Annex - 4

Manual for Bundle Pipe Replacement

Table of Contents

1 Work flow & Work Items 1
2 Daily Report Sheet 8
3 Check Sheet of Old Pipe Cut & New House Connection 10
4 Leakage Test Record 11

1 Work flow & Work Items

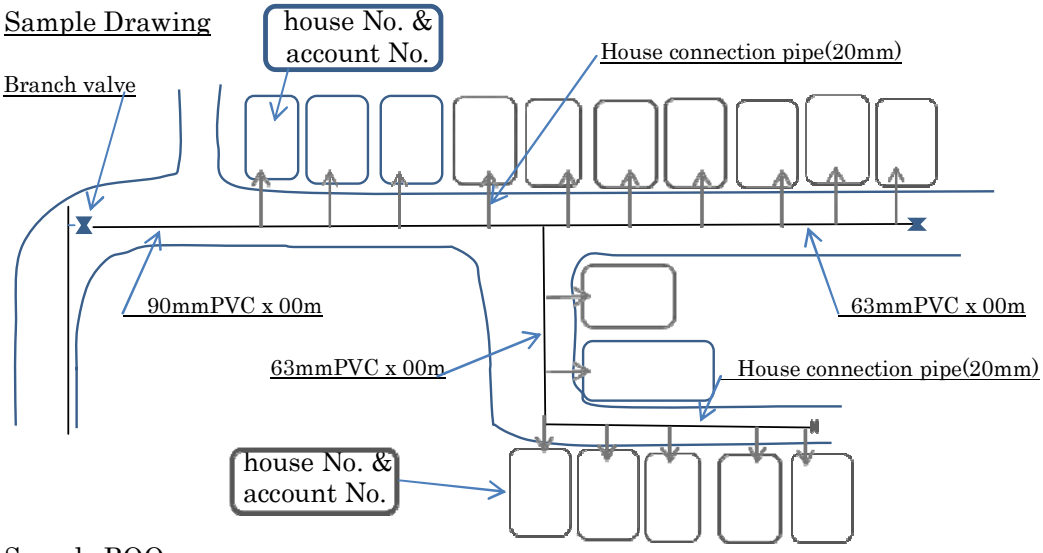
Work flow & Work Items for Engineers of O.I.C office
on Replacement of Bundle Pipe / Long House Connection

1 st Step Preparation Stage [Preparation of tender drawings/BOQ]

1 Eniginners of O.I.C office shall conduct site survey and prepare drawings and BOQ to suite the survey result.

Sample outline drawing and BOQ

Sample Drawing



Sample BOQ

Item	Spec.	Q,ty	Remarks
Branch valve	80mm S/V	1	
T-branch	90 x 90 PVC	1	
-ditto-	90 x 63 PVC	1	
Common pipe-1	90mm PVC	63 m	
Common pipe-2	63mm PVC	85 m	
Reducer	90 x 63 PVC	1	
Saddle branch	90 x 20 mm	6	
-ditto-	63 x 20 mm	30	
House connection pipe	20 mm PVC	40 m	
Coupling	80 mm	2	
Repair socket	90 mm	1	
Adopter	80 mm	1	
Bend	63 mm	2	
Bolts & Nuts	16 x 75 mm	16	
Solvent cement	500 gr	1	
Excavation -1	by hand	9.0 m3	
Excavation -2	by machine	9.6 m3	
Backfill		9.0 m3	
Cement		00 m3	
Sand		00 m3	

2 If Commonon pipe is installed by Contractor, drawings and BOQ shall be submitted to Tender Branch for Tendering Procedure.

3 Tendering and Selection of A contractor (by Tender Branch)

4 After the contract is made, engineers of O.I.C office will receive tender drawings and BOQ approved for conducting and supervising the work.

2 nd Step	Construction Stage	[Conduct and Supervise Site Work]

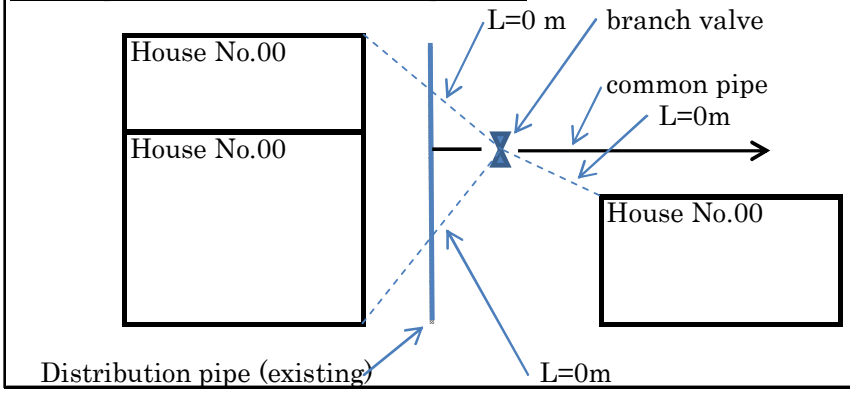
Expected boundary of responsibility

i. Trenching & laying of common pipes are to be done by Contractor under supervision of NWSDB
ii. All pipes, fittings, specials, valves and accessories are to be prepared by NWSDB
iii. A branch valve is installed by NWSDB
iv. House connections are to be carried out by NWSDB

1. Installation of a branch valve and recording of the branch valve position

Engineers/Supervisors of O.I.C office shall install branch valve and then record the branch valve position by conduting tie measurement / offsets

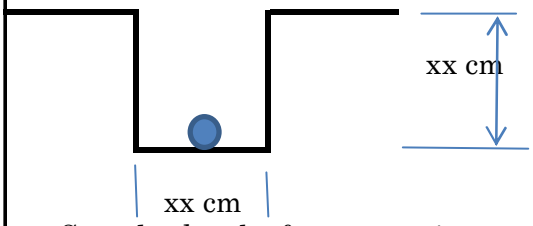
Sample sketch of branch valve position



2-1 Supervise trenching &laying of common pipes & backfilling.
Make the contractor record
excavation depth, width, length and common pipe route
and each house connection branch point

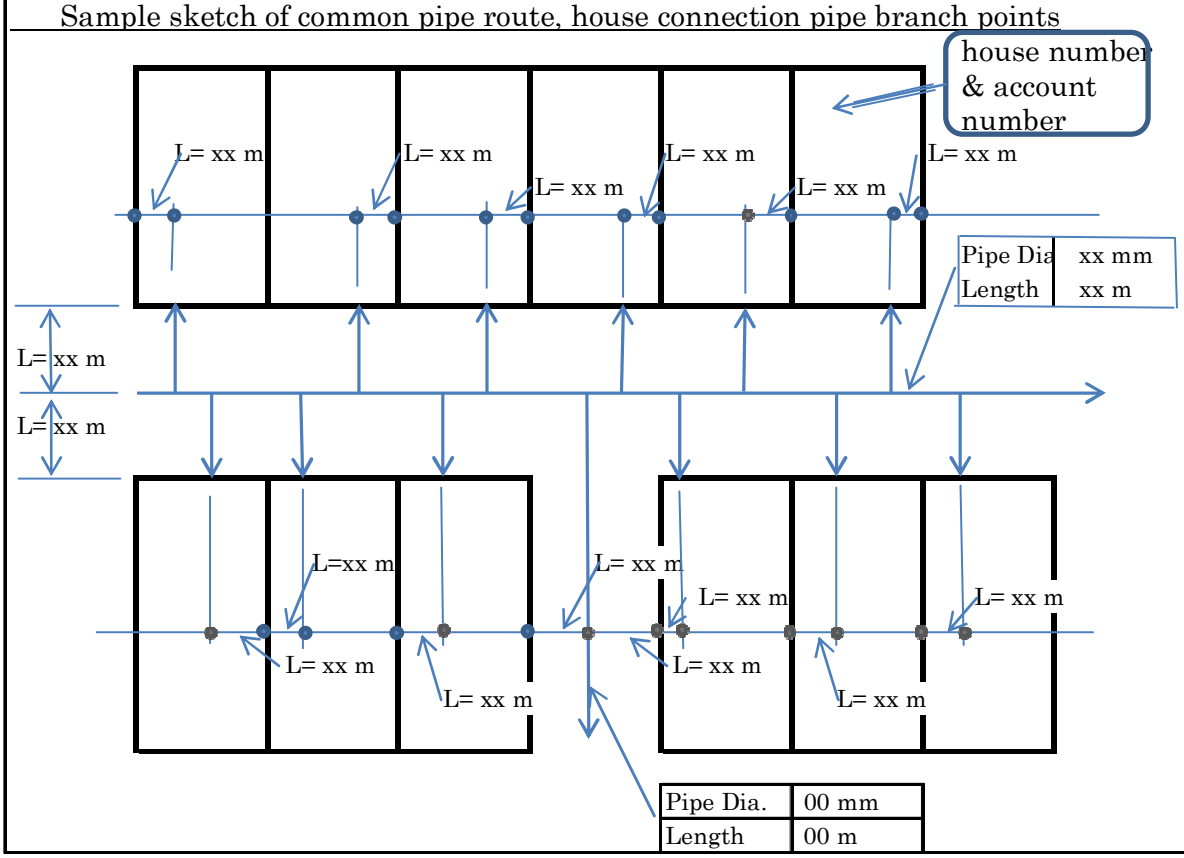
2-2. Make the contractor prepare & submit daily report describing daily progress
(See attched format -1,[**daily report**])

Sample sketch of trench measurement



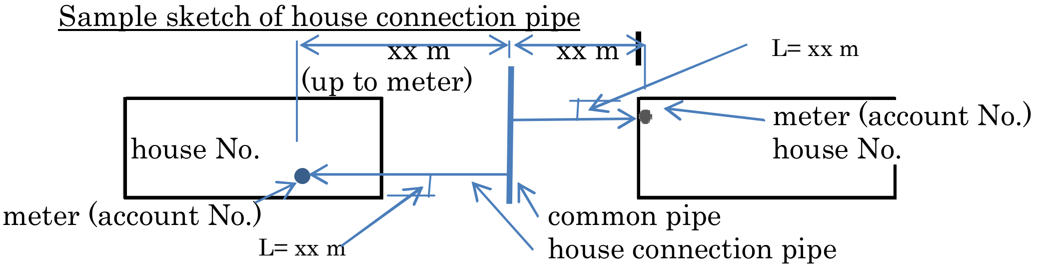
Excation volume total
xx m3

Sample sketch of common pipe route, house connection pipe branch points



3. Iaying of house connection pipes and take record of each house connection pipe length

Sample sketch of house connection pipe



Note: house connection shalll be installed upto water meter.
Valve before the meter shall be replaced.

4. Cut a long distance connection at ferrule or nearest point.
Check a house which water supply is stopped.
connection from the new common pipe. (by the Board)

Cut a long distance connection and stop water*

Connection shall be cut at ferrule or nearest point. Cut location sahh be recorded.

See Note in the next page

Check a house which water suppy is stopped.
(Check sheet shall be filled)

Give connection to the house from new common pipe

Connection shall be done upto water meter.
(Valve before the meter shall be replaced.)
Upon confirmation of proper connection, the check sheet shall be filled.

Enter all account number of the target area before the activities

Sample check list of old pipes cut, water stop and new house connection

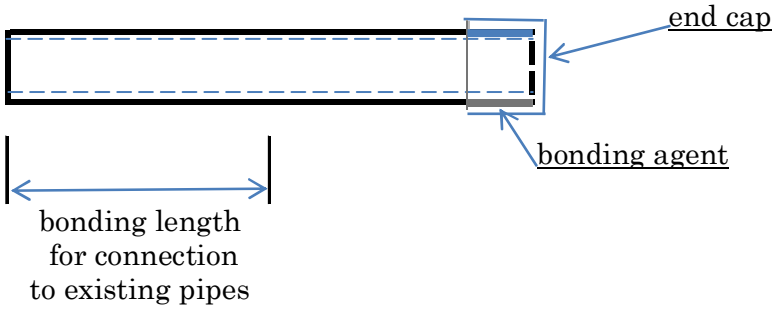
Acount No.	Existing bundle pipe cut	Confirmation of water stop	Connection from new common pipe	Remarks
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	
○○	Confirmed ☐	Confirmed ☐	Confirmed ☐	

Note: End cap fixing of the old bundle pipe shall be performed by following.

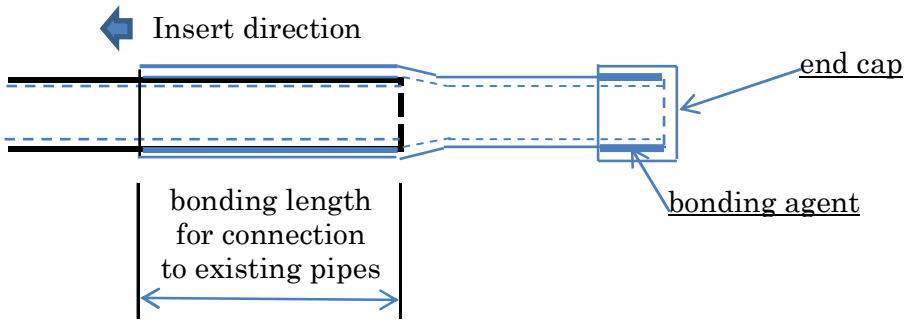
1 Intention:
Due to shortage of bonding length of end caps with existing pipes, end caps may lose at end caps fixing work under passing water conditon.
Therefore, it should provide end cap components in advance at shop having preferable circumstances for bondings.
And, to make sure fixing end cap components tightly with existing pipe, bonding length for connection should be loger enough than end cap fixings.

2 Steps to be taken

A) Provide end cap components at a shop before site work starts



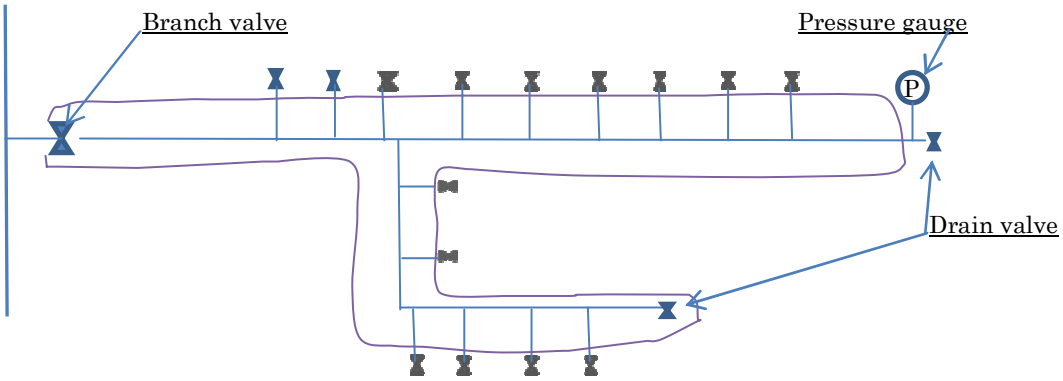
B) Insert the end cap connecton to existing pipes after heating of end cap component and apply bonding agent on the outer surface of the existing pipe.



5. Leakage Test

Engineers shall conduct leakage test and take record the test result before house connection.

Note: all house connection valves, drain valves and branch valve are closed before pressure reading start.



Sample of Leakage Test Record

Site(place)		
Date/Time		
Name of Supervisor		
Name of staffs		
Test device(water pressure)		(if employed)
Pressure gauge		
Pressure reading	kg/cm2	Remarks
At beginning		
10 min. later		
20 min. later		
30 min. later		
40 min. later		
50 min. later		
60 min. later		
Evaluation		
Note		

6. Compile As-Build Drawings and Record (by the Board)

Engineers shall compile as-build drawings, record and ralated document.

As-build drawings & documents shall be as follows:

1) As-build drawings (revised version of the common pipe contract drawings) (by the Contractor)
2) Daily report (common pipe laying and excavation) (by the Contracgtor)
3) House connection pipe laying sketch drawings (by the Board)
4) Bundle pipes (old pipes) cut and new house connection confirmation sheet (by the Board)
5) Leakage test record (by the Board)
6) BOQ (revised) (by the Board)

2 Daily Report Sheet

Form of daily report on bundle pipe replacement

Daily Report Sheet for Bundle Pipe Replacement

Contract No. and Title Contract Period Work Location Name & Address of the Contractor	: : : :	
Daily report sheet		
Date:	Start Time:	Finished Time:
Location:		
Sketch of work done with Tie measurement/offsets		
Material used		Special description
Machinery used		
Damaged other utilities		Repaired/not repaired
Repaired Material used, if any		

Siganture of NWSDB Officer

Signature of the Contractor

Form of daily report on bundle pipe replacement

SAMPLE

Daily Report Sheet for Bundle Pipe Replacement

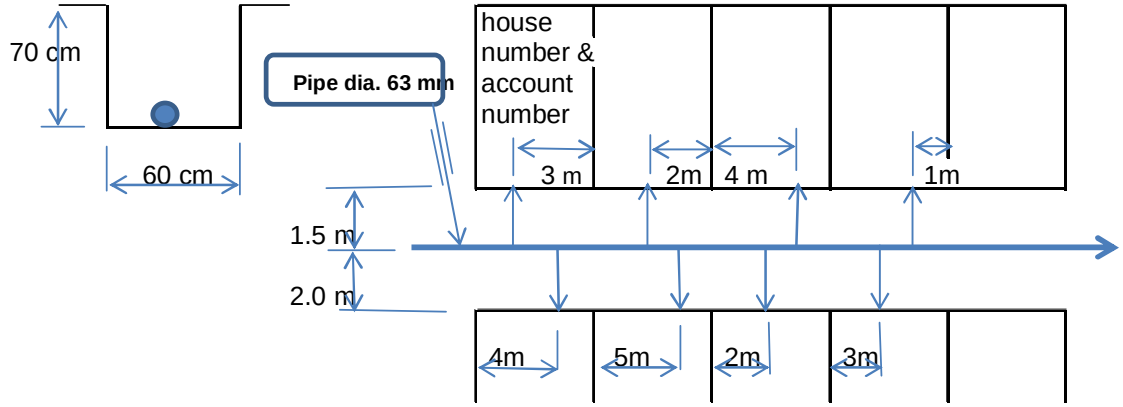
Contract No. and Title	:
Contract Period	:
Work Location	:
Name & Address of the Contractor	:

Daily report sheet

Date: Start Time: Finished Time:

Location:

Sketch of work done with Tie measurement/offsets



Material used	Special description
63 mm PVC x 32 m Saddle branch (63mmx20mm) x 8 pcs	

Machinery used

Damaged other utilities

Repaired/not repaired

Repaired Material used, if any

Siganture of NWSDB Officer

Signature of the Contractor

3 Check Sheet of Old Pipe Cut & New House Connection

Check Sheet of Old Pipe Cut & New House Connection

Site Location				
Date				
Time		Start:	Finished:	
Name of Engineer				
Check Sheet				
Account No.	Existing bundle pipe cut	Confirmation of water stop	Connection from new common pipe	Remarks
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
	Confirmed ☐	Confirmed ☐	Confirmed ☐	
Note:				

Note: Account number shall be filled before execution of field activities

Signature NWSDB Officer

4 Leakage Test Record

Form of Leakage Test Record

Site Location (place)		
Date		
Time	**Start:**	**Finished:**
Name of Engineer		
Test device(pressure machine		**(if employed)**
Pressure gauge		
Pressure Reading	**m**	**Remarks**
At beginning		
10 min. later		
20 min. later		
30 min. later		
40 min. later		
50 min. later		
60 min. later		
Evaluation		
Note		
Sketch drawing		

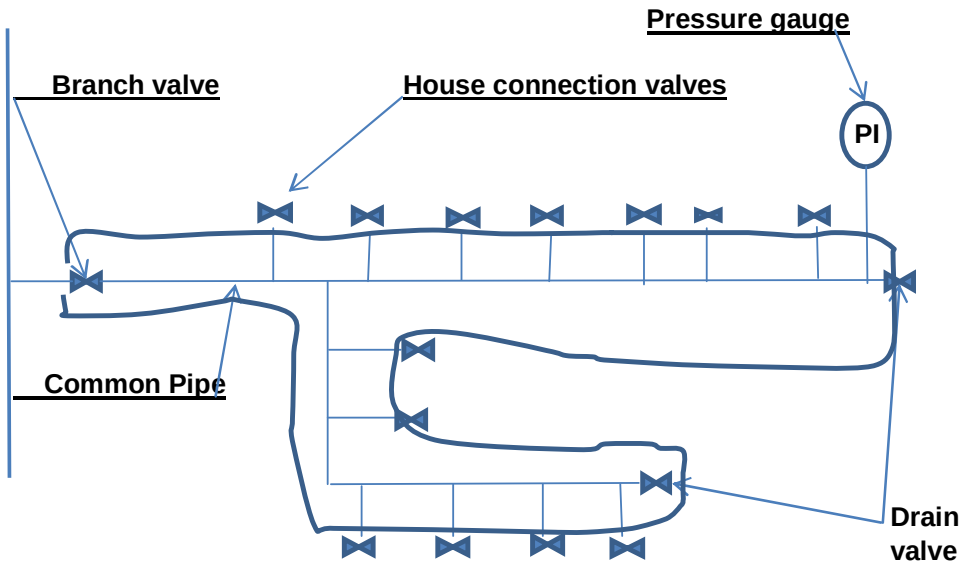
Signaure NWSDB Officer

Form of Leakage Test Record

SAMPLE

Site Location (place)		
Date		
Time	**Start:** **Finished:**	
Name of Engineer		
Test device(pressure machine		**(if employed)**
Pressure gauge		
Pressure Reading	**m**	**Remarks**
At beginning		
10 min. later		
20 min. later		
30 min. later		
40 min. later		
50 min. later		
60 min. later		
Evaluation		
Note		

Sketch drawing



Signaure NWSDB Officer

Annex - 5

Manual for Operation Methods of Leakage Detection Equipment

Table of Contents

Introduction 1
Flow chart of Leak detection 2

1. Ultra-Sonic Flow Meter (Model : Tokyo Keiki UFP-20) 3
2. Magnetic locator (Model : Schonstedt GA-72Cd) 9
3. Metal Pipe locator (Model : Goldak 2310) 12
4. Listening stick (Model : Fujitecom LS-1.5) 16
5. Electric Acoustic Rod (Model : Palmer Lmic) 19
6. Water Leak detector (Model : FCS S30) 21
7. Leak noise correlator (Model : Primayer Eureka) 25

*Operation Manuals by the manufactures are not attached to the Supporting report, but will be attached to the Manuals to be submitted to NWSDB.

Operation Manual of Leak Detection Equipment

Octomber,2012

Prepared by *Mr. E.G.Uple P De Silva*
Mr. H.G.M. Chandima
Mr. M.S.C. Prera
Mr. M.G. Ariyatilake
Mr. K. Prema lal Silva

Introduction

This operation manual is combined leak detection equipment and utilized for the NWSDB staff who are relating to water leak detection activity.

This is not only a basic operation of equipment but also add the key points from the experiences of editors at site.

Detailed operation manual are attached and use them when you need more information.

There are basic equipment for leak detection given such as (1)Ultrasonic flow meter ,(2)Valve locator, (3)Metal pipe locator,(4) Listening stick, (5)Electric listening stick,(6)Water leak detector and (7)leak noise correlator.

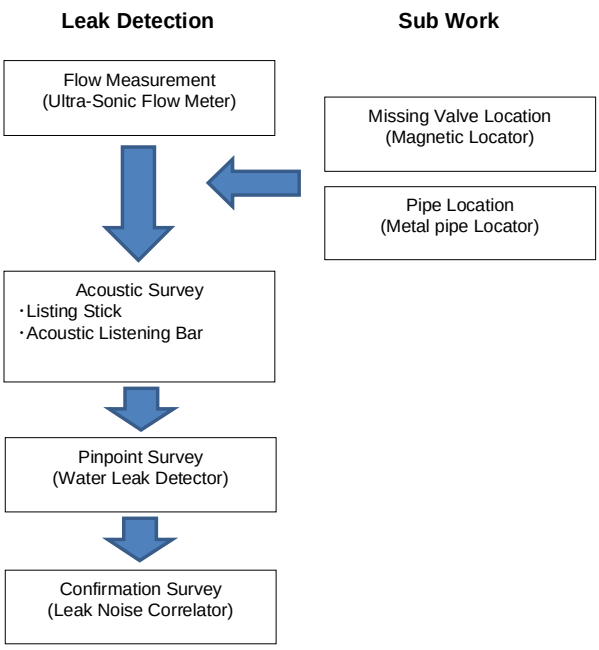
This manual is utilized for in house training of NRW staff who are in charge of leak detection work or new comers.

Flow chart of Leak detection

Leak detection is conducted as shown in the following figures.

Leak detection is narrow downed to pinpoint in large area.

Leak sound is detected by leak detection equipment.



Flow measurement should be executed for realizing leak amount in the zone by the Flow meter before leak detection.

A missing valve or unknown pipe should be detected by the locators as a sub work.

Acoustic survey should be conducted to customer meter and other fittings to find leak sound by the listening stick.

Pinpoint survey should be conducted for pipe line from the surface by the water leak detector.

Confirmation survey is conducted to the suspicious point which are detected by the leak detection by the leak noise correlator.

1. Ultra-Sonic Flow Meter

Model : Tokyo Keiki UFP-20

(1)Role of Equipment

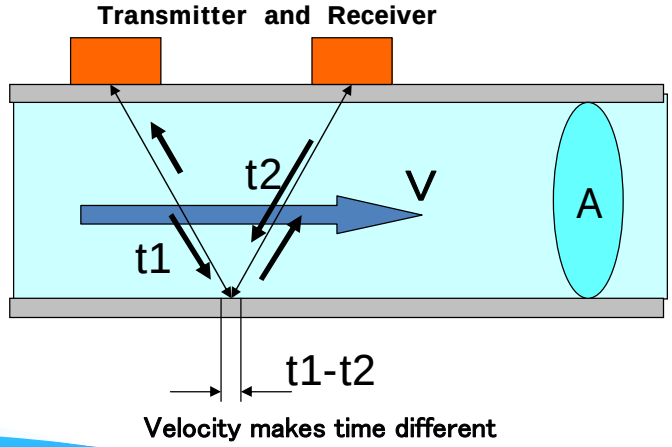
The ultra sonic flow meter can be used as a temporary measurement device from the outside of pipe.

It can measure the inflow and minimum night flow (MNF) in the subzone for the calculation of NRW ratio.

(2) Principle

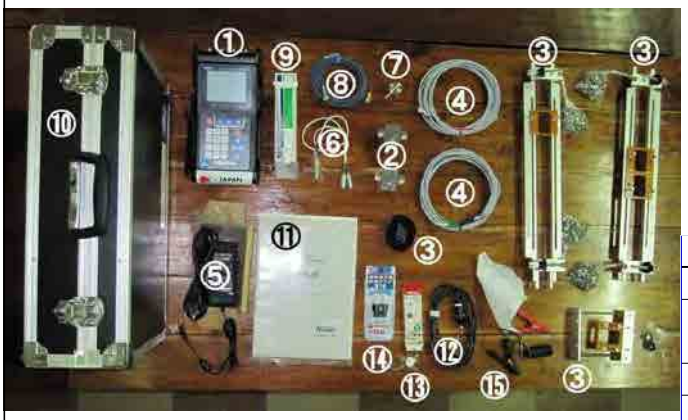
- A time difference which receive the signal from the Transducers will be changed by the inside velocity.
- Ultra-sonic flow meter measures the time different between outward and return signals with transducers and transmit it to the main unit.
- Flow quantity is calculated by the time different and pipe diameter.

Q=AV



6

(3)Component



System Components		
①	UFP-20 Main unit with Battery and Protection cover	1 pc
②	Medium transducer (nominal diameter 20A～50A (Z-path method) /65A～500A (V-path method))	1 set
③	Mounting fixture for medium transducer	1 set
④	Transducer cable (7m)	1 set
⑤	AC adapter	1 pc
⑥	Thickness gauge/sound speed measurement	1 set
⑦	Test piece	1 pc
⑧	Analog output cable	1 pc
⑨	Silicone grease for acoustic couplant	1 pc
⑩	Carrying case	1 pc
⑪	Instruction manual (English)	1 pc
⑫	Cigarette lighter cable	1 pc
⑬	USB memory (2GB)	1 pc
⑭	Transforming plug (C type to B type)	1 pc
⑮	Battery clamp cable with vehicle outlet	1 pc

7

①Main unit

Main unit can be measured velocity and flow direction by inputting pipe data and saving it to inside memory.

②Transducers type and size

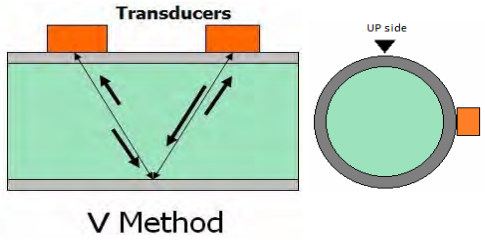
There are two types of transducers, standard type and large type.
The standard type can be measured 20 mm to 250mm in pipe diameter and large type is available from 300 to 5000mm.

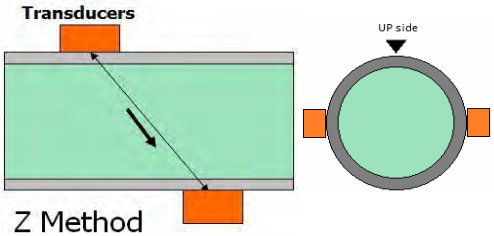
③ *Installation type*

There are two types of installation method.

One is called “V” method which is installed transducers side by side on the same side.

The other hand, “Z” method is installed transducers face to face.





(4) How to operate at beginning

- Input pipe information such as outer diameter, pipe thickness, pipe material, sensor type, flow method as well as a liquid type for the mounting space of transducers.

(5)How to mount the transducers

- Polish the mounting place to keep clean between transducers and pipe surface.
- Adjust the mounting space on the guide
- Put the grease on the transducers.
- Hold the sensor guide tightly with guide chain and transducers are adhered to the pipe.

- Check the ***Normal signal*** after installing transducers on the pipe.

- Check the ***Flow direction*** by the positive or negative signal.
  If negative sign is turned on, reconnect the cable position and check it.

- Set the "***Zero clear***" commando which zero point is fixed automatically even water is moving.

- Set the "***Data recording"*** commando which with starting time, flow unit, recording interval and integrated volume.
  flow data should be saved into the internal memory or storage media.

Procedure of flow measurement

Input pipe information
Circumference, Pipe material, Wall thickness , lining material and thickness, Kind of liquid ,Type of transducer, Type of transducer mounting.

↓

Output of sensor mounting space
Mount the transducer and hold it on the pipe tightly

↓

Check the signal and flow data
Check the normal signal and flow direction

↓

Set the flow unit and data saving commando
Input the flow unit, saving file name, saving interval and starting time.

↓

Start flow measurement
Indicate velocity, quantity and direction.

6.Caution

(1)Maintenance

・Inside battery should be charged once in three months when you do not use it frequently.

・Wipe grease from the transducers when put back to the storage case.

(2)Sensor mounting

・Transducers have to keep a distance more than 10D (10 times to diameter) at upstream from the 90 degree bend or valve and also keep 5D at downstream from it due to avoiding turbulence.

・Transducer should not be mounted on the top of pipe to avoiding air pocket.

(3)Error (always do the double check before measurement for taking accuracy)

- When indicate “Error ” signal on any pipes, check the spacing distance and cable connections.
- When indicate “Error” signal on the CI pipe, check the surface condition and make a flat if surface is not uneven by the electric grinder.
- Change the mounting method from V to Z.
  (specially large diameter and scaling pipe)

(4)Measurement condition

- Think about a location and pipe condition before measurement.
  PVC Pipe is the best material due to no corrosion and scaling.
  The materials of the pipe condition are good in order of PVC, DCIP, Steel and CIP.
- Make sure to keep a water protection, flow meter is not water proof.
  (avoid to install the meter in the rain or it’s possibility)

2.Magnetic locator

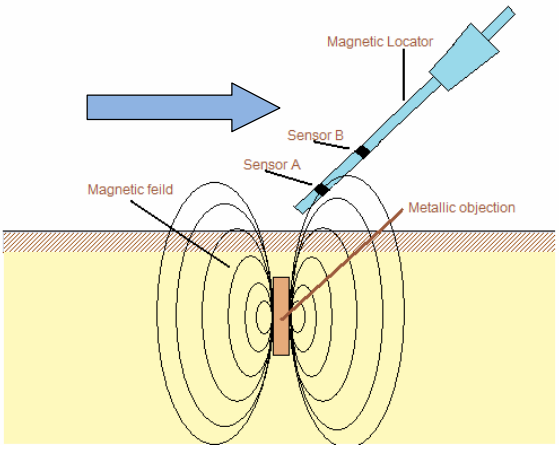
Model : Schonstedt GA-72Cd

(1)Role of Equipment

Detects the buried valve or valve box location from surface when they are missing at site.

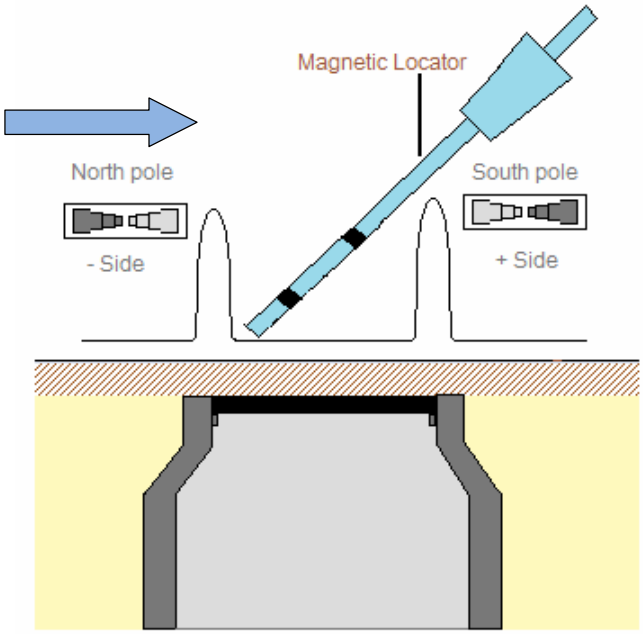
(2)Principle

Find the magnetized objections (Buried valve or valve box)



- Metallic objection in the soil has been magnetized for the long time effected by the earth's magnetic field.
- Detectable depth sometimes is different depending on the strength of magnetizing, but normally can be possible for more than 3m.

The magnetic locator when crosses above the magnetized metallic objection, the internal magnetic sensor will alert with a high sound at the negative and positive poles, which are at the edges of objection.



18

(3)Components

Main unit
Carrying case

19

(4)How to use

- Turn on the main switch and select the detective mode depending on size and depth of objection.

- Move the magnetic locator horizontally above the objection slowly and carefully.

- Mark the point where sensor alerts.

(5)Caution

- Check the residual quantity of battery before use.
- Do not give a shock strongly to sensor.
- Storage it to the carrying case when in not use.

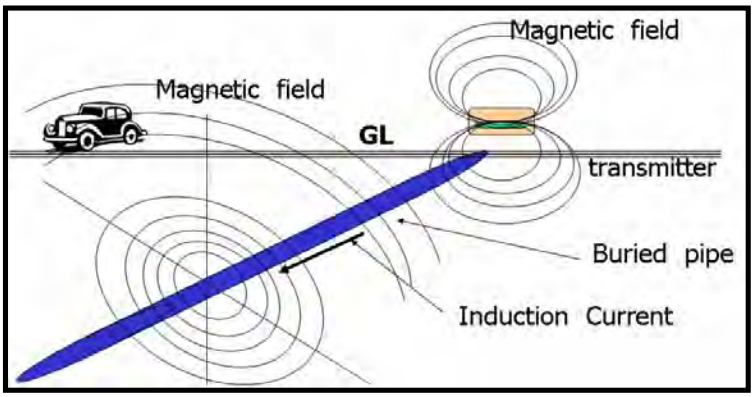
3. Metal Pipe locator

Model : Goldak 2310

(1)Role of Equipment

Detect the location of metallic pipe or cable and its depth.

(2)Principle



When radio frequency current flow to the buried metallic pipe from the transmitter, it makes inductive loop around metallic pipe and receive it by the receiver unit.

(3)Component

System Components		
①	Receiver	1pc
②	Transmitter	1pc
③	Direct connection cable (with clip, 1bundle/set)	1pc
④	Instruction manual (English)	1pc
⑤	Accessory bag /transmitter case	1pc
⑥	AC adapter	1pc
⑦	Battery box	1pc
⑧	Eneloop size AA battery(8pcs) with battery charger	1set
⑨	Transforming plug(C type to B type)	2pcs
⑩	Earth bar	1pc
⑪	Battery case	1pc

(4)How to use

①Inductive mode

・Adjust the frequency on 116Hz and signal strength of transmitter and receiver before detection.
Put on the transmitter above the pipe line if location is known.
If not, across the road two persons who hold the transmitter and receiver parallel, and move them at
same speed and same direction.

- Put on the transmitter above the point which receives the strongest signal.
- Adjust the indicating line to the guide point in the circle.
- Measure depth of pipe with depth mode above the pipe line.

② Direct mode

When metal pipes are buried closely, induction current get into one line by the inductive method.

By the direct method, only target line can be found to get the induction current by using clipping cable to the valve or other metallic and transmitter.

Connecting cable should be the outer side of target line otherwise cable obstruct the accurate detection.

(5)Caution

- Check the residual quantity of battery of receiver and transmitter before use.
- A distance between transmitter and receiver keeps at least 10m (more than five times of pipe depth) because receiver frequency is affected by the magnetic current from transmitter.

4.Listening stick

Model : Fujitecom LS-1.5

(1)Role of Equipment

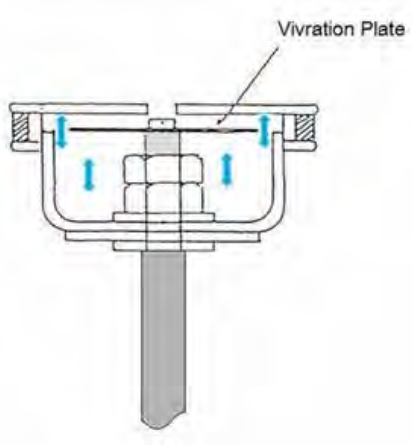
To check the leak sound at the customer's meter or other fittings.

(2) Principle

When listening stick contact leaking pipe, leak sound propagate to the head part with stick.

The leak sound is amplified by the vibration plate inside.

Listing stick is a very simple device.
It has a long stick and head part which amplifies the sound by the vibration plate.



(3)Component

Listening stick is very simple device. It has a steel stick and head part which amplifies the sound by the vibration plate and make a clear sound.

(4)How to use

- Contact the listening stick to the meter, valve and fittings.
- listen to the sound carefully.
- If “Shee” or “Huee” sound on it, mark the location on the survey map with house number or landmark.
- When water leak detector find the leak, it is checked on the road by the listening stick.
- Listening stick can not only check the sound at meter but also can use as a device of confirmation survey.

(5)Caution

- Do not hold the stick during listening otherwise vibration sound become small. Operator should hold the head part when listen.
- listening stick should be contacted to metal part because sound on non-metallic propagate shortly with low frequency.
- Do not hold to turn toward sharp edge to the people otherwise people will be received injuries.

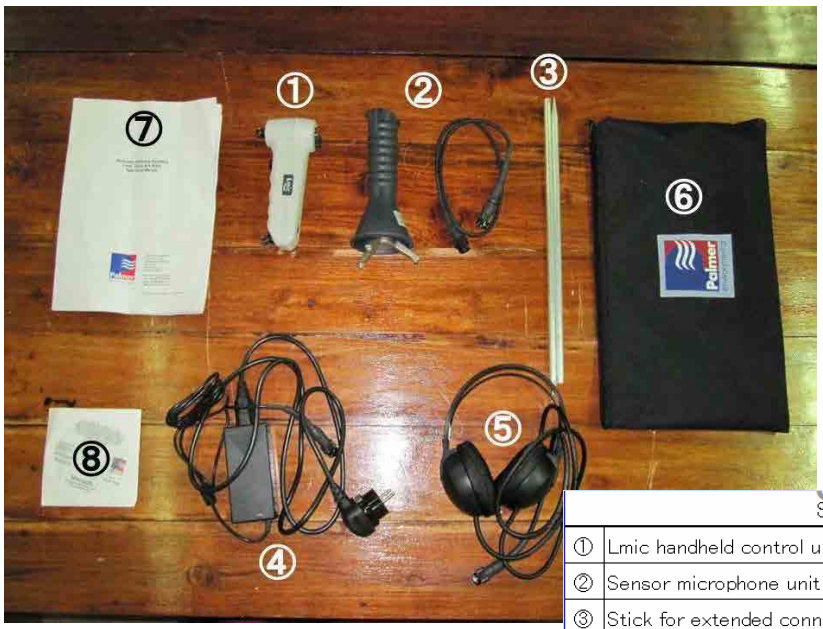
5.Electric Acoustic Rod

Model : Palmer Lmic

(1) Principle

When listening stick contact to leaking pipe, leak sound is amplified by the amplifier unit inside more louder and clearly.

(2)Components



System Components		
①	Lmic handheld control unit	1 pc
②	Sensor microphone unit	1 pc
③	Stick for extended connection	2 pcs
④	AC adapter for battery charger	1 pc
⑤	Headphone	1 pc
⑥	Storage case	1 pc
⑦	Instruction manual (English)	2 pcs
⑧	Instruction manual CD (English)	1 pc

(3)How to use

- Stick contact to the meter and press the button.
- Listen the sound carefully.
- If “Shee” or “Huee” sound on it, mark the location on the survey map with house number or landmark.
- Sensor microphone unit can be use as a leak detector.

(4)Cautions

- Check the residual battery before use.
- Recharge it fully If color is red, charge lamp changes color from red to green when recharge is completed.
- Do not give a strong shock to the hand prove because sensor will be broken.

6.Water Leak detector

Model : FCS S30

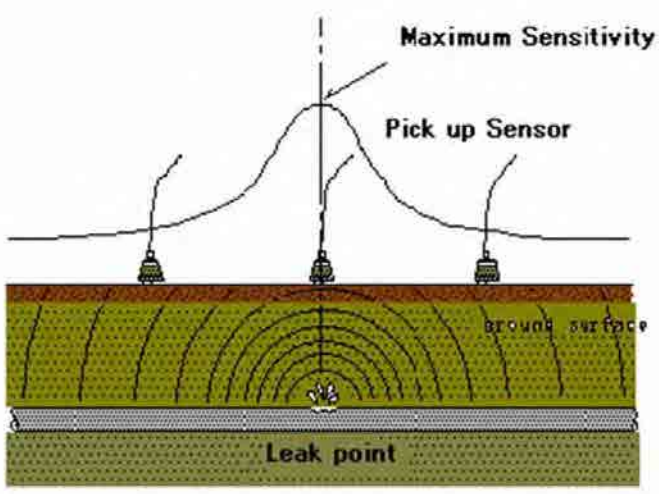
(1)Role of Equipment

Detect the exact leak point on the road surface by the pinpointing method.

