	as Hg
10.	Total Zinc	mg/l			1	as Zn
11.	Total Copper	mg/l			1	as Cu
12.	Total Lead	mg/l			1	as Pb
13.	Free Ammonia	mg/l			0,1	as NH_3
14.	Free Chlorine	mg/l			0,05	as Cl
15.	Fluoride	mg/l			2	as ion F
16.	Nitrite	mg/l			1	as ion NO_2
17.	Phosphate	mg/l		2		as ion Po_4
18.	Sulfide	mg/l			0,1	as ion S
19.	Biological Oxygen demand	mg/l		20	30	as O_2
20.	Chemical Oxygen demand	mg/l		50	80	as O_2
21.	pH	mg/l	6,5		8,5	
22.	Methylene Blue Test					negative
23.	Oxidisable by $KMnO_4$	mg/l		60	90	as O_2
24.	Suspended Solids	mg/l		20	-	

List 3 (Cont'd)

QUALITY OF DISCHARGES/OVERFLOWS/LEAKAGE FROM INDUSTRY, MINING AND HOUSEHOLDS

No.	Parameter	Unit	Min. Permissible	Ave. over 24 hrs.	Max. Permissible	Remarks
	S. Organic Chemical					
1.	Hydrocarbons	mg/l			10	
2.	Oil and Grease	mg/l			10	
3.	Total Phenol				0,1	as phenol
4.	Cyanide	mg/l			0,1	as ion Cn

Advantages of Alum and PAC for Coagulation

a. Dosing maintenances of PAC is easier because its optimum dosage is more wide.

b. A little amount of PAC dosage is necessary in the case that raw water is of high value of Turbidity such as more than 500 ppm.

c. As PAC forms strong floc which has easy sedimentation and filtration, Turbidity value of treated water using PAC is becoming rather low.

d. Lime dosage as coagulant aid is decreased as PAC consumes a little amount of M-Alkalinity of the raw water, 0.15 ppm/PAC 1 ppm and 0.45 ppm/Alum 1 ppm.

e. Effectiveness of coagulation using PAC is not much affected by fluctuations of raw water temperature.

f. PAC is more expensive than Alum.

g. PAC is less effective when water indicates high value of pH caused by algal growth, because high pH value of the water has to decrease by dosing much more amount of PAC until pH 6.5 and 7.5 of coagulation range.

While employment of PAC has to be decided on the basis of coagulation tests through the two seasons.

Table Coagualtion Tests of Alum and PAC

by PDAM-Jakarta

Sampled River	Sunter		Krukut		Banjir Canal	
Plant	Pulogadung		Cilandak		Muara Karang	
Chemicals	Dosage (ppm)	Recidual Turbidity (NTU)	Dosage (pom)	Recidual Turbidity (NTU)	Dosage (ppm)	Recidual Turbidity (NTU)
Alum Salfate	35	6.0	20	7.5	30	1.0
Soda Ash	0		12.5		10	
PAC	11	5.5	5.7	3.0	7.5	0
Soda Ash	0		4.0		0	

Gonsideration

a. PAC had effective coaguation power, its dosage is 1/3 - 1/4 of Alum.

b. PAC had less washing frequency than Alum.

c. PAC has less decrese of PH value than Alum.

d. PAC has easy operation in its application.

The test were caaried out using sample of wet season, February and March, 1983.

Attachment 4. Water Quality of the Ciburial Spring by PDAM

Tobble Water Quality of the Ciburial Spring BY PAM

Year		1982													1983							
Month		1	2	3	4	5	6	7	8	9	10	11	12	avg	1	2	3	4	5	Avg	Max	Min
Parameter	Unit																					
Turbidity	ppm SiO_2																					
Color	Unit Pt.Co	0-5	0-5	0-5	0-5	0-5	0-5	0-5		0-5	0-5	0-5		0-5	0-5	0-5	0-5	0-5	0-5	0-5	5	0
Conductivity	Umho/cm	180	285	200	195	105	200	190		195	120	120		195		114	100	120		177	285	114
PH		6.9	6.9	7.1	6.5	7.3	7.3	7.3		7.1	7.1	7.5		7.1	7.3	6.9	7.1	6.5	7.0	7.05	7.8	6.5
Oraganic Matter	PP, KmO_2	2.5	0.95	1.58	1.58	1.26	1.58	1.37		2.53	1.09	5.0		2.0	1.26	1.09	2.53	2.04	1.26	2.0	5.0	1.26
M.Alkalinity	ppm $CaCO_3$	65	80	70	80	70	70	80		85	100	65		76	65	70	70	65	70	74	100	65
T-Hardness		2.6	2.7	2.4	3.0	2.8	2.8	3.6		3.0	2.2	2.8		2.9	2.6	2.6	3.2	2.6	3.2	2.9	3.8	2.2
Ca-Hardness	ppm Ca	11.4	11.4	11.3	12.8	11.4	15.7	14.3		12.0	12.0	12.0		12.7	8.6	12.0	10	12.8	18.5		18.5	10
Mg-Hardness	ppm Mg	4.3	4.7	3.4	5.1	5.1	2.6	7.7		0.6	1.7	4.3		4.8	6.0	3.4	7.7	3.4	2.6		8.6	1.7
Iron	ppm Fe	neg	neg	neg	neg	neg	neg	neg		neg	neg	neg		neg	neg	neg	neg	neg	trc	neg	neg	
Manganese	ppm Mn																					
Sulfate	ppm SO_4	trc	neg	neg	neg	neg	trc	trc		neg	neg	neg		neg	trc	neg	neg	neg	trc	trc	trc	neg
Ammonium	ppm NH_4	neg	neg	neg	neg	neg	neg	neg		neg	neg	neg		neg	neg	neg	neg	neg	neg	trc	neg	
Nitrite	ppm NO_2	neg	neg	neg	neg	neg	neg	neg		neg	neg	neg		neg	neg	neg	neg	neg	neg	neg	neg	
Chloride	ppm Cl	7.1	11.4	7.4	7.0	10.6	12.0	10.6		9.3	6.4	7.1		9.0	6.4	9.9	9.3	9.2	7.8	8.8	10.6	6.4
Feacial Coli	MPN/100ml	0	0	43	70		0	0		0	0	0			23	0	0	21	0	-	70	0

Note : One sample/Month

Attachment 5. Result of Detergent Removal at Pejompongan Plants (1976) by PDAM

Table Result of Detergent Removal at Pejompongan Plants (1976)

Plant	Date	Detergent concentration (ppm) Rawa Water	Settled Water	Filtered Water	Clear Water
	9 Apr	-	-	0.5	-
II	17 May	0.72	-	0.61	-
	18 May	1.30	-	0.16	-
	26 May	0.76	-	-	0.74
	15 May	0.25	-	-	0.125
	17 May	0.37	-	-	0.36
I	21 May	-	3.22	2.84	-
	24 May	-	-	1.0	0.60
	26 May	0.76	-	-	0.61

Note : Quoted from "Report on Survey of synthetic Detergents in the Banjir Canal" by PAM and Cipta Karya.

Attachment 6. Survey Result of Toxic Matters of the Canal Water

Hasil Analisa Residu Pestisida Saluran Tarum Barat

(gram/l)

by Cipta Karya

Jenis Residu Pestisida	Lokasi							
	1	2	3	4	5	6	7	8
B H C	tt	tt	tt	0.0235	tt	tt	tt	0.0235
Lindan	tt	tt	tt	tt	tt	tt	tt	tt
Aldirin	tt	tt	0.026	tt	tt	tt	tt	tt
Paraguat	tt	tt	tt	tt	tt	0.40	0.16	tt
Dieldrin	tt	tt	0.067	tt	tt	tt	tt	tt
Endrin	tt	tt	tt	tt	tt	tt	tt	tt
D.D.T.	tt	tt	tt	tt	tt	tt	tt	tt
Diazinon	tt	tt	tt	tt	tt	tt	tt	tt
Penitrotion	tt	tt	tt	tt	tt	tt	tt	tt

Keterangan : tt tidak terditaksi
1: Water of West Tarum Canal at Cipinane River
2: Water of West Tarum Canal before Bekasi River
3: Water of West Tarum Canal before Cikarang River
4: Water of West Tarum Canal before Cibeet River
5: Water of Bekasi River
6: Water of Cikarang River
7: Water of Cibeet River
8: Water of Jatiluhur Dam

II. SUPPLEMENT
TO
REPORT AND DATA
ON
WATER QUALITY AND TREATMENT PROCESS

SUPPLEMENT TO REPORT AND DATA ON

WATER QUALITY AND TREATMENT PROCESS

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INTRODUCTION

This report is prepared to describe the results of the study carried out since the submission of the Interim Report (of the Master Plan), considering that some additional data of water quality have become available and also useful comments and suggestions have been given.

The report covers mainly: 1) water quality and treatment at the existing plants, 2) additional study on raw water improvement, 3) study on analytical results of river and canal water provided by the authority, and 4) recommendations prepared based on this study.

The substantial conclusions obtained from the present study will be incorporated in the final Master Plan to be submitted at the end of the present study period and reflected in the feasibility study now underway.

To make the report as concise as possible, the descriptions are limited to the study additionally made. For reference, however, the report on water quality study prepared at the time of submission of the Interim Report is attached hereto.

1. CONDITIONS OF THE EXISTING TREATMENT SYSTEM

Based on the data of water quality in 1983 at the existing three plants obtained from PDAM and the present field survey, conditions of the existing treatment system are reviewed and described hereunder.

1.1 Raw Water Quality

Tables 1 and 2 show raw water qualities of the Pejompongan and Pulogadung Plants monitored by PDAM. Characteristics of the quality parameters from among the items in the tables are indicated as follows :

(1) Raw Water of the Pejompongan Plants

a. Turbidity value was high, 228 NTU in annual average and changeable in seasons from 23 to 981 NTU.

b. Ammonium, which shows pollution of water mainly caused by inflow of domestic wastes, was high compared with 0.5 mg/l of the Raw Water Standard established by Ministry of Health as shown in Appendix, Table 4.

Analytical results of Ammonium carried out by the present study in August 1983, indicated high concentrations, 1.2 and 2.3 mg/l, although the results by the plant laboratory were low, 0.6 mg/l.

c. Concentrations of dissolved organic substances, Alkalinity, Organic Matter and Ammonium, were high.

(2) Raw Water of the Pulogadung Plant

a. Turbidity values were low compared with those of the Pejompongan.

b. Ammonium concentrations were very high, 0.7 to 4.6 mg/l in monthly average, and were in a wide fluctuation by months, especially in the dry season.

c. Concentrations of dissolved organic substances were as high as those of the Pejompongan.

1.2 Treated Water Quality

Treatment conditions are summarized below, which are concluded from review of the quality data in 1983 of clarified, filtered and finished water shown in Tables 3 to 9.

(1) Pejompongan Plants

Treatment processes practiced are coagulation using Alum and Polymer, sedimentation by Accelator and rapid sand filtration in the Plant I and coagulation using Alum, sedimentation by Pulsator and rapid sand filtration in Plant II.

a. Plant I

i. The clarified water quality indicates sufficient removal of Turbidity, 4.3 to 5.1 NUT in monthly average, and filtered water was 1.3 to 1.6 NTU in monthly average, constantly below the Drinking Water Standard as shwon in Table 10.

ii. Removal of Ammonium was not satisfactory in the clarified water having almost same concentration with that of the raw water. And then the filtered water had always positive sign of Ammonium not meeting the said Standard.

iii. Organic Matter removal is not sufficient, because more than 10 mg/1 of its concentrations appeared in the clarified water in March, April, June to November and in the filtered water in August and September.

iv. Color values of the filtered water sometimes exceeded 5 units of the permissible value of the Standard, and the annual average in the clarified water was 8.2 units.

v. Faecal Coli appeared in 28 samples out of 123 (22.8%) in the finished water as seen in Table 11.

Numbers of Faecal Coli were 300 MPN/100 ml in the clarified water and 1,500 MPN/100 ml in the filtered water, according to the field survey on 11 July 1984 as shown in Table 12.

b. Plant II

i. Removal of Turbidity by sedimentation and filtration was good, having 3.1 to 3.9 NTU in monthly average in the clarified water and always below 0.9 NTU in the filtered water.

ii. Ammonium almost always was found in the clarified water, and the filtered water also had positive sign, except in March and April. The concentration of Ammonium was, by the test of the present survey, 0.8 mg/1 in the clarified water and 0.6 mg/1 in the filtered water in August 1983, although the results of the plant laboratory were 0.4 mg/1 in monthly maximum.

iii. Organic Matter of the filtered water was above 10 mg/l of the Standard in August and September together with more than 10 mg/l in maximum every month in the clarified water.

(2) Pulogadung Plant

Treatment processes at the Plant are coagulation using Alum and Pre-chlorine, sedimentation by conventional type and rapid sand filtration with intermediate chlorination.

i. Turbidity was removed sufficiently by sedimentation judging from its low value, 3.55 NTU in annual average and 2.7 to 5.7 NTU in monthly average. The finished water had constantly low Turbidity below the Standard.

ii. Ammonium almost always remained in the finished water and its concentration was high during July to October affected by its high concentrations of the raw water in same months.

iii. Organic Matter in the finished water sometimes was above the Standard in June and July.

iv. Color values of the finished water were 5 to 10 units, generally exceeding the permissible value of 5 units of the Standard.

v. Faecal Coli in the finished water appeared in 2 samples of the 45 samples.

1.3 Faecal Coli in Distribution System

The number of positive sign of Faecal Coli in the distribution system tested by PDAM is shown in Tables 13.to 16. The summary of findings of the data presented is as follows :

a. The presence of Faecal Coli in the distribution system is undesirable. The presence of Faecal Coli is evidenced by the high percentage of positive sign in the samples.

b. The tap water in the whole served area, except the central area, shows high positive signs, more than 20% of the total samples.

c. In the whole served area, positive signs were higher in July through December than other months in 1983.

The following are considered to be reasons for presence of Faecal Coli in the tap water.

a. Faecal Coli remains in the finished water of the treatment plants due to insufficient disinfection. This remaining Faecal Coli may be growing in the distribution pipelines.

b. As there are areas where water pressure is very low, there may be cases the water pressure becomes negative due to suction by pump and polluted ground water infiltrates in the pipe. Then the polluted water containing Faecal Coli may be possibly distributed.

1.4 Recommendations for Treatment

The following are recommendations for improving present treatment conditions of the existing water supply system based on the supplemental study at this time and an overall review on water quality and the treatment conditions.

a. Raw water improvement of both plants is imperative as recommended in the Master Plan report, because the data of the raw water quality in 1983 also showed serious deteriorated conditions not meeting the Raw Water Standard and concentrations of Ammonium, Organic Matter, Color and Faecal Coli in the finished water have been above the Drinking Water Standard.

b. Strengthening of chlorination is recommendable for removing the above mentioned pollutants at sedimentation basin and filter.

c. Quantitative analysis of Ammonium exceeding 0.6 mg/l should be carried out daily at the Pejompongan I and II. And quality of the clarified water in same parameters as the raw water analysis should be analysed at the Pulogadung to know treatment conditions by sedimentation.

2. REVIEW OF IMPROVEMENT PROGRAMS OF THE EXISTING PLANTS

Raw water improvement and short term improvement of the existing three plants were proposed and discussed in the Master Plan. Further, regarding this matter findings newly obtained from review of the latest data of these plants are presented as follows.

2.1 Raw Water Improvement

a. It is known that the water of the proposed intake point at Buaran had desirable quality generally meeting the Raw Water Standard.

b. Pre-chlorination is to be made even when the raw water is taken from the WTC. The maximum dosage will be 10 mg/l, based on the quality of the water at BTB 49, namely, maximum 0.75 mg/l of Ammonium and average 0.77 mg/l of dissolved Iron.

c. Pre-treatments by aeration and powdered activated carbon, which are not effective in removing Ammoniun and Faecal Coli, will not be considered in the feasibility study.

d. The raw water pipeline may have favorable side effect of reducing concentrations of Ammonium, Iron, Odor and MBAS by biological oxidization.

2.2 Short Term Improvement

Necessary improvement of the treatment processes of the three plants to meet the present deteriorated raw water was proposed in the report mentioned earlier in Introduction. Items of the recommended improvements were as follows :

i. Strengthening of Pre-chlorination

ii. Employment of Intermediate-chlorination to the Pejompongan I and II

iii. Strengthening of Post-chlorination

iv. Strengthening of activated carbon treatment

Based on the additional survey and analysis of the data obtained, these improvement items are reviewed and supplemental explanations are described hereunder.

a. Strengthening of Pre-chlorination

Pre-chlorination is to be conducted constantly, as recommended previously, because pollutants, Ammonium, Organic Matter, Faecal Coli, Color and Odor not meeting the Drinking Water Standard are fouhd in the clarified and the finished water. A maximum dosage of chlorine, 10 mg/l, for improvement work will be taken for design considering the maximum chlorine dosage required for the water of the WTC at Buaran, which is proposed for the raw water improvement.

b. Employment of Intermediate-chlorination to the Pejompongan I and II

Intermediate-chlorination to the clarified water before filtration should be employed to keep filtered water free from Faecal Coli. This measure will remove pollutants at filter bed. This dosage should be to the extent free residual chlorine will remain in the filtered water. In the case that 10 mg/l of pre-chlorine is dosed in the dry season, free residual chlorine may not remain in the clarified water, because chlorine requirements of the raw water in this season will be more than 10 mg/l.

c. Strengthening of Post-chlorine

In order to continuously keep sufficient residual chlorine in the finished water, post-chlorine dosage should be practised. Dosage of 2 to 3 mg/l may be appropriate judging from the results of the present dosage rate and disinfection conditions of the plants.

d. Activated Carbon Treatment

Activated carbon has been practised so far, but not necessarily effective. It might not be feasible and practicable to strengthen the carbon treatment to the extent of being effective. On the other hand, chlorination is proposed to be reinforced. Considering the above, activated carbon treatment will not be taken up in the feasibility study.

3. ANALYSIS OF WATER QUALITY DATA OF WATER SOURCES

Water quality of the WTC and rivers crossing it together with the present water sources of the existing three plants has been surveyed by DPMA from November 1983 to the present. The survey results are summarized and characteristics of the water quality are briefly reviewed on the basis of the above data, 16 samples at each 21 location. This review is supplemental to the reports already submitted.
On the other hand, the survey results on the Ciliwung, Sunter, Cipinang rivers, the Banjir Canal and the Setiabudi reservoir are summarized to know the present conditions of water pollution. Data of water quality are shown in Attachment.

Concentrations of each quality item obtained are considered to be reliable judging from relation to their concentrations and environmental conditions around water sources, although water quality has been analyzed in several days after sampling, which should be analyzed as fast as possible after sampling.

3.1 Characteristics of Water Quality of the WTC

Quality characteristics of the WTC water from the Jatiluhur dam to the canal end are summarized below :

a. Water of the outlet of the dam which is the origin of the WTC water has low concentrations with small fluctuations in almost all quality parameters compared with those of the WTC water. Thus, the water is suitable for water supply.

b. Concentrations of Ammonium, Organic Matter, Turbidity and number of Faecal Coli gradually increase through the flow of the WTC due to mixing of water of confluent rivers having higher concentrations.

c. The canal water in the section between Bekasi and BTB 49, which was proposed for the intake site of the raw water improvement and the expansion project, has desirable quality similar to water of upstream Bekasi.

d. Water of the canal end has Ammonium and Organic Matter in the widest fluctuations and these maximum concentrations are fairly high, 0.83 mg/l of Ammonium and 50 mg/l of Organic Matter.

e. Pesticides of the WTC water were below the Raw Water Standard.

f. MBAS of the WTC water in the section was usually low, less than 0.2 mg/l.

3.2 Water Quality of Water Sources for the Existing Plants

Water qualities of rivers and canal for the Pejompongan and the Pulogadung are summarized to clarify extent and circumstances of pollution.

(1) Water sources for the Pejompongan Plants

a. Raw water of the plants is seriously polluted:

Dissolved Oxygen	:	1.1 to 5.4 mg/l, 2.8 mg/l in average
Organic Matter	:	9.5 to 159 mg/l, 41 mg/l in average
Ammonium	:	0.29 to 1.29 mg/l, 0.72 mg/l in average

Faecal Coli : 1.1×10^7 MPN/100 ml in average

Disssolved Iron : 0.75 mg/l in average

b. Number of Faecal Coli and Organic Matter abruptly increased from 6×10^5 to 5×10^7 MPN/100 ml and 18.5 to 38 mg/l, respectively, in the section between MT. Haryono and Manggarai of the Ciliwung river, and dissolved oxygen decreased in inverse proportion in the section.

c. Ammonium increases in the section between Setiabudi and the intake point from 0.46 to 0.72 mg/l in average.

d. Water of the Baru Barat river and the Setiabudi pond which is discharged to the canal is as bad as domestic wastewater.

(2) Water Soruces for the Pulogadung Plant

a. Raw water of the plant is deteriorated similarly to that of Pejompongan :

Dissolved Oxygen : 0 to 3.7 mg/l, 2.1 mg/l in average

Organic Matter : 13.3 to 119 mg/l, 53.7 mg/l in average

Ammonium : 0.24 to 1.43 mg/l, 0.73 mg/l in average

Faecal Coli : 1.6×10^8 MPN/100 ml in average

Dissolved Iron : 0.85 mg/l in average

b. When water qualities at the intake point and 1 to 1.5 km upstream are compared, the water of the intake point is worse as seen in pollutant concentrations, namely, 32 to 53.7 mg/l of Organic Matter, 0.31 to 0.73 mg/l of Ammonium and 1.5 x 10^7 to 1.6 x 10^8 MPN/100 ml of Faecal Coli in average.

c. The Cipinang river has more polluted water than the Sunter. But presently, the water thereof is not taken into the Pulogadung, because a dividing wall was constructed in the Sunter river from the confluence point to the intake site late in 1983.

3.3 Recommendations for Water Pollution Control

As described so far, raw water of the existing plants has been seriously polluted year after year. On the other hand, the water of the WTC is still in a state of low pollution.

The following are recommendations for water pollution control from the view point of safe water production and easy operation of the water treatment plants.

a. Change of discharge points from Setiabudi and Melati ponds.

Much of domestic waste is discharged from the above ponds by pumping out to the Banjir canal, once or twice a day. It is recommended to change the discharge point to downstream of the intake point, especially in the dry season.

b. Increase of flushing water to the Banjir canal and the Sunter river.

The water of the Banjir canal and the Sunter river has been polluted by inflow of wastes, especially in the dry season. It is therefore, recommendable to increase flushing water to these waterways.

c. Prevention of inflow of waste water into the WTC.

In order to control pollution of the WTC water, it is recommendable to prevent inflow of waste water into the WTC, as surveyed by NEDECO consultants.

d. Others

Fundamental prevention of the water pollution has to be considered in future from the view point of overall environmental preservation. The following are recommended :

i. Prohibition of dumping wastes into the water source rivers and canals.

ii. Regulation of discharge of wastewater from the industries.

iii. Establishment of drainage and sewerage as practicable.

iv. Periodical survey and monitoring of water quality of water sources.

Regarding the WTC in particular, such survey will be useful for deciding the timing of the completion of Canal 1.

Table 1 Raw Water Quality of the Pojompongan I Plant 1983, monthly Report by PDAM.

Month		Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness oD	Calcium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl⁻)	Coliform Groups (MPN/100)
	max	150	863	6.9	18.8	80.0	80.0	3.1	14.9	4.30	25.2	6.0			0.60	0.06	4.5	41.5	
1	ave	150	421	6.7	9.9	62.5	62.5	2.4	12.2	2.58	12.8	2.0	Pos	Neg	0.55	0.04	4.0	12.9	
	min	150	157	6.6	8.8	32.5	32.5	1.9	9.2	1.72	6.4	1.0			0.25	0.025	3.0	9.9	
	max	150	667	6.8	15.4	85	85	3.2	15.1	6.02	25.2	2.2			0.60	0.07	3.0	16.0	
2	ave	150	325	6.6	11.0	67.5	67.5	2.5	11.4	3.87	12.6	1.4	Pos	Neg	0.50	0.04	3.5	13.9	
	min	150	144	5.5	6.8	50	50	1.7	2.1	2.58	6.5	1.0			Neg	Neg	3.0	9.3	
	max	150	713	6.8	15.4	100	100	7.0	14.2	4.7	29.7	7.0			0.6	0.09	4.0	18.6	
3	ave	150	293	6.7	9.9	65	65	2.4	11.4	3.4	13.1	1.8	Pos	Neg	0.5	0.05	3.5	14.1	
	min	150	105	6.7	7.7	50	50	2.0	7.8	1.5	6.8	0.5	Neg		0.4	0.02	3.0	9.9	
	max	150	506	6.8	13.2	80	80	3.3	22.8	4.73	22.1	4.4			0.6	0.08	4.5	17.0	
4	ave	150	222	6.7	9.9	65	65	2.5	12.2	3.67	11.8	1.8	Pos	Neg	0.5	0.05	3.5	14.1	
	min	150	23	6.7	8.8	55	55	2.2	7.7	2.15	6.6	0.6	Neg		0.4	0.01	3.5	10.6	
	max	150	727	6.8	13.2	80	80	3.2	17.4	6.8	20.5	4.0			0.6	0.085	4.5	17.6	
5	ave	150	256	6.7	9.9	62.5	62.5	2.5	12.1	3.4	13.4	1.8	Pos	Neg	0.5	0.05	3.5	13.1	
	min	150	143	6.7	8.8	45	45	1.7	6.7	2.1	4.7	0.7	Neg		0.4	0.025	3.0	10.2	
	max	150	437	6.9	17.6	100	100	4.8	25.7	6.8	18.9	2.5			0.6	0.085	4.5	54.9	
6	ave	150	185	6.7	11.0	72.5	72.5	2.8	13.0	4.3	10.3	1.9	Pos	Neg	0.6	0.055	3.5	16.0	
	min	150	149	6.7	8.8	60	60	2.2	7.1	2.5	4.7	0.9	Neg		0.6	0.025	3.0	12.7	
	max	150	201	6.9	17.6	90	90	3.5	17.1	6.0	18.9	2.5			0.6	0.055	4.5	28.4	
7	ave	150	176	6.7	11.0	86	86	2.9	14.2	3.8	12.8	1.5	Pos	Neg	0.6	0.055	3.5	14.2	
	min	150	163	6.7	8.6	60	60	2.4	11.4	1.7	7.2	0.9	Neg		0.6	Neg	3.0	14.2	
	max	150	189	6.9	17.6	100	100	3.6	17.8	6.4	18.0	2.0			0.6	0.08	4.0	22.7	
8	ave	150	138	6.8	11.0	80	80	3.3	15.7	4.7	12.4	1.4	Pos	Neg	0.6	0.05	3.5	16.9	
	min	150	102	6.7	8.8	70	70	2.8	11.4	2.5	8.5	1.0	Neg		0.6	Neg	3.0	15.6	
	max	150	185	7.0	17.6	110	110	4.8	28.5	7.5	18.0	2.0	Pos		0.6	0.085	4.5	24.8	
9	ave	150	153	6.9	13.2	90	90	3.4	16.4	4.7	12.6	1.3	trc	Neg	0.6	0.02	3.5	21.2	
	min	150	138	6.8	8.8	70	70	2.6	11.4	2.5	9.4	Neg	Neg		0.6	Neg	3.0	15.0	
	max	150	249	7.0	17.6	100	100	4.4	22.1	6.0	18.6	3.0			0.6	0.095	4.0	24.5	
10	ave	150	148	6.9	13.2	85	85	3.3	17.8	3.4	13.3	1.5	Pos	Neg	0.6	0.065	3.3	18.1	
	min	150	124	6.7	8.8	70	75	2.8	11.4	2.5	9.4	1.0			0.6	Neg	3.0	14.9	
	max	150	981	6.9	17.6	90	90	4.0	17.1	10.3	24.0	4.4			0.6	0.095	4.0	26.2	
11	ave	150	225	6.7	10.0	67.5	67.5	2.7	13.5	3.4	11.8	1.6	Pos	Neg	0.6	0.06	3.4	17.8	
	min	150	151	6.6	8.8	40	40	2.2	4.4	1.7	4.7	1.1			0.6	0.03	3.0	9.2	
	max	150	373	6.8	13.2	90	90	3.6	17.1	7.3	17.3	3.7			0.6	0.008	4.5	26.2	
12	ave	150	190	6.7	11.0	75	75	2.8	14.9	3.0	12.3	1.5	Pos	Neg	0.6	0.055	3.5	19.1	
	min	150	123	6.5	8.8	50	50	2.4	9.9	1.7	7.2	0.1			0.6	Neg	3.0	12.0	
	ave	150	226	6.7		73	2.8	2.8	13.7	3.7	11.3	1.6	Pos	Neg	0.56		3.5	16.4	

