

National Water Supply & Drainage Board

Summary Report

Sri Lanka

The Completion Report of Verification Survey with the Private Sector for Disseminating Japanese Technologies for Non-Revenue Water Reduction Program

November, 2017

Japan International Cooperation Agency

Tesco Asia Co., Ltd.

Pictures of each aspect of the project

	
<p>Site inspection at Wegiriya Reservoir (2015/5/20)</p>	<p>Meter replacement work (2015/11/17)</p>
	
<p>Leak detection works (2016/6/3)</p>	<p>Workshop on piping method (2016/8/26)</p>
	
<p>Commencement of the new meter reading system(2016/11/3)</p>	<p>Meter reading by the new system (2016/11/1)</p>

BACKGROUND

Confirmation of the current status of development issues and development needs in the target country

The high rate of Non-Revenue Water (NRW) has been a longstanding problem in Sri Lanka. The estimated national average rate of NRW is 33%. To improve this situation, the National Water Supply and Drainage Board (NWSDB) has stressed the importance of NRW reduction as one of the prioritized tasks and the Japan International Corporation Agency (JICA) has been supporting this effort by conducting capacity development projects in Colombo. Some of these projects leveraged the service pipes' construction management know-how from Nagoya City Waterworks and Sewerage Bureau (NCWSB).

Tesco Asia Co., Ltd. (TA), a company located in Nagoya City, offers consulting services for water supply, sewage facility operation and their maintenance. In 2012, TA and NCWSB participated in a seminar on NRW management held in the Greater Kandy Water Supply Project (GKWSP). At this occasion, NWSDB's Regional Support Center-Central (RSC-Central) and GKWSP indicated an interest in Japanese know-how and its technology that were introduced by TA and requested guidance and assistance for NRW reduction in GKWSP. The estimated rate of NRW in GKWSP is 36% and the coverage of the waterworks in the area is approximately 50-60%.

1. Outline of the pilot survey for disseminating sme's technologies

(1) Purpose

In this project in the Kandy district, we aim to provide a policy package of equipment and technology necessary to reduce non-revenue water in the project areas and increase water supply to a greater population. It also contributes to the further improvement of water supply management. At the same time, we aim to demonstrate the effect of reducing non-revenue water, and to consolidate the foundation of dissemination of the measures to reduce non-revenue water after project completion.

(2) Activities

A. Activities related to the reduction of the NRW of the Survey area:

- a) Conducted a baseline study in the Survey area to grasp the status quo of NRW.
- b) Replaced existing old water meters and measured actual water usage in the Survey area. At the time of the replacement, the situation of unjust connections was examined.
- c) Provided instructions on how to handle a leak checker to NWSDB's meter-readers who carried out leakage checking at the time of routine meter reading.
- d) Identified leakage locations performed by the local company entrusted by TA. Identified leakage locations and repaired by NWSDB.
- e) In order to reduce human errors in the process of billing, handy terminals and related computer system

introduced. The guidance for handling the system was offered to NWSDB.

f) The change of NRW rates of the Survey area before and after the Survey was closely examined.

B. Activities related to enhancement of leakage prevention technologies and the management capability for the service pipe construction and repair:

a) Analyzed the current situations and challenges of the construction and repair management system of NWSDB in reference to the service pipe construction management system and the construction standards of NCWSB, and prepared advisory activities for improvement of the NWSDB management system.

b) Provided technical guidance aiming to prevent service pipe leakages for engineers and technical workers of NWSDB.

c) Organized seminars and workshops to enhance construction management capability and mastery of leakage prevention technologies.

d) Organized training activities in Japan for nominated staffs of NWSDB.

C. Activities related to formulation of a plan for the dissemination of the NRW reduction service package in Sri Lanka:

a) Conducted an analysis to understand present water supply situation and status quo of NRW in Kandy and other areas of Sri Lanka. The analysis included the estimation of the potential demand for the service package.

b) Potential challenges for disseminating the service package were assessed.

c) Carried out seminars or workshops to introduce and promote the service package and the activities conducted under the Survey

(3) Information of Product/ Technology to be Provided

a) Water Meter

Name	Water Meter
Specification	Vane wheel type meter $\phi 15\text{mm}$
Dimension	L:100mm H:92mm W:89mm
Characteristics	Only a small vane wheel exists in the meter duct. Obstruction of water flow is minimum.
Comparative advantage	Meter defective rate is 1/10000 or less



b) Leak Checker

Name	Leak Checker (SV1108)
Specification	Time integration system, Bluetooth V1.2
Dimension	L:222mm, H:63mm, W:330mm
Characteristics	Measure water leakage within 1 □ 5 seconds
Comparative advantage	There is no similar equipment in Japan



c) Meter reading, Billing, Invoice printing System

Name	Meter reading system: Hydro K.ing
Specification	Meter-reading and billing system with Android tablet and portable printer
Dimension	Tablet type:7 Portable printer: 4 inches
Characteristics	Automatic water charge calculation and printing of invoice
Comparative advantage	The leak checker outcome can be registered in this system.



