

## **Annexes**

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**Annex 2: Work Plan**

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### **Annual Program**



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- (3) ANNUAL PROGRAM FOR NRW REDUCTION of 3<sup>rd</sup> Year (June 2012)



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

**ANNUAL PROGRAM  
FOR  
NRW REDUCTION**

**prepared under the activities of**

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

**May 2010**





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## Chapter 1 PURPOSE AND EXPECTED OUTPUT

### 1.1 Purpose and Outputs of the Program

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”:

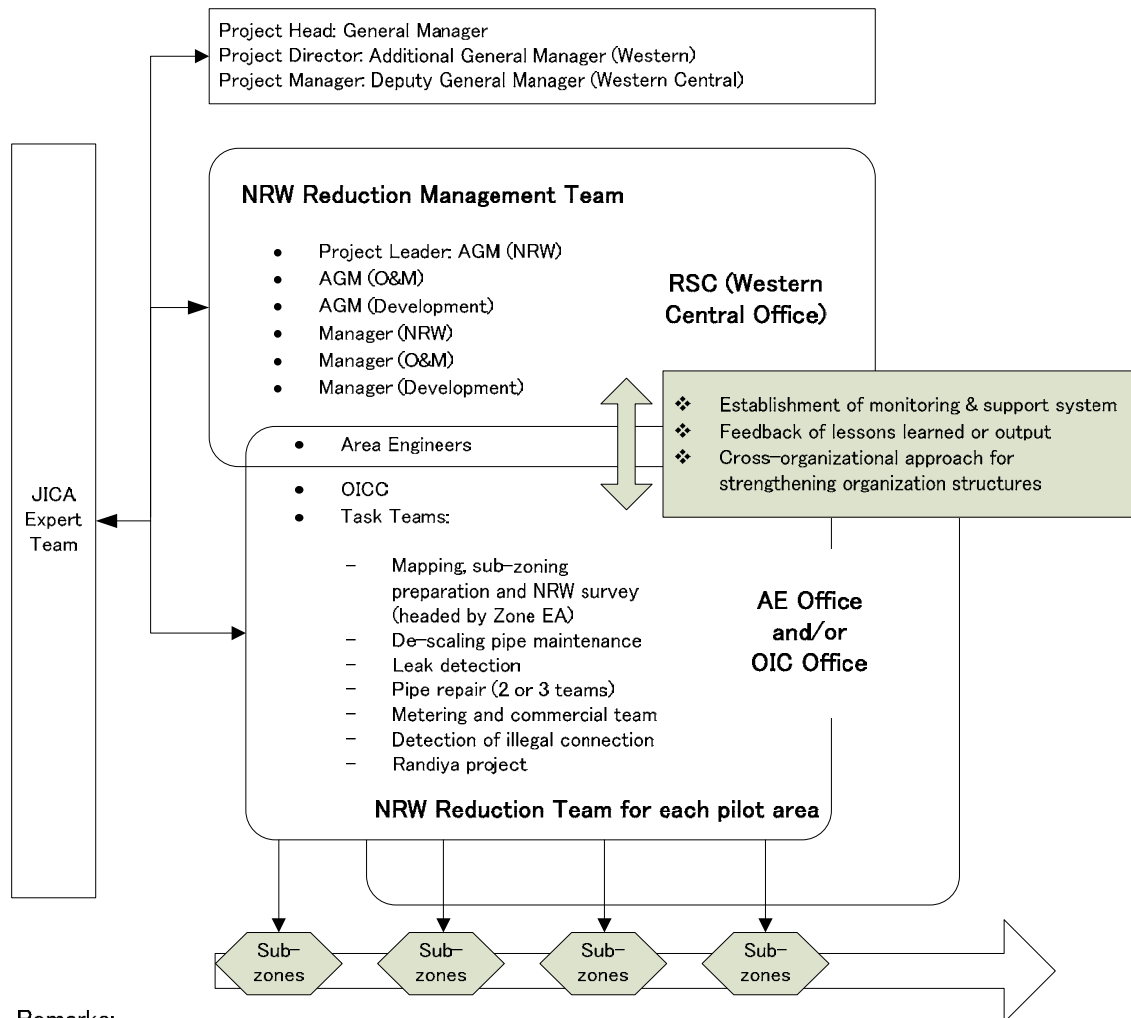
- 2-1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan.
- 2-2 NWSDB officers/staff engaged in “NRW reduction Teams” acquire proper leak detection, plumbing and pipe repairing skills.
- 2-3 An average NRW ratio in the pilot areas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

## 1.2 Target Personnel for Training

As shown in the R/D signed on 22<sup>nd</sup> April, 2009, C/P was assigned as Figure 1.2-1.



Remarks:

AGM: Assistant General Manager  
 EA: Engineering Assistant  
 RSC: Regional Support Center

AE: Area Engineer  
 OIC(C): Office in Charge  
 Sub-zones: Distribution Block with approximately 500 connections

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

**Figure 1.2-1 Organization Structure for Project Activities**

### 1.2.1 Organization of NRW Reduction Management Team

Members of NRW Reduction Management Team has been appointed based on R/D.

### 1.2.2 Organization of NRW Reduction Team

Structural Image of NRW Reduction Team is shown in Figure 1.2-2.