Table 2 Raw Water Quality of the Pulogadung Plant 1983, Monthly Report by PDAM

Month		Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness dH	Calcium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl)	Coliform [illegible]
1984	max	7 150	96	6.9	30.8		105	4.6	21.4	7.7	22.1	2.2			[illegible]			31.9	
1	ave	7 150	52	6.8	16.3		64.9	3.0	15.6	4.2	16.9	1.0	Trace	Neg	0.70			16.2	
	min		30	6.7	8.8		35	2.4	12.1	0.2	12.8	Neg	Neg		0.05			14.2	
1983	max	7 150	144	7.1	18.0		95.0	4.6	25.0	7.7	20.5	1.2			1.15			17.5	
2	ave	7 150	91	6.8	13.2		72.7	3.6	19.1	4.3	15.5	0.74	Trace	Trace	0.70			12.4	
	min		52	6.5	9.8		55.0	3.0	16.2	0.8	4.4	0.45			0.50			7.1	
	max	7 150	207	7.1	22.4		75	4.7	27.8	7.1	25.4	1.2			1.4			14.2	
3	ave	7 150	[illegible]	6.9	12.6		50	3.8	18.4	4.3	15.4	0.95	Trace	Neg	0.70			10.5	
	min		54	6.5	3.3		40	2.7	14.2	0.4	6.2	0.8			0.45			7.0	
	max	7 150	201	7.1	17.6		95	4.2	28.5	6.0	21.2	3.8			2.2			16.4	
4	ave	7 150	100	6.8	11.5		64	3.2	19.8	2.6	14.5	2.7	Pos	Neg	1.0			11.8	
	min		54	6.5	4.4		40	2.4	12.1	0.4	9.6	0.25			0.3			5.3	
	max	7 150	112	7.1	17.6		80	4.8	24.9	9.8	22.5	3.2			3.0			17	
5	ave	7 150	57	6.9	11.8		63.5	3.1	14.3	3.5	13.2	1.4	Neg	Neg	1.2			11.2	
	min		23	6.6	4.4		40	2.3	12.1	0.5	4.2	0.5			0.3			7.1	
	max	7 150	39	7.1	33.0		91	3.8	22.8	4.7	25.2	2.4			8.0			23	
6	ave	7 150	31	7.0	13.9		65.7	2.0	10.2	2.3	15.0	1.19	Trace	Neg	2.56			14.3	
	min		23	6.9	6.6		42.5	1.0	5.7	0.4	4.7	0.3			0.35			7.1	
	max	7 150	89	7.3	24.2		150	3.6	17.6	12	32.8	5.0			24.1			31.9	
7	ave	7 150	42	7.1	10.4		97.9	1.7	8.2	2.0	14.6	1.1	Trace	Neg	3.0			17.4	
	min		22	6.9	6.6		6[illegible]	1.3	4.2	0.4	3.1	Trace			0.5			7.1	
	max	7 150	32	7.5	44		150	3.1	14.2	6.6	72.6	3.5	-	-	12.5			49.7	
8	ave	7 150	18.2	7.3	22		107	1.75	8.5	2.6	28.2	1.0	Trace	Trace	4.0			21.9	
	min		13	7.1	6.6		85	1.4	6.4	1.2	3.4	Trace			1.2			12.4	
	max	7 150	25	7.3	39.6		167	2.4	16.4	4.3	48.9	1.3			13.5			31.9	
9	ave	7 150	20	7.2	18.8		118	1.6	9.8	2.3	27.4	0.6	Neg	Neg.	4.6			20.3	
	min		16	7.1	8.8		80	1.4	4.2	0.1	11.0	0.45			0.9			15.9	
	max	7 150	70	7.1	35.2		137	5.5	37.1	4.3	30	1.2			12.0			35.5	
10	ave	100–150	38.5	7.1	19.1		94.4	2.8	16.2	2.0	16.6	0.6	Neg	Trace	2.9			19.9	
	min	70	15	7.1	11.0		72	1.4	7.4	0.4	7.9	0.3			0.2			14.2	
	max	7 150	120	7.1	26.4		125	5.0	24.9	11.8	20.0	2.6			2.0			21.9	
11	ave	7 150	43	7.0	20.1		75.3	3.9	18.7	3.5	14.0	0.5	Trace	Neg	0.95			14.3	
	min		26	6.5	11.0		47	2.9	12.1	0.8	5.0	Trace			0.4			10.6	
	max	7 150	52	7.1	32		125	4.2	22.1	9.4	32.8	1.9			3.5			33.7	
12	ave	7 150	25	7.0	18.5		78	3.5	17.0	4.0	23.5	0.65	Neg	Neg	1.10			21.3	
	min		20	6.9	8.8		50	2.8	4.9	2.7	14.2	Trace			0.05			14.2	
Ave		7 150	53.5	7.0			78.5	2.8	10.5	3.1	17.7	1.0			1.95			16	

Table 3 Clarified Water Quality of the Pejomoonsan I Plant 1983

(Accelator)

Month		Color Unit	Turbidity Unit (NTU)	pH	ppm (CO2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness oD	Calsium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl⁻)	Coliform Group
1	max	10	6.7	6.4	15.4	65	65	2.9	14.2	5.1	6.3	0.30		33	0.6	0.05	7.0	15.6	
	ave	6	4.2	6.2	12.0	55	55	2.3	12.1	2.5	4.7	0.15	Neg	17	0.4	0.04	6.0	12.8	
	min	5	2.7	6.1	8.8	45	45	1.8	7.8	2.1	3.4	0.09		13	0.2	0.025	4.5	8.6	
2	max	12	5.1	6.5	15.4	75	75	3.1	14.9	6.8	9.5	0.20		31	0.6	0.065	8.0	16.1	
	ave	8	4.3	6.2	12.1	55	55	2.3	10.7	3.8	5.4	0.09	Neg	31	0.45	0.04	6.0	13.1	
	min	5	3.0	5.9	8.8	40	40	1.6	2.1	2.1	3.0	trc		10	Neg	Neg	4.5	9.5	
3	max	11	5.4	6.6	15.2	90	90	3.5	20.7	4.3	11.1	0.9		32	0.60	0.07	7.0	34.2	
	ave	8	4.6	6.3	12.1	60	60	2.5	11.4	3.4	6.2	0.30	Neg	22.5	0.30	0.045	6.0	15.2	
	min	8	3.4	6.1	9.9	35	35	1.8	8.5	2.1	2.1	Neg		10	0.20	0.020	5.5	11.2	
4	max	12	5.4	6.3	15.4	90	90	3.0	19.2	6.8	13.4	0.16		40	0.60	0.07	7.0	16.4	
	ave	9	4.8	6.3	13.2	60	60	2.5	11.4	3.8	3.5	Neg	Neg	24	0.50	0.045	6.0	14.0	
	min	8	3.2	6.0	11.0	45	45	2.2	7.1	2.5	1.5			20	0.30	0.03	5.5	11.2	
5	max	12	5.7	6.5	17.6	70	70	3.0	13.5	6.4	9.1			32	0.60	0.09	6.5	17.3	
	ave	9	5.1	6.3	13.2	57	57	2.5	11.4	3.8	5.6	Neg	Neg	25	0.50	0.05	6.0	13.9	
	min	7	4.5	6.1	11.0	30	30	1.9	8.5	2.5	4.6			20	0.05	0.03	5.0	11.3	
6	max	12	[illegible]	[illegible]	[illegible]	85	85	4.3			11.0	0.8		32	0.60	0.095	7.5	22.0	
	ave	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	65	[illegible]			4.3		Neg	23	0.55	0.06	6.0	15.9	
	min	7	[illegible]	[illegible]	[illegible]	60	60	[illegible]			2.5	Neg		10	0.50	0.009	4.5	11.0	
7	max	12	6.3	6.7	17.6	90	90	3.4	17.1	6.5	13.0			32	0.6	0.095	6.5	22.0	
	ave	9	4.9	6.4	13.2	75	75	2.9	13.5	4.3	8.3	Neg	Neg	24	0.6	0.06	6.0	17.5	
	min	7	4.6	6.3	8.8	60	60	2.6	9.9	2.5	3.7			18	0.6	Neg	5.0	14.1	
8	max	12	5.6	6.7	17.6	90	90	3.6	17.1	6.4	18.4	0.8		42	0.6	0.095	6.5	24.1	
	ave	8.9	5.0	6.4	14.2	80	80	3.2	14.9	4.7	10.5		Neg	28	0.6	0.065	6.0	17.2	
	min	7	4.6	6.3	11.0	70	70	2.8	12.8	3.4	6.3	Neg		20	0.6	0.015	5.5	12.7	
9	max	12	5.4	6.5	17.6	100	100	4.4	21.4	10.3	11.0	0.65		45	0.6	0.095	7.5	25.5	
	ave	6	4.9	6.3	15.4	80	80	3.5	15.7	5.5	7.9		Neg	32	0.6	0.05	6.5	20.5	
	min	5	4.6	6.2	11.0	60	60	2.8	8.5	3.4	6.3	Neg		19	0.6	Neg	5.5	15.6	
10	max	11	6.3	6.4	17.6	80	80	3.4	17.1	6.0	13.0	0.4		34	0.6	0.085	6.0	22.0	
	ave	8	5.2	6.3	13.2	65	65	3.0	14.2	4.3	7.5		Neg	29	0.6	0.06	5.5	17.4	
	min	8	4.8	6.3	13.2	60	60	2.6	9.9	3.4	3.8	Neg		19	0.6	0.04	5.0	12.7	
11	max	12	8.9	6.5	17.6	95	95	3.8	18.5	6.0	12.3	0.89		30	0.60	0.095	6.5	22.7	
	ave	83	5.0	6.3	13.2	60	60	2.7	13.5	3.4	7.6		Neg	23	0.54	0.05	6.0	17.4	
	min	5	3.6	6.1	8.8	40	40	1.6	8.5	1.7	3.1	Neg		18	0.40	Neg	5.5	11.3	
12	max	10	5.7	6.5	17.6	75	75	3.0	14.9	4.3	6.9	0.4		30	0.6	0.095	7.0	17.0	
	ave	7	4.9	6.3	13.2	55	55	2.4	12.8	2.5	5.3		Neg	26	0.6	0.055	6.0	13.0	
	min	5	3.5	6.1	11.0	35	35	2.1	11.4	1.7	4.1	Neg		17	0.6	0.020	5.5	10.6	
Ave		8.2	4.8	6.3			64	2.5			6.6				0.54		6.0	14.2	

Table 4 Filtered Water Quality of the Pejompongan I Plant 1983, Monthly Report by PDAM

Month		Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO_2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness oD	Calsium ppm	Magnesium ppm	Organic matter ppm (as $KMnO_4$)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO_2)	Ammonium ppm (as NH_4-N)	Nitrate ppm (as NO_3-N)	Oxygen ppm (as O_2)	Chloride ppm (as Cl^-)	Coliform Groups (MPN/100)
	max	5	4.0	6.3	15.4	90	90	2.9	14.2	6.4	5.3			25	0.25	0.04	6.0	17.2	
1	ave	5	1.[illegible]	6.1	12.1	50	50	2.5	12.1	3.0	3.6	Neg	Neg	22	0.02	0.01	5.5	12.0	
	min	5	0.9	6.0	11.0	40	40	1.9	7.1	1.7	1.5			11	Neg	Neg	4.5	10.8	
	max	5	4.7	6.3	16.5	75	75	2.9	14.9	6.0	6.0			24	0.50	0.06	7.0	17.0	
2	ave	5	1.5	6.2	11.0	55	55	2.3	10.7	3.4	4.3	Neg	Neg	16	0.16	0.023	5.3	12.4	
	min	5	0.6	5.5	8.8	42	42	2.0	8.5	1.7	2.3			8	Neg	Neg	4.5	11.1	
	max	7	2.1	6.3	13.2	80	80	3.1	14.9	4.7	6.7			25	0.60	0.075	6.0	17.0	
3	ave	6	1.3	6.2	11.0	52	52	2.3	11.0	3.4	4.7	Neg	Neg	17	0.33	0.02	5.0	14.1	
	min	5	0.6	6.1	7.7	35	35	1.7	6.4	2.1	3.6			8	Neg	Neg	4.0	7.1	
	max	10	2.2	6.3	17.6	80	80	3.4	14.2	4.7	8.6			24	0.60	0.045	7.0	17.1	
4	ave	6	1.4	6.2	12.1	57	57	2.5	11.9	3.4	4.4	Neg	Neg	18	0.25	0.025	5.0	14.7	
	min	5	1.1	6.0	11.0	40	40	2.2	8.5	2.5	1.5			15	Neg	Neg	4.0	12.7	
	max	8	2.4	6.3	13.2	70	70	3.0	14.9	5.1	7.8			24	0.60	0.22	6.0	17.1	
5	ave	6	1.5	6.2	11.0	55	55	2.5	12.1	3.4	4.4	Neg	Neg	18	0.25	0.02	5.0	13.9	
	min	5	1.0	6.0	8.8	40	40	1.9	7.1	2.5	1.5			15	Neg	Neg	4.0	12.7	
	max	8	3.2	6.5	15.4	70	70	3.5	17.4	8.6	6.9			24	0.60	0.05	6.5	22.0	
6	ave	6	1.5	6.3	11.0	60	60	2.8	13.1	4.3	3.8	Neg	Neg	18	0.55	0.030	5.5	16.4	
	min	5	1.3	6.1	8.8	45	45	2.2	5.7	2.5	1.8			7	0.35	Neg	5.0	12.7	
	max	8	1.9	6.5	17.6	80	80	3.8	17.8	6.0	9.4			24	0.60	0.095	6.5	20.3	
7	ave	6	1.4	6.3	11.0	65	65	3.0	14.9	3.8	5.8	Neg	Neg	18	0.55	0.035	5.5	17.2	
	min	5	1.0	6.2	4.4	50	50	2.6	10.7	2.5	1.8			14	0.50	Neg	5.0	12.7	
	max	7	2.1	6.5	17.6	90	90	3.7	18.5	6.4	11.0			32	0.60	0.095	6.5	24.1	
8	ave	5	1.4	6.4	13.2	75	75	3.2	14.9	4.7	8.2	Neg	Neg	21	0.60	0.04	5.5	17.5	
	min	5	1.0	6.2	8.8	60	60	2.8	11.4	3.4	3.4			15	0.60	0.03	5.0	14.2	
	max	8	1.7	6.5	17.6	90	90	5.0	22.8	12.0	11.0			33	0.60	0.08	7.0	26.9	
9	ave	6	1.4	6.3	15.4	75	75	3.6	17.1	5.1	6.3	Neg	Neg	24	0.60	0.015	5.5	21.8	
	min	5	1.2	6.1	8.8	70	70	3.0	11.2	3.4	2.3			14	0.60	Neg	4.5	15.6	
	max	7	1.8	6.4	17.6	80	80	3.8	18.5	6.0	9.4			30	0.60	0.04	6.0	19.3	
10	ave	5	1.4	6.3	13.2	75	75	3.1	14.9	4.3	6.9	Neg	Neg	22	0.55	0.025	5.0	13.9	
	min	5	1.2	6.3	8.8	60	60	2.8	11.4	2.5	3.1			15	Neg	0.02	5.0	12.7	
	max	7	5.1	6.5	60	90	90	4.2	18.5	6.0	8.8			24	0.6	0.065	6.5	22.7	
11	ave	5	1.6	6.3	13.2	57	57	2.6	12.8	3.4	5.2	Neg	Neg	18	0.3	0.02	5.5	17.2	
	min	5	1.0	6.0	8.8	40	40	1.8	9.9	1.7	1.5			14	Neg	Neg	4.5	11.3	
	max	7	1.9	6.4	17.6	80	80	2.8	16.4	4.3	6.3			35	0.60	0.06	6.5	19.9	
12	ave	5	1.4	6.3	13.2	60	60	2.5	17.5	2.5	4.6	Neg	Neg	20	0.56	0.049	5.5	16.8	
	min	5	1.0	6.2	13.2	40	40	2.1	12.5	1.7	3.1			13	0.45	0.02	5.0	12.7	
Ave		5.5	1.4	6.3			61	2.6			4.5				0.38		5.3	13.9	

Table 5 Clarified Water Quality of the Pejompongan II Plant 1983, Monthly Report by PDAM

Month	Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness dH	Calsium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl⁻)	Coliform Groups (MPN/100
1983 max		4.0	6.3			40	2.4	17.1	4.3	12.0				0.5			17	
1 ave	10-20	3.8	6.0			27	2.1	11.4	2.4	7.6	Neg			0.04			12	
min		3.2	6.0			20	1.4	8.5	0.8	5.3				0			8	
1983 max		3.6	6.0			43	3.2	15.7	4.3	11.0				0.1			20	
2 ave	10-20	3.2	6.0	16		32	2.7	13.3	3.5	8.7	Neg			0.02			15	
min		3.0	5.9			25	2.0	9.9	3.0	7.2				0			13	
max		4.5	6.2	23		40	3.0	15.7	4.3	11.0				0.05			19	
3 ave	10-20	3.3	6.0	15.7		33	2.4	12.1	3.3	7.8	Neg			0.002			13.3	
min		2.8	5.9	11		25	1.6	8.5	1.7	5.6				0			10	
max		4.9	6.0	13		40	3.0	17.1	4.3	12.3				0.05			[illegible]	
4 ave	10-20	3.3	5.9	12		29	2.6	13.4	3.0	8.5	Neg			0.003			14	
min		2.8	5.9	9		20	1.6	9.9	0.8	5.0				0			10	
max		4.5	6.1			45	3.4	17.1	4.3	11.7				0.3			17	
5 ave	10-20	3.2	6.0			31	2.7	13.6	3.1	8.0	Neg			0.06			14	
min		2.3	5.9			20	1.8	10.7	1.7	6.6				0			10	
max		3.8	6.3			60	3.3	15.7	4.3	11.2				0.4			17	
6 ave	10-20	3.1	6.1			32	2.6	13.5	3.5	8.5	Neg			0.07			14	
min		2.5	6.0			25	2.3	9.9	2.1	6.6				0			11	
max		3.5	6.3			60	3.2	19.9	4.3	14.2				0.4			23	
7 ave	10-20	3.1	6.1			40	2.7	13.6	3.3	8.7	Neg			0.09			15	
min		2.8	6.0			25	2.0	7.1	0.8	4.7				0			13	
max		3.8	6.3			55	4.0	28.5	5.2	16.4				0.4			20	
8 ave	10-20	3.3	6.2			47	3.3	10.3	3.6	9.4	Neg			0.3			17	
min		2.8	6.0			35	2.8	14.2	2.5	6.9				0.2			13	
max		4.6	6.5			65	4.1	27.1	7.3	11.4				0.5			26	
9 ave	10-20	3.5	6.3			56	3.3	17.1	3.8	9.0	Neg			0.25			20	
min		3.2	6.3			10	2.8	11.4	1.2	7.9				0.1			17	
max		5.5	6.2			60	3.6	19.9	5.1	17.6				0.5			20	
10 ave	10-20	3.5	6.1			35	2.8	14.3	3.3	8.9	Neg			0.2			15	
min		2.8	6.0			15	1.8	9.9	1.7	3.4				0			10	
max		6.0	6.3			40	2.8	19.9	4.3	11.				0.3			13	
11 ave	10-20	3.9	6.1			27	2.1	11.4	2.6	6.3	Neg			0.07			12	
min		2.8	6.0			25	0	7.1	0.8	2.5				0			8	
max		4.0	6.3			60	3.6	17.8	6.9	12.3				0.6			24	
12 ave	10-20	3.6	6.1			38	2.7	13.3	3.4	8.4	Neg			0.2			15	
min		3.2	6.0			20	2.0	9.9	0.8	5.3				0			9	
Ave		3.4	6.1			35.6	2.7			8.3				0.1			14.8	

Table 6 Filtered Water Quality of the Pejompongan II Plant 1983, Monthly Report by TDAM

Date	Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Bicarbonat ppm	M-Alkalinity ppm	Hardness oD	Calcium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl⁻)	Coliform Groups (MPN/100)
1983 max		0.9	6.3			40	2.6	15.7	4.3	8.8				0.05			15	
1 ave	0-5	0.6	6.0			27	2.2	11.5	2.3	5.8	Neg			0.003			11	
min		0.4	6.0			20	1.6	9.9	0.8	1.9				0			8	
1983 max		0.6	6.0			45	3.5	17.8	4.3	8.8				0.1			17	
2 ave	0-5	0.4	5.9	13		32	2.9	15.8	3.1	5.4	Neg			0.007			14	
min		0.3	5.9			25	1.8	12.8	1.7	3.4				0			11	
max		0.9	6.0			40	3.2	23	4.3	7.9				0			15	
3 ave	0-5	0.5	5.9			35	2.6	13.3	2.9	6.2	Neg			0			12	
min		0.3	5.8			25	1.8	9.9	1.7	4.7				0			10	
max		0.9	6.0			40	3.2	19.2	4.3	7.9				0			13	
4 ave	0-5	0.5	5.9			29	2.7	14.4	2.8	6.0	Neg			0			13	
min		0.3	5.9			20	1.8	9.9	1.7	3.7				0			9	
max		0.5	6.1			40	3.5	19.2	3.4	8.5				0.2			14	
5 ave	0-5	0.4	6.0			31	2.9	15.8	3.0	6.2	Neg			0.02			12	
min		0.2	5.9			25	2.0	9.9	2.1	3.0				0			10	
max		0.4	6.3			40	3.2	17.8	3.4	8.2				0.2			15	
6 ave	0-5	0.3	6.2			32	2.5	15.9	2.3	5.6	Neg			0.03			12	
min		0.2	6.0			25	2.2	11.4	1.7	4.1				0			10	
max		0.5	6.3			60	3.4	21.4	4.3	9.1				0.2			20	
7 ave	0-5	0.4	6.1			40	2.8	15.2	3.1	6.6	Neg			0.045			15	
min		0.3	6.0			20	2.4	9.9	0.8	3.7				0			12	
max		0.6	6.3			70	3.5	21.8	5.2	13.3				0.4			20	
ave	0-5	0.4	6.2			47	2.3	17.8	3.2	7.9	Neg			0.15			16	
min		0.3	6.2			35	2.4	14.2	0.4	5.6				0			14	
max		0.6	6.5			65	4.0	30.7	6.4	11.7				0.3			23	
9 ave	0-5	0.4	6.3			56	3.4	17.4	4.0	7.1	Neg			0.12			17	
min		0.3	6.3			45	3.0	14.2	1.2	3.8				0			14	
max		0.8	6.3			50	3.8	25.7	6.0	9.8				0.3			28	
10 ave	0-5	0.5	6.1			35	2.9	14.7	3.4	6.2	Neg			0.07			13	
min		0.4	6.0			15	2.0	9.9	0.8	2.2				0			10	
max		0.9	6.3			40	3.0	15.7	4.3	2.3				0.3			14	
11 ave	0-5	0.6	6.0			27	2.2	11.7	2.4	5.2	Neg			0.006			11	
min		0.4	6.0			15	1.6	8.5	0.8	1.8				0				
max		0.8	6.3			60	3.4	17.1	5.2	9.8				0.3			20	
12 ave	0-5	0.6	6.2			38	2.7	13.8	3.2	6.8	Neg			0.085			13	
min		0.5	6.0			20	1.8	9.9	0.8	3.7				0			8	
Ave	0-5	0.5	6.1			35.7	2.5		2.8	6.2				0.045			13.3	

Table 7 Finished Water Quality of the Pejompongan II Plant 1983, Monthly Report by PDAM

Month	Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Residual chlorine ppm	M-Alkalinity ppm	Hardness oD	Calsium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl⁻)	Coliform Groups (MPN/100)
1984 max		0.8	7.3		1.0	50	3.2	19.9	3.4	7.9				0			10	
1 ave	0-5	0.6	7.0		0.65	78	2.9	17.3	2.2	4.6	Neg			0			10	0/11
min		0.4	6.9		0.5	30	2.4	14.1	0.8	1.5				0			6	
1983 max		0.6	7.3	14	1.0	50	7.8	21.4	3.4	6.9				0			15	
2 ave	0-5	0.5	7.0	9	0.8	35	3.3	19.4	2.5	2.8	Neg			0			12	0/12
min		0.4	6.7	6	0.6	30	2.8	14.9	1.7	1.5				0			10	
max		0.9	7.5		0.9	45	3.8	21.4	4.3	7.9				0			15	
3 ave	0-5	0.6	7.0		0.7	35	3.2	17.6	2.6	4.4	Neg			0			12.7	0/11
min		0.4	5.7		0.5	30	2.6	15.7	0.8	1.5				0			[illegible]	
max		0.9	7.1	10	0.9	50	3.5	21.4	4.7					0			16	
4 ave	0-5	0.5	7.0	7	0.7	35	3.1	18.2	2.3	2.8	Neg			0			11	0/11
min		0.3	6.9	5	0.6	20	2.0	17.1	0.8	1.5				0			10	
max		0.6	7.1		1.0	45	3.7	22.1	3.0	5.7				0			15	
5 ave		0.5	6.9		0.7	40	3.2	19.3	2.2	3.0	Neg			0			11	0/12
min		0.3	6.5		0.5	70	2.8	8.5	1.7	1.5				0			9	
max		0.6	7.4		0.9	35	4.0	24.4	3.4	4.7				0			20	
6 ave	0-5	0.5	7.1		0.8	38	3.3	19.5	2.4	2.8	Neg			0			11	0/12
min		0.4	6.9		0.6	30	2.8	17.1	1.7	1.5				0			8	
max		0.6	7.9		1.2	55	4.2	21.4	4.3	5.6				Trace			12	3/9
7 ave	0-5	0.5	7.0		0.7	47	3.3	16.3	2.6	3.8	Neg			0			12	(30 -
min		0.4	6.9		0.4	35	2.6	14.2	1.2	2.2				0			10	2900)
max		0.6	7.1		1.2	60	4.8	25.7	5.1	7.9				Trace			22	3/12
8 ave	0-5	0.5	7.0		0.8	52	3.9	22.5	3.3	5.7	Neg			0			15	
min		0.4	6.8		0.4	40	3.0	19.9	0.8	3.4				0			11	(11 - 2400)
max		0.7	7.1		1.2	75	4.8	29.2	6.0	6.9				0			21	1/11
9 ave	0-5	0.5	7.0		0.7	62	3.8	19.9	4.1	4.9	Neg			0			13	
min		0.4	6.9		0.6	55	3.4	17.1	1.7	1.8				0			10	
max		0.8	7.0		1.0	60	4.8	25.7	6.0	6.7				0			15	0/11
10 ave	0-5	0.5	6.8		0.6	44	3.5	19.2	3.6	4.5	Neg			0			11	
min		0.5	6.7		0.2	30	2.8	12.8	1.3	1.5				0			10	
max		0.8	7.1			50	3.4	21.4	4.3	6.9				0			10	0/12
11 ave	0-5	0.6	7.0			36	2.9	16.2	2.3	4.2	Neg			0			10	
min		0.4	6.9			20	2.2	12.8	0.8	1.5				0			9	
max		0.8	7.2		1.0	75	3.8	22.8	5.1	7.3				0			10	0/11
12 ave	0-5	0.6	6.9		0.7	50	3.5	18.8	3.3	5.2	Neg			0			10	
min		0.4	6.7		0.5	35	2.8	15.7	0.8	1.8				0			10	
Ave	0-5	0.5	7.0		0.71	46	3.3			4.1				0			11.2	7/135

Table 8 Clarified Water Quality of the Pulogadung * 1983

Month	Turbidity (NTU)			Residual Chlorine (mg/1)		
	Ave	Max	Min	Ave	Max	Min
1	2.7	4.1	2.0	0.49	1.0	0
2	4.1	8.8	1.8			
3	3.0	3.8	2.0			
4	2.9	3.7	2.2	0.3	1.2	0
5	2.8	6.2	1.7	0.15	0.24	0.05
6	3.0	7.5	2.0	0.11	0.27	0
7	3.8	9.5	1.9	0.065	0.5	0
8	5.7	18.7	1.9	0		
9	4.0	5.1	3.2	0		
10	3.6	5.7	2.0	0		
11	4.0	4.7	3.7	0		
12	3.0	5.0	2.0	0.15	0.8	0
Ave	3.55					

* Monthly Report by PDAM

Table 9 Finished Water Quality of the Pulogadung Plant 1983, Monthly Report by PDAM

