11.4 Existing Condition

In this section, to understand the existing conditions concerning unaccounted-for water, information of the itemized categories provided by the PWA Headquarters, Regional Office and Waterworks will be examined.

11.4.1 Total Unaccounted-for Water

The data of water production, water sales and unaccounted-for ratio from 1978 to 1984 are shown in Table-11.1 and plotted in Fig-11.1.

Similar monthly data from October 1984 to April 1986 are shown in Table-11.2 and plotted in Fig-11.2. Table-11.2 lists the number of connections and unaccounted-for water per connection per month also.

The data in 1978 - 1984 show that the ratio fluctuated from 20 to 56 % and the more recent data of 1984 to 1986 show the ratio's fluctuation narrowed from 12 to 27 %. In Table-11.2, the average of 16 months, from Oct. 1984 to Apr. 1986, was 36 % and that of 12 months of 1985 33.2 %.

However, the authenticity of the recent data was doubted, because the flow meters measuring the output of two treatment plants, both Ubon and Warin, were out of order when inspected by the leakage survey team.

Lacking reliable means of measurement, the reported water production was estimated by the distribution pumps' rated capacity and the duration of pumping operation. Change of the rated capacity under the back pressure of distribution and by the aging of the pumps were disregarded.

Installing a ultra sonic flow meter on the outlet pipe of the Warin Treatment Plant, measurement of the plant's output was made on two days for 24 hours. Fig-11.3 and 11.4 show the flow pattern on the two days and the output, the accumulated flow, was 3,975 cu m/day for the first day (Fig-11.3) and 3,692 cu m/day for the second day (Fig-11.4).

For the first and second day, the estimated output estimated by the present practice were 3,382 and 2,962 cu m/day respectively (Table-11.3).

The underestimation was 15 % for the first day and 20 % for the second day. Although the same test was not made on the output of the Ubon Treatment Plant, similar situation might have existed there also.

When the unaccounted-for ratio is calculated on underestimated production, the ratio is underestimated, too.

When an actual production of 100 cu m/d is underestimated by 15 %, the production is counted as 85 cu m/d and if 65 % of the 85 cu m/d is sold and 35 % is estimated as the unaccounted-for ratio, then;

actual production	:	10 cu m/d
estimated production	:	85 cu m/d
estimated sales	:	55.2 cu m/d (85 x 0.65)
estimated unaccounted-for	:	29.8 cu m/d (85 x 0.35)
actual unaccounted-for	:	44.8 cu m/d (100 - 55.2)

If the underestimation of the output is 20 %, the actual unaccounted-for ratio will be 52 % instead of the estimated 35 %.

As mentioned before, the presently estimated ratio is about 35 %, but hereafter 45 % will be considered as existing.

Table-11.1 PAST UNACCOUNTED-FOR WATER RATIO

YEAR	TOTAL WATER PRODUCTION (cu m/year)	TOTAL WATER SALES (cu m/year)	UNACCOUNTED-FOR WATER RATIO (%)
1975	5,317,308	3,722,116	30.0
1976	4,055,682	2,905,198	28.4
1977	4,723,337	3,186,709	32.5
1978	7,343,766	3,226,800	56.1
1979	7,188,892	4,587,058	36.2
1980	6,536,757	3,685,100	33.5
1981	6,215,186	4,943,187	20.5
1982	7,412,564	4,856,392	34.5
1983	7,186,391	5,511,141	22.8
1984	8,028,823	5,131,667	36.1

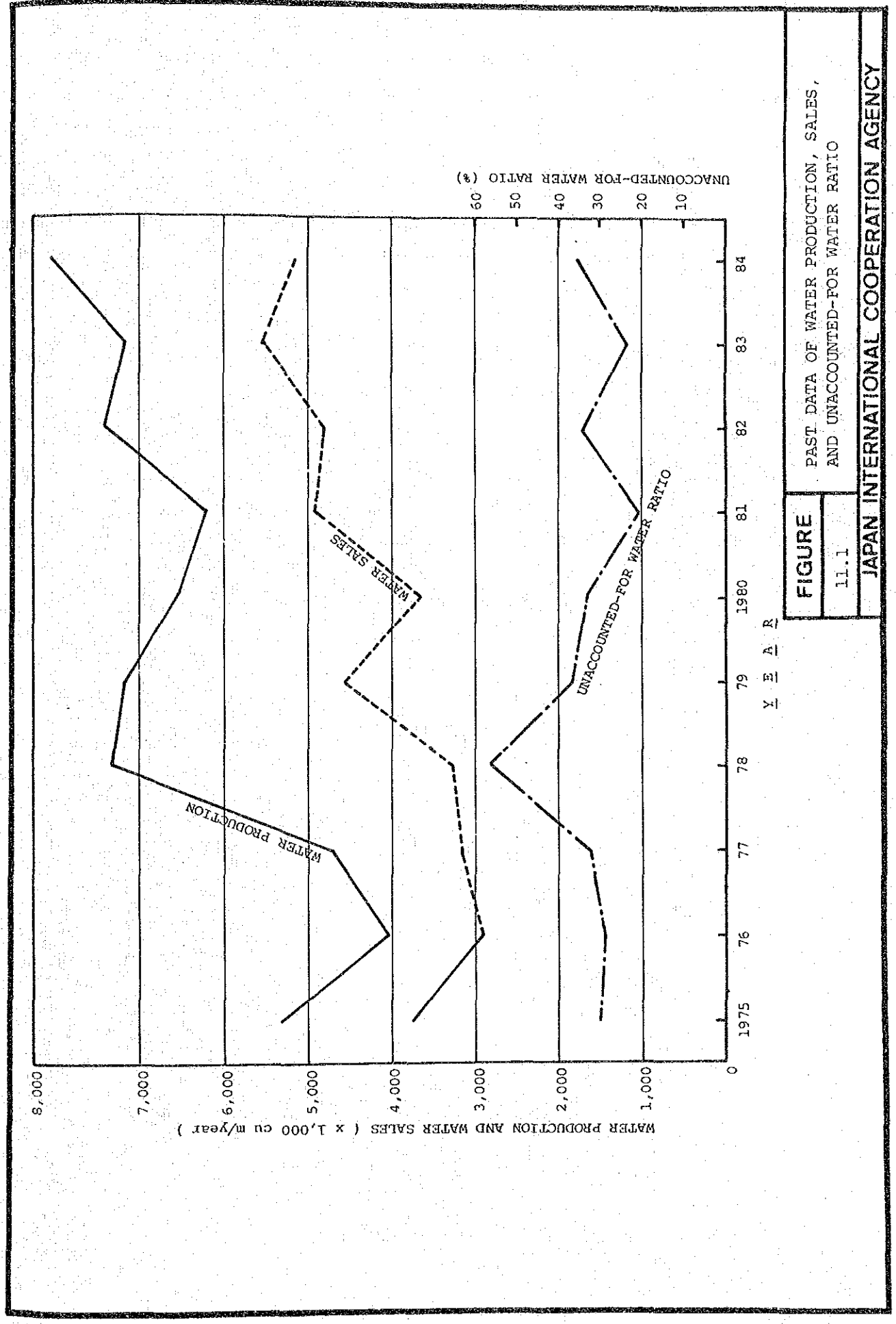

FIGURE 11.1 PAST DATA OF WATER PRODUCTION, SALES, AND UNACCOUNTED-FOR WATER RATIO

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Table-11.2 RECENT DATA OF WATER PRODUCTION AND WATER SALES IN UBON AND WARIN

	(A) WATER PRODUCTION (cu m/month)	(B) WATER SALES (cu m/month)	(C) UNACCOUNTED -FOR WATER (cu m/month)	D=(C/A)x100 UNACCOUNTED -FOR WATER RATIO (%)	(E) NUMBER OF CONNECTION (number)	(F)=(C)/(E) UNACCOUNTED -FOR WATER PER CONNEC. (m3/con/mon)
OCT. 1984	646,082	336,428	309,654	47.9	10,344	29.9
NOV.	627,268	408,094	219,174	34.9	10,279	21.3
DEC.	608,070	379,328	228,742	37.6	10,425	21.9
JAN. 1985	602,520	415,267	187,253	31.1	9,873	19.0
FEB.	632,427	373,760	258,667	40.9	9,963	26.0
MAR.	649,500	376,032	273,468	42.1	9,983	27.4
APR.	590,185	391,067	199,118	33.7	10,124	19.7
MAY.	614,094	434,739	179,355	29.2	10,128	17.7
JUN.	543,990	379,090	164,900	30.3	10,127	16.3
JUL.	525,505	337,324	188,181	35.8	10,145	18.5
AUG.	515,030	394,200	120,830	23.5	10,197	11.8
SEP.	506,600	376,194	130,406	25.7	10,249	12.7
OCT.	516,506	360,959	155,547	30.1	10,943	14.2
NOV.	503,840	347,336	156,504	31.1	10,979	14.3
DEC.	503,030	290,766	212,264	42.2	11,012	19.3
JAN. 1986	541,080	302,378	238,702	44.1	11,081	21.5
FEB.	528,050	318,735	209,315	39.6	11,116	18.8
MAR.	619,770	352,405	267,365	43.1	11,169	23.9
TOTAL	10,273,547	6,574,102	3,699,445	AVE, 36.0		
TOTAL OF YEAR 1985	6,703,227	4,476,734	2,226,493	AVE, 33.2		

