APPENDIX 11

UNACCOUNTED-FOR WATER STUDY

APPENDIX 11

APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

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APPENDIX 11 UNACCOUNTED-FOR WATER STUDY

11.1 Introduction

Unaccounted-for water is defined as the difference between the volume of produced water (water production) and that of sold water (water sales). The water production is measured as the outflow of treatment plant, while the water sales is calculated as the sum of customer meters' reading.

Included in the water sales are discount rate consumption, bad debt, public use and others.

Discount rate is applied to the consumption by veterans, waterworks staff and hospitals. As the consumption is very small in size, the impact on the whole revenue is almost negligible.

Bad debt is the uncollected credit which should be written off. Although some consumers delay regular payment because of handy money's shortage or unwillingness by reason of their dissatisfaction with the service, payment is made eventually in most cases. Bad debt is also negligibly small.

Regarding the public use, most of the public institutions are paying the normal rate duly, excepting those applied with discount rates.

All of the water sales can be considered revenue-bearing or accounted-for water practically in Thailand.

This study aims for setting up the framework to reduce unaccounted-for water in the future. During the field leakage survey undertaken as a part of the study, some useful and important findings were made, as reported in the Attachment herewith. Some of the essential findings are quoted in the main report.

In the following sections, classification of the unaccounted-for water, existing conditions related to the issue, framework for reduction are discussed.

11.2 Classification of the Unaccounted-for Water

For the present study, "Unaccounted-for Water" is classified into four categories, as shown below;

1) Illegal Connection
2) Meter Reading Error
3) Metering Loss (Under-sensitivity of Consumer's Meter)
4) Leakage

1) Illegal Connection

Illegal connections are defined as intentional mismanagement of water meters and pipeworks conspired to steal the public supply water. They include breaking or bypassing water meters and making a connection unlawfully. The water consumed through such connection is stolen partly or wholly.

2) Meter Reading Error

Meter reading error occurs in such cases as 1) the meter reader fails to read the meter because of very difficult accessibility, and 2) the meter reader mistakes reading. The part of water guessed for consumption and under-estimated by mistaken reading becomes unaccounted-for water.

3) Metering Loss

Undersensitive or malfunctioning water meters under-register the actual flow. The under-registered part of water becomes the unaccounted-for.

4) Leakage

Water loss caused by leakage from cracks, holes and loose joints of pipes and fittings before flowing into consumers' meter belongs this classification. However, the water loss from the plumbing on the down-stream side of water meter is not classified herein.

11.3 Approach of the Study

The four categories of unaccounted-for water itemized in the previous section are sorted out into two groups by the way of approach, namely;

Group 1 : Reducible by Institutional Management
- Illegal Connection
- Meter Reading Error

Group 2 : Reducible by Technical Management
- Metering Loss
- Leakage

The following steps will be taken in narrowing down the leakage:

- estimation of the total unaccounted-for water, firstly
- estimation of the metering loss, secondly
- estimation of the illegal connections' loss and meter reading error, thirdly
- deducting the sum of the second and third from the first

The balance calculated by the deduction is designated as the leakage.

11.4 Existing Conditions

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 yearly data of the ratio in 1978 - 1984, though fluctuating in the early years, showed a tendency of gradual decrease converging to about 10 % in the last few years.

The monthly data showed the average of unaccounted-for ratio for the whole period as 12.7 % and for 1985 as 14.1 %.

For this study, 14 % is assumed as the present ratio reasonably from the above data.

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 (%)
1978	258,745	193,956	25.0
1979	301,689	205,148	32.0
1980	294,282	260,544	11.5
1981	915,515	733,487	19.9
1982	3,327,949	2,978,433	10.5
1983	5,199,565	4,753,615	12.0
1984	6,590,375	5,909,651	10.3

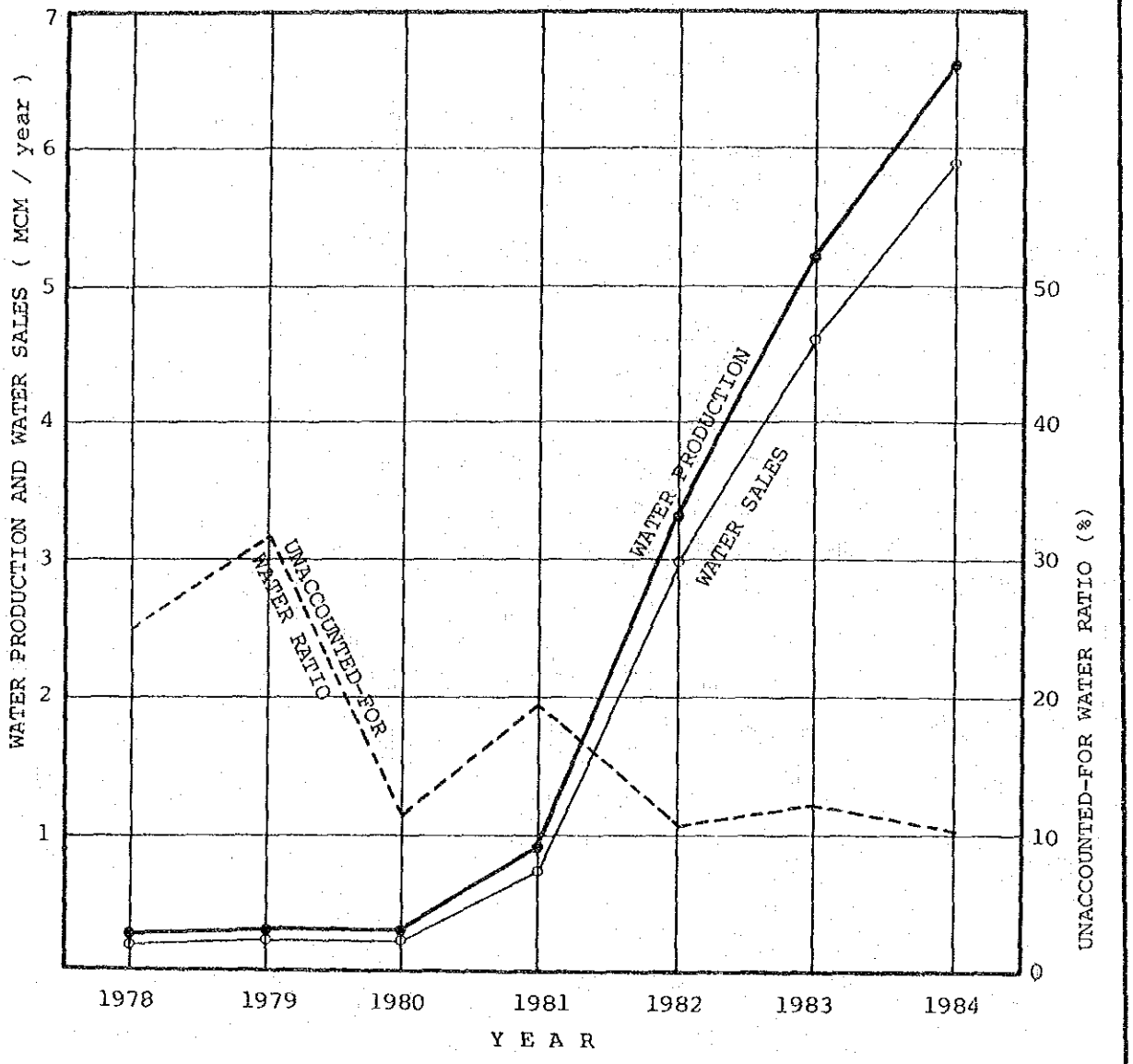

FIGURE	PAST DATA OF WATER PRODUCTION, SALES, AND UNACCOUNTED-FOR WATER RATIO
11.1	

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Table-11.2 RECENT DATA OF WATER PRODUCTION AND WATER SALES

	(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/conn/mon)
OCT. 1984	590,375	567,331	23,044	3.9	4,392	5.2
NOV.	581,500	502,412	79,088	13.6	4,504	17.6
DEC.	626,000	572,329	53,671	8.6	4,590	11.7
JAN. 1985	649,875	599,195	50,680	7.8	4,678	10.8
FEB.	601,315	528,646	72,669	12.1	4,784	15.2
MAR.	709,250	625,932	83,318	11.7	4,905	17.0
APR.	680,500	694,497	-13,997	-2.1	5,050	-2.8
MAY.	631,625	440,159	191,466	30.3	5,089	37.6
JUN.	632,625	512,881	119,744	18.9	5,172	23.2
JUL.	665,500	520,441	145,059	21.8	5,255	27.6
AUG.	631,850	596,230	35,620	5.6	5,357	6.6
SEP.	583,000	569,628	13,372	2.3	5,474	2.4
OCT.	578,450	421,486	156,964	27.1	5,511	28.5
NOV.	527,694	467,390	60,304	11.4	5,566	10.8
DEC.	630,900	482,822	148,078	23.5	5,619	26.4
JAN. 1986	620,645	570,847	49,798	8.0	5,734	8.7
FEB.	650,500	587,907	62,593	9.6	5,786	10.8
MAR.	727,500	592,288	135,212	18.6	5,956	22.7
APR.	709,650	646,689	62,961	8.9	6,120	10.3
TOTAL	12,028,754	10,499,110	1,529,644	AVE, 12.7		
TOTAL OF YEAR 1985	7,522,584	6,459,307	1,063,277	AVE, 14.1		