(4) Counterpart Organization

Under the Ministry of City Planning and Water Supply, there is the National Water Supply and Drainage Board which is responsible for national water supply. The water supply system in Harispattuwa is administered by the Manager (Operation and Maintenance), Kandy North under Regional Support Centre-Central (RSC-Central).

Greater Kandy Water Supply Project (GKWSP) is responsible for the construction of the purification plant and the pipe line.

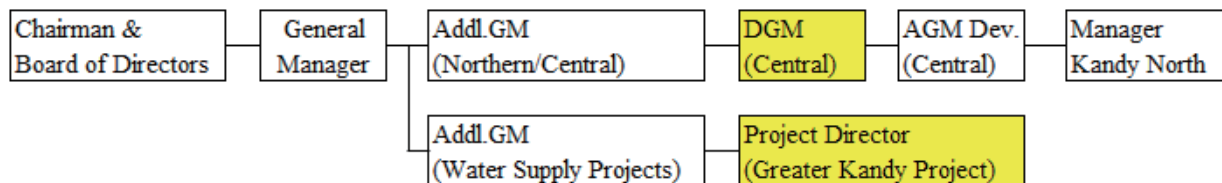


Figure1 Organization chart

(5) Target Area and Beneficiaries

Three water supply areas, namely Wegiriya, Kulugammana and Kondadeniya in Harispattuwa Division in Kandy North, Sri Lanka.

(6) Duration

From March 2015 to November 2017

(7) Progress Schedule

Contract Period 2015/3/25~2017/11/30	2015												2016												2017																							
	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12														
1 Equipment loading																																																
Meters	[Gantt chart: In Japan (Plan) from Apr to Oct 2015; In Sri Lanka (Result) from Oct to Dec 2015]																																															
Work equipment	[Gantt chart: In Japan (Result) from Apr to Oct 2015; In Sri Lanka (Plan) from Oct to Dec 2015]																																															
2 Meter replacement																																																
Contractor work	[Gantt chart: In Sri Lanka (Plan) from Sep to Dec 2015]																																															
OIC work	[Gantt chart: In Sri Lanka (Result) from May to Jul 2016]																																															
3 Leakage detection																																																
Technical guidance	[Gantt chart: In Sri Lanka (Plan) from Sep to Oct 2015; In Sri Lanka (Result) from Jan to Dec 2016]																																															
Work by Leak checker	[Gantt chart: In Sri Lanka (Plan) from Sep to Dec 2015; In Sri Lanka (Result) from Jan to Dec 2016]																																															
Identification work	[Gantt chart: In Sri Lanka (Plan) from Sep to Dec 2015; In Sri Lanka (Result) from Jan to Dec 2016]																																															
4 Meter reading/ Billing																																																
Software production	[Gantt chart: In Japan (Plan) from Apr to Oct 2015; In Japan (Result) from Oct 2015 to Dec 2016]																																															
Technical guidance	[Gantt chart: In Sri Lanka (Plan) from Apr to Oct 2015; In Sri Lanka (Result) from Oct 2015 to Dec 2016]																																															
Meter reading work	[Gantt chart: In Sri Lanka (Plan) from Sep to Dec 2015; In Sri Lanka (Result) from Jan to Dec 2016]																																															
5 Construction Management/ Technical guidance																																																
Construction Management	[Gantt chart: In Sri Lanka (Plan) from Apr to Oct 2015; In Sri Lanka (Result) from Oct 2015 to Dec 2016]																																															
Technical guidance	[Gantt chart: In Japan (Plan) from Apr to Oct 2015; In Sri Lanka (Plan) from Oct 2015 to Dec 2016]																																															
6 Training/Seminar																																																
Seminar/Workshop	[Gantt chart: In Sri Lanka (Plan) from Sep to Oct 2015; In Sri Lanka (Result) from Jan to Dec 2016]																																															
Training in Japan	[Gantt chart: In Sri Lanka (Plan) from Oct to Nov 2015]																																															
7 Business development activity																																																
Proposal planning	[Gantt chart: In Japan (Plan) from Oct to Dec 2016; In Sri Lanka (Result) from Jan to Dec 2017]																																															
8 Reporting	1												2												3												F.R											

..... In Japan (Plan) In Japan (Result) 1~3 : Intermediate report
..... In Sri Lanka (Plan) In Sri Lanka (Result) F.R : Final report