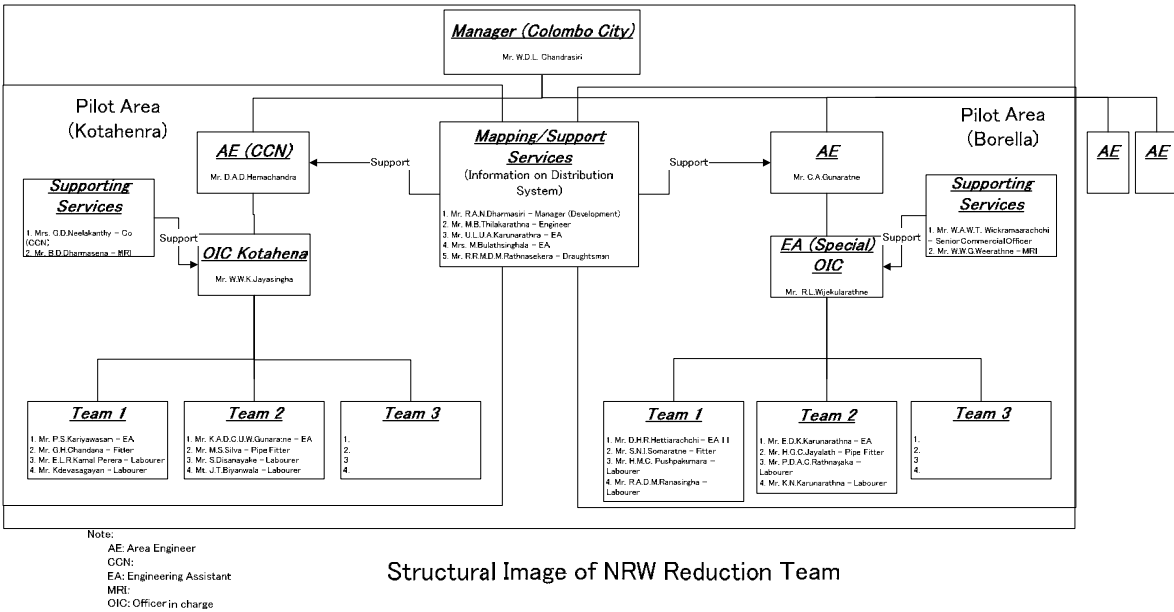


Figure 1.2-2 Structural Image of NRW Reduction Team

## Chapter 2 INPUT

At the time of the 1<sup>st</sup> JCC, budget allocation was decided as follows.

- The Sri Lankan side allocates necessary budget according to the R/D and the M/M on this Project (signed on 22 April 2009), to ensure effective implementation of the Project.
- NWSDB ensures that the budget for customs duties/taxes, 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.

As mentioned the above, it was decided to subsidize the expenses related to the Project activities from the regular budget of NRW Section and O&M Section. Afterward, budget plan for the total period of the Project was prepared as follows.

**Table 1.2-1 Total Estimated Cost for the Capacity Development Project for NRW  
Reduction in Colombo City – 2010, 2011 and 2012**

Se. No.	Description	Unit	Qty	Rate	Amount
<b>1</b>	<b><u>STAFF</u></b>				
a	Allow for Engineering Assistants. Rate to include Salary, Over time and Subsistence for three years for 06 nos of EAA	item			21,830,040.00
b	Allow for Skilled Labourers. Rate to include Salary, Over time and subsistence for three years for 06 nos of Fitters and 06 nos of Drivers	item			32,531,112.00
c	Allow for Un Skilled Labourers. Rate to include Salary, Over time and Subsistence for three years for 12 nos labourers	item			30,005,856.00
<b>2</b>	<b><u>TRANSPORT</u></b>				
a	Allow for cost of Vans. Rate to include Fuel cost, Services, Tyres & Tubes and Repair & Maintanance cost for 04 nos of Vans for three years.	item			2,882,400.00
b	Allow for cost of 02 nos of Hired Vehicles for three years	item			4,320,000.00
<b>3</b>	Allow for cost of Excavators. Rate to include Fuel Cost, Services, Tyres & Tubes and Repair & Maintanance cost for 02 nos of Excavators for three years	item			6,302,400.00
<b>4</b>	Cost for purchasing of Concrete Chambers.	Nos	180	50,000.00	9,000,000.00
<b>5</b>	Allow for cost of Taxes and custom duty for Vehicles and Equipment.	item			22,000,000.00
<b>6</b>	Allow for cost of Valve Raising work for three years.	item			3,000,000.00
<b>7</b>	Allow for cost of Leak Repaired work for three years. Rate to include 80 nos of leaks repaired per month approximately.	item			4,320,000.00

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8	Allow for cost of Materials for Leak Repair works for three years.	item			15,000,000.00
9	Allow for cost of scraping and Lining of Pipe Lines for three years.	item			6,000,000.00
10	Allow for cost of Purchasing of 10 nos of Car Batteries and 02 nos of Battery Charges.	item			90,000.00
11	Office Refurbishment including Partitioning, Airconditioning, Furniture, etc.	item			2,500,000.00
	<b>SUB TOTAL 1</b>				159,781,808.00
12	Allow for cost of Road Re-instatement charges. Rate to include for installing valves & Meters and for Leak Repair works for three years.	item			3,300,000.00
	<b>SUB TOTAL 2</b>				163,081,808.00
13	Allow for 10% contingencies				16,308,180.80
	<b>SUB TOTAL 3</b>				179,389,988.80
14	Allow for VAT 12%				21,526,798.66
	<b>GRAND TOTAL</b>				200,916,787.46

After the above total cost is approved by NWSDB, required budget for each year will be allocated from the total budget.

## Chapter 3 OUTLINE OF THE PILOT PROJECT

### 3.1 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.

### 3.2 Outline of the Pilot Project

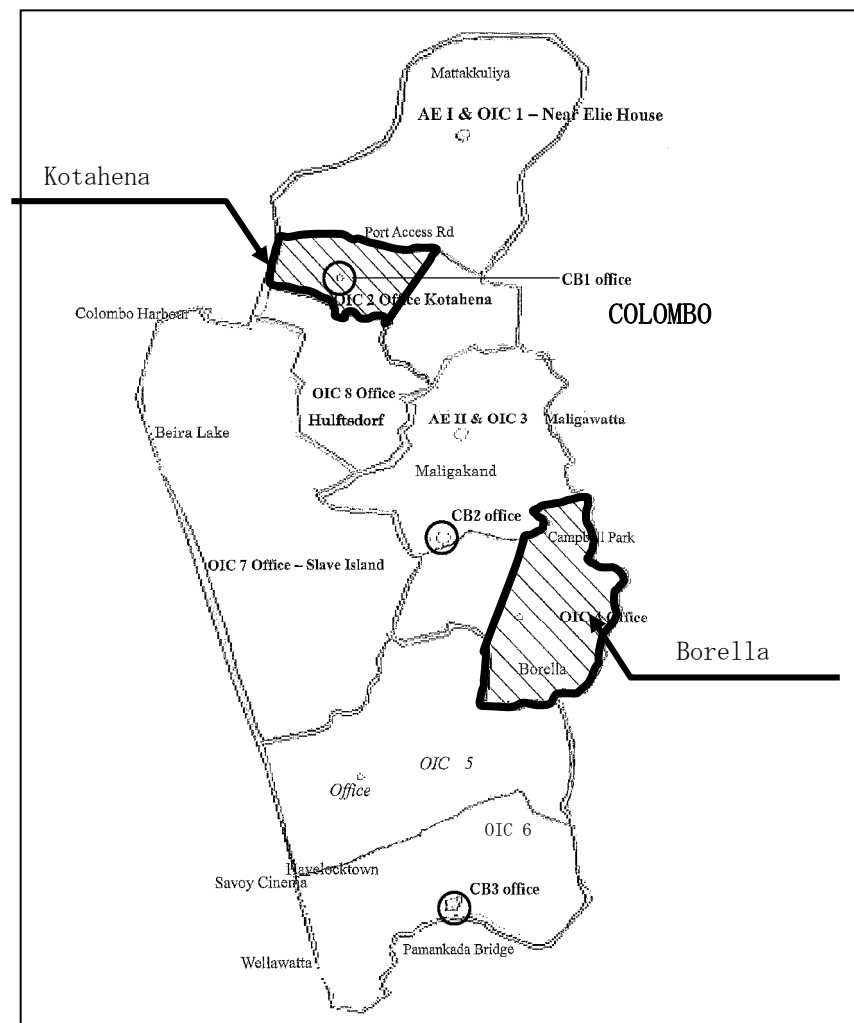
"Pilot Area" are Two (2) locations, namely "Kotahena" and "Borella". NWSDB is scheduled to conduct “Water Sector Development Project (II)” in Colombo City (WSD-II), which is the 39<sup>th</sup> ODA Loan Project for GOSL by GOJ. WSD-II is to improve water supply facilities in Colombo City, including replacement 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 3.2-1.