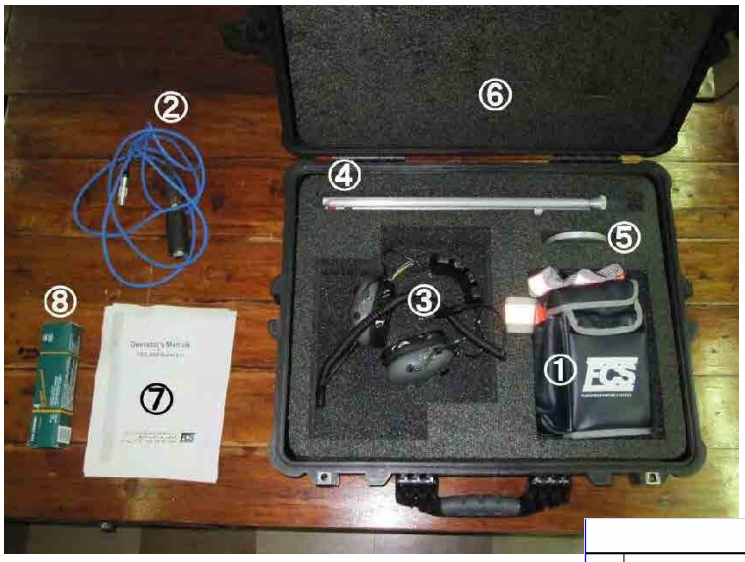
(2) Principle

When pressure increased to the pressure element which a sensor has built-in from the outside, an electric current is generated.

This generated electric current is amplified with a main unit and output it as a leak of water sound after conversion to an electrical signal.



(3)Components



System Components		
①	Main unit	1 pc
②	Pick up sensor	1 pc
③	Headphone	1 pc
④	Steel probe rod set	1 pc
⑤	Disk plate for acoustic of road surface	1 pc
⑥	Storing case	1 pc
⑦	Instruction manual (English)	2pcs
⑧	Dielectric Grease	1 pc

(4)How to use

- Connect the sensor cable and headphones to main unit.
- Check the residual battery quantity by the level gauge meter.
- Adjust the sound level with volume knob which a making it by the foot noises.

Level meter

At site

・Put on the sensor gently approximately 50cm on each step.

・Keep a distance at least 2m each other during survey due to avoiding foot noises.

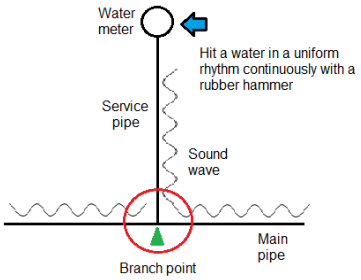
・Move the sensor forward, backward, left and right side when find a suspicious sound.

・Mark the point which is detected the loudest point on the surface with color splay, and also mark the point on the survey map with house number.

(5)Applied method for pipe line detection

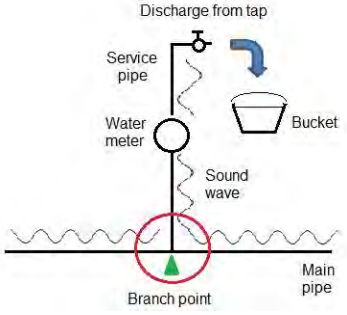
・Water leak detector can detect the sound which propagate to pipe line or “T joint” by making a sound as water usage from the road surface.

・Water leak detector can utilize for the detection of non-metallic pipeline by hitting water meter or discharging water.



①Hitting method make a sound to the service pipe when continuously hit the water meter by rubber hammer.

②Discharging method make a sound as similarly leak noise at T joint or at ferrule point .



Try both methods when trace a non-metallic line. The line is drawn by point-to-point.

(6)Cautions

- Do not drop the sensor strongly.
- Check battery condition at fixed interval.
- Storage the equipment to the carrying box when in not use.

7.Leak noise correlator

Model : Primayer Eureka

(1)Role of Equipment

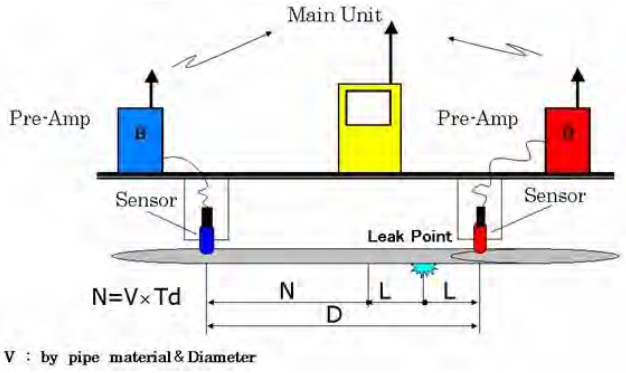
Confirmation work is conducted on the final stage of leak detection survey for avoiding extra excavation.

Leak noise correlator can identify the exact point just inputting the pipe information.

(2)Principle

Leak sound travels to both sides from the leak point at same speed if pipe material and diameter are in same conditions.

When leak point is just center between sensors blue and red, leak sound travel at same time to the both sensors.



V : by pipe material & Diameter

However, leak point close to red side like a figure, it travel to the red side faster than blue with difference time.

This is called “Time difference (Td)”

Leak noise correlator calculates Td which is transmitted from the preamplifiers every each second.

Td 0 meaning center , and –Td is close to blue sensor , and + Td is close to red sensor.

The leak point calculate D(total length between two sensor) – N (V: velocity of pipe speed X Td: time delay) / by 2 = leak position from red sensor.

Pipe diameter, pipe material, total distance should be inputted as the pipe information.

The peak point appear on the screen with the leak distance from both side sensor when the leak is between two sensors.

(3)Components

System Components		
①	Acceleration sensor	2pcs
②	Digital radio transmitter	2pcs
③	Reception module	1pc
④	Hard tablet type Computer	1pc
⑤	Magnetic Vehicle Mount Antenna	1pc
⑥	Headphone	1pc
⑦	Hard carry case (with battery charger)	1pc
⑧	Software CD	1pc
⑨	Instruction manual (English)	2pcs
⑩	Car Charge Cable	1pc
⑪	Mains Charger	1pc
⑫	Transmitter Programming Y-Cable	1pc
⑬	Receiver Unit USB Cable	1pc

Tablet Pc ·····Correlator's software can check correlation of sound and analyze a possibility of leak.

Catch the sound by the sensors and transmit the sound signal to the main unit at fixed interval.

(4)How to use

Transmitter and sensor

- Connect the sensor to transmitter and turn on switch.
- Select the power mode low and High.
- Check the sound /battery indication, Red lamp turns on when residual battery is low.
- Set the red and blue sensors onto fittings directly.

Pc tablet

- Turn on the switch and select the correlator's program.
- Select the run menu and check the correlation.
- If there is leak, correlation peak appears on the screen.
- Input pipe information such as pipe material, pipe diameter and distance.
- Select the addition key If there are difference pipe data between two sensors.
- Select the run key, correlator will indicate the leak position.

(5)Factors to affect for the leak detection

①Length :
Since leak sound sometimes does not reach to both sides or when distance is longer in the town area signal does not reach to main unit. If there is possibility like so, sensors should be installed less than 500m in length. Try it again on shorter distance if correlator does not get the peak from leak.

②Pipe material:
Metal pipe has long propagation characteristics better than non-metallic pipes.
Try use it in good material condition.

③Pipe size:
Large diameter pipe has a characteristics which is higher attenuation rate of leak sound propagation.

④Leak figure:
Hole type figure makes more loudness sound which generate friction vibration to pipe when getting out from the pipe with pressured water.

(6)Caution

①Battery

・Check the residual battery quantity of main unit and transmitters.

・Pc unit should be recharged at fixed interval otherwise battery life will be short.

②At site

・Do not identify the leak location at one time, Try again difference route if there are fittings.

Annex - 6

Execution Plan

Annex -6 Execution Plan

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
(NWSDB)
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

EXECUTION PLAN
on
NRW Reduction in Colombo

Prepared under the activities of

JAPANESE TECHNICAL COOPERATION
FOR
THE CAPACITY DEVELOPMENT PROJECT
FOR NON REVENUE WATER REDUCTION
IN COLOMBO CITY

October 2012

Table of Contents

PART A CAPACITY DEVELOPMENT PROJECT 1
Chapter A1 Outline of the Project 1
A1.1 Background 1
A1.2 General Schedule 3
A1.3 Purpose and Outputs of the Project 3
A1.4 Target Area 4
A1.5 General Structure of the Project Organization 7
A1.6 Organization of NRW Reduction Management Team 7
A1.7 Organization of NRW Reduction Team 7
A1.8 Project Design Matrix 9
A1.9 Procured Equipment 11
Chapter A2 Findings from the Project 12
A2.1 The Executed Activities 12
A2.2 The Results 25
A2.3 Difficulties and Problems 30
A2.4 The Results 32
Chapter A3 Water Audit 40
A3.1 Definition and Methodology 40
A3.2 Water Balance in Borella 41
PART B EXECUTION PLAN 64
Chapter B1 Policy and Target of NRW Reduction 64
Chapter B2 Improvement of Measurement System 64
B2.1 Purpose of Measurement System 64
B2.2 Current Activities and target 64
B2.3 Future Plan 65
Chapter B3 Unbilled Authorized Consumption 66
B3.1 Free Water Outlets 66
B3.2 Randiya Program 66
B3.3 Another Program 66
B3.4 Continuation of the Current Activities 66
Chapter B4 Reduction of Apparent Losses 68
B4.1 Unauthorized consumption 68
B4.2 Metering Error 69
B4.3 Estimation of required cost and period 70
Chapter B5 Reduction of Real Losses 71
B5.1 Distribution System in the Better Condition Area Similar to Borella 71
B5.2 Distribution System in Poor Condition Area Similar to Kotahena 76
B5.3 Required Equipment 77
B5.4 Cost and Benefit 77
Chapter B6 Improvement of GIS 79
B6.1 GIS for Planning and Ordinal O&M 79
B6.2 Improvement / Updating of GIS for O&M 79
B6.3 Updating GIS Data as Ordinal O&M Activities 79
B6.4 Utilization of GIS for O&M 80
B6.5 Required Input for Preparation of GIS for entire Colombo City 80
Chapter B7 PR Activities 82
B7.1 Activities Executed by the Project 82
B7.2 Current Activities 82
B7.3 Future Activities 83
Chapter B8 Organizational Improvement 84
B8.1 Current Approach on Organizational Improvement 84

B8.2 Required Additional Input....84
Chapter B9 Action Plan....86
Chapter B10 Evaluation and Monitoring of Implementation....88
Chapter B11 Other Recommendations....89
B11.1 Other Recommendations on O&M improvement....89
B11.2 Recommendation on system improvement program....89
B11.3 Recommendation on Revision of Water Act....89

Supporting Report 1: Results of Pilot Activities
Supporting Report 2: Manual for Bundle Pipe Replacement
Supporting Report 3: Manual for Operation Methods of Leakage Detection Equipment
Supporting Report 4: Leakage Recording System
Supporting Report 5: GIS Improvement Methods
Supporting Report 6: Cost and Benefit

Note
- Supporting Report 1, Supporting Report 4 and Supporting Report 5 are not presented in this Project Completion Report
- Supporting Report 2 is presented in Annex - 4 of this Project Completion Report as an output of the Project's activities.
- Supporting Report 3 is presented in Annex - 3 of this Project Completion Report as an output of the Project's activities.
- Supporting Report 6 is presented in Annex - 7 of this Project Completion Report

List of Figures & Tables

Figures:

Figure A1-1 General Schedule of the Project....3
Figure A1-2 Locations of Pilot Project Area (Kotahena & Borella)....6
Figure A1-3 Organization Structure for Project Activities....7
Figure A1-4 Structural Image of NRW Reduction Team....8
Figure A2-1 Work Flow of Activities in Pilot Area....14
Figure A2-2 Format for Record of Valve Condition....15
Figure A2-3 Format for Customer Check List....15
Figure A2-4 Format for Leak Record Sheet....16
Figure A2-5 Sub-zone Assignment in Kotahena Pilot Area....28
Figure A2-6 Sub-zone Assignment in Borella Pilot Area....29
Figure A3-1 Water Balance before and after NRW Reduction Activities (B1)....43
Figure A3-2 Transitional Change of Water Balance according to NRW Reduction Activities (B1)....44
Figure A3-3 Water Balance before and after NRW Reduction Activities (B3)....46
Figure A3-4 Water Balance before and after NRW Reduction Activities (B4, Fairfield Road)....48
Figure A3-5 Water Balance before and after NRW Reduction Activities (B4, Magazine Road)....50
Figure A3-6 Water Balance before and after NRW Reduction Activities (B6)....52

Figure A3-7 Water Balance before and after NRW Reduction Activities (K1) 56
Figure A3-8 Transitional Change of Water Balance according to NRW Reduction Activities (K1) 57
Figure A3-9 Water Balance before and after NRW Reduction Activities (K2) 58
Figure A3-10 Transitional Change of Water Balance according to NRW Reduction Activities (K2) 59
Figure A3-11 Water Balance before and after NRW Reduction Activities (K3&K4) 60
Figure B5-1 Flow Chart of Leakage Detection and Repair 72
Figure B5-2 Concept of Procedure for Responding and Recording Leakage Cases 75

Tables:

Table A1-1 List of procured equipment 11
Table A2-1 Sub-zones Outside of the Pilot Project Area 21
Table A2-2 General Feature of the Pilot Area (Borella) 25
Table A2-3 General Feature of the Pilot Area (Kotahena) 25
Table A2-4 General Characteristics of Each Sub-zone (Borella) 26
Table A2-5 General Characteristics of Each Sub-zone (Kotahena) 27
Table A2-6 Summary of Result in B1 32
Table A2-7 Summary of Result in B2 (Tentative) 33
Table A2-8 Summary of Result in B3 33
Table A2-9 Summary of Result in B4 (Fairfield Road) 34
Table A2-10 Summary of Result in B4 (Magazine Road) 34
Table A2-11 Summary of Result in B5 35
Table A2-12 Summary of Result in B6 35
Table A2-13 Summary of Result in B10 36
Table A2-14 Summary of Result in K1 37
Table A2-15 Summary of Result in K2 38
Table A2-16 Summary of Result in K3&K4 38
Table A2-17 Summary of Result in K6 39
Table A3-1 IWA's Terminology for NRW 41
Table B3-1 Free Water Outlets in Colombo City (Survey-2008) 66
Table B5-1 Information of Storage Tank (Housing Estate, Apartment, etc.)* 74
Table B5-2 Required Cost vs. Benefit in a Sub-zone (5,000 Connections) 78
Table B6-1 Required Input for GIS Preparation 81
Table B7-1 Effects of PR activities 82
Table B9-1 Summary of Activities to Be Executed 86
Table B9-2 Recommended Urgent Action Plan 87

PART A CAPACITY DEVELOPMENT PROJECT

Chapter A1 Outline of the Project

A1.1 Background

For the National Water Supply and Drainage Board (NWSDB), which is in charge of water supply and sewerage service in the most part of the Democratic Socialist Republic of Sri Lanka (Sri Lanka), high rate of Non Revenue Water (NRW) has been a longstanding problem in its operation and management. In Colombo City, where aged pipes still remain in many parts of its distribution system, the NRW rate as of 2008 is reported to be 54.1%, higher than its nationwide average of 33.0%. To tackle this problem, NWSDB has been working to reduce the rate of NRW in several ways such as leak repair, detection/elimination of illegal connections, removal of public standpost and converting its users to individual connection, and billing system improvement. However, NWSDB still faces difficulties to reduce NRW to satisfactory level.

To improve this situation, NWSDB has stressed the importance of reduction of NRW as one of the most priority tasks to be tackled and set a target to reduce NRW in its "Corporate Plan, 2007" (CP-2007) that stipulates its forthcoming business activities during the period between 2007 and 2011. In order to achieve the target, however, it is necessary for NWSDB to have an outside aid to improve its faculties of practical implementation or experiences in NRW reduction measures.

Under this circumstances, the government of Sri Lanka (GOSL) requested the government of Japan (GOJ) for assistance to NWSDB through conducting a technical cooperation project regarding NRW reduction. The Japan International Cooperation Agency (JICA) has conducted a fact-finding survey on water supply sector in Sri Lanka from 2007 to 2008. Based on the above formal request by GOSL and information collected through the fact-finding survey, JICA and the officials of Sri Lanka concerned came to an agreement to conduct "the Capacity Development Project For Non Revenue Water Reduction in Colombo City" (the Project). Both of the parties agreed and signed the "Record of Discussion between Japan International Cooperation Agency and the Authorities Concerned of the Government of Democratic Socialist Republic of Sri Lanka on Japanese Technical Cooperation for the Capacity Development Project for Non Revenue Water Reduction in Colombo City" (R/D) in April 2009.

To conduct the aforementioned Technical Cooperation Project, JICA organized the JICA Expert Team (JET) to dispatch it to Sri Lanka. JET has commenced its activity in Sri Lanka since 9th November, 2009 and is scheduled to continue it until October 2012, which is divided into 3 phases, namely 1st Project Year (Oct/2009 to Mar/2011), 2nd Project Year (Apr/2011 to Mar/2012) and 3rd Project Year (Apr/2012 to Oct/2012).

A1.1.1 Current Activities for NRW Reduction

NWSDB has formulated a five-year plan called "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region, June 2007" (SA-2007). The SA-2007 places the issues of NRW reduction as an urgent task, and provides 8 activities toward NRW reduction as shown below, for restructure of implementation system or programs for input.

Annex -6 Execution Plan

(1) Action Path I: Re-organization of Colombo City

(2) Action Path II: Pilot Projects in Kalutara & Gampaha Region

This action path aims "to implement pilot projects in Kalutara & Gampaha Regions as many as possible in order to enhance capacity building and create awareness among entire staff".

(3) Action Path III: Pipe Replacement in Colombo City

This action path aims "to initiate one or more projects in Colombo City to replace pipes which are beyond economical repairs. It should be programmed in such away to get its benefits during 5^{th} year and onwards".

(4) Action Path IV: Strengthen of NRW Section

(5) Action Path V: Work Programme for Preventive Approach

(6) Action Path VI: Review of Specification to Pipe Specials

(7) Action Path VII: Strengthening Legal Activities

(8) Action Path VIII: Incentive & Penalty to Meter Reader

A1.2 General Schedule

Figure A1-1 shows the general schedule of the Project.

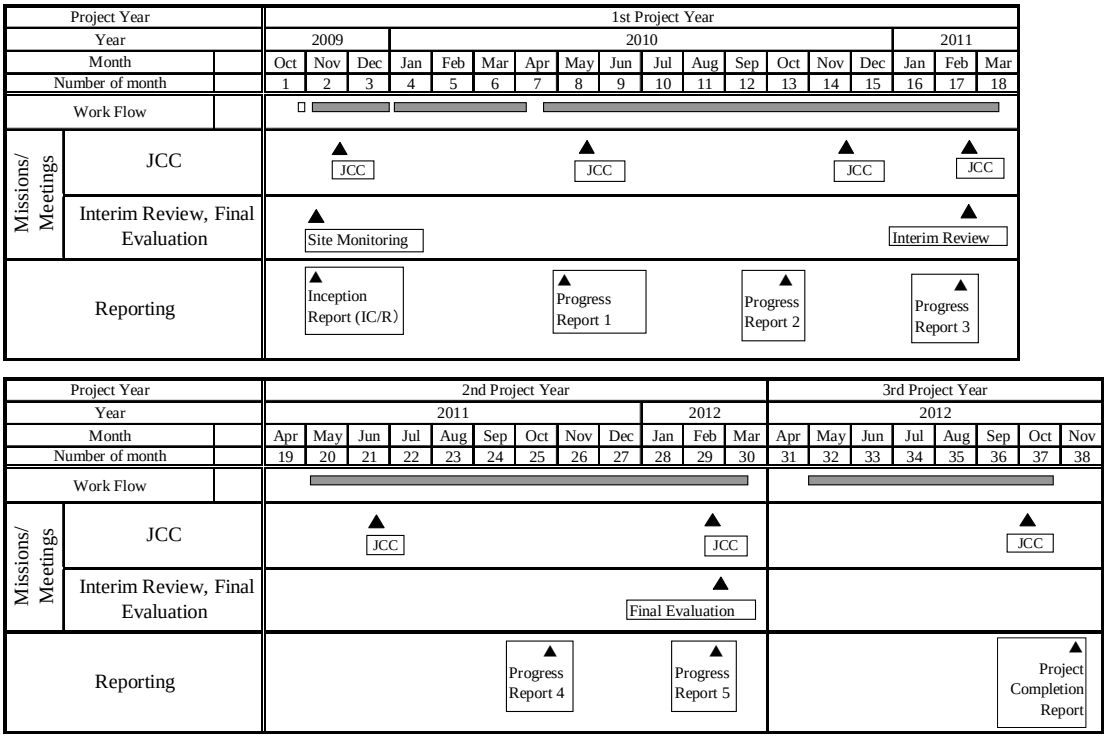


Figure A1-1 General Schedule of the Project

Above schedule is based on the Plan of Operation (PO) attached as Annex A-1.

A1.3 Purpose and Outputs of the Project

The “Duration of the Project” is from November 2009 to October 2012.

The “Project Purpose” is as follows.

“NWSDB's capacity to implement NRW reduction activities in Colombo city is strengthened.”

"Objectively Verifiable Indicators" for the “Project Purpose”:

1 Number of NRW reduction activity records will increase compared to what was before the Project.
2 The budget to be allocated for NRW reduction will increase compared to what was before the Project.
3 An execution plan to achieve reduction of NRW ratio by one (1) percentage point per annum, as per the Goal 2.1 of "Corporate Plan 2007-2011", is prepared and incorporated into relevant plans/programs of NWSDB.

In addition, expected “Outputs” of the Project and their respective “Objectively Verifiable Indicators” are as follows.

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.

"Objectively Verifiable Indicators" for the “Output 1”:

1-1 An annual program for NRW reduction in the pilot areas is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years).
1-2 NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget, etc.) as planned.
1-3 NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams".

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.

"Objectively Verifiable Indicators" for the “Output 2”:

2-1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan.
2-2 NWSDB officers/staff engaged in “NRW reduction Teams” acquire proper leak detection, plumbing and pipe repairing skills.
2-3 An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.

Note) "Objectively Verifiable Indicator" can be used as a benchmark to evaluate whether “Project Purpose” and “Outputs” are achieved. This indicator should be monitored during the course of the Project.

To achieve the above “Project Purpose”, NWSDB and JICA Expert Team (JET) will mutually keep in mind that NWSDB is to play a major role with distinctive ownership in conducting the Project and JET is to support NWSDB.

A1.4 Target Area

A1.4.1 Location of the Target Area

The target area of the Project is Colombo City. Two (2) locations of “Pilot Area”, in which a series of NRW reduction activities are planned and implemented, has been designated in Borella and Kotahena in Colombo City. A scale of each “Pilot Area” is equivalent to cover approximately 5,000 connections.

A1.4.2 Outline of the Pilot Project

"Pilot Area" are Two (2) locations, namely "Kotahena" and "Borella". NWSDB is scheduled to conduct “Water Sector Development Project (II)” in Colombo City (WSD-II), which is the 39th ODA Loan Project for GOSL by GOJ. WSD-II is to improve water supply facilities in Colombo City, including replacement of aged distribution pipes or facilitation of individual connection in a tenement garden. WSD-II is assistance to NWSDB from “hardware side”. On the contrary, the Project intends to provide assistance to NWSDB from “software side”, by strengthening the capacity of individuals and organizations working for NRW reduction.

Contents of the Pilot Project can be outlined as follows.

- Pilot Project in Kotahena:

Conduct a series of NRW reduction activities with replacement of aged pipes. However, only four (4) aged pipe lines will be replaced under the WSD-II scheme. In order to realize good coordination, constant communication will be maintained with the Project Director (PD) of WSD-II.

- Pilot Project in Borella
  Conduct a series of NRW reduction activities without replacement of aged pipes.

Locations of each pilot area are shown in Figure A1-2.

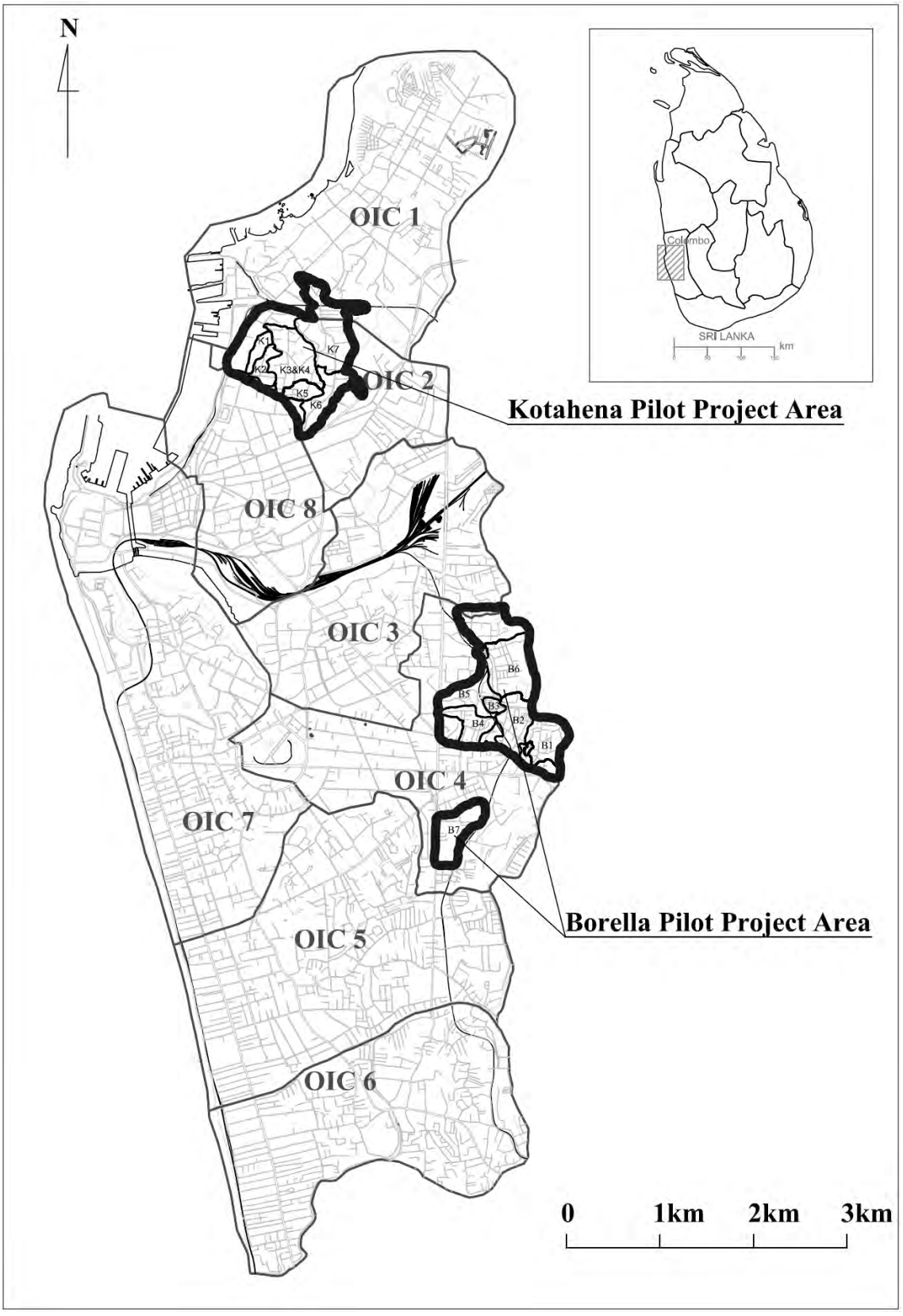
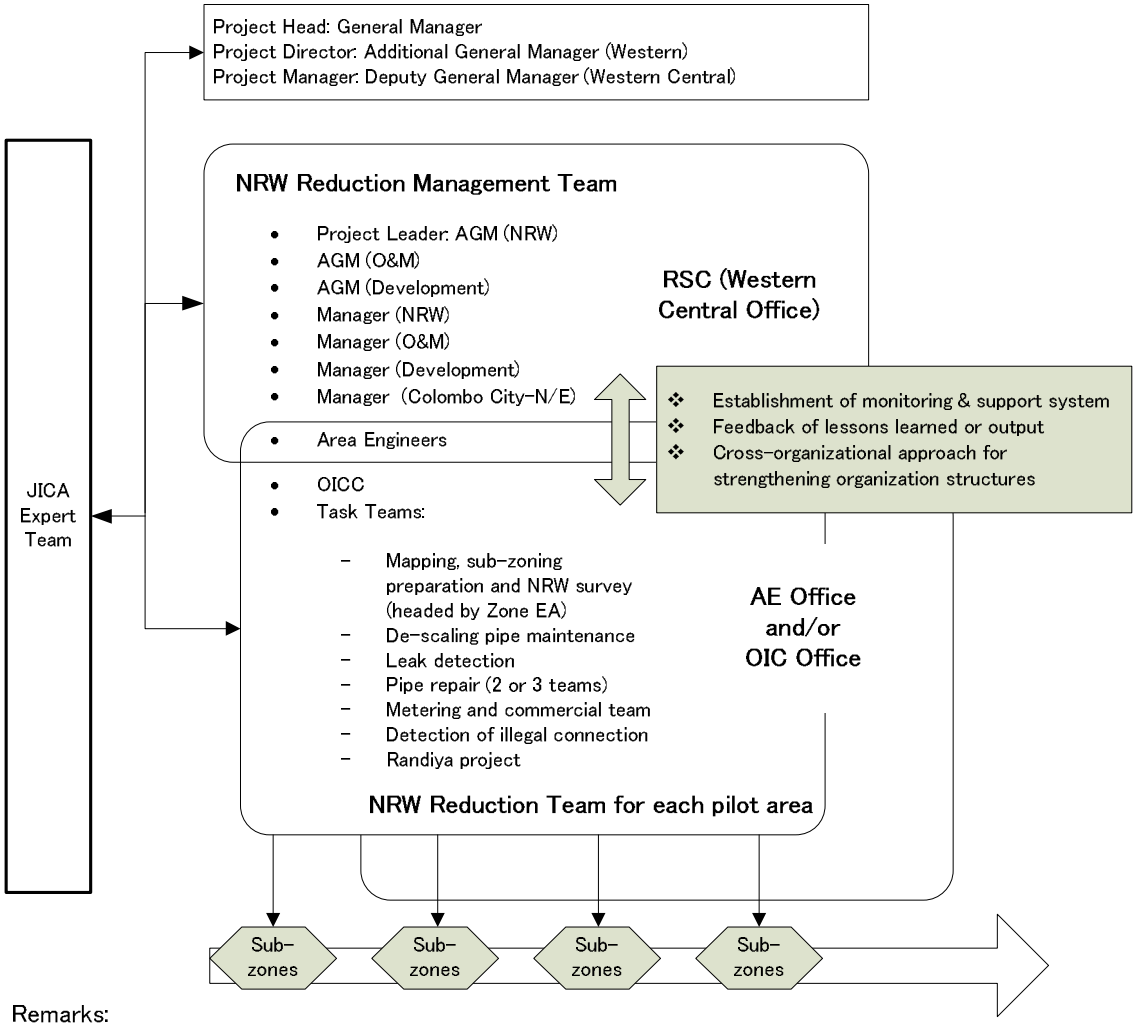


Figure A1-2 Locations of Pilot Project Area (Kotahena & Borella)

A1.5 General Structure of the Project Organization

As shown in the R/D signed on 22nd April, 2009, C/P was assigned as Figure A1-3.



＊Based on the "ANNEX IV" of R/D & "Attachment IV" of M/M

Figure A1-3 Organization Structure for Project Activities

A1.6 Organization of NRW Reduction Management Team

Members of NRW Reduction Management Team has been appointed based on R/D. Member List of NRW Reduction Management Team is shown in Annex A-2.

A1.7 Organization of NRW Reduction Team

As well as the NRW Reduction Management Team mentioned above, NRW Reduction Team has been organized.

Structural Image of NRW Reduction Team is shown in Figure A1-4.

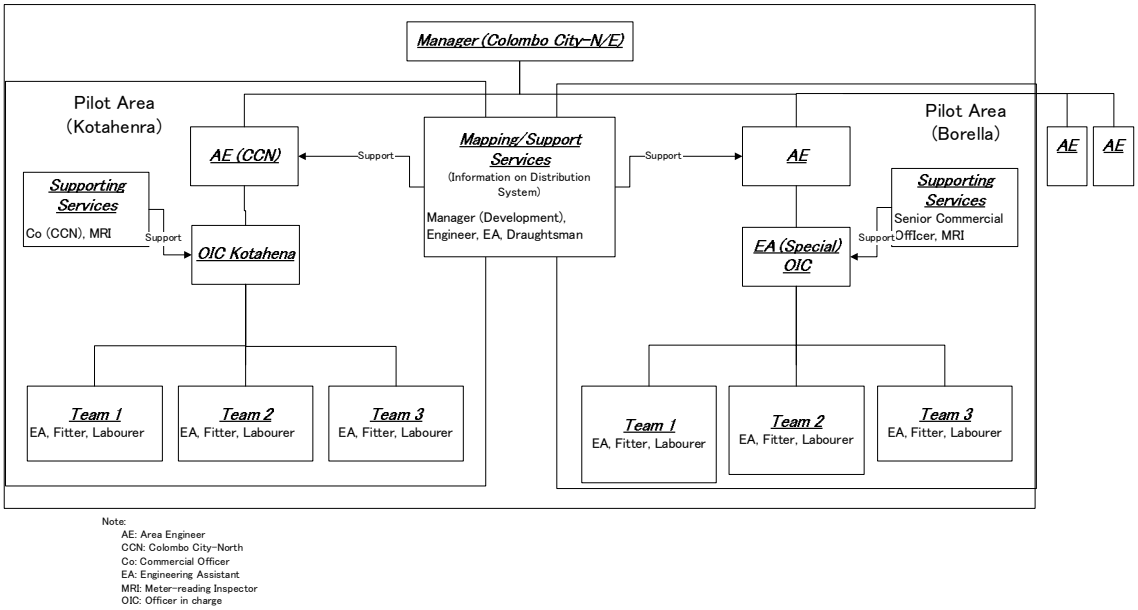


Figure A1-4 Structural Image of NRW Reduction Team

Team 1 has been headed by each zone officer in charge and its supporting staff. Team 2 has been formed by staffs belong to NRW Section.

As for the Team 3, at the beginning of the Project, a zone officer other than Borella or Kotahena were planned to be assigned to the Pilot Activities under the Project and change to other zone officer in turn after a series of OJT, so that experience and knowledge obtained through the Project is supposed to be shared among C/P staff as many as possible. However, Team 3 was cancelled due to unavailability of cadre for those officers. Accordingly, the Project could not give training as many as originally expected.

A1.8 Project Design Matrix

Project Design Matrix (PDM) is a logical framework that summarizes a project. The original PDM (PDM_0) is based on the minutes of meeting between JICA and the Democratic Socialist Republic of Sri Lanka signed on April 22, 2009 (M/M). The PDM_0 was revised at the part of "Duration of the Project" and the "Input of Japanese Personnel" at the occasion of 1st JCC Meeting. Another revision was made at the 5th JCC Meeting on commencement of the 2nd Project Year. The latest PDM (PDM_2) is shown below.

Project Design Matrix (PDM_2)

Project title: **Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka**
Duration: **November 2009-October 2012**
Target Area: **Colombo City, Sri Lanka**
Target Group: **Officers and staff of NWSDB (Western-Central Division)**
Date: **22nd June, 2011**

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The NRW ratio in Colombo city is reduced.	1 NRW reduction activities are comprehensively conducted by 22 zone offices in CMC area in accordance with the execution plan. 2 Decrement of NRW ratio per annum in CMC area exceeds one (1) percentage point up to 2017.	1 Annual report of NWSDB 2 Record of NRW ratio	
Project Purpose NWSDB's capacity to implement NRW reduction activities in Colombo city is strengthened.	1 Number of NRW reduction activity records will increase compared to what was before the Project. 2 The budget to be allocated for NRW reduction will increase compared to what was before the Project. 3 An execution plan to achieve reduction of NRW ratio by one (1) percentage point per annum, as per the Goal 2.1 of "Corporate Plan 2007-2011", is prepared and incorporated into relevant plans/programs of NWSDB.	1 Annual report of NWSDB	1 NWSDB secures the budget for scaling-up of the NRW activities. 2 Necessary equipment such as pipes, saddles and meters are provided by NWSDB. 3 Over-aged pipes in selected zone of CMC area are replaced.
Outputs 1 Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced. 2 Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	1.1 An annual program for NRW reduction in the pilot area is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years). 1.2 NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget etc.) as planned. 1.3 NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams". 2.1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan. 2.2 NWSDB officers/staff engaged in "NRW reduction Teams" acquire proper leak detection, plumbing and pipe repairing skills. 2.3 An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.	1.1 Annual report of NWSDB 1.2 Project record, Quarterly progress report 1.3 Project record, Quarterly progress report, training materials 2.1 Project record, Quarterly progress report 2.2 Project record, Quarterly progress report 2.3 Project record, Quarterly progress report	1 Officers and staff trained by the project will continue with NRW activities of NWSDB.

Annex -6 Execution Plan

Activities	Inputs		
	Japan	Sri Lanka	
1-1 Organize a "NRW Reduction Management Team" at Western-Central Regional Support Center. 1-2 Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region". 1-3 Prepare an annual program of NRW reduction activities for the pilot areas*. 1-4 Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams". 1-5 Assess progress of NRW reduction activities in the pilot areas. 1-6 Review the annual program of NRW reduction activities based on the feedback/lessons learnt in the pilot areas and prepare the program for the following year. 1-7 Evaluate activities in the pilot areas through out the Project period and prepare an "execution plan" to apply the Project outcome to entire area Colombo city 2-1 Select two (2) pilot areas. 2-2 Organize "NRW Reduction Team (a group of OlC**, EA** and gangs***)" at the pilot areas. 2-3 Review and modify pipeline network drawings of the pilot areas by using GIS, which shall be used for the NRW reduction activities. 2-4 Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio. 2-5 Prepare a NRW reduction work plan for each pilot area incorporating leak detection, pipe repairing, plumbing and activities for the reduction of non-physical losses****. 2-6 Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team". 2-7 Implement NRW reduction activities according to the work plan. 2-8 Measure results of NRW reduction team's work (NRW ratio etc.) and provide feedback to "NRW Reduction Management Team" for revision of the annual program.	1. Personnel Chief Advisor /NRW reduction programming Deputy Chief Advisor /NRW reduction monitoring and evaluation Leak detection Advisor Arrangement of pipeline drawing and customer data Service pipe connection advisor Coordinator 2. Equipment Leak detector Pipe locator Portable ultrasonic flow meter Vehicle, etc. 3. Overseas Training Overseas Training for NWSDB counterpart personnel	1. Personnel Project Head Project Director Project Manager Counterpart personnel for - "NRW Reduction Management Team" - "NRW Reduction Team" 2. Facilities Office space, furniture and facility. 3. Local cost Cost for the isolation of pilot project areas (including installation of chambers for flow meters) Pipe-repairing Cost Cost for road opening/reinstatement Project management Cost 4. Others	Pre-conditions 1 NWSDB secures the budget for implementation of the NRW activities at pilot areas. 2 Recruitment of personnel to be assigned to the pilot areas is completed.

*: Pilot area corresponds to jurisdiction of "zone officer" (Approx. 5,000 connection). The pilot area will be divided into smaller blocks (Approx. 500 connections) to conduct the program.

**: Proposed positions in "Strategic-Approach for Non-Revenue Water Reduction in Colombo Metropolitan Region" (Feb.2008)

***: A work unit which is composed of plumber, labor etc.

****: Activities for non-physical losses reduction include measures against illegal connections and bypass connections, replacement of defective customer meters and estimated billing.

A1.9 Procured Equipment

The equipment procured for this project is shown in Table A1-1.

Table A1-1 List of procured equipment

Procured year		Equipment	Qty	Unit	Use
First year	1	Correlation Leak Detector	2	pieces	Leak detection for pipelines at greater depth under high noise level circumstances.
	2	Electronic Leak Detector	5	pieces	Picking up sound of leak noise that travels across soil.
	3	Pipe Detector (Non-Metal)	3	pieces	Detecting buried non-metal pipe.
	4	Data Logger with Pressure Inducer	8	pieces	Measuring water pressure in a sub-zone.
	5	Acoustic Rod - Digital Type	5	pieces	Picking up sound of leak noise with amplifier.
	6	Pipe Detector (Metal)	4	pieces	Detecting buried metal pipe.
	7	Laptop Computer	2	sets	Data analysis for flow and pressure measurement.
	8	Listening Stick	6	pieces	Picking up sound of leak noise.
	9	Boring Bar	2	pieces	Tools that are used to bore road surface to confirm location of leakage.
	10	Drill Bit	30	pieces	Tools that are used to bore road surface to confirm location of leakage.
	11	Hammer Drill	2	pieces	Tools that are used to bore road surface to confirm location of leakage.
	12	Pressure Gauge for House Connection	6	pieces	Measuring water pressure at a water tap in a sub-zone.
	13	Portable Ultrasonic Flowmeter	2	pieces	Measuring flow in a sub-zone.
	14	Portable Ultrasonic Flowmeter	8	pieces	Measuring flow in a sub-zone.
	15	DC12V Cable for Ultrasonic Flowmeter	8	pieces	To use car battery for ultrasonic flowmeter
	16	Generator	2	sets	To drive hammer drill.
	17	Valves (φ100-200mm)	60	pieces	To isolate pilot areas
	18	Plastic customer meter assembly	200	pieces	To measure water consumption by customer
	19	Crew CABs (Double cabin trucks)	2	sets	To convey tools and equipment together with workforce
	20	Pickup trucks	2	sets	To convey tools and equipment together with workforce
	21	Micro excavators	2	sets	To excavate soil for installation of valves and pipes
	22	Metal locator (Valve locator)	5	pieces	To find out buried valves
	23	Projector	1	piece	For presentation during discussion
Second year	24	High Accuracy Hand-held GPS	1	set	To utilize in field work for GIS activity
	25	Desktop PC	6	sets	To use GIS softwares
	26	External HDD	6	pieces	To file GIS data
	27	UPS	6	pieces	To make ready for electric power failure
	28	MS Office	6	sets	To use MS Office soft ware
	29	Virus Protection	6	sets	To guard PC from Virus
	30	A3 Printer	4	sets	To print out documents and drawing
	31	A4 Scanner	1	set	To scan documents and drawing
	32	Plotter (A0)	1	set	To print out drawing of A0 size
	33	GIS Software-1 (Arc View 10)	2	sets	To utilize for GIS acttivity (Ex. To update pipeline location)
	34	GIS Software-2 (AutoCAD Map 3D 2011)	4	sets	To utilize for GIS acttivity (Ex. To update pipeline location)
	35	Satellite Image	1	set	To utilize as basemap in GIS softwares

* Third year: no item

Chapter A2 Findings from the Project

A2.1 The Executed Activities

A2.1.1 Work Flow of Pilot Project

Work flow of activities in Pilot Area are illustrated in Figure B5-1. Activities may be divided into preparatory works and activities for NRW reduction. These activities were monitored by regular weekly meetings between JET and C/P.

