Democratic Socialist Republic of Sri Lanka
National Water Supply and Drainage Board

Democratic Socialist Republic of Sri Lanka

The Project for Enhancement of Operational Efficiency and Asset Management Capacity of Regional Support Center-Western South of NWSDB in Sri Lanka

Final Report

October 2021

Japan International Cooperation Agency

CTI Engineering International Co., Ltd.
Yokohama Water Co., Ltd.

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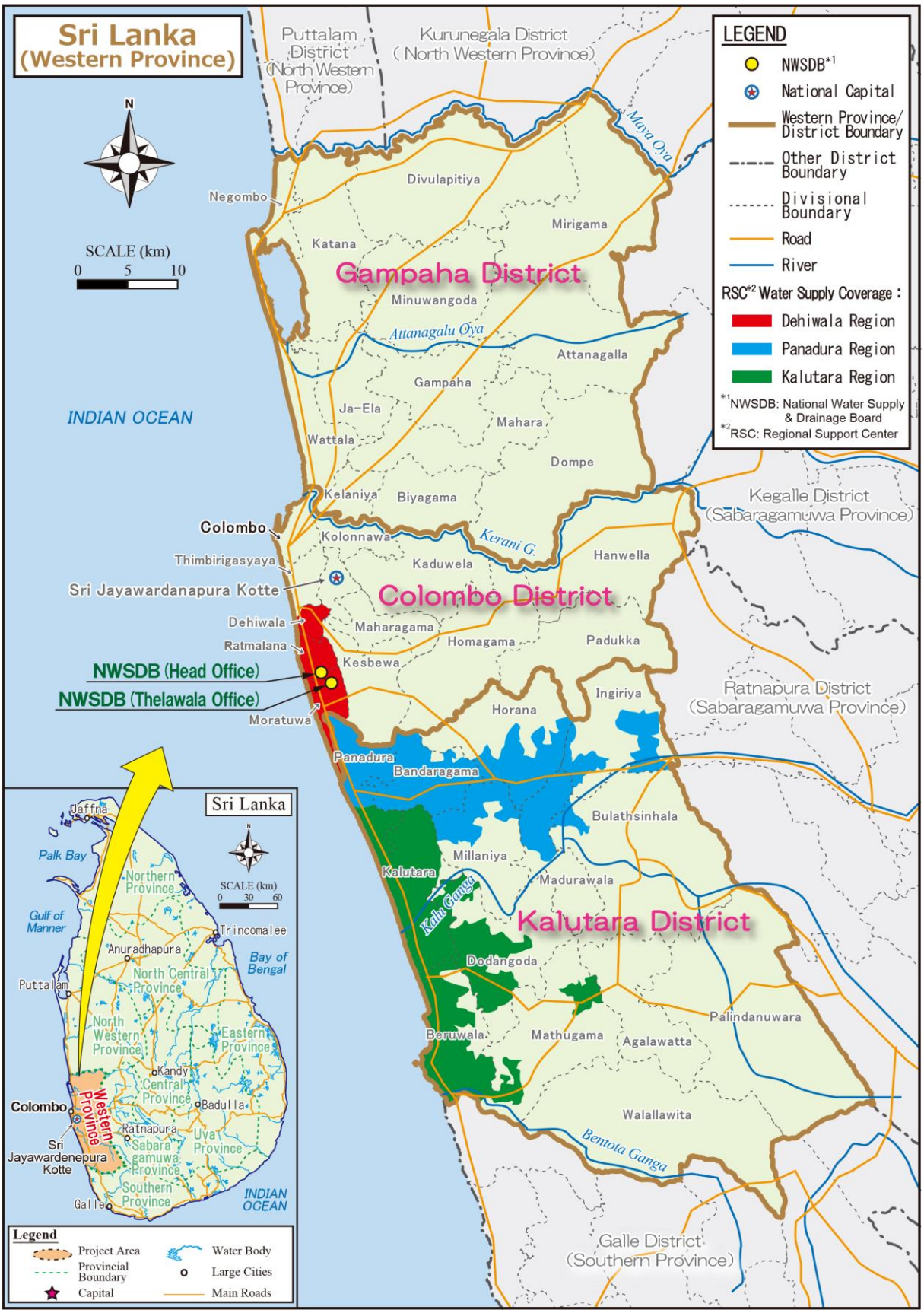


Location Map of Project

Project Photo (1/4)

			
P-1	1st JCC	P-2	2nd JCC
1st JCC held on 11th October 2018		2nd JCC held on 1st August 2019	
			
P-3	Japan training in Kobe city	P-4	Japan training in Nagoya city
Japan training in Kobe city in May 2019		Japan training in Nagoya city in February 2020	
			
P-5	Seminar on AM	P-6	Workshop on AM
Seminar style information sharing on the outline and purpose of AM, NWSDB's current activity related to AM		Workshop style discussion on the maintenance activity of pipes, NWSDB's issues about management cycle and its solutions	

Project Photo (2/4)

<table>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td>P-7</td><td>Meeting on DMA creation</td><td>P-8</td><td>Field survey for the DMA creation</td></tr>
<tr><td colspan="2">Discussed DMA creation method using maps before field survey</td><td colspan="2">Confirmed site condition in detail to consider the DMA creation method</td></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td>P-9</td><td>Chamber of flow meter in DMA3</td><td>P-10</td><td>Measurement of inflow to DMA4</td></tr>
<tr><td colspan="2">Installed electromagnetic flow meter and data logger with internal modem and created remote monitoring system online</td><td colspan="2">Measured inflow volume to DMA4 with ultrasonic flow meter</td></tr>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td>P-11</td><td>House to house survey in DMA4</td><td>P-12</td><td>Road survey in DMA4</td></tr>
<tr><td colspan="2">Confirmed the leakage sound around service pipes with listening stick in the point where leakage may occur</td><td colspan="2">Confirmed the leakage sound on the route of distribution pipe with leakage detector</td></tr>
</table>

Project Photo (3/4)

			
P-13	Leakage repair of meter connection	P-14	Record of repaired leakage
Repaired the detected leakage at the meter connection		Recorded the place of repaired leakage and detailed information about the repair	
			
P-15	Existing training	P-16	Demonstration of equipment
MD&TD's existing lecture style training		Demonstration of equipment in the existing training	
			
P-17	Cut section of service pipe which has burr	P-18	Wearing sandal in construction site
Cut section of service pipe in the actual construction site. There is burrs due to the insufficient chamfering		Workers often wear sandals in construction site	

Project Photo (4/4)

			
P-19	RP interview	P-20	TY
Confirmed the capacity of RP, discussed about training contents and training guideline		TY at Thelawala premises	
			
P-21	Opening ceremony of TY	P-22	TOT (Installation of DI pipe)
Opening ceremony of TY held on 22nd January 2020		Conducted TOT of installation of DI pipe at pipe connection area of TY	
			
P-23	TOT (Underground leakage survey)	P-24	HDPE training conducted by MD&TD
Conducted TOT of underground leakage survey at leakage survey area of TY		HDPE training conducted by MD&TD. RP instructed the way to use equipment and so on to trainees.	

Table of Contents

Abbreviation

Abbreviation	Proper name
ADB	Asian Development Bank
Addl. GM	Additional General Manager
AGM	Assistant General Manager
AM	Asset Management
AMS	Asset Management System
C/P	Counterpart
DMA	District Metered Area
DGM	Deputy General Manager
GCWWMIIP	Greater Colombo Water and Wastewater Management Improvement Investment Program
GEP	Google Earth Pro
GIS	Geographical Information System
GM	General Manager
IIMM	International Infrastructure Management Manual
JCC	Joint Coordinating Committee
JET	JICA Expert Team
JICA	Japan International Cooperation Agency
MD&TD	Manpower Development and Training Division
MNF	Minimum Night Flow
NCWSB	Nagoya City Waterworks & Sewerage Bureau
MWS	Ministry of Water Supply
NAWS	Nagoya Water and Sewage General Service Co., Ltd.
NRW	Non-Revenue Water
NWSDB	National Water Supply and Drainage Board
OIC	Officer in Charge
OJT	On-the-Job Training
PD	Project Director
PDM	Project Design Matrix
PDMRC	Planning and Design Procedure Manual Review Committee
PM	Project Manager
PO	Plan of Operations
P&D(W-S)	Planning and Design Section (Western South)
R/D	Record of Discussions
RP	Resource Person
RSC	Regional Support Center
RSC(W-S)	Regional Support Center (Western-South)
RSC(W-C)	Regional Support Center (Western-Central)
SBU	Strategic Business Unit
SCADA	Supervisory Control and Data Acquisition
SIV	System Input Volume
TMM	Top Management Meeting
TOT	Training of Trainers
TY	Training Yard
VAT	Value Added Tax

1 Outline of Project

1.1 Background

The National Water Supply and Drainage Board (NWSDB) was established in 1975 as a principal authority to provide safe drinking water and facilitate the provision of sanitation in Sri Lanka, presently under the Ministry of City Planning and Water Supply. NWSDB has been improving water supply facilities throughout the country for the realization of a stable water supply. According to the latest corporate plan (Corporate Plan 2020 -2025), although coverage of the water supply system of densely populated Colombo District has reached 92.1%, overall coverage in the country is still 40.0%, currently. Therefore, NWSDB will continue to enhance water supply capacity and improve the quality of services.

Enhancement of efficiency of their business operation and expansion of water supply system are required to achieve the target of the corporation plan. NWSDB has been considering the introduction of Asset management to (1) improve their business operation by effective distribution of O&M and investment fund and (2) formulate a business plan based on prioritized renewal of aging assets. As a part of this, NWSDB has been pushing forward for hardware development to introduce Asset management through an ADB project. Also, they express readiness to learn from the cases in Japan and implement Asset management of pipes, which occupy most assets of water supply facilities.

Enhancement of their capacity of leakage control and their daily O&M work would directly lead to a reduction in non-revenue water (NRW) and an improvement of business operation.

Improving the quality of pipe installation not only prevent leakages but also prolonging the lifetime of pipelines. However, in NWSDB, leakage control work is taking only supportive measures in response to leakages identifiable on the ground, and there is a lack of capacity for measures against subsurface leakage. In addition, there are problems regarding the quality of pipe installation and technical skill of fitters and supervisors, such that fitters do not understand appropriate procedure of pipe jointing and installation, and supervisors cannot recognize the adequacy of construction procedure.

Following the above situation, Sri Lankan Government requested technical assistance in capacity development of NWSDB to Japan in July 2016.

In order to formulate a technical cooperation project, JICA dispatched several survey missions, and both of Sri Lankan government and Japanese side agreed on the framework of the project and implementation policy. The agreement was compiled in Record of Discussions dated January 11, 2018. Then, the project started on 1st September 2018 as a 3-year project.

1.2 Outline

1. Overall goal	:	The enhanced works of pipelines management are expanded in NWSDB.
2. Project Purpose	:	Pipelines management works of NWSDB are enhanced.
3. Outputs	:	1) Asset management of pipelines is introduced to NWSDB. 2) Capacity for leakage control is enhanced in the pilot activity site. 3) Capacity for implementation of training programmes on leakage control is enhanced.
4. Contents	:	Technical Cooperation regarding the enhancement of Asset management, Leakage control and capacity for implementation of training sessions
5. Project area	:	Regional Support Center (Western South) NWSDB Training Division at Thelawala NWSDB Head Office Pilot activity site：An OIC area in Regional Support Center (Western South) area
6. Authorities concerned	:	Government ministry in charge: Ministry of Water Supply : MWS Implementing Agency: National Water Supply and Drainage Board of Sri Lanka (NWSDB)
7. Period of project	:	September 2018 – August 2021 (36 months)

1.3 Implementation Policy

The basic policies for the total activities and each output are summarized in the following table. Due to pandemic of COVID-19, travel restriction was imposed, thus the policy of remote assistance has been added since 2020.

Table 1.3.1 Basic Concept of the Project

Item	Basic Concept
Total	Smooth and effective implementation by creation of team in each output Consideration of safety and health Information sharing by use of communication tools, i.e., scheduled meeting, mailing list, TV conference, circulation of weekly report, etc. Association of outputs aiming for more effective activities Enhance cooperation with other projects
Output 1	Preparation of Guidelines based on the ISO and referring “Asset Management Guidelines for Waterworks, 2009” published by the Ministry of Health, Labour and Welfare of Japan. Strengthening Asset Management System by the strong participation of Top management Improvement of capacity of data collection by the rationalizing of data collecting procedure and utilization of existing data bases.
Output 2	Strengthening the capacity of taking measures for underground leakage by OJT Establishment of survey procedure with creation of DMAs Preparation of widely applicable procedure manual Habituating of record making for updating database Realization of effectiveness through quantification and cost-benefit analysis Introduction of preventive measures (It will connect to Asset Management)
Output 3	Formulation of training programs that meet training needs Construction of TY to enable practical training Building up the RP by TOT Training of next-generation RPs by trained RPs Establishment of evaluation system for effective training implementation
Remote assistance	Utilizing the web conferencing system to build consensus by better communication and explanation Timely procurement with the help of local staff Procurement in Japan for shortening the lead time Improving the quality of remote instruction by document and visual material preparation Use of communication tools, such as SNS Accompanying of local staff at the site activities and providing information to experts by video recording Introduction of easy-to-learn technology transfer using audiovisual materials such as YouTube videos

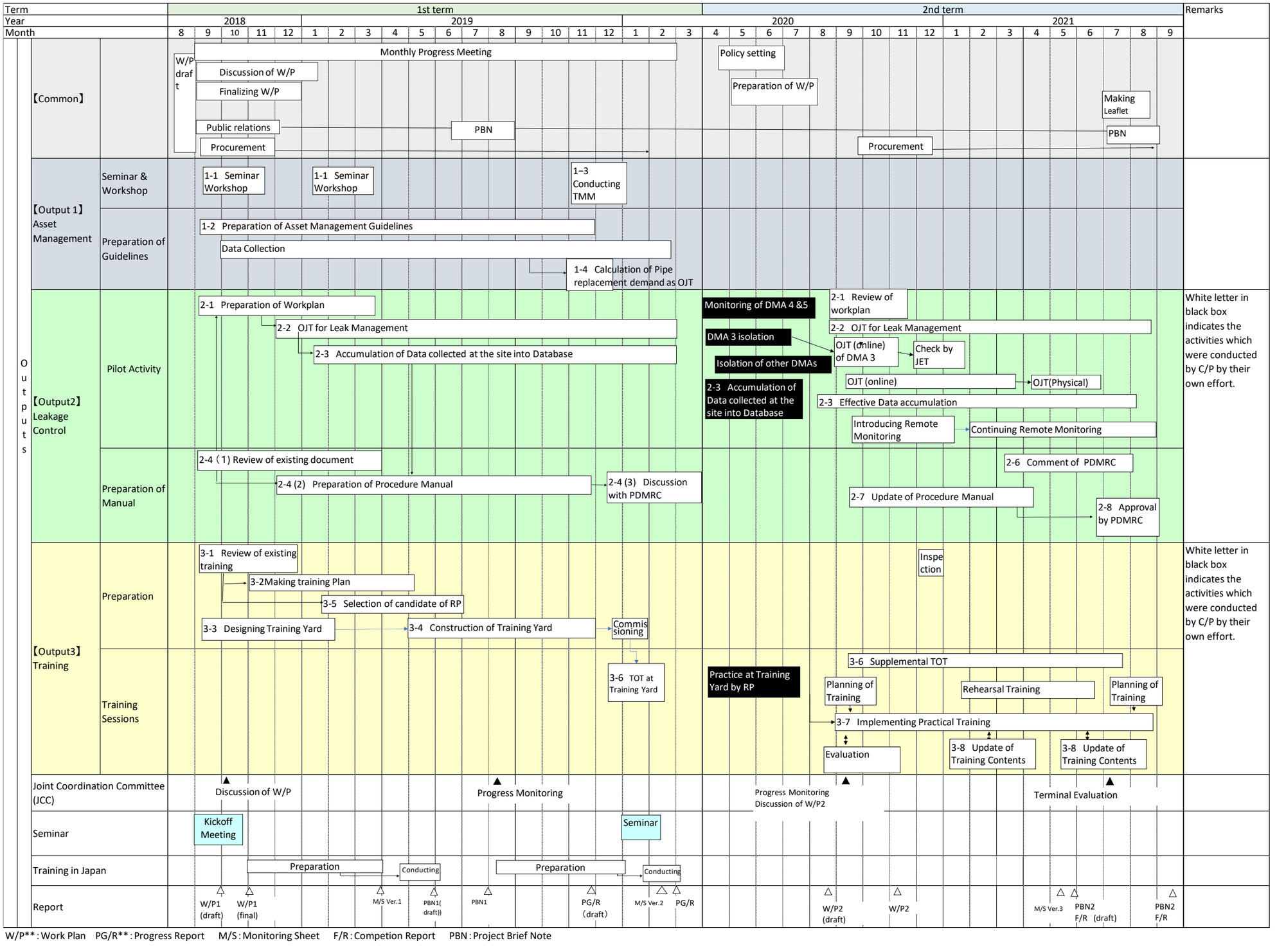
1.4 Project Schedule

The 1st term of the project had been planned from September 2018 to August 2019. However, it was extended until March 2020 for the following reasons:

- It took time for reaching an agreement between NWSDB and Japanese side on the design concept of TY.
- It was difficult to procure quality DI pipe in local market, so the procurement period was longer than expected due to importing process. And the construction period had to be longer than original plan.
- Due to the terrorist attack in Sri Lanka on April 22, 2019, the project was suspended by the temporary restriction of long-term expert activities and the suspension of short-term expert dispatch. It also delayed the signing of TY construction contract until the resumption of project activity.
- The construction of TY was delayed due to unusual weather condition of continuous rain in June to August, which was expected as dry season in an average year, and the delay of pump supply manufactured overseas. Therefore, all the programmes of TOT were postponed because the programs only could be conducted after completion of the TY.

The 2nd term of the project was planned to start immediately after the end of the 1st term. However, due to the global pandemic of COVID-19, isolation policies were adopted in many countries including Japan and Sri Lanka from March 2020, so the expert could not travel to Sri Lanka, even the long-term expert who planned to move in April. All parties searched for a support implementation procedure which is applicable under such a condition, so the official start of the 2nd term of activities was delayed until September 2020. During this time, the local secretary and assistant engineer continued the activity for maintaining communication between the C/P and JET. While the C/Ps should have worked under restriction of travel and work, the project activity has not stopped with the remote assistance of experts.

The final project implementation schedule is shown in Figure 1.4.1.



W/P** : Work Plan PG/R** : Progress Report M/S : Monitoring Sheet F/R : Competion Report PBN : Project Brief Note

Figure 1.4.1 Flow of Project Schedule

1.5 Implementation Structure

Project implementation structure is shown in Figure 1.5.1

A work team was organized for each output, which mainly consisted of Manpower Development & Training Division of NWSDB, Regional Support center (Western-South) (RSC (W-S)) and Regional Support center (Western-Central) (RSC (W-C)). Sri Lankan and Japanese leaders of each work team managed the progress and found out solutions to challenges.

Also, Additional General Manager (Addl GM) of NWSDB (Western) and Assistant General Manager (AGM) of RSC (W-S) were assigned as Project Director and Project Manager, respectively and manage the whole project. Joint Coordinating Committee meeting with the participation of the Ministry of Water Supply, JICA and all project stakeholders was held regularly to monitor the progress and make decisions in the course of the Project.

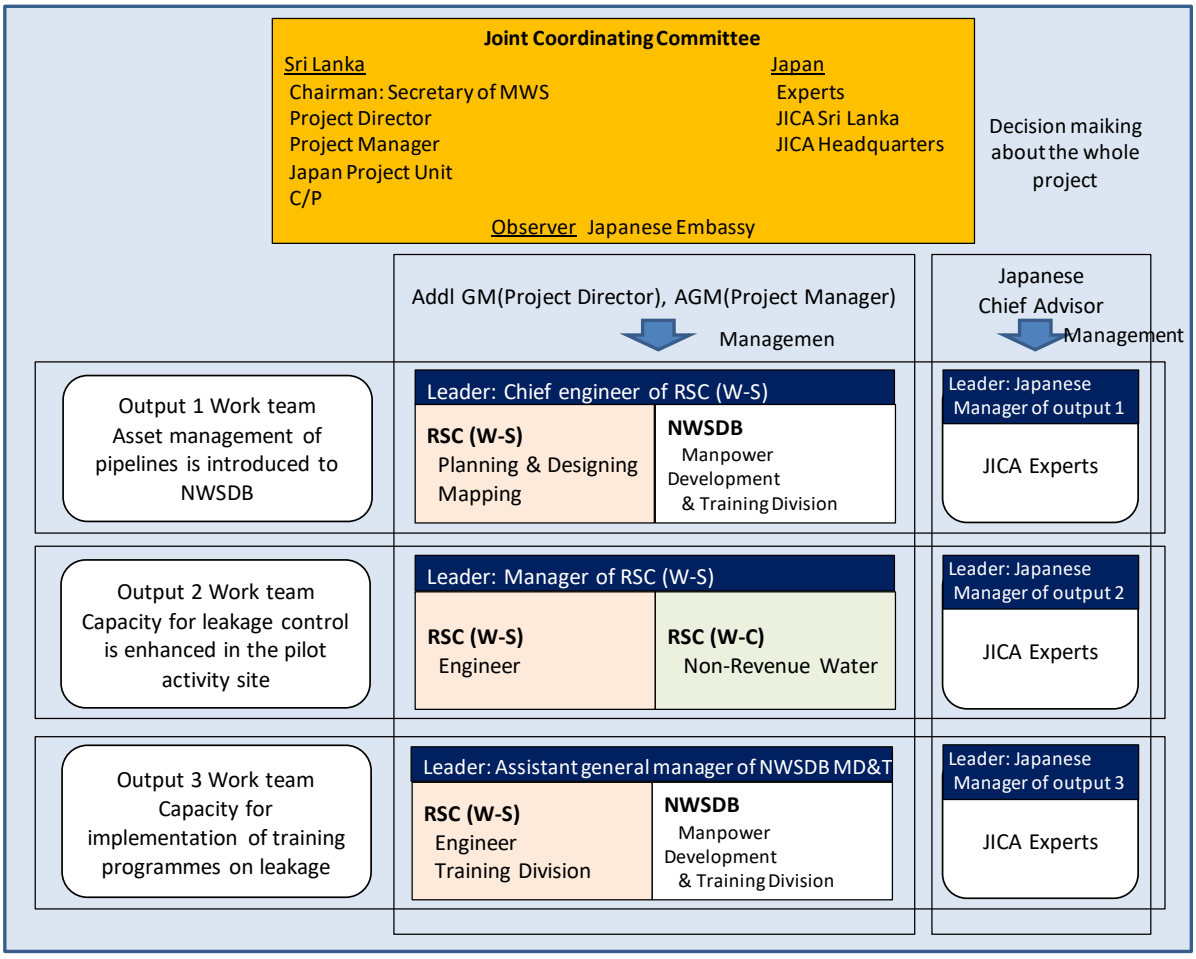


Figure 1.5.1 Project implementation structure

The project had been planned to be operated by one long-term expert who stayed and worked continuously in Sri Lanka and other short-term experts, such as shuttle dispatching style, therefore, local assisting staff members were hired to ensure continuity of operations. However, due to COVID-19 spreading,

long-term expert returned to Japan in March 2020. The successor's dispatch was considered, but it did not happen.

Japanese Expert Team (JET) and C/P have held regular meetings in each output and furthermore, held monthly progress meeting which has been chaired by PD with the participation of JET, C/P and concerning persons to discuss matters of progress, problem in activity and solutions.

After the epidemic of the COVID-19, it became difficult to meet physically, but the C/P meeting continued as an online meeting on a regular basis, and PD and PM participated sometimes. In addition, an online meeting for project management was held with PD and PM with chief advisor when necessary. After resuming travel to experts, we used both online and local conferences to make experts in Japan be able to participate.

1.6 Input from Project

Input from Japanese side and Sri Lanka side are as below.

1.6.1 Input from Japanese Side

(1) Experts

Dispatch of JETs and works conducted in Japan by JETs are shown in Figure 1.6.1 and Figure 1.6.2.

	Expert	Name	Organization	Rank		Dispatch	2020 9	10	11	12	2021 1	2	3	4	5	6	7	8	9	10	Sri Lanka Total Day	M/M
Works in Sri Lanka	Team Leader (Chief Advisor)	Yasuko KAMEGAI	CTII	2	Plan	3						40			30			30			100	3.33
					Revised Plan	2						78						42			111	3.70
					Actual	1		(7 days were no work during quarantine period)			2/13~4/15	55					67			6/10~8/28 13 days were no work during quarantine period)	122	4.07
	Team Leader (Chief Advisor)	Yasuko KAMEGAI	CTII	4	Revised Plan	0															9	0.30
					Actual	0								4/16~4/2	9						9	0.30
	Pipeline Management/ Leakage Reduction Plan	Takuji YOSHIDA	Nagoya	-	Plan	**															-	-
					Actual	**															-	-
	Deputy team leader/Leakage Control (1)	Koji NAITO	CTII	3	Plan	3							45			30			30		105	3.50
					Revised Plan	1									105						105	3.50
					Actual	1						3/6~ ~5/6 days were works of other project)		86							86	2.87
	Leakage Control (2)	Yasuhiro MATSUOKA	YWC	4	Plan	1							45								45	1.50
					Revised Plan	1									45						45	1.50
					Actual	0															0	0.00
	Design, Construction and Supervision of Training Yard (Mechanical and Electrical)	Shuji SATO	CTII	4	Plan	1					9										9	0.30
					Revised Plan	0															0	0.00
					Actual	0															0	0.00
	Planning and Operation of Training Programmes	Kenta SATO	Nagoya	-	Plan	**															-	-
					Actual	**															-	-
	Training Material /Project Coordination	Toru MIYAO	CTII	4	Plan	3							30			30		45			105	3.50
					Revised Plan	1												105			105	3.50
					Actual	0											6/5~ 9/2	88			90	3.00
																				Plan	**375**	**12.50**
																				Actual	**307**	**10.23**

Legend: Dispatch Plan; Works in Japan; Actual dispatch; No works during quarantine period; Works of other project

CTII: CTI Engineering International Co.,Ltd. YWC: Yokohama Water Co.,Ltd.

Figure 1.6.1 Dispatch of JET

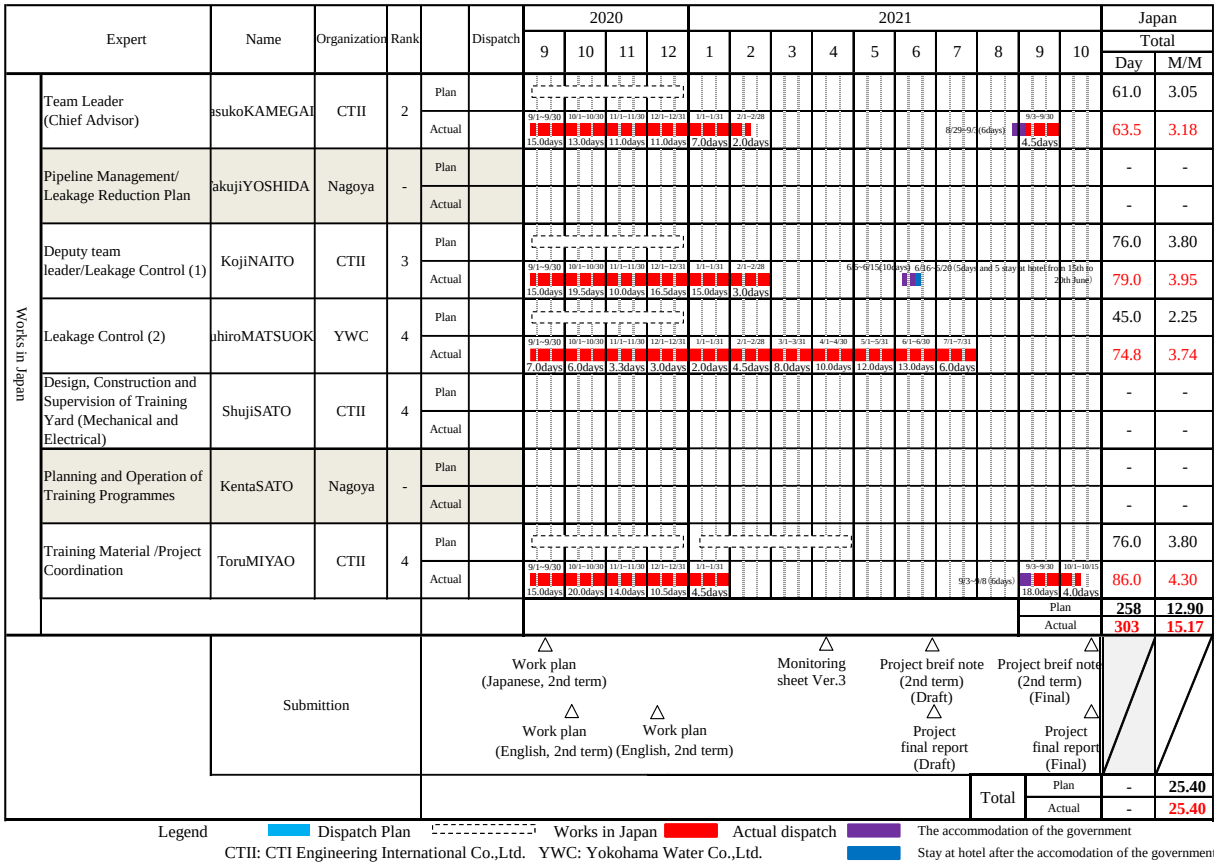


Figure 1.6.2 Works Conducted in Japan by JET

(2) Equipment

Equipment which was procured in this project is shown in Table 1.6.1 to Table 1.6.3.

Table 1.6.1 Equipment list procured in this project (Output1)

No.	Name	Quantity	Location
1	Laptop PC	1	RSC(W-S)

Table 1.6.2 Equipment list procured in this project (Output2)

No.	Name	Quantity	Location
1	DMA creation material	1	Horethuduwa Regional Stores Or installed in DMA
2	Portable ultrasonic flow meter	3	RSC(W-S)
3	Insertion electromagnetic flow meter	3	RSC(W-S)
4	Pressure gauge	10	OIC Panadura Office
5	Leakage detector	3	OIC Panadura Office
6	Non metal pipe detector	1	RSC(W-S)
7	Metal pipe detector	1	RSC(W-S)
8	Metal detector	1	OIC Panadura Office
9	Electronic acoustic bar	3	OIC Panadura Office
10	Acoustic bar	6	OIC Panadura Office
11	Measuring wheel	1	RSC(W-S)
12	Boring bar	3	OIC Panadura Office

No.	Name	Quantity	Location
13	Hammer drill	3	OIC Panadura Office
14	Portable water meter test kit	1	OIC Panadura Office
15	Portable generator	3	OIC Panadura Office
16	Water pressure test pump	1	OIC Panadura Office
17	Turbine flowmeter	1	RSC(W-S)
18	Wireless pulse logger	1	RSC(W-S)
19	Modem data logger	2	Installed in DMA
20	Electromagnetic flowmeter	2	Installed in DMA
21	Electro fusion machine	2	RSC(W-S)
22	Laptop PC	2	RSC(W-S)
23	Tablet	1	RSC(W-S)
24	Tools		
24-1	Straight pipe wrench	2	OIC Panadura Office
24-2	Chain wrench 50mm	2	OIC Panadura Office
24-3	Chain wrench 75mm	2	OIC Panadura Office
24-4	Plastic pipe cutter	2	OIC Panadura Office
24-5	PE pipe cutter	3	OIC Panadura Office
24-6	Quick action tube cutter	2	OIC Panadura Office
24-7	Chamfer	4	OIC Panadura Office
24-8	Torque wrench	2	OIC Panadura Office
24-9	Driver set	2	OIC Panadura Office
24-10	PVC pipe tapping machine	5	RSC(W-S)
24-11	Socket fusion welding machine	3	Horethuduwa Regional Stores
24-12	Power Connection Cable	1	RSC(W-S)
24-13	Road breaker	3	Horethuduwa Regional Stores
24-14	Asphalt cutter	3	Horethuduwa Regional Stores
24-15	Butt fusion welding machine	3	Horethuduwa Regional Stores
24-16	Engine driven DI pipe cutter	1	RSC(W-S)
25	Consumables		
25-1	Drill bit	3	OIC Panadura Office
25-2	Drill bit (500mm)	2	Horethuduwa Regional Stores
25-3	Air pump	1	RSC(W-S)
25-4	Tapping saddle	2	RSC(W-S)
25-5	Car battery	1	RSC(W-S)

Table 1.6.3 Equipment list procured in this project (Output3)

No.	Name	Quantity	Location
1	Portable ultrasonic flow meter	2	MD&TD Storage
2	Insertion electromagnetic flow meter	2	MD&TD Storage
3	Pressure gauge	12	MD&TD Storage
4	Leakage detector	4	MD&TD Storage
5	Non metal pipe detector	1	MD&TD Storage
6	Metal detector	2	MD&TD Storage
7	Acoustic bar	10	MD&TD Storage
8	Measuring wheel	2	MD&TD Storage
9	Boring bar	1	MD&TD Storage

No.	Name	Quantity	Location
10	Hammer drill	1	MD&TD Storage
11	Portable water meter test kit	2	MD&TD Storage
12	Portable generator	1	TY Storage
13	Water pressure test pump	2	MD&TD Storage
14	Laptop PC	1	MD&TD Office
15	Tools		
15-1	Butt fusion welding machine	3	TY Storage
15-2	Straight pipe wrench	2	MD&TD Storage
15-3	Chain wrench 50mm	2	MD&TD Storage
15-4	Chain wrench 75mm	2	MD&TD Storage
15-5	Plastic pipe cutter	2	MD&TD Storage
15-6	PE pipe cutter	3	MD&TD Storage
15-7	Quick action tube cutter	2	MD&TD Storage
15-8	Chamfer	4	MD&TD Storage
15-9	PE pipe scraper	2	MD&TD Storage
15-10	Torque wrench	2	MD&TD Storage
15-11	Driver set	2	MD&TD Storage
15-12	PVC pipe tapping machine	2	MD&TD Storage
15-13	DI pipe tapping machine	2	MD&TD Storage
15-14	Socket fusion welding machine	2	MD&TD Storage
15-15	DI pipe cutter	2	MD&TD Storage
15-16	Pipe jointing tool	1	MD&TD Storage
15-17	Pipe dismantling tool	1	MD&TD Storage
15-18	Cut/cross section	1	MD&TD Storage
15-19	Engine driven DI pipe cutter	1	MD&TD Storage
15-20	Electro fusion machine	3	MD&TD Storage
15-21	Wireless tour guide system	1	MD&TD Storage
15-22	Hacking tool	1	MD&TD Storage
15-23	Hot air gun	2	MD&TD Storage
16	Consumables		
16-1	Drill bit	3	MD&TD Storage
16-2	Safety grass	10	MD&TD Storage
16-3	DI pipe coupling socket (80mm)	1	MD&TD Storage
16-4	Socket for PVC/PE pipe (20mm)	10	MD&TD Storage
16-5	Gland packing	1	MD&TD Storage
16-6	Rubber gasket	3	MD&TD Storage
16-7	Double compression socket for 20mm PE pipe	2	MD&TD Storage
16-8	Pedestal fan	4	MD&TD Storage
16-9	Video camera	1	MD&TD Office
16-10	Trolley	5	MD&TD Storage
16-11	Chair	1	MD&TD Storage
16-12	Helmet rack	2	MD&TD Storage
16-13	Hanger rack	2	MD&TD Storage
16-14	Marking tape	1	MD&TD Storage
16-15	Tool box	12	MD&TD Storage
16-16	Work cloth	10	MD&TD Storage
16-17	Helmet	10	MD&TD Storage

No.	Name	Quantity	Location
16-18	Exhaust fan	2	TY Storage & Pump House
16-19	Convex	3	MD&TD Storage
16-20	Electro fusion fittings	1	MD&TD Storage
16-21	Transparent pipes	1	MD&TD Storage
16-22	Consumables for HDPE training	1	MD&TD Storage

(3) Training in Japan

Overseas training programmes were held in Kobe city in May 2019 and in Nagoya city in February 2020. The details are as shown below.

1) Training in Kobe City

- Period: 8th – 16th May 2019
- Participants: The maximum number of participants was 5 people. JET requested NWSDB to select the candidates for Japan training considering the following:
  - To be selected from project members and to have the person contribute to the activities of this project after the training in Japan.
  - Participation of management position such as GM, PD and PM
- Eventually, the following 5 people were selected as participants of the overseas training.

Table 1.6.4 Participants of Program in Japan (Kobe)

Name	Position
Mr. PERERA Thotagamuwe Widanage Sunith	Additional General Manager Water Supply Project Division, NWSDB
Mr. TUDUGALAMUDALIGE Rohan Jayantha Fernando	Assistant General Manager RSC (W–S), NWSDB
Ms. FERNANDO Warushahennadige Rangika S.	Civil Engineer RSC (W–S), NWSDB
Mr. GALMANGODA GURUGE Manoj Chandra K. D. S.	Chief Engineer Water Supply Project Division, NWSDB
Ms. WEERASINGHE ARACHCHILLAGE Ramya C. W.	Chief Engineer (Planning & Designs) RSC (W–S), NWSDB

- Purposes:
  - To understand the actual situation of Asset Management in Kobe city including not only management of pipeline but also consideration of financial balance, tariff structure and so on.
  - Inspection of GIS, which is utilized in office and site of Kobe city
  - Sharing knowledge to the participants which can be reflected into Asset Management of NWSDB from Japanese experience
- Contents:

  [Lecture]

  Asset Management and improvement of efficiency of business operation

Improvement of accuracy of Asset Management database and setting of prioritization of renewal demand

Outlook of future facility plan

[Inspection]

Central monitoring room of the water supply management center (facility management using SCADA)

Sengari dam, Sengari water treatment plant, large capacity transmission main pipe, water science museum

[Discussion]

Panel discussion about promotion of Asset Management

Discussion about activities of output 1 (4 times in total)

Training program is as below.

Table 1.6.5 Program of Japan training (Kobe)

Day			Subject	Lecturer
1 9th May (Thu)	9:30 10:30	10:30 11:30	Briefing Orientation	JICA
	13:00	13:20	Opening ceremony	Kobe city
	13:30	14:00	[Lecture] Waterworks in Kobe city	Kobe city
	14:00	15:00	[Lecture] History of Pipe Renovation and Application of GIS Mapping	Kobe city
	15:00	16:00	[Lecture] Asset Management and Effective Business Management in the World and Japan	Kobe city
	16:00	17:00	[Discussion] Recognition and Actual Situation of Asset Management level in RSC-WS based on the report from C/P	JET
2 10th May (Fri)	9:00	10:00	[Lecture] Improvement of Asset Management Database and Prioritization of replacement	Kobe city
	10:00	10:30	[Lecture] Accuracy of GIS and Actual Pipe Asset	Kobe city
	10:45	11:45	[Lecture] Water Facility Replacement Planning – Future Construction Demand （Balancing Water Demand and Budget Income）	Kobe city
	13:15	14:15	[Lecture] Control of Water Facilities / Central Control Center	Kobe city
	14:15	15:00	[Lecture] Response to Pipe Accident with Telemeter and GIS	Kobe city
	15:15	16:00	[Inspection] Large Capacity Transmission Main and Water Science Museum	Kobe city
	16:00	17:00	[Discussion] The Role of Top Management in Asset Management	JET
11th May			Japanese history program	
12th May			Holiday	
3 13th May (Mon)	9:00	10:15	[Lecture] Tariff Setting and Bill Collection, Application of Smart Meter	Kobe city
	10:30	12:00	[Lecture] Pipe Management and Asset Management in Nagoya City – Leakage Control and Capacity Development	Nagoya city
	13:30	14:20	[Lecture] Application of ISO 55000s in the world and Japan	Prof. Fujiki
	14:20	17:00	[Discussion] Discussion about promotion of Asset Management	Prof. Fujiki Nagoya city Kobe city
4 14th	9:00	11:00	[Discussion] Improving Water Service and Management in NWSDB using Knowledge of Asset Management	JET

May (Tue)	13:00	14:15	[Inspection] Sengari dam, Water treatment plant, Small scale hydroelectric power generation	Kobe city
	16:00	16:40	[Discussion] What kind Asset Management is necessary for NWSDB	Kobe city
5 15th May (Wed)	9:00	11:00	[Discussion] Improvement plan of Asset Management in NWSDB/RSC(W-S)	JET
	11:00	12:00	[Presentation] Action plan for Asset Management in NWSDB/RSC(W-S)	JET
	13:30	14:00	Evaluation of the Course and Discussion for Technical Cooperation Program by JICA	JICA
	14:15	14:45	Closing Ceremony	JICA
	15:00	16:00	Exchange of ideas	JICA

Reference: Kobe city

In order to share concrete image of application of Asset Management, JET planned to have discussion time every day, and held the debate for promotion of Asset Management chaired by Professor Osamu Fujiki from the Kyoto University Graduate School of Business Administration. In the last day of Japan training, participants presented their plan to positively proceed activities such as setting pilot site by themselves.

Also, participants reported the contents of Japan training to GM and submitted a report about Japan training. They conducted their own activities to share the output of the Japan training.

2) Training in Nagoya city

- Period: 17th – 28th February 2020
- Participants: JET requested NWSDB to select the candidates for Japan training considering the following.
  - To be selected from output 3 RP
  - Responsible person of TY management
  - Output 2 C/P who is expected to be the RP
  - Who may contribute to this project after the training in Japan.
- Eventually, the following 8 people were selected as participants of the Japan training.

Table 1.6.6 Participants of Program in Japan (Nagoya)

Name	Position
Mr. Saman Duwegoda	Senior Engineering Asst. (Civil), NWSDB
Mr. R. Y. S. Manathunga	Engineer CI. I (Civil), NWSDB
Mr. W. A. D. G. Jayaruwan	Mechanical Engineer, NWSDB
Mr. L.P. Horanage	Engineer (SP), NWSDB
Mrs. W. D. Wimalasiri	Engineer, MD&TD, NWSDB
Mr. Chandana Epa	Officer in Charge, OIC Panadura, NWSDB
Mr. Janaka Kalunamuni	Zone Officer, OIC Panadura, NWSDB
Mr. L. Eshwarage	Area Engineer, RSC (W–S), NWSDB

- Purposes:
  - To learn the appropriate construction and instruction methods through the actual training in TY of Nagoya

- To consider the method which can be applicable to NWSDB from the training and construction management in Nagoya
- To learn the way of human resource development and technical transfer in Kobe

- Contents:

[Actual training]

Training of installation of service pipe system, tapping and water pressure test

Actual training of acoustic bar and correlation type leakage detector

Leakage repair

Installation of DI pipe

[Lecture]

Method of construction management in Nagoya

Plumbing pipework training

Human resource development and technical transfer in Kobe

Replacement plan of distribution pipe and AM

Details of leakage and analysis of distributed water

Guidelines of pipe installation in Nagoya

[Inspection]

Construction site of pipe installation

[Discussion]

Follow-up the progress of making training guideline

Self-evaluation considering the TOT

Training program is as below.