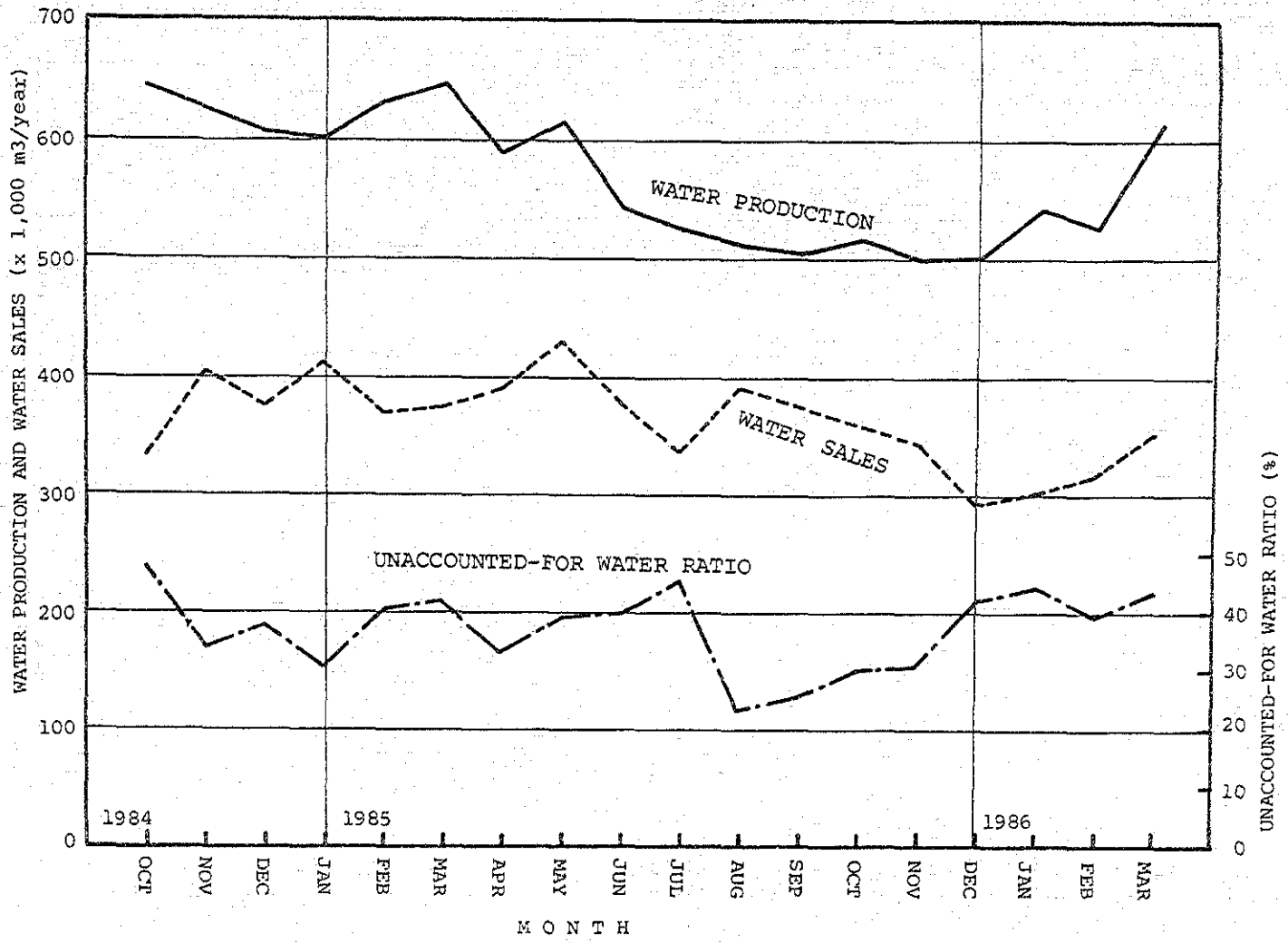

FIGURE	RECENT DATA OF WATER PRODUCTION, SALES AND UNACCOUNTED-FOR WATER RATIO
11.2	

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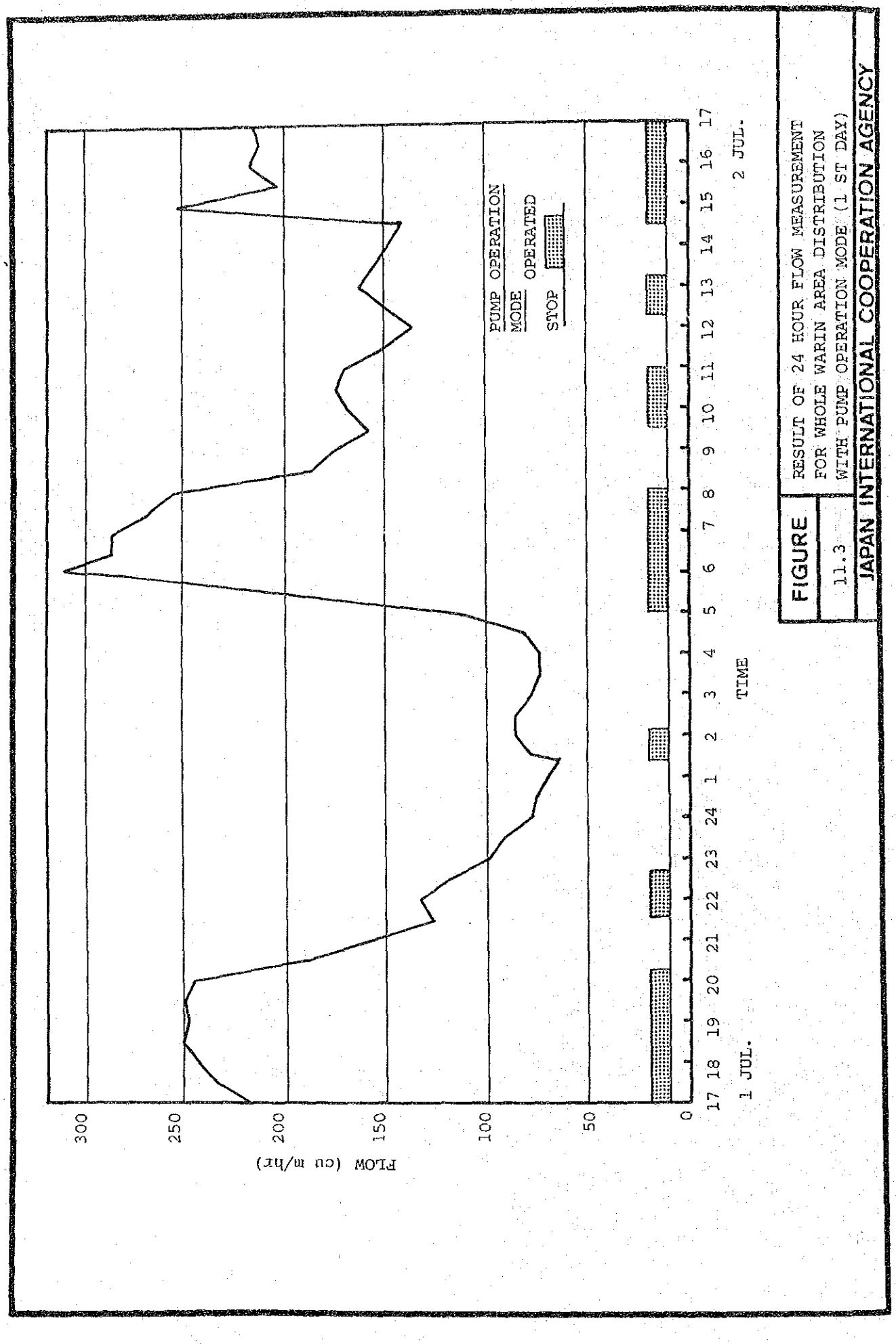

FIGURE 11.3

RESULT OF 24 HOUR FLOW MEASUREMENT FOR WHOLE WARIN AREA DISTRIBUTION WITH PUMP OPERATION MODE (1 ST DAY)

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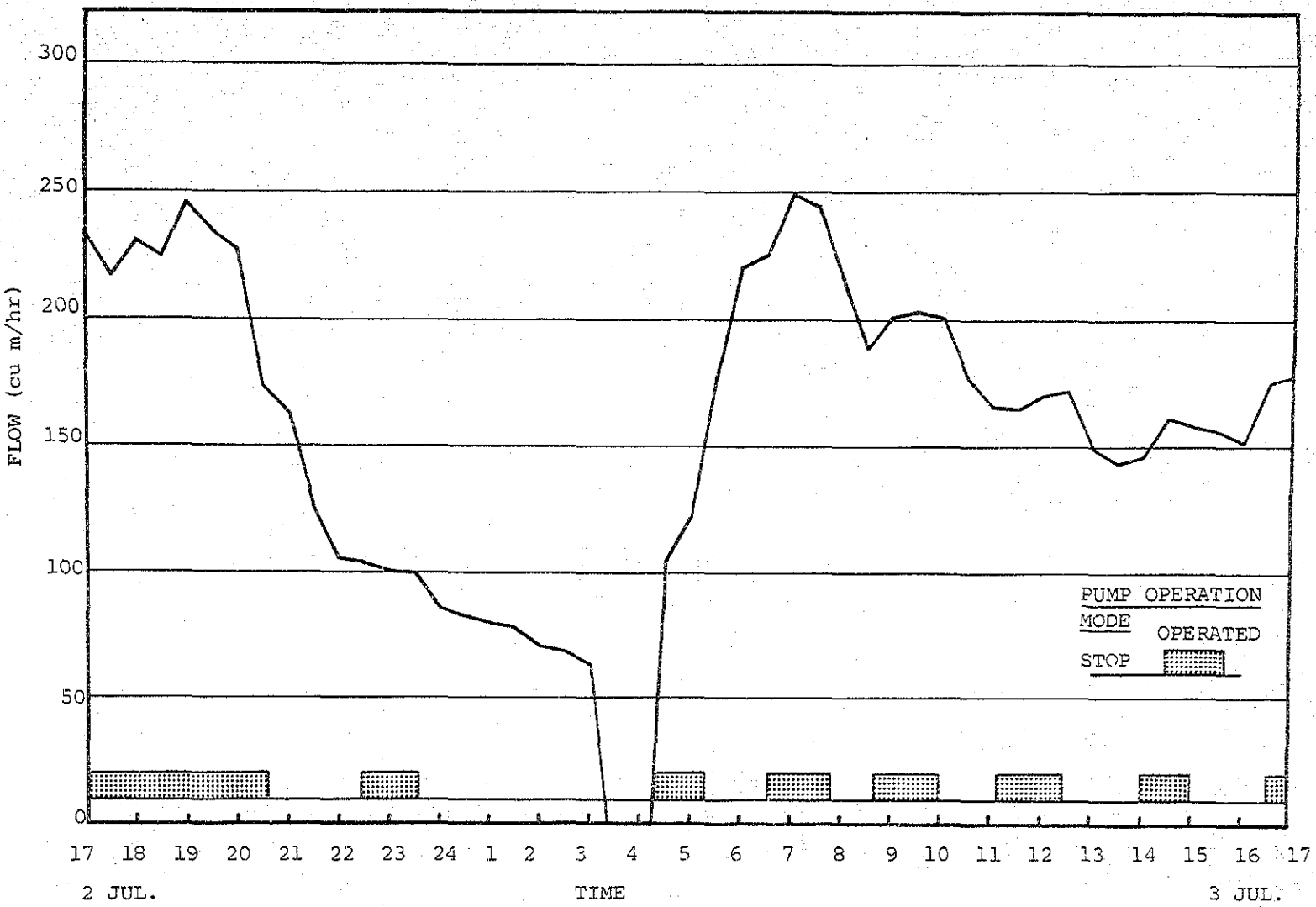

FIGURE	RESULT OF 24 HOUR FLOW MEASUREMENT FOR WHOLE WARIN AREA DISTRIBUTION WITH PUMP OPERATION MODE (2 ND DAY)
11.4	

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Table-11.3 PUMP OPERATION DATA OF WARIN TREATMENT PLANT

1. 1st day (1 Jul. to 2 Jul., 1986)

Operation Time Start - Stop	Operation Period (hr)	Pump Capacity (cu m/hr)	Flow Quantity (cu m)
17:00 - 20:15	3.25	250	1012.5
21:35 - 22:40	1.08	300	540.0
1:20 - 2:10	0.83	300	474.0
5:00 - 6:00	1.00	250	460.0
6:00 - 8:00	2.0	250	700.0
9:30 - 11:00	1.50	250	575.0
12:15 - 13:15	1.00	250	450.0
14:30 - 17:00	2.50	250	625.0
		Total =	3,381.5

2. 2nd day (2 Jul. to 3 Jul., 1986)

Operation Time Start - Stop	Operation Period (hr)	Pump Capacity (cu m/hr)	Flow Quantity (cu m)
17:00 - 20:35	3.58	250	1095
22:25 - 23:35	1.16	300	574
4:15 - 5:20	1.08	300	574
6:35 - 7:50	1.42	250	580
8:40 - 10:00	1.33	250	563
11:00 - 12:30	1.33	250	563
14:00 - 15:00	1.00	250	480
16:00 - 17:00	1.00	250	125
		Total =	2,962

11.4.2 Illegal Connection

Illegal connections are usually uncovered by information from neighboring consumers.

When an illegal connection is uncovered, the consumer must pay, in addition to the penalty fixed under the PWA regulation, the tariff for the stolen water on the estimation by PWA. The penalty for a 1/2 in. illegal connection is ฿5,000.

The informer is awarded with 20 % of the penalty and 50 % of the water tariff paid to PWA by the illegal consumer.

The record of illegal connections uncovered in Ubon-Warin Waterworks is shown in Table-11.4.

Table-11.4 NUMBER OF ILLEGAL CONNECTION FOUND

MONTH (1985)	NUMBER OF ILLEGAL CONNECTION FOUND
JAN	3
MAY	2
JUN	1
AUG	1
SEP	2
OCT	1
NOV	2
DEC	1
TOTAL =	13

Data Source: Ubon-Warin Waterworks

As shown above, 13 illegal connections in total were found in 1985 in Ubon-Warin. (4 in Pattaya, 12 in Chiangmai in the same year, for reference)

The illegal connections' number is less than 0.1 % of the total connections' number of 10,127 in the mid-term of 1985. Even if the illegal consumers use water more wastefully than other consumers, their consumption may be estimated at more or less than 1 % of the produced water.

1 % is counted for the unaccounted-for ratio by illegal connections.

11.4.3 Meter Reading Error

During the field leakage survey, it was found that some water meters were installed at inaccessible spots and others buried underground completely. Very probably those meters had not been read for several months, it seemed.

As no maps of showing the exact location of water meters has been prepared, spotting them shall depend fully on the meter readers' memory or the consumers' guidance.

Presently practiced is that a meter reader, once allocated to an area, is not transferred to other areas. Periodical change of the allocated area together with improvement of preparation of the maps will help decrease the error of meter reading.

So far no check system of preventing or decreasing the meter reading error has been tried and the unaccounted-for volume of water or ratio has not been available.

The loss due to meter reading error is not counted herein.

11.4.4 Metering Loss

According to the manufacturers' information, - 5 % error is tolerated for the least flow rate at about 30 l/h in a 1/2 inch meter. The error becomes larger when the flow rate falls lower.

When water is discharged from a tap opened ordinarily under normal pressure, the flow is larger than the said 30 l/h and under-registration is

not brought about.

However in Ubon-Warin, the field survey disclosed that many consumers' taps, slightly opened, were dripping to fill vessels in kitchen and bathroom. The practice might have come from unsteady and unreliable supply condition in the past. The flow rate, apparently less than 30 l/h, results in under-registering the actual consumption, another cause of the unaccounted-for water.

From the result of meter accuracy test which was carried out for 10 consumers' meters in Pattaya (See Appendix 11 of Pattaya Report), it was learned that the difference between the master meter and the sum of tested consumers' meters was 4 %. The average age of tested meters was 5 years after installation.

Fig-11.5 shows the result, classified by the size and age, water meters surveyed in Ubon-Warin.

60 % of all the meters is used in the service for more than 6 years and nearly 25 % of it for more than 11 years, without being replaces and chacked of accuracy of measurement.

Upon consideration of the above, the unaccounted-for ratio due to under-registration of meter is assumed as 5 %.

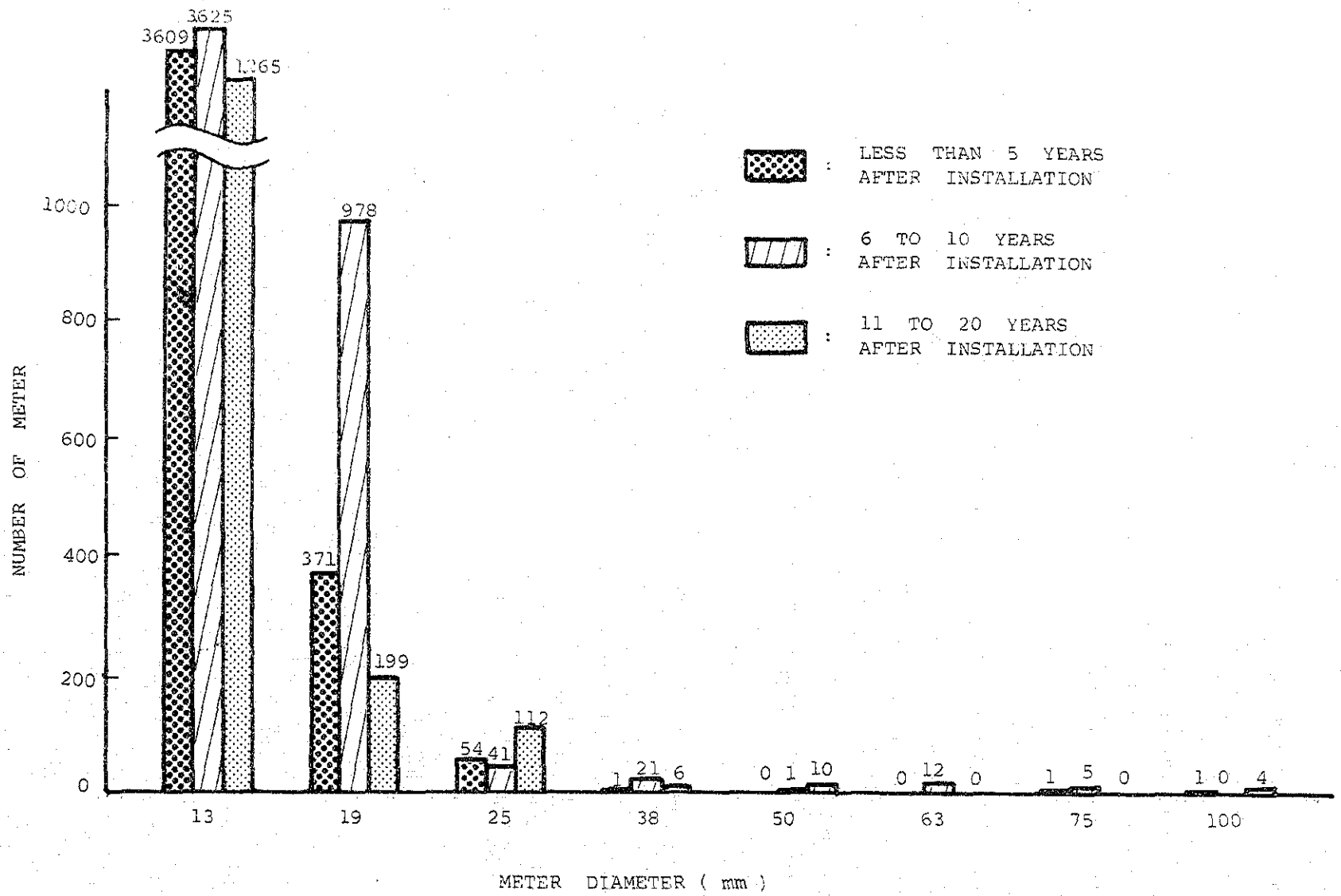

FIGURE	CONSUMER'S METER CLASSIFICATION BY METER SIZE AND YEARS AFTER INSTALLATION
11.5	

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11.4.5 Leakage

In the foregoing subsections estimated were: 45 % for the total unaccounted-for ratio, 1 % for illegal connections, nil for meter reading error and 5 % for meter loss (under-registration).