Month		Color Unit (Pt.Co)	Turbidity Unit (NTU)	pH	ppm (CO2)	Residual chlorine ppm	M-Alkalinity ppm	Hardness oD	Calcium ppm	Magnesium ppm	Organic matter ppm (as KMnO4)	Iron ppm (as Fe)	Manganese ppm (as Mn)	Sulfat ppm (as SO2)	Ammonium ppm (as NH4-N)	Nitrate ppm (as NO3-N)	Oxygen ppm (as O2)	Chloride ppm (as Cl$^-$)	Coliform Groups (MPN/100)
1984	max		3.0	8.1	22	0.7	70	4.1	23.5	7.2	9.4				0.55			26.2	
1	ave	5-10	2.0	7.1	13.9	0.1	50	3.3	17.9	3.9	7.15	Neg	Neg	Trace	0.10			17.9	
	min		1.7	6.9	0	0	20	2.1	15.7	0.4	2.0				Trace			14.2	
1983	max	15	6.5	7.6	19.2	1.90	85	5.2	28.5	7.3	8.4			85	0.45			20.3	
2	ave	5-10	2.9	7.0	11.4	0.72	53.5	3.9	22.9	3.25	3.75	Trace	Neg	50	0.27			17.9	
	min	0	1.0	6.8	4.4	0.	35	3.1	16.4	0.8	1.6			35	0.15			10.6	
	max	10	1.6	7.9	22	1.4	70	5.4	25.4	7.1	8.8				0.3			20.2	
3	ave	5-10	1.3	7.2	15.4	1.2	45	5.0	19.2	3.4	3.86	Neg	Neg	Trace	0.17			13.8	
	min	5	0.9	6.7	2.2	1.0	30	3.0	17.7	0.7	1.2				0.1			7.1	
	max	10	2.5	7.8	17.7	1.2(0.4)*	80	5.7	39.3	12.0	9.4			85	0.35			35.5	
4	ave	5-10	1.6	7.1	10.5	0.86(0.04)	51.8	4.7	24.6	6.5	6.0	Trace	Neg	27	0.18			25.6	
	min	5	1.0	6.9	2.2	0.45(0)	40	3.5	20.4	3.1	2.1			Neg	Trace			17.7	
	max	10	3.1	7.8	22	1.2(0.1)	79	11.2	26.4	8.6	6.6			43	Trace			25.5	
5	ave	5-10	1.87	7.1	11.4	0.65(0.01)	51.5	3.4	19.4	3.3	3.8	Neg	Neg	20	Trace			15.1	
	min	5	1.3	6.9	4.4	0.3(0)	27	2.8	14.9	0.8	1.1			10	Trace			6.6	
	max	10	3.2	7.9	22	1.4(0)	91	4.2	24.9	5.1	10.7			35	0.25			28.4	
6	ave	5-10	2.07	7.3	10.1	1.05(0)	55.4	2.2	11.9	1.8	5.3	Neg	Neg	24	0.03			17.3	
	min	5	1.0	7.0	1.2	0.5(0)	36	1.2	7.5	0	1.2	Neg	Neg	Trace	Neg			8.8	
	max		3.5	7.5	39.6	1.2(0.05)	140	3.8	17.8	5.5	10.3	0.3		100	0.60			46.1	
7	ave	5-10	2.5	7.2	16.6	0.9(0.01)	72	2.5	9.2	2.0	6.5	Trace	Neg	55	0.44			21.3	
	min		1.1	6.9	4.4	0.6(0)	30	2.0	4.9	0.4	1.2	Neg		Trace	0.15			10.6	
	max		4.3	7.4	50.6	1.6(0)	125	3.0	17.8	16.7	9.7	0.15			0.5			40.5	
8	ave	5-10	3.75	7.2	30.7	1.3(0)	75	2.7	13.0	2.5	8.5	Trace	Neg	Pos	0.29			29.5	
	min	0	2.1	6.9	6.6	0.6(0)	65)	1.6	7.1	0.4	Neg				Trace			21.0	
	max		3.0	7.5	48.4	1.3(0)	135	3.2	15.7	3.4	9.9	0.15			0.90			36.5	
9	ave	5-10	2.35	7.2	18.8	1.1(0)	98.3	2.2	10.0	2.1	7.9	Neg	Pos	Pos	0.68			25.9	
	min		1.9	6.9	4.4	0.9(0)	60	1.9	5.7	0.8	2.2	Neg			0.15			12.8	
	max		2.6	7.3	39.6	1.4(0)	145	6.9	35.5	6.8	9.4				0.9			35.7	
10	ave	5-10	2.1	7.0	33.4	1.1(0)	78.5	3.6	26.8	2.3	5.5	Neg	Neg	Pos	0.3			26.3	
	min		1.5	6.9	6.6	0.9(0)	35	2.6	23.0	0.8	1.2				Neg			23.0	
	max		2.9	7.2	39.6	1.4(0)	125	5.2	30	6.8	7.7				0.15			35.5	
11	ave	5-10	2.2	7.0	19.2	1.1(0)	65.2	4.3	22.1	3.5	4.1	Neg	Neg	Neg	0.05			21.3	
	min		1.9	6.8	4.4	0.9(0)	37	4.0	11.4	0.0	1.2				Trace			19.5	
	max		2.4	8.0	28.4	1.4(0)	105	4.9	29.9	5.1	9.9	0.1			0.25			30.1	
12	ave	5-10	1.9	7.2	18.3	1.1(0)	65	4.0	18.2	3.4	8.0	Trace	Neg	Trace	0.15			21.3	
	min		1.3	6.9	0	0.8(0)	45	3.0	15.2	0.4	3.4	Neg			Neg			17.7	
Ave			2.2	7.1		0.93	63.5	3.5	17.9	3.1	5.9				0.22			21.1	

* ( ) shows residual chlorine concentrations in filtered water.

Table 10 Drinking Water Standard

Substances	(Unit)	Indonesia Standard (Highest desirable level)	Indonesia Standard (Maximum permissible level)	WHO International Standards (Hihgest desirable level)	WHO International Standards (Maximum permissible level)
Chemical Substances					
Total Solids	(mg/l)	500	1,500	500	1,500
Colour (plantinumcobalt)		5	50	5	50
Turbidity		5 mg/l	25	5 JTU	25
Taste		Unobjectionable		Unobjectionable	
Odor		"		"	
Iron (Fe)	(mg/l)	0.1	1.0	0.1	1.0
Manganese (Mn)	(mg/l)	0.05	0.5	0.05	0.5
Copper (Cu)	(mg/l)	0.05	1.5	0.05	1.5
Zinc (Zn)	(mg/l)	1.00	15	5.0	15.0
Calcium (Ca)	(mg/l)	75	200	75	200
Magnesium (Mg)	(mg/l)	30	150	30	150
Sulphates (SO4)	(mg/l)	200	400	200	400
Chlorides (Cl)	(mg/l)	200	600	200	600
pH	-	7.0 - 8.5	6.5 - 9.2	7.0 - 8.5	6.5 - 9.2
Total Hardness	(mg/l)		10^{o}D	100	500
Toxic Substances			(Upper limit of concentration)		(Upper limit of concentration)
Lead (pb)	(mg/l)		0.1		0.1
Arsenic (As)	(mg/l)		0.05		0.05
Selenium (Se)	(mg/l)		0.01		0.01
Chronium (hexaralent) (Cr^{+6})	(mg/l)		0.05		-
Cynide (Cn)	(mg/l)		0.05		0.05
Cadmium (Cd)	(mg/l)		0.01		0.01
Barium (Ba)	(mg/l)				-
Phonolic Substances	(mg/l)	0.001	0.002	0.001	0.002
Substances which may affect Health					
Mercury (Hg)	(mg/l)		0.001		0.001
Fluorides (F)	(mg/l)		2.0		0.6 - 1.7
Nitrates (NO3)	(mg/l)		20		-
Chemical Indicators of Pollution					
COD	(mg/l)				-
BOD	(mg/l)				-
Total Nitrogen exclusive of NO3	(mg/l)				-
Ammonia	(mg/l)		0.0		-
Carbon chloroform extract	(mg/l)				
Organic Matter (KMnO4)	(mg/l)		10		
Bacteriological					
germs			0.0		
Pathogenic germs			0.0		
Faecal coli	N/100 ml		0.0		

Table 11 Positive Number of E. Coli at Clear Water

1983

Plants/Month		1	2	3	4	5	6	7	8	9	10	11	12	Total	%
Pejompongan	I	0/11	2/12	4/12	2/12	2/12	2/10	4/8	5/12		3/11	1/12	3/11	28/123	22.8
"	II	0/11	0/12	0/12	1/12	0/12	0/10	2/8	2/12		0/11	0/12	0/11	5/123	4.1
Pulogadung		0/ 4	0/4	0/4	0/4	0/4	1/4	0/4	0/4		0/4	1/5	0/4	2/45	4.4
%		0	7.1	14.3	10.7	7.1	12.5	35.3	25		11.5	6.9	11.5		12
Cilandak		0/1	0/1	0/1	0/1	0/1	0/1	0/1			1/1		0/1	1/10	10
Muara Karang		1/2	0/3	0/4	0/3	0/2	-	1/2	0/2		0/2	0/3	1/2	3/25	12
Sunter		0/2	0/3	0/3	1/2	1/3	0/1	-	0/1		0/2	0/2	0/1	2/20	10
Cengkareng							0/1	0/1	0/1		0/1	1/2	1/2	2/8	25
Cakung		0/4	0/4	0/4	2/4	0/4	0/4	1/4	0/4		0/4	3/6	0/4	6/46	13
Pejaten												0/1	1/1	1/2	50
Pesing		0/1		0/1	0/2	0/2	0/1	1/1	1/2		0/1	0/3	0/1	2/15	13.3
Total		1/36	2/39	4/41	6/40	3/40	3/32	9/29	8/39		4/37	6/46	6/38	52/417	12.5

Table 12 Number of Faecal Coli at the Three Plants (JICA Study Team) (MPN/100 ml)

Date	Pejompongan I 11 July 1984	Pejompongan II 25 July 1984	Pulogadung 27 July 1984
Raw water	6×10^7	5.4×10^5	1×10^7
Clarified water *	300	500	0
Filtered water *	1,500	900	0
Finished water	-	100	0

Date	28 July 1984	26 July 1984	1 August 1984
Raw water	5.4×10^5	1.5×10^7	
Clarified water *	500	200	400
Filtered water *	3,000	400	0
Finished water	0	0	0

* Residual chlorine of the clarified and filtered water is nil at the Pejompongan and positive at the Pulogadung.

Table 13 Number of Faecal Coli in Tap Water 1983, Monthly Report by PDAM

(MPN/100 ml)

Month / Location	1	2	3	4	5	6	7	8	9	10	11	12	Positive/ Total
1. West Jakarta	460	7 2,400	7 2,400	-	460	31	75	43	460	7 2,400	93	93	36/165
	4	23	4		43	9	15	21	93	1,100	9	43	
							7	9	23	460	9	23	(21.8 %)
							4	4	4	240		4	
							4			43			
										9			
2. Central Jakarta	-	-	4	-	-	-	460	23	98	7 2,400	-	460	12/192
							400		4	1,100		4	
							93		4				(6.3 %)
3. East Jakarta	240	75	-	93	-	43	4	43	72,400	210	210	460	
	210			15		4		7	43	9	9	240	
	43			9					23			240	29/95
	43			9					4			240	
												93	(30.5 %)
												4	
												4	
4. North Jakarta	21	240	9	-	9	-	15	150	240	1,100	-	-	
			4		4		4	93	4	1,100			
							4	23		23			20/95
								4					(23.0 %)
								4					
								4					
5. South Jakarta	460	-	-	-	93	-	1,140	28	72,400	240	-	-	
					23		9	21	72,400	43			20/71
							4	9	1,100	21			
							4	4	7	7			(28.2 %)
									4				

Table 14 Positive Number of E. Coli in Tap Water BY PDAM 1983

Sampling Area / Month	1	2	3	4	5	6	7	8	9	10	11	12	Total
West Jakarta													
Positive/Total	2/13	2/14	2/13	0/14	2/13	2/14	5/14	4/14	4/14	6/14	3/14	4/14	36/165
Positive %	15.4	14.3	15.4	0	15.4	14.3	35.7	28.6	48.6	42.8	21.4	28.6	21.8
East Jakarta													
Positive/Total	4/8	1/8	0/7	4/8	0/8	2/8	1/8	2/8	4/8	2/8	2/8	7/8	29/95
Positive %	50	12.5	0	50	0	25	12.8	25	50	25	25	87.5	30.5
South Jakarta													
Positive/Total	1/6	0/5	0/6	0/6	2/6	0/6	4/6	4/6	5/6	4/6	0/6	0/6	20/71
Positive %	16.7	0	0	0	33	0	66	66	83	66	0	0	28.2
North Jakarta													
Positive/Total	1/8	1/9	2/8	0/8	2/7	0/8	3/8	6/8	2/8	3/8	0/7	0/8	20/95
Positive %	12.5	11.1	25	0	28.6	0	37.5	75	25	37.5	0	0	23.0
Central Jakarta													
Positive/Total	0/16	0/16	1/16	0/16	0/16	0/16	3/16	1/16	3/16	2/16	0/16	2/16	12/192
Positive %	0	0	6.2	0	0	0	18.8	6.2	18.8	12.4	0	12.4	6.3
Whole Jakarta													
Positive/Total	8/51	4/52	5/50	4/52	6/50	4/52	16/52	17/52	18/52	17/52	5/51	13/52	117/613
Positive %	15.7	7.7	10	7.7	12	7.7	30.8	32.7	34.6	32.7	9.8	25	18.9

Table 15 Positive Faecal Coli in Tap Water BY PDAM

Location of Jakarta	Total 1981	Total 1982	Total 1983	Month (1981 - 1983) 1	2	3	4	5	6	7	8	9	10	11	12	Three years Total
West																
Positive/Total	20/156	29/131	36/165	5/40	5/42	2/39	7/40	6/38	8/39	9/40	9/26	11/40	9/40	6/40	9/28	85/452
Positive %	12.8	22.1	21.8	12.5	11.9	5.1	17.5	15.8	20.5	22.5	34.6	27.5	22.5	15.0	32.1	18.8
East																
Positive/Total	23/81	14/68	29/95	9/21	4/22	0/20	8/21	2/22	6/22	4/22	7/15	6/21	4/22	7/22	9/14	66/244
Positive %	28.4	20.6	30.5	42.8	18.2	0	38.1	9.1	27.3	18.2	46.7	28.6	18.2	31.8	64.3	27.0
South																
Positive/Total	9/75	12/59	20/71	4/19	2/18	1/18	0/18	5/17	3/18	8/18	4/12	9/19	6/19	2/17	0/12	41/205
Positive %	12.0	20.3	28.1	21.1	11.1	5.6	0	29.4	16.7	44.4	33.3	47.4	31.6	11.8	0	20.0
North																
Positive/Total	27/82	21/71	20/95	4/22	4/23	7/21	4/20	7/21	2/21	10/22	8/15	6/23	9/23	5/22	3/15	68/248
Positive %	32.9	29.6	23.0	18.2	17.4	33.3	20.0	33.3	9.5	45.4	53.3	26.1	39.1	22.7	20.0	27.4
Central																
Positive/Total	4/182	8/148	12/192	0/47	2/44	1/45	1/40	1/47	0/46	8/47	1/31	5/48	2/47	1/48	2/32	24/522
Positive %	2.2	5.4	6.3	0	4.5	2.2	2.5	2.1	0	17.0	3.2	10.4	4.2	2.1	6.3	4.6
Whole Jakarta																
Positive/Total	83/576	84/477	117/613	22/149	17/149	11/143	20/139	21/145	19/146	39/149	29/99	37/151	30/151	21/149	23/101	284/1,666
Positive %	14.4	17.6	18.9	14.8	11.4	7.7	14.4	14.5	13.0	26.2	29.3	24.5	19.9	14.1	22.8	17.0

Table 16 Sampling Points of Tap Water by PDAM, 1983

I. Jakarta Barat

1. Jl. Palmerah
2. " Tanjung Duren
3. " Daan Mogot
4. " Jelambar
5. " Angke
6. " Mukalive
7. " S. Parman
8. " Pejagalan
9. " Bendengan Sel.
10. " P. Tubagus Angke
11. " Jatibaru
12. " Sawah Lio
13. " Songsi
14. " Jembatan Lima

II. Jakarta Pusat

15. Jl. Senayan
16. Jl. S. Gerong
17. " Cicurug
18. " Tm. Suropati
19. " Rasamala
20. " Cikini Raya
21. " Borobudur
22. " Kramat Raya
23. " Abdul Muis
24. " Tm. Jatibaru
25. " K. Caringin
26. " Kesehatan
27. " Merdeka Timur
28. " Bungur Besar
29. " Howitzer
30. " Cempaka Putih Tengah

III. Jakarta Timur

31. Jl. Pendidikan
32. " Cawang Baru Tengah
33. " Cawang Baru Barat
34. " Otista Raya
35. " Kp. Melayu
36. " Selamat Ryyadi
37. " P.Mas
38. " Dempo

IV. Jakarta Utara

39. Jl. Pluit Indah
40. " gedung Panjang
41. " Lodan
42. " Karang Bolong
43. " Ancol
44. " Cadang
45. " Warakas IV
46. " Bawang Putih

V. Jakarta Selatan

47. Jl. Sisingamangaraja
48. " Panglima Polim
49. " Darmawangsa
50. " P. Indah
51. " Dr. Supomo
52. " M.T. Haryono
53. " Cibinong

