6.6.4 Summary of Problems Identified

Following problems are identified through site visiting and interview with community people in sample AMDs with respect to facilities and O&M:

- Inventory of community water supply system, which would be basic information for O&M is not properly organized or kept in record systematically.
- Condition of existing facilities and situation of O&M are different from site to site. In well-managed AMDs, minor technical problems are smoothly recovered by revenue of water charge or occasional contribution by users. On the contrary, in poorly-managed AMDs, there were many cases that troubled or damaged facilities were unsolved and not repaired. It is necessary to exchange information and know-how among WUO leaders to learn lessons from case studies in other AMDs.
- Water quality does not seem to be checked at regular intervals as long as the Study Team interviewed at the site.
- It is important to select appropriate pump, pipe materials and pipe diameter according to its specific condition in planning and design stage. However, uniformly-designed facilities are introduced in many AMDs, without consideration of specific conditions such as geographical features, demand, etc. For example,:
    - Intake pump without water level switch is burnt down by idle operation when water level drops down.
    - Where pump head is not enough, booster pump without water level switch is additionally installed in midway of transmission lines. It causes damage in pump by idle operation when water level drops down.
    - In some AMDs, PVC pipes are exposed above ground. PVC pipes are easily deteriorated under exposure of ultraviolet ray and it would be a cause of leakage or pipe damage.
    - Earth covering of GIP/PVC is not always sufficient to stand against vehicle load, where pipe is crossing roadway.
- Further, through the review of existing manuals of O&M for water supply systems provided by counterpart, following aspects are confirmed:
    - There is a sort of a set of standard manuals for operation and maintenance of water supply system prepared by the central government.

- This set of manuals is intended to cover general aspects of operation and maintenance of water supply systems, including facilities of PDAM (not limited to community water supply systems).
- This set of manuals is to be recommended to revise and to edit according to the local condition of each community.
- Contents of manuals would be interpreted as they are rather too advanced and too technical for villagers who are responsible for daily operation and maintenance.

6.7 UFW Survey

In this section, the terms of NRW and UFW are defined as follows:

- NRW consists of UFW, meter error and unbilled authorized consumption.
- UFW is lost water volume through leakages or consumption by illegal connections.
- Unbilled authorized consumption such as water for fire fighting or use in public park can be negligible in these survey areas because the series of UFW survey were conducted within limited areas.

6.7.1 Outline of the UFW Survey

(1) General

A series of UFW surveys have been conducted at the 7 selected areas in the Study Area as shown in Table 6.7.1 and its location is shown in Figure 6.7.1. These areas were selected through discussion among officials concerned in the Study Area. The main objectives of this survey are:

- To comprehend actual situation of UFW in the Study Area.
- To pursue technology transfer on UFW survey and data analysis through on-the-job training for PDAM staff concerned.

This UFW survey was categorized into following 2 types, according to actual site condition.

- Isolated Survey:

  In case there are not too many inlet pipes or customers in the survey area, survey area was hydraulically isolated to measure system input volume or consumption in the survey area.

- Non-Isolated survey:

  In case it is not feasible to complete hydraulic isolation work within limited time frame but considered to be important area in terms of comprehension of actual situation of UFW, the survey was focused on detection of leakage, its type, number (frequency per km) and OJT (on-the-job training) for leakage detection work in such area.

Table 6.7.1 General Feature of Selected Areas for UFW Survey

Selected Area for UFW Survey		*Number of Customers*	*Length of Distribution Pipes (km)*	*Major Pipe Material*	*Type of Survey Method*	*Major Land Use*	*Period of Survey*	
Responsible PDAM	*Site*						*From*	*To*
Yogyakarta	Wirokarten	188	2,120	PVC	Isolated	Residential	5 December, 2006	20 December, 2006
	Malioboro	773	5,450	PVC, AC, GI	Non-Isolated	Commercial	29 May, 2007	26 July, 2007
	Banteng*)	352	2,760	PVC, AC	Isolated	Residential		
Sleman	Pakem	216	8,100	PVC	Isolated	Residential, Agricultural		
	Perum GTA	437	5,090	PVC	Non-Isolated	Residential		
Bantul	Plam Sewu	154	1,840	PVC, AC	Isolated	Residential		
	Imogiri	195	10,420	PVC, AC	Non-Isolated	Agricultural		
Total		2,315	35,780					

Note:

– *Banteng is located in Sleman Regency but serviced by PDAM Yogyakarta*

– *Wirokartan is located in Bantul Regency but serviced by PDAM Yogyakarta*

7 locations in the Study Area (4 isolated survey areas and 3 non-isolated survey ares) were selected for UFW survey based on the discussion with counterpart staff.

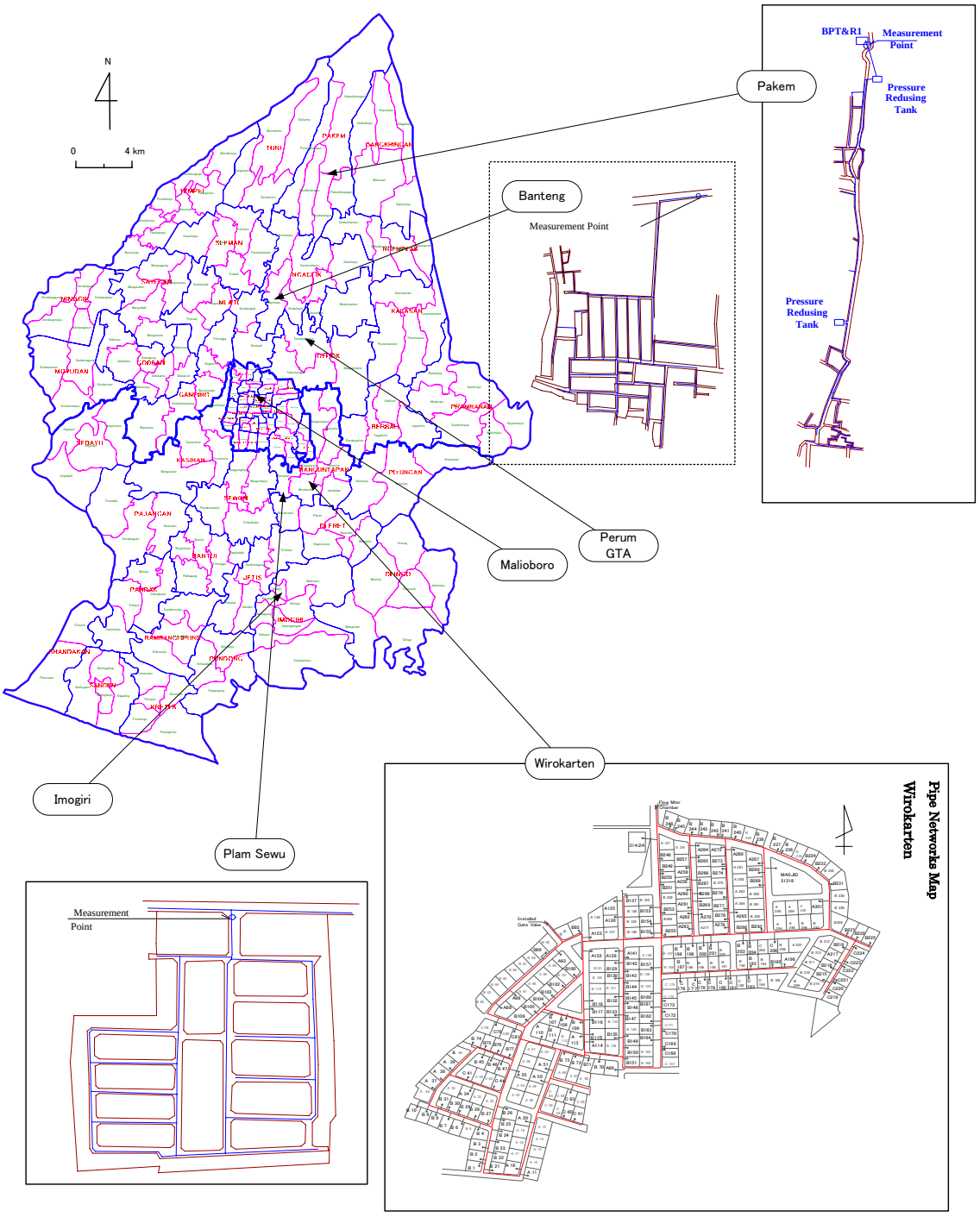

Figure 6.7.1 Locations of Selected Areas for UFW Survey

(2) Special Considerations for OJT

15 staffs from PDAM Yogyakarta participated in NRW survey conducted during the period of 5 December, 2006 to 20 December, 2006 (hereinafter referred to as the "1st Survey"). 17 staffs participated in another survey conducted from 29 May, 2007 to 26 July, 2007 (hereinafter referred to as the "2nd Survey"), 7 from PDAM Yogyakarta and 5 each from PDAM Sleman and PDAM Bantul. In order to facilitate smooth implementation of survey as well as to ensure effective technology transfer, special attention was paid to staff assignment or survey scheduling so that the staffs who had already experienced the 1st Survey could give necessary orientation or direction to those who newly participated from the 2nd Survey.

6.7.2 Methodology

A series of the NRW survey was conducted in accordance with the procedure shown in Figure 6.7.2.

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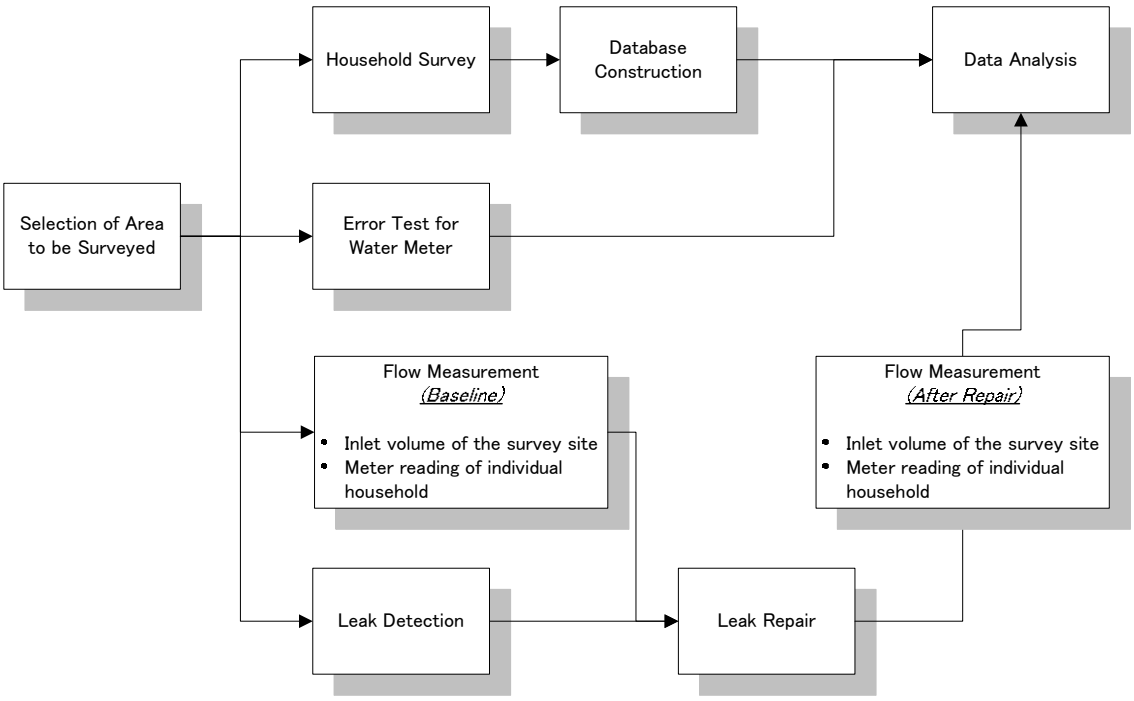

Figure 6.7.2 Procedure of the Survey

Upon selection of the survey areas, household survey was conducted to confirm family size (number of people in household) through door-to-door survey. In addition, field investigation was conducted to confirm exact locations for distribution pipes or valves since detailed and precise drawings for the distribution network system were not available at PDAM offices

concerned.

After above-mentioned preparation works, location for ultrasonic flow meter installation was determined to measure water flow into the survey site for 24 hours. Meter reading for water meters for individual house connection were conducted one by one to measure total water consumption in the survey site

6.7.3 Result of Survey

(1) Household Survey

Table 6.7.2 outlines the result of household survey. According to the result, there are totally 3,186 households in the selected 7 areas. 2,315 households out of 3,186 or 73 % of total households receive water supply service by PDAM. Other households, which do not receive PDAM service, obtain water from private well in general, especially in Wirokarten or Imogiri. The number of households supplied by PDAM would potentiall be less that 73 % in fact because there are some houses which register PDAM service but does not use PDAM water.

Table 6.7.2 Result of Household Survey

Region	Area Name	Number of Household	Effective Answer	Number of PDAM Customers	Average Family Member	PDAM Service Population
Isolated Area						
Sleman	Pakem	287	213	216 (75%)	4.1	885
Yogyakarta	Banteng	376	118	352 (93%)	3.8	1,337
	Wirokarten	296	80	188 (63%)	4.1	758
Bantul	Plam Sewu	183	103	154 (84%)	3.8	585
Sub Total		1,142		910 (79%)	3.9	3,565
Non Isolated Area						
Sleman	Perum GTA	450	---	437 (97%)	---	---
Yogyakarta	Maliobolo	863	---	773 (89%)	---	---
Bantul	Imogiri	731	707	195 (26%)	3.9	760
Sub Total		2,044		1,405 (69%)	3.9	3,565
Total	Seven Areas	3,186	---	2,315 (73%)	3.9	---

(2) Meter Accuracy Test

A number of water meters for individual customer dates back more than 10 years since its installation and they are still in use, without calibration, repair or replacement. In order to check accuracy of water meters, a series of meter accuracy test was conducted picking up 168 customer's water meter randomly from selected 7 areas. An electromagnetic meter and a

Woltmann-type meter, whose accuracy were officially certified in Japan, were used for the meter tests. Out of totally 168 meters, test measurements were conducted for 24 consecutive hours for 28 meters and remaining 140 were tested in shorter time. In test measurement, test meter was installed immediately after the objective meter to compare the value indicated in respective water meter. Table 6.7.3 summarizes the outline of the result of the accuracy test. According to the test result, more than 40 % of tested water meter have over 10 % of measurement error.

Table 6.7.3 Meter Accuracy Test

Indicated Value (value of test meter set as 100%)	24hrs measure		Limited time measure		Total	
	Samples	%	Samples	%	Samples	%
～49.9%	5	18%	8	6%	13	8%
50%～89.9%	1	4%	11	8%	12	7%
90%～109.9%	**10**	**36%**	**87**	**62%**	97	58%
110%～149.9%	7	25%	10	7%	17	10%
150%～	1	4%	19	14%	20	12%
Reversed Fitting	1	4%	1	1%	2	1%
Outlier	3	11%	4	3%	7	4%
Total	28	100%	140	100%	168	100%

**"Reversed fitting" was shown negatively value*

**"Outlier" was more over the 1000% value*

(3) Measurement of System Input Volume

In order to know the volume of water flowing into the selected survey area, a series of flow measurement were conducted in the 4 isolated survey areas. The measurement were conducted at before and after leak repair to know baseline condition of UFW and effect of leak repair work. An ultrasonic flow meter was used for this measurement. The results of the measurement are summarized in Table 6.7.4 and Figure 6.7.3.

Table 6.7.4 Flow Measurement Result

Area	Study Area Name		Inlet Volume (m^3/day)	Average Flow (ltr/sec)	Minimum Flow (ltr/sec)
Sleman	Pakem	before	834.86	9.62	8.69
	(SP, 4 inch)	after	667.75	7.69	6.50
Yogya	Banteng	before	441.23	5.10	3.00
	(ACP, 4 inch)	after	393.48	4.55	2.18
	Wirokarten	before	104.92	1.21	0.43
	(PVC, 4 inch)	after	99.42	1.15	0.27
Bantul	Pelam Sewu	befor	165.92	1.91	0.92
	(ACP, 3 inch)	after	89.59	1.03	0.37

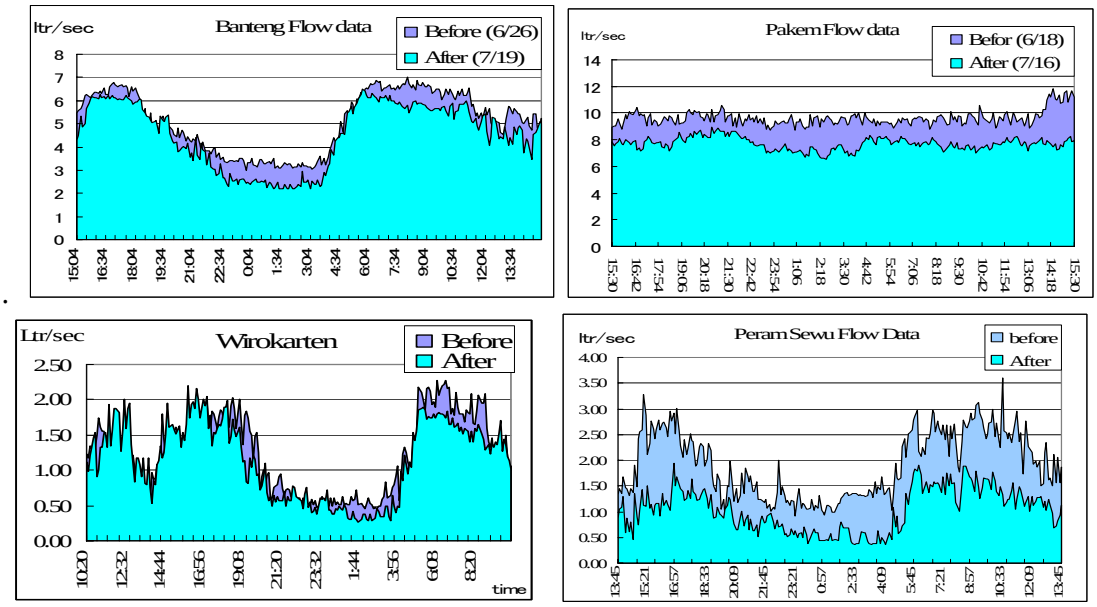

Figure 6.7.3 Variation of Flow in Isolated Areas

(4) Meter Reading for Customers

A series of meter reading for individual customer were carried out to measure actual consumption in 4 isolated areas. The result of meter reading is summarized in Table 6.7.5.

Table 6.7.5 Result of Meter Reading

Surveyed Area		Number of Customers	Working Meter	Consumption (m3/day)	Per Capita Consumption (m3/capita/day)	Supplied Population in working meter	Estimated Consumption (m3/day)
Sleman	Pakem	216	196 (90%)	95.2	0.261	364	230.98
Yogyakarta	Banteng	352	269 (76%)	308.1	0.278	1,108	371.68
	Wirokarten	188	142 (75%)	68.5	0.113	606	78.12
Bantul	Plam Sewu	154	78 (50%)	56.2	0.136	413	79.56
Total		**910**	**685 (75%)**	**528.0**	**0.212**	**2,491**	---

(5) Baseline Condition of NRW

In general, UFW can be estimated on the basis either subtracting estimated consumption from total system input or nighttime minimum flow. In this survey, the former basis would be more appropriate to estimate UFW because of following reasons:

- There should be many houses in the Study Area which have water tank so that they can store water with keeping open their water tap in nighttime.
- Therefore, nighttime minimum flow would not necessarily represent amount of UFW.

Table 6.7.6 outlines the amount of UFW in each survey area.

Table 6.7.6 UFW in Survey Area

Target Area for NRW Survey		System Imput Volume	Estimated Consumption	*Lost Volume*			
				Estimated Based on Meter Reading		Estimated Based on Nighttime Minimum Flow	
		a	b	c = a − b	c / a	d	d / a
		m3/d	m3/d	m3/d		m3/d	
Sleman	Pakem	834.86	230.98	603.88	72.3%	750.81	89.9%
Yogyakarta	Banteng	441.23	371.68	69.55	15.8%	259.20	58.7%
Yogyakarta	Wirokarten	104.92	87.12	17.80	17.0%	37.15	35.4%
Bantul	Pelam Sewu	165.92	79.56	86.36	52.0%	79.48	47.9%
Total		*1,546.93*	*769.34*	*777.59*	*50.3%*	*1,126.64*	*72.8%*

According to the above table, average UFW in the 4 selected areas is 50.3 %. In addition, meter error was assumed to be 4.0 % based on the result of meter accuracy test. Figure 6.7.4 shows breakdown of NRW in the survey area.

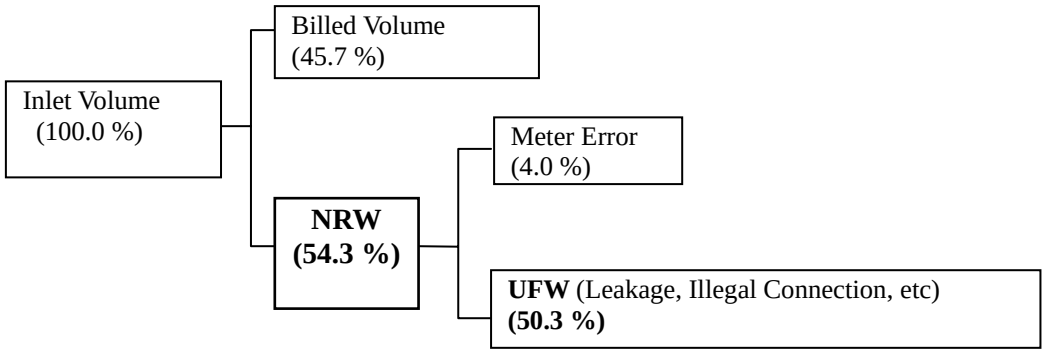

Figure 6.7.4 Baseline Condition of NRW and Its Components in Survey Area

(6) Leak Detection

A series of leak detection works were also conducted in the selected isolated areas. Leak detectors or stethoscopic bars were used for this detection works, with a special emphasis on technical transfer for its use through OJT as the detection work with this kind of instruments requires certain amount of skill or experiences. The detection works had to be conducted during midnight to avoid interference caused by noise, generated by traffic or residents' daily activities including their water use in and around survey area so that the PDAM staff could identify sound of leakage among various kind of noises easily.

The leak detection works were carried out, covering 2,511 of service connections and totally 35.78 km of distribution pipes. Through this detection works, illegal connections were also identified in some areas. Table 6.7.7 and Figure 6.7.5 summarizes the result of leakage detection works.

Table 6.7.7 Result of Leak Detection Work

Survey Area		Number of Customer	Total Length of Distribution Pipe (m)	Leakage Identified on			Freauency of Leakage per km (Number of Leaks / km)	Illegal Connection	
				Distri -bution	Service Connection	Total		Identif ied	%
Sleman	Pakem	216	8,100	18	22	40	4.9	1	0.4%
	Perum GTA	437	5,090	---	8	8	1.6	--	0%
Yogya-karta	Wirokarten	188	2,120	---	10	10	4.7	1	0.5%
	Banteng	352	2,760	5	17	22	8.0	1	0.3%
	Maliobolo	773	5,450	6	39	45	8.3	1	0.1%
Bantul	Plam Sewu	154	1,840	2	10	12	6.5	1	0.6%
	Imogiri	195	10,420	4	18	22	2.1	1	0.5%
Total		**2,315**	**35,7800**	**35**	**124**	**159**	**4.4**	**6**	**0.2%**

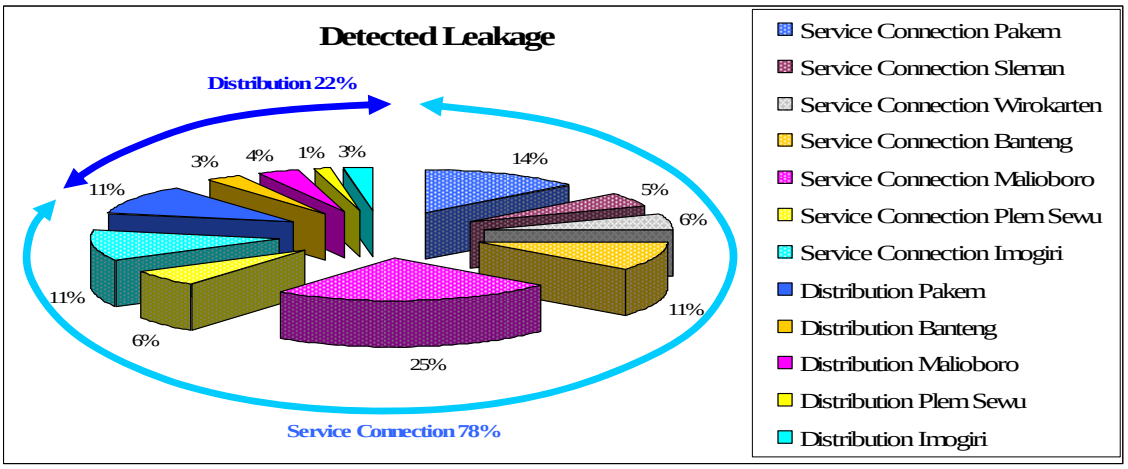

Figure 6.7.5 Breakdown of Leakage in Survey Area

Considering actual conditions, the major causes for leakage in survey area could be followings:

- Sleman area:
  High pressure at end part of distribution area caused by extreme difference of elevation.
- Yogyakarta area･
  Aged pipes and fittings.
- Bantul area
  Damage caused by recent earthquake disaster.