**Figure 3.2-1 Locations of Pilot Project Area (Kotahena & Borella)**

## Chapter 4 SCHEDULE OF THE ACTIVITIES

### 4.1 General

For smooth and effective implementation of the countermeasures and for easy monitoring and evaluation of the project activities, C/P and JET are jointly formulating a sub-zoning plan. This sub-zoning plan intends to divide a pilot area with the scale of 5,000 connections into smaller areas with the scale of about 500 connections. Order of implementation or practical schedule in each sub-zone was jointly prepared by C/P and JET. It will be modified /updated to suit the progress.

NRW reduction activities to be conducted under this Project will be supported by regular budget allocated to NRW Section and O&M Section of NWSDB. However, charges or taxes related to custom clearance for equipments and machineries to be donated by Japanese side will be specially earmarked by NWSDB. NWSDB side considers that “requesting budget on a case-by-case basis” is more realistic than “preparing special budget in advance” to cover additional or unexpected works. Accordingly, NWSDB side has allocated more budget to both NRW Section and O&M Section than the last year, so that the both sections can cover necessary cost for extra personnel input, overtime, labor, vehicle, etc. for the Project activities on a priority basis. In this connection, NWSDB has intention to extend its Project activities beyond the target Pilot Areas of the Project, as a part of its regular work program.

As for the numerical target setting of NRW reduction by the Project, JET and C/P side share the view that it is more practical to consider it after execution of the activities in a few sub-zones. The major target at the initial stage is to improve the capability of staffs, to know the actual situation of NRW and to find the effective methods for NRW reduction.

#### 4.1.1 Activities for Output 1

Table 4.1-1 summarizes the activities related to "Output 1".

**Table 4.1-1 Activities for the "Output 1"**

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.	
No.	Activities
<b>1-1</b>	Organize a “NRW Reduction Management Team” at Western-Central Regional Support Center.
<b>1-2</b>	Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region".
<b>1-3</b>	Prepare an annual program of NRW reduction activities for the pilot areas.
<b>1-4</b>	Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams".
<b>1-5</b>	Assess progress of NRW reduction activities in the pilot areas.
<b>1-6</b>	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.
<b>1-7</b>	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

#### 4.1.2 Activities for Output 2

Table 4.1-2 summarizes the activities related to "Output 2".

**Table 4.1-2 Activities for the "Output 2"**

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	
<i>No.</i>	<i>Activities</i>
<b>2-1</b>	Select two (2) pilot areas.
<b>2-2</b>	Organize "NRW Reduction Team (a group of OIC, EA and gangs)" at the pilot areas.
<b>2-3</b>	Review and modify pipeline network drawings of the pilot areas.
<b>2-4</b>	Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio.
<b>2-5</b>	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.
<b>2-6</b>	Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team".
<b>2-7</b>	Implement NRW reduction activities according to the work plan.
<b>2-8</b>	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.

## 4.2 Schedule

Figure 4.2-1 shows the work flow of the future activities.

For the time being, following activities are scheduled for next 6 months.

### Activities Related to Output1

- Revision of the Annual Program
- Prepare an Annual Program of NRW Reduction Activities
- Review Existing Training Programs Related to NRW Reduction and Conduct the Training for "NRW Reduction Teams"
- Assess Progress of NRW Reduction Activities in the Pilot Areas