(1) Preparatory Works

- Preparation of Survey Map:
  - Before starting site survey, map of a sub-zone that shows location of key facilities (pipes or valves) on base map (road or major building) was prepared.
- Selection of Sub-zone:
  - With reference to the drawings, boundary of a sub-zone was tentatively determined. Due to the lack of accuracy of the existing drawings, the boundary of had to be subject to change depending on actual condition at site.
- Detection of Pipe and Valve:
  - Route of pipelines was verified at site survey.
  - Locations of valves and their function were verified at site survey. To verify and record the condition of the valve, a record format as shown in Figure A2-2 was prepared.
- Installation of Valves and Meter Chamber:
  - Additional valves were installed wherever necessary to isolate the sub-zone.
  - Flow meter was installed at the inlet of the sub-zone. In case it was very difficult to maintain system pressure after isolation, plural number of inlet points and/or outlet point(s) were considered.
  - In case it was difficult to isolate the sub-zone, boundary of sub-zone or point/number of inflow (outflow) point(s) were changed.
- Review of Monthly Billing Data and Customer Survey:
  - In parallel with the isolation work, billing records of all customers within the boundary of sub-zone were collected and reviewed, to establish revenue water before NRW reduction activities.
  - Based on the review of the billing record, customer list was prepared, for the purpose of checking current connection status, meter condition, number of family member, with or without of overhead tank or sump and its condition, illegal connection, and so on. A record format is shown in Figure A2-3.
  -

(2) Actions for NRW Reduction

- Leak Detection Work
  - Visible leak were identified through site observation and/or report by residents.
  - Acoustic survey using listening stick were conducted to check sound of leaks at pipe apparatus (eg., customer meters, valves, etc.).
  - Pinpointing survey were conducted to check sound of leaks under road surface by picking up leakage noise by leak detector. Pinpointed locations were marked by spray paint on its road surface in order to confirm existence of leak by confirmation survey another day.
  - Confirmation survey were conducted at those pinpointed location to verify whether it was

really leaking or not.

- Leak Repair Work
  - Identified leakages were then repaired.
  - Repaired leak were then recorded into leak record format sheet as shown in Figure A2-4.
- Survey/Action for Other NRW-related Issues
  - Locations of free water outlets (FWO) in sub-zone were specified and meters were fixed at each FWO to monitor consumption.
  - Leakage or overflow at overhead tanks or sumps were also major items to be considered. Therefore, necessary action (eg., fix bulk meter before tanks or sumps, repair overflow or leaks, etc.) was taken.
  - Bundle pipes (and long-distance service line) were also major issues to be considered. Bundle pipe replacement works were also conducted (cutting bundle pipes, laying common pipes and converting house connection to the newly installed common pipes)

(3) Monitoring of Result and Work Progress

- Measurement and Analysis after NRW Reduction
  - System inflow was measured after NRW reduction activities.
  - Depending on obtained result, step testing were conducted whenever necessary to narrow down suspicious sections of high NRW.
- Monitoring Result and Progress
  - Result and work progress were monitored by regular weekly meeting among JET, NRW Reduction Team and NRW Reduction Management Team.
  - Necessary actions or required modification in methods were discussed at the meeting.

Annex -6 Execution Plan

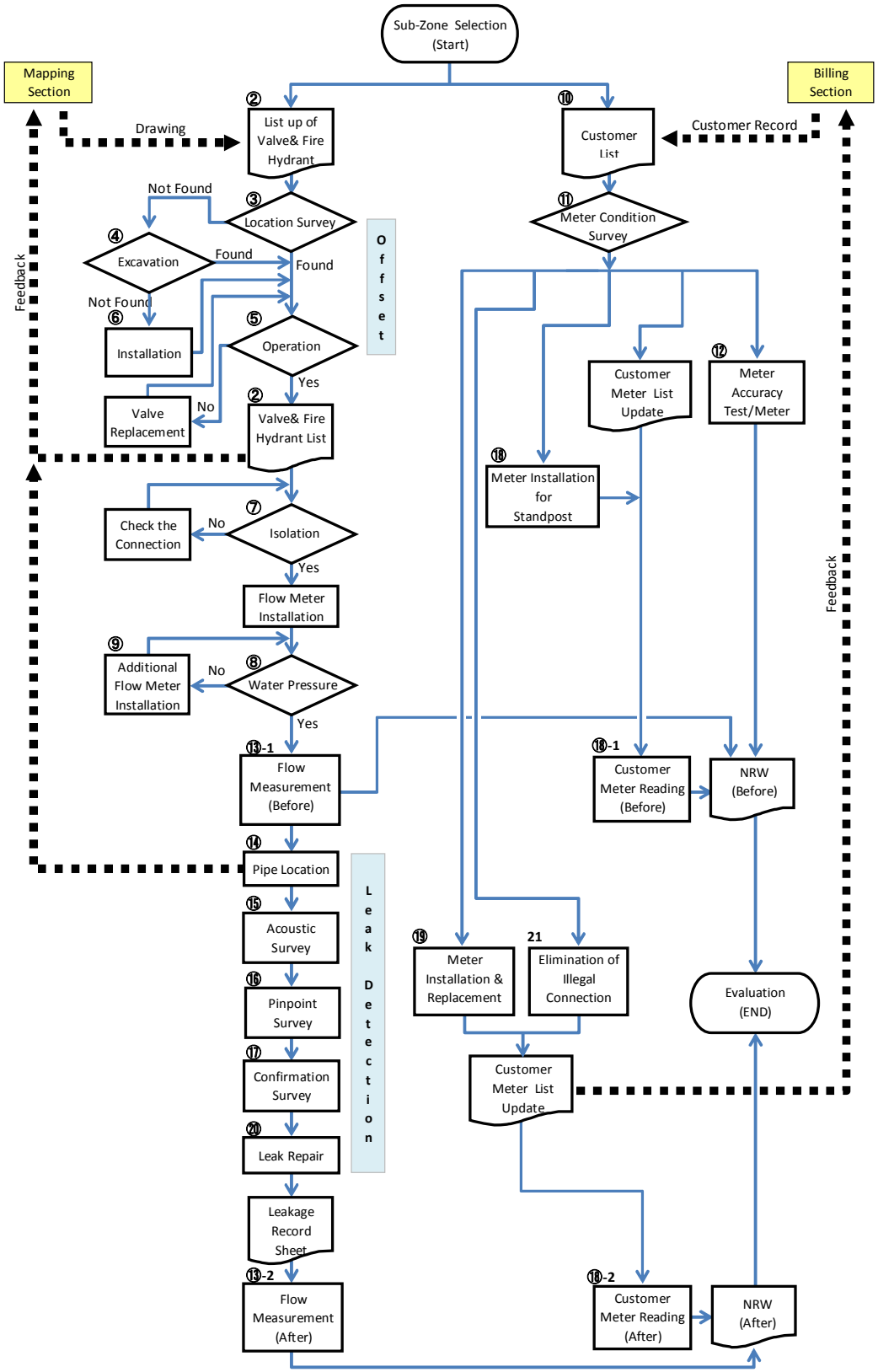


Figure A2-1 Work Flow of Activities in Pilot Area

Valve condition checking list

Name of Pilot area:
Name of Sub zone :

Item	No.	Size(mm)	Pipe material	Condition						
				Location (Existence, Buried)	Valve cover (OK, Non,)	Direction (Clockwise, Anticlockwise)	Operable (C, NC)	Number of rotation to be closed	Need for a replacement	Remarks
Valve	V-1									
	V-2									
	V-3									
	V-4									
	V-5									
	V-6									
	V-7									
	V-8									
	V-9									
	V-10									
Fire Hydrant	H-1									
	H-2									
	H-3									
	H-4									
	H-5									
	H-6									
Wash out	W-1									
	W-2									
	W-3									
Stand post	No.	Size	Material	Meter(Y, N)	Condition	Remarks				
	PT-1									
	PT-2									
	PT-3									

Figure A2-2 Format for Record of Valve Condition

Customer meter check list

Name of Pilot area:
Name of Sub zone :

No.	Customer name	Customer ID,	Road name /House No,	Record		Survey				
				Previous month consumption (m3)	Meter conditon (W, N, U, I, NA, O)	Family's Number	Number of tap	Tank Overhead, Ground (Y, N)	Meter condition (W, N, U, I, NA, O)	Remarks
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

W: Working
N: Non-working
U: Unmetered
I: Illegal Connection
NA: Not Access
O: Others

Figure A2-3 Format for Customer Check List

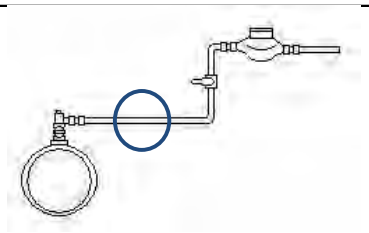
Leakage Record Sheet

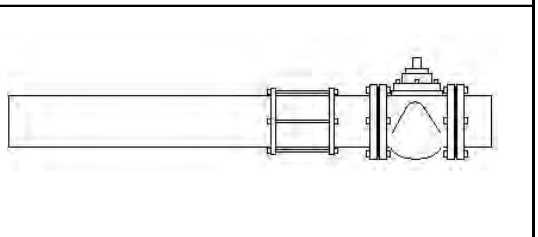
Ref. No 47

Borella_1 Second Activity

Date of survey:		Street No	Gothami Road
Account No,		House No	24/215
Main Pipe	CIP , PVC , GP, Others( )	Location	Pipe , Connection , Valve , Others
		Condition	Hole , Crack , Brakeage , Packing , Unknown , Others
Diameter	mm	Cause	Corrosion , Water pressure , Deterioration (Aging) Wrong Construction , Traffic load, Unknown , Others
House Connection	(PVC), GP, Others( )	Location	(Pipe), Connection , Valve , Others
		Condition	Hole, (Crack), Brakeage , Loose Connection , Packing , Unknown , Others
Diameter	20 mm	Cause	Corrosion , Water-pressure , Less Adhesive , Deterioration , (Wrong Construction) , Traffic load , Unknown , Vandalism , Others
Depth	60 cm	Ground	Asphalt , (Concrete), Gravel , Grass , Soil , Others
Leakage Size	Large , (Middium), Small	Leakage Quqntitiy (Measured)	

Point of Leakage





Date of Repair : , , 2010 Time/ : ~ : (H)	Material	Exavation Size(m x m x m) Pipe (Dia: mm Length: m), Socket (Pis) , Elbow ( ) Others ( ) Worker ( ) Other Expence( )

Photo Before

Photo Under Repair

Remarks

Figure A2-4 Format for Leak Record Sheet

(4) Selection of the Pilot Project Area

C/P and JET jointly selected the Sub-zones in the Pilot Project Area in Kotahena and Borella. A series of the Pilot Activities has been successfully conducted on the whole, even if unexpected obstacles has been encountered. The initial sub-zones for both Pilot Areas of about 500 house connections each were carefully selected, paying attention to "less interconnection with the neighbor the sub-zones" with "relatively high pressure", so that the C/P staff may be able to have OJT in easier area in early stage of the Project.

(5) Hydraulic Isolation

C/P and JET jointly collected information on pipeline network in the sob-zones in Pilot Areas, and modified the existing pipeline network drawings incorporating the identified information. The identified information was then sent to Maligakanda Office for updating the drawings. The updated drawings are to be collected by mapping section once a year to compile with other updated drawings.

Mapping Section keeps the electronic database of the network drawings with AutoCAD format for entire area of the Colombo City, which was organized under the assistance of the Norwegian project in year of 2000. However, C/P and JET often faced difficulties in specifying exact location of some buried valves, fittings or fire hydrants under pavement, because the existing pipeline network drawings are not always correct or accurate. In addition to the above, there were lots of unknown pipes, which might have been installed without records during the period of operation and maintenance by CMC. Because of the difficulties in specifying buried valves or hydrants, C/P and JET have been tried to find out these missing facilities as much as possible, by means of various ways such as, on-site detection using magnetic locator or making inquiry to the neighbors. Once information obtained, the specified location was excavated and tie-measurement (offset) was recorded. Nevertheless, these effort did not give good success in case a valve did not have cover (i.e., without valve cover of metal, it was difficult for magnetic locator to locate it). In a similar way, C/P and JET have traced route/location of pipelines by means of on-site confirmation using pipe detector (metal/ non-metal) or inquiry to neighbors.

It shall be noted that C/P and JET faced difficulties in isolation works. The major problems which have limited smooth progress of the Pilot Project are listed below.

- Existing drawings was not accurate as mentioned above
- There were several unknown / unexpected pipes at the site
- Some house connections were connected to numeral distribution pipes
- There were unexpected valves which disturb water flow in the system
- Picking up sound for valve close check was sometimes difficult because of low system pressure
- Due to lack of valves, identification of connection pipes to outside of the sub-zone required long time
- It was not easy to secure backhoe at required timing

Despite above mentioned difficulties, NWSDB has endured the situation and has been taking necessary actions positively in order to progress the Project.

(6) Leak Detection and Repair

Leak detection and its repair works were conducted under the Pilot Project activities. NWSDB sometimes faced difficulties in leak detection work due to low pressure and/or high ground water level.

Regarding pipe repair works, several issues to be improved have been identified. Issues and possible actions to be taken are presented in PGR-4. Among these issues, C/P and JET shared necessity of adequate manuals to keep quality of repair works. An updated general

idea/outline of manual for leak repair work is presented in PGR-4, which have been used for discussion and development of manual taking into account of the actual situation.

(7) Activities on Improving Service Connection

JET and NWSDB shares the view that one of the considerable factors of high NRW is unidentified leakage from "bundle pipes" (or so-called "spaghetti pipes"), which are directly connected to distribution main without common pipe, with a long distance from branch point to customer meter. This type of service pipe installations have often been observed especially in highly populated area of Colombo City. In general, leakages on bundle pipes were often overseen and remain unidentified due to difficulty in identifying route of pipes. Further, even route could be anyhow identified, it is sometimes the case that new houses exists on a route of pipeline and it makes almost impossible to detect/repair leaks.

Through the activities in Kotahena, many cases of bundle pipes have been identified. Therefore, NRW Reduction Team implemented several number of works to improve arrangement of service connections (cutting all identified bundle pipes and branching common pipe instead, after then service connection line to be connected to the newly-installed common pipe). Followings are activities having been conducted under the Pilot Project.

- MNF measurement to verify the effect of the above works did not show good result as expected. JET suspected that the workmanship of the works may have not been as good as required (eg., cutting point or method of cutting may be not appropriate, installation of new pipe may be low quality).
- Base on the above guess, JET prepared a draft manual for works for replacement of bundle pipes. The manual for improvement works for bundle pipe is presented in Supporting Report. This manual should be referred to on future works and brushed up as necessary.
- At the previous works that had been conducted by NWSDB during absence of JET, bundle pipes had been cut just before customer meters. NWSDB then conducted cutting works again, to cut the bundle pipe at a branching point from distribution main. However, it had been still doubtful whether this re-cutting works conducted and completed at all places.
- In response to the above experience, JET advised NWSDB that:
  - The bundle pipes should be cut at the branching point (should not be near customer meter).
  - Reconnection should be given only to customer who are suspended as a result of the above cutting work once common pipe is laid.
- There were many cases of leaks at the end-capped point after cutting due to poor workmanship. One of the reason for poor workmanship may be because end-capping was always conducted without stopping water. JET proposed possible measures for end-capping in case water cannot be stopped during works..
- In addition, JET and C/P shared the views that the following idea should be incorporated into the Execution Plan:
  - measures to prevent customers from modifying service line without permission should be taken.
  - Employing PE pipes may be one of options, as modifying attempt is not as easy as PVC.

(8) Review/Arrangement of Pipeline Drawings

1) Update of Drawings

C/P and JET updated the existing drawings of Sub-zones in Kotahena and Borella, based on new information obtained through the activities mentioned in the previous sub-section. Updated drawings for Sub-zones of Kotahena and Borella are presented in Annex A-3 of PGR-5.

In addition, C/P and JET prepared a format of offset record sheet and recorded any identified valves on the sheet. Example of recorded sheets are available in PGR-1.

2) GIS

a) Contents of the Activities

Expected Results/Effects within the Project Period are as follows.

- Meter reading work will be more effective/quicker.
- Meter reader's rotation system can be operated easily and effectively.
- Meter reader's fraud can be checked easily (eg. identify unreadable meter).
- Illegal use can be checked easily (disconnected user, unusual water use).
- Leakage-frequent location can be identified easily.
- Any NWSDB officer can find valves even after they are covered by pavement.
- Location of valve to be closed can be easily identified for leak repair work.
- Response for customer's complain /accident can be speeded up.
- Pipeline network drawing can be updated /edited quickly/easily.

To gain the above result/effects, following activities have been conducted in the Pilot Area.

- Update of base map (at least road, landmark...)
- Position of customer meter
  - Logged by GPS
  - Relationally linked with customer database
- Data input for pipelines, valves and others
  - For asset management (diameter, pipe material, year of installation, other information obtained through the Project)
  - For record of NRW issues (leak repair, illegal connection...)
- Data input for record of leakage/illegal use.
- Study/planning on usage of constructed database

b) Manpower Input by NWSDB for the Project

At the 5th JCC, NWSDB decided to input following staff for GIS training.

- Mapping Section:
  - One number of advisor (GIS planning/ utilization) (initial stage, part time)
- Maligakanda Office:
  - Two numbers of Draftsmen (base map update / data input)
- NRW/O&M Section:
  - Two numbers Engineering Assistant (field survey for customer meter position with GPS)

c) OJT for GIS

Procurement was delayed for about two months due to delay of tax reimbursement procedure by NWSDB due to delay of tax reimbursement procedure for procurement and preparation of space for GIS. These delay affected to the starting of basic training for about three months.

A series of trainings such as basic concept of GIS, operation of software/hardware device, field survey, data input work or practical use in day-to-day O&M have been conducted under this activity.

(9) Other NRW Reduction Activities

In addition to the activities for leak detection/repair works, following activities have been conducted.

1) Activities against Unbilled Authorized Consumption

This activity mainly intended to monitor consumption for each Free Water Outlet (standpost ,public bath or toilet) by installing water meter. In this activity, a standpost may have been cancelled to transfer individual connection, wherever possible.

2) Activities against Illegal Connections

In this activity, it was inspected if there was any running water tap with the valve just around a water meter closed at a house-to-house survey (at the same time, it was checked if the water would be flowing out from the tap). Especially, any previous illegal user or previously suspended user were thoroughly investigated.

In addition, many meter-tampering cases by users have been reported. According to C/P staff, some users do not feel hesitation/guilty to repair/tamper pipes/meters by themselves. As a part of solution, C/P conducted activity for application of meter-sealing to water meters to prevent meter-tampering by user.

3) Activities against Meter-related Error.

C/P conducted activity for meter replacement. Regarding meter-related error, it was necessary for C/P to tackle with issues related to meter reader or estimated bill. In order to highlight the loss by estimated billing or misreading, it was tried to compare a difference between billing record and actual meter reading. To get reliable data, meter-reading/recording must be properly and precisely conducted. Accordingly, NWSDB recruited additional two meter readers who could concentrate on it.

A2.1.2 Expansion of NRW Reduction Activities to the Other Areas

By recognizing the importance of expanding the NRW reduction activities to entire Colombo city, NWSDB seeks several ways to facilitate smooth and quick expansion/dissemination of the Project activities.

(1) Selection of Sub-Zones outside of the Pilot Area

Some areas have been selected from other than the Pilot Areas to execute the same activities simultaneously. Two Area Engineers who are in charge of the Pilot Project have selected two sub-zones for isolation by the beginning of April 2010.

In addition to the above, Area Engineers in Colombo City, who are in charge of other area than Pilot Areas, also attending weekly meeting to execute the similar activities in their area by using their own resources. They have also selected other two sub-zones for isolation by the beginning of April 2010. Sub-zones outside of the Pilot Project Area are specified in Table A2-1. NWSDB has conducted the activities in the above areas independently, with the advice of JET whenever necessary.

Table A2-1 Sub-zones Outside of the Pilot Project Area

Name/address of sub-zone	*Feature of sub-zone*	*Selected by:*	*Timing of selection / commencement / completion*	*Remarks*
Kent road sub-zone, Colombo East	216 houses	AE in charge of the Pilot Project	selected by the end of Apr. 2010	- Location Map available in PGR (1) - Completed and NRW figure established.
Handala Frerry road sub-zone, Colombo North	219 houses	AE in charge of the Pilot Project	selected by the end of Apr. 2010	- Location Map available in PGR (1) - Activities completed, however, measurement failed (isolation might have been failed)
Mohideen Masjin road sub-zone, Colombo West	586 houses	Responsible AE for this area who attends weekly meeting	selected by the end of Apr. 2010	- Location Map available in PGR (1) - Activities cancelled due to extreamly low pressure after isolation.
Kirulapura sub-zone, Colombo South	537 houses	Responsible AE for this area who attends weekly meeting	selected by the end of Apr. 2010	- Location Map available in PGR (1) - Completed and NRW figure established.
Aramaya Place (consists of Aramaya Place and Aramaya Lane)	875 houses (Aramaya Place for 575 and Aramaya Lane for 300)	OIC of Borella (Mr. Gunawardena)	selected by the end of January 2012.	- Isolation work under progress. - Location Map shown in. Annex A-4

(2) Participation of Member from Other Area to NRW Reduction Team

NWSDB assigned the staffs from other areas, not limited to the one from Pilot Project Area, to have work experience in the NRW reduction activities to be conducted under the Project.

A2.1.3 Major Meetings

(1) Joint Coordination Committee

1) 1st JCC

The 1st Joint Coordination Committee (JCC) was held on 24th November, 2009 and its minutes of meeting was signed on 25th November, 2009. On this meeting, JET explained the contents of Inception Report to the Sri Lankan side and following topics were discussed and confirmed by both Sri Lankan and Japanese sides.

- Project Design Matrix
- Regular Meetings
- Confirmation on Budget Allocation
- Members of JCC
- Pilot Areas
- Members of NRW Reduction Management Team and NRW Reduction Team for each Pilot Area
- Machinery and Equipment to be Procured by JICA
- Acceptance of Inception Report
- Target of the Project
- 2nd JCC Meeting

2) 2nd JCC

The 2nd Joint Coordination Committee (JCC) was held on 31st May, On this meeting, JET explained the contents of Progress Report (1) to the Sri Lankan side. In this meeting, following topics were raised and discussed by both Sri Lankan and Japanese sides.

- Progress of project activities in Pilot Areas
- Importance of dissemination of findings and lessons learnt through the project
- Difficulties in incorporating the newly obtained information (location of valves, etc.) through the pilot activities into the existing GIS database
- Schedule of the next JCC Meeting (3rd JCC Meeting)

3) 3rd JCC

The 3rd Joint Coordination Committee (JCC) was held on 30th November 2010 and JET explained the contents of Progress Report (2) to the Sri Lankan side. In this meeting, following topics were raised and discussed by both Sri Lankan and Japanese sides.

- Progress of project activities in Pilot Areas
- Initial & Present NRW values of the each pilot zone.
- Estimation of cost & requirement of resources for completing the activities in pilot zone.
- Possibility to implement the similar activities in other part of Colombo
- Schedule of the next JCC Meeting (3rd JCC Meeting)

4) 4th JCC

The 4th Joint Coordination Committee (JCC) was held on 23rd February, 2011, in order to agree the contents and the result of "Joint Mid-Term Review Report for the Capacity Development Project for Non Revenue Water (NRW) Reduction in Colombo City in Democratic Socialist Republic of Sri Lanka" between Japanese and Sri Lankan sides. The "Mid-term Review Team" gave recommendations to the Project and NWSDB side as follows.

- For the Project
  - The mid-term review revealed that un-updated information on pipeline networks and location of valves and fire hydrants hinders the smooth implementation of the pilot activities. Thus, the Team recommends that the Project explore measures to tackle this issue and find an effective way to accumulate the valuable location information obtained through the project activities.
  - The Team recommends the Project come up with reliable benchmarks to explicitly demonstrate the benefits of NRW reduction, e.g. increase of revenue, reduction of O&M cost, etc.
  - The Team recognized the importance of the execution plan, and recommends that the Project make it as applicable and expandable as possible by considering the technical sustainability. Then, the execution plan would be utilized as an action plan which contributes to achieve the NRW reduction target set in the new Corporate Plan as well as the new Business Plan from 2012 to 2016.
  - The Project should explore an effective collaboration between ODA loan program and technical assistance to produce synergetic effects between them.

- For NWSDB
  - The NWSDB's executives shall take immediate actions to mobilize more EAs, filling the cadre of EAs in O&M section and hiring at least two EAs, and increase the C/Ps who are fully get involved in the pilot activities. With the additional input of personnel, the rotation system

mentioned on the page 15 of this report should be reconsidered in order to disseminate the learning of the pilot activities to the entire Colombo city.

- The mid-term review revealed that the shortage of vehicles hinders the smooth implementation of pilot activities, and based on the recommendations from the Team, the NWSDB's executives promised to tackle the issue urgently.
- The mid-term review team found out that due to the limited length of distribution line replacement in Kotahena by the ODA loan, i.e. Water Sector Development Project (II), the comparative analysis between NRW reduction by distribution line replacement and NRW reduction by other techniques became difficult to be implemented in an originally-planned scale. The Team recommends that NWSDB explore the possibility to utilize own funds or foreign funds such as Water Sector Development Project (I), and implement a comparative study as soon as possible in order to enrich learning from the pilot activities. For the time being, as it is doing so, NWSDB should proceed with replacement of bundled service connections by its own fund.
- Regarding activities for (i) GIS restructuring and (ii) public relations, NWSDB will submit concrete proposals to JICA by March 4, 2011.
- NWSDB will submit action plans for each recommendation mentioned above to JICA.

5) 5th JCC

Before completion of 1st Project Year, NWSDB prepared its proposals for inclusion of issues on reinforcement of current GIS and PR activities into the Project. To include GIS and PR activities, NWSDB convened the 5th JCC to determine several essential points, such as revision of PDM" or organization and implementation system under the Project and future expansion. The conclusion of JCC is shown below.

- GIS
  - It is decided by JCC to update PDM from its previous version in order to appraise or make clear the position of GIS in the Project. The revised PDM (PDM_2) is shown as ######.
  - Organization/implementation system under the Project are decided. Activities under the Project and future expansion will be conducted under Additional GM (P&P).
- PR Activities
  - PR activities under the Project should be reviewed every year.
  - The result of review will be incorporated into successive annual program and the execution plan that is to be prepared on completion of the Project.
  - The Project Leader of NRW Reduction Management Team will be responsible for the PR activities for the Project

6) 6th JCC

The 6th Joint Coordination Committee (JCC) was held on 15th February, 2012, in order to agree the contents and the result of "Joint Report of Terminal Evaluation on the Japanese Technical Cooperation for the Capacity Development Project for Non Revenue Water Reduction in Colombo City in Sri Lanka" between Japanese and Sri Lankan sides. The "Terminal Evaluation Team" gave recommendations to NWSDB side as follows.

- Dissemination of systematic approach of NRW reduction
  - It is recommended that at least AEs and OICs/EAs from all OIC areas participate in both the weekly meetings and pilot project activities in order to disseminate methods of NRW

reduction to the other areas.

- Replacement of aged pipeline
  - NWSDB should proceed with the pipe replacement work under Japanese ODA loan project in Kotahena as early as possible to complete the work by June 2012, so that the comparative analysis can be obtained before the completion of the Project.
- Smooth implementation of internal procedure
  - NWSDB should allocate vehicles for field activities on GPS field works and PR activities.
  - NWSDB should review the working efficiency of GIS operators to promote the data input on GIS.
- Budget and human resources for NRW reduction measures
  - NWSDB should secure sufficient budget and human resources even after the Project.
- Utilization of experienced staff
  - NWSDB should make full use of trained staff under the Project in order to disseminate their experience to the other areas.
- Implementation of updating pipe networks in routine work and effective utilization of the information
  - NWSDB should keep updating the GIS database based on collected information in the course of pilot activities under the Project.
  - NWSDB should extend such activities to the other areas.
- Establishing GIS and utilization
  - NWSDB should continue activities for GIS database construction/update and utilizing it in its planning and O&M work.
- Coordination with M/P by JICA and other project
  - NWSDB should keep good coordination with other on-going/future projects including M/P study under JICA.

(2) Regular Meetings for NRW Reduction Management Team and NRW Reduction Team

As confirmed in the 1st JCC, NWSDB convenes the regular meetings and appoint the chairpersons who are in charge of holding the meetings and preparation of each meeting memorandum in English, during entire period of the Project.

Considering the present situation, NWSDB and JET has discussed to regularize the regular meetings for NRW Reduction Management Team and NRW Reduction Team with the following manner.

- Initially, concentrate on launching and getting activities and weekly meeting for "NRW Reduction Team" on track.
- To facilitate regularizing the weekly meetings and give prompt and right advice to the members of "NRW Reduction Team", someone from "NRW Reduction Management Team" will keep attending this meeting as much as possible.
- Once the activities and the weekly meetings get on the right track, it is expected that there would be many issues, opinions or feedbacks to be conveyed to management level. Meetings for management class will be launched around this timing.

In line with the above idea, 1st Weekly Meeting was held on 22nd January, 2010 and weekly meetings are held every week in principle with the initiative of NWSDB.

In the course of having a series of weekly meetings for NRW Reduction Team, NWSDB and JET found that it was more practical to hold the weekly meetings presided with a member of NRW Reduction Management Team, rather than holding regular meetings for the NRW

Reduction Management Team separately, so that the Management Team can properly monitor the progress of the activities in a pilot project area. Important issues on the activities of NRW reduction teams are reported and discussed among management level at regular monthly meeting titled as "Meetings with Western Central Senior Management on NRW Reduction Activities". Accordingly, NWSDB and JET decided that meeting for NRW Reduction Management Team would be convened whenever necessary.

A2.2 The Results

NRW values and its transitional changes according to the progress of NRW reduction activities are presented in this section. Details are available in "Supporting Report. In principle, these NRW figures are supported by the followings:

- Total system input volume: actual flow measurement.
- Revenue water (RW): recent billing record that is available in NWSDB (or actual meter reading in some sub-zones).
- Non-revenue water (NRW): balance between the above total system input and RW

General feature of the Pilot Area is shown in Table A2-2 and Table A2-3. General characteristics of each sub-zone are presented in Table A2-4 and Table A2-5. Figure A2-5 and Figure A2-6 show respective sub-zone assignment.

Table A2-2 General Feature of the Pilot Area (Borella)

Sub-zone		B1	B2	B3	B4-FF	B4-MGZ	B5	B6	B7	B8	B9	B10
Number of connection		584	624	360	162	291	840	1,117	200	186	593	191
Population		2,738	3,079	1,371	692	1,311	3,798	5,310	1,000 *c)	996	2,965	1,030
Area (km^2)		0.177	0.143	0.026	0.074	0.039	0.196	0.313	0.199	0.043	0.063	0.182
Population density (person/km2)		15,469	21,531	52,731	9,351	33,615	19,378	16,965	5,025	23,163	47,063	5,659
Method of isolation		Full	Full	Full	Full	Full	Full	Full	Sample	Full	Full	Sample
Characteristics of sub-zone		B-similar	B-similar	B-similar	B-similar	K-similar	K-similar	B-similar	B-similar	B-similar	K-similar	B-similar
Number of FWO	before activities	2	6	0	2	25	11	7	1	2	1	0
	After activities	1	6	0	2	25	11	7	1	2	1	0
Main Pipe Length (m) by pipe material	PVC	853	194	1,009	1,010	762	460	3,280	2,520	–	1,314	773
	CI	1,480	2,768	1,388	779	700	1,571	2,440	1,487	–	–	581
	DI	–	–	–	–	–	–	–	1,461	–	–	–
	GP	–	–	–	–	–	–	–	–	–	–	–
	Total	2,333	2,962	2,397	1,789	1,462	2,031	5,720	5,468	611 *a)	1,314	1,354

Table A2-3 General Feature of the Pilot Area (Kotahena)

Sub-zone		K1	K2	K3&K4	K5	K6	K7	K8	K9	K10
Number of connection		397	426	1,383	115	159	1,545 *b)	769 *b)	201 *b)	300 *b)
Population		1,697	2,231	7,174	575 *c)	795	7,725 *c)	3,845 *c)	1,005 *c)	1,500 *c)
Area (km^2)		0.056	0.066	0.256	0.091	0.150	0.239	0.138	0.196	0.080
Population density (person/km2)		30,304	33,803	28,023	6,319	5,300	32,322	27,862	5,128	18,750
Method of isolation		Full	Full	Full	Sample	Full	Sample	Sample	Sample	Sample
Characteristics of sub-zone		K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar
Number of FWO	before activities	14	33	19	4	–	3	–	3	–
	After activities	14	33	19	2	–	3	–	3	–

Note:

**a) Pipeline drawing not available in this area. Estimated based on road lenth.*

**b) Estimated based on billing record*

**c) Estimated based on average number per family, multiplied by number of connection. Average number of family is assumed to:*

Table A2-4 General Characteristics of Each Sub-zone (Borella)

Sub-Zone	*General Characteristics*
B1	- This sub-zone covers eastern part of the Borella Pilot Area, with its eastern side facing to canal. - Middle or higher-income families with large properties are dominant along 'Gothami Road'. - Low-income families and their settlements are dominant along the canal.
B2	- This sub-zone shares its eastern border with B1. - Northern side of this sub-zone faces to the canal. - Middle or higher-income families with large properties are dominant along 'Kuruppu Road'. - Low-income families are highly populated especially long the canal in northern part of the sub-zone.
B3	- This sub-zone is shared by many government's apartments. - Sumps or elevated tanks are used in these apartments.
B4 (FF)	- Middle or higher-income families with large properties are dominant along Fairfield Road.
B4 (MGZ)	- Low-income families are dominant along Magazine Road. - Many free water outlets can be observed. - Many bundle pipes can be identified.
B5	- This sub-zone shares its eastern border with the canal and dominated by low-income families. - Many free water outlets can be observed. - There are police's quarters and their related facilities in the western part of this sub-zone. - Many bundle pipes can be identified.
B6	- This sub-zone shares its western border with the canal and dominated by low-incom families along the canal. - Middle-class families live in the eastern side of this sub-zone. - There also are priority customers such as military camp and its related facilities or cricket stadium. - Many bundle pipes can be identified in the part of this area where low-income group is dominant.
B7	- Along the eastern side of the 'Baseline Road', where a lot of apartment exist. - Low-income families are dominant in the eastern part of this apartment's area. - Sample zone is established in the eastern part of this sub-zone.
B8	- This sub-zone is located in between 'Baseline Road' and railway track. - Low-income families are dominant.
B9	- Low-income families are dominant. - As individual connection is available for most of houses, there are only small number of free water outlets.
B10	- Along 'Kotte Road', with being dominated by middle or higher income group. - Sample zone is established along Elliot Place, where there are a number of police's quarters.

Table A2-5 General Characteristics of Each Sub-zone (Kotahena)

Sub-Zone	*General Characteristics of Each Sub-zone*
K1	- Dominated by low-income families. - Several apartments and many free water outlets can be observed. - Many bundle pipes can be identified.
K2	- Dominated by low-income families. - Many free water outlets can be observed. - Many bundle pipes can be identified.
K3&4	- Dominated by priority customers (large-scale consumers) such as schools, temples, police's quarters or churches. - Low-income families are also dominant. - Many bundle pipes can be identified.
K5	- There are several priority customers such as schools, apartments or churches. - Sample zone is established alongside of '6th Lane'.
K6	- This sub-zone covers a part of 'Bloemendhal Road'. - There are priority customers such as stadium or schools.
K7	- Sample zone is established in a part of 'Parmananda Road'. - Low-income families are dominant. - Many free water outlets can be observed. Many bundle pipes can be identified.
K8	- This sub-zone is located in northern part of the Kotahena Pilot Area, and covers the area along the 'Walls Road' and railway track. - Low-income families are dominant and a lot of free water outlets can be observed particularly along the railway track. - Sample zone is established in southern side of the railway track. - Many bundle pipes can be identified.
K9	- This sub-zone covers industrial area along the 'St. Andrews Avenue' and residential area of '16th Lane'. - Sample zone is established along '16th Lane'. - Many bundle pipes can be identified.
K10	- This sub-zone covers commercial area along 'George R. De Silva Mw.'. - This area is a commercial area on the whole and apartments are scattered in the eastern part.

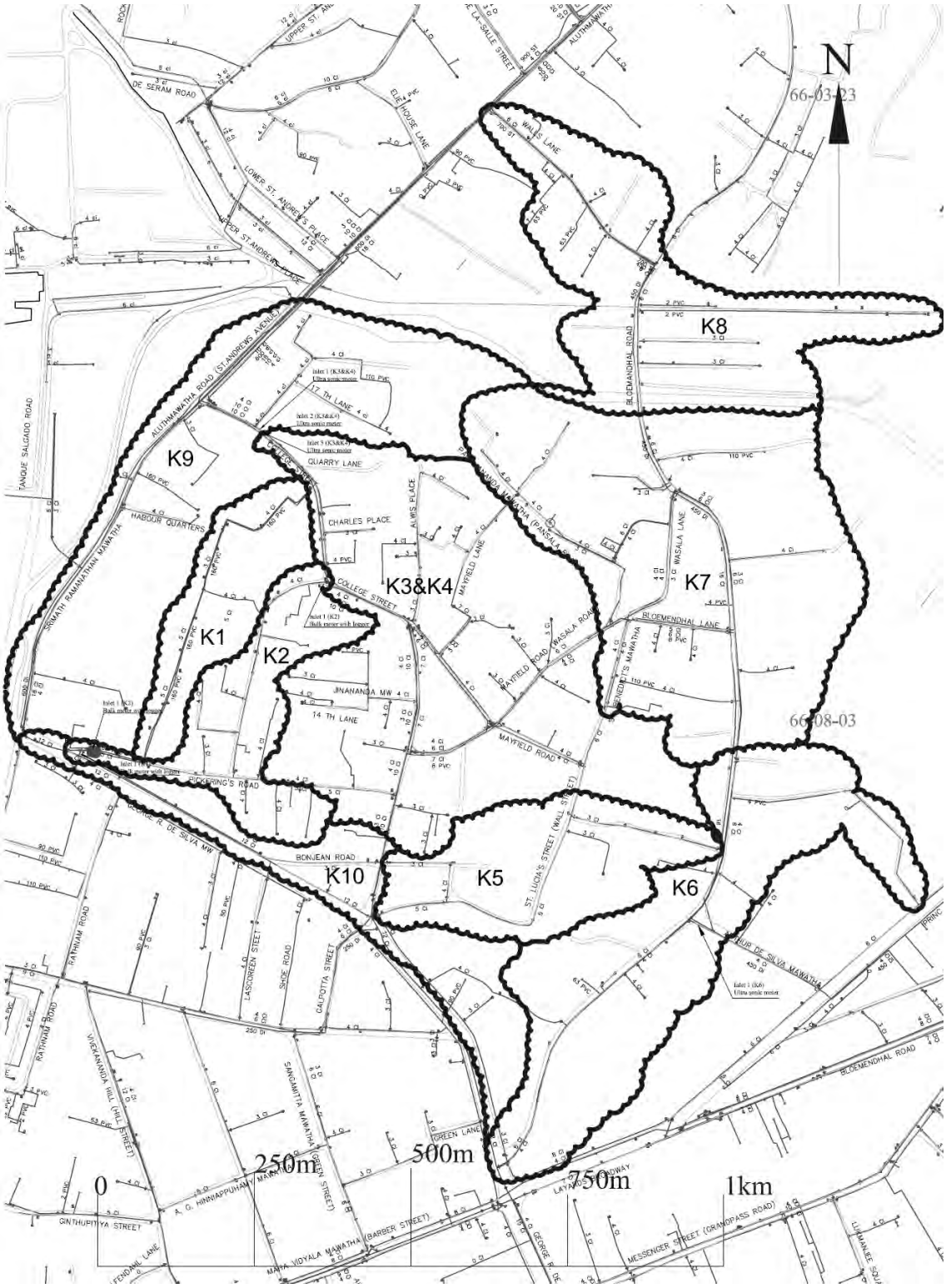


Figure A2-5 Sub-zone Assignment in Kotahena Pilot Area

Figure A2-6 Sub-zone Assignment in Borella Pilot Area

A2.3 Difficulties and Problems

A2.3.1 Difficulties Encountered

Several difficulties, which are causing the delay of works, are observed as listed below.

(1) Information and data
Location of valves could not be found since they are covered by pavement without valve surface covers and data such as detailed drawings and tie-measurements are not always available. Pipeline data are also missing or incorrect even if drawings are available. There were lots of unexpected pipeline and interconnection since the works were done without proper planning.

Due to the above circumstances, confirmation of valve location or pipeline route took extremely long time. In addition, hydraulic isolation works had to be subject to a try-and-error approach due to existence of unexpected interconnections and this also took long time.

(2) Vehicles:
Moderate numbers of vehicle were allocated to the Project activities after several discussions and driver are not always available. However field works sometimes suspended without information due to shortage of heavy vehicles such as crane mounted trucks.

Vehicle shortage often prevented the moves of additionally introduced activities such as GIS/GPS activities and PR activities do not proceed due to shortage of vehicles.

(3) Personnel
After assigning the two teams to concentrate on the Project, progress of the pilot activities became improved. However the activities were sometimes suspended due to unexpected reasons such as union activities and health problem sometimes.

(4) Permission for road excavation
Application process was not necessarily taken previously considering the required time. This problem contributed to taking long time in isolation works especially in B4 and B6.

(5) Meter chamber
Preparation of meter chambers to be installed in heavy traffic roads took times.

(6) Materials and tools
Materials of NWSDB were stored in several places without proper information and it sometimes took time to find the availability. Due to uncertain whereabouts of necessary materials or tools, NWSDB sometimes faced difficulties in preparing necessary materials/tools at necessary time. This was one of major concern to take long time for isolation works especially in B4 and B6.

(7) Data collection through meter condition survey and customer meter reading
It took long time. One of the reasons was that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason was that service pipes were installed inside house building in many cases and it is required to ask permission for the meter checking from the customers.

A2.3.2 Countermeasures

In order to expedite the progress, several countermeasures were considered as listed below.

- Zone officers and EA understand the long term plan and find the required preparation works.
- Inform the requirement / shortage to upper level without delay.

- Make necessary materials/tools are always available.
- Alternatives in case the isolation is quite difficult.
- How to boost up motivation for staff.

The measures to be taken were reviewed throughout the execution of the activities. The work procedures were also revised / modified to suite the actual situation. Nevertheless, these efforts could not completely improved the delayed schedule.

However isolation works, the most time consuming works, have been completed (or are almost completed soon) in sub-zone K1, K2, K3&4, K5, K6, K7, B1, B2, B3, B4, B5, B6 and B7. In addition, sample-zone method were employed in such areas where full-scale isolation trial would not be practical.

After practicing sample-zone method, good progress has been gained in the final stage of the Project activities. Isolation activities are time-consuming and it will not be practical to disseminate the activities to outside of the pilot areas. In order to overcome the situation, modified activities by using sample zone isolation would be an option to conduct NRW reduction activities to the other area in Colombo City.

A2.4 The Results

A2.4.1 NRW Reduction in Borella

(1) B1

Table A2-6 summarizes result of NRW reduction through the activities. 2nd Activities were conducted to do step testing to narrow down suspected area/section that contributed to high NRW. NRW rate has been reduced from 40% to 18% as a result of the activities. It took long time for isolation of this sub-zone.