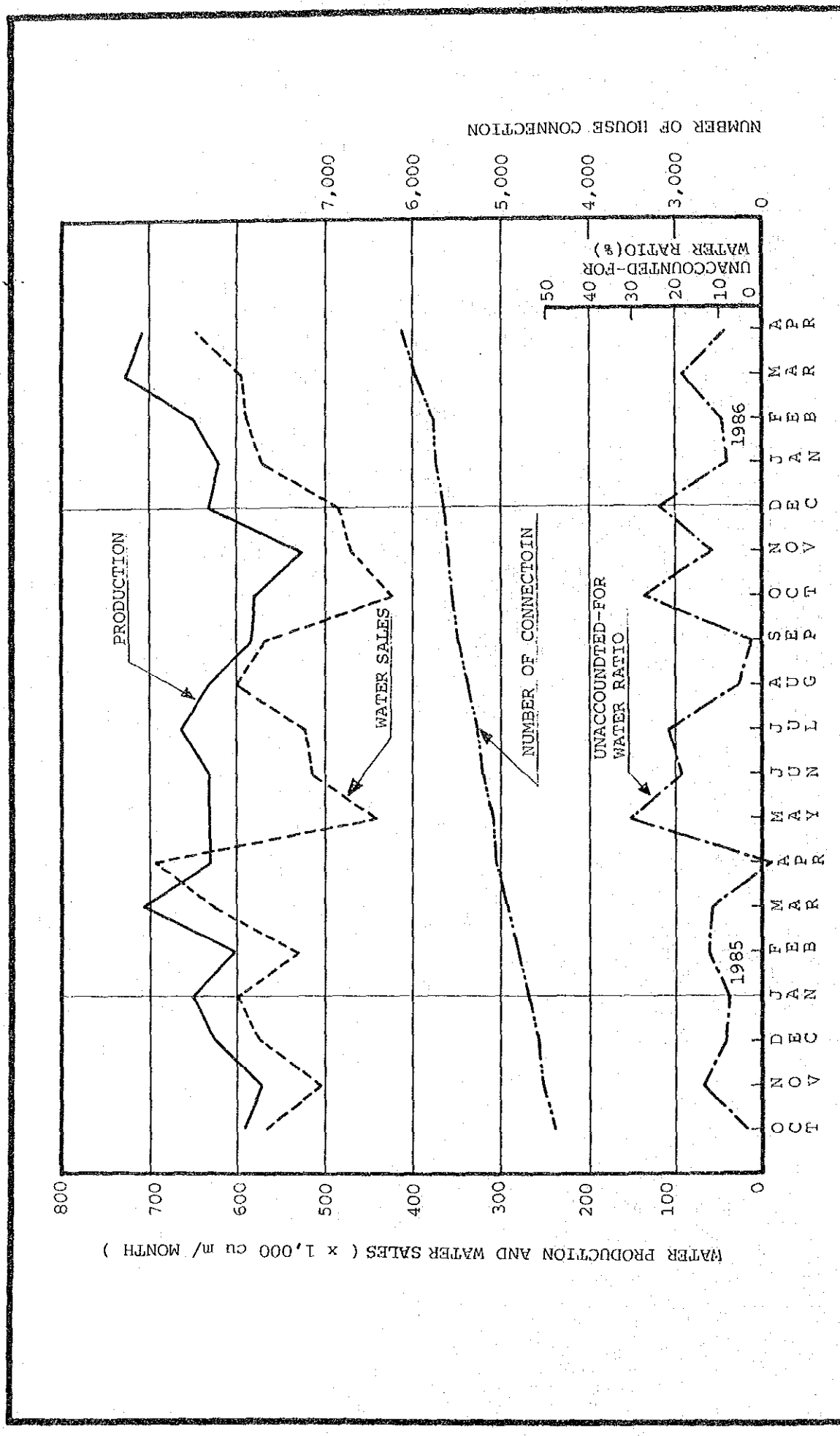

FIGURE	RECENT DATA OF WATER PRODUCTION, SALES, NUMBER OF CONNECTION, AND UNACCOUNTED-FOR WATER RATIO
11.2	

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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 Pattaya Waterworks is shown in Table-11.3.

Table-11.3 NUMBER OF ILLEGAL CONNECTION FOUND

MONTH (1985)	NUMBER OF ILLEGAL CONNECTION FOUND
FEB	1
MAY	1
OCT	1
NOV	1
TOTAL =	4

Data Source: Pattaya Waterworks

As shown above, 4 illegal connections in total were found in 1985 in Pattaya, relatively lower than Chiangmai's 12 and Ubon/Warin's 13 in the same year.

The illegal connections' number is less than 0.1 % of the total connections' number of 5,100 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 a few meters 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 due to the error has not been made known.

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 Pattaya, 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.

In the field survey, the master meter (ultrasonic flowmeter) reading was taken to be compared with 10 consumers' meters. The connection arrangement is shown in Fig-11.3 and the result in Table-11.4.

The testing method was reading the master and consumers' meters simultaneously at 30 minutes' interval, calculating. Each meter's consumption, followed by comparing the master meter's and the sum of consumers' meters.

As shown in Table-11.4, the difference was 4 % of the master meter's consumption.

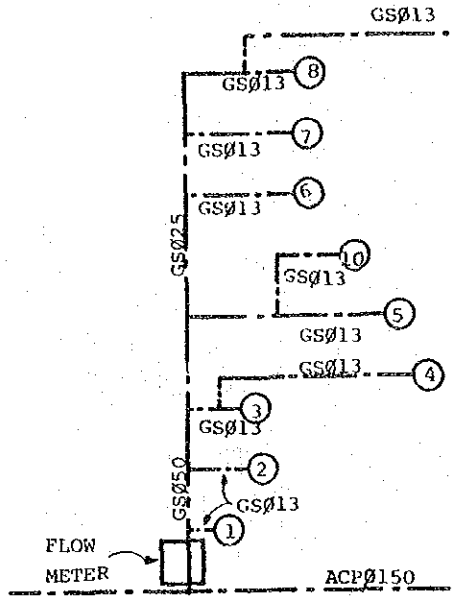
Distributed water in Pattaya is not controlled of its pH and the pH, around 7.0 in dry season, falls less than 6.5 sometimes in rainy season. Corrosion in the galvanized steel connection pipes was observed and it might be suspected of causing inaccuracy of measurement.

From the above, the unaccounted-for ratio due to under-registration of meters is assumed as 5 %.

Fig-11.4 shows the result, classified by the size and age, of water meters surveyed in Pattaya.

25 % of all the meters is used in the service for more than 6 years and nearly a half of it for more than 11 years, without being replaced and checked of accuracy of measurement.

As a meter's accuracy is said to become unreliable after 8 years of service usually, according to the manufacturers' information, the above situation may be affecting under-registration also.



LEGEND

——— :PIPE

—○— :METER OF HOUSE CONNECTION

NON SCALE

METER NO.	MANUFACTURER	YEAR OF INSTALLATION
1	ASAHI	1985
2	ASAHI	1984
3	KENT	1980
4	KENT	1975
5	KENT	1983
6	KENT	1975
7	KENT	1983
8	ASAHI	1985
9	KENT	1979
10	KENT	1983

FIGURE	LAYOUT OF SURVEY AREA FOR METER ACCURACY MEASUREMENT
11.3	

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Table-11.4 RESULTS OF SURVEY FOR METER ACCURACY

METER NUMBER	MANUFACTURER	YEAR OF INSTALLATION	METER READ START (A)	METER READ END (B)	CONSUMPTION (l) (A) - (B)
1	ASAHI	1985	427,220	427,289	69
2	ASAHI	1984	173,173	173,223	50
3	KENT	1980	17,523	17,571	48
4	KENT	1975	427,070	427,077	7
5	KENT	1983	330,085	330,112	27
6	KENT	1975	713,807	713,818	11
7	KENT	1983	2,142,929	2,142,989	60
8	ASAHI	1985	742,455	742,475	20
9	KENT	1979	660,207	660,208	1
10	KENT	1983	607,617	607,655	38
				TOTAL CONSUMPTION (l)	329
				CONSUMPTION MEASURED BY ULTRASONIC FLOW METER (l)	343