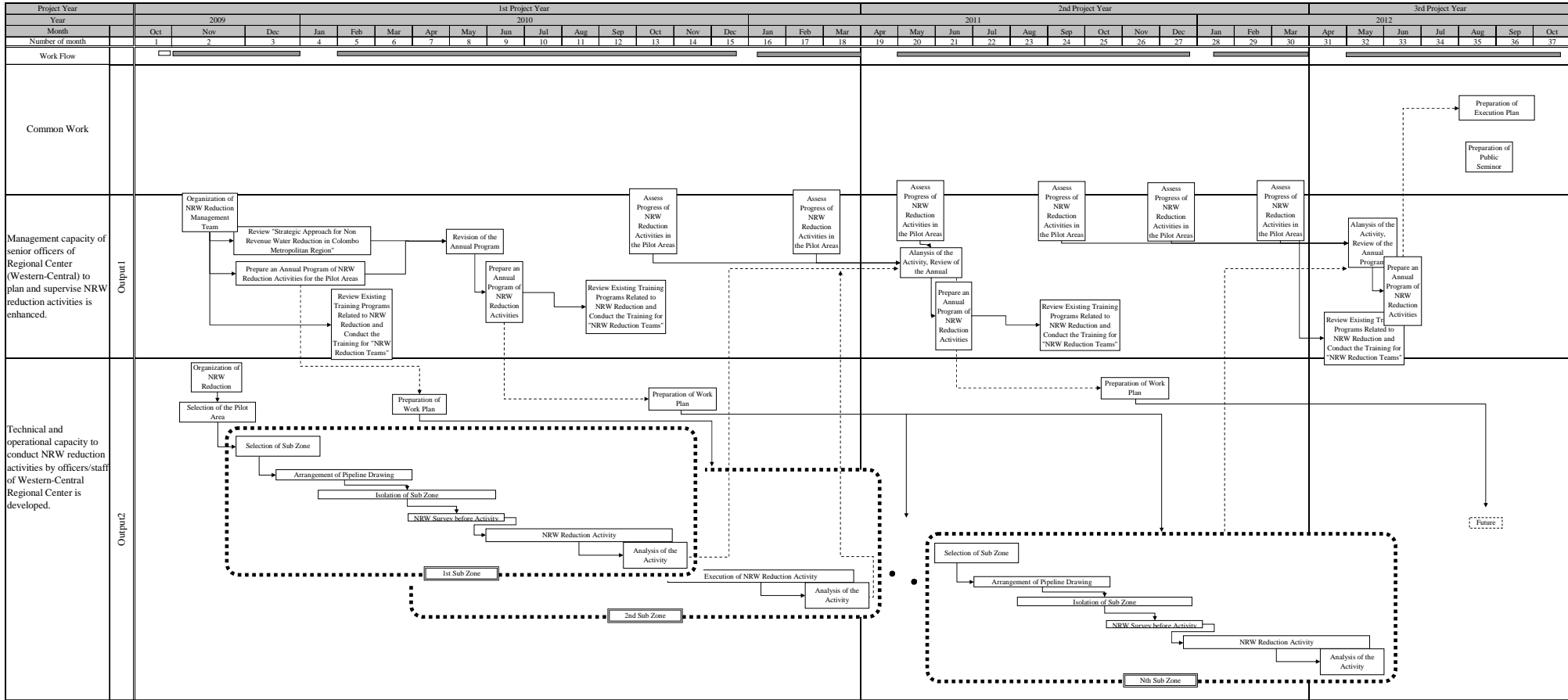
### Activities Related to Output2

- Arrangement of Pipeline Drawing for sub zones
- Selection and Isolation of sub zones
- NRW Survey before Activity for sub zones
- NRW Reduction Activity for sub zones
- Analysis of the Activity for sub zones
- Preparation of Work Plan for sub zones

### Other Activities

- Preparation of Training Programs and Materials
- Training • OJT
- Progress Report 2
- Training in the Third Country / Japan
- PDM Modification

## Annex – 1 Annual Program (1)



**Figure 4.2-1 Work Flow of the Future Activities**

**NATIONAL WATER SUPPLY AND DRAINAGE BOARD (NWSDB)  
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## Chapter 1 PURPOSE AND EXPECTED OUTPUT

### 1.1 Purpose and Outputs of the Program

The “Project Purpose” is as follows.

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

- 1 Number of NRW reduction activity records will increase compared to what was before the Project.
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In addition, expected “Outputs” of the Project and their respective “Objectively Verifiable Indicators” are as follows.

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"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”:

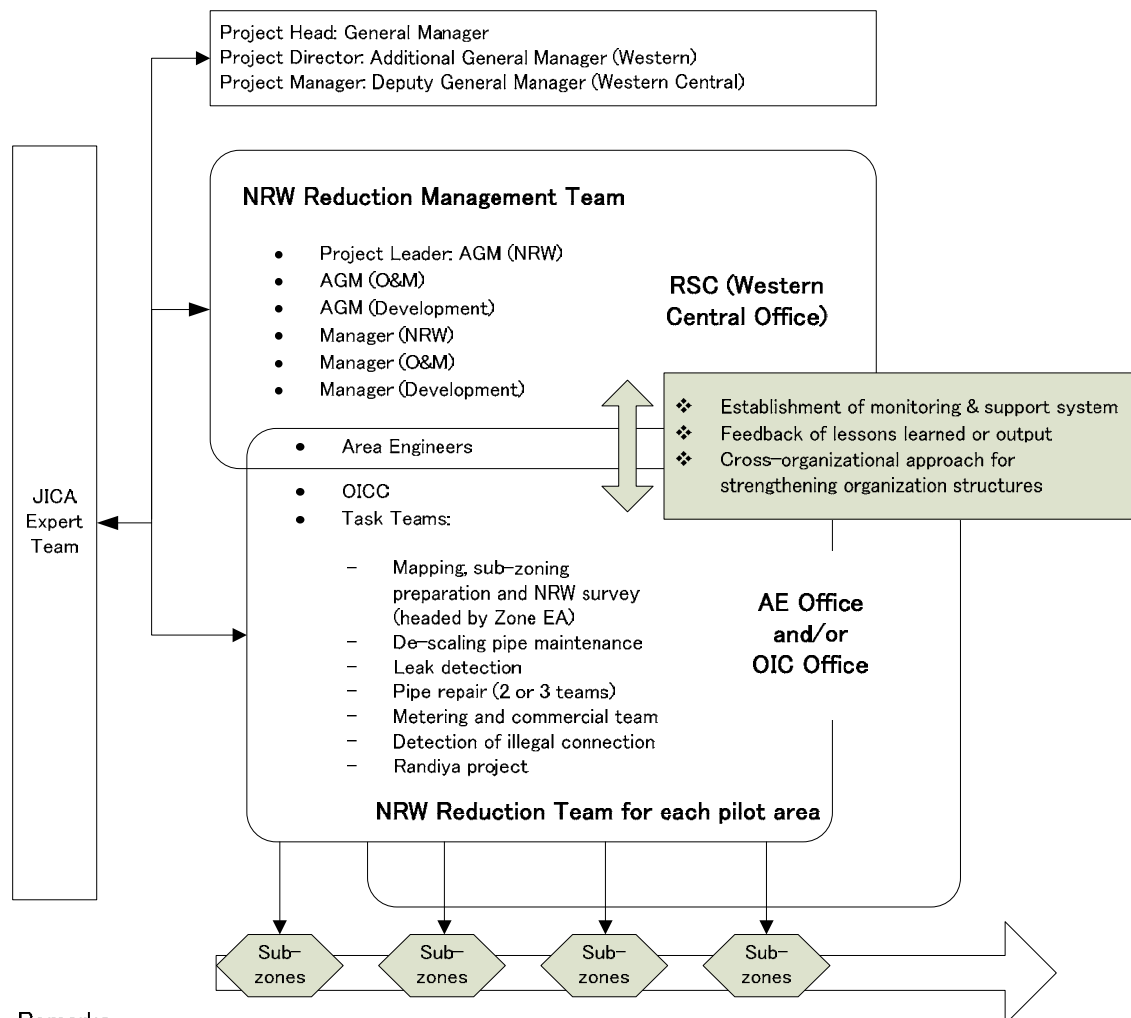
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To achieve the above “Project Purpose”, NWSDB and JICA Expert Team (JET) will mutually keep in mind that NWSDB is to play a major role with distinctive ownership in conducting the Project and JET is to support NWSDB.