ATTACHMENT

Table and Figure of Quality of WTC Water

October 1983 - May 1984

By DPMA Survey

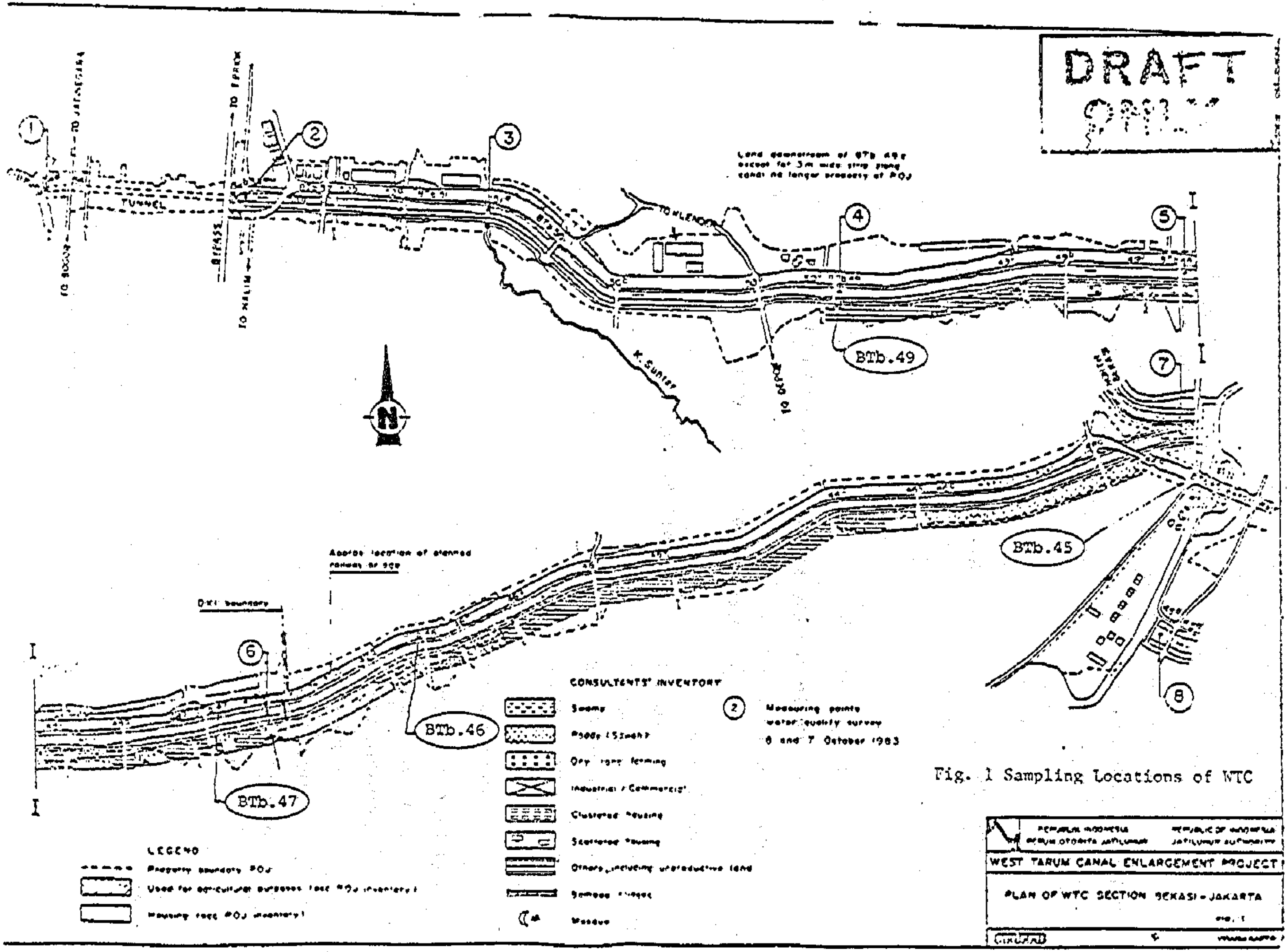

Fig. 1 Sampling Locations of WTC

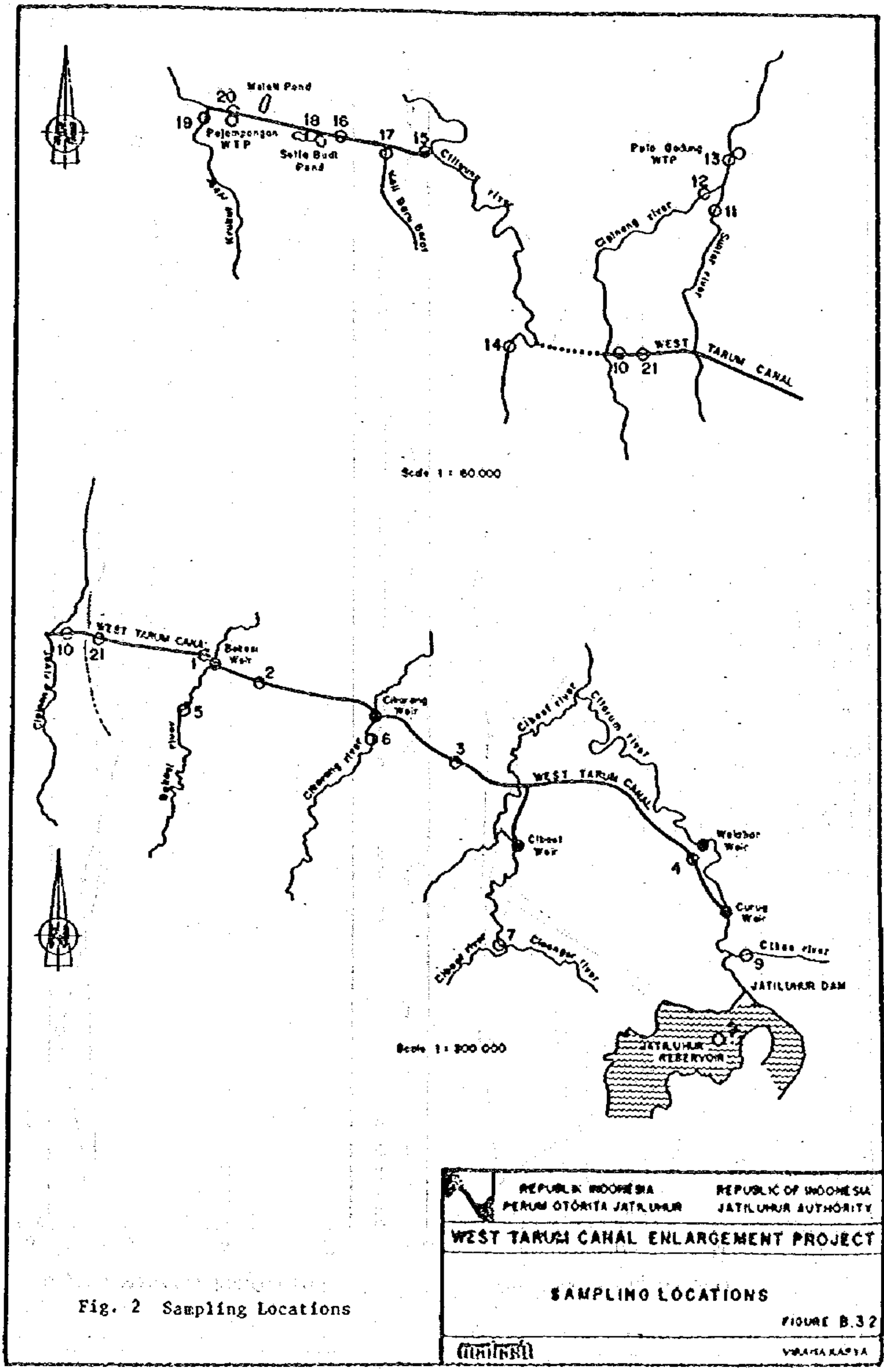

Fig. 2 Sampling Locations

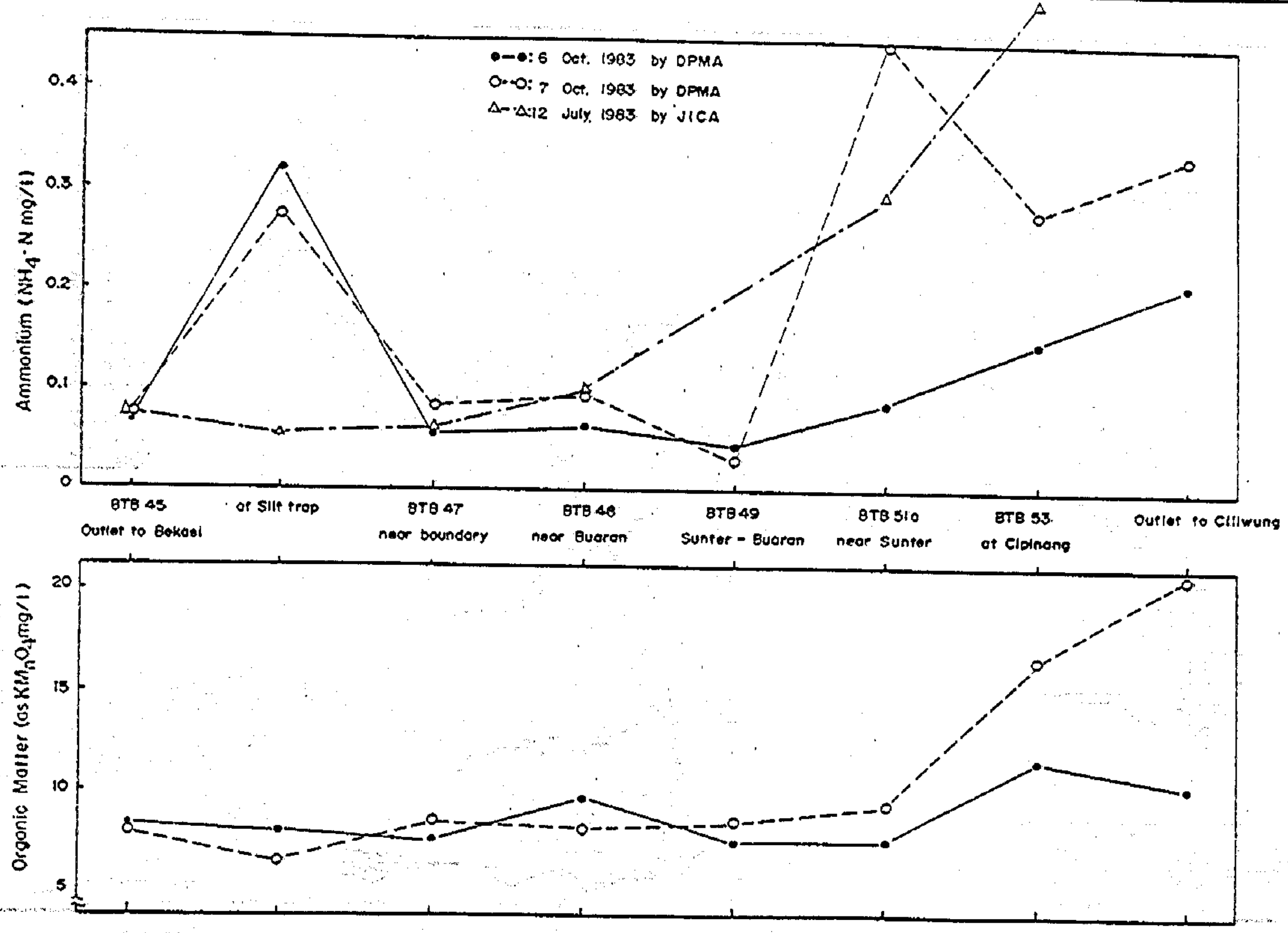

Fig. 3 Water Quality of WTC between Bekasi and Ciliwung by DPMA / JICA

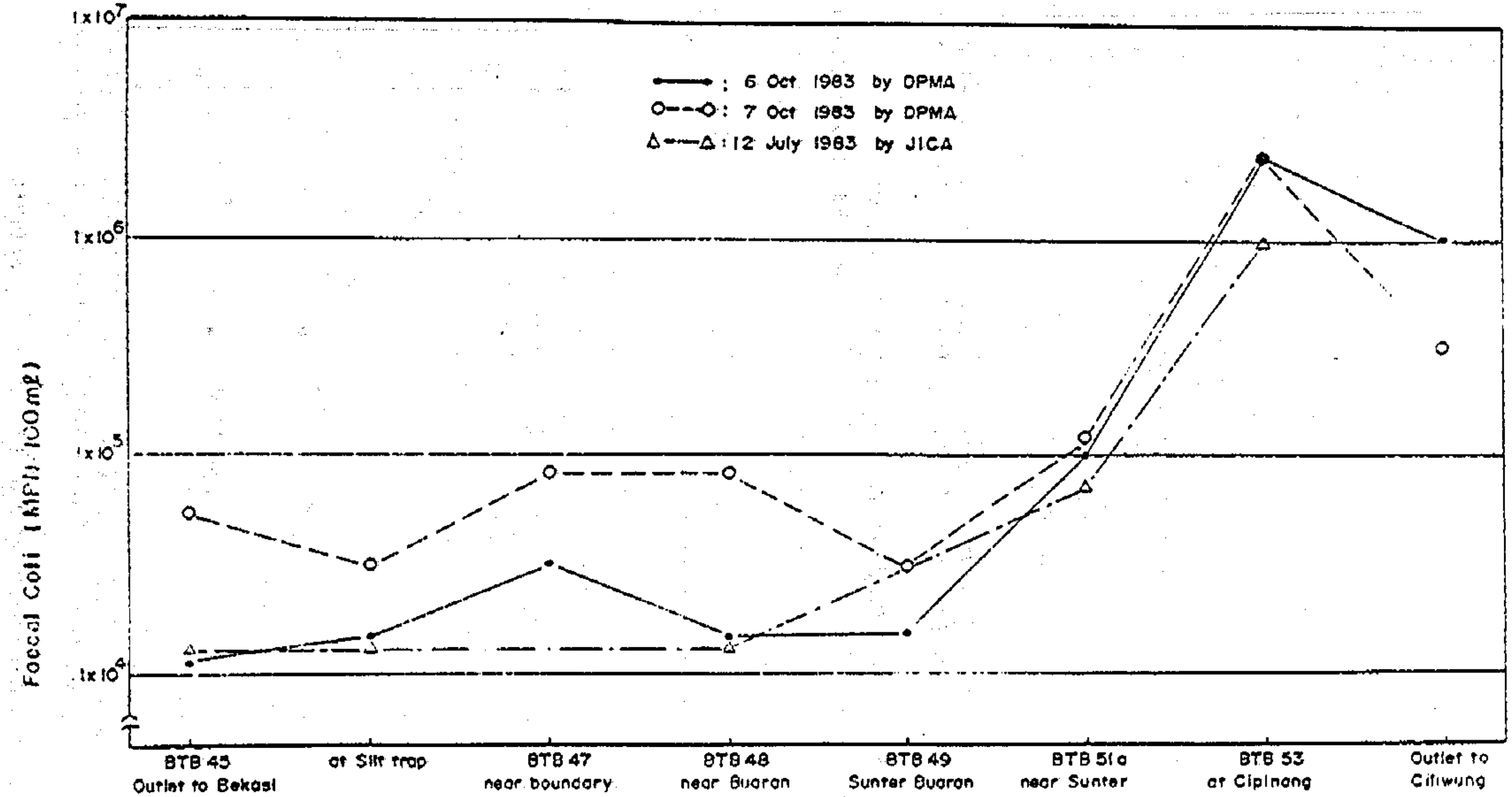

Fig.4 Water Quality of WTC between Bekasi and Ciliwung, by DPMA/JICA

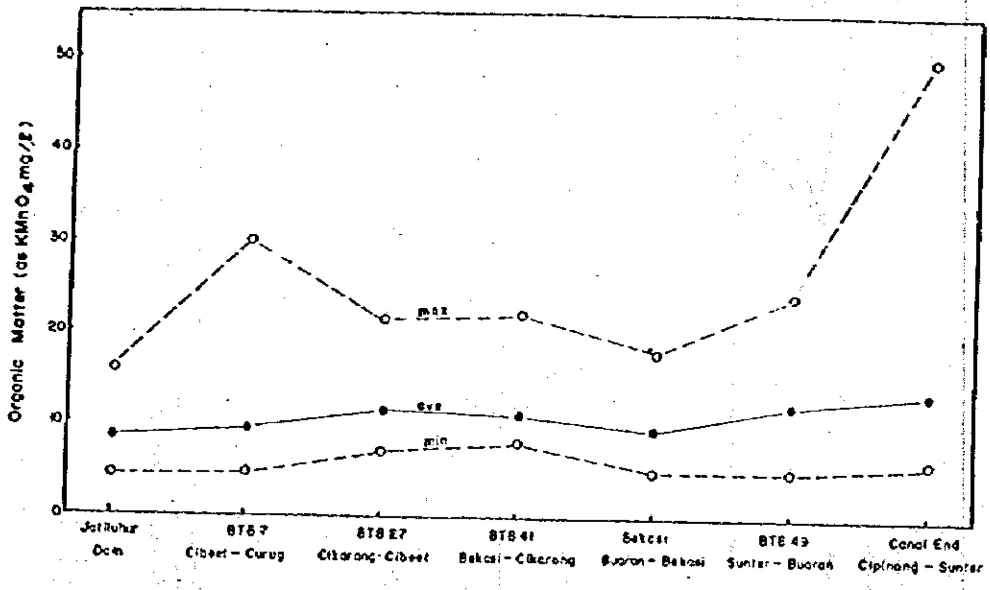

Fig. 5 Water Quality of WTC (Organic Matter) by DPMA
Nov 1983 - May 1984, 16 samples

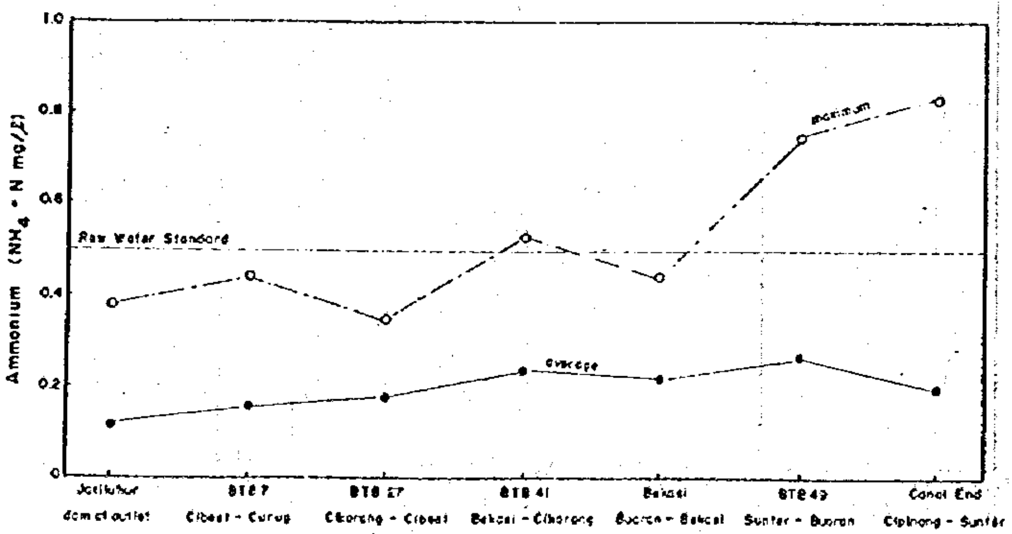

Fig. 6 Water Quality of WTC (Amonium) by DPMA
Nov 1983 - May 1984, 16 samples

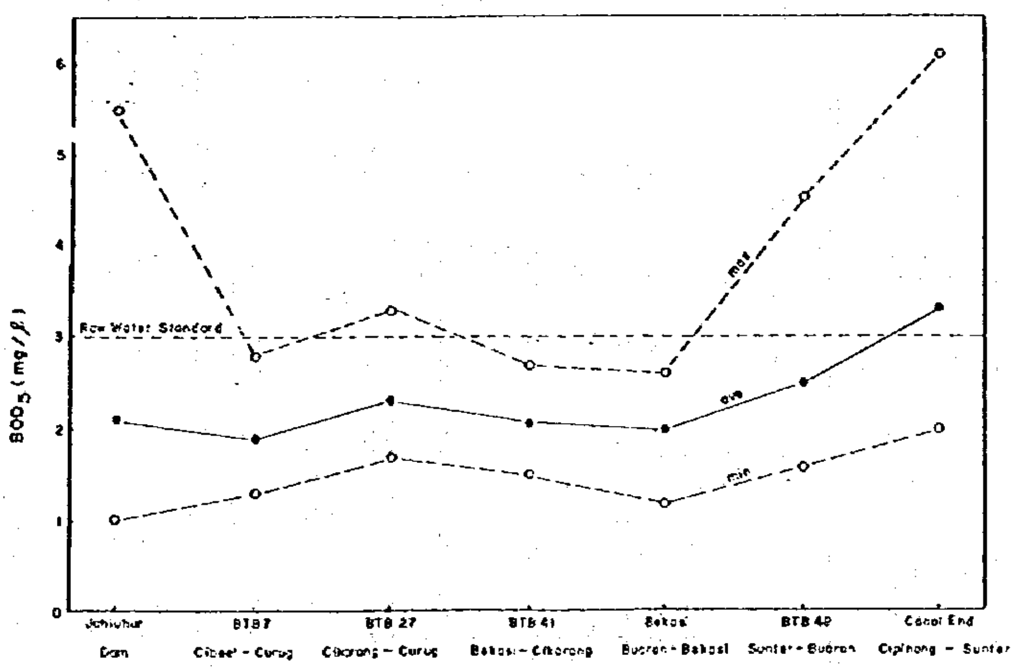

Fig. 7 Water Quality of WTC (BOD5) by DPMA
Nov 1983 - May 1984, 16 samples

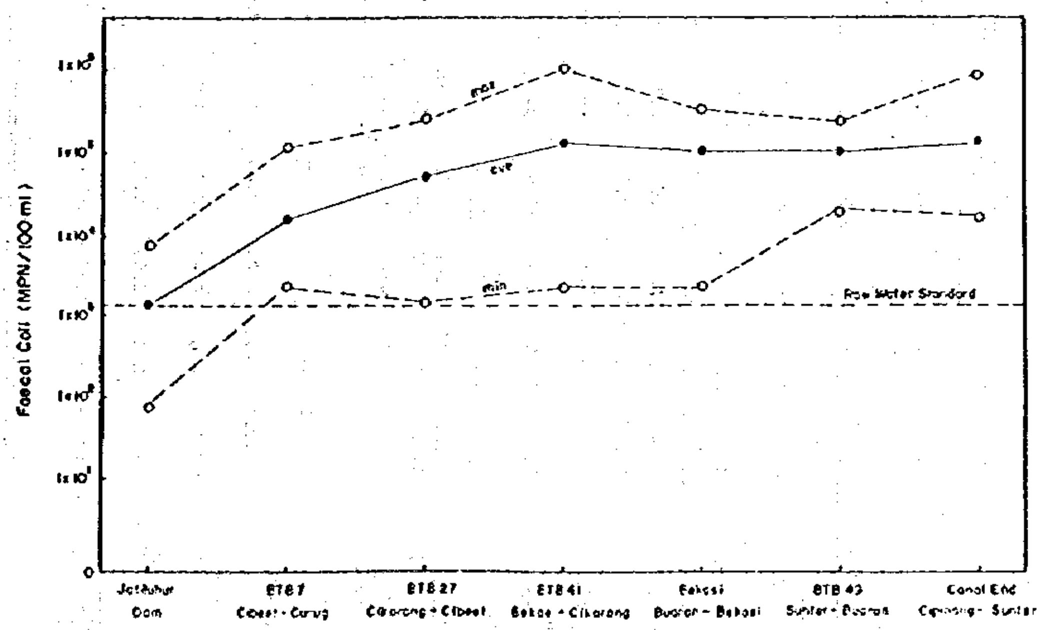

Fig 8 Water Quality of WTC (Faecal Coli) by DPMA
Nov 1983 - May 1984, 16 samples

Table I Water Quality Analysis on Bekasi River at Cikunir (No.5)

	1983 1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	1984 12 Jan	26 Jan	9 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	6.9	6.5	6.2	7.2	6.4	6.4	6.9	7.1	7.3	6.8	6.2	6.6	6.2	6.9	2.1	6.2	
pH	7.2	7.9	7.2	7.7	8.0	7.7	7.5	7.3	7.3	7.0	7.6	7.2	6.8	7.5	6.9	7.9	
Conductivity (μmho/cm)	130	128	112	160	128	123	150	131	134	132	137	146	113	152	132	135	
Turbidity (mg/l SiO2)	-	[illegible]	21	100	102	49	30	90	39	25	34	55	75	127	102	18	55.4
Color (Unit Pt Co)	25	30	20	20	15	[illegible]	10	10	15	15	10	20	15	20	15	15	
SS* (mg/l)	168	31	100	302	60	28	35	95	47	30	29	112	78	151	154	60	
BOD_5 (mg/l)	1.4	1.5	2.1	2.7	1.2	1.8	2.0	2.1	1.6	2.0	1.3	1.8	1.0	2.3	1.5	1.4	1.6
COD (mg/l)	14.6	6.5	4.4	9.8	3.8	3.7	4.4	9.3	3.5	4.8	5.5	10.3	4.4	7.4	8.8	7.9	
TOC (mg/l)	-	2.4	3.6	5.2	2.9	2.1	7.7	7.5	1.5	3.4	-	3.3	-	5.1	2.7	3.8	
O.Matter* (mg/l $KMnO_4$)	11	15.9	11.5	11.0	5.0	6.5	8.6	9.9	6	5.4	5.2	8.2	6.6	19.9	9.5	4.4	9.0
Alkalinity (mg/l)	52	60	52	52	43	47	53	51	49	61	50	56	39	48	50	44	50.4
Iron (diss/total (mg/l)	1.0/ 17.6	0.37/ 1.7	0.02/ 0.77	2.2/ 6.9	0.62/ 6.0	0.46/ 4.5	0.5/ 2.15	0.58/ 5.5	0.5/ 3.0	0.44/ 3.3	1.6/ 2.6	0.92/ 7.0	0.21/ 4	1.33/ -	0.45/ 6.9	0.3/ 1.5	4.72
Mn* (diss/total (mg/l)	0.08/ 0.25	ud/ 0.01	ud/ ud	ud/ 0.02	0.04/ 0.07	0.02/ 0.09	0.03/ 0.06	0.07/ 0.1	0.05/ -	0.09/ 0.09	0.06/ 0.06	0.15/ 0.17	ud/ -	0.11/	0.04/ 0.19	ud/ 0.07	0.05
Ammonia - N (mg/l)	0.001	ud		0.19	0.0	0.34	0.95	0.35	0.16	0.18	0.15	0.15	[illegible]	ud	ud	[illegible]	[illegible]
Nitrite - N (mg/l)	0.013	0.014	0.004	0.007	0.3	0.012	0.014	0.013	0.005	0.11	ud	ud	0.0	ud	0.014	[illegible]	
Nitrate - N (mg/l)	2.5	0.6	0.45	0.7	6.0	0.16	0.48	-	0.7	0.7	0.19	0.1	0.3	0.52	0.33	0.39	
MBAS (mg/l)	-	0.24	0.09	0.02	-	0.014	0.04	0.022	-	-	-	-	ud	0.05	ud	-	0.0?
E.Coli (MPN/100 ml)	2.3x $10^?$	?.3x $10^?$	9.3x 10^4	4.6x 10^5	-	9.3x 10^4	9x10^3	9.3x 10^4	2.4x 10^4	4.3x 10^4	9.3x 10^4	2.4x 10^5	-	-	2.4x 10^5	4.3x 10^4	1.2x

DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

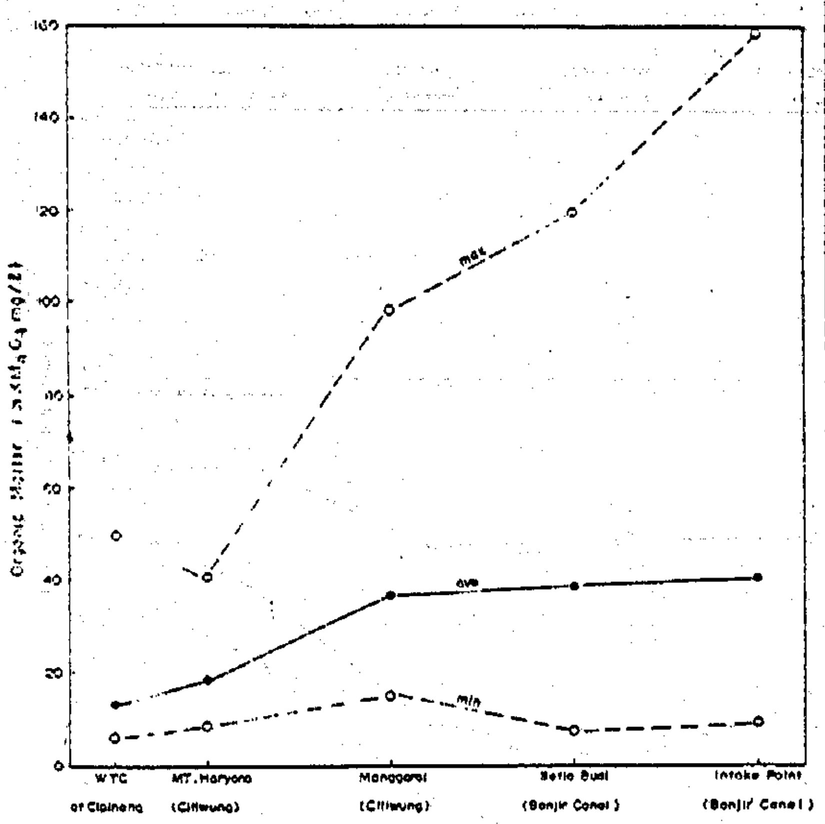

Fig. 9 Water Quality Concerning Raw Water to Pejompongan
by DPMA
Nov 1983 - May 1984, 16 samples

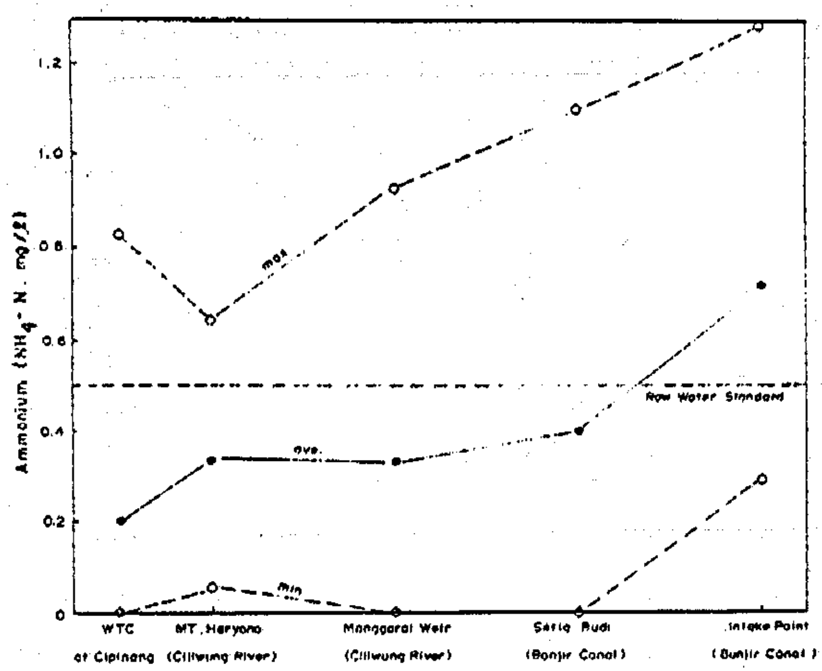

Fig. 10 Water Quality Concerning Raw Water to Pejompongan
by DPMA
Nov 1983 - May 1984

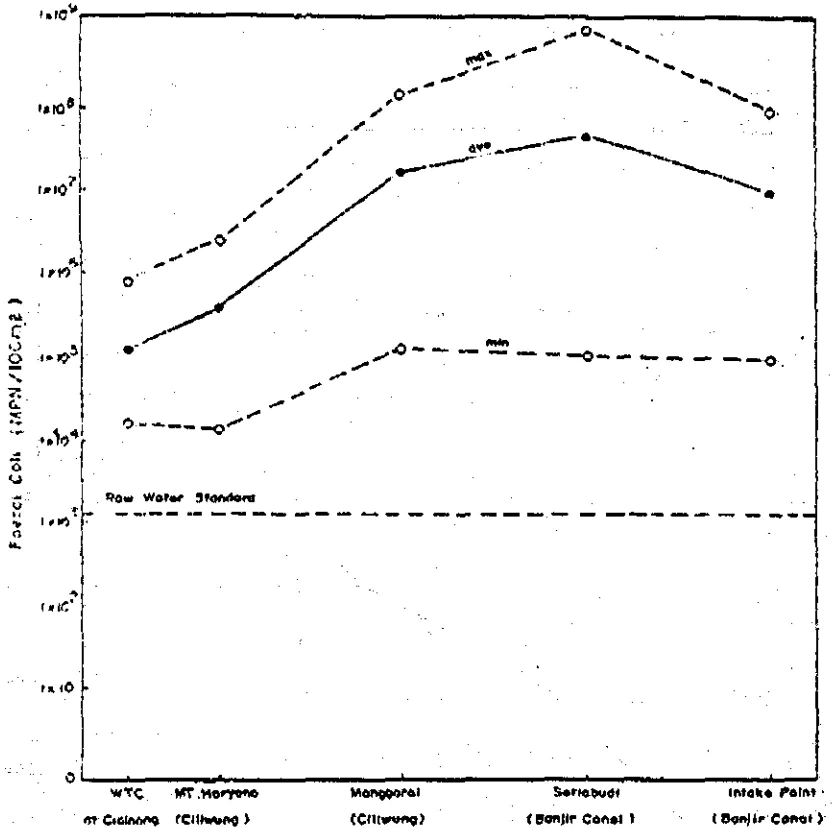

Fig. 11 Water Quality Concerning Raw Water to Pejompongan

by DPMA
Nov 1983 – May 1984

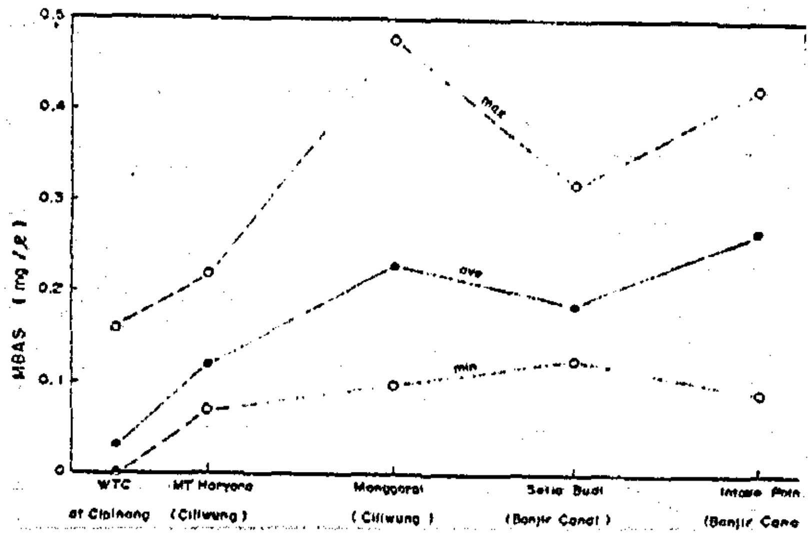

Fig. 12 Water Quality Concerning Raw Water to Pejompongan

by DPMA
Nov 1983 – May 1984, 16 samples

Table 2 Water Quality Analysis on Baru Barat River (No.17)

	1983					1984											
	1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	12 Jan	26 Jan	9 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	0	0	0	0	2.3	0	0.7	1.8	1.3	1.6	0	0	0	0	1.2	1.1	0.6
pH	6.7	7.2	7.1	6.9	6.6	7.6	6.5	6.6	7.0	6.8	7.1	7.0	7.0	7.3	6.7	0.8	
Conductivity* (umho/cm)	789	906	711	548	147	595	232	209	203	221	410	201	904	303	195	242	-
Turbidity (mg/l SiO2)		60	45	12.5	236	20	51	106	49	90	39	150	26	11	106	40	69
Color (Unit Pt Co)	30	Black	Dark	30	15	45	20	15	20	25	20	25	Black	45	30	15	-
SS* (mg/l)	46	243	190	46	265	43	175	115	91	118	52	130	58	26	127	40	-
BOD_5 (mg/l)	82	89	56	69	15	51	33	17	25	28.5	35	50	43.5	40	11.5	23	43
COD (mg/l)	93	89	65	91	33	67	36	20.5	29	37	40	103	58.3	78	28.4	33	56
TOC (mg/l)		82	58	71	16.6	75	35	20	-	23	-	-	-	-	10.2	13	
O.Matter* (mg/l KMnO4)	325	203	173	206	56.5	202	151	63	-	50	51.4	186	180	71	53	72	124
Alkalinity (mg/l)	296	330	240	215	40	171	68	70	70	77	134	61	283	111	55	67	143
Iron (diss/ total (mg/l)	1.2/ 3.8	1.5/ 3.1	3.2/ 3.4	1.8/ 2.6	1.5/ 23.6	2.1/ 3.0	1.7/ 7.7	1.1/ 8.1	1.29/ 6.4	1.4/ 13	1.8/ 5.2	1.8/ 10	1.8/ 3.2	4.6/ 6.6	0.87/ 5.1	1.5/ 4.7	1.8
Mn* (diss/ total (mg/l)	0.69/ 0.76	0.49/ 0.49	0.48/ 0.53	0.58/ 0.58	0.1/ 0.28	0.38/ 0.44	0.26/ 0.33	0.11/ 0.27	0.2/ 0.2	0.34/ 0.44	0.83/ 1.1	0.35/ 0.36	0.72/ 0.84	0.51/ 0.52	0.12/ 0.21	0.19/ 0.28	0.4
Ammonia - N (mg/l)	0.025	15.1	13.0	13.5	1.2	9.3	1.55	1.4	1.05	2.7	8.0	1.9	1.7	7.2	1.3	5.9	5.3
Nitrite - N (mg/l)	0.063	0.22	0.15	0.006	0.04	0.007	0.003	0.024	0.024	0.022	0.008	0.006	0.071	ud	0.062	0.016	
Nitrate - N (mg/l)	1.3	1.4	1.55	0.7	1.1	0.46	1.54	1.0	0.9	0.9	0.14	0.21	0.22	0.03	0.11	0.31	
MBAS (mg/l)	11.1	9.4	9.6	4.5	0.86	3.26	0.46	1.19	-	-			9.9	3.3	0.68	1.84	4.7
E.Coli (MPN/100 ml)	1.1×10^{8}	2.4×10^{9}	4.6×10^{8}	7.5×10^{7}	9.3×10^{7}	1.1×10^{9}	1.1×10^{9}	4×10^{7}	1.1×10^{11}	9.3×10^{6}	1.1×10^{9}	4.3×10^{8}	2.4×10^{10}	2.8×10^{8}	1.1×10^{11}	2.4×10^{10}	1.7×10^{10}

DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

Table 3 Water Quality Analysis on Setia Budi Pond (No.18)