METERING LOSS = ((343-329)/343)X100 = 4 %

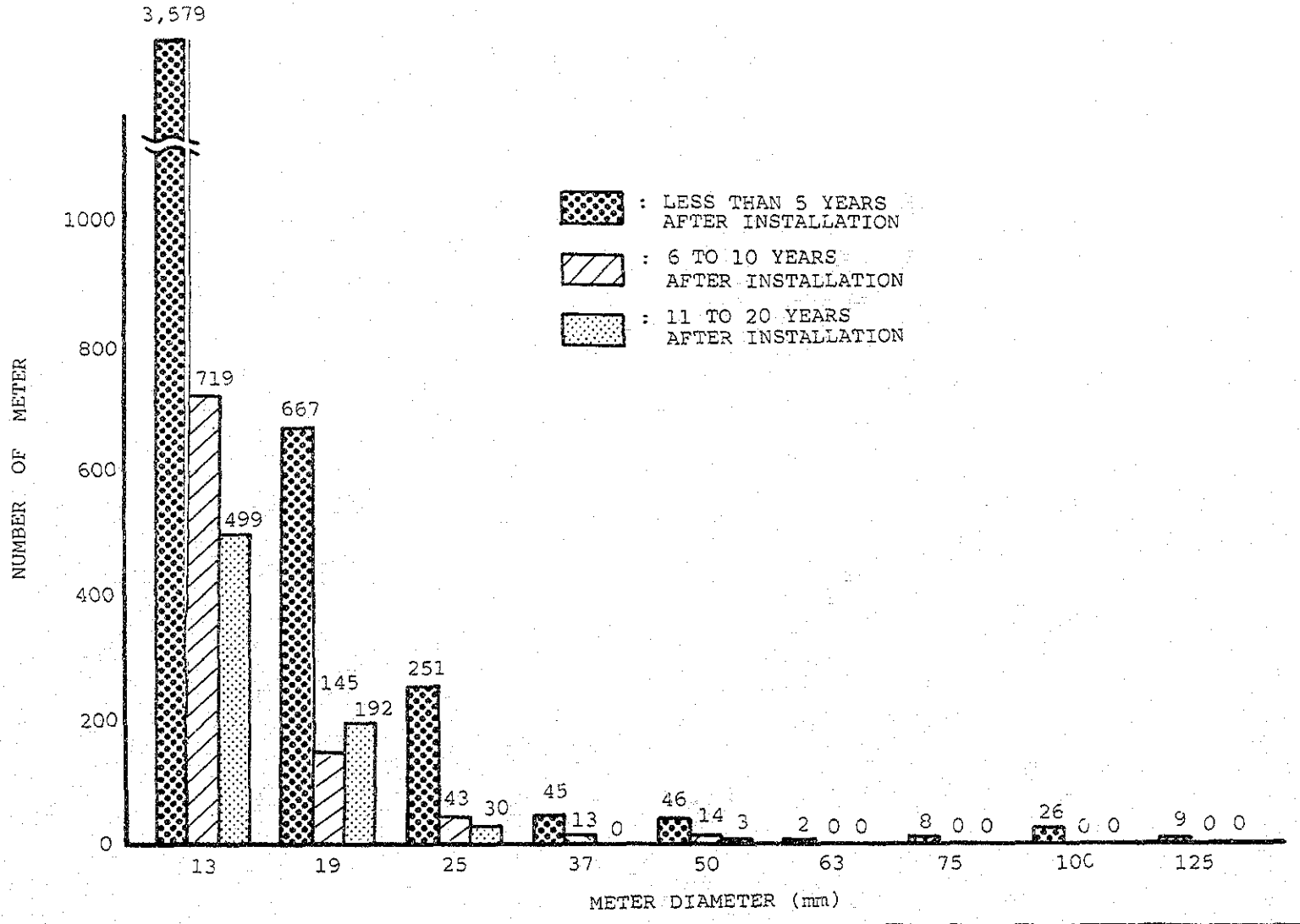

FIGURE	CONSUMER METER CLASSIFICATION
11.4	BY METER SIZE AND YEARS AFTER INSTALLATION
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11.4.5 Leakage

In the foregoing subsections estimated were: 14 % 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 14 %, is calculated as 8 % therefore.

Detection of leakage in Pattaya 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-11.5 shows the number of repair works made in 1985 and for the size of Pattaya, the number seems too low. Presumably undetected and or uninformed leakage is taking place.

The leakage ratio resulted from surveying two cases, a large block of 206 connections and a small block of 90 connections, was 54.2 % for the large and 39.4 % for the small, far higher than the 8 % estimated previously. The surveyed area in Na Klua still uses many old pipes installed in around 1971 and is the worst area regarding leakage problems. Besides, even the large block takes only about 1/30 of the whole distribution system, in view of the number of connections.

11.4.6 Conclusions

In Pattaya, the leakage loss is largest of the several factors affecting unaccounted-for ratio, though the ratio, 8 %, is far lower when compared with other waterworks' cases.

Efforts to lower each factor of the unaccounted-for ratio are worth making, as described in the following sections.

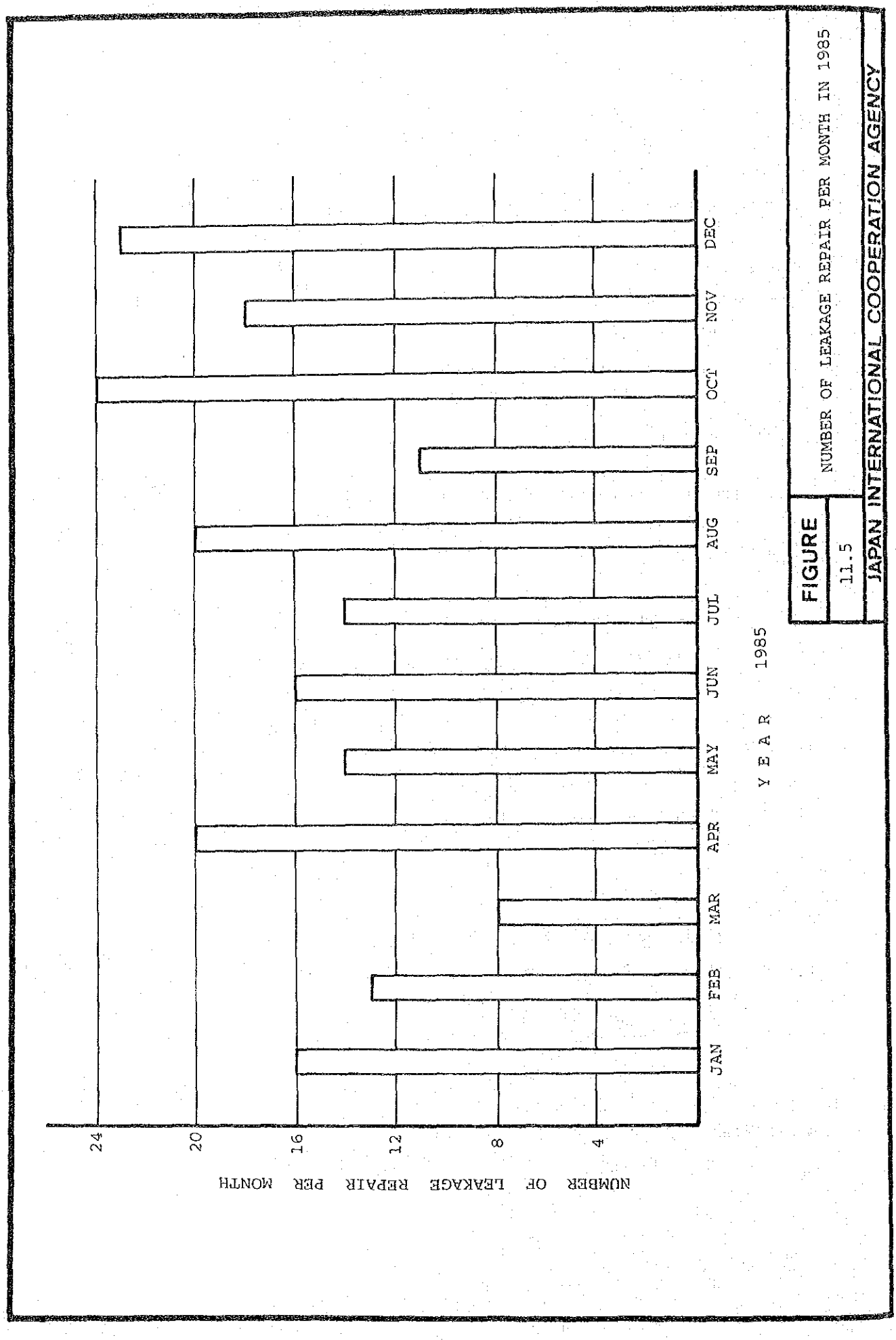

FIGURE 11.5 NUMBER OF LEAKAGE REPAIR PER MONTH IN 1985

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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 any more 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 Pattaya 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-11.6 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.