Table A2-6 Summary of Result in B1

	Initial Measurement			***After Primary Activities***			***After 2nd Activities***	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	392.7	60.1%		450.7	77.8%		450.7	82.1%
NRW	260.4	39.9%		128.9	22.2%		98.3	17.9%
Total System Input	653.1	100.0%		579.6	100.0%		549.0	100.0%
MNF	312 l/min			249 l/min			206 l/min	
Pressure at MNF (m) (Canal)	18.2 m			19.6 m			19.0 m	
Pressure at MNF (m) (Gotami Rd)	14.2 m		=>	16.2 m		=>	15.0 m	
Measured on:	3-12 Jun, 2010			25 Aug - 2 Sep, 2010			3 - 7 Feb, 2011	
Remarks				* 9 meters installed * 7 meters replaced * 8 leagalized * 34 leaks repaired * 1 storerage tanks improved			* after a series of step testing and further 12 leak repair works	

(2) B2

A series of NRW activities under Primary Activities were completed. However, result of flow measurement are still being under verification. The result of the initial flow measurement and initial NRW shown in Table A2-7 is a tentative one at this stage. It took long time for isolation of this sub-zone.

Table A2-7 Summary of Result in B2 (Tentative)

	Initial Measurement			*After Primary Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*
RW	441.9	38.3%		Waiting for measurement	
NRW	712.1	61.7%			
Total System Input	1,154.0	100.0%			
MNF	655 l/min				
Pressure at MNF (Rodney 12" line)	8.1 m				
Measured on:	16 Feb, 2012		=>		
Remarks				* 25 meters installed * 7 meters replaced * 15 leagalized * 31 leaks repaired (Service :31 Main:0) * 1storerage tanks improved	

(3) B3

Table A2-8 summarizes result of NRW reduction through Primary Activities. NRW rate has been reduced from 84% to 29% as a result of the activities. This area is government's housing estate.

Table A2-8 Summary of Result in B3

	Initial Measurement			*Midstream of Primary Activities*			*After Primary Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	187.7	15.9%		187.7	49.8%		201.3	71.4%
NRW	995.3	84.1%		189.3	50.2%		80.7	28.6%
Total System Input	1,183.0	100.0%		377.0	100.0%		282.0	100.0%
MNF	l/min			106 l/min			55 l/min	
Pressure at MNF	.0 m			.0 m			.0 m	
Measured on:	7-8 Dec, 2010		=>	18-19 Nov, 2010		=>	20-21 Jan, 2010	
Remarks				* Repair overflow at major sump			* 14 meters installed * 17 meters replaced * 19 leagalized * 19 leaks repaired (NRW reduction activities terminated at this point.)	

Note1: About 6 % of results of customer meter reading (After) are not yet completed due to closed house. Accordingly, assumed value has been tentatively employed in calculation.

(4) B4 (Fairfield Road)

Table A2-9 summarizes result of NRW reduction through the activities. Primary Activities and 2nd Activities were conducted in this area. NRW rate has been reduced from 60% to 27% as a

result of the activities.

Table A2-9 Summary of Result in B4 (Fairfield Road)

	Initial Measurement			*After Primary Activities*			*After 2nd Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	150.0	39.9%		150.0	66.4%		166.1	73.5%
NRW	226.0	60.1%		76.0	33.6%		59.9	26.5%
Total System Input	376.0	100.0%		226.0	100.0%		226.0	100.0%
MNF	120 l/min			67 l/min			67 l/min	
Pressure at MNF	12.8 m		=>	.0 m		=>	5.7 m	
Measured on:	27-28 Oct, 2011			18-19 Jan, 2012			Feb 24-27, 2012	
Remarks	Total system input is supported by actual mesurement result plus estimated value of one leak that had been fixed earlier than initial measurement.			After repairing 5 leaks (Service 4 and main 1)			Consumption at one house is newly accounted to RW after replacing defective meter before its sump.	

(5) B4 (Magazine Road)

Table A2-10 summarizes result of NRW reduction through the activities. Primary Activities and 2nd Activities were conducted in this area. NRW rate has been reduced from 62% to 52% as a result of the activities. Pipe condition was very poor and there were a lot of free water in this sub-zone. Therefore, this area was regarded as Kotahena-similar area.

Table A2-10 Summary of Result in B4 (Magazine Road)

	Initial Measurement			*After Primary Activities*			*After 2nd Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	203.3	38.4%		203.3	42.4%		203.3	47.6%
NRW	325.7	61.6%		276.7	57.6%		223.7	52.4%
Total System Input	529.0	100.0%		480.0	100.0%		427.0	100.0%
MNF	249 l/min			186 l/min			156 l/min	
Pressure at MNF	8.9 m		=>	5.9 m		=>	6.5 m	
Measured on:	27-28 Oct, 2011			18-19 Jan, 2012			Feb 24-27, 2012	
Remarks				After repairing 22 leaks (Service 18 and main 4)			After repairing 7 service leaks	

(6) B5

Leak detection work was completed. Leak repair work is being underway and waiting for flow measurement after leak repair as of the end of September 2012. The result of the initial flow measurement and initial NRW are shown in Table A2-11.

Table A2-11 Summary of Result in B5

	Initial Measurement			*After Primary Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*
RW	510.0	37.7%			
NRW	841.0	62.3%			
Total System Input	1,351.0	100.0%	=>	Waiting for measurement	
MNF	862 l/min				
Pressure at MNF	14.3 m				
Measured on:	10-13 Feb, 2012				
Remarks				* Waiting for leak repair.	

(7) B6

Table A2-12 summarizes result of NRW reduction through Primary Activities. NRW rate has been reduced from 50% to 28% as a result of the activities.

Table A2-12 Summary of Result in B6

	Initial Measurement			*After Primary Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*
RW	760.2	50.5%		879.1	71.6%
NRW	743.8	49.5%		347.9	28.4%
Total System Input	1,504.0	100.0%		1,227.0	100.0%
MNF	386 l/min			282 l/min	
Pressure at MNF	-		=>	-	
Measured on:	10-11 Feb, 2012			29 Jun -2 Jul, 2012	
Remarks				* 19 meters replaced * 31 leaks repaired (NRW reduction activities terminated at this point.)	

(8) B7

Leak repair works are now being underway as of the end of September 2012. Trials for flow measurement are being conducted by isolating a part of selected area of the sub-zone (sample zone method).

(9) B8

Leak repair work was completed and waiting for flow measurement after leak repair as of the end of September 2012.

(10) B9

Leak detection work was completed. Leak repair work is being underway and waiting for flow

measurement after leak repair as of the end of September 2012.

(11) B10

Table A2-13 summarizes initial NRW. Massive loss was suspected in premises of police's quarter. Accordingly, situation was checked by installing bulk meters at the individual inlets of the sumps. Out of 170 m^3/d of NRW, 149 m^3/d is lost after sumps owned by police's quarter. Trials for flow measurement are being conducted by isolating a part of selected area of the sub-zone (sample zone method).

Table A2-13 Summary of Result in B10

		Initial Measurement	
		m3/day	*(%)*
RW		55.2	24.5%
NRW	***Water Loss before Sump***	21.8	9.7%
	Water Loss after Sump	148.7	65.9%
Total System Input		225.7	100.0%
MNF		-	
Pressure at MNF		-	
Measured on:		9-10 Aug, 2012	
Remarks		* Water loss after sump is determined by installing 7 bulk meters before individual quarters for police.	

A2.4.2 NRW Reduction in Kotahena

(1) K1

Table A2-14 summarizes result of NRW reduction through the activities. NRW ratio was reduced from 85% to 51% after a series of NRW reduction activities. However, NRW ration still remains high even after activities. In addition, rebounding of NRW rate has been observed after about 6 months between Primary Activity and 2nd Activity, and after 3rd Activity.

In terms of saved water volume, nevertheless, 804 m^3/d could be saved as a result of Activities, which contributed to massive water loss in this sub-zone.

Table A2-14 Summary of Result in K1

	Initial Measurement			*Midstream of Primary Activities*			*After Primary Activities*			*Before 2nd Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	200.3	15.5%		249.0	23.9%		249.0	27.1%		249.0	19.6%
NRW	1,094.7	84.5%		792.1	76.1%		669.0	72.9%		1,019.0	80.4%
Total System Input	1,295.0	100.0%		1,041.1	100.0%		918.0	100.0%		1,268.0	100.0%
MNF	690 l/min			480 l/min			330 l/min			600 l/min	
Pressure at MNF	18.6 m		=>	18.7 m		=>	19.5 m		=>	18.2 m	
Measured on:	19-26 May, 2010			24-30 Sep, 2010			11-22 Nov, 2010			5 - 9 May, 2011	
Remarks				* 41 meters installed * 18 meters replaced * 49 leagalized * 56 leaks repaired * 2 storerage tanks improved			* 2 meters installed * 18 leaks repaired			* acitivities resumed after 6 months	

	After 2nd Activities			*Midstream of 3rd Activities*			*After 3rd Activities (1)*			*After 3rd Activities (2)*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
	249.0	26.9%		249.0	42.6%		280.6	49.1%		280.6	39.4%
	676.0	73.1%		336.0	57.4%		290.4	50.9%		432.4	60.6%
	925.0	100.0%		585.0	100.0%		571.0	100.0%		713.0	100.0%
	330 l/min			120 l/min			120 l/min			200 l/min	
=>	18.3 m		=>	19.2 m		=>	17.1 m		=>	22.9 m	
	24-26 Jun, 2011			1 Sep, 2011			26-27 Oct, 2011			10-12 May, 2012	
	* 590 m CI pipe lines abondoned * 782 m common pipes installed and connected to customers (bundle pipes remained)			* after disconnecting most of bundle pipes * after a series of step testing and further 16 leak repair works			* after disconnecting some remaining bundle pipes			* NRW regained after 6 months. * another 5 visible leaks have been observed according to Mr. Premakumara (22/May)	

Note 1): There was six-month of blank period between "After 2nd Activities" and "Before 3rd Activities". System inflow and MNF regained during this period.

Note 2): The value of "RW" was updated at the time of "6th Activities" based on the billing record of recent three months.

(2) K2

Table A2-15 summarizes result of NRW reduction through the activities. NRW ratio was reduced from 79% to 70% after a series of NRW reduction activities. However, NRW ratio still remains high even after activities. In addition, rebounding of NRW rate has been observed after about 6 months between Primary Activity and 2nd Activity.

In terms of saved water volume, 325 m^3/d could be saved as a result of Activities.

Table A2-15 Summary of Result in K2

	Initial Measurement			*After Primary Activities*			*Before 2nd Activities*			*After 2nd Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*
RW	267.4	21.5%		279.9	24.4%		279.9	21.5%		279.9	30.0%
NRW	977.6	78.5%		868.1	75.6%		1,019.1	78.5%		653.1	70.0%
Total System Input	1,245.0	100.0%		1,148.0	100.0%		1,299.0	100.0%		933.0	100.0%
MNF	771 l/min			686 l/min			797 l/min			462 l/min	
Pressure at MNF	17.4 m		=>	17.4 m		=>	17.3 m		=>	18.5 m	
Measured on:	19-23 Nov, 2010			27-28 Jan, 2011			30/Jun - 1/Jul, 2011			27-28 Jun, 2012	
Remarks				* 12 meters installed * 8 meters replaced * 23 legalized * 51 leaks repaied						* 42 leaks repaired	

Note 1): There was five-month of blank period between "After Primary Activities" and "Before 2nd Activities". System inflow and MNF regained during this period.

(3) K3&K4

Table A2-16 summarizes result of NRW reduction through Primary Activities. Trials for flow measurement were conducted by isolating entire area of the sub-zone (full-scale isolation).

Table A2-16 Summary of Result in K3&K4

	Initial Measurement			*After Primary Activities*	
	m3/day	*(%)*		*m3/day*	*(%)*
RW	1,155.7	27.3%		1,169.0	29.3%
NRW	3,084.3	72.7%		2,820.0	70.7%
Total System Input	4,240.0	100.0%		3,989.0	100.0%
Minimum Night Inflow (l/min)	2,856 l/min			2,763 l/min	
Pressure at MNIF	-		=>	-	
Measured on:	22 Feb, 2012			15-16 Aug, 2012	
Remarks				* 8 meters installed * 18 meters replaced * 5 leagalized * 34 leaks repaired	

(4) K5

Primary Activities have been completed. Flow measurement after Primary Activities have been completed. Result of measurement is being verified as of the end of September 2012.

(5) K6

Table A2-17 summarizes initial NRW. Activities in this sub-zone intends to the effect of pipe replacement work without conducting typical NRW reduction activities (eg., activities against leakage, illegal connection, free water, meter error, etc.). Completion of replacement work is

being waited as of the end of September 2012. Trials for flow measurement are being conducted by isolating entire area of the sub-zone (full-scale isolation).

Table A2-17 Summary of Result in K6

	Initial Measurement			***After Primary Activities***	
	m3/day	*(%)*		*m3/day*	*(%)*
RW	946.6	54.8%		Waiting for measurement	
NRW	780.4	45.2%			
Total System Input	1,727.0	100.0%			
MNF	1,154 l/min				
Pressure at MNF	23.9 m		=>		
Measured on:	12-13 Jul, 2011				
Remarks				* Waiting for competion of pipe replacement work under other project.	

(6) K7

Primary Activities have been completed and waiting for measurement after Primary Activity as of the end of September 2012. Trials for flow measurement are being conducted by isolating a part of selected area of the sub-zone (sample zone method).

(7) K8

Leak survey (confirmation survey) is being underway as of the end of September 2012. Trials for flow measurement are to be conducted by isolating a part of selected area of the sub-zone (sample zone method).

(8) K9

Leak repair work have been completed and waiting for measurement after Primary Activity as of the end of September 2012. Trials for flow measurement are being conducted by isolating a part of selected area of the sub-zone (sample zone method).

(9) K10

Leak survey (confirmation survey) is being underway as of the end of September 2012. Trials for flow measurement are to be conducted by isolating a part of selected area of the sub-zone (sample zone method).

Chapter A3 Water Audit

A3.1 Definition and Methodology

A3.1.1 General

NRW in Colombo City comprises several factors, such as leaks from pipes or fittings, consumption at free water outlets (public standposts, bath tap or toilet tap), illegal use and meter-related loss. Comprehending actual conditions of NRW, which is supported by actual measurement of system input and individual component of NRW, is the first and important step toward developing and practicing effective countermeasure against NRW.

In this section, following terminologies are used, with the mentioned meanings.

- NRW reduction activities: any activities to reduce NRW in designated Sub-zone, such as leak detection/repair, elimination of illegal connections, etc.
- Initial Measurement: measurement of inflow volume of water that enters into a Sub-zone before taken any measure falling under "NRW reduction activities".
- Primary Activity: a series of NRW reduction activities to be conducted before getting the figures of NRW reduction rate. Usually, a NRW reduction activity may be concluded with this "Primary Activity".
- 2^{nd} (3^{rd}, 4^{th}.....) Activity: a series of further NRW reduction activities to be conducted after the above "Primary Activity". These further activities may be conducted in case that the previous activities could not gain good result. The principal purpose of these further activities is as follows.
  - To research main cause why NRW could not be reduced by the previous activities.
  - To seek effective way for further reduction of NRW and to take action if it is practical.
- The "2^{nd} (3^{rd}, 4^{th}.....) Activity" includes followings.
  - Detection/repair of leakages caused by system pressure increase as a result of the leakage repair that has been done earlier.
  - Verification/elimination of illegal use identified after the previous activities.
- (Before): any values/activities to be obtained/conducted before taking Primary Activity.
- (After): any values/activities to be obtained/conducted after taking "Primary Activity".
- Sample zone: a part of sub-zone that is selected to isolate a part of the sub-zone, in case it is not practical to isolate entire area of the sub-zone.
- Kotahena-similar area: a sub-zone with relatively old and poor network condition.
  - many free water outlets are observed.
  - many long-distance service connection (bundle pipes) are observed.
  - many houses are above pipelines and it makes difficult to trace.
  - many illegal cases are found.
  - highly-populated area.
- Borella-similar area: a sub-zone with relatively new and better network condition.

A3.1.2 Components of System Input

With reference to "IWA Water Balance (2000)", system input and its breakdown are defined as shown in Table A3-1.

Table A3-1 IWA's Terminology for NRW

<table>
<tr><td rowspan="6">System Input Volume
m^3/year</td><td rowspan="2">Authorized Consumption
m^3/year</td><td rowspan="2">Billed Authorized Consumption
m^3/year</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water
m^3/year</td></tr>
<tr><td>Billed Non-metered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption
m^3/year</td><td>Unbilled Metered Consumption (water used for fire fighting, etc)</td><td rowspan="6">Non-Revenue Water
m^3/year</td></tr>
<tr><td>Unbilled Un-metered Consumption (free water distributed at standpipes)</td></tr>
<tr><td rowspan="4">Water Losses
m^3/year</td><td rowspan="2">Apparent Losses
m^3/year</td><td>Unauthorized Consumption</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses
m^3/year</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connecting up to Customers' Metering</td></tr>
</table>

Based on the definition and categorization by the IWA, each component of NRW is calculated/determined as explained in the following subsection.

A3.1.3 Methodology for Determination of Each Component

Methodology of water balance analysis is available in Supporting Report.

A3.2 Water Balance in Borella

Following subsections outline summary of water balance for each sub-zone.

A3.2.1 B1

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

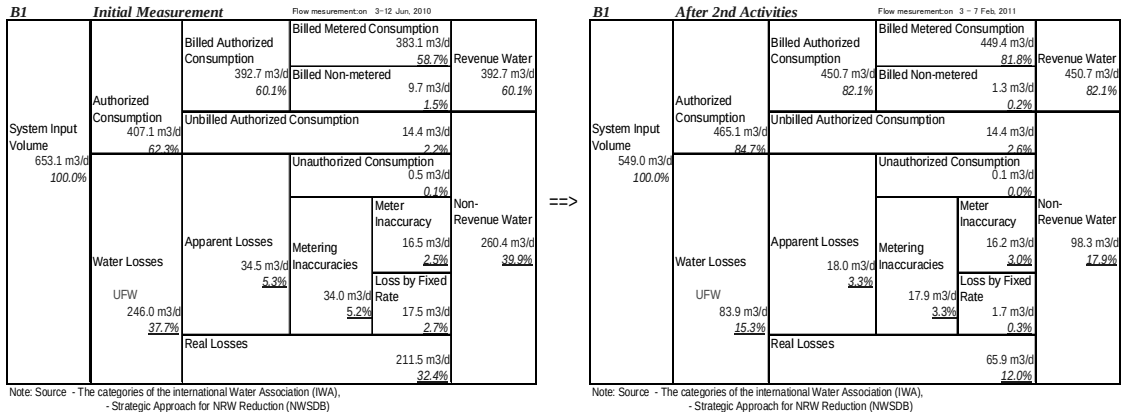
- Number of connection: 584
- Total length of pipelines according to pipe material:
  - PVC: 853 m
  - CI: 1,483 m
- Number of free water outlet: 2
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area

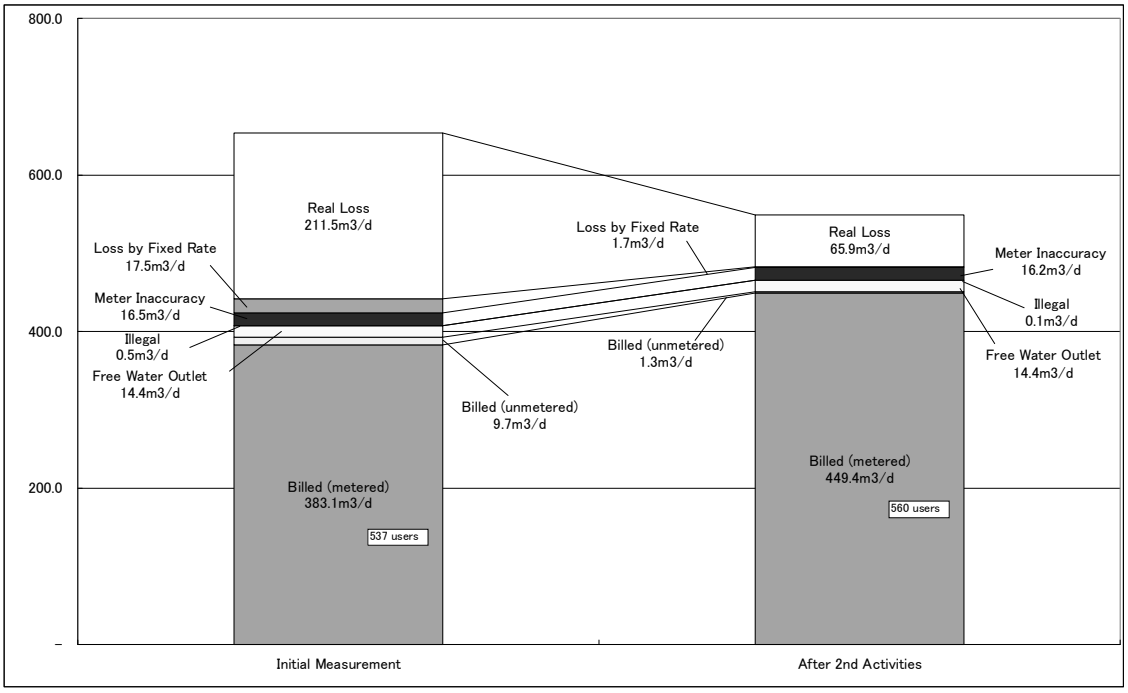
(2) Result of Water Balance Analysis

Figure A3-1 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone. Figure A3-2 shows transitional change of water balance according to NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced through a series of activities from 32% to 12% (145 m^3/d could be saved).
  - Reduction from 32% to 17% through Primary Activities (saving 115 m^3/d)
  - Reduction from 17% to 12% through 2^{nd} Activities (saving 30 m^3/d)
- This area was relatively good condition. Therefore, it is considered that Primary Activities was effective.
- It is regarded that Primary Activities alone may contributed to reducing real loss effectively in this sub-zone.





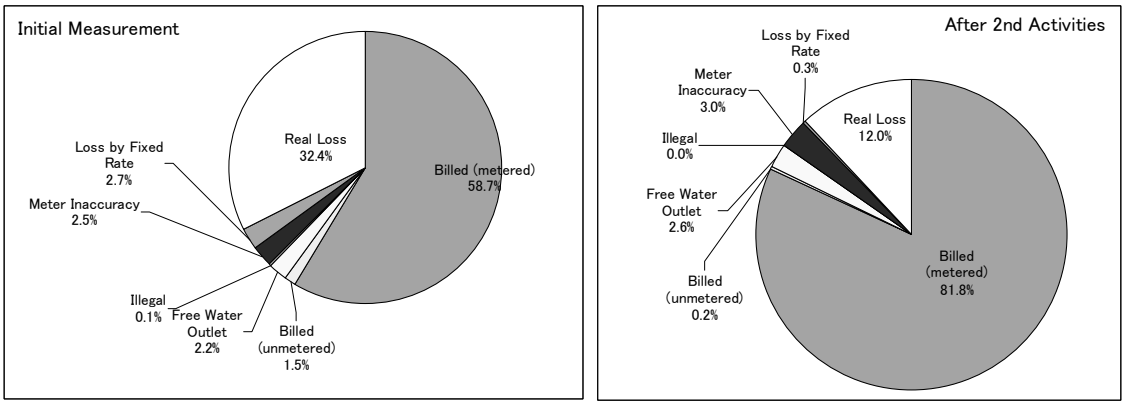
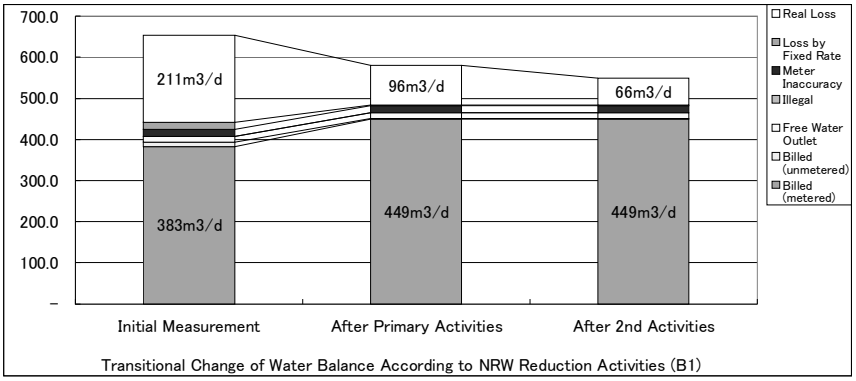


Figure A3-1 Water Balance before and after NRW Reduction Activities (B1)

B1_detailed



Components				*Initial Measurement*			*After Primary Activities*			*After 2nd Activities*		
				m3/day	*(%)*		*m3/day*	*(%)*		*m3/day*	*(%)*	
RW	Billed Authorized Consumption		Billed (metered)	383.1	58.7%	=>	449.4	77.5%	=>	449.4	81.8%	
			Billed (unmetered)	9.7	1.5%	=>	1.3	0.2%	=>	1.3	0.2%	
NRW	Unbilled Authorized Consumption	Unbilled un-metered Consumption	Free Water Outlet	14.4	2.2%	=>	14.4	2.5%	=>	14.4	2.6%	
	Apparent Losses	Unauthorized Consumption	Illegal	0.5	0.1%	=>	0.1	0.0%	=>	0.1	0.0%	
		Metering Inaccuracy	Meter Inaccuracy	16.5	2.5%	=>	16.2	2.8%	=>	16.2	3.0%	
			Loss by Fixed Rate	17.5	2.7%	=>	1.7	0.3%	=>	1.7	0.3%	
	Real Losses		Real Loss	211.5	32.4%	=>	96.5	16.6%	=>	65.9	12.0%	
			Total System Input	653.1	100.0%	=>	579.6	100.0%	=>	549.0	100.0%	
			MNF (l/min)	312			249			206		
			MNF (converted to m3/day)	449			359			297		
			Pressure at MNF (m) (Canal)	18.2			19.6			19.0		
			Pressure at MNF (m) (Gotami Rd)	14.2			16.2			15.0		
			Measured on:	3-12 Jun, 2010			25 Aug - 2 Sep, 2010			3 - 7 Feb, 2011		
				* Active leakage control			* after step testings					

Figure A3-2 Transitional Change of Water Balance according to NRW Reduction Activities (B1)

A3.2.2 B2

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 624
- Total length of pipelines according to pipe material:
  - PVC: 194 m
  - CI: 2,768 m
- Number of free water outlet: 6
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may be done once flow measurement after Primary Activities becomes available.

A3.2.3 B3

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

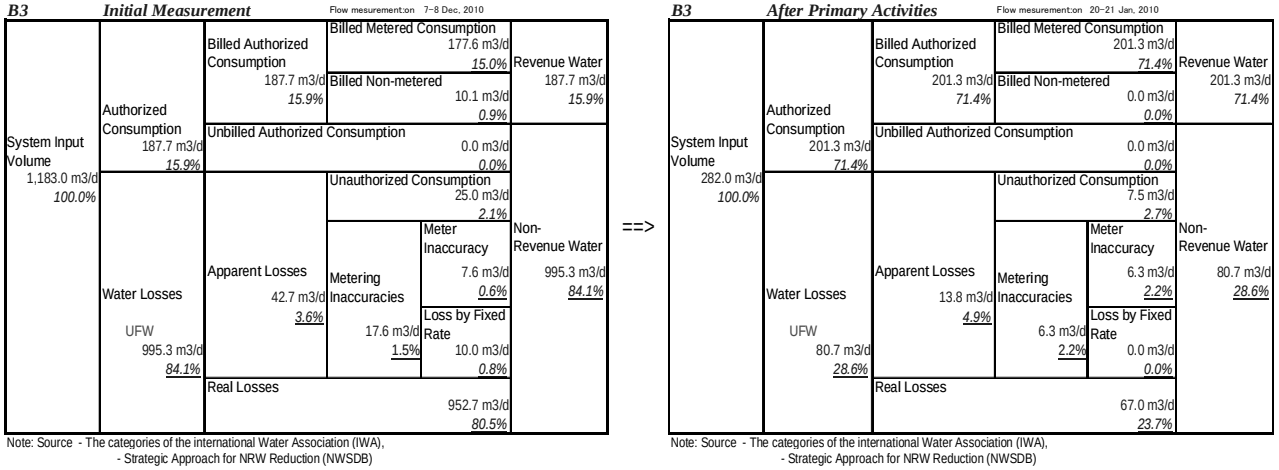
- Number of connection: 624
- Total length of pipelines according to pipe material:
  - PVC: 360 m
  - CI: 2,397 m
- Number of free water outlet: 0
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area
- Others: This area is housing estate.

(2) Result of Water Balance Analysis

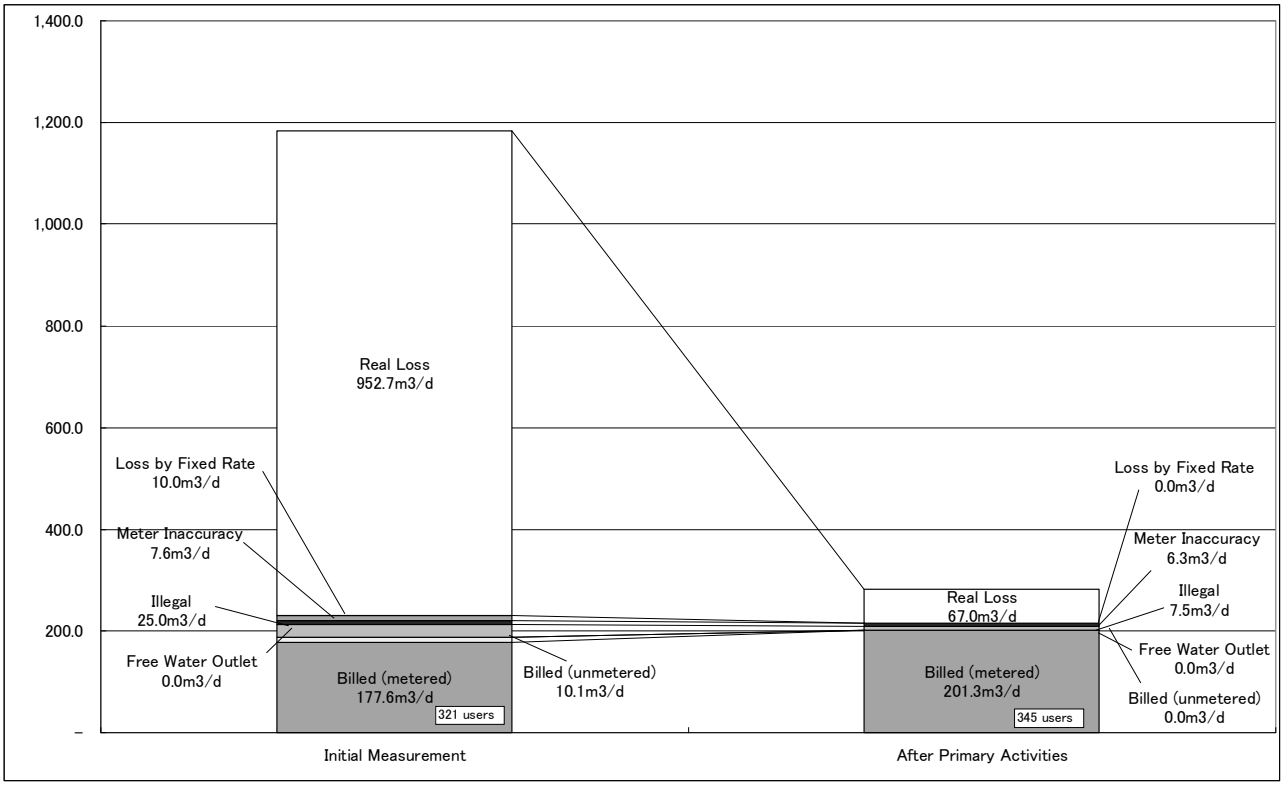
Figure A3-3 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced through a series of activities from 81% to 24% (886 m^3/d could be saved).
- Massive loss at a major sump has been observed in the midstream of the Primary Activity and this could contribute to huge amount of real loss in this sub-zone.
- It is regarded that Primary Activities alone may contributed to reducing real loss effectively in this sub-zone.



Note: Source - The categories of the international Water Association (IWA),
- Strategic Approach for NRW Reduction (NWSDB)



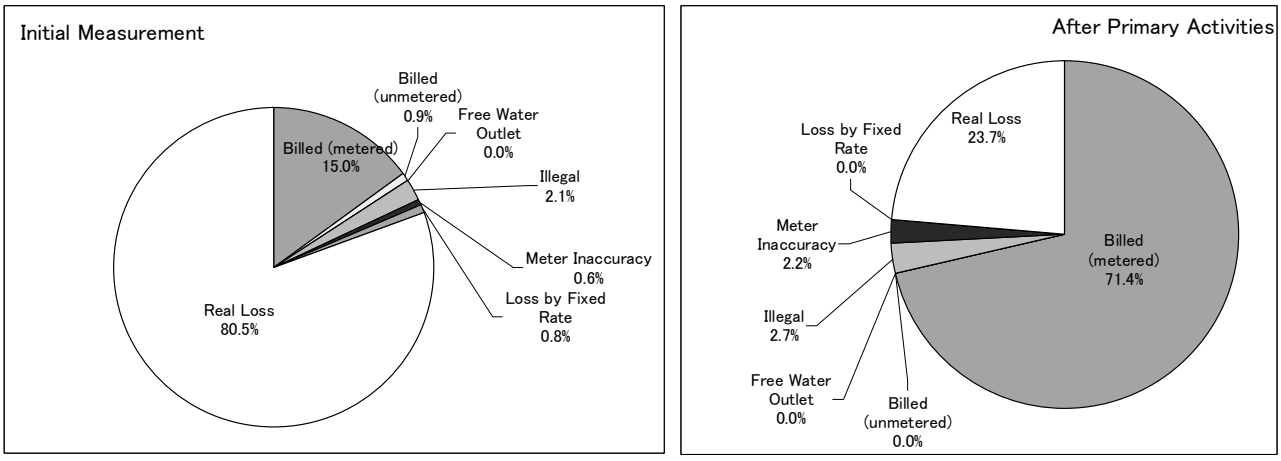


Figure A3-3 Water Balance before and after NRW Reduction Activities (B3)

A3.2.4 B4 (Fairfield Road)

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

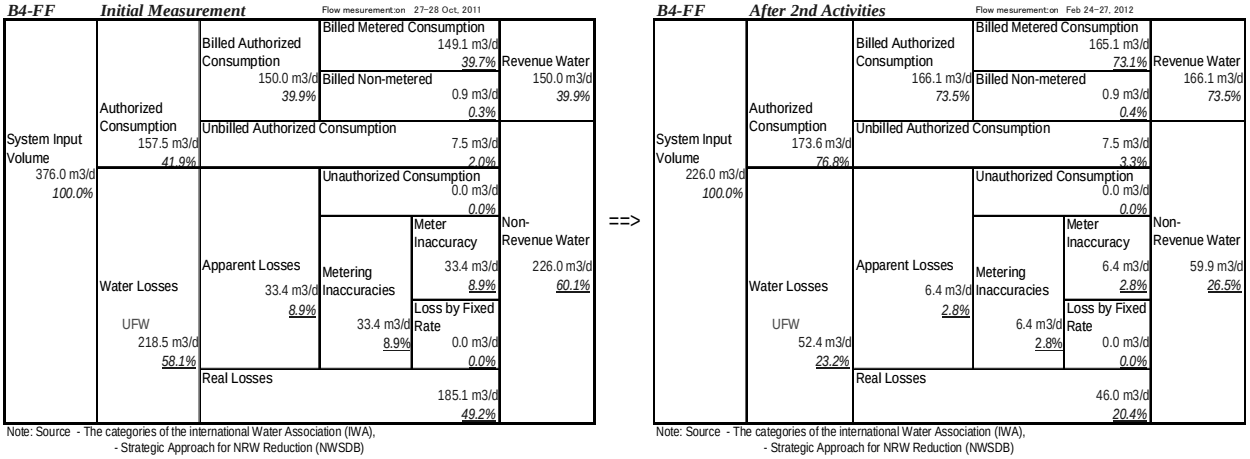
- Number of connection: 162
- Total length of pipelines according to pipe material:
  - PVC: 1,010 m
  - CI: 779 m
- Number of free water outlet: 2
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area

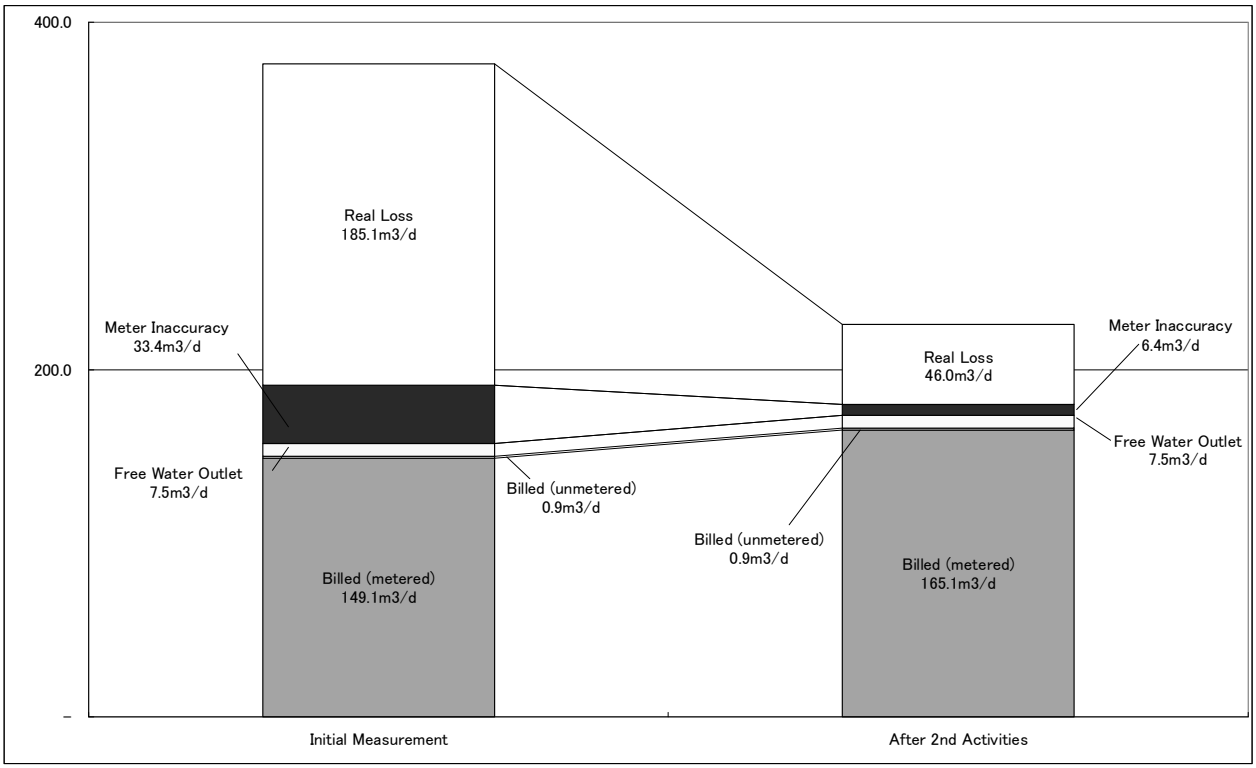
(2) Result of Water Balance Analysis

Figure A3-4 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced through a series of activities from 49% to 20% (139 m^3/d could be saved).
- It is regarded that Primary Activities alone may contributed to reducing real loss effectively in this sub-zone.