(6) Effect of Leakage Reduction

In general, leak detection and repair work would have significant contribution for reduction of UFW if take a look at the past similar case studies. Table 6.7.8 and Figure 6.7.6 show the result of UFW before and after leak repair work in the selected 4 isolated areas.

Table 6.7.8 Effect of Leak Detection and Repair on UFW Reduction

Survey Area		Inlet Volume		Estimated Consumption	UFW		Reduced UFW	UFW (%)		Reduced UFW
		Before	After		Before	After		Before	After	
		m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	m^3/day	%	%	%
		a	b	c	d = a - c	e = b - c	f = d - e	g= d / a	h = e / b	i = g - h
Sleman	Pakem	834.86	667.75	230.98	603.88	436.77	167.11	72.3%	65.4%	6.9%
Yogyakarta	Banteng	441.23	393.48	371.68	69.55	21.8	47.75	15.8%	5.5%	10.3%
Yogyakarta	Wirokarten	104.92	99.43	87.12	17.8	12.31	5.49	17.0%	12.4%	4.6%
Bantul	Pelam Sewu	165.92	89.59	79.56	86.36	10.03	76.33	52.0%	11.2%	40.8%
	Total	***1,546.93***	***1,250.25***	***769.34***	***777.59***	***480.91***	296.68	***50.3%***	***38.5%***	***11.8%***

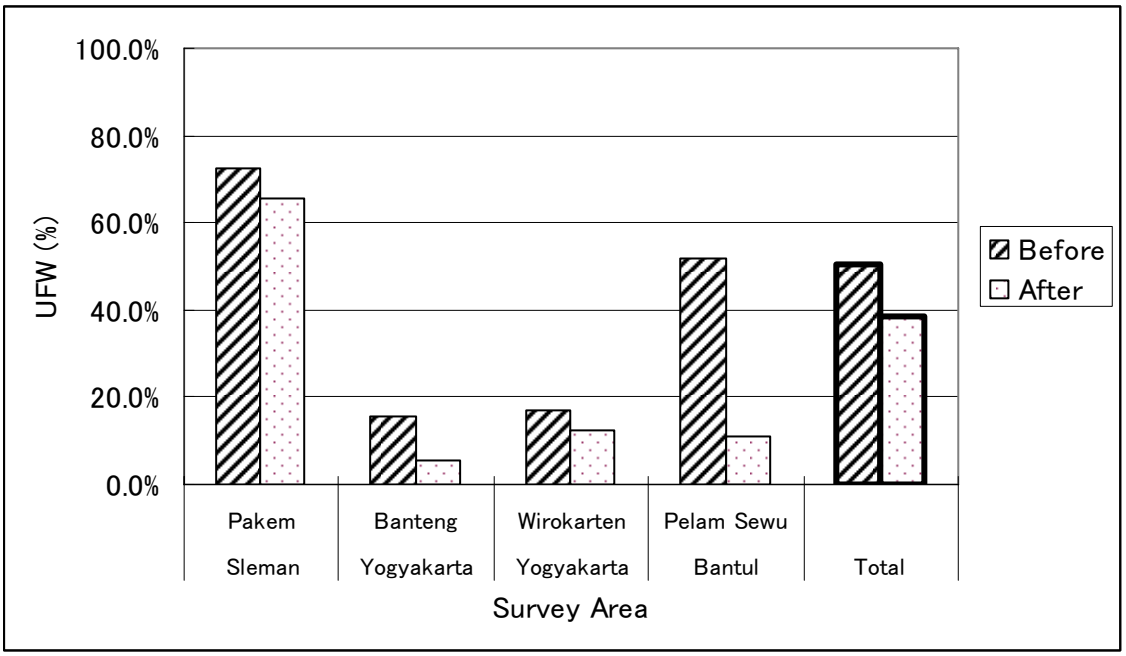

Figure 6.7.6 Effect of Leak Detection and Repair on UFW Reduction

By detection and repair work for leakage, UFW in the 4 selected isolated areas could be reduced from 50.3 % to 38.5 % or approximately 300 m^3/day, which is equivalent to more than 100,000 m^3/year. A program of leak reduction should be focused in future master plan formulation stage.

6.7.4 Future Task

Through this survey, many cases of leakage caused by damaged distribution pipes have been identified in the selected survey areas. This indicates that the major factor for or the cause of UFW would be a leakage. Therefore, water supply providers such as responsible PDAMs or concerned officials should be more aware of the importance of finding an efficient way of leak detection and repair, to save limited water resource or cost relating to water supply. In order to carry out leak detection and repair effectively and efficiently, following issues should be considered:

- Setting up organization/department for UFW Reduction, especially for leak detection and

repair work.

- Setting up special program for UFW reduction, such as:
  - Formulation of step-by-step approach with a concrete numeric target.
  - Identify priority area for UFW reduction.
- Securing sufficient budget for UFW reduction.
- Formulation of effective training program and its implementation.
- Construction, arrangement and maintenance of database for existing drawing so that officials concern can refer correct existing drawing at any time.
- Creating standard method of work flow for leak detection and repair work in order to facilitate quick and smooth operation.

However, at present, the PDAMs concerned in the Study Area do not have sufficient budget, equipment or human resources to formulate and to implement necessary countermeasures for UFW reduction. For the above reason, the PDAMs require assistance in terms of procurement of necessary equipment or training for UFW reduction program. As for the necessary equipment for UFW reduction, at least following items would be required:

- Leakage investigation devices:
  - Sounding sticks
  - Leak detector
  - Leak noise correlator/logger
  - Metal pipe locator
- Flow measurement devices:
  - Handheld test meters (for testing meters for individual customer)
  - Portable ultrasonic flow meter

6.8 Results of Water Quality Analysis

Water quality survey for water sources and drinking water was conducted in this Study in order to comprehend the outline of the quality of water supply service in the Study Area. Sampling points were selected based on the discussion with the counterpart staff so that the results could represent and reflect general trend and actual condition as much as possible. Analysis items were in accordance with the guidelines for Indonesian drinking water.

As for the survey for water sources, totally 52 samples were picked up from existing major water sources (50 samples from deep wells, shallow wells and springs) and 2 samples from the Progo River (one sample each at dry condition and wet condition). As for the survey for drinking water quality, 11 samples from the outlet of water treatment plants and 49 samples from water tap for individual connections.

6.8.1 Results of Water Quality Analysis of Water Sources

A series of sampling activities carried out for 39 PDAMs and 11 Community Water Supply Systems from December 2006 to February 2007. In addition, for Progo River as candidate for the source of Bulk Water Supply Project, the samplings were carried out twice of December 2006 and January 2007.

(1) Existing Water Sources for PDAMs and Community Water Supply Systems

The number of sampling points for existing water sources is 50. 39 of them are for the PDAMs and 11 points are for the Community Water Supply Systems. Figure 6.8.1 shows the location of sampling points for water sources of PDAM Yogyakarta. Figure 6.8.2 and 6.8.3 are for PDAM Sleman and PDAM Bantul.

The analysis results of water sources for PDAMs are shown on following Table 6.8.1 and that of Community Water Supply Systems are on Table 6.8.2. Sampling locations for community water supply systems are show in Figure 6.8.4.

Summary of the results for PDAMs is as follows:

- Coliform were found in every shallow well and many deep wells
- In 13 water sources, values of Iron exceed the standard of drinking water
- In 23 water sources, values of Manganese exceed the standard of drinking water.
- In many sources, values of Colour and Turbidity exceed the standard.
- Water of all sources are in alkaline state (pH is over 7.0)

Summary of the results for Community is as follows:

- Coliform were found in every source except one deep well
- In a water source, value of Iron exceeds the standard of drinking water
- In 3 water sources, values of Manganese exceed the standard of drinking water
- In all sources, values of Colour exceed the standard

Figure 6.8.1 Location of Sampling Points for Water Sources of PDAM Yogyakarta

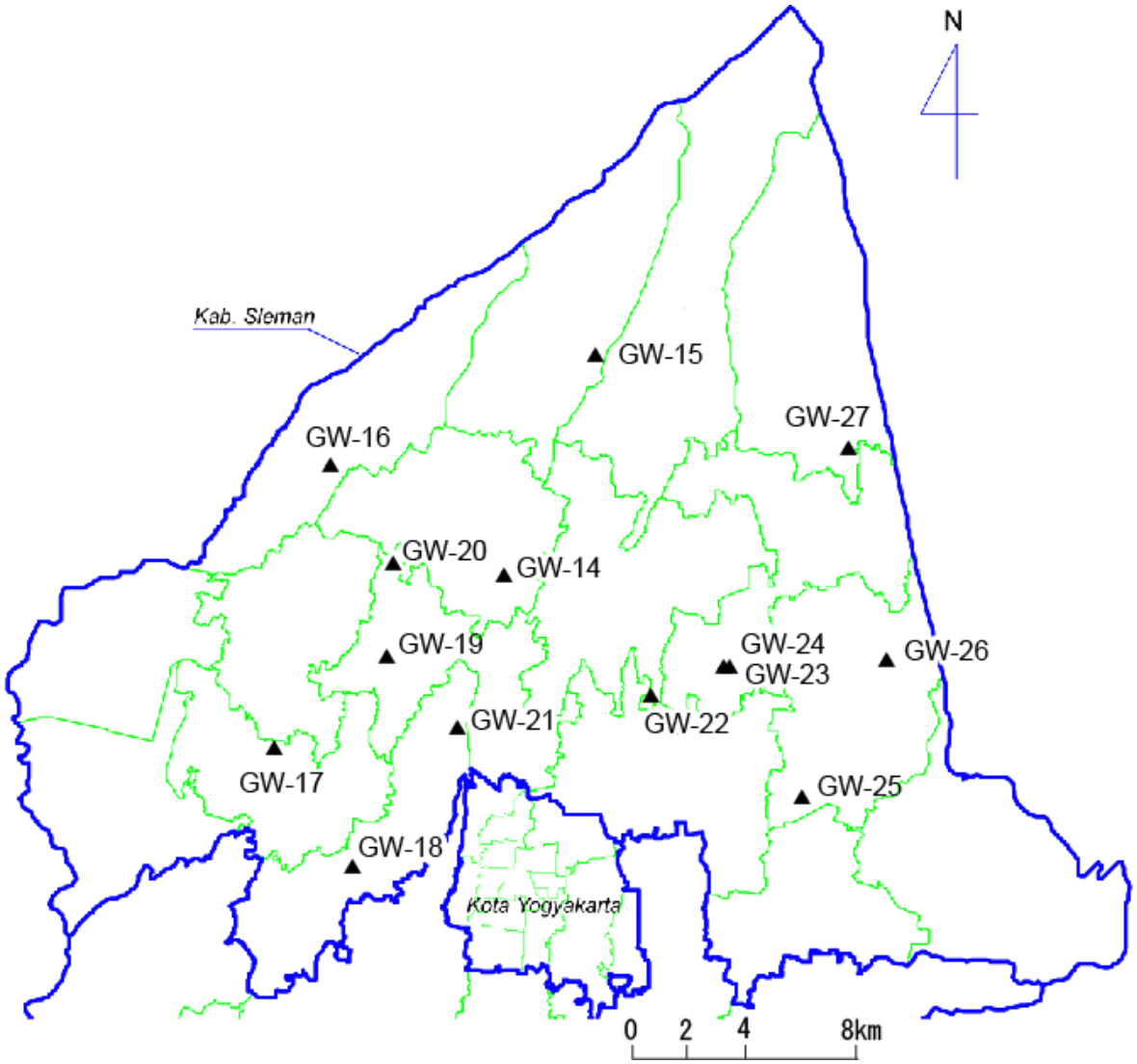

Figure 6.8.2 Location of Sampling Points for Water Sources of PDAM Sleman

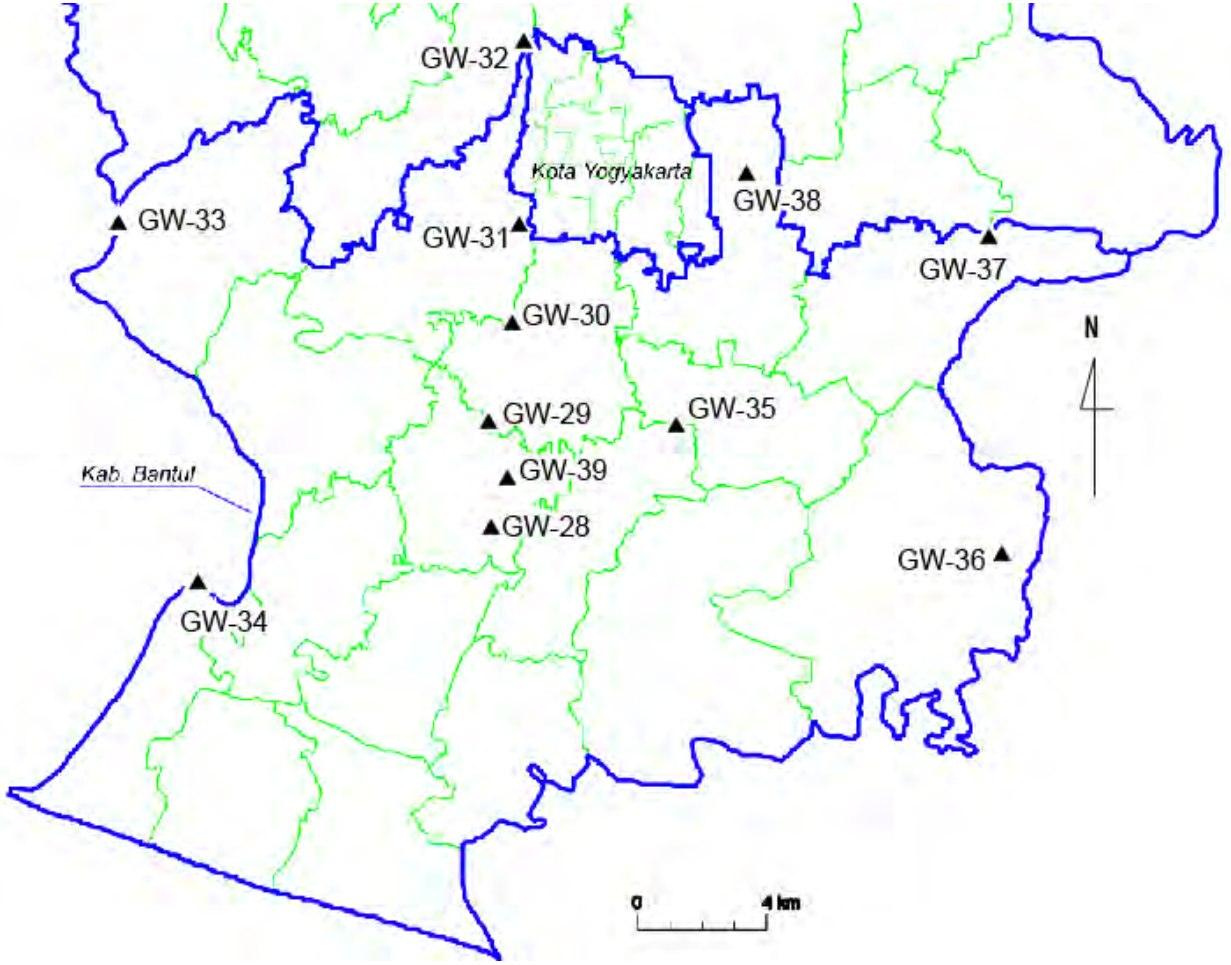

Figure 6.8.3 Location of Sampling Points for Water Sources of PDAM Bantul

Table 6.8.1 Results of Water Quality Analysis for Water Sources of PDAMs (1/3)

No.			GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8	GW-9	GW-10	GW-11	GW-12	GW-13	Standard Value		
Code, Name/Location			BR1	B4	B11	Jongkang	N3	N6	N10	K1	K6	KG1	Umbul Wadon	Bedoyo	Besi2	Indonesia	WHO Guideline	
			Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Yogyakarta	Drinking Water	GV (*1)	ACV (*2)
Type(*a)			DW	DW	DW	SW	DW	DW	DW	DW	DW	DW	Spring	SW	SW			
Coordination	Latitude(dd'mm'ss's)		S07'45'45'7	S07'45'20'2	S07'44'22'0	S07'44'56'7	S07'43'34'4	S07'43'15'5	S07'43'01'9	S07'45'39'4	S07'45'46'3	S07'49'05'6	S07'35'34'3	S07'39'00'2	S07'41'57'0			
	Longitude(ddd'mm'ss's)		E110'20'42'8	E110'20'26'3	E110'19'55'2	E110'22'18'3	E110'23'57'2	E110'23'24'7	E110'22'26'1	E110'22'53'0	E110'23'19'3	E110'23'44'6	E110'26'24'3	E110'25'52'9	E110'24'56'8			
Elevation.(m)			137	150	163	163	236	237	232	171	152	117	916	502	305			
Date of Sampling			06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	06.02.07	16.01.07	06.02.07	06.02.07			
Item	Notation	Unit																
Coliform	CT	MPN/100mL	**1100**	**240**	**2400**	**460**	**43**	**21**	**15**	**2400**	**43**	**15**	**23**	**2400**	**9**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**2400**	**93**	**2400**	**460**	**43**	**11**	**9**	**210**	**43**	**3**	**23**	**1100**	**4**	0	0	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.01	0.01	-
Flouride	F	mg/L	0.270	0.050	0.120	0.350	0.110	0.140	0.080	0.060	0.050	0.140	0.070	0.290	0.220	1.5	1.5	-
Nitrate	NO_3^-	mg/L	0.8	1.2	2.5	2.5	2.6	0.9	1.2	0.7	0.4	1.6	2.5	1.1	0.8	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.010	0.004	0.007	0.019	0.008	0.005	0.004	0.009	0.004	0.006	0.005	0.011	0.030	3	3	-
Sodium	Na	mg/L	17.3	20.0	22.0	28.2	37.3	21.0	40.9	20.3	27.6	45.1	78.9	16.2	24.3	200	-	200
Potasium	K	mg/L	104.8	103.9	115.0	150.1	109.9	102.9	115.0	94.9	129.0	178.3	24.2	76.8	157.2	-	-	-
Temp.	T	℃	28.0	28.0	28.0	29.0	28.0	28.0	28.0	29.0	29.0	30.0	22.0	26.0	27.0	-	-	-
Electrical Conductivity	EC	mS/m	25.0	26.0	26.0	48.0	45.0	22.0	52.0	30.0	32.0	47.0	24.0	20.0	27.0	-	-	-
Alkalinity (as CaCO3)		(mg/L)	88.6	73.9	78.8	65.2	82.8	86.9	83.7	63.5	58.8	95.3	9.2	64.0	58.2	-	-	-
Color		TCU	**23.0**	13.0	**27.0**	**41.0**	**56.0**	**29.0**	15.0	14.0	14.0	**33.0**	**32.0**	**61.0**	**16.0**	15	-	15
Turbidity		NTU	**20.0**	**6.0**	**22.0**	0.2	2.0	**8.2**	1.8	**12.0**	3.2	**8.7**	0.7	0.4	0.5	5	-	5
Taste		dilution	2.0	0.0	1.3	0.0	0.0	0.0	0.0	2.0	2.5	0.0	0.0	1.3	1.3	-	-	-
Odour		dilution	4.0	20.0	20.0	1.0	1.0	1.0	0.0	0.0	0.0	5.0	20.0	2.0	1.0	-	-	-
pH			8.1	8.3	8.5	8.1	**8.7**	8.3	**8.9**	8.3	**8.7**	**8.9**	7.3	**9.4**	8.3	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	90.0	90.0	90.0	221.0	222.0	131.2	240.0	150.0	150.0	70.0	118.2	110.5	145.6	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	76.8	78.4	73.6	115.2	86.4	54.4	102.4	76.8	80.0	97.6	70.4	65.6	76.8	500	-	0.0
Calcium	Ca	mg/L	16.8	17.2	16.8	26.0	20.8	12.0	21.2	18.4	17.6	19.2	12.0	12.4	18.4	-	-	-
Magnesium	Mg	mg/L	2.9	2.9	1.9	3.4	1.9	1.9	5.3	3.8	2.9	6.2	6.7	4.8	3.8	-	-	-
Sulfate	SO_4	mg/L	26.4	30.5	33.9	34.8	50.6	15.3	40.0	25.6	30.5	27.4	110.0	34.5	27.5	250	-	250
Chloride	Cl	mg/L	48.5	49.0	46.2	72.5	54.6	34.7	64.5	48.8	50.2	61.8	13.6	41.5	48.7	250	-	250
Iron	Fe	mg/L	0.17	**0.31**	0.24	0.30	0.25	**0.33**	0.27	0.08	**0.84**	0.18	0.07	0.28	0.03	0.3	-	0.3
Manganese	Mn	mg/L	**0.151**	**0.200**	**0.137**	0.007	**0.130**	**0.266**	**0.133**	**0.557**	0.067	**0.343**	0.000	0.070	0.000	0.1	0.4	0.1
Copper	Cu	mg/L	0.1	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.1	1	2	1
Zinc	Zn	mg/L	0.2	0.4	0.1	0.1	0.0	0.2	0.1	0.2	0.6	0.0	0.2	0.5	0.0	3	-	3
Dissolved Oxigen	DO	mg/L	5.5	4.7	3.9	6.1	8.5	5.8	6.4	4.5	5.3	7.8	7.0	8.6	8.6	-	-	-
Phenole Compound		mg/L	0.002	0.000	0.002	0.002	0.003	0.002	0.000	0.001	0.000	0.003	0.001	0.002	0.000	-	-	-

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

*(*a):Type of Water Source : SW means Shallow Well, DW means Deep Well*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.1 Results of Water Quality Analysis for Water Sources of PDAMs (2/3)