The leakage ratio, deducting the sum of 1 % and 5 % from 45 %, is calculated as 39 % therefore.

Detection of leakage in Ubon-Warin is mostly made accidentally by the consumers, passers-by and waterworks staff. Receiving information from them, the waterworks send personnel to repair the leaking spots.

Fig-11.6 shows the numbers of repair works made in 1985. On the average, five spots were repaired in a day. In spite of such efforts of the waterworks, presumably undetected and or uniformed leakage is taking place, because the detection of leakage is done in passive way as mentioned above.

The leakage ratio resulted from surveying two cases, a big block of 206 connections and a small block of 106 connections, was 8.4 % for the big and 9.2 % for the small, far lower than the 39 % estimated previously.

The reason for difference between the above leakage ratios is considered to be as follows:

1) The condition of the survey blocks was found to be better than anticipated beforehand. The Study Team collected the information on the existing pipe condition from the waterworks staff to select the survey blocks in the area where leakage had occurred frequently. Actually many leaks were found out but they were small quantitatively.

2) During the survey period, the study team found accidentally rather big leaks in the commercial area, out of the survey block. It is likely that many big leaks are taking place in areas other than surveyed blocks.

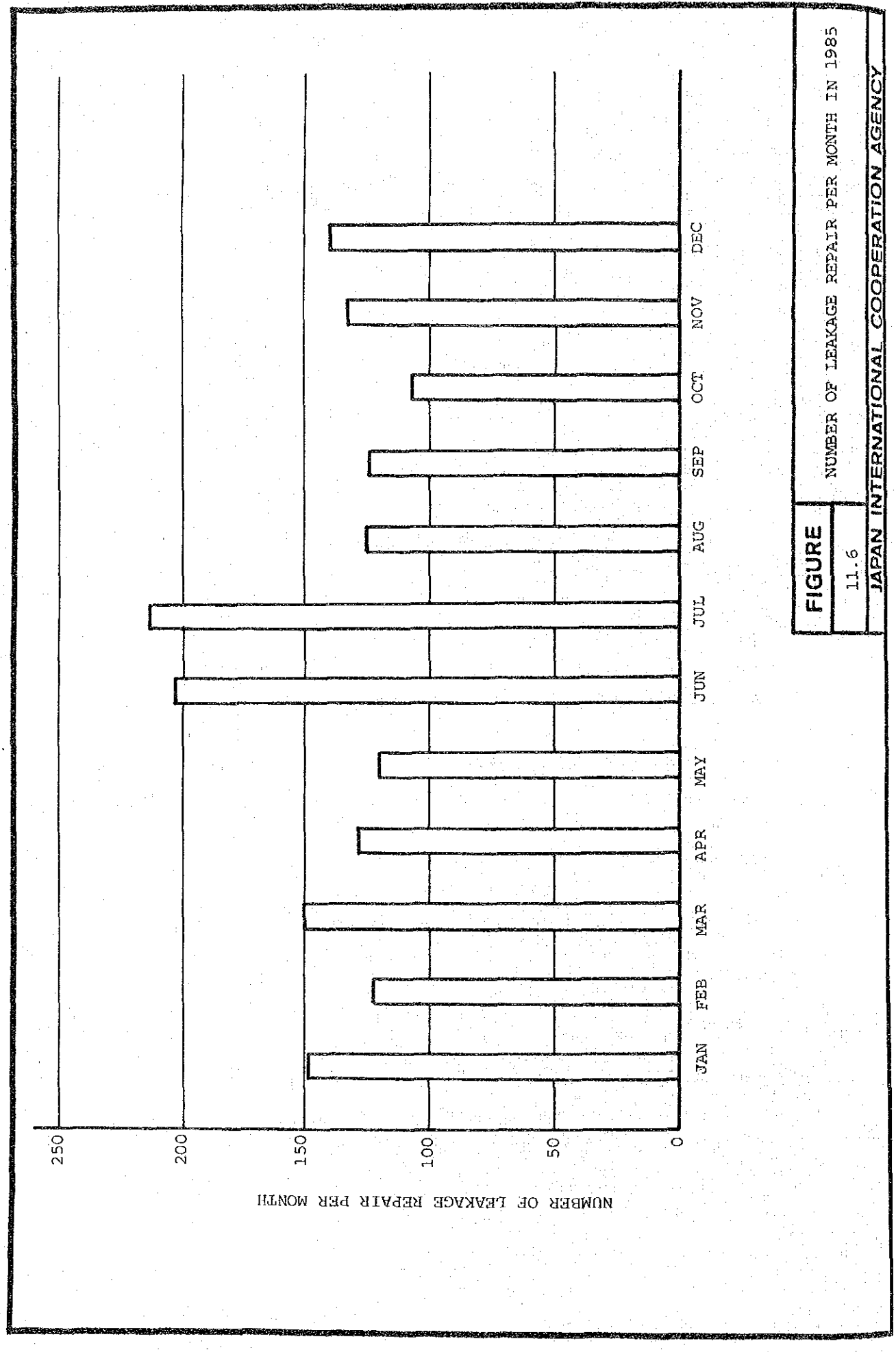

FIGURE 11.6 NUMBER OF LEAKAGE REPAIR PER MONTH IN 1985

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11.4.6 Conclusions

In Ubon-Warin, the leakage loss is largest of the several factors affecting the unaccounted-for ratio, and there is much possibility in reducing it.

But the efforts to lower not only leakage but each factor of the unaccounted-for ratio are worth making, as described in the following sections.

11.5 Reduction of Unaccounted-for water

11.5.1 Illegal Connections

The present situation of illegal connection, estimated at 1 % of the total unaccounted-for water, is very satisfactory. The PWA regulation which imposes penalty upon the unlawful consumers and awarding the informers seems to be effective.

In fact however, no assurance is given whether all illegal connections have been uncovered and such connections will not be made anymore in future.

Desirable approaches will be promoting public relations to stimulate the public-mindedness of people against such illegality and encourage meter readers and bill collectors to find illegal connections.

11.5.2 Meter Reading Error

Estimating the error made in reading water meters is most difficult and it was counted out of the unaccounted-for water estimation.

However, some ways of preventing and decreasing can be discussed herein.

It is necessary to make a guideline or manual for installing meters in rightful ways. Basic considerations will be that the meters are safe from accidental damage, inundation and suchlike and easy for connection, disconnection and reading. The existing meters installed wrongly shall be relocated.

Also necessitated is that the ledgers and maps of recording every house connection in the distribution system shall be prepared and filed, so that they are made available to any waterworks official.

As suggested previously in 11.4.3, rotating the allocated areas of meter readers are worth trying.

11.5.3 Metering Loss

Metering loss, or the loss due to under-registration of meters, in Ubon-Warin was assumed as 5 % in the ratio.

The figure was established partly on the manufacturers' information and the observation of the manner of water consumption, backed up by the result of field leakage test.

The following measures are recommended for reducing the loss:

1) Maintaining Accuracy

Overhaul at regular intervals, say 6 years, changing parts and checking accuracy, is to be practiced and records of the overhaul be kept in file.

2) Checking Meter Size

Over- or under-sized meters register inaccurate consumption. A meter size shall be checked periodically of its suitableness for consumption especially for large consumers.

11.5.4 Leakage

To prevent future occurrence of leakage, much consideration is to be given in selecting pipe material and class, pipeline route and alignment, burying and joining methods of new pipelines. When rehabilitation and repair works are made on existing pipelines, unreliable parts of pipeline shall be thoroughly replaced, abandoned parts be cut off from living parts completely.

Of distribution pipelines, maps recording exact alignment, depth, location of valves, fittings, service connections shall be prepared and filed. In case any change is made on existing conditions, like by road improvement and urban renewal, the maps shall be updated immediately.

Of every service connection, a ledger and map shall be made and filed. In them, length, size, material of service pipes, location of service connection, stop valve, meter shall be recorded. They are subject to updating when necessary, too.

Availability of those maps and ledgers is indispensable for successful execution of leakage control.

Fig-11.7 shows a case of leakage control program drawn schematically.

PREPARATORY WORKS

Preparatory works are the works to be done in preparation of execution of the leakage control program.

Training of staff in detection and repair of leakage control is to be given at all the levels of PWA, Head Office, Regional Office and waterworks.

In Regional Office and waterworks organization, a team assigned to leakage control is formed by the trained staff.

The team selects areas for the leakage survey plan, upon consideration of various factors like the past occurrence of leakage, consumption in the area, etc.

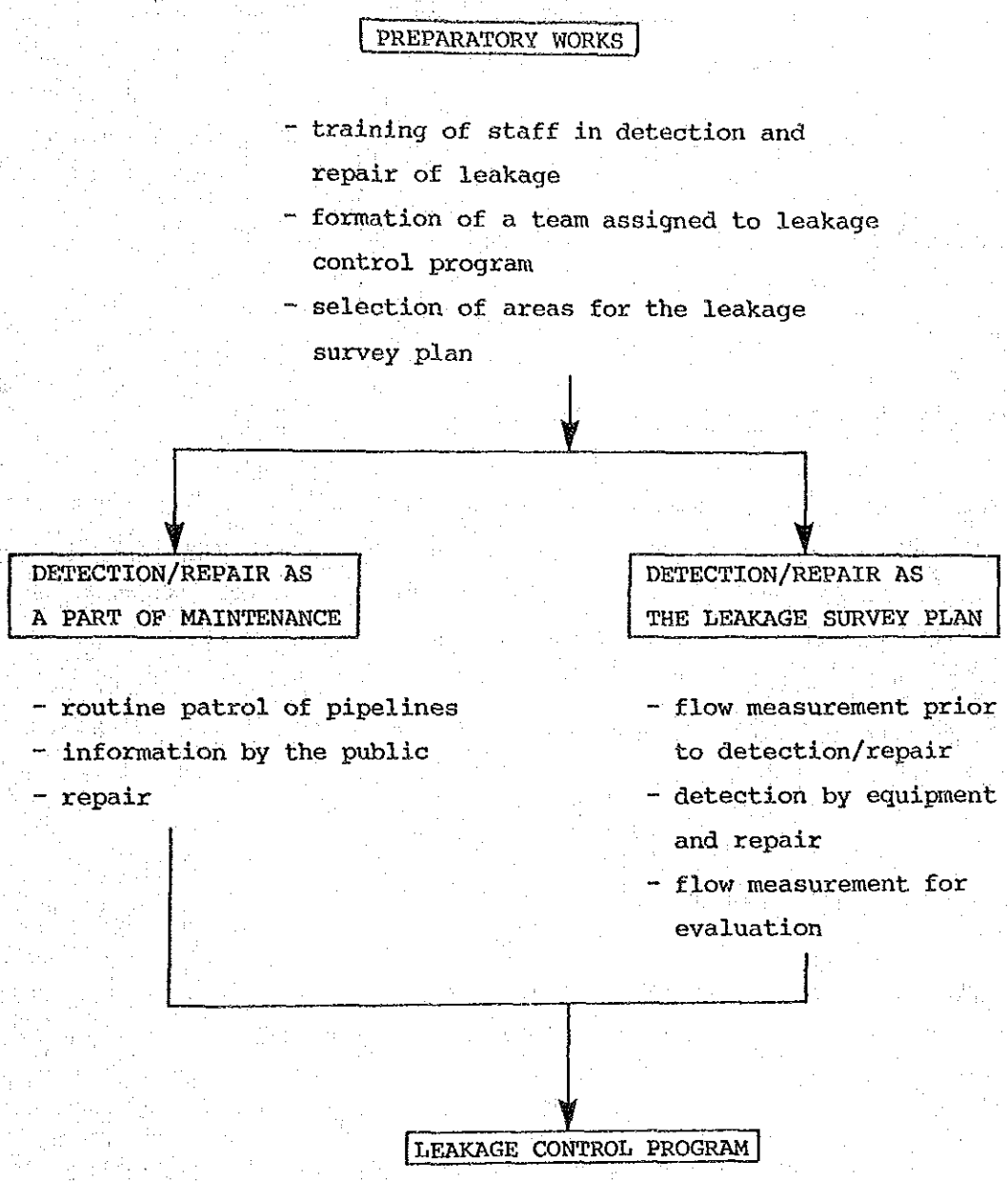

FIGURE	LEAKAGE CONTROL PROGRAM
11.7	

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DETECTION/REPAIR AS A PART OF MAINTENANCE

Patrol of pipelines to detect leakage, under a plan, is practiced as a routine work of the maintenance.

Information given by the public of leakage is responded with gratitude.

Leakage detected by the patrol and reported by the public is repaired by the maintenance staff, as a routine work also.

DETECTION/REPAIR AS THE LEAKAGE SURVEY PLAN

The inflow to the selected area is measured before and after the detection and repair works. The pre-measurement is to gain informations of existing pressure/flow conditions affected by the consumption and leakage. The post-measurement is to evaluate the detection/repair works' effectiveness.

The leakage survey plan carried out for the Ubon/Warin waterworks is reported in the attached paper.

LEAKAGE CONTROL PROGRAM

Informations of the distribution pipework and service connections gained in the leakage survey plan's implementation shall be used for updating the existing maps and ledgers.

The result of the leakage survey plan is to be used for controlling the pressure in the surveyed area, as overpressurization is found to affect adversely on leakage sometimes.

Overall evaluation of leakage reduction works shall be made under the coordination of engineers, administrative and financial managers. The effectiveness of implementation of the leakage control program shall be studied from the angles like cost performance, working conditions of personnel, organization re-structuring as well as technical improvement.

The leakage control program shall be executed at regular intervals. Because the leakage ratio of Ubon-Warin estimated at 39 % presently shall be lowered to realize the planned unaccounted for ratio in 2010, 20 %.

ATTACHMENT

FIELD LEAKAGE SURVEY

ATTACHMENT

FIELD LEAKAGE SURVEY

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1. Introduction

The field leakage survey in Ubon-Warin was carried out from June 30 to July 11 in 1986, and covered 2.3 % of the distribution pipes of whole length of the network as shown in Fig-11.8. The field leakage survey aimed the following goals.

1) to identify the preparatory works necessitated for effective execution of a leakage abatement program in future

2) to transfer practical know-hows of handling the instruments used for leakage survey and to introduce the methodology of leakage survey to the counterparts

3) to study major causes of leakage

4) to recommend a leakage abatement program prepared based on all findings of the leakage survey

2. Method of Leakage Survey

In this leakage survey, a certain area was isolated from the rest of distribution areas by closing appropriate valves, and then measurement of the inflow to the area was made for 24 hours continuously and sound detection of leakage within the area was carried out at midnight when the background noise was lowest. The advantage of 24 hours' measurement was that it could study about the minimum flow at midnight as well as the flow pattern in the area.