(8) Manning Schedule

Duties	Name	Affiliation	2015												2016												2017												Total			
			Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec						
Project leader	Tsunoo Suehiro	Tesco Asia	Plan	10	14	10	5	10	10	10	15	10	5	14	5	10	10	15	10	5	14	5	10	10	15	10	5	14	5	10	10	15	10	5	14	5	10	10	15	10	104	120
			Result	8	14	15	6	10	10	10	15	5	8	14	7	10	8	21	3	7	15	14	8	9	10	14	25	8	20	14	15	7	20	10	142	156						
Legal orders	Kazuki Kobara	Tesco Asia	Plan	5	7			5		5		5	10			10		5	10			10		5	10			10		5	10			10		27	20					
			Result	3	7							3	7					3	7					3	7					3	7					14	10					
Counselor	Kohei Matsuda	Tesco Asia	Plan	5	14	5	5	10	5	5		8				15	8	5	10			5		5	10			10		5	10			10		45	110					
			Result	5	14	7	3	10	6	5	3	9	8	3	2	3	8	3	10			3		3	10			15	8	15	8	14	10	81	140							
Local representative	Kenji Fujiki	Tesco Asia	Plan																																	610	0					
			Result																																	592	0					
Chief Advisor	Takao Yamaguchi	Enterprise Diagnostician	Plan																																	21	10					
			Result																																	37	6					
Local counselor	Tatsuyuki Kikuta	NIS	Plan	3				3	2	2		2						3				2		2						1	2					19	0					
			Result	3								2					3				1		2						1	2					19	0						
Advisor	Tsutomu Nagasaka	Waterworks Engineer	Plan																																	14	0					
			Result																																12	0						
Instructor Water works	Takayuki Kamiya	Nagoya city Waterworks Sewerage Bureau	Plan	14																																14	0					
			Result	14																															14	0						
Instructor Water works	Jun Matsui	Nagoya city Waterworks Sewerage Bureau	Plan																																	31	0					
			Result																																19	0						
Instructor Water works	Takao Ihari	Nagoya city Waterworks Sewerage Bureau	Plan	14																																35	0					
			Result	14																															35	0						
Advisor	Yamshiro Shinji	Waterworks Engineer	Plan	14																																92	0					
			Result	14																															92	0						
Instructor Construction	Takashi Morita	Expert Construction	Plan																																	87	0					
			Result																																116	0						
Instructor Leak detection	Kamunori Suzuki	Suido Sogo Planning	Plan																																	174	0					
			Result																																174	0						
Instructor Leak detection	Junichi Takahashi	Suido Sogo Planning	Plan																																	22	0					
			Result																																12	0						
Total																																		2657	572							

■ : In Sri Lanka
 □ : In Japan

(9) Implementation System

The counterpart of TA in this project is Regional Support Center (Central). However GKWSP, Manager (O/M), Kandy North and TA discussed from time to time to proceed the project. Actual project works such as meter replacement, were carried out by the direction of engineers of both GKWSP and Kandy North Manager mobilizing workers of contractors. TA’s experts gave guidance to the works.

Japanese side: Tesco Asia Co., Ltd.

Nagoya City Waterworks and Sewerage Bureau

Suido Sogo Planning Inc.