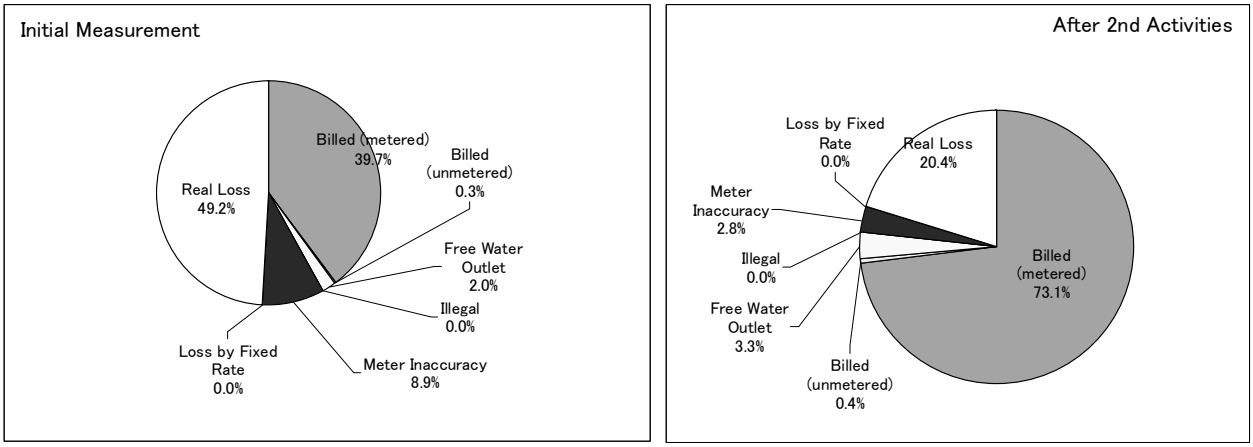


Figure A3-4 Water Balance before and after NRW Reduction Activities (B4, Fairfield Road)

A3.2.5 B4 (Magazine Road)

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

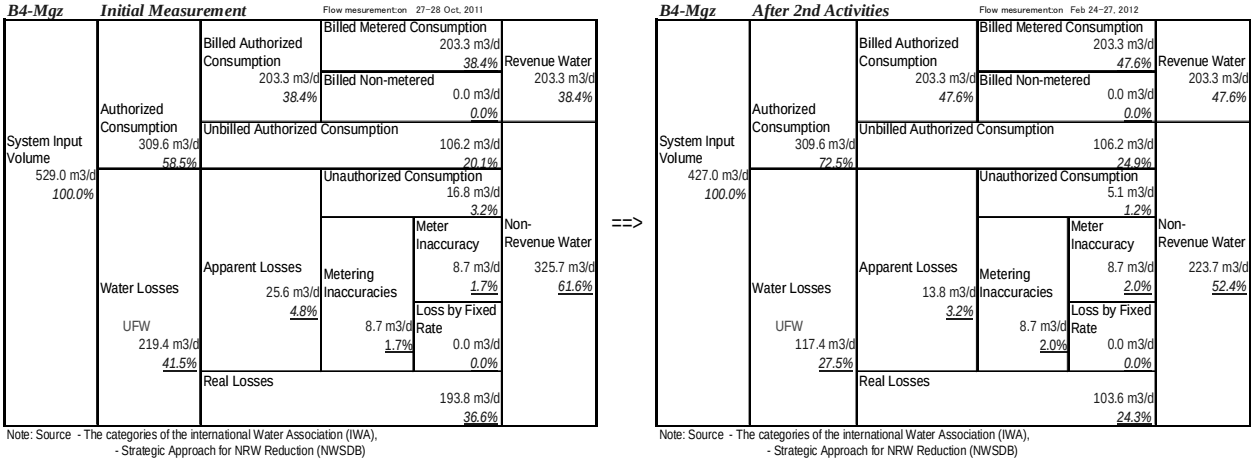
- Number of connection: 291
- Total length of pipelines according to pipe material:
  - PVC: 762 m
  - CI: 700 m
- Number of free water outlet: 25
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

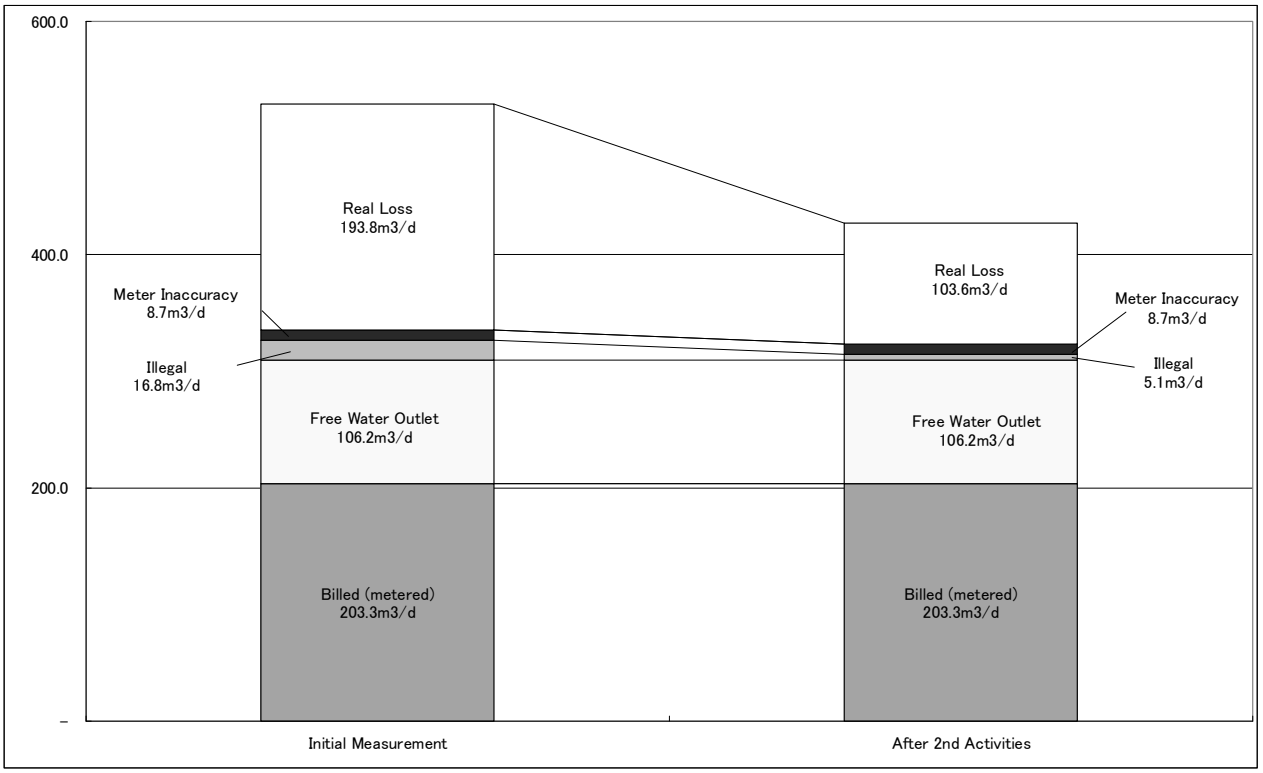
(2) Result of Water Balance Analysis

Figure A3-5 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced through a series of activities from 37% to 24% (90 m^3/d could be saved).
- Assuming that no action is taken for free water outlets (FWOs), amount of its consumption remains constant. This means contribution rate of FWOs becomes more significant after the NRW reduction activities because the total system input may become smaller after the activity. It is considered that measures for FWOs may be effective in this type of sub-zone.





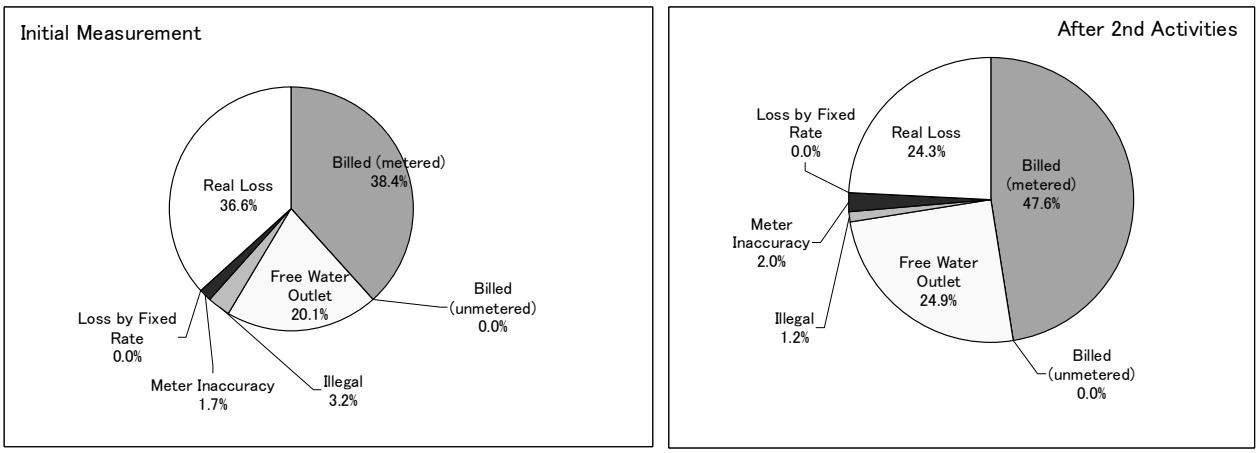


Figure A3-5 Water Balance before and after NRW Reduction Activities (B4, Magazine Road)

A3.2.6 B5

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 840
- Total length of pipelines according to pipe material:
  - PVC: 460 m
  - CI: 1,571 m
- Number of free water outlet: 11
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may be done once flow measurement after Primary Activities becomes available.

A3.2.7 B6

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 1,117
- Total length of pipelines according to pipe material:
  - PVC: 3,280 m
  - CI: 2,440 m
- Number of free water outlet: 7
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area

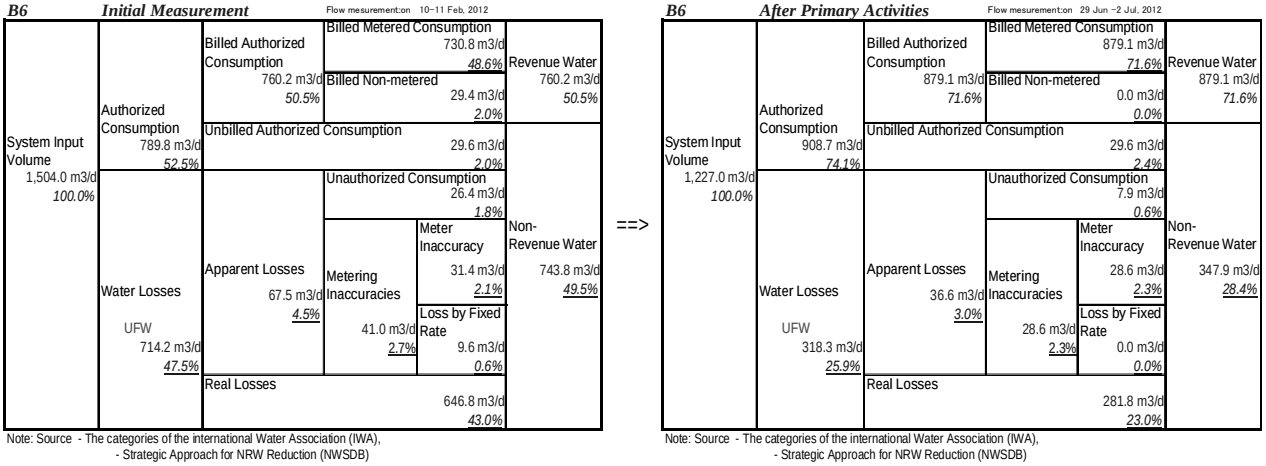
(2) Result of Water Balance Analysis

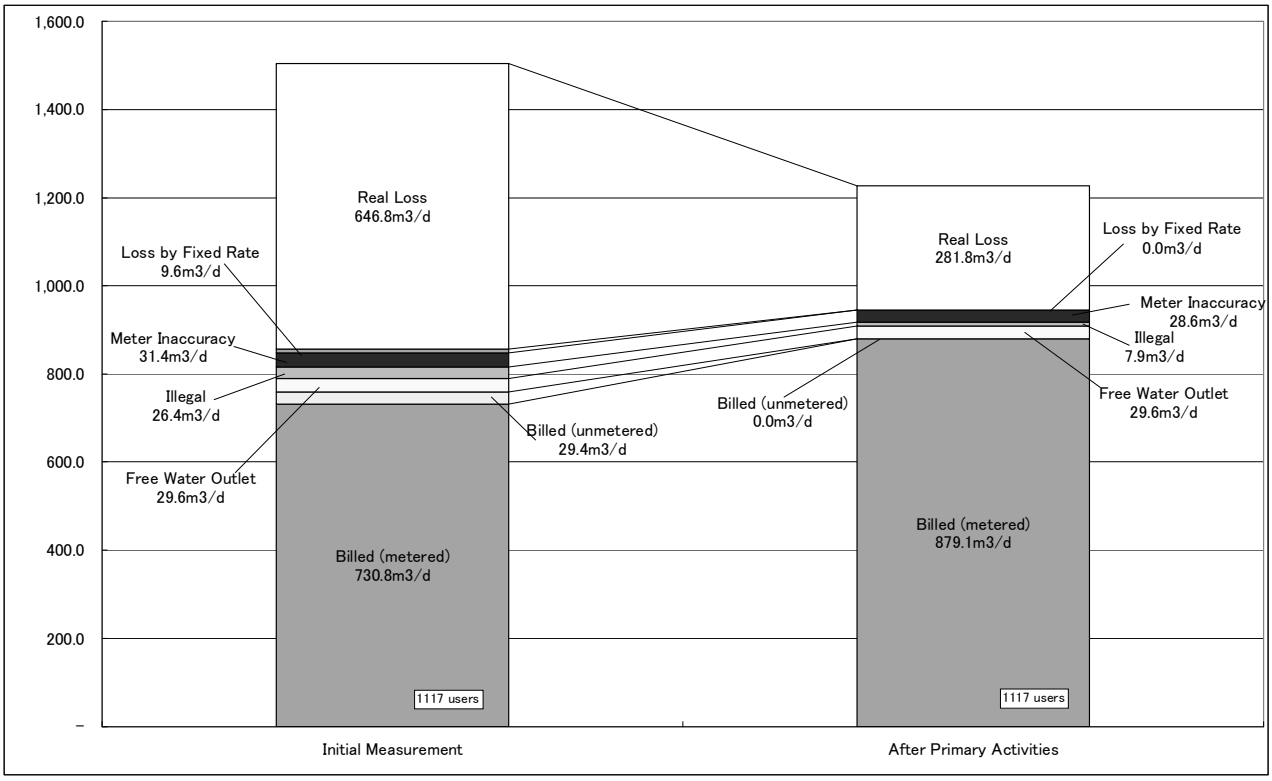
Figure A3-6 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced through a series of activities from 43% to 23% (365 m^3/d could be saved).
- It is regarded that Primary Activities alone may contributed to reducing real loss effectively in this sub-zone.

Annex -6 Execution Plan





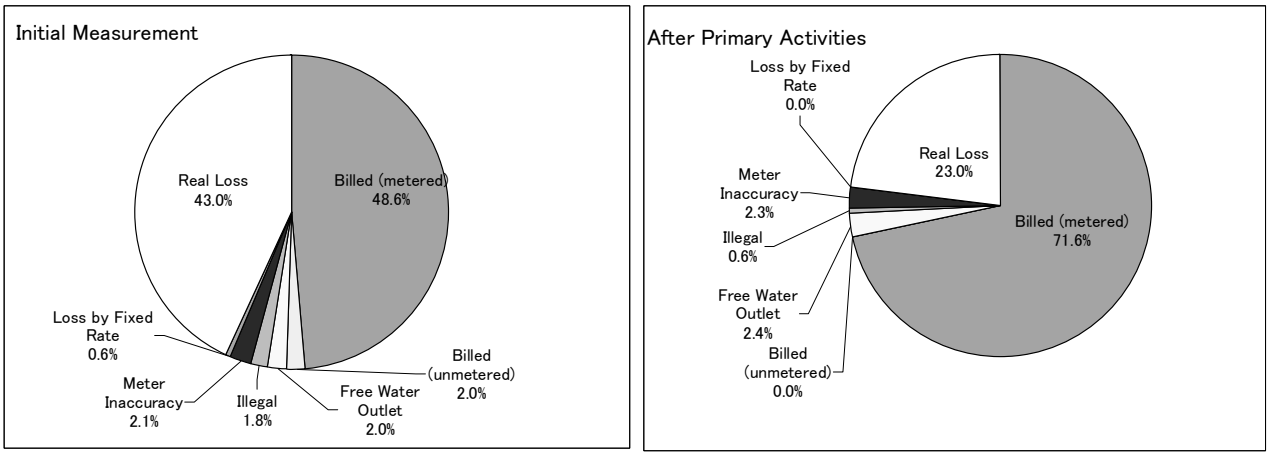


Figure A3-6 Water Balance before and after NRW Reduction Activities (B6)

A3.2.8 B7

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - PVC: 2,520 m
  - CI: 1,487 m
  - DI: 1,461 m
- Number of free water outlet: 1
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Borella-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.9 B8

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 186
- Total length of pipelines according to pipe material:
  - PVC: Under verification (not on the existing drawings)
  - CI: Under verification (not on the existing drawings)
- Number of free water outlet: 2
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Borella-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may be done once flow measurement after Primary Activities becomes available.

A3.2.10 B9

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 593
- Total length of pipelines according to pipe material:
  - PVC: 1,314 m
- Number of free water outlet: 1
- Method of flow measurement: Full-scale isolation.

- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.11 B10

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 191
- Total length of pipelines according to pipe material:
  - PVC: 773 m
  - CI: 581 m
- Number of free water outlet: 0
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Borella-similar area

(2) Result of Water Balance Analysis

In this sub-zone, NRW reduction activities have not conducted other than installing bulk meter before police's quarter. Accordingly, water balance is not calculated in this area.

A3.2.12 Water Balance in Kotahena

A3.2.13 K1

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 397
- Total length of pipelines according to pipe material:
  - PVC: 692 m
  - CI: 707 m
- Number of free water outlet: 14
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

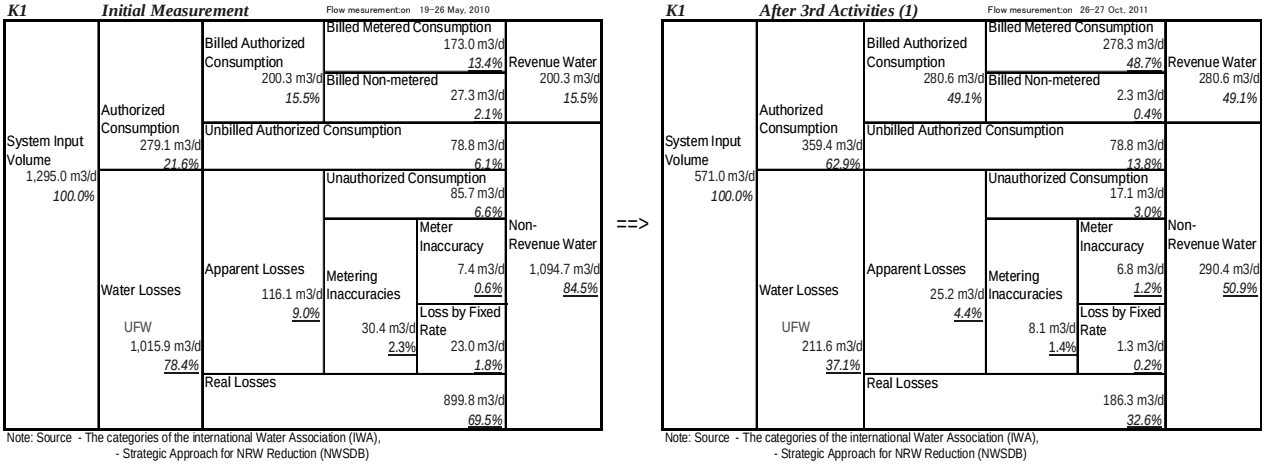
Figure A3-7 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone. Figure A3-8 shows transitional change of water balance according to NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

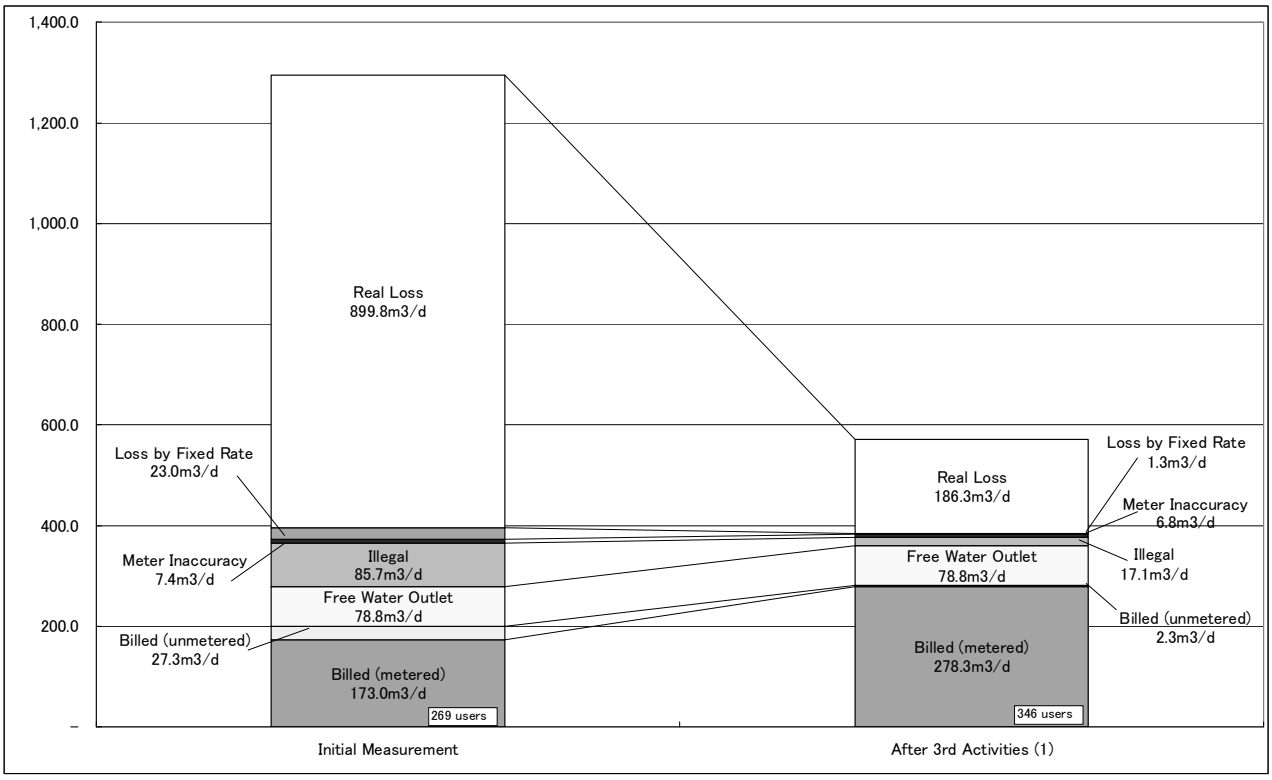
- Real loss could be reduced from 70% to 33% through a series of activities (saving 714 m^3/d).

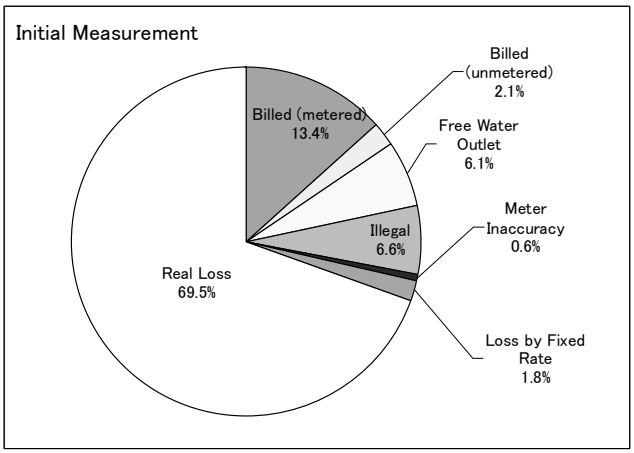
- Reduction from 70% to 62% through Primary Activities (saving 335 m^3/d)
- Rebounding from 62% to 72% after 6 months (increasing 350 m^3/d)
- Reduction from 72% to 62% through 2nd Activities (saving 343 m^3/d). Old CI abandonment, and common pipe installation and connection to customers were conducted under this activities (bundle pipes had remained at this stage).
- Reduction from 62% to 33% through 3rd Activities (saving 386 m^3/d). Disconnection of bundle pipes accompanied with step testing and further leak repair were conducted under this activities (bundle pipes had been disconnected immediately after branch from main pipes).
- Rebounding from 33% to 46% after 7 months (increasing 142 m^3/d)

- Real loss could not be reduced effectively by Primary Activities alone. Further, NRW was rebounding as time went by. This may because of poor area condition (there were many old CI pipes, bundle pipes, pipes under houses, free water outlets).



Note: Source - The categories of the international Water Association (IWA),
- Strategic Approach for NRW Reduction (NWSDB)





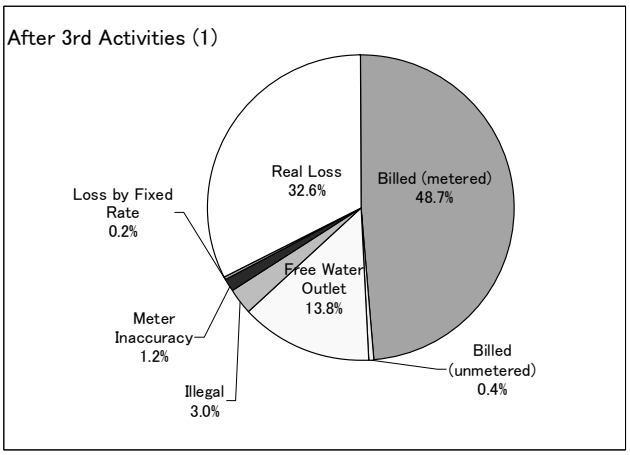
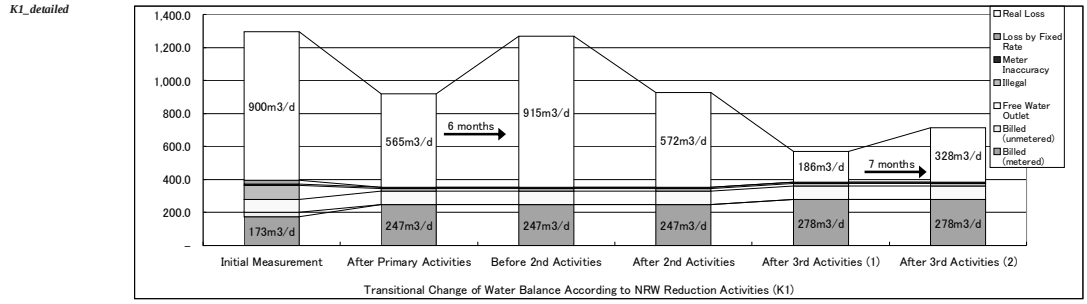


Figure A3-7 Water Balance before and after NRW Reduction Activities (K1)



Components				Initial Measurement			After Primary Activities			Before 2nd Activities			After 2nd Activities			After 3rd Activities (1)			After 3rd Activities (2)	
				m3/day	(%)		m3/day	(%)		m3/day	(%)		m3/day	(%)		m3/day	(%)		m3/day	(%)
RW	Billed Authorized Consumption		Billed (metered)	173.0	13.4%	=>	246.7	26.9%	=>	246.7	19.5%	=>	246.7	26.7%	=>	278.3	48.7%	=>	278.3	39.0%
			Billed (unmetered)	27.3	2.1%	=>	2.3	0.3%	=>	2.3	0.2%	=>	2.3	0.2%	=>	2.3	0.4%	=>	2.3	0.3%
NRW	Unbilled Authorized Consumption	Unbilled un-metered Consumption	Free Water Outlet	78.8	6.1%	=>	78.8	8.6%	=>	78.8	6.2%	=>	78.8	8.5%	=>	78.8	13.8%	=>	78.8	11.1%
	Apparent Losses	Unauthorized	Illegal	85.7	6.6%	=>	17.1	1.9%	=>	17.1	1.4%	=>	17.1	1.9%	=>	17.1	3.0%	=>	17.1	2.4%
		Metering Inaccuracy	Meter Inaccuracy	7.4	0.6%	=>	6.8	0.7%	=>	6.8	0.5%	=>	6.8	0.7%	=>	6.8	1.2%	=>	6.8	1.0%
			Loss by Fixed Rate	23.0	1.8%	=>	1.3	0.1%	=>	1.3	0.1%	=>	1.3	0.1%	=>	1.3	0.2%	=>	1.3	0.2%
	Real Losses		Real Loss	899.8	69.5%	=>	565.0	61.5%	=>	915.0	72.2%	=>	572.0	61.8%	=>	186.3	32.6%	=>	328.3	46.1%
	Total System Input			1,295.0	100.0%	=>	918.0	100.0%	=>	1,268.0	100.0%	=>	925.0	100.0%	=>	571.0	100.0%	=>	713.0	100.0%
	MNF (l/min)			690			330			600			330			120			200	
	MNF (converted to m3/day)			994			475			864			475			173			288	
	Pressure at MNF (m)			18.6			19.5			18.2			18.3			17.1			22.9	
	Measured on:			19-26 May, 2010			11-22 Nov, 2010			5 - 9 May, 2011			24-26 Jun, 2011			26-27 Oct, 2011			10-12 May, 2012	

Typical NRW reduction activities
* After 6 months
* After 7 months
* Old CI abondonment
* Common pipe installation connection to customers (bundle pipes remained)
* Disconnectionf of bundle pipes
* After step testings & further leak repair

Figure A3-8 Transitional Change of Water Balance according to NRW Reduction Activities (K1)

A3.2.14 K2

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 426
- Total length of pipelines according to pipe material:
  - CI: 1,468 m
- Number of free water outlet: 33
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

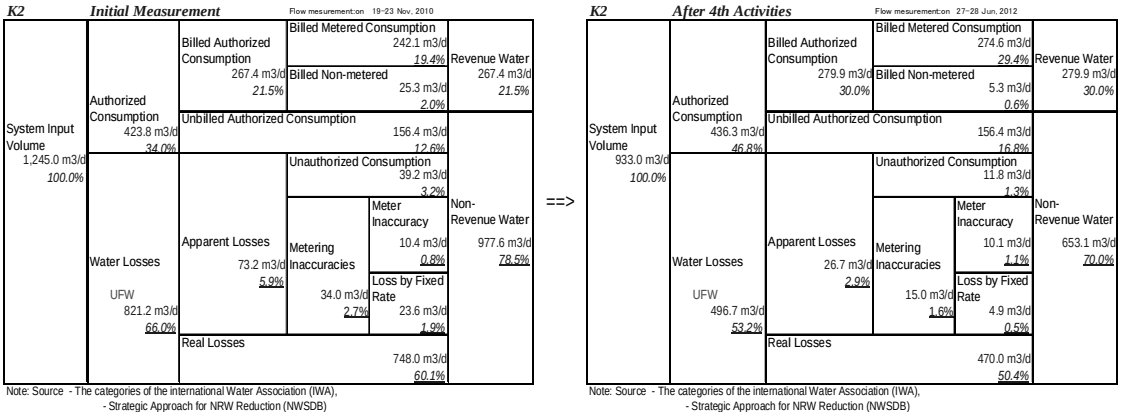
(2) Result of Water Balance Analysis

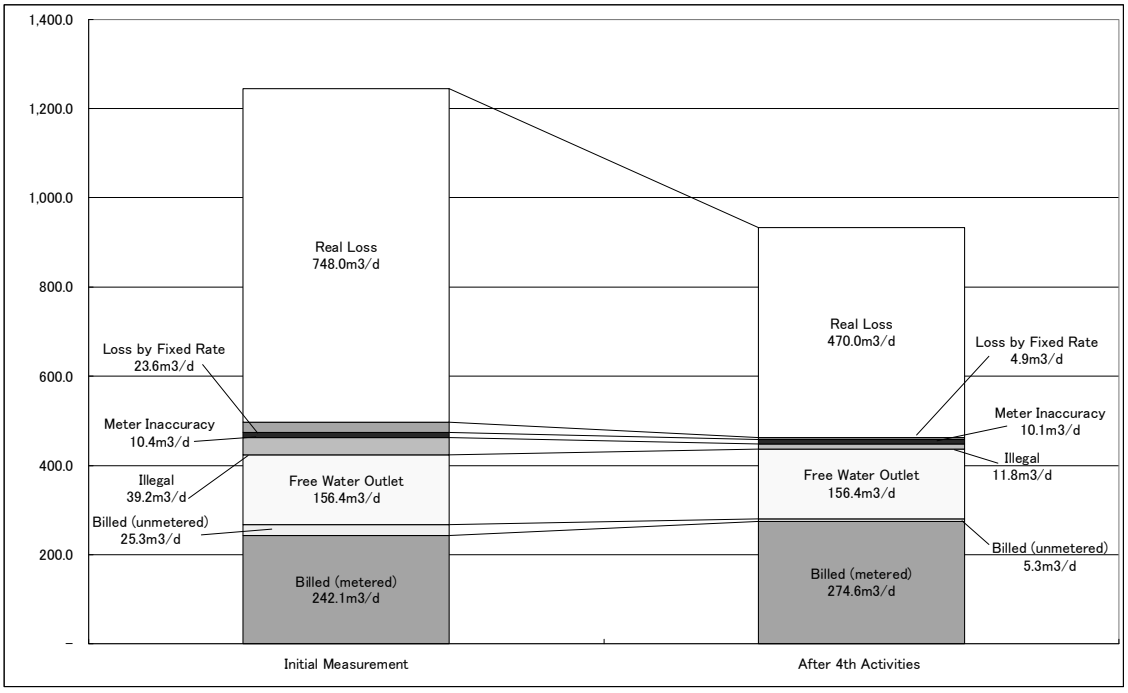
Figure A3-9 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone. Figure A3-10 shows transitional change of water balance according to NRW reduction activities in the sub-zone.

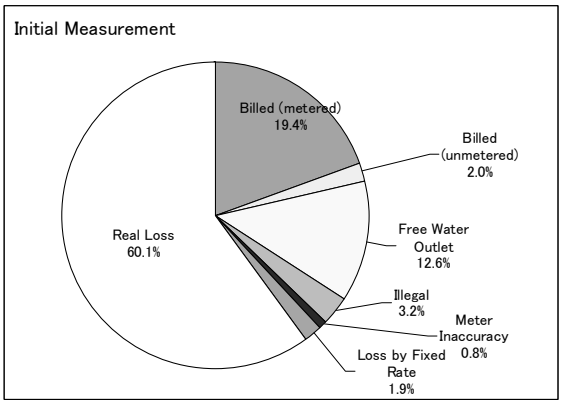
Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced from 60% to 50% through a series of activities (saving 278 m^3/d).
  - Rate of real loss remained 60% even after Primary Activities (saving 63 m^3/d)
  - Rebounding from 60% to 64% after 5 months (increasing 151 m^3/d)
  - Reduction from 64% to 50% through 2nd Activities (saving 366 m^3/d). Leak repair had been conducted under this activities.

- Real loss could not be reduced effectively by Primary Activities alone. Further, NRW was rebounding as time went by. This may because of poor area condition (there were many old CI pipes, bundle pipes, pipes under houses, free water outlets).







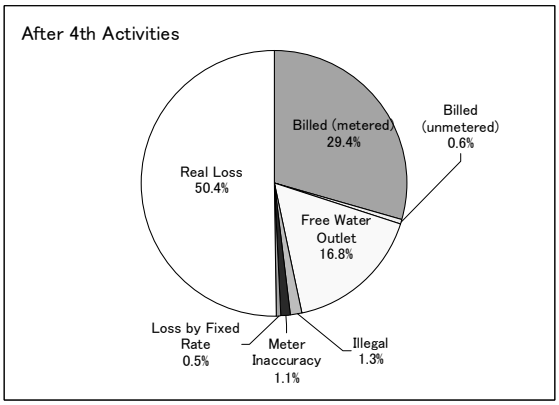
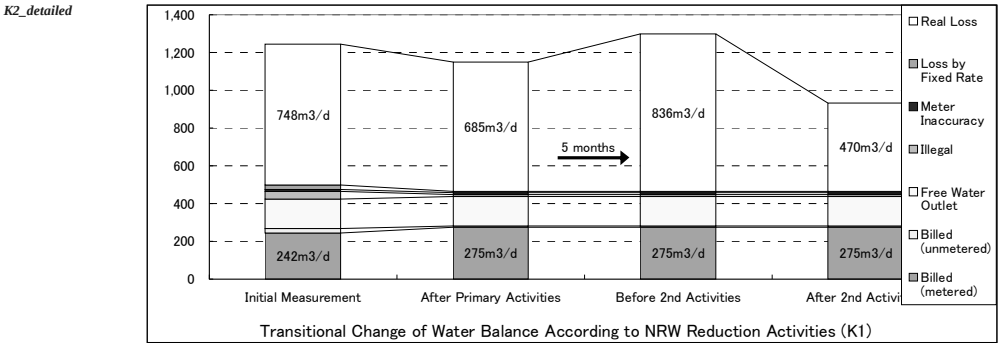


Figure A3-9 Water Balance before and after NRW Reduction Activities (K2)



Components				Initial Measurement			After Primary Activities			Before 2nd Activities			After 2nd Activities	
				m3/day	(%)		m3/day	(%)		m3/day	(%)		m3/day	(%)
RW	Billed Authorized Consumption		Billed (metered)	242.1	19.4%	=>	274.6	23.9%	=>	274.6	21.1%	=>	274.6	29.4%
			Billed (unmetered)	25.3	2.0%	=>	5.3	0.5%	=>	5.3	0.4%	=>	5.3	0.6%
NRW	Unbilled Authorized Consumption	Unbilled un-metered Consumption	Free Water Outlet	156.4	12.6%	=>	156.4	13.6%	=>	156.4	12.0%	=>	156.4	16.8%
	Apparent Losses	Unauthorized	Illegal	39.2	3.2%	=>	11.8	1.0%	=>	11.8	0.9%	=>	11.8	1.3%
		Metering Inaccuracy	Meter Inaccuracy	10.4	0.8%	=>	10.1	0.9%	=>	10.1	0.8%	=>	10.1	1.1%
			Loss by Fixed Rate	23.6	1.9%	=>	4.9	0.4%	=>	4.9	0.4%	=>	4.9	0.5%
	Real Losses		Real Loss	748.0	60.1%	=>	685.0	59.7%	=>	836.0	64.4%	=>	470.0	50.4%
			Total System Input	1,245.0	100.0%	=>	1,148.0	100.0%	=>	1,299.0	100.0%	=>	933.0	100.0%
			MNF (l/min)	771			686			797			462	
			MNF (converted to m3/day)	1110			988			1148			665	
			Pressure at MNF (m)	17.4			17.4			17.3			18.5	
			Measured on:	19-23 Nov, 2010			27-28 Jan, 2011			30/Jun - 1/Jul, 2011			27-28 Jun, 2012	

Typical NRW reduction activities
* After 5 months
* 42 leaks repaired

Figure A3-10 Transitional Change of Water Balance according to NRW Reduction Activities (K2)

A3.2.15 K3&K4

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

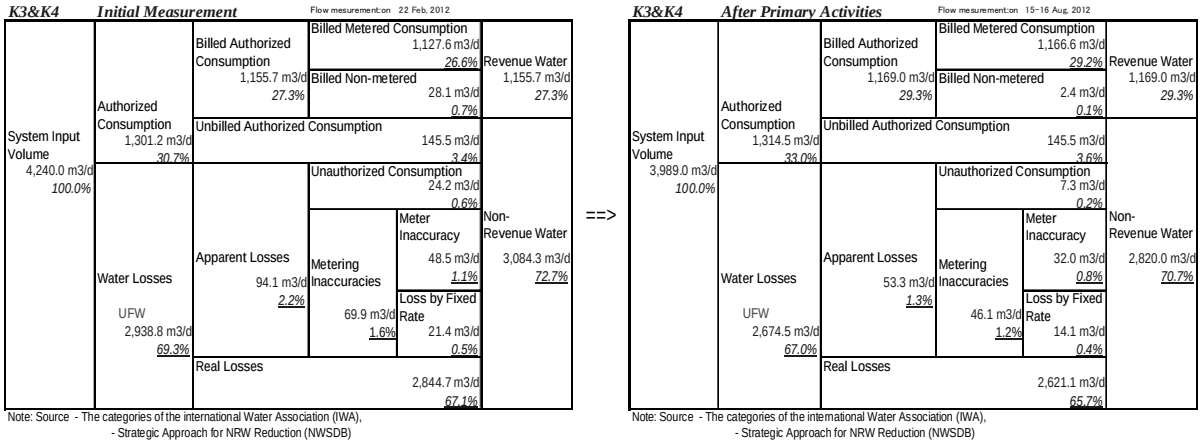
- Number of connection: 1,383
- Total length of pipelines according to pipe material:
  - PVC: 173 m
  - CI: 7,160 m
- Number of free water outlet: 19
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

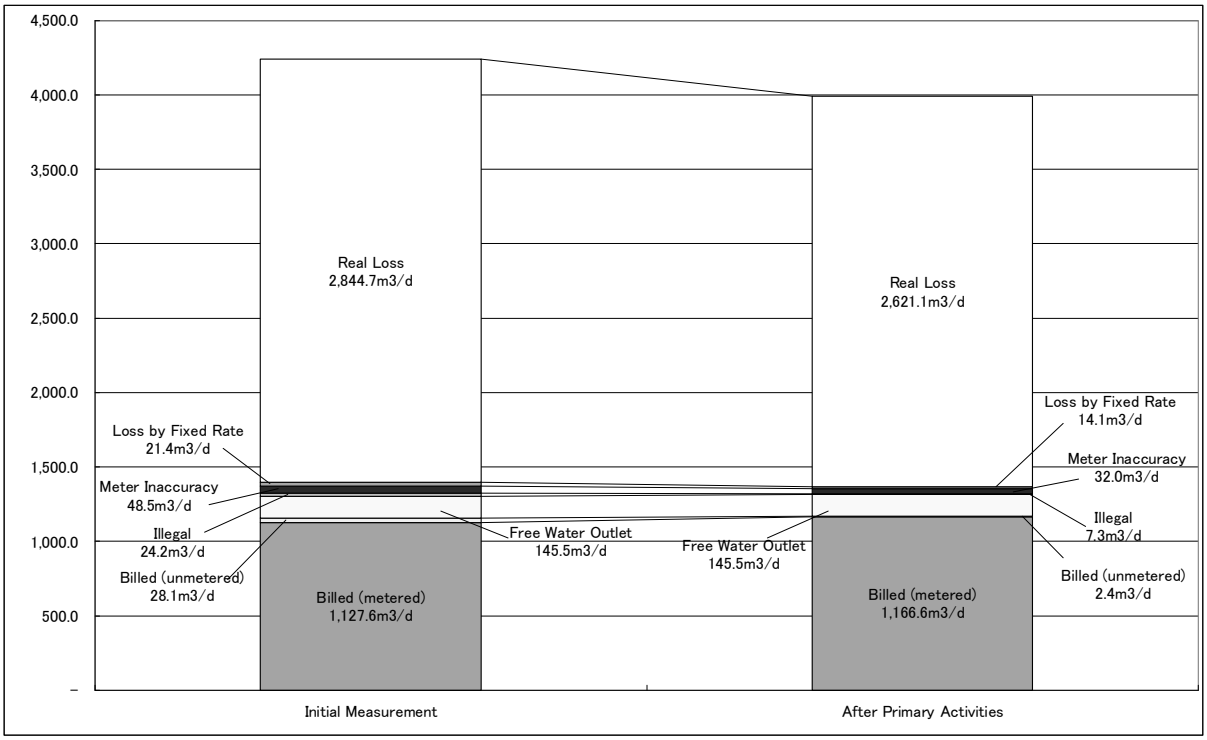
(2) Result of Water Balance Analysis

Figure A3-11 shows result of water balance analysis for before and after NRW reduction activities in the sub-zone.

Following are the findings and possible factors that may have affected to the results:

- Real loss could be reduced from 67% to 66% through a series of activities (saving 224 m^3/d).
- Real loss could not be reduced effectively by Primary Activities alone. This may because of poor area condition (there were many old CI pipes, bundle pipes, pipes under houses, free water outlets).





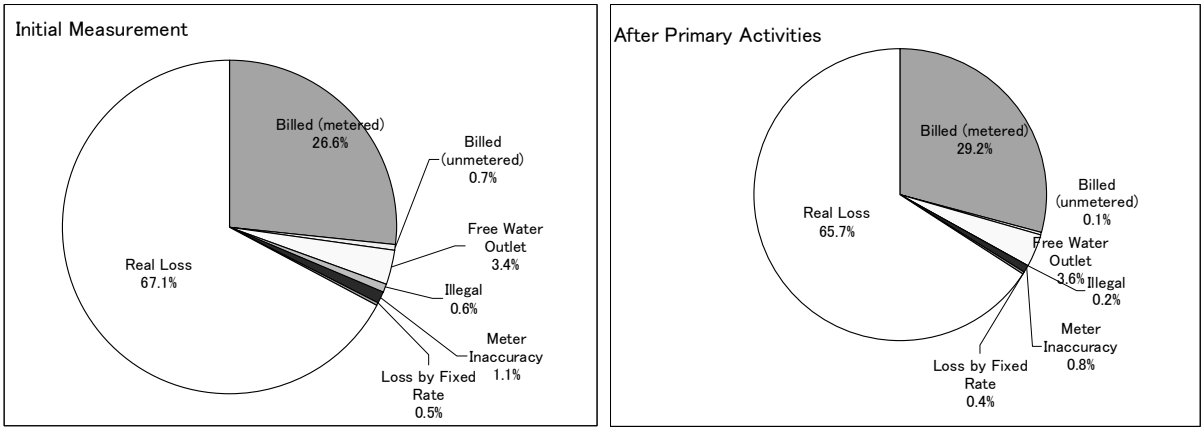


Figure A3-11 Water Balance before and after NRW Reduction Activities (K3&K4)

A3.2.16 K5

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - CI: 867 m
- Number of free water outlet: 4
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.17 K6

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: 159
- Total length of pipelines according to pipe material:
  - PVC: 336 m
  - CI: 2,307 m
- Number of free water outlet: Not surveyed
- Method of flow measurement: Full-scale isolation.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will see the effect of pipe replacement work only.