No.			GW-14	GW-15	GW-16	GW-17	GW-18	GW-19	GW-20	GW-21	GW-22-B	GW-23	GW-24	GW-25	GW-26	GW-27	Standard Value		
Code, Name/Location			Tuk Dandang	SB22 Surondadi	SB09 Blimbingan	SB10 Kramen-I	SDK01	Sidomoyo	SB33	SB04 Nogotiro	JL.Kakap	SB31 Kregan	Kregan	Cupuwatu	SB28 Ringin Sari	SB24	Indonesia	WHO Guideline	
			Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Sleman	Drinking Water	GW (*1)	ACV (*2)
Type(*a)			Spring	DW	DW	DW	SW	SW	DW	DW	DW	DW	SW	SW	DW	DW			
Coordination	Latitude(dd'mm'ss's)		S07'42'30'3	S07'38'37'8	S07'40'37'0	S07'45'35'6	S07'47'44'0	S07'44'00'2	S07'42'20'8	S07'45'14'6	S07'44'41'2	S07'44'11'2	S07'44'10'5	S07'46'28'8	S07'44'04'6'	S07'40'13'4			
	Longitude(ddd'mm'ss's)		E110'21'47'9	E110'23'25'9	E110'18'40'9	E110'17'44'9	E110'19'07'2	E110'19'43'6	E110'19'48'1	E110'20'58'5	E110'24'24'3'	E110'25'43'2	E110'25'40'6	E110'27'06'4	E110'28'37'2	E110'27'56'1			
Elevation (m)			221	477	241	128	99	168	213	148	47	196	195	134	57	389			
Date of Sampling			29.12.06	29.12.06	29.12.06	29.12.06	16.01.07	29.12.06	29.12.06	29.12.06	02.02.07	02.01.07	02.01.07	02.01.07	02.02.07	02.01.07			
Item	Notation	Unit																	
Coliform	CT	MPN/100mL	**11000**	0	**230**	**150**	**460**	**23**	0	**9**	**3**	**23**	**240**	**43**	0	**240**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**11000**	0	**230**	**150**	**460**	**23**	0	**7**	0	**9**	**43**	**15**	0	**1100**	0	0	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.01	0.01	-
Flouride	F	mg/L	0.080	0.170	0.120	0.120	0.080	0.120	0.080	0.100	0.140	0.650	0.700	0.190	0.110	0.180	1.5	1.5	-
Nitrate	NO_3^-	mg/L	2.3	1.5	1.3	1.5	0.5	2.0	1.1	1.8	0.5	1.0	2.2	2.8	0.8	1.3	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.005	0.004	0.002	0.003	0.007	0.006	0.001	0.008	0.017	0.002	0.006	0.007	0.024	0.000	3	3	-
Sodium	Na	mg/L	45.2	73.2	114.2	101.0	56.0	45.9	44.0	88.6	15.3	60.2	91.4	41.0	17.8	65.3	200	-	200
Potasium	K	mg/L	14.5	16.5	24.5	28.3	26.0	21.0	23.0	23.2	80.8	19.4	27.1	19.6	109.9	23.3	-	-	-
Temp.	T	℃	27.0	24.0	29.0	28.0	30.0	29.0	28.0	28.0	29.0	28.0	25.0	29.0	29.0	28.0	-	-	-
Electrical Conductivity	EC	mS/m	19.0	18.7	85.0	67.4	36.9	28.1	27.0	38.0	27.0	31.0	25.4	20.0	32.0	37.1	-	-	-
Alkalinity (as CaCO3)		(mg/L)	77.6	78.5	202.3	271.6	16.6	100.7	97.9	128.4	78.8	110.0	77.6	57.3	75.2	128.4	-	-	-
Color		TCU	**93.0**	**90.0**	**111.0**	**101.0**	**46.0**	**89.0**	**122.0**	**96.0**	**84.0**	**63.0**	**42.0**	**36.0**	**66.0**	50.0	15	-	15
Turbidity		NTU	0.8	3.4	2.7	0.0	1.0	0.6	**18.0**	**15.0**	**43.0**	**5.1**	0.4	0.7	17.0	15.2	5	-	5
Taste		dilution	0.0	0.0	5.0	0.0	1.3	2.5	0.0	1.0	5.0	10.0	0.0	0.0	1.3	0.0	-	-	-
Odour		dilution	2.5	4.0	5.0	10.0	1.0	10.0	20.0	5.0	1.0	2.0	1.3	4.0	2.5	4.0	-	-	-
pH			7.3	7.6	7.8	7.8	7.2	7.7	7.3	8.0	**8.6**	7.7	7.0	7.9	8.5	7.7	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	104.0	94.2	415.0	179.3	159.9	155.9	143.9	199.7	149.9	256.7	142.2	107.3	167.2	151.2	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	51.2	34.4	166.4	160.0	107.2	67.2	72.0	64.0	75.2	54.4	59.2	43.2	86.4	78.4	500	-	0.0
Calcium	Ca	mg/L	9.6	8.0	23.2	28.0	14.8	14.4	12.8	10.8	10.8	8.4	10.4	7.6	18.0	12.0	-	-	-
Magnesium	Mg	mg/L	3.8	0.7	22.1	14.4	14.4	2.9	6.2	6.2	9.6	6.2	5.3	3.8	4.3	9.1	-	-	-
Sulfate	SO_4	mg/L	78.0	73.0	161.0	164.0	85.0	108.0	97.0	95.0	32.3	**525.0**	**487.0**	**514.0**	31.5	**384.0**	250	-	250
Chloride	Cl	mg/L	73.3	73.3	**419.8**	**289.8**	23.6	106.6	100.0	153.3	47.2	14.4	7.7	8.8	54.6	9.1	250	-	250
Iron	Fe	mg/L	0.07	**0.68**	**0.62**	**1.64**	0.20	0.04	**2.54**	0.24	0.26	**1.03**	0.06	0.04	0.27	1.2	0.3	-	0.3
Manganese	Mn	mg/L	0.01	0.02	**0.20**	**0.35**	**0.91**	0.09	**0.40**	0.05	**0.18**	**0.56**	0.00	0.02	**0.32**	0.229	0.1	0.4	0.1
Copper	Cu	mg/L	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.1	1	2	1
Zinc	Zn	mg/L	0.0	0.2	0.1	0.2	0.1	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.1	3	-	3
Dissolved Oxigen	DO	mg/L	8.0	6.1	4.3	4.0	5.3	9.7	6.6	8.4	5.5	4.8	4.5	8.5	4.4	6.9	-	-	-
Phenole Compound		mg/L	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.003	0.000	0.000	0.001	0.002	0.000	-	-	-

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

*(*a):Type of Water Source : SW means Shallow Well, DW means Deep Well*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.1 Results of Water Quality Analysis for Water Sources of PDAMs (3/3)

No.			GW-28	GW-29	GW-30	GW-31	GW-32	GW-33	GW-34	GW-35	GW-36	GW-37	GW-38	GW-39	Standard Value		
Code, Name/Location			Sumberbatikan	Krandohan-1	Kaliputih-1	Tegal Senggotan	Kasihan-2	Kalijoho Argosari	Celan Trimurti	Sindet Trimulyo	Ngreboh' Rejosari,Jati	Wanunjoyo Lor,	Banguntapan	Bantul-Timur, Trirenggo	Indonesia	WHO Guideline	
			Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Bantul	Drinking Water	GW (*1)	ACV (*2)
Type(*a)			DW	SW	DW	DW	DW	River	SW	SW	Spring	SW	DW	DW			
Coordination	Latitude(dd'mm'ss's)		S07'54'27'0	S07'52'39'3	S07'51'02'3	S07'49'20'3	S07'46'13'3	S07'49'24'4	S07'55'30'3	S07'52'44'2	S07'54'58'3	S07'49'33'2	S07'48'27'2	S07'53'40'6			
	Longitude(ddd'mm'ss's)		E110'20'27'1	E110'20'23'3	E110'20'52'8	E110'20'55'8	E110'20'58'3	E110'14'03'0	E110'15'26'9	E110'23'37'2	E110'29'15'8	E110'29'00'5	E110'24'50'5	E110'20'43'9			
Elevation.(m)			36	52	66	87	129	52	39	57	169	101	116	57			
Date of Sampling			05.01.07	05.01.07	05.01.07	05.01.07	05.01.07	05.01.07	05.01.07	09.01.07	09.01.07	09.01.07	09.01.07	05.01.07			
Item	Notation	Unit															
Coliform	CT	MPN/100mL	**23**	**240**	0	0	0	**2400**	**4**	**4**	**43**	**240**	**240**	**23**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**4**	**240**	0	0	0	**2400**	**4**	0	**43**	**240**	**93**	**23**	0	0	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.01	0.01	-
Flouride	F	mg/L	0.460	0.760	0.390	0.290	0.320	0.180	0.420	0.340	0.470	0.340	0.660	0.320	1.5	1.5	-
Nitrate	NO_3^-	mg/L	1.3	1.4	1.4	0.2	0.7	1.2	1.2	1.6	2.5	3.9	2.6	1.6	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.007	0.009	0.006	0.007	0.003	0.010	0.008	0.014	0.014	0.017	0.063	0.007	3	3	-
Sodium	Na	mg/L	157.4	88.7	86.2	83.2	105.7	62.1	91.8	84.0	29.3	79.3	118.4	154.3	200	-	200
Potasium	K	mg/L	26.3	33.8	39.4	26.1	103.2	27.8	31.4	29.1	16.3	25.0	32.2	22.0	-	-	-
Temp.	T	℃	30.0	29.0	28.0	28.0	29.0	29.0	29.0	29.0	29.0	31.0	30.0	30.0	-	-	-
Electrical Conductivity	EC	mS/m	80.0	50.0	49.5	49.0	35.6	28.0	39.0	41.0	58.5	39.0	59.0	80.0	-	-	-
Alkalinity (as CaCO3)		(mg/L)	369.4	188.0	186.1	173.7	148.9	111.7	171.8	156.5	309.3	112.2	153.7	331.2	-	-	-
Color		TCU	**38.0**	**45.0**	**81.0**	**79.0**	**81.0**	**116.0**	**56.0**	**35.0**	**48.0**	**37.0**	**48.0**	**40.0**	15	-	15
Turbidity		NTU	0.3	1.6	**25.0**	**18.0**	**8.0**	**16.0**	3.8	0.7	0.4	0.4	1.0	0.5	5	-	5
Taste		dilution	0.0	0.0	5.0	1.3	5.0	2.5	1.3	0.0	0.0	1.0	1.0	0.0	-	-	-
Odour		dilution	4.0	2.5	20.0	4.0	1.3	0.0	4.0	1.0	0.0	1.0	1.3	0.0	-	-	-
pH			9.1	7.9	7.1	7.3	7.4	8.4	7.9	8.1	7.9	7.9	**9.2**	**8.8**	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	350.0	230.0	230.0	259.0	178.0	137.0	170.0	113.0	275.0	178.0	246.0	380.0	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	124.8	147.2	152.0	110.4	100.8	113.6	134.4	97.6	110.4	105.6	81.6	100.8	500	-	0.0
Calcium	Ca	mg/L	14.0	9.6	14.0	10.0	9.0	8.2	13.0	11.8	13.0	9.8	9.2	9.8	-	-	-
Magnesium	Mg	mg/L	3.8	6.2	7.2	9.1	8.6	14.4	9.1	1.0	1.9	8.2	2.4	6.7	-	-	-
Sulfate	SO_4	mg/L	63.0	128.0	116.0	153.0	130.0	139.0	100.0	153.0	97.0	112.0	161.0	67.0	250	-	250
Chloride	Cl	mg/L	40.6	20.7	23.8	24.9	6.7	7.7	83.7	31.5	43.4	40.6	56.0	50.1	250	-	250
Iron	Fe	mg/L	0.17	0.07	**1.22**	**1.21**	**1.09**	**0.66**	**0.41**	0.24	0.24	0.06	0.27	0.11	0.3	-	0.3
Manganese	Mn	mg/L	**0.114**	**0.940**	**1.752**	**0.776**	**0.925**	0.069	**0.593**	**0.589**	0.040	0.013	0.033	**0.263**	0.1	0.4	0.1
Copper	Cu	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	**1.3**	0.1	0.1	0.1	1	2	1
Zinc	Zn	mg/L	0.1	0.4	0.1	0.2	0.1	0.2	0.3	0.2	0.5	0.1	0.7	0.2	3	-	3
Dissolved Oxigen	DO	mg/L	5.2	5.7	4.0	5.1	5.1	9.2	5.4	6.0	9.5	5.6	6.6	4.8	-	-	-
Phenole Compound		mg/L	0.001	0.000	0.002	0.000	0.001	0.000	0.000	0.001	0.002	0.002	0.000	0.000	-	-	-

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

*(*a):Type of Water Source : SW means Shallow Well, DW means Deep Well*

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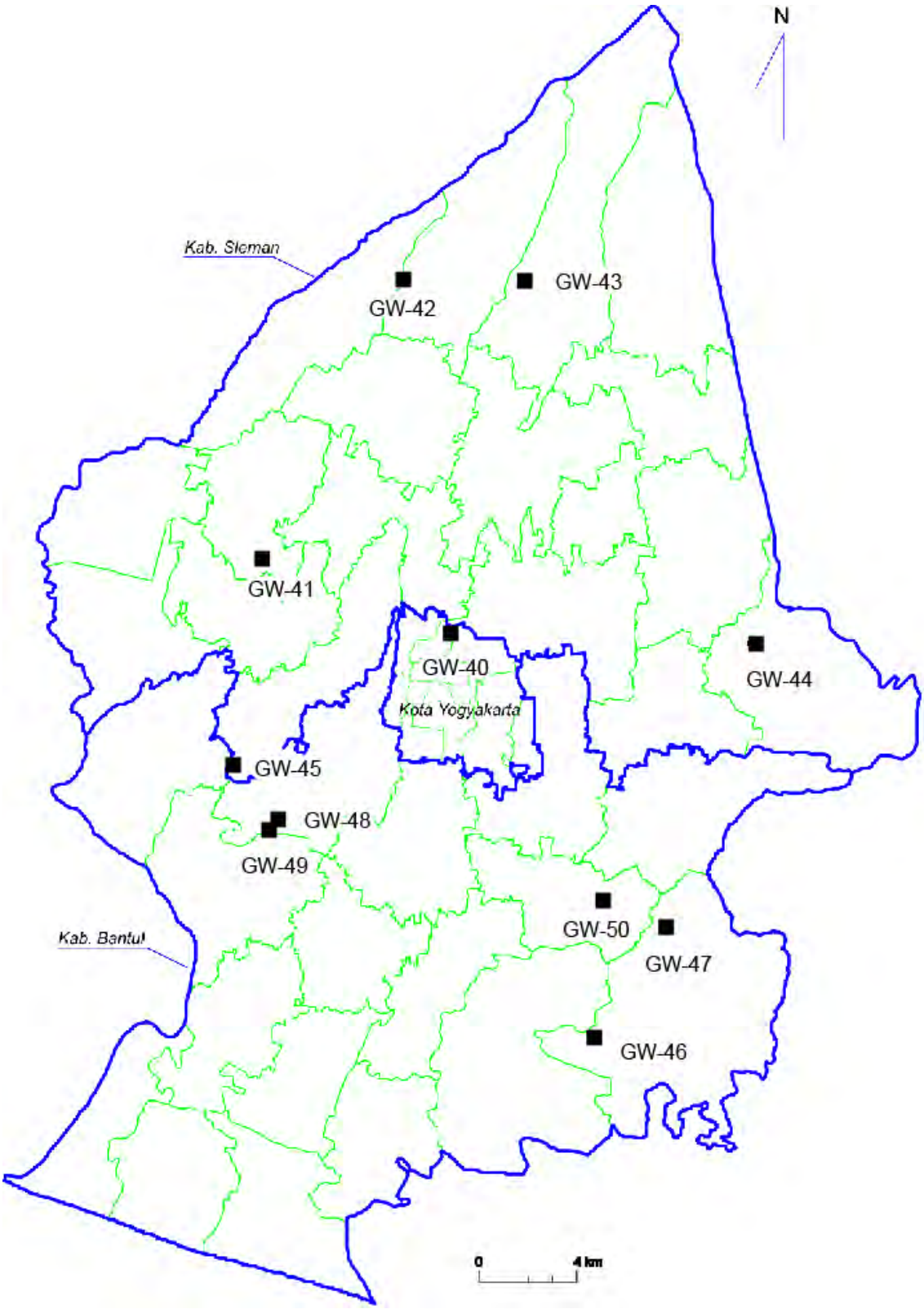

Figure 6.8.4 Location of Sampling Points for Water Sources of Community Water Supply Systems

Table 6.8.2 Results of Water Quality Analysis for Water Sources of Community Water Supply System

No.			GW-40	GW-41	GW-42	GW-43	GW-44	GW-45	GW-46	GW-47	GW-48	GW-49	GW-50	Standard Value		
Code, Name/Location			Jetisharjo	Klangkapan II Seyengan, Margoluwih	Bangunsari I Bangunkerto Turi	Nepen Pakem, Candibinangun	Sumberwatu Sambirejo Prambanan	Sembung, Balecatur, Gamping,	Mangunan I Dlingo Mangunan	Terong I Terong Dlingo	Jojoran, Triwidadi	Bangen Bibis Bangunjiwo Kasihan	Bawuran Jambon	Indonesia	WHO Guideline	
			Yogyakarta	Sleman	Sleman	Sleman	Sleman	Sleman	Bantul	Bantul	Bantul	Bantul	Bantul	Drinking Water	GV (*1)	ACV (*2)
Type(*a)			Spring	Spring	Spring	Spring	DW	DW	SW	SW	SW	SW	SW			
Coordination	Latitude(dd'mm'ss's)		S07'46'38'0	S07'45'04'1	S07'38'39'4	S07'38'43'1	S07'46'54'9	S07'49'40'5	S07'55'49'5	S07'53'17'6	S07'51'14'3	S07'51'07'3	S07'52'41'7			
	Longitude(ddd'mm'ss's)		E110'22'16'7	E110'18'00'4	E110'21'11'8	E110'24'00'8	E110'29'06'0	E110'17'23'5	E110'25'30'4	E110'27'07'0	E110'17'02'8	E110'18'12'6	E110'25'35'4			
Elevation.(m)			125	133	407	485	122	134	366	363	0	119	99			
Date of Sampling			16.01.07	29.12.06	02.01.07	02.01.07	02.01.07	29.12.06	09.01.07	09.01.07	02.02.07	05.01.07	02.02.07			
Item	Notation	Unit														
Coliform	CT	MPN/100mL	2400	**64**	**1100**	**23**	0	**750**	**150**	**2400**	**9300**	**93**	**4300**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	2400	**39**	**460**	**9**	0	**750**	**93**	**210**	**2100**	**93**	**700**	0	0	-
Arsenic	As	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.01	0.01	-
Flouride	F	mg/L	0.050	0.080	0.230	0.140	0.100	0.060	0.420	0.420	0.170	0.240	0.060	1.5	1.5	-
Nitrate	NO_3^-	mg/L	9.1	2.2	2.7	1.8	2.8	1.4	1.8	2.7	0.3	2.0	0.6	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.013	0.006	0.005	0.004	0.006	0.001	0.011	0.011	0.005	0.010	0.003	3	3	-
Sodium	Na	mg/L	47.9	79.6	19.2	45.7	48.4	92.8	59.0	99.2	10.3	54.8	40.9	200	-	200
Potasium	K	mg/L	23.8	31.2	6.1	22.9	17.4	25.3	15.8	20.9	42.6	8.7	109.9	-	-	-
Temp.	T	℃	30.0	28.0	24.0	25.0	28.0	31.0	26.0	27.0	29.0	27.0	31.0	-	-	-
Electrical Conductivity	EC	mS/m	38.0	27.6	28.9	18.5	34.0	93.0	26.5	12.3	81.0	70.9	66.0	-	-	-
Alkalinity (as CaCO3)		(mg/L)	9.2	435.2	54.5	67.5	124.7	103.5	159.4	127.0	65.8	365.6	82.2	-	-	-
Color		TCU	39.0	**76.0**	**43.0**	**39.0**	**35.0**	**92.0**	**55.0**	**53.0**	**158.0**	**60.0**	**54.0**	15	-	15
Turbidity		NTU	0.7	**9.0**	0.5	2.9	0.6	2.1	**20.0**	2.0	1.6	0.2	2.4	5	-	5
Taste		dilution	0.0	4.0	0.0	0.0	20.0	0.0	2.0	10.0	0.0	1.0	0.0	-	-	-
Odour		dilution	20.0	5.0	2.0	0.0	4.0	20.0	10.0	4.0	0.0	1.3	0.0	-	-	-
pH			6.9	7.8	7.0	6.8	7.7	7.8	7.3	6.5	8.0	7.2	8.9	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	196.6	138.3	139.6	94.3	176.2	172.3	147.7	61.8	420.0	349.0	360.0	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	96.0	329.6	62.4	40.0	72.0	64.0	91.2	59.2	87.5	142.4	184.0	500	-	0.0
Calcium	Ca	mg/L	9.2	77.6	108.0	8.8	14.8	9.2	10.8	5.0	29.5	14.4	40.4	-	-	-
Magnesium	Mg	mg/L	10.6	5.8	5.8	1.4	3.8	4.8	1.0	5.8	2.2	8.2	6.7	-	-	-
Sulfate	SO_4	mg/L	135.0	70.0	**486.0**	**524.0**	**498.0**	206.0	105.0	132.0	16.5	102.0	42.1	250	-	250
Chloride	Cl	mg/L	21.9	123.3	16.1	7.4	13.7	139.9	30.1	35.7	58.5	8.1	116.3	250	-	250
Iron	Fe	mg/L	0.1	**0.40**	0.10	0.00	0.00	0.30	0.10	0.10	0.10	0.10	0.20	0.3	-	0.3
Manganese	Mn	mg/L	0.060	0.017	0.016	0.013	**0.298**	**0.149**	0.045	0.013	0.074	0.072	**0.854**	0.1	0.4	0.1
Copper	Cu	mg/L	0.0	0.09	0.05	0.05	0.04	**1.88**	0.07	0.06	0.07	2.12	0.11	1	2	1
Zinc	Zn	mg/L	0.1	0.35	0.10	0.10	0.78	2.41	0.60	0.93	0.10	0.16	0.12	3	-	3
Dissolved Oxigen	DO	mg/L	4.8	4.0	4.3	6.0	7.0	6.8	6.1	7.8	5.2	8.0	6.1	-	-	-
Phenole Compound		mg/L	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.001	0.002	-	-	-

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

*(*a):Type of Water Source : SW means Shallow Well, DW means Deep Well*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table6.8.3 shows the number of water sources those analyzed classified by location and type.

Table 6.8.3 Number of Water Sources in Each District and Type

District¥Type	Deep Well	Shallow Well	Spring	River	Total
Yogyakarta	1	–	1	–	2
Sleman	19	7	5	–	31
Bantul	6	9	1	1	17
Total	26	16	7	1	50

Following tables show the relationships between water quality (especially iron and manganese) and location, type of water source.

Table 6.8.4 Number of Water Sources exceed the Standard Value of Fe (0.3mg/L)

District¥Type	Deep Well	Shallow Well	Spring	River	Total
Yogyakarta	0	–	0	–	0
Sleman	8	0	1	–	9
Bantul	3	1	1	0	5
Total	11	1	2	0	14

Table 6.8.5 Percentage of Water Sources exceed the Standard Value of Fe

District¥Type	Deep Well	Shallow Well	Spring	River	Total
Yogyakarta	0%	–	0%	–	0%
Sleman	42%	0%	20%	–	29%
Bantul	50%	11%	100%	0%	29%
Total	42%	6%	29%	0%	28%

Table 6.8.6 Number of Water Sources exceed the Standard Value of Mn (0.1mg/L)

District¥Type	Deep Well	Shallow Well	Spring	River	Total
Yogyakarta	1	–	0	–	1
Sleman	15	1	0	–	16
Bantul	5	4	0	0	9
Total	21	5	0	0	26

Table 6.8.7 Percentage of Water Sources exceed the Standard Value of Mn

District¥Type	Deep Well	Shallow Well	Spring	River	Total
Yogyakarta	100%	–	0%	–	50%
Sleman	79%	14%	0%	–	52%
Bantul	83%	44%	0%	0%	53%
Total	81%	31%	0%	0%	52%

Summary of the results for existing water sources is as follows:

- In deep wells, there are many water sources that have high values of iron (Fe) and manganese(Mn) exceed the standard and the percentage of the wells exceed the standard of Fe and Mn in Bantul is slightly higher than Sleman.
- In shallow wells in Sleman, 14 % of wells have the high values of Mn exceed the

standard.

- On the other hand, 44% of shallow wells in Bantul have the values of Mn exceed the standard.
- Groundwater is flowing by gravitation, so groundwater in Bantul is relatively old than it in Sleman and the higher values of Bantul indicates the groundwater flow in the study area.

The above analysis result indicates that there are problems in terms of coliforms, iron, manganese, color and turbidity. Especially, samples for springs and shallow wells have a trend to show high value of coliforms. As springs or shallow wells are relatively vulnerable to pollution in general, following issues should be thoroughly taken into account:

- Necessity of protection of well in construction/O&M.
- Necessity of adequate recommendations in terms of improvement of sanitary facilities.

(2) Progo River

Sampling activities were carried out under both dry and wet conditions at the possible future intake point by the future DBOT project in the Progo River. The results of water quality analysis are shown on Table 6.8.8.

Summary of the results is as follows:

- Coliform were found at both time
- Values of Colour exceed the standard both time
- Values of Turbidity, pH and Iron exceed the standard once

The analysis result indicates that this water could be used for water source without any problem in terms of water quality as long as being accompanied by a conventional treatment method such as coagulation, flocculation, filtration and disinfection. Nevertheless, following issues should be noted and monitored to consider the Progo River as one of alternatives for future water source:

- Drastic water quality change originated from volcanic activity.
- Future land use change in upstream area (such as agricultural activities including usage of pesticides or new development of industry or housing area).