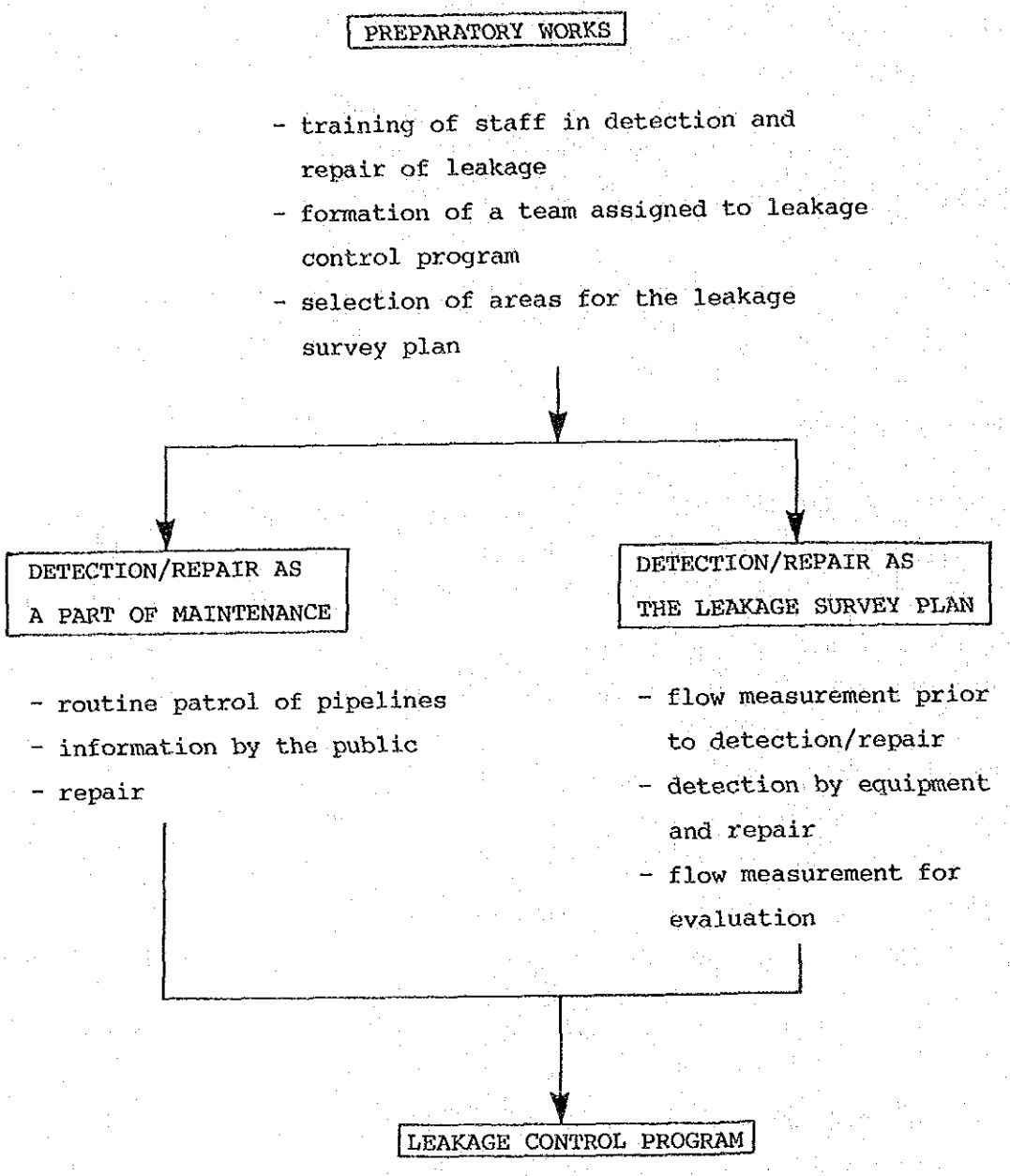

FIGURE	LEAKAGE CONTROL PROGRAM
11.6	

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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 Pattaya 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 Pattaya estimated at 8 % presently shall be maintained to realize the planned 15 % unaccounted for ratio from 1985 to 2010.

ATTACHMENT

FIELD LEAKAGE SURVEY

ATTACHMENT

FIELD LEAKAGE SURVEY

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1. Introduction

The field leakage survey in Pattaya was carried out from June 9 to June 21 in 1986, and covered 1.3 % of the distribution pipes of whole length of the network as shown in Fig-11.7. 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.

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

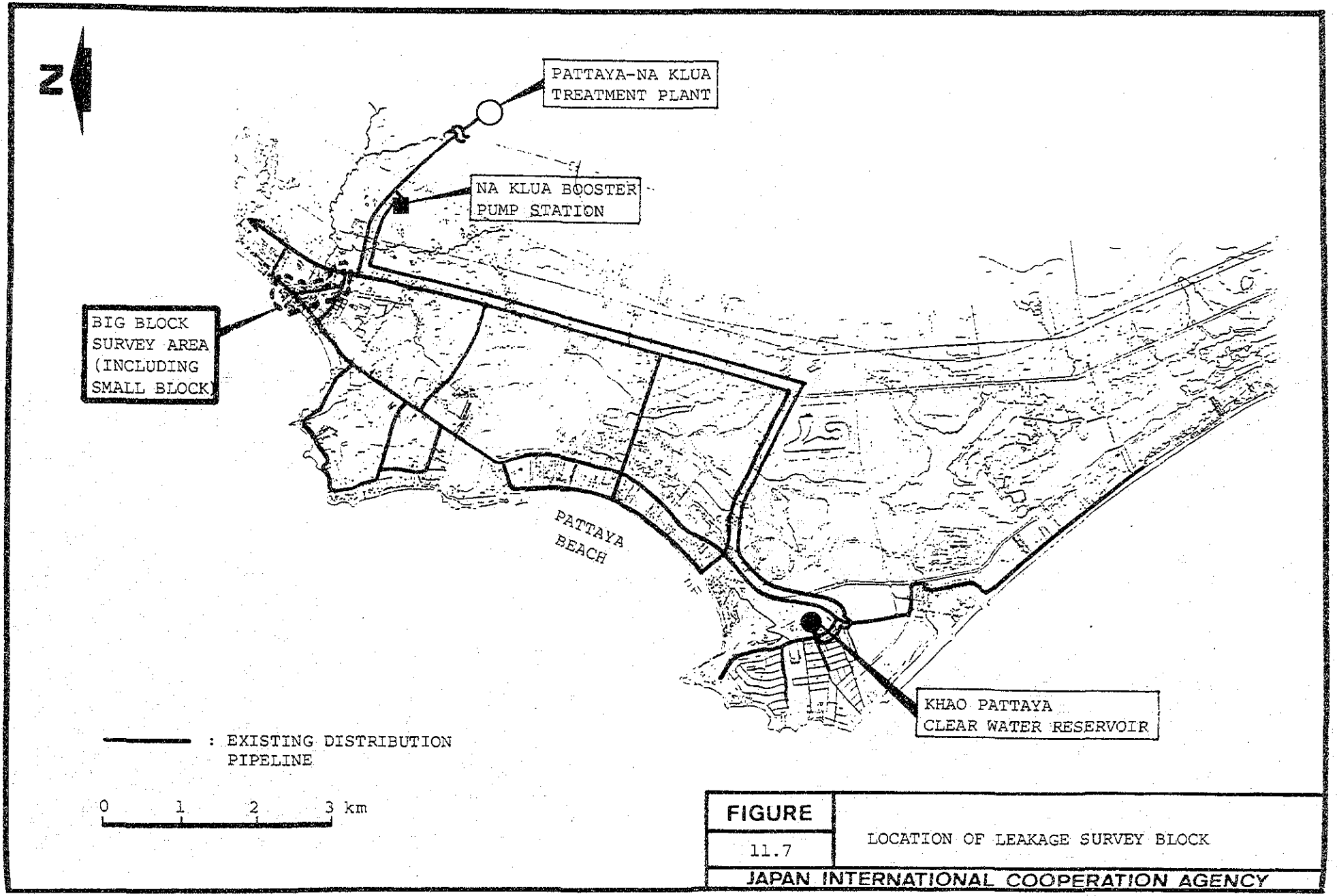

FIGURE	LOCATION OF LEAKAGE SURVEY BLOCK
11.7	

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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 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-11.8 and 11.9 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-11.9 for the survey of the Small Block.