A3.2.18 K7

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - PVC: 262 m
  - CI: 4,617 m
  - DI: 304 m
- Number of free water outlet: 3
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.19 K8

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - PVC: 776 m
  - CI: 1,668 m
  - DI: 269 m
  - SP: 369 m
- Number of free water outlet: Under verification
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.20 K9

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - PVC: 114 m
  - CI: 3,669 m
  - DI: 887 m
- Number of free water outlet: 3
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

A3.2.21 K10

(1) General Features of the Sub-zone

General features of the sub-zone are as follows.

- Number of connection: Under verification
- Total length of pipelines according to pipe material:
  - PVC: 65 m
  - CI: 2,163 m
- Number of free water outlet: Under verification
- Method of flow measurement: Sample zone.
- Category of sub-zone nature: Kotahena-similar area

(2) Result of Water Balance Analysis

Result of water balance analysis may not be conducted since this sub-zone will go for sample zone method.

PART B EXECUTION PLAN

Chapter B1 Policy and Target of NRW Reduction

Policy and Target of NRW Reduction are as follows.

- NRW reduction by 9.4% in Colombo city during the period of 2012 – 2016.(cooperate plan 2012-2016)
- Continue emphasis on NRW reduction as an integral part of NWSDB operations.
- Implement short-term and long-term measures for the reduction of NRW in Colombo city.
- Continue to identify short term and long term measures for the reduction of NRW Colombo.

Being given high priority to reduction of NRW, various activities were adopted to reduce Apparent losses and Physical losses. Reduction of apparent losses has achieved the set target, which needs to be sustained. Cooperate plan with target of NRW reduction by 9.4% in Colombo city during the period of 2012 – 2016 were prepared based on the projection that there will be funds available for replacement of deteriorated pipes. The on-going master plan project would discuss pipes that need replacement or for rehabilitation. ADB has indicated that funds would be made available for pipe replacement.

It is the essential activities to replace / rehabilitate pipe system for NRW reduction. A lager efforts are required to reduce NRW and to keep at a certain level since there remains lots of leakage and illegal connections from unfound pipes even after NRW reduction activities. In several areas, NRW will not be reduced to a satisfactory level even after a large efforts input. However actions shall be taken to reduce NRW and keep the water loss at minimum level while waiting for pipe replacement / rehabilitation.

Since NRW reduction is one of the highest priority issues, proper action shall be taken to reduce NRW for sustaining the system even after pipe replacement/system improvement.

This execution plan will discuss the activities to be executed before completion of pipe replacement / system improvement. Recommended activities will also be useful in the area where pipe replacement will take times. Know-how of these activities will be useful even for the new system after pipe replacement.

Chapter B2 Improvement of Measurement System

B2.1 Purpose of Measurement System

Major purposes of measurement system are summarized below.

- To select the problematic area
- To know the occurrence of pipe burst and other accidents by monitoring water flow
- To know the efforts/achievement on NRW reduction in each area

All the inflow to Colombo City are measured now, and sub measurement points are under installation to measure the flow to each Area Engineer (AE). This will allow to calculate the NRW for each AE. The change in NRW could be used as a measure for further action.

B2.2 Current Activities and target

Following activities are / will be executed.

- Inflow & Out flow entering the CC & Area Engineer to be monitored.

- Location of measuring points to be confirmed with map & field.
- NWSDB Staff to be trained for the flow measurement.
- Monitoring area limited with no of connection.
- Area to be selected with less number of measuring points.

Area Engineer (Pamankada) to measure the inflow and outflow at the boundary measurement points chambers has been placed and initial reading has been taken. To initiate the measurements in the balance Area Engineer boundary there are ten chambers to be placed.

B2.3 Future Plan

Future plan will be discussed in Master Plan and formulation of DMA system will be executed by ADB project. Required meters will be installed along with the pipe replacement / rehabilitation work. Adequate monitoring and measurement system are expected to be introduced after creation of DMA.

Chapter B3 Unbilled Authorized Consumption

B3.1 Free Water Outlets

The situation of free water outlets is summarized as shown in Table B3-1.

- Free water outlets contribute 10.5 % of the CC NRW, according to previous study by NWSDB.
- Free water ratio in Kotahena and Borella will largely contribute to NRW ratio especially after the leakage is repaired as discussed in Chapter A1.
- Randiya project is under execution to change the free water outlets to individual house connections.
- A program commenced to meter free water outlets in Colombo city since 2011 September.

Table B3-1 Free Water Outlets in Colombo City (Survey-2008)

Free Water Outlets	Number
Stand post	1,790
Bath Tap	1,393
Toilet Tap	853

In accordance with the survey carried out in 2008 there were 4036 water outlets as detailed in table B4-1. Since, then under the on-going Randiya program of converting free water outlets to individual house connections presently there are 3200 outlets, contributing to 9.8 % of NRW. Another program was initiated to meter the free water outlets in Colombo City since September 2011. Under this program society's were formed by the users and they take responsibility to manage and pay for the water. Very concessionary rate has been charged for the water that has been used.

B3.2 Randiya Program

This project tries to change free water outlets to individual house connections upon the agreement of the customers.
Under this program those who use common outlet are given an opportunity to get water to their homes at a concessionary rate and agree to discontinue the available free water outlets. This program has been implemented for over a decade. It is slow and time consuming

B3.3 Another Program

NWSDB tries to establish community for collection of water charge from free water outlets. Meters will be installed at free water outlets. Special tariff system under category 93 will be applied.

In the underserved settlements there is practical problem in disconnecting Toilet taps or even provision of individual connection in such instance to quantify the consumption a water meter is installed to the common outlet after forming a society. The society will pay for the water consumed at a concessionary rate. The program was initiated eight months ago; already 480 society has been formed.

B3.4 Continuation of the Current Activities

The program is being implemented by using the NWSDB's staff. However it is necessary to expedite the process by increasing the input in order to catch up the plan to be completed within three years.

Annex -6 Execution Plan

It is desirable to execute the activities by outsourcing as a Project in order to expedite the progress and to complete the activities. Outsourcing is also preferable in the aspects of the sustainability.

Chapter B4 Reduction of Apparent Losses

Apparent Losses are composed of "Unauthorized consumption" and "Metering error", which are discussed below.

B4.1 Unauthorized consumption

B4.1.1 Current Activities

It is important to encourage customers to stop and /or to inform illegal activities. There were some users who do not feel hesitation/guilty to tamper pipes and meters by themselves.

NRW section is now executing legalization of unauthorized consumption. In this activity, valves just before the water meter is closed and premise taps are checked for water flow. These activities are executed *on the random check base*, while all the houses were checked as "customer Survey" and all the suspicious houses were inspected in the pilot area activities.

Publicity and awareness have been made among underserved settlements, which have deterred obtaining connection through unauthorized method. As per the records, detection of unauthorized consumption has reduced to 5% over the inspection lately.

B4.1.2 Future Activities

When all the distribution pipes and service connections are replaced in a careful manner, unauthorized consumption will be eliminated. In this case, it is required to put efforts to prevent new unauthorized connection.

However continuous inspection is required before the elimination of all the unauthorized connections.

(1) Improvement of Current Inspection Methods
It is recommended to modify t*he random base inspection* in a following manner:

1) Alternative 1 (highly recommended option);
It is recommended to execute "customer survey" at all the houses to detect suspected houses of unauthorized usage as following manner in addition to present methods:

Step 1: Meter readers collect information of all the customers. Required information is same with the customer survey executed in Pilot Areas. (customer meter, family number, meter condition etc.)
Step 2: OIC office collects, inputs and analyzes the data in order to list up suspected houses to be inspected.
Step 3: EAs execute inspection at suspected houses

2) Alternative 2
If it is hard to find the suspected houses, inspection shall be made in selected connections. For the selection, billing record and GIS will be useful. Selected connection could be following:

- Low consumption,
- Previous illegal connection,
- Disconnected place
- Area where public standposts are removal

(2) Other Effective Methods

In order to prevent unauthorized connection by tampering meters and pipes by consumer, following activities shall be executed.

a) Meter sealing: Meter shall be sealed with wire and distinctly identifiable identification mark as executed in Pilot Areas. It is expected to prevent meter-tempering by user.
b) Pipe Material of Service Connection: Suitable pipe material shall be selected for service connection such as PEP which will be effective for prevention unauthorized connection as well as leakage.
c) Education and PR activities: Customers shall know that it is illegal to touch / repair service connections before customer meters. Hand bills will be useful for customers to aware that it is illegal to tamper or repair the water meter.

B4.2 Metering Error

B4.2.1 Current Activities

Major reasons of metering error are as follows.

a) Inaccuracy of meters: Inaccurate meter case the difference between volume of water flow and reading.
b) Reading errors by meter readers: Meter readers sometimes make mistakes in reading of meter and/or recording of the reading results
c) Fixed rate: The difference between billed amount (estimated bill) and usage must be large when meter is not read due to no meter or inaccessibility. Estimated bill is prepared based on consumption

Rotation system of meter readers was planned and NWSDB has started the practice in order to know and decrease reading errors. In addition, activity for meter replacement is being conducted when meters are defective.

B4.2.2 Future Activities

Following activities are required for the metering error.

a) Periodical replacement of customer meters
b) Periodical check of meter accuracy
c) Preventative maintenance of bulk meters
d) Improvement of accessibility to meters by relocating to outside the houses
e) Education to meter readers
f) Rotation system of meter readers
g) Application of special (high) rates to continuous estimated (fixed) rates customers

Rotation system of meter readers and replacement of defective meters shall be continued. More interaction is expected among meter readers. Education of the meter readers on accurate meter reading is also essential.

In addition, the policy of replacement of meter after seven years of installation is recommended to be introduced. Those premises which meters are inaccessible shall be requested to shift the meter location in such a way the meter reading could be obtained without entering the premises.

NWSDB has tried to apply special high tariff to the customers of continuous fixed rate and find effective. Strict rules of application of this high rate system shall be discussed and executed in entire Colombo City in order to improve accessibility to meters.

B4.3 Estimation of required cost and period

The cost involved to be incorporated into the annual operation & Maintenance budget.

Chapter B5 Reduction of Real Losses

Execution plan focuses on reduction of real losses from distribution system, since the Project deals distribution system but not transmission system.

B5.1 Distribution System in the Better Condition Area Similar to Borella

B5.1.1 Pilot Area Activities and Recommended Modification

As discussed in Part A Capacity Development Project, NRW is reduced to an acceptable without pipe replacement in relatively better condition area in Borella. However even in Borella, there are lots of place where reduction of NRW ratio does not reduced to a satisfactory level.

In the better condition area, a large efforts and long period are required to reduce NRW in a small area of around 500 connections. Therefore pilot activities are found to be useful but not practical without modification. The most time consumption activities are isolation of the area. There are lots of unknown pipes, interconnection and valves, which shall be located before isolation of the area. While training is given to NWSDB's staff on usage of pipe locators and magnetic locators (for valves), it requires long period to located them.

In order to disseminate the NRW reduction activities in the other area of relatively better conditions, it is necessary to modify the activities by avoiding isolation of the areas. The isolation can be executed after pipe replacement and creation of District Meter Area (herein after referred DMA).

It is recommended to select / isolate simple sample area instead of the entire area. NRW for the sample area will be calculated in order to check the results of the activities. Actual reduction of NRW will be calculated in a larger area such as DMA. Since the sample area may not represent the whole area, estimation of volume of repaired leakage is also useful to know / check the results of the activities.

B5.1.2 Expected Effects

In B1 area where pipe condition is relatively better, NRW ratio is reduced from 40% to 22% by a series of activities including legalization of unauthorized connection and leakage detection / repair (Step 1). By introducing step test for leakage detection, NRW ratio is reduced from 22% to 18% (Step 2). Step test could be executed only after isolation of the area.
NRW cannot be reduced to the level of 2nd Step by modified activities, which will not isolate the area.
In the case of B1, target of NRW will be around 22 %. Considering the results of sub-zone of B1, B3, B4, and B6, target of NRW will be less than 30% in areas similar to Borella, or relatively good condition areas.

B5.1.3 Major Activities to be executed

Following activities are recommended to be executed in the relatively better condition areas.

(1) Active Leakage Control

Systematic leakage detection as executed in Pilot Areas is found to be very useful.
Customer survey shall be executed to collect basic information such as family members and

meter conditions as preparatory works. It is recommended to select and isolate simple sample area together and then install bulk meter to check the results of the activities. If it is hard to find suitable sample area, NRW reduction will be calculated from assumed leakage volume recorded in Leakage Repair Sheet. .

It is recommended to execute systematic leakage detection, which is the combination of acoustic survey, pinpointing survey and confirmation survey in addition to visible leakage survey.
After the detection, leakage shall be repaired without delay. It is required to allocate proper gangs with required vehicle, tools and material. In order to ensure the quick attendance to the leakage "Leak recoding system" is also recommended as described later.

The expected flow chart of leakage detection and repair is shown in Figure B5-1.

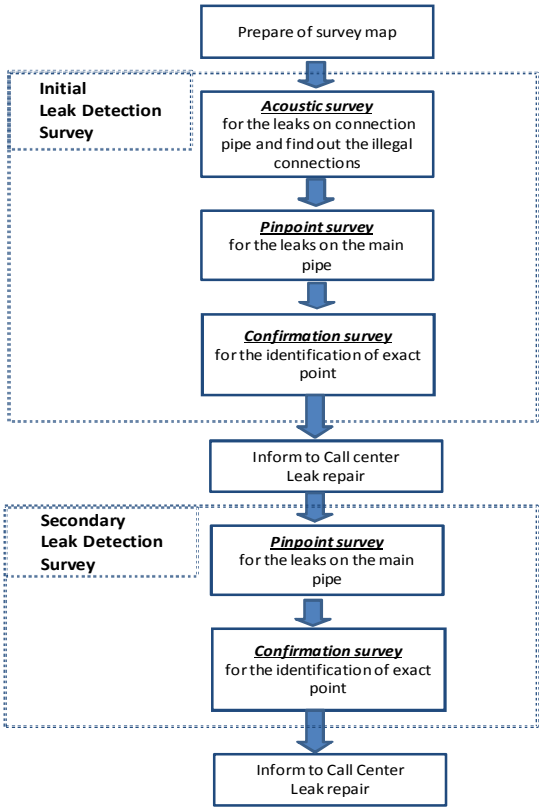


Figure B5-1 Flow Chart of Leakage Detection and Repair

Leakage repair after Initial Leakage Detection, further leakage occurred in pilot areas. This is why Secondary leakage Detection and repair are considered to be necessary. .

(2) Replacement of long house connection

It is difficult to find leakage from long distance connections and /or bundle pipes, which are installed under houses. After finding and repair, leakage will occur soon form other joints. Illegal connections are also anticipated from the long house connection. Considering these situations, it is required to stop installation of new long distance connection and /or bundle pipes. Existing long distance connections /bundle pipes have to be replaced with a larger diameter pipe, called common pipe, with short connections.
It is recommended to replace long distance house connections and/ or bundle pipes in following manner:

1) Installation of Common pipe following instruction described in Manual

NWSDB is executing replacement of these connection pipes with common pipe. However, the replacement works could be improved farther. It is required stop supplying water to abandoned connection pipes. Installation and disconnection shall be done in proper manner following "manual for replacement of long house connection / bundle pipes". (See Supporting Report.)

2) Meter installation near the main pipe

Customer meter shall be installed / relocate to the place closer to the boundary of the premises near the distribution pipe in order to reduce leakage from house connection pipe. Customers will pay much attention to leakage after the meter and water losses will be reduced since they are responsible for leakage in their premises. This action will also contribute to easy access to the meter for reading.

3) Replacement with PEP

Usage of PEP for house connection pipe will help reduction of water losses even if it is long since PEP has less number of sockets where leakage frequently occurs.

(3) Storage tanks (Sumps)

A large amount of water is lost from the storage tanks (sumps) before customer meters. Following actions shall be taken:

a) Tanks (sumps) for individual houses:
If customer meters are not installed before the tanks of individual houses, meters shall be installed at proper place before the tanks. Customer shall be responsible for water losses by leakage or overflow.

b) Tanks (sumps) for housing estates / apartments (Especially Government- owned housing scheme):
Tanks (sumps) are constructed before customer meters especially in Government-owned housing scheme, while bulk water is supplied to tanks (sumps) in relatively new private apartments. These tanks for Government-owned housing schemes are not always maintained in a proper manner and water is lost continuously. Repair of malfunctioned ball valves and leakage from the tanks will contribute to a large reduction of NRW.
In sub zone of B2, B3 and B10, a huge loss of water after such tanks (sumps) are found.

At lease following actions will be taken:

- Prepare list of tanks (sumps) and collect information of location, capacity, number of house connection supplied from the tank, condition of ball taps, existence and condition of bulk meters on all the inlet pipes.
- Install bulk meters on all the inlet pipes if they do not exist, and then measure water volume entered into the tanks. The volume shall be compared with total billing to the all customers supplied from the tank.
- The difference between them is NRW. It is required to collect the shortage from individual customers or community. Information on required repair shall also be given to them.

After calculating water loss in these tanks, required actions shall be discussed even if it is relatively a sensitive matter.

Sample form of the list is shown in Table B5-1

Table B5-1 Information of Storage Tank (Housing Estate, Apartment, etc.)*

Location (Adress)	Capacity m3	Supply Connection	Meter (exist, condition) Inlet	Outlet	Baypass before meter	Ball tap	Leakage wall	pipe, etc	Remarks (Age,etc)

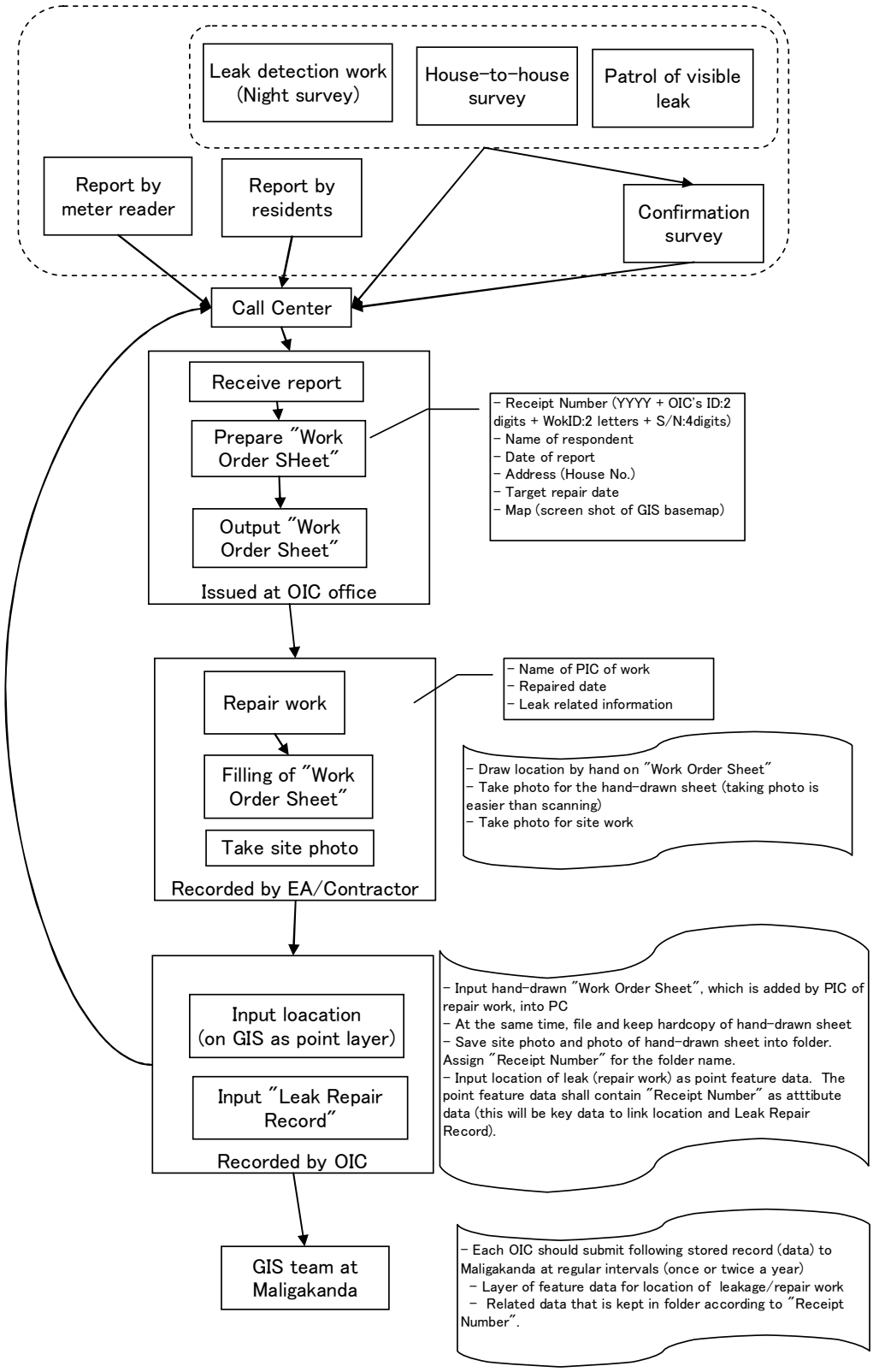
*; Not Bulk Supply but tariff collection from individual houses

(4) Leak Repair Record

Whenever leakage are found and repaired leak record shall be filled.
The recommended system flow is as below:

- Step 1: Report all the leakage to relevant OIC through Call Center
- Step 2: Prepare Repair Order Sheet at OIC office and give order to Zone officer for repair/ supervision.
- Step 3: Repair leakage quickly, fill the Repair Order Sheet with required information and report to OIC (Zone officers' activities). Estimation of reduced leakage volume shall also be recorded
- Step 4: Record the information to database and locate at GIS at OIC office.

This system can highlight and give warning to "slow attendance to leakage". It will contribute to promotion of quick attendance to leakage.
The record can also be used to find area/ pipeline of frequent leakage occurrence.
Leak Repair Record process is explained in Supporting Report.
Procedure for Responding and Recording Leakage Cases is summarized in Figure B5-2.



Advantages of keeping leak record (practical use)
Identify leak-frequent line/area
List up outstanding work to be done (list up any work more than 7 days after leak report)

Figure B5-2 Concept of Procedure for Responding and Recording Leakage Cases

(5) Evaluation of NRW Reduction by the Activities

When DMA is formulated or the area is isolated, NRW can be calculated by measuring system input volume and billing records. NRW shall be calculated before and after the activities to know the achievement of the activities. It shall be noted that Priority customers' consumption shall not be forgotten to be included in the billing records since commercial office knows normal customers but not Priority customers.

However, DMA is not formulated and the area is difficult to isolate at the current system. In the case, the effects of NRW reduction activities can be guessed from the sample area if it is suitable size. At the same time leakage reduction volume can be calculated from "the number of repaired leakage" and "size of leakage". Minimum night flow will also give the idea since it will be reduced after the activities. Even when it is difficult to know the NRW reduction amount, water pressure will be increased and water supply condition will be improved.
If activities are executed in entire Colombo city at the same time, NRW reduction can be observed from input volume to entire Colombo city.

B5.2 Distribution System in Poor Condition Area Similar to Kotahena

B5.2.1 Pilot Area Activities

As discussed in Part A Capacity Development Project, reduction volume of leakage is significant by pilot activities while NRW ratio could not be reduced to satisfactory level.

For example, in K1, NRW amount reduced by a series of activities to less than 1/3 of original, from 1,095 m^3/day to 290 m^3/day and water loss by leakage is reduced to about 1/5 of original, from 900 m^3/day to 187 m^3/day. The activities include leakage detection and repair, abandon of CI pipes and bundle pipe replacement.
However NRW ratio is reduced from 84% to 50% and NRW (leakage volume) increase drastically in a short period after leakage repair. It is assumed that water pressure increase by repair of leakage will cause other leakage at weak points. There are lots of weak points in the system. This situation will not be improved without replacement of distribution pipes and house connections.
The fact proofs that this kind of area is high priority for pipe replacement.

- PVC pipes are relatively good condition in the system. However it is recommended to replace PVC pipes together with CI pipes in order to reduce NRW and create DMAs with following reasons:
  - Information of PVC installed under houses is not always available.
  - Lots of leakage are found from PVC
  - Existing PVC pipe give connection to unknown pipes
  - Illegal connection will be taken from existing PVC pipes.
  - There are lots of unknown interconnection of PVC pipes
  - It takes very long time to detect these unknown pipes and connections.
-

B5.2.2 Major Activities to Be Executed

- Among the activities for poor condition areas similar to Kotahena, action for "Storage tanks (sumps)" will be the first priority. Reduction of water loss at the storage tanks (sumps) will be

the most urgent and effective works.

- It is also effective to execute the other actions listed below in order to reduce leakage volume while waiting for pipe replacement.
  - Active Leakage control
  - Replacement of long house connections (in accordance with manual)
  - Leak Repair record
  - Eliminate all pipes under houses.
- It is found that combination of “Active leakage control” and “appropriate replacement of long house connection” is much effective in the poor condition area.

B5.3 Required Equipment

Required equipment for the recommended activities is listed below.

- Leak Detection and measurement
  - Listening Stick
  - Electric Listening Bar
  - Water Leak Detector
  - Metal pipe Locator
  - Valve Locator
  - Leak Noise Correlator
  - Hammer Drill, Drill Bit
  - Boring Bar
  - Drainage Pump
  - Generator
  - Ultrasonic flow meter
  - Digital Water Pressure Logger
  - Valves
  - Van/ Crew CABs
- Leakage Repair
  - PC & Printer for OIC office
  - Camera for EAs
  - JCB (Backhoe)
  - Van/ Crew CABs
  - Boom truck
  - Pipe material for repair work
  - Heavy duty Backhoe in AE’s office,
  - Boon trucks in each manager’s office

The vehicle fleet needs to be in good condition with reduction of time spent in garage for repairs. Replacement is required on regular interval.

B5.4 Cost and Benefit

Table B5-2 shows required cost versus benefit in a sub-zone with a scale of 5,000 connections.

Details are available in Supporting Report.

Table B5-2 Required Cost vs. Benefit in a Sub-zone (5,000 Connections)

	Required Cost per 5,000 Connections *1) *2)			Benefit per 5,000 Connections			
	Cost per 1,250 Connections (LKR) For 1st & 2nd Activities		Cost (LKR/y)	Saved Real Loss per 5,000 Connections (m3/d) *3)	Saved Real Loss per 5,000 Connections (m3/y, compensated) 4)	Unit Rate for Water (LKR/m3) *5)	Benefit (LKR/y)
Borella-simillar Area	964,063	4	3,856,252	1,886.0	311,191.2	24	7,468,589
Kotahena-simillar Area	1,257,615	4	5,030,460	1,855.4	166,988.4	24	4,007,721

Following conditions are considered in the above calculation:

*1): Including labour and material for leak detection and repair for 1st and 2nd activities

*2): Supposed to conduct leak detection and repair once a year

*3): Based on data obtained through Pilot Activities

*4): Compensated value considering rebound of leakage with the assumption that:

- Rebound rate for leakage for Borella-similar area:
  10% of saved water in the first month will decrease every month and go back to original status after 11 months
- Rebound rate for leakage for Kotahena-similar area:
  20% of saved water in the first month will decrease every month and go back to original status after 6 months

*5): Unit amount (LKR) per water loss (m^3) specified by NWSDB for cost vs. benefit calculation.

In Kotahena similar area, Benefit is relatively small. However if the leak detection/repair activities are executed together with replacement of bundle pipe/long service connection in appropriated manner, benefit will be significantly increased due to increase of leakage reduction and decrease of rebound rate.

Chapter B6 Improvement of GIS

B6.1 GIS for Planning and Ordinal O&M

When pipe replacement/installation are executed, GIS shall be improved for the new system by accommodating the information of As-built Drawings. The improved GIS will be useful for modeling of hydraulic analysis and DMA system. The targeted pipes will be relatively larger size.

On the other hand, GIS shall be improved especially for ordinal O&M. For the purpose, it is required to continue GIS creation activities done in PA of the Project. The targeted pipes will be relatively small size.

This execution plan will focus on the later type of GIS for ordinal O&M, while both types shall be prepared on the same GIS base, but may be different layer.

B6.2 Improvement / Updating of GIS for O&M

GIS is improved and/or updated in Pilot Areas by the Project. Continuous activities are recommended to cover the entire CMC in the following manner.

c) Update of Base Map: Information of Satellite Image will be used to update GIS base map.
d) Improvement of Base Map: Information of small paths shall be added by locating with GPS.
e) Update of pipeline information: Existing drawing data shall be updated whenever data is available
f) Valve location; Valves cannot be located when they are covered with road surface. The location shall be identified and recorded by both tie-measurement and also by GPS whenever they are found by excavation or detected.
g) Related storage tanks: Location and other information of storage tanks (sumps) before customer meter shall be recorded in GIS if the locations are not rectified.
h) Priority connection/ house connection: The location shall be recorded in GPS by using survey data and GPS data. Customer data shall be synchronized to the location. It will be desirable to synchronize the data automatically but it is also good to use CD or other media for the purposes.
i) Leak repair record: Leak repair record shall be prepared and recorded with the location marked in GPS.

B6.3 Updating GIS Data as Ordinal O&M Activities

GIS data is recommended to be updated as daily O&M activities in the following three steps.

(1) Step 1: Data Collection through daily O&M activities by Zone officers and OICs

New information of pipes and apparatus such as valves will be collected by excavation for repair works and detection of pipe location. It is also required to collect data and information available at offices such as record of previous project. In addition, information shall be collected by hearing from experienced officer and residents. These kinds of information shall be given to the officer in charge at Maligakanda Office through AEs after confirmation.

(2) Step 2: Improvement / Updating of GIS database at Maligakanda Office
The officer in charge at Maligakanda Office shall be responsible for improvement / Updating the GIS database with assistance of a GIS operator. The information shall be given to Mapping section.

(3) Step 3: Mapping Section check and update GIS
Mapping section will check the GIS database updated by Maligakanda Office and then improve GIS.

Similar updating system to the above is already introduced by NWSDB but not practically used. The project has given training of Step 1 and Step 2 in Pilot Area. There are discussion of decentralization and development of the system at Regional Support Center level.
In either case, the activities of Step 1 and Step 2 shall be improved and disseminated to entire area of CMC.

It is noted that the discovered valves shall be located by using GPS as well as using tie-measurement in order to find them after they are covered by road surfacing.

B6.4 Utilization of GIS for O&M

Existing GIS is not used for daily O&M activities. However GIS is prepared for usage. GIS can be up-dated adequately when they are used. Utilization method of GIS includes below:

a) Respond to customer complain quickly by showing the location on maps
b) Find frequent leaked pipes
c) Find covered valve location at site
d) Identify operable valves
e) Locate continuous “fixed-rate” consumption for survey
f) Arrange illegal connection survey by finding suspicious connections
g) Recommend meter reading routes
h) Update maps and compile/search information easily

For the utilization of GIS, all the OIC office shall be equipped with a PC with AutoCAD Map software and a A3 printer. Drawings of adequate size shall be printed out whenever zone officers requires for the site works.

B6.5 Required Input for Preparation of GIS for entire Colombo City

Required input for Preparation of GIS, consisting of “Base map preparation (continuation) for entire Colombo”, “Locating of Meter locations (consumers) on the base map”, and “Preparation of final GIS database” are estimated.
The following activities are required of preparation of GIS:

a) Image Digitizing (Base map preparation)
b) Field data collection using GPS (Locating small roads and important locations)
c) Field data collection (Consumer data)
d) Data entering to the database by GIS staff / Computer operator
e) Other data collection using GPS (Valves, Free water outlets etc)
f) Field Verification (Data gaps and incorrect records)

Required inputs for the above activities are estimated based on the experience of Pilot activities as shown in Table B6-1.

Table B6-1 Required Input for GIS Preparation

Required personnel	*Option 1*	*Option 2*
GIS supervisor/Analyst	94	45
GIS operator	222	75
GPS Field officer	242	14
Field officer	6	137
Helper (Field)	485	154
Driver	249	151
Data entry operator	0	30
Meter reader (NWSDB)	6	6

Note Option 1: When continue the same methodology used in the pilot areas
Option 2: When proposed methodology (simplify field data collection without GPS) is applied.

The input of the MM is large and it is not practical for NWSDB to increase the staff for the purposes. Therefore it is recommended to out sourcing and complete the preparation within at most one and a half year to start usage at an early stage.
Details are discussed in Supporting Report.

Chapter B7 PR Activities

B7.1 Activities Executed by the Project

The major purposes of PR activities executed by the Project are as follows.

- Internal PR to NWSDB
  - To encourage the staffs executing NRW in Pilot Areas
  - To disseminate the activities to other NWSDB staff who would be potentially engaged in NRW activities in Colombo City
- PR to public
  - To make the residents understand the Project
  - To reduce unauthorized consumption
  - To make customers to inform leakage to NWSDB
  - To conserve water from free water outlets

The activities and effects are summarized in Table B7-1.

Table B7-1 Effects of PR activities

No	Activities	Effect
1	Handbill, pen	· Distribution of handbill and pen can encourage the interest, draw attention to understand the Project and obtain cooperation by the customer. .
2	DVD	· DVD was prepared and will be used in school and others to inform importance of NRW activities to improve the services.
3	Poster & Calendar	· Students draw poster, which are also developed as calendar · Display of the poster and calendar in public space can encourage customers to save water and no illegal action. Preparation of drawings for poster has encouraged the students to understand importance of water.
4	School Activities	· PR officer give presentation and students draw their understanding. · Students can obtain knowledge of negative impacts of leakage, illegal connection, and wastage. · It is expected that students educate their parents.
5	Cap, T-shirt	· NWSDB does not have uniform. Customers can easily recognize as NWSDB workers by the caps and T-shirts and workers can work easily. · Caps and T-shirts improve a sense of solidarity among NWSDB staffs.
6	Seminar	· Staff can share the findings and experiences to reduce NRW effectively. · Presentation of the finding encourage the staffs engaged to the Project

B7.2 Current Activities

NWSDB is now executing the similar activities mainly to appeal water conservation. Major activities are as follows.

a) School children awareness program
b) Office awareness program
c) Print and electronic media communication and publicity
d) Posters and Hand bill campaign

PR activities by the Project have contributed to improvement of these activities.

B7.3 Future Activities

Customers do not aware that police may take action to illegal activities such as unauthorized connections. It is illegal to change service pipe by consumer even for repair purpose. However customers are now arranging service pipes without hesitation. The situation will cause increase of leakage and new unauthorized connection. PR activities are very important for residents to stop this custom.

In addition to continuation of the current activities, following activities will be executed.

a) Discuss the purpose of PR activities for each action
b) Utilize the video prepared by the Project for the School children /office awareness program and others.
c) Improve and utilize handbill, poster and calendar
d) Prepare uniform for field staff
e) Prepare manual for notification of water suspension to the customers

In addition, it will be useful if PR activity specialist for water works authorities introduce the new PR methods or recommend NWSDB for further improvement.

Chapter B8 Organizational Improvement

B8.1 Current Approach on Organizational Improvement

Current approach on organization improvement is under execution following the idea of "A Strategic Approach for None Revenue Water Reduction in Colombo Metropolitan Region of National Water Supply & Drainage Board". For improvement of human resources, "revision of incentive" and "expansion of trainings" are indicated to be important. In addition, "attitude changing program" will be required.

B8.2 Required Additional Input

Following additional input of teams will be required to execute the recommended activities.

(1) GIS preparation
It is recommended to prepare GIS by out-sourcing considering required input and period. However if it is prepared by NWSDB, large input by GIS preparation team will be required.

(2) Updating of GIS data
At Maligakanda office, at least one Engineer who is responsible for GIS data updating and one GIS operator for input the data are required. Organizational improvement of mapping section is also required.

(3) Teams for customer survey if meter readers cannot handle it.

(4) Leak Repair Record
One officer is required for each OIC office for issuing "Repair order sheet" and input data to "Leak repair record" database including locating the leak points on GIS.
This task will be drastically reduced after replacement of pipes and then other office may take the position as a additional job.

(5) Leak Detection Teams
Required member of one team of Leak Detection Team:

- - One EA
- - Three labors
- - One vehicle with driver

One team will be able to detect one zone officer area of about 5000 connections in about 6 months.(* see the Note below).

If one Leakage Team is assigned to one OIC, leak detection in the OIC area will be finished in about one and a half (1.5) years. Zone officer is expected to attend repair of all leakage without delay and will be difficult to execute leakage detection if the organization and duties of zone officers remain same.

However, the required input for leakage detection will be decreased drastically after pipe replacement/ rehabilitation and each zone officer is expected to execute leakage detection and repair in his zone.

It might be better for the same team to execute leakage detection and repair at one time. Even in this case, all the leakage shall be reported to Call Center following leakage record system.

Annex -6 Execution Plan

* Note: Leakage Detection by one team

Activities	Anticipated speed	Required day-team
Acoustic survey:	80 connections/team/day	63
Pinpoint:	2km / team / day	20-40
Confirmation Survey	10 locations /team/day	14-18 (Borella), 36-50 (Kotahena)

Chapter B9 Action Plan

The activities to be executed are summarized as Table B9-1.

Table B9-1 Summary of Activities to Be Executed

Item	*Contents*	*Description*
Unbilled Authorized Consumption (Free Water Outlets)	Community formation	Enhance the current activities
Unauthorized Consumption	Investigation	Improve random base checking by using customer data
Metering Error	Education to Meter readers	Revision of the tasks and training
Real Losses	Leakage Detection	Continuation of the pilot activities with some modification
	Leakage Repair / Recording	Continuation of the pilot activities with some modification
	Bundle pipe replacement	Replacement of bundle pipe by using / following the manual.
	Storage tanks/ sumps	List up and measure water loss volume to make clear the seriousness of the problem.
GIS for O&M	Preparation	Continuation of the pilot activities with some modification
	Usage	Usage of GIS especially by O&M field staff
PR activities	Improvement of current activities	Introduction of new idea such as school curriculum and manual for notification of water suspension.
Water Act	Study required Amendment	Recommendation on amendment such as improvement of illegal connections

Recommended Urgent Action Plan, which includes key tasks, responsible organization ant the time frame, is shown in Table B9-2.

Table B9-2 Recommended Urgent Action Plan

Actions required	Organisation responsible	20012	2013											2014											2015										
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1) Leakage Detection																																								
Traininig and Supervision	NWSDB (NRW+OM) & External Consultants																																							
Set up of Leak Detection Teams and training	NWSDB(NRW) & External Consultants																																							
Procurement of Tools/ Equipment	NWSDB & External Consultants																																							
Leak Detection ZO area 1	NWSDB(NRW, OM) & Contractors &																																							
Leak Detection ZO area 2																																								
Leak Detection ZO area 3																																								
2) Leakage Repair / Recording																																								
Set up Leakage Record System	NWSDB (OIC Office) & External Consultants																																							
Procurement of Tools/ Equipment	NWSDB (NRW, OM) & External Consultants																																							
Leakage Repair	NWSDB (OIC office)																																							
3) Bundle Pipe Replacement																																								
Traininig (Mannual methods)	NWSDB(OIC) & External Consultants																																							
Execution of Bundle pipe replacement / Supervision	NWSDB(OIC Office) & Contractor																																							
4) Storage Tank / Sumps																																								
Collection of Information	NWSDB (OM) & External Consultants																																							
Installation of meters and comparison with customer data	NWSDB (OM) & External Consultants																																							

Actions required	Organisation responsible	20012	2013											2014											2015										
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
5) GIS Preparation																																								
Updating of exisiting Base Map / Field Data Collection (Small roads using GPS)	NWSDB(OM, NRW) & External Consultants																																							
Field Data Collection (Customer Data w/o GPS)																																								
Field Data Collection (Others with GPS)																																								
Data Input (Customer data and others)																																								
Preparation of Field Database																																								
Procurement of Tools/ Equipment																																								
Updating of GIS	NWSDB (Maligakanda)																																							
Training of GIS Usage	NWSDB (O&M) & External Consultants																																							

Actions required	Organisation responsible	20012	2013											2014											2015										
		10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
6) Unbilled Authorized																																								
Community creation for standpost	NWSDB & NGO																																							
7) Unauthorized Connection																																								
Customer Survey	NWSDB(Meter reader) & External Consultants																																							
Selection of house to be surveyed	NWSDB (NRW unit) & External Consultants																																							
Illegal connection survey & Legalization	NWSD (NRW unit)																																							
8) PR activities																																								
Upgrading PR activities	NWSDB & External Consultants																																							
9) Training to Meter Readers																																								
Revision of tasks and training to Meter Readers	NWSDB & External Consultants																																							
10) Amendment of Water Act																																								
Recommendation on the amendment	NWSDB & External Consultants																																							

Chapter B10 Evaluation and Monitoring of Implementation

It is recommended to organize an evaluation and monitoring committee.
The committee shall monitor the activities and evaluate the performance.
Periodical water audit will be also useful.

NRW cannot be measured by execution of the activities until the area is isolated and inflow is measured. Evaluation of the implementation will be done considering the following:

- NRW ratio reduction in entire Colombo City
- Decrease of water inflow to entire Colombo City
- Increase of water consumption in the area where actions are taken
- Increase of water pressure and improvement of customer satisfaction in the above area
- The number and size of leakage repaired in the above area
  - (Leakage at service pipe/ 100 connections)
  - (Leakage at distribution pipe / km)
- Decrease of minimum night flow in the above area or entire Colombo city
- The reduction of NRW volume in entire Colombo City

Among the above, "reduction of NRW volume" will be the suitable methods to evaluate the effects of the activities,

When 8 teams are assigned and execute leakage detection and each OIC repair the leakage found quickly, leakage in 16 zone officer's areas out of total 22 will be reduced in a year, since each team will investigate the zone officer area of about 5,000 connections in 6 months.

If 8 zone officers in Borella-similar-area and 8 in Kotahena-similar-area are assigned, reduction volume of NRW will be estimated about 3,800,000 m^3/year as follows:

Borella-similar area:	311,000 x 8 =	2,488,000
Kotahena-similar-area:	167,000 x 8 =	1,336,000
	Total	3,824,000

It shall be noted that when bundle pipe replacement is done especially in the Kotahena area, the reduction volume will become much larger than Borella-similar-area.

Chapter B11 Other Recommendations

B11.1 Other Recommendations on O&M improvement

Previous sections of Execution Plan discuss the several improvement methods of O&M for reduction of NRW based on the finding through the Capacity Development Project. In addition to this, recommendations for O&M improvement other than finding through the Project are listed below:

- Competition for the NRW reduction activities among each zone
- Introduce License / qualification for plumbing (house connection)
- Encouragement of Quick attendance to leakage information (ex. In addition to "Leak Repair Recording system")
- Revision of Role of Meter Reader and education

Revised (new) Tasks of Meter Readers will be following:

- Customer relation – Appeal "Call 1939"
- Read master meter and child meter
- Read public standpost reading
- Find and Inform visible leakage to OIC
- Customer survey (House to house survey)

Requirement for the improvement of meter reader's Activities will be:

- Education / Training
- Uniform
- Rewarding (Giving recommendation)
- Re-consideration of the position

B11.2 Recommendation on system improvement program

In addition to recommendation for O&M improvement, followings are recommended for system improvement based on finding of the Capacity Development Project:

- All of existing PVC pipes to be replaced (especially for isolation at boundary area) as discussed in sub-section "B5.2.1 Pilot Area Activities". If problematic PVC is to be replaced, these pipes shall be found from experience of filed officers and findings from the similar activities executed in the pilot areas
- Preparation and execution of Standard for Service Connection
- The standard shall include:
  - Meter Location to be shifted for easy reading and shortening service pipe length
  - House connection to be branched from nearest point of distribution pipe
  - Record sheet (including sketch) of house connection to be prepared / filled

B11.3 Recommendation on Revision of Water Act

It is useful to improve the current Water Act by giving power on inspection of illegal connection. At the moment, NWSDB cannot take proper action for illegal inspection when customers refuse to allow it.