A flow meter of the portable ultra-sonic type, made by Tokyo Keiki in Japan, was installed on an inflow pipe to the area, a closed system without connection to other distribution areas.

Two ways of the midnight measurement were carried out. One was named the direct measurement and another the indirect measurement.

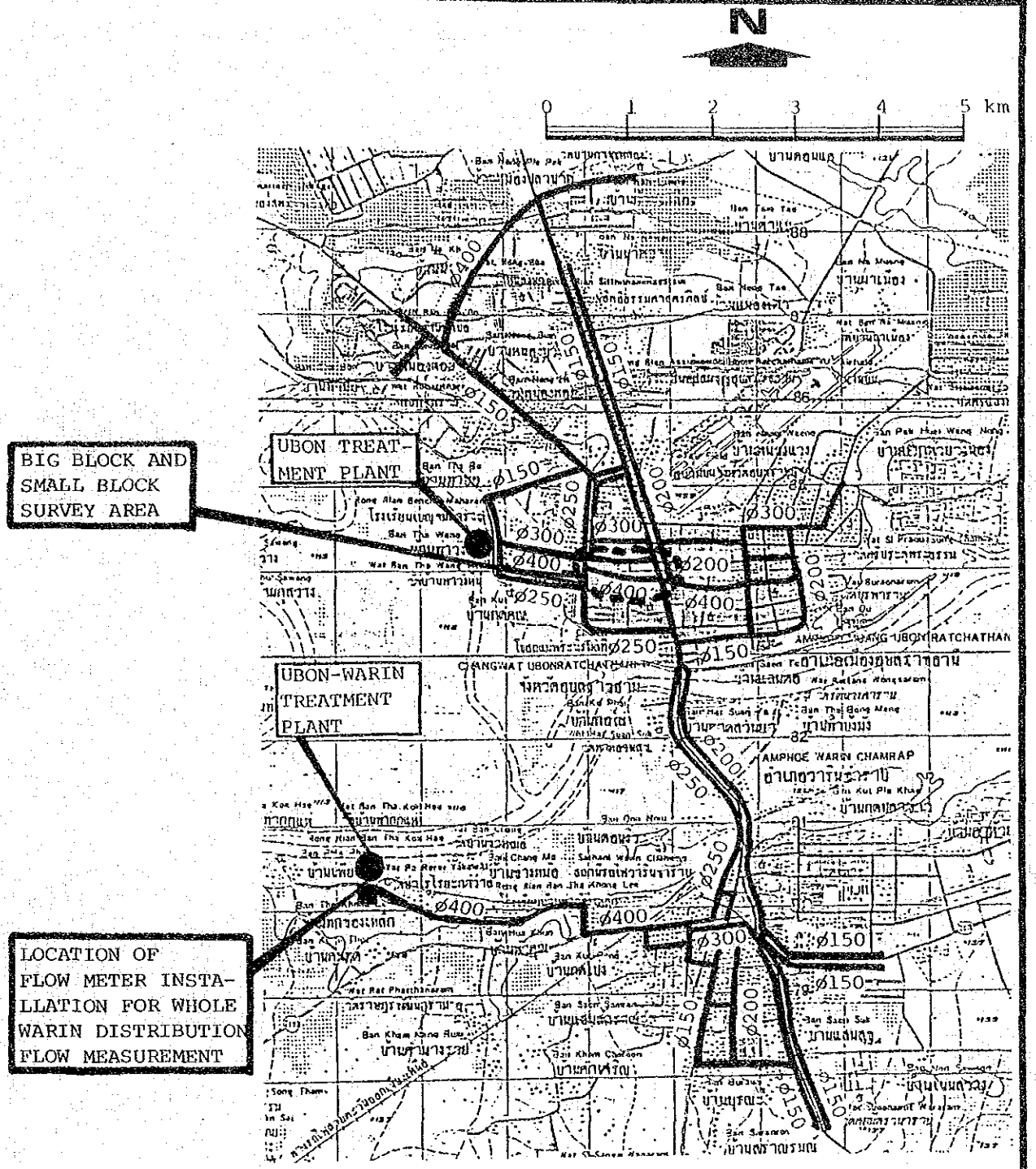

FIGURE	LOCATION OF LEAKAGE SURVEY AREA
11.8	

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The direct measurement was measuring the inflow, after all consumers' taps were ensured to have been closed. The reading indicated the leakage loss presumably.

The indirect measurement was measuring the inflow without any assurance of the consumers' tap condition. The reading can be approximate to the leakage loss, as the consumption at midnight would be small negligibly.

To train the PWA counterparts on the methodology and technology described above, two areas, named "Big Block" and "Small Block" because of their size, were selected as the pilot area of survey. The direct measurement was made on the Small Block and the indirect measurement on the Big Block.

In selecting the survey area (block), the following matters were considered:

(1) the survey block is not a newly developed one
(2) leakage in the block seems to be highly probable, according to the waterworks' experience
(3) pipelines in the block are partly or wholly made of the so-called Class 15 Asbestos Cement Pipe manufactured years ago for low pressure service
(4) service pressure in the block is relatively high
(5) the block is entirely of residential use and does not contain any consumers like factories, hotels, hospitals and facilities which use water for 24 hours continuously
(6) the inflow pipe is conveniently conditioned for installation of the flow meter

Details of the steps taken in the leakage survey is shown in Figs-11.9 and 11.10 schematically.

To ask the consumers' cooperation for closing their taps during the midnight survey, from 1:00 to 4:00 a.m. on the appointed date, announcement was made by distributing handbills to every consumer in the area, prior to "Measurement Procedure" shown in Fig-11.10 for the survey of the Small Block.

PREPARATION PROCEDURE

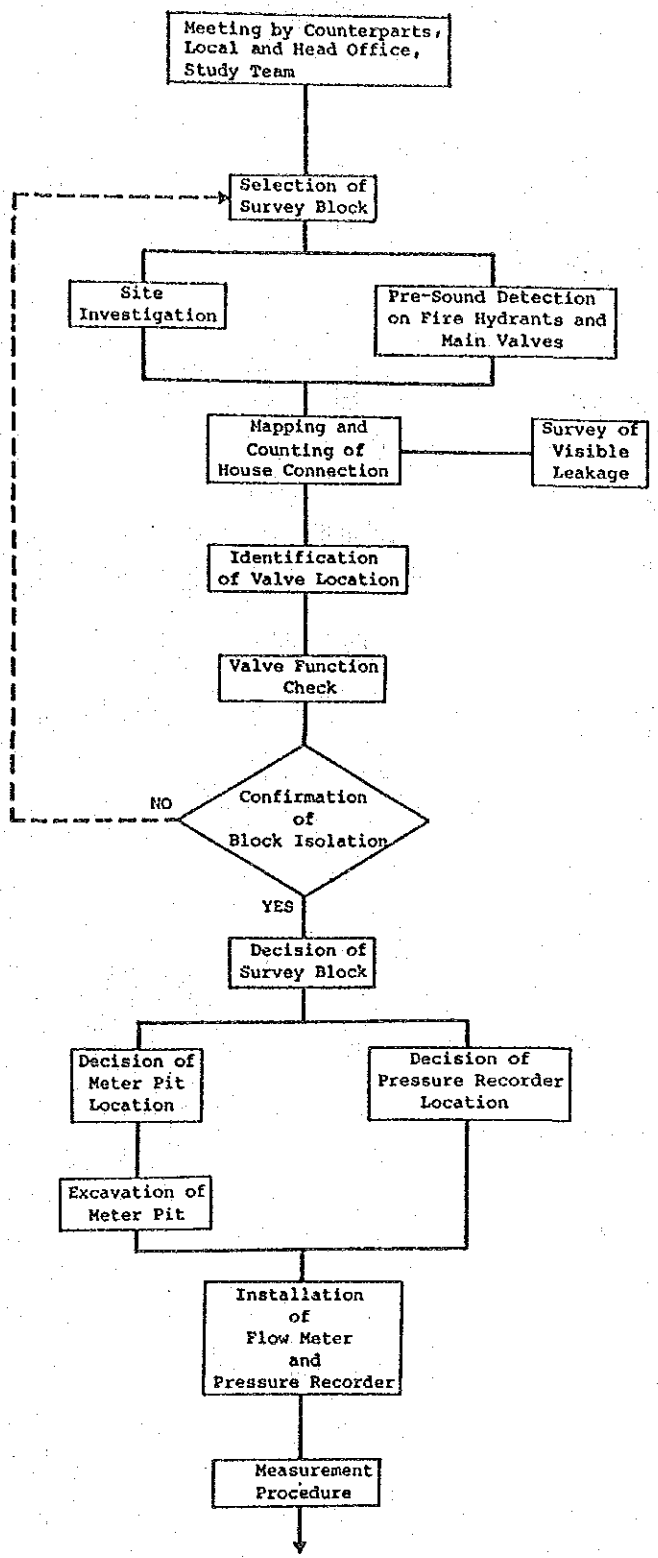

FIGURE	PREPARATION PROCEDURE FOR LEAKAGE SURVEY
11.9	

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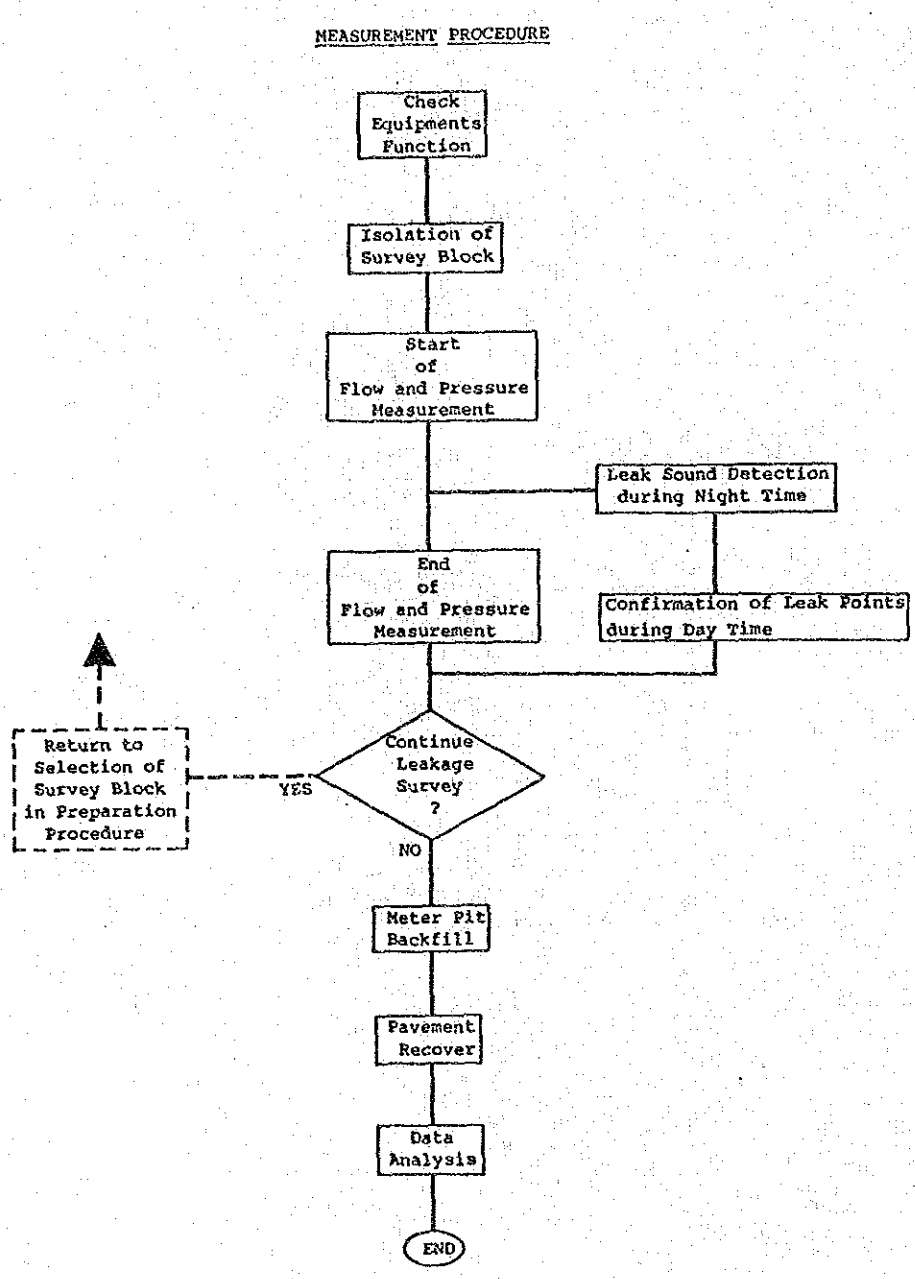

FIGURE	MEASUREMENT PROCEDURE FOR LEAKAGE SURVEY
11.10	

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3. Activities of Leakage Survey Team

Six counterparts from the PWA Head Quarters, Ubon Regional Office and Ubon-Warin Waterworks worked willingly with the Study Team. The activities of the Study Team and the counterparts are summarized below.