## 1.2 Target Personnel for Training

As shown in the R/D signed on 22<sup>nd</sup> April, 2009, C/P was assigned as Figure 1.2-1.



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**Figure 1.2-1 Organization Structure for Project Activities**

### 1.2.1 Organization of NRW Reduction Management Team

Members of NRW Reduction Management Team has been appointed based on R/D.

### 1.2.2 Organization of NRW Reduction Team

Structural Image of NRW Reduction Team is shown in Figure 1.2-2.

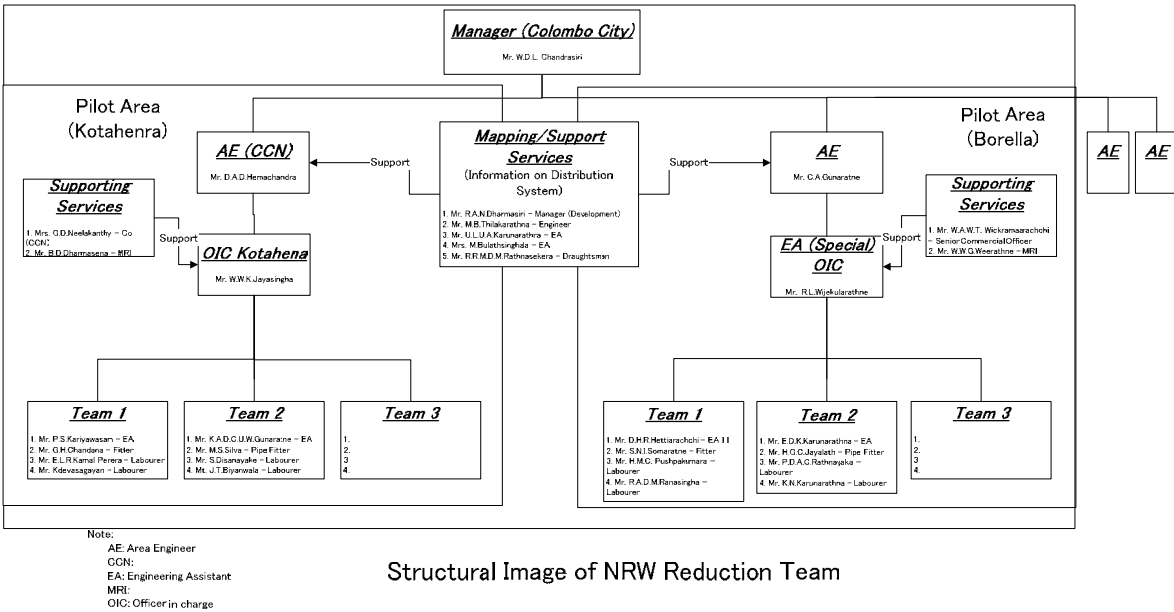


Figure 1.2-2 Structural Image of NRW Reduction Team

## Chapter 2 OUTLINE OF THE PILOT PROJECT

### 2.1 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.

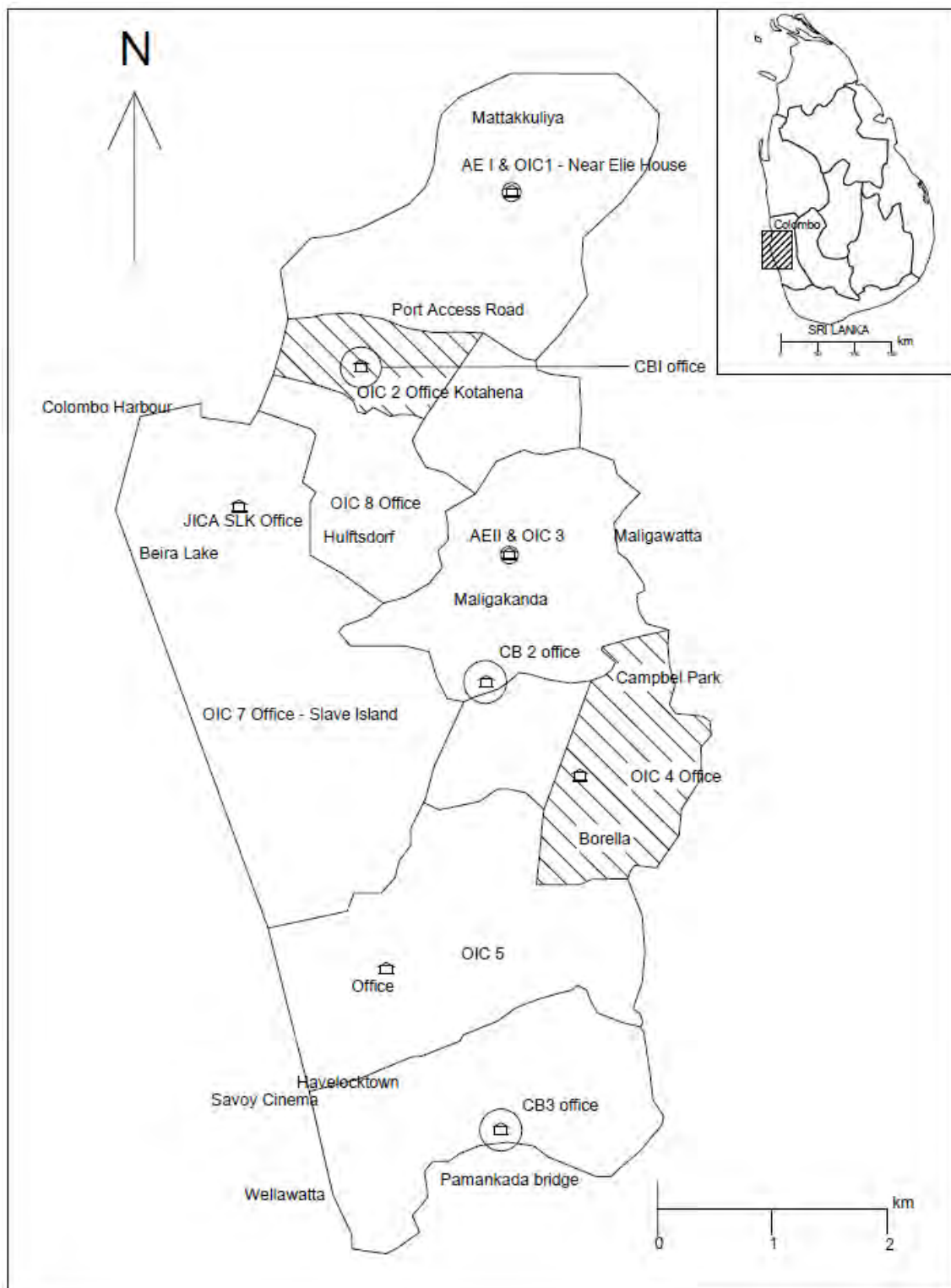
### 2.2 Outline of the Pilot Project

"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 39<sup>th</sup> 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.

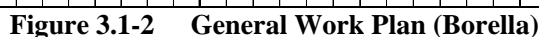
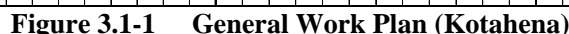
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Conduct a series of NRW reduction activities with replacement of aged pipes. However, only four (4) aged pipe lines will be replaced under the WSD-II scheme. In order to realize good coordination, constant communication will be maintained with the 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 2.2-1.



**Figure 2.2-1 Locations of Pilot Project Area (Kotahena & Borella)**

The NRW Reduction Management Team prepared work plans for both Pilot Project Areas before starting activities in Pilot Project Areas. Figure 3.1-1 and Figure 3.1-2 show general work plan in both Pilot Project Areas.



It was originally planned to complete leakage detection and repair works in these two sub-zones by the end of August 2010. While the major field activities for these two sub-zones in Kotahena and Borella have finished on 10 July, 2010 and 2<sup>nd</sup> September, 2010 respectively, data collection through “meter condition survey” and “customer meter reading” needed long time and calculation of NRW ratio was delayed from the schedule. Further, data collection had to be repeated several times due to numerous errors in the collected data and absence of customer

at the houses.

Even though the NRW reduction activities were followed as per originally planned, the NRW value remain still high in some sub-zones in Kotahena.

In order to identify high-NRW-contributing segment in K1, a "step testing" has been conducted in K1. In this step testing, K1 was divided into three areas. However, this step testing could not clearly identify the high-NRW-contributing area. This result implies that numbers of unidentified leakages that are yet to be discovered are more contributing to high NRW ratio in this area, than unidentified major illegal uses. Some of leakages are not detected where leak sound is very weak due to constantly low pressure and where house connection pipes are not located due to pipe routes under buildings.

Therefore, some new activities were introduced to implement in Kotahena such as abandonment of the existing CI pipe line after transferring the house connection from CI line to existing PVC line, and introduction of common pipe line instead of existing bundle pipes. In addition to the above, extra resources & time were allocated to implement the step testing for identifying high MNF area in these two sub zone for reducing the NRW further. These additional input/activities may also make some work items behind the schedule.

As NWSDB had strong interest whether it was possible to reduce NRW further in Borella as well, a step testing was conducted in B1 as done in K1. The step testing contributed to identifying a segment with larger volume of leakage and to reducing it. These additional works were also one of the causes of delay from the original schedule.