Table 1.6.7 Program of Japan training (Nagoya)

Date	Time	Subject	Lecturer
1. 2/17 Mon	09：30～11：00	Briefing	JICA Chubu
	11：00～11：30	Program orientation	JICA Chubu
	11：30～12：00	Course orientation	NAWS
	13：30～13：40	Greetings from executives of NCWSB	Ms. Shimizu Kikuko
	13：40～15：30	[L] Outline of Nagoya waterworks	NCWSB
	15：40～16：40	[L] Construction quality management	NCWSB
2. 2/18 Tue	09：00～09：30	Courtesy call on Director general of NCWSB	NCWSB
	10：15～10：45	Preparation of inspection of construction site	NCWSB
	10：45～12：00	[I] Inspection of construction site	NCWSB
	13：00～15：00	[I] Inspection of construction site	NCWSB
	15：00～16：30	[L] Outline of Technical education center	NCWSB
3. 2/19 Wed	09：30～12：00	[L] Construction management	NCWSB
	13：00～14：00	[L] Plumbing pipework training	NCWSB, NAWS
	14：10～15：00	[L] Follow-up the progress of making training guideline	JET, NCWSB
	15：10～16：30	[L] Self-evaluation considering the TOT	JET, NCWSB
4. 2/20 Thu	09：30～10：30	[L] Orientation of technical education center	NCWSB
	10：45～12：00	[I] Inspection of preparation of training	NCWSB
	13：00～13：30	[L] Human resource development and technical transfer in Kobe	Kobe city
	13：30～16：30	[D] Discussion	JET
5. 2/21	09：30～10：00	[L] Training on installation of vinyl pipe	NCWSB
	10：15～11：00	[P] Training on pipe installation	NCWSB, NAWS

Fri	11：10～12：00	[P] Training on installation of service pipe system	NCWSB, NAWS
	13：00～14：30	[P] Training on tapping and water pressure test	NCWSB, NAWS
	14：45～15：30	[P] Training on clean up	NCWSB, NAWS
2/22		Holiday	
2/23		Holiday	
2/24		Holiday	
6. 2/25 Tue	09：50～11：00	[P] Training on acoustic bar and correlation type leakage detector	NCWSB, NAWS
	11：15～12：00	[P] Training on correlation type leakage detector	NCWSB, NAWS
	13：00～14：30	[P] Training on correlation type leakage detector and leakage repair	NCWSB, NAWS
	14：40～15：15	[P] Training on clean up	NCWSB, NAWS
7. 2/26 Wed	09：30～10：20	[L] Training on installation of DI pipe	NCWSB
	10：35～11：20	[P] Training on installation of DI pipe	NCWSB, NAWS
	11：30～12：00	[P] Training on installation of DI pipe	NCWSB, NAWS
	13：00～14：35	[P] Training on installation of DI pipe	NCWSB, NAWS
	14：45～15：15	[P] Training on clean up	NCWSB, NAWS
8. 2/27 Thu	09：30～12：00	[L] Replacement plan of distribution pipe and AM	NCWSB
	13：30～15：15	[L] Details of leakage and analysis of distributed water	NCWSB
	15：30～16：30	[L] Guidelines of pipe installation in Nagoya	NCWSB
9. 2/28 Fri	09：30～12：00	[D] Conclusion of Japan training	JET, NCWSB
	13：30～15：00	Evaluation of the course and discussion for technical cooperation program by JICA	JICA Chubu
	15：30～16：30	Closing ceremony	JICA Chubu

[L]: Lecture, [P]: Practical training, [D] Discussion, [I]: Inspection

Reference: Nagoya city

Participants learned a lot of things from practical training of Nagoya city, method of maintenance and operation of TY. Also, they took part in the question-and-answer session and exchanged their opinions actively. This training in Japan was very effective because NWSDB has applied the knowledge learned in Nagoya to the training program and TY effectively. Also, the two participants of output 2 members have been promoted to the RP to conduct the new training module.

1.6.2 Input from Sri Lankan side

(1) C/P

C/P who was assigned by Sri Lankan side is shown in Table 1.6.8. Also, the RP of output 3 is shown in Table 1.6.9.

Table 1.6.8 C/P list

	Name	Position, organization
Project Director	- Mr. C C H S Fernando	Additional General Manager, NWSDB
Fomer Project Director	- Mr. PERERA Thotagamuwe Widanage Sunith	
Fomer Project Director	- Mr. B. S. Wijemanna	
Project Manager	- Mr. S K Samantha Kumara	Assistant General Manager, RSC(W–S), NWSDB
Fomer Project Manager	- Mr. TUDUGALAMUDALIGE Rohan Jayantha Fernando	
Output 1 (terminated in the end of 1st phase)	- Ms. G D Kumari (leader of output 1)	Chief Engineer, RSC(W-S) (P&D)
	- Ms. D.N.S. Dewage	Eng. Assistant, RSC(W-S) (P&D)
	- Mr. Ajith de Alwis	Officer in charge (Panadura), RSC(W-S)
	- Mr. S. Anthony	Chief Engineer (Mapping)
	- Ms. Sujatha Kalubowila	Chief Engineer (Design manual), P&D Documentation
	- Ms. Pramila Dissanayake	Engineer (Design manual), P&D Documentation
	- Ms. P K R Dabare	Senior / Chief Accountant, RSC(W-S)
	- Ms. K A Wasantha	Cost Accountant, RSC(W-S)
	- Ms. Chatra Jasinghe	Senior Training Officer, RSC(W-S)
Former Output 1	- Ms. Anusha Adihetty	Chief Engineer, P&D, RSC(W-S)
	- Mr. M S Mohamed Rizwan	Chief Engineer (Mapping)
	- Mr. A D Ranasooriya	Chief Engineer (GIS & Mapping)
	- Mr. Kamal Wickramashinghe	Manager-Training (Technical), MD&TD
	- Mr. D P M Chandana	AGM, MD&TD
Output 2	- Ms. N D E Samudi Nirasha (leader of output 2)	Manager (P&C), RSC(W-S)
	- Mr . Ruwan Kalapuge	Engineer (P&C), RSC(W-S)
	- Ms. Madushi Prashanthika	Engineer (P&C), RSC(W-S)
	- Mr. Chandana Epa	Engineering assistant (Panadura - Horana), RSC(W-S)
	- Mr. Dumindu Warapitiya	Area Engineer (Panadura - Horana), RSC(W-S)
	- Mr. Ajith De Alwis	Officer in charge (Panadura), RSC(W-S)
	- Mr. Janaka Karunamuni	Zone officer of Zone 1 (Panadura), RSC(W-S)
	- Mr. Herath	AGM, NRW, RSC (W-C)
	- Ms. K. W. P. M. Thilakarathne	Manager, NRW, RSC(W-C)
	- Ms. Sujatha Kalubowila	Chief Engineer (Design manual), P&D Documentation
	- Ms. Pramila Dissnayake	Engineer (Design manual), P&D Documentation
Former Output 2	- Mr. A B V P Preshantha R Somarathna	Engineer, RSC(W-S)
	- Mr. K L Edirisinghe	AGM, NRW, RSC (W-C)
Output 3	- Ms. P.M.T.D. Pannila	AGM, MD&TD
	- Ms. Dedunu Wimalasiri	Engineer (Technical Tr), MD&TD
	- Ms. Champa Jayasinghe	Senior Training Officer (Technical Tr), MD&TD
	- Ms. Chathra Jasinghe	Training Officer, RSC(W-S)
	- Mr. Prashantha Somarathna	Engineer, RSC(W-S) (P&D)
Former Output 3	- Ms. P.M.T.D. Pannila	Chief Engineer (Constructin), RSC(W-S)
	- Mr. Kamal Wickramashinghe	Manager-Training (Technical), MD&TD
	- Mr. D P M Chandana	AGM, MD&TD
	- Mr. Lasantha Roopasinghe	AGM, MD&TD
	- Mr. Lenin Eshwarage	Area Engineer (Moratuwa), RSC(W-S)

Table 1.6.9 RP list

	Name	Responsible training
1	Mrs. Manel Thilakarathne	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test
2	Mr. Pradeep Perera	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test
3	Mr Kasun Roopasinghe	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test
4	Mr Upul De Silva	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test
5	Mr Mahinda Kumara	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair
6	Mr. R Y S Manathunga	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair
7	Mr K M K G Karunarathne	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair
8	Mr. H M Abeykoon Bandara	2-b. PVC Distribution Pipe Installation 3-b. PVC Service Pipe Installation
9	Mr Saman Duwegoda	2-b. PVC Distribution Pipe Installation 2-c. DI Distribution Pipe Installation 3-b. PVC Service Pipe Installation 4-b. PVC Distribution & Service Pipe Repair 4-c. DI Distribution Pipe Repair 4-d. Valve and Accessory Repair
10	Mr Anurudda Perera	2-c. DI Distribution Pipe Installation 4-c. DI Distribution Pipe Repair
11	Mr. L P Horanage	4-b. PVC Distribution & Service Pipe Repair 4-c. DI Distribution Pipe Repair 4-d. Valve and Accessory Repair 7. How to use the data obtained from pilot activity
12	Mr. W A G D Jayaruwan	5-a. Water Meter
13	Mr. Manju Malkelum	5-b. Flow Measurement 5-c. Pressure Measurement
14	Ms Samudi Nirasha	7. How to use the data obtained from pilot activity
15	Mr. Chandana Epa	7. How to use the data obtained from pilot activity
16	Mr Janaka Karunamuni	7. How to use the data obtained from pilot activity
17	Mr Ajith Alwis	7. How to use the data obtained from pilot activity

(2) Facilities, equipment and office

Facilities, equipment and office which was prepared by Sri Lankan side are shown in Table 1.6.10.

Table 1.6.10 List of Facilities, equipment and office

	Details
Facilities	MD&TD training room, Meeting room of RSC(W-S), Storage for equipment
Equipment	Office supplies
Office	Room of MD&TD ground floor (it was changed to 2nd floor later, then again back to the ground floor)

(3) Expenses related to project

Expenses related to project paid by Sri Lankan side is as below.

- Accommodation fee and transportation fee for the participants of seminar, workshop and TOT.
- Construction cost related to pilot site activity
- A part of construction cost borne by C/P related to TY (leveling of ground, etc.)
- VAT and custom clearance

1.7 Meeting and Report

Main meetings and reports which were conducted in the project are as below.

1.7.1 Joint coordinating committee (JCC)

JCC was held 4 times. The outlines of each JCC are as below.

- 1st JCC
  - Date: 11th October 2018
  - Venue: Ministry of City Planning and Water supply (at that time), Sri Jayewardenepura Kotte

Contents: Confirmation of implementation plan of project, confirmation of pilot project site, confirmation of cost borne by Sri Lankan side and Japanese side respectively

- 2nd JCC
  - Date: 1st August 2019
  - Venue: Ministry of City Planning Water supply and Higher Education (at that time), Sri Jayewardenepura Kotte

Contents: Progress of the project, confirmation of output 1 activity, confirmation of holding top management meeting, confirmation of pilot site of output 1, details of Japan training in Nagoya city, plan and progress of TY construction

- 3rd JCC
  - Date: 29th September 2020
  - Venue: Ministry of City Planning Water supply and Higher Education, Sri Jayewardenepura Kotte and Web meeting

Contents: Outline of implementation plan of project in 2nd term, Progress of Output 2 and Output 3, detailed implementation plan of output2 and output 3 in 2nd term, Project budget

- 4th JCC
  - Date: 12th August 2021
  - Venue: Web meeting

Contents: All implemented project activity and outcome, result of terminal evaluation, explanation about procedure manual, Discussion

1.7.2 Top Management Meeting (TMM)

TMM was held to enhance Output 1 activity with the participation of the top management who were GM and Addl GMs. The detail of the meeting is described in Chapter 2.4 .

- Date: 26th November 2019
- Venue: Conference room at NWSDB Head Office
- Contents: Importance of involvement of Top Management in Asset Management, current problem and future perspective, significance of policy setting. Asset management budget

1.7.3 Terminal Evaluation

The Terminal Evaluation was jointly conducted by JICA and NWS&DB. The members of the Terminal Evaluation Team are shown below. Besides Ms. Tamura, the other Japanese members attended online. The evaluation started from 1st July 2021 with the kick-off meeting, and the evaluation result was presented and approved at the 4th JCC held on 12th August 2021.

Table 1.7.1 Members of the Terminal Evaluation Team – JICA

Name	Title	Assigned area
Mr. Inoue Yoichi	Director, Water Resources Team 1, Water Resources Group, Global Environment Department, JICA	Team Leader
Mr. Hattori Toshiyuki	Technical Advisor, JICA	Waterworks Management Plan
Ms. Fujita Akiko	Deputy Director, Water Resources Team 1, Water Resources Group, Global Environment Department, JICA	Project Management
Ms. Tamura Tomoko	Consultant, Kaihatsu Management Consulting Lanka (Pvt.) Ltd.	Project Analysis and Evaluation

Table 1.7.2 Members of the Terminal Evaluation Team – NWSDB

Name	Title
Eng. Senani Jayasinghe	Assistant General Manager (North Central)
Eng. T H V I Fernando	Assistant General Manager (Donor Coordination)

1.7.4 Report and training document

Reports and training documents which were created in the 1st term of project are shown in Table 1.7.3.

Table 1.7.3 List of reports and documents

Name		Date of creation	Contents
Report	Work plan (1st term)	September 2018	Work plan of this project (Japanese)
	Work plan (1st term)	December 2018	Work plan of this project (English)
	Progress report 1	February 2020	Progress of the project in 1st term
	Monitoring sheet Ver.1	May 2019	Progress, delay and improvement of this project
	Monitoring sheet Ver.2	February 2020	Progress, delay and improvement of this project
	JICA project brief note (1st term)	July 2019	Outline of plan and progress of this project
	Progress report (1st term)	March 2020	Progress of project as of March 2020
	Work plan (2nd term)	September 2020	Work plan of this project in 2nd term (Japanese)
	Work plan (2nd term)	September 2020	Work plan of this project 2nd term (English)
	Monitoring sheet Ver.3	March 2021	Progress, delay and improvement of this project
	JICA project brief note (2nd term)	October 2021	Outline of plan, outcome and future outlook
	Final report	October 2021	Plan, outcome and future outlook of this project

Documents	Draft of AM guideline	December 2019	AM guideline about pipeline
	Work plan for water leakage control	July 2019	Work plan with action policy of water leakage control
	Procedure manual for water leakage control	November 2019	Procedure manual for water leakage control such as underground leakage
	Training curriculum and training guideline	December 2019	Curriculum and guidelines for practical training in TY
	Work plan for water leakage control Ver. 2	October 2020	Revised work plan with action policy of water leakage control
	Guideline of training No.7 “How to use the data obtained from pilot activity”	May 2021	Guideline about water leakage control based on the pilot activity of output 2

1.7.5 Workshop, C/P meeting, Seminar

Workshops, C/P meetings and seminars which were conducted in the project are shown in Table 1.7.4.

Table 1.7.4 List of Workshops, C/P meetings and seminars

Name		Date	Outline
Output 1	1st seminar	12th October, 2018	Introduction of Asset Management and information sharing
	1st workshop	15th October, 2018	Importance of information collection for Asset Management
	2nd seminar	18th January, 2019	Pipeline Asset Management in Japan
	2nd workshop	22nd January, 2019	Estimation method of year of pipeline installation
Output 2	Weekly meeting	Once a week (October 2018 – March 2020)	Confirmation of plan and progress
	C/P meeting	Once or twice a month (June 2020 – August 2021)	Confirmation of plan and progress (Web meeting)
Output 3	C/P meeting	17th October, 2018	Explanation of activities of output3
	C/P meeting	26th November, 2018	Result of inspection of training in NWSDB
	RP meeting	6th March, 2019	Explanation of outline of this project to RP
	RP meeting	25th July, 2019	Explanation of training document that RP creates
	1st workshop	5th August, 2019	Outline of practical training in training center of Nagoya city
	C/P meeting	8th December, 2019	Explanation of progress of TOT preparation
	C/P meeting	Once or twice a month (June 2020 – August 2021)	Confirmation of plan and progress (Web meeting)
	Review meeting	28th October 2020	Training on leakage detection and DMA creation
	Review meeting	17th November 2020	Training on water meter
	Review meeting	30th December 2020	Training on water meter
	Presentation by Nagoya city about SBU	23rd June 2021	Presentation by Nagoya city about plan of SBU of MD&TD

Although the final seminar was planned at the end of the project, it was canceled due to the spike of new cases of COVID-19 in Sri Lanka. However, since C/P was eager to disseminate and promote the project outcomes, JET decided to make a brochure of this project. The brochures were distributed to NWSDB managers, related organizations, other training organizations, contractors, and suppliers. Also, it will be posted on the website of NWSDB and SNS.

2 Contents and Result of Activities in Output 1

Output1: Asset management of pipelines is introduced to NWSDB.

The activities and achievement in the 1st term of the Output 1 are described below.

2.1 History of Change of Scope

This project has started its activities based on the PDM and PO agreed by JICA and NWSDB and specified in the R/D. JET conducted seminars and workshops to share the image of asset management, and introduced the ISO 55000 series, which were the international standards of asset management. Then, JET and C/P agreed upon the use of ISO 55000 series as a base of the activity. Experience of Japanese water utilities and "Asset Management Guidelines for Waterworks, 2009" published by the Ministry of Health, Labour and Welfare of Japan would be referred to in application of ISO 55000 series.

However, C/P expectation was high in asset management, and they have requested for more advanced activities, such as multi-parameter analysis, system integration of database, etc. In response, JET conducted an assessment of the current status of asset management in NWSDB and prepared and submitted a diagnostic report with the target level to be achievable in the project in March 2019 (See Chapter 2.2.5).

At the training in Japan on asset management held in Kobe in May 2019, several discussions were held for the expectations of NWSDB on JET input for data collection, database updating, analysis, and guideline preparation. NWSDB and JET also discussed the matters regarding the evaluation of the current situation, specific technologies required, and future directions, etc. C/P stated that they would voluntarily select pilot sites and start specific activities related to asset management. C/P and JET reached the same understanding that the active involvement of top management was important to implement asset management systematically. On the basis of mutual understanding that strong participation of top management is necessary to establish a systematic asset management system, it was decided that Top Management Meeting (TMM) be held regularly. TMM was dedicated to the Asset Management during the project period, and it was expected to be absorbed into usual meeting in future, and both sides agreed on change of output 1 activities which includes PDM and PO at the 2nd JCC.

An excerpt of the PDM changed for Output 1 is shown below. The changed parts were indicated by shading.

Table 2.1.1 Changed Parts of PDM

Activity (original)	Activity (after changing)
1.1 Conduct seminar/ workshops, including Overseas Training(s) in Japan, on asset management of pipelines to the management of NWSDB	No change
1.2 Develop a draft of guideline for asset management	No change
	1.3 Conduct Top Management Meeting for formulation of AMS - Conducting Top Management Meeting on regular basis - Incorporating Asset Management in the regular Development Meeting of RSC-WS
1.3. Conduct a trial calculation for renewal demand of	1.4 Conduct a trial calculation for renewal demand and

pipelines in the pilot activity site - Collecting necessary data of pipelines for the trial calculation. - Conducting OJT for NWSDB staff for conducting trial calculation and analysis - Conducting the trial calculation for practical exercises	prioritization of pipe lines in the pilot activity site - Collecting necessary data of pipelines for the trial calculation. - Conducting OJT for NWSDB staff for conducting trial calculation and analysis - Conducting the trial calculation for practical exercises - Conducting OJT of prioritization of pipe replacement - The outcome of practice is shared at JCC

*Changed parts are indicated by shading

In the original plan, the practice was to be held for the calculation of pipe replacement demand, however, C/P requested the practice of prioritization of pipe replacement as well. Therefore, the activity of prioritization was added to the OJT item and description of PDM was changed as well.

However, the difference between the project activity and the request of NWSDB side was realized through the project activity. The main differences are summarized as follows:

Table 2.1.2 Difference between C/P and JET in Concept of Asset Management

	Japanese experience and interpretation by JET	NWSDB's request
1	Introduction of asset management to stabilize long-term finance with medium to long term perspective	Replace/repair to extend the life of asset under relatively short period perspective due to difficulty of securing stable funding
2	Preparation of guidelines to meet ISO55001 requirement for continuous improvement with PDCA cycle	Practical, consistent, and clear guidelines which RSC can follow
3	Only replacement is considered for pipeline management	Not only replacement, but repair shall be considered with cost comparison
4	To conduct the pipe replacement demand calculation and prioritization	Detail design level accurate cost calculation
5	The calculation and prioritization use 4 factors, i.e., aging factor, incident risk score, hydraulic function score, water quality retention score	Addition of parameters which are difficult to collect and quantify, such as soil type, laying depth, traffic condition, system pressure, water quality, country of manufacture and workmanship

To respond to the situation above, a mission team was dispatched from JICA headquarters to adjust the discrepancies in the requirement and the activities. Holding several discussions, Japanese side proposed revising the guidelines and adding an activity to introduce prioritization process of pipe renewal with limited factors at the pilot site. But NWSDB declined the proposal. As a result, both sides reached a conclusion that the experience in Japanese context were different to Sri Lankan context and it was comprehended that, NWSDB requirement on Asset Management could not be served within the experiences in Japanese condition. Therefore, both sides agreed on discontinuing Outputs-1.2, 1.3 and 1.4 activities and excluding them from the 2nd term activities

In the following, the contents of the activities are described along with the revised PDM.

2.2 [Activity 1.1] Conduct seminar/workshop, including overseas training in Japan, on asset management of pipelines to the management of NWSDB.

In this section, contents and results of Seminars/Workshop and capacity assessments were presented.

2.2.1 Current conditions and issues of Asset Management in NWSDB

JET had started the survey in September 2018 to identify issues to be discussed in the seminar and workshop.

(1) Findings in September 2018

Mid-term organizational missions and visions of NWSDB are set forth in the Corporate Plan every 5 years. In the corporate plan applied to 2016 ~ 2020, Goal 1 was to "increase water supply and sanitation coverage" and NWSDB had been working diligently towards this goal. On the other hand, some pipelines in the water supply system were aging and require renewal. NWSDB was implementing pipeline renewal for some sections. However, there was no comprehensive renewal plan with priority basis, so the renewal works were not coordinated well. NWSDB management strongly desired a systematic Asset Management System (AMS).

(2) Issues in Early Stage of the Project and Approach to Solve

JET identified 2 major issues in September 2018 against the systematic implementation of AMS.

1) Establishment of organizational and implementation structure for implementing Asset Management

At the beginning of the project there was no department responsible for Asset Management at NWSDB Head Office[1]. In addition, responsibilities for Asset Management of each departments were unclear since they were not defined in the division of work. Furthermore, the process for promotion of the AMS was not shared between the management level and the working level. Clarifying the Asset Management roles of each department, reflecting them in the 5-year plan, and establishing an organizational decision-making system for decisions such as budget allocations were issues in NWSDB. Each RSC prepared an action plan and secured the required budget. They also prepared action plans for the following year. However, consideration of "coordination with the financial plan" and "prioritization with medium and long-term perspectives" were not in a view.

Budget and personnel allocation are required to continuously collect and update necessary data for Asset Management works.

2) Establishment of a database, and continuous data collection and its utilization

For implementation of Asset Management, organized information of water supply facilities was required. NWSDB collected information for individual assets so far; however, important data such as pipeline laying year were not registered. In addition, since associations between the available data were not made, it was not possible to calculate scientifically pipeline renewal demand and prioritize renewal from a long-term planning perspective using the available data. For this reason, formulation of an efficient database, based on the understanding of the importance of collection and accumulation of data

[1] The position of Addl.GM (Consumer and Asset Management) was newly created in NWSDB by the restructure in February 2021, who is responsible for NRW, mapping and asset management.

for calculating the pipeline renewal demand, was an important issue. Especially, collection of important lacking data, such as pipeline laying year was required. Furthermore, an organizational structure to continuously collect and update data, such as water leak records, needed to be established.

2.2.2 Considering Direction of Asset Management to be Introduced in NWSDB

As a result of above analysis, JET identified the necessary approaches for establishing ASM as follows:

1) Establishment of organizational and implementation structure of Asset Management
2) Construction of database and continuous data collection and utilization, and
3) Estimation of the lacking data.

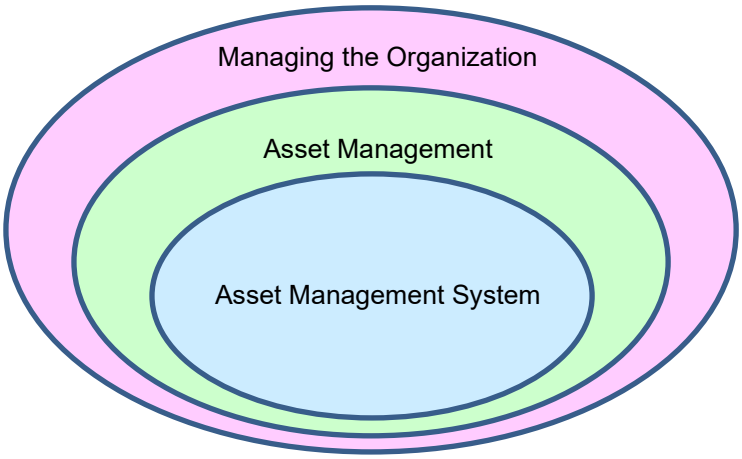
To conduct the above approaches, Asset Management to be introduced in NWSDB was considered based on ISO55001 and "Asset Management Guidelines for Waterworks, 2009" published by the Ministry of Health, Labour and Welfare of Japan.

ISO55001 was established in 2014 as an international standard for Asset Management, defining the requirements for establishing an organizational structure, implementation, maintenance, and improvement for Asset Management. The figure below shows the relationship of terms regarding Asset Management between the ISO55000 series of standards.

ISO55001 aims to make Asset Management implementation effective and efficient by establishing a well functioning AMS within the organization.

When AMS functions well within an organization, effective and efficient Asset Management can be implemented.

Several sections within NWSDB have ISO9001 and ISO17025 certification, and internal training for ISO is implemented regularly. Therefore, the organization seemed familiar with ISO procedures. Considering such basic conditions, utilization of the ISO management cycle seemed applicable for the achievement of sustained improvements of Asset Management in NWSDB through the PDCA cycle.



Source: ISO55000

Figure 2.2.1 Relationship of terms regarding Asset Management in the ISO55000 series

Accordingly, JET decided that the seminar and workshop were to promote the ISO55000 series and the Asset Management guidelines published by the Ministry of Health, Labour and Welfare of Japan in order to bring the experiences of Japanese waterworks to NWSDB

2.2.3 1st Seminar and Workshop

A seminar and workshop for the introduction of Asset Management of pipelines were held to respond to the issues identified above. In the 1st seminar/workshop, the Japanese Asset Management experience was shared with the C/P with the objective of gaining mutual understanding of the importance of continued effort for sustained Asset Management activities and long-term perspective.

(1) 1st seminar

Knowledge and experience of Asset Management of NWSDB and Japan were shared in the 1st seminar. JET presented 2 cases, C/P presented one case, and discussions were held regarding them. As a result, knowledge and experiences of Japanese Asset Management were shared. At the same time, the need for the improvement of Asset Management in NWSDB was understood, and the effectiveness of ISO55001 for achieving the desired outcomes was recognized.

Table 2.2.1 Outline of 1st Seminar on Asset Management

Date	Morning time of 12th October 2018
Venue	MD&TD
Objectives	Introducing and knowledge sharing of Asset Management
Target	Management of NWSDB, Manager of C/P
Participants	Addi.GM, DGM, AGM, Manager of RSC WS, Output1 C/P etc. (18 persons)
Agenda	➢ Opening Remarks Project Director, Additional General Manager (Western) ➢ Introduction of the project Dr. Yasuko Kamegai (Ms), Chief Advisor- JICA Project ➢ Introducing of Asset Management Guidelines, Ms Saeko Osaki, Asset Management Expert JICA Project - Current Asset Management Activities in NWSDB, Ms. Anusha Adhihetty, W-S, NWSDB - Knowledge sharing of Asset Management, and Case Study in Japan, Mr. Makoto Matsushita, Asset Management Expert, JICA Project ➢ Summarization Mr. Yoshinobu Ono, Deputy Chief Advisor/Asset Management Expert, JICA Project
Outcome	The knowledge and experience of asset management in Japan were shared. ➢ Asset management activities are already carrying out as a daily work in NWSDB. ➢ Future renewal demand of pipeline should be realized for asset management. ➢ NWSDB need to improve activity for sustainable water supply for a long time to come. ➢ C/Ps understood importance of introduction of asset management guidelines in NWSDB. ➢ C/Ps understood importance of proper data collection.

Source: JET

(2) 1st workshop

In the 1st workshop, 3 themes of workshop regarding the importance of data collection were held. The participants understood that Asset Management helps effective implementation of pipeline renewal works and that knowledge of future pipeline renewal demand is important for those works.

Table 2.2.2 Outline of 1st Workshop on Asset Management

Date	Morning time on 15th October 2018
Venue	MD&TD
Objectives	Importance of Data Collecting for Asset Management
Target	C/P and Staff of Asset management-related section
Participants	Project Manager, Output1C/P etc (12 persons)
Agenda	➢ Opening Remarks Project Manager, Assistant General Manager (Western South) ➢ Purpose of the Workshop and Summary of previous Seminar Mr. Yoshinobu Ono, Deputy Chief Advisor/Asset Management Expert, JICA Project ➢ Workshop 1 – Discussion 1 Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita/ Mr. Yoshinobu Ono - Sharing information about the pipe management works - Classifying Asset Management works, relationship ➢ Workshop 2 – Discussion 2 Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita/ Mr. Yoshinobu Ono - Sharing Problem/difficulty and its cause ➢ Workshop 3 – Discussion 3 Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita/ Mr. Yoshinobu Ono - Finding solutions? ➢ Summarization Mr. Makoto Matsushita, Asset Management Expert, JICA Project
Outcome	NWSDB has understood that Asset Management is helpful to implement renewal effectively. ➢ The knowledge and experience of pipe management in Western-South were shared. ➢ Data collection and accumulation work related to Asset Management is being implemented in RSC(WS). ➢ Regarding data collection and accumulation work, NWSDB need to enrich Asset Management database for taking advantage of Asset Management ➢ NWSDB should be improved It is necessary to improve activity, which will lead to sustainable water supply. ➢ Future pipe replacement demand should be recognized from accumulated data, and a basic material for preparing a pipe renewal plan.

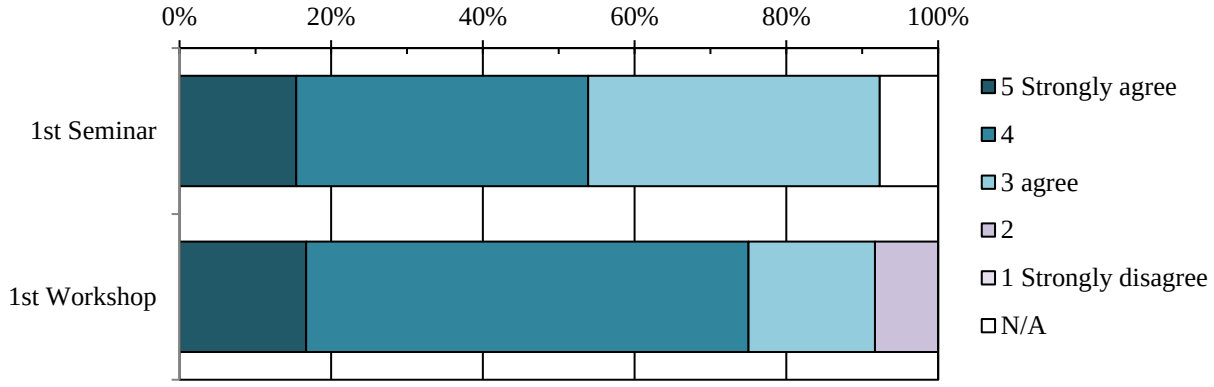
Source: JET

(3) Results of questionnaire

Questionnaires were given to participants of the seminar and workshop. The results showed that the seminar and workshop were effective. A majority of participants “agreed” or “strongly agreed” that the seminar and workshop were achieved their objectives.

However, one participant disagreed that the objectives were achieved. The reason for this result was that this participant was not directly involved in pipe maintenance works and therefore could not understand the contents presented.

The answer to "Do you think that general outcomes and objectives of seminar/workshop achieved?"



Source: JET

Figure 2.2.2 Questionnaire results of the 1st seminar and workshop

2.2.4 2nd seminar and workshop

The themes of the 2nd seminar and workshop were 1) establishment of implementation structure for Asset Management and 2) estimation method for pipeline laying year missing from data of RSC (W-S).

(1) 2nd seminar

In the 2nd seminar, Asset Management implementation structure and workflow established in the City of Kobe was introduced. As a result, consensus was made that a specific department dedicated to Asset Management was not needed at NWSDB and that Asset Management related operations can be carried out as part of regular operations within the existing organizational structure.

Table 2.2.3 Outline of 2nd Seminar on Asset Management

Date	Afternoon time on 18th January 2019
Venue	Auditorium, RSC(W-S)
Objectives	Practice and issue of an implementation structure and PDCA cycle of asset management
Target	Management of NWSDB, Manager of C/P
Participants	Addi.GM, DGM, AGM, Manager of RSC WS, Output1 C/P etc. (21 persons)
Agenda	➢ Opening Remarks Project Director, Additional General Manager (Western) ➢ Objective of 2nd Asset Management Seminar Mr. Yoshinobu Ono, Deputy Chief Advisor/Asset Management Expert, JICA Project ➢ Asset Management – Practice in Kobe Mr. Takumi Sato, Kobe City Waterworks Bureau ➢ Current implementation structure, PCDA cycle and issues of AMS in RSC(W-S) Ms. Anusha, RSC(W-S), NWSDB ➢ Water pipe Information System of Kobe City (Mapping System) Mr. Kento Ueda, Kobe City Waterworks Bureau ➢ How to promote AMS in RSC(W-S) using PDCA cycle. (Discussion) Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita/ Mr. Yoshinobu Ono ➢ Summarization Mr. Makoto Matsushita, Asset Management Expert, JICA Project
Outcome	The following policies have been decided towards the future. ➢ The image of “PDCA cycle” should be reflected actual behavior, as “Annual Evaluation Meeting” in RSC(WS) with the DGM and AGM. ➢ The future pipe asset should be figured out using past data. - Estimation of replacement demand in future - Consideration of budgeting capacity according to the income - Proposal of realistic investment plan for replacement

Source: JET

(2) 2nd workshop

The 2nd workshop focused on brainstorming methods for confirming pipeline laying year. For example, in the Pilot Area of Panadura, of the 440 km of laid pipe, laying year is unknown for 298 km (approximately 70%). In order to set priorities for pipeline renewal, methods for confirming when pipes were installed were questioned and discussed.

Table 2.2.4 Outline of 2nd Workshop on Asset Management

Date	Afternoon time on 22nd January 2019
Venue	Auditorium, RSC(W-S)
Objectives	Formation of database and an application of Asset Management
Target	C/P and Staff of Asset management-related section
Participants	Project Manager, Output1C/P etc. (22 persons)
Agenda	➢ Opening Remarks Project Manager, Assistant General Manager (Western South) ➢ Input 1, How to promote Asset Management in RSC(W-S). Mr. Makoto Matsushita/ Ms. Saeko Osaki, Asset Management Expert ➢ Workshop 1(Group Discussion) How to confirm each installation year of pipeline Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita ➢ Input 2, Structure of database and an application of Asset Management in Kobe city. Mr. Kento Ueda, Kobe City Waterworks Bureau ➢ Workshop 2(Group Discussion) Required O&M information for Asset Management - What for do we utilize GIS mapping? Facilitator: Ms. Saeko Osaki/ Mr. Makoto Matushita
Outcome	As an estimation method of the installation year of the pipeline, the following information is given an opinion that it is effective, and it was decided to perform the estimation work based on the information in the future project activity. - Pipe material - Leak record - Contract documents - Information from customers - Information from veteran staff - Fixed asset register

Source: JET

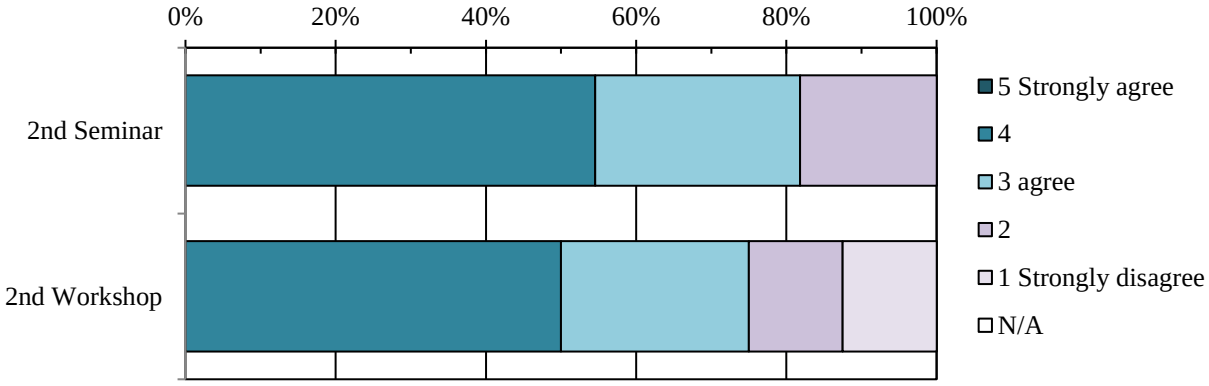
(3) Results of questionnaire

Questionnaires were given to participants of the seminar and workshop. The results showed that the seminar and workshop were effective. A majority of participants “agreed” or “strongly agreed” that the seminar and workshop achieved their objectives.

However, 2 participants disagreed that the objectives were achieved.

The reason for their disagreement was that they had experience in Asset Management and felt that NWSDB already had high levels of Asset Management competence. And they wanted the higher levels topics and broader scope in the seminar/workshop. On the other hand, JET figured out that the important data of pipe laying year were not accumulated, that is, the C/P didn’t recognize the current situation well.

The answer to "Do you think that general outcomes and objectives of seminar/workshop achieved?"



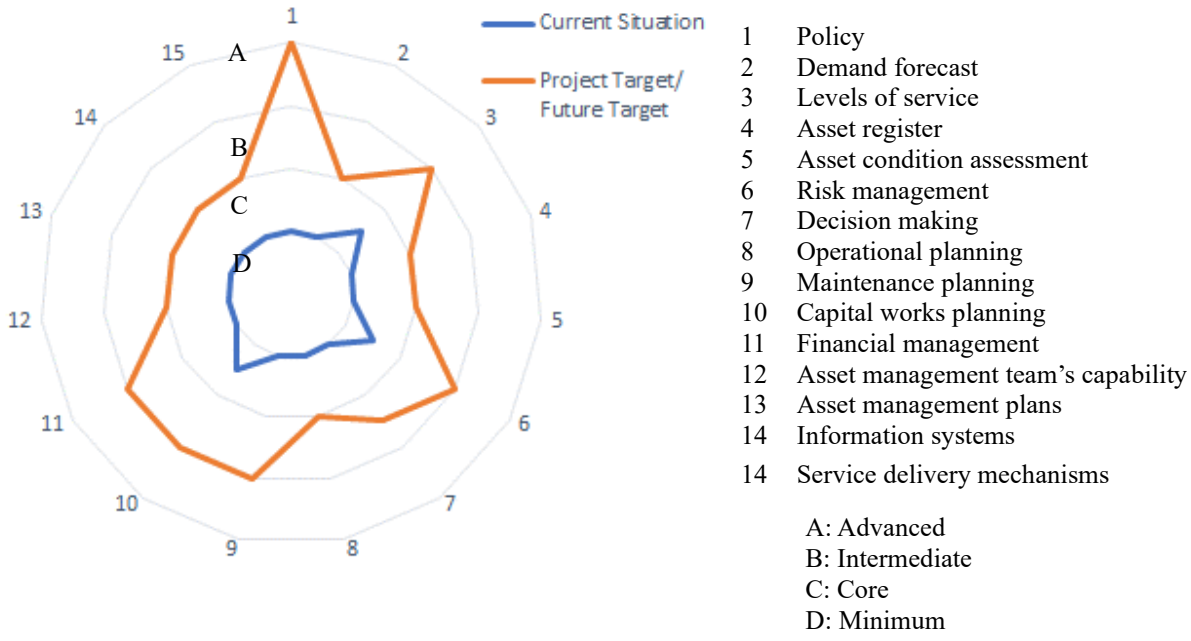
Source: JET

Figure 2.2.3 Questioner results of the 2nd Seminar and Workshop

2.2.5 Assessment of Asset Management implementation in NWSDB

In March 2019, JET assessed the current state of Asset Management of NWSDB using the International Infrastructure Management Manual (IIMM). The manual provides a self-evaluation table for 15 aspects, with a 4-level ranking system. The results are shown in Figure 2.2.4 and Table 2.2.5. JET evaluated the present state of NWSDB and tentatively set targets for this project based on the evaluation of each aspect. JET has set these target levels as levels which could be achieved if NWSDB could perform the activities specified in the guidelines. Of the 15 aspects described here, 6 aspects were included in the scope of this project. In the Table 2.2.5, they are shown in dark blue color, and labeled "Scope of the Project" in the title. On the other hand, 9 aspects shown in light blue in this table are not included in the scope. This evaluation result was shared with the C/P in the Monthly C/P Meeting held in March 2019. Understanding the evaluation result has been obtained by the participants of the training in Japan, held in May 2019.

However, this was the assessment by JET, and later the difference of opinion in proceeding method of Output 1 was realized and the evaluation result was not confirmed by NWSDB.