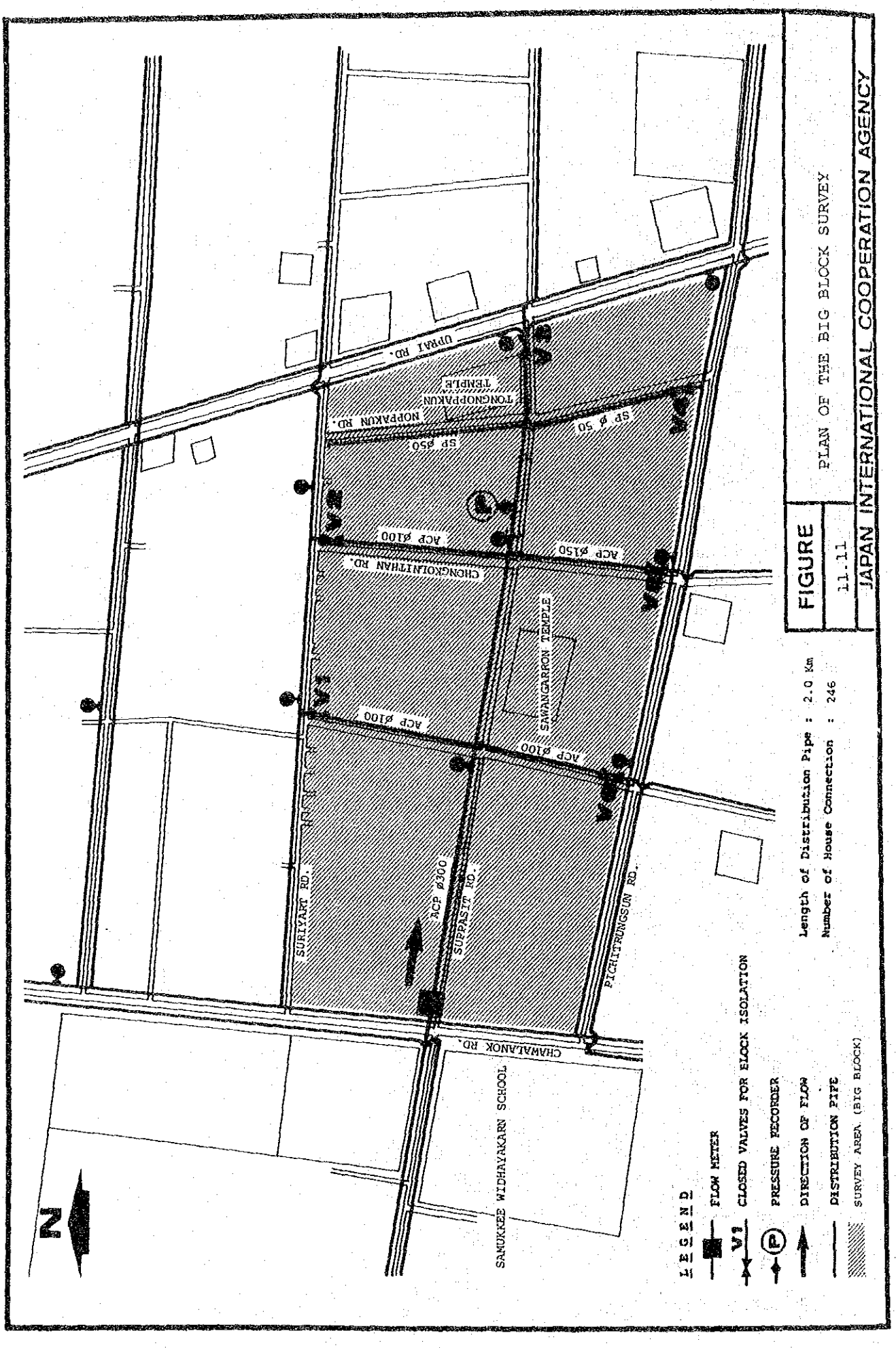
3.1 Big Block Survey

The area, of which the total length of distribution pipes is 2.0 km and the number of house connections 246, was selected as a Big Block. Materials of the distribution pipes in the survey block were of ACP Class 15 (0.76 km), ACP Class 20 (0.84 km) and SP (0.4 km). The SP pipe was not shown on the existing maps. It was found during the confirmation work of the block isolation. Most of the service pipes were of SP and PVC pipes are used for some connections.

Regarding the Big Block, the Study Team intended to select an area which covered at least 500 house connections but after site investigation, it was found that necessary valves for block isolation were missing under pavement, or inoperatable because of deterioration even when located with a metal locator. Eventually, the requirement of connection number was found unrealistic.

The Study Team selected the 246 connections area as a Big Block. The plan of the Big Block is shown in Fig-11.11. A pit was excavated to install the flow meter on the inflow pipe (ACP, ϕ300) to the survey block, and a pressure recorder was installed on a consumer's faucet. There were four fire hydrants in the block, but all of them could not be used for the pressure recorder installation, because they were found leaking when operated.

24 hours' measurement of the flow and pressure was carried out from July 8 to July 9, 1986. During the 24 hours' measurement, locating leaking spots was tried by detecting sound with stethoscopic bars and sound detectors. Several spots of leakage, invisible but detectable by sound, were located and confirmed of leakage on the next day, after digging the ground. The leakages were repaired immediately by the service section of the water-works.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SAMUKKEE WIDHAYAKARN SCHOOL
CHAWALANOK RD.
SURIYART RD.
SUPPASIT RD.
PICHITRUNGSUN RD.
CHONGKOLNITHAN RD.
UPRAI RD.
NOPPAKUN RD.
TONGNOPPAKUN TEMPLE
SAWANGARON TEMPLE
ACP ø300
ACP ø100
ACP ø150
SP ø50
LEGEND
FLOW METER
CLOSED VALVES FOR BLOCK ISOLATION
PRESSURE RECORDER
DIRECTION OF FLOW
DISTRIBUTION PIPE
SURVEY AREA (BIG BLOCK)
Length of Distribution Pipe : 2.0 Km
Number of House Connection : 246
FIGURE
11.11
PLAN OF THE BIG BLOCK SURVEY
JAPAN INTERNATIONAL COOPERATION AGENCY

3.2 Small Block Survey

The area, of which the length of distribution pipes is 0.7 km and the number of house connections, was selected as a Small Block. Material of distribution pipe is ACP (Class 15), the plan of the Small block is shown on Fig-11.12.

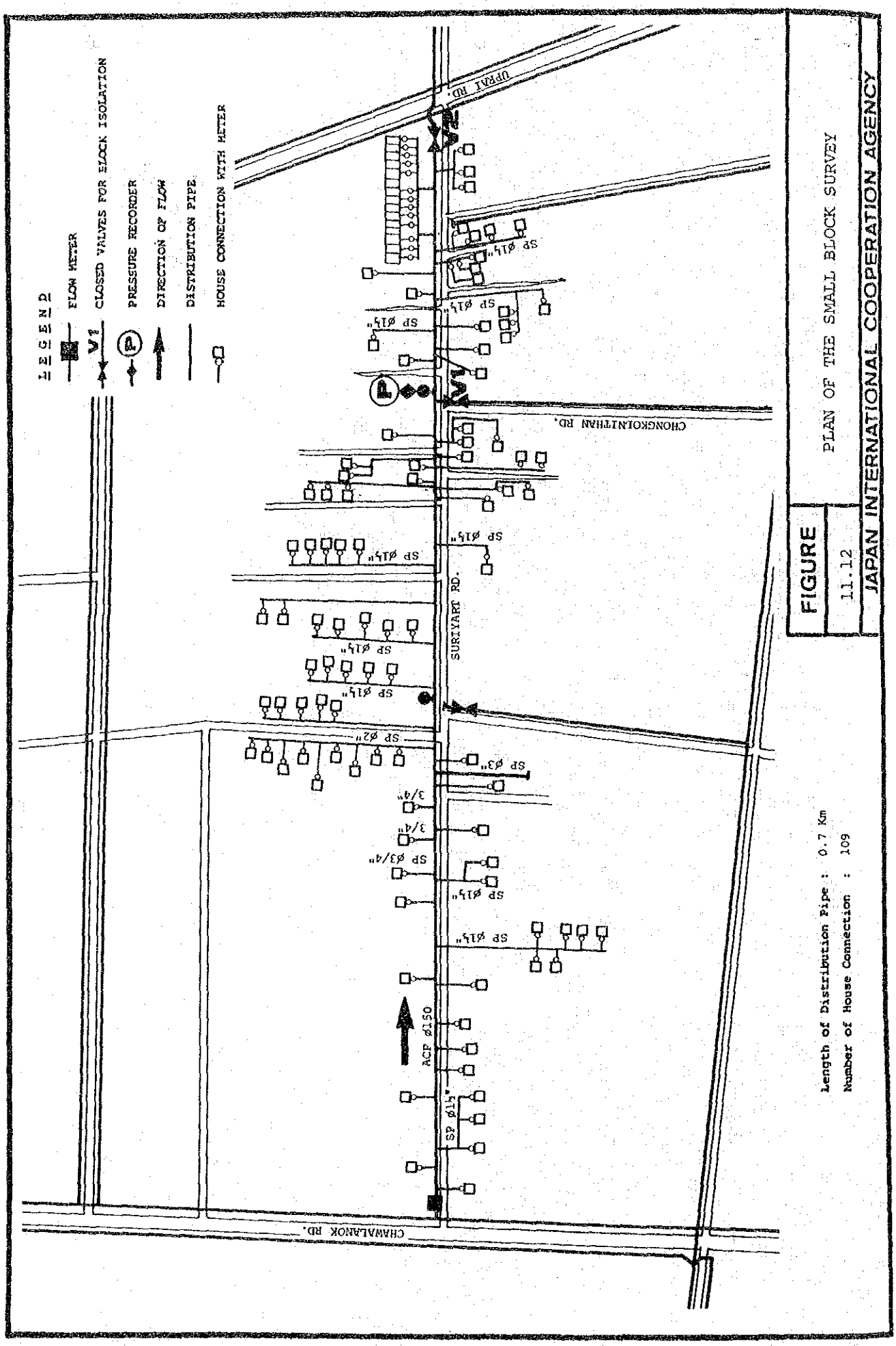
Regarding selection of a Small Block, in cases of the similar leakage surveys carried out in Pattaya, Suphanburi and Chiangmai a section of the Big Block was selected as a Small Block, but in Ubon a Small Block was selected out of the Big Block.

A pit was excavated to install the flow meter on the inflow pipe (ACP, ϕ150) to the survey block and a pressure recorder was set on a fire hydrant as shown in Fig-11.12.

24 hours' measurement of the flow and pressure was carried out on July 9 to July 10, 1986.

Concurrently with the measurement, sound detection of leakage on the distribution pipes was made, using stethoscopic bars and sound detectors.

To see whether the consumers' taps were closed as requested by PWA, every service pipe was sound-detected at midnight. Where the result was positive in a few cases, the service pipe were inspected the next day and faulty taps were found to be the cause.


LEGEND
FLOW METER
CLOSED VALVES FOR BLOCK ISOLATION
PRESSURE RECORDER
DIRECTION OF FLOW
DISTRIBUTION PIPE
HOUSE CONNECTION WITH METER
UPRAI RD.
CHONGKOLNITHAN RD.
SURIYAPT RD.
CHAWALANOK RD.
SP Ø1½"
SP Ø2"
SP Ø3"
SP Ø3/4"
3/4"
ACP Ø150
SP Ø1½"
FIGURE
11.12
PLAN OF THE SMALL BLOCK SURVEY
JAPAN INTERNATIONAL COOPERATION AGENCY
Length of Distribution Pipe : 0.7 Km
Number of House Connection : 109

3.3 Technology Transfer of Leakage Survey to the Counterparts

Two counterparts of the O & M Department of PWA Head Quarters, two counterparts of the Ubon Regional Office and two counterparts of Ubon-Warin Waterworks were assigned to work closely with the Study Team, throughout the survey period.

One of the objectives of this leakage survey was to transfer the know-hows of handling instruments, as well as the methodology of leakage survey to the counterparts, so that they would be able to prepare a similar program in future.

Ubon Regional Office and Ubon-Warin Waterworks were found in possession of main instruments used widely in leakage survey, as listed in Table-11.5. They were the same ones the Study Team intended to demonstrate and fortunately some of the counterparts had used them before. So the demonstration and instruction of handling the instruments were smoothly understood by the counterparts.

Though the instruments were familiar, practical lessons of using them in the field survey had not been given by experienced leakage survey experts before, it seemed. Skillful use of the instruments is essential in bearing effective results, especially with leak sound detectors and stethoscopic bars, as many kinds of sound, resembling leakage sound, disturb right judgment.

In this survey, however, an experienced leakage expert of the Study Team could give practical know-hows to be used in searching for and locating leakage spots to the counterparts, through the field work.

The ultrasonic flow meter used in this survey was promised for donation to PWA after the completion of the study and familiarization with the meter was thought to be important. Practical method of installation and operation was demonstrated in details by the Study Team. The counterparts tried hard in leaning them with positive willingness.

In addition to the practical know-hows of field survey, the methods of planning like selecting a survey area in the distribution network were learned by the counterparts.

All of the counterparts, while gaining practical experience, became aware of existing problems of obstacles to be tacked by themselves. Those problems discussed during the survey by the Study Team and counterparts are raised and summarized in Chapter 5.

Table-11.5 INVENTORY OF THE INSTRUMENTS FOR LEAKAGE SURVEY

Ubon Regional Office

1.	Water Leak Detector (Fuji WL-200)	2 sets
2.	Electric Sound Detector (Fuji FSB-4L)	3 sets
3.	Metal Locator (Fuji F-80)	4 sets
4.	Iron Pipe & Live Cable Locator (Fuji PL-801)	4 sets
5.	Non Metallic Pipe Locator (Fuji PL-130)	1 set
6.	Water Pressure Recorder (Fuji DW-4892)	4 sets

Ubon-Warin Waterworks

1.	Water Leak Detector (Fuji WL-200)	1 set
2.	Electric Sound Detector (Fuji FSB-4L)	1 set
3.	Metal Locator (Fuji F-80)	1 set
4.	Iron Pipe & Live Cable Locator (Fuji PL-801)	1 set

4. Survey Result

4.1 Big Block Survey

4.1.1 Flow and Water Pressure

24 hours' flow and pressure patterns measured in the Big Block are shown on Fig-11.13. The minimum flow was 0.8 cu m/hr and the maximum flow 22.5 cu m/hr. The minimum pressure observed was 1.3 kg/sq cm in early morning and the maximum pressure 2.4 kg/sq cm during day time.

Three distribution pumps (nominal capacity 400, 400, 200 cu m/hr respectively) are ordinarily operated during day time and one pump (200 cu m/hr) is operated during midnight. The reason why the pressure during midnight is relatively lower than the one during daytime is due to the shift operation of these three pumps.

The 24 hours' flow into the Big Block was 528 cu m/day, when integrated mathematically.

4.1.2 Leakage Detected

Nine leaking spots were found in the Big Block survey. Two underground leakages were detected by sound during the night and confirmed by digging the next day. Some of the seven leaks on exposed pipes were sound-detected initially and tracked out while the others were detected visually.

During the measurement of flow at midnight, the flow showed apparently small values, suggesting no big leakage. Actually, the biggest leakage which was sound-detected, then repaired on the next day was estimated to be about 0.3 cu m/hr.