The situation of the progress for both pilot areas in June 2011 is summarized below.

#### (1) Pilot area in Kotahena

- **Sub-zone 1 (K1):** The initial NRW reduction activities are completed. Under secondary activities, the 5 inch CI pipe line has already been disconnected and the replacement of bundle pipe, disconnection of existing bundle pipes near the ferrule and transferring of house connections are under progress.
- **Sub-zone 2 (K2):** The initial NRW reduction activities were completed. Measurement of inflow after primary activities is under progress.
- **Sub-zone 3&4 (K3 & K4):** Some defective boundary valves were repaired or installed for completing the isolation. Data collection of "meter condition survey" has been completed. Isolation work in this area is taking long time due to complexity of pipeline network.
- **Sub-zone 3&4 (K5):** Surfacing boundary valves for isolation is in progress
- **Bloemendhar Road (K6):** Pipe replacement work under Japanese ODA lone project in progress. Part of the Bloemendhar road was selected for isolation work as this whole area is relatively difficult to isolate due to complexity of pipe line network. Pre arrangement for measurement of inflow is in progress.

#### (2) Pilot Area in Borella

- **Sub-zone 1 (B1):** After completing NRW reduction activities, the recorded NRW value is in satisfaction level and further inflow measurement will be recorded once per month for monitoring NRW.
- **Sub-zone 2 (B2):** The activities for the leak detection work were completed. The Initial flow measurement work has not been completed. As ultrasonic meter could not get signal from the 12 inch CI pipe line (due to possible internal encrustation and/or severe surface rust/corrosion) the pipe replacement in measurement part is being processed. The replacement works are

delayed due to unavailability of relevant specials and taking long time to purchase the material.

- **Sub-zone 3 (B3):** the zone activities were completed
- **Sub-zone 4 (B4):** the zone boundary was extended due to insufficient number of consumers in early selected area and Isolation work is under progress.
- **Sub-zone 5 (B5):** some defective boundary valves were repaired and Isolation work is under progress
- **Sub-zone 6 (B6):** New boundary valves were installed and Isolation work is under progress
- **Sub-zone 7 (B7):** the zone area was identified and Isolation work is in progress.

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

- **Information and data:** Location of valves cannot 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.
- **Vehicles / drivers:** Sufficient numbers of vehicle and driver are not always available. Field works sometimes suspended without information due to shortage of vehicles. The availability of vehicle is improving.
- **Personnel:** Several assignments are given to the key personnel, while the priority is given to the Project.
- **Overtime:** Since overtime is limited and special approval shall be taken from top management for extra overtime and allowance for night work is not applied, it is difficult to keep incentive for NRW activities.
- **Backhoe:** There are several heavy duty activities which require larger capacity than the back hoes procured in the Project.
- **Permission for road excavation:** Application process is not necessarily taken previously considering the required time.
- **Meter installation:** Replacement of large sized pipes for meter installation taken long time due to material shortage and others.
- **Valves and fittings:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that NRW reduction teams are not accustomed to meter readings.