Source: JET

Figure 2.2.4 Assessment Results of NWSDB Asset Management Level

Table 2.2.5 Assessment Results of NWSDB Asset Management Level (Details)

	Asset Management Aspect	Minimum	Core	Intermediate	Advanced
1	Policy	Corporate expectations are expressed informally and simply: all departments must update asset plans every 3 years.	Policy statements are defined for all significant activities. There is a clear link to corporate goals, and action plans and accountabilities are stated.	All policy and strategies are reviewed and adopted by executive team each year. Detailed plans, resources, responsibilities, and time frames are in place.	Asset management policy and strategy are integrated into the organization's business processes and subject to audit, review, and updating procedures.
		Current situation：Minimum NWSDB does not have a clear policy of asset management.			
		Future Target**：Advanced NWSDB will integrate the policy and strategy of asset management into the business plan, which will be inspected, reviewed and updated on the basis of the guidelines*.			
2	Demand forecast (scope of the Project)	Demand forecasts are based on experienced staff predictions. Past demand trends and likely future growth patterns are considered.	Demand forecasts are based on robust projections. Risks associated with demand change are broadly understood and documented.	Demand forecasts are based on mathematical analysis of past trends and primary factors. A range of scenarios is developed.	Demand forecast includes risk assessment of different demand scenarios with identified mitigation actions.
		Current situation：Minimum NWSDB conducts demand forecast of replacement for limited types of pipes such as AC and CI in limited area but does not understand the demand of the other types of pipes.			
		Project Target***：Core NWSDB will be able to forecast the demand of replacement based on the information of installation date and service life.			
3	Levels of service	Asset's contribution to the organization's objectives and some basic levels of service have been defined.	Customer groups have been defined and requirements informally understood. Levels of service and performance measures are in place covering a range of service attributes. There is annual reporting against service targets.	Customer group needs are analyzed. Costs to deliver alternative levels of service are assessed. Customers are consulted on significant service levels and options.	Levels of service consultation strategy is developed and implemented. Technical and customer levels of service are integral to decision making and business planning.
		Current situation：Minimum-Core NWSDB defines some customer groups, such as large customers, and requirements of them are understood informally. However, the criteria of service level and performance are not clear.			
		Future Target：Intermediate NWSDB will analyze the need of customer group and evaluate the cost of services.			
4	Asset register (scope of the Project)	Basic physical information is recorded in a spreadsheet or similar (location, size, type), but may be based on broad assumptions or may be incomplete.	There is sufficient information to complete asset valuation (same as for minimum level, plus replacement cost and asset age life). Asset hierarchy, asset identification, and asset attribute systems are documented.	A reliable register of physical and financial attributes is recorded in an information system with data analysis and reporting functionality. A systematic and documented data collection process is in place. There is a high level of confidence in critical asset data.	Information on work history type and cost, condition, performance, etc., is recorded at the asset component level. There is a systematic and fully optimized data collection program. There is a complete database for critical assets and minimal assumptions for noncritical assets.
		Current situation：Minimum-Core Basic physical information is recorded into GIS database but many of attributes have no information. Also, the accumulation of the asset information related asset management is insufficient.			

	Asset Management Aspect	Minimum	Core	Intermediate	Advanced
		Project Target：Core NWSDB will have enough information for the evaluation of asset, and be able to understand the future cost of replacement and spending year.			
5	Asset condition assessment (scope of the Project)	Condition assessment is conducted at asset group level (top down). This supports minimum requirements for managing critical assets and statutory requirements (e.g., safety).	Condition assessment program is in place for major asset types prioritized based on asset risk. Data supports asset life assessment. Data management standards and processes are documented. A program for data improvement is developed.	Condition assessment program is derived from cost‐benefit analysis of options. A good range of condition data for all asset types may be sampling based. Data management processes are fully integrated into business processes. Data validation process is in place.	The quality and completeness of condition information supports risk management. Life-cycle decision making and financial performance reporting are done. Periodic reviews of program suitability are carried out.
		Current situation：Minimum NWSDB assesses the condition of asset as an asset group (not individual).			
		Project Target：Core NWSDB will be able to assess the risks of assets based on the inventory with risk assessment and prioritization. NWSDB will estimate the life time of pipelines. NWSDB will establish documented standards of data management and its procedure.			
6	Risk management (scope of the Project)	Critical assets are understood by staff involved in maintenance and renewal decisions.	A risk framework is developed. Critical assets and high risks are identified. Risk management strategies are documented for critical assets and high risks.	Systematic risk analysis assists key decision making. Risk register is regularly monitored and reported on. Risk is managed consistently across the organization.	A formal risk management policy is in place. Risk is quantified and risk mitigation options are evaluated. Risk is integrated into all aspects of decision making.
		Current situation：Minimum-Core NWSDB assesses the risk of AC and CI pipes. The risk of water leakage is evaluated by the staff’s experience.			
		Project Target：intermediate The top management of NWSDB will be reported the result of systematic risk analysis. The risk is consistently managed in the organization. For example: Number of leakage per length (frequency), Number of customers of suspicion (Impact), hour of suspicion (Impact), Suspicion of important facilities such as hospital (Impact) etc.			
7	Decision making	All decisions are based largely on staff judgment and agreed corporate priorities.	Formal decision-making techniques (cost‐benefit analysis, multicriteria analysis) are applied to major projects and programs.	Formal decision-making and prioritization techniques are applied to all operational and capital asset programs within each main budget category. Critical assumptions and estimates are tested for sensitivity to results.	The same as for intermediate, plus the framework enables projects and programs to be optimized across all activity areas. Formal risk-based sensitivity analysis is carried out.
		Current situation：Minimum Decision making has been done based on the judgment of particular section(s).			
		Future Target：Core-Intermediate The procedure of official decision-making and prioritization will be applied to all capital expenditure and Operating expense in the main budgetary items.			

	Asset Management Aspect	Minimum	Core	Intermediate	Advanced
8	Operational planning	Operational responses are understood by key staff, but plans may not be well documented and are mainly reactive in nature. Asset utilization is measured for some key assets but is not routinely analyzed.	Emergency response plan is developed. Demand management is considered in major asset planning. Asset utilization is measured for critical asset groups and is routinely analyzed.	Emergency response plans and business continuity plans are routinely developed and tested. Demand management is a component of all operational decision making. Asset utilization is measured and analyzed for most asset groups.	Operational plans are routinely analyzed, tested, and improved. Formal debriefs occur after incidents. Asset utilization is measured in real time and effectiveness is analyzed across all asset groups. Operational programs are optimized using cost‐benefit and risk analysis.
		Current situation：Minimum Key staff members understand operational responses. The plan is not documented enough, thus the operational response is taken against the raised needs. They have a record of repair, but it is not utilized for future operation and maintenance.			
		Future Target：Core NWSDB will establish emergency response plan and be able to understand the water demand and asset usage rate by analysis.			
9	Maintenance planning	Organizational objectives and how asset functions support these are understood. Maintenance planning is compliant with legislation and regulation Maintenance records are maintained.	Asset criticality is considered in response processes, fault tracking, and closure process. Strategy for prescriptive versus performance-based maintenance is developed. Key maintenance objectives are established and measured	There are contingency plans for all maintenance activities. Asset failure mode is understood. The frequency of preventive maintenance is optimized using cost‐benefit analysis. Maintenance management software is implemented.	Forensic root cause analysis is used for major faults. Optimization of all reactive and planned programs alongside renewal planning. Procurement models are fully explored.
		Current situation：Minimum NWSDB understands the purpose of the organization and function of asset. The level of importance of each asset is not linked to the maintenance plan.			
		Future Target：Intermediate NWSDB will consider the importance of assets, and perform the maintenance with the consideration cost/benefit with regard to risk analysis.			
10	Capital works planning	There is a schedule of proposed capital projects and associated costs based on staff judgment of future requirements.	Projects have been collated from a wide range of 出典 s such as hydraulic models, operational staff, and risk processes. Capital projects for the next 3 years are fully scoped and estimated.	Same as for core level, plus formal options analysis and business case development has been completed for major projects in the 3‐5 year period. Major capital projects for the next 10‐20 years are conceptually identified and broad cost estimates are available.	Long-term capital investment programs are developed using advanced decision-making techniques such as predictive renewal modeling.
		Current situation：Minimum-Core There are replacement plan of AC and CI pipes and related cost schedules, but the plans are not harmonized to budgetary plan. There is no long-term plan.			
		Future Target：Intermediate NWSDB will be able to identify the main demand of replacement in next 10 to 20 years, and understand the required amount of budget and work load. NWSDB will be able to make a replacement plan with the adjustment to budget scale.			

	Asset Management Aspect	Minimum	Core	Intermediate	Advanced
11	Financial management	Assets are valued in compliance with accounting standards and 10-year forecasts, and are generally based on extrapolation of past expenditures.	10-year forecasts are based on asset management data including expected life, renewals, and service levels. Clear underpinning assumptions are stated. Expenditures are classified according to asset management categories.	Asset valuations and revaluations have a high level of confidence. Financial forecasts are tied exclusively to asset management systems.	All financial data have a very high level of confidence. Financial modeling is used to simulate various capital expenditure scenarios and impacts on life- cycle costs and service delivery.
		Current situation：Minimum NWSDB values the asset based on the accounting rule. The future projection seems to be calculated by the extrapolation of past expenditures.			
		Future Target：Intermediate NWSDB will value and revalue the asset confidently. The main future demand of replacement in decades is calculated based on the asset management data.			
12	Asset management teams capability (scope of the Project)	Asset management is allocated primarily to one or two people who have asset management experience.	Coordination occurs through a steering group or committee. Asset management training occurs for primary staff. The executive team has considered options for asset management functions and structures.	All staff in the organization understand their role in asset management, it is defined in their job descriptions, and they receive supportive training aligned to that role. A person on the executive team has responsibility for delivering the asset management policy and strategy.	A formal asset management capability-building program is in place and routinely monitored. The asset management structure has been formally reviewed with consideration of the costs and benefits of options.
		Current situation：Minimum The management of asset is not performed by a group. The staff who assigned the task conducts the database recording.			
		Project Target：Core NWSDB will systematically manage assets based on the guidelines. The executives understand the asset management.			
13	Asset management plans	Asset management plan contains basic information on assets, service levels, planned works and financial forecasts (5-10 years), and future improvements.	In addition, the plan contains an executive summary, description of services and key critical assets, top-down condition and performance description, future demand forecasts, description of supporting asset management processes, 10-year financial forecasts, and 3-year asset management improvement plan.	In addition, the plan contains an analysis of asset condition and performance trends, (past and future) customer engagement in setting levels of service, and risk techniques applied to major programs.	In addition, the plan contains evidence of programs driven by comprehensive Object Database Management techniques, risk management programs, and level of service versus cost trade-off analysis. Improvement program is largely complete with a focus on ongoing maintenance of current practice.
		Current situation：Minimum NWSDB makes asset management plan which contains basic information on assets, service levels, planned works and financial forecasts. It is not sure whether the plan meets a budget plan or not.			
		Future Target：Core The top management of NWSDB will share the target asset management level with the identification of key critical asset, and be able to forecast 10-year financial condition.			

	Asset Management Aspect	Minimum	Core	Intermediate	Advanced
14	Information systems (scope of the Project)	Asset resister can record core asset attributes − size, material, etc. Asset information reports can be manually generated for asset management plan input.	Asset register enables hierarchical reporting (at components to facility level). Customer request tracking and planned maintenance functionality is enabled. System manual reports to be generated for valuation and renewal forecasting.	There is more automated analysis reporting on a wide range of information. Key operations, unplanned maintenance, and condition and performance information is held.	Financial asset and customer service systems are integrated and all advanced asset management functions are enabled.
		Current situation：Minimum Asset resister can record core asset attributes−size, material, etc.			
		Project Target：Core Asset resister will be able to report hierarchically based on the inventory data. The key data will be accumulated in NWSDB and utilized for analysis by use of spread sheet manually.			
15	Service delivery mechanisms	Service delivery roles are clearly allocated (internal and external) generally following historic approaches.	Contracts are in place for external service provision. Core functions are defined.	Internal service level agreements are in place with internal providers. Contracting approaches are reviewed to identify the best delivery mechanism. Tendering and contracting policy is in place. Competitive tendering practices are applied.	All potential service delivery mechanisms are reviewed and formal analysis is carried out. Risks, benefits, and costs of various outsourcing options are considered.
		Current situation：Minimum Service delivery roles are allocated generally following historic approaches.			
		Future Target：Core NWSDB will determine definitions of service delivery in terms of asset management.			

* Guidelines: Guidelines means 1st Draft Asset Management Guidelines in NWSDB. The contents of Guidelines shall be expanded through the project activity.

** Future Target: Middle term target which the project does not assist directly but it is a target to achieve an overall (3 to 5 years)

*** Project Target: The target to achieve the end of project period

Source: The New Zealand Asset Management Support Group 2011. *International Infrastructure Management Manual*.

2.2.6 Achievement

(1) Seminars and Workshops

The knowledge and experiences of Japanese waterworks on Asset Management were shared with NWSDB. The commitment of NWSDB to introduce Asset Management and importance of implementation of renewal works based on the results of renewal prioritization obtained from data analysis were confirmed. In addition, the method for confirming pipeline laying year, which is necessary for calculation of pipeline renewal demand, was decided. Level of achievement is 100% (refer to section 2.2.3 and 2.2.4)

In the training in Japan, Kobe city's experience and present approach were explained, and participants recognized the importance of introduction of a mid-term to long-term perspective at the seminars and discussion opportunities.

(2) Evaluation of Asset Management Implementation

JET conducted assessment at the initial stages of the project and evaluated Asset Management level of NWSDB, then JET shared the target to be achieved with NWSDB. The Important aspect to be achieved on Asset Management were shared.

2.3 [Activity 1.2] Develop a draft of guideline for asset management

2.3.1 Preparation of 1st Draft of Asset Management Guideline

Asset Management Guidelines were prepared for establishing the continuous improvement system of PDCA (Plan- Do- Check- Action) cycle, which consisted of next (1) to (4).

(1) Making decision of starting Asset Management,
(2) Management understands necessity of renewal on the basis of the reported result of renewal demand calculation from RSC,
(3) Management will make a plan and a policy of pipe renewal with the financial basis, and
(4) Steady implementation of pipe renewal.

JET started the preparation of a draft of guideline to meet the ISO 55001 requirements with the consideration of PDCA cycle. The table of contents of the first draft of the Asset Management Guideline is shown below.

Table 2.3.1 Table of Contents of draft Asset Management Guideline

8 Operation
- 8.1 Operational planning and control
- 8.2 Management of change
- 8.3 Outsourcing

9 Performance evaluation
- 9.1 Monitoring, measurement, analysis and evaluation
- 9.2 Internal audit
- 9.3 Management review

10 Improvement
- 10.1 Nonconformity and corrective action
- 10.2 Preventive action
- 10.3 Continual improvement

2.3.2 Analysis and Issues of Implementation of Asset Management at NWSDB

As described above, NWSDB and JET concluded the discontinuity of making Asset Management Guidelines. Until making conclusion, many discussions were held and following issues were identified.

1) The asset management understood by NWSDB was the method of rationally prioritizing sections of pipe renewal in shorter terms. It is far different from the Japanese waterworks' approach to sustain the business stably for the middle- to long-term view.
2) The asset management of pipelines practiced in Japan is to focus on rational replacement of aged pipeline with seismic-resistant one at an affordable level of annual capital investment. In contrast, NWSDB considers much shorter-term pipe renewal plans with due considerations on economic advantage of repairing and continuing use of old pipe versus replacement.
3) Another difference is pipe material. Sri Lanka uses the plastic pipe widely, while Japan mostly uses ductile Iron pipe. As a result, the latter has less experience of the plastic pipe, and it was difficult to provide the basic technical information relating to asset management, e.g., life of plastic pipe.
4) NWSDB wanted to use asset management for identifying the asset which needs to be replaced or repaired. This idea is not only of working-level staff but also of management-level official.
5) However, what both parties seek were the same, that is, to sustain the water supply by keeping healthy infrastructure with appropriate management based on the valuation of current asset.
6) The fundamental lessons of the asset management can be obtained from activities of Output 2 and Output 3.

2.4 [Activity 1.3] Conduct Top Management Meeting (TMM) for formulation of asset management

2.4.1 Objectives and implementation plan for TMM

In order to enhance the asset management in NWSDB, the importance of decision-making at the management level was understood through the seminars and the overseas programme in Japan. As a result, it was decided in the 2nd JCC to regularly conduct Top Management Meeting (TMM). TMM will be an

opportunity for management to make decisions about Asset Management of pipelines associated with the project. At the stage of preparation of TMM, contents of the TMM were expected to include reflection of Asset Management in the medium and long-term policies (the next Corporate Plan) and budgeting based on business priorities. In addition, issues of other Output activities discovered through this process will be included in agenda. GM, Addl. GM, DGM (RSC-WS) and PM (AGM RSC-WS) will be basic members of the TMM.

The 1st TMM was held on 26th November 2019. GM opened the meeting. Then, JET Chief Advisor gave a brief summary of the project and explained the purpose of the TMM. Mr. Rohan (former PM) presented the C/P's concept of Asset Management. Dr. Matushita of the City of Kobe (JICA expert) then presented the proposal for Asset Management introduction in NWSDB. The JET Chief Advisor summarized the conclusions of the meeting as follows:

- Create specialized budget item for pipe replacement as the Asset Management Budget.
- Include the Asset Management Policy in the next Corporate Plan.
- Discuss the Asset Management Policy and objectives of the next Corporate Plan in the next TMM.

Mr. Rohan's presentation included requests for introduction of software and renewal demand forecasting needed for planning short-term pipe replacement program for Asset Management. This showed a divergence from the long-term Asset Management using the excel sheet proposed by the Japanese-side. Each RSC plans and implements works including pipeline repair/replacement within the budget allocated for a year. What RSC needs is a list of existing assets with urgency ranking of repair/replacement to take measures when the budget becomes available.

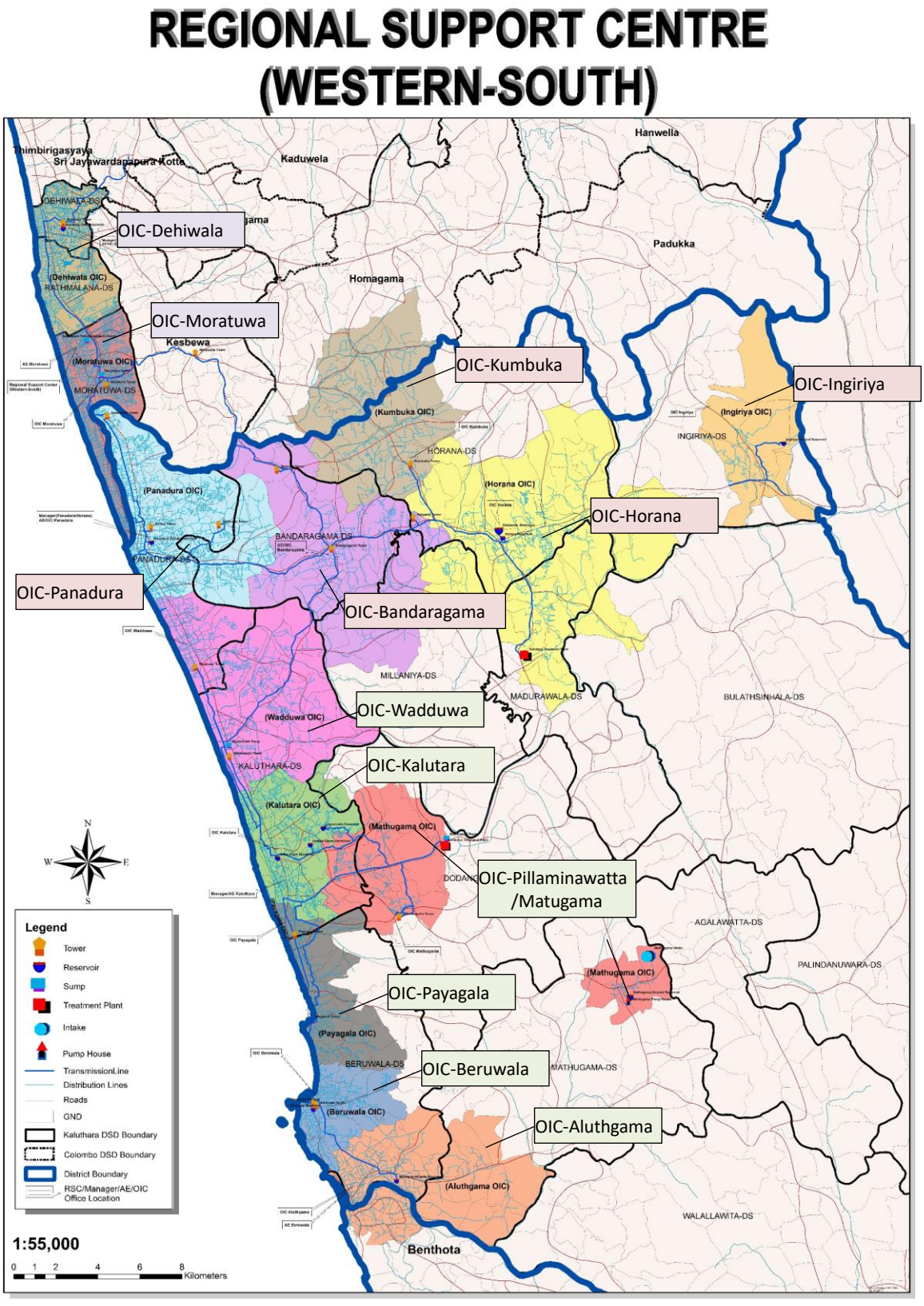
After determining the end of the Output 1 activity, the TMM has not been held, and the corporate plan does not include a description about specific budgeting as asset management.

2.5 Collect necessary data of pipelines for the trial calculation of renewal demand in the pilot site

2.5.1 Status of Data Collection in NWSDB

JET obtained raw data (excel file) of pipeline attributes from the Planning and Design Section (P&D (WS)). The data includes pipeline attributes (pipe material, diameter, laying year, etc.) extracted from the GIS database for the entire RSC (W-S) area. Figure 2.5.1 shows the locations of the RSC (W-S) Officers in Charge (OIC) offices.

Table 2.5.1 Progress of pipeline laying year estimation for the entire RSC (W-S)shows analysis of the "pipeline laying year" attribute input rate for each OIC office.



Source: RSC/WS, NWSDB

Figure 2.5.1 Location of OIC Offices in RSC (W-S)

Table 2.5.1 Progress of pipeline laying year estimation for the entire RSC (W-S)
(as of the end of July 2021)

Manager office	管延長 (m)	AE office	管延長 (m)	OIC office	管延長 (m)	データ入力進捗度 (%)
Dehiwala	729,815	Dehiwala	373,975	Dehiwala	373,975	ー
		Moratuwa	355,840	Moratuwa	355,840	ー
Panadura/Horana	1,236,741	Panadura	460,582	Panadura	460,582	100
		Bandaragama	776,159	Bandaraga	277,003	60
				Horana	291,805	100
				Ingiriya	43,011	100
				Kumbuka	164,340	100
Kalutara	888,656	Kalutara	515,618	Wedduwa	248,559	100
				Kultara	190,370	50
				Mathugam	76,689	100
		Aluthgama	373,038	Aluthgama	117,000	100
				Beruwala	105,101	100
				Payagala	150,937	100

P&D RSC(W-S) has continued the data collection and estimation of pipe laying year for the entire RSC (W-S) managing area. They planned to complete the work by October 2020, but due to the influence of COVID-19 the progress was behind. The importance of this data is fully understood, and data collection continues even after the completion of Output 1 activity. NWSDB plans to carry out the estimation work of the pipeline laying year underway at RSC (W-S) for the entire NWSDB controlled area in the future.

2.5.2 Consideration of Data Items to be Collected

As a result of discussions between C/P and JET, it was confirmed that in addition to pipe laying year, data such as “renewal year for each pipe material” and “unit cost for pipeline renewal” were important factors for calculation of pipeline renewal demand.

Data items to be collected were divided into the following 5 categories. Table 2.5.2 shows the specific data items to be collected.

(1) Specification: laying year, pipe material, joint type, diameter, length, and other specification data.

(2) Incident: leak repair history, complaints history, and other incidental data.

(3) Condition: water pressure, future water demand, and other O&M data.

(4) Cost: fixed asset value (net book value), unit cost for pipeline renewal, leak repair cost, and other cost data.

(5) Others: other data such as map of water supply area.

Table 2.5.2 Data items to be collected for pipeline asset management

No.	CATEGORY	DATA ITEM	SOURCE	CURRENT STATUS	IMPORTANTCE
1	Specification	Laid Year	ArcGIS	○	MANDATORY
2	Specification	Pipe Material	ArcGIS	○	MANDATORY
3	Specification	Joint Type		Not Registered	OPTIONAL
4	Specification	Inner Lining (Cement Lining)		Not Registered	OPTIONAL
5	Specification	Polyethylene Sleeve		Not Registered	OPTIONAL
6	Specification	Diameter	ArcGIS	○	MANDATORY
7	Specification	Pipe Length	ArcGIS	○	MANDATORY
8	Management	Leak Repair Detail	Google Earth Pro	△	MANDATORY
9	Management	Customer Complaint Record	Commercial Operations Manager	Collecting	OPTIONAL
10	Incidental	Distribution Water Quality	Water Safety Plan	△	OPTIONAL
11	Incidental	Water Pressure		Collecting	OPTIONAL
12	Incidental	Future Water Demand	WaterGEMS	○	OPTIONAL
13	Incidental	Hospitals and Public Facilities	Customer Record	Collecting	OPTIONAL
14	Incidental	Ground Condition		Not Registered	OPTIONAL
15	Cost	FAR	Fixed Assets Register	○	MANDATORY
16	Cost	Pipe Renewal Cost	Rate Book NWSDB-2018	○	MANDATORY
17	Cost	Leak Repair Cost	Contractor's Bill	○	OPTIONAL
18	Cost	Public Price List on Labor, Materials	Rate Book NWSDB-2018	○	OPTIONAL
19	Cost	Water Tariff Table of NWSDB	NWSDB Website	○	OPTIONAL
20	Other	Map of Water Supply Scheme	ArcGIS, PDF	△	OPTIONAL

Source: Project Team

2.5.3 Data collection and registration method

Data collection and registration are implemented by the following procedure in P&D (WS) and Area Engineer (AE) Office – Aluthgama (includes Aluthgama, Beruwala and Payagala OIC offices). Figure 2.5.2 shows the location of the AE Office - Aluthgama.

(1) Leak repair and pipe installation data are registered by each OIC offices, on paper, on a daily basis.

(2) Staff at each OIC office inputs the paper data of (1) into the desktop PC. Google Earth Pro (GEP) is used as the digitization tool. The results of mapping are shown in Figure 2.5.2.Leak repair record and Figure 2.5.3 Pipe information, valve locations.

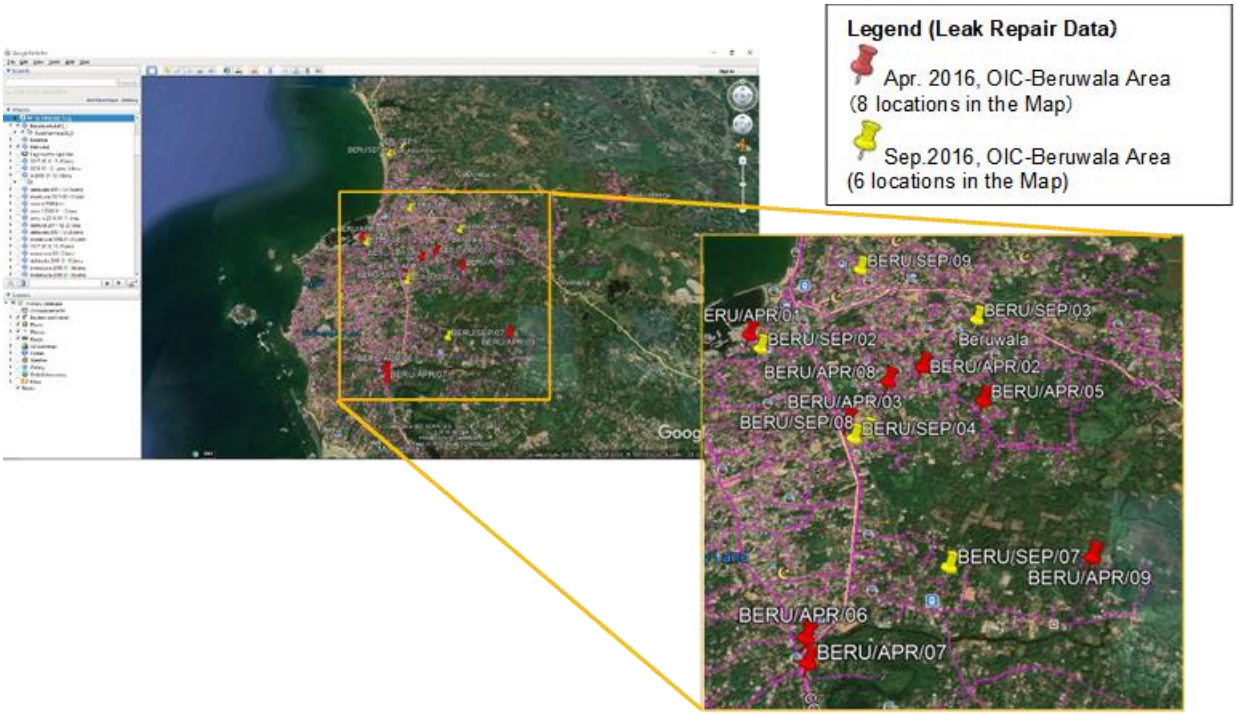
Note: laying year, and ID number of construction were not registered in the GEP data.

(3) Staff at each OIC office sends the electronic data of (2) to the P&D (WS) by email every month.

(4) P&D (WS) staff enter the data received in (3) into ArcGIS every month. At this time, the P&D (WS) staff confirms the pipeline laying year and registers it in ArcGIS.

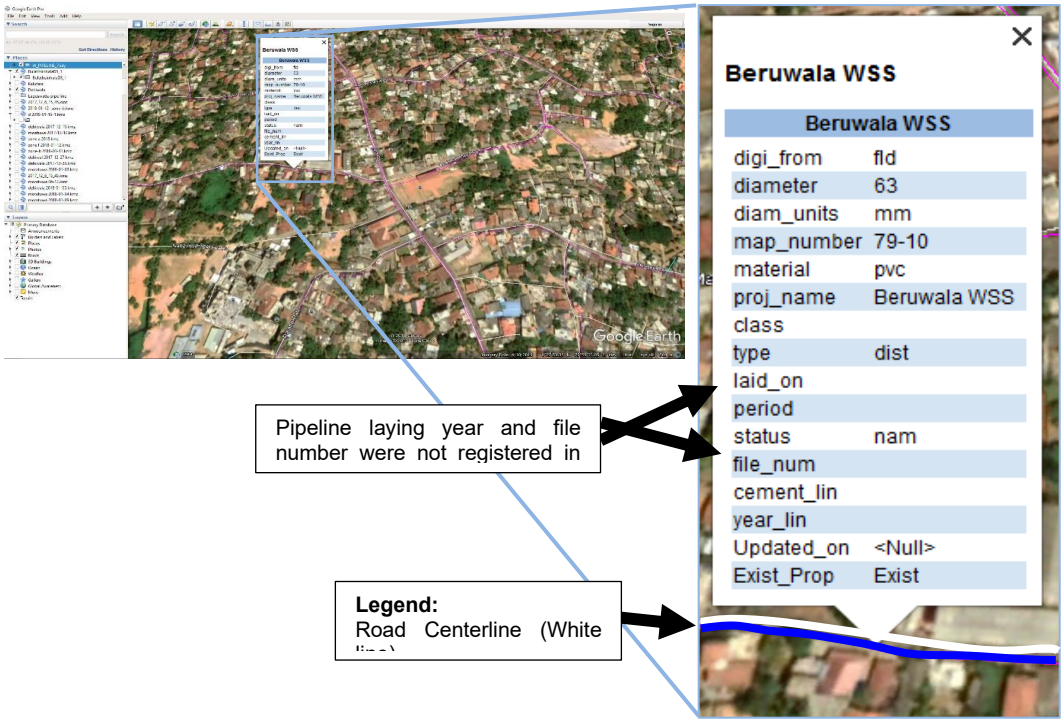
One issue with the current data collection and registration method is that leak repair data are not linked to the pipeline data in the GIS database. By linking the various point data with pipeline data in ArcGIS, “utilization of various data” necessary for calculating pipeline renewal demand becomes possible.

On the other hand, Manager Office - Dehiwala outsources all leak repair works. All repair records are digitized by the contractor and submitted to the OIC office. Accumulating these data over several years and combining them in the GIS database will make them useful for renewal demand calculation.



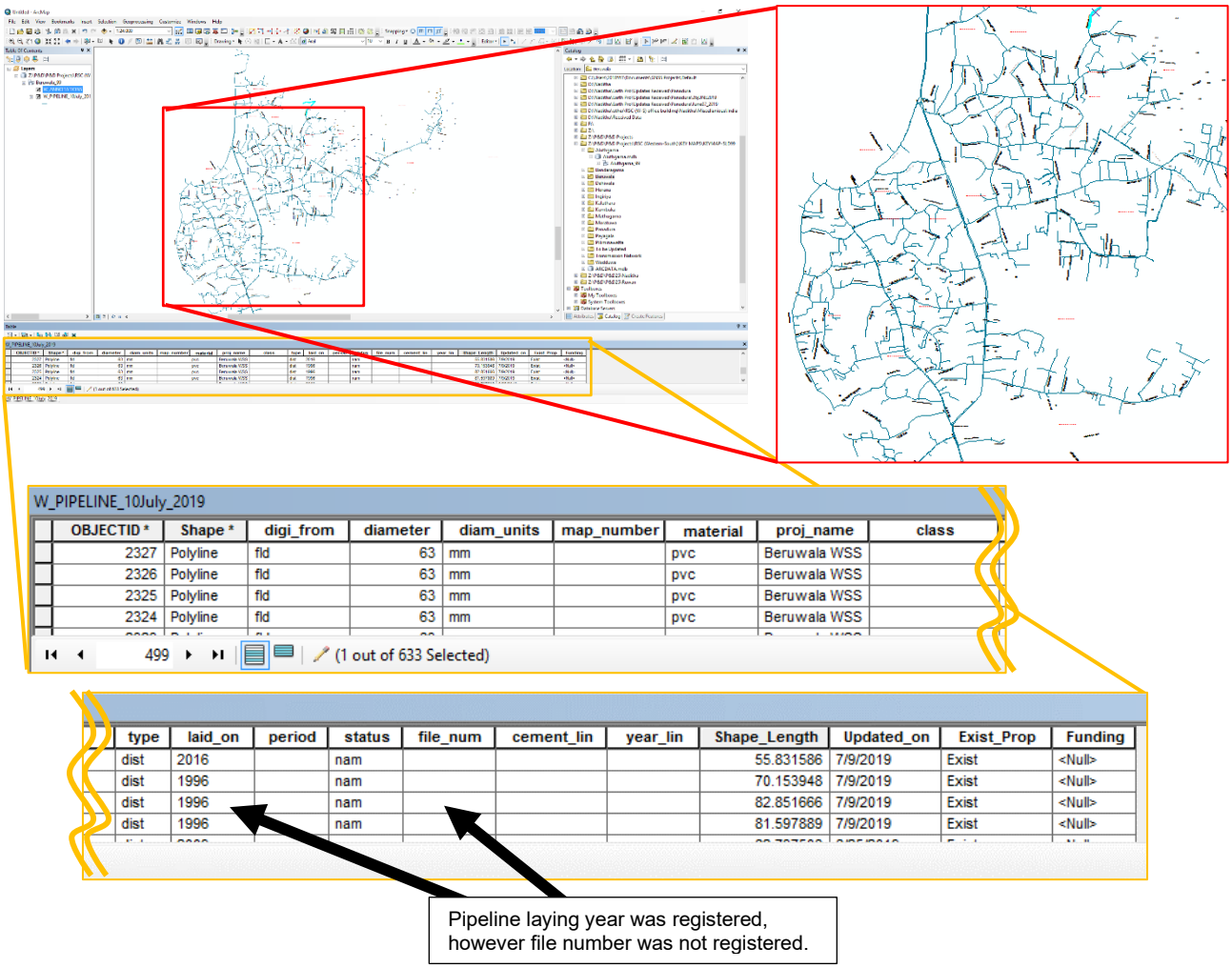
Source: RSC/WS, NWSDB

Figure 2.5.2 Leak repair data showed by GEP



Source: RSC/WS, NWSDB

Figure 2.5.3 Pipeline attribution data registered in GEP



Source: RSC/WS, NWSDB

Figure 2.5.4 Pipeline attribution data registered in ArcGIS database

ADB is implementing the Greater Colombo Water and Wastewater Management Improvement Investment Program (GCWWMIIP) with NWSDB, which supports asset management as one of sub-projects. It started its activities earlier, therefore we have kept contact closely to prevent the overlapping. ADB assists mainly the field of improving GIS of NWSDB, i.e, introduction of ArcGIS to the headquarters of the main system, registration of existing data in the database, establishment of a web GIS system, training of GIS staff at each manager office, etc, as well as procurement of GPS system for accurate measurement of coordinates.

In the series of support of GCWWMIP, the following procedure is planned to be introduced to improve the data collection measures, and the data transfer route will be significantly changed.

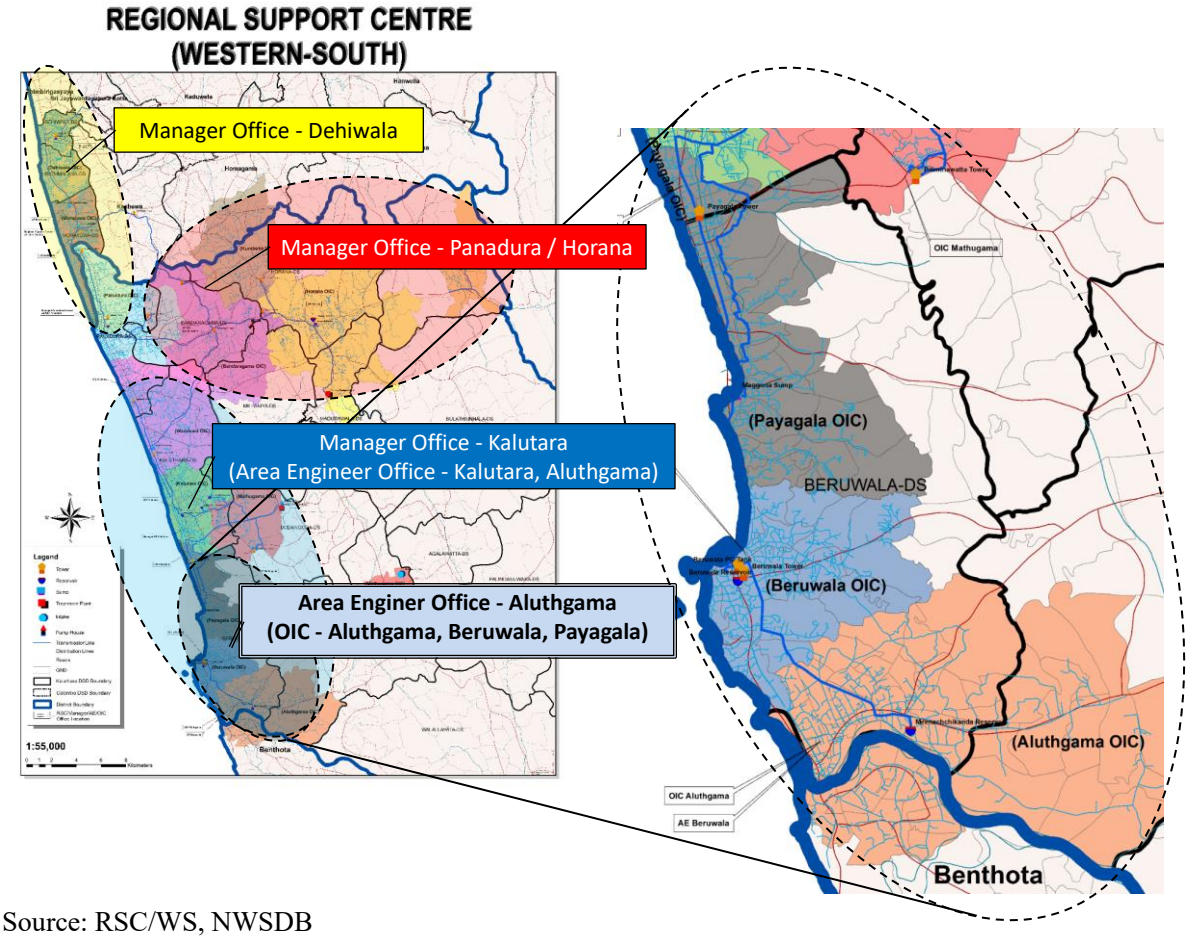
The manager office will be responsible for updating the data from site, but they will not directory perform with the GIS system in Head Office which will be managed by a specialist with careful data verification. The system development was processing as of July 2021, and once it will be completed the new data management procedure will be implemented using the newly organized data path.

JET has proposed the introduction of pipe laying year data as one of the required attribute information and it was reflected in the system.

2.5.4 Characteristics of Pilot Area

Panadura Zone 1 had been selected as the pilot site for both activities of Output 1 and Output 2. However, this area was found unsuitable for Output 1 for practicing the prioritizing the pipe renewal, because most of the pipelines were old and less variety.

On the other hand, in the training in Japan, C/P proposed to set up a pilot site suitable for Output 1 separately, therefore, C/P and JET started looking for the suitable site for Output 1 as the place to calculate the replace demand and put the priority, besides the Panadura Zone 1 would be used for the site of collecting and accumulating the data.



Source: RSC/WS, NWSDB

Figure 2.5.5 Location of manager offices, area engineer offices and OIC offices of RSC (W-S)

Area Engineer Office --Aluthgama (OIC --Aluthgama, Beruwala, Payagala) was selected as the pilot site for Output 1 by the following procedure (See Figure 2.5.6).

(i) C/P and JET compared the NRW rate and the number of leaks for each Manager Office of RSC (W-S), and selected 3 locations that are considered to be highly vulnerable: Manager Office --Dehiwala, Manager Office --Kalutara, Manager Office --Panadura / Horana (See Table 2.5.3 and Figure 2.5.7).

(ii) ii. The most vulnerable location of Manager Office – Dehiwala had had a replacement plan of pipeline by the other project, so that the second vulnerable location of Kalutara was selected.