Table 6.8.8 Results of Water Quality Analysis for Progo River

No.			Intake-1	Intake-2	Standard Value		
Location of Sampling Coordinates	Latitude(ddd'mm'ss's)		S07'39'57'8	S07'39'57'8	Indonesia	WHO Guideline	
	Longitude(ddd'mm'ss's		E110'16'03'1	E110'16'03'1	**Drinking Water**	GV(*1)	ACV(*2)
Date of Sampling			26.12.06	12.01.07			
Item	Notation	Unit					
Coliform	CT	MPN/100mL	**21000**	**150000**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**21000**	**150000**	0	0	-
Lead	Pb	mg/L	0.000	0.001	0.01	0.01	-
Arsenic	As	mg/L	0.0003	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0023	0.0030	0.01	0.01	-
Cyanide	Cn	mg/L	0.013	0.010	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0002	0.001	0.001	
Flouride	F	mg/L	0.080	0.050	1.5	1.5	-
Nitrate	NO_3^-	mg/L	3.2	1.0	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.020	0.010	3	3	-
Aluminum	Al	mg/L	**0.83**	0.07	0.2	-	0.2
Sodium	Na	mg/L	13.2	34.1	200	-	-
Temperature	T	℃	26.0	29.0	-	-	-
Electrica Conductivity	EC	ms/m	15.0	26.8	-	-	-
Alkalinity (CaCO3)		(mg/L)	60.06	12.94	-	-	-
Color		TCU	**511**	**56**	15	-	15
Turbidity		NTU	**461**	2.45	5	-	5
Taste		dilution	20.0	0.0	-	-	-
Odour		dilution	20.0	0.0	-	-	-
pH			8.1	**9.5**	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	87.7	134.7	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	39.4	80.0	500	-	0.0
Calcium	Ca	mg/L	6.2	10.4	-	-	-
Magnesium	Mg	mg/L	4.37	11.52	-	-	-
Sulfate	SO_4	mg/L	98.0	74.0	250	-	250
Chloride	Cl	mg/L	60.0	24.6	250	-	250
Iron	Fe	mg/L	**0.33**	0.14	0.3	-	0.3
Manganese	Mn	mg/L	0.021	0.000	0.1	0.4	0.1
Copper	Cu	mg/L	0.17	0.03	1	2.0	1.0
Zinc	Zn	mg/L	0.059	0.194	3	-	3.0
Dissolved Oxigen	DO	mg/L	7.5	8.0	-	-	-
Suspended Solid	SS	mg/L	489.0	10.0	-	-	-
Phenole Compound		mg/L	0.004	0.001	-	-	-
Total Phosphorous		mg/L	1.360	0.047	-	-	-
BOD		mg/L	8.75	5.85	-	-	-
COD		mg/L	57.25	32.50	-	-	-
$KMnO_4$ Consumption		mg/L	32.92	11.92	-	-	-
Ammonium(NH3+NH4)		mg/L	2.75	0.66	-	-	-
Pesticde (total)		mg/L	0.000	0.000	-	-	-

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-* **0.33**

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

6.8.2 Results of Water Quality Analysis of Finished Water and Tap Water

The main water sources of the majority of WTP operated by PDAMs in the Study Area are deep wells. In general, typical treatment method is aeration, coagulation, sedimentation, filtration and disinfection by chlorination.

(1) Treated Water from Water Treatment Plant of PDAM

The samplings were carried out from December 2006 to February 2007. The locations of 11 sampling points for treated water are indicated on Figure 6.8.5 and the results of analysis are shown on Table 6.8.9. Table 6.8.10 shows effectiveness of treatment by comparing quality of raw water and finished water

Summary of the results is as follows:

- Except 2 samples, Coliform were found in all
- For 2 samples, Values of Iron exceed the standard slightly
- For 6 samples, Values of Manganese exceed the standard
- Values of Colour of all samples exceed the standard except one

The analysis result of the samples from 11 points of the PDAM's WTP indicates the followings.

- In general, iron and manganese are efficiently removed through treatment. However, color is not removed effectively. This fact suggests that sedimentation and filtration would not demonstrate sufficient effect in a treatment process.
- Coliforms are detected from finished water. This suggests that disinfection by chlorination is not conducted or insufficient in many WTPs.

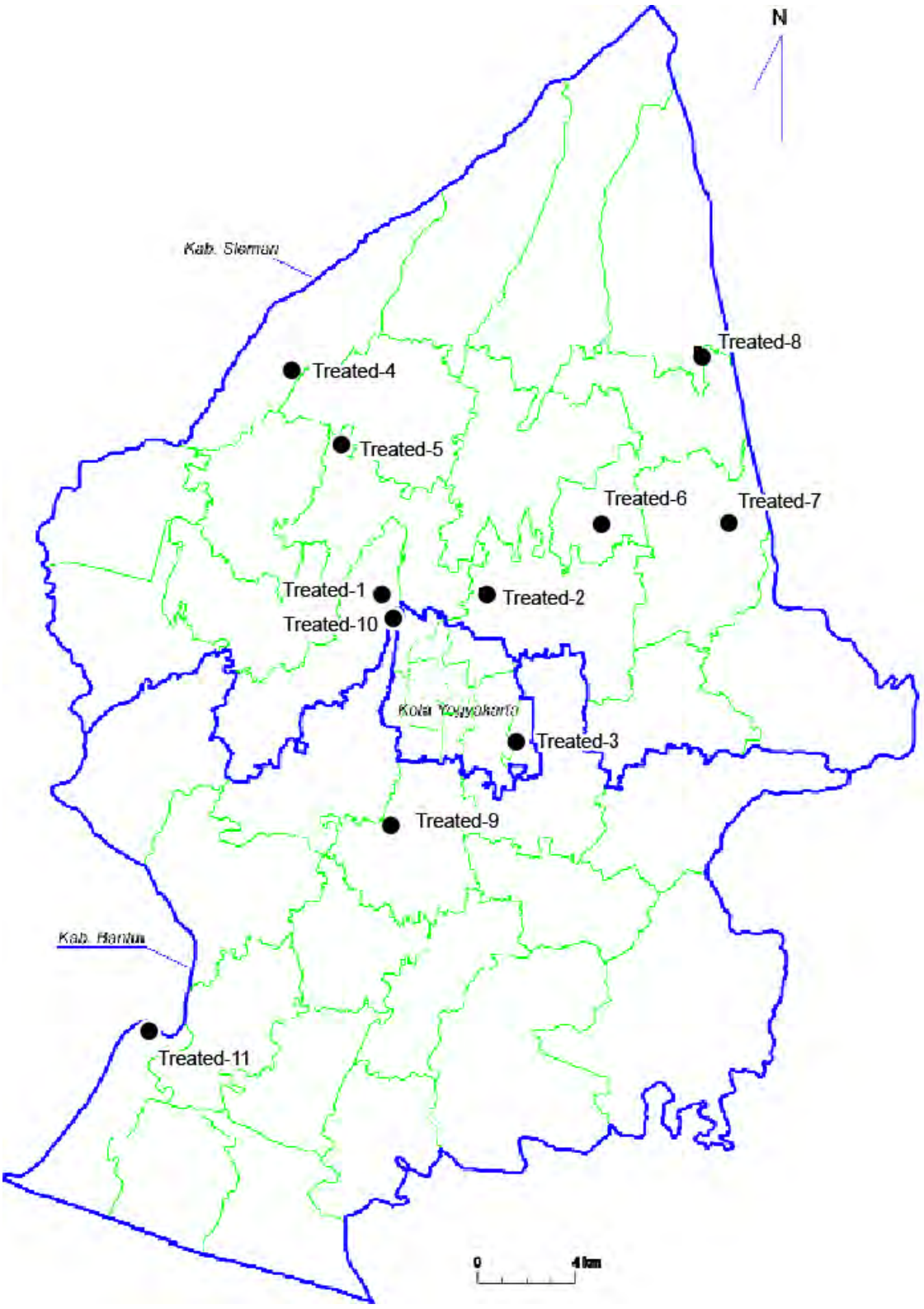

Figure 6.8.5 Location of Sampling Points for Treated Water from Water Treatment Plants of PDAMs

Table 6.8.9 Results of Water Quality Analysis of Treated Water from Water Treatment Plants of PDAMs

No.			Treated-1	Treated-2	Treated-3	Treated-4	Treated-5	Treated-6	Treated-7	Treated-8	Treated-9	Treated-10	Treated-11	Standard Value		
Code, Name/Location			PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	PDAM Treated Water	Indonesia	WHO Guideline	
			Reservoir Bedog near BR1	Reservoir Karangayam	Reservior KG1 near KG1 Well	SB09 Blimbingan	SB33	SB31 Kregan	SB28	SB24	Kaliputih-1	Kasihan-2	Celan, Trimurti	Drinking Water	GV (*1)	ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'45'45'7	S07'45'39'5	S07'49'05'6	S07'40'37'0	S07'42'20'8	S07'44'11'2	S07'44'04'6	S07'40'13'4	S07'51'02'3	S07'46'13'3	S07'55'30'3			
	Longitude(ddd'mm'ss's)		E110'20'42'8	E110'23'02'6	E110'23'44'6	E110'18'40'9	E110'19'48'1	E110'25'43'2	E110'28'37'2	E110'27'56'1	E110'20'52'8	E110'20'58'3	E110'15'26'9			
Date of Sampling			06.02.07	06.02.07	06.02.07	29.12.06	29.12.06	02.01.07	02.02.07	02.01.07	05.01.07	05.01.07	05.01.07			
Item	Notation	Unit														
Coliform	CT	MPN/100mL	**210**	**240**	**2400**	**240**	**15**	**210**	**43**	**210**	0	0	**4**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**21**	**43**	**2400**	**240**	**4**	**210**	**23**	**210**	0	0	**4**	0	0	-
Lead	Pb	mg/L	0.000	0.000	0.000	**0.003**	**0.002**	**0.003**	0.000	0.000	0.007	0.007	**0.009**	0.01	0.01	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0028	0.0027	0.0022	0.0051	0.0037	0.0008	0.0027	0.0008	0.0015	0.0029	0.0033	0.01	0.01	-
Cyanide	Cn	mg/L	0.003	0.001	0.002	0.001	0.003	0.010	0.001	0.010	0.010	0.009	0.012	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0000	0.0002	0.0000	0.0001	0.0000	0.0001	0.0000	0.0000	0.0006	0.001	0.001	-
Flouride	F	mg/L	0.120	0.080	0.160	0.010	0.060	0.130	0.310	0.130	0.250	0.250	0.270	1.5	1.5	-
Nitrate	NO_3^-	mg/L	1.7	1.3	1.5	0.7	1.9	1.6	2.7	1.6	0.0	0.0	0.0	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.005	0.006	0.009	0.002	0.005	0.005	0.004	0.005	0.270	0.250	0.250	3	3	-
Residual Chlorine		mg/L	**0.020**	**0.020**	**0.020**	**0.000**	**0.000**	**0.000**	**0.020**	**0.000**	**0.020**	**0.030**	**0.030**	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.000	0.000	0.000	**0.45**	0.13	0.13	0.08	0.13	0.07	0.10	0.06	0.2	-	0.2
Sodium	Na	mg/L	22.4	27.7	37.2	130.7	81.5	76.4	16.9	76.4	71.9	50.9	48.7	200	-	200
Temp.	T	℃	28.0	29.0	29.0	29.0	27.0	27.0	29.0	27.0	29.0	28.0	31.0	-	-	-
Electrical Conductivity	EC	mS/m	28.0	38.0	42.0	81.9	27.7	33.3	32.0	33.3	51.1	35.8	36.0	-	-	-
Alkalinity		CaCO3(mg/L)	73.9	88.6	98.5	197.7	97.0	113.7	73.8	113.7	187.1	147.0	158.4	-	-	-
Color		TCU	6.0	**29.0**	**27.0**	**67.0**	**92.0**	**57.0**	**68.0**	**57.0**	**66.0**	**57.0**	**42.0**	15	-	15
Turbidity		NTU	2.5	2.6	3.1	0.8	1.7	2.2	4.1	2.2	**6.7**	3.8	4.8	5	-	5
Taste		dilution	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	2.0	2.5	-	-	-
Odour		dilution	20.0	20.0	10.0	20.0	20.0	0.0	0.0	0.0	10.0	1.3	0.0	-	-	-
pH			**8.9**	**8.9**	**9.1**	7.8	7.3	8.1	8.7	8.1	7.4	8.0	**8.8**	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	90.0	201.0	59.0	423.0	146.7	166.0	162.5	166.0	259.0	175.0	185.4	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	78.4	73.6	78.4	160.0	64.0	59.2	84.8	59.2	24.9	8.1	12.6	500	-	0.0
Calcium	Ca	mg/L	18.0	15.6	18.4	22.4	12.8	9.2	20.0	9.2	12.8	9.4	12.4	-	-	-
Magnesium	Mg	mg/L	1.9	3.4	1.4	21.1	3.8	6.7	1.4	6.7	0.3	0.0	0.2	-	-	-
Sulfate	SO_4	mg/L	18.9	23.4	5.6	213.0	140.0	**742.0**	17.0	**742.0**	133.0	**524.0**	115.0	250	-	250
Chloride	Cl	mg/L	49.5	46.8	49.5	**779.7**	73.3	10.5	52.2	10.5	1.2	0.4	1.3	250	-	250
Iron	Fe	mg/L	0.2	0.13	0.15	0.03	0.10	**0.38**	0.08	**0.38**	0.08	0.05	0.07	0.3	-	0.3
Manganese	Mn	mg/L	0.007	**0.151**	**0.305**	0.006	0.022	**0.156**	0.098	**0.156**	**0.695**	0.006	**0.282**	0.1	0.4	0.1
Copper	Cu	mg/L	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	**1.5**	**2.1**	**1.9**	1	2.0	1.0
Zinc	Zn	mg/L	0.1	0.0	0.1	0.2	0.1	0.5	0.1	0.5	0.5	0.1	0.2	3	-	3.0
Dissolved Oxigen	DO	mg/L	8.0	5.9	7.3	6.5	6.6	6.3	6.5	6.3	6.3	8.0	7.0	-	-	-
Suspended Solid	SS	mg/L	9.0	17.0	4.0	1.0	0.0	1.0	2.0	1.0	3.0	3.0	4.0	-	-	-
Phenole Compound		mg/L	0.000	0.000	0.000	0.002	0.002	0.001	0.000	0.001	0.000	0.002	0.000	-	-	-
Total Phosphorous		mg/L	0.021	0.014	0.027	0.014	0.023	0.083	0.042	0.083	0.017	0.105	0.019	-	-	-
$KMnO_4$ Consumption		mg/L	8.2	7.6	6.6	10.3	6.2	9.4	6.0	9.4	7.2	7.5	5.6	-	-	-
Ammonium (NH3+NH4)		mg/L	0.15	0.34	0.54	0.06	0.24	0.21	0.20	0.21	0.21	0.00	0.01	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.10 Water Quality Comparison between Raw Water and Finished Water

						Treating method : 2+3			Treating method : 2+3			Treating method : 2+3			Treating method : 1+2+3			Treating method : 2+3		
No.			Standard Value			GW-16	Treated-4		GW-20	Treated-5		GW-23	Treated-6		GW-26	Treated-7		GW-27	Treated-8	
Code, Name/Location			Indonesia	WHO Guideline		Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference
			Drinking Water	GV (1*)	ACV (2*)	SB09 Blimbingan	SB09 Blimbingan		SB33	SB33		SB31 Kregan	SB31 Kregan		SB28	SB28		SB24	SB24	
Item	Notation	Unit																		
Coliform	CT	MPN/100mL	0	0	-	**230**	**240**	10	0	**15**	15	**23**	**210**	187	0	**43**	43	**240**	**210**	-30
Escherichia Coli	E-coli	MPN/100mL	0	0	-	**230**	**240**	10	0	**4**	4	**9**	**210**	201	0	**23**	23	**1100**	**210**	-890
Color		TCU	15	-	15	**111**	**67**	-44	**122**	**92**	-30	**63**	**57**	-6	**66**	**68**	2	50	**57**	7
Turbidity		NTU	5	-	5	2.70	0.75	-1.95	**18.00**	1.70	-16.3	**5.10**	2.20	-2.9	17.00	4.10	-12.9	15.20	2.20	-13
Iron	Fe	mg/L	0.3	-	0.3	**0.62**	0.03	-0.59	**2.54**	0.10	-2.44	**1.03**	**0.38**	-0.65	0.27	0.08	-0.19	**1.23**	**0.38**	-0.85
Manganese	Mn	mg/L	0.1	0.4	0.1	**0.198**	0.006	-0.1923	**0.405**	0.022	-0.3824	**0.558**	**0.156**	-0.402	**0.322**	0.098	-0.224	**0.229**	**0.156**	-0.0724

Treatment plants noted below are treating multiple water sources

						Treating method : 2+3			Treating method : 2+3			Treating method : 2+3			Treating method : 1+2+3+4			Treating method : 1+2+3+4		
No.			Standard Value			GW-30	Treated-9		GW-32	Treated-10		GW-34	Treated-11		GW-1	Treated-1		GW-10	Treated-3	
Code, Name/Location			Indonesia	WHO Guideline		Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference	Water Source	After Treatment	Difference
			Drinking Water	GV (1*)	ACV (2*)	Kaliputih-1	Kaliputih-1		Kasihan-2	Kasihan-2		Celan Trimurti	Celan, Trimurti		BR1	Reservoir Bedog near BR1		KG1	Reservior KG1 near KG1 Well	
Item	Notation	Unit																		
Coliform	CT	MPN/100mL	0	0	-	0	0	0	0	0	0	**4**	**4**	0	**1100**	**210**	-890	**15**	**2400**	**2385**
Escherichia Coli	E-coli	MPN/100mL	0	0	-	0	0	0	0	0	0	**4**	**4**	0	**2400**	**21**	-2379	**3**	**2400**	**2397**
Color		TCU	15	-	15	**81**	**66**	-15	**81**	**57**	-24	**56**	**42**	-14	**23**	6	-17	**33**	**27**	-6
Turbidity		NTU	5	-	5	**25.00**	**6.72**	-18.28	**8.00**	3.84	-4.16	3.80	4.80	1	**20.00**	2.45	-17.55	**8.70**	3.10	-5.6
Iron	Fe	mg/L	0.3	-	0.3	**1.22**	0.08	-1.14	**1.09**	0.05	-1.04	**0.41**	0.07	-0.34	0.17	0.16	-0.01	0.18	0.15	-0.03
Manganese	Mn	mg/L	0.1	0.4	0.1	**1.752**	**0.695**	-1.0564	**0.925**	0.006	-0.919	**0.593**	**0.282**	-0.3104	**0.151**	0.007	-0.144	**0.343**	**0.305**	-0.038

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

red means the value increased after treatment

Treating method

1: aeration
2: sedimentation
3: sand filtration
4: chlorination

(2) Tap Water

40 points for PDAM tap water and 9 points for tap water of community water supply systems were selected for this analysis. In the results of the analysis, excessive color over guideline value, insufficient amount of residual chlorine and detection of coliforms were observed in many sampling points. It is necessary to be well-considered for importance of disinfection to maintain appropriated concentration of chlorine at any water tap.

The locations of 49 sampling points for tap water of PDAMs and Community Water Supply systems are indicated on Figure 6.8.6 – 6.8.8 by each region. From Tap-1 to 40 are for PDAMs, Tap-41 to 49 are for Community Water Supply Systems. The results of the analysis are shown in Table 6.8.11 and Table 6.8.12

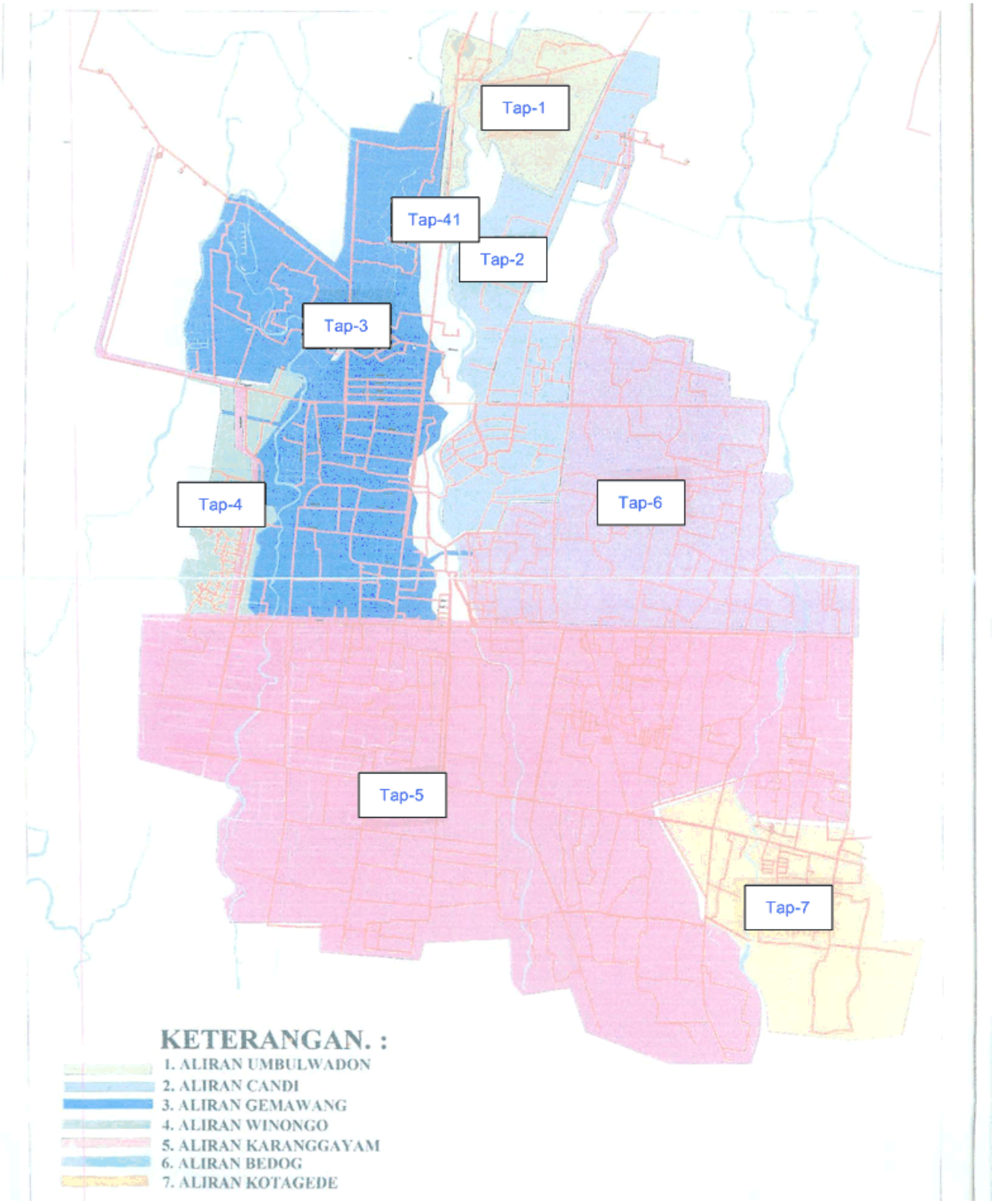

Figure 6.8.6 Location of Sampling Points for Tap Water in Yogyakarta Municipality