Annex - 7

Cost and Benefit
for
Leak Detection and Repair

Table of Contents

1 Required Cost for NRW Reduction Activities 1
2 Water Saving by NRW Reduction Activities 8
2.1 Water Saving per Day 8
2.2 Water Saving per Year 9
3 Water Saving by NRW Reduction Activities 9
4 Cost versus Benefit of Leak Detection/Repair plus Replacement of Bundle Pipe 10

List of Figures & Tables

Figures:

No Figures

Tables:

Table 1-1 Unit Cost Employed in Cost Estimate for NRW Reduction Activities 1
Table 1-2 Average Number of Leakage 1
Table 1-3 Cost Estimate for NRW Reduction Activities for Borella-similar Area (1/3) 2
Table 1-4 Cost Estimate for NRW Reduction Activities for Borella-similar Area (2/3) 3
Table 1-5 Cost Estimate for NRW Reduction Activities for Borella-similar Area (3/3) 4
Table 1-6 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (1/3) 5
Table 1-7 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (2/3) 6
Table 1-8 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (3/3) 7
Table 1-9 Summary of Cost (by NWSDB, for 1,250 houses) 8
Table 1-10 Summary of Cost (by private sector, for 1,250 houses) 8
Table 2-1 Water Saving for Real Loss 9
Table 2-2 Total Amount of Saved Water per Year 9
Table 3-1 Required Cost vs. Benefit in a Sub-zone (5,000 Connections) 10
Table 4-1 Cost versus Benefit for Leak Detection and Repair 11

1 Required Cost for NRW Reduction Activities

Required cost for conducting NRW reduction activities related to leak detection and repair is estimated on the basis of the followings unit cost show in Table 1-1.

Table 1-1 Unit Cost Employed in Cost Estimate for NRW Reduction Activities

Code	Work Item	Unit Rate		Remarks	Source
LB	Labour	1,500.00	LKR/day		Interview from NRW Section
OF	Officer	2,500.00	LKR/day		Interview from NRW Section
JC	JCB	2,500.00	LKR/hour		Interview from NRW Section
VH	Vehicle	3,500.00	LKR/day	Including fuel/insurance/driver	Interview from NRW Section
CH	Chamber	40,000.00	LKR/piece	for 1,350 mm x 1,250 mm x 1,000 mm	Interview from NRW Section
VA	Valve	21,000.00	LKR/piece	= [16,800 (4") + 25,200 (6")] / 2	NWSDB Rate Book (2011)
CO	Coupling (for isolation or meter chamber or main leak repair)	5,100.00	LKR/piece	≒ [4,372 (4") + 5,829 (6")] / 2	NWSDB Rate Book (2011)
PI-1	Pipe piece (for isolation or meter chamber or main leak repair)	3,072.00	LKR/piece	≒ [2,459 (4") + 3,686 (6")] / 2	NWSDB Rate Book (2011)
PI-2	Pipe piece (for service pipe leak repair)	108.00	LKR/piece	= LKR27/m (1/2") x 4m (1 piece of straight pipe)	NWSDB Rate Book (2011)
MT	Meter	1,900.00	LKR/piece	Including accessories. In case NWSDB staff do installation work by themselves	NWSDB Rate Book (2011)
RD	Charge by RDA/CMC	6,250.00	LKR/m2	≒ [8,500 (RDA) + 4,000 (CMC)] / 2	Interview from NRW Section

In this cost estimation, average number of leakages are employed with reference to the result obtained through Pilot Activities.

Table 1-2 Average Number of Leakage

Kotahena-similar Area			*Avg. for 1,250 houses (Kotahena-similar area)*	
Connection			*Setting Value*	
Leakage	*Prm. Act*	*Main*	Main:	5
		Service	Service:	172
	2nd Act	*Main*	Main:	2
		Service	Service:	61

Borella-similar Area			*Avg. for 1,250 houses (Borella-similar area)*	
Connection			*Setting Value*	
Leakage	*Prm. Act*	*Main*	Main:	5
		Service	Service:	63
	2nd Act	*Main*	Main:	2
		Service	Service:	20

Possible work items and its cost for Borella-similar area, with an equivalent scale of 1,250 connections, are presented in Table 1-3, Table 1-4 and Table 1-5. Similarly, the ones for Kotahena-similar area are presented in Table 1-6, Table 1-7 and Table 1-8.

Annex -7 Cost and Benefit for Leak Detection and Repair

Table 1-3 Cost Estimate for NRW Reduction Activities for Borella-similar Area (1/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Borella)													
Work Item						*Code*	*Nos*		*Unit Rate*		*Subtotal 1*	*Subtotal 2*	*Remarks*
1	*sub zone selection*												
	1-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	1-2	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												6,000.0	
2	*Isolation*												
	2-1	*Identifying boundary valve (locating)*											
		2-1-1	Officer			OF	0.33	Man-day	2,500.0	LKR/day	825.0		
		2-1-2	Labour			LB	1.00	Man-day	1,500.0	LKR/day	1,500.0		
		2-1-3	Vehicle			VH	0.33	Car-day	3,500.0	LKR/day	1,155.0		
	2-2	*Expose buried boundary valves*											(average 1 valves to be exposed)
		2-2-1	Officer			OF	0.33	Man-day	2,500.0	LKR/day	825.0		
		2-2-2	Labour			LB	1.00	Man-day	1,500.0	LKR/day	1,500.0		
		2-2-3	Vehicle			VH	0.33	Car-day	3,500.0	LKR/day	1,155.0		
	2-3	*Isolation*											
		2-3-1	*Installation of new valve*										
			2-3-1-1	Officer		OF	1.00	Man-day	2,500.0	LKR/day	2,500.0		
			2-3-1-2	Labour		LB	3.00	Man-day	1,500.0	LKR/day	4,500.0		
			2-3-1-3	Vehicle		VH	1.00	Car-day	3,500.0	LKR/day	3,500.0		
			2-3-1-4	Valves		VA	1.00	Pieces	21,000.0	LKR/piece	21,000.0		
			2-3-1-5	Coupling (for isolation or meter chamber or main leak repair)		CO	2.00	Pieces	5,100.0	LKR/piece	10,200.0		
			2-3-1-6	Pipe piece (for isolation or meter chamber or main leak repair)		PI-1	1.00	Pieces	3,072.0	LKR/piece	3,072.0		
			2-3-1-7	JCB		JC	5.00	Hours	2,500.0	LKR/hour	12,500.0		assumed 5 hours/valve
			2-3-1-8	Charge for road reinstatement by RDA/CMC		RD	2.50	m2	6,250.0	LKR/m2	15,625.0		assumed 2.5 m2/vavle x 1 valves
		2-3-2	*Confirmation of Isolation & Boundary*										
			2-3-2-1	Officer		OF	0.50	Man-day	2,500.0	LKR/day	1,250.0		
			2-3-2-2	Labour		LB	1.50	Man-day	1,500.0	LKR/day	2,250.0		
			2-3-2-3	Vehicle		VH	0.50	Car-day	3,500.0	LKR/day	1,750.0		
												85,107.0	
3	*Installation of chambers*												
	3-1	*Meter chamber installation work*											
		3-1-1	Officer			OF	0.33	Man-day	2,500.0	LKR/day	825.0		
		3-1-2	Labour			LB	1.00	Man-day	1,500.0	LKR/day	1,500.0		
		3-1-3	Vehicle			VH	0.33	Car-day	3,500.0	LKR/day	1,155.0		
	3-2	Meter chamber				CH	1.00	Pieces	40,000.0	LKR/piece	40,000.0		
	3-3	Coupling				CO	2.00	Pieces	5,100.0	LKR/piece	10,200.0		
	3-4	Pipe piece (for isolation or meter chamber or main leak repair)				PI-1	1.00	Pieces	3,072.0	LKR/piece	3,072.0		
	3-5	JCB				JC	6.66	Hours	2,500.0	LKR/hour	16,650.0		
	3-6	Charge for road reinstatement by RDA/CMC				RD	2.00	m2	6,250.0	LKR/m2	12,500.0		* Assumed 2.0 m2 (1.5 m2 x 1 sites. * Site is proximity to the valve just after meter.)
												85,902.0	
5	*Initial flow measurements*												Security
	5-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	5-2	Labour				LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
	5-3	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												10,500.0	

Table 1-4 Cost Estimate for NRW Reduction Activities for Borella-similar Area (2/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Borella)														
		Work Item				*Code*	*Nos*		*Unit Rate*		*Subtotal 1*	*Subtotal 2*	*Remarks*
	6	***Establish initial NRW***											
		6-1	Officer			OF	4.0	Man-day	2,500.0	LKR/day	10,000.0		
												10,000.0	
	7	***Leak survey***											
mon	***7-1***	***Acoustic survey***											* Assumed 80 houses/day/officer for 1,250 houses on condition that meter reader will do this work
		7-1-1	Officer			OF	16.0	Man-day	2,500.0	LKR/day	40,000.0		* 1,250 houses / 80 houses/day/officer = 15.7 day/officer
		7-1-2	Labour			LB	48.0	Man-day	1,500.0	LKR/day	72,000.0		
		7-1-3	Vehicle			VH	16.0	Car-day	3,500.0	LKR/day	56,000.0		
mon	***7-2***	***Pinpoint survey***											* 10 km of total pipe length for 1,250 connections
		7-1-1	Officer			OF	5.0	Man-day	2,500.0	LKR/day	12,500.0		* Assumed 2km/officer/night
		7-1-2	Labour			LB	15.0	Man-day	1,500.0	LKR/day	22,500.0		
		7-1-3	Vehicle			VH	5.0	Car-day	3,500.0	LKR/day	17,500.0		
ific	***7-3***	***Confirmation survey***											* 68 leaks for 1,250 houses * Assumed 50% to be visible and balance 50% to be subject to confirmation survey
		7-2-1	Officer			OF	3.5	Man-day	2,500.0	LKR/day	8,750.0		* 10 leaks per officer per day for confirmation survey * ie; 68 x 50% / 10 = 1.7 days
		7-2-2	Labour			LB	10.5	Man-day	1,500.0	LKR/day	15,750.0		
		7-2-3	Vehicle			VH	3.5	Car-day	3,500.0	LKR/day	12,250.0		
												257,250.0	
	8	***Leak repairing work***											* 68 leaks for 1,250 houses (5 for main and 63 for service)
		8-1	Officer			OF	8.5	Man-day	2,500.0	LKR/day	21,250.0		* 3 main leaks can be repaired per day * 10 service leaks can be repaired per day
		8-2	Labour			LB	25.5	Man-day	1,500.0	LKR/day	38,250.0		
		8-3	Vehicle			VH	8.5	Car-day	3,500.0	LKR/day	29,750.0		
		8-4	Coupling (for isolation or meter chamber or main leak repair)			CO	10.0	Pieces	5,100.0	LKR/piece	51,000.0		* 2 couplings for 1 main leak
		8-5	Pipe piece (for isolation or meter chamber or main leak repair)			PI-1	2.0	Pieces	3,072.0	LKR/piece	6,144.0		* 4 leaks per 1 piece of DCIP straight pipe (6m/piece) * ie; 5 leak /4 = 1.25 piece
		8-6	Pipe piece (for service pipe leak repair)			PI-2	8.0	Pieces	108.0	LKR/piece	864.0		* 8 leaks per 1 piece of PVC straight pipe (4m/piece) * ie; 63 leaks/8 = 7.875 pieces
		8-7	JCB			JC	25.0	Hours	2,500.0	LKR/hour	62,500.0		* 5 hours per 1 main leak
		8-8	Charge for road reinstatement by RDA/CMC			RD	14.0	m2	6,250.0	LKR/m2	87,500.0		* 2.00 m2/leak for main pipe leak x 5 leaks * 0.25 m2/leak for service leak x 12.6 (20% of 63 service leak will be within CMC (RDA) limit) * ie; 2.00 x 5 + 0.25 x 12.6 = 13.6 m2
												297,258.0	
	9	***Recording leak record into database***											
		9-1	Officer			OF	2.0	Man-day	2,500.0	LKR/day	5,000.0		
												5,000.0	
	10	***Flow measurement***											
		10-1	Officer			OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
		10-2	Labour			LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
		10-3	Vehicle			VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												10,500.0	
	11	***Establish Interim NRW***											
		11-1	Officer			OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
												2,500.0	

Table 1-5 Cost Estimate for NRW Reduction Activities for Borella-similar Area (3/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Borella)														
		Work Item				*Code*		*Nos*		*Unit Rate*		*Subtotal 1*	*Subtotal 2*	*Remarks*
12	*Further Leak Detection for 2nd activities*													* 22 of further leaks for 1,250 houses (2 for main and 20 for service)
mon	*12-1*	*Pinpoint survey*												* 10 km of total pipe length for 1,250 connections
		12-1-1	Officer			OF	5.0	Man-day	2,500.0	LKR/day	12,500.0		* Assumed 2km/officer/night
		12-1-2	Labour			LB	15.0	Man-day	1,500.0	LKR/day	22,500.0		
		12-1-3	Vehicle			VH	5.0	Car-day	3,500.0	LKR/day	17,500.0		
ific	*12-2*	*Confirmation survey*												* Assumed 50% to be visible and balance 50% to be subject to confirmation survey
		12-2-1	Officer			OF	1.5	Man-day	2,500.0	LKR/day	3,750.0		* 10 leaks per officer per day for confirmation survey * ie; 22 x 50% / 10 = 1.1 days
		12-2-2	Labour			LB	4.5	Man-day	1,500.0	LKR/day	6,750.0		
		12-2-3	Vehicle			VH	1.5	Car-day	3,500.0	LKR/day	5,250.0		
												68,250.0		
13	*Further Leak repairing work for 2nd activities*													
	13-1	Officer				OF	3.0	Man-day	2,500.0	LKR/day	7,500.0		* 3 main leaks can be repaired per day * 10 service leaks can be repaired per day
	13-2	Labour				LB	9.0	Man-day	1,500.0	LKR/day	13,500.0		
	13-3	Vehicle				VH	3.0	Car-day	3,500.0	LKR/day	10,500.0		
	13-4	Coupling (for isolation or meter chamber or main leak repair)				CO	4.0	Pieces	5,100.0	LKR/piece	20,400.0		* 2 couplings for 1 main leak
	13-5	Pipe piece (for isolation or meter chamber or main leak repair)				PI-1	1.0	Pieces	3,072.0	LKR/piece	3,072.0		* 4 leaks per 1 piece of DCIP straight pipe (6m/piece) * ie; 2 leak /4 = 0.5 piece
	13-6	Pipe piece (for service pipe leak repair)				PI-2	3.0	Pieces	108.0	LKR/piece	324.0		* 8 leaks per 1 piece of PVC straight pipe (4m/piece) * ie; 20 leaks/8 = 2.5 pieces
	13-7	JCB				JC	10.0	Hours	2,500.0	LKR/hour	25,000.0		* 5 hours per 1 main leak
	13-8	Charge for road reinstatement by RDA/CMC				RD	5.0	m2	6,250.0	LKR/m2	31,250.0		* 2.00 m2/leak for main pipe leak x 2 leak * 0.25 m2/leak for service leak x 4 (20% of 20 service leak will be within CMC (RDA) limit) * ie; 2.00 x 2 + 0.25 x 4 = 5 m2
													111,546.0	
14	*Recording leak record into database*													
	14-1	Recording into database				OF	1.0		2,500.0	LKR/day	2,500.0			
													2,500.0	
15	*flow measurement*													
	15-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0			
	15-2	Labour				LB	3.0	Man-day	1,500.0	LKR/day	4,500.0			
	15-3	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0			
													10,500.0	
16	*Establish final NRW*													
	16-1	Officer				OF	0.5	Man-day	2,500.0	LKR/day	1,250.0			
													1,250.0	

Annex -7 Cost and Benefit for Leak Detection and Repair

Table 1-6 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (1/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Kotahena)														
					Work Item	Code	Nos		Unit Rate		Subtotal 1	Subtotal 2	Remarks
1	sub zone selection												
	1-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	1-2	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												6,000.0	
2	Isolation												
	2-1	Identifying boundary valve (locating)											
		2-1-1	Officer			OF	0.3	Man-day	2,500.0	LKR/day	825.0		
		2-1-2	Labour			LB	1.0	Man-day	1,500.0	LKR/day	1,500.0		
		2-1-3	Vehicle			VH	0.3	Car-day	3,500.0	LKR/day	1,155.0		
	2-2	Expose buried boundary valves											(average 1 valves to be exposed)
		2-2-1	Officer			OF	0.3	Man-day	2,500.0	LKR/day	825.0		
		2-2-2	Labour			LB	1.0	Man-day	1,500.0	LKR/day	1,500.0		
		2-2-3	Vehicle			VH	0.3	Car-day	3,500.0	LKR/day	1,155.0		
	2-3	Isolation											
		2-3-1	Installation of new valve										
			2-3-1-1	Officer		OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
			2-3-1-2	Labour		LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
			2-3-1-3	Vehicle		VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
			2-3-1-4	Valves		VA	1.0	Pieces	21,000.0	LKR/piece	21,000.0		
			2-3-1-5	Coupling (for isolation or meter chamber or main leak repair)		CO	2.0	Pieces	5,100.0	LKR/piece	10,200.0		
			2-3-1-6	Pipe piece (for isolation or meter chamber or main leak repair)		PI-1	1.0	Pieces	3,072.0	LKR/piece	3,072.0		
			2-3-1-7	JCB		JC	5.0	Hours	2,500.0	LKR/hour	12,500.0		assumed 5 hours/valve
			2-3-1-8	Charge for road reinstatement by RDA/CMC		RD	2.5	m2	6,250.0	LKR/m2	15,625.0		assumed 2.5 m2/vavle x 1 valves
		2-3-2	Confirmation of Isolation & Boundary										
			2-3-2-1	Officer		OF	0.5	Man-day	2,500.0	LKR/day	1,250.0		
			2-3-2-2	Labour		LB	1.5	Man-day	1,500.0	LKR/day	2,250.0		
			2-3-2-3	Vehicle		VH	0.5	Car-day	3,500.0	LKR/day	1,750.0		
												85,107.0	
3	Installation of chambers												
	3-1	Meter chamber installation work											
		3-1-1	Officer			OF	0.3	Man-day	2,500.0	LKR/day	825.0		
		3-1-2	Labour			LB	1.0	Man-day	1,500.0	LKR/day	1,500.0		
		3-1-3	Vehicle			VH	0.3	Car-day	3,500.0	LKR/day	1,155.0		
	3-2	Meter chamber				CH	1.0	Pieces	40,000.0	LKR/piece	40,000.0		
	3-3	Coupling				CO	2.0	Pieces	5,100.0	LKR/piece	10,200.0		
	3-4	Pipe piece (for isolation or meter chamber or main leak repair)				PI-1	1.0	Pieces	3,072.0	LKR/piece	3,072.0		
	3-5	JCB				JC	6.7	Hours	2,500.0	LKR/hour	16,650.0		
	3-6	Charge for road reinstatement by RDA/CMC				RD	2.0	m2	6,250.0	LKR/m2	12,500.0		* Assumed 2.0 m2 (1.5 m2 x 1 sites. * Site is proximity to the valve just after meter.)
												85,902.0	
5	Initial flow measurements												Security
	5-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	5-2	Labour				LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
	5-3	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												10,500.0	

Annex -7 Cost and Benefit for Leak Detection and Repair

Table 1-7 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (2/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Kotahena)														
		Work Item				*Code*	*Nos*		*Unit Rate*		*Subtotal 1*	*Subtotal 2*	*Remarks*
6	*Establish initial NRW*												
	6-1	Officer				OF	4.0	Man-day	2,500.0	LKR/day	10,000.0		
												10,000.0	
7	*Leak survey*												
mon	*7-1*	*Acoustic survey*											* Assumed 80 houses/day/officer for 1,250 houses on condition that meter reader will do this work
		7-1-1	Officer			OF	16.0	Man-day	2,500.0	LKR/day	40,000.0		* 1,250 houses / 80 houses/day/officer = 15.7 day/officer
		7-1-2	Labour			LB	48.0	Man-day	1,500.0	LKR/day	72,000.0		
		7-1-3	Vehicle			VH	16.0	Car-day	3,500.0	LKR/day	56,000.0		
mon	*7-2*	*Pinpoint survey*											* 10 km of total pipe length for 1,250 connections
		7-1-1	Officer			OF	5.0	Man-day	2,500.0	LKR/day	12,500.0		* Assumed 2km/officer/night
		7-1-2	Labour			LB	15.0	Man-day	1,500.0	LKR/day	22,500.0		
		7-1-3	Vehicle			VH	5.0	Car-day	3,500.0	LKR/day	17,500.0		
ific	*7-3*	*Confirmation survey*											* 177 leaks for 1,250 houses * Assumed 50% to be visible and balance 50% to be subject to confirmation survey
		7-2-1	Officer			OF	9.0	Man-day	2,500.0	LKR/day	22,500.0		* 10 leaks per officer per day for confirmation survey * ie; 177 x 50% / 10 = 8.85 days
		7-2-2	Labour			LB	27.0	Man-day	1,500.0	LKR/day	40,500.0		
		7-2-3	Vehicle			VH	9.0	Car-day	3,500.0	LKR/day	31,500.0		
												315,000.0	
8	*Leak repairing work*												* 177 leaks for 1,250 houses (5 for main and 172 for service)
	8-1	Officer				OF	19.5	Man-day	2,500.0	LKR/day	48,750.0		* 3 main leaks can be repaired per day * 10 service leaks can be repaired per day
	8-2	Labour				LB	58.5	Man-day	1,500.0	LKR/day	87,750.0		
	8-3	Vehicle				VH	19.5	Car-day	3,500.0	LKR/day	68,250.0		
	8-4	Coupling (for isolation or meter chamber or main leak repair)				CO	10.0	Pieces	5,100.0	LKR/piece	51,000.0		* 2 couplings for 1 main leak
	8-5	Pipe piece (for isolation or meter chamber or main leak repair)				PI-1	2.0	Pieces	3,072.0	LKR/piece	6,144.0		* 4 leaks per 1 piece of DCIP straight pipe (6m/piece) * ie; 5 leak /4 = 1.25 piece
	8-6	Pipe piece (for service pipe leak repair)				PI-2	22.0	Pieces	108.0	LKR/piece	2,376.0		* 8 leaks per 1 piece of PVC straight pipe (4m/piece) * ie; 172 leaks/8 = 21.5 pieces
	8-7	JCB				JC	25.0	Hours	2,500.0	LKR/hour	62,500.0		* 5 hours per 1 main leak
	8-8	Charge for road reinstatement by RDA/CMC				RD	19.0	m2	6,250.0	LKR/m2	118,750.0		* 2.00 m2/leak for main pipe leak x 5 leaks * 0.25 m2/leak for service leak x 34.4 (20% of 172 service leak will be within CMC (RDA) limit) * ie; 2.00 x 5 + 0.25 x 34.4 = 18.6 m2
												445,520.0	
9	*Recording leak record into database*												
	9-1	Officer				OF	2.0	Man-day	2,500.0	LKR/day	5,000.0		
												5,000.0	
10	*Flow measurement*												
	10-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	10-2	Labour				LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
	10-3	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												10,500.0	
11	*Establish Interim NRW*												
	11-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
												2,500.0	

Table 1-8 Cost Estimate for NRW Reduction Activities for Kotahena-similar Area (3/3)

Estimation for work input for subzone near 1,250 houses (this area with approx. 1,250 houses assumed to have a sample zones) ---- (for Kotahena)														
		Work Item				Code	Nos		Unit Rate		Subtotal 1	Subtotal 2	Remarks
12	Further Leak Detection for 2nd activities												* 63 of further leaks for 1,250 houses (2 for main and 61for service)
mon	12-1	Pinpoint survey											* 10 km of total pipe length for 1,250 connections
		12-1-1	Officer			OF	5.0	Man-day	2,500.0	LKR/day	12,500.0		* Assumed 2km/officer/night
		12-1-2	Labour			LB	15.0	Man-day	1,500.0	LKR/day	22,500.0		
		12-1-3	Vehicle			VH	5.0	Car-day	3,500.0	LKR/day	17,500.0		
ific	12-2	Confirmation survey											* Assumed 50% to be visible and balance 50% to be subject to confirmation survey
		12-2-1	Officer			OF	3.5	Man-day	2,500.0	LKR/day	8,750.0		* 10 leaks per officer per day for confirmation survey * ie; 63 x 50% / 10 = 3.15 days
		12-2-2	Labour			LB	10.5	Man-day	1,500.0	LKR/day	15,750.0		
		12-2-3	Vehicle			VH	3.5	Car-day	3,500.0	LKR/day	12,250.0		
												89,250.0	
13	Further Leak repairing work for 2nd activities												
	13-1	Officer				OF	7.5	Man-day	2,500.0	LKR/day	18,750.0		* 3 main leaks can be repaired per day * 10 service leaks can be repaired per day
	13-2	Labour				LB	22.5	Man-day	1,500.0	LKR/day	33,750.0		
	13-3	Vehicle				VH	7.5	Car-day	3,500.0	LKR/day	26,250.0		
	13-4	Coupling (for isolation or meter chamber or main leak repair)				CO	4.0	Pieces	5,100.0	LKR/piece	20,400.0		* 2 couplings for 1 main leak
	13-5	Pipe piece (for isolation or meter chamber or main leak repair)				PI-1	1.0	Pieces	3,072.0	LKR/piece	3,072.0		* 4 leaks per 1 piece of DCIP straight pipe (6m/piece) * ie; 2 leak /4 = 0.5 piece
	13-6	Pipe piece (for service pipe leak repair)				PI-2	8.0	Pieces	108.0	LKR/piece	864.0		* 8 leaks per 1 piece of PVC straight pipe (4m/piece) * ie; 61 leaks/8 = 7.625 pieces
	13-7	JCB				JC	10.0	Hours	2,500.0	LKR/hour	25,000.0		* 5 hours per 1 main leak
	13-8	Charge for road reinstatement by RDA/CMC				RD	8.0	m2	6,250.0	LKR/m2	50,000.0		* 2.00 m2/leak for main pipe leak x 2 leak * 0.25 m2/leak for service leak x 13 (20% of 61 service leak will be within CMC (RDA) limit) * ie; 2.00 x 2 + 0.25 x 13 = 7.25 m2
												178,086.0	
14	Recording leak record into database												
	14-1	Recording into database				OF	1.0		2,500.0	LKR/day	2,500.0		
												2,500.0	
15	flow measurement												
	15-1	Officer				OF	1.0	Man-day	2,500.0	LKR/day	2,500.0		
	15-2	Labour				LB	3.0	Man-day	1,500.0	LKR/day	4,500.0		
	15-3	Vehicle				VH	1.0	Car-day	3,500.0	LKR/day	3,500.0		
												10,500.0	
16	Establish final NRW												
	16-1	Officer				OF	0.5	Man-day	2,500.0	LKR/day	1,250.0		
												1,250.0	

The above table can be summarized as Table 1-9.

Table 1-9 Summary of Cost (by NWSDB, for 1,250 houses)

Cost (LKR per 1,250 houses)								
B-similar					*K-similar*			
964,063	Detection:	325,500			1,257,615	Detection:	404,250	
	Sample zone activities & repair:	638,563	Sample:	222,259		Sample zone activities & repair:	853,365	Sample: 222,259
			Repair:	416,304				Repair: 631,106

In case the above works could be entrusted to private sector, required timeframe may be shortened. In this case, required cost may be summarized as Table 1-10.

Table 1-10 Summary of Cost (by private sector, for 1,250 houses)

Cost (LKR per 1,250 houses)								
B-similar					*K-similar*			
1,422,978	Detection:	589,000			1,912,030	Detection:	731,500	
	Sample zone activities & repair:	833,978	Sample:	304,924		Sample zone activities & repair:	1,180,530	Sample: 304,924
			Repair:	529,054				Repair: 875,606

Note:
Unit cost for officer: assumed to be 3 times of NWSDB.
Unit cost for vehicle: assumed to be 2 times of NWSDB.

2 Water Saving by NRW Reduction Activities

2.1 Water Saving per Day

Water saving per day in terms of real loss is estimated based on the result obtained through the Pilot Activities as shown in Table 2-1.

Table 2-1 Water Saving for Real Loss

Saved Real Loss in Borella-similar Area

	Real Loss (m3/d)		Reduction of Real Loss (m3/d)	Nos of Connection	Remarks (as of 2/Oct/2012)
	Before	After			
B1	211.5	96.5	115.0	584	Result before step test.
B2			319.0	624	Real loss estimated thru number of leakage.
B3					This area is housing estate. Excluded from calculation as this sub-zone has special characteristics.
B4-FF	185.1	46.0	139.1	162	
B6	646.8	281.8	365.0	1,117	
B7					Sample zone. Leak repair underway.
B8					Leak repair completed. Waiting for measurement after leak repair.
B10					Sample zone. Excluded from calculation due to massive loss within police quarters.
	1,043.4	*424.3*	*938.1*	*2,487*	
For 5,000 connections			*1,886.0*		

Saved Real Loss in Kotahena-similar Area

	Real Loss (m3/d)		Reduction of Real Loss (m3/d)	Nos of Connection	Remarks (as of 2/Oct/2012)
	Before	After			
K1	899.8	565.0	334.8	397	Result before bundle pipe replacement.
K2	748.0	470.0	278.0	426	
K3&K4	2,844.7	2,621.1	223.6	1,383	
K5					Sample zone. Primary Act completed. Waiting for measurement. Real loss estimated as 128 m3/d thru number of leakage. Nos of connection is not yet confirmed.
K6					Waiting for completion of pipe replacement work. Measurement will be done after transfering service pipes to new line.
K7					Sample zone. Primary Act completed. Waiting for flow measurement.
K8					Sample zone. Leak survey (confirmation survey) underway
K9					Sample zone. Leak detection completed. Waiting for flow
K10					Sample zone. Leak survey (confirmation survey) underway
B4-MGZ	193.8	103.6	90.2	291	
B5					Leak detection completed. Leak repair underway. Waiting for flow measurement after leak repair.
B9					Leak detection completed. Leak repair underway. Waiting for flow measurement after leak repair.
	4,686.3	*3,759.7*	*926.6*	*2,497*	
For 5,000 connections			*1,855.4*		

Note: Based on the result as of 2/Oct/2012.

2.2 Water Saving per Year

Water saving per month for the first month after repair is calculated simply by multiplying the saving amount per month by 30 days.

- Borella-similar area: 1,886.0 m^3/day x 30 days = 56,580 m^3/month
- Kotahena-similar area: 1,855.4 m^3/day x 30 days = 55,663 m^3/month

The amount of water saving per year is then estimated, so that saving water per month would gradually decrease as time goes by, considering rebound of leakage after repairing. The result of calculation is shown in Table 2-2.

Table 2-2 Total Amount of Saved Water per Year

	Amount of Saved Water (m3/month, compensated value)												Total Saved Water (m3/y)
	1	2	3	4	5	6	7	8	9	10	11	12	
B-similar	56,580	50,922	45,264	39,606	33,948	28,290	22,632	16,974	11,316	5,658	0	0	**311,191**
K-similar	55,663	44,530	33,398	22,265	11,133	0	0	0	0	0	0	0	**166,988**

↑ NRW Reduction Activities

Rebound Rate for Leakage	for B-similar	10%
	for K-similar	20%

3 Water Saving by NRW Reduction Activities

Supported by the estimations discussed in the previous section, required cost and benefit is calculated.

Table 3-1 shows required cost versus benefit in a sub-zone with a scale of 5,000 connections.

Table 3-1 Required Cost vs. Benefit in a Sub-zone (5,000 Connections)

	Required Cost per 5,000 Connections *1) *2)			Benefit per 5,000 Connections			
	Cost per 1,250 Connections (LKR) For 1st & 2nd Activities		Cost (LKR/y)	Saved Real Loss per 5,000 Connections (m3/d) *3)	(m3/y, compensated) *4)	Unit Rate for Water (LKR/m3) *5)	Benefit (LKR/y)
Borella-simillar Area	964,063	4	3,856,252	1,886.0	311,191.2	24	7,468,589
Kotahena-simillar Area	1,257,615	4	5,030,460	1,855.4	166,988.4	24	4,007,721

Following conditions are considered in the above calculation:

*1): Including labour and material for leak detection and repair for 1st and 2nd activities

*2): Supposed to conduct leak detection and repair once a year

*3): Based on data obtained through Pilot Activities

*4): Compensated value considering rebound of leakage with the assumption that:

- Rebound rate for leakage for Borella-similar area:
  10% of saved water in the first month will decrease every month and go back to original status after 11 months
- Rebound rate for leakage for Kotahena-similar area:
  20% of saved water in the first month will decrease every month and go back to original status after 6 months

*5): Unit amount (LKR) per water loss (m^3) specified by NWSDB for cost vs. benefit calculation.

4 Cost versus Benefit of Leak Detection/Repair plus Replacement of Bundle Pipe

According to the above result, cost exceeds the benefit in Kotahena-similar area. In case that leak detection/repair activities would be conducted together with replacement of bundle pipe/long service connection in appropriate manner in Kotahena-similar Area, more benefit should be obtained because leakage can be reduced more and rebound after leak repair could be moderated.

Cost required for leak detection and repair and its benefit were calculated and compared under the Project's activities. Table 4-1 summarizes the result of the analysis.

Table 4-1 Cost versus Benefit for Leak Detection and Repair

	Cost (yen)	Benefit (Yen)				
		Saved Real Loss per 5,000 Connections		Unit Rate for Water (Yen/m3)	Benefit per 5000 Connections (Yen/y)	Benefit (Yen/y)
		m3/d Initial	m3/y Compensated			
Borella-similar Area	26,036,642	1,886	311,191	14.7312	4,584,220	50,426,417
Kotahena-similar Area	79,999,660	4,861	802,141	14.7312	11,816,500	129,981,504
Total	***106,036,302***					***180,407,921***

- Cost including leak detection/repair plus bundle pipe replacement
- Unit rate of NWSDB
- LKR 1 = ¥ 0.6138

- Rebound rate of leakage:
  - ✓ Borella-similar Area ➔ 10%/month: assumed that leakage volume goes back to the original status in 11 months after completion of leak repair
  - ✓ Kotahena-similar Area ➔ 10%/month: assumed to follow similar trend as Borella-similar area after leak repair work plus bundle pipe replacement

Following conditions/assumptions were employed in this calculation.

- Work to be done:
  - Borella-similar area: only leak detection and repair.
  - Kotahena-similar area: leak detection and repair plus bundle/long pipe cutting and converting to proper service pipe.
- Leak detection/repair: to be repeated twice.
- Number of leakage to be repaired and required work volume: based on the result obtained through activities in PA.
- Unit cost for labour and material: referred to "NWSDB Rate Book (2011)" and interview with NWSDB staff.
- Unit amount per water loss: based on information given by NWSDB for cost versus benefit calculation.
- Rebound rate of leakage: 10 %
- Cost for bundle pipe work: assumed to be approximately 46 million. This value is based on assumption without concrete base.
- Number of Borella- and Kotahena-similar area in entire Colombo City: 11 zones each (5,000 connections per one zone). Colombo City is divided into 22 zone officer's areas.

The analysis for cost versus benefit for leak detection and repair in entire Colombo City demonstrates that:

- Cost: approximately 106 million Yen
- Benefit: approximately 180 million Yen

According to the analysis, benefit for leak detection and repair exceeded the cost. Although this trial calculation is based on many assumptions, implementing leak detection and repair work would be significant in reduction of NRW in Colombo City.

Annex - 8

Minutes of Joint Coordination Committee

MINUTES OF MEETING
ON
THE FIRST JOINT COORDINATING COMMITTE MEETING
FOR
THE CAPACITY DEVELOPMENT PROJECT
FOR NON REVENUE WATER (NRW) REDUCTION
IN COLOMBO CITY
BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
AND
NATIONAL WATER SUPPLY AND DRAINAGE BOARD (NWSDB)

The Japan International Cooperation Agency (hereinafter referred to as "JICA") and the authorities concerned of the Government of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GOSL") including the National Water Supply and Drainage Board (hereinafter referred to as "NWSDB") exchanged the Record of Discussions (hereinafter referred to as the "R/D") and the Minutes of the Meetings (hereinafter referred to as the "M/M") on Japanese Technical Cooperation for the Capacity Development Project for Non Revenue Water (NRW) Reduction in Colombo City (hereinafter referred to as "the Project") on 22 April, 2009. Based on R/D and M/M, the first Joint Coordination Committee (hereinafter referred to as "JCC") to discuss the contents of the Inception Report (hereinafter referred to as "IC/R") on the Project was held on 24 November, 2009, chaired by Eng. K.L.L.Premanath, General Manager of NWSDB. Those who attended the meeting are listed in "Annex-1" attached hereto.

The JICA Expert Team (hereinafter referred to as "JET) explained the main contents of the IC/R, work plan/schedule and expected outputs and indices. GOSL side agreed the contents of the IC/R with some comments. The main points to have been discussed, comments and agreements reached during the meeting are as in the document attached hereto.

Colombo on 25 November 2009

Mr. Shinkichi Kobayashi
Chief Advisor
JICA Expert Team

Eng. K.L.L.Premanath
General Manager
National Water Supply and Drainage Board
Sri Lanka

Witnessed by:

Mr. Kazuya Suzuki
Director
Environmental Management Division 1
Environmental Management Group
Global Environment Department
Japan International Cooperation Agency

The Attached Document

1. Project Design Matrix

It is decided by JCC to update Project Design Matrix (PDM) as mentioned in the IC/R from its original version attached to the R/D. Revised points are the "Duration of the Project" and the "Input of Japanese Personnel". The revised PDM is shown in Annex-2.

2. Regular Meetings

As agreed after discussion on the IC/R, NWSDB will convene the regular meetings and appoint the chairpersons who are in charge of holding the meetings and preparation of each meeting memorandum in English, during entire period of the Project as follows.

Meeting	*Chaired by*
Weekly Meetings for the "NRW Reduction Team" and JET"	Manager (Operation and Maintenance)
Bi-Weekly Meetings for the "NRW Reduction Management Team" and JET	Deputy General Manager (Western-Central)
Monthly Progress Meetings among the "NRW Reduction Management Team", "NRW Reduction Team", Senior Officers of NWSDB, JET and other Organizations Concerned.	Additional General Manager (Western)

3. Confirmation on Budget Allocation

It is confirmed that the Sri Lankan side allocates necessary budget according to the R/D and the M/M to ensure effective implementation of the Project.

NWSDB ensures that the budget for customs duties/tax, fees for customs clearance, storage and inland transportation etc. to be incurred in relation to import or procurement of the equipment provided by JICA, is available from the allocation made by the Department of National Budget. Meanwhile the budget for NRW section and O&M section will be used for the other activities.

4. Members of JCC

The member of JCC is confirmed as below.

(1) Sri Lankan members:

- General Manager (*Project Head*), NWSDB as chair person of JCC
- Additional General Manager-Western (*Project Director*), NWSDB
- Additional General Manager-P&P, NWSDB
- Additional General Manager-W-S, NWSDB
- Deputy General Manager-Western Central (*Project Manager*), NWSDB
- Project Director of KGWSP
- Assistant General Manager for Development, Regional Support Center (Western-Central), NWSDB
- Assistant General Manager for NRW Reduction, Regional Support Center (Western-Central), NWSDB
- Assistant General Manager for O&M, Regional Support Center (Western-Central), NWSDB
- Assistant General Manager –JPU, NWSDB

- Director, Japan Division, External Resources Department, Ministry of Finance and Planning
- Director, National Planning Department, Ministry of Finance and Planning (to be nominated)
- Assistant Director (P&M) from Ministry of Water Supply and Drainage (to be nominated)
- JICA Expert for NWSDB (Water and Sanitation Sector Advisor)
- Others invited by the members

(2) Japanese members:

- Experts for the Project
- Representatives of Japan Embassy in Sri Lanka
- Representatives of JICA Sri Lankan Office
- JICA mission and others dispatched by JICA

It is agreed that JCC meeting will be held, but not limited to every six months, to execute the functions as described in R/D.

5. **Pilot Areas**

It is confirmed that two (2) pilot areas will be established in Borella area and Kotahena area in Colombo City, and that the Project shall identify their exact locations and boundaries by the end of December 2009.

It is also confirmed that the pipes to be installed by KGWSP as rider mains along both sides of Bloemendhal Road and Srimath Ramanathan Mawatha-Aluth Mawatha Road, shall not be changed. Project Director of KGWSP will control the timing of pipe installation to coordinate the timing of the Pilot Project.

6. **Members of NRW Reduction Management Team and NRW Reduction Team for each Pilot Area**

The members of NRW Reduction Management Team and NRW Reduction Team for each Pilot Area are confirmed as below:

NWSDB Executive

(1) Project Head: General Manager
(2) Project Director: Additional. General Manager (Western)
(3) Project Manager: Deputy General Manager (Western-Central)

NRW Reduction Management Team in Western-Central Office

(1) Assistant General Manager (NRW)
(2) Assistant General Manager (O&M)
(3) Assistant General Manager (Development)
(4) Manager (NRW)
(5) Manager (O&M)
(6) Manager (Development)
(7) Area Engineers

NRW Reduction Team for each pilot area in AE Office and/or OIC Office

(1) Area Engineer
(2) Engineer (Development Colombo City)
(3) Officer in Charge
(4) 3 Task Teams (each team will execute all tasks for "Leak detection", "Pipe repair", "Detection of illegal connection" and "Randiya Project").
(5) Tasks of "Mapping and sub-zoning preparation" and "De-scaling of pipeline" are to be undertaken by other groups under direction of the Engineer (Development Colombo City).
(6) Tasks of "Meter reading and commercial activities" are to be undertaken by other groups under direction of each Area Engineer

7. Machinery and Equipment to be Procured by JICA

After discussion on the equipment listed in the IC/R and the R/D, NWSDB requested and JICA agreed following equipment to be procured by JICA. NWSDB promised to take necessary measures and cost for import, storage and inland transportation etc. to be incurred in relation to import or procurement of the equipment.

Machinery and Equipment agreed in R/D

- Valves for isolating pilot areas (φ100-200mm) 60
- Portable ultrasonic flow meters with compatible sensors to different diameters 10
- Data loggers with pressure inducers 8
- Pipe detectors (metal) 4
- Pipe detectors (non-metal) 3
- Acoustic rods (Listening bars) - digital type 5
- Electronic leak detectors 5
- Correlation leak detectors (Correlators or equivalent) with necessary accessories 2
- Plastic customer meter assembly 200
- Lap top computers 2
- Crew CABs (Double cabin trucks) 2
- Pickup trucks 2
- Micro excavators 2

Other Equipment requested by NWSDB for the Project

- Metal locator (Valve locator) 5
- Listening stick 6
- Boring bar 2
- Drill bit 30
- Hammer drill 2
- Pressure gauge for house connection 6
- Generator 2
- Projector 1

8. Acceptance of Inception Report

The IC/R is accepted by the JCC with following revisions:

1) 3.2 Assignment Schedule of JET (Page 5)
Following sentence shall be added.
"The schedule will be modified to suite the situation."