(iii) Aluthgama (OIC --Aluthgama, Beruwala, Payagala) in Kalutara was finally selected because this was the place of most advanced in the progress of the estimation work of the pipeline laying year by C/P.

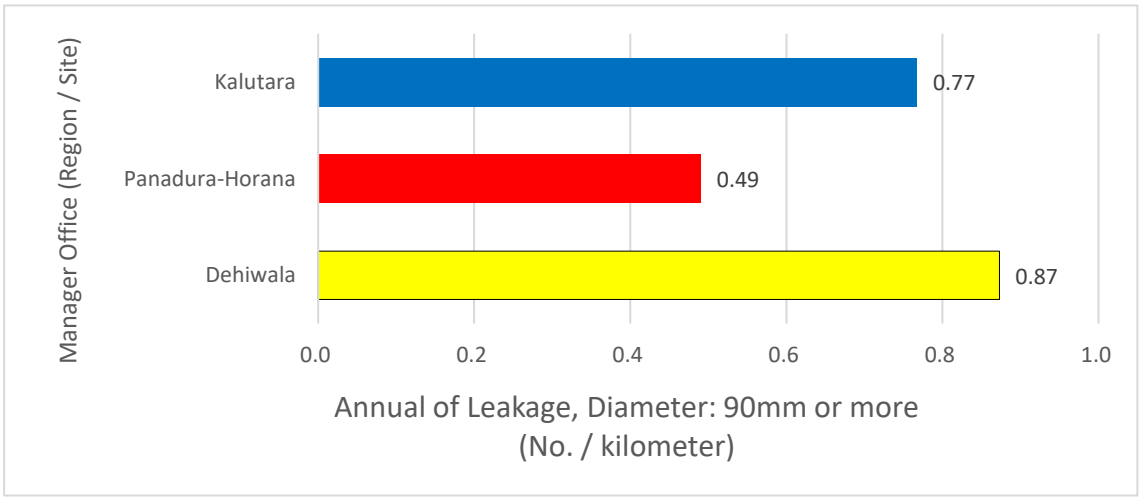
(iv)

Table 2.5.3 NRW rate for each manager office in RSC(W-S) as of Aug. 2018

RSC (WESTERN-SOUTH) - Aug 2018

Manager Office (Region / Site)	No. of Connections (Aug 2018)	NRW (%)	Leaks (Aug 2018) cumulative		Defective Meters (Aug 2018)	Replacing of Defective Meters (up to Aug 2018)		Estimated Bills (Aug2018)
		Aug-18	Reported	Repaired	Nrs.	Progress (Perticular)	Progress (Cumilative)	Nrs.
Kalutara	69,347	16.70	4,817	4,817	266	266	2,076	628
Panadura-Horana	82,899	12.05	3,370	3,370	196	196	898	142
Dehiwala	108,644	25.83	7,732	7,732	619	619	3,447	961
RSC (W-S) Overall	**260,890**	**20.35**	**15,919**	**15,919**	**1,081**	**1,081**	**33,645**	**1,731**

Source: RSC/WS, NWSDB



Source: Based on RSC/WS, NWSDB data. Edited by JET

Figure 2.5.6 Number of occurrence of water leaks per km of pipeline for each manager office in RSC(W-S) for 14 months from July 2017 to August 2018

2.5.5 Achievement

The necessity of data collection work has been recognized by C/P and efforts are underway in 2021 as well.

2.6 [Activity 1-4] Conduct a trial calculation for renewal demand of pipelines in the pilot site

In November 2019, JET held an explanation session for staff of RSC (W-S) and OIC Offices to outline the calculation procedure for pipeline renewal demand (including prioritization of renewal). Sixteen people from NWSDB attended the session. The summary is shown in Table 2.6.1

Table 2.6.1 Outline of the meeting of the Calculation Method for Pipeline Renewal Demand

Date	Afternoon time on 25th November 2019
Venue	RSC(W-S)
Objectives	Explanation of calculation method of pipe renewal demand
Target	C/P and Staff of Asset management-related section
Participants	Project Manager, Output1C/P etc. (16 persons)
Agenda	➢ Opening Remarks Project Manager, Assistant General Manager (Western South) ➢ Current situation of Output 1 Mr. Ono, Asset Management Expert ➢ Explanation 1 Outline of Calculation for Renewal Demand of Pipelines. (1st OJT) Mr. Hayashi, Asset Management Expert ➢ Discussion for setting renewal standard of each material of pipe ➢ Discussion for the pipe materials after pipeline replacement ➢ Explanation 2 Outline for prioritization of Pipeline Renewal (2nd OJT) Mr. Hayashi, Asset Management Expert ➢ Discussion for the information for the prioritization ➢ Summarization
Outcome	JET outlined the calculation method for pipeline renewal demand. Calculation conditions such as renewal year of pipe, pipe material, and parameters for prioritization were discussed. ➢ C/P generally agreed with the proposed renewal year of pipelines. ➢ The pipe material after renewal is set as HDPE for distribution line and DI for transmission line. ➢ C/P decide on the parameters for prioritization of pipe renewal based on NWSDB's experience.

JET explained the calculation method according to the flow shown in Figure 2.6.1 and the calculation conditions such as the installation years of the pipeline, the pipe material for replacement, and the parameters for prioritization were discussed.

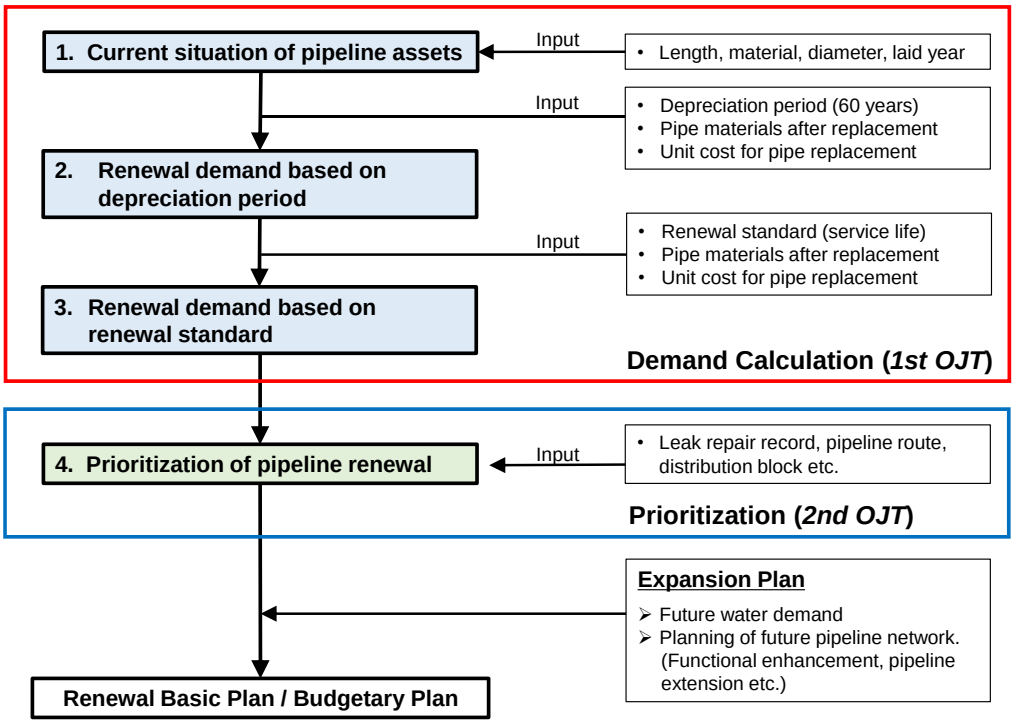


Figure 2.6.1 Flowchart of calculation for renewal demand of pipelines, including setting of priority of renewal

2.7 Summary of Output 1 Activities

The Output 1 activity ended with completion of sharing the policy and implementing method of asset management in Japan. The project concentrated into the activities of Output 2 and Output 3 afterward, and following results connected to asset management have been obtained.

1) The technical transfer has been done from the viewpoints of evaluation of the vulnerability of pipelines, cost/benefit analysis of pipeline repair, and data collection that will be necessary for asset management in the future.

2) Above results in Output 2 were introduced into the new training module and the Output 2 members became the RP to teach it based on their experience. The knowledge obtained at the site will be transferred to the other NWSDB staff members.

3 Contents and Result of Activities in Output 2

Output 2: Capacity for leakage control is enhanced in the pilot activity site.

The activities carried out to achieve the Output 2 and the results are described below.

3.1 [Activity 2.1] Develop a work plan for enhancement of the existing leakage control works in the pilot activity site

3.1.1 Policies for preparation of a work plan

In formulating the work plan for water leakage control, the following three basic policies were established.

- Shows the steps necessary for NWSDB to understand the relation between water leakage countermeasures and non-revenue water reduction and to compare the effects of water leakage countermeasures with quantitative indicators.
- Organize the process for improving management of water leakage control basing on the PDCA cycle.
- Clarify the methods related to water leakage countermeasures in the flowchart.

3.1.2 Work plan

(1) Preparation process of the work plan

The following facts were confirmed through collecting the existing information when the project start.

- There is no official document in NWSDB that specifies the procedure and method of water leakage countermeasures.
- There is no material corresponding to the activity plan draft at the pilot site of this project.

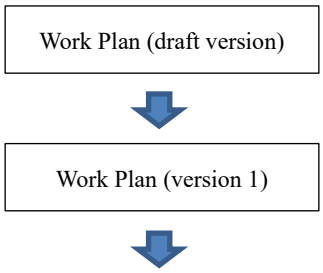
Therefore, Japanese Expert Team (JET) and NWSDB collaborated to prepare a provisional work plan before the start of pilot activities.

This work plan was considered as a guideline that clarified the specific activity procedure of Output 2 at the selected pilot site.

The conventional countermeasures for water leakage implemented in RSC W-S have been limited to "passive ground leak countermeasures" based on reports from residents and irregular reports from field staff. Therefore NWSDB pointed out that it is necessary to promote more aggressive water leakage reduction activities starting with this Project.

In creating the work plan, JET emphasized the practice of "active countermeasures for underground water leakage" and aimed to improve the efficiency of countermeasures, identify and establish effective activities through practical work in OJT format with JET.

The preparation process of the work plan is as shown below: .



・Provisional plan after selection of pilot site

・Table of contents structure according to PDCA cycle

・Reflects the results of DMA4 activities started in November 2018.

・Evaluate the effect of water leakage reduction measures by the degree of improvement in the non-revenue water ratio.

・Reflects the results of DMA5 activities started in June 2019.

・Reflects the results of DMA3 activities started in June 2020

・Clarified future work contents along with progress in all DMAs as of May 2021.

・Evaluated the effect of leakage reduction measure by the change of Minimum Night Flow.

・Determined the document name as "Work Plan & Progress of Pilot Activity for Enhancement of Leakage Control Capacity".

Figure 3.1.1 Preparation process of the work plan

Table 3.1.1 Contents of the work plan (draft version)

Contents
1. Management method of pilot activity
1.1 Purpose of the work plan
1.2 Management Method of the work plan
1.3 Target area of the pilot area
1.4 Related organization
2. Strategy of pilot activities
3. Management of pilot activities by PDCA
3.1 Plan
3.1.1 Target setting
3.1.2 Collection of data
3.1.3 DMA planning
3.1.4 Activity planning
3.2 Do
3.2.1 Preparation work for DMA creation
3.2.2 Field work for DMA creation
3.2.3 Collection of customer data
3.2.4 Commercial loss
3.2.5 Physical losses
3.2.6 Leakage repair work
3.2.7 Re-measurement after leakage repair works
3.3 Check (Evaluation)
3.3.1 Evaluation
3.4 Action
3.4.1 Reflecting the evaluation result

(2) Selection of the Pilot Site

As a result of discussions between JET and RSC W-S, both parties agreed that the pilot site to practice the activities for Output 2 would be selected according to the following four criteria.

- The safety of JET and RSC-WS staff can be ensured when carrying out activities.
- Easy to move from the project office to the site.
- The effect of water leak countermeasures can be expected from preliminary data such as non-revenue water and frequency of water leaks.
- It is not difficult to hydraulically separate the distribution pipe network.

As a result, from the three candidate sites shown below, the area called Zone 1 under the control of OIC Panadura was considered to be the most appropriate, and this area was selected as the pilot site.

Table 3.1.2 Candidate site for pilot site

Items	1	2	3 (selected)
Manager office	Kaluthala	Dehiwala	Panadura-Horana
OIC (Office in charge)	Payagala	Moratuwa	Panadura
Area name	Maggona	---	Zone 1
Number of connections	3,000 approx.	5,000 approx.	7,000 approx.
NRW ratio of OIC	Less than 20% [B]	Less than 10% [C]	Less than 15% [B]
Pipeline	Relatively new system	Relatively new system	Relatively old system (more than 40 years)
Frequency of leakage	Medium [B]	Low [C]	Medium [B] (High risk (Old Pipe))
Accessibility between RSC and Project office	45km / 1 hour [C]	0km / 3 min. [A]	8km / 20 min. [A]
Easiness for isolation to DMA	Relatively easy to isolate into 2/3 DMAs [A]	Relatively difficult, Need flow meter and valves [C]	Relatively easy to isolate into 1/2 DMAs, Need flow meter and valves [C]
Water supply hours	24 hours	24 hours	24 hours

[A]: High effect of implementation and convenience, [C]: Not high, [B]: Between [A] and [C]
Source: Project Team

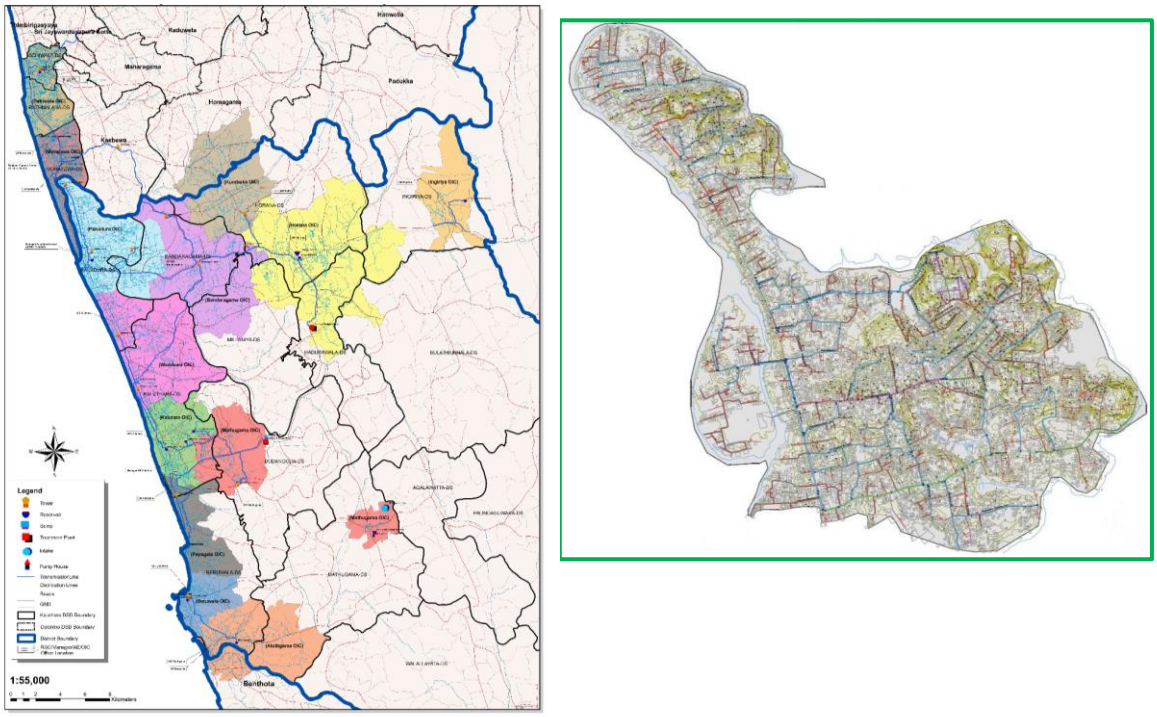
Table 3.1.3 information of pipeline of the selected pilot site

DN	Material	Extension	Ratio
50mm	PVC	911.9m	2.7%
63mm	PVC	3,012.6m	8.8%
90mm	PVC	18,561.2m	53.9%
110mm	PVC	2,528.4m	7.4%
160mm	PVC	4,232.2m	12.2%
225mm	PVC	1,056.6m	3.1%
250mm	DI	886.9m	2.6%
400mm	DI	705.3m	2.1%
450mm	DI	311.6m	0.9%
500mm	DI	1,942.4m	5.6%
DN not specified		236.7m	0.7%
Total		34,385.8m	100.0%

Source: Calculated from existing drawings and GIS data

Table 3.1.4 Information of clients of the selected pilot site

Category	No. of connection	Ratio
Domestic	6,378	93.4%
Poverty house	117	1.7%
School	6	0.1%
Commercial facility	300	0.1%
Religious facility	10	0.2%
Government institution	12	0.1%
Other	5	100.0%
Total	6,828	
Population	63,952	person
Population/Household	9.85	person



Source: RSC/WS, NWSDB

Figure 3.1.1 Pilot area location map

(3) Establishment of District Metered Areas (DMAs)

At the start of the pilot activities, in order to carry out the leak investigation efficiently and effectively, JET and RSC W-S adopted a method of separating the area as a distribution control district.

This distribution control district is called DMA (District Metered Area) which makes it possible to control the amount of water supplied by a flow meter.

In the case of Japan, DMA is called a leak control area, and it differs slightly in that the water distribution control section in Japan is composed of several DMAs.

The following effects can be expected by advancing the activities for each DMA.

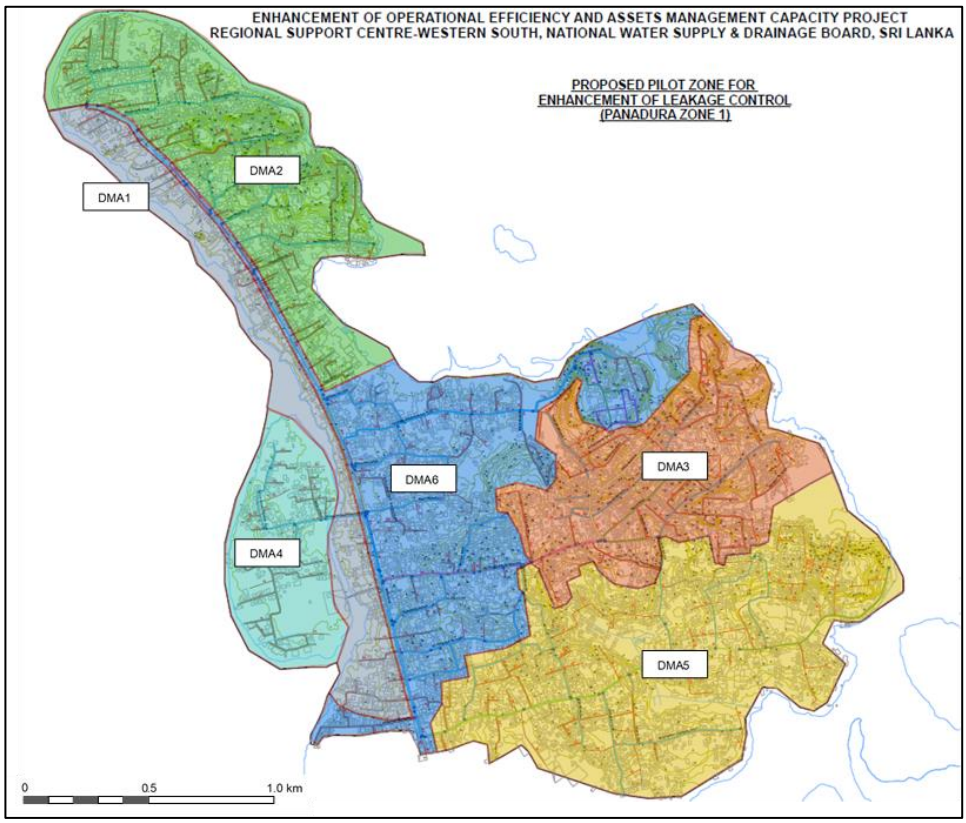
- Flow rate can be measured for each hydraulically independent section, making it easier to identify areas where water leaks occur.
- The effect of reducing water leakage can be quantitatively grasped since the amount of inflow water in the section is measured accurately.
- The area subject to water outage can be reduced during leak investigations and repairs.
- By repeating the activity with multiple DMAs, the application power under different conditions will be strengthened.
- By comparing the amount of water used in the DMA with the amount of inflow water, an accurate non-revenue water ratio can be calculated on a monthly basis.

JET proposed to divide the pilot site into 6 DMAs, and agreed with C/P at the meeting in February 2019 after confirmation of the pipeline layout, caliber, topography, elevation difference, etc. of the target area from existing documents.

In the DMA separation work, it is necessary to clarify the difference from the pipeline information on the figure while actually operating the sluice valve at the site.

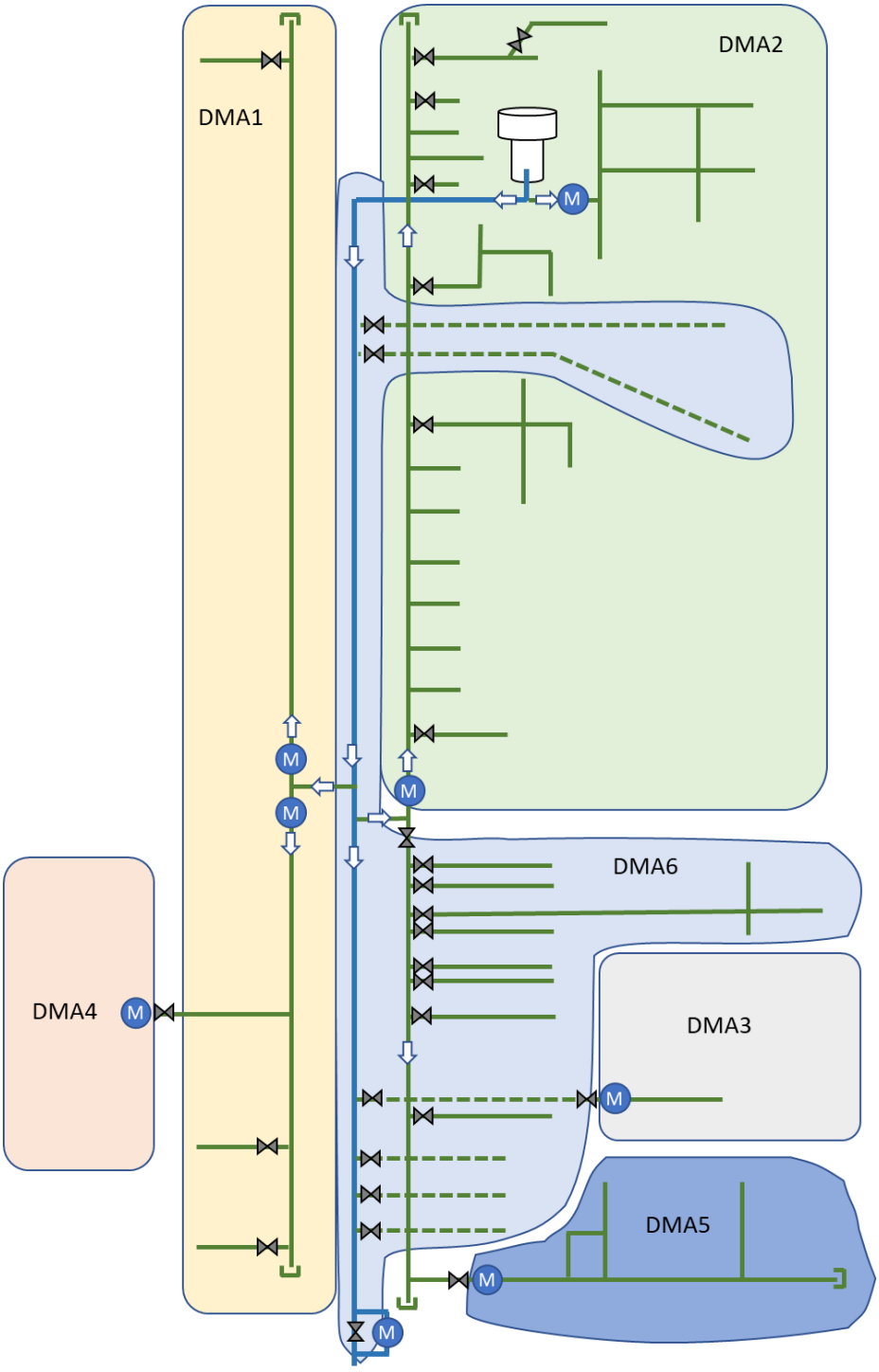
Since the boundaries to the DMA assumed on the drawing at the beginning are corrected as the project activity progresses, the DMA division diagram is updated frequently.

The final constructed DMA and boundaries are as shown below:



Source: Project Team

Figure 3.1.2 DMAs in the pilot site



Source: Project Team

Figure 3.1.3 Schematic of DMA division

3.1.3 Achieved Contents

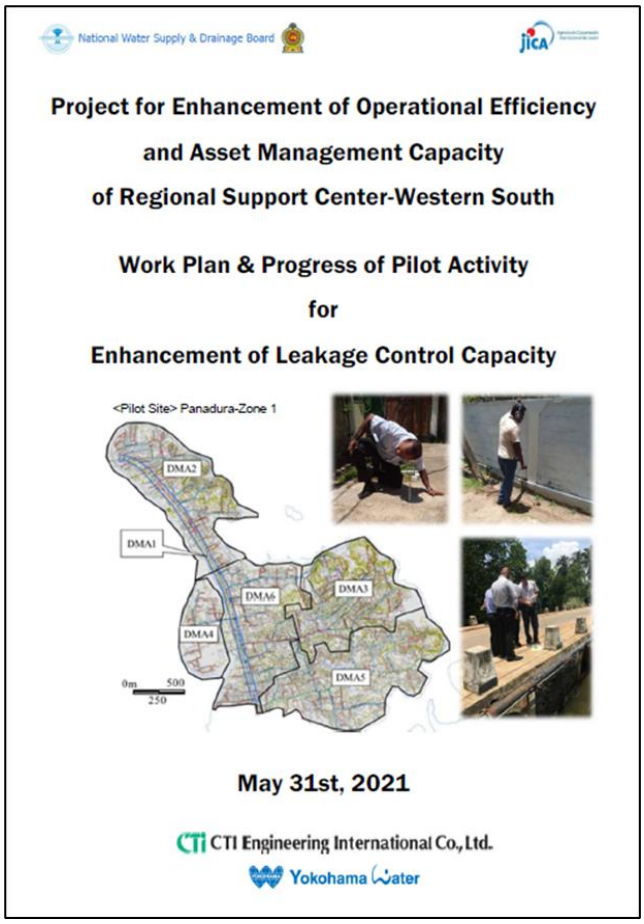
After the draft version was prepared, the work plan was revised in consideration of the activity status of DMA4, the first activity area in the pilot area, and the first version was prepared in July 2019.

After that, based on the water pipe information of all DMAs, the second version of the work plan was prepared in May 2021 after clarifying the water leakage countermeasure process applied to each DMA while advancing the boundary setting.

The local activities of JET related to Output 2 were completed in early June 2021. Subsequent work such as leak detection and repair, and evaluation based on quantitative indicators was left to the self-help efforts of the C/P side.

The second version of the work plan is named "Work Plan and Progress Report of Pilot Activities", and in addition to the progress so far, future activity procedures are specified in detail. This document, together with the separately prepared leak control procedure manual, helped to carry out the activities efficiently.

Achievement of work plan preparation is 100%.


National Water Supply & Drainage Board

JICA

Project for Enhancement of Operational Efficiency and Asset Management Capacity of Regional Support Center-Western South

Work Plan & Progress of Pilot Activity for Enhancement of Leakage Control Capacity

<Pilot Site> Panadura-Zone 1

May 31st, 2021

CTI Engineering International Co., Ltd.

Yokohama Water

Contents

Figure 3.1.2 Contents of the Work Plan (2nd version)

At the beginning of the project, C/Ps had already mastered the technique necessary to manage the leakage appeared at the ground surface, but less skilled to search efficiently and effectively for invisible underground leakages. JET revised the work plan to stipulate a quantitative method for making subsectors in a complicated pipe network, flow rate and water pressure measurement, and evaluation of the vulnerability of pipe network. It contributed the strengthening the technical capabilities of C/P.

3.2 [Activity 2.2] Implement OJT for leakage control works, such as leakage survey and repairs, including preparation, hydraulic separation, flow measurement, leakage survey and repairs, monitoring and evaluation

3.2.1 Policy for OJT activities

Along with the preparation of the work plan, the OJT activity policy was discussed with the C/P, and it was agreed to proceed with the activities while paying attention to the following points.

[Purpose of OJT]

NWSDB's RSC-WS staff will be able to efficiently implement measures against underground leaks through learning the techniques required for DMA management, leak detection, operation and maintenance of

detection equipment, leak repair, measurement of leak reduction, cost-effectiveness analysis of activities carried out, and leak monitoring.

[Target person of OJT]
Mainly OIC Panadura staff and RSC W-S engineers who have jurisdiction over the OJT pilot site. However, by encouraging participation from other OICs, JETs aim to disseminate the technology of NWSDB throughout the organization.

[Expected impact of OJT]
Strengthen collaboration between RSC W-S and MD&TD and contribute to improving the quality of practical training at training centers.

3.2.2 Target Person of OJT

The staff who participated in the OJT activities are as follows, but some of them participate only in regular meetings.

Table 3.2.1 Members of C/P related to Output 2

Name	Organization	Positon
Ms. Nalayini Goonewardana	AGM RSC W-S	・Project Manager of C/P side ・General management of the entire activities and decision making
Ms. Samudi Nirasha	P&C Manager, RSC W-S	・Team leader of Output 2 ・ Planning of activities and budget management ・Evaluation of progress of activities ・Summarizing reference data
Mr. Prasantha Somarathna	P&C Engineer, RSC W-S	・Collection of NRW data ・Collection of GIS data ・Technical support for OIC Panadura
Mr. Ajith Alwis	P&C Engineer, RSC W-S	・Collection of NRW data ・Collection of GIS data ・Technical support for OIC Panadura
Ms. Madushi Prasanthika	E A P&C	・Assistance for team leader
Ms. K Iresha Hemanthi	E A P&C	・Assistance for team leader
Mr. Chandana Epa	Chief, OIC Panadura	・Management of local activities in the pilot site
Mr. Janaka Karunamuni	Zone Officer, OIC Panadura	・Responsible person of pilot of local activities the pilot site
Mr. S.T.D.O. Aapiti	Acting Manager Panadur-Horana	・Backup support
Mr. Warapitiya	Area Engineer, Panadura	・Backup support

Source: JET

3.2.3 Schedule of the entire activities

This project is divided into the following two terms, and the DMAs targeted for activities are different for each. Although the activities in each period are continuous, the rapid spread of the COVID-19 infection from the beginning of 2020 has restricted the activities of JET from March to August 2020.

These 6 months were the transition period until the start of the 2nd term, and the work was carried out by the self-help efforts of the C/P side, but the activities tended to be stagnant due to the restrictions of the activities due to strong lockdown and so on.

Table 3.2.2 Target area and its activity items

Phase	Period	Target area	Principal activities
Term 1	From September 2018 to February 2020	DMA4 DMA5	・Construction and sub-zoning of DMAs ・1st Step Test ・Identification of area to be attended with high priority ・Leak detection and repair ・2nd Step Test ・Evaluation of NRW ratio ・Cost/Benefit Calculation
Transition period	From March 2020 to August 2020	DMA4 DMA5	・Revision of the work plan basing on the results of Term 1 ・NRW monitoring in DMA4 and DMA5
		DMA3	・Construction and sub-zoning of DMA ・Replacement of valves
Term 2	From September 2020 to October 2021	DMA3	・Preparation of water supply pressure distribution ・1st Step Test ・Leak detection and repair ・2nd Step Test ・Identification of area to be attended with high priority ・Construction of the remote monitoring system ・Evaluation of NRW ・Evaluation of Minimum Night Flow ・Cost/Benefit Calculation
		DMA1	・Construction and sub-zoning of DMA ・1st Step Test ・Modification of sub-zoning plan, replacement of valves ・2nd Step Test ・Identification of area to be attended with high priority ・Leak detection
		DMA2	・Construction and sub-zoning of DMA ・1st Step Test

Phase	Period	Target area	Principal activities
			・Identification of area to be attended with high priority
		DMA6	・Sub-zoning of DMA ・1st Step Test ・Identification of area to be attended with high priority
		DMA5	・Construction of the remote monitoring system

The activity schedule for each DMA is shown below.

Table 3.2.3 Pilot activity schedule in Term-1

Items	2018																2019																																																2020							
	Sep				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				June				July				Aug				Sep				Oct				Nov				Dec				Jan				Feb			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
DMA4																																																																									
Construction of DMA and Sub-zoning										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																																																
Data collection about billed water/unbilled water																						■	■	■	■																																															
Confirmation of customer meter location																						■	■	■	■																																															
Measurement of inflow volume																							■																																																	
Step test / Measurement of MNF																										■																	■		■																											
House-to-house survey																												■																																												
Road surface survey																													■														■																												
Pin-point leak survey																														■													■																												
Leak repair																														■	■	■											■																												
Customer meter accuracy test																										■	■																																												
Cost/Benefit Calculation																																											■	■	■	■	■	■	■	■	■																				
DMA5																																																																									
Construction of DMA and Sub-zoning																														■	■	■										■	■	■	■																											
Data collection about billed water/unbilled water																																																							■	■	■	■	■	■	■	■	■	■								
Confirmation of customer meter location																																																																									
Measurement of inflow volume																																																																									
Step test / Measurement of MNF																																																			■																	■				
House-to-house survey																																																								■	■	■	■	■												
Road surface survey																																																											■	■	■	■	■									
Pin-point leak survey																																																													■	■	■									
Leak repair																																																												■	■	■	■	■								
Cost/Benefit Calculation																																																																					■	■	■	■

Table 3.2.4 Pilot activity schedule in Term-2 including the transition period

Items	2020																																								2021																															
	Mar				Apr				May				June				July				Aug				Sep				Oct				Nov				Dec				Jan				Feb				Mar				Apr				May				June				July				Aug			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
DMA3																																																																									
Construction of DMA and Sub-zoning															■	■	■	■	■	■	■	■	■	■	■	■	■	■																																												
Data collection about billed water/unbilled water																	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
Confirmation of customer meter location																																																																								
Measurement of inflow volume																													■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Step test / Measurement of MNF																													■																														■													
Construction of the remote monitoring system																																																					■																			
House-to-house survey																																													■	■	■	■	■	■	■	■																				
Road surface survey																																																	■	■	■	■	■	■																		
Pin-point leak survey																																																			■	■	■	■																		
Leak repair																																																			■	■	■	■	■	■	■															
Customer meter accuracy test																																																										■	■	■	■											
Cost/Benefit Calculation																																																						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
DMA1																																																																								
Construction of DMA and Sub-zoning																			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																																				
Measurement of inflow volume																																																																								
Step test / Measurement of MNF																																																		■					■																	
Additional work for Sub-zoning																																																					■	■																		
Identification of high pripríty area																																																								■	■															
House-to-house survey																																																													■	■	■									
Road surface survey																																																													■	■	■									
Pin-point leak survey																																																																								
Leak repair																																																																								
Cost/Benefit Calculation																																																																								
DMA2																																																																								
Construction of DMA and Sub-zoning																																				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																				
Measurement of inflow volume																																																							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Step test / Measurement of MNF																																																								■																
Identification of high pripríty area																																																									■	■														
House-to-house survey																																																																								
Road surface survey																																																																								
Pin-point leak survey																																																																								
Leak repair																																																																								
Cost/Benefit Calculation																																																																								
DMA6																																																																								
Planning of Step Test																																																				■	■	■	■	■	■															
Trial measurement of inflow																																																					■																			
Step test / Measurement of MNF																																																											■													
Identification of high pripríty area																																																												■												
House-to-house survey																																																																								
Road surface survey																																																															■									
Pin-point leak survey																																																															■									
Leak repair																																																															■									
Cost/Benefit Calculation																																																																								
DMA5																																																																								
Construction of the remote monitoring system																																																							■																		
Monitoring of MNF																																																								■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

3.2.4 Achievements brought about by OJT activities

(1) Enhancement of skills

The following are the evaluations at the end of the project regarding the strengthening of the technology necessary to implement underground water leakage countermeasures efficiently and effectively in accordance with the OJT objectives confirmed at the time of formulating the work plan.

Table 3.2.5 Achievements brought about by OJT activities

No	Skills to be learned	Achievement
1	DMA construction and sub-zoning planning	・C/P has become able to extract / organize information from pipeline drawings and make DMA plans. ・C/P has been able to investigate existing valves and flow meters and accurately grasp their defects. ・C/P now has an accurate understanding of the conditions to be considered in DMA planning. ・C/P has become able to propose alternative methods for DMA conversion in water pipe networks (DMA6) that cannot be completely hydraulically separated.
2	Data collection at the start of water leakage reduction activities	・C/P understood that accurate information such as pipeline length, non-revenue water ratio, number of customers, etc. is indispensable for analysis of success or failure of activities and cost effectiveness. ・While the existing database is not well maintained, C/P is now able to collect and accumulate information by its own efforts.
3	Pressure drop test	・C/P understood the importance of water pressure measurement when confirming the DMA boundary. ・C/P is now able to measure long-term water pressure using a data logger. ・C/P understood the factors of water pressure fluctuation during daytime and nighttime, and the relation between flow rate and water pressure. ・C/P has become able to estimate water pipe network anomalies using water pressure drop test results
4	Measurement of the amount of water flowing into the DMA.	・C/P is now able to measure the amount of inflow water using an ultrasonic flow meter. ・C/P is now able to evaluate the accuracy of existing bulk meters using an ultrasonic flow meters. ・C/P is now able to understand the differences in the mechanism of turbine flowmeters and ultrasonic flowmeters, and the advantages / disadvantages of these meters. ・C/P learned how to use an insertion type electromagnetic flowmeter
5	Measurement of Minimum Night Flow (MNF)	・C/P has been able to set the measurement time according to the scale of DMA. ・C/P is now understood the importance of flow measurement intervals according to the purpose of use. ・C/P is now understood factors other than water leakage contained in MNF.

No	Skills to be learned	Achievement
		・C/P is now able to select the MNF value appropriately from data with large flow rate fluctuations and compare it with the entire DMA.
6	Step Test	・C/P is now able to identify the valves that need to be operated according to the sub-sector division diagram and specify them in the work procedure manual. ・C/P is now able to estimate the amount of inflow water for each subzone by utilizing the measurement results at the site. ・C/P is now able to judge the validity of the test result based on the valve operation information at the time of performing the step test.
7	Calculation of indicators necessary to identify prioritized area for leak reduction	・C/P is now able to identify priority areas using MNF and customer count data. ・C/P is now able to identify priority areas using MNF and pipeline extension data.
8	House-to-house survey	・Although the OIC Panadura staff had experience at the time of starting the project, there was need for improvement in work efficiency. ・While working on-site in collaboration with JET, C/P has seen improvements in team formation and survey speed, enabling efficient work at the end of Term 1.
9	Road surface survey	・The OIC Panadura staff had experience at the time of starting the project. ・The support of the JET was intended for a wide range of staff, including assistant workers, and technical assistance was completed up to the use and maintenance of the equipment procured in the project. ・The level of the road surface sound survey of C/P was sufficient, and minute water leakage noise could be detected without any problem.
10	Pin-point leak survey	・The know-how of leak location identification survey using a boring bar and a hammer drill was transferred from JET. ・Boring techniques are used in all DMA leak detection tasks to pinpoint location.
11	Customer meter accuracy test	・The accuracy test of customer meter in DMA4 was conducted and the technology was transferred to C/P. ・The accuracy test was conducted only on one flow band. In the work plan (2nd version), a comparison with the instrumental error curve of the water meter was shown, and the procedure of 3-point calibration was understood by C/P through the study session.
12	Leak repair	・The leak repair technique was at a sufficient level, and there were no problems with the quality of the materials that C/P used. ・Although the records associated with the repair work and its management system were inadequate, the format of the leak repair records was improved through the project activities, and all leak repairs carried out in the pilot area are now recorded. ・At the start of the project, there was a lack of understanding of the method for calculating the amount of water leakage, but C/P learned how to estimate the amount of

No	Skills to be learned	Achievement
		water leakage reduction as a daily average value using changes in water pressure fluctuation trends and minimum night flow.
13	Recording and database of leak repair data	・OIC Panadura staff and RSC-WS staff have begun efforts to understand the importance of leak repair records in water distribution network evaluation and calculation of renewal demand, and to reflect them in the database.
14	Calculation of NRW	・C/P understood the components of non-revenue water, how to calculate it, and how to collect the data needed to calculate the amount of water billed. ・C/P understands the error in the non-revenue water rate resulting from the difference between the meter reading interval of the customer meter and the meter reading interval of the bulk meter. ・C/P understood that it is necessary to evaluate the non-revenue water rate by comprehensively judging not only the monthly average value but also multiple numerical values such as the daily average value, the 3-month average value, and the 6-month average value.
14	Remote monitoring techniques	・Using DMA3 and DMA5 as test cases, the existing bulk meter was updated to an electromagnetic water meter. ・C/P understood the mechanism of the electromagnetic water meter and the mechanism of converting the flow rate into a pulse signal. ・C/P has learned how to build an inexpensive monitoring system that utilizes a mobile phone network, and has become able to set up a logger with a modem and perform daily maintenance. ・C/P is now able to monitor daily nighttime minimum flow changes using flow / water pressure data stored on a web server. ・C/P has been able to instantly grasp abnormalities in daily water distribution and water pressure using remote monitoring, and DMA3 realized quick leak repair.

(2) Cost/benefit of OJT

1) How to calculate the Cost/Benefit value

Water pipes deteriorate over time due to the effects of aging, corrosion, external forces, etc., and water leaks from all parts of the pipes. Unless the water pipe is completely renewed, new water leaks will occur in the surrounding area even if repairs are carried out. This is called Leakage Recurrence.

The same can be said for the amount of non-revenue water or water leakage reduced through pilot activities, so it will gradually return to the original level immediately after the end of the activity.

For example, assuming a period of 3 years for the reduced leak to return to its original level, the benefits obtained up to that point correspond to the amount of water in the range of the triangle below. The actual leak restoration does not occur linearly, but here JET and C/P adopt this idea to facilitate the calculation.