	1983					1984											
	1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	12 Jan	26 Jan	9 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	0	0	0	0.	0.4	0.4	0	0	.0	0	0	0	0	0.55	0.55	0	0.1
pH	6.8	7.0	6.9	6.8	7.2	7.4	7.4	7.0	7.2	7.0	7.2	7.2	6.8	7.2	7.2	7.2	
Conductivity (umho/cm)	737	953	684	683	541	766	815	676	698	513	745	374	901	439	473	1,008	-
Turbidity (mg/l SiO2)	0	29	25	10	44	21	30	32	23	35	35	75	21	23	37	30	31
Color (Unit Pt Co)	35	40	60	40	40	40	35	30	25	25	40	25	45	30	25	Orange	-
SS* (mg/l)	100	124	78	52	24	45	44	16	36	42	27	102	29	27	35	56	-
BOD_5 (mg/l)	150	45	39	46	25	53	34.6	53	38	36	38	30	33	29	14	60	45
COD (mg/l)	146	50	45	68	34	62	40	61	58	55	44	57.7	34	71	35	82	59
TOC (mg/l)	-	40	42	48	30	59	38	52	21	32	-	-	-	-	10.3	70	-
O.Matter* (mg/l $KMnO_4$)	553	171	96	162	104	174	159	136	130	144	61	99	127	48	69	146	149
Alkalinity (mg/l)	258	361	262	301	190	230	304	229	259	186	287	116	294	130	132	304	240
Iron (diss/ total (mg/l)	0.74/ 8.3	0.83/ 1.0	0.95/ 1.3	1.0/ 2.2	0.44/ 3.8	1.34/ 1.93	0.96/ 2.0	0.89/ 1.9	0.86/ 1.73	0.84/ 4.1	0.84/ 1.9	0.95/ 9.9	0.83/ 1.7	0.83/ 2.3	0.22/ 1.9	0.73/ 1.5	0.83 -
Mn* (diss/ total (mg/l)	0.66/ 0.9	0.68/	0.57/ 0.6	0.57/ 0.58	0.45/ 0.52	0.71/ 0.76	0.6/ 0.63	0.46/ 0.61	0.62/ 0.67	0.55/ 0.61	0.93/ 1.09	0.5/ 0.55	0.72/ 0.81	0.53/ 0.62	0.43/ 0.56	0.74/ 0.85	0.61
Ammonia - N (mg/l)	0.03	20	15.2	16.2	1.4	18	15.6	14.2	10.3	8.2	22.4	11.4	9.5	10.5	5.7	11	11.9
Nitrite - N (mg/l)	1.09	0.49	0.34	0.008	0.005	0.004	0.006	0.005	0.015	0.01	0.014	0.006	0.078	0.004	0.006	ud	
Nitrate - N (mg/l)	1.4	0.9	0.72	0.6	0.2	0.37	0.55	0.8	0.6	0.8	0.1	0.42	0.33	0.23	0.14	0.63	
MBAS (mg/l)	7.6	7.4	6.4	3.8	4.8	2.4	2.65	4.3					8.0	5.0	2.3	8.6	5.3
E.Coli (MPN/100 ml)	1.1×10^8	1.5×10^8	2.1×10^7	9×10^6	4.6×10^8	1.1×10^9	4.6×10^8	1.1×10^9	1.1×10^{11}	1.5×10^9	1.1×10^9	9.3×10^8	2.4×10^{10}	1.5×10^8	1.1×10^{11}	2.4×10^{10}	1.7×10^{10}

DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

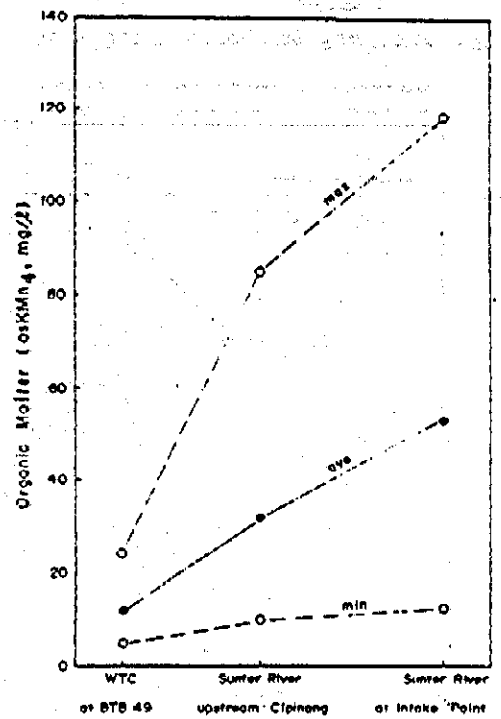

Fig. 13 Water Quality Concerning Raw Water to Pulogadung
by DPMA
Nov 1983 - May 1984

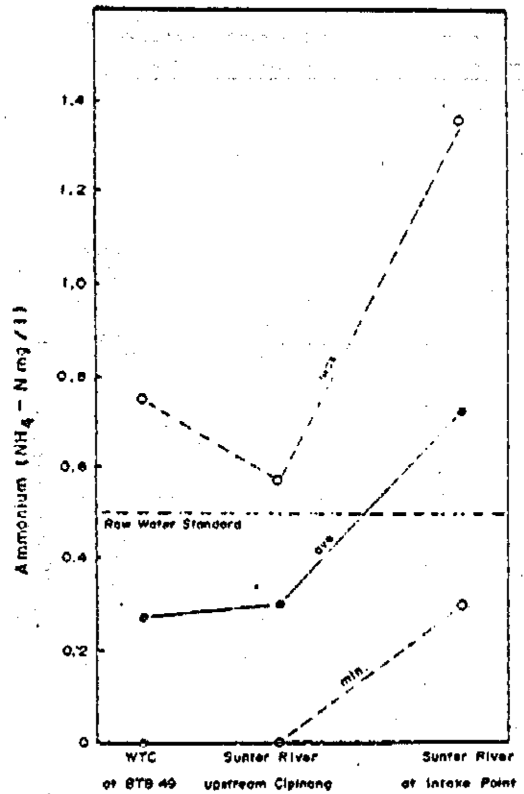

Fig. 14 Water Quality Concerning Water to Pulogadung
by DPMA
Nov.1983 - May 1984

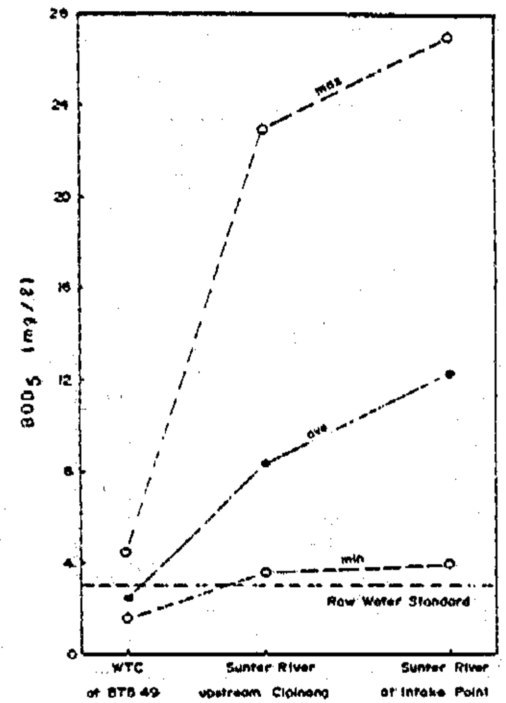

Fig. 15 Water Quality Concerning Raw Water to Pulogadung
by DPMA
Nov 1983 – May 1984

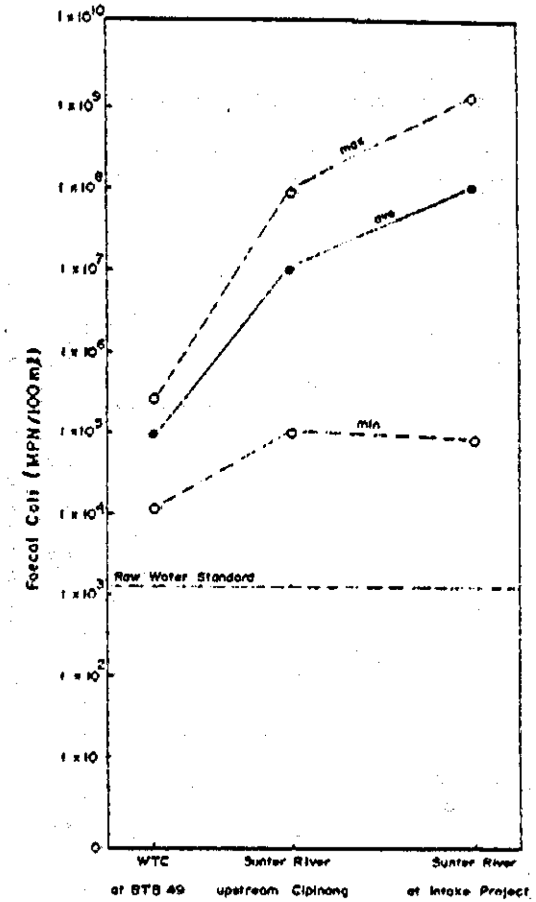

Fig. 16 Water Quality Concerning Water to Pulogadung
by DPMA
Nov 1983 – May 1984

Table 4 Water Quality on WTC, Banjir Canal and Sunter River

Parameter	Unit	Maximum *1) Desirable	Maximum *1) Permissible	WTC at BTB 49 2*) Ave	WTC at BTB 49 2*) Max	WTC at BTB 49 2*) Min	Banjir Canal 2*) at Intake Ave	Banjir Canal 2*) at Intake Max	Banjir Canal 2*) at Intake Min	Sunter River *2) at Intake Ave	Sunter River *2) at Intake max	Sunter River *2) at Intake min
A. Chemical												
Total Iron	mg/l		1.0	8.1	32.4	0.41	11.0	86	2.0	6.8	27	3.4
Chromium	"		0.5		ud	ud		0.05	ud		ud	ud
Cadmium	"		0.01		ud	ud		ud	ud		ud	ud
Cobolt	"		1.0									
Manganese	"		0.5	0.17	0.41	ud	0.55	2.25	0.19	0.55	0.93	0.23
Mercury	"		0.005		ud	ud		ud	ud		ud	ud
Copper	"		1.0		0.03	ud		0.09	ud		0.1	ud
Lead	"		0.05		ud	ud		ud	ud		ud	ud
Ammonia	"	0.01	0.5	0.27	0.75	ud	0.72	1.29	0.29	0.73	1.43	0.24
Nitrite and Nitrate	"	nil	10		1.8	0.12		1.9	0.53		1.2	[illegible]
B. Organic Chemical												
Oil and Grease			Nil									
Pesticides												
a. Aldrin	μg/l	nil	0.03		ud	ud		0.04	ud		0.011	ud
b. Malthion	"				ud	ud		ud	ud		ud	ud
c. D.D.T	"	nil	1.0		ud							
d. Lindan	"	nil	3.0		ud	ud		ud	ud		ud	ud
e. BHC	"				ud	ud		ud	ud		ud	ud
f. Dieldrin	"	nil			ud	ud		ud	ud		0.048	ud
g. Endrin	"				ud	ud		ud	ud		ud	ud
h. Parathion					ud	ud		ud	ud		ud	ud
MBAS	mg/l	nil	0.5	0.05	0.2	ud	0.27	0.43	0.09	0.38	0.49	0.08
BOD	"		3	2.5	4.5	1.6	11.0	40.5	2.6	12.3	27	4.0
DO	"	6		6.3	7.1	5.7	2.8	5.4	1.1	2.1	3.7	0
pH		6.5	8.5		8.0	6.9		7.7	6.4		7.4	6.4
C. Microbilogical												
Coliform	per 100ml		10,000	$1.1x10^5$	$4.6x10^5$	$1.5x10^4$	$1.1x10^7$	$1.1x10^8$	$6.4x10^5$	$1.6x10^8$	$2.4x10^9$	$9.3x10^4$
Faecal Coli	"		2,000									

*1) Quality of Water From Water Bodies (Raw Water) referred to in Article 2 of Republic of Indonesia Health Minister NO.173/Men.Kes/Per/VIII/77

*2) Data carried out by DPMA, Nov 1983 to May 1984, 16 samples.

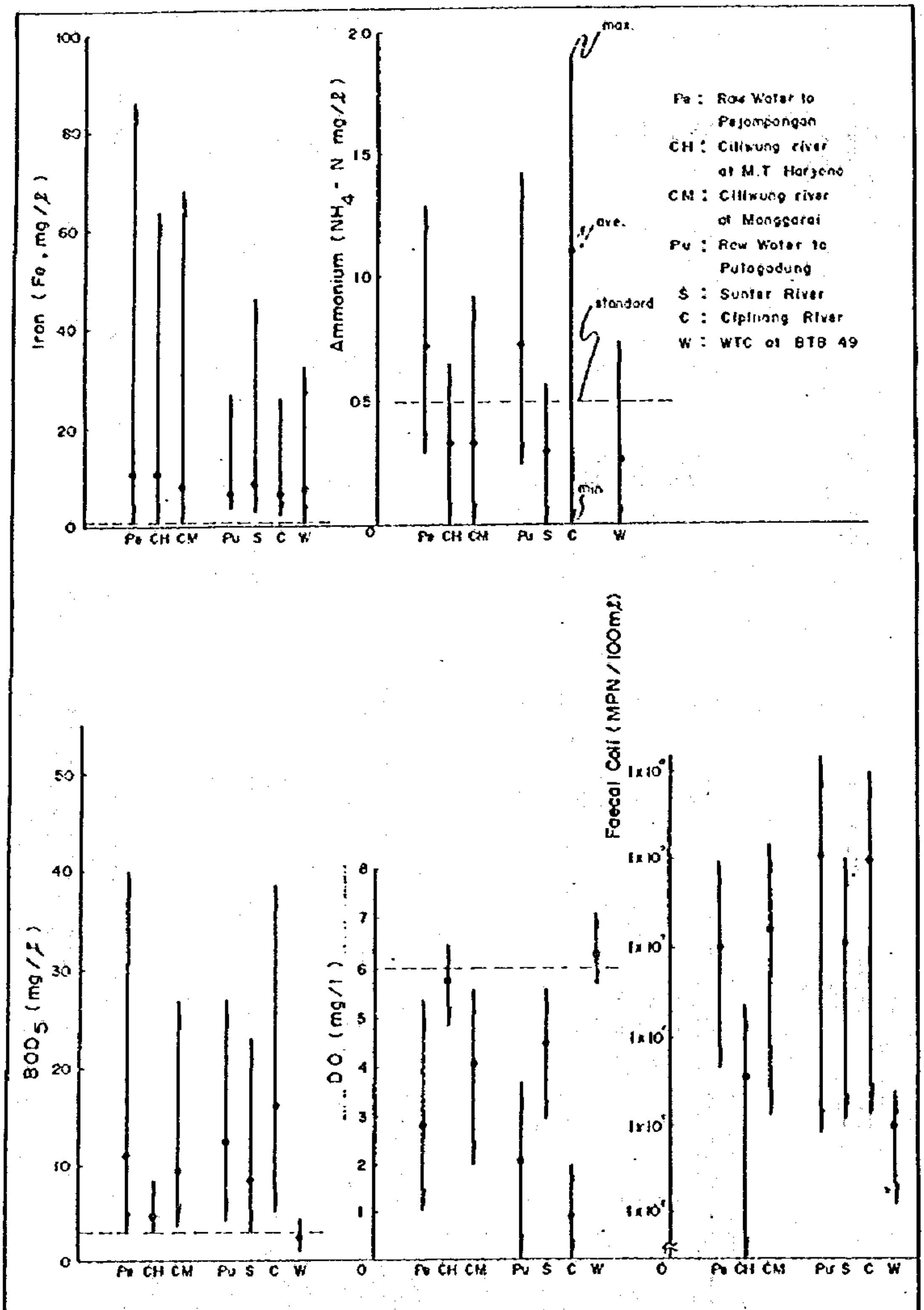

Fig. 17 WATER QUALITY ON WATER SOURIES

Table 5 Water Quality Analysis on WTC near Bekasi (No.1)

	1983 1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	1984 12 Jan	26 Jan	2 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	6.6	6.3	6.1	7.0	6.4	6.4	6.0	7.1	6.9	6.7	6.2	6.3	6.4	6.4	6.9	6.7	6.5
pH	6.9	7.8	7.2	7.8	7.3	7.6	7.7	7.1	7.8	6.9	7.2	7.4	7.1	7.1	7.1	7.9	
Conductivity (umho/cm)	146	139	129	189	134	142	145	127	148	141	144	142	132	132	155	145	
Turbidity (mg/l SiO2)		30	26	55	70	49	33	255	41	56	41	75	60	265	59	21	76
Color (Unit Pt Co)	20	20	25	20	30	25	20	15	15	15	15	15	15	15	25	15	19
SS* (mg/l)	280	19	81	158	73	22	72	202	61	80	46	47	88	357	94	52	
BOD_5 (mg/l)	2.6	2.4	2.5	2.2	2.4	1.6	2.0	2.0	2.4	2.0	1.3	1.2	2.5	2.0	2.0	1.2	2.0
COD (mg/l)	11	11.6	4.5	6.1	5.4	4.8	3.6	5.3	6.7	6.7	4.4	11.5	5.0	5.6	8.8	6.9	
TOC (mg/l)		3.4	3.6	3.0	2.6	2.1	4.7	2.1	2.3	2.2		2.4		3.3	2.0	3.8	
O.Matter* (mg/l KMnO4)	14	14.4	10.5	9.1	9.8	7.4	8.3	10.1	10	4.1	5.9	6.2	8.0	17.7	9.5	5.1	9.4
Alkalinity (mg/l)	62	60	60	66	47	56	50.9	45	53	64	61	59	50	55	46	51	55
Iron (diss/ total (mg/l)	0.81/ 19	1.3/ 2.9	0.1/ 1.05	1.3/ 11.3	0.59/ 6.6	0.98/ 4.45	0.5/ 2.0	1.3/ 9.5	0.59/ 3.0	0.39/ 3.1	0.57/ 3.8	0.9/ 4.1	0.49/ 3.4	2.8/ 3.0	0.43/ 4.8	0.28/ 1.7	
Mn* (diss/ total (mg/l)	0.06/ 0.29	ud/ 0.02	ud/ ud	0.01/ 0.04	0.04/ 0.1	0.08/ 0.1	0.05/ 0.05	0.04/ 0.17	0.06/ 0.08	0.07/ 0.11	0.04/ 0.08	0.1/ 0.12	ud/ 0,07	0.23/ 0.43	0.03/ 0.12	ud	
Ammonia - N (mg/l)	ud	0.04	0.13	0.33	0.1	0.28	0.44	0.3	0.42	0.29	0.05	0.29	0.37	0.10	ud	0.13	0.22
Nitrite - N (mg/l)	0.015	0.018	0.005	0.01	0.005	0.002	0.016	0.017	0.009	0.015	ud	ud	0.031	0.002	0.003	0.007	
Nitrate - N (mg/l)	0.6	0.8	0.63	0.70	0.1	0.47	0.50	0.8	0.50	0.8	0.25	0.25	0.22	0.2	0.32	0.16	
MBAS (mg/l)	0.04	0.12	0.07	0.02	0.07	0.05	0.03	0.02					0.17	0.15	0.03		
E.Coli (MPN/100 ml)	$4.3x10^4$	$2.1x10^4$	$2.3x10^4$	$2.1x10^5$	$9.3x10^4$	$4.3x10^4$	$9.3x10^3$	$4.6x10^3$	$2.4x10^4$	$4.3x10^4$	$4.3x10^4$	$2.4x10^5$	-	$4x10^3$	$4.6x10^5$	$2.4x10^5$	1.5x10[illegible]

* : DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

Table 6 Water Quality Analysis on WTC at BTB 49(No21) By DPMA

	1983					1984											
	1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	12 Jan	26 Jan	2 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	5.8	6.0	5.7	6.2	6.8	6.8	6.5	6.6	7.1	6.1	4.7	6.1	6.1	6.2	[illegible]	[illegible]	[illegible]
pH	7.4	7.3	7.7	7.7	7.5	7.3	7.7	7.7	8.0	6.9	7.5	7.7	7.1	7.6	[illegible]	[illegible]	
Conductivity (umho/cm)	155	170	153	162	140	137	149	123	156	131	137	138	123	86	129	172	
Turbidity (mg/l SiO2)		36	160	71	160	86	63		39	58	144	60	99	94	159	45	91
Color (Unit Pt Co)	25	20	25	20	25	20	15	15	10	15	15	15	15	15	25	25	18.7
SS* (mg/l)	1051	86	228	252	184	32	58		59	74	120	122	83	92	202	67	
BOD_5 (mg/l)	3.3	2.9	3.8	4.5	2.2	2.6	2.4	2.0	1.6	2.0	2.7	1.6	2.7	2.1	2.6	1.6	2.5
COD (mg/l)	18.2	7.9	9.3	10.2	10.9	5.6	3.2	8.0	3.6	4.8	9.5	7.7	5.2	5.0	12.3	5.8	7.9
DOC (mg/l)		3.2	5.2	6.4	3.4	3.4	2.4	2.9	3.0	3.0			1.5		4.1	3.8	
O.Matter* (mg/l KMnO4)	24	17.8	18	16.3	9.5	8.1	8.6	12.4	7.0	14	10.4	9.9	9.6	10.9	13.5	5.1	12.2
Alkalinity (mg/l)	64	59	64	72	44.7	56.3	44.5	37	38	45	50	62	45	42	42	51	51
Iron diss/total (mg/l)	0.93/ 32.4	0.36/ 0.41	0.3/ 5.28	2.3/ 12.7	1.4/ 13	0.83/ 5.7	0.59/ 3.8	0.77/ 4.1	0.28/ 3.0	0.39/ 4.6	0.49/ 7.1	1.7/ 7.1	0.45/ 5.6	0.37/ 8.1	0.64/ 12.9	0.54/ 4.0	0.77
Mn* diss/ total (mg/l)	0.08/ 0.61	ud/ ud	ud/ 0.17	0.09/ 0.09	0.07/ 0.23	ud/ 0.12	0.07/ 0.08	0.1/ 0.18	0.03/ 0.07	0.02/ 0.11	0.04/ 0.14	0.12/ 0.15	ud/ 0.15	0.04/ 0.18	0.04/ 0.38	0.04/ 0.11	0.04
Ammonia - N (mg/l)	0.001	0.10	0.18	0.11	0.09	0.32	0.47	0.35	0.47	0.27	0.05	0.23	0.75	0.08	ud	0.46	0.27
Nitrite - N (mg/l)	0.019	0.014	0.002	0.015	0.013	0.002	0.009	0.012	0.009	0.006	0.005	0.002	0.019	ud	0.003	0.008	
Nitrate - N (mg/l)	1.8	1.3	1.42	0.60	2.0	0.40	0.75	0.9	0.6	0.6	0.22	0.38	0.50	0.6	0.12	0.38	
MBAS (mg/l)	0.06	0.02	0.10	0.06	0.05	0.09	0.03	0.03					0.02	ud	0.007	0.2	0.05
Coliform (MPN/100 ml)	2.4×10^5	4.3×10^4	4.3×10^4	1.5×10^4	4.3×10^4	7.5×10^4	2.3×10^4	1.4×10^4	3.9×10^4	2.4×10^5	7.5×10^4	2.3×10^5	1.5×10^3	2×10^4	4.3×10^4	4.6×10^5	1.1×10^5

* DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

Table 7 Water Quality Analysis on WTC at Cipinang (No.10)

	1983					1984											
	1 Nov	17 Nov	1 Dec	15 Dec	29 Dec	12 Jan	26 Jan	2 Feb	23 Feb	8 Mar	22 Mar	5 Apr	19 Apr	3 May	17 May	31 May	Ave
DO* (mg/l)	4.8	5.7	6.9	6.2	5.8	6.7	6.4	6.5	6.7	6.0	4.3	6.1	5.7	6.0	5.9	6.2	6.0
pH	7.6	6.5	7.3	7.4	7.7	7.3	7.7	7.6	7.6	6.9	7.8	7.6	7.0	7.7	7.1	7.4	
Conductivity [illegible]	178	175	174	164	146	141	162	125	168	138	131	136	133	124	132	168	
Turbidity (mg/l SiO2)		[illegible]	[illegible]	41	144	61	60	159	39	45	135	75	99	79	129	42	83
Color (Unit Pt-Co)	25	15	25	20	25	25	15	10	10	25	20	15	15	15	20	20	18.4
SS* (mg/l)	1,496	187	144	119	211	118	86	153	82	64	172	133	109	79	186	60	
BOD_5 (mg/l)	6.1	4.8	2.5	2.5	2.8	2.6	2.8	2.3	2.2	2.4	3,7	4.4	3.1	4.5	3.5	2.0	
COD (mg/l)	32.5	9.0	7.1	9.7	9.1	5.2	4.2	5.3	4.3	6.2		10.2	10.2	10	13.7	6.1	
TOC (mg/l)		5.6	3.6	3.6	3.8	2.3	3.0	2.5	4.7	3.3		10			4.6	7.1	
O.Matter* (mg/l [illegible])	50	20	34	11.6	10.8	8.7	9.2	13	7.0	6.6	17.4	9.4	10	15.3	13.8	[illegible]	[illegible]
Alkalinity [illegible]	75	66	85	71	40.2	54.5	53	39	39	40	47	50	45	[illegible]	42	[illegible]	[illegible]
[illegible] total (mg/l)	1.7/ 66	0.36/ 6.3	0.57/ 1.23	2.0/ 11	1.3/ 13	0.43/ 83	0.38/ 5.0	0.48/ 9.3	0.33/ 3.7	0.39/ 2.9	0.43/ 8.5	1.7/ 7.7	0.34/ 5.0	0.46/ 6.2	1.1/ 9.4	0.41/ 4.8	
Mn* (diss/ total (mg/l))	0.09/ 1.27	ud/ 0.07	ud/ ud	0.06/	0.08/	0.01/ 0.18	0.03/ 0.12	0.03/ 0.1	0.02/	0.03 0.09	0.02/ 0.18	0.16 0.18	ud/ 0.2	0.04/ 0.1	0.1/ 0.24	0.06 0.13	
Ammonia - N (mg/l)	0.002	0.13	0.15	0.10	0.12	0.34	0.24	0.15	0.21	0.12	0.83	0.10	0.62	0.05	ud	0.01	0.20
Nitrite - N (mg/l)	0.002	0.025	0.005	0.00	0.00	0.002	0.007	0.01	-0.06	0.01	ud	0.004	0.02	ud	0.004	0.41	
Nitrate - N (mg/l)	1.3	1.5	0.40	0.60	0.1	0.47	0.38	0.8	0.5	0.7	0.45	0.31	0.24	0.16	0.06	0.05	
MBAS (mg/l)	0.01	ud	0.04	0.02	0.0	0.16	0.03	0.03					0.05	0.07	0.04	ud	
Coli (MPN/100 ml)	9.3×10^4	9.3×10^4	9.3×10^4	9×10^4	9.3×10^4	9.3×10^4	9.3×10^5	2.8×10^4	4.3×10^5		4.3×10^5	2.3×10^5			2.4×10^5		1.9×10^5

* DO: Dissolved Oxygen, SS: Suspended Solid, O.Matter: Organic Matter, Mn: Manganese

Water Quality and Treatment Processes for Cisadane System.'

After the submission of the interim report of the Master Plan, direct withdrawal of the surface water of the Cisadane River was decided, whereas the Master Plan proposal was to take water impounded at the upper reaches of the River through a canal to be constructed in the future. Because of this change of the intake site, a further study of water quality has become necessary. This short paper, therefore, reports results of the additional study of surface water quality at the newly proposed intake site.

1. Characteristics of Water Quality

Surface water quality of the Cisadane River at Serpong, near the proposed intake site, is shown on Tables 1 to 3. The source of Table 1 is the report of Cisadane-Jakarta-Cibeet Water Resources Development, and Tables 2 and 3 show the results of the present field survey. Fig. 1 shows variations of water quality of the River according to location and season.

Reviewing all the above data, major characteristics of the water are summarized as follcws :

a. Turbidity : 21 to 589 NTU, 191 NTU in average
b. Color : 5 to 125 units, 45 units in average
c. Organic Matter : 4.7 to 10.7 mg/l, 6.5 mg/l in average
d. Iron : 0.55 to 3.86 mg/l, 1.43 mg/l in average
e. Ammonium : 0 to 0.32 mg/l, 0.13 mg/l in average
f. Faecal coli: 1.1×10^3 and 7×10^4 MPN/100 ml, 3.5×10^4 MPN/100 ml in average

2. Treatment Processes and Chemical Applications

Considering the water quality mentioned above, the following treatment processes will be applied to the raw water.

a. Pre-chlorination

Pre-chlorination will be employed to oxidize Color, Iron and Ammonium.

b. Coagulation

Coagulation using Alum will be employed to remove Turbidity and oxidized substances by sedimentation. Pre-lime as coagulant aid will be used for adjusting pH and Alkalinity of the raw water. Meanwhile, polymer is not considered necessary from Jar Test result carried out by the present study as shown in Tables 4 and 5.

c. Sedimentation

Sedimentation will be employed for removing Turbidity and oxidized substances.

d. Rapid sand Filtration

Rapid sand filtration will be employed to remove remaining Turbidity in the clarified water.

e. pH control of Treated Water

pH of the filtered water will be between 6 to 6.5 reduced by Alum dosage. Therefore, pH of the filtered water will be adjusted by lime to more than pH 7.3.

f. Disinfection

Disinfection by chlorine will be made to the extent of residual chlorine remaining in the treated water.

