ANNEX 17
REDUCTION OF UNACCOUNTED-FOR WATER

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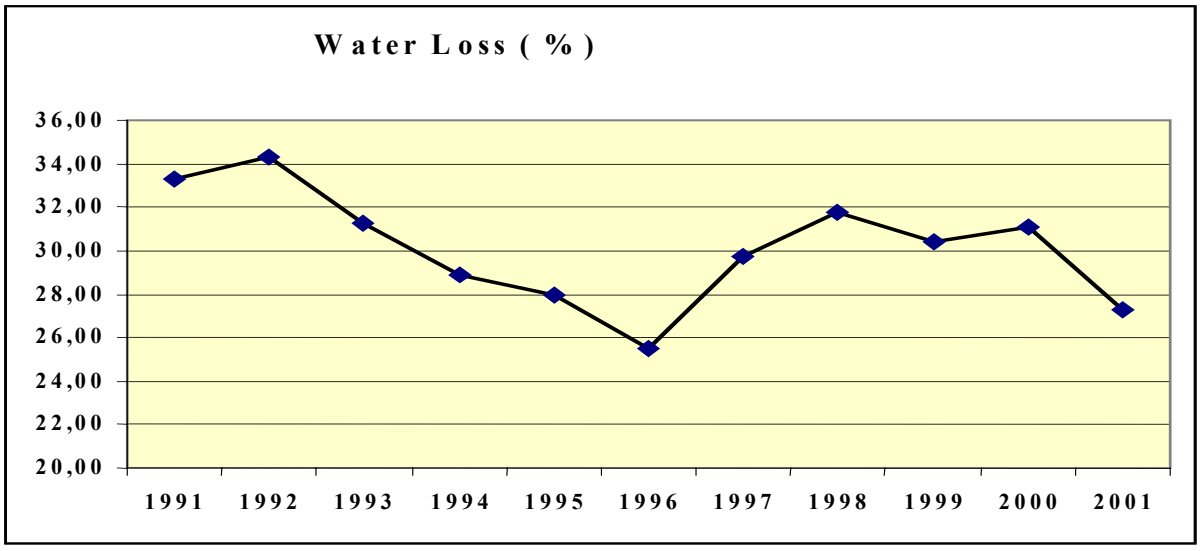
(1) Water Loss in Nam Papa Vientiane Capital City

According to the reports on Leak Detection Campaign and Reduction Unaccounted-for Water of Nam Papa Vientiane Capital City (NPVC), the losses in terms of volumes of unaccounted-for water represented about 30% of the water transmitted to the distribution network. Figure 1 shows the water loss since 1991.

The report mentioned that this figure showed a change from decease to increase in 1997 which might be caused by commissioning of the second phase of Chinaimo Water Treatment Plant. NPVC continues to leakage repairing works.

Figure 1 Water Loss in Nam Papa Vientiane Capital City



Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

(2) Leak Detection Campaign and Reduction of Unaccounted-for Water by the French Development Agency (AFD)

In year 2002, the government of Lao PDR and the French Development Agency concluded a project for extension of potable water supply network in Vientiane. This 5-Months Project had two main objectives:

- To reduce the unaccounted-for water ratio from 30% to 25% in one or more pilot areas
- To establish a two-year action plan for reducing the unaccounted-for water ratio in the whole Vientiane

Execution of the project was scheduled for following 4 phases

- Phase 1 (January 2002): Mission establishment, preliminary review and assessment, commencement of field activities.

- Phase 2 (February 2002): Preliminary field surveys and laboratory tests for completing the preliminary diagnostic and assessment, breakdown of losses by type, purchase of devices, staff training.
- Phase 3 (March, April and May 2002): Actions to reduce unaccounted-for water in the pilot zones. Newly purchased devices such as acoustic correlator to be used during this stage.
- Phase 4 (May 2002): Assessment of the results and elaboration of a two-years action plan for the reduction of unaccounted-for water in the whole Vientiane.

The followings are the major points achieved through the project and to be considered in preparation of the Master Plan by JICA study.