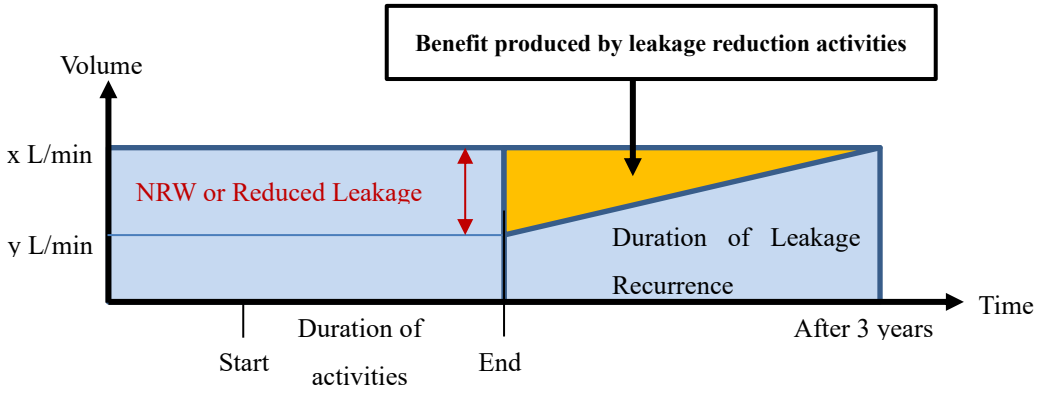


Figure 3.2.1 Concept of Cost/Benefit Calculation

Benefit = Production cost of drinking water × Reduced leakage volume × Duration of effect × 1/2

2) NRW of DMA4

The baseline of DMA 4 at the start of activities was 23.5%.

The total activity period is about 5 months, and the non-revenue water rate in August 2019, when a series of leak repairs were completed, dropped to 9.4% with a decrease of minus 14.1 points.

The purpose of this pilot activity is to enhance the capacity of water leakage reduction. JET and C/P adopted NRW ratio as the evaluation indicator of DMA4 since NRW ratio is one of the business performance indicators adopted by NWSDB.

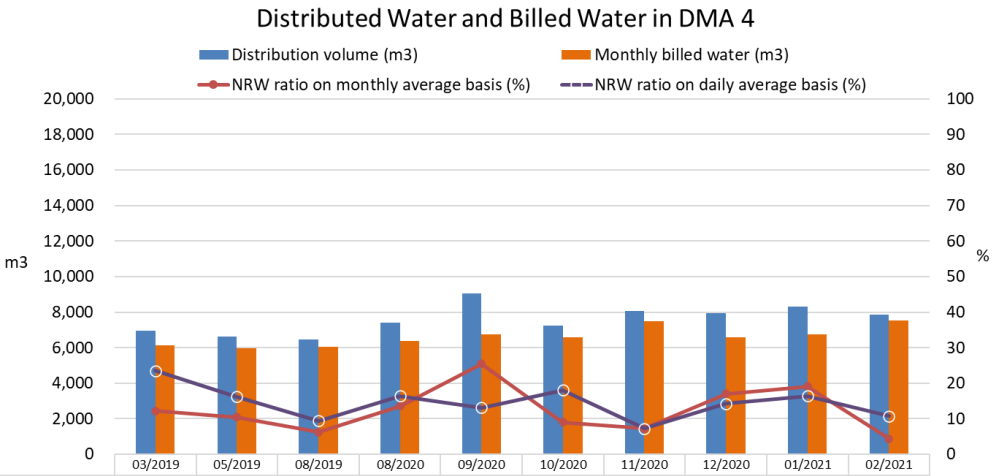
In this area, no connection suspected of stealing water was found during listening, and from C/P's experience, it is considered that there is no use of water with illegal connection, and the decrease in non-revenue water amount is almost the same as the decrease in water leakage amount.

Even after the end of the activity, no significant increase in the non-revenue water rate has been observed.

Table 3.2.6 Benefit of pilot activities in DMA 4

Item	Before pilot activities (March 2019)	After pilot activity (August 2019)
Average inflow volume	257.9 m^3/day	223.2 m^3/day
Average billed water	197.3 m^3/day	202.2 m^3/day
NRW ratio*1	23.5 %	9.4 %
Benefit	257.9 m^3/day×23.5% - 223.2 m^3/day×9.4% = 39.6 m^3/day → 14,454 m^3/year LKR55 × 14,454 m^3/year × 3 years × 1/2 = LKR 1,192,455	

*1: The NRW ratio is calculated based on the daily average amount of water.



	03/2019	05/2019	08/2019	08/2020	09/2020	10/2020	11/2020	12/2020	01/2021	02/2021
Distribution volume (m3)	6,962	6,641	6,472	7,393	9,035	7,228	8,083	7,941	8,325	7,865
Monthly billed water (m3)	6,116.0	5,946.0	6,067.0	6,391	6,730	6,579	7,497	6,590	6,733	7,524
Monthly NRW (㎥/month)	846	695	405	1,002	2,305	649	586	1,351	1,592	341
NRW ratio on monthly average basis (%)	12.2	10.5	6.3	13.6	25.5	9.0	7.2	17.0	19.1	4.3
NRW ratio on daily average basis (%)	23.5	16.2	9.4	16.4	13.1	18.1	7.2	14.2	16.4	10.7

Figure 3.2.2 Monitoring of NRW ration in DMA 4

3) NRW of DMA 5

The baseline of DMA 5 at the start of activities was 28.8%.

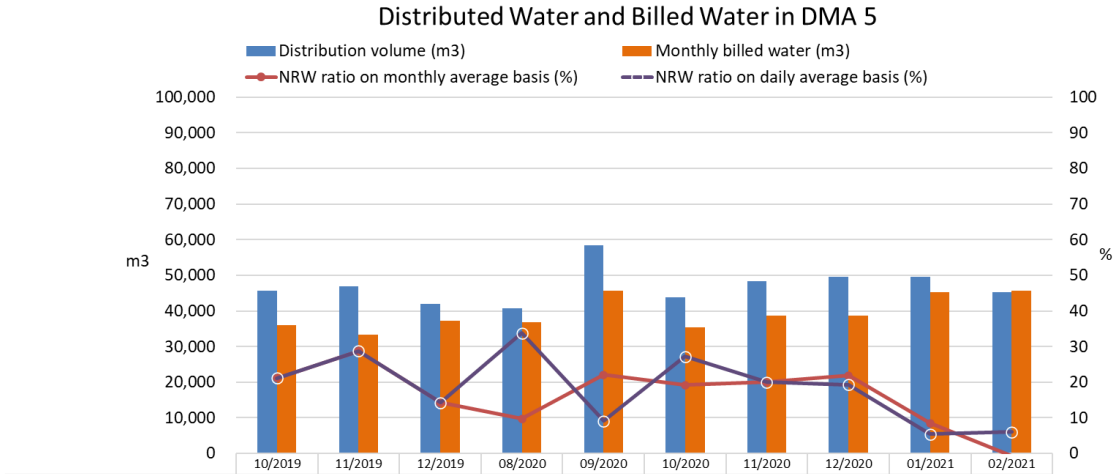
The total activity period is about 4 months, and the non-revenue water rate in January 2020, when a series of leak repairs were completed, dropped to 14.3% with a decrease of minus 6.8 points.

DMA 5 was divided into eight sub-sectors, and the amount of inflow water at night was low in all six sub-sectors where leakage countermeasures were implemented. This can be judged to be the effect of water leakage countermeasures.

Table 3.2.7 Benefit of pilot activities in DMA 5

item	Before pilot activities (October 2019)	After pilot activities (December 2020)*2
Average inflow volume	1,563.2 m^3/day	1,401.0 m^3/day
Average billed water	1,113.7 m^3/day	1,200.6 m^3/day
NRW ratio*1	28.8 %*3	14.3 %
Benefit	1,563.2 m^3/day×28.8% - 1,401.0 m^3/day×14.3% = 249.9 m^3/day → 91,213.5 m^3/year LKR55 × 45,588.5 m^3/year × 3 years × 1/2 = LKR 7,525,113	

*1: The NRW ratio is calculated based on the daily average amount of water.
*2: The activity ended in January 2020, but the highly reliable December data for non-revenue water data was used instead.
*3: In the case of DMA5, the non-revenue water rate of 28.8% is the value from October to November. In the NWSDB aggregation, it is processed as the November value. For this reason, there was a discrepancy between the aggregation month and the graph below.



	10/2019	11/2019	12/2019	08/2020	09/2020	10/2020	11/2020	12/2020	01/2021	02/2021
Distribution volume (m3)	45,670	46,896	42,030	40,834	58,476	43,750	48,400	49,500	49,550	45,350
Monthly billed water (m3)	36,019	33,411	37,219	36,869	45,567	35,364	38,716	38,664	45,332	45,669
Monthly NRW (m^3/month)	9,651	13,485	4,811	3,965	12,909	8,386	9,684	10,836	4,218	-319
NRW ratio on monthly average basis (%)	21.1	28.8	14.3	9.7	22.1	19.2	20.0	21.9	8.5	(0.7)
NRW ratio on daily average basis (%)	21.1	28.8	14.3	33.8	9.1	27.3	20.0	19.3	5.5	6.0

Figure 3.2.3 Monitoring of NRW ration in DMA 5

4) Leakage reduction in DMA 3

Due to the spread of the COVID-19 infection that continued from the beginning of 2020, it became difficult to evaluate the activity results in DMA3 using the amount of non-revenue water because the meter reading work of customer meters and bulk meters became impossible as usual.

Therefore, the effect of water leakage reduction was estimated from the change in the value of "Minimum Night Flow" rate confirmed while conducted the step test, and the cost effectiveness was calculated from this result.

As of the end of May 2021, while the results of DMA3 leak countermeasures have been steadily shown, leaks have been confirmed in areas where the need for leak countermeasures was initially judged to be low.

C/P continues to take measures against water leakage, but it will take more time to reduce water leakage

in the entire DMA. Therefore, the cost-effectiveness of water leakage countermeasures was calculated from the decrease in the minimum nighttime flow rate in the two sub-sectors where the countermeasures were implemented.

Table 3.2.8 Benefit of pilot activities in DMA 3

Item	Before pilot activities (October 2020)	After pilot activities (May 2021)
Inflow (MNF) to Subzone 2	102.0 L/min	48.2 L/min
Inflow (MNF) to Subzone 4	98.3 L/min	46.9 L/min
Total	200.3 L/min	95.1 L/min
Benefit	Reduced leakage volume : (200.3 L/min – 95.1 L/min) = 104.20 L/min Reduced leakage volume as daily average: 76 L/min (after rectification with pressure fluctuation data) LKR55 × 0.076 m^3/min × 60 × 24 × 365 × 3 years × 1/2 = LKR 3,295,490	

5) Cost Benefit analysis of DMAs where the activities finished

The calculation results of cost-benefit in the three DMAs where the activities were completed with the support of JET are as follows, and it was found that sufficient effects can be expected if the duration of the effects is 3 years.

Table 3.2.9 Cost-benefit analysis of pilot activities

Item	Classification	Amount (LKR)		
		DMA 4	DMA 5	DMA 3
Total cost		**990,031**	**1,459,536**	**1,624,738**
DMA Construction	Labor	241,173	241,376	176,470
	Machinery			208,324
	Material	49,212	60,384	65,272
Leak detection	Labor	337,500	266,639	332,314
	Machinery	120,973	115,527	172,433
Leak repair		241,173	669,925	669,925
Other		-	132,685	-
Total benefit		**1,192,455**	**7,525,113**	**3,295,490**
Benefit / Cost		**1.20**	**5.15**	**2.03**

In this analysis, the unit price of water supply per 1 m^3 of drinking water (expressed as Production Cost in NWSDB) was used in order to convert the reduced amount of non-revenue water (leakage amount) into monetary value. That is, it is assumed that all of the reduced water volume will be effectively used

within the same DMA or adjacent distribution areas.

However, even if the reduced leaks are used to supply water to other customers, some of them are actually lost as non-revenue water.

In project activities, these preconditions are explained to the C/P, accurate calculation of non-revenue water is indispensable for accurately grasping the results of activities, and continuous monitoring of non-revenue water will continue. The C/P understood that it was necessary to make a final decision based on the results.

(3) Utilization of remote monitoring system

In the Term 2 of the project, JET introduced a system that can remotely monitor the amount of DMA inflow and water pressure. This remote monitoring system has the following features and effects.

- Since this is a cloud-based monitoring system that utilizes a Web server, C/P can check the DMA status remotely even under the curfew caused by COVID -19 pandemic.
- Since the monitoring service is provided by the manufacturer of the data logger, the user can use it only by paying the communication SIM and communication fee.
- The built-in battery allows it to be used for more than 5 years, so there is no need to secure an external power supply.
- The effect of leak repairs carried out by on-site staff can be confirmed in a timely and quantitative manner, which is effective in maintaining / improving motivation.

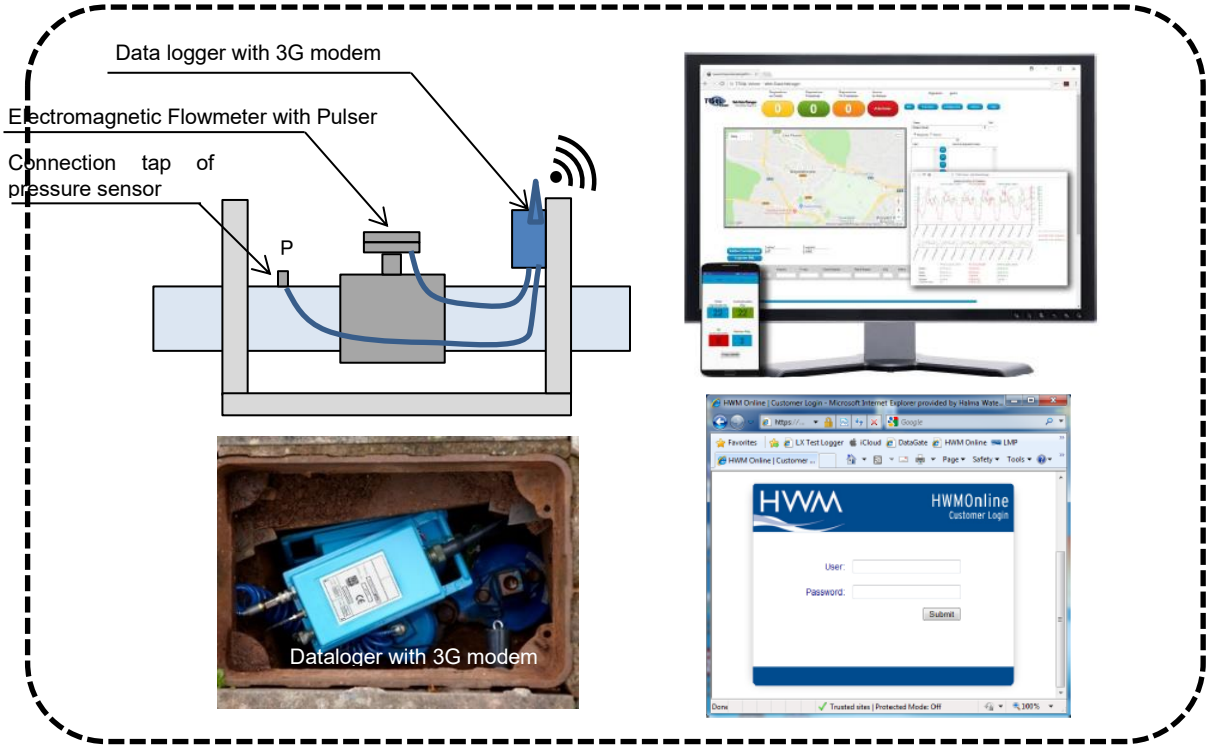


Figure 3.2.4 Outline of remote monitoring system

The equipment was installed on-site on April 8, 2021 for DMA3 and April 16, 2021 for DMA5.
After that, JET set up the equipment to enable stable monitoring while checking the communication status.
The effect of this system is as described above, but the C/P side plans to continue monitoring even after the project is completed.
The cost-effectiveness of activities in DMA is analyzed by setting the duration of the effect to 3 years, but the period varies depending on the characteristics of the distribution pipe network, water pressure, and external conditions.
By conducting medium- to long-term monitoring, it is possible to estimate the tendency of leak restoration and the duration of effect with higher accuracy, and it can be used as a tool for determining the cycle of future leak management activities.

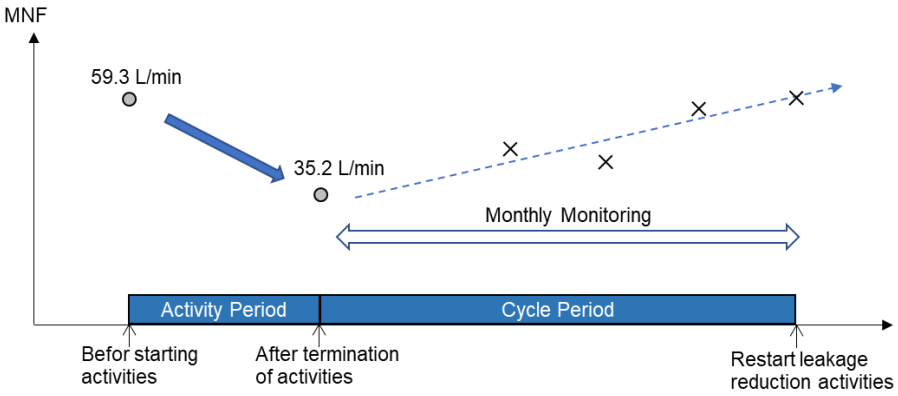


Figure 3.2.5 Relation between leak recurrence speed and cycle period of activities

Photo 3.2.1 Installation of electromagnetic flowmeter

The following graph is the record of the flow rate and water pressure of the DMA3 at the inlet. The minimum water pressure is very low at 5m during the day, while it rises to 35m at night. The height difference to the reservoir which is the starting point of the distribution is 35 to 40 m, and the water pressure at night is nearly equivalent to the hydrostatic head, and it is thought that the low water pressure during the daytime is caused by the head loss in the route of water distribution network.

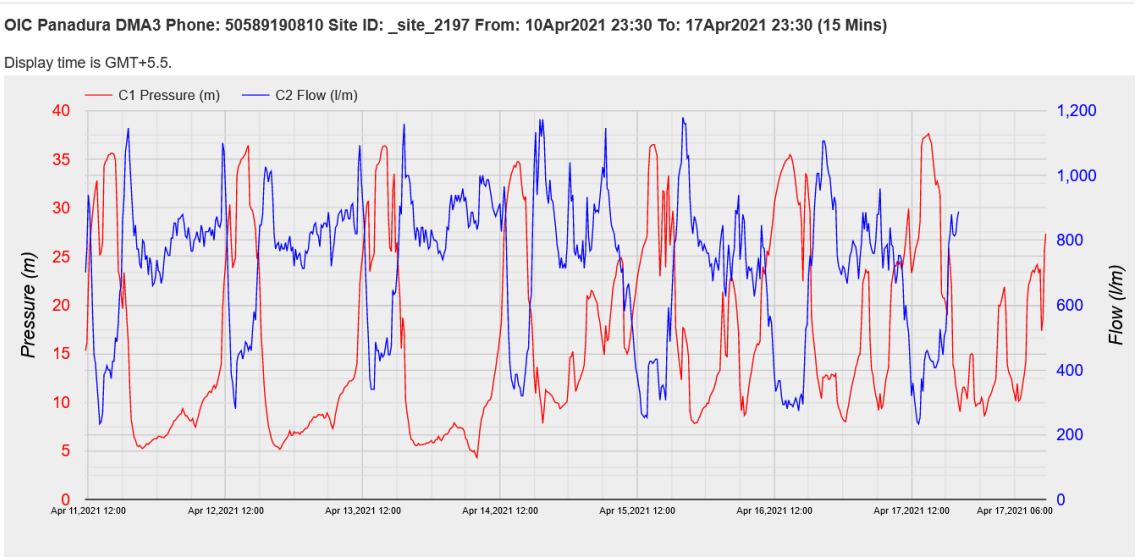


Figure 3.2.6 Monitoring screen on Web browser

3.2.5 Achievement of OJT Activities

In OJT activities in the Term 1, the basic skills of RSC-WS and OIC Panadura staff were strengthened, and in the second phase, support was provided so that C/P could take the initiative in the activities.

For this purpose, DMA 4 and DMA 5, which were considered to be suitable for acquiring basic technology, were selected as the activity areas for the 1st term. OJT activities was moved to the advanced stage based on the skills obtained in the 1st term. The OJT implementation process is shown below.

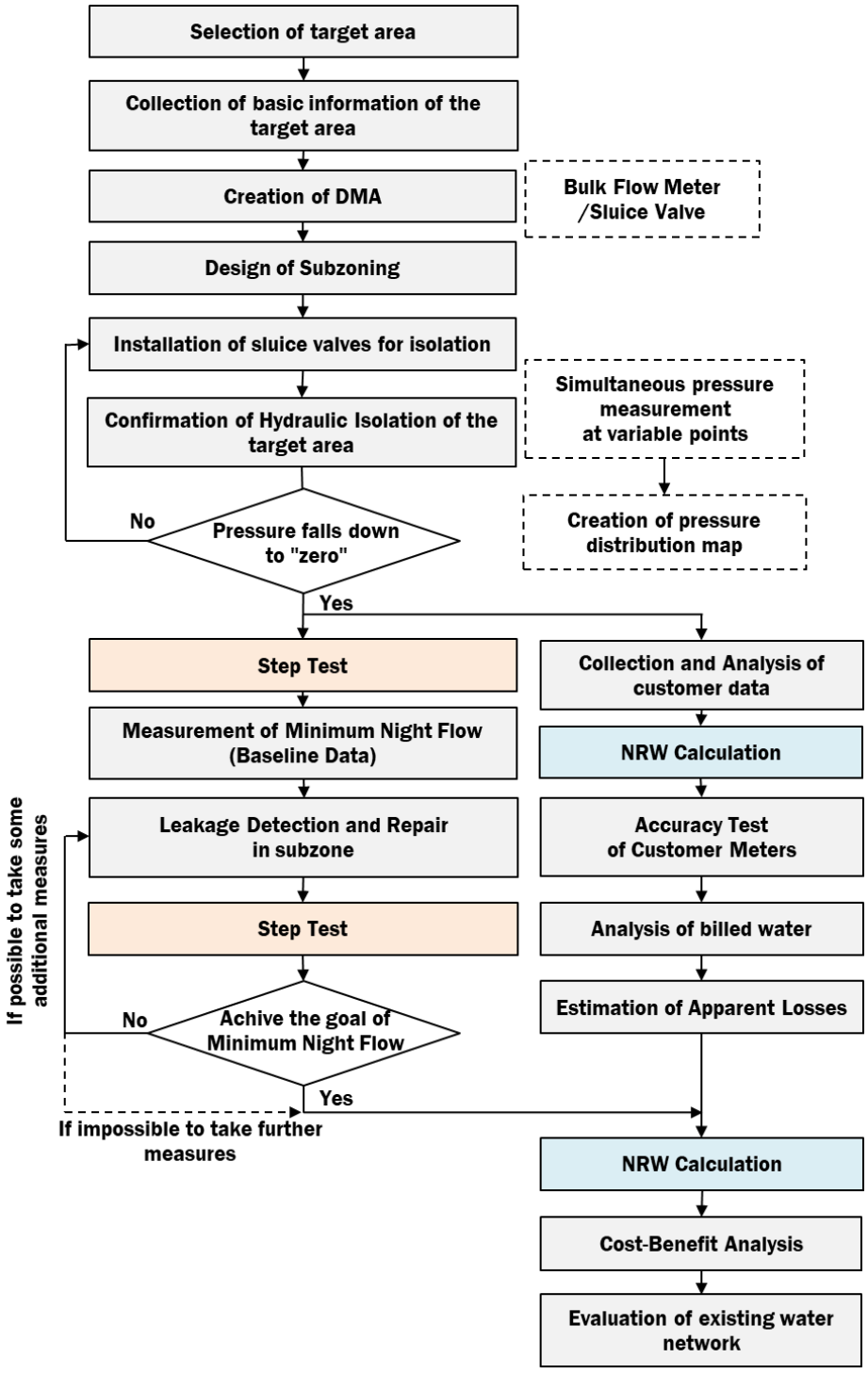


Figure 3.2.7 Flow of OJT activities

The pilot activity of Output 2 was carried out under the organizational management system shown below. Since the pilot site of this project was located in the area under the jurisdiction of OIC Panadura, the field activities were carried out by the staff including the engineers of OIC Panadura.

The leader of the pilot project was the manager of P & C of RSC WS, who was responsible for securing the necessary equipment and materials for the activities, obtaining permits, and coordinating with other departments within NWSDB, while receiving reports from OIC Panadura.

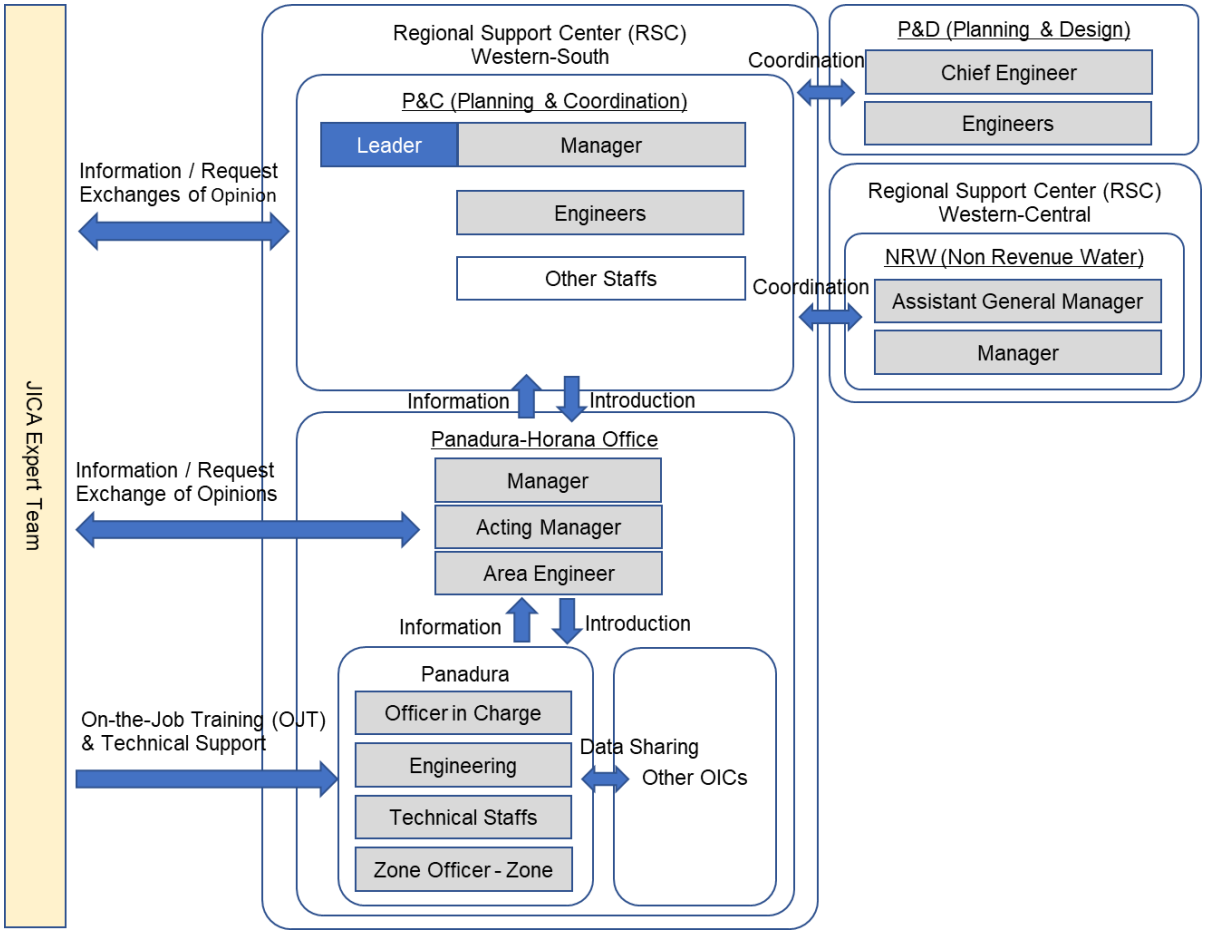


Figure 3.2.8 Operational system of pilot activities

Details of the activities of each DMA in the target pilot site are described in the attached "Work Plan and Progress Report (May 2021)".

3.2.6 Capacity Assessment

A capacity assessment was conducted in order to grasp the practical ability of the counterpart's water leakage countermeasure work and visually confirm the degree of improvement in technical capabilities through OJT activities.

(1) Target Person

- 3 engineers of RSC W-S
- 2 engineers of OIC Panadura engaged in on-site pilot activities

(2) Assessment Time

The capacity assessment was carried out in two parts as follows.

At the beginning of the project, an interim assessment was scheduled for May 2020, but the interim

assessment was omitted because the activity schedule was significantly delayed due to the impact of the COVID-19 disaster. Therefore, the assessments were conducted as follows.

- At the start of pilot activities: January 2019
- At the end of pilot activities: May 2021

(3) Method of Rating

The evaluation items were classified into 6 fields, each of which was subdivided as shown below, and the degree of understanding and practical ability of each item was investigated by the method of C/P's own judgment in 5 stages.

Table 3.2.7 5 stages of capacity rating

Stage	Reason of rating
5	Being able to conduct duties on one's own initiative, Being able to train subordinates and colleagues having sufficient knowledge and experience.
4	Being able to conduct duties on one's own initiative having sufficient knowledge and experience.
3	Being able to conduct duties with the help of others having a certain level of knowledge and experience.
2	Having some knowledge and experience, but almost insufficient level.
1	No having knowledge nor experience, and totally insufficient level.

Table 3.2.8 Evaluation items of capacity assessment

1. Basic Knowledge on NRW	
1.1	I understand what is IWA Water Balance Component
1.2	I understand what is Billed water component
1.3	I understand what is NRW component
1.4	I understand why NRW is an important issue
1.5	I understand what is Authorized Consumption Component
1.6	I understand what is Water losses Component
1.7	I can calculate NRW ratio
2. Planning on NRW countermeasure	
2.1	I can plan NRW reduction activities for Real (Physical) losses
2.2	I can plan NRW reduction activities for Apparent (Commercial) losses
2.3	I can plan DMA creation
2.4	I can evaluate customer consumption data
2.5	I have cost estimation knowledge for NRW reduction activities
3. Leak detection (Real Losses)	
3.1	I understand cause of Leakage
3.2	I have knowledge of leak detection survey method & Equipment shown as below
3.3	I can estimate leakage volume on the leaking pipe
3.4	I understand the cause of recurrence of leakage
4. Leakage repair work	
4.1	I understand proper leakage repair work and pipe replace work
4.2	I understand the need for pipe washing after water suspension during construction work
4.3	I understand safety management regarding construction work
4.4	I can supervise repair work and pipe laying work (service pipe)
4.5	I can supervise repair work and pipe laying work (distribution pipe)
5. Commercial losses (Apparent losses)	
5.1	Influence of Meter accuracy
5.2	Influence of Illegal connection
5.3	Water use amount by NWSDB themselves
5.4	Unbilled metered consumption, discount for specific parties(Army, temple, Government
6. Data collection	
6.1	I understand the necessary data for NRW reduction activities
6.2	I understand how to collect the necessary data
6.3	I understand the necessary data for Asset Management

(4) Ingenuity in Implementation of Capacity Assessment

Many of NWSDB's managerial class staff have the appropriate academic background and technical skills. In addition, they are fully aware of their responsibility to take charge of water services in Sri Lanka and to provide stable and reliable water services.

Capacity evaluation for such qualified personnel requires an approach that respects the positions within the organization on the C/P side and past careers. Therefore, JET conducted interviews in the form of personal interviews using survey sheets and adopted an evaluation method based on self-evaluation.

In addition, only for the first time, after objectively grasping the events that JET noticed before the activity was implemented, the evaluation points are shown and added as a reference with the understanding of the C/P side.

The method of personal interview is a time-consuming and inefficient task, but it is a method that should be actively adopted when the number of target persons is limited as in this case.

This will prevent the guidance in the project from being one-way and creating a communication barrier between JET and the C/P. It also contributed to the efficient realization of the results of subsequent

technical guidance.

(5) Result of Capacity Assessment

The results of the capacity assessment conducted in two parts are as follows. No specific personal name is given in this report considering personal privacy.

In addition, the final capacity assessment for the target person of C could not be conducted since this person was transferred to other section in the middle of the project.

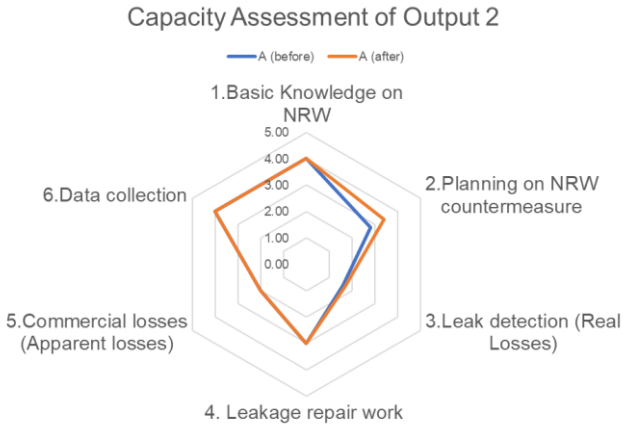
Table 3.2.9 Result of 1st capacity assessment

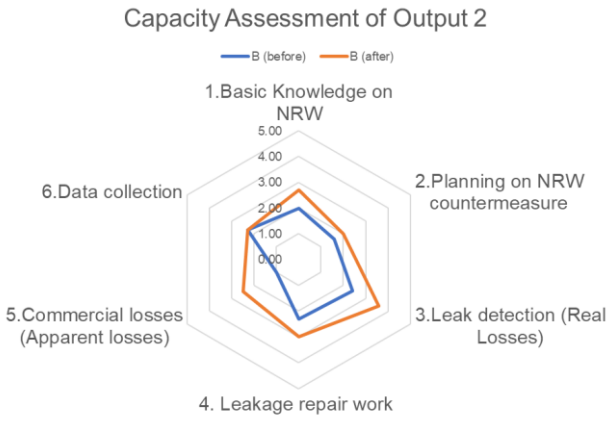
Evaluation comparison table using average values						
C/P Self evaluation JET evaluation	1.Basic Knowledge on NRW	2.Planning on NRW countermeasure	3.Leak detection (Real Losses)	4. Leakage repair work	5.Commercial losses (Apparent losses)	6.Data collection
A	4.0	2.8	1.6	3.0	2.0	4.0
JET evaluation	3.0	2.3	1.8	2.4	2.0	2.3
B	2.0	1.6	2.4	2.3	1.0	2.3
JET evaluation	2.2	1.7	2.5	2.3	1.8	2.0
C	3.1	2.8	3.4	4.0	2.8	3.0
JET evaluation	3.0	2.4	2.4	3.0	2.3	2.0
D	2.1	1.2	2.0	2.9	1.8	2.3
JET evaluation	2.0	1.6	2.3	3.2	2.3	2.0
E	1.7	1.0	2.4	4.0	3.5	3.0
JET evaluation	1.9	1.5	2.4	3.3	2.5	2.0
CP Average	2.6	1.9	2.4	3.2	2.2	2.9
JET Average	2.4	1.9	2.3	2.8	2.2	2.1

Table 3.2.10 Result of 2nd capacity assessment

Evaluation comparison table using average values						
C/P Self evaluation JET evaluation	1.Basic Knowledge on NRW	2.Planning on NRW countermeasure	3.Leak detection (Real Losses)	4. Leakage repair work	5.Commercial losses (Apparent losses)	6.Data collection
A	4.0	3.4	1.7	3.0	2.0	4.0
JET evaluation						
B	2.7	2.0	3.6	3.0	2.5	2.3
JET evaluation						
C						
JET evaluation						
D	3.4	2.8	3.1	3.5	2.5	3.3
JET evaluation						
E	3.3	3.0	3.4	3.8	4.0	3.3
JET evaluation						
CP Average	3.4	2.8	3.0	3.3	2.8	3.3
JET Average						

*1: Yellow cell means increase of rate and blue cell means decrease of rate

Target	A (RSC-WS)
	
【General comments】 Since this person is enrolled in the RSC-WS office and is engaged in planning and data collection work on a daily basis, his high ability has been confirmed from the beginning of the project. Having basic knowledge about the components of non-revenue water through existing literature and guidelines. Being aware that his own daily work is a managerial position and there is a lack of experience and knowledge of on-site level non-revenue water reduction technology, so the enhancement of practical skill focusing the apparent losses that was not covered by this project is needed. In this regard, JET evaluated that this person had a very calm and accurate grasp of his abilities. In formulating a plan to reduce non-revenue water, it was possible to show an efficient approach policy for all prescribed DMAs, and it became possible to proceed with water leakage countermeasures with an approach different from ordinary DMA like DMA6. These facts satisfied this person and contributed to the improvement of evaluation points. This person has a strong desire to expand the results of this activity to other regions.	

Target	B (RSC-WS)
	

【General comments】

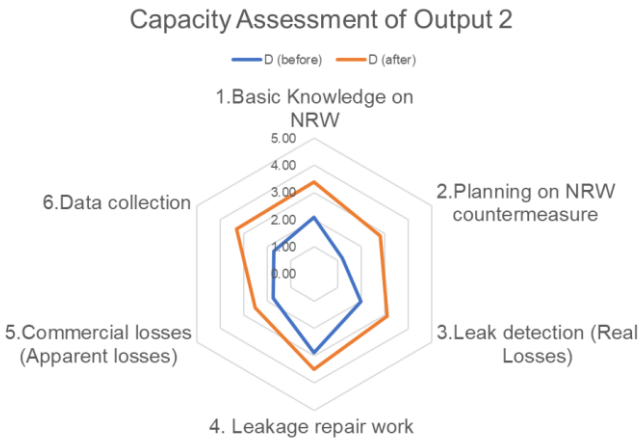
This person is enrolled in the RSC W-S office and plays the role of assisting the manager, and is proficient in on-site water leakage reduction countermeasure technology since this person was originally an OIC staff member.

In the project activities, this person was actively involved in on-site activities to make up for the lack of OIC technology, and improved his ability for leak detection, repair, and apparent loss (meter accuracy control).

Until now, this person had acquired skills through daily work with OIC engineers, but this project activity was meaningful because this person had no experience of receiving direct guidance from highly qualified experts.

On the other hand, in the management technology and planning from the global perspective of non-revenue water, the person himself admits that he is lacking in ability, which remains as a future issue.

Target	D (OIC Panadura)



【General comments】

This person is a engineer of OIC Panadura.

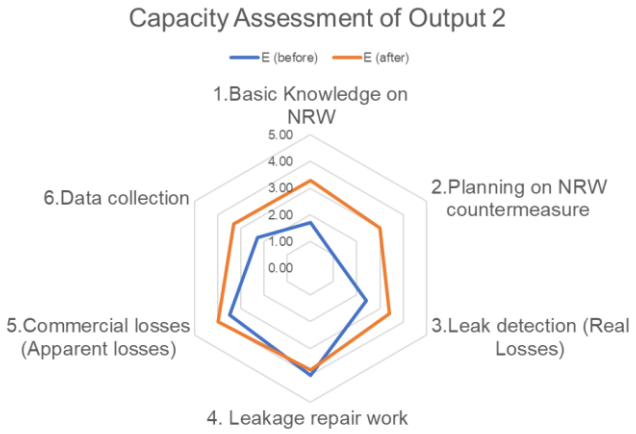
This person has a basic knowledge of non-revenue water from the beginning of the project, and he has experienced water leakage countermeasures on daily basis in OIC, so these abilities are relatively high.

On the other hand, in the past work, he was overwhelmed by daily work, and lacked experience / knowledge in planning based on the evaluation of the current state of the pipe network, making strategies for measures against non-revenue water, and collecting / utilizing data.

In this project, as one of the most important staff of OIC Panadura, I have been involved in pilot activities in collaboration with JET, so the lack of planning ability and data collection / utilization ability have been definitely improved.

In addition, global knowledge of non-revenue water has increased, leading to an overall balanced capacity.

Target	E (OIC Panadura)



【General comments】

This person is a engineer of OIC Panadura.

This person has extensive experience in field operations in Colombo and OIC in local cities, and has a high ability to detect and repair leaks from the beginning of the project.

In the past, this person has received technical support for measures against non-revenue water from the World Bank, and is not only familiar with leak detection equipment and its handling, but also capable of detecting minute leak noise.

On the other hand, since this person has specialized in water leakage countermeasures as a field operation, this person has no experience of evaluating the overall picture of non-revenue water management and the current state of the pipe network from quantitative data and utilizing it for strategy making. Therefore, there was a need to enhance these planning capabilities.

In this project, this person has been involved in pilot activities in collaboration with JET as one of the most important staff of OIC Panadura. Thanks to this, the lacking ability to formulate plans, collect and utilize data has definitely improved, and the global knowledge about non-revenue water has increased, so that we have acquired a balanced ability as a whole.

In the self-evaluation, the evaluation score of the leak repair technology is lower.

When I confirmed this background in an interview, it was the result of re-evaluating my own level that I was aware of at the time while proceeding with concrete work with JET through project activities.

3.2.7 Cost Calculation Sheet of Leakage Survey

JET prepared a cost calculation sheet in excel format and its guideline. It was attached to the Procedure Manual as an appendix.

(1) Purpose

C/Ps intends to conduct leakage detection surveys over wide areas. Therefore, it must accurately estimate budgets and working periods, and efficiently plan for water leakage detection surveys. To this end, the project team, JET, in collaboration with the C/P, prepared a calculation sheet to enable such budgetary and working period considerations to be more effectively and easily understood.

(2) Preparation Methodology

The following two points were taken into account for the preparation.

- The department which is concerned with NRW reduction will use it for the planning and budget estimation of a leakage survey
- The engineers who work at OIC will use it for estimating workload and duration of the survey

(3) Structure of Excel Sheet

This consists of seven sheets. The user shall fill the two cost setting sheets with unit price of equipment and personnel, and four sheets to set the extent of the survey and number of teams to work, then the estimated cost and necessary time for completion will be automatically calculated.