Treatment processes as planned above are schematically shown in Fig. 2.

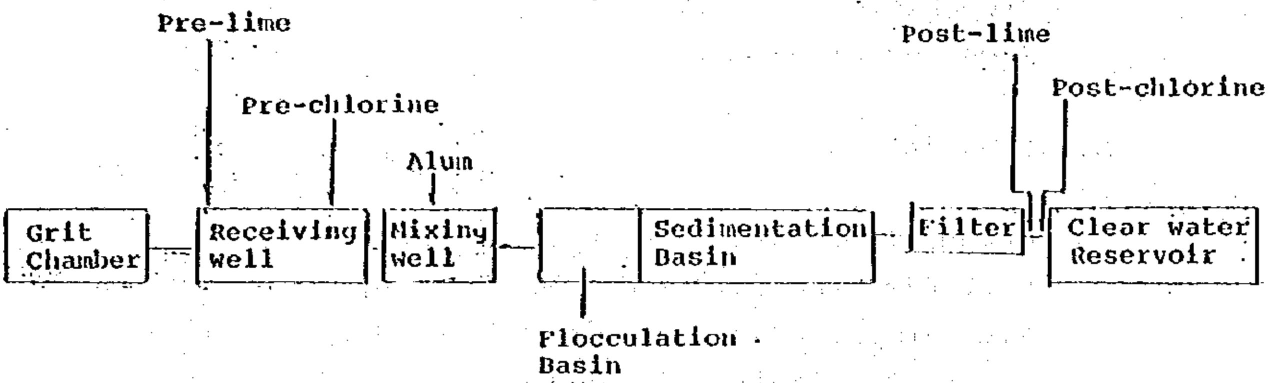

Fig. 2 Treatment Processes of the Cisadane System

Table 1 Water Quality of the Cisadane River at Serpong

Parameter		Unit	1-11-76	21-11-76	30-12-76	8-1-77
Temperature		°C	30	29	26	30
Color		Unit PtCo	< 5	45	20	10
Taste		-				
Odor		-				
Turbidity		mg/ l SiO2	288.4	589.0	176.0	47.4
Dissolved Solid		mg/l	65	125	47	60
Suspended Solid		"	75	11	221	164
Total Solid		"	140	136	268	224
Conductivity		µmho/cm	95.2	93.0	58.8	68.5
pH		-	7.2	7.8	7.6	8.1
Organic Matter		mg/l KMnO4	8.37	6.94	10.74	3.48
Acidity		mg/l				
Alkalinity		"				
C.O.D.		"				
D.O		"	8.25	6.89	8.3	8.36
Karium	(K)	mg/l	1.35	1.61	1.20	1.44
Natrium	(Na)	"	5.09	8.85	3.30	3.83
Calcium	(Ca)	"	4.78	1.59	1.89	2.31
Magnesium	(Mg)	"	0.0	1.36	0.89	2.31
Iron	(Fe)	"	1.43	3.86	0.96	0.55
Manganese	(Mn)	"	0.0	0.0	0.0	0.0
Ammonium	(NH4)	"	0.32	0.00	0.272	0.19
Chloride	(Cl)	mg/l	7.35	21.65	0.25	5.71
Sulphate	(SO4)	"	1.03	2.66	5.60	6.17
Nitrate	(NO3)	"	1.52	1.86	0.00	0.00
Nitrite	(NO2)	"	0.076	0.03	0.023	0.01
Phosphate	(PO4)	"	0.39	0.26	0.086	0.115
Silica	(SiO2)	"	12.5	10.0	12.5	10.0
Bicarbonate	(HCO3)	"	23.48	41.0	24.03	27.5
Carbondioxide	(CO2)	"	4.38	5.40	2.73	8.74

" Cisadane - Jakarta - Cibeet Water Resources Development "
Executive Summary January 1979

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA
PERUSAHAAN AIR MINUM JAYA

Jalan Penjernihan II --- Pejompongan
Telp. : 582256

PAM JAYA

No. Lab. : 39/ 130/Lab/II/1984
Lampiran :
Perihal : PEMERIKSAAN AIR --

Table 2

Jakarta, 4 Maret 1984

Kepada Yth.
NIHON SUIDO CONSULTANT,
JL PENJERNIHAN I
JAKARTA.

Hasil pemeriksaan contoh air : RAW WATER CISADANE.
Lokasi : SERPONG
Pengambilan dilakukan oleh : PENGIRIM CONTOH
Contoh air tsb. kami terima tgl. : 22 FEBRUARI 1984.

	Fisika		Hasil Analysa	STANDARD Maksimum yang dianjurkan	STANDARD Maksimum yang dibolehkan	
1.	Warna	:	70	5.-	50.	ppm Pt-Co
2.	Turbidity	:	21	5.	25.	ppm Si 02
3.	Bau	:	tak berbau			
4.	Rasa	:	tak berasa			
5.	DHL	:	73		Micriohoms	
	Kimia					
6.	pH	:	6.9	6,5	9,2	
7.	Zat padat	:		500.	1500.	ppm.
8.	Zat Organik	:	4,74	–	10	ppm KMn04
9.	Carbon Dioksida bebas	:	4,4	–	0.0	ppm CO2
10.	Alkalinity					
	a. P.Alkalinity	:	0,0	–	–	ppm CaCO3
	b. M.Alkalinity	:	40,0	–	–	ppm CaCO3
	c. Carbonat	:	0,0	–	–	ppm CaCO3
	d. Bicarbonat	:	40,0	–	–	ppm CaCO3
11.	Total Hardness	:	2,0	5.	10.	°D
	a. Calsium Hardness	:	9,99	75.	200.	ppm Ca ++
	b. Magnessium Hardness	:	2,58	30.	150.	ppm Mg ++
12.	Besi	:	0,65	0,1	1,0	ppm Fe ++
13.	Mangan	:	negatief	0,05	0,5	ppm Mn ++
14.	Sulphate	:	negatief	200.	400.	ppm SO4
15.	Phosphate	:	negatief	–	–	ppm PO4
16.	Ammonium	:	trace	–	0,0	ppm NH4
17.	Nitrite	:	0,015	–	0,0	ppm NO2
18.	D. O.	:	6.5	–	–	ppm 02
19.	Silika	:		–	–	ppm SiO2
20.	Chlorida	:	6,39	200.	600.	ppm Cl
21.	Sisa Chlor	:		–	–	ppm Cl2
22.	Detergent	:	0,1423			

Keterangan.-

Kepala Laboratorium
PAM DKI JAYA

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA

PERUSAHAAN AIR MINUM JAYA

Jalan Penjernihan II – Pejompongan
Telp.: 582256

Jakarta, 14 Juli 1984

No. Lab. : /Lab/VII/1984.
Lampiran :
Perihal : PEMERIKSAAN AIR.–

Table 3

Kepada Yth.
NIHON SUIDO CONSULTANT.
JL PENJERNIHAN I .
J-A-K-A-R-T-A.

Hasil Pemeriksaan contoh air : RAW WATER CISADANE .
Lokasi : SERPONG (CILANGKAP) .
Pengambilan dilakukan oleh : PENGIRIM CONTOH .
Contoh air tersebut kami terima tgl.: 11 JULI 1984 .

			Hasil Analysa	STANDARD Maksimum yang dianjurkan	STANDARD Maksimum yang diperbolehkan	
	Fisika					
1.	Warna	:	125	5.	50.	ppm Pt-Co.
2.	Turbidity	:	27			ppm. Si O2
3.	Bau	:	tak berbau			
4.	Rasa	:	tak berasa	5.	25.	
5.	DHL	:	69			Micromhos
	Kimia					
6.	PH	:	7.1	6.5	9.2	
7.	Zat padat	:		500	1500	ppm.
8.	Zat Organik	:	5,056	-	10	ppm. KMnO4
9.	Carbon Dioksida bebas	:	4,4	-	0.0	ppm. CO2
10.	Alkalinity					
	a. P. Alkalinity	:	0,0	–	–	ppm.CaCO3
	b. M. Alkalinity	:	55,0	-	–	ppm.CaCO3
	c. Carbonat	:	0,0	–	–	ppm.CaCO3
	d. Bicarbonat	:	55,0	–	–	ppm.CaCO3
11.	Total Hardness	:	1,8	5.	10.	°D
	a. Calsium Hardness	:	9,996	75.	200.	ppm.Ca++
	b. Magnessium Hardness	:	1,72	30.	150.	ppm.Mg ++
12.	Besi	:	1,11	0.1	1.0	ppm.Fe ++
13.	Mangan	:	trace	0,05	0,5	ppm.Mn ++
14.	Sulphate	:	trace	200.	400.	ppm. SO4
15.	Phosphate	:	negatif	–	–	ppm.PO4
16.	Ammonium	:	trace	–	0.0	ppm NH4
17.	Nitrite	:	trace	–	0,0	ppm.NH4
18.	D. O.	:		-	–	ppm.O2
19.	Silika	:		–	–	ppm.SiO2
20.	Chlorida	:	7,10	200.	600.	ppm.Cl
21.	Sisa Chlor	:		-	–	ppm.Cl2
22.	Total Coli	:	7 x 10⁴	0		MPN/100ml

Keterangan.– Secara kimia/fisika menurut Per.Men.Kes.no.:01/BIRHUKMAS/I/1975 , air tersebut perlu ditreatment .

KEPALA
Sub. Bid. Kwalitas & Laboratorium
PAM. DKI. JAYA

(ny. M o e l y a n i)

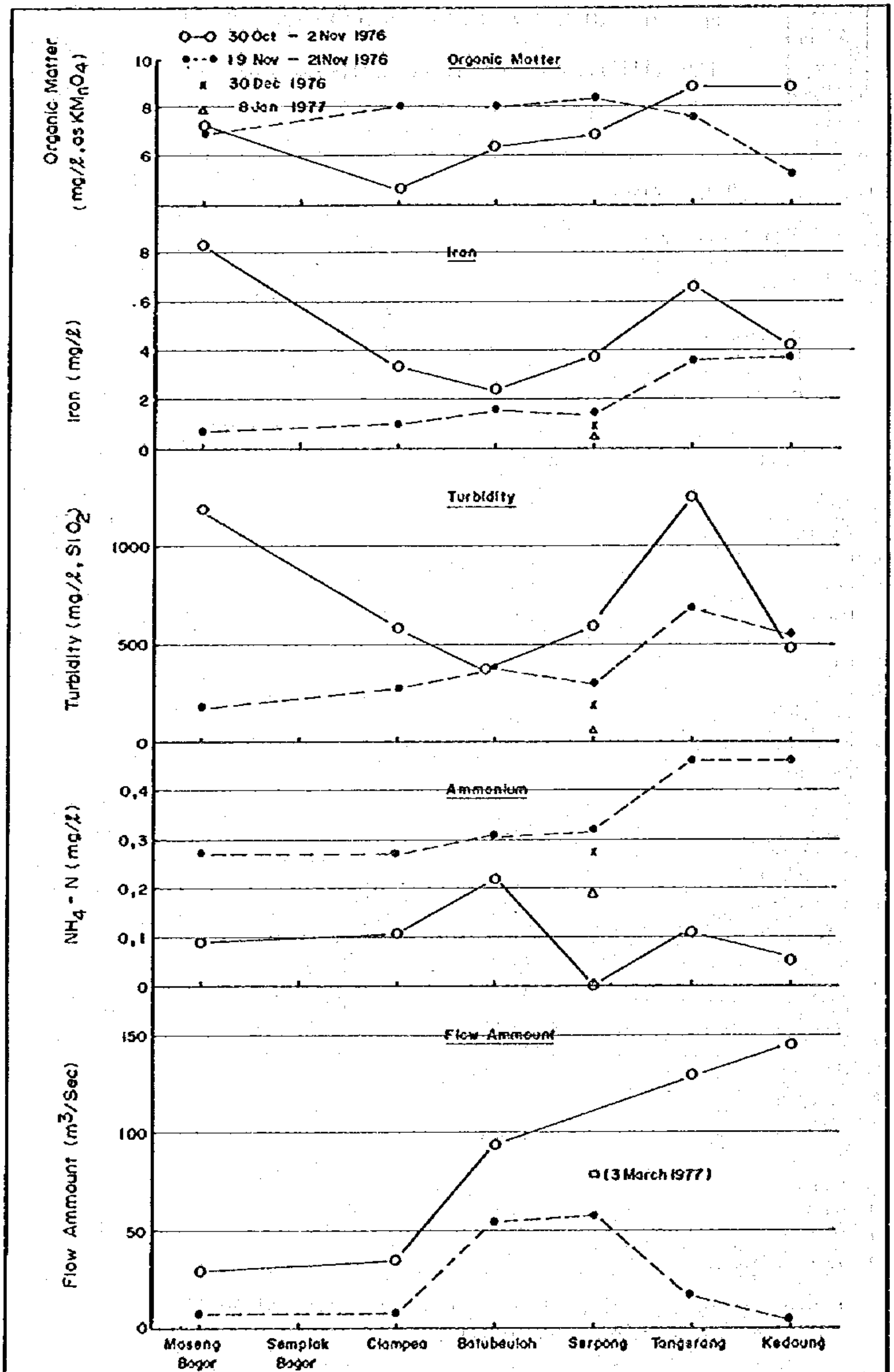

Fig. 1 Water Quality of Cisadane River by CJC, Executive Summary Jan. 1979.

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA
PERUSAHAAN AIR MINUM JAYA
Jalan Penjernihan II – Pejompongan
Telp. : 581943 - 582938 - 582652 - 584993 - 587019
Telex. 44216 PAMJAYA.

Table 4

No. 40/130/Lab/II/1984 Jakarta, 4 Maret 1984

Lamp. : -

Hal. : Percobaan coagulasi Kali Cisadane .

Kepada Yth.
NIHON SUIDO,
Jakarta.

Dengan hormat ,

Bersama ini kami sampaikan hasil percobaan coagulasi air sungai Cisadane sebagai berikut .:

Dosis Alum-sulfat : ppm .	dosis Konanfloc : ppm	pH	Turbiditit NTU
0,0	0,0	6.9	73
10	0,0	6.4	5.0
15	0,0	6.3	4.3
20	0,0	6.2	3.6
25	0,0	6.1	5.6
30	0,0	6.0	6.2
35	0,0	5.9	9.8
10	0,1	6.4	5.6
15	0,1	6.3	4.6
20	0,1	6.2	3.7
25	0,1	6.1	5.8
30	0,1	6.0	7.4
35	0,1	5.9	19

Demikian hasil percobaan kami agar dapat dipergunakan sebagaimana perlunya.

Ka.Sub.Dit Kualitas & Laboratorium
PAM DKI Jaya

(Ir. Rulyani)
NIP/IAI 470011/96/16346.

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA
PERUSAHAAN AIR MINUM JAYA
Jalan Penjernihan II – Pejompongan
Telp. : 581943 - 582938 - 582652 - 584993 - 587019
Telex. 44210 PAMJAYA.

Table 5

No. : /Lab/VII/1984 Jakarta , 14 Juli , 1984 .
Lamp. : -
Hal. : Percobaan kali cisadane untuk coagulasi .

K e p a d a Yth.

N I H O N S U I D O .

J a k a r t a .

D e n g a n h o r m a t ,

Bersama ini kami sampaikan percobaan coagulasi air sungai Cisadane yang berlokasi di Cilangkap sebagai berikut.:

Dosis Alum-sulphate ppm.	Dosis Flocculan aid ppm.	pH.	Turbidity N T U
Penrimaan contoh tanggal 11 Juli 1984, percobaan coagulasi tanggal.12/7-'84			
0,0	0,0	7.1	27
10	0,0	6.5	8.9
15	0,0	6.3	5.8
20	0,0	6.1	5.5
25	0,0	6.1	4.9
30	0,0	6.0	9.5
	Konanfloc 1000.		
10	1.0	6.5	9.0
15	1.0	6.3	4.7
20	1.0	6.1	4.0
25	1.0	6.1	3.5
30	1.0	6.0	4.7
	Zucclar 110		
20	0,05	6.1	4.5
25	0,05	6.1	4.2
30	0,05	6.0	6.8

Demikian hasil percobaan kami ,agar dapat dipergunakan sebagaimana perlunya.

Ka.Sub.Bid.Kwalitas & Laboratorium
Bidang Produksi PAM

(ny.H o e l y a n i)
NIP/NRK.470011796/16346.

PEMERINTAH DAERAH KHUSUS IBUKOTA JAKARTA

PERUSAHAAN AIR MINUM JAYA

Jalan Penjernihan II -- Pejompongan
Telp 582256

PAM JAYA

Table 6

Nomor : /130/Lab/II/84 Jakarta, 4 Maret 19 84

Lampiran :

Prihal : PEMERIKSAAN AIR.

Kepada Yth.

Nihon Suido Consultant
Jl. Penjernihan I
Jakarta Pusat
JAKARTA

Hasil pemeriksaan air : Raw Water Cisadane
Lokasi : Serpong
Pengambilan dilakukan oleh : Pengirim Contoh
Contoh air tsb. kami terima tgl. : 22 Februari 1984

No.	pH	COLIFORM BACT	M.P.N. 100 ml	BACT COUNT/ml (Angka kuman / ml)
1.	6,9	Positif	1100.	1650.

KETERANGAN : Secara Bacteriologis menurut Standart International W.H.O.
Air tersebut ....

Kepala
Seksi Kwalitas & Laboratorium
Bidang Produksi

(Ny. M. Moeljono)

Attachnent

Consideration of the Cost Saving of Chemicals

by

Relocation of Intake

CONSIDERATION OF THE COST SAVING OF CHEMICALS BY RELOCATION OF INTAKE

It is obvious that considerable amount of chemicals is required to treat the present raw water to acceptable level. However, it will be hardly expected to produce such quality of water constantly due to the difficulty to control and adjust chemical dosage rate time to time according to the fluctuation of raw water quality, especially during dry season. Under this Circumstances, precise comparison of chemical consumption to be applied for both present and WTC will be unattainable.

In this short paper, examination of cost saving of chemicals is, however, attempted tentatively based on the raw water quality of both plants. As the result, about 40% of cost saving of chemicals was calculated when raw water is conveyed directly from WTC as shown in the table below. As for Alum and Polimer, comparison of dosage rates for both raw water is made according to the average rates presently applied in the existing plants and jar test result of WTC water. Figures in the Table on chlorine dosage rates show the required average rates, but in practice, the present rate of each plant is lower than those required due to the limit of equipment capacity and economy in operation. Activated carbon is presently applied during dry season for removal of color and odor as the main purpose, and more dosage, however, will be needed to remove them in the tolerable range judging from the present raw water quality and the fact of their existence in the treated water.

Cost Saving of Chemicals

by

Relocation of the Intake

Plant	Alum	Polimer	Lime	Chlorine	Activated Carbon	Cost
	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(Rp./m3)
Pejompongan I						
Present	40	0.03	17	12	2	23.2
After Relocation	30	0.03	17	8	0	14.5
Pejompongan II						
Present	45	-	17	12	2	24.0
After Relocation	35	-	17	8	0	15.3
Pulogadung						
Present	60	-	17	12	2	26.4
After Relocation	35	-	17	8	0	15.3

Note :
- dosage rates in the table show annual average rates.
- unit prices of chemicals used for cost estimate are as follows; (prevailing unit price used for the existing plants)

Chemicals:	Alum	Polimer	Lime	Chlorine	Activated Carbon
Unit price (Rp./kg)	162	882	40	1,115	1,320

MASTER PLAN FOR
JAKARTA WATER SUPPLY DEVELOPMENT PROJECT

M4. APPENDIX MIII-3

UNACCOUNTED-FOR WATER STUDY

UNACCOUNTED-FOR STUDY

Contents

ATTACHMENTS

UNACCOUNTED-FOR WATER

1. INTRODUCTION

To prepare a master plan of water supply of PDAM on a most realistic and feasible basis, it is of vital importance 1) to estimate the unaccounted-for water or its ratio to the total water demand, and 2) to work out a practicable plan to reduce unaccounted-for water.

By the above item 1), future water requirement, based on which the capacity of the future water supply system is to be planned, can be estimated. By the item 2), measure to be taken will be presented and activities to reduce unaccounted-for water as planned will be performed. Such activities are essential to achieve the goal determined by the master plan, and to run the water supply enterprise on a sound management basis.

From the above consideration, the objective of the present study on unaccounted-for water is defined as itemized below.

1) Identification of current unaccounted-for water.

2) Recommendation of practical goal for reduction of unaccounted-for water, on which the projection of future water demand will be made, and

3) Recommendation of a framework for activities to be undertaken concertedly for leakage reduction.

2. CLASSIFICATION OF UNACCOUNTED-FOR WATER

"Unaccounted-for water" is the difference between the quantity of water distributed and the quantity of water billed. For the present study, "unaccounted-for water" is classified into a number of categories, as shown below.

1) Leakage
2) Underregistration of meters
3) Illegal connections
4) Water uses not chargeable
5) Billing errors
6) Failure of payment

(1) Leakage

Leakage can be classified roughly into two categories, namely leaks from the distribution system including valves, firehydrants, airvalves, drain valves, etc., and leaks from service connections including corporation cocks, meters, etc.

Usually leaks from the service connections are many in number and immense in quantity. Leaks from the piping of a service connection would be registered as consumption, but in reality a larger part of such leaks is not registered and not chargeable.

(2) Underregistration of Meters

By mechanical reasons of meter, there are many instances of underregistration. The balance between the meter reading and the actual flow becomes unaccounted-for water. Major causes for such underregistration are under- or over-size of the meter for the flow to be measured, and deterioration of parts of the meter.

(3) Illegal Connections

Illegal connections which are to be treated in this study are 1) tampered meter, 2) bypassing the meter and 3) unregistered connection. Water consumed through such illegal connections becomes unaccounted-for water.

(4) Water Uses not Chargeable

Water uses for fire fighting, flushing mains, sprinkling in the public park and the like are a legal consumption. This consumption should be excluded from the unaccounted-for water, although the amount be included in the projection of water demand.

(5) Billing Errors

Billing errors often occur in such cases as 1) the service connection is not metered, 2) the meter reader fails to read the meter because of no access, and 3) the meter reader makes a mistake in reading. These errors should be corrected by improvement in the management.

(6) Failure in Payment

Water consumption for which the payment fails becomes eventually unaccounted-for water. Eliminatinon of such unaccounted-for water is responsibility of the management.

3. APPROACH OF THE STUDY

As will be understood from the classification of unaccounted-for water, the categories can be grouped into two groups, namely,

Group 1 : Illegal connections, water uses not chargeable, billing errors and failure of payment, problems of which should be solved by management.

Group 2 : Leakage and under-registration of meters, which is to be dealt with technically.

Regarding the Group 2 losses, it has been found by the present field survey that losses, especially leakage, cannot be determined quantitatively. At the present stage it is considered more appropriate to define the balance of the total amount of unaccounted-for water less loss of the Group 1 and under-registration as loss of leakage. And loss by under-registration is estimated and included in the Group 1.

From this consideration, the total production and consumption billed and the Group 1 will first be described, followed by the leakage. Further to facilitate to grasp the whole picture of the water supply system, major items of the facilities are briefed in Attachment 1.

The component of unaccounted-for water and approach of estimate of water loss of each category are shown as follows:

Component of Unaccounted-for Water

Unaccounted-for Water (Production - consumption billed)

- Illegal Use
- Under-registration
- Under-estimation
- Public Water Uses
- Water loss by Unbilled Connections
- Leakage

Water Loss by Illegal Use = (illegal connections) x (adjusted unit consumption)

Water loss by under-registration = (metered connections) x (adjusted unit consumption metered - unit consumption metered)

Water Loss by Under-estimation = (connection billed by estimate) x (adjusted unit consumption metered - unit consumption billed by estimate)

Leakage = (total amount of unaccounted-for water) - (water losses of above three + public water uses + water loss by unbilled connections)

Data and information, the basis to estimate the above water losses, are obtained from Sensus Program*, monthly reports by the Customer Division and the Meter Division for meter accuracy together with the field surveys. The data obtained from the Sensus Program are adjusted to the figures at present as of 1982/83.

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* SENSUS PROGRAM is the program that PDAM commenced in 1978 aiming to expose illegal connections as the main purpose. Door to door survey has conducted through whole service area. Various data, beside illegal connections, concerning unaccounted-for water were collected.

4. PRODUCTION AND CONSUMPTION

Annual production and consumption records of PDAM are shown in Table 4.1. Percentage of unaccounted-for water has decreased from 59 % in 1977 to 53 % in 1983. This decrease is considered to be partly owing to the efforts of PDAM for combating water leaks, and partly because of low water pressure caused by insufficient supply capacities. A slight increase of unaccounted-for water recorded in 1983 may be due to water pressure rise, as Pulogadung Plant started its operation.

Further, details of production and consumption will be considered in the following subsections.

4.1 Total Production

Presently, measurement of production, which is the fundamental factor for unaccounted-for water reduction activities, is in the following condition:

- Pulogadung metered
- Pejompongan II metered. The meter was installed in September 1983.
- Pejompongan I metered, but not functioning. The meter will be rehabilitated in the ongoing rehabilitation project.
- Ciburial Spring metered but not functioning.
- Other mini plants not metered or not functioning.

The production of those plants which have no measurement record is estimated in the following manner. That is, 1) major plants, as a product of operating pump units and their rated capacities, 2) mini plants, by the same manner as 1), 3) Ciburial Spring, as 300 l/sec, and 4) well, as 120 l/sec respectively.

Total production in the fiscal year 1982/83, thus estimated, was 199 million m3, including all plants and the spring.

4.2 Total Consumption

Total water consumption in the fiscal year 1982/83 was about 93 million m3. This amount includes consumption billed on the assumption basis for reasons that some service connections are unmetered, some meters are not functioning or not readable, and the like. The total consumption, therefore, is considered not necessarily reliable.

To obtain a reliable water consumption, the following items must be studied:

- Illegal connections, and by-passing.

- Unmetered connections, which are billed but not correctly.

- Non-functioning meters and unreadable meters.

4.3 Unaccounted-for Water

Roughly speaking, the balance of the total production less the total consumption is considered as the unaccounted-for water, and in the fiscal year 1982/83 is amounted to 199 - 93 = 106 million m3, which is about 53 % of the total production.

Table 4.1

Water Production and Billed Water consumption

Year	Total Water 1/ Production (million m^3)	Total 2/ Water Billed (million m^3)	Percentage of Unaccounted-for Water (%)
1977	159.5	64.9	59
1978	173.3	68.7	60
1979	174.8	75.9	57
1980	178.0	83.2	53
1981	179.7	86.2	52
fiscal year 1982/83	199.0	93.0	53

1/ from Monthly Report (Jan. 1977 - Apr. 1983), Bidang Produksi, Direktur Produksi/Teknik, PDAM

2/ from Monthly Report, Bidang Letbang, PDAM

5. GROUP 1 UNACCOUNTED-FOR WATER

Sensus Program, commenced a few years ago and finished at the end of 1983, has collected various data concerning unaccounted-for water. In this section, the relevant data will be analyzed and, where required, the analysis will be supplemented by field survey. The result is shown in the following sections.

5.1 Illegal Use

Illegal use will consist of water uses by unregistered connections and by-passed connections. According to the Sensus Program, 12,175 number of illegal connections were found, which is about 11 % of total connections. Table 5.1 shows the summary of illegal connections found by the Sensus Program with percentage of illegal connections to the total of each category of users.

Table 5.1 Number of Illegal Connections

Category of Users	Non-registered Connection		By-pass Connection		Total	
	(Nos)	(%)	(Nos)	(%)	(Nos)	(%)
Cabang and Unit	9,500	7.8	4,900	3.9	14,400	11.4
Bulk User	11	0.8	11	0.8	22	1.6
Public Hydrant	410	29.5	-	-	410	29.5
Total	9,921		4,911		14,832	

Nos of illegal connections are obtained applying ratio (%) presented in Sensus Program to the present number of service connections in each category.

Unit consumption (m^3/conn. per month) of each category in 1982/83 and their adjusted figures are shown in Table 5.2. The adjusted unit consumption was produced taking into account of meter accuracy and under estimation for billing.