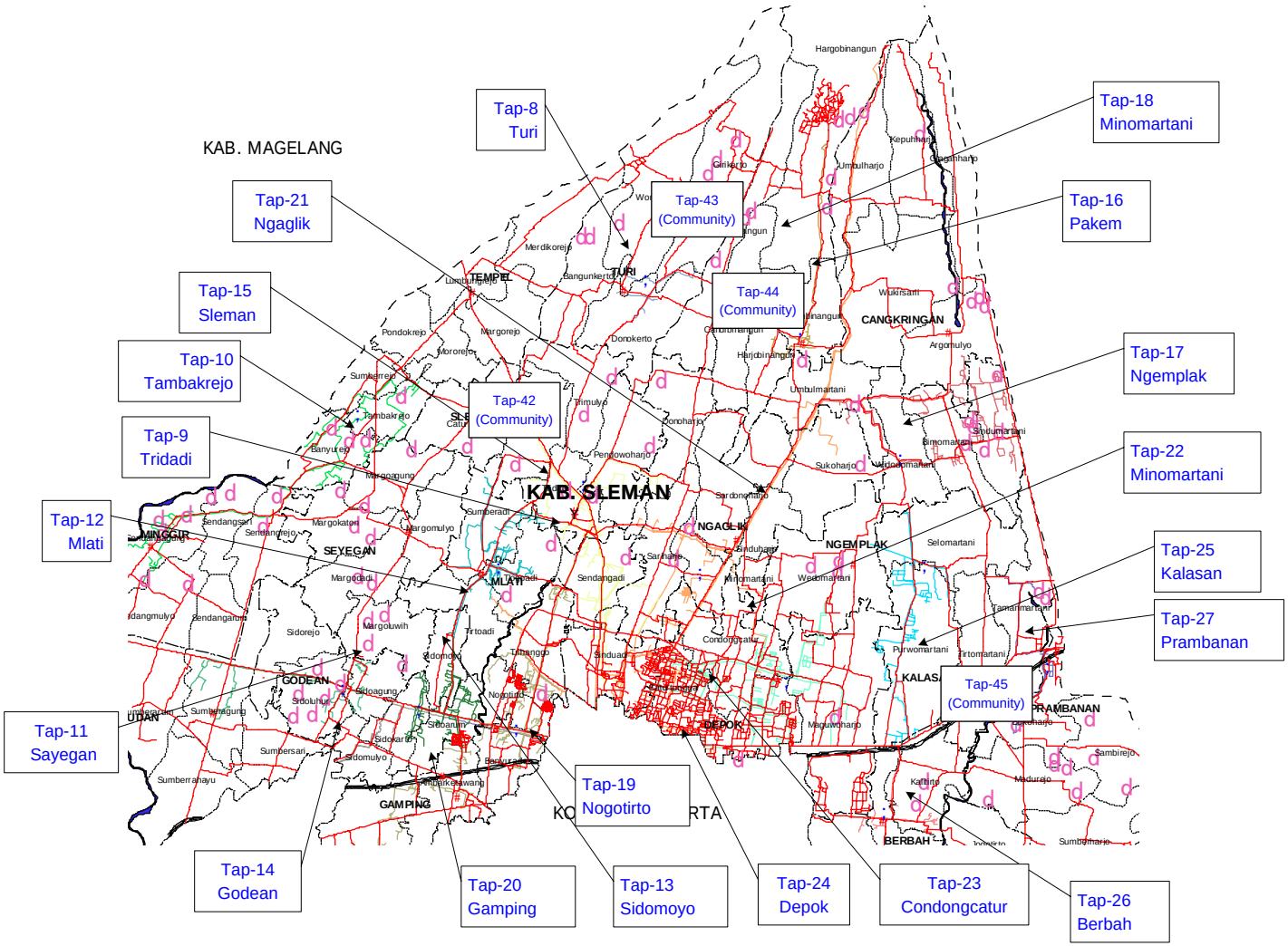

Figure 6.8.7 Location of Sampling Points for Tap Water of Sleman Regency

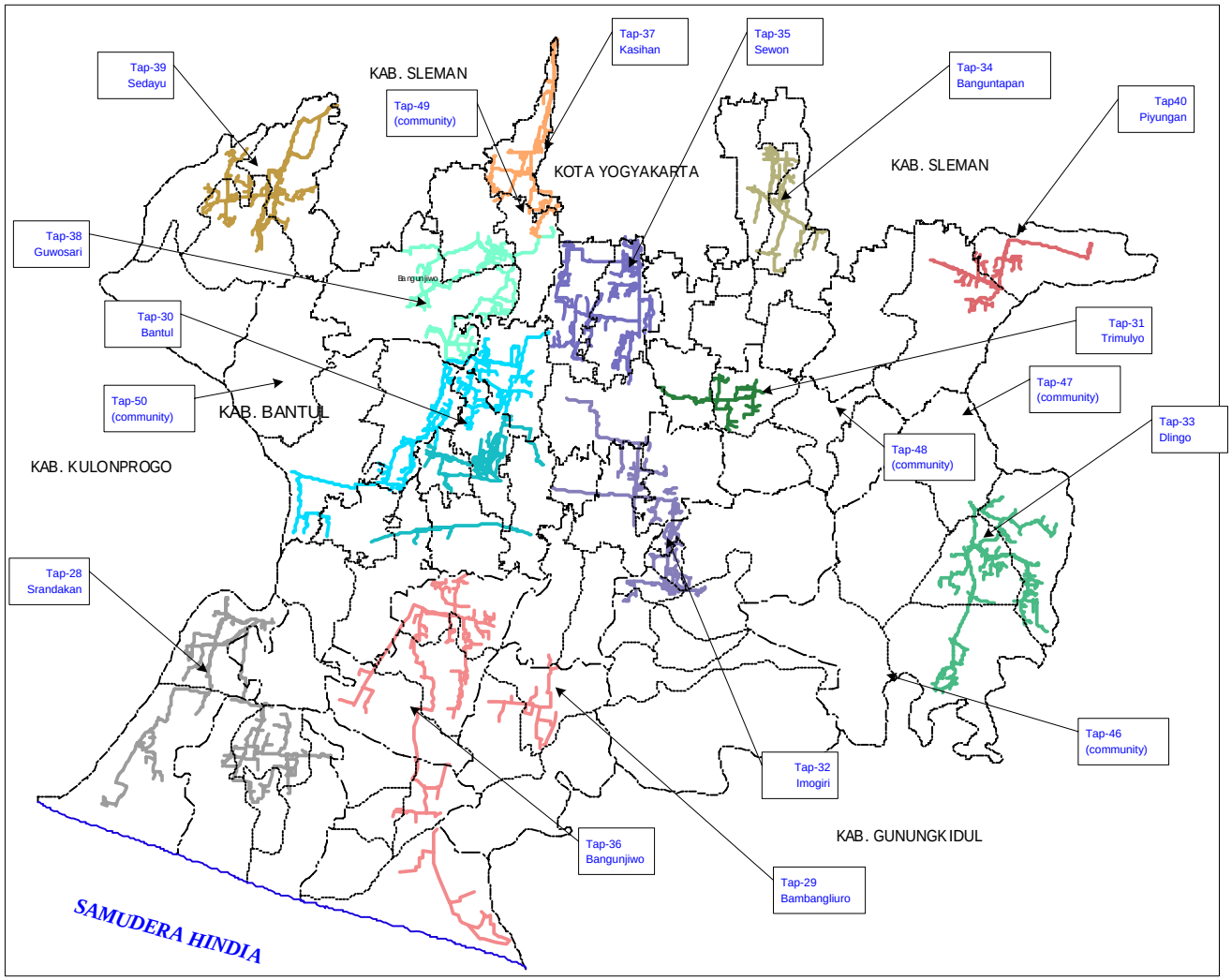

Figure 6.8.8 Location of Sampling Points for Tap Water of Bantul Regency

Table 6.8.11 Results of Water Quality Analysis of Tap Water of PDAMs (1/3)

No.			Tap-1	Tap-2	Tap-3	Tap-4	Tap-5	Tap-6	Tap-7	Tap-8	Tap-9	Tap-10	Tap-11	Tap-12	Standard Value		
Code, Name/Location			PDAM Tap Water 1.Aliran Umbulwadon Service Area	PDAM Tap Water 2. Aliran Candi Service Area	PDAM Tap Water 3. Aliran Gemawang Service Area	PDAM Tap Water 4. Aliran Winongo Service Area	PDAM Tap Water 5. Aliran Karanggayam Service Area	PDAM Tap Water 6. Aliran Bedog Service Area	PDAM Tap Water 7. Aliran Kotagede Service Area	PDAM Tap Water Turi (275 SR) Service Area	PDAM Tap Water Tridadi (485 SR) Service Area	PDAM Tap Water Tmbrejo (420 SR) Service Area	PDAM Tap Water Sayegen (45 SR) Service Area	PDAM Tap Water Mlati (725 SR) Service Area	Indonesia	WHO Guideline	
															Drinking Water	GV (*1)	ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'40'01'3	S07'42'30'6	S07'46'57'5	S07'47'54'5	S07'45'37'3	S07'48'16'3	S07'49'12'5	S07'39'12'5	S07'40'45'5	S07'40'45'6	S07'43'20'3	S07'43'12'5			
	Longitude(ddd'mm'ss's)		E110'25'31'9	E110'24'37'7	E110'21'53'7	E110'21'10'8	E110'22'52'4	E110'21'05'6	E110'23'58'0	E110'22'33'8	E110'18'39'7	E110'18'39'8	E110'18'27'1	E110'19'37'8			
Date of Sampling			16.01.07	16.01.07	16.01.07	06.02.07	16.01.07	16.01.07	06.02.07	02.01.07	29.12.06	29.12.06	29.12.06	29.12.06			
Item	Notation	Unit															
Coliform	CT	MPN/100mL	**93**	**23**	0	**2400**	0	0	**2400**	**39**	**9**	**230**	**150**	**3**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**43**	**23**	0	**210**	0	0	**2400**	**39**	**15**	**230**	**150**	**3**	0	0	-
Lead	Pb	mg/L	0.000	**0.005**	**0.000**	0.000	**0.009**	0.007	0.000	**0.004**	0.000	**0.013**	**0.006**	**0.006**	0.01	0.01	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0016	0.0031	0.0026	0.0036	0.0030	0.0025	0.0019	0.0008	0.0027	0.0032	0.0031	0.0031	0.01	0.01	-
Cyanide	Cn	mg/L	0.007	0.008	0.004	0.002	0.011	0.009	0.003	0.013	0.003	0.004	0.012	0.001	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0005	0.0000	0.0002	0.0006	0.0000	0.0001	0.0000	0.0000	0.0004	0.0001	0.001	0.001	-
Flouride	F	mg/L	0.250	0.400	0.090	0.080	0.090	0.080	0.140	0.190	0.010	0.120	0.130	0.050	1.5	1.5	-
Nitrate	NO_3^-	mg/L	4.6	4.7	5.0	2.0	4.3	1.8	1.5	1.6	1.3	1.9	1.4	1.6	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.007	0.005	0.010	0.005	0.004	0.004	0.006	0.003	0.005	0.008	0.006	0.006	3	3	-
Residual Chlorine		mg/L	**0.002**	**0.003**	**0.002**	**0.030**	**0.002**	**0.002**	**0.010**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.07	0.06	0.05	0.00	0.07	0.03	0.00	0.09	0.12	**0.87**	0.07	**0.83**	0.2	-	0.2
Sodium	Na	mg/L	32.9	47.9	59.9	25.8	45.9	70.2	36.1	27.8	48.2	161.2	105.8	59.4	200	-	200
Temp.	T	℃	28.0	31.0	27.0	30.0	34.0	31.0	29.0	25.0	31.0	28.0	28.0	28.0	-	-	-
Electrical Conductivity	EC	ms/m	25.0	23.0	35.0	32.0	26.0	32.0	45.0	20.7	29.0	74.2	27.0	34.5	-	-	-
Alkalinity		CaCO3(mg/L)	9.2	12.0	14.8	64.0	9.2	12.0	196.3	82.2	100.7	202.3	264.2	85.9	-	-	-
Color		TCU	**33.0**	**32.0**	**58.0**	2.0	**36.0**	**35.0**	15.0	**61.0**	**75.0**	**94.0**	**104.0**	**68.0**	15	-	15
Turbidity		NTU	1.0	0.6	3.2	0.8	0.5	1.4	1.9	4.2	1.3	0.7	2.9	1.2	5	-	5
Taste		dilution	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Odour		dilution	20.0	20.0	20.0	10.0	20.0	20.0	10.0	4.0	0.0	0.0	0.0	0.0	-	-	-
pH			7.6	7.6	8.1	**8.7**	7.6	8.0	**9.2**	7.4	7.3	8.0	7.5	7.7	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	120.9	123.1	185.0	223.0	131.8	162.1	183.0	100.1	149.0	419.0	146.6	174.7	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	72.0	80.8	89.6	73.6	68.8	81.6	86.4	41.6	80.0	160.0	241.6	78.4	500	-	0.0
Calcium	Ca	mg/L	12.4	10.8	12.0	17.2	10.8	12.0	20.0	7.6	11.2	23.2	59.6	14.4	-	-	-
Magnesium	Mg	mg/L	6.7	11.0	12.5	1.4	7.7	10.1	1.9	3.4	10.6	20.1	1.0	6.2	-	-	-
Sulfate	SO_4	mg/L	185.0	124.0	134.0	18.3	120.0	118.0	5.6	**606.0**	141.0	215.0	**325.0**	176.0	250	-	250
Chloride	Cl	mg/L	20.3	16.6	44.5	46.0	21.3	19.6	52.3	5.3	96.6	**403.1**	90.0	126.6	250	-	250
Iron	Fe	mg/L	0.07	0.06	**0.79**	0.27	0.18	0.29	**0.35**	**0.66**	0.1	0.1	0.2	0.1	0.3	-	0.3
Manganese	Mn	mg/L	0.049	**0.118**	**0.156**	0.077	0.013	**0.122**	**0.168**	0.028	0.016	0.000	0.007	**0.112**	0.1	0.4	0.1
Copper	Cu	mg/L	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	1	2.0	1.0
Zinc	Zn	mg/L	0.2	0.4	0.1	0.1	0.5	0.1	0.0	0.1	0.2	0.1	0.2	0.1	3	-	3.0
Dissolved Oxigen	DO	mg/L	8.0	7.0	5.5	6.9	8.0	7.1	8.0	6.3	7.0	6.8	5.5	7.1	-	-	-
Suspended Solid	SS	mg/L	7.0	1.0	3.0	1.0	1.0	1.0	1.0	12.0	1.0	2.0	7.0	0.0	-	-	-
Phenole Compound		mg/L	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001	-	-	-
Total Phosphorous		mg/L	0.008	0.080	0.344	0.021	0.065	0.073	0.026	0.008	0.025	0.012	0.036	0.002	-	-	-
$KMnO_4$ Consumption		mg/L	9.2	12.0	14.8	5.7	9.2	12.0	6.6	11.0	6.6	9.4	9.7	3.4	-	-	-
Ammonium (NH3+NH4)		mg/L	2.67	2.75	1.05	0.10	2.75	0.48	0.26	0.35	0.04	0.06	0.12	0.03	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.11 Results of Water Quality Analysis of Tap Water of PDAMs (2/3)

No.			Tap-13	Tap-14	Tap-15	Tap-16	Tap-17	Tap-18	Tap-19	Tap-20	Tap-21	Tap-22	Tap-23	Standard Value		
Code, Name/Location			PDAM Tap Water Sidmoyo (700 SR) Service Area	PDAM Tap Water Godean (680 SR) Service Area	PDAM Tap Water 4. Sleman (2950 SR) Service Area	PDAM Tap Water Plakem (190 SR) Service Area	PDAM Tap Water Ngemplak (1110 SR) Service Area	PDAM Tap Water Bimomartani (300 SR) Service Area	PDAM Tap Water 5. Nogotirto (1740 SR) Service Area	PDAM Tap Water 6.Gamping (1440 SR) Service Area	PDAM Tap Water Ngaglik (640 SR) Service Area	PDAM Tap Water 2. Minomartani (1390 SR) Service Area	PDAM Tap Water Condongctr (1485 SR) Service Area	Indonesia	WHO Guideline	
														Drinking Water	GV (*1)	ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'45'03'8	S07'49'39'8	S07'42'55'5	S07'39'54'2	S07'42'03'4	S07'42'01'8	S07'45'14'4	S07'40'53'4	S07'43'23'3	S07'44'24'9	S07'45'17'9			
	Longitude(ddd'mm'ss's)		E110'19'12'8	E110'17'23'2	E110'21'22'4	E110'25'47'0	E110'27'04'2	E110'27'31'1	E110'20'58'0	E110'17'52'9	E110'24'02'5	E110'24'30'2	E110'24'25'0			
Date of Sampling			29.12.06	29.12.06	29.12.06	02.01.07	02.01.07	02.01.07	29.12.06	29.12.06	02.01.07	02.01.07	02.01.07			
Item	Notation	Unit														
Coliform	CT	MPN/100mL	**75**	0	0	0	**23**	**240**	**2400**	**9**	**1100**	**23**	**28**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**75**	0	0	0	0	**460**	**75**	**9**	**460**	**14**	**0**	0	0	-
Lead	Pb	mg/L	0.000	0.000	0.000	**0.001**	0.000	**0.003**	0.000	**0.009**	0.007	0.007	0.000	0.01	0.01	-
Arsenic	As	mg/L	0.0012	0.0006	0.0000	0.0000	0.0004	0.0000	0.0004	0.0015	0.0000	0.0000	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0027	0.0035	0.0066	0.0012	0.0047	0.0031	0.0014	0.0028	0.0057	0.0037	0.0023	0.01	0.01	-
Cyanide	Cn	mg/L	0.005	0.005	0.007	0.009	0.009	0.014	0.013	0.010	0.008	0.008	0.004	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.001	0.001	-
Flouride	F	mg/L	0.030	0.050	0.050	0.140	0.150	0.100	0.100	0.100	0.140	0.120	0.140	1.5	1.5	-
Nitrate	NO_3^-	mg/L	2.0	2.0	2.4	1.5	1.3	1.2	2.7	1.7	2.6	1.6	5.0	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.014	0.009	0.012	0.005	0.006	0.004	0.011	0.006	0.008	0.002	0.005	3	3	-
Residual Chlorine		mg/L	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.14	0.09	0.16	0.09	0.18	0.11	0.07	0.09	0.09	0.08	0.10	0.2	-	0.2
Sodium	Na	mg/L	41.8	61.4	72.0	37.3	47.1	32.0	65.6	67.3	73.4	56.0	66.0	200	-	200
Temp.	T	℃	29.0	28.0	26.0	25.0	26.0	26.0	29.0	29.0	26.0	26.0	27.0	-	-	-
Electrical Conductivity	EC	ms/m	22.0	32.0	18.6	24.7	25.0	18.5	39.0	35.0	36.9	27.0	30.6	-	-	-
Alkalinity		CaCO3(mg/L)	95.7	96.1	175.5	63.8	65.6	79.5	126.6	140.4	92.4	113.7	97.0	-	-	-
Color		TCU	**82.0**	**78.0**	**70.0**	**50.0**	**43.0**	**47.0**	**92.0**	**86.0**	**52.0**	**52.0**	**50.0**	15	-	15
Turbidity		NTU	0.5	0.6	1.8	0.3	0.5	0.8	0.8	2.1	2.4	**6.1**	1.7	5	-	5
Taste		dilution	0.0	0.0	0.0	0.0	0.0	2.0	1.0	0.0	2.5	0.0	0.0	-	-	-
Odour		dilution	0.0	0.0	0.0	4.0	4.0	4.0	4.0	0.0	4.0	20.0	0.0	-	-	-
pH			7.6	7.9	8.1	7.7	7.8	7.7	7.9	7.5	7.1	8.2	8.1	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	149.4	168.8	115.0	112.2	120.0	98.5	197.5	179.5	177.0	138.0	168.4	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	75.2	83.2	60.8	52.8	56.0	43.2	65.6	272.0	75.2	62.4	59.2	500	-	0.0
Calcium	Ca	mg/L	15.2	13.2	11.6	10.4	10.0	8.0	12.8	9.2	12.4	9.6	10.8	-	-	-
Magnesium	Mg	mg/L	4.3	9.1	4.3	3.4	4.8	3.4	4.3	70.6	7.7	7.2	4.8	-	-	-
Sulfate	SO_4	mg/L	140.0	132.0	143.0	**698.0**	**486.0**	**471.0**	80.0	118.0	**613.0**	**369.0**	**482.0**	250	-	250
Chloride	Cl	mg/L	106.6	119.9	113.4	8.1	11.6	2.8	163.2	133.3	11.6	9.8	11.6	250	-	250
Iron	Fe	mg/L	0.01	0.02	0.16	0.05	0.04	0.15	0.11	0.23	0.24	0.5	0.3	0.3	-	0.3
Manganese	Mn	mg/L	0.009	**0.156**	0.064	0.000	0.016	0.018	0.041	**0.944**	**0.103**	0.030	0.016	0.1	0.4	0.1
Copper	Cu	mg/L	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	1	2.0	1.0
Zinc	Zn	mg/L	0.1	0.3	0.2	0.3	0.3	0.3	0.1	0.2	0.3	0.2	1.0	3	-	3.0
Dissolved Oxigen	DO	mg/L	8.3	6.4	9.2	9.0	8.5	9.3	7.4	5.9	4.5	8.3	8.4	-	-	-
Suspended Solid	SS	mg/L	2.0	0.0	1.0	2.0	2.0	1.0	0.0	0.0	2.0	4.0	5.0	-	-	-
Phenole Compound		mg/L	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	-	-	-
Total Phosphorous		mg/L	0.086	0.025	0.018	0.012	0.014	0.065	0.026	0.017	0.089	0.034	0.108	-	-	-
$KMnO_4$ Consumption		mg/L	6.9	9.1	7.2	10.0	7.8	11.6	10.7	8.1	10.0	8.8	8.1	-	-	-
Ammonium (NH3+NH4)		mg/L	0.20	0.10	0.26	0.36	0.61	0.32	0.27	0.51	0.64	0.32	0.53	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.11 Results of Water Quality Analysis of Tap Water of PDAMs (3/3)

No.			Tap-24	Tap-25	Tap-26	Tap-27	Tap-28	Tap-29	Tap-30	Tap-31	Tap-32	Tap-33	Tap-34	Standard Value		
Code, Name/Location			PDAM Tap Water 1. Depok (1320 SR) Service Area	PDAM Tap Water 3. Kalasan (1545 SR) Service Area	PDAM Tap Water Berbah (180 SR) Service Area	PDAM Tap Water Prambanan (420 SR) Service Area	PDAM Tap Water Srandakan Service Area	PDAM Tap Water Bambanglipuro Service Area	PDAM Tap Water Bantul Service Area	PDAM Tap Water Trimulyo Service Area	PDAM Tap Water Imogiri Service Area	PDAM Tap Water Dlingo Service Area	PDAM Tap Water Banguntapan Service Area	Indonesia	WHO Guideline	
														Drinking Water	GV (*1)	ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'45'32'6	S07'45'43'4	S07'43'16'9	S07'46'42'3	S07'56'24'44	S07'54'22'5	S07'53'3.5'1	S07'48'2.5'6	S07'55'58'1	S07'54'09'8	S07'49'00'8			
	Longitude(ddd'mm'ss's)		E110'24'26'1	E110'26'44'6	E110'26'38'3	E110'28'.59'6	E110'14'42'9	E110'18'45'3	E110'20'14'5	E110'23'47'7	E110'22'21'7	E110'28'09'8	E110'24'51'6			
Date of Sampling			02.01.07	02.01.07	02.01.07	02.01.07	05.01.07	05.01.07	05.01.07	09.01.07	09.01.07	09.01.07	09.01.07			
Item	Notation	Unit														
Coliform	CT	MPN/100mL	**93**	**460**	**43**	**43**	**2400**	**23**	**43**	**240**	**93**	**460**	**460**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**9**	0	**23**	**43**	**3**	**23**	**43**	**7**	0	**150**	**460**	0	0	-
Lead	Pb	mg/L	0.000	0.000	0.000	**0.004**	**0.006**	0.000	0.000	0.000	0.000	0.000	0.000	0.01	0.01	-
Arsenic	As	mg/L	0.0000	0.0000	0.0004	0.0008	0.0002	0.0003	0.0004	0.0003	0.0000	0.0003	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0021	0.0032	0.0021	0.0028	0.0022	0.0014	0.0005	0.0016	0.0026	0.0066	0.0026	0.01	0.01	-
Cyanide	Cn	mg/L	0.010	0.006	0.009	0.011	0.007	0.016	0.010	0.009	0.011	0.013	0.012	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0000	0.0000	0.0002	0.0002	0.0000	0.0002	0.0006	0.0000	0.0000	0.001	0.001	-
Flouride	F	mg/L	0.140	0.140	0.130	0.100	0.150	0.270	0.180	0.500	0.290	0.140	0.500	1.5	1.5	-
Nitrate	NO_3^-	mg/L	1.5	5.2	8.2	5.6	1.9	2.4	1.5	1.7	1.9	2.6	1.9	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.005	0.006	0.005	0.005	0.007	0.008	0.006	0.007	0.007	0.010	0.007	3	3	-
Residual Chlorine		mg/L	**0.000**	**0.000**	**0.000**	**0.000**	**0.020**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.08	0.08	0.10	0.08	0.12	0.07	0.08	0.05	0.05	0.05	0.05	0.2	-	0.2
Sodium	Na	mg/L	63.3	93.8	42.0	52.8	71.0	133.1	46.6	56.2	147.2	20.7	92.1	200	-	200
Temp.	T	℃	27.0	27.0	29.0	29.0	29.0	33.0	29.0	29.0	31.0	29.0	33.0	-	-	-
Electrical Conductivity	EC	ms/m	28.6	24.0	20.0	30.0	36.0	80.0	47.0	38.0	74.0	59.8	59.0	-	-	-
Alkalinity		CaCO3(mg/L)	84.1	66.5	62.8	122.0	157.5	368.4	191.9	188.0	345.5	319.8	161.3	-	-	-
Color		TCU	**62.0**	**53.0**	**40.0**	**37.0**	**37.0**	**35.0**	**39.0**	**37.0**	**37.0**	**45.0**	**45.0**	15	-	15
Turbidity		NTU	0.9	0.2	0.2	0.5	0.8	0.6	0.7	0.5	0.7	0.7	0.9	5	-	5
Taste		dilution	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	-	-	-
Odour		dilution	0.0	0.0	0.0	0.0	10.0	1.3	4.0	2.0	1.0	0.0	1.0	-	-	-
pH			7.2	8.2	7.8	8.0	8.3	**9.0**	7.8	**8.8**	**8.9**	7.9	**8.9**	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	142.5	119.1	105.6	144.6	195.2	370.0	220.0	145.0	455.0	290.0	267.0	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	57.6	56.0	41.6	94.4	128.0	120.0	137.6	105.6	131.2	128.0	86.4	500	-	0.0
Calcium	Ca	mg/L	10.8	12.8	7.6	15.2	13.0	11.6	13.6	11.2	13.4	11.2	9.6	-	-	-
Magnesium	Mg	mg/L	4.3	1.4	3.4	10.1	7.2	8.2	8.6	4.8	7.2	11.5	2.9	-	-	-
Sulfate	SO_4	mg/L	**627.0**	**573.0**	**561.0**	**498.0**	176.0	63.0	150.0	91.0	59.0	82.0	135.0	250	-	250
Chloride	Cl	mg/L	6.3	7.4	7.7	9.1	11.9	40.6	18.6	36.1	61.6	36.7	65.8	250	-	250
Iron	Fe	mg/L	0.06	0.04	0.05	0.08	0.05	0.07	0.06	0.00	0.05	0.05	0.26	0.3	-	0.3
Manganese	Mn	mg/L	0.001	0.025	0.018	0.017	0.025	0.029	**0.111**	0.017	**0.191**	0.030	0.025	0.1	0.4	0.1
Copper	Cu	mg/L	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.1	1.5	0.1	1	2.0	1.0
Zinc	Zn	mg/L	0.1	0.1	0.1	0.3	0.1	0.2	0.2	0.2	0.3	0.2	0.1	3	-	3.0
Dissolved Oxigen	DO	mg/L	5.8	6.3	8.9	8.3	8.8	7.2	4.0	7.2	5.3	7.5	5.8	-	-	-
Suspended Solid	SS	mg/L	1.0	1.0	2.0	3.0	6.0	2.0	4.0	2.0	2.0	4.0	3.0	-	-	-
Phenole Compound		mg/L	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.144	0.000	0.002	0.000	-	-	-
Total Phosphorous		mg/L	0.206	0.123	0.073	0.065	0.017	0.058	0.027	0.001	0.023	0.001	0.151	-	-	-
$KMnO_4$ Consumption		mg/L	6.9	7.2	9.7	8.8	9.7	7.5	10.7	11.0	10.0	6.6	9.1	-	-	-
Ammonium (NH3+NH4)		mg/L	0.34	0.30	0.24	0.19	0.00	0.00	0.00	0.26	1.31	2.50	0.45	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.12 Results of Water Quality Analysis of Tap Water of PDAMs and Community Water Supply Systems (1/2)