PREPARATION PROCEDURE

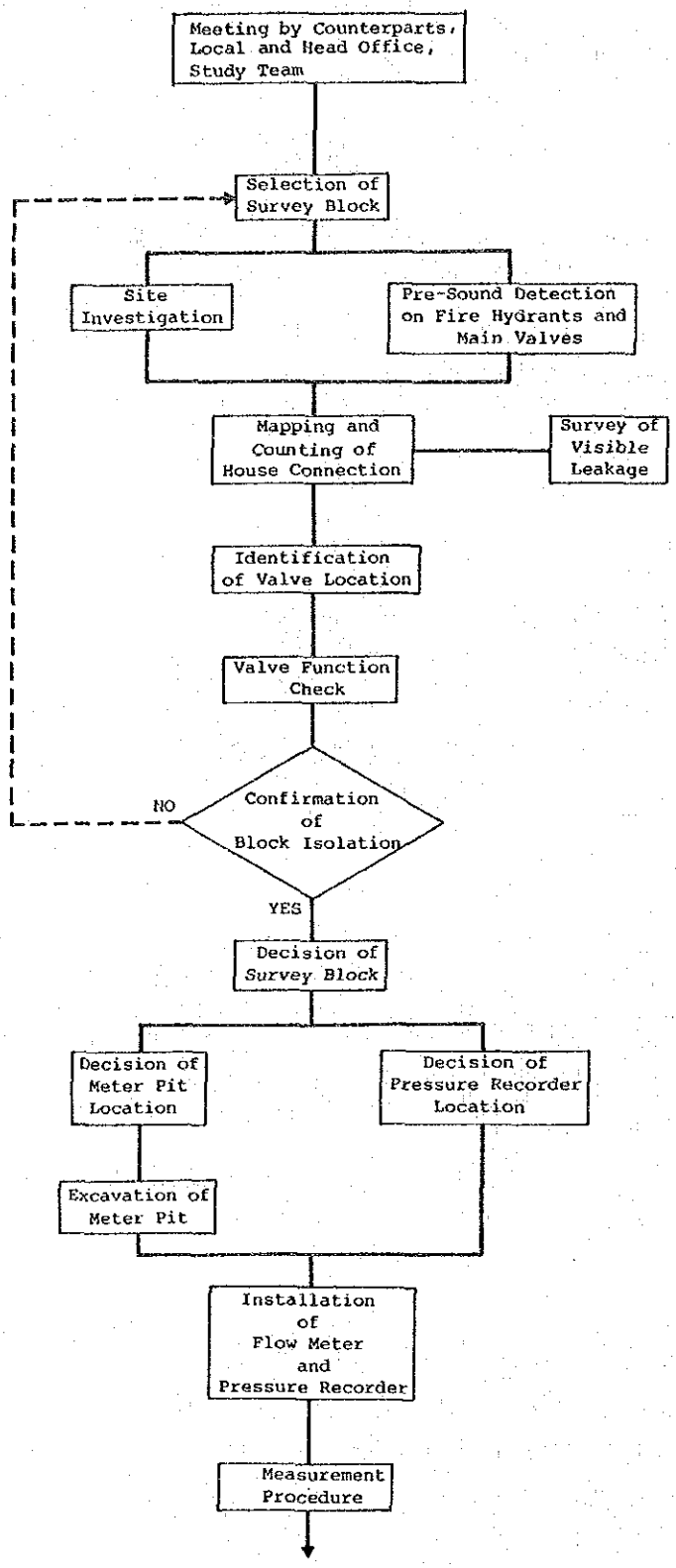

FIGURE 11.8	PREPARATION PROCEDURE FOR LEAKAGE SURVEY

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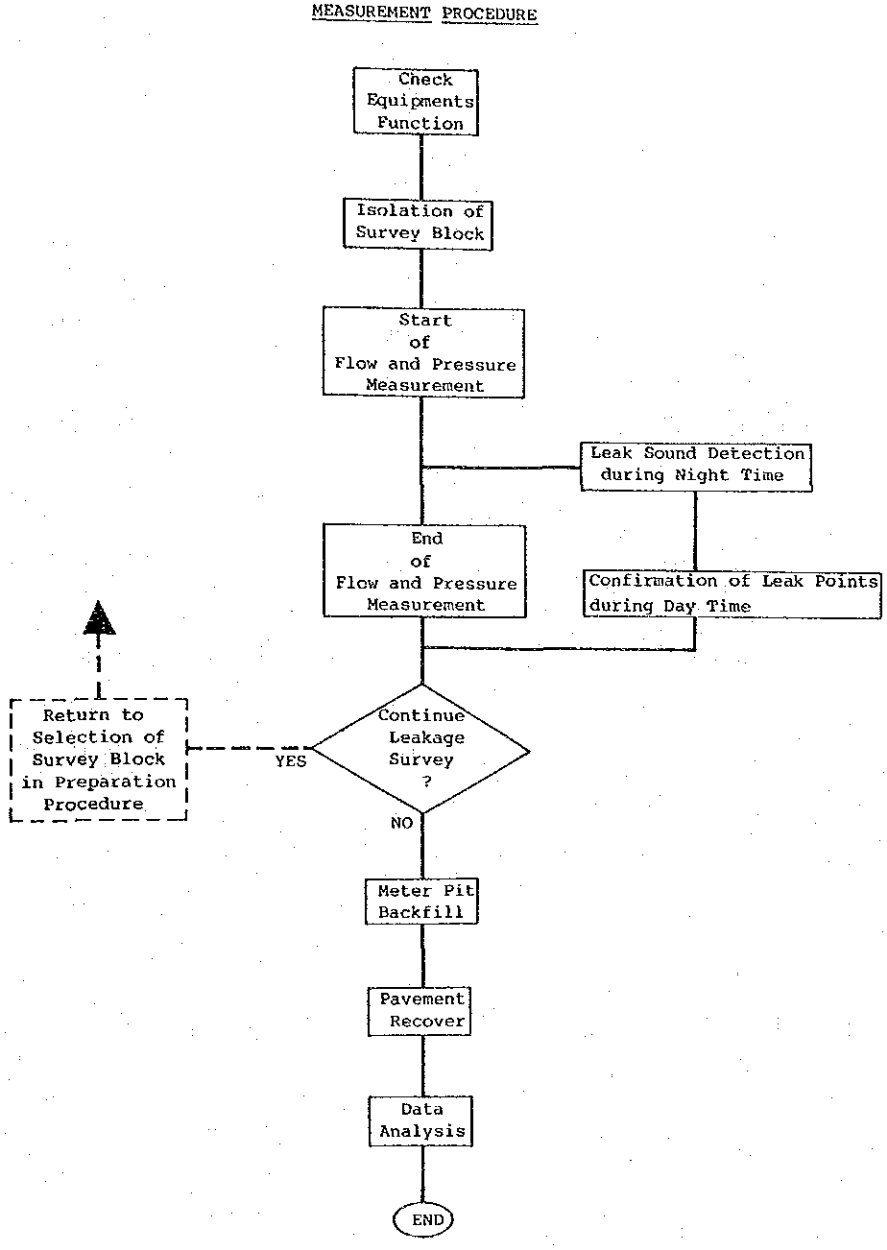

FIGURE	MEASUREMENT PROCEDURE FOR LEAKAGE SURVEY
11.9	

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3. Activities of Leakage Survey Team

Nine counterparts from the PWA Head Quarters, Chonburi Regional Office and Pattaya Waterworks worked willingly with the Study Team. The activities of the Study Team and the counterparts are summarized below.