Sri Lanka side: National water Supply & Drainage Board

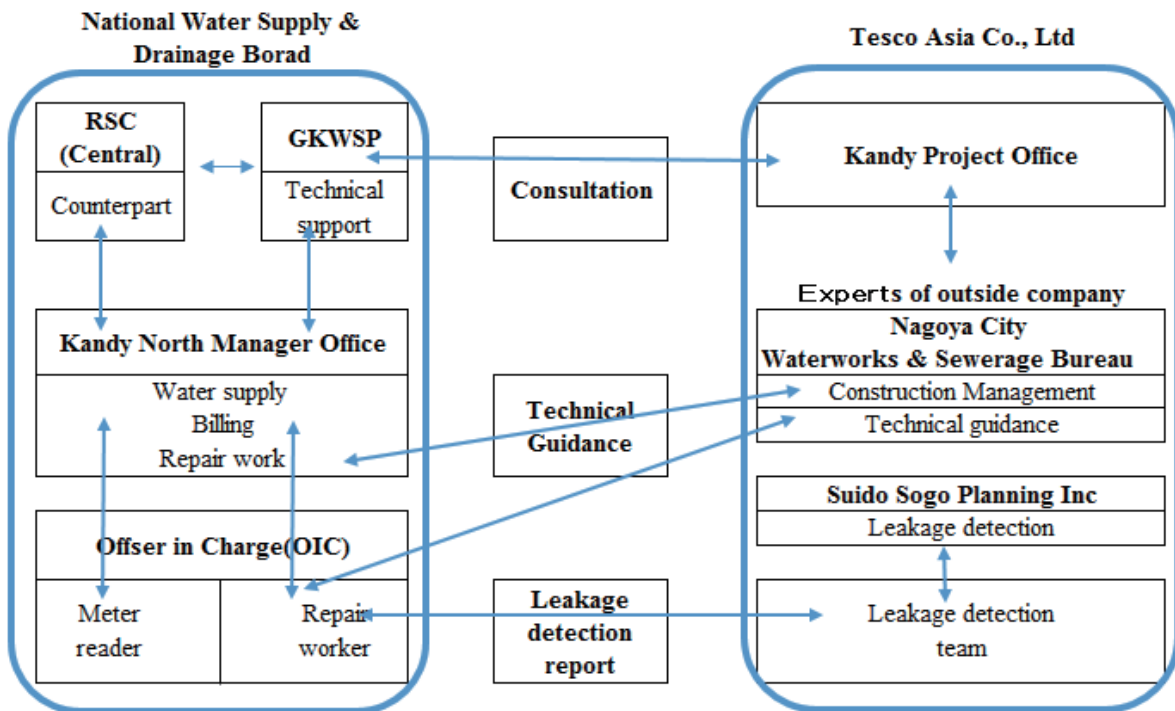


Figure 2 Project implementation structure

2. Achievement of the survey

(1) Outputs and Outcomes of the Survey

The amount of non-revenue water and the non-revenue water rate before this project were not clear, so we could not quantitatively clarify the reduction rate of non-revenue water, but by introducing Japanese technology and products, we could contribute to the reduction of NRW in the project area.

a) Meter Replacement

We aimed at the reduction of NRW by the replacement of existing water meters by Japanese-made meters. The meter replacement was implemented by the commissioned contractors. They had finished the replacement of 5,418 water meters by the middle of January 2016 except those very difficult to change.

After the termination of contract with contractors at the end of January 2016, Japanese specialists in charge of waterworks technology investigated the meter replacement situation and instructed the local workers to cope with difficult cases and replaced as many as 5,621 meters with Japanese meters. Ultimately, 5896 meters were installed, including new connections.

i Meter Replacement Works

Meter replacement started from mid-November 2015, after preparing the manual for the meter replacement work and holding briefing sessions. Three contractors were chosen by bidding to work in the same project area. Prior to the work, work contents and method, handling of meters and attached parts, operation procedures, data recording of replaced meters (entry of meter control sheet) etc., were explained to the team leaders of 9 groups of 3 contractors in total.

Table 1 Number of replaced meters

	Scheduled No.	Nov.	Dec.	Jan.	Completed No. by the end of Jan.	Addnl. No.	Total
Wegiriya	2,003	1,000	734	173	1,907	28	1,935
Kulugamma	1,555	42	0	1,551	1,593	44	1,637
Kondadeniya	2,084	0	1,643	275	1,918	131	2,049
Total	5,642	1,042	2,377	1,999	5,418	203	5,621

ii NRW Reduction Effect by Meter Replacement

By the leakage detection using leak checkers and the replacement of existing meters by Japanese-made meters, the non-revenue water rate of the project area was surely reduced. However, it is difficult to clarify the exact amount and rate of NRW reduction, because non-revenue water data for each project area before the project is not available. Tesco Asia conducted an ex-post statistical survey based on the NWSDB commercial data, the result of the survey showed obvious increase of charged water volume and decrease of NRW rate.

Changes in the amount of charged water in the project area before and after the replacement of the meters are as follows. Existing meters had an evident tendency to indicate less than the actual amount when they failed. This was found by the sample survey of the meters removed in the project area. Also, if the meter is immovable, the meter reader will make an estimate reading, the estimated meter reading may be less, rather than greater than the actual water amount. After the meter replacement the charged water amount per month increased from 21% to 29% in three project areas in comparison to the time before the replacement.

The replaced Japanese meters did not fail at all, thus contributing to the reduction of meter repair cost.

Table 2 Change of charged water volume before and after the meter replacement

Project area	Charged water amount: m ³ /month		Increase rate	New connections between Oct. 2015 and Feb. 2016
	Before replacement Oct. 2015	After replacement Feb. 2016		
Wegiria	29,636	38,283	29.18%	4
Kulugamma	21,410	25,854	20.76%	4
Kondadeniya	30,105	36,914	22.62%	0
Total/Average	81,151	101,051	24.52%	8

The effect of meter replacement appeared in the charged water revenue. After the replacement, there were complaints from consumers who received their water bill. They complained about the sudden increase in the water charge. As there was a revision of VAT rate at the same time, it is not possible to say that the meter replacement was the only reason for the increase in water charge. However there was the obvious increase in the water charge revenue by 33% on average.