No.			Tap-35	Tap-36	Tap-37	Tap-38	Tap-39	Tap-40	Tap-41	Tap-42	Tap-43	Tap-44	Tap-45	Standard Value		
Code, Name/Location			PDAM Tap Water	PDAM Tap Water	PDAM Tap Water	PDAM Tap Water	PDAM Tap Water	PDAM Tap Water	Community Tap Water	Community Tap Water	Community Tap Water	Community Tap Water	Community Tap Water	Indonesia	WHO Guideline	
			Sewon Service Area	Bangunjiwo Service Area	Kasihan Service Area	Guwosari Service Area	Sedayu Service Area	Piyungan Service Area	Jetisharjo Service Area	Klangkapan II Service Area Margoluwih, Seyengan	Bangunsari I Service Area Bangunkerto, Turi	Nepen Service Area Candibinangun, Pakem	Sumberwatu Service Area Prambanan, Sambirejo	Drinking Water	GV (*1)	ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'49'54'6	S07'51'07'3	S07'46'13'9	S07'51'02'4	S07'49'24'5	S07'50'07'3	S07'45'37'4	S07'45'03'1	S07'38'50'1	S07'47'02'0	S07'47'02'0			
	Longitude(ddd'mm'ss's)		E110'21'12'5	E110'17'31'2	E110'20'58'8	E110'20'52'2	E110'14'05'0	E110'28'36'6	E110'22'52'3	E110'17'55'8	E110'21'11'8	E110'24'11'7	E110'29'48'0			
Date of Sampling			05.01.07	05.01.07	05.01.07	05.01.07	05.01.07	09.01.07	16.01.07	29.12.06	02.01.07	02.01.07	02.01.07			
Item	Notation	Unit														
Coliform	CT	MPN/100mL	**4**	0	0	**39**	0	**460**	**2400**	**1100**	**15**	**2400**	**2400**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	0	0	0	**23**	0	**15**	**2400**	**1100**	**9**	**9**	**23**	0	0	-
Lead	Pb	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	**0.003**	**0.009**	0.000	0.007	0.000	0.01	0.01	-
Arsenic	As	mg/L	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0011	0.0000	0.0000	0.0010	0.0010	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0039	0.0023	0.0013	0.0031	0.0021	0.0048	0.0010	0.0020	0.0020	0.0019	0.0037	0.01	0.01	-
Cyanide	Cn	mg/L	0.010	0.012	0.011	0.011	0.011	0.012	0.011	0.011	0.013	0.009	0.010	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.003	0;003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.001	0.001	-
Flouride	F	mg/L	0.230	0.240	0.200	0.160	0.500	0.340	0.030	0.050	0.130	0.150	0.090	1.5	1.5	-
Nitrate	NO_3^-	mg/L	1.8	1.5	1.8	0.9	2.4	3.9	1.3	2.7	7.6	2.0	0.8	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.016	0.004	0.007	0.015	0.008	0.014	0.001	0.006	0.006	0.006	0.001	3	3	-
Residual Chlorine		mg/L	**0.000**	**0.000**	**0.000**	**0.000**	**0.050**	**0.000**	-	-	-	-	-	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.09	0.08	0.06	0.09	**0.24**	0.07	0.05	0.10	0.18	0.08	0.14	0.2	-	0.2
Sodium	Na	mg/L	104.6	72.0	84.0	51.3	35.3	56.0	41.3	43.0	34.6	43.5	54.8	200	-	200
Temp.	T	℃	27.0	28.0	29.0	29.0	30.0	29.0	31.0	27.0	24.0	27.0	29.0	-	-	-
Electrical Conductivity	EC	ms/m	41.0	46.8	34.0	51.0	31.0	21.0	33.0	29.0	29.0	19.2	35.0	-	-	-
Alkalinity		CaCO3(mg/L)	242.4	168.0	140.3	176.6	83.0	111.7	8.8	100.7	50.8	69.3	128.4	-	-	-
Color		TCU	**59.0**	**63.0**	**62.0**	**80.0**	**60.0**	**36.0**	**32.0**	**85.0**	**40.0**	**52.0**	**39.0**	15	-	15
Turbidity		NTU	0.8	0.9	0.5	2.1	0.8	0.6	0.6	1.9	0.9	0.4	0.8	5	-	5
Taste		dilution	1.3	5.0	0.0	4.0	1.3	0.0	0.0	0.0	0.0	20.0	0.0	-	-	-
Odour		dilution	0.0	2.0	1.3	1.0	1.3	0.0	4.0	0.0	5.0	0.0	0.0	-	-	-
pH			7.3	7.7	7.9	7.4	7.7	7.8	7.6	7.4	7.0	6.9	7.6	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	263.0	239.0	169.0	262.0	157.0	96.4	185.0	151.2	144.5	100.2	189.5	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	134.4	120.0	34.2	128.0	86.4	84.8	68.5	64.0	65.6	41.6	97.6	500	-	0.0
Calcium	Ca	mg/L	13.0	14.2	9.8	13.8	8.4	8.6	7.4	10.4	11.2	8.4	14.4	-	-	-
Magnesium	Mg	mg/L	9.1	1.9	3.8	5.3	5.8	4.8	8.1	6.7	6.2	2.4	12.0	-	-	-
Sulfate	SO_4	mg/L	161.0	187.0	**267.0**	128.0	195.0	201.0	128.0	102.0	**456.0**	**476.0**	**543.0**	250	-	250
Chloride	Cl	mg/L	23.5	24.9	7.0	24.2	8.4	37.4	20.3	119.9	15.1	6.7	11.6	250	-	250
Iron	Fe	mg/L	0.05	**0.44**	0.11	0.24	0.06	0.07	0.05	0.02	0.04	0.0	0.0	0.3	-	0.3
Manganese	Mn	mg/L	**1.464**	**0.466**	0.034	**3.019**	0.013	0.034	0.001	0.042	0.013	0.042	0.048	0.1	0.4	0.1
Copper	Cu	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.0	1	2.0	1.0
Zinc	Zn	mg/L	0.1	0.8	0.1	0.2	0.5	0.1	0.1	0.2	0.1	0.1	1.6	3	-	3.0
Dissolved Oxigen	DO	mg/L	5.7	8.0	8.4	6.5	8.0	7.1	6.9	5.7	6.0	7.5	4.0	-	-	-
Suspended Solid	SS	mg/L	2.0	4.0	2.0	3.0	3.0	10.0	1.0	3.0	1.0	2.0	5.0	-	-	-
Phenole Compound		mg/L	0.000	0.002	0.002	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000	-	-	-
Total Phosphorous		mg/L	0.016	0.014	0.013	0.020	0.023	0.002	0.052	0.084	0.007	0.063	0.037	-	-	-
$KMnO_4$ Consumption		mg/L	6.9	6.6	6.9	6.6	7.2	5.9	8.8	10.0	8.8	9.1	8.5	-	-	-
Ammonium (NH3+NH4)		mg/L	0.30	0.01	0.00	0.13	0.00	0.02	0.28	0.41	0.38	0.29	0.49	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2): Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3): Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

Table 6.8.12 Results of Water Quality Analysis of Tap Water of Community Water Supply Systems (2/2)

No.			Tap-46	Tap-47	Tap-48	Tap-49	Standard Value		
Code, Name/Location			Community Tap Water Mangunan I Service Area Dlingo, Mangunan	Community Tap Water Terong I Service Area Dlingo, Terong	Community Tap Water Triwidadi Service Area Jojoran	Community Tap Water Jambon Service Area Bawuran	Indonesia Drinking Water	WHO Guideline GV (*1)	 ACV (*2)
Coordination	Latitude(dd'mm'ss's)		S07'55'49'9	S07'53'17'5	S07'51'17'0'	S07'52'41'5			
	Longitude(ddd'mm'ss's)		E110'25'29'7	E110'27'06'9	E110'16'59'3'	E110'25'35'8			
Date of Sampling			09.01.07	09.01.07	02.02.07	02.02.07			
Item	Notation	Unit							
Coliform	CT	MPN/100mL	**21**	**210**	**2400**	**1100**	0	0	-
Escherichia Coli	E-coli	MPN/100mL	**7**	**210**	**1100**	**460**	0	0	-
Lead	Pb	mg/L	0.000	0.000	0.000	0.000	0.01	0.01	-
Arsenic	As	mg/L	0.0010	0.0000	0.0000	0.0000	0.01	0.01	-
Chromium	Cr	mg/L	0.000	0.000	0.000	0.000	0.05	0.05	-
Selenium	Se	mg/L	0.0029	0.0036	0.0057	0.0014	0.01	0.01	-
Cyanide	Cn	mg/L	0.012	0.013	0.001	0.001	0.07	0.07	-
Cadmium	Cd	mg/L	0.0000	0.0000	0.0000	0.0003	0.003	0.003	-
Mercury	Hg	mg/L	0.0000	0.0000	0.0000	0.0000	0.001	0.001	-
Flouride	F	mg/L	0.230	0.120	0.050	0.040	1.5	1.5	-
Nitrate	NO_3^-	mg/L	1.2	1.3	1.5	1.7	50	50(*3)	-
Nitrite	NO_2^-	mg/L	0.025	0.180	0.004	0.004	3	3	-
Residual Chlorine		mg/L	–	–	–	–	0.6-1.0	-	0.6-1.0
Aluminum	Al	mg/L	0.06	0.08	0.07	0.10	0.2	-	0.2
Sodium	Na	mg/L	56.5	51.8	9.0	43.9	200	-	200
Temp.	T	℃	26.0	26.0	28.0	31.0	-	-	-
Electrical Conductivity	EC	ms/m	26.5	15.6	73.0	70.0	-	-	-
Alkalinity		CaCO3(mg/L)	157.5	217.0	152.6	147.7	-	-	-
Color		TCU	**55.0**	**63.0**	**58.0**	**61.0**	15	-	15
Turbidity		NTU	1.9	0.8	0.4	0.4	5	-	5
Taste		dilution	0.0	0.0	0.0	0.0	-	-	-
Odour		dilution	1.3	1.0	0.0	0.0	-	-	-
pH			7.3	5.8	8.0	**9.8**	6.5-8.5	-	-
Total Dissolved Solids	TDS	mg/L	161.4	87.8	370.0	350.0	1,000	-	1,000
Total Hardness	($CaCO_3$)	mg/L	100.8	80.0	161.6	187.2	500	-	0.0
Calcium	Ca	mg/L	10.8	11.2	37.2	39.6	-	-	-
Magnesium	Mg	mg/L	4.3	10.6	3.8	8.6	-	-	-
Sulfate	SO_4	mg/L	100.0	100.0	10.7	23.4	250	-	250
Chloride	Cl	mg/L	42.7	28.6	101.8	117.0	250	-	250
Iron	Fe	mg/L	0.04	0.06	0.14	0.05	0.3	-	0.3
Manganese	Mn	mg/L	**0.324**	**0.141**	0.053	0.011	0.1	0.4	0.1
Copper	Cu	mg/L	0.1	0.0	0.0	0.1	1	2.0	1.0
Zinc	Zn	mg/L	0.2	0.5	0.2	0.1	3	-	3.0
Dissolved Oxigen	DO	mg/L	6.1	6.2	8.2	7.9	-	-	-
Suspended Solid	SS	mg/L	3.0	2.0	1.0	2.0	-	-	-
Phenole Compound		mg/L	0.000	0.001	0.000	0.000	-	-	-
Total Phosphorous		mg/L	0.017	0.019	0.038	0.037	-	-	-
$KMnO_4$ Consumption		mg/L	7.8	4.3	8.5	9.2	-	-	-
Ammonium (NH3+NH4)		mg/L	0.06	0.03	0.29	0.48	-	-	1.5

*(*1): Guidelin Value in "WHO Guidelines for Drinking-Water Quality -DRAFT-*

*(*2):Acceptable Value in "WHO Guidelines for Drinking-Water Quality - DRAFT-*

*(*3):Guideline Value for short-term exposure in bottle-fed infants*

0.33 : value that exeeds Indonesian Standard (Drinking water)

CHAPTER 7

ADMINISTRATION

AND

MANAGEMENT OF WATER SUPPLY SYSTEM

CHAPTER 7 ADMINISTRATION AND MANAGEMENT OF WATER SUPPLY SYSTEM

7.1 Overview of Water Sector Administration and Performance

The roles of province, regency/municipality and PDAM are clearly separated. The DIY Province is responsible only for policy planning and implementation crossing regencies/municipality. PDAMs are responsible for planning & design, financing, construction and operation of the facilities owned by the regency's/municipality's governments. Regency's/municipality's governments provide PDAMs with subsidies if necessary and act as an regulator by way of tariff appraisal/approval, performance monitoring & evaluation, etc.

The water supply and sewerage are vital services, the water and sanitation sector must be "sustainable". "To be sustainable" means to be able to provide long-term water supply and sewerage services to the entire population, without detrimental effects to the environment, via an operation that is efficient and financially sound. The Vision for the JICA Master Plan clearly adopts sustainable service provision as its overarching goal (see Chapter 12 of this report).

Sustainability of the water supply and sanitation system should be achieved at two levels: the country sector level and operator level. For each of these two levels, internationally-accepted benchmark indicators were selected – five (5) corresponding to the sector, and ten (10) corresponding to the operator – which are considered to indicate best their sustainability. The parameters selected as sustainability indicators for evaluating the sector and the operating utilizes are listed in Tables 7.1.1 and 7.1.2, respectively.

7.1.1 Evaluation at Sector Level

The results of evaluation at the sector level are summarized in Table 7.1.3. The water sector in Indonesia is well-organized. Table 7.1.4 indicate the division of roles of the four main entities (central, provincial, district and operators). The table shows a clear-cut separation between main functions (policy planning, regulation and operation) and progressive delegation of functions from the central/regional governments to the local government. No overlaps and gaps between entities are seen in major fuctions.

Table 7.1.5 indicates trends of capital investment and subsidies for each district for past three years. The table indicates: (i) the capital investment growing for Yogyakarta, steady for Sleman, and diminishing for Bantul; and (ii) no subsidy for Yogyakarta and heavy, growing

subsidies for Sleman and Bantul. The tariff structure is adequate for the three PDAMs as the volume-based and differential system is used for the three PDAMs. But, adequacy of tariff levels varies among the PDAMs: adequate for Yogyakarta; acceptable for Bantul; and unacceptable for Sleman.

7.1.2 Evaluation at Operator Level

The results of evaluation at the operator level are summarized in Table 7.1.6. From this table, the following problems and issues are identified.

- First, availability of water sources: the municipality and Bantul need water from outside, while Sleman is able to manage own demand from own source.
- Second, low water service coverage (direct access basis) for Sleman and Bantul. The service coverage for the municipality can be considered to be adequate, but low for sewerage service coverage. Though sewerage is not PDAM's job, the municipal government should pay more attention to sanitation to upgrade clean image of the City as an international tourist destination.
- Third, high water losses for all PDAMs.
- Fourth, overstaffing for all.
- Fifth, poor financial performance particularly for Sleman and Bantul partially.

From this assessment and dialogues with persons concerned, it can be concluded that the root problem for poor performance of Sleman and Bantul is especially lack of cost recovery from tariff revenues. Low cost recovery needs subsidy from the government, and then the government intervention reduces autonomy. Reduced autonomy causes lack of motivation for running the company well. This causes overstaffing and high losses. Overstaffing and high NRW brings low investment and poor O&M. Low investment and poor O&M makes consumers unsatisfied.

Therefore the core problems would result from low tariffs and lack of autonomy, and the core solutions include a transparent policy, an independent regulatory body, a paradigm shift in tariffs, and involvement of civil society.

Table 7.1.1 Performance Monitoring Indicators for Governments

Indicator	Checkpoint	Qualification
1. Sector Organization	• Clear-cut division of roles between Province and City/Regency • Clear-cut separation between Policy making and operation • Delegation of authorities from Province to City/Regency	good acceptable problematic
2. Trend of investments	• Trend of annual investments in past years （Amounts of capital and O&M investments, their shares of public investment and GDRP）	growing steady diminishing
3. Trend of subsidies	• Trend of government subsidies in past years （Amounts of subsidies for capital and O&M investments, their shares of the total government subsidies）	diminishing steady growing
4. Tariff structure	• Tariff is measured by used volume-base (consumers pay for water in proportion to their actual use) and is differential (increasing tariffs for higher consumption)	adequate acceptable inadequate
5. Tariff level	• The extent to which tariff covers O&M costs and capital costs	adequate acceptable unacceptable

(Source) WB, JBIC

Table 7.1.2 Performance Monitoring Indicators for Operators (PDAMs)

Indicator	Definition	Benchmark
A. Management Plan		
1-1 Water sources	Availability of stable water sources in future	
1-2 Water service plan	Availability of reliable water service plans	
B. Water supply service		
2. Water service coverage	Percentage of population connected to public (PDAM) water supply services	
3. Service quality	Water quality, continuity of supply, water pressure, etc	
C. Sewerage service		
4. Sewerage service coverage	Percentage of population connected to public sewerage services	
5. Sewage treatment	Percentage of sewage undergoing treatment of any type	
6. Water to sewerage coverage ratio	Ratio between water coverage and sewerage coverage	
D. Operational performance		
7. Water losses (UfW)	Percentage of water not sold to water produced	23% or less (WB)
8. Staff per water connection (SWC)	No. of staff per thousand water connections	5 or less (WB)
E. Financial performance		
9-1 Working ratio (WR)	Ratio of O&M costs to revenues	0.68 or less (WB)
9-2 Operating ratio (OR)	Ratio of full costs (O&M costs and capital recovery costs) to revenues	
10 Collection rate (CR)	Ratio of collection to billing	0.8 or more (WB)

(Source) WB, JBIC

Table 7.1.3 Summary of Evaluation at Sector Level

Indicator	Checkpoint	Qualification
1. Sector organization	• Clear-cut division of roles between Province and City/Regency • Clear-cut separation between Policy formulation/regulation and service provision • Delegation of authorities from Province to City/Regency	Good Good Good
2. Trend of investments	• Trend of annual investments in past years （Amounts of capital and O&M investments, their shares of public investment and GDRP）	Growing for Yogyakarta Steady for Sleman Diminishing for Bantul
3. Trend of subsidies	• Trend of government subsidies in past years （Amounts of subsidies for capital and O&M investments, their shares of the total government subsidies）	No subsidy for Yogyakarta Heavy, growing subsidies for Sleman and Bantul
4. Tariff structure	• Tariff is measured by used volume-base (consumers pay for water in proportion to their actual use) and is differential (increasing tariffs for higher consumption)	Adequate
5. Tariff level	• The extent to which tariff covers O&M costs and capital costs	Adequate for Yogyakarta Acceptable for Bantul Unacceptable for Sleman

(Source) JICA Study Team

Table 7.1.4 Division of Roles of Main Entities Concerned

Role	Central Gov.	Provincial Gov.	District Gov.	PDAMs
Establishing laws and regulations	✓			
Policy planning	✓	✓		
Investment planning (capital)			✓(Rural)	✓(Urban)
Investment planning (O&M)				✓
Funding for investment (capital)			✓ (Subsidy)	✓
Funding for investment (O&M)				✓
Ownership of assets			✓	
Tariff proposal preparation				✓
Tariff appraisal/approval			✓	
Design & Construction				✓
Operation				✓
Maintenance				✓
Management				✓
Billing & collection				✓
Customer relations				✓
Setting performance M&E standards	✓			
Conducting performance M&E			✓	

(Source) JICA Study Team

Table 7.1.5 Capital Investment for Water Supply Systems (for PDAM and AMD)

Kota: Yogyakarta

Year	Kota Gov. Budget (Million Rp.)			Capital Investment for Water Supply System (Million Rp.)						
	Total	Routine Budget	Development Budget	PDAM own fund	Regency/ Kota Fund	Provincial Gov. Fund	Central Gov. Fund (DAK)	Central Gov. Fund (DAU)	Other	Total
2004	428,693	58,352	370,341	3,500	0	0	0	0	0	3,500
2005	450,654	70,775	379,879	5,500	0	0	0	0	0	5,500
2006	571,236	65,606	505,630	5,700	0	0	0	0	0	2,500

Regency: Sleman

Year	Regency Gov. Budget (Million Rp.)			Capital Investment for Water Supply System (Million Rp.)						
	Total	Routine Budget	Development Budget	PDAM own fund	Regency/ Kota Fund	Provincial Gov. Fund	Central Gov. Fund (DAK)	Central Gov. Fund (DAU)	Other	Total
2004	488,078	121,124	366,954	1,000	0	500	0 (AMD)	500 (AMD)	500	2,500
2005	488,677	121,123	366,954	1,000	55	0	460 (AMD)	1,800 (AMD)	0	3,315
2006	704,213	176,650	527,563	500	676 575 (PDAM) 101 (AMD)	0	1,010 (AMD)	1,932 (AMD)	0	4,118

Regency: Bantul

Year	Regency Gov. Budget (Million Rp.)			Capital Investment for Water Supply System (Million Rp.)						
	Total	Routine Budget	Development Budget	PDAM own fund	Regency/ Kota Fund	Provincial Gov. Fund	Central Gov. Fund (DAK)	Central Gov. Fund (DAU)	Other	Total
2004	680,969	396,427	284,542	127	0	0	0 (AMD)	200 (AMD)	0	327
2005	680,968	396,426	284,542	274	0	250	1,130 (AMD)	289 (AMD)	3,000	4,943
2006	530,728	141,956	388,772	0	0	866	1,130 (AMD)	2,072 (AMD)	200	4,268

(Source) Indetifikashi Memorandum Program dan Projek Air Minum (for each District)

Table 7.1.6 Summary of Evaluation at Operator Level

Indicator	Yogyakarta	Sleman	Bantul	Benchmark for Big Urban Area
A. Management Plan				
1-1 Water sources	Needs external sources (now and future)	Internal sources available (now and future)	Needs external sources (now and future)	
1-2 Water service plan	Plan available	Plan available	Plan available	
B. Water supply service				
2. Water service coverage	64%	13%	9%	
3. Service quality	Potable water quality, 24-hr supply, acceptable water pressure	Potable water quality, 24-hr supply, acceptable water pressure	Clean water quality, less-than 24 hr supply, acceptable water pressure	
C. Sewerage service	PU Kota is responsible	PU Regency is responsible	PU Regency is responsible	
4. Sewerage service coverage				
5. Sewage treatment				
6. Water to sewerage coverage ratio				
D. Operational performance				
7. Water losses (UfW)	39%	52%	42%	23% or less (WB)
8. Staff per water connection (SWC)	8.5	10.1	11.9	5 or less (WB)
E. Financial performance				
9-1 Working ratio (WR)	69%	142%	97%	68% or less (WB)
9-2 Operating ratio (OR)	99%	190%	132%	
10 Collection rate (CR)	97%	97%	97%	85% or more (WB)

(Source) JICA Study Team

7.2 Administration and Management of 3 PDAMs

7.2.1 Organizations of Each PDAM

(1) PDAM Yokyakarta

Piped water supply system in central city area of Yogyakarta was built in the Colonial era, and there was water service operation in 1948, which is now being operated by PDAM Tirtamarta Yogyakarta. It was established under the regulation No. 3 1976 PERATURAN DAERAH KOTAMADYA DAERAH TINGKAT II YOGYAKARTA. The corporation is owned by the autonomous regional government headed by WALIKOTAMADYA, which operation is lead by three directors and controlled by Supervisory board. The supervisory board members consist of Assistant Secretary of the government and representatives of the community and customers. The duties of Supervisory board are:

1) budget and expenditure validation of the company
2) monitoring and evaluation on management of the company
3) the goals and directions of development

4) monitoring and evaluation on company policy
5) agreement on investment for development

The board of directors is composed by President Director, Technical Director and General Director. The organization chart is shown in the following figure and more detail is attached in the Appendix 7.1 Figure 1 and the job description under Walikota Yogyakarta Decision No.162/KD/1987 is attached in Appendix 7.2.