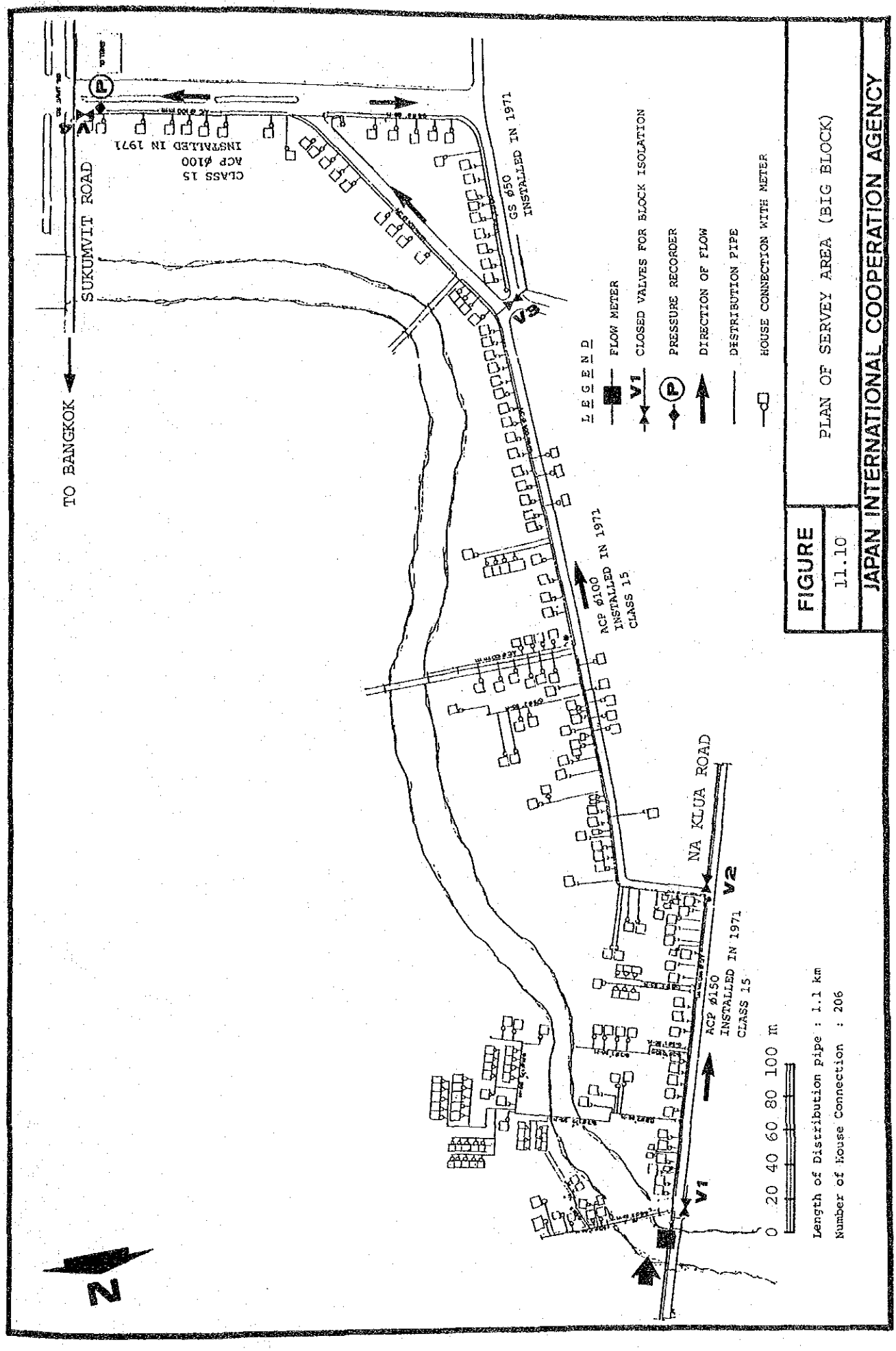
3.1 Big Block Survey

The area, of which the total length of distribution pipes is 1.1 km and the number of house connections 206, was selected as a Big Block. Materials of the distribution pipes in the survey block were of ACP Class 15, ACP Class 20 and SP. 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 206 connections area as a Big Block. The drawing of the Big Block is shown in Fig-11.10. The flow meter was installed on a pipe bridge (SP ϕ 150 mm) and a pressure recorder was installed on a fire hydrant at the other end of the survey block. There were three fire hydrants in the block, but two of them could not be used for pressure recorder installation, because they were found leaking when opened.

24 hours' measurement of the flow and pressure was carried out from June 16 to June 17, 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 waterworks.


SUKUMVIT ROAD
TO BANGKOK
CLASS 15
ACP ϕ100
INSTALLED IN 1971
GS ϕ50
INSTALLED IN 1971
V3
LEGEND
FLOW METER
V1 CLOSED VALVES FOR BLOCK ISOLATION
PRESSURE RECORDER
DIRECTION OF FLOW
DISTRIBUTION PIPE
HOUSE CONNECTION WITH METER
ACP ϕ100
INSTALLED IN 1971
CLASS 15
NA KLUA ROAD
V2
ACP ϕ150
INSTALLED IN 1971
CLASS 15
V1
0 20 40 60 80 100 m
Length of Distribution pipe : 1.1 km
Number of House Connection : 206
N
FIGURE
11.10
PLAN OF SERVEY AREA (BIG BLOCK)
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3.2 Small Block Survey

A section of the Big Block was selected as the Small Block. The total length of distribution pipes was 0.2 km and the number of house connections was 90 in the block. The location and plan is shown in Fig-11.11.

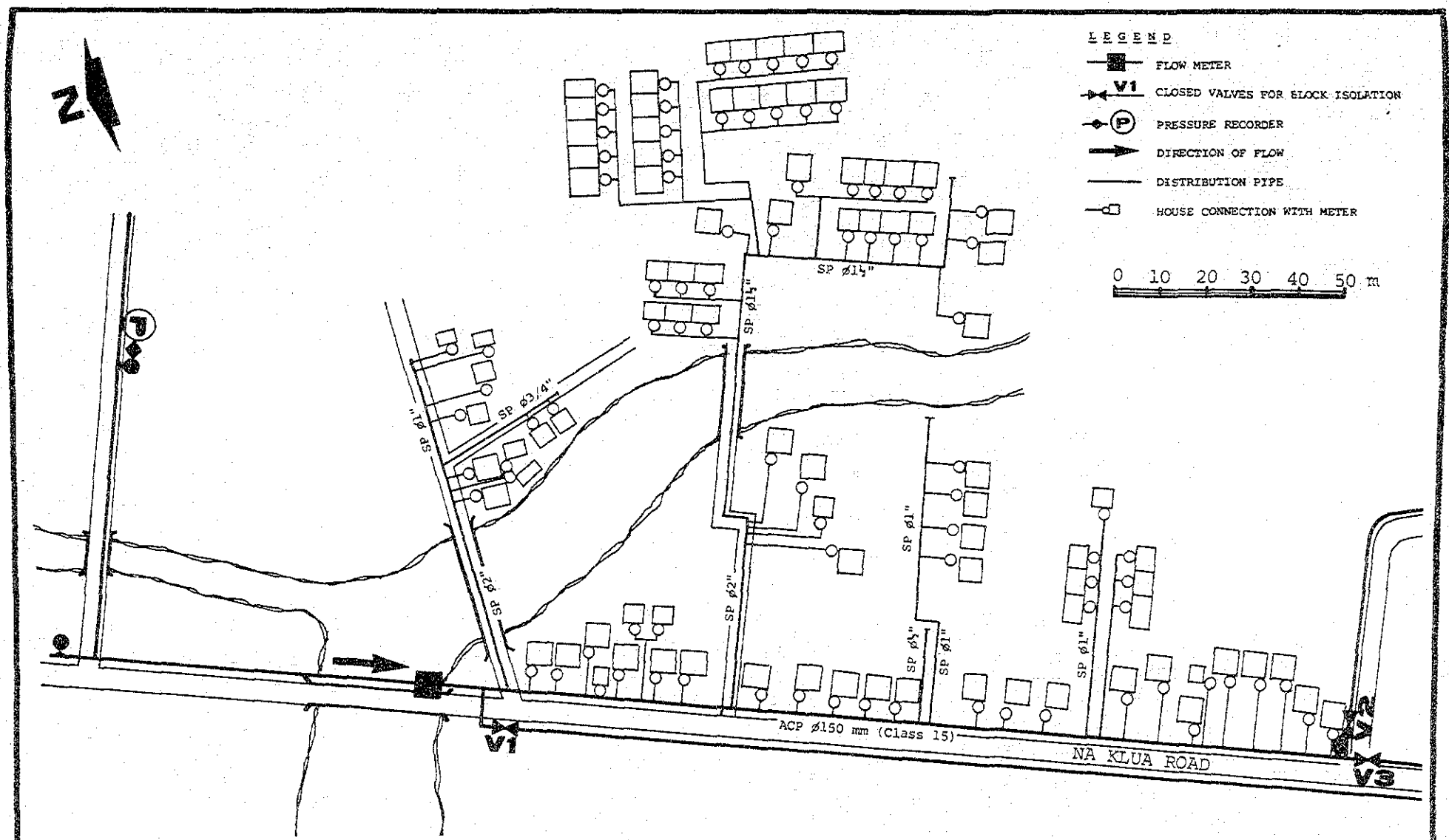
As the Small Block was an upstream section of the Big Block, the same point of flow measurement as in the case of the Big Block was used. As to the pressure measuring point, a fire hydrant shown in Fig-11.11 was selected, as the fire hydrants existing in the block were found unuseful due to similar reasons as experienced with the Big Block survey. The pressure measuring point, as it was closely located to the flow measuring point and the consumption between the two points was obviously very small, was considered to be good enough.

Most of the distribution pipes were ACP Class 15, except the pipe bridge of SP 150 mm on which the flow meter was installed. For service connections, SP was used mostly and PVC partly.

24 hours' measurement of the flow and pressure was carried out on June 18 to June 19, 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 was inspected the next day and faulty taps were found to be the cause.



Length of Distribution Pipe : 200 m
Number of House Connection : 90

FIGURE	PLAN OF SURVEY AREA (SMALL BLOCK)
11.11	

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3.3 Technology Transfer of Leakage Survey to the Counterparts

Two counterparts of the Planning Section of PWA Head Quarters, four counterparts of the O & M Department of PWA Head Quarters, two counterparts of the Chonburi Regional Office and one counterpart of the Pattaya Water-works 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.

Chonburi Regional Office was 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 counter-parts 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 opera-tion was demonstrated in details by the Study Team. The counterparts tried hard in learning 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

Chonburi Regional Office

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

4. Survey Results

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-11.12. The minimum flow was 14.8 cu m/hr and the maximum flow 45.3 cu m/hr. The minimum pressure observed was 0.4 kg/sq cm in the evening and the maximum pressure 2.0 kg/sq cm at midnight. The flow and the pressure were correlated reasonably.

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

4.1.2 Leakage Detected

Seven 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 five 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 large values, suggesting substantial leakage. Actually, a large leak was sound-detected then and it was repaired the next day. The leakage was estimated to be about 5.0 cu m/hr.

The said situation is shown in Fig-11.12.

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 across sewer ditches and close to consumer meters.