Numbers of new water connections are indicated in Tables 2 and 3. The numbers are very small, therefore the effect of the new connection to water charge increases was very limited.

Table 3 Change of water charge revenue before and after the meter replacement

Project area	Water charge revenue Rs/Month		Increase rate	New connections between Oct. 2015 and Feb. 2016
	Before replacement Oct. 2015	After replacement Feb. 2016		
Wegiria	1,119,560	1,539,163	37.48%	4
Kulugamma	693,586	915,509	32.00%	4
Kondadeniya	987,399	1,282,840	29.92%	0
Total/Average	2,800,545	3,737,512	33.46%	8

iii Survey of the defective and immovable meters

In the process of meter replacement, we found unexpected effects not only to reduce NRW but also to contribute to the improvement of the management bases of NWSDB.

A Japanese waterworks expert discovered a meter repair record in the OIC Office one day and simply analyzed the record. Failure rate of the existing meters was very high.

Total number of defective meters in Harispattuwa Division including our project areas in 2015 was 1,314 units out of total 15,683, defective rate was 8.37%.

Table 4 Broken and immovable meters (Harispattuwa)

	Total No. of Meters	Japanese-made meters	Proportion of Japanese meters in total	Number of failures	Failure Rate
2015	15,683	0	0%	1,314	8.37%
2016	16,685	5,896	35.33%	794	4.75%

Meanwhile, the Japanese-made meters used for the replacement have been highly acclaimed for their superior quality of 0% failure rate since their replacement one and a half years ago. Reduction of repair costs by the introduction of Japanese-made meters can contribute to the betterment of financial situation of the Water Board.

Repair cost in Harispattuwa Division was as follows. Total number of meters in Harispattuwa was 16,685, of which 5,896 were replaced with Japanese-made meters. Since no Japanese meter failed, meter failure rate in Harispattuwa decreased by 40%. In the future all meters will be replaced by Japanese-made meters; no repair cost will be necessary.

Table 5 Repair cost for broken meters (Harispattuwa)

	Proportion of Japanese meters in total	Number of failures	Repair cost (Rs)	Compare with 2015
2015	0%	1,314	7,884,000	0%
2016	35.33%	794	4,764,000	-39.6%
Business project is to be introduced	100%	0	0	-100%

According to the records of the OIC Office, among the 1,203 repaired meters, 151 (12.6%) meters failed within 1 year, 208 (17.3%) meters failed within 2 to 3 years, 844 (70.1%) failed after functioning for 3 years or more. These records revealed that about 30% of meters are broken within 3 years.

b) Leak detection

TA contracted a Japanese leak detection expert to train Sri Lankan workers as leak detectors and instructed the use of Leak Checkers and leakage detection devices. They developed their detection skills and engaged in practical detection works. The leak detection process starts with screening possible leakage by using the Leak Checker for individual domestic meters. The leak detection team will locate the possible leakage by using acoustic and electronic detection devices.

The Japanese expert visited Sri Lank six times and performed training sessions including nighttime detection on the road for Sri Lankan detectors during 1 year and 4 months from February 2015 to June 2016.

The leak detection team found 341 leak locations and contributed to early detection and early repair of leakage.

The leak detection service includes both screened leaks detection and large scale leakage detection at the request of the RSC-Central or the Manager (Operation/Maintenance), Kandy North.

Table 6 indicates locations of leakage detected by the leak detection team in the project.

Among leakages in the project areas, Wegiriya occupies more than a half (cf. Table 6 Total number of detected leakage). This tells us that as the Wegiriya water supply system began earlier than the other areas, aging of the supply pipes proceeded rapidly.

Table 6 Detected leakage locations

Leakage location	Leakage location survey						Total (cases)
	Public road			Private site			
Category	Distribution main	Saddle	Service pipe	Domestic service pipe	Up-stream of meter	Down-stream of meter	
Wegiriya	30	6	11	33	31	26	137
Kulugammana	25	6	6	9	9	1	56
Kondadeniya	26	7	7	13	17	0	70
Out of Zone	53	9	8	7	1	0	78
Total	134	28	32	62	58	27	341
Proportion	39.3%	8.2%	9.4%	18.2%	17.0%	7.9%	100%
	56.9%			43.1%			