The cause of leakage were considered to be as follows:

a) Corrosion of Pipes

The produced water, uncontrolled of its low pH, may be a cause of corrosion. Heavy corrosion was recognized on the exposed pipes laid

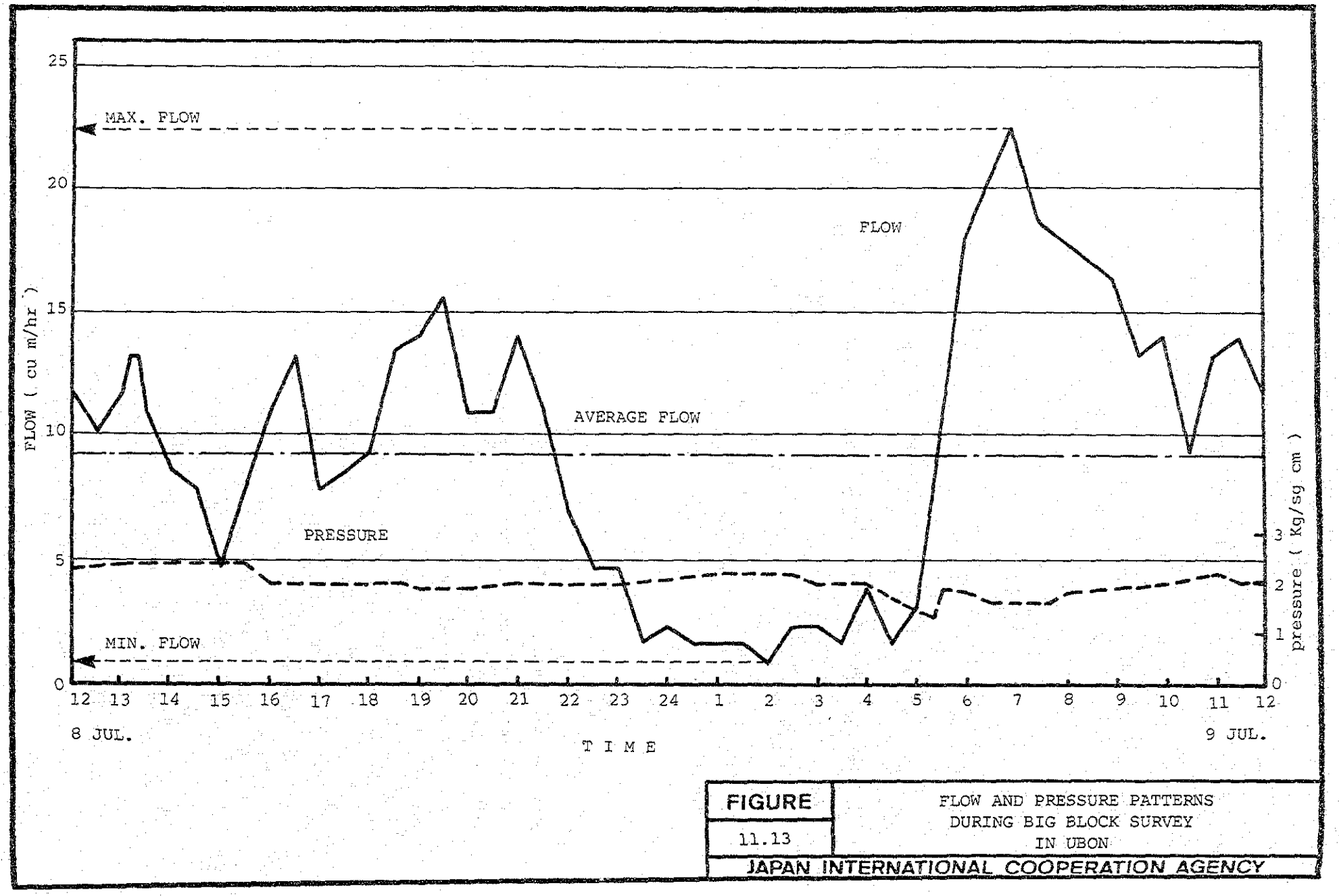


FIGURE	FLOW AND PRESSURE PATTERNS DURING BIG BLOCK SURVEY IN UBON
11.13	
JAPAN INTERNATIONAL COOPERATION AGENCY	

across/along sewer ditches and close to consumer meters.

b) Poor Workmanship of Service Pipe Laying

The buried depth is too shallow, indicating that PWA standards are not observed strictly. In backfilling rough-edged crushed stones and bricks, damaging to the pipes, are often used seemingly.

c) Poor Workmanship of Joint

Visible leakage is seen often on the joints of service pipes. Poor workmanship is suspected of causing it.

4.1.3 Leakage Ratio Estimation

Leakage ratio in the surveyed area was calculated, although it was not the sole purpose of this leakage survey.

The minimum flow at midnight was modified upon consideration of the difference of pressure, at midnight and average in the daytime, and it was designated as the leakage loss. The leakage ratio was 8.4 %. Under the average pressure, the leakage per unit pipe length per day was calculated as 9.2 cu m/km/day.

4.2 Small Block Survey

4.2.1 Flow and Water Pressure

24 hours' flow and pressure patterns measured in the Small Block are shown in Fig-11.13. The minimum flow and the maximum flow were 0.4 cu m/hr and 12.2 cu m/hr, respectively. The minimum pressure was observed at 0.5 kg/sq cm around midnight and the maximum pressure was observed at 2.0 kg/sq cm pressure around 3 p.m. The pressure fluctuation was due to the pump operation described in 4.1.1.

The 24 hours' flow into the Small Block was 121 cu m/day, when integrated mathematically.

4.2.2 Leakage Detected

Five leaking spots were found in the Small Block survey. Two underground leakages were detected by sound during the night and confirmed by digging the next day. Three leakages on exposed pipes were tracked out.

The main cause of the leakage was found to be pipe corrosion.

4.2.3 Leakage Ratio Estimation

The minimum flow was modified upon consideration of the difference of pressure, at midnight and average in the daytime, and it was designated as the leakage loss. The leakage ratio was 9.2 %. Under the average daytime pressure, the leakage per unit pipe length per day was calculated as 15.8 cu m/km/day.

4.3 Summary of Survey Results

The results of both Big Block Survey and Small Block Survey are summarized in Table-11.6.

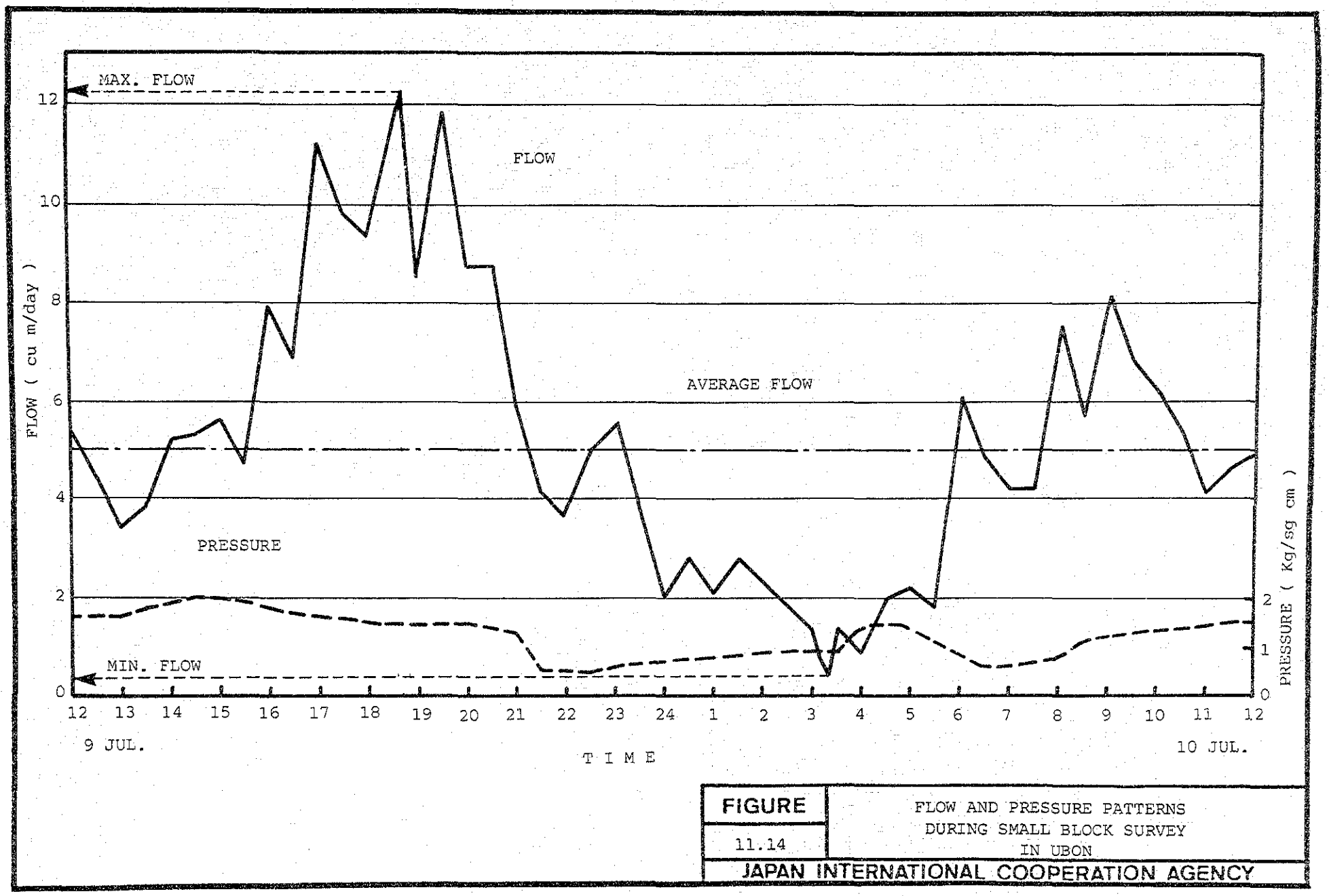


FIGURE	FLOW AND PRESSURE PATTERNS DURING SMALL BLOCK SURVEY IN UBON
11.14	
JAPAN INTERNATIONAL COOPERATION AGENCY	

Table-11.6 SUMMARY OF SURVEY RESULTS IN UBON

	ITEM OF RESULTS	UNIT	BIG BLOCK	SMALL BLOCK
A	LENGTH OF DISTRIBUTION PIPE	(km)	2.0	0.7
B	NUMBER OF HOUSE CONNECTION	(number)	246.0	109.0
C	MAXIMUM FLOW	(cu m/hr)	22.5	12.2
D	MINIMUM FLOW	(cu m/hr)	0.8	0.4
E	AVERAGE FLOW	(cu m/hr)	9.1	5.0
F	ACCUMULATED FLOW	(cu m/day)	219.0	121.0
G	MAXIMUM PRESSURE	(kg/sq cm)	2.4	2.0
H	MINIMUM PRESSURE	(kg/sq cm)	1.3	0.5
I	AVERAGE PRESSURE	(kg/sq cm)	2.0	1.2
J	PRESSURE WHEN THE MINIMUM FLOW WAS OBSERVED	(kg/sq cm)	2.2	0.9
K	AVERAGE WATER FLOW PER PIPE LENGTH PER HOUR	(cu m/hr/km)	4.6	7.1
	***** ASUMING : MINIMUM FLOW = LEAKAGE *****			
L	MODIFIED LEAKAGE BY AVERAGE PRESSURE	(cu m/hr)	0.8	0.5
M	LEAKAGE AMOUNT PER DAY	(cu m/day)	18.3	11.1
N	ESTIMATED LEAKAGE RATIO	(%)	8.4	9.2
O	LEAKAGE PER PIPE LENGTH	(cu m/day/km)	9.2	15.8
P	LEAKAGE PER HOUSE CONNECTION	(cu m/day/con.)	0.1	0.1

NOTE : F = E x 24
K = E / A
L = D x SQR(I / J)
M = L x 24
N = (M / F) x 100
O = M / A
P = M / B

5. Finding and Conclusion

Major findings of the survey are described as follows:

1) The existing drawings are not prepared satisfactorily. Some of new pipes and old valves are not shown. It is recommended to prepare complete drawings not only for leakage survey but also routine maintenance and future expansion plan.

2) Approximately 100 valves on the distribution pipes were recently replaced by the aid of the World Bank. But, even some of them in the drawings are undetectable, probably because of road construction work made later.

3) Some fire hydrants were found not-operable because of deterioration of the valves.

4) Visible leaks on exposed service pipes were particularly noticed, where they were laid along sewer flumes.

5) Of the fourteen (14) leak spots found in the Big and Small Block Surveys, the causes are supposed to be as follows:

Cause	Case
Corrosion	10
Loose or inappropriate joints	2
Malfunction of consumer's faucet	1
Deteriorated valve of service connection	1

6) The Study Team found accidentally two rather big leaks in the commercial area, out of the survey blocks. One appeared on the road surface, gushing through broken pavement from the underground. The other leak was found flowing into the bottom of a storm sewer pit. The waterworks staff explained that these leakages had not been repaired because they were inaccessible.

7) In Table-11.6, Item K designates the average water flow per hour per unit pipe length. When the value is larger, the probability of occurrence of leakage is considered to be higher.

For the Big and Small Blocks, the values were 4.6 and 7.1 respectively.

Another indicator is the number of connections per unit pipe length, calculated by dividing Item B by Item A in the table and expressed in the unit of number/km. Again, the larger value suggests the higher probability.

For the Big and Small Blocks, the values were 123 and 155 respectively.

Collecting such data of various waterworks will be helpful in studying leakage problems comparatively and in making a guideline in future.

8) The leak volume calculated by the following formula is indicative of a pipeline's leakage condition:

$$Q = (Q_m / L) \times (P_s / P)^{1/2}$$

where, Q = Leak volume per hour per unit pipe length, (cu m/hr/km)

Q_m: Measured minimum flow per hour, (cu m/hr)

L : Distribution pipe length in the surveyed area, (km)

P_s: Standard water pressure, (2 kg/sq cm)

P : Water pressure when the minimum flow is recorded, (kg/sq cm)

After Q_m and P are measured, Q is calculated with the given L and P_s.

Q values were 0.4 and 0.85 respectively for the Big and Small Blocks. In case of the waterworks in Japan, the value from 0.5 to 1.2 is seen often and considered as acceptable.

There is technical and economical limits in reducing leakage. Setting up its own indicator as calculated above is realistic for each water-works, upon consideration of existing management, technical level of detection and repair of leakage, staff's availability and capability, benefit of leakage reduction for conservation or development of water sources, future expansion plan, etc.

APPENDIX 12

OPERATION AND MAINTENANCE OF THE SYSTEM

APPENDIX 12

APPENDIX 12 OPERATION AND MAINTENANCE OF THE SYSTEM

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12.2 Software and Hardware of Water Supply Service ..... A12 - 1

12.3 Laws ..... A12 - 1

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12.1 Introduction

The raison d'etre of the water supply service is supplying clean and low-price water in abundance to consumers, in order to improve the public hygiene and promote the living environments. Operation and maintenance of the water supply system aim to realize the reason of the existence.

The water supply service shall manage a public enterprise, by utilizing water sources, a natural and national resource, and supplying potable water to the general public. The service, therefore, has responsibility for utilizing the resource effectively and managing the enterprise soundly.