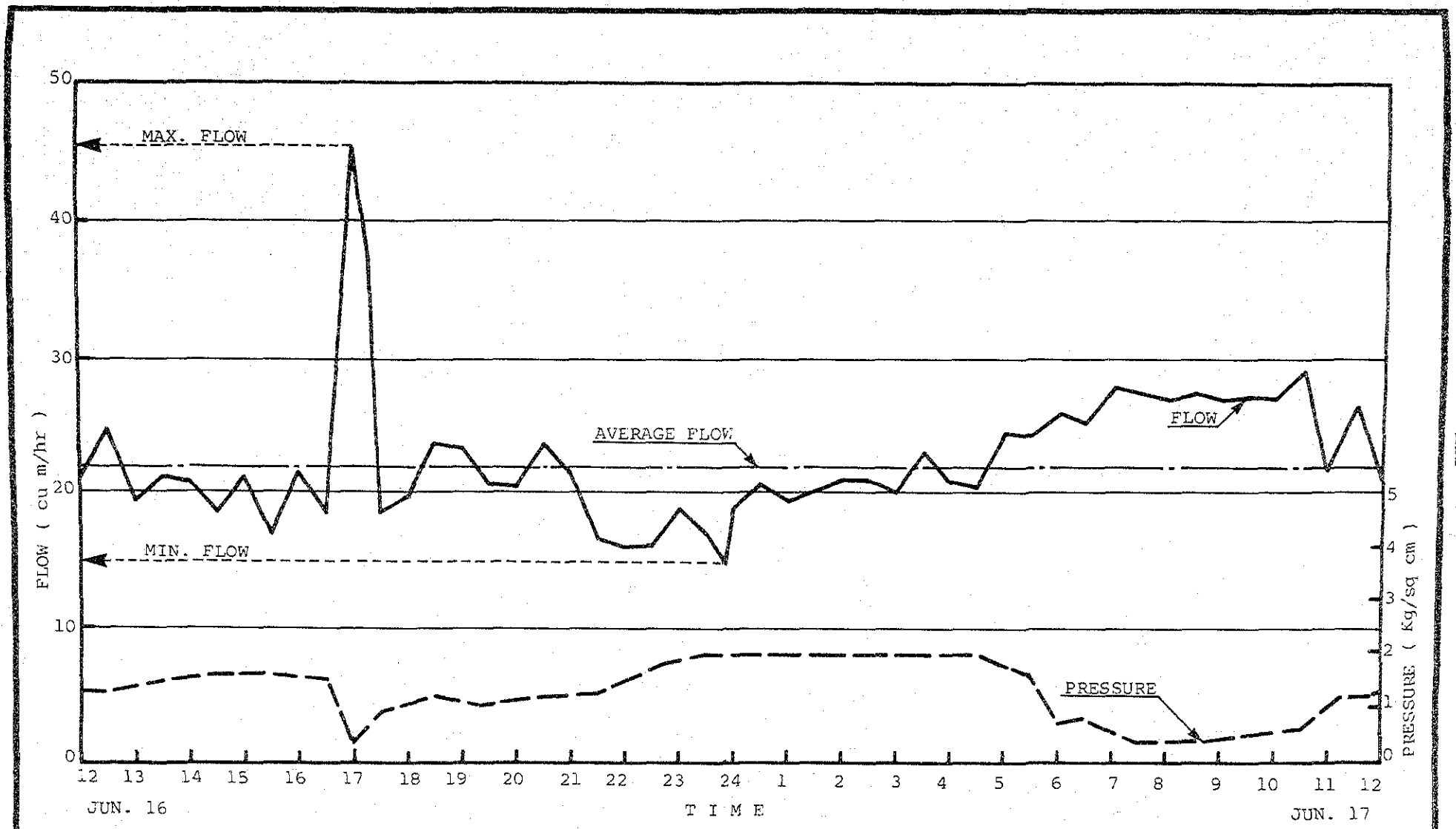

FIGURE	FLOW AND PRESSURE PATTERNS DURING BIG BLOCK SURVEY IN PATTAYA
11.12	

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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 54.2 % inclusive of the before mentioned large leakage. Under the average daytime pressure, the leakage per unit pipe length per day was calculated as 260 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 3.4 cu m/hr and 12.2 cu m/hr, respectively. The minimum pressure was observed at 0.8 kg/sq cm in the morning and the maximum pressure was observed at 2.4 kg/sq cm pressure at midnight. The flow from 1:00 am to 4:00 am didn't fluctuate much, possibly because the consumers taps were closed under the PWA's request. Checking all service connection, only two houses were sound-detected. Their faulty taps were causing sound but leakage was small, it was found under an inspection made the next day.

The registered minimum flow shown in Fig-11.12 is considered as the leakage in the area reasonably. The flow and pressure shows correlation apparently.

The 24 hours' flow into the Small Block was 169 cu m/day, when integrated mathematically.

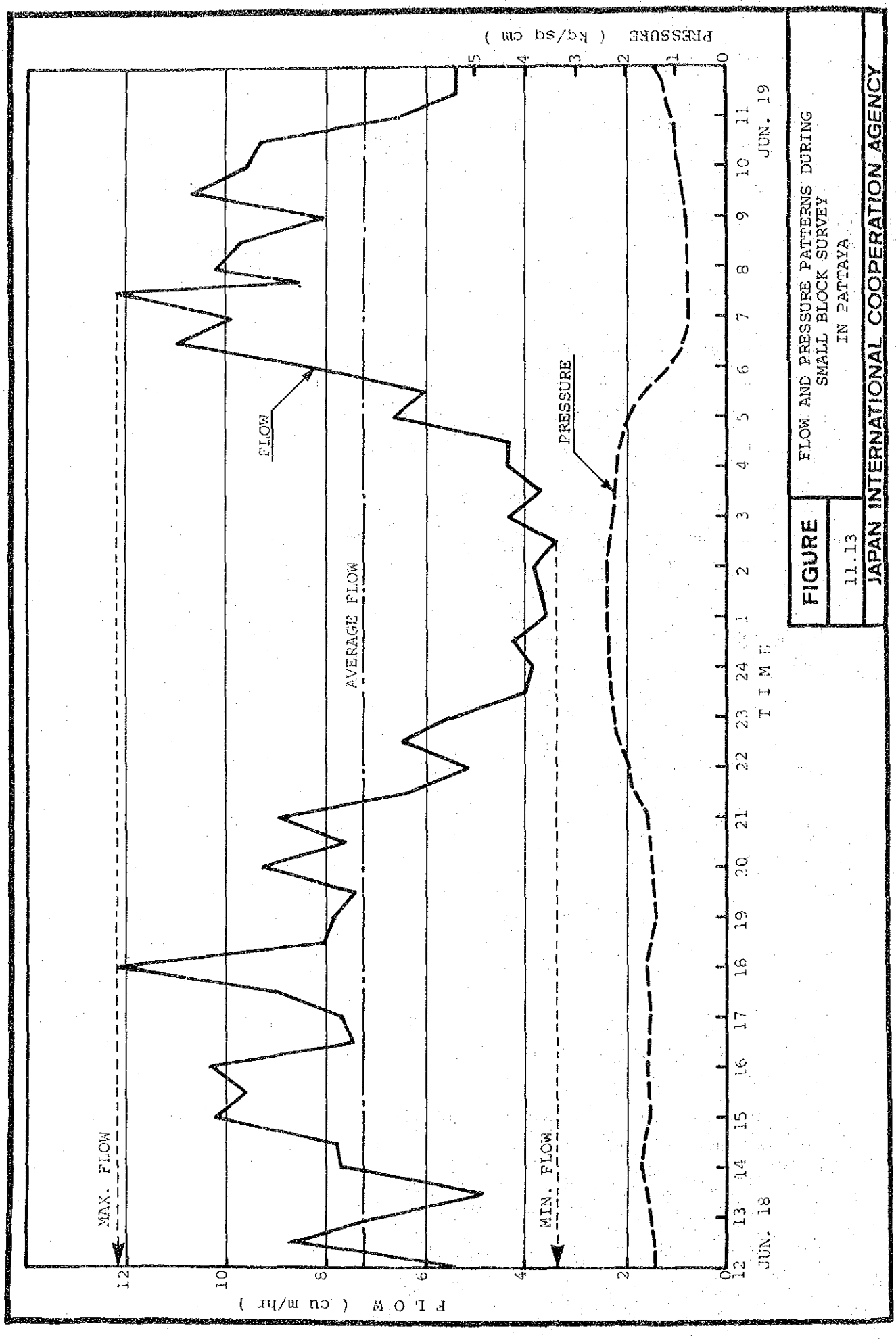
4.2.2 Leakage Detected

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 causes of the leakage were found to be caused by 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 ratio was 39.4 %. Under the average daytime pressure, the leakage per unit pipe length per day was calculated as 333 cu m/km/day.


PRESSURE (kg/sq cm)
FLOW (cu m/hr)
TIME
JUN. 18
JUN. 19
MAX. FLOW
MIN. FLOW
AVERAGE FLOW
FLOW
PRESSURE
FIGURE
11.13
FLOW AND PRESSURE PATTERNS DURING SMALL BLOCK SURVEY IN PATTAYA
JAPAN INTERNATIONAL COOPERATION AGENCY

4.3 Summary of Survey Results

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

5. Finding and Conclusion

Major findings of the survey are described as follows:

1) The existing drawings are not prepared satisfactorily. It doesn't show actual pipelines and location of valves. Some valves (specially old ones) are not shown and the recently laid pipes are not shown, too. It is recommended to prepare complete drawings not only for leakage survey but also routine maintenance and future expansion plan.