1) Zoning for experimental (Pilot Zones)

Five pilot zones were chosen representing the situation in various districts of the city. The main features of zones are summarized as follows:

Table 1 Pilot Zones

Zone	Branch Office concerned	Feature of zone	Length of the pipelines in zone
I	Sisattanak	Close to Phonethane Reservoir (Pressure of 0.11 to 0.25 MPa)	22,3 km
II	Sisattanak	Relatively close to Phonethane reservoir. Partially supplied from the main of 800 mm of Chinaimo. Very low pressure in the day. (Pressure of 0 to 0.12 MPa)	21,2 km
III	Sikhottabong	Very close to the station of Kaolieo. (Pressure of 0 to 0.25 MPa)	20,2 km
IV	Xaisettha - Xaithani	Very close to Phonekheng reservoir. (Pressure of 0.05 to 0.21 MPa)	34,50 km
Sidamdouane	Chanthabuli	Relatively close to Phonekheng reservoir. (Pressure of 0.05 to 0.1 MPa)	26,40km
Total for 5 zones			125 km, 25% of the total length of pipelines in the network

Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

2) District Metering, Waste Metering, Step Test

The AFD project will apply the methods widely used for detection of water loss. Those methods are District Metering, Waste Metering, Step Test. Zoning as initial steps for the District Metering was made as pilot area in the 5 months intensive project. District Metering was proposed in the action plan for 2 years 2003 and 2004. Waste Metering and Step Test will be applied in future. The zone is to be isolated from pipe networks and the inflow to the zone is to be measured continuously by installed water meter. This

measurement is referred to as "District Metering". District metering is to grasp profile of inflow to the zone such as peak flow, minimum flow, and total volume of inflow to the zone. If an abnormal flow is measured, the pipelines in the zone should be investigated. Volume of unaccounted-for water is defined as the difference between the total inflow to the zone and the sum of water volume measured by individual water meters in the zones. The pipelines in the zones are to be formed into several sub-zones which are also temporarily isolated from others. The inflow to the sub-zone is to be measured by water meter, usually portable meter. This measurement is referred to as "Waste Metering". The difference of flow between the minimum flow measured and the flow known as consumed at the measuring time will be principally physical loss from the pipes. The minimum flow is usually measured at midnight. The pipelines in the sub-zones are to be divided into several sections by isolation valves referred to as step valves. If further investigation on pipelines of certain sub-zone is required as a result of waste metering, the waste metering with operation of step valves to detect leakage in section by section will be conducted. This measuring is referred to as "Step Test". Among the above methods, only District Metering will relate to planning the transmission mains.

3) Leak Detection and Repair

Intensive leak detection was conducted in each zone. The result is summarized below:

Table 2 Leakage Detection Summary (1)

Pilot Zone	Pipeline Length km	Connection	Leakage Detected			Leakage Flow Rate		Leakage Repaired	
			Total	Street	Connection	Small	Large		(%)
Customer		1600	116		116	116		109	94
Sisamdouane	26.4	2453	104	24	80	95	9	104	100
Zone 1	22.3	2073	105	24	81	86	19	61	58
Zone 2	21.2	1967	80	10	70	67	13	38	48
Zone 3	20.3	1882	82	2	80	74	8	81	99
Zone 4	34.5	3206	137	14	123	126	11	66	48
Total for Zone	124.7	11581	508	74	434	448	60	350	69
Total	124.7	11581	624	74	550	564	60	459	74

Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

Detected leakage per pipeline length is summarized in Table 3.

Table 3 Leakage Detection Summary (2)

Pilot Zone	Leakage Detected per km		
	Small	Large	Total
Sisamdouane	0.3	3.6	3.9
Zone 1	0.9	3.9	4.7
Zone 2	0.6	3.2	3.8
Zone 3	0.4	3.7	4.1
Zone 4	0.3	3.7	4.0
For all zones	0.5	3.6	4.1

Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

The leakage points tabulated in the above were visible type. Detection of invisible leakage by equipment such as acoustic correlater, microphone etc will be conducted after all of visible leakage repaired because those equipment is to utilize noise from leakage from pipes, however, noise was low due to low pressure in the pipelines.