Table 5.2

Unit Consumption

Category	Unit Consumption Registered in 1982/83	Adjusted Unit Consumption
	(m^3/conn./month)	(m^3/conn./month)
Cabang and Unit	36.7	39.4
Bulk User	2,632	3,242
Public Hydrant	382	400

Loss of water can be estimated as the product of number of illegal connections and average consumption adjusted in each category. The estimated loss of water is, thus obtained, approximately 27,000 m3/day as shown below;

Table 5.3 Water Loss of Illegal Connections

Category	Illegal Connections	Unit Consumption	Water Loss (m^3/month)
Cabang and Unit	14,400	39.4	567,400
Bulk User	22	3,242	71,300
Public Hydrant	410	400	164,000
Total	14,832		802,700 (26,800 m^3/day)

5.2 Under-registration by Inaccuracy and Oversizing of Meters

With the time, accuracy of meters deteriorates, and on the other hand oversizing of meters causes under-registration.

There are about 133,000 meters of various sizes and years installed on service connections. According to the latest data of Meter Division of PDAM, meters of 18 different brands are installed on the service connections and about 42 % of the total is as old as more than 10 years since installing without replacement. Table 5.4 shows the summary of meters by sizes and years at present, April 1984.

Over-sizing of meters, especially in large size meter, has been observed as indicated in the consumption records of bulk meters as shown below:

Meter Dia.	Consumption Records (Average Day, m3/day)
3"	86
4"	188
6"	422
8"	1,334
10"	1,506
12"	2,978
16"	958

Source: Division of Meter Khusus, PDM as of December 1983.

It was observed during the site investigation that some customers have no reservoirs in their premises, which may cause big variation of flow through the meter. Also improper pipe arrangement after the meter was observed that the pipe has been laid on the same elevation of the meter up to the reservoir, as the result, partial flow of the meter may occur when inflow is small and water level of the reservoir is lower than the elevation of inlet pipe.

Table 5.4 Weter Meters Installed on Service Connections

Installing Year	Number of Meters 0.5	3/4	1	1 1/2	2	3	4	6	8	10	12	14	16	unknown	Total
More than 30 years	16,626	64	16	14	11	0	1	0	0	0	0	0	0	0	16,877
10 - 30 years	35,626	1,885	818	209	220	85	64	28	6	4	3	0	1	0	38,949
Sub Total	52,397	1,949	834	223	231	85	65	28	6	4	3	0	1	0	55,826
5 - 10 years	20,492	264	5	8	23	0	0	0	0	0	0	0	1	0	20,793
Less than 5 years	54,931	456	779	17	123	55	57	17	3	0	1	0	0	0	56,439
Total	127,820	2,669	1,618	248	377	140	122	45	9	4	4	0	2	0	133,058

Source of data; Meter Division, PDAM as of April 1984

This will cause inadequate registration of meter for the actual.

Regarding accuracy of meters, there are no data available. Therefore, 30 smaller sizes (1/2 - 3/4") and 7 larger sizes (3" and larger) of meters were tested at a meter shop and on the field respectively. The results thereof showed weighted average registration accuracy that 95 % for smaller size meters and 80 % for larger size meters. It should be noted that the figure shows the approximate percentage and has a limited accuracy.

From the Sensus Program, metered water consumption in 1982/83 was estimated at 6,544,000 m3/month, out of which about 3,779,000 m3/month was registered by smaller size of meter and 2,765,000 m3/months was by larger size meters. Under-registration by inaccuracy of meter thus estimated is approximately 29,700 m3/day.

Table 5.5 Water Loss of Under-registration

Size of Meter	Average Accuracy	Metered* Consumption	Water Loss by Under-registration
	(%)	(m^3/month)	(m^3/month)
Smaller	95 1/	3,779,000	198,900
Larger	80 1/	2,765,000	691,300
Total		6,544,000	890,200 (29,700 m^3/day)

1/ tentatively assumed, see table 1.5, 1.6 and 1.7 in Attachment 1.

* Metered consumption is estimated based on the percentage of non/defective metered connection and estimated/metered consumption as shown in Table 5.10. In the table, larger size of meter is assumed to be used only for Bulk User (3" and larger).

5.3 Underestimation by Estimated Billing

Approximately 23 % of service connections are billed by estimated water usage based on the average consumption in the past three months or 30 - 50 m3/month per connection generally. Table 5.8 shows the conditions of water meter according to the survey result of the Sensus Program conducted by PDAM. Weighted average percentage of connections billed by estimate was calculated and number of such connections was estimated as shown below:

Table 5.6 Number of Connections Billed by Estimate

Category	Billed Connection (1982/83) (Nos)	Weighted Average in Percentage (%)	Connections Billed by Estimate (Nos)
Residential and Small Commercial	104,600	22.3	23,300
Non-residential	12,500	30.3	3,800
Public Hydrant	1,010	26.8	270
Bulk User			
(1/2' - 2")	860	48.0	410
(3" and larger)	310	-	-
Total	119,280	23.3	27,780

The ratio (percantage) of estimated/metered consumption for each category of users was studied by the sample analysis, and was obtained at 95 %, 86 % and 100 % for residential and small scale commercial, non-residential, and public hydrant respectively. Data on bulk users were, not obtained during the survey, but based on information of PDAM, all connection for bulk users was assumed to have water meter.

Water loss by the under-estimation is estimated at about 6,000 m^3/day. Table 5.7 shows the result of the analysis.

Table 5.7 Water Loss by Under-estimation

Category	Connections Billed by Estimate (Nos)	Metered 1/ Consumption (m^3/conn.mon)	Estimated 2/ Consumption (m^3/conn.mon)	Water Loss by Under-estimation (m^3/month)
Residential and Small Commercial	23,300	35	31	93,200
Non-Residential	3,800	76	62	53,200
Public Hydrant	270	400	380	5,400
Bulk User				
(1/2" - 2")	410	410	340	28,700
(3" and larger)	-	-	-	-
Total	27,780			180,500 (6,000 m^3/day)

1/ unit metered consumption is adjusted by accuracy of meter, See Table 5.14.

2/ See Table 5.10

5.4 Public Water Uses

Public water uses include fire fighting, pipeline flushing and public sector unbilled connections. Water consumption for fire fighting is roughtly estimated at 100,000 m3/year or 9,000 m3/month which is equivalent to about 0.1 % of production based on the information of the Fire Department of DKI. Number of fire hydrants used in a year is about 500, for 50 % of fire cases, and estimated unit water consumption for a hydrant is 200 m3 per usage.

Water consumption for serveral fountains measured by water meters and recorded was about 30,000 m3/month which amounts to about 0.2 % of production. There is no available data and information for other uses. The total water use, however, is provisionally estimated at 1 % of production.

5.5 Water Loss by Unbilled Connections

According to the report of the Customer Division, about 8 % of total registered connections is not billed. These connections are not always the source of water loss. Reasons of unbilled may be as follows:

- newly installed connection with no water supply, and they have not been reported and/or recorded.

- disconnected customers, without report or record, are still kept in the registration.

- there are some customers who are not billed while water is supplied. This is also included in water loss.

The survey result of the Sensus Program indicates that about 2 % of registered connections are not functioning because the house has become vacant. Thus no meter readings are made.

Some water loss may occur from the unbilled connections, however, the amount of such water loss is hardly estimated at present. Therefore, water loss of this category is not counted in unaccounted-for water, in this study.

Table 5.8 Illegal Connections

Cabang/Unit	Registered Connections	Illegal	EX PAM	Sub-total Number	Sub-total %	By-passed Connections With pump	Without pump	Number	%	Total Number	Total %
Cabang											
JKT PUSAT	34,268	1,345	891	2,236	6.5	2,695	124	2,819	8.2	5,055	14.8
UTARA	9,439	1,448	30	1,478	15.7	210	5	215	2.3	1,693	17.9
BARAT	33,338	643	35	678	2.0	788	8	796	2.4	1,474	4.4
SELATAN	10,580	0	1,009	1,009	9.5	136	24	160	1.5	1,169	11.0
TIMUR	8,473	428	660	1,088	12.8	118	20	138	1.6	1,226	14.5
BOGOR	1,479	165	21	186	12.6	2	0	2	0.1	188	12.7
Unit											
VIII BEN-HIL	7,065	0	309	309	4.4	84	28	112	1.6	421	6.0
IX CEMPAKA PUTIH	3,272	334	27	361	11.0	204	4	208	6.4	569	17.4
X METER KHUSUS	1,323	0	11	11	0.8	6	4	10	0.8	21	1.6
XI HYDRANT	1,206	246	110	356	29.5	3	0	3	0.2	359	29.8
TOTAL	110,443	4,609	3,103	7,712	7.0	4,246	217	4,463	4.0	12,175	11.0

Source of data: LAPORAN HASIL PENDATAAN TERPADU, TAHUN 1978 S/D TAHUN 1983
TEAM SENSUS PDAM DKI JAYA 1984

Table 5.9 Estimated Illegal Connections for Cabang and Unit, 1982/83

Cabang/ Unit	Registered Connection	Illegal Connection Percentage	Illegal Connection Number	By-pass Connection Percentage	By-pass Connection Number	Total
PUSAT	34.973	6.5	2,273	8.2	2,868	5,141
UTARA	13,699	15.7	2,151	2.3	315	2,466
BARAT	33,079	2.0	662	2.4	794	1,456
SELATAN	12,417	9.5	1,180	1.5	186	1,366
TIMUR	16,629	12.8	2,129	1.6	266	2,395
BOGOR	1,681	12.6	212	0.1	2	214
U - VIII	8,593	4.4	378	1.6	137	515
U - IX	4,746	11.0	522	6.4	304	826
Total	125,817	7.5	9,507	3.9	4,872	14,379
			(9,500)		(4,900)	(14,400)

Table 5.10 Estimated and Metered Consumption, 1982/83

Category	Total Consumption (m3/month)	Connection Metered (Nos)	Connection Estimated (Nos)	Percentage of Estimated/Metered Consumptions 4/ (%)	Consumption (m3/month) Metered	Consumption (m3/month) Estimated
Residential and Small Commercial	3,430,000	81,300	23,300	95	2,696,000	734,000 (31)
Non-Residential	863,000	8,700	3,800	86	627,000	236,000 (62)
Public Hydrant	386,000	740	270	100	283,000	103,000 (380)
Bulk User						
(3" and larger)	2,765,000	310	-	100	2,765,000 3/	-
(1/2" - 2")	314,000	450	410	(86) 1/	176,000 2/	138,000 (340)
Total	7,757,000	91,500	27,780		6,544,000	1,213,000

1/ tentative used the figure of Non-residential.

2/ 10.2 % of total consumption applying the percentage of Dec. 1983.

3/ 89.8 % of total consumption applying the percentage Dec. 1983.

4/ See Table 5.10

Table 5.11 Percentage of Connection Billed by Estimate 1/

Category		Registered Connection 1982/83	Percentage of Connection Billed by Estimate	Weighted percentage
Residential & Small Commercial				
Jakarta	PUSAT	29,900	24.5 2/	
	UTARA	9,100	38.7	
	BARAT	29,100	15.9	
	SELATAN	11,600	27.2	
	TIMUR	7,000	10.0	
	Total	86,700		22.3 %
Non-Domestic				
	PUSAT	5,090	31.8 2/	
	UTARA	530	43.6	
	BARAT	3,980	33.8	
	SELATAN	800	16.0	
	TIMUR	1,470	18.4	
	Total	11,870		30.3 %
Public Hydrant				
	PUSAT	412	18.4 2/	
	UTARA	367	50.0	
	BARAT	477	17.0	
	SELATAN	54	60.0	
	TIMUR	82	0	
	Total	1,392		26.8 %
Bulk User				
	PUSAT	727		
	UTARA	83		
	BARAT	114		
	SELATAN	130		
	TIMUR	255		
	Total	1,309	(1 1/2" - 2") -	48.0 %
			(3" and larger)	0

1/ excluded Cabang Bogor, Unit VII PLUIT/ANCOL, VIII BEN-HIL, CEMPAKA PUTIH, KELENDER, KINCIR ANGIN and AIR MANCUR.

2/ See Table 5. 8

Table 5.12 Summary of Water Meter Conditions

Category	Sample Connection	No Meter	Non-function Damaged	Non-function Burried	Non-function Total	Cannot Read Soaked	Cannot Read Blurred Glass	Cannot Read Total	Total	Percentage
Residential & Small Commercial										
Jakarta PUSAT	600	15	10	16	26	11	95	106	147	24.5
UTARA	269	41	1	6	7	33	23	56	104	38.7
BARAT	578	17	9	13	22	13	40	53	92	15.9
SELATAN	173	3	20	7	27	0	17	17	47	27.2
TIMUR	209	2	4	4	8	0	11	11	21	10.0
Sub-total	1,829	78	44	46	90	57	186	243	411	22.5
Non-Domestic										
Jakarta PUSAT	296	4	7	33	40	6	44	50	94	31.8
UTARA	117	14	2	11	13	11	13	24	51	43.6
BARAT	473	8	5	123	128	13	11	24	160	33.8
SELATAN	25	0	1	0	1	0	3	3	4	16.0
TIMUR	266	1	6	31	37	1	10	11	49	18.4
Sub-total	1,177	27	21	198	219	31	81	112	358	30.4
Public Hydrant										
Jakarta PUSAT	38	3	1	1	2	1	1	2	7	18.4
UTARA	32	11	1	1	2	2	1	3	16	50.0
BARAT	47	4	0	1	1	1	2	3	8	17.0
SELATAN	5	3	0	0	0	0	0	0	3	60.0
TIMUR	9	0	0	0	0	0	0	0	0	-
Sub-total	131	21	2	3	5	4	4	8	34	26.0
Meter Khusus										
1/2" - 2"				- not available -						
3" - 16"										
Sub-total										

Table 5.13 Percentage of Estimated/Metered Consumption

Residential and Small Scale Commercial

Cabang	Percentage of Estimated/Metered Consumption	Number of Registered Connection in 1982/83
PUSAT	43.8/43.8 = 100	29,900
UTARA	21.7/28.9 = 75	9,100
BARAT	31.7/31.5 = 101	29,100
TIMUR	32.7/40.3 = 81	7.000

weighted average percentage of estimated/metered consumption 95 %

note: the above consumption is m3/conn.month

Non residential

Category of User	Metered Consumption Connection (Nos)	Metered Consumption Consumption (m3/conn.month)	Estimated Consumption Connection (Nos)	Estimated Consumption Consumption (m3/conn.month)
Government Offices	10	855	2	266
Industries	2	31	1	26
Commercials	205	6,888	40	945
Inpres Market	8	1,903	2	56
Hotel	36	1,158	11	405
Services	22	1,090	4	204
Private Offices	10	673	4	504
Bank	4	119	4	119
Service Station	2	16	1	13

weighted average percentage of estimated/metered consumption 86 %

Public Hydrant

No significant difference is found.

Bulk User

Tentatively percentage for smaller size (1/2" - 2") is applied for that of non-residential consumption.

Table 5.14 Unit Metered Consumption

Category	Connections Billed	Metered (Nos)	Metered (%)	Estimated 2/ Metered Consumption (m3/month)	Unit Metered Consumption 3/ Registered (m3/conn.month)	Unit Metered Consumption 3/ Adjusted (m3/conn.month)
Residential and Small Commercial	104,600	81,300	77.7	2,696,000	33.2	35
Non-Residential	12,500	8,700	69.6	627,000	72.1	76
Public Hydrant	1,010	740	73.3	283,000	382	400
Bulk User						
(1/2' - 2')	860	450	52.3	176,000	391	410
(3" and larger) 1/	310	310	100	2,765,000	8,919	11,100
Total	119,280	91,500		6,544,000		

1/ registered connections are assumed to be all billed

2/ adjusted by the percentage of estimeted/metered consumption, see Table 5.5

3/ adjusted by accuracy of meter, see page 12

Table 5.15 Unit Water Consumption By Categories (1982/83)

		Domestic and Small Commercial			Non-Domestic			Total		
		Consump.	Connect.[3/]	Unit Consump.	Consump	Connect.[3/]	Unit Consump.	Consump.	Connect.	Unit Consump.
Cabang	PUSAT	929,000	28,900	32.1	420,000	4,810	87.3	1,349,000	33,710	40.0
	UTARA	186,000	7,970	23.3	13,000	510	25.5	199,000	8,480	23.5
	BARAT	696,000	28,500	24.4	108,000	3,890	27.8	804,000	32,390	24.8
	SELATAN	542,000	10,400	52.1	78,000	740	105.4	620,000	11,140	55.7
	TIMUR[1/]	315,000	11,400	27.6	95,000	1,460	65.1	410,000	12,860	31.9
	BOGOR	61,000	1,520	40.1	30,000	150	200.0	91,000	1,670	54.5
Unit VII PLUTI/ANCOL		115,000	3,630	31.7	12,000	270	44.4	127,000	3,900	32.6
VII BEN-HIL		366,000	7,840	46.7	71,000	470	151.1	437,000	8,310	52.6
IX CEMPAKA PUTIH		220,000	4,430	49.7	36,000	210	171.4	256,000	4,640	55.2
Sub-total		3,430,000	104,600	32.8	863,000	12,500	69.0	4,293,000	117,100	36.7
X METER KHUSUS[2/]		18,000	120	150.0	3,061,000	1,050	2,915.2	3,079,000	1,170	2,631.6
XI HYDRANT		386,000	1,010	382.2	-	-	-	386,000	1,010	382.2
Kincir Angin		1,000	12	83.3	2,000	5	400.0	3,000	17	176.5
Air Mancur		-	-	-	30,000	12	2,500.0	30,000	12	2,500.0
TOTAL		3,835,000	105,700	36.3	3,956,000	13,600	290.9	7,791,000	119,300	65.3

1/ including water consumption of KELENDER
2/ including water consumption of ABRI
3/ billed connection

6. GROUP 2 UNACCOUNTED-FOR WATER

From the analysis of Group 1 unaccounted-for water, the leakage losses are estimated at about 222,000 m3/day. This is an estimated amount, as described so far in the preceding sections. In order to ascertain the reliability of the estimation, a field survey was carried out, details of which are attached to this report as Attachment 6.

PDAM has detected a great number of leaks (visible leaks) and repaired them. In fiscal year 1982/83, 4,578 cases of leaks were repaired. Fig. 6.1 shows the cases of leak repair by monthly. According to the report, the cases increase during dry season, which will indicate that the detection of leaks is rather difficult in the rainy season. Generally, leaks are found by the customer and informed to PDAM.

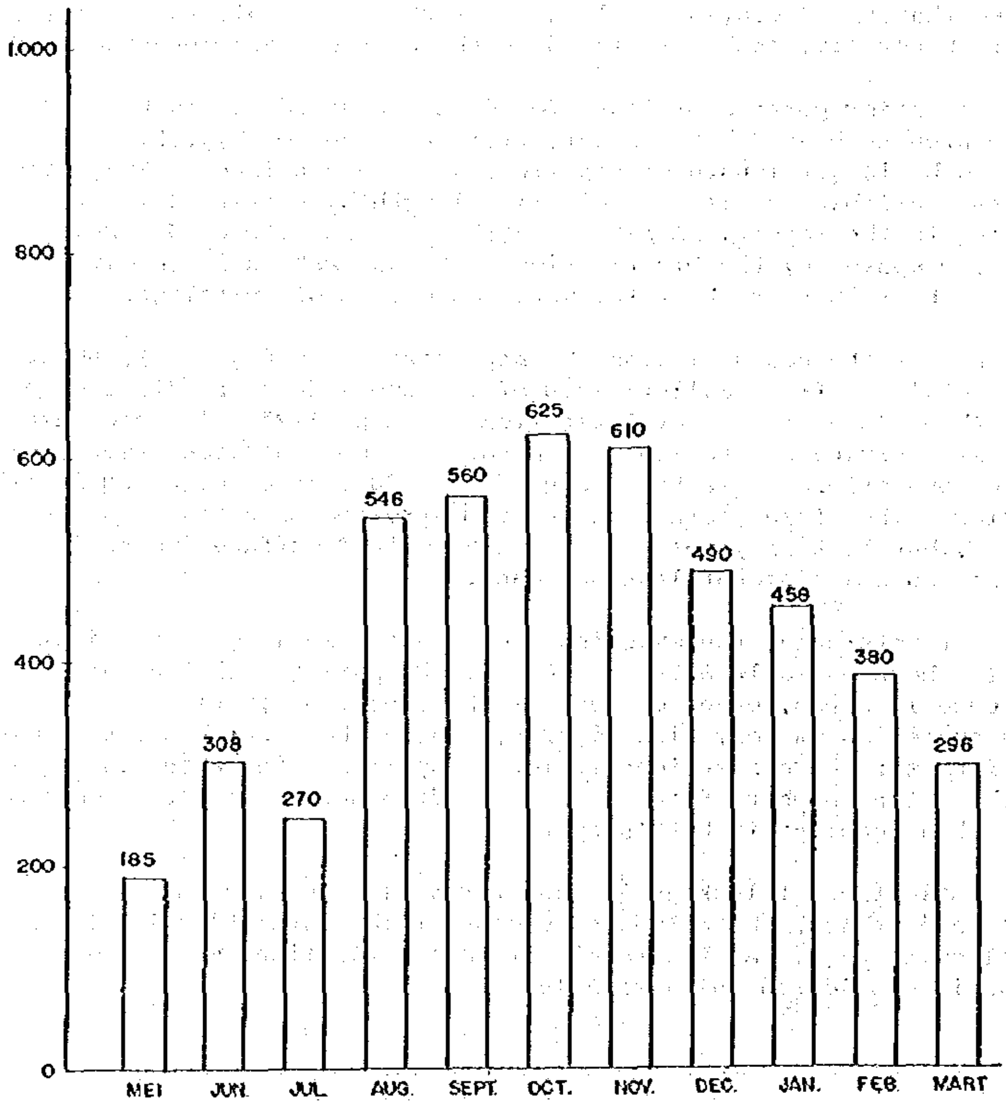
The major portion of leaks found and repaired was in the old service area such as Jakarta Pusat, Utara as shown on Fig. 6.2. This may be caused by longer length of pipelines and old pipelines. Presently, no data are available on areawise pipeline length by sizes. However, according to the report, DATA-DATA PENANGGULANGAN KEBOCORAN PIPA, 1982/83, prepared by the Distribution Division PDAM, a large part of leaks as about 88 % of the total were found from old pipelines.

As for the cases of leaks by pipe sizes (See Fig. 6.2), about 90 % of the total was from smaller sizes of pipes or 150 mm in diameter and less. About 43 % of the total was from pipes of 1/2" - 1" which are almost all service connections. Generally, number of leak cases from service connections is in the range of 85 - 90 % as experienced in other countries. Therefore, more leakage from service connections may be existent, but leaks may not appear on the ground surface due to low water pressure and small amount leak per case.

For reference, the experience on leakage in large size cities in Japan is shown on Table 6.1-1 and 6.1-2. Comparing with the record experience in Japan, cases of leaks found from distribution main of PDAM's system shows very high figures, and on the other hand, cases of leaks from service connections is low. Experience in Japan may suggest that the actual number of cases of leaks from service connections may be larger than recorded in PDAM's system.

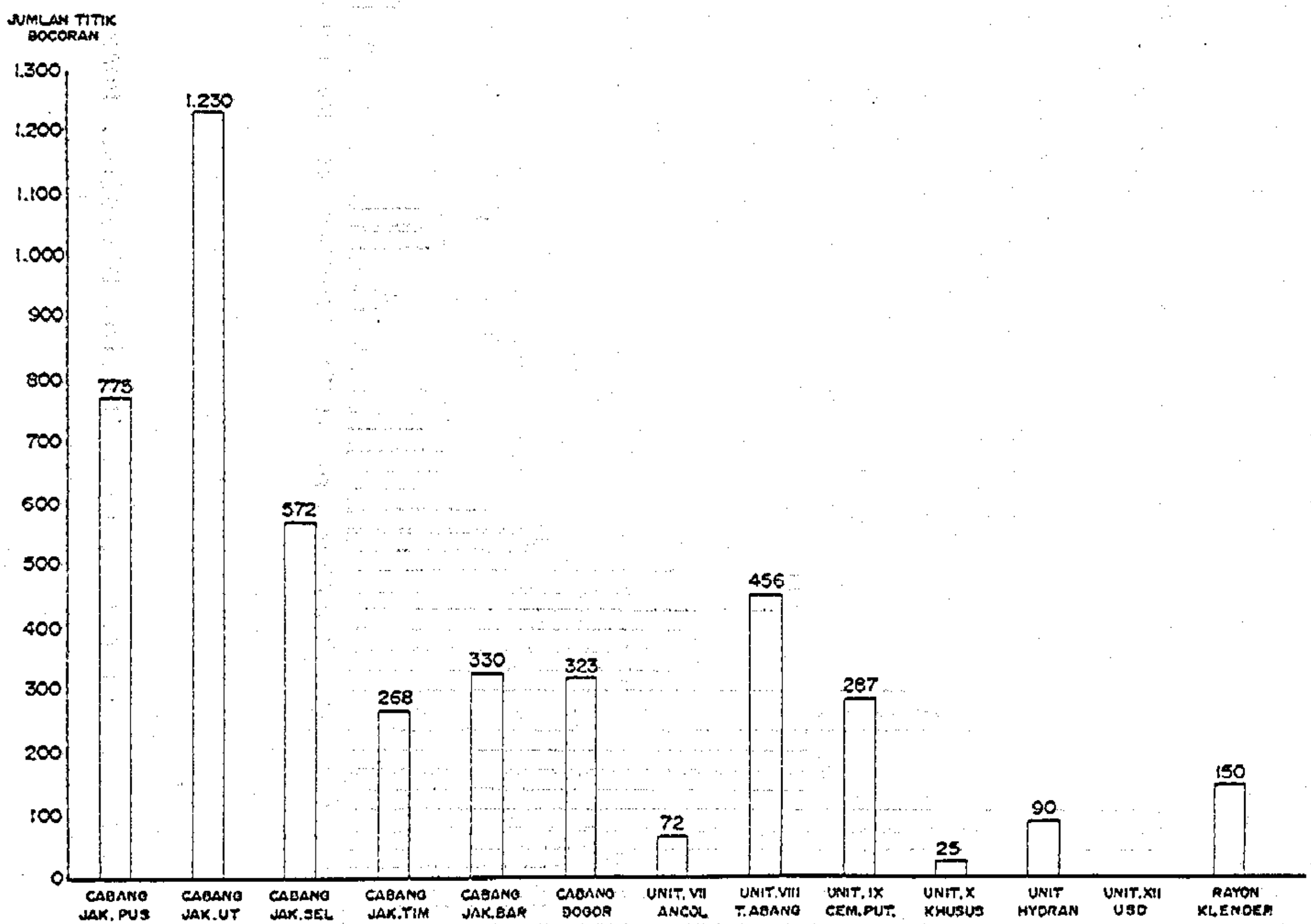
Estimation of leakage is made for a reference, using the figures in the said tables. Detailed assessment of the estimation is shown in the following page. As the result of this estimation, water loss by leakage is considered quite sizable.