- Table 1. Total survey cost and working hours table for leak detection
- Table 2. Cost table of flow measurements (minimum night flow and step test)
- Table 3. Cost table of house-to-house surveys
- Table 4. Cost table of road surface surveys
- Table 5. Cost table of identification surveys
- Basis of labor costs in each table
- Basis of equipment prices in each table (purchase and ownership prices per day)

1) Determination of Conditions

The basic conditions necessary for the calculation were determined by the discussion with C/P on the basis of the experience of the pilot activity.

- Items of survey
- Manpower and labour cost
- Type, quantity, and cost of leak investigation equipment required for each investigation
- Workload
- Working hours per day

The considering points in the discussions are shown below.

- Items of survey

  The four working items were decided as items to be defined.
  - Flow measurement including step test and drop test
  - House-to-house survey
  - Road survey
  - Identification survey
- Manpower and labour cost

  The labour cost was determined based on the determined by the real conditions of staff assignment at the activity in DMA 3.

Table 3.2.1 Necessary Manpower in Calculation

Survey Item	Necessary staff members per survey team		
	EA(Chief)	Fitter	Unskilled labor
Flow measurement Main Team	1	2	1
Flow measurement Valve Team	1	2	1
House-to-house survey	1	1	1
Road surface survey	1	2	1
Identification survey	1	2	1

Table 3.2.2 Labour Cost per hour

Basis of Labor cost in Each Table		
Labor Level	Unit	Unit cost (Rs.)
EA(Chief)	Person/hour	247
Fitter	Person/hour	182
Un Skilled labor	Person/hour	159

- Type, quantity, and cost of leak investigation equipment required for each investigation

  The equipment listed in the calculation sheet is same as the equipment used at the pilot site, and its price is same as procurement price of this project. Two cases were considered for cost setting, i.e., there is no equipment and need to procure, and there is equipment and only need to consider the equipment ownership cost.

Table 3.2.3 Equipment required for the Survey per team

Types of equipment use for each survey		Item of survey			
		Flow Measurement	House to House Survey	Road Surface Survey	Identification Survey (Suspected leak location)
Equipment	Leak Detector			1	1
	Generator	1			1
	Hammer Drill				1
	Acoustic Rod		1	1	2
	Boring Bar				1
	Pressure Logger	1 /sub zone			
	Flow Meter (Portable type)	1			
	Vehicle	1	1	1	1

Table 3.2.4 Cost of Equipment

Basis of Equipment Price in Each Table Purchase & Ownership for 1day		
Item	Purchase Price (Rs.)	Ownership Price for 1 day (Rs.)
Leak Detector	463,266	741
Generator	290,000	958
Hammer Drill	23,261	44
Acoustic Rod	59,148	166
Boring Bar	45,275	543
Pressure Logger	1,700,000	3,750
Flow Meter (Portable type)	5,300,000	20,140
Vehicle	-	2,500

Ownership cost was estimated by use of following equation which is defined by the table of cost calculation of equipment ownership cost of Japanese Association of leakage Investigation.

$$Ownership\ cost\ per\ day = procurement\ cost \times \left(\frac{0.9 + factor\ of\ O\&M}{service\ life} + Annual\ management\ ratio\right) \div standard\ working\ days$$

The following table summarizes the figures necessary for calculation. The ownership cost of generator is based on the standard unit cost of Japan Construction Machinery and Construction Association. Further, the vehicle cost is calculated by the NWSDB standard.

Table 3.2.5 Table of Ownership Cost

Item	Depreciation rate (%)	Service life (year)	Factor of O&M (%)	Annual management ratio (%)	Standard working day (day)
Leak Detector	90	8	60	7	160
Generator	Standard unit cost of Japan Construction Machinery and Construction Association				
Hammer Drill	90	7	75	7	160
Acoustic Rod	90	3	30	5	160
Boring Bar	90	7	75	7	160
Pressure Logger	90	5	50	5	50
Flow Meter (Portable type)	90	8	70	10	80
Vehicle	Standard unit cost of NWSDB				

- Workload

  The basic data for workload are the working records and the results of the pilot activities in DMA 4 and 5. The working records are analyzed to calculate the respective working hours. After that, JET compares the survey quantity of each DMA and calculates the survey quantity conducted by one team in one hour.

Table 3.2.6 Analysis result of DMA 4

Survey Item	Teams	Frequency	Total working hours of 1 team	Workload per team
Flow measurement	2	2 times	16.0 hours	4 hours per 1 time
House-to-house survey	2	281 houses	27.6 hours	10.28 houses/hour
Road surface survey	2	3.3km	14.0 hours	235.71m
Identification survey	1	18points	5.0 hours	3.60 points
Customer density				85.2 houses /km

Table 3.2.7 Analysis result of DMA 5

Survey Item	Teams	Frequency	Total working hours of 1 team	Workload per team
Flow measurement	2	2 times	24.0 hours	6 hours per 1 time
House-to-house survey	2-3	1376 houses	48.0 hours	28.7 houses
Road surface survey	2-3	5.8km	37.5 hours	155.65m
Identification survey	1-2	It could not be separated from house-to-house survey		
Customer density				123.96 houses/km

Comparing the analyzed figures by the hourly workload of DMA4 and DMA5, DMA5 took longer time per survey in the flowrate measurement. This is because DMA5 has more subzones for step test and took more time for preparation and measurement.

The efficiency of DMA5 has improved in the house-to-house survey. On the other hand, the amount of workload per hour of DMA5 for the road survey was smaller than that of DMA4, even though the survey was conducted at night in good conditions and after the survey skill is acquired. This was caused by the different working style in DMA that the point survey was conducted at once.

JET and C/P determined the standard workload as below with the discussions.

- The customer density will affect the work progress, i.e., workload in lower density area is less efficient than higher density area because of the time of transport. Therefore, we set the two different conditions of the customer density. The road survey is not affected by the customer density.
- The workload of identification survey is determined by the result of DMA4.

Table 3.2.8 Standard Workload

Standard workloads of calculation sheet (work speed)		
Survey item	Less than 100 houses per 1 km of pipeline	Over 100 houses per 1 km of pipeline
Flow measurement	4.0 hours per operation	6.0 hours per operation
House-to-house survey	13.6 houses per hour	28.7 houses per hour
Road surface survey	235 m per hour	
Identification survey	3.6 locations per hour	

- Working hours per day

  The labour cost and total working time were calculated on an hourly basis. The equipment cost was calculated on a daily basis with the 5 hours working time per day.

2) Terms of Use

This calculation sheet is targeted to be used at the third step shown in Figure 3.2.1. The person who uses the sheet estimates the required personnel, budget, and construction period will examine whether the plan is feasible to implement or not.

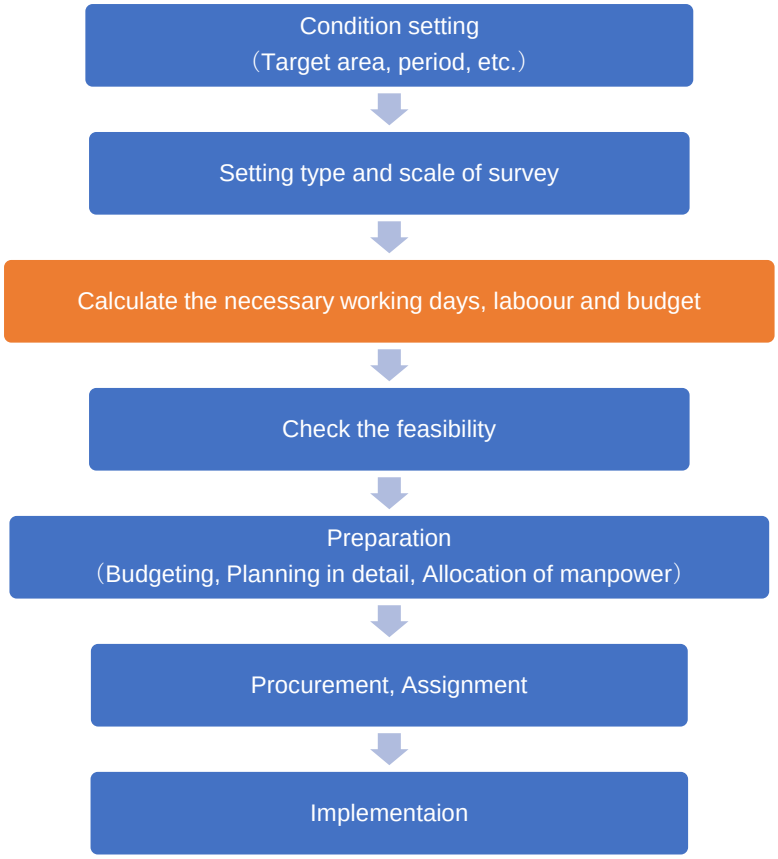


Figure 3.2.1 Steps of Survey

3) The review of the sheet

This sheet was prepared mostly based on the experience at the pilot activity and the cost in year of 2021. It must be modified to meet the latest conditions. The following items should be modified when the condition will be changed.

- When changing the basic cost data of labor and equipment in the calculation sheet

  The basis of labor cost and the basis of equipment cost in each table is based on the results of pilot activities as of 2021. When planning in the future, if the labor cost and equipment cost is different, NWSDB can change the unit price. However, it should be noted that the calculation result will not reflect the actual situation unless the correct basis is used. The planner must make this change on the right evidence and be approved by the budget and NRW section in RSC.

- When changing the workload

  The standard workloads reflect the pilot activity performance of 2019-2021. NWSDB can change the workload in the future. However, it should be noted that the calculation results will not reflect the actual situation unless the correct basis is used. The planner must make this

change on the right evidence and be approved by the budget section, NRW section, and chief of site survey in RSC.

The workload will be recalculated for the modification following the below steps.

1) Refer to the precedents of surveys conducted under the same survey conditions or conduct test surveys.

2) Determine the workload (work per hour) based on precedents and test results. Let this workload be A.

3) Conduct survey workload in the setting of A.

4) When the survey is complete, calculate the actual workload from the survey records. Let this workload be B.

5) In subsequent surveys, workload B will be used to develop the plan.

6) However, it is necessary to record the survey conditions under which the workload was decided and leave it as basic data.

4) Deliverables

There are two deliverables as follows

- Excel sheet: “Survey cost & Working hour calculation sheet for leak detection planning”
- Guidelines: Calculation sheet Guideline

It is attached in Procedure Manual

3.3 [Activity 2.3] Accumulate collected data during leakage control works to the existing database

3.3.1 Collected Data and Collection Method

(1) Collection method

Data has been collected on the basis of leakage repair records, such as basic pipeline information of the pilot site and information about the leakages. Leakage repair records were compiled by JET from existing forms submitted by the repair contractor to the OIC. The existing repair records did not include information such as leak location map, area map, customer ID, details of equipment used for repair, leakage volume, etc. JET modified the existing one and added more information for the future use in the asset management. It is well accepted by the C/P and improved through the pilot activity by the opinion of C/P. The Sinhala version was also prepared for the easy use of field workers.

(2) Collected Data

The data below will be gathered. In addition, if discrepancies in piping or valve conditions are found between the drawings and field conditions, it will be recorded and reflected in the data.

Table 3.3.1 List of Collected Data

Collected data	Method of data collected
Current condition of pipe laying and valve installation	Confirmation of current status of pipe mapping and pilot site activities
Pipe length, pipe type	GIS data
Number of water supply connection	OIC, RSC customer information
Leakage point [Address, location, meter number, customer number, etc.]	Water leakage repair record table
Leakage situation [Pipe type, diameter, leak location, leak cause, leak amount, pipe depth, road pavement type, traffic volume, etc.]	Water leakage repair record table
Information of repair of water supply equipment [Repair method, repair equipment, repair labor cost, repair time]	Water leakage repair record table

Source: JET

3.3.2 Data Collection Method

Pipeline information at the pilot site is very limited. There were no as-built drawings of pipelines of the whole area. Therefore, schematic diagrams were created by referring to as-built drawings one-by-one, GIS maps, and knowledge of OIS staff.

Information about location and repair works are collected by the OIC on the “leakage repair record sheet” and submitted to the management office. The management office transfers the information to a ledger and accumulates the data. For subsequent reflection in the database etc., the leakage repair information is entered into the GEP by the OIC or Manager Office and integrated into the P&D of the RSC.

Although the data collection method had been prepared in 1st term, but the practical implementation was remained.

Although the DMA activity has proceeded slowly due to COVID-19 influence, C/P collected the DMA 3 repair records by use of new format and it would be entered into the GIS database at the RSC（W-S） P&D. However, ADB project is going to change the GIS data management procedure in whole NWSDB, and the responsibility of data entry will move from P&D to manager office. Therefore, the work related to the data entry is currently suspended. The data collected by the project will be put into the new system after it will be ready. On the other hand, the use of geotagging photograph was proposed by the JET for making easier the data collection, and OIC agreed on the use of this method.

3.3.3 Achievement

The pipeline information obtained at the pilot activities was reflected in the DMA management drawings and utilized by the OIC Panadura staff. In addition, the leak repair records have been collected in the new format. JET recommended to make a working map at the site with necessary information and the survey and leakage information were recorded at the DMA activity as follows.

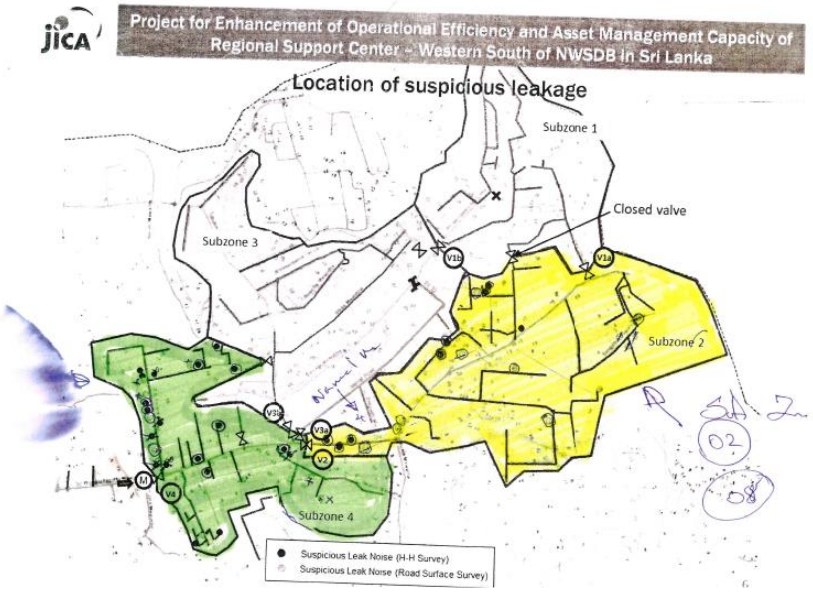
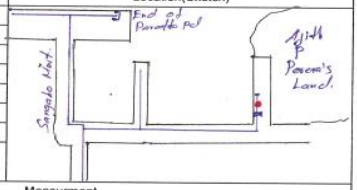


Figure 3.3.1 Record of Leakage Survey

The Project for Enhancement of Operational Efficiency and Asset Management Capacity of Regional Support Center-Western South of NWSDB in Sri Lanka

Leak Repair Detail Sheet	National Water Supply & Drainage Board			
	Office	Panadura		
	Officer	Janaka Karunamuni		
Work day	Day		Time	13.00 - 15.00
Attendance day	Day	17/02/2021		
Work reason	Complain	Meter reader	Leak detection	Other ✓
Compainer's name & add	House to house Survey.			
Leakage location	Adress	End of Sangaba Mw.		
	Meter No.	-		
	Consumer No.	-		
	Coordinate	-		
Type of Leak	Meter	Connection pipe(Joint , pipe)	Ferrule	Distribution pipe
Cause of Leak				
Nature of repair	Diameter & Material	63 mm PVC		
Leake repair	Yes ✓	No	Leak volume	M3/h
Material of use	63 mm PVC End cap.			

Machinery Used	Location(Sketch)
(1) Power Light (1.5.1)Hrs	
(2) Night work (1.5.2)Hrs	
(3) Water Pump(Dewatering)Hrs	
(4) Others	
Fitter - 01 Labour - 02.	

Measurement

BOQ Item No.	Description	Unit	L(m)	B(m)	D(m)	Qty

Comment

Contractor Officer — NWSDB Officer

Figure 3.3.2 Leakage Repair Record at the Pilot Site

3.4 [Activity 2.4] Create a Procedure Manual for Leakage Control

3.4.1 Results of review of existing documentation related to leakage control

JET obtained the manual from the training department of NWSDB and reviewed the sections related to water leakage, shown in Table 3.4.1. Although the existing manual has some sections that can be used, it is not used at present. Furthermore, many staff members were not even aware of the existence of the manual. In addition, the contents of the existing manual are limited to introduction of the types and standards of water leakage survey equipment. It cannot be used for the selection of equipment or for other important decisions. Therefore, JET determined that including the entire contents in the new procedure manual is not suitable. For this reason, the manual being created will be prepared based on actual site conditions and with specific contents that can be incorporated in the implementation plan.

Table 3.4.1 List of existing materials

No.	Name of Material
1	Leak Detection and Repair Procedure
2	Pipe Material Selection Process
3	Service Connection Procedure
4	Water Meter Selection, Standardization & installation Process
5	Meter testing & Calibration Process
6	Manual on Bench Marking and Monitoring Procedure for NRW Reduction
7	Managers Manual for NRW
8	Managing Water loss by understanding the reticulation
9	NRW Reduction in Colombo city by adoption of low-cost strategies

Source: Project Team, Report by Mr. Koide

Some parts of the manual that was obtained have very relevant information. However, despite having been created recently, even staff of the NRW Section specializing in water leakage control activities did not know of its existence. Some manuals had never been used. Only some staff members of relevant departments when these manuals were created knew about them. Even if leakage control information was initially recorded, it can be seen that the manuals have not been consulted since then. The reason they were not consulted are presumed to be as follows;

- ✧ The contents are limited to general theory, and it is more of a guideline and commentary than a manual. When field conditions deviate from those described in the manual, activities described in the manual cannot be considered or implemented.
- ✧ The DMA, which is the basic requirement for the activities, cannot be created due to reasons such as complex or non-ideal distribution network, low water pressure, and need for a large amount of equipment. And dependent activities also cannot be performed.
- ✧ Cost effectiveness is unknown. Therefore, it is not possible to proceed with procurement of equipment and start actual activities.
- ✧ The advantages and disadvantages of leakage survey equipment and pipe materials are explained. However, it is not possible to determine from the manual which is suitable for the site situation and which should be selected.

✧ There is barely enough time for surface leakage countermeasures implemented in the field currently. Implementation of additional activities using the manual is difficult.

This project will strive to create a more practical Procedure Manual. Case studies will be introduced to make it easier to reference. Strategies for widespread distribution of the manual area also being considered, such as introducing it in the curriculum of Output 3.

3.4.2 Create a Procedure Manual (Draft) for Leakage Control

(1) Policy for drafting the Procedure Manual

Discussions were held between JET and C/P, and the following 3 points regarding the policy for drafting the procedure manual were agreed to.

1) Use methods described in the existing manual, particularly regarding specific methods related to underground leakage control.
2) Create procedures appropriate for the site conditions while conducting pilot site activities.
3) Include opinions of the C/P as activities are implemented.

The Procedure Manual would be created adhering to the following 3 policies.

- In the detailed planning report completed in September 2017, underground leakage, pipe installation (connections), data collection, O&M, and standard drawings for piping facilities were proposed as contents to be included in the Procedure Manual. Based on this, C/P (mainly Output 2) will be consulted, and contents determined.
- Include topics related to pipe installation requested by the C/P.
- As mentioned before, contents related to underground leakage and pipe installation in the existing manual is limited to general discussion. Useful contents from the existing manual will be reflected in the Procedure Manual created in this project. However, in order to create a practical and effective Procedure Manual, issues and resolutions actually experienced during pilot site activities will be used.

The table of contents of the draft Procedure Manual was created after reviewing existing manuals, and considering desires of the C/P and conditions in the pilot site. Comments from the C/P were taken. Based on these comments, the Procedure Manual is currently being written.

- January 2019: Review of existing manuals was completed.
- June 2019: TOC proposed by JET.
- July 2019: TOC submitted to PD and P/C, and asked for comments.
- September 2019: Procedure Manual created. Submitted to C/P and asked for comments.
- November 2019: Comment was received to generalize the measures described. Response was that procedures of pilot site activities were emphasized.
- November 2019: JET and C/P explained the Procedure Manual to JPU, and obtained approval.

The table of contents for the “Procedure Manual of Active Leakage Control Against Underreported Leakage” is shown below.

1. Outline of the manual
2. Assessment of current Situation
  2-1. Water balance analysis
  2-2. Classification of leakage
  2-3. Estimation of leakage volume
  2-4. Leakage recurrence
3. Practice of active leakage control
  3-1. Planning
  3-2. Setting target area
  3-3. Minimum night flow measurement
  3-4. Step test
  3-5. Leakage survey
  3-6. Repair of pipes, laying of pipes
  3-7. Evaluation of the activity
4. Management of pipe network map and database
5. Application of Leakage control
Appendix
1. Usage of leak detection equipment
2. Sample of DMA
3. Sample of a result in Minimum night flow measurement
4. Sample of a result in Step test
5. Sample of record table of leakage

Source: JET, Report by Mr. Koide

3.4.3 Discussions with PDMRC

The proposed Procedure Manual was submitted to PDMRC through C/P in February 2020 after modification based on the discussions with C/P and JPU.

The followings were added.

- Calculation method of flow rate at the time of washout
- Description about the illegal connection
- Important notice for the flow meter selection and installation
- Procedure of repair of asbestos cement pipe
- Basic of pipe layout, design concept, selection criteria for DMA work
- References

3.4.4 Update of the Manual based on the Pilot Activity

C/B analysis was reconducted based on the real figure obtained at the pilot site. Lessons learned and know-hows were attached as appendices as below. The part of appendices will be modified and updated with the progress.

Appendix 1：Case Study of Pilot Site Activity in Panadura RSC(W-S)

Appendix 2：Guideline for Cost and Working Days Calculation Sheet for Leakage Detection Planning

Appendix 3：Introduction of Remote Monitoring System

Appendix 4：Mechanism of Ultrasonic Flow Meter

Appendix 5：Data Collection and Management

Appendix 6：Manuals of Instruments introduced by the Project

Appendix 7：Backfilling Instatement

Appendix 8：Theft Prevention Strategy

3.5 [Activity 2.5] Request PDMRC to approve the procedure manual

Draft of the procedure manual was submitted to the PDMRC through the Output 2 leader. The modification and responding to the comment have been done. The letter of approval by PDMRC was issued by PD to the project chief advisor on 11th August 2021. Then, the manual is official document to be used in whole NWSDB.

The approval of the procedure manual was reported and confirmed at the 4th JCC held on 12th August.

The final approved version of the procedure manual is attached as Annex.

3.6 Achievement

C/Ps have developed their skill to take active measures with a plan against invisible leakages such as underground leakages since the daily work for leakage control on existing pipelines had mainly conducted on the visible leakage or reported leakage by customers/ staff. Through the pilot site activity, C/Ps obtained the knowledge and experience for the active leakage control and became to determine the effective procedure by themselves. In addition, they are able to evaluate the result from the viewpoint of cost/benefit consideration. RSC (W-S) has a plan to conduct similar activities in other areas, and it is expected that it will be established as an activity to reduce the current leak level.

The procedure manual was developed for conducting the above activities. The knowledge from the pilot activities was included to reflect the actual situation of NWSDB, and the revision was made with the opinions of C/P, management and PDMRC.

Considering that the manual should be easy to refer for practicing similar activity, the case study, explanation of monitoring and equipment manuals were attached as appendices. In addition, a training program based on this manual has been formulated, and it will help expanding the outcomes of pilot activity to other RSCs in the future.

4 Contents and Result of Activities in Output 3

Output 3: Capacity for implementation of training programmes on leakage control is enhanced

4.1 [Activity 3.1] Review status of the current training programmes on leakage control conducted at the training center and RSCs

4.1.1 Information Collection of Existing Trainings

JET collected information about the contents and implementation system of the training that NWSDB has been providing to the staff. The results are summarized below.

(1) Internal Training

NWSDB has the MD&TD, which is responsible for human resources development and training. It occupied 2 floors on the east wing of the NWSDB building in Telawala and has 5 training rooms, a library, and staff offices (at the time of September 2021). Internal training was held almost every day, and the training covers a wide range of fields, from accounting to practical work. In addition to internal training, the department is responsible for human resources development through external training to support staff obtain master's degrees at other institutions/ universities in Sri Lanka, overseas training, advancement to universities, etc. NWSDB owns and manages a database of all staff members, and refers to the training history, position, work location, etc., for the purpose of selection of the target persons, and notifies them the training which they are recommended to attend.

The internal training covers more than 100 courses and it's conducted more than 200 times a year. Table 4.1.1 shows the number of training courses by sector in 2017 and 2018.

Table 4.1.1 Sector-wise Number of Course and Training

Item	2017		2018	
	Course	Training	Course	Training
Technical	47	90	54	95
Not technical	33	90	43	100
Computer and IT	22	50	24	50
Total	102	230	121	245

Source：JET prepared based on the document of MD&TD

Training is usually conducted as one-day course, and a certificate of participation is issued. People that participate in long-term training for more than 3 days deserve to obtain a Certificate of completion of training course.

Table 4.1.2 shows the summary of the training sessions in the year of 2018 related to the training sessions to be implemented in this project (NRW, water leakage repair, water leakage detection, pipe connection) among the training sessions conducted by MD&TD.

Table 4.1.2 Summary of the Training Sessions in the Year of 2018

Related to the Training to be implemented in this project

NO.	TITLE OF THE PROGRAMME	TARGET GROUP	DURATION (DAYS)	Q1	Q2	Q3	Q4	TOTAL
TECHNICAL COURSES								
1	Pre-shipment Inspection Procedure of DI/PE Pipes Fitting & Specials	Engineers	1				1	1
3	NRW Control Methods in Distribution System Management	EAA	1		1	1	1	3
11	Pipeline Repairing Methods	EAA	2	1	1	1	1	4
17	Repair and Maintenance of Flow Meters & Bulk Meters	EAA-Mechanical	1		1			1
21	PE Pipe Laying and Service Connection	EAA	1	1		1	1	3
23	Water Meter Connection and Meter Shifting	Pipe Fitters/Laborers	1	1			1	2
24	Construction of Transmission & Water Distribution Systems	Engineers/ EAA	2	1				1
31	New Connection Procedures and Preparation of Estimates for House Connections	EAA	1	1		1		2
32	Illegal Connection and Disconnection Procedures	EAA	1		1		1	2
40	Pipe Laying Methodology	EAA/ Supervisors	1			1	1	2
43	Maintenance of Distribution System	EAA/Fitters	1	1			1	2
44	Rehabilitation and Upgrading of Existing Facilities to Optimize the Quantity of Water	Engineers	2	1		1		2

Source：JET prepared based on the document of MD&TD

Most of technical training sessions were conducted as lectures in the lecture room on the 1st floor of the Thelawala Office where MD&TD is located, also facility tours were planned sometimes based on training purposes. In addition, a demonstration was conducted outdoors by a RP in the training of pipe connection. The training was devised that the training participants could observe the situation clearly. However, training participants had very limited opportunities for hands-on learning.

(2) RP

NWSDB calls trainers as RPs. Basically, they are selected from NWSDB staff members. If there are no appropriate personnel, the trainer is invited from an external organization according to the training content. The list of RPs has not been compiled into a database, but the organization considers it necessary and is building a database.

MD&TD selects RP based on experience, specialty, presentation skills, etc., and interviews. There is no certification system.

The allowance of RPs is shown in Table 4.1.3.

Table 4.1.3 Allowance of RP

Training category	Executive (Higher than engineer) (LKR/hour)	Non-executive (LKR/hour)
Lecture with handouts	1,000	800
Practical training	500	500
Demonstration		
Discussion		

Training category	Executive (Higher than engineer) (LKR/hour)	Non-executive (LKR/hour)
Mater / PhD qualified	3,900	2,100
Graduate / Professional qualified	3,600	1,950
Other lectures	1,800	1,500
Demonstration	700	700

Source：Hearing of Manager- Training (Technical Tr)

(3) Training Material

The existing training materials related to the topics in this project are summarized in Table 4.1.4, such as pipe connection, leak repair, leak detection, and NRW. Except for Material Nos. 8 and 9, these are written in English.

Table 4.1.4 List of Training Material

No.	Training Title	Contents
1	Training Programme on NRW control Methods in Distribution System Management	I. Introduction to NRW and NRW reduction II. Field Demonstration Online Tracing and Leak Detection and Instrumentation III. Line Tracing and Leak Detection and Instrumentation IV. Field Demonstration on Flow Measuring Instruments
2	Training Programme on Flow Measurement Control Techniques	I. Introduction to flow measurements II. Need of flow measurements III. Basic introduction to the types of flow measurements IV. Types of flow measuring equipment related to the water purification and transportation industry V. Most commonly used flow measuring equipment in modern WTP and WSS. VI. Selection criteria of a flow meter VII. Selection of a proper location for the installation of flow meters VIII. Commissioning of flow meters
3	Training Programme on Flow Meters, Level Meters, LD equipment and NRW measuring for EAA	I. Leak Detection II. Flow meters / Level meters III. Demonstration on Leak Detection Equipment and Flow Meters
4	Training Programme on Operation and Maintenance Water Distribution Systems for Engineering Assistants	I. Introduction to Water Distribution Systems II. Operation of to water distribution Systems III. Maintenance to Water Distribution Systems IV. Repair of Pipeline Systems
5	Training Programme on Operation and Maintenance Water Distribution System	I. Introduction to Water Distribution Systems II. Design Parameters and material Used III. Operational Requirements IV. Water Loss management
6	Training Programme on Pipeline leakage Testing	I. Pipe laying basic requirements II. Back filling & problems encounter during pipe laying III. Pressure testing requirements IV. Maintenance requirements of pipe distribution systems

No.	Training Title	Contents
7	Training Programme on Strategies on NRW Reduction for EAA	I. Introduction to water loss management II. Sustainable water loss Management III. Physical loss Management IV. Detection of unauthorized consumption & legal procedures
8	Training Programme on Supervision of New Connection Procedures	I. Introduction to house connection procedures II. Related Board circulars III. Responsibilities of work supervisors IV. Handling of the direct labor/ sub-contractor V. Preparation of material list and quality of new connection work VI. Water meter fixing and sealing VII. Safety at Field
9	Training Programme on Under Pressure Water Main Tapping	I. Standard usage procedures of Tapping Equipment II. Proper tools & Equipment III. Maintenance & safety at work IV. Field Demonstration and hand on experience to pressure tapping machine
10	Refresher Course on Pipeline fittings and Specials	I. Introduction to pipeline construction II. Laying / jointing methods III. Pipeline specials and Different pipeline materials jointing
11	Training Programme on Construction of Transmission and Distribution Systems for Engineers	I. Introduction to Transmission & distribution systems II. Different types of pipe materials, Fittings, Valves, Specials III. Different types of pipe joints, Special joints IV. Details of Structures in Transmission / Distribution Systems V. Preparation, Excavation and Pipe Laying Methodologies VI. Instrumentation & Flow Measurement VII. Pressure Testing and Disinfection Procedures VIII. Commissioning handing over and taking over of newly constructed WDS IX. Capitalization of transmission and distribution systems
12	Training Programme on Pipeline Repairing Methods for Engineering Assistants	I. Importance of maintenance work II. Maintenance of Pipeline System III. Repairs to Pipeline System IV. Demonstration of Lead (PB) joint
13	Introduction of PE in place of UPVC for Engineers & EAA	I. Material Qualities of PE and Advantage of using PE pipes for Distribution II. Applying of PE pipes for Distribution systems III. Demonstration
14	PE pipe Connection Producers	I. Introduction to PE pipes and Specials II. PE pipes connection procedure III. Demonstration of PE pipe connection
15	Training Programme on PE pipe Laying and Service Connections	I. Properties of PE pipes II. Introduction to PE pipes and Specials Ill. Jointing methods of PE pipes & PE service connection IV. Demonstration

Source：JET prepared based on the document of MD&TD (English notation is same as original)

(4) Training implemented by RSC

In addition to the training provided by MD&TD, each RSC provides training. Training operations at the RSC (W-S) are conducted mainly by Training Officers belonging to the P&C Unit.

RSC provides training to the staff members of RSC and the target trainees are selected based on the training contents. RSC made a questionnaire survey to all staff members, about 800 persons, in order to know training needs. After that, at the meeting for determination of annual training programme, the training programme of both MD&TD and RSCs were discussed and finalized. Therefore, programme overwrap is rare.

The training courses implemented at all RSCs in 2018 include 14 technical training courses, 16 non-technical training courses, and 171 training sessions were conducted in 1 year. RSC (W-S) held 6 technical training courses, 11 non-technical training courses total 31 training sessions. One training session was held in 1 day.

4.1.2 Review result of training and Actual Construction

In 2018, NWSDB conducted training sessions related to the project activity 25 times at MD&TD and 6 times at RSC(W-S) by November. JET participated in some training sessions in November 2018. The result of review is described as follows. The training sessions JET participated are listed in Table 4.1.5. Also, JET inspected the construction site to consider the idea of practical training and design of TY. The constructions JET inspected are also shown in Table 4.1.5.

Table 4.1.5 Trainings Attended by JICA Experts

Date	Place	Details	
22nd October, 2018	Kawdana	Construction	Installation of 160mm PVC pipe (Rubber ring joint)
25th October, 2018	Homagana	Construction	Installation of 225mm PE pipe (Butt fusion) Connection of 20mm PE service pipe (Socket fusion) Connection of 20mm PVC pipe (Cementing) Tapping of PE pipe (Electro fusion)
30th October, 2018	Panadura	Construction	Connection of 20mm PE service pipe (Socket fusion) Tapping of PVC pipe (Branch saddle, Mechanical) Installation of 15mm water meter
1st November, 2018	Thelawara	Training	Method of non-revenue water management in distribution pipe network
8th November, 2018	Thelawara	Training	Installation of PE distribution pipe and service pipe
9th November 2018	Thelawara	Training	Hot tapping of PVC pipe
12th, 13th November, 2018	Ambathale	Training	Repair of water leakage of water conveyance pipe and distribution pipe
14th, 15th November, 2018	Thelawara	Training	Installation of water conveyance pipe and distribution pipe

Source：JET

The skilled RPs were conducting the training on their expertise at the training of leakage control in NWSDB. These training sessions were systematically implemented not only with classroom lectures but also with programs that include demonstrations and practical experience. The RPs have high capability, and they seemed to give lectures that attracted the participants' interest. They have made an effort to improve the training materials, which are prepared in English or Sinhala.

At the end of each training, RP delivered training evaluation questionnaire on training contents, RP, training materials, etc., and the results are fed back to next training.

The training contents incudes advanced lectures based on the actual situation of NRW management in NWSDB, such as theft of water and the quality of meter readers, etc. The hands-on learning for the pipe location/depth survey, buried valve survey has already been conducted, but it was not sufficient. The level of training was considered quite high as at the facility what they had.

On the other hand, in a drilling operation of construction site, an accurate and clean hole could be made by using a correct instrument. However, they sometimes used a hand drill for convenience, which causes problems such as improper drilling and/or generation of burrs. Also, the removal of burr at the edge of service pipe was not enough and some workers were wearing sandals in construction site.

MD&TD personnel talked at the interview that they worried about that some trainees did not implement the practice they learned at the training when they returned to work. Even if the trainees learned the right procedure, they won't get used to it. MD&TD mentioned 2 reasons, thus (1) no similar equipment at working place, and (2) negligence of staff. The main concern of the MD& TD was how to take measures to (2).

4.1.3 Recommendation for Future Training

As mentioned above, NWSDB provided well designed training sessions with experienced RPs. However, practical training for the trainees, which is necessary for improving skills, was hardly conducted. Therefore, it was thought that the training could be improved effectively by combining the conventional lecture room training and practical training in the TY which was planned to be constructed in this project.

It was said that the training by the experienced RP was not used fully at the site. One of the reasons was difficulty to understand and realize the procedure for the site work by classroom lecture. Therefore, the practice would be effective for skill improvement. On the other hand, it was also worth considering that the lecturer would check the status of the equipment owned by trainee's working place through a questionnaire during the training in order to enhance the applicability of training results.

Training should be designed with the consideration of trainees' specialty, i.e., the training for the field person like as fitters (plumber) and training for the engineer were different. JET recommended setting the respective training sessions for the purpose of skill upgrading of field person and the purpose of improvement of capacity of supervisor.

As a result of the JET's inspection of the training and construction site, JET considered necessary training contents shown in Table 4.1.6.

Table 4.1.6 Necessary Training Contents

	Training Item	Case of Real Situation at the Site
1	Practice of tapping by use of tapping equipment	Without using a drilling machine, holes were made with a handmade screw drill, it results in water leakage and water flow obstruction.
2	Providing the proper use of tools and work procedures for water pipe connection by practical training	Improper use of tools and construction management based on experience or intuition of plumber, it results in water leakage and water flow obstruction.
3	Providing the proper construction methods to prevent water leakage by PVC pipe joint training	There were some problems such as lack of careful check of pipe joints, excessive application of lubricant, presence of untreated burrs, etc.
4	Practical training for construction supervisors with an emphasis on Inspection of PE pipe joint completion	Inspection of joints is important, but only simple visual inspection was done

Source：JET

4.2 [Activity 3.2] Plan of practical training programmes on leakage control such as underground leakage control, pipe laying and jointing, service connection, and accumulation of data

4.2.1 Consideration of practical training and reflection to the design of training yard

The contents to be reflected into the practical training and design of TY from the above study are as below:

(1) Contents from the inspection of construction

- Regarding pipe jointing training
  - Existing pipe type and pipe fittings for distribution pipe and service pipe
  - Diameter of service pipe and water meter

- Regarding non-metallic pipe detection training
  - Installation of marker tape
- Regarding pipe jointing training
  - Method of water pressure test
- Regarding design of TY and procurement of materials
  - Specifications of service pipe
- Regarding leakage repair training
  - Repair materials for distribution pipe
- Regarding water meter training
  - Information about water meter which could be a good reference for water meter training
- Necessity of training of proper tapping works, jointing of service pipe, PVC and PE pipe

(2) Contents from the inspection of existing training sessions

- Necessity of organizing the training, which doesn't overlap with the existing training
- Training can utilize the TY

The training of this project covers not only training of installation and jointing of service pipe where typical leakage tends to occur but also tapping of service pipe which requires proper works. And the training No.7 "How to use the data obtained from pilot activity" was established to expand the knowledge and experience of Output 2 pilot activity.

Also, based on other basic training sessions and above knowledge, JET considered the items of practical training and designed the TY. The list of practical training at the TY is shown in Table 4.2.1. Accordingly, the TY was designed as Figure 4.2.1

Table 4.2.1 List of Practical Training (1/2)

Subject Area	Training Title	Contents
1. Leak Detection	a. Underground Leakage Survey b. Valve, Metal Pipe and Non-Metal Pipe Locating	- Leaking point survey of distribution and service pipe with acoustic listening stick and electric leak detection - Valve and leakage pit locating - service pipe & distribution pipe locating
2. Distribution Pipe Installation	a. HDPE Distribution Pipe Installation	- HDPE distribution pipe installation by Butt fusion joint and Flange joint - Under Pressure Tapping - Pressure test
	b. PVC Distribution Pipe Installation	- PVC distribution pipe installtion by Rubber ring joint, Solvent cement joint
	c. DI Distribution Pipe Installation	- DI distribution pipe installation by Push fit joint and Flange joint - Under Pressure Tapping - Pressure test
3. Service Pipe Installation	a. HDPE Service Pipe Installation	- HDPE service pipe installation by Socket fusion joint and Thread joint - Pressure test
	b. PVC Service Pipe Installation	- PVC service pipe installation by Solvent cement joint and Thread joint - Pressure test
4. Leak Repair	a. HDPE Distribution & Service Pipe Repair	- Leak repair of HDPE distribution pipe with repair clamp and coupling - Leak repair of HDPE service pipe with repair clamp, socket fusion, compression joint and hack joint
	b. PVC Distribution & Service Pipe Repair	- Leak repair of PVC distribution pipe with repair clamp and coupling - Leak repair of PVC service pipe with repair clamp and coupling
	c. DI Distribution Pipe Repair	- Leak repair of DI distribution pipe with repair clamp and coupling
	d. Valve and Accessory Repair	- Leak repair of gate valve, air valve and fire hydrant
5. Measurement	a. Water Meter	- Customer meter accuracy test
	b. Flow Measurement	-Flow measurement by ‘Ultrasonic flow meter’ and ‘Insert type electromagnetic flow meter' - Visualization of data
	c. Pressure Measurement	- Pressure logging and visualization of data
6. DMA	DMA Creation & Step Test	- Basic and Method of DMA creation Step test
7. How to use the data obtained from pilot activity	How to use the data obtained from pilot activity	- Knowledge about Non-Revenue Water - Implementation Steps of Pilot activities for Lekage reduction - Evaluation of DMA using indicator and making strategy for leakage reduction - Sustainable use of created DMA - Theoru and Practice of Pulse signal measurement for water flow monitoring

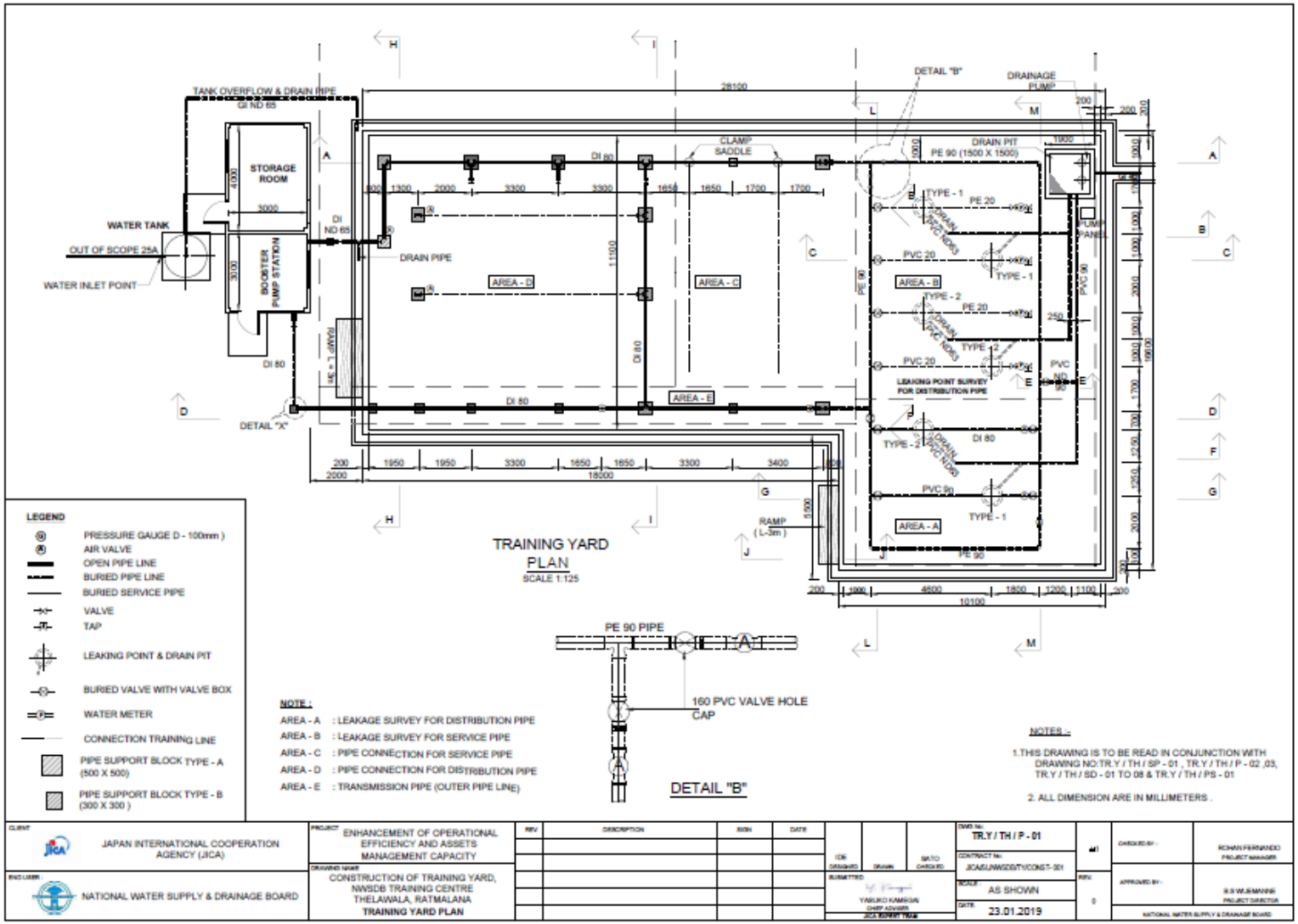


Figure 4.2.1 Plan of TY

4.2.2 Draft training guideline and curriculum

Based on the above draft of practical training, training guideline and curriculum have been prepared. To refine the training guideline and curriculum with RP, JET prepared the 1st draft and supported RP in revising them. Also, the training guideline and curriculum were revised based on the result of TOT of January 2020.