4) Water Meter Investigation

Water meter investigation in each zone was also conducted by testing in site as well as by calibration on test bench in workshop at NPVC. In addition, consumption profile with date logger was also measured for both small meters and large meters. The result of investigation is summarized below:

Table 4 Water Meter Investigation Summary

Pilot Zone	Meter Inves-tigated	Anomalies of Meter Detected			Corrected Anomalies		Anomalies per 1000 connections		
		Total	Re-placed	Rein-stalled	Number	(%)	Re-placed	Rein-stalled	Total
Customer	1600	202	62	140	184	91	39	88	126
Sisamdouane	2453	130	96	34	130	100	39	14	53
Zone 1	2073	100	61	39	19	19	29	19	48
Zone 2	1967	252	177	75	40	16	90	38	128
Zone 3	1882	140	54	86	140	100	29	46	75
Zone 4	3206	235	165	70	128	54	51	22	73
Total	11581	1059	615	444	641	61	53	38	91

Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

Investigation for water meters of large consumer, more than 2,000 m^3/month, concluded that (i) meters were not properly installed; (ii) lack of accessories and fittings of meter: (iii) much leakage from service pipes of large consumers, especially governmental authorities.

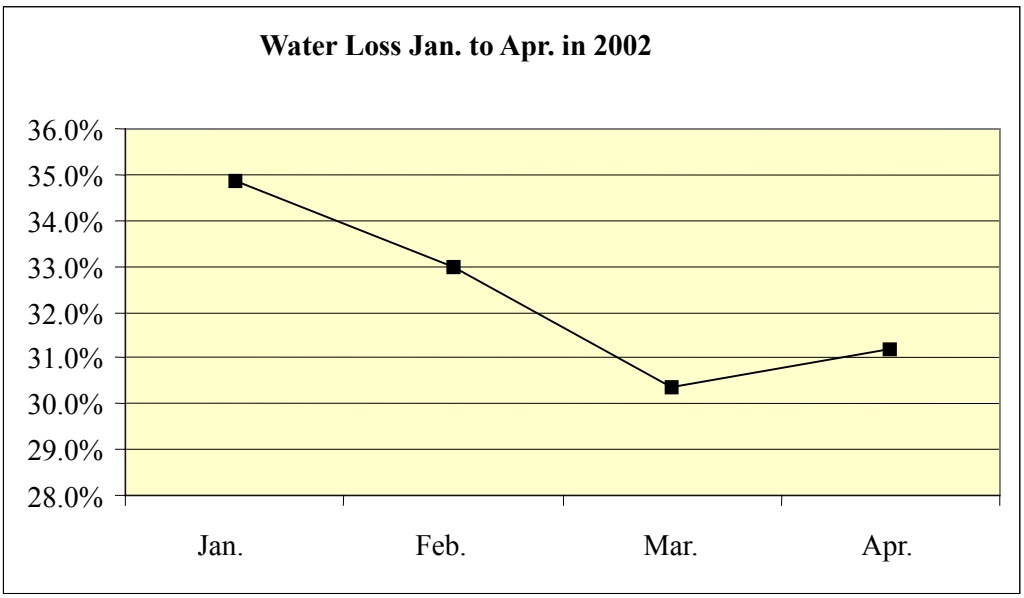
The investigation result on 6 water meters in 15 mm also showed that size of water meter was larger than appropriate size because 24 % of water consumed below the transition flow rate (Qt). The transition flow Qt is a limit of permissible error specified by the standards for measuring and more error will be included in the

measurement at below Qt.

5) Result of the project

The intensive detection of leakage and repairing works in the pilot zones resulted in improvement of the UFW ratio as shown in Figure 2.

Figure 2 Water Loss from January to April in 2002



Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

The balance of production and consumption in January to May 2002 is tabulated in Table 5.