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

- Review adequate allocation of NWSDB resources (personnel, equipment, budget, etc. )
- Area engineers / OIC take initiative to prepare weekly schedules by reviewing longer term work plan and then instruct the zone officers and EA to take actions according to the plan.
- Zone officers and EA understand the long term plan and find the required preparation works.
- Continue improvement of customer meter reading
- Make understand the contents / filling methods of leak repair records

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 improve the delayed schedule.



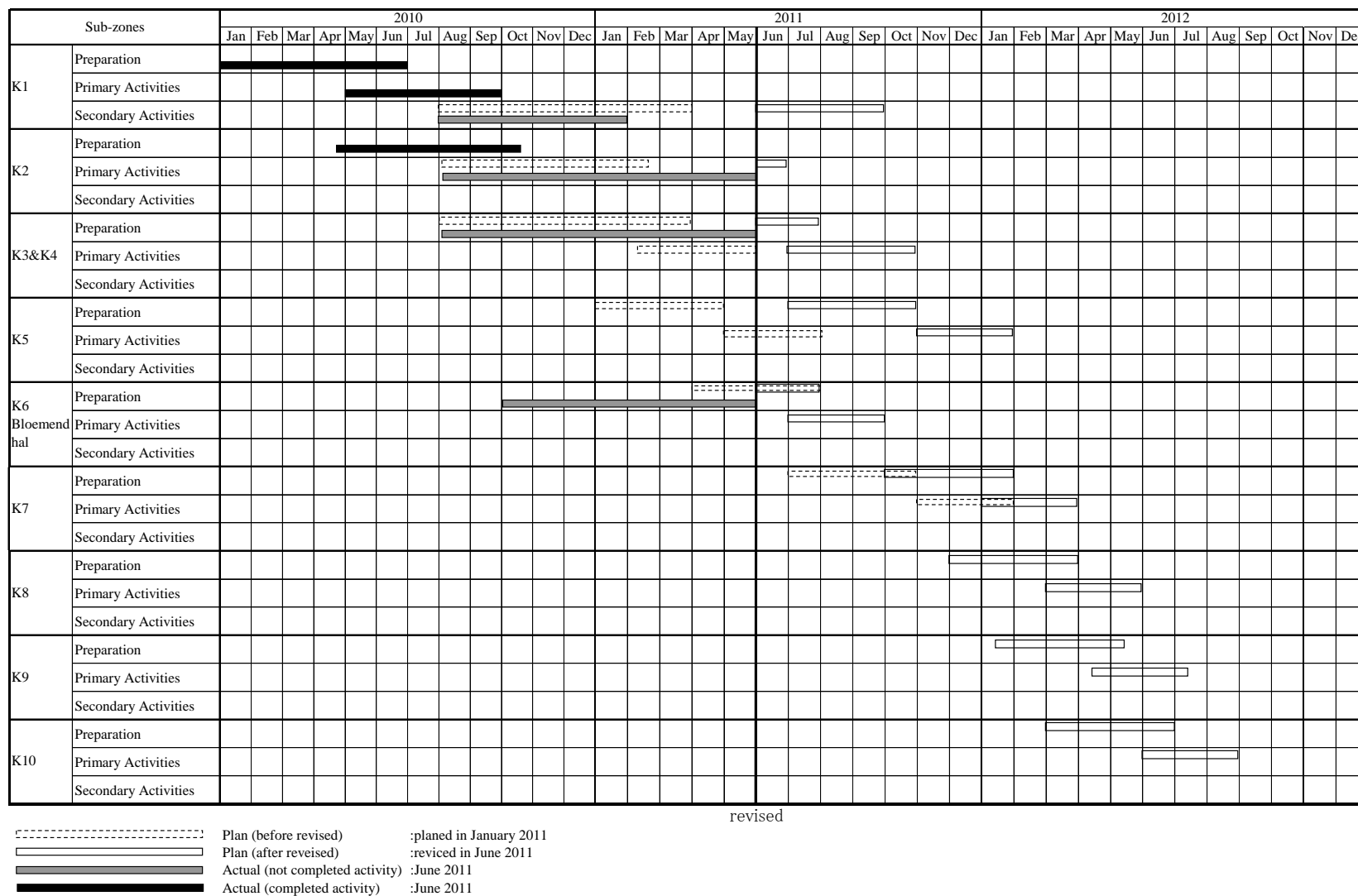
According to the original schedule, at least four or five Sub-zones are expected to be completed in Pilot Areas of Kotahena and Borella by the end of June 2011. However, they are yet to be completed. Major reasons of delay are as follows.

- Isolation works took long time due to inaccurate drawings.
- C/P staff who are engaged in the Pilot Activities as a key member struggle with difficulties in focusing on the activities because they have to take care of other routine works as well.
- JCBs (backhoes) or vehicles cannot always be arranged properly or promptly.
- It took long time to install meter (especially in B2).
- The work progress during JET's absence was slow

On the whole, it is estimated that the original work plan is delayed about three to four months.