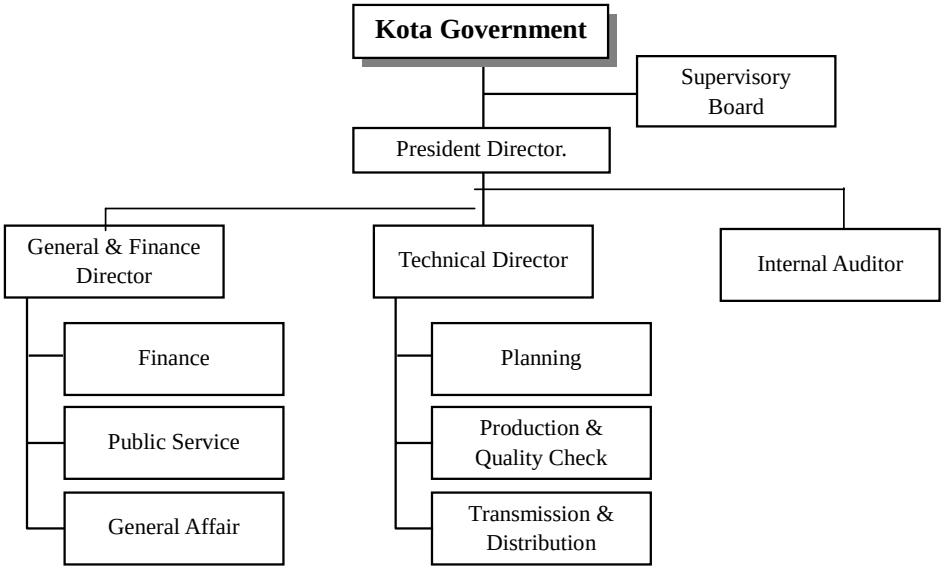

Figure 7.2.1 PDAM Yogyakarta Organization Structure

(2) PDAM Sleman

PDAM Sleman started in 1981 as BPAM (Regional Water Bodies managed by the central government), and changed status to PDAM under Sleman Prefecture Regulation No.3, 1991 as a drinking water service company, which is owned by the autonomous regional government headed by BUPATI KEPALA DAERAH TINGKAT II, and which operation is lead by three directors and controlled by Supervisory board. The supervisory board members consist of Assistant Secretary of the government and representatives of the community and customers. The organization chart under Mayor Decree No.364/Kep.KDH/1996 is shown in the following figure

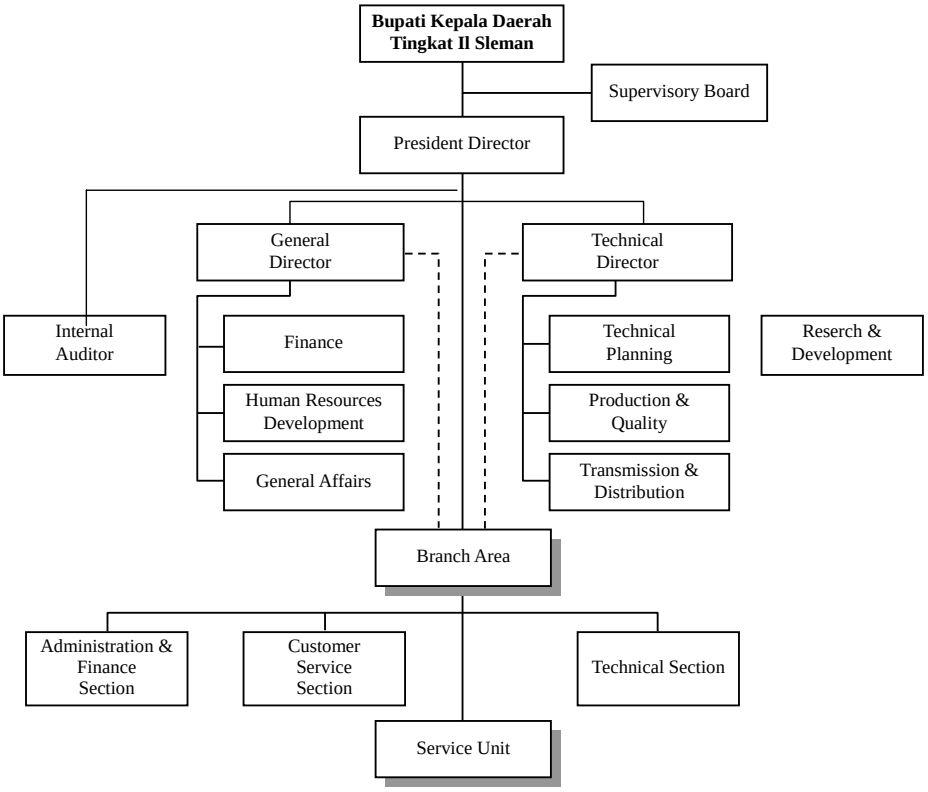

Figure 7.2.2 PDAM Sleman Organization Structure

(3) PDAM Bantul

PDAM Bantul started in 1984 as BPAM, and changed status to PDAM under Prefecture Regulation No. 11 1990 PERATURAN DAERAH KABUPATEN DAERAH TINGKAT II BANTUL, which is owned by the autonomous regional government headed by BUPATI KEPALA DAERAH TINGKAT II, and which operation is lead by three directors and controlled by Supervisory board. The supervisory board members consist of Assistant Secretary of the government and representatives of the community and customers. The organization chart is shown in the following figure

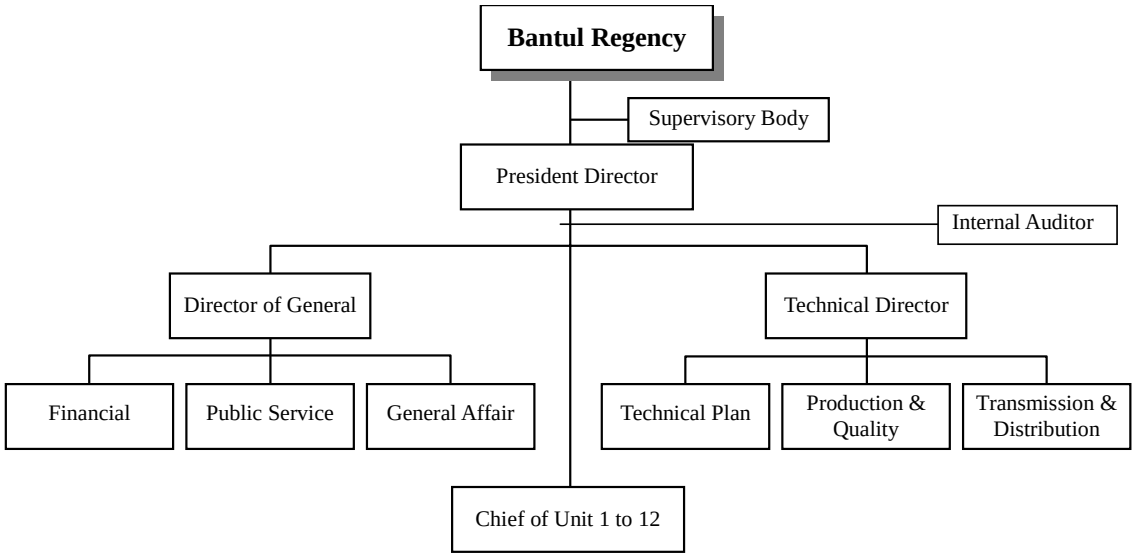

Figure 7.2.3 PDAM Bantul Organization Structure

7.2.2 Present Managerial and Financial Situation of Each PDAM

(1) PDAM Yogyakarta

Financial management is efficient. Tariff level (Full/Base/Low) is calculated according to MOHA Instruction Manual No.8/1998 which is attached in Annex 7.3. Actual tariff calculated as water revenue divided by consumption volume in the year 2005 could almost cover full cost recovery as follows:

Table 7.2.1 Tariff Level

Unit Rp/m^3

Full Rate; full cost recovery including profit	1,742
Base Rate; operating cost and loan repayment	1,554
Low Rate; operating cost recovery	1,452
Actual tariff	1,734

Source: JICA Study Team based on PDAM Yogyakarta 2005 financial statement

As the result, income statement shows stable revenue and profit increase as follows:

Table 7.2.2 Profit and Loss

Unit Rp million

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Revenue	9,470	10,237	13,711	13,332	15,648	18,500
Direct cost	4,338	5,106	6,341	6,802	7,669	9,003
Direct profit	5,132	5,131	7,379	6,530	7,979	9,497
In-direct cost	3,233	3,611	5,048	4,440	5,651	6,488
Operating income	1,899	1,520	2,322	2,090	2,328	3,009

Source: Audited financial statement

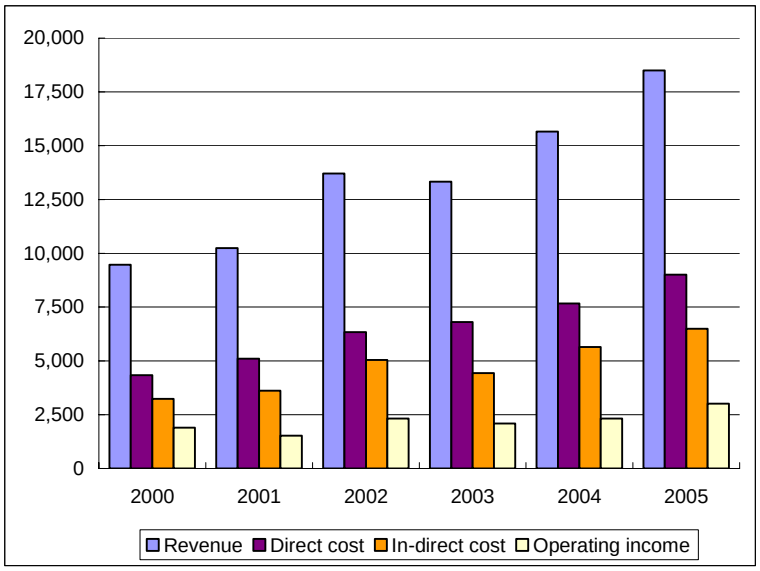

Figure 7.2.4 Profit and Loss

Revenue and profit are increasing in these 2 years by absorbing direct costs. Total cost is divided to direct costs which consist of purchase cost of well water, treatment cost and distribution cost, and indirect costs including financial cost. In 2005 with comparison of the previous year, purchase cost, treatment cost and distribution cost increased by 19%, 34% and 5% respectively. Profit and Loss Statement is shown in the Appendix 7.1 Table 1, and unit cost is calculated as follows:

Table 7.2.3 PDAM Yogyakarta Unit Cost in 2005

	Rp million	Rp/m3
Production cost	6,283	589
Distribution cost	2,720	255
Administration cost	6,488	608
Total	15,491	1,452

Source: JICA Study Team

Break even point versus revenue in 2005 is 68 percent which shows fairly good position. Since there is no water source in the administrative boundary, it is essential to get water sources from outside.

In 1984, asset was revaluated to make surplus for Rp.1,223 million which contributed to equity. In 2002, the central government loan originated by Swiss donor was converted to grant capital for Rp.10,770 million and invested project assets owned by the central government was transferred to PDAM for Rp. 2,239 million which listed in equity stating that its status is not yet determined[1]. Equity amounts for Rp.23,912 in 2005, and equity ratio is 76 percent which shows borrowing capability. (Balance Sheet and Cash flow Statement are shown in the

[1] PDAM Yogyakarta Audited financial statement 2004-2005

Appendix 7.1 Table 2 and Table 3)

Account receivable analysis shows that all three PDAMs are fairly good position with collection period for less than 3 months but in case of PDAM Yokgakarta, bad debt over one year counted 17 percent of outstanding account receivables (account receivables comparison is shown in the Appendix 7.1 Table 4 and account receivable flowchart of PDAM Yogyakarta is shown in the Appendix 7.1 Figure 2).

Performance evaluation based on guideline of MOHA (which is shown in Appendix 7.4) in the aspects of finance, operation and administration is as follows:

Table 7.2.4 PDAM Yogyakarta Performance

Finance Aspect								
		Maximum		2001	2002	2003	2004	2005
1	Profit ratio to productive assets	>10%		0.09	0.12	0.1	0.11	0.11
	Value	5	Improvement 5	4	6	4	6	5
2	Profit ratio to revenue	>20%		0.21	0.21	0.19	0.18	0.17
	Value	5	Improvement 5	5	5	4	4	4
3	Current ratio	1.75～2.0		1.48	5.23	6.35	4.7	4.94
	Value	5		3	1	1	1	1
4	Ratio of long term debt to equity	≤0.5		0.63	0.07	0.07	0.05	0.05
	Value	5		4	5	5	5	5
5	Ratio of total assets to total loan	>2		3.45	16.03	17.39	21.45	25.17
	Value	5		5	5	5	5	5
6	Ratio of operational cost to operational revenue	≤0.5		0.89	0.86	0.87	0.88	0.86
	Value	5		2	2	2	2	2
7	Ratio of operational profit to installment and interest payment	>2.0			23.15	20.68	6.76	26.98
	Value	5		5	5	5	5	5
8	Ratio of productive assets to water selling	≤2.0		2.8	2.04	2.1	1.85	1.77
	Value	5		4	4	2	5	5
9	Term of billing	≤60		37.24	39.34	40.52	43.48	50.62
	Value	5		5	5	5	5	5
10	Billing effectiveness	>90%		—	—	—	—	0.99
	Value	5		—	—	—	—	5
Total Value	Maximum 60							42
Calcu lation	Score 45							31.50

Operational Aspect			2005	Value
1	Scope of service population (Municipal) %	=Number of Service population/ population	47	3
		+improvement This year - last year	-5	0
2	Water quality	Drinking water/Clean water/Not either	Drinking	3
3	Water continuity	All customer get 24 hrs or not	24hrs	2
4	Productivity %	=Production capacity/Connecting capacity	100	4
5	Water loss %	=Distribution-selling water in main meter/Distribution	30.98	2
		+improvement This year - last year	0.34	0
6	Water meter check %	=water meter checked customer -new connection/All customer	90	3
7	New connection speed Working days	Contract-connection	7	1
8	Customer complaint handling %	=Complaint handled/Total complaints	100	2
9	Easily service	There is a service point outside office or not	yes	2
10	Employee per 1,000 customers (Municipal)	Contract employees included	8.56	3
Total Value	Maximum 47			25
Calculation	Score40			21.28
Administrative Aspect			**2005**	**Value**
1	Corporate plan implementation	Full, partial or not	Partial	3
2	Organization plan and job description implementation	Full, partial or not based on Corporate plan	Partial	3
3	Standard operation procedure	Full, partial or not based on Corporate plan	Partial	3
4	As Built Drawing	Full, partial or not based on Corporate plan	Partial	3
5	Guideline of employee performance such as career and salary	Full, partial or not based on Corporate plan	Partial	3
6	Master plan and company budget	Full, partial or not based on Corporate plan	Partial	3
7	Internal report	On time or not	On time	2
8	External report	On time or not	On time	2
9	Independent auditor's opinion	True without exception-Not true	True without exception	4
10	Action plan of investigation report of Last year	None finding-No action plan	Follow-up	3
Total Value	Maximum 36			29
Calculation	Score 15			12.08
Classification	Score	Performance		
	>75	Very good		
	>60-75	**Good**		**64.86**
	>45-60	Enough		
	>30-45	Not enough		
	≤30	Not good		

Source: PDAM Yogyakarta Finance and Technical Division and JICA Study Team

(2) PDAM Sleman

PDAM Sleman was established in 1991. Since them, human resources have much administration staff among 186 permanent staff as of 2006, resulting high administration cost (human resources comparison is shown in the Appendix 7.1 Table 4). Management admits

redundancy and endeavors to activate personnel. In addition, price hike in fuel and electricity is burden for the PDAM. Actual tariff does not cover operating cost as follows:

Table 7.2.5 Tariff Level

Unit Rp/m^3

Full Rate; full cost recovery including profit	3,756
Base Rate; operating cost and loan repayment	3,144
Low Rate; operating cost recovery	3,038
Actual tariff	1,732

Source: JICA Study Team based on PDAM Sleman financial statement in 2005

Income statement shows as follows

Table 7.2.6 Profit and Loss

Unit Rp million

	2000	2001	2002	2003	2004	2005
Revenue	2,326	2,747	3,021	5,351	5,794	5,781
Direct cost	2,194	2,681	2,898	3,530	3,941	4,054
Direct profit	132	66	123	1,821	1,853	1,727
In-direct cost	1,680	2,864	3,320	3,962	5,260	5,069
Operating income	-1,548	-2,798	-3,197	-2,141	-3,407	-3,342

Source: Audited financial statement

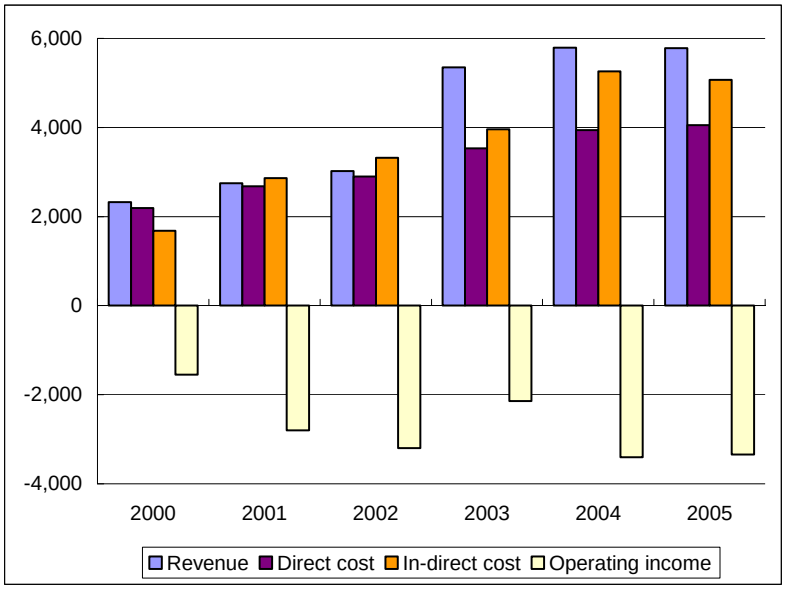

Figure 7.2.5 Profit and Loss

From the beginning of operation, it has not made a good performance in financial aspect[2] resulting red equity in the amount of minus Rp 5 billion after consumption of paid-in capital for Rp 15 billion (equity comparison is shown in the Appendix 7.1 Table 6). The regional government made rescue loan to pay salary since 2004.

[2] PDAM Sleman Rescue proposal September 2005

Unit cost is calculated as follows:

Table 7.2.7 PDAM Sleman Unit Cost in 2005

	Rp million	Rp/m3
Production cost	2,320	772
Distribution cost	1,734	577
Administration cost	5,069	1,688
Total	9,123	3,038

Source: JICA Study Team

Income Statement, Balance Sheet and Cash flow Statement are shown in Appendix 7.1 Table 7, Table 8 and Table 9, respectively.

Performance evaluation based on guideline of MOHA in the aspects of finance, operation and administration is as follows:

Table 7.2.8 PDAM Sleman Performance

Finance Aspect							
	Table PDAM Sleman Performance	**Maximum**		**2002**	**2003**	**2004**	**2005**
1	Profit ratio to productive assets	>10%		-0.17	-0.11	-0.18	-0.20
	Value	5	Improvement 5	1	3	1	1
2	Profit ratio to revenue	>20%		-1.03	-0.37	-0.56	-0.61
	Value	5	Improvement 5	1	6	1	1
3	Current ratio	1.75～2.0		0.12	0.15	0.10	0.07
	Value	5		1	4	1	1
4	Ratio of long term debt to equity	≤0.5		3.13	6.22	-9.60	-2.36
	Value	5		1	1	1	1
5	Ratio of total assets to total loan	>2		1.67	1.75	1.63	1.54
	Value	5		3	4	3	3
6	Ratio of operational cost to operational revenue	≤0.5		2.06	1.40	1.59	1.58
	Value	5		1	1	1	1
7	Ratio of operational profit to installment and interest payment	>2.0			-0.39	-0.82	-1.02
	Value	5			1	1	1
8	Ratio of productive assets to water selling	≤2.0		6.32	3.79	3.42	3.17
	Value	5		2	4	4	4
9	Term of billing	≤60		40	47	41	41
	Value	5		5	5	5	5
10	Billing effectiveness	>90%		0.83	0.90	0.90	0.98
	Value	5		3	5	5	5
Total Value	Maximum 60						23
Calculation	Score 45						17.25

Source JICA Study Team

PDAM Sleman has geographical advantage such as water resources, increasing population, industry development and so on. Reconstruction of financial situation is essential to proceed improved policy and strategy.