Table 5 Balance of Production and Consumption

	Monthly consumption in m^3			
Year 2002	Jan	Feb	Mar	May
Water Distributed				
Chinaimo	2,801,389	2,839,184	2,570,180	2,871,081
Kaolieo	689,264	679,648	727,296	733,984
Thadeua	6,892	9,843	9,928	12,481
Total	3,497,545	3,528,675	3,307,404	3,617,546
Sales of Water				
Agency				
Sisattanak	434,976	441,016	417,615	439,246
Saythani	405,346	426,455	429,769	447,582
Chantabury	327,532	347,384	326,041	338,148
Sikhottabong	329,839	335,057	316,248	338,267
Total	1,497,693	1,549,912	1,489,673	1,563,243
Commercial Section				
Category 1	491,053	474,757	535,056	509,886
Category 2	31,598	31,278	29,722	29,036
Category 3	180,595	201,316	180,105	187,520
Category 4	23,580	24,409	21,166	15,264
Total	726,826	731,760	766,049	741,706
Thadeua				
Thadeua	53,524	82,592	47,433	183,549
Tankers				
Nampapa				60
Private	800			
Total	800	0	0	60
Total	2,278,843	2,364,264	2,303,155	2,488,558
Internal Use or Permissible Use				
Fire Fighting				274
Damage of pipe networks				652
Total	0	0	0	926
Total Consumption	2,278,843	2,364,264	2,303,155	2,489,484
Loss	1,218,702	1,164,411	1,004,249	1,128,062
Ratio (%)	34.8	33.0	30.4	31.2

Source: Final Report, Leak Detection Campaign and Reduction Unaccounted-for Water

The project concluded that the estimated volume of water saved by repairing visible leakage in the pilot zones was 138,000 m3/month or 3.9 % of the production volume. Analysis of leakage summarized the

following breakdown of the UWF ratio, the average 32.4 % as follows:

- Invisible leakage (19.1 %)
- Unreported leakage visible leakage (7.0 %)
- Commercial loss and water meter error (4.7 %)
- Reported leakage and others (1.6 %)

6) Action plan for two years 2003 and 2004

The 5-months project concluded that it should be possible to reduce the ratio down to 25% by the end of 2004 provided that following conditions are effectively implemented:

a. Implementation of various sub-projects aiming reduction of physical and commercial losses (including metering losses)

Sub-projects are:

- Continuation of the visible leak detection and repair campaign
- Invisible leak detection campaign
- Installation of district meters
- Defective meters replacement campaign
- Large meter resizing campaign
- Old meter replacement campaign
- Replacement of old mains and house connections*
- Loss reduction in the capital city and governmental premises

*: on going by Nam Papa Vientiane Capital City

b. Institutional strengthening of NPVC including various components: more adapted organization, improvement of the management information system (including the billing system), improved monitoring, staff training and responsibility.

Institutional strengthening comprises:

- Technical assistance to implement the institutional strengthening and the monitoring of the 2-Years Action Plan
- Creation of an UFW Reduction Department in charge of leak detection and repair, meter management, customer consumption monitoring, reporting.
- Definition, purchase and installation of a new Customer Management System
- Purchase of equipment and tools definition,
- Training program

7) UFW Reduction Method (Reference)

In addition to the detection and repair, The AFD project will apply the methods widely used for detection of water loss. Those methods are District Metering, Waste Metering, Step Test. Zoning as initial steps for the District Metering was made as pilot area in the 5 months intensive project. District Metering was proposed in the action plan for 2 years 2003 and 2004. Waste Metering and Step Test will be applied in future. The zone is to be isolated from pipe networks and the inflow to the zone is to be measured continuously by installed water meter. This measurement is referred to as "District Metering". District metering is to grasp profile of inflow to the zone such as peak flow, minimum flow, and total volume of inflow to the zone. If an abnormal flow is measured, the pipelines in the zone should be investigated. Volume of unaccounted-for water is defined as the difference between the total inflow to the zone and the sum of water volume measured by individual water meters in the zones. The pipelines in the zones are to be formed into several sub-zones which are also temporarily isolated from others. The inflow to the sub-zone is to be measured by water meter, usually portable meter. This measurement is referred to as "Waste Metering". The difference of flow between the minimum flow measured and the flow known as consumed at the measuring time will be principally physical loss from the pipes. The minimum flow is usually measured at midnight. The pipelines in the sub-zones are to be divided into several sections by isolation valves referred to as step valves. If further investigation on pipelines of certain sub-zone is required as a result of waste metering, the waste metering with operation of step valves to detect leakage in section by section will be conducted. This measuring is referred to as "Step Test". Among the above methods, only District Metering will relate to planning the transmission mains.