As for to the service, the people shall pay attention to maintaining cleanness of the water sources and normality of water supply facilities as well as supporting the waterworks management.

Looking as above, cooperation of the supply service and consumers is essential.

12.2 Software and Hardware of Water Supply Service

The water supply service shall be looked into of the two sides, software and hardware. The software is institutional matters such as laws, acts and regulations, while the hardware is physical matters like facilities and equipments.

For the improvement of operation and maintenance, good establishment of the software and hardware is essential.

12.3 Laws

In order to develop the water supply service in a country, the following laws, among others, shall be legistrated and enforced:

For protection and conservation of water sources to be used by the service, laws of Water Pollution Control, Groundwater Control and Natural Environment Protection are needed.

Corresponding with advancement of a country, systematic and organized development of water resources becomes essential. For it, Water Resources Development Law will be effective.

To establish the position of water supply service, Water Supply Service Law is to be legistrated.

To secure employment of competent personnel for the service, a law concerning Status of Public Servants will have to established in coordination with Labor Law.

In Criminal Law stipulation of the crimes of damaging waterworks' facilities, pollution or poisoning water source and stealing water is necessary.

In some countries, illegality concerning the service can be corrected only by means of judicial action. On the part of the service, it is too complicated and troublesome. Instead, the service shall be authorized to take administrative actions like compulsory investigation and penalization. Details of such actions empowered to the service shall be determined and legalized.

Legally and administratively and on both the national and local levels, the water supply service shall be coordinated to other public services such as city planning, road maintenance and housing. Legal and administrative adjustment between the water supply and other services is needed.

12.4 Hardware-oriented Software

Industrial Standards ruling the materials and products used widely and commonly shall be established. The water supply service will benefit by it, as they are used also by the service.

Waterworks Standards applicable to materials and products used by the water supply service are to be prepared.

Design Criteria shall be revised and updated periodically, not only by the staff assigned to the design department/section but also participated by the staff to the departments/sections of procurement, planning and construction, as well as operation and maintenance.

Regarding the above mentioned Industrial Standards, Waterworks Standards and Design Criteria, academic fields' people are to be asked to give advice and private sectors' involvement, by manufacturers, suppliers and contractors, are to be welcomed.

12.5 Organization

A water supply system consists, by the widely accepted concepts, raw water intake and transmission, treatment, distribution and service, following the flow of water.

Usually the waterworks organization is formed after the above division. Upon the local conditions, two or three divisions can be merged to one, for instance, a system using well water may have a division managing intake/transmission/distribution or another system, small sized, will have a division handling distribution/service.

In a large city where it is divided into a number of reasonably-sized districts, the water supply service may have the district office. For such a setup, the district office deals with meter-reading and tariff-collecting, as well as taking technical care of service facilities.

In whatever way a waterworks is organized, a few essential matters are to be considered.

12.5.1 Personnel Management

Assigning the right persons to the right positions is most essential for any organization.

In every aspects of personnel management, fairness is to be regarded. In recruitment, promotion and reshuffle, selection based on the qualification

and past performance of capability and personality shall be made on competitive basis. Favoritism and nepotism shall be avoided by any means.

Aside from the responsible department/division for the matters of personnel, a committee making selection or decision or recruitment, promotion and reshuffle is to be formed in the organization.

In operation and maintenance of a water supply system, the knowledge learned by experience is as valuable as the theoretical technology learned in school. Therefore, experienced technicians shall be given a fair share of opportunities of being promoted to certain levels. When this kind of promotion is realized often, it will help activate young aspiring technicians and even skilled labors.

This promotion system will also influence favorably the success of training of personnel.

12.5.2 Training

Training courses for all levels and different fields of occupation are to be planned and carried out. Participation in the training course followed by accumulation of experience on the job shall be regarded fairly as a qualification. The qualified persons shall be encouraged to attend to higher level of the training course.

To evaluate and improve the effectiveness of a training course, making examination of the participants shall be practiced. Each one's achievement will be used for awarding a license or qualification which can be referred to in the occasions of promotion or assignment of a new promising position.

In low level training courses, the instructors are to be appointed from not only high officials but also persons who have been promoted from lower rank on the merit as suggested above.

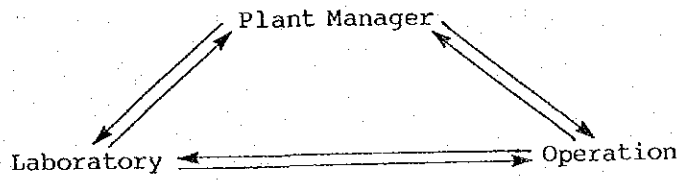
12.5.3 Internal Coordination

In any organization, internal coordination is essential in functioning the whole efficiently and smoothly.

The first point to be stressed is reporting-back or feeding-back of information. In a treatment plant for instance, optimum dosage is determined by the laboratory and reported to the plant manager. The results of actual application of the dosage shall be sent back to the laboratory with comments by the operator, so that, the laboratory is to be learn the difference of mechanical and hydraulic conditions between jar testing and plant performance.

Regarding the whole system, internal feed-back between the divisions of intake/transmission, treatment, distribution and service is to be routinized.

The second point is, so to speak, horizontal coordination as shown below.



From the rule of organization, the plant manager is the coordinator. When different or conflicting information is reported to him from below, he has to adjust, harmonize and decide. However on the daily routine matters, difference can be settled between the interested parties by themselves, partly contradicting the rule of organizational functioning.

In the operation and maintenance of treatment plant and whole supply system, such horizontal coordination or exchange of information is speedy and efficient, and it accords with the first point mentioned before.

As shown above, the way of thinking will make three channels of two-way communication in the picture. Generally speaking, multi-channel, vertical and horizontal two-way communication is to be activated.

12.5.4 Recording and Record Processing

The procedures of recording and record processing shall be ruled within an organization.

Operation and maintenance records, for each of intake/transmission, treatment, distribution and service, are to be made in specified formats, regarding the daily routine works.

Formats of reporting accidental matters are to be prepared also.

Record processing means creating higher-level information by coordinating and integrating the collected records. In the beginning, the methodologies shall be agreed by the participants from different departments/divisions and the aims of using the higher-level information shall be clarified.

12.5.5 Checklists for Preventive Maintenance

Preventive maintenance is most essential. Sensing and correcting abnormality of facilities and equipments, at earlier stages, will certainly end in saving substantial cost of maintenance.

It shall be perceived and tried into everyday's works, by all staff from the top to the bottom. Especially the senior and middle level personnel are expected to contribute, as they are experienced and knowledgeable.

Formats of checklists on the facilities, equipments and machineries which need periodical checking are to be prepared.

12.6 Hardwares for Operation and Maintenance

Hardwares needed in the operation and maintenance are outlined.

12.6.1 Manuals

Manuals covering the following subjects, among others, are needed*

- pipeline
- valve and valve operation
- pumps and appurtenance
- water treatment machinery
- chemical system and operation
- filter operation
- clear water reservoir operation
- leakage survey and repair
- consumers' meter

12.6.2 Maps, Drawings and Ledgers

Maps of pipelines including the location of valves, air valves, drain valves, hydrants and others, are to be kept, in sufficient number and good order and, when any modification works are made on the pipelines, the maps shall be revised immediately. The location of auxiliaries is often found lost when looked for and detailed maps showing the location, relative to permanent structures, are to be attached. The approximate depth of pipes and auxiliaries is to be filled in these maps preferably, when opportunities of finding them occur.

Drawings of the major facilities are also to be revised when modification is made on them.

In principle, materials and devices, design and installation works of private plumbing systems shall be, all of them, under the control of the waterworks authority, For each plumbing system, a ledger shall kept in file.

The documents are to be made in duplicate or triplicate, depending on the importance of them, and to be kept in file in the waterworks, regional office and head office.

12.6.3 Vehicles

Considering the work volume and number of personnel engaged in various tasks of operation and maintenance, vehicles like bicycles, motorbikes, vans, trucks and sedans are to be allocated for the use of waterworks.

Mobility is a key matter in operation and maintenance works.

12.6.4 Communication system

Communication system between the waterworks office, treatment plant, pumping station, operation/maintenance chief's office and the field staff team is to be made immediately when need arises. Public telephone system shall be fully utilized for the communication and a radio system between a mobile station and fixed station will be effective.

For a large plant or where offices are set apart in a large site, an in-plant telephone system is to be installed, because frequent exchange of information is preferable, as mentioned in 12.5.3 previously.

Assuming various cases of emergency, communication plan shall be prepared well beforehand.

12.6.5 Meters and Meter Management System

a service meter is said to become inaccurate after about 6 years of service. It will mean that 16 % of existing meters is to be replaced by new or renewed ones. If additional requirement for new customers is counted, about 20 % of the presently installed number shall be kept ready for use in the warehouse.

A meter management system is to be established, as well as the stockpiling

of meters. As the hardware parts of the system, warehouse, repair shop and meter-testing shop will be needed.

12.6.6 Simple Monitoring system

A simple monitoring system, by a number of testing devices and with the help of the waterworks personnel and citizens, is to be formed.

The devices are portable pressure gauges, residual chlorine testers and hand-made turbidity meters consisting of pre-made test tubes of standard turbidity.

The portable pressure gauge is a model which is inserted to the household tap, pushed and held by hand for measuring pressure.

The residual chlorine tester is the widely used kit, containing chemical, small test tube and rotating disc of color comparison.

The turbidity meter consists of a few test tubes. To each of them, a set of standard turbidity, for example, 1,2,4,8 and 16 ppm, is prepared by laboratory, contained and sealed. A sample of unknown turbidity is compared with them for rough estimation of turbidity.

Selecting the participants of the monitoring system shall be made on the location of their houses, points of collecting informative data, and capability in handling the testers. The participants will be the laboratory workers of knowledge and experience, engineers of the waterworks, citizens such as school teachers of chemistry and engineering, and well learned persons working in the fields of science and engineering.

The participants are to test water of their taps on the pre-fixed timing periodically. The collected data showing various spots' water quality and pressure are to be plotted on the map, to overview the service area's condition.

The kind of citizens participation will help promoting the public relations.

12.7 Public Relation

In the foregoing sections, the issues related to improve operation and maintenance of the waterworks have been discussed, mostly from the standpoints of water supply service.

Some of the issues cannot be achieved without the support and cooperation of the pubic.

12.7.1 Legal and Administrative Issues

In 12.3 the following laws were named and explained of the necessity:

- Water Pollution Control
- Groundwater Control
- Natural Environment Protection
- Water Resources Development
- Water Supply Service

Also discussed in 12.3 was that the water supply service shall be empowered administratively to make compulsory investigation and penalizing actions against illegality concerning the water source and supply service.

Regarding the above, strong support of the public is necessary.

12.7.2 Public Enlightenment

The water supply service shall be positive in enlightening the public on the necessity of clean water, taking opportunities of involving in school education, civilian and women groups' activities.

As a form of excursion, the primary and secondary school children can visit the water intake and treatment plant to learn about water supply service. For higher educational institutions, sending the waterworks staff to give lectures on the subject like waterworks engineering, water pollution control and others will be fruitful.

On the occasions of festival and recreational events, the waterworks shall take advantage of them for campaigning its cause and activities.

12.7.3 Personnel in the Front

The meter readers, tariff collectors, service system repairmen and receptionists in the office make direct contacts with the customers.

They shall be nice and kind so that customers can speak out opinion on the supply service freely. Some of the customers viewpoints will be helpful for improvement of the service and these well-intended people shall be asked for more help in future.

Like awarding the informers of illegal connection, awarding the people detecting leakage on the public pipeline is worth studying, as it will save the works of operation and maintenance staff. The same can be applied to the case of finding faulty meters.

The customers are to be taught of making simple repairs by themselves. It will also save inefficient input of manpower on the part of waterworks.

In case of accidents needing major repair works, the damages inflicted on the private property shall be immediately compensated. Delayed action on such matters will damage the public relation as well as the waterworks image.

12.7.4 Advance Notice

The date of the meter readers' and tariff collectors' visit to the consumers shall be noticed in advance. Or, more preferably, a certain date is fixed on each specific section of the service area.

Advance notices are also needed in the case of pipeline works which cause failure or shortfall of supply to consumers. The purpose, date, time and duration of the works and foreseeable inconvenience shall be informed.

APPENDIX 13

SCOPE OF WORK

APPENDIX 13

Minutes of Meeting

SCOPE OF WORK
FOR
MASTER PLAN
AND
FEASIBILITY STUDY
ON
PROVINCIAL WATER SUPPLY PROJECTS
IN
THE KINGDOM OF THAILAND
AGREED UPON BETWEEN
PROVINCIAL WATERWORKS AUTHORITY
AND
JAPAN INTERNATIONAL COOPERATION AGENCY

BANGKOK, 1985

細田三朗

Saburo HOSODA
Leader
JICA Preliminary Study Team

Dr. Tawat Wichaidit
The Governor
Provincial Waterworks
Authority

I. INTRODUCTION

In response to the request of the Government of Thailand, the Government of Japan decided to implement a Master Plan and a Feasibility Study on Provincial Water Supply Projects (Chiangmai, Ubon-Ratchathani, Suphanburi and Pattaya) in Thailand (hereinafter referred to as "the Study") within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of Thailand, signed on November, 1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan, will undertake the study, in accordance with the relevant laws and regulations in force in Japan and in close cooperation with the authorities of Thailand. The Provincial Waterworks Authority (hereinafter referred to as "PWA") shall act as counter agency to the Japanese Study Team and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the study. The present document sets forth the Scope of Work for the study.

II. OBJECTIVE OF THE STUDY

The objective of the study is to prepare a Master Plan (long term basic plan) for the Provincial water supply projects in Chiangmai Municipality and its Surrounding Communities Sansai, San-Kamphaeng, Saraphi and Hang Dong, Ubon-Ratchathani Municipality, Warin Chamrap Municipality Suphanburi, and Pattaya up to the next 20 years, (2006) and to carry out a feasibility study (short term development plan) for a project selected from the result of the Master Plan study.

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III. OUTLINE OF THE STUDY

The Study will be composed of field surveys and data collection in Thailand and of analysis works in both Thailand and Japan.

The items to be covered by the Study are as follows:

(i) Phase I; Master Plan Study (Long term basic plan)

a. Data collection and analysis
b. Delineation of served areas for planning
c. Projection (estimation of population and Water demand etc.)
d. Study of existing water supply system (facilities, Management, and Organization etc)
e. Study of water sources (based on the available data)
f. Planning of appropriate water supply system (Organization, Operation and Management Plan)
g. Rough estimation of cost for construction, operation and maintenance
h. Preparation of implementation program
i. Identification of the project including immediate improvement and rehabilitation for the Feasibility Study.