Operational Aspect			2005	Value
1	Scope of service population (Regency) %	=Number of Service population/ population	14.60	1
		+improvement This year - last year	0.74	1
2	Water quality	Drinking water/Clean water/Not either	Drinking	3
3	Water continuity	All customer get 24 hrs or not	yes	2
4	Productivity %	=Production capacity/Connecting capacity		
5	Water loss %	=Distribution-selling water in main meter/Distribution	46.88	1
		+improvement This year - last year	5.03	
6	Water meter check %	=water meter checked customer -new connection/All customer		
7	New connection speed Working days	Contract-connection	6	2
8	Customer complaint handling %	=Complaint handled/Total complaints	86.42	2
9	Easily service	There is a service point outside office or not	yes	2
10	Employee per 1,000 customers (Regency)	Contract employees included	10.11	4
Total Value	Maximum 47			18
Calculation	Score 40			15.32
Administrative Aspect			**2005**	**Value**
1	Corporate plan implementation	Full, partial or not	Partial	3
2	Organization plan and job description implementation	Full, partial or not based on Corporate plan	Partial	3
3	Standard operation procedure	Full, partial or not based on Corporate plan	Partial	3
4	As Built Drawing	Full, partial or not based on Corporate plan	Partial	3
5	Guideline of employee performance such as career and salary	Full, partial or not based on Corporate plan	Partial	3
6	Master plan and company budget	Full, partial or not based on Corporate plan	Partial	3
7	Internal report	On time or not	On time	2
8	External report	On time or not	Not on time	1
9	Independent auditor's opinion	True without exception-Not true	True without exception	4
10	Action plan of investigation report of Last year	None finding-No action plan	Follow up	2
Total Value	Maximum 36			27
Calculation	Score 15			11.25
Classification	Score	Performance		
	>75	Very good		
	>60-75	Good		
	>45-60	Enough		
	>30-45	**Not enough**		**43.82**
	<=30	Not good		

Source: PDAM Sleman Finance Division

(3) PDAM Bantul

PDAM Bantul started operation with 17 systems in 1992. However it can not clear break even point (break even point comparison is shown in the Appendix 7.1 Table 10). It could not operate as a healthy corporation up to now and caused many complaints of quality and quantity from customers. Actual tariff does not cover operating cost as follows:

Table 7.2.9 Tariff Level

Unit Rp/m^3

Full Rate; full cost recovery including profit	2,092
Base Rate; operating cost and loan repayment	No repayment
Low Rate; operating cost recovery	1,686
Actual tariff	1,326

Source: PDAM Bantul financial statement in 2005

Income statement shows as follows

Table 7.2.10 Profit and Loss

Unit Rp million

	2001	2002	2003	2004	2005
Revenue	2,093	2,978	3,466	3,843	4,026
Direct cost	1,500	1,624	1,890	2,137	2,404
Direct profit	593	1,354	1,576	1,706	1,622
In-direct cost	958	1,702	2,075	1,883	1,875
Operating income	-365	-348	-499	-177	-253

Source: Audited financial statement

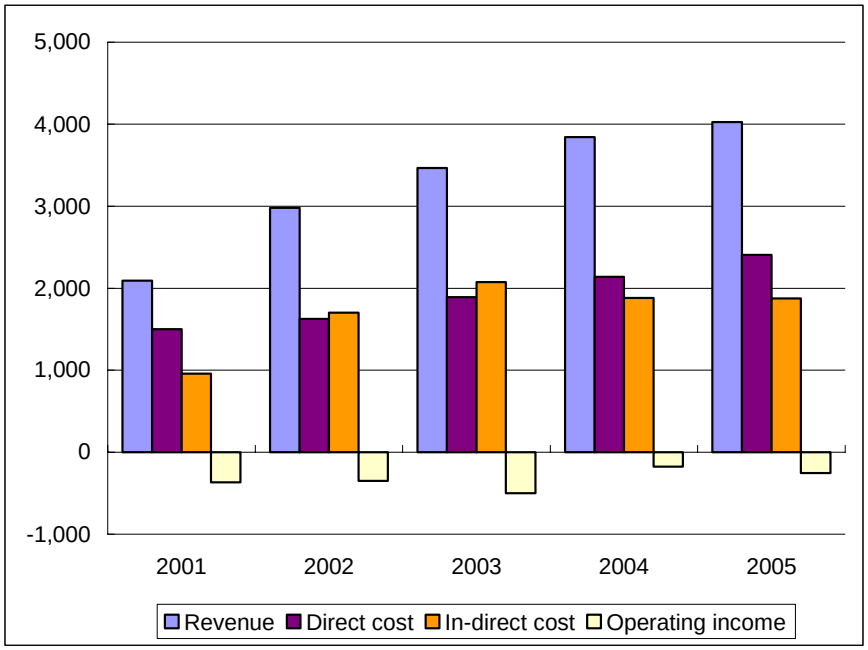

Figure 7.2.6 Profit and Loss

Graph shows indirect cost is well controlled. Expansion to break even point should be management target.

Revenue is increasing every year. Direct profit cannot increase because of direct costs which consist of water source cost, processing cost and distribution cost. Water source cost increased by 21% in 2005 mainly due to electricity price hike for pumping. Electricity cost in 2002 was Rp 687 billion and in 2005 increased to Rp 1,215 billion, 1.8 times as much. Unit cost is calculated as follows:

Table 7.2.11 PDAM Bantul Unit Cost in 2005

	Rp million	Rp/m3
Production cost	1,717	677
Distribution cost	687	271
Administration cost	1,875	739
Total	4,279	1,686

Source: JICA Study Team

Account receivable analysis shows that all three PDAMs are fairly good position with collection period for less than 3 months but in case of PDAM Bantul, bad debt over 2 years counted 20 percent of outstanding account receivables.

Income Statement, Balance Sheet and Cash flow Statement are shown in the Appendix 7.1 Table 11, Table 12 and Table 13, respectively.

Performance evaluation based on guideline of MOHA in the aspects of finance, operation and administration is as follows:

Table 7.2.12 PDAM Bantul Performance

Finance Aspect								
		Maximum		**2001**	**2002**	**2003**	**2004**	**2005**
1	Profit ratio to productive assets	>10%		-0.04	-0.04	-0.05	-0.02	-0.02
	Value	5	Improvement 5	1	1	1	3	3
2	Profit ratio to revenue	>20%		-0.17	-0.11	-0.12	-0.04	-0.06
	Value	5	Improvement 5	1	3	1	4	1
3	Current ratio	1.75～2.0		8.60	3.26	1.64	3.61	6.15
	Value	5		1	1	4	1	1
4	Ratio of long term debt to equity	<=0.5		0	0	0	0	0
	Value	5		5	5	5	5	5
5	Ratio of total assets to total loan	>2		0	0	0	0	0
	Value	5		5	5	5	5	5
6	Ratio of operational cost to operational revenue	<=0.5		1.17	1.12	1.14	1.05	1.06
	Value	5		1	1	1	1	1
7	Ratio of operational profit to installment and interest payment	>2.0						
	Value	5		5	5	5	5	5
8	Ratio of productive assets to water selling	<=2.0		3.84	2.70	2.28	2.75	2.54
	Value	5		4	4	4	4	4
9	Term of billing	<=60		33.37	37.35	34.07	37.10	43.99
	Value	5		5	5	5	5	5
10	Billing effectiveness	>90%			0.73			0.97
	Value	5						5
Total Value	Maximum 60							35
Calculation	Score 45							26.25

Operational Aspect			**2005**	**Value**
1	Scope of service population (Regency) %	=Number of Service population/ population	8.08	1
		+improvement This year - last year		
2	Water quality	Drinking water/Clean water/Not either	Clean	2
3	Water continuity	All customer get 24 hrs or not	Not yet	1
4	Productivity %	=Production capacity/Connecting capacity	96.19	4
5	Water loss %	=Distribution-selling water in main meter/Distribution +improvement This year - last year	40.65	1
6	Water meter check %	=water meter checked customer -new connection/All customer	100	1
7	New connection speed Working days	Contract-connection	6	2
8	Customer complaint handling %	=Complaint handled/Total complaints	100	2
9	Easily service	There is a service point outside office or not	Yes	2
10	Employee per 1,000 customers (Regency)	Contract employees included	11.47	3
Total Value	Maximum 47			19
Calculation	Score40			16.17
Administrative Aspect			**2005**	**Value**
1	Corporate plan implementation	Full, partial or not	Partial	3
2	Organization plan and job description implementation	Full, partial or not based on Corporate plan	Partial	3
3	Standard operation procedure	Full, partial or not based on Corporate plan	Partial	3
4	As Built Drawing	Full, partial or not based on Corporate plan	Partial	3
5	Guideline of employee performance such as career and salary	Full, partial or not based on Corporate plan	Full	4
6	Master plan and company budget	Full, partial or not based on Corporate plan	Partial	3
7	Internal report	On time or not	On time	2
8	External report	On time or not	Not on time	1
9	Independent auditor's opinion	True without exception-Not true	True without exception	4
10	Action plan of investigation report of Last year	None finding-No action plan	Follow up	2
Total Value	Maximum 36			28
Calculation	Score 15			11.67
Classification	Score	Performance		
	>75	Very good		
	>60-75	Good		
	>45-60	**Enough**		**54.09**
	>30-45	Not enough		
	≤30	Not good		

(4) Comparison of PDAM in Unit cost

Table 7.2.13 Unit Cost of PDAM

(Unit Rp/m3)

PDAM	Yogyakarta	Sleman	Bantul
Production			
Raw water	38	0	-
Operation	217	567	-
Maintenance	24	26	-
Depreciation	98	56	-
Processing			
Operation	173	85	-
Maintenance	5	6	-
Depreciation	34	32	-
Sub Total	589	772	677
Transmit & Distribution			
Operation	146	169	-
Maintenance	22	42	-
Depreciation	87	367	-
Sub Total	255	578	271
Administration			
Personnel	379	779	-
Maintenance	68	98	-
Depreciation	68	26	-
Others	93	785	-
Sub Total	608	1,688	739
Total	1,452	3,038	1,687

Source: Composed by JICA Study Team from PDAM Financial statements
Details are not available from PDAM Bantul

It is noted that

1) production and processing cost sub-total of PDAM Sleman include electricity for Rp 301/m3 and fuel for Rp 104/m3

2) administration cost-others of PDAM Sleman includes delayed interest and penalty from the central government for Rp 687/m^3

7.2.3 SWOT Analysis of PDAM

Points of strength, weakness, opportunity and threat among others are as follows:

(1) PDAM Yogyakarta

Strength:
- Financial potentiality
- Efficiency in service area
- Administration

Weakness:
- Water loss
- Water source
- Scope of service

Opportunity:
- Business area

Threat:
- Population decrease tendency

(2) PDAM Sleman

Strength:
- Production capacity
- Gravity water source
- Shallow well

Weakness:
- Water loss
- Scattered population
- Water meter

Opportunity:
- New housing area
- Industrial area
- Water resources

Threat:
- Financial Situation
- Disconnection

(3) PDAM Bantul

Strength:
- Production capacity
- Piping network
- Quantity and pressure control system
- Fee collection system

Weakness:
- Water loss
- Water quality
- Water resources cost
- Scattered population

Opportunity:
- New housing area
- Industrial area
- Seaport

Threat:
- Disaster
- Disconnection

7.2.4 Policy and Strategy of Each PDAM

Based on SWOT analysis of each PDAM, gap between present condition and vision 2020 should be minimized by consensus on what to do as policy and how to do by strategy.

(1) PDAM Yogyakarta

- Funding source

As mentioned above, it is capable for borrowing. Depending on investment plan, whether

water source development and/or rehabilitation for water loss improvement or else, funding sources are needed. It is recommended 5 year corporate plan should be authorized and disclosed for further study.

- Creditability strengthening

Financial analysis shows healthy level. Performance classification category is good. PERPAMSI PDAM Kota benchmark listed top 10 PDAMs in 15 categories of financial indications. PDAM Yogyakarta appears in 8 categories. There are 8 primary benchmarks in PERPAMSI PDAM Kota including finance, customer, technical and operation. PDAM Yogyakarta appears in 5 categories among top 10 PDAM Kota. PERPAMSI PDAM Kota benchmark is shown in Appendix 7.1 Table 14.

(2) PDAM Sleman

- Reconstruction of corporation

Central and Sleman regional government should consider comprehensive support to reconstruct PDAM management and operation including debt payment due to the central government for Rp 20 billion (outstanding loan for Rp.11 billion and accrued interest for Rp.9 billion), and due to the regional government and others for Rp 2 billion as of 2005. In order to stop interest accrual and penalty, PDAM applied to Ministry of Finance and is waiting for "Write-Off of State/Regional Government Receivables" according to Law No.33/2004 and Government Regulation No.14/2005, and "Write-Off and Rescheduling of State Receivables and Regional Development Account Loan" according to MOF Regulation No.107/PMK.06/2005.

- Water meter

Among 19,500 registered household, broken water meters are 1,825 and not accurate are 9,800. Water meter must be replaced every 4 years, but not executed because customer's deposits were used to cover company's deficit[3]. The regional government is making investment for water meter according to PDAM projection, which is expected to complete by the end of 2006. This investment is being made by the fund of regional government at this stage. It may be recognized as governmental subsidy to the PDAM, and invested assets will be maintained by the PDAM.

- Connection

Total domestic connections since 1982 are 22,900 units, revoked or sealed are 5,300 units, monthly bill issued are 17,600 units including minimum usage, whereas registered household 19,500, and therefore 1,900 units are user-without payment. Some customers quit because of

[3] PDAM Sleman GAMBARAN April 2006

water quality without treatment or insufficient supply caused by distribution leakage[4]. PDAM is now doing door-to-door contact to solve the problem.

- Tariff

Tariff has been revised recently by BUPATI DECISION No 5/2006 which is shown in Appendix 7.5. Base tariff for residential A1 increase from Rp.1,000/m^3 to Rp.1,500/m^3. It is expected to improve operational cash flow in 2007 together with meter replacement mentioned above. The tariff is scheduled to increase every 6 month until base tariff reach Rp.2,000/m3. Tariff analysis is discussed with the tariff of PDAM Bantul.

(3) PDAM Bantul

- Operational cash flow

Water source cost increased due to electricity for pumping to almost 2 times in these 3 years. Revenues are increasing but there is a threat of disconnection because of complaints from customers about quality. In order to increase operational cash flow, scope of service area should be increased.

- Investment

Even though financial position is weak, 94% of equity ratio in 2005 shows the room for borrowing. The government support is essential to reach BEP (break even point). In 2003, WTP was installed in SEDAYU at the cost of regional government for Rp.3 billion. Water meters must be maintained properly to reduce NRW.

- Tariff

Collection system is one of strength because there is coordination with Bank Rakyat Indonesia and PDAM has service units at every Kecamatan in service. However, tariff has never been revised since 2002. It is recommended to revise periodically to catch up inflation. It is understood that PDAM Bantul is processing tariff revision based on the guideline and procedure stipulated in MOHA Decree which is shown in Appendix 7.6.
Tariff must be cleared article 3 of the guideline stipulating as follows:

1) Tariff must be affordable by the consumer, and
2) Affordability is not more than 4% of total income.

Tariff analysis was made comparing with 7 major PDAM tariff as shown in the following table. 7 major PDAMs are Jakarta, Surabaya, Bandung, Medan, Ujung Pandang, Malag and Semarang taken at random and whose tariff is shown in shown Appendix Table 15.

[4] PDAM Sleman PREDIKSI May 2006

Table 7.2.14 Tariff Comparison

Customer	Consumption Brakets	7 PDAMs 2000-2001 Average Rp/m³	7 PDAMs 2000-2001 Indicator (A2=100)	Sleman Tariff 2006 Rp/m³	Sleman Comparison with Average	Sleman Comparison with Indicator (A2=100)	Bantul Tariff 2002 Rp/m³	Bantul Comparison with Average	Bantul Comparison with Indicator (A2=100)	Yogyakarta Tariff 2005 Rp/m³	Yogyakarta Comparison with Average	Yogyakarta Comparison with Indicator (A2=100)
Social General	0-10	344	36	1,500	4.4	236	1,000	2.9	184	750	2.2	206
	11-20	361	38	1,500	4.2	224	1,000	2.8	174			
	above 20	475	50	1,500	3.2	171	1,000	2.1	133	800	1.7	159
Special Social A	0-10	429	45	1,500	3.5	189	1,000	2.3	147	750	1.7	165
	11-20	511	54	1,750	3.4	185	1,250	2.4	154			
	above 20	974	103	2,000	2.1	111	1,500	1.5	97	1,250	1.3	121
Average					3.4	186		2.3	148		1.7	163
Residential A1	0-10	758	80	1,500	2.0	107	1,000	1.3	83	750	1.0	94
	11-20	1,101	116	2,000	1.8	98	1,250	1.1	72			
	above 20	2,124	225	2,250	1.1	57	1,500	0.7	45	1,650	0.8	73
Residential A2	0-10	946	100	1,750	1.9	100	1,500	1.6	100	1,000	1.1	100
	11-20	1,391	147	2,250	1.6	87	1,875	1.3	85			
	above 20	2,669	282	2,500	0.9	51	2,250	0.8	53	1,650	0.6	58
Residential A3	0-10	1,230	130	2,000	1.6	88				1,650	1.3	127
	11-20	1,796	190	2,500	1.4	75						
	above 20	3,061	324	2,750	0.9	49				1,950	0.6	60
Average					1.5	79		1.2	73		0.9	85
Small Commercial	0-10	2,509	265	3,900	1.6	84	2,500	1.0	63	2,125	0.8	80
	11-20	3,049	322	3,900	1.3	69	2,500	0.8	52			
	above 20	4,937	522	4,500	0.9	49	3,000	0.6	38	2,775	0.6	53
Small Industry	0-10	2,696	285	5,000	1.9	100	2,500	0.9	58	3,200	1.2	112
	11-20	3,446	364	5,000	1.5	78	2,500	0.7	46			
	above 20	5,164	546	7,000	1.4	73	3,000	0.6	37	3,200	0.6	59
Big Commercial	0-10	3,611	382	4,250	1.2	64	3,000	0.8	52	4,250	1.2	111
	11-20	4,329	458	4,250	1.0	53	3,000	0.7	44			
	above 20	6,239	659	5,500	0.9	48	3,600	0.6	36	4,250	0.7	64
Big Industry	0-10	4,104	434	5,500	1.3	72	5,000	1.2	77	4,675	1.1	108
	11-20	5,106	540	5,500	1.1	58	5,000	1.0	62			
	above 20	6,936	733	8,000	1.2	62	6,000	0.9	55	4,675	0.7	64
Average					1.3	68		0.8	52		0.9	81

Source : Study team

Indicator means price against residential A2 whose minimum bracket is 100 and comparison with indicator means percentage against 7 PDAMs' indicator of 3 PDAMs' residential A2 whose minimum bracket is 100.

Since Yokyakarta bracket is different from others, comparison is not accurate but it relatively shows that progressive rate is low and that tariff for business is also low. PDAM Bantul should take into consideration progressive rate for the purpose of revenue and water save, and non-domestic tariff because they can add value and transfer cost to last beneficiaries.

7.2.5 The Master Plan

The master plan will be formulated in the next phase and above policy and strategy will be materialized in the master plan.

7.3 Community Water Supply System

7.3.1 Development Plan and Construction Process

(1) Development Plan

PU of district government deals with SPAM development for the area where PDAM does not provide service according to PP 16/2005. Following to MDG targets, DIY policy and strategy aims at service coverage of 80% for urban area and 60% for rural area by 2015. At this stage, community demand initiates application for development to village head after water source finding.

(2) Construction Process

Approval of Kabpaten PU by confirming WUO formation at the community and water quality check by Kabpaten Health Department is needed for water supply system construction.

After the development of system, it is given to village for their independent operation and maintenance. Water users association is maintained by social work. PDAM may help WUO for O&M training at the request of village head. Community water supply system organization chart is as follows:

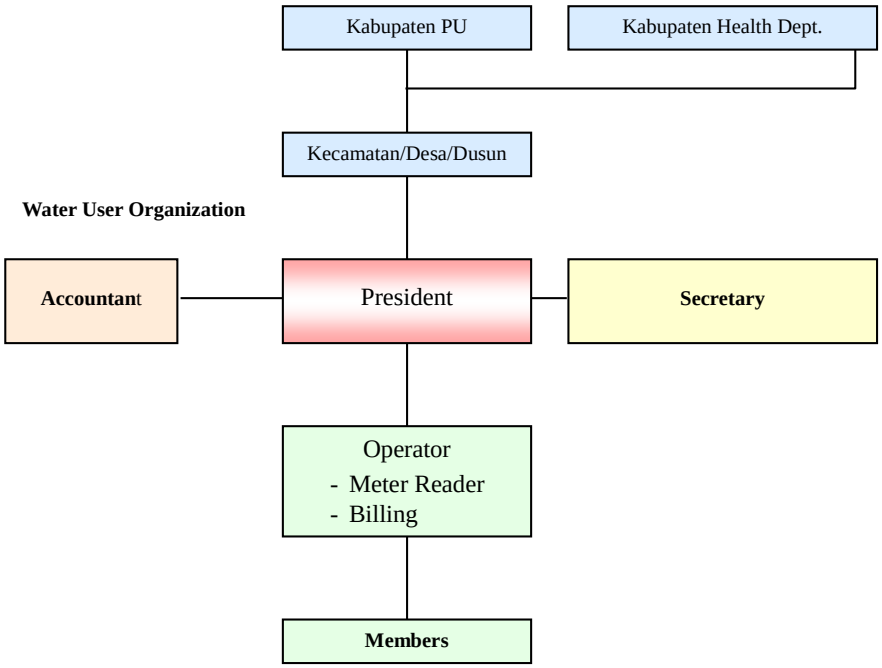

Figure 7.3.1 Community Water Supply Organization Chart

7.3.2 Funding

Initial capital investment is made by the Central Government through DAK (special allocation fund of the central government). DAU (general allocation fund from the central government) is also used for capital investment to AMD (Air Minum Desa).[5] In case of Bantul Region, investment cost is born by APBN for 80 percent and APBD for 20 percent. There are some cases with 100 percent born by APBN or in other cases, 10% of investment fund was contributed by community or in other community, labor contribution was made. Regulatory role of AMD is under the responsibility of regional PU with its budget and after the construction, O&M is WUO's responsibility but repairs or replacement of property is often carried out by donor's fund such as UNICEF.

7.3.3 Present WUO

In the study area there are community water supply system servicing clean water with water user organization. At present there are one system in Kota Yogyakarta for urban poor, 40 systems in Sleman region and 63 systems in Bantul region both for rural people.[6]

Water users are organized at DUSUN level (community in village) normally by 100～200 household. There is a water user organization DESA level in Sleman District with more than

[5] see Table 7.1.5 Capital Investment for Water Supply
[6] Since there in no monitoring database, information obtained by site visit survey.

3,000 household like quasi PDAM. They have their own name of organization such as "TIRTA MULYA" or "MITRA TIRTA SEMBADA"

Scale of water users association under EPP in Bantul District is relatively small as 24～75 HH (household) in each 7 systems in 5 DUSUN, which are now controlled by a coordinator and by DESA officials for reconstruction of damage caused by the earthquake. The disaster is affecting water sources. Shallow wells dry up and pumping pipe must go down to the depth of 65m from 10m before the earthquake. It cost Mangnan II for Rp.33 million to install a set with electric pump.

Organization is maintained by volunteer with the concept of GOTONG-ROYONG.

Water fee is fixed for around Rp.4,000～Rp.20,000/HH/month in Sleman District. There are few who have house connection with water meter. House connection cost is born by the beneficiary. In Bantul District, water fee from farmers is fixed for Rp.7,000 ～ Rp.8,000/HH/month and from others it is fixed for Rp.20,000～Rp.30,000/HH/month. In EPP, water fees are now under suspension except electricity minimum charge for Rp.40,000/system/month.

In Yogyakarta city, there is a system named as "UAB TIRTA KENCANA" for Kampung located along the Code river banks with low income household. Development accomplished by the community is as follows:

1991: UAB Tirta Kencana was founded. The water was delivered to 6 household.
1999: Ministry of Public Work provided water pump, production and distribution pipes which delivered water to 23 householders.
2001: Under the program of redevelopment and rehabilitation of slums areas by Ministry of Public Work, coverage area expanded to 55 household.
2006: CIDA and AIT assisted to increase the coverage to 115 household together with Gadjah Mada University's water purification technology.

Each house has water meter with rental cost Rp.1,500/month. Water fee is Rp. 9,000/HH/month up to 15m3, additional Rp.700/m3 to 30m3 and Rp.1,000/m3 for over 30m3. Electricity cost of motor for tanks in the amount of one million rupiah per month is a burden for them.

7.3.4 O&M Situation

O&M is carried out by WUO. Labor service is being normally done at volunteer base except

pump operator and tap keeper. Tariff is decided to share recurrent O&M cost such as electricity consumption charges, over head tank cleaning charges and labor salary etc. Capital cost can not cover by the tariff. Door to door tariff collection is made by tap keeper. It is observed there are problems in electricity price hike and pump motor replacement cost to improve sustainability. Research conducted by Bantul Kabpaten Health Department found 80% of well water of community water supply system was not proper to consume especially in the southern region of Bantul city.[7]

7.3.5 Governmental Administration

No data base is available in both PU at Sleman and Bantul even though PU of district government is obliged to deal with SPAM development. It is useful for WUO to make annual report to the regional government to exchange information and necessary assistance for sustainable operation and maintenance of the system including donor's support.

7.3.6 Recommendation

DIY Province Government issued Governor Decision No.2/TIM/2007 regarding establishment of the Team for formulation of Regional Policy and Strategy for SPAM on the day of January 5, 2007. The DIY Government and the three District Governments are about to prepare the regional policy and strategy for SPAM. It is recommended that regional government put priority on funding for SPAM in rural area development, database construction for monitoring sustainability and invite donor's assistance.

[7] PDAM Bantul Corporate Plan 2001-2005