The training guideline and curriculum have each common table of contents and detailed information related to each training is written in accordance with these table of contents. Regarding the information written in the curriculum such as training flow, it was combined into training guideline in response to the comments of RP so that necessary documents will not be complicated.

The common table of contents is shown as below, and the draft of training guideline and curriculum are shown in Annex 3.

< Table of contents of a training guideline >

1	Outline
	1.1 Purpose
	1.2 Flow of training with time schedule
	1.3 Safety notice
2	Knowledge acquisition
	Details of the knowledge of each training such as characteristic of each training target, implementation way of training and points in actual construction management etc.
3	Practice
	The method to conduct training in TY such as Procedures, necessary materials and important points etc.

4.2.3 Achievement

The training guidelines was prepared without problems through the works with RP. Also, it was created as very practical one based on the current situation of NWSDB by reflecting the knowledge gained from the inspection and improving it after TOT. It is expected that NWSDB will improve their capacity of conducting training and practical skill significantly by utilizing this practical training. Therefore, the achievement level is 100%.

4.3 [Activity 3.3] Design a Training Yard

4.3.1 Concept of Training Yard

The TY has practical training facilities operated under MD&TD of NWSDB for training all staff members of NWSDB nationwide. The concept of TY was considered on the basis of training programmes, which is explained in Chapter 4.2 . Since this TY is under the technical assistance project, the construction is not the main purpose of the project. Therefore, the basic policy was that the facility is necessary and sufficient for practical training which could achieve the project purpose. On the other hand, the NWSDB side had information on TYs in Japan, Thailand, etc., and has very high expectations for the TY facilities, and

envisioned highly sophisticated facilities such as multi-story building, so in recognition of this, it took time to fill the gap.

JET explained the proposal of TY design and training contents that met the needs necessarily and sufficiently. After several discussions, finally both sides agreed on the design concept.

Figure 4.3.1 depicts the layout of TY which consists of 3 parts, and the facilities are divided into 3 parts for each training category. In addition, there are a pump house, water tank and a storeroom.

Pipe Connection Area	:	Training on connecting distribution pipes and service pipes for DI and resin pipes.
Leakage Survey Area	:	Training on how to use leakage detection equipment using buried pipes with artificially leaked holes. Buried pipe types are DI and resin pipes with 2 types pavement in order to represent the real situation at the site.
Flow Measurement Area	:	Practice of flow measurement and step test using exposed pipe

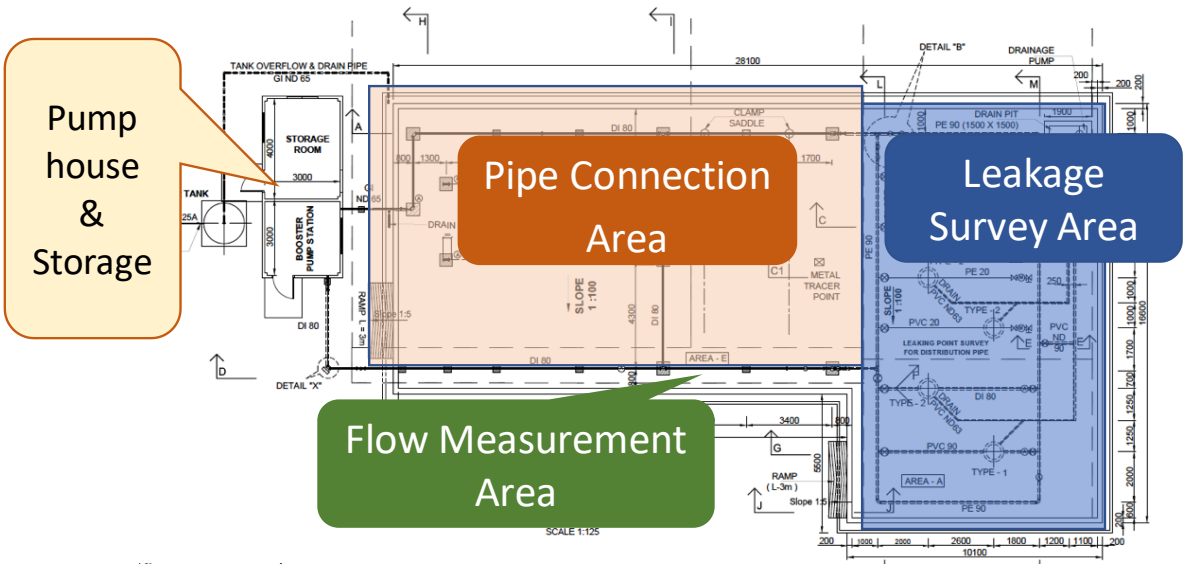


Figure 4.3.1 Layout of TY

The items that have been agreed upon after discussions are shown below:

(1) The minimum pressure is set to 0.5 bar, taking into account the needs of the NWSDB due to the fact that the water pressure is low.

(2) To consider the real situation of Sri Lanka, there are 2 types of pavement, i.e., concrete and asphalt.

(3) Pipe burying depth is 1m of NWSDB standard for distribution pipe, and 0.6 m for service connection. C/P requested the deeper depth, but JET explained the difficulty of hearing the leakage sound. Then, both parties agreed on the OJT by use of correlator at the site. However, the correlator's effectiveness will be checked at the site and its necessity will be evaluated.

(4) DI tapping will be conducted.

(5) Diameter of the pipe is 150mm maximum to consider its handling at training.

4.3.2 Specifications of Training Yard

As described in 4.3.1, both sides agreed on the concept of the TY design, and based on that, detailed design was prepared. The final specification is shown below

(1) Total System

- Layout: Water leak detection yard: Back side Piping connection yard: Front side
- Location of Pump Room : It is separated from leakage survey area to reduce the impact of disturbing noise in training
- Design leakage Water Flow：50 LPM – 100 LPM (L per min)
- Water Pressure：0.5 – 4bar (it is controlled by the pump outlet valve and end valve)
- Pump：One pump each for high pressure and low pressure for water leakage test, 1 large capacity pump for flow meter test, totaling to 3 pumps
- Water Tank：5 m^3 (Cylindrical tank, vertical installation)
- Water flow system: circulation type
- Installation of pressure regulating valve
- Flow meter for checking TY water flow: 1
- Flap type flow meter in pump house: 4
- Sunshade: Roof at the pipe connection yard is installed

(2) Leakage Survey Area

1) Survey of Distribution Pipe

- Pipe Type：DI, PVC
- Diameter：DI 80 mm, PVC 90 mm
- Depth：1 m
- Pavement：Asphalt

- Water Pressure：0.5 – 4 bar
- Artificial Leaking Method：Hole drilling

2) Survey of Service Pipe

- Pipe material：PVC、HDPE (Two each, Four total)
- Diameter：20 mm
- Buried depth：0.6 m
- Pavement：Asphalt and concrete
- Water Pressure：0.5 – 4 bar
- Artificial Leaking Method：Hole drilling

(3) Pipe Connection Area

1) Distribution Pipe Connection

<Specifications>

- Branching diameter：DI 80 mm
- Blanching point：2 points for straight pipe connection
- Blanching height：350 mm
- Pressure test： Pressurized by hand pump, pressure is NWSDB standard
- Countermeasure against thrust force： Concrete thrust block installation

＜Training Contents＞

- Pipe material：DI、PVC、HDPE
- Diameter：Basically DI 80 mm, PVC & HDPE 90 mm (Applicable for 150mm DI)
- Pipe connection distance：7.6 m (Extendable at the condition of no pressure)

2) Service Pipe Connection

<Specification>

- Branching diameter：20 mm
- Blanching point：2
- Blanching height：350 mm
- Pressure test：1.5 bar (by use of circulation pump) Pressure is determined based on NWSDB standards when implemented with hand pump

<Training Contents>

- Pipe material：PVC、HDPE
- Diameter：20 mm
- Pipe connection distance：more than 7 m
- Meter test：Applicable for both new one and aged one

3) Tapping (It is conducted at the pipe connection area, not at the outer main line)

<Specifications>

- Branching diameter：90 mm（PVC、HDPE）、80 mm（DI）150mm(DI)

The tapping from 63mm were observed at the site, so 63 mm will be considered for the training

- Pressure test：1.5 bar

<Training Contents>

- Pipe material：PVC、HDPE、 DI
- Diameter： 20 mm tapping from 90mm（80mm、150mm）It will be decided by consideration of actual condition
- Under-Pressure tapping branch: Conducted with a diameter of less than 50 mm

(4) Outer main pipeline

1) Specifications

- Pipe material：Buried pipe：HDPE, Exposed pipe：DI
- Diameter：HDPE 90 mm、DI 80 mm
- Buried depth：1 m
- Exposed pipe： Flow meter is installed upstream
- Detection Tape：It is buried at part of the outer pipeline near the leakage survey area (for metal detection training)
- Valves：Air valve, gate valve, adapter, coupling (for repair training)
- Others：Branch point for insertion type flow meter installation training

2) Notes for Training

- Flow measurement: Conducted by ultrasonic flowmeter (at the uppermost stream of the exposed pipe)
- Installation of insertion type flowmeter
- Metal detection： Marker Tape and buried valves
- Non-metal pipe detection： Conducted at the outer distribution pipe (buried PE pipeline)
- Repair of valves：Conducted at pipe connection area
- Step Test：Step test can be performed to divide the area by valve operation

4.4 [Activity 3.4] Set up a Training Yard

4.4.1 Selection of Contractor

For the selection of contractor, the following conditions were taken into account for the making short list in order to select a contractor with the capability to ensure the quality of construction work by the information of C/P ‘s contractor registration information and past performance record.

- Trustable company or organization

- Registered in the Construction Industry Development Authority as a contractor in Sri Lanka in the field of water and sewage, and its grade must be C4 or higher
- Similar work experience in the past
- Having enough engineers and technicians to perform the work with sufficient quality

The progress in time series is shown below.

7th March 2019 JET sent bid invitations to the 10 short listed companies.

15th March 2019 JET held pre-bid meeting for the above companies. 8 companies participated.

10tth April 2019 at 3:30 pm Tender closed, 2 bids were submitted.

15th April 2019 JET requested Finite which was the 1st bidder to submit documents for bid confirmation

21st April 2019 Terrorist incident

8th June 2019 JET sent a letter of award

5th July 2019 Contract was signed

17th July 2019 Construction commencement

In response to the terrorist attack that occurred in Sri Lanka on April 21 2019, JICA suspended fielding JET until late June, and JET thought that the JET's supervision was needed both demonstration of proper construction management (supervision) and ensuring workmanship of the works. Therefore, JET suspended signing the contract until release of suspension, or the date of signing on 5th July 2019.

4.4.2 Input on Construction

Both sides bear the cost for construction as follows:

<Japanese side>

- Basic design and detailed design
- Making bidding document
- Construction management
- Cost of construction
- Assignment of 2 construction supervising experts (civil and M&E)
- One local staff members for construction management

<Sri Lankan side>

- Provision of land of constriction and temporary yard
- Land clearing
- Removal of buried object
- Assignment of construction supervisor
- VAT and custom duty

4.4.3 Summary of Progress

After the signing of contract on 5th July 2019, the construction was commenced on 17th July 2019 and the scheduled completion date was of 3rd December 2019.

Since it is the first facility in Sri Lanka to intentionally generate water leaks to listen to sound, JET examined the procedure to generate leak sound to meet the purpose and how to treat the drainage. Under the guidance of JET, the temporary test facility was prepared, and 3 different size holes were drilled to determine the appropriate hole size and protective measures for holes.

After starting construction, a progress meeting was held every other week, in which the contractor, JET and NWSDB staff participated for checking process and quality control. The rainfall of this year continued during the expected dry season from July to August, and it caused considerable delays in foundation work. The construction supervision experts instructed the contractor to take the following measures to catch up.

- Extension of construction time in a day and weekend
- Increase of the number of workers (already increased, but instructed to further increase the number of workers and the team structure)
- Input of heavy machinery
- Early implementation of works that can be brought forward
- Multiple work simultaneously

However, the progress of the construction could not be recovered, furthermore, it took. time to procure pumps with special specifications, so the construction period had to be extended. JET reviewed the construction plan again, and flexibly changed the assignment schedule of construction management expert who should supervise special constructions such as leak pipe installation for the quality management purpose.

The completion inspection was conducted with NWSDB on 17th January 2020. The construction was completed on condition that minor defects would be corrected. On 22nd January 2020, NWSDB hosted the completion ceremony, and invited many guests from Japan (Embassy and JICA) and NWSDB.

Photo 4.4.1 Whole Picture of TY

4.4.4 Plan of ADB

ADB is currently conducting a large-scale building construction project as a subproject of GCWWMIIP (Greater Colombo Water and Wastewater Management Improvement Investment Program) in the vicinity, including training rooms and accommodations, specifically for NWSDB training purposes from November 2016 to October 2022. ADB is planning to construct training facilities at the immediate area of the JICA TY by use of a part of the above budget to cover the NWSDB requested facilities which had not been covered by the JICA project, such as the facilities for pipe connection of large-diameter pipes, repair of valves, installation of water supply facilities, and pipe laying training, etc. The design concept is supplemental facilities of JICA-supported part, and the curriculum will be created in line with the concept of Japanese side. JET provided information of design of the TY and summary of curriculum to the ADB project team. JET also participated in the discussion session with NWSDB staff, which was conducted during the design concept study stage in December 2019 and made comments. Originally the completion was planned within 2020, but it has been delayed due to the COVID-19 pandemic and the tender documents are under preparation as of the end of this project.

4.5 [Activity 3.5] Select candidates for RP

4.5.1 Selection of Candidates

Prior to the selection of candidates for RP, JET collected information with C/P about NWSDB staff that have experience of our practical training and selected proper RP for this project out of experienced NWSDB staff. Also, JET proposed to assign multiple people to some training sessions since it was assumed that RP can't participate in the training due to their regular work sometimes.

As a result of the discussion with C/P, manager of the whole training was selected. Also, C/P commented that one RP, Fitter and Helper is appropriate for 15 trainees considering the perspective of economy and training efficiency. In response to this comment from C/P, JET proposed to add an Assistant RP to the trainer side, and it was decided that the member of trainer side consist of RP, Assistant RP, Fitter and Helper. When trainees are divided into some groups, Fitter and Helper have the important role to assist and confirm the actual works of all groups. Therefore, JET assigned a fixed Fitter and Helper also to each training so that Fitter and Helper can get used to the training method and assist the trainee's actual works properly.

Selected RP and responsible training are shown in Table 4.5.1.

Table 4.5.1 List of RP and their responsible training

Subject Area	Training Title	RP	Assistant RP	Fitter	Helper	Administration work
1. Leak Detection	a. Underground Leakage Survey b. Valve, Metal Pipe and Non-Metal Pipe Locating	Mrs. Manel Thilakarathne Mr. Pradeep Perera Mr Kasun Roopasinghe Mr Upul De Silva	Mr Pradeep De Silva Mr. Chandana Epa Mr Lenin Eshwarage	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	Ms Dedunu Wimalasiri, Ms Niranjala Gamage
2. Distribution Pipe Installation	a. HDPE Distribution Pipe Installation	Mr Mahinda Kumara Mr. R Y S Manathunga Mr K M K G Karunarathne	Mr A P B Senevirathne Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	b. PVC Distribution Pipe Installation	Mr. H M Abeykoon Bandara Mr Saman Duwegoda	Mr. Janaka Karunamuni Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	c. DI Distribution Pipe Installation	Mr Anurudda Perera Mr Saman Duwegoda	Mr G P R Abhayawardene Mr V O Athuruliya Mr Kasun Kaushalya, Mr H K Deshappriyaa Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
3. Service Pipe Installation	a. HDPE Service Pipe Installation	Mr Mahinda Kumara Mr. R Y S Manathunga Mr K M K G Karunarathne	Mr A P B Senevirathne Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	b. PVC Service Pipe Installation	Mr H M Abeykoon Mr saman Duwegoda	Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
4. Leak Repair	a. HDPE Distribution & Service Pipe Repair	Mr Mahinda Kumara Mr. R Y S Manathunga Mr K M K G Karunarathne	Mr A P B Senevirathne Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	b. PVC Distribution & Service Pipe Repair	Mr. Saman Duwegoda Mr. L P Horanage	Mr Pradee De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	c. DI Distribution Pipe Repair	Mr. Saman Duwegoda Mr. L P Horanage Mr. Anurudda Perera	Mr G P R Abhayawardene Mr V O Athuruliya Mr Kasun Kaushalya, Mr H K Deshappriyaa Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	d. Valve and Accessory Repair	Mr. Saman Duwegoda Mr. L P Horanage	Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
5. Measurement	a. Water Meter	Mr. W A G D Jayaruwan	Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	b. Flow Measurement	Mr. Manju Malkelum	Mr Pradeep Perera Mr Chamara Perera Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
	c. Pressure Measurement	Mr. Manju Malkelum	Mr Pradeep Perera Mr Chamara Perera Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
6. DMA	DMA Creation & Step Test	Mrs Manel Thilakarathne Mr Pradeep Perera Mr Kasun Roppasinghe Mr Upul De Silva	Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	
7. How to use the data obtained from pilot activity	How to use the data obtained from pilot activity	Ms Samudi Nirasha Mr L H Horanage Mr. Chandana Epa Mr Janaka Karunamuni Mr Ajith Alwis	Mr Pradeep De Silva	Mr P G Gunasena	Mr Kasun Kostha Mr Gihan Fernando	

4.5.2 Achievement level

Regarding selection of RP and assignment of responsible training, JET could conduct them utilizing each experience without problems through the discussion and interview with C/P and RP. Therefore, the achievement level is 100%.

4.6 [Activity 3.6] JICA Experts conduct TOT for the RP

4.6.1 Plan of TOT

TOT was conducted after completion of construction of TY in January 2020. JET taught RP the operation method of TY and the way to instruct the trainees in practical training. The outline of TOT is as below.

- TOT
  - Date: 17th – 27th January 2020
  - Trainer: JET
  - Participant: RP and non- RP selected by MD&TD
  - Details: JET taught the way to conduct practical training in TY to RP. JET and RP improved training guideline based on the knowledge gained by using those documents in practical training.

In the TOT held in January 2020, some training sessions could not be conducted due to the delay in delivery of equipment by contractor of TY. Therefore, JET conducted supplementary TOT for those incomplete training sessions from July 2020. The details of supplementary TOT is shown in 4.6.3 .

RP conducted the rehearsal of training after the completion of TOT or supplementary TOT. JET confirmed the procedures of training and capacity of RP in rehearsal. After the rehearsal, JET confirmed the issues about training contents with RP and proposed solutions to the issues. If detailed discussion was necessary to confirm the RP's idea and consider the solutions, JET held a review meeting with C/P and RP.

Originally, JET planned to conduct these activities in person, but since the limitation of dispatch of experts was imposed due to the COVID-19 pandemic, JET conducted them through e-mail and Web meeting. Also, JET adopted methods to enhance the effectiveness of remote work such as creating training videos, recording RP's training sessions by video camera and considering improvements through the recorded video.

4.6.2 Details and Output of TOT

JET conducted TOT for total 6 days from 17th to 27th January 2020 and conducted total 17 practical training sessions. Time schedule of TOT was divided into morning session and afternoon session and some TOT were conducted for a whole day depending on the volume of training contents. Regarding flow of TOT, JET explained the training contents based on the training guideline in training room at first, conducted practical training in TY and confirmed the necessary revision of guideline and understanding of training contents in training room.

Almost all scheduled practical training sessions were conducted in TOT. JET was able to teach how to use TY and equipment, important point of technical procedure. It was, therefore, confirmed that almost all participants acquired methods for conducting practical training in TY sufficiently. In addition to this, JET provided training on how to use the equipment which participants had never used before and important points to conduct proper procedures. Many participants acquired knowledge about leakage survey, pipe installation and so on. Moreover, participants asked a lot of questions about methods and TY, so it is confirmed that the participants have high willingness to participate in this TOT.

On the other hand, regarding the part of TOT, JET could not conduct practical training with participants due to the shortage of time caused by lack of experience of participants about the practical training, delay of delivery from contractor of TY and so on. JET, therefore, decided to conduct supplementary training with participants.

The details, outputs and so on of all TOT are shown in Table 4.6.1.

Table 4.6.1 Details and Outputs of TOT

1-a. Underground Leakage Survey	
Detail	Lecture, Leakage survey of distribution pipe and service pipe with listening stick and leak detector, Leakage survey with the different water pressure
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Nothing
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
Correlation water leak detection	
Detail	Lecture, Leakage survey with correlator
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Specify the advantages and disadvantages of correlator
Future plan	Correlator didn't show performance under the pressure of 1 bar which is general pressure of water supply in Sri Lanka. It is confirmed that correlator shows performance when water pressure increased 4 bar. The average pressure in Sri Lanka, however, is about 1 bar so practical training of 4 bar has not reproduce general situation of water supply in Sri Lanka and doesn't have enough effect as training. Therefore, JET discussed with RP and decided not to adopt this training to MD&TD training.
1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	
Detail	Lecture, Metallic, non-metallic pipe and valve detection with metal detector and pipe locator
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Specify how to use equipment and important point of training
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
2-a. HDPE Distribution Pipe Installation	
Detail	Lecture, Pipe cutting, Butt fusion welding connection, Flange & coupling connection
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently. However, JET will teach remaining practical training sessions such as butt fusion welding connection, pressure test and tapping in supplemental TOT since JET couldn't conduct them in this TOT due to the request of equipment by RP and shortage of materials.
Request from participant	Use of hydraulic type butt fusion welding machine
Necessary additional training	Butt fusion welding connection, Pressure test, Tapping
Revision of guideline	Revise the necessary materials, specify how to connect pipes by butt fusion welding
Future plan	JET will consider the details of requested equipment, prepare necessary materials, conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.

2-b. PVC Distribution Pipe Installation	
Detail	Lecture, Pipe cutting, Rubber ring & solvent cement connection
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Preparation for heat
Necessary additional training	Nothing
Revision of guideline	Nothing
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
2-c. DI Distribution Pipe Installation	
Detail	Lecture, Flange connection, Pressure test
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently. However, JET will teach remaining practical training sessions such as socket & coupling connection and tapping in supplemental TOT since JET couldn't conduct them in this TOT due to the shortage of materials.
Request from participant	More complex DI connection training
Necessary additional training	Socket & coupling connection, Tapping
Revision of guideline	Nothing
Future plan	JET will prepare necessary materials, conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.
3-a. HDPE Service Pipe Installation	
Detail	Lecture, Socket, thread, hack & compression connection
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Pressure test
Revision of guideline	Nothing
Future plan	JET will prepare necessary materials, conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.
3-b. PVC Service Pipe Installation	
Detail	Lecture, Socket & thread connection, Pressure test
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Record connection training of Japan training in Nagoya city and utilize the video for future TOT
Necessary additional training	Nothing
Revision of guideline	Add checklist for proper procedure
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
4-a. HDPE Distribution & Service Pipe Repair	
Detail	Lecture, Socket, thread, hack and compression connection, Installation of repair clamp
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Nothing

Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
4-b. PVC Distribution & Service Pipe Repair	
Detail	Lecture, Installation of repair clamp, Distribution & service pipe cutting, Repair with coupling
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Nothing
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
4-c. DI Distribution Pipe Repair	
Detail	Lecture, Installation of repair clamp, Pipe cutting, Repair with coupling
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Add photo to guideline
Necessary additional training	Nothing
Revision of guideline	Add photo to guideline
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
4-d. Valve and Accessory Repair	
Detail	Lecture, Repair of air valve
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently. However, JET will teach remaining practical training sessions such as valve repair in supplemental TOT since JET couldn't conduct them in this TOT due to the shortage of materials.
Request from participant	Repair of fire hydrant
Necessary additional training	Repair of valve and fire hydrant
Revision of guideline	Write about repair of fire hydrant
Future plan	JET will prepare necessary materials, conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.
5-a. Water Meter	
Detail	Lecture, Installation of water meter, Measurement with test meter, Reading water meter
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Nothing
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
5-b. Flow Measurement	
Detail	Lecture, Water flow measurement with ultra-sonic flow meter, Data visualization
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently. However, JET will teach remaining practical training sessions such as

	water flow measurement with insert type flow meter in supplemental TOT since JET couldn't conduct them in this TOT due to the shortage of materials.
Request from participant	Nothing
Necessary additional training	Water flow measurement with insert type flow meter
Revision of guideline	Specify how to use equipment
Future plan	JET will prepare necessary materials, conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.
5-c. Pressure Measurement	
Detail	Lecture, Installation of pressure logger, Data acquisition
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently. However, JET will teach remaining practical training sessions such as data analysis in supplemental TOT since JET couldn't conduct them in this TOT.
Request from participant	Nothing
Necessary additional training	Data analysis
Revision of guideline	Nothing
Future plan	JET will conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.
6. DMA Creation & Step Test	
Detail	Lecture, DMA creation, Step test
Output	Participants acquired methods including the above for conducting practical training in TY sufficiently
Request from participant	Nothing
Necessary additional training	Nothing
Revision of guideline	Nothing
Future plan	JET will confirm whether RP can conduct practical training properly or not, and then, RP will conduct practical training as trainer.
7. Data collection *It was changed to "7. How to use the data obtained from pilot activity" later	
Detail	Lecture (data collection, data processing and update regarding NRW, pipe, repair and asset management)
Output	Participants acquired methods including the above for conducting this training in TY sufficiently. However, participants gave opinions that it is better not to adopt asset management to training, but to focus on the data collection and data processing. Therefore, JET will revise guideline into the one focused on the data collection and data processing of equipment and materials. JET will conduct the supplemental TOT.
Request from participant	Conduct training focused on the data collection and data processing
Necessary additional training	Training focused on the data collection and data processing
Revision of guideline	Revise guideline into the one focused on data collection and data processing of equipment and materials
Future plan	JET will conduct necessary additional training and confirm whether RP can conduct practical training properly or not, then, RP will conduct practical training as trainer.


Photo 4.6.1 TOT at TY

4.6.3 Supplemental TOT

JET conducted the supplemental TOT for the training contents which could not be partially conducted in TOT. The list of supplemental TOT is shown in the Table 4.6.2. Since it was difficult to teach the methods in person because of the limitation of dispatch of experts due to COVID-19 pandemic, JET created training videos for the training 2-a, 2-c, 3-a, 4-d and 5-c. Regarding the training 5-b, JET conducted supplemental TOT in person after the dispatch of experts. Regarding the training 7, supplemental TOT was conducted through a Web meeting from the perspective of utilization of the data which was collected by the output 2 pilot activity for NRW control.

Table 4.6.2 List of supplemental TOT

Subject Area	Training Title	Contents of Supplemental TOT
2. Distribution Pipe Installation	a. HDPE Distribution Pipe Installation	・ Butt fusion joint, Pressure test (Training video) ・ Under pressure tapping (Training video)
	c. DI Distribution Pipe Installation	・ Push fit joint (Training video) ・ Under pressure tapping (Training video)
3. Service Pipe Installation	a. HDPE Service Pipe Installation	・ Pressure test (Training video)
4. Leak Repair	d. Valve and Accessory Repair	・ Repair of gate valve (Training video) ・ Repair of fire hydrant (Training video)
5. Measurement	b. Flow Measurement	・ Flow measurement with insertion electromagnetic flow meter and data visualization (Supplemental TOT was conducted in Sri Lanka)
	c. Pressure Measurement	・ Data visualization (Training document of PowerPoint)
7. How to use the data obtained from pilot activity	How to use the data obtained from pilot activity	・ How to use the data obtained from pilot activity (Supplemental TOT through Web meeting)

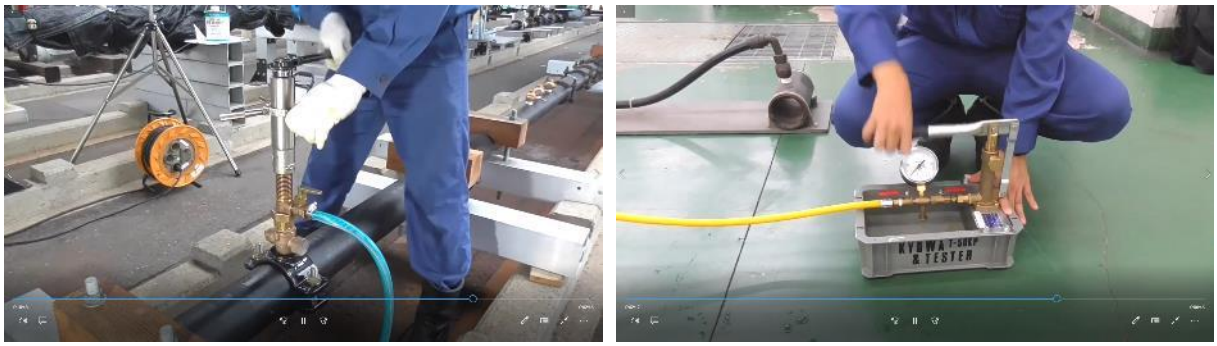


Photo 4.6.2 Training video

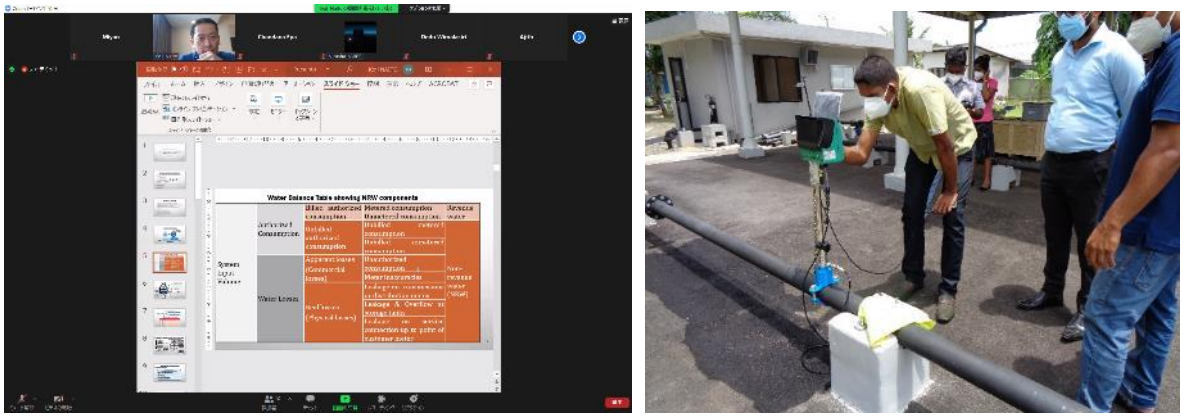


Photo 4.6.3 Supplemental TOT of No.7 (Left) and No. 5-b (Right)

4.6.4 Rehearsal and Review meeting

After completion of training TOT or supplemental TOT, rehearsal was conducted to confirm the procedures of training and capacity of RP. Also, JET, C/P and RP conducted the review meeting through a web meeting after the rehearsal and confirm the result and issues.

The result of rehearsal and review meeting is shown in Table 4.6.3. Although RP could conduct the proper procedures imitating the action of JET in TOT, some issues were found in the rehearsal because a long time passed since the last TOT due to the COVID-19 pandemic, or the rehearsal was conducted by RP only without the guidance of JET. JET confirmed those issues and proposed solutions to RP through e-mail or web meeting.

Table 4.6.3 Result of rehearsal and review meeting

Date	Item	Contents	Situation in the end of project
17th July 2020	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	It was difficult to listen the sound of leakage because water is pooling on the surface of leakage detection area of TY. Repairment of TY surface is necessary. The improvement of method of non-metal pipe detector is necessary because the sound is echoing	TY surface was repaired not to generate the water pool It was decided in the end that non-metal pipe locating is conducted in the service pipe next to the TY which can be detected

Date	Item	Contents	Situation in the end of project
28th July 2020	1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	It was confirmed that the training of non-metal pipe detector can be conducted well in the service pipe next to TY The training of detection of buried valve is difficult because the metal detector is affected by the buried DI pipe and buried beams of TY	It was decided in the end that non-metal pipe locating is conducted in the service pipe next to the TY which can be detected The metal detector which can erase the influence of other metals was procured in the 2nd phase.
30th July 2020	6. DMA Creation & Step Test	The valves of TY were cleaned because they got sand and didn't move. DMA creation and Step test was conducted without problems.	RP can conduct DMA creation and step test without problems
28th October 2020	Review meeting ・ 1-a. Underground Leakage Survey	JET and RP conducted a review meeting through web meeting and confirmed the result of rehearsal and RP's idea. As a result, experienced RP can detect the leakage, but it was difficult for inexperienced trainees to detect the leakage on the concrete surface due to the echo of sound. Therefore, JET proposed improvement plans such as reduction of water pressure, turning the volume of leakage detector down and revision of guidelines.	The guideline of underground leakage survey was revised. It was decided in the end that inexperienced trainees conduct the underground leakage survey from the asphalt surface, and concrete surface is conducted after trainees get used to the leakage sound.
	Review meeting ・ 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	It was confirmed that the detection of buried valve is difficult due to the effect of other metals. Therefore, valve will be buried again confirming the detectable depth, and a metal detector which consider the effect of other metals will be procured in 2nd phase. Regarding the non-metal pipe detector, JET will add the proper installation way of vibrator into the guideline because the sound of vibrator is too loud.	The metal detector which can erase the influence of other metals was procured in the 2nd phase. It is decided in the end that non-metal pipe locating is conducted in the service pipe next to the TY which can be detected
	Review meeting ・ 6. DMA Creation & Step Test	DMA creation and Step test were conducted without problems and RP understands the procedures of training sufficiently.	RP can conduct DMA creation and step test without problems
17th November 2020	Review meeting ・ 5-a. Water Meter	JET and RP conducted a review meeting through web meeting and confirmed the result of rehearsal and RP's idea. As a result, it was decided that the installation of bulk meter and more detailed photos of water meter are added into guideline.	Installation of bulk meter and more detailed photos of water meter were added into guideline. RP will conduct the training with the revised guideline.
30th December 2020	Review meeting ・ 5-a. Water Meter	Based on the previous review meeting, the installation of bulk meter and more detailed photos of water meter were added into guideline, and JET explained them to RP. RP will conduct the training according to the revised training guideline in TY in future.	Installation of bulk meter and more detailed photos of water meter were added into guideline. RP will conduct the training with the revised guideline.
2nd March 2021	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	JET added more detailed explanation of leakage detection on the concrete surface into guideline and RP conducted the improved method in TY. However, it was still difficult to narrow down the leakage point less than 1.5 m area. Also, regarding the non-metal pipe detector, although JET added the proper method of the installation way of	The guideline of underground leakage survey was revised, and finally RP is now able to detect the leakage point. The guideline of non-metal pipe locating was revised, and RP is now able to use the non-metal pipe

Date	Item	Contents	Situation in the end of project
		vibrator, the volume of sound is still loud, and it was difficult to detect the non-metal pipe. JET will consider the improvements again.	detector properly.
9th June 2021	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating	JET added the explanation about the way of reducing the volume of leakage detector, way of narrowing down the detection area and installation way of vibrator using cloths in guideline in detail. Also, local staff confirmed that the improved method works well. As a result of RP's trial of improved methods, RP could narrow down the leakage area on the concrete surface. But since it was still difficult for inexperienced trainees to detect the sound on the concrete surface, it was decided that RP will teach the way of leakage detection to trainees carefully and trainees will start the leakage detection from the asphalt surface so that trainees can get used to the sound of leakage steadily. Regarding the non-metal pipe detector, RP could reduce the volume of vibrator by the improved method. And it was decided to use the service pipe which is next to the TY because the service pipe of TY was too short to detect. Eventually, it was confirmed that RP can conduct this training smoothly with the improved methods.	The guideline of underground leakage survey was revised. It was decided that inexperienced trainees conduct the underground leakage survey from the asphalt surface, and concrete surface is conducted after trainees get used to the leakage sound. The guideline of non-metal pipe locating was revised, and RP is now able to use the non-metal pipe detector properly. It was decided that non-metal pipe locating is conducted in the service pipe next to the TY which can be detected

4.6.5 Capacity Assessment

JET created capacity assessment sheet (Annex 4) and conducted capacity assessment before TOT held in January 2020 and at the end of project activity in August 2021. The target of capacity assessment is RP. The target number of RP were changed due to the retirement, replacement and change of training contents during the project period. The assessment items were divided into 4 major categories. This capacity assessment was conducted by self-evaluation for each assessment items on a scale of 1 to 5.

The assessment items of capacity assessment are as below.

Table 4.6.4 Assessment items of capacity assessment

1. Planning training program

1-1 Capability of planning of training purpose and outline
1-2 Understanding of Training details
1-3 Understanding of training timetable
1-4 Understanding of procedure for evaluation of training outcome

2. Creating training document

2-1 Expertise knowledge
2-2 Capability of creating lecture material
2-3 Capability of creating presentation material

2-4 Capability of creating easily understandable document

3. Explanation

3-1 Teaching attitude
3-2 Explanation speed, loudness of voice, eye contact
3-3 Communication with participants
3-4 Explanation of document and materials
3-5 English level

4. Conducting practical training

4-1 Expertise knowledge
4-2 Capability of operation of general tools
4-3 Capability of manipulation of specific equipment
4-4 Capability of conducting proper method

(1) Result of assessment

The result of capacity assessment is shown in Table 4.6.5. Also, the result of average value of capacity assessment is shown in Figure 4.6.1. Many RP could improve their capacity through the project activity, in particular, RP feels that the capacity for conducting practical training was improved by the TOT in TY and implementation of practical training.