Table 7. Detected leakage volume

Leakage location	Leakage location survey						Total (m ³ /h)
	Public road			Private site			
Category	Distribution main	Saddle	Service pipe	Domestic service pipe	Up-stream of meter	Down-stream of meter	
Wegiriya	21.23	12.65	4.96	3.48	0.28	0.06	137
Kulugammana	11.49	4.64	3.34	0.92	0.05	0.01	56
Kondadeniya	27.23	2.73	9.50	3.07	0.84	0	70
Out of Zone	55.10	9.73	2.19	4.47	0.03	0	78
Total	115.05	29.75	19.99	11.94	1.2	0.07	341
Proportion	64.6%	16.7%	11.2%	6.7%	0.6%	0.1%	100%
	92.6%			7.4%			

Leakage volume by the large water mains accounts for more than 60% of the total volume. Leakage from high diameter water pipes tends to be large scale. Causes of leakage are considered to be the aging of pipes, piping work failure and vehicle load on the pipe from the road surface.

c) Improvement of meter reading system

We surveyed the present meter reading and billing system, water charge collection, billing data management etc. As we anticipated meter reading by hand might cause NRW, we decided to develop the Handy Terminal (HT) for automatic meter reading.

TA established a very good cooperative relationship with the IT department of NWSDB and completed the software for the HT. Introduction of the Japanese portable printer was an innovation. We are convinced that this meter reading and billing system with HT and printer works properly. Almost all of customers who received the bills welcomed them as a reliable document.

i Handy Terminal (HT)

The commencement ceremony of the operation of the new meter reading system with HT and portable printer was held in November 2017 with the attendance of DGM-IT.

However, the data for meter reading are downloaded for Harispattuwa Division as a whole divided into 3 cycles a month. Meter readers take out their own portion from the printed meter-reading cum billing sheet for Harispattuwa and then go to read the meters. It remains difficult to split the meter reader's data for HT. This has been done empirically and there are no clues in the database.

Fundamentally, meter reading is carried out by meter readers' walking order. This is not based on the water supply area, such as Wegiriya. TA required the result for the project area, but the meter reading system is not organized that way.

Meter readers compromised and carried out meter reading by HT for Wegiria for 1 cycle. The outcome was fine as mentioned above, but this ad hoc practice is not realistic. When we can expand the project as far as the whole area of Harispattuwa Division, contradiction of HT problems will be solved and we can demonstrate epoch-making progress in meter reading in Sri Lanka.

ii Portable Printer

It took lot of time to formulate the format of a bill written in three languages of Sinhalese, Tamil and English. The printers became usable in November 2016. However as the operation of HT was postponed, the use of the printers has also remained experimental. Later improvement of the usage has continued.

d) Supply pipe management and technical guidance for repair

We investigated the status of the water supply system, piping material, and work site of piping and repair.

Our external expert of the project (Engineers of NCWSB) discussed with engineers and technicians of the Kandy North Regional Manager's Office and OIC Office to clarify pipe construction standards, piping works management etc., in Kandy, Sri Lanka. Nagoya City Engineers prepared a standard to be included in the contract document with contractors who will be engaged in piping works in the future.

We held NRW reduction seminars and workshops and introduced new products to reduce NRW and proposed improvement for pipe laying works management and pipe repair techniques on the basis of their observations and the result of the discussion with the Sri Lankan counterpart.

Later on the occasion of the visit of Nagoya City Engineers, TA organized workshops for technical guidance for local technicians and workers for their technical advancement.

i Guidance for piping work management

NCWSB sent their engineers to Kandy, Sri Lanka in accordance with the contract between the City and TA. TA organized sessions for technical guidance to local technicians and workers as follows when Nagoya City engineer joined our delegation to Kandy.

Delegation	From	To
First	17 May 2015	31 May 2015
Second	07 February 2016	18 February 2016
Third	12 February 2017	20 February 2017
Fourth	17 July 2017	23 July 2017

The first delegation implemented a survey of the status of construction and plumbing sites and also inspected piping material including meters. This survey revealed several problems and tasks. These problems were examined by NCWSB and a number of suggestions for the piping works standard were made. TA prepared the Sinhalese piping works standard. These suggestions are detailed in Table 8.

Table 8. Problems and Suggestions

Problems		Suggestions
Pipe laying management		
1	The construction work of the water supply pipe is supposed to be done by the contractor, but a checking system for the construction has not been established (water leakage due to defective construction).	Confirmation by photographs. Photo submission must be required. The check list has to be prepared beforehand. Check list must be submitted and confirmed by the Water Board inspector.
2	Domestic meters often located at the innermost places of a private land. Long service pipe is buried at insufficient depth. Leakage tends to happen by force on the ground.	For the new connection work, thoroughly enforce regulation of meter location nearest to the public/private boundary, and set up standard for the burial depth. Criteria shall be clearly stated in the contract document.
3	Protection measures for branch saddle with shallow soil cover are not yet decided.	Protection standards including concrete placing etc. are to be specified. Material is to be prepared. These are clearly stated in contract document.
4	There are leakages from branch saddles broken by excessive tightening.	Resin saddle breaks when bolts are tightened too much, prevent breaking by using a torque wrench for tightening.