Fig. 6.1 Cases of Leaks Repaired Monthly



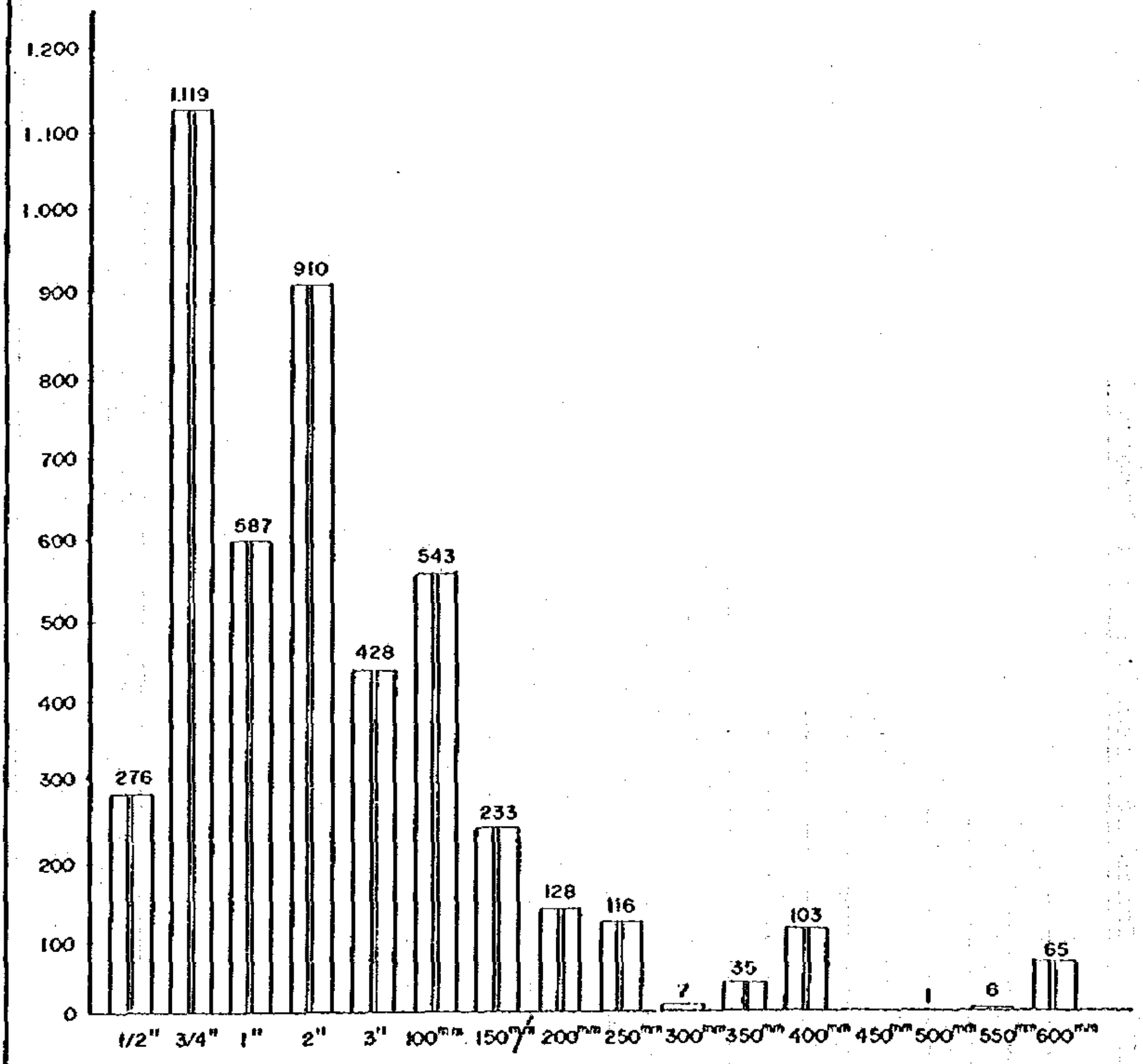
Source of Data : Distribution Division, PDAM.

Fig.6.2 Cases of Areawise Leak Repaired



Source of Data : Distribution Division, PDAM.

Fig. 6.3 Cases of Leaks Repaired by Pipe Size



Source of Data : Distribution Division, PDAM.

Assessment of the Present Leakage of the System

According to the experiences on leakage in the large size cities in Japan, leaks from the distribution mains and service connections are ranging approximately from 0.1 to 0.4 and 0.8 to 2 cases per kilometer respectively. As for the amount of leakage for the distribution mains and service connections, it ranges 0.1 - 0.4 and 0.3 - 0.9 m3/hr/km.

Supposing that the above figures can be applied to the present PDAM pipeline system, approx. 3,400 km in total, the cases of leaks from the distribution mains and the service connections will be estimated as about 400 - 1,400 cases and 2,800 - 6,600 cases respectively.

On the other hand, the actual cases of leaks found in 1982/83 were about 2,600 for distribution mains and about 2,000 for the service connections.

Comparing the above two estimation, it is found that the difference in the estimate in distribution mains becomes about 2 - 6 times. And as mentioned before, more leaks can be estimated in the service connections than the report made in 1982/83 when comparing the above two estimation.

The amount of the leakage of the system is estimated based on the estimate of cases of leaks and unit leakage per case using the assumed figures as follows:

Cases of leaks	:	distribution mains	3,000 cases
		service connections	5,000-10,000 cases
Unit rate of leakage	:	1-2 m^3/hr/case for distribution mains	
		0.25-0.5 m^3/hr/case for service connections	

Estimated leakage is ranging from 4,250 m^3/hr to 11,000 m^3/hr or 100,000 m3/day to 260,000 m3/day.

Table 6.1-1 Classification of Cases of Leak Recorded In Major Cities in Japan

(Cases/km)

Particulars	Sapporo	Sendai	Tokyo	Osaka	Kita Kyushu	Total
Pipe length surveyed (km)	799	1,505	3,523	3,366	1,369	10,562
Distribution Mains						
Pipe	0.12	0.08	0.06	0.07	0.15	0.48
Valves	0.06	0.05	0.03	0.04	0.16	0.34
Fire hydrant	0.01	0.01	0.01	0.01	0.04	0.08
Others	0	0	0.01	0.01	0.01	0.03
Sub-total	0.19	0.14	0.11	0.13	0.36	0.93
Service Connections						
Service pipe	0.37	0.27	0.25	0.45	0.71	2.05
Corporation stop	0.05	0.08	0.08	0.12	0.21	0.54
Stop valve	0.16	0.25	0.26	0.67	0.70	2.04
Water meters	0.25	0.19	0.30	0.27	0.18	1.19
Household plumbing	0.16	0	0.02	0.04	0.55	0.27
Others	0.12	0.03	0.04	0.05	0.11	0.35
Sub-total	1.11	0.82	0.95	1.60	1.96	6.44
Total	1.30	0.96	1.06	1.73	2.32	7.37

Table 6.1-2 Classification of Leaks Recorded In Major Cities in Japan

(m^3/hr/km)

Particulars	Sapporo	Sendai	Tokyo	Osaka	Kita Kyushu	Total	Average Rate
Pipe length surveyed (km)	470	970	2,100	1,733	929	6,203	
Distribution Mains							
Pipe	0.21	0.35	0.09	0.14	0.38	1.17	0.23
Valves	0.01	0.02	0.01	0.02	0.04	1.10	0.02
Fire hydrant	0	0	0	0.01	0.02	0.03	0
Others	0	0	0.02	0	0	0.02	0
Sub-total	0.22	0.37	0.12	0.17	0.44	1.32	0.25
Service Connections							
Service pipe	0.65	0.20	0.19	0.22	0.18	1.44	0.29
Corporation stop	0.07	0.07	0.11	0.07	0.08	0.40	0.08
Stop valve	0.01	0.02	0.03	0.02	0.05	0.13	0.03
Water meters	0.03	0.01	0	0	0.03	0.07	0.01
Household plumbing	0.04	0	0	0.01	0.01	0.06	0.01
Others	0.06	0.03	0.01	0.04	0.03	0.17	0.03
Sub-total	0.86	0.33	0.34	0.36	0.38	2.27	0.45
Total	1.08	0.70	0.46	0.53	0.82	3.59	0.70

7. CONCLUSION OF ANALYSIS AND TARGET OF REDUCTION

7.1 Conclusion of Analysis

On the basis of the analysis of the Sensus Program and related survey, the water loss by administrative aspect and under-registration is estimated at about 12 %. Therefore, the loss by the leakage is calculated at about 41 %.

The following table shows the summary of the components of unaccounted-for water which are provisionally estimated.

Table 7.1 Preliminary Estimate of Unaccounted-for Water

Causes	Unaccounted-for Water (percentage of production)
Illegal Use	5 %
Under-registration	5 %
Under-estimation by Estimated Billed Consumption	1 %
Public Uses	1 %
Leakage	41 %
Total	53 %

7.2 Target of Reduction of Unaccounted-for Water

Present losses by category and target of reduction thereof are presented on Table 7.2.

Table 7.2 Target of Reduction of Unaccounted-for Water

Category	Present (1982)	Target: Immediate (by 1990)	Target: Final (by 2005)
Illegal	5 %	3 %	1 %
Under-registration	5 %	3 %	2 %
Under-estimation	1 %	-	-
Public Uses	1 %	1 %	1 %
Leakage	41 %	33 %	21 %
Total	53 %	40 %	25 %

Measures to be taken to reduce unaccounted-for water are described in the following.

Illegal Use

To reduce water losses by the illegal connections, to establish regulations on illegal usage will be indispensable. Also, promortion of public relations will be required to reduce such connections together with enforcement of the above regulation. Recently, PDAM has started the preparation of such regulation. It is recommendable that the regulation is to be set in force urgently. The regulation, under preparation at present, mainly consists of the following:

- To establish the supporting system to enforce the regulation.
- To take action of inspection, control and supervision to protect the facilities/pipe networks and water source, covering the following:
  illegal use or drilling of wells, tampering of meter, delinquency of water bills, use of suction pump, by-passed connection and direct connection from service pipes, illegal installation of hydrant and moving the hydrant to other places, change of size of service connection, damaging of seal, and etc.

Under-registration

As shown in Table 5.4, there still installed a large number of old meters in the system. PDAM presently concentrates his effort on replacement of such old meters. Therefore, meters are tested only when they are delivered to the site but no test is made when they are sent back to the Meter Shop. On the basis of the record on meter accuracy and year of installation, life of meter should be decided and meters are to be replaced within a reasonable life of service to keep accuracy of registration. For large size of meters, especially the accuracy is to be examined not only at the meter shop but also at field by checking actual use of water and its variation. If the size of meters is not adequate comparing with actual consumption, those meters are to be replaced with that of the adequate size immediately. The reservoir will be necessary in the premises of the customer to maintain the flow rate constant and the accuracy of the meter. According to the information, water meters are damaged sometimes due to intrusion of sand and debris, because of insufficient flushing of pipelines after installation. Pipelines after installation should always be cleaned by flushing. At present, no equipment is available for testing of large size of meters above 250 mm. Testing equipment for such meters should be provided.

Water loss by under-registration may be unavoidable. Some 2 % of under-registration will be allowed due to the limit of meter accuracy.

Under-estimation

Water loss by under-estimation can be avoided by installing new water meters or replacing defective meters on service connections.

Public Uses

Water loss by public uses will be allowed for the same percentage of production at the present as one percent. However, the amount used for public purposes is to be measured/estimated and recorded.

Leakage

To achieve the reduction of water loss through leakage, several measures are to be conducted step by step. They will be as follows:

- To reinforce the present activities on leak detection and leak repair for visible leakage. In addition to this, leak detection and repair of invisible leaks especially from service connections are to be performed.

- To detect pipelines from which frequent leaks are made, and replace such pipelines with new pipes. Old pipelines, especially in the old service areas, should be replaced as early as practicable together with old service connection.

- To conduct intensive leakage survey and study on leakage abatement program including preparation of detailed maps of distribution pipelines. Rehabilitation of valves is also necessary step by step.

- To make a plan for the training for leak detection and leak repairing practices, and to engage them for leakage control work in the pilot area with the assistance of specialists of this field.

- To conduct leak detection and repair following the priority order of areas which will be defined by the above survey.

Details of the measures mentioned above will be described in the following chapter, especially for the short term water loss reduction program.

8. REDUCTION OF UNACCOUNTED-FOR WATER

To accomplish the purpose of unaccounted-for water reduction, works of several different categories must be carried out simultaneously. All effects of those works are interdependent and unless all works are carried out systematically, meaningful results cannot be expected.

As analysed in the previous sections, unaccounted-for water is roughly composed of 1) under-registration and under-estimation of consumption due to inaccuracy of meter and non-metered/defective metered connections, 2) water loss by illegal connections, and 3) water loss by system leakage.

As for the item 1), a comprehensive program must be established for meter installation and replacement, and for the item 2), customers regulation, now under preparation, must be put in force to eliminate illegal connections. For the item 3), it is imperative to conduct old-pipe replacement, especially for small size of pipes, and at the same time to prepare a short term preparatory program which becomes the basis for full-fledged leakage abatement activities.

Rough framework of activities to be undertaken to reflect the requirements in the above items, especially item 1) and 3), is described in detail hereunder, and the sequence of works is shown in Fig. 8.1.

8.1 Metering Program

Metering is an essential factor in abating unaccounted-for water. First, non-metered connection should be metered and old and defective meters be replaced. And all meters should be maintained as accurate as practicable by establishment of routine works for meter testing and periodical replacement. As for the large size meter for bulk users, sizes of meter should be checked and they should be adjusted to the adequate size according to the manufacturers' instructions. The meter testing equipment should be prepared, since no such equipment for large size meters, ø 6" and larger in diameter, is equipped in the Meter Shop. Also, bulk meters of the existing treatment plants including mini-plants should be replaced or newly installed where no meters are installed or defective meters are installed.

At present estimated number of meters to be installed or replaced are approximately 74,000 nos. including non-metered connection, damaged metered connections and old meters which record less accuracy.

Water Meter to be Replaced or Installed

Unmetered Connection:		8,500
Old Meters:	more than 30 years	16,900
	10 - 30 years	39,000
	Total	55,900
Defective or Bureied Meters[1]:		5,400
Allowance (5%)		4,200
Total		74,000

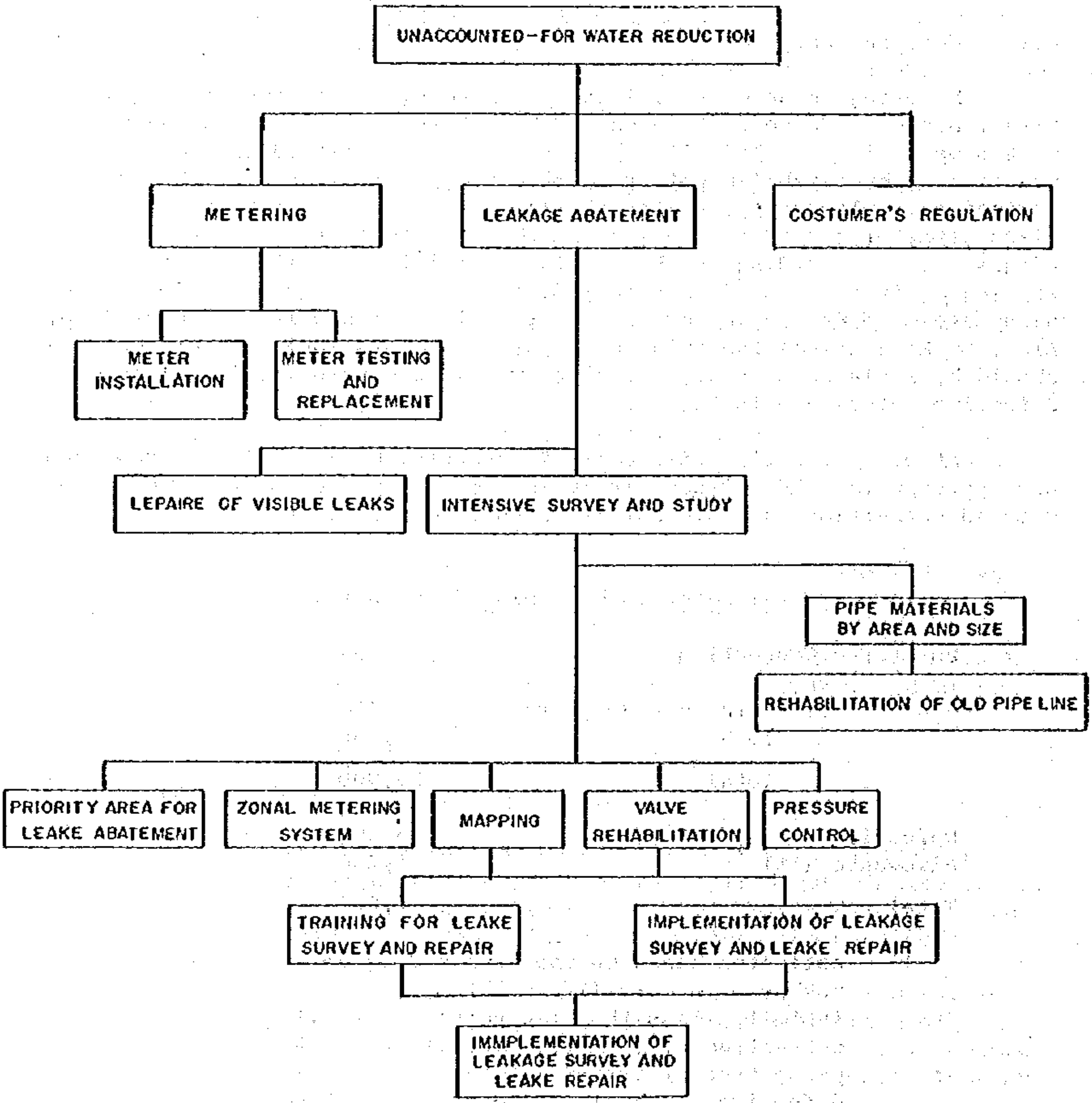
1) estimated based on the Sensus Program as followed present number of meters (1/2 - 2")

installed less than ten years:	77,100
percentage of defective meters:	3 %
percentage of buried meters:	4 %
defective and buried meters	5,400

2) large sizes of meters (3" or larger) in not included in the above figure because they are checked frequently in the field and defective meters is considered as minor portion of a total even if there is existence.

Fig. 8.1

SEQUENCE OF WORKS FOR UNACCOUNTED FOR WATER REDUCTION



8.2 Leakage Abatement

Leakage abatement works will consist of two components, i.e. one is routine work to repair visible leaks according to the periodical patroll and information from the customer, and another one is more positive action to detect underground leaks and repair them. The former work has been conducted by PDAM and large number of leaks were repaired. In the fiscal year 1982/83, 4,578 cases of leaks were found and repaired. However, such a way of leakage control will not be enough to reduce the present big amount of leakage. Furthermore the leakage will increase according to the pressure increase by completion of the extension works including the First Stage Project now under way. Therefore, more positive measurements on leakage abatement are required.

Necessary steps to achieve the target of leakage reduction will be as follows:

- 1st step:
  - to repair visible leaks from service connections especially in areas and pipeline more leaks are found than others.
  - to replace old pipelines and service connections.
  - to install stop cocks on service connections for leak detection from the service connections.
- 2nd step:
  - to conduct intensive leakage survey and study on leakage abatement.
  - to conduct training of PDAM stuff.
  - to conduct leak detection and repair in pilot area together with PDAM stuff.
  - to assess the effect on leakage abatement based on the above pilot project together with PDAM stuff.
  - to establish organization and stuffing.
- 3rd step:
  - to conduct leak detection and leakage repair by PDAM's own stuff in priority order of areas.

1) Leakage Repair of Service Connection

In addition to the present leakage abatement work, it will be necessary to conduct invisible leakage repair especially from the service connections. For the leakage detection of the service connections, it is necessary to install the stop cocks on the service connections. This works will be also inevitable for the next step areawise leakage abatement work. Leak detection and leakage repair work is to be conducted firstly from the old service areas. While conducting repair work, it is important to record the causes and location of leaks and the amount of leakage. The necessary tools and equipment are to be prepared for the works such as pipe detector, leak detector, etc.

2) Replacement of Old Pipelines

The total length of distribution pipelines is estimated at about 2,340 km, which is excluding smaller sizes of pipelines, ø 50mm and smaller, since their exact length is not known according to PDAM. Based on the analysis on small size pipeline length, made on the maps of sample areas, the total length is estimated at about 1,050 km. Thus, a total length of the present distribution pipeline was estimated at 3,400 km.

About 26 % of the total length of the trunk mains, which is ø 300 mm and larger and still in service, was installed in 1920's. These old pipelines are designed to be abandoned where new trunk mains are installed in parallel under the First Stage Project now under way (see Attachment 1, Fig. 1.4). The remained old pipeline will not be necessary to be replaced right now because the amount of leakage from such pipeline will be minor portion.

Replacement of old pipeline is to be concentrated to the smaller sizes pipelines. According to the estimate of PDAM, 10 - 15 % of the total length of secondary and tertiary mains (ø 250 mm and smaller) was installed before and in 1950's. The total length of pipeline installed in 1920's will be about 200 km if 50 % of a total length is such old pipelines. These pipelines will be the ones to be replaced in the immediate future. At the same time of replacement of old pipelines, the old service connections shall also be replaced. The number to be replaced is roughly estimated at 10,000 based on the ratio of length and service connections for old pipeline and total pipeline.

3) Intensive Survey and Study on Leakage Abatement

Since several problems are found in the present system, intensive measures on leakage abatement will be imperative to slove them. The program will include the following surveys and studies and the implementation of actual works for leakage abatement will follow such program. It should be noted that PDAM stuff is desirable to join the survey and study by organizing the special team, which will be the principal part of the future leakage abatement program.

- Detailed study on present distribution practice and problems
- Mapping and recording system
- Management of distribution practice
- Water production and metering
- Bulk user study
- Isolated area study
- Corrosion study
- Leak repair study
- Zonal metering study
- Pressure control study
- Unaccounted-for water component study
- Area-wise implementation schedule for leak detection and leakage repair program

4) Training

Training of PDAM stuff for leak detection, leakage repair practice and mapping and recording system, will be inevitable. The timing of such training is desirable some time at the end of the above survey and study. The necessary items for training and tools and equipment will be identified during the above study.

5) Test Operation for Leak Detection and Leakage Repair Practice in Pilot Areas

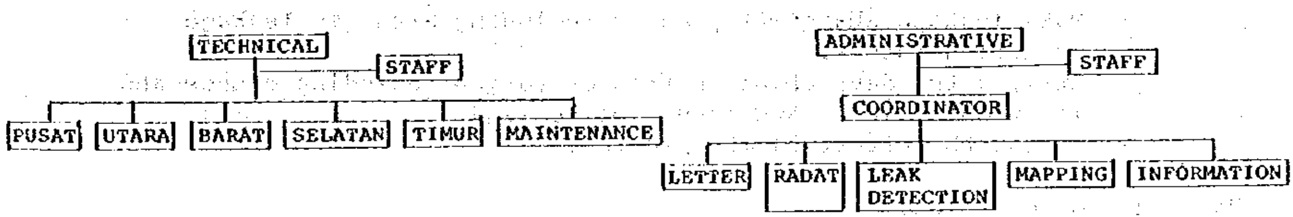
Based on the above works, the test operation of the leak detection and leakage repair works will be desirable in pilot areas. The works will be undertaken by the specialist together with PDAM stuff. The pilot areas will be selected by the above study and two areas will be adequate. Adequate size of a pilot area will be area covering approximately 10 km distribution pipeline and it will be further deviced by four to five divisions covering about two km distribution pipeline length. The details are subject to the study in the above study. During the test operation, mapping and recording system on distribution pipelines and service connections are necessary together with arrangement of stop cocks on service connections and rehabilitation of valves.

6) Organizational Aspect

Presently each branch office has the responsibility of leakage repair for small sizes pipelines and service connections. And these for distribution mains are made by the Distribution Division. However, to encounter the complexity and composite of leakage abatement works, the branch offices have a limited engineering and drafting capabilities. Therefore, the responsibility of the works should be concentrated to a single office or section in the central office and adequate organization is required.

Recently, PDAM organized a new team for leakage abatement works with 78 personnel and staff. They are transferred from branch offices and the Distribution Division. The chart of the new organization is presented in Fig. 8.2.

Fig. 8.2 New Organization for Leakage Abatement

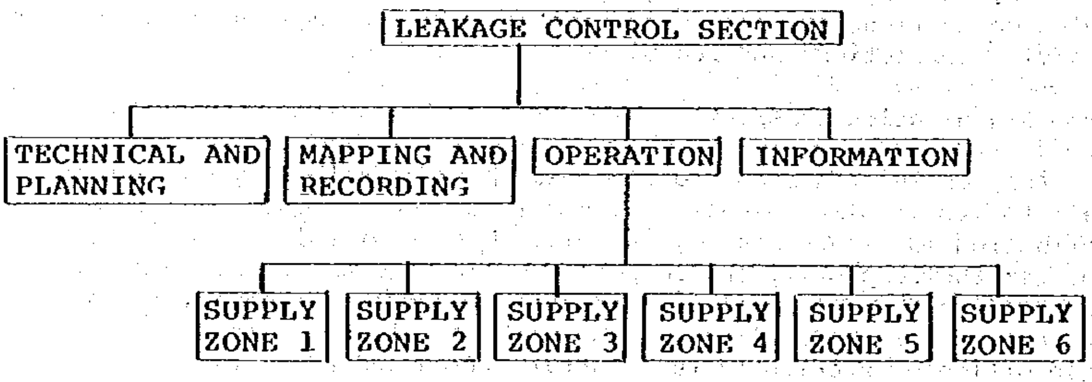


According to the new organization of PDAM, the service area is divided into five zones which are corresponding to the five districts. PDAM is planning to concentrate its effort to the repair works of visible leakage at the moment. As mentioned in the above, it will not be enough to work on only for visible leak repair but effort should also be paid to find leaks in the underground especially from the service connections.

The organization to be established in the future should have the overall responsibility for water loss reduction program including data compilation and overall loss prevention planning. The works will have two components, i.e., engineering and operational, and unless they are properly coordinated, effective works could not be achieved.

From the standpoints of the above concepts and to meet the improved distribution system in the First Phase Project, the following framework of organization is suggested.

Fig. 8.3 Frame Work of Proposed Organization



General task covered by each task unit in the above organization are briefly described hereunder:

Technical and Planning:

- Make leakage abatement program including areawise leakage reduction target.
- Analyze the data obtained from operation including causes and location of leaks and amount of leakage.
- Assess the effect of the program.

Mapping and Recording:

- Make new maps or correct the existing maps for distribution pipelines and service connections in detail including valves, hydrants, stop cocks of service connections, conditions of road surface, etc.

- Deliver the maps to divisions and branch offices concerned.
- Record the results of leak detection and leakage repair works including causes and location of leaks and amount of leakage, pressures and etc.

Operation:

- Conduct routine patrol of service area and find leaks and repair them.
- Conduct areawise leak detection and leakage repair works.
- Maintain tolls and equipment for leak detection and leakage repair works and supply materials for repair.

Information:

- Make necessary publication to the citizen according to the works.
- Make necessary action against consumers having illegal connections which were found during operation.
- Make necessary coordination with offices and personnel concerned according to the operation.

It is suggested that the details for required organizational measures be facilitated by the use of consultant services during the course of the Intensive Survey and Study on Leakage Abatement mentioned in the above.

8.3 Implementation of the Program

Considering the nature of the program, the period for implementation is considered for five years as a reasonable term. The implementation schedule is shown in Fig. 8.4.

8.4 Cost Estimate of the Project

Based on the above mentioned measures for reducing unaccounted-for water, the cost estimate was made. Cost estimate includes new water meter installation and replacement, old distribution pipe replacement, old service connection replacement, withdrawal of old trunk mains, leakage abatement survey and study, training of PDAM staff and test operation in pilot areas. The summary of the cost estimate is shown in Table 8.1

Fig 8.4 Implementation Schedule

Item Year	1985	1986	1987	1988	1989	1990
1. Water Meter Installation and Replacement	=====	=====	=====	=====	=====	=====
2. Replacement of Old Pipeline		=====	=====	=====	=====	=====
3. Service Connection Installation and Replacement		=====	=====	=====	=====	=====
4. Intensive Survey and Study		=====	=====			
5. Training for Leak Detection and Repair			=====			
6. Implementation of Leak Detection and Repair in Pilot Area				=====	=====	=====

Table 8.1 Summary of Cost Estimate

	TOTAL		1985		1986		1987		1988		1989		1990	
	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C	F/C	L/C
1. Water Meter	1,998	-	324	-	324	-	324	-	324	-	324	-	378	-
2. Service Conn.	340	160	-	-	68	32	68	32	68	32	68	32	68	32
3. Distribution Pipe														
- Tertiary & Second	2,480	2,540	-	-	496	508	496	508	496	508	496	508	496	508
- Trunk Main (Disposal)	-	2,600	-	-	-	720	-	780	-	1,040	-	-	-	-
- Sub-total	2,480	5,140	-	-	496	1,288	496	1,548	496	1,548	496	508	496	502
4. Engineering Service														
- Leakage Abatement Study	1,558	576	-	-	779	288	779	288	-	-	-	-	-	-
- Training	173	40	-	-	-	-	173	40	-	-	-	-	-	-
- Leak Detection and Repair	563	194	-	-	-	-	-	-	163	43	226	85	174	66
Sub-total	2,294	810	-	-	779	288	952	328	163	43	226	85	174	66
TOTAL	7,112	6,110	324	-	1,667	1,608	1,840	1,648	1,051	1,623	1,114	625	1,116	606
5. Contingencies														
- Physical (20%)	1,422	1,223	65	-	333	322	368	330	210	325	223	125	223	121
- Price	2,934	3,796	58	-	438	706	645	912	467	1,099	604	505	722	574
Sub-total	4,356	5,019	123	-	771	1,028	1,013	1,242	677	1,424	827	630	945	695
TOTAL COST	11,468	11,129	447	-	2,438	2,636	2,853	2,890	1,728	3,047	1,941	1,255	2,061	1,301

ATTACHMENTS