2), 4.2.2 Basic Policy 2: Enhancement of Project Management based on PDCA Cycle
(1) STEP 1 Plan (Page 10).
Following sentence shall be added.
"Alternative methods would be suggested for implementation and the most suitable method will be selected after discussion between JET and NWSDB. The target will be set after execution of NRW reduction activities in the initial sub-zone for the purpose of evaluating the activities and the methods employed."

9. Other Issues

9.1 DGM (W/C) mentioned that NWSDB has a target of reducing NRW in Colombo City from 52.7% to 32%. General Manager requested the JICA Expert Team (JET) whether JET has any set overall target to reduce NRW within the project period. The Team Leader mentioned that at present JET has no set target as this Technical Cooperation Project is to develop the capacity of NWSDB staff and the achievement of NRW reduction depends on several factors, which include replacement of aged pipes and capability of staff. However, effects of NRW reduction by the project will be found in the course of the project activities. Target setting for NRW reduction will be discussed again in the 2nd JCC meeting.

* Addl. General Manager (Western) mentioned that NWSDB allocates funds, every year to reduce the NRW in Colombo City.

9.2 Mr. W.A.D.S. Gunasinghe, Director questioned that the capacity development project is to be implemented utilizing the existing O&M staff, without any additional staff and how it is practicable.

* AGM (NRW) answered that the capacity development project will be the on the job training programme and JET will advice and guide the NWSDB staff.

9.3 AGM (O&M – W/C) questioned that whether the pilot project can be extended to additional two zones. JET mentioned that they mainly want to concentrate only on the two pilot project zones for developing staff capacities efficiently. But General Manager mentioned that O&M section can commence the activities in other zones in parallel.

9.4 General Manager instructed NWSDB staff to submit concept paper and cabinet paper for this project.

9.5 Further, AGM (O&M – W/C) mentioned that in Kotahena pilot zone where pipes are to be replaced, the present NRW to be established before commencing the pipe replacement enable to compare the results.

9.6 General Manager (NWSDB) questioned about the availability of required O&M and NRW staff for Colombo City.

* DGM (W/C) mentioned that technical staff are available and few non technical staff and two office buildings are required.

* General Manager (NWSDB) mentioned that we have to evaluate the NRW reduction with the availability of entire staff.

10. 2nd JCC Meeting

2nd JCC meeting will be held in May 2010. The details will be informed by NWSDB later.

Annex-1: List of Participants

Annex-2: Project Design Matrix (Revised on 25 November, 2009)

Annex-1

List of Participants

【Sri Lankan side】

Eng. K.L.L. Premanath	General Manager, NWSDB as chair person of JCC
Eng. S.K. Wijethunga	Additional General Manager - Western, NWSDB
Eng. Mrs. P.N.S. Yapa	Deputy General Manager - Western Central (Project Manager), NWSDB
Eng. K.W. Premasiri	Assistant General Manager for Development, Regional Support Center (Western-Central), NWSDB
Eng. S.G.G. Rajkumar	Assistant General Manager for NRW Reduction, Regional Support Center (Western-Central), NWSDB
Eng. S.A. Rasheed	Assistant General Manager for O&M, Regional Support Center (Western-Central), NWSDB
Eng. M.M. Umar Lebbe	Assistant General Manager –JPU, NWSDB
Ms. S.A. Batagoda	Assistant Director, Japan Division, External Resources Department, Ministry of Finance and Planning
Mr. W.A.D.S. Gunasinghe	Director, National Planning Department, Ministry of Finance and Planning
Ms. D.A.S. Dahanayake	Assistant Director (Planning & Monitoring), Planning & Monitoring Division, Ministry of Water Supply and Drainage
Ms. C.N. Kumari	Planning Assistant, Ministry of Water Supply and Drainage
Mr. Yoshiki Omura	JICA Advisor

【Japanese side】

JICA Mission

Mr. Kazuya Suzuki	Mission Leader
Ms. Akiko Kawata	Cooperation Planning

JICA Sri Lanka Office

Ms. Manjuri Adikaram	Project Specialist

JICA Expert Team

Mr. Shinkichi Kobayashi	Chief Advisor
Mr. Tetsuji Kawamura	JICA Expert
Mr. Hiroki Niimura	JICA Expert

Annex-2

Project Design Matrix

Project title: Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka
Duration: November 2009-October 2012
Target Area: Colombo City, Sri Lanka
Target Group: Officers and staff of NWSDB (Western-Central Division)
Date:

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The NRW ratio in Colombo city is reduced.	1 NRW reduction activities are comprehensively conducted by 22 zone offices in CMC area in accordance with the execution plan. 2 Decrement of NRW ratio per annum in CMC area exceeds one (1) percentage point up to 2017.	1 Annual report of NWSDB 2 Record of NRW ratio	
Project Purpose NWSDB's capacity to implement NRW reduction activities in Colombo city is strengthened.	1 Number of NRW reduction activity records will increase compared to what was before the Project. 2 The budget to be allocated for NRW reduction will increase compared to what was before the Project. 3 An execution plan to achieve reduction of NRW ratio by one (1) percentage point per annum, as per the Goal 2.1 of "Corporate Plan 2007-2011", is prepared and incorporated into relevant plans/programs of NWSDB.	1 Annual report of NWSDB	1 NWSDB secures the budget for scaling-up of the NRW activities. 2 Necessary equipment such as pipes, saddles and meters are provided by NWSDB. 3 Over-aged pipes in selected zone of CMC area are replaced.
Outputs 1 Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced. 2 Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	1.1 An annual program for NRW reduction in the pilot area is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years). 1.2 NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget etc.) as planned. 1.3 NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams". 2.1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan. 2.2 NWSDB officers/staff engaged in "NRW reduction Teams" acquire proper leak detection, plumbing and pipe repairing skills. 2.3 An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.	1.1 Annual report of NWSDB 1.2 Project record, Quarterly progress report 1.3 Project record, Quarterly progress report, training materials 2.1 Project record, Quarterly progress report 2.2 Project record, Quarterly progress report 2.3 Project record, Quarterly progress report	1 Officers and staff trained by the project will continue with NRW activities of NWSDB.

Activities	Inputs		
	Japan	Sri Lanka	
1-1 Organize a "NRW Reduction Management Team" at Western-Central Regional Support Center. 1-2 Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region". 1-3 Prepare an annual program of NRW reduction activities for the pilot areas*. 1-4 Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams". 1-5 Assess progress of NRW reduction activities in the pilot areas. 1-6 Review the annual program of NRW reduction activities based on the feedback/lessons learnt in the pilot areas and prepare the program for the following year. 1-7 Evaluate activities in the pilot areas through out the Project period and prepare an "execution plan" to apply the Project outcome to entire area Colombo city 2-1 Select two (2) pilot areas. 2-2 Organize "NRW Reduction Team (a group of OIC**, EA** and gangs***)" at the pilot areas. 2-3 Review and modify pipeline network drawings of the pilot areas. 2-4 Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio. 2-5 Prepare a NRW reduction work plan for each pilot area incorporating leak detection, pipe repairing, plumbing and activities for the reduction of non-physical losses****. 2-6 Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team". 2-7 Implement NRW reduction activities according to the work plan. 2-8 Measure results of NRW reduction team's work (NRW ratio etc.) and provide feedback to "NRW Reduction Management Team" for revision of the annual program.	1. Personnel Chief Advisor /NRW reduction programming Deputy Chief Advisor /NRW reduction monitoring and evaluation Leak detection Advisor Arrangement of pipeline drawing and customer data Service pipe connection advisor Coordinator 2. Equipment Leak detector Pipe locator Portable ultrasonic flow meter Vehicle, etc. 3. Overseas Training Overseas Training for NWSDB counterpart personnel	1. Personnel Project Head Project Director Project Manager Counterpart personnel for - "NRW Reduction Management Team" - "NRW Reduction Team" 2. Facilities Office space, furniture and facility. 3. Local cost Cost for the isolation of pilot project areas (including installation of chambers for flow meters) Pipe-repairing Cost Cost for road opening/reinstatement Project management Cost 4. Others	Pre-conditions 1 NWSDB secures the budget for implementation of the NRW activities at pilot areas. 2 Recruitment of personnel to be assigned to the pilot areas is completed.

*: Pilot area corresponds to jurisdiction of "zone officer" (Approx. 5,000 connection). The pilot area will be divided into smaller blocks (Approx. 500 connections) to conduct the program.

**: Proposed positions in "Strategic-Approach for Non-Revenue Water Reduction in Colombo Metropolitan Region" (Feb.2008)

***: A work unit which is composed of plumber, labor etc.

****: Activities for non-physical losses reduction include measures against illegal connections and bypass connections, replacement of defective customer meters and estimated billing.

Capacity Development Project for NRW Reduction in Colombo City

Minutes of the Second Joint Coordinating Committee Meeting

Date: 31st May 2010
Place: Conference Room at the Head Office of NWSDB
Time: 2.00 pm - 3:45 p.m.

Attendance

Mr. Karunasena Hettiarachchi	Chairman, NWSDB
Mr. K.L.L.Premanath	GM, NWSDB
Mr. S.K. Wijethunga	Addl. GM (W), NWSDB
Mr. D.N.J. Ferdinando	Addl. GM (P&P), NWSDB
Mr. M.M. Umar Lebbe	AGM (JPU), NWSDB
Mr. S.G.G. Rajkumar	AGM (NRW), NWSDB
Mrs. M.A.C. Hemachandra	AGM (W), NWSDB
Ms. S.A.Batagoda	Asst. Director, ERD
Ms. D.A.S. Dahanayake	AD (P&M), MWS&D
Mr. Arinda Elapata	Project Specialist, JICA
Mr. Yoshiki Omura	JICA Advisor
Mr. Sinkichi Kobayashi	Team Leader, JET
Mr. Akihiko Okazaki	Specialist, JET

With the attendance of Mr. Karunasena Hettiarachchi, the new Chairman of NWSDB, meeting was opened.

Mr. K.L.L.Premanath, GM, chair person of JCC, made an opening address and gave a brief explanation on the scope of the project, which is a grant by JICA. It was also explained that this is the second meeting of JCC which is decided to meet every six months.

Mr. S.G.G. Rajkumar, AGM (NRW) gave presentation on the physical work done. In the presentation he informed a two week delay at Kotehena and a three week delay at Borella due to difficulties in human resources, vehicles, road permits and approvals from the Municipal Council, PSD, Traffic Police and the weather. He also informed that the activities in other sub zones were commenced in order to overcome the delays.

Mr. S. Kobayashi, Team Leader of JET, explained the contents and major issues of the Progress Report 1.

The major comments and discussions are as follows:

1. Mr. Karunasena Hettiarachchi, Chairman of NWSDB, expressed that the benefits from this pilot project should go to the other areas, where work should be done in parallel to this project.

Through this project, it is necessary to train officers who will be able to provide training to other local staffs. He also mentioned that cooperation from consumers is a very importance issue for NRW reduction. He requested to consider the activities to educate consumers and make them as active participants. He further stated that NRW reduction activities should be executed in other areas by using the ideas, findings, and knowledge of the Project. Local funding could also be made available for the activities if necessary. He stressed the importance of having NWDB's own program and a Task Force to reduce NRW in the country. The priority activities shall be found/identified during the course of this project.

2. Mr. D.N.J. Ferdinando, Addl. GM (P&P) expressed the view that the methods employed for the pilot project targeting 500 customers cannot be directly applied to the other areas because it requires large resource input such as manpower and vehicles. It is recommended to work out more suitable methods for a large single area of, for example, 5000 customers. Rules to repair visible leakage in a certain period will also be useful.

   GM mentioned that this pilot project is to develop capacity of staffs on NRW reduction and to identify suitable methods throughout the pilot activities. In order to find suitable methods for execution of NRW reduction activities in not only the project area but in entire Colombo city , finding in the pilot activities will be useful. It is expected that JET will work together with NWSDB to find the suitable methods for NRW reduction in Colombo city.

3. In response to the question on updating of the pipeline drawings, Mr. Rajkumar, AGM (NRW), stated that the existing drawings are difficult to incorporate the newly obtained information such as locating valves. Therefore it is necessary to update the maps by using the GIS systems. GIS is available in Mapping Section and it is needed to train O&M section staff by using the equipment. However, the utilization of GIS system is not included in the scope of this project.

4. Mr. Arinda Elapata, Project Specialist, JICA, posed the questions regarding the ownership of the project and the disseminating of information gathered from this project.

   Mr. Rajkumar, AGM (NRW), responded that the Zonal Offices under each Area Engineer are given the responsibility of continuing the process in reducing NRW. He also mentioned that weekly meetings are held for the two pilot areas that are located under Area Engineer East and North. The Area Engineers South and West are also attending the weekly meeting and have commenced the NRW process in parallel to the pilot project. He thanked JET for the support.

5. Mr. S.K.Wijetunga, Addl. GM, mentioned the importance of reducing internal leakages and wastages in the houses. Together with NRW reduction, it is necessary to consider suitable methods for reducing the leakages/wastage.

The third JCC meeting will be held at 2.00 pm on 1st November 2010 at the Conference Room of the Head Office of NWSDB

3nd JCC

Capacity Development Project for NRW Reduction in Colombo City

Minutes of the Third Joint Coordinating Committee Meeting

Date: 30th November 2010
Place: Conference Room at the Head Office of NWSDB
Time: 2.30 pm - 3:45 p.m.

Attendance

Mr. K.L.L.Premanath	GM, NWSDB
Mr. S.K. Wijethunga	Addl. GM (W), NWSDB
Mr. B.W.R. Balasuriya	Addl. GM (WSP) NWSDB
Mr. W.B.G.Fernando	DGM – (W/C), NWSDB
Mr. K.W. Premasiri	AGM – (W/C – Development), NWSDB
Mr. M.M. Umar Lebbe	AGM (JPU), NWSDB
Mr. S.G.G. Rajkumar	AGM (NRW), NWSDB
Mr. S.A. Rasheeed	AGM (W/C – O&M), NWSDB
Ms. C.J.D. Perera	PD (KGWSP), NWSDB
Mr. Arinda Elapata	Project Specialist, JICA Sri Lanka Office
Mr. Sinkichi Kobayashi	Team Leader, JET
Mr. Akihiko Okazaki	Expert, JET

Mr. K.L.L.Premanath, GM, chair person of JCC, made an opening address and commenced the "Third JCC'.

The GM briefly explained the importance of this project for the capacity development of NRW for implementation by NWSDB

After confirmation of the minutes of the "Second JCC", the GM requested JICA to address the meeting.

Mr. Arinda Elepata, Project Specialist, JICA Sri Lanka Office, informed that they were interested to know, how much of the plan has been fulfilled.

Mr. S.G.G. Rajkumar, AGM (NRW), made a presentation on the physical work done. In the presentation he informed the methodology adopted in implementing the project and the benefit derived by the NWSDB staff by way of training and experience.

Mr. S. Kobayashi, Team Leader of JET, explained the progress of the Project described in Progress Report 2. He highlighted the steps taken and the results of NRW reduction in some areas.

The major comments and discussions are as follows:

1. Mr. W.B.G. Fernando, DGM-(W/C) noted that several NRW studies were done earlier on the same basis as this project but proper NRW reduction activities have not been implemented due

to lack of resources. He stressed that additional resources shall be allocated for actual work. The studies of the previous NRW projects were not implemented.

GM explained that this project is different from the previous projects. This project is executed for capacity building of the NWSDB's staff on NRW reduction.

2. Mr. S.A.Rasheed, AGM – (W/C – O&M) said that a lot of work is done under this project and it will be advisable to replace pipes where it is found to be necessary in order to complete the work for the respective zones.

   He also informed it is important to find most effective activities for reducing NRW in the pilot area in order to implement priority activities in the whole area of Colombo. He also informed there are problems on availability of vehicles to carry out the work.

   GM informed the acknowledgement of the problem.

3. In response to a question by GM, AGM NRW informed it is agreed two officers from O&M and one officer from NRW are allocated to each zone. Additional staffs were provided for meter survey on occasional basis.

4. GM expressed satisfaction in the system adopted and the reduction of NRW by this project. After showing the wish to extend the activities in other areas, GM posed the question, whether a similar system, with similar resources could be adopted for NRW in the other parts of Colombo.

   In response, it was explained larger input/resources will be required to execute daily operations and to execute similar activities in all areas of Colombo simultaneously.

5. Upon the inquiry on previous similar activities, AGM, NRW, explained the steps that they took in the Wellawatte and Colombo 5 areas to reduce NRW. A team visited every individual house and completed the repair of leak, meter repair, detection and regularization of unauthorized consumption. After the activities, no complaints have been received for low pressure in these areas up to now.

6. GM and Mr. S.K.Wijetunga, Addl. GM requested AGM, NRW to forward a proposal, based on the experience gained from this project, to replace pipes and to implement a similar system in the other areas of Colombo, indicating cost and resources required.

   GM informed that the NRW has been more than 50% for several years in Colombo, hence the proposal will be useful.

7. In additional to the weekly meeting, among NRW reduction team, Management Team and JET, meetings with top level (Project Director and Project Manager) are agreed to be held, especially to resolve all shortcomings and to maintain the momentum of the staff.

8. JET informed that NWSDB has requested to use the Customer Meters supplied to the project, in areas outside the pilot zone. AGM, NRW explained the meters are fluidic oscillator type, which can be used in difficult condition area to reduce NRW. Any shortcoming for the pilot zone will be provided by NWSDB. Mr. Arinda Elepata informed that he will check from JICA and confirm.

The fourth JCC meeting will be held in February 2011, during the visit of the audit of JICA.

4th JCC

THE FOURTH JOINT COORDINATING COMMITTEE MEETING
FOR
THE CAPACITY DEVELOPMENT PROJECT
FOR NON REVENUE WATER (NRW) REDUCTION
IN COLOMBO CITY

Time and Date: At 13:30HR on 23 February 2011
Place: Conference Room at the Head Office of NWSDB

Mr. K.L.L.Premanath	GM, NWSDB
Mr. S.K. Wijethunga	Addl. GM (W), NWSDB
Mr. B.W.R. Balasuriya	Addl. GM (WSP) NWSDB
Mr. D.N.J Ferdinando	Addl. GM - (P&P)
Mr. Yoshiki Omura	JICA Mission
Mr. Masahiro Ueki	JICA Mission
Mr. Tsuyoshi Hara	JICA SL Representative
Ms. Misa Oishi	JICA Mission
Mr. Arinda Elapata	Snr. Proj.Specialist, JICA Sri Lanka Office
Mr. W.B.G.Fernando	DGM – (W/C), NWSDB
Mr. S.G.G. Rajkumar	AGM (NRW), NWSDB
Mr. K.W. Premasiri	AGM – (W/C – Development), NWSDB
Mr. S.A. Rasheeed	AGM (W/C – O&M), NWSDB
Mr. M.M. Umar Lebbe	AGM (JPU), NWSDB
Ms. C.J.D. Perera	PD (KGWSP)
Ms. D.A.S. Dahanayake	AD (P&M), MWS&D
Ms. V.A.C.N. Kumari	Plan Asst., MWS&D
Mr. Shinkichi Kobayashi	Team Leader, JET
Mr. Tetsuji Kawamura	JET
Mr. Hiroki Niimura	JET

Mr. K.L.L.Premanath, GM, chair person of JCC, made an opening address and commenced the "Fourth JCC' and requested Mr. Yoshiki Omura to address the meeting.

Mr. Omura thanked the GM and NWSDB, and summarized the Mid Term Review that the Evaluation Team appreciates the NWSDB's efforts while there are some recommendations for improvement.

He also informed that high investment was made to replace pipes in Tokyo after World War II and the establishment of the Leakage Detection Unit contributed NRW reduction. He mentioned JICA's contributions to NWSDB so far made. He stressed that it is essential to execute proper NRW reduction activities as maintenance works even after the replacement of pipes.

Mr. Masahiro Ueki, explained the methodology applied for the Mid Term Review, based on the five evaluation criteria with reference to the methodologies employed by international donors.

He also stressed that in the case the project has not achieved good results as planned or shortages are found, problems should be identified and solutions should be recommended.

Ms. Misa Oishi, explained the results of the Mid Term Review on Relevance, Effectiveness, Efficiency, Impact, Sustainability Conclusion, Recommendations and Lessons Learned.

She also identified four recommendations, 1) NWSDB increase C/Ps who are fully get involved in the pilot activities, 2) NWSDB's executives tackle the issue of vehicle shortage urgently, 3) NWSDB explore possibility of distribution line replacement in Kotahena to enrich learning from the pilot activities, and 4) NWSDB submit concrete proposals for GIS restructuring and public relations to JICA by March 4, 2011 for JICA's consideration.

Discussion:

GM raised s question on future pipe replacement plan and JICA responded it would be discussed jointly by NWSDB & JICA in the course of formulation of M/P for Colombo water supply system, which would be implemented under the engineering services of JICA Loan project.

GM expressed the intention that NWSDB will take actions following the recommendations indicated in the Evaluation Report(p.20).

JICA requested GM to make it clear the timing and responsible personnel of the actions to satisfy the recommendations.
GM informed that details will be explained in an action plan which will be drawn up soon and forwarded to JICA.

In response to a question by JICA regarding budget allocation for the Project, GM informed that Ministry of Finance has not approved the budget and NWSDB will negotiate with the Ministry. The next ODA meeting will also be utilized for the discussion on the matter.

GM informed necessary staff for the Project will be employed by using this budget allocation. However, when the budget for the Project is not approved by the Ministry after the trials, NWSDB will use its own budget for the employing the staff within three month time.

Addl. GM - (P&P) suggested to check the conditions of the pipes when they are exposed or repaired. There is an idea that if the pipes are clogged but structural condition is good, it will be better to rehabilitate pipe inside by scraping & lining or pipe insertion. Important information can be obtained during the activities. .

5th JCC

MINUTES OF MEETING
ON
THE FIFTH JOINT COORDINATING COMMITTE MEETING
FOR
THE CAPACITY DEVELOPMENT PROJECT
FOR NON REVENUE WATER (NRW) REDUCTION
IN COLOMBO CITY

The Japan International Cooperation Agency (hereinafter referred to as "JICA") and the authorities concerned of the Government of Democratic Socialist Republic of Sri Lanka (hereinafter referred to as "GOSL") including the National Water Supply and Drainage Board (hereinafter referred to as "NWSDB") exchanged the Record of Discussions (hereinafter referred to as the "R/D") and the Minutes of the Meetings (hereinafter referred to as the "M/M") on Japanese Technical Cooperation for the Capacity Development Project for Non Revenue Water (NRW) Reduction in Colombo City (hereinafter referred to as "the Project") on 22 April, 2009. Based on R/D and M/M, JICA organized the JICA Expert Team (hereinafter referred to as "JET") to start the Project in November 2009 and the Project activity is to be continued until October 2012. The Project period is divided into three phases, namely 1st Project Year (October 2009 to March 2011), 2nd Project Year (April 2011 to March 2012) and 3rd Project Year.

Before completion of 1st Project Year, NWSDB prepared its proposals for inclusion of issues on reinforcement of current geographic information system (hereinafter referred to as "GIS") and public relation (hereinafter referred to as "PR") activities into the Project, seeking possibilities to obtain further input by Japanese side in successive 2nd and 3rd Project Years. In response to the above proposals, JICA will decide to include GIS and PR activities if the JCC would be convened and accomplish the following items.

- To determine several essential points on GIS, such as revision of Project Design Matrix (hereinafter referred to as “PDM”), organization/implementation system under the Project and future expansion.
- To determine revising methods of PR activities by using annual program and the execution plan. Organization/implementation system in NWSDB should also be decided.
- To exchange the signed minutes of meeting for the above JCC among parties concerned.

In order to determine the aforementioned issues, the fifth JCC was held on 22th June 2011, chaired by Eng. K.L.L.Premanath, General Manager of NWSDB. Those who attended the meeting are listed in "Annex-1" attached hereto.

The main points to have been discussed and agreements reached during the meeting are as in the document attached hereto.

Colombo on 22th June, 2011

Mr. Shinkichi Kobayashi Chief Advisor JICA Expert Team		**Eng. K.L.L.Premanath** General Manager National Water Supply and Drainage Board Sri Lanka

5th JCC

The Attached Document

JCC discussed on the following items for inclusion of GIS and PR activities into the Project.

- PDM shall be revised to evaluate GIS activities.
- JCC shall make clear the organization / implementation system for GIS under the Project
- Future expansion methods shall be written in MM of JCC
- PR activities shall be revised in annual program and included in execution plan
- JCC shall make clear the organization / implementation system for PR activities under the Project

The conclusion of JCC is shown below.

1. GIS

1) PDM

It is decided by JCC to update PDM from its previous version in order to appraise or make clear the position of GIS in the Project.
The revised PDM (PDM_2) is shown in Annex-2.

2) Organization/implementation system under the Project

It is decided by JCC to list the staff who will work for GIS preparation under the Project.

	Position	Name	Role
1	Additional General Manager-P&P	Mr. D.N.J. Ferdinando	Person in charge
2	Chief Engineer, Mapping Section	Mr. J. Seekkuge	Provision of technical input for GIS planning/ training/ utilization (initial stage, part time)
3	Staff from Mapping Section (EA Spl. Mapping)	Mr. A.D. Ranasooriya	
4	Draft person from Maligakanda Office	Ms. Omesha	base map update / data input
5	Engineering Assistant 1	To be named*	field survey for customer meter position with GPS
6	Engineering Assistant 2	To be named*	

Note1) To be named*: The members will be nominated by the end of July 2011.

Note 2) If a person(s) in the list is transferred, the successor of the position succeed the role.

After GIS is prepared, GIS will be used for improving the activities of meter readers and asset management in addition to the updating of the exiting GIS. Several ways of the utilization of GIS shall be examined and tried in the Project. JCC decided key staff for the utilization of GIS as follow

	Position	Name	Role
1	Additional General Manager-P&P	Mr. D.N.J. Ferdinando	Person in charge
2	Chef Engineer, Mapping Section	Mr. J. Seekkuge	Take initiative for the planning of the usage
3	Project Leader, AGM (NRW)	Mr. S.G.G. Raj Kumar	Supervision and planning of utilization
4	AGM (Development)	Mr. K.W. Premasiri	Planning of utilization
5	Manager, Colombo City	Mr. R.A.N. Dharmasiri	Planning and utilization
6	Area Engineer (Kotahena)	Mr. I.R.B. Waruna	Supervision of the trial usage in Kotahena Pilot area
7	Area Engineer (Borella)	Ms. W.C.A. Gunarathna	Supervision of the trial usage in Borella Pilot area
8	OIC (Kotahena)	Mr. W.W.K. Jayasinghe	Execution of trial usage in Kotahena pilot area
9	OIC (Borella)	Mr. R.L. Wijekularathna	Execution of trial usage in Borella pilot area

Note: If a person(s) in the list is transferred, the successor of the position succeed the role.

3) Future expansion

Additional GM-P&P and Chief Engineer of Mapping Section together with AGM(Development) will coordinate the GIS issues in the Project period and then take initiatives for dissemination of GIS to entire Colombo city in the future by reviewing the results of the Project activities.

2. PR Activities

1) Monitoring and revision of PR activities

PR activities under the Project should be clearly indicated in the annual program, so that the activities should be reviewed every year and the result of review will be incorporated into successive annual program and the execution plan that is to be prepared on completion of the Project.

2) Organization/implementation system under the Project

The Project Leader of NRW Reduction Management Team will be responsible for the PR activities for the Project

PR activities for smooth execution and assistance of the Project will be done in the following manner.

- NRW reduction management team and NRW reduction team for each pilot area should execute PR activities with consultation of JET.
- The commercial officers for the pilot zone shall be involved in the PR activities under instruction of the Project Leader
- A public relation officer in Western Central Regional Support Center will initiate important PR activities under the instruction of the Project Leader.

3. Next JCC Meeting

Next JCC meeting will be held in *******. The details will be informed by NWSDB later.

Annex-1: List of Participants

Annex-2: Project Design Matrix (Revised on 22nd June, 2011)

5th JCC

Annex-1

List of Participants

【Sri Lankan side】

Eng. K.L.L. Premanath	General Manager, NWSDB as chair person of JCC
Eng. S.K. Wijethunga	Additional General Manager - Western, NWSDB
Eng. D.N.J. Ferdinando	Additional General Manager – P&P, NWSDB
Eng. W.B.G. Fernando	Deputy General Manager - Western Central (Project Manager), NWSDB
Eng. S.G.G. Rajkumar	Assistant General Manager for NRW Reduction, Regional Support Center (Western-Central), NWSDB
Eng. S.A. Rasheed	Assistant General Manager for O&M, Regional Support Center (Western-Central), NWSDB
Eng. M.M. Umar Lebbe	Assistant General Manager –JPU, NWSDB
Ms. C.J.D. Perera	PD (KGWSP), NWSDB
Mr.T.M.G.P. Thennakoon	Assistant Director, National Planning Department, Ministry of Finance and Planning
Ms. N. Waidyrathna	Assistant Director, Ministry of Water Supply and Drainage
Ms. W.G. Janaki	Development Assistant, Ministry of Water Supply and Drainage

【Japanese side】

JICA Sri Lanka Office

Mr. Takuya Otsuka	Senior Representative
Akihide Takeo	Representative
M. Arinda I. Elapata	Senior Project Specialist

JICA Expert Team

Mr. Shinkichi Kobayashi	Chief Advisor
Mr. Masami Ogura	JICA Expert
Mr. Toru Aoki	JICA Expert

Annex-2

Project Design Matrix

Project title: **Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka**
Duration: **November 2009-October 2012**
Target Area: **Colombo City, Sri Lanka**
Target Group: **Officers and staff of NWSDB (Western-Central Division)**
Date:

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The NRW ratio in Colombo city is reduced.	1 NRW reduction activities are comprehensively conducted by 22 zone offices in CMC area in accordance with the execution plan. 2 Decrement of NRW ratio per annum in CMC area exceeds one (1) percentage point up to 2017.	1 Annual report of NWSDB 2 Record of NRW ratio	
Project Purpose NWSDB's capacity to implement NRW reduction activities in Colombo city is strengthened.	1 Number of NRW reduction activity records will increase compared to what was before the Project. 2 The budget to be allocated for NRW reduction will increase compared to what was before the Project. 3 An execution plan to achieve reduction of NRW ratio by one (1) percentage point per annum, as per the Goal 2.1 of "Corporate Plan 2007-2011", is prepared and incorporated into relevant plans/programs of NWSDB.	1 Annual report of NWSDB	1 NWSDB secures the budget for scaling-up of the NRW activities. 2 Necessary equipment such as pipes, saddles and meters are provided by NWSDB. 3 Over-aged pipes in selected zone of CMC area are replaced.
Outputs 1 Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced. 2 Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	1.1 An annual program for NRW reduction in the pilot area is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years). 1.2 NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget etc.) as planned. 1.3 NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams". 2.1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan. 2.2 NWSDB officers/staff engaged in "NRW reduction Teams" acquire proper leak detection, plumbing and pipe repairing skills. 2.3 An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.	1.1 Annual report of NWSDB 1.2 Project record, Quarterly progress report 1.3 Project record, Quarterly progress report, training materials 2.1 Project record, Quarterly progress report 2.2 Project record, Quarterly progress report 2.3 Project record, Quarterly progress report	1 Officers and staff trained by the project will continue with NRW activities of NWSDB.
Activities 1-1 Organize a "NRW Reduction	Inputs Japan	Sri Lanka	

Management Team" at Western-Central Regional Support Center. 1-2 Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region". 1-3 Prepare an annual program of NRW reduction activities for the pilot areas*. 1-4 Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams". 1-5 Assess progress of NRW reduction activities in the pilot areas. 1-6 Review the annual program of NRW reduction activities based on the feedback/lessons learnt in the pilot areas and prepare the program for the following year. 1-7 Evaluate activities in the pilot areas through out the Project period and prepare an "execution plan" to apply the Project outcome to entire area Colombo city 2-1 Select two (2) pilot areas. 2-2 Organize "NRW Reduction Team (a group of OlC**, EA** and gangs***)" at the pilot areas. 2-3 Review and modify pipeline network drawings of the pilot areas by using GIS, which shall be used for the NRW reduction activities 2-4 Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio. 2-5 Prepare a NRW reduction work plan for each pilot area incorporating leak detection, pipe repairing, plumbing and activities for the reduction of non-physical losses****. 2-6 Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team". 2-7 Implement NRW reduction activities according to the work plan. 2-8 Measure results of NRW reduction team's work (NRW ratio etc.) and provide feedback to "NRW Reduction Management Team" for revision of the annual program.	1. Personnel Chief Advisor /NRW reduction programming Deputy Chief Advisor /NRW reduction monitoring and evaluation Leak detection Advisor Arrangement of pipeline drawing and customer data Service pipe connection advisor Coordinator 2. Equipment Leak detector Pipe locator Portable ultrasonic flow meter Vehicle, etc. 3. Overseas Training Overseas Training for NWSDB counterpart personnel	1. Personnel Project Head Project Director Project Manager Counterpart personnel for - "NRW Reduction Management Team" - "NRW Reduction Team" 2. Facilities Office space, furniture and facility. 3. Local cost Cost for the isolation of pilot project areas (including installation of chambers for flow meters) Pipe-repairing Cost Cost for road opening/reinstatement Project management Cost 4. Others	Pre-conditions 1 NWSDB secures the budget for implementation of the NRW activities at pilot areas. 2 Recruitment of personnel to be assigned to the pilot areas is completed.

*: Pilot area corresponds to jurisdiction of "zone officer" (Approx. 5,000 connection). The pilot area will be divided into smaller blocks (Approx. 500 connections) to conduct the program.

**: Proposed positions in "Strategic-Approach for Non-Revenue Water Reduction in Colombo Metropolitan Region" (Feb.2008)

***: A work unit which is composed of plumber, labor etc.

****: Activities for non-physical losses reduction include measures against illegal connections and bypass connections, replacement of defective customer meters and estimated billing.

6th JCC

Capacity Development Project for NRW Reduction in Colombo City

Meeting Memo of the Sixth Joint Coordinating Committee Meeting

Date: 15th February 2012
Place: Conference Room at the Head Office of NWSDB
Time: 10.00 am - 11:30 am

Attendance

Mr. K. Hettiarachchi	Chairman, NWSDB
Mr. K.L.L. Premanath	GM, NWSDB
Mr. S.K.Wijethunga	Addl. GM - (W), NWSDB
Mr. B.W.R. Balasuriya	Addl. GM - (WSP), NWSDB
Mr. D.N.J Ferdinando	Addl. GM - (P&P), NWSDB
Mr. W.B.G. Fernando	DGM - (W/C), NWSDB
Mr. S.G.G.Rakjumar	AGM - (NRW), NWSDB
Mr. T.G.Heenkande	Manager, NRW, NWSDB
Mr. T.M.P.D. Thennakoon	AD – NDP
Mr. Takuya Otsuka	Snr. Representative, JICA, SL
Mr. Yoshiki Omura	JICA Mission Leader
Mr. Ryosuke Isobe	JICS Mission
Ms. Tomoko Kashihara	Representative, JICA, SL
Ms. Ayako Namura	JICA Mission
Mr. Arinda Elapata	Snr. Project Specialist, JICA, SL
Mr. Shinkichi Kobayashi	Team Leader, JET
Mr. Tetsuji Kawamura	Member, JET
Mr. Akihiko Okazaki	Member, JET
Mr. Toru Aoki	Member, JET

The sixth JCC meeting was chaired by the Mr. K Hettiarachchi, Chairman, NWSDB

OPENING ADDRESS
The Chairman welcomed the members and in his opening address he informed of the importance of NRW. He mentioned that in the past the NRW results were not encouraging. Regular weekly meetings were held in his office with the management staff of NWSDB on the reduction of NRW. He showed the application of the reduction of NRW in the pilot areas.
He further mentioned that NWSDB has achieved from 10% to 20% of NRW in some new areas and was endeavoring to bring down the NRW figures to single digit in the future.

ADDRESS BY JICA
Mr. Yoshiki Omura, JICA mission Leader, explained the project purpose and noted that recognized engineers of NWSDB have gained detail knowledge by taking a systematic approach in this project. Further he said that the technical training in Japan and other countries also had contributed to the capacity development of the counterpart members.
The Project is one of the most successful capacity development projects and the efforts of NWSDB's staff are appreciated.

Mr. Omura informed that the Project is a small step to achieve great results in NRW, which will also require necessary investment by NWSDB..

CONFIRMATION ON THE ISSUES RAISED IN THE FIFTH JCC MEETING

On confirmation of issued raised in the Fifth JCC meeting, Mr. Rajkumar, AGM (NRW), mentioned three issues, i.e. GIS, PR Activities and Pipe replacement. GIS activities have commenced and presently being done at several sub zones in the pilot areas of Kotehena and Borella. PR activities, such as preparation / distribution of handbills to residents, a poster campaign among selected schools and a video presentation, are being carried out. Pipe replacement in Kotahena area by using the remaining funds of GCWRP is to be commenced soon.

PROGRESS OF THE ACTIVITIES AND ACHIEVEMENT OF THE PROJECT

Mr. Rajkumar, AGM (NRW), made a detail presentation on the Progress of activities and the achievements of the project from the November 2009 to date.

EVALUATION RESULTS

Ms. Ayako Namura, a member the JICA mission, presented the Evaluation results with the detail report given in the documents presented at the JCC.

RECOMMENDATION BY THE EVALUATION TEAM

Mr. Ryosuke Isobe, a member of JICA mission, presented his report on Recommendation of the Evaluation Team.

DISCUSSIONS

The Chairman commented that it would be necessary to consider the exchanging of ideas with other project in order to achieve good results. He also mentioned the importance of leakage in distribution mains and transmission system while it is outside the scope of the Project. NWSDB proposed JICA to consider the possibility of inclusion of NRW reduction in larger size pipes into the Project.

Mr. W.B.G. Fernando, DGM - (W/C), mentioned that budget and staff of NRW / O&M sections for the normal activities were used for the Project since counterpart funds or any other special budget were not allocated. It would be necessary to allocate proper budget for this kind of Project also. The duplication of the same activities in other areas with the same conditions will not be practical.

Mr. DN.J. Ferdinando, Addl. GM (P&P), requested for information on the percentage of operable existing valves in order to formulate future NRW plans. Mr. Rajkumar, AGM (NRW), responded that most of valves were covered by road surface and hard to find out.
Mr. DN.J. Ferdinando stressed that it is import to record the findings of the Project for preparation of future NRW reduction plan.

ACTIVITIES OF THE NEXT STAGE

MR. S. Kobayashi, Team Leader of JET, explained the major activities of the next stage, especially preparation of execution plan, which would be prepared by the management team based on the findings and discuss the revised activities to be applied to other areas.
He also recommended that Area Engineers and OICs of the other areas should take part in the project activities in order to disseminate the activities to entire Colombo city.

The Seventh JCC meeting will be held in six months time.

7th JCC

Capacity Development Project for NRW Reduction in Colombo City

Minutes of the Seventh Joint Coordinating Committee Meeting

Date: 5th October 2012
Place: Conference Room at the Head Office of NWSDB
Time: 2.00 pm - 3:30 pm

Attendance

Mr. K. Hettiarachchi	Chairman, NWSDB
Mr. K.L.L. Premanath	GM, NWSDB
Mr. S.K.Wijethunga	Addl. GM - (W), NWSDB
Mr. W.B.G. Fernando	DGM - (W/C), NWSDB
Mr. K.T.P. Fernando	DGM (PC)
Mr. K.W. Premasiri	AGM (W/C/ Development)
Mr. M.M. Umar Lebbe	AGM (JPU)
Mr. S.G.G.Rajkumar	AGM - (NRW), NWSDB
Mr. A.K. Kapuruge	AGM (W/C – O&M)
Mr. K.P.R.S. Samarasinghe	AGM
Ms. C.D.J. Perera	PD (KGWSP)
Mr. T.G.Heenkande	Manager, NRW, NWSDB
Mr. Hiroyuki ABE	Snr. Representative, JICA
Ms. Tomoko Kashihara	Representative, JICA, SL
Mr. Arinda Elapata	Snr. Project Specialist, JICA, SL
Mr. Shinkichi Kobayashi	Team Leader, JET
Mr. Tetsuji Kawamura	Member, JET
Mr. Akihiko Okazaki	Member, JET
Mr. Toru Aoki	Member, JET

The seventh JCC meeting was chaired by the Mr. K Hettiarachchi, Chairman, NWSDB

OPENING ADDRESS
The Chairman welcomed the members.

ADDRESS BY JICA
Mr. Hiroyuki ABE, Senior Representative, JICA SL made a brief explanation of the project. He mentioned that it is most important to follow the Execution Plan and continue with NRW activities in the future.

ACKNOWLEDGEMENT OF THE ISSUES RAISED IN THE SIXTH JCC MEETING
The minutes of the Sixth JCC meeting was acknowledged without any comments.

RESULTS / ACHIEVEMENTS OF THE ACTIVITIES
Mr. S.G.G. Rajkumar, AGM, NRW made a presentation on the achievements of the activities, followed with details of PR activities and DVD presentation that will be use for future PR activities.

EXECUTION PLAN

Mr. Shinkichi Kobayashi, Team Leader, JET presented the Execution Plan to disseminate NRW reduction activities to entire Colombo City.

COMPLETION REPORT / PROJECT BRIEF REPORT

Mr. Kobayashi explained Project Completion Report and Project Brief Note which summarizes the key points of the project to share the information and lessons learned among authorities concerned. JCC understood and agreed the contents of the Project Completion Report. JCC also understood the purpose of Project Brief Note and acknowledged the Project Brief Note to be disseminated to public.

DISCUSSION

1. About GIS

Mr. W.B.G. Fernando, DGM (W/C) regarding GIS informed that several years back a similar project was carried under NORAD assistance after a comprehensive proposal was made for GIS. The GIS is not used effectively. He asked whether a study of the facts was made when recommending the present GIS programme.

Mr. Rajkumar replied that:

- GIS database, which had been constructed under the NORAD assistance, was not necessarily utilized in O&M activities due to several reasons, such as, O&M staff could not refer to the database easily, base map was outdated, location of facilities (valves or pipes) were not always correct, etc.
- Above mentioned background have been well-considered on requesting to JICA for inclusion of GIS issues into the Project, so that the database may be utilized at O&M level

Mr. Rajkumar added that the user friendly GIS programme started midway of the Capacity Building project to address the shortcomings of NRW activities.

Mr. Kobayashi supplemented that basic information of GIS prepared by NORAD project will be used. The major difference of the current activities is that this program focuses on usage. PC was provided to OIC for GIS usage and outputs (Maps) are brought to the sites.

The Chairman agreed Mr. Fernando on the importance of the reasons why the NORAD was not used. He also commented that it is necessary to consider the modern technology will become easy to use and utilized efficiently a few years after introduction and also to take account of the Human Factor – administration, social, technical, economical and financial reasons.

The Chairman also mentioned that he have requested the Arthur Clark Centre to formulate and CCTV system for the NWSDB to monitor the workings of the Board.

2. About Execution Plan

Execution plan was basically agreed. If there are any other comments, the information will be informed to JET soon.