5	Qualification of engineers of contractors are only judged by their years of experience, their knowledge of construction techniques and construction management is sometimes not sufficient.	As for qualification requirement for engineers and technicians of a contractor, establish a rule to require participation in study meetings on construction technology and management.
Piping works standards		
6	There is leakage from the thermal fusion bonded part of the polyethylene pipe.	Mark the connection depth on the insertion side. Prepare the guideline on handling polyethylene pipes, such as confirmation of holding time at fusion.
7	If there is a gap between the meter and foundation concrete, unnecessary load is applied to the meter due to the weight of the meter.	Add concrete and fill the gap. Confirm there is no gap between meter and concrete stand.
8	Because there are no established meter administration rules, the meters are not properly managed. Some meter locations are not registered either on the map or the ledger.	Create the ledger including records such as year of use, installation location, installation date etc., for managing meters.
Guidance on piping method		
9	When bonding the PVC pipe by the socket, if excessive adhesive is applied, it flows in and adheres to the meter.	Notify the piping supervisor and workers, to not use excessive adhesive for connecting the pipes, and keep pipes for certain period of time until sufficient adhesive force is realized.
10	Under non water cut off piping, muddy water contamination or sucking of PVC particles happens	Attach temporary cap to the pipe, clean cut surface and remove foreign matter securely. In case of piping works upstream of the meter, remove the meter and discharge water to prevent clogging of the meter.
11	Contamination by mud or sand at the time of new connection works.	Remove dirt and sand adhering to the branch saddle or the pipes with cloth or alike when fixing the branch saddle or connecting the pipeline.
12	Piping parts such as packing or sockets are laid directly on the ground.	Instruct plumbers not to leave the parts directly on the ground. (Include this instruction in the meter replacement manual)
Others		
13	There is no means for removing contaminants in the pipe which causes clogging of the meter.	Consider installation of drain equipment. (In Japan, fire hydrant is used.)

ii Technical guidance for piping

As the water facilities in Harispattuwa were constructed over 25 years ago, leakage accidents occur frequently. Meanwhile, virtually no technical guidance or training has been given to plumbers working in the field. TA conducted guidance to prevent water leakage based on construction standards prepared by Nagoya City Waterworks and Sewerage Bureau, from the basic piping technique on the following schedule.

Delegation	From	To
First	7 February 2016	6 March 2016
Second	14 August 2016	11 September 2016
Third	12 February 2017	12 March 2017
Fourth	3 June 2017	1 July 2017

The piping technology guidance course was targeted at both the staff of the OIC (Officer in Charge), which is responsible for the maintenance of the water supply facilities in Harispattuwa under the Regional Manager of Kandy North and technicians and workers of G Construction, a company contracting the leakage repair with OIC.

iii Result of the technical guidance for piping works

With the piping technique guidance over four times, the following results have been attained.

- Piping accuracy was improved by using tools manufactured in Japan.
- Cleaning the pipes and fittings before piping construction.
- Drilling could be done quickly by using Japanese drilling tools.
- Backfilling and compaction around the pipes, backfilling up to temporary restoration and rolling pressure are improved.
- Installation of security facilities at the construction site started.
- People began to pay attention to tidying up the material warehouse and to cleaning the tools.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

a) Business development plan

We discussed with NWSDB a sustainable plan of business in line with the outcome of this Project. At the end of the Project, we prepared a business plan to follow the outline of the JICA project, and discussed this with GM and other executives of NWSDB. We also explained to the Ministry of Finance about the plan and requested their cooperation.

As a measure to reduce the financial burden on the Sri Lanka side, we have proposed a PPP (Public-Private Partnership) project. Of the NRW reduction packages, we proposed that meter replacement component be implemented first, since it can contribute to the financial management of NWSDB by reducing the expenditure for repair works and increasing revenue, thus generating funds to cover the project cost. When it comes to the stage that the project cost is secured by NWSDB, then the next step of activities in

other components can be implemented. It is this stepwise business development plan that we proposed.

• "Stepwise NRW reduction package" is the model for dissemination

As the first step, we will aim to improve income and expenditure balance by reducing NRW and reducing meter repair costs, through the implementation of meter replacement business component.

As the second step, we will conduct leakage detection work with the earnings of the first stage as a source of funds, and aim to improve profit through the further reduction of NRW.