Table 4.6.5 Summary of result of Capacity Assessment

At the implementation of TOT (Janaury 2020)

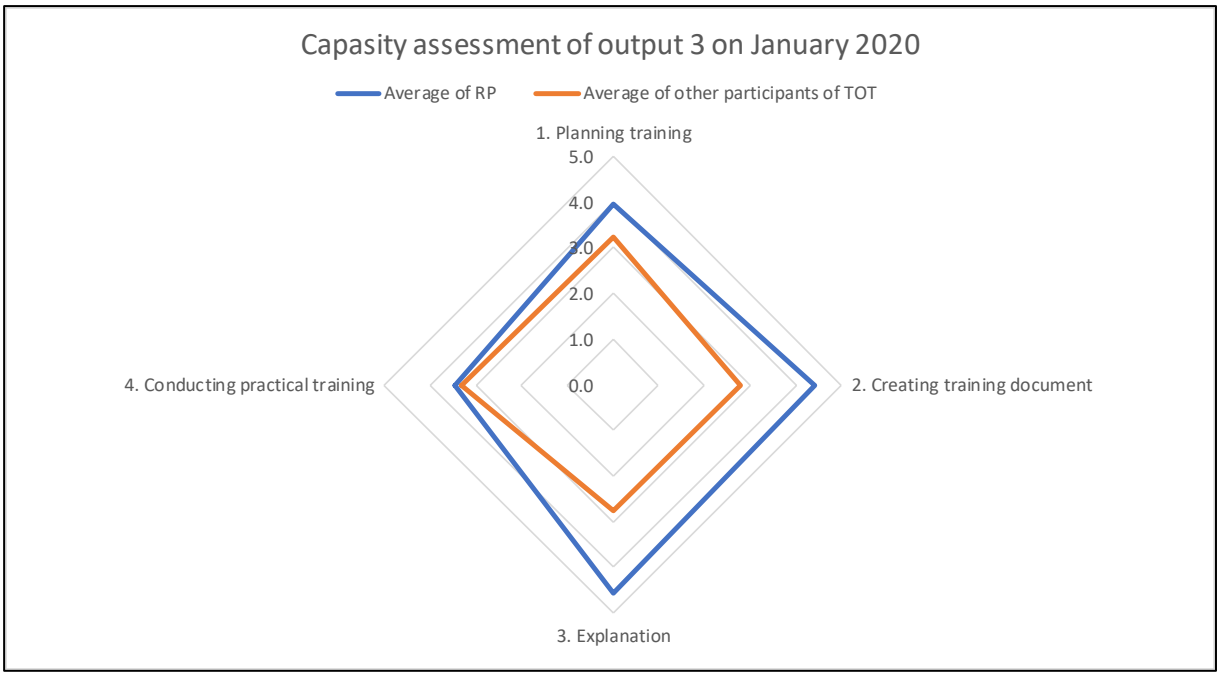
C/P Self evaluation		1. Planning training	2. Creating training document	3. Explanation	4. Conducting practical training
RP	A	3.3	4.0	4.4	3.3
	B	3.3	4.0	4.8	3.3
	C	4.0	5.0	5.0	3.3
	D	3.3	3.8	4.2	3.0
	E	4.8	4.8	4.0	4.3
	F	5.0	5.0	5.0	4.3
	G	3.8	4.5	4.4	2.3
	H	4.5	4.3	4.6	4.3
Average		4.0	4.4	4.6	3.5

At the end of project works in Sri Lanka (August 2021)

C/P Self evaluation		1. Planning training	2. Creating training document	3. Explanation	4. Conducting practical training
RP	A	5.0	4.3	4.6	4.5
	B	4.0	4.3	4.8	4.5
	C	4.0	5.0	5.0	4.5
	D	4.0	4.0	4.4	4.0
	E	3.8	4.8	4.0	3.0
	F	5.0	4.8	4.8	5.0
	G	4.0	5.0	5.0	4.0
	H	4.5	5.0	4.2	5.0
	I	4.8	5.0	4.8	5.0
	J	4.0	4.0	4.8	4.0
	K	4.0	3.8	4.0	4.0
	L	4.0	3.3	4.8	3.8
	M	5.0	4.0	4.4	5.0
Average		4.3	4.4	4.6	4.3

*The number of RP were changed from TOT in January 2020 due to the retirement, replacement and change of training contents

* Red color: Higher than 4 points



*1: Poor, 3: Moderate, 5: Excellent

Figure 4.6.1 Results of capacity assessment

(2) Evaluation by category

1. Planning training program: It was confirmed during the implementation of TOT that the RP has a certain level of capacity for planning training program as of the beginning of the project since they are already conducting a lot of lecture type training. After that, RP learned the procedures of practical training in TY in detail and they are now understand the concrete procedures of training such as method of actual works and necessary time schedule. Therefore, it is agreed that RP's capacity for planning training program was improved as of the end of the project.
2. Creating training document: It is confirmed that RP have a high-level capacity for creating training documents as of the beginning of the project since they are aiming to conduct training which trainees can understand easily. In this project, JET revised training guidelines with RP and it is considered that RP acquired the experiences and knowledge about creating training documents as of the end of the project.
3. Explanation: As described above, it is confirmed that RP has a high-level capacity for explanation as of the beginning of the project since they are already conducting a lot of lecture type training sessions. Since JET instructed the way to conduct the practical training in TY, the result of capacity assessment in August 2021 also shows high score and it is confirmed that RP has confidence to explain the procedures of practical training as of the end of the project.
4. Conducting practical training: RP didn't have the confidence to conduct the practical training as of the beginning of the project because they were conducting only demonstration in training. After that, RP feels that the capacity for conducting practical training was improved by the learning and practice of method to use the TY and equipment in the TOT and practical training. Therefore, it is said that RP has the enough capacity for conducting practical training as of the end of the project.

4.6.6 Achievement

TOT, necessary supplemental TOT and rehearsal for each training were completed and NWSDB is now ready to conduct the practical training by themselves. Therefore, the achievement level is 100%.

4.6.7 RP certification system for securing next generation RP

The scheme of certification of RP in MD&TD was to select the candidate of RP from the experienced staff in each division and register the staff as RP. Therefore, MD&TD didn't have the criteria and systematic scheme to select the RP. MD&TD was selecting the appropriate person for RP by discussing with other divisions each time. Furthermore, RP didn't have the recognition as a trainer occasionally and some RP were reluctant to conduct the training because they were busy due to the regular work. Also, MD&TD recognizes the current scheme to search the RP at the timing of recruitment of new RP is inefficient and the system to select the RP with the clear criteria is necessary.

In the context of the above situation, JET and C/P created RP certification system to select the RP with the clear criteria.

The RP certification system consists of documentation screening, implementation of TOT if necessary and evaluation of competence by a MD&TD panel. A candidate of RP is rated with the evaluation points based on experience and capacity for conducting practical training in each step, and eventually, the candidate is certified based on 4 grades of RP or assistant RP according to the acquired points. After the RP certification, MD&TD panel continues to evaluate the RP based on the number of conducted training sessions as trainer and improved capacity periodically, and the RP who acquires high score can get promoted to the higher grade of RP. It is expected that this system contributes to motivate the RP to conduct the training sessions. RP certification system is planned to be included in the concept paper of the "Water Excellent Center" which is the MD&TD's future training unit.

The RP certification system is shown in Table 4.6.6.

Table 4.6.6 RP certification system

Step 1. Recommendation of candidates from related division of NWSDB

Open invitations are sent by MD&TD to interesting, qualified persons to conduct training courses and practical sessions for NWSDB staff.

Step 2. Documentation screening by MD&TD like below

MD&TD evaluates candidate comprehensively based on the following items.

- ✓ Trainer qualifications – 20 points
  - 20 points: PhD
  - 17 points: M. Degree/PG Dip
  - 15 points: Degree
  - 10 points: Diploma
  - 5 points: Certificate course or any other
- ✓ Trainer Experience in relevant field – 25 points
  - 25 points: 15 years or more
  - 20 points: 10-14 years
  - 15 points: 5-9 years
  - 10 points: 2-4 years
- ✓ Recommendation from manager of department which the candidate currently belongs to – 5 points

  < Perspective of evaluation >

  i. Motivation for guidance and training of other staff
     - Motivation to share one's knowledge to other staff
     - Brief and kind explanation

  ii. Confidence from other staff
     - Wide range of knowledge and skill
     - Suitable advice to other staff
     - Reliance from other departments

  iii. Motivation of self-development about water works and trainer
     - Motivation to conduct training or seminar as trainer
     - Motivation to study of work in water supply

  iv. Involvement of activities related to training area and hence have up to date knowledge

  The candidate has been involved in the activities related to training area and has up to date knowledge

Step 3. Attendance at TOT (if necessary)

MD&TD arranges TOT for candidate of RP time to time when the candidate will be assigned as RP of actual training in TY.

<Key learning point >

- ✓ Acquiring knowledge about related guideline, equipment and actual site
- ✓ Skill acquisition about procedure and preparation of training, way of effective instruction

Step 4. Evaluation of competence of RP by a MD&TD panel like below

i. Conducting a discussion with candidate of RP by a panel appointed by MD&TD to identify the competence of the candidates – 20 points

< Perspective of evaluation >

Presentation skills, Ability to make documents, Knowledge related to the subject area, actual site and customer services, Ability to conduct practical training in TY (If the candidate will be RPs of training

in TY) etc.

The interview panels should represent by:

- AGM (MD&TD)
- 2 Subject Matter Experts
- 2 Trainees

ii. Periodical Assessment of RPs – 30 points

In order to encourage the RPs, and to evaluate the competence level, an assessment will be conducted by a panel

< Perspective of evaluation >

Similar capacity as Step 4.i. like below

- Number of training programmes or training hours conducted
- Varity of subject areas
- Assist MD&TD to develop new curriculums
- Feedback from trainees etc.

Step 5. Issuance of certificate

Certified RPs are registered, and the participation of training is prioritized.

Also, the RPs are rated based on the following RP Grading System which is consist of the points earns from Step 1 – Step 4.

- Points above 80. -Master RP
- Points 71-80-Grade 1 RP
- Points 61-70- Grade 2 RP
- Points 51-60 -Grade 3 RP
- Points less than 50-Assitant RP

The RP can gradually promote up to Master RP according to their training experience (according to the points earn from Periodical Assessment of RPs)

4.7 [Activity 3.7] Implement the practical training programmes

The practical training programmes will be conducted in 2nd term of this project due to the delay of construction of TY.

RP who has understood the implementation procedures of training conducted the practical training with trainees as a trainer.

4.7.1 Point of practical training

Following points was considered for conducting practical training successfully.

- Theme of practical training is determined based on the needs and characteristics of trainees.
- C/P and JET consider the incentive mechanism to motivate positive participation for further skill improvement. Issuing official certification is considered such as certification of attendance, license of technique, etc.
- C/P and JET consider the management method of training guideline so that the guidelines will be

revised as necessary in future

- To obtain the budget for following year, JET assists the budgeting based on the number of expected trainees and training frequency.

4.7.2 Implementation of practical training

The practical training was conducted by MD&TD from August 2020. However, MD&TD could conduct only limited number of practical training sessions in the project period because the training which people gather in TY was prohibited and NWSDB staff working in the office was limited due to the start of COVID-19 pandemic from the beginning of 2020.

As a result of the discussion with C/P, trainees were divided into “Engineer and Engineer assistant” and “Fitter”. The former training focus on the management of construction and the latter training focus on the construction skills.

When the implementation of practical training, MD&TD confirmed the needs of trainees by distributing the questionnaire of Google forms to each division. It indicates that MD&TD is willing to make the training sessions better.

The target trainee groups and training contents are shown in Table 4.7.1 and the outline of implemented practical training sessions is shown in Table 4.7.2.

Table 4.7.1 Target group and contents

Target	Purpose	Contents
Engineer Engineer Assistant	Strengthen the construction management capacity	Trainee learns the important points to guide contractor and check the construction.
Fitter	Strengthen the construction capacity	Trainee obtains the skill of correct construction procedures. Mother language training

Table 4.7.2 List of implemented practical training

Date	Training	Outline	Situation at the end of project
18th August 2020	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test	The leakage detection, detection of buried valve and non-metal pipe detection were conducted. About 12 trainees such as assistant engineer of NWSDB participated. The training was well received by participants because it was good opportunity to learn the method of leakage detection and way to use equipment.	Since the issues about underground leakage survey, metal and non-metal locating were confirmed in the training, guideline was revised and now this training can be conducted without problems. (Refer Table 4.6.3 for details)
9th September 2020	1-a. Underground Leakage Survey 1-b. Valve, Metal Pipe and Non-Metal Pipe Locating 6. DMA Creation & Step Test	The leakage detection, detection of buried valve and non-metal pipe detection were conducted. About 14 trainees such as assistant engineer of NWSDB participated. Participants commented their appreciation about the timely explanation of way to use the necessary equipment for them even though it was under the COVID-19 pandemic. On the other hand, participants requested the prevention measures for noise in TY and	Since the issues about underground leakage survey, metal and non-metal locating were confirmed in the training, guideline was revised and now this training can be conducted without problems. (Refer Table 4.6.3 for details) The

Date	Training	Outline	Situation at the end of project
		leakage detection on the soil and gravel surface.	noise of works around TY and training will be adjusted properly and leakage detection on the soil and gravel surface are not conducted in this TY.
22nd September 2020	5-a. Water Meter	About 14 trainees such as assistant engineer of NWSDB participated. The training of water meter with the portable water meter test kit was conducted without problems. However, participants requested more detailed information about water meter and other test method of water meter.	Installation of bulk meter and more detailed photos of water meter were added into guideline. (Refer Table 4.6.3 for details)
30th September 2020	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair	About 14 trainees such as assistant engineer of NWSDB participated. Installation of HDPE distribution and service pipe, repair of HDPE pipe were conducted smoothly, but some equipment and consumables were not enough.	Necessary equipment and consumables were procured in the 2nd phase of this project and RP is now able to conduct this training without problems.
4th March 2021	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair	The explanation of basic knowledge of HDPE pipe, installation of distribution and service pipe, repair of HDPE pipe were conducted. About 18 trainees such as assistant engineer of RSC (W-S) participated. The training was well received by participants because most of participants were office worker, and it was good opportunity to learn the method of actual site.	There were no problems and RP is now able to conduct this training without problems.
15th March 2021 – 2nd April 2021	Plumber training	This training was conducted as an original training of NWSDB for the plumber of private company and NWSDB fitter. It was conducted total 15 days from 15th March to 2nd April. The training contents consist of lectures about service pipe system and basic knowledge of drawings, tools and installation, practical training of DI, PVC and HDPE pipe in TY. The developed training module by this project was utilized in this plumber training. In this training, the RP always talked to the participants and participants proceeded the works discussing each other. On the other hand, there were some issues about the safety, improvements of training procedures and increase of the number of trainer side.	JET explained the issues about the safety and improvements of training procedures to RP. The necessary staff of trainer side was secured.
7th April 2021	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution &	The explanation of basic knowledge of HDPE pipe, installation of distribution and service pipe, repair of HDPE pipe were conducted. About 45 trainees such as assistant engineer of RSC (W-S) participated. The training was well received by participants because most of participants were office workers, and it was good opportunity to learn the actual method of HDPE pipe	There were no problems and RP is now able to conduct this training without problems.

Date	Training	Outline	Situation at the end of project
	Service Pipe Repair	installation.	
13th July 2021	2-a. HDPE Distribution Pipe Installation 3-a. HDPE Service Pipe Installation 4-a. HDPE Distribution & Service Pipe Repair	The explanation of basic knowledge of HDPE pipe, installation of distribution and service pipe, repair of HDPE pipe were conducted. The training was conducted through web meeting because the training which people gather was prohibited due to the COVID-19. About 12 trainees such as engineer and assistant engineer of OIC office participated. The training contents were so detailed one that the satisfaction level of participants was very high. However, since it was online training, participants commented that they want to attend the practical training next time.	Since the COVID-19 situation was not good until the end of the project, the actual training for the participants of this program will be conducted in future.
3rd August 2021	7. How to use the data obtained from pilot activity	Output 2 C/P conducted the training as trainer about "How to use the data obtained from pilot activity for NRW reduction". About 20 trainees such as engineer and assistant engineer of RSC(W-S) participated. The training contents were so detailed, including the definition of NRW, method of NRW control, way to create DMA and way to conduct step test. The satisfaction level of participants was so high because the participants could learn a valuable information.	There were no problems and RP is now able to conduct this training without problems.

4.7.3 Incentive mechanism

Incentive mechanism was considered to motivate the NWSDB staff to participate in training sessions and conduct the proper method in actual site. The considered incentive mechanism is shown in Table 4.7.3.

Table 4.7.3 Incentive mechanism

Item	Outline
Issuance of certificate to trainee	A certificate is issued to trainee after the participation of training. The issuance of certificate is approved by NWSDB, and it is issued to trainees as of the end of the project.
Announce the trainees on the HP of NWSDB	NWSDB announces the trainees or the organization which participated a training on the HP of NWSDB so that the trainees is known as the trained person who can conduct the proper method. The announcement on the HP is approved by NWSDB, so it will be announced in the future training. Also, the participants of plumber training are registered in the application developed by NWSDB and customers can choose the trained plumbers through the application.
Encouragement by NWSDB manages	NWSDB managers encourage NWSDB staff to attend the training by sending an e-mail, asking to create a goal about the participation of training and managing its progress. These encouragement measures will be included in the concept paper of the "Water Excellent Center" which is the MD&TD's future training unit.

4.7.4 Management of training guideline

The training guideline should be utilized as the important property of MD&TD in future, and it is desirable that MD&TD manage the training guideline in the same way as the past MD&TD documents. Therefore, Ms. Dedunu Wimalasiri (MD&TD, Engineer) and Ms. Niranjala Gamage (MD&TD) is assigned as the responsible person of management of training guideline and the procedures to revise the training guideline was decided.

4.7.5 Annual training plan after 2021

The part of annual training plan in 2021 is shown in Figure 4.7.1. The training of leakage detection and pipe installation which were developed in this project are included from training no. 33 to no. 40. It means the budget for those training has been assigned already and the training sessions will be conducted in future. However, MD&TD has not been able to conduct the training as planned due to the COVID-19 pandemic from 2020, and most of the training will be postponed to next year.

In-House Training Plan 2021 Annex IA

ENGINEERING / TECHNICAL IN-CLASS (MDTD / RSC LEVEL)

No	Title	Target Group	Duration (Days)	Q1	Q2	Q3	Q4	Total
28	Design of Water Retaining Structures to BS Code	Engineers	3		1			1
29	Design of Reinforced Concrete Structures to Euro Code	Engineers	8			1		1
30	Planning & Design of Water Treatment Plants	Engineers	3	1				1
31	Planning & Design of Wastewater Treatment Plants	Engineers	3			1		1
32	Planning & Design of Transmission and Distribution Systems	Engineers	3			1		1
33	Underground Leakage Survey on Distribution Pipes & Service Pipe Lines and Metalic & Non Metalic Pipe Tracing	ENG / EAA /Pipe Fitters	1		1	1	1	3
34	HDPE Pipe Installation (Distribution & Service)	ENG / EAA / Pipe Fitters	1		1		1	2
35	PVC Pipe Installation (Distribution & Service)	ENG / EAA / Pipe Fitters	1		1	1		2
36	DI Pipe Installation	ENG / EAA / Pipe Fitters	1		1	1	1	3
37	Leak Repair Works (HDPE/PVC/DI/Accessories)	ENG / EAA / Pipe Fitters	1		1	1	1	3
38	Training on Water Flow and Pressure Measurements	ENG / EAA / Pipe Fitters	1		1		1	2
39	DMA Creation and Step Testing	ENG / EAA / Pipe Fitters	1		1	1	1	3
40	Data Collection of Pipe Line and Asset Management	ENG / EAA / Pipe Fitters	1		1	1	1	3
41	Water Meter Error Calculation	ENG / EAA / Pipe Fitters	1		1	1	1	3
42	Refresher Course for Plumbers	Plumbers/Fitters	15	2	3	3	3	11
43	Obtaining NVQ from RPL Method	Draftspersons/ Electricians	3			2		2
44	O&M of Water Treatment Plants and Distribution Systems for Navy	Navy Staff	40	1				1
45	O&M of Water Treatment Plants and Distribution Systems for Navy	EAA	2	1			1	2
46	Field Training for Plant Technicians	PPT	60		1	1		2
47	Laboratory Safety, Instrument Calibrations & Maintenance	Laboratory Staff	1			1	1	2
48	Calculation of Input Price Indices	ENG / QS/EAA	1		1	1		2
49	Introduction to CESMM3 & Preparation of BOQ	Eng./EAA	3		1	1		2
50	Operation & Maintenance of Transmission & Distribution Pipe Lines	EAA(Civil) in O&M Section	1		1	1		2

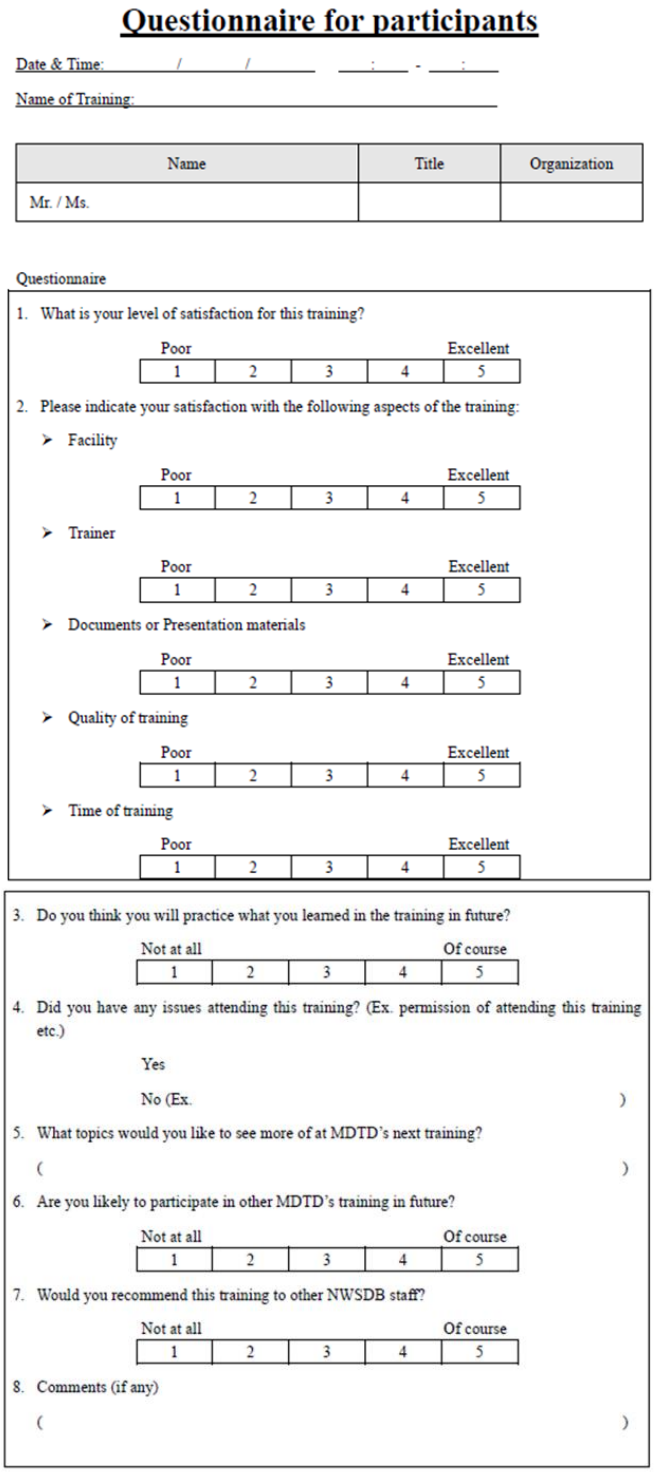
Manpower Development & Training Divisionn 6

Figure 4.7.1 Annual training plan in 2021

4.8 [Activity 3.8] Assess the result of training and update the contents of training as needed

When the practical training was conducted, local staff recorded the training with video camera and JET confirmed the good points and improvements. Then, JET and C/P discussed the good points and improvements of practical training in output 3 meeting. Furthermore, JET and C/P created a questionnaire

for trainees and revised the training guidelines based on the acquired feedback through the questionnaire. The questionnaire for trainees is shown in Figure 4.8.1.



Questionnaire for participants

Date & Time: ____/____/____ ___:___ - ___:___

Name of Training: _____

Name	Title	Organization
Mr. / Ms.		

Questionnaire

1. What is your level of satisfaction for this training?

Poor				Excellent
1	2	3	4	5

2. Please indicate your satisfaction with the following aspects of the training:

- Facility

Poor				Excellent
1	2	3	4	5

- Trainer

Poor				Excellent
1	2	3	4	5

- Documents or Presentation materials

Poor				Excellent
1	2	3	4	5

- Quality of training

Poor				Excellent
1	2	3	4	5

- Time of training

Poor				Excellent
1	2	3	4	5

3. Do you think you will practice what you learned in the training in future?

Not at all				Of course
1	2	3	4	5

4. Did you have any issues attending this training? (Ex. permission of attending this training etc.)

Yes

No (Ex.)

5. What topics would you like to see more of at MDTD's next training?

( )

6. Are you likely to participate in other MDTD's training in future?

Not at all				Of course
1	2	3	4	5

7. Would you recommend this training to other NWSDB staff?

Not at all				Of course
1	2	3	4	5

8. Comments (if any)

( )

Figure 4.8.1 Questionnaire for participants

4.9 Achievement

In the output 3 activities, C/P and R/P were able to improve their capacity about practical training, and practical training in TY was introduced into the NWSDB successfully. Also, since the practical training sessions were included in the annual training plan and NWSDB is preparing to establish the Water excellent center which is the specialized unit for training, it is certain that NWSDB will continue the actual training by themselves sustainably. Moreover, since the RP certification system and incentive mechanism are planned to be included into the NWSDB scheme, it is expected that these systems will contribute to the promotion of implementation of training by RP and participation to training by NWSDB staff.

The main reason of this outcome is owing to the active involvement and motivation of C/P. The factors which generated this involvement and motivation of C/P are shown below.

- Some C/P participated the Japan training at Nagoya city, so they have an image what kind training is conducted in the country which has advanced water supply system. C/P, therefore, has the clear goals to aim for the similar training system to improve Sri Lankan water supply system, and it contributed to the motivation of C/P.
- Since JET communicated with C/P often and answered C/P's questions and requests carefully, we could make a good relationship. Although the dispatch of JET to Sri Lanka was difficult due to the COVID-19, JET and C/P could communicate through web meeting and message application more often, and JET could answer the C/P's questions and requests timely. It is considered as one of the factors to keep the motivation of C/P.
- Since the timing of this project was same with the Sri Lankan government's policy to improve the coverage of water supply system and construction of training center by ADB project, it was good timing for NWSDB to focus on the improvement of construction quality of water supply system. This effective timing of this project, therefore, was one of the factors to generate the active involvement of C/P.

5 Achievement

5.1 Level of Achimenes of the Project Purpose

Project Purpose: Pipelines management works of NWSDB are enhanced.

The following table is a summary of achievement of each activity.

Table 5.1.1 Summary of Achievement

Output	Activity	Achievement	Achievement Level
Output1	1.1 Conduct seminar/ workshops, including Overseas Training(s) in Japan, on asset management of pipelines to the management of NWSDB	Completed	100%
	1.2 Develop a draft of guideline for asset management	Not implemented	
	1.3 Conduct Top Management Meeting for formulation of Asset Management System (AMS)	Not implemented	
	1.4 Conduct a trial calculation for renewal demand of pipelines in the pilot activity site	Not implemented	
Output 2	2.1 Develop a work plan for enhancement of the existing leakage control works in the pilot activity site	Completed	100%
	2.2 Implement OJT for leakage control works, such as leakage survey and repairs, including preparation, hydraulic separation, flow measurement, leakage survey and repairs, monitoring and evaluation	Pilot site activity at 5 DMA out of 6 DMA was completed. The first step test in the remaining DMA was completed. and the vulnerable areas were identified. C/P has started the leak survey, but it has not been completed within the project period due to lock-down imposed by the situation of COVID-19. On the other hand, C/P were able to complete the activity in two DMAs successfully by themselves after the expert left. Therefore, it is concluded that the technical transfer has been successfully completed.	100%
	2.3 Accumulate collected data during leakage control works to the existing database	Data format was prepared and used. OIC has accumulated the data from the site, but the data update in GIS is delayed because ADB project is changing the data flow system.	80%
	2.4 Develop procedure manuals for leakage control, including underground leakage control, pipe laying and jointing, service connection, accumulation of data, etc.	The first draft was submitted in February 2020. The result of pilot site activity has been reflected into the manual for updating.	100%
	2.5 Request PDMRC to approve the procedure	The revised version was submitted in	100%

	manuals.	July 2021 to obtain the comment. Then, the comments were reflected for revision, and it was re-submitted. PDMRC approved it on 11th August 2021.	
Output 3	3.1 Review status of the current training programmes on leakage control conducted at the training center and RSCs	Completed	100%
	Plan practical training programmes on leakage control such as underground leakage control, pipe laying and jointing, service connection, accumulation of data	Completed	100%
	3.3 Design a training yard	Completed	100%
	3.4 Set up a training yard	Completed	100%
	3.5 Select candidates for trainers (RPs)	Completed	100%
	3.6 JICA Experts conduct training of trainers (TOT) for the RPs.	TOT was conducted in January 2020. Supplementary training sessions were held for the uncompleted parts, and all were completed.	100%
	3.7 Implement the practical training programmes.	The planned practical training programmes cannot be completed because the gathering training session was prohibited due to spread of COVID-19. However, MD&TD intended to carry out as much as possible and introduced on-line training, etc. All the training modules were practiced including rehearsal sessions.	90%
	3.8 Evaluate the training programmes after implementation and revise them as necessary.	The training programmes have been modified based on the opinion and suggestion by the participants and experts.	100%

5.1.1 Achievement of Output 1

(1) Indicator 1: The seminars/workshops on asset management are appreciated by more than 75% of the participants.

Activity 1.1 was a series of activities holding seminars and workshops effectively. Two seminars and two workshops were held, and questionnaire surveys were conducted to know whether the purpose of the seminar/workshop was satisfactorily achieved or not. Responses from the survey showed the following, 92.3 % indicated that the 1st seminar was satisfactory and 91.7 % indicated that the 1st workshop was satisfactory. The answers to the same question for the second seminar and workshop were as follows: 81.8% indicated that the seminar was satisfactory and 75% indicated that the workshop was satisfactory. The purpose of introducing the experience of Japan and the asset management system was achieved.

(2) Indicator 2: The process and experience of trial calculation are shared at a JCC meeting

Indicator 2 was deleted because the activities related to Output 1 were suspended after February 2020 based on the minutes signed by JICA and NWSDB on January 30, 2020.

From the above results, the target of Output 1 that is "Asset management of pipelines is introduced to NWSDB" was not achieved. Therefore, Output 1 has not been achieved.

5.1.2 Achievement of Output 2

(1) Indicator 1: Pilot project on leakage control is implemented effectively.

The C/Ps have steadily developed their technical skills and learned how to take preventive measures against the leakage through the activities in 6 DMAs at the pilot site. They are now able to identify the vulnerable area by sub-zoning method for improving efficiency. NRW ratio was not reliable due to the abnormal conditions which were created by the restrictions related to COVID-19, the evaluation of the effectiveness was measured by the reduction rate of MNF. The benefit has been more than the cost in all calculated cases, and it proved the high efficiency. C/Ps understood the importance of continuous monitoring for watching the recurrence of leakage, and fully used the remote monitoring system introduced by the project. The monitoring system used mobile phone communication network, therefore, C/Ps and experts could remotely monitor water pressure and water flow. It was suitable for preventing the virus infection because it reduced the frequencies of visiting the site by C/P. After the expert in charge of Output 2 left, C/Ps have worked for the completion of pilot activities for about three months and showed good performance. Therefore, Indicator 1 was achieved.

(2) Indicator 2: The procedure manuals for leakage control is approved by JCC.

The procedure manual was prepared in collaboration with the C/Ps, revised with the experience and knowledge through the pilot site activities, and submitted in July 2021. PDMRC approved it on 11th August 2021, and it was reported and confirmed at the 4th JCC. Therefore, Indicator 2 was achieved.

5.1.3 Achievement of Output 3

(1) Indicator 1: The candidate trainers (resource persons), who participate in the TOT become able to teach the practical training developed by Output 3.

In total 69 participants have attended TOTs of the developed seven training modules such as leak detection, distribution pipe laying, domestic pipe laying, water leak repair, flow rate/ pressure measurement, DMA creation & step test, and utilization of data obtained from pilot activities. In addition, seven supplementary TOTs were conducted to improve the content and implementation method of the training. As a result, the trained RPs have conducted the practical training with a few exceptions that could not be conducted due to restrictions on gathering. The simulated training (called rehearsal training) was conducted with trainees for the modules that could not be practiced within the project period. The

evaluation from the participants was high, and it was considered that the capacity of RPs has reached a sufficient level even from the viewpoint of experts. Therefore, Indicator 1 was achieved.

(2) The training programmes conducted by the resource persons are appreciated by more than 75% of the participants.

All the training sessions have been well received by the participants, and the questionnaire survey results after the training showed that the participants' satisfaction level was 87.5% on average. Therefore, Indicator 2 was achieved.

5.1.4 Achievement of Project Purpose

(1) Indicator 1: The asset management guideline is approved by JCC

It was deleted and not achieved.

(2) Indicator 2: The procedure manuals for leakage control are approved by the PDMRC.

The experience and knowledge obtained at the pilot site of Output 2 were compiled into the Procedure Manual with the cooperation of C/Ps. In addition, the case study of the pilot activity was attached as an annexure and to share the real experience to other NWSDB staff members. The Procedure Manual was approved by the PDMRC on August 11, 2021. Therefore, it is considered that Indicator 2 has been achieved, and activities based on the manual will proceed in NWSDB in the future.

(3) Indicator 3: Necessary budget is allocated for implementing the practical training programmes developed by Output 3, and incorporated in the Annual Training Plan of MD&TD.

Practical training was incorporated into the annual training plan of 2021 of MD&TD with the budgeting. The 2022 training plan is under development at the end of the project, but practical training will be incorporated as in the 2021 plan, and budgetary measures will be taken. Therefore, Indicator 3 was achieved.

NWSDB continues to work towards its government goal of achieving 100% water supply in Sri Lanka by 2025. In order to achieve the goal, it is necessary to expand the pipeline, and there is an urgent need to train staff members of NWSDB to accomplish the certain level of skill. It is a big challenge, and human resource development is highlighted in NWSDB. Through the project activity, it has been known the effectiveness of the practical training, and NWSDB is keen to continue it.

5.2 Expected achievement of overall goal

(1) Indicator 1: The leakage control works are implemented in the area(s) other than the pilot activity site in accordance to the procedure manuals for leakage control.

While the Procedure Manual was approved, the training module of knowledge sharing of the activities of the pilot project were introduced into the NWSDB training. The members of Output 2 became RPs and have started training sessions. There is a plan to continue and expand the training to other RSCs even after the project is over. Therefore, the results of the project activities will be shared with all NWSDB staff. Therefore, it is considered that the Indicator 1 of overall goal will be achieved.

(2) Indicator 2: Practical training programmes developed by Output 3 are continuously implemented.

NWSDB has a policy of changing material of pipe to HDPE for both new laying and replacing, and there is an urgent need of training of HDPE pipes installation in particular. Therefore, MD&TD has a plan to develop the more RPs for the practical training of HDPE pipe installation by providing TOT. Those who received TOT in the TY will return to each RSC then start training at their place where will be a satellite training place to the local staff members. MD&TD considers that it will work effectively for the rapid increase of skilled staff.

MD&TD has also started its own training that combines the individual training modules developed in the project. In addition, MD&TD obtained the board approval for training to the private sector. The TY and training module will be used to improve the capabilities of not only NWSDB but also any persons who work in the water supply sector in Sri Lanka. There is no doubt that it will be used throughout. The TY has also been accredited as a skill assessment facility for plumbers by the Tertiary and Vocational Education Commission (TVEC), which is the governing body for training in Sri Lanka.

In addition, there is a plan of the construction of additional facilities by ADB assistance, and further expansion is expected. From the above, it is expected that the results will exceed the results which was expected at the start of the project.

6 Lessons Learned

6.1 Ingenuity

6.1.1 Enhancing Motivation through Collaborative Work and Emerging of Outcomes

In the Output 2 and Output 3 activities, JET continued the collaborative work with C/P steadily with corrected directions by incorporating opinions of the C/P. C/P has been motivated by realizing the outcomes, as a result they have improved the ownership to the Project activity. The improvement in motivation of C/P appealed to the management and it helped take over the Project outcomes in future.

6.1.2 Distance Assistance

We were unable to travel for about a year, and during that time the distance assistance was conducted. Although various remote measures have been taken in many projects, the following measures worked successfully in this project.

- Preparation of visual teaching material: Video recording of the handling of equipment was effectively introduced. The experts used text-to-speech software which synthesize the English speech it sounds like a native speaker by prepared a script. It was shared on youtube so that anyone who shared the link can see it from anywhere.
- Video recording of work: The local staff of the project shot the video at the site work and training and shared it with JETs. The video materials made it possible for experts who could not go to the site to understand the issues better and give accurate instructions.
- Improvement of presentation materials: Although regular C/P meetings were continued, the explanation was made by the use of presentation materials using PowerPoint and shared in advance to promote understanding even if there is a disturbance online.

It was difficult to read the facial expression of the person wearing face mask on a small display, so the above preparations compensate for the communication.

Since these procedures contribute to improving the effectiveness of communication, they will be used even if face-to-face guidance becomes possible.

We tried to continue the activity even JET could not travel to Sri Lanka, and the above ingenuities worked. However, by resuming the dispatch of experts from February 2021, the project progress moved significantly faster, and the motivation of C/P seemed higher. Under such circumstances, online meetings are being used extensively, but there is no doubt that face-to-face meetings have a high advantage in terms of efficiency and motivation improvement in a technical transfer project. The good relationship which was created before the starting of the pandemic helped to continue good relationships in the time of remote assistance. Therefore, we hope the end of the pandemic allows physical contact and makes joint work possible.

6.1.3 Introduction of Remote Monitoring

In the second phase, a small-scale monitoring system was introduced in the pilot site to monitor water flow and pressure. It realized the real-time monitoring via SIM card of mobile phone communication network. This technology was well received by C/P because it can be installed by ourselves with a low budget wherever we want. The introduction of this system had the following major advantages.

1) Experts can monitor the local situation in real-time even from Japan.

2) The problem occurrence can be found out without visiting the site.

Under the influence of COVID-19, there is a great advantage that data can be obtained even during lock-down situations, and the chance of infection can be reduced by remote monitoring.

6.1.4 Effective Training in Japan

The Nagoya programme of training Japan was planned to improve the capacity of RPs and C/Ps for implementing the practical training at the TY and brought about the big impact effectively. It is explained as follows how much it was effective and what ingenuity the Japanese side considered.

- Selection of participants

  JET proposed the participants who must have been selected from the RPs, candidates of future RPs and the person to manage the TY and practical training programmes, and proposal was accepted by NWSDB. All participants have become the driving forces of the Project activities, thus, it can be said that the important key point of the success of the training in a foreign country is to provide the necessary training to the person who needs the training. In addition, the two participants who participated as candidates of RPs became RPs as intended during the Project period.

- Customized training programme

  The expert who has the experience to work with C/Ps contributed to the planning of training contents based on the identified needs. The training host organization made specially customized training programmes for the participants to meet the training needs. They showed the backyard of the TY, know-how and tips of the training implementation, handling of the equipment, etc., and these all were so practical and applicable immediately. The participants applied the techniques they learned to their own training when they came back, and it brought about a notable improvement in the training programmes.

6.1.5 Cooperation with ADB Project

As a component of GCWWMIIP, ADB is engaged in projects related to this project, such as training center building construction, support of training content improvement, and development of asset management system. We were able to cooperate as follows, but it was unfortunate that we could not keep pace together due to the significant delay of the ADB caused by the COVID-19 situation. Since external factors will increase, collaboration with other projects requires an appropriate distance, and it is considered that this degree of cooperation was appropriate.

1) Construction of a TY for the training program

- From the design stage, ADB consultants participated in the meeting for determining the curriculum and facilities of the yard together, therefore, the concept of practical training was shared and understood. ADB will construct the additional part of the TY which is requested by the NWSDB, and the shared ideas are incorporated into the additional part.
- ADB and JET exchanged opinions at the preliminary design stage of ADB part of TY construction. Currently, the ADB activity has stopped due to the influence of the COVID-19.

2) Exchange of opinions on GIS system design

- ADB has been developing a GIS system of NWSDB and supporting data collection as a part of its asset management project. In this project, both parties had discussions several times and additional proposals for GIS attribute data were made to be adopted.
- On the other hand, the project devised a procedure to transfer information for the data collected in the project activity, but since the establishment of a new data path was started in the ADB project, the data updating system will be modified to suit the new system.

6.2 Lessons Learned

6.2.1 Importance of Needs Assessment

It was pointed out in the report of the terminal evaluation that is "formulate a technical cooperation project of a new subject based on sufficient preparation and proper needs identification". Asset management was a new subject for both JICA and NWSDB in technical cooperation. The report suggests that the approach and the scope of the project should have been discussed from the outset with a clear understanding of the difference in financial and budgeting system, as well as the infrastructure development stages (e.g. developing, maintenance, replacing stages) between Japan and the partner country when forming a technical cooperation project of a new subject, or which is about a long-term planning, such as asset management. The asset management in water supply in Japan was difficult to apply directly to the NWSDB because there are basic differences which are summarized in the following table.

Table 6.2.1 Differences in Basic Conditions

Conditions in Japan	Conditions in Sri Lanka
Water infrastructure is almost established in Japan, and currently the main concerns are on maintenance and renewal of existing facilities rather than new expansion.	It is in the expansion phase, and main concerns are to invest capital in new facilities and expansion. Therefore, the allocation of maintenance costs is not enough with a plan, moreover, it is difficult to prepare for future renewal demand.
The aged pipes will be replaced due to the viewpoint of countermeasure to earthquake.	The desire to repair and prolong the lifetime of pipes due to limitation of the budget.
The experience of plastic pipe is limited in water supply.	Mainly use the plastic pipe.
Asset is managed by the sophisticated software based on the accumulated data on database.	Since only few data are accumulated, the assessment of the asset is difficult. However, NWSDB is positive in the introduction of new software.

The identification process of needs and differences between both countries in the preparatory stage of the project or early stage of the project implementation should have been practiced.

6.2.2 Design and Construction of Training Yard

The design of the TY was also an issue in the final evaluation, but the R / D and minutes at the time of project formation did not include the scope of training and TY, so both sides needed to compromise the gap of the facilities which Sri Lankan side expected and the Japanese side could provide. Many discussions were required to reach an agreement due to the big differences in facilities to be built, and it was a factor in reducing the efficiency of the project. The consultant has made a contract with the instruction to design the minimum facilities which are necessary and sufficient for the training curriculum. On the other hand, NWSDB thought of a big and full-fledged TY which they had visited in Japan. The lesson is that it was necessary to document the scopes at the project formulating stage.

In addition, the following point should have been considered.

i. Roof of the entire facility: A roof was installed for the yard for pipe connection, which has a relatively long training period, but there is no roof for the leak detection area. In countries with high temperatures, such as Sri Lanka, the conditions during activities were hard even within a short time.

ii. Sufficient storage: The storage space is not enough to store all material and equipment.

ADB is planning to construct additional facilities including a storage room, and it is expected that the inconvenience will be solved, but when constructing such a facility in another project, the above will be taken into consideration.

On the other hand, other requests from the NWSDB side, which were multiple types of pavements, variable water pressure setting, introduction of different pipe types, etc. effectively worked in the practical training. It is the first full-scale practical training facility in the field of water supply in Sri Lanka, and both the RPs and trainees were very pleased to participate in the practical training at the TY.

6.3 Afterword

6.3.1 Future Plan of MD&TD

MD&TD is eager to develop and expand the practical training using the TY. Human resource development is an urgent task and exactly meet the business plan of NWSDB. Therefore, MD&TD aims to become a base for training and knowledge sharing as the Center of Excellence for Water. Moreover, MD&TD has a desire to increase autonomy by being a Strategic Business Unit (SBU). The implementation of this project met the strong needs of MD&TD expansion plan, so that it is concluded that the timing of the project implementation based on the needs is one of the important reasons of success.

MD&TD was interested in the cases of NAWS a subsidiary of Nagoya City, and Yokohama Water Co., Ltd., a subsidiary of Yokohama City, because of the plan to be a SBU or an independent subsidiary. We were pleased to share the information for the future development of the MD&TD. The further achievement is expected.

6.3.2 Acknowledgement

We would like to say special thanks to all project members who worked hard for the completion of the project as planned even under difficult situations. It is very much thanking the suggestions and assistance of all concerning persons to this project. It is appreciated that two waterworks bureaus in Japan, Nagoya and Kobe sent the experts and backed up from Japan.