2) Some valves shown in the drawings are missing, probably because of road construction work made later.

3) Some valves are deteriorated. Leakage was observed at the gland of valves when they were operated.

4) Some fire hydrants were found not-operatable because of deterioration of the valves.

5) Distribution pipes in the survey area were laid under the public road and some service pipes which were extruded across sewer flumes were corroded badly. Two leaks under such a condition were found during the survey.

6) Seven leak spots were found in the Big and Small Block Surveys and their causes are considered to be as follows:

Cause	Case
Corrosion	5
Loose or inappropriate joints	1
Malfunction of consumer's faucet	1

Table-11.6 SUMMARY OF SURVEY RESULTS IN PATTAYA

ITEM	DESCRIPTION	UNIT	BIG BLOCK	SMALL BLOCK
A	LENGTH OF DISTRIBUTION PIPE	(km)	1.1	0.2
B	NUMBER OF HOUSE CONNECTION	(number)	206.0	90.0
C	MAXIMUM FLOW	(cu m/hr)	45.3	12.2
D	MINIMUM FLOW	(cu m/hr)	14.8	3.4
E	AVERAGE FLOW	(cu m/hr)	22.0	7.1
F	ACCUMULATED FLOW	(cu m/day)	528.0	169.0
G	MAXIMUM PRESSURE	(kg/sq cm)	2.0	2.4
H	MINIMUM PRESSURE	(kg/sq cm)	0.4	0.8
I	AVERAGE PRESSURE	(kg/sq cm)	1.3	1.6
J	AVERAGE WATER FLOW PER HOUR PER UNIT PIPE LENGTH	(cu m/hr/km)	20.0	35.5
	* * * * * ASUMING : MINIMUM FLOW = LEAKAGE * * * * *			
K	MODIFIED LEAKAGE BY AVERAGE PRESSURE	(cu m/hr)	11.9	2.8
L	LEAKAGE AMOUNT PER DAY	(cu m/day)	286.4	66.6
M	ESTIMATED LEAKAGE RATIO	(%)	54.2	39.4
N	LEAKAGE PER PIPE LENGTH	(cu m/day/km)	260.3	333.1
O	LEAKAGE PER HOUSE CONNECTION	(cu m/day/con.)	1.4	0.7

NOTE : F = E x 24
J = E / A
K = D x (I / G)^0.5
L = K x 24
M = (L / F) x 100
N = L / A
O = L / B

7) In Table-11.6, Item J 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 20 and 35.5 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 187 and 450 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 and P are measured, Q is calculated with the given L and P_s.

Q values were 13.5 and 15.9 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 waterworks, 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

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.

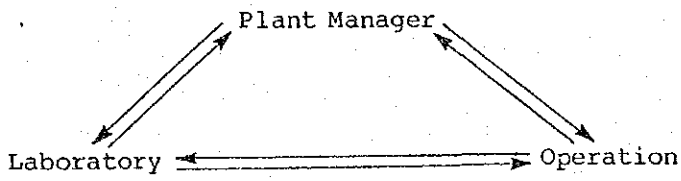
12.5.3 Internal Coordination

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

S.H

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.

S.H

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,

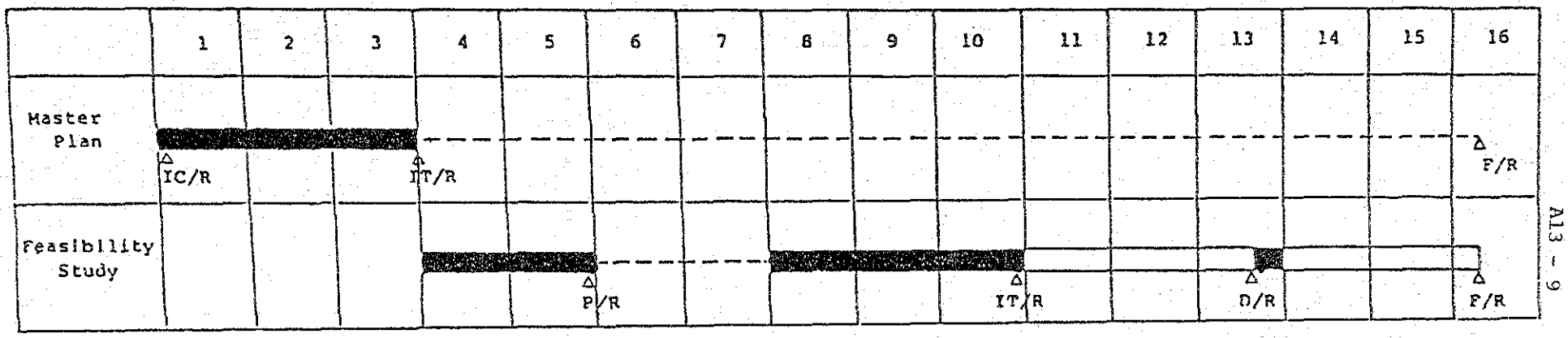
(1) to dispatch, at its own expense, study teams to Thailand,

(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.

ANNEX I

Tentative Schedule for Master Plan, Feasibilisy 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

5. 4

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 Division
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 Satayasunhasakul	Corporate Planning Division
Mr. Nived Vachiraanan	Corporate Planning Division
Mr. Prathom Khoysomboon	Corporate Planning Division
Mrs. Anu Songsakchai	Corporate Planning Division
Mrs. Bussara Rasameamornwiwat	Corporate Planning Division
Mr. Prapon Chanakitjanukit	Corporate Planning Division

Operation and Maintenance I

Mr. Virusah Mahakkapong	Director
Mr. Wiroon Pungrongthanin	Chief, Water Production Section
Mr. Verrapun 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 Amornleetrakul	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 Co;;ection and Reporting Section

Engineering Department

Mr. Anunt Sahasak	

Central Laboratory

Mrs. Chitra Tritham	Head, Chemical Section

Pattaya

Mr. Nakorn Jirasvetakul	Director, Regional Office No.1
Mr. Sukit Pibulvej	Assistant Director, Regional Office No.1
Mr. Pricha Ukachote	Assistant Director, Regional Office No.1
Mr. Prasert Utong	Manager, Pattaya Waterworks
Mr. Kangwan Pinkaeo	Chief, Service Section, Pattaya Waterworks
Mr. Tinnakorn Danpongsuwan	Chief, Cost Estimation and Design Work, Regional Office No.1
Mr. Saman Uthaisri	Regional Office No.1
Mr. Prasart Nuchsiri	Regional Office No.1

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

APPENDIX 15

MEMBER LIST OF ADVISORY COMMITTEE AND STUDY TEAM

APPENDIX 15

APPENDIX 15 MEMBER LIST OF ADVISORY COMMITTEE AND STUDY TEAM

Advisory Committee

Mr. Saburo Hosoda (Chairman)	Director, Riverhead Forestry Office, Bureau of Waterworks, Tokyo Metropolitan Government
Mr. Tsutomu Nagasaka	Nagoya Waterworks Bureau
Mr. Masuji Ide	Yokohama Waterworks Bureau
Mr. Hajime Nishikawa	Kobe Waterworks Bureau

Ministry of Foreign Affairs

Mr. Teruyoshi Kumashiro	Development Cooperation Division
Mr. Takeo Sato	Development Cooperation Division

Ministry of Health and Welfare

Mr. Syuhei Kato	Water Supply and Environmental Sanitation Department
Mr. Hiroyuki Endo	Water Supply and Environmental Sanitation Department
Mr. Tsutomu Sakagawa	Water Supply and Environmental Sanitation Department

JICA

Mr. Hiroyoshi Ihara	Social Development Cooperation Department
Mr. Shozo Matsuura	Social Development Cooperation Department
Mr. Yoichi Seki	Social Development Cooperation Department, Coordinator

Study Team

Mr. Osamu Wakamoto (Team Leader)	General Director, Overseas Service Department, Nihon Suido Consultants Co., Ltd.
Mr. Hiroshi Machida (Co-Team Leader)	Director, Overseas Service Department Nihon Suido Consultants Co., Ltd.
Mr. Tatsuya Samukawa	Advisor, Overseas Service Department Nihon Suido Consultants Co., Ltd.
Mr. Shigeyoshi Kagawa	Nihon Suido Consultants Co., Ltd.
Mr. Hideki Kondo	Nihon Suido Consultants Co., Ltd.
Mr. Hideki Asada	Nihon Suido Consultants Co., Ltd.
Mr. Toshio Yamada	Nihon Suido Consultants Co., Ltd.
Mr. Masakazu Inamiya	Nihon Suido Consultants Co., Ltd.
Mr. Takemasa Mamiya	Nihon Suido Consultants Co., Ltd.