As the third step, it seems to be suitable to implement remedial measures for meter reading and the billing system.

We also discussed with Kandy Municipal Council Waterworks Department about replacing existing meters with Japanese-made meters, and have submitted a proposal.

NWSDB acknowledged the effectiveness of Japanese-made meters and prepare to replace existing meters with Japanese meters in the remaining service areas in Harispattuwa and some areas in the Colombo periphery. Tesco Asia participates in the formulation of the development plan. However the funding for the project is the problem and delays the progress.

As for the construction management and technological standards, the engineering staff under the manager (O/M) of Kandy North started activities to enforce the contents of guidance given by experts of NCWSB. Good results of the pilot project to reduce non-revenue water can be expected.

3. Future prospects

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

a) The amount of water leakage discovered by leakage detection work, when simply converted to the yearly volume, would amount to 1,560,000m³/year.

Assuming that half of this was used effectively, and that the amount of water consumption per one connection (household) is 14m³/ month, the above amount corresponds to the annual water consumption of 4,600 households.

b) The coverage rate of water supply scheme in Kandy area is 60%, and the demand for water supply is continuing to increase. The leakage detection work can respond to the demand of water without securing a new water source, and therefore can greatly contribute to the improvement of the water supply coverage rate. When the water leakage detection work is implemented in the areas where there is a high demand of water supply and also has a high amount of water leakage, such business situation can increase the water supply volume without preparing the water source, and therefore will be able to perform an important role for promoting water supply in such areas.

c) Discovery of the high defect rate of the existing water meters is another achievement of the Project which will contribute to the improvement of the waterworks management. If more meters Japan manufactured are introduced in the future, it will have a great influence on the account balance of the

water business in Sri Lanka, which will contribute to the formulation of future plans for water supply projects.

(2) Lessons Learned and Recommendation through the Survey

In this project, TA required the counterpart to bear the cost of meter replacement. It seemed that it was hard for them to secure the funds. But fortunately thanks to a strong leader in the NWSDB, although it took time, we were able to proceed with the replacement of meters. It is necessary to negotiate beforehand whether they can bear the cost or avoid such a component that causes such a burden on the counterpart. It is also important to find and secure a key person during the preparation period.

a) Recommendation to NWSDB

i NWSDB fixes the selling price of water very low. The gap between the selling price and production cost is filled by the government subsidy. It is desirable to secure fund from its revenue for future investment for the maintenance of distribution pipeline and provide stable supply of water. For this purpose it is necessary to raise the selling price up to a certain level.

ii When TA prepared the project in the survey area in Harispattuwa, TA faced difficulties to obtain basic data for planning. The billing data are well organized and maintained as a database, it can be obtained in the same format for everywhere in the country and past data are also available. In other fields, however, it is very difficult to obtain data with this accuracy.

The NRW is defined as the difference between the amount of water supply and the amount of charged water in a certain area, however grasping the amount of water supply is actually very difficult. Water supply pipes were laid unplanned in order to satisfy the immediate demand, so even if a water supply area is set up, the corresponding water supply volume is sometime difficult to get in fact.

We could not obtain basic figures such as water supply as time series data. The basic data of day to day operation must be kept in time series and prepared for future planning.

iii Water charge revenue is fundamental factor in the water supply business. However, regulation of the water meter has been neglected. It is necessary to prepare management regulations of the water meter, determine the period of use of the meter, use a meter that can accurately measure, and then collect the fee.

b) Recommendations for KN and OIC

In order to improve future piping technology, we would like to propose the following:

i Since the construction record of the repair work is inadequate, it is impossible to investigate past records and to investigate the causes of leakages. So it is necessary to prepare and manage repair records in future.

ii Since there is too much work for OIC office, the organizational reform of OIC office is necessary. In order to maintain service pipeline construction and repair standard, it is preferable to set up foreman who can give instruction to workers and inspect their performance. Foremen will be brought up from workers by training.

- iii It is necessary to hold technical lectures and safety instruction seminars for plumbers and field workers. In addition, in order to improve the quality of construction, it is desirable to introduce a qualification system such as piping technicians and plumbing technicians.
- iv The OIC office supervisor should preferably have knowledge and experience in waterworks, so that he/ she can also serve as supervisor of the construction site.
- v Currently, OIC offices are not equipped with maps of water distribution pipes or water supply pipes, but such maps are necessary for systematic repair work and leakage exploration. Therefore, it is necessary to create such maps for each OIC office.
- vi In order to facilitate the transportation of construction machinery handed over by JICA, as well as to improve the speed of repair work, it is necessary to strengthen the mobility and logistics of construction work.

ATTACHMENT: OUTLINE OF THE SURVEY