(ii) Phase II; Feasibility Study (Short term development plan)

a. Delineation of project area
b. Estimation of population to be served
c. Estimation of water demand
d. Study of improvement of existing facilities
e. Study of water sources
f. Layout of facilities
g. Study for alternative plans

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h. Preliminary design (including design criteria)
i. Study of construction materials and labour force
j. Estimation of costs of construction, operation and maintenance
k. Preparation of Construction method and procurement method of materials and equipments
l. Study of Tariff System
m. Estimation of benefits
n. Economic Studies and Financial analysis
o. Study of organization, operation and management plan
p. Preparation of implementation schedule.

IV WORK SCHEDULE

The study will be conducted in accordance with the tentative schedule as shown in the Annex I herewith attached.

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V. REPORTS

JICA shall prepare and submit the following reports in English to the Government of Thailand.

1) Inception Report
   - Copies 30
   . at the beginning of the Field Survey (Master Plan Study)

2) Progress Report
   - Copies 30
   . at the end of Field Survey (feasibility study)

3) Interim Report
   - Copies 30 each
   . within 3 months from the beginning of the Master Plan Study
   . within 7 months from the beginning of the Feasibility study

4) Draft Final Report
   - Copies 30
   . within 10 months from the beginning of the feasibility study

5) Final Report with summaries
   - Copies 50 each
   . within 16 months from the beginning of the Master Plan study
   . within 13 months from the beginning of the Feasibility study

The PWA shall submit her comments to JICA within one month after the receipt of Draft Final Report.

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VI. UNDERTAKING OF THE GOVERNMENT OF THE KINGDOM OF THAILAND

1. In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand dated November 5, 1981, the Government of the Kingdom of Thailand shall accord benefits to the Japanese study team as follows:-

(1) to permit the members of the Japanese study team to enter, leave and sojourn in Thailand for the duration of their assignment therein and exempt them from alien registration requirements and consular fees,

(2) to exempt the members of the Japanese study team from taxes, duties and any other charges on equipment, machinery and other materials brought into Thailand for the conduct of the Study,

(3) to exempt the members of the Japanese study team from income taxes and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Japanese study team for their services in connection with the implementation of the Study,

(4) to bear claims, if any arises against the members of the Japanese study team resulting from, occuring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Japanese study team.

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2. To facilitate smooth conduct of the Study, PWA shall take necessary measures in cooperation with other relevant organization;

(1) to secure permission for entry into private properties or restricted areas for the conduct of the Study,

(2) to secure permission for the study team to take all data and documents (including photographs) related to the Study out of Thailand to Japan.

(3) to provide the medical services as needed (Its expenses will be chargeable on members of the Japanese study team),

(4) to ensure the safety of the members of the Japanese study team when and as it is required in the course of the Study.

3. PWA shall, at its own expense, provide the Japanese study team with the followings:

(1) available data and information related to the Study,

(2) counterpart personnel,

(3) suitable office space with necessary equipment,

(4) credentials or identification cards.

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VII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures,

(1) to dispatch, at its own expense, study teams to Thailand,

(2) to pursue technology transfer to the Thai counterpart personnel in the course of the Study.

VIII. JICA and PWA shall consult with each other in respect of any matter that may arise from or in connection with the Study.

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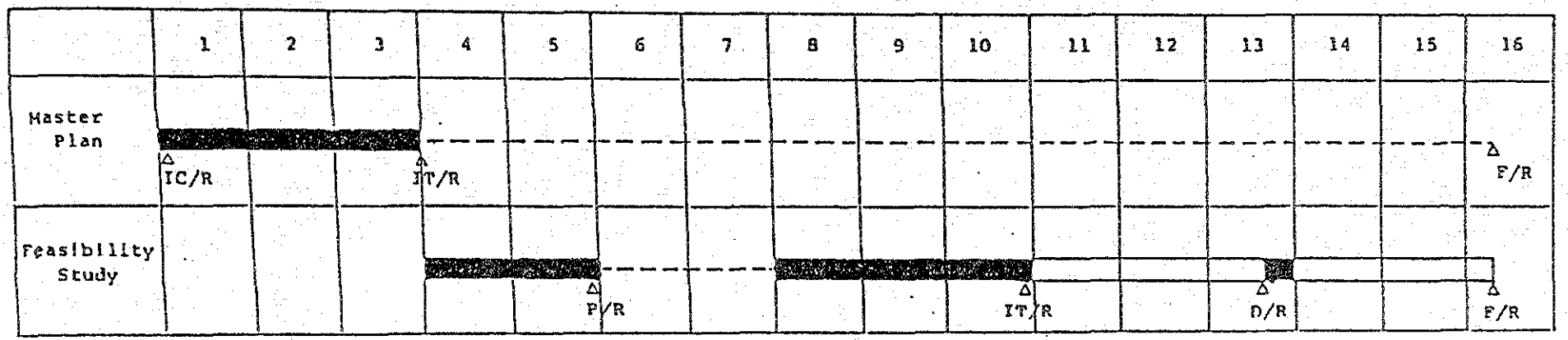
ANNEX I

Tentative Schedule for Master Plan, Feasibility Study



* Remarks

In Thailand

In Japan

IC/R Inception Report
P/R Progress Report
IT/R Interim Report
D/R Draft Final Report
F/R Final Report

MINUTES OF MEETING

ON

THE SCOPE OF WORK FOR THE MASTER PLAN

AND

FEASIBILITY STUDY

ON

PROVINCIAL WATER SUPPLY PROJECTS

AUG. 13, 1985

BANGKOK, THAILAND

細田三朗

Saburo HOSODA
Leader
JICA Preliminary Study Team

DR. TAWAT Wichaidit
The Governor
Provincial Waterworks Authority

MINUTES OF MEETING

The Japanese Preliminary Study Team and the Thai counterpart of PWA held a series of discussions during July 30 - August 13, 1985 concerning the Scope of Work.

The present minutes were prepared to confirm the main issues discussed and matters agreed upon both parties.

A. Both parties confirmed the followings :-

1. Scope of Work

The Japanese Study Team (hereinafter referred to as "the Study Team") shall implement a Master Plan and a Feasibility Study of Provincial Water Supply Projects in Thailand based on available data which the Study Team will study in cooperation with PWA, whose items are shown in Annex I.

(1) The Master Plan will be selected by optimal solution by technical and economical evaluation.

(2) Delineation of served areas for planning will be implemented in consideration of such as economic, geographical and related aspects.

(3) Estimation of water demand will be implemented not only in terms of total demand but also divided in categories such as domestic, institutiona commercial and industrial demand.

(4) The Study Team will implement the water sources studying on hydrological, hydrogeological, geophysical survey etc., based on such available data.
The Study Team will evaluate to determine the availability of alternative water sources.

(5) In Feasibility Study, "Study for alternative plans" will include the selection of optimal plan.

(6) Estimation of benefits of optimal plan will be implemented not only in direct but also indirect aspects such as improvement of human health etc., in general terms.

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(7) Water leakage detection concerning preparation of drawings and systematic detection of pipe bursts, etc., will be surveyed, studied and prepared in "Study of organization, operation and management plan" so that the Water Leakage Detection Program will be implemented by PWA.

2. Undertaking of PWA

PWA shall, at its own expense, provide the Study Team with the followings :-

- Counterpart personnel : 3 Engineers, during the study period
  Non-technical personnel : 1 Clerk (Full Time), 1 Clerk (Part Time)
- Main Office : Space (10 personnels occupied) with necessary equipment
  (Desk, Chair, Locker, Telephone (1) (local use), Air Conditioning, in PWA H.Q.)
  Field Office : Suitable office space with Desk, Chair, etc. at Chiangmai, Ubon-Ratchathani, Suphanburi, Pattaya in PWA Regional Offices

3. Technical Training

PWA requested that her counterparts will be invited to Japan for technical training, Japanese side promised to take the request for favorable consideration.

B : Attendants of the discussions :

1. PWA Side (Corporate Planning Department)
   - Mr. PRAKIT Chanurai
     Acting Chief, Planning Division
   - Miss. ORAPIN Assavanig
     Chief, International Cooperation Section
   - Mr. PRAPON Chanakitjanukit , Engineer
   - Mr. JAROON Upanan , Engineer
   - Mr. SUTHEE Asawapichaid , Engineer

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2. Japanese Side

- Mr. Saburo HOSODA
  Director of Riverhead Forestory Office, Bureau of Waterworks, TOKYO METROPOLITAN GOVERNMENT
- Mr. Yoichi SEKI
  Special Advisor to the Director, Social Department, JAPAN INTERNATIONAL COOPERATION AGENCY
- Mr. Tsutomu NAGASAKA
  Engineer, Atsuta Office, NAGOYA WATERWORKS BUREAU
- Mr. Masuji IDE
  Engineer, Northern Water Control Center, YOKOHAMA WATERWORKS BUREAU
- Mr. Hajime NISHIKAWA
  Engineer, Water Supply Division, MINISTRY OF HEALTH AND WELFARE

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Annex I

I. Importance of the Project

(1) Relationship between the budget and the Relevant Development Plan.
(2) Utilization Plan of technical transfer
(3) Priority, urgency of the Project
(4) Advantageous effect
(5) Solved problem

II. Outline of four cities

(1) Data
- Hydrology
- Climate
- Geography

(2) Type of cities
(3) The movement of population and economics
(4) Order of importance of the cities
(5) Arrangement of electricity supply, water supply and drainage situation
(6) Characteristics
(7) Public health

III. References

PWA

(1) Laws and regulations
(2) Purpose of activity
(3) Organization
(4) Management situation
(5) Budget plan

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(6) Future plan
(7) Outline of PWA's undertaking
(8) Process of decision making of budget and policy

Four cities

IV. Outline of four cities's waterworks
(1) Statistics of facilities
(2) Statistics of population and water demand
(3) Served area
(4) Present situation of the waterworks facilities
  a. Intake facilities
  b. Conveyance, water transmission, distribution and service installation
  c. Purification facilities
  d. Maintenance of facilities
  e. Water sources
(5) Prospects of future water works facilities (in details)
(6) Technical Standard
(7) Water rate system
(8) Budget plan
(9) Technique period, cost of construction

V. Present evalution of waterworks (including analyses of causes)
(1) Technique (man-power)
(2) Management system waterworks
(3) Stock of equipment, existance of repair works factory
(4) Situation of finance
(5) Management plans for improvement

VI. Relation with other administrative organizations

VII. Adjustment of map drawing in projected area
(1) Map of topography, etc.
(2) Drawing of facilities
(3) Drawing of piping
(4) Process chart for facilities

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VIII. Existing problem in PWA

IX. Technical and economical cooperation by foreign countries or international organizations in recent years in relation with waterworks

X. Others

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APPENDIX 14

OFFICIALS CONCERNED IN THAILAND

APPENDIX 14

APPENDIX 14 OFFICIALS CONCERNED IN THAILAND

Provincial Waterworks Authority

Dr. Tawat Wichaidit	Governor
Mr. Sawasdi Orvichian	Deputy Governor
Mr. Anant Tantidhamma	Deputy Governor
Dr. Wanchai Ghooprasert	Assistant Governor

Corporate Planning Department (CPD)

Mr. Chatpong Chucharoen	Director
Mr. Sukhon Sitthilertpisan	Acting Chief, Planning Division
Miss Orapin Assavanig	Chief, International Cooperation Section
Mr. Prakit Chanurai	Acting Chief, Policy and Planning Work
Dr. Sarawoot Chayovan	Chief, Water Resources Development Project
Mr. Wanchai Lowatanatrakul	Project Coordinator, Corporate Planning Division
Mr. Thaworn Nitipavachon	Water Resources Development Project
Mrs. Pinporn Phongsri	Corporate Planning Division
Miss Wirawan Kaeopradith	Corporate Planning Division
Mr. Jaroon Upanan	Corporate Planning Division
Mr. Somkriat Piriyakakul	Water Resources Development Project
Mr. Udomsak Siriaksorn	Water Resources Development Project
Mr. Sanit Kitchawan	Corporate Planning Division
Mr. Suthee Asawapichaid	Corporate Planning Division
Mr. Pisit Hongvanishkul	Corporate Planning Division
Mr. Piray Satayasunhusakul	Corporate Planning Division
Mr. Nived vachiraanan	Corporate Planning Division
Mr. Prathom Khoysomboon	Corporate Planning Division
Mrs. Anu Songsakchai	Corporate Planning Division
Mrs. Bussara Rasamiamornwiwat	Corporate Planning Division
Mr. Prapon Chanakitjanukit	Corporate Planning Division

Operation and Maintenance I

Mr. Virusah Mahakkapong	Director
Mr. Wiroon Pungronothanin	Chief, Water Production Section
Mr. Veerapun Henprasert	
Mr. Pichai Pirapaemakul	
Mr. Sombun Kheawchalua	
Mr. Sommai Tossila	
Mr. Phichai Pirapatanakul	

Operation and Maintenance II

Mr. Sitthichai Pissathanporn	Director
Mr. Wuthichai Usaha	Chief, Water Distribution Section
Mr. Prasong Nimwattana	
Mr. Surachai Jarikhuan	
Mr. Chuer Panyasiri	
Mr. Ruthai Intarapalit	

Accounting and Finance Department

Mrs. Virayu Amornlectrakul	Director
Mrs. Vanida Taechasaen	Chief, Accounting Division
Miss Sompis Amornrodjanawong	Head, Loan Account
Miss Chantira Chulothok	Head, General Ledger
Mrs. Somsong Pantaranontaka	Acting Director, Budget Division

Analysis and Evaluation Department

Miss Chindarat Suwanabhat	Chief, Data Collection and Reporting Section

Engineering Department

Mr. Anunt Sahasak	

Central Laboratory

Mrs. Chitra Tritham	Head, Chemical Section

Ubon and Warin

Mr. Chaweng Chusri	Director, Regional Office No.8
Mr. Arun Thaichareon	Formerly Director, Regional Office No.8
Mr. Prakong Janatakamma	Manager, Ubon Waterworks
Mr. Rittirong Jaiyasin	Assistant Director, Regional Office No.8
Mr. Prakiat Sritanyarat	Head, Construction Supervisor, Regional Office No.8
Mr. Thavorn Chatisaranuvat	Head, Technical Service, Regional Office No.8
Mr. Anupan Ketsiri	Head, Ubon Waterworks
Mr. Niyom Netavong	Ubon Waterworks

Embassy of Japan

Mr. Yasunobu Takayama	First Secretary

JICA Bangkok Office

Mr. Motonori Gotoh	Representative
Mr. Shin-ichi Suzuki	Deputy Director
Mr. Takahito Hino	Assistant Resident Representative

JICA Expert

Mr. Masaru Tanaka	Provincial Waterworks Authority
Mr. Kumpei Igarashi	Provincial Waterworks Authority