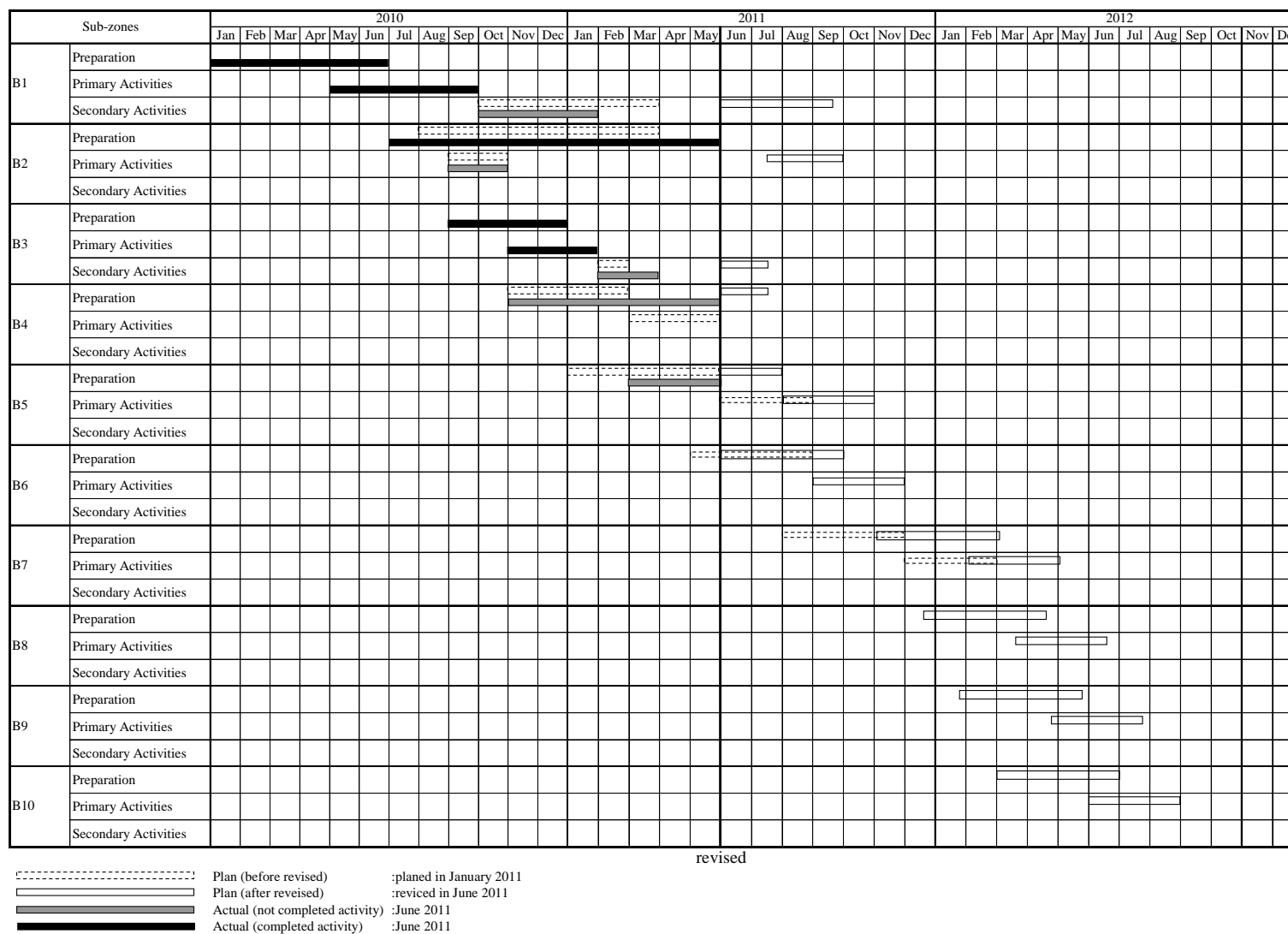
Considering the above, original work plans for both areas have been revised by C/P and JET in June 2011. The tentative schedule for both areas are shown in Figure 3.1-3 and Figure 3.1-4.

## Annex – 1 Annual Program (2)



**Figure 3.1-3 Revised Work Plan (Kotahena)**

# Annex – 1 Annual Program (2)



**Figure 3.1-4 Revised Work Plan (Borella)**

### 3.2 Monitoring and Evaluation of NRW in Pilot Area

#### 3.2.1 NRW in Sub-zone K1

Table 6.1-1 shows the result of analysis of water balance.

**Table 3.2-1 Water Balance in Sub-zone K1**

Component			Water Balance (Before)			Water Balance (After "Primary Activities")			Water Balance (After Leak Repairing under "Secondary Activities")	
			m3/day	(%)		m3/day	(%)		m3/day	(%)
Revenue Water	Billed Authorized Consumption	Metered	190.88	14.74%	=>	248.29	23.85%	=>	248.29	27.05%
		Unmetered								
NRW	Unbilled un-metered		1,104.12	85.26%		792.83	76.15%		669.71	72.95%
	Apparent Losses									
	Real Losses									
Total System Input			1,295	100%		1,041	100%		918	100%
MNF (l/min)			690			480			330	
MNF (converted to m3/day)			993.60			691.20			475	

Note1: Breakdowns of each component are under verification.

Note2: Breakdown of the presented values here is calculated on a trial basis in this report. However, it should be reviewed after completing the "Secondary Activities".

Table 3.2-2 shows summary of works done in this Sub-zone.

**Table 3.2-2 Work Summary in Sub-Zone-K1 (After Activities)**

No	Description		Identified thru "Primary Activities"	Identified thru "Secondary Activities"	Current Status (Feb/2011)	Remarks
1	Public Standpost (Unbilled Authorized consumption)	Found	14	14	14	
		Removed (After Providing individual house Connections )	0	0	0	
2	Unmetered	Found	45	0	45	4 remains
		Metered	41	0	41	
3	Meter working Problem	Found	19	0	19	1 remains
		Replaced	18	0	18	
4	Illegal use	Detected	53	0	53	4 remains
		Legalized or Disconnected	49	0	49	
5	Leakage	Found	52	14	66	
		Service Main	3	1	4	
		Repaired	55	15	70	
6	Leakage/ Overflow from Storage Tanks	Found	2	0	2	
		Repaired	2	0	2	

### 3.2.2 NRW in Sub-zone K2

Table 3.2-3 shows the result of analysis of water balance.

**Table 3.2-3 Water Balance in Sub-zone K2**

Component			Water Balance (Before)			Water Balance (After)	
			m3/day	(%)		m3/day	(%)
Revenue Water	Billed Consumption	Metered	267.45	21.48%	=>	Works under progress	
	Authorized Consumption	Unmetered					
NRW	Unbilled un-metered Consumption		977.55	78.52%			
	Apparent Losses						
	Real Losses						
Total System Input			1,245.00	100.00%	1,148.00		
MNF (l/min)			771		686.1		
MNF (converted to m3/day)			1110.24		987.98		

### 3.2.3 NRW in Sub-zone B1

Table 3.2-4 shows the result of analysis of water balance.

**Table 3.2-4 Water Balance in Sub-zone B1**

Component			Water Balance (Before)			Water Balance (After "Primary Activity")			Water Balance (After "Secondary Activity")	
			m3/day	(%)		m3/day	(%)		m3/day	(%)
Revenue Water	Billed Consumption	Metered	390.12	59.73%	=>	449.35	77.52%	=>	459.45	83.69%
	Authorized Consumption	Unmetered								
NRW	Unbilled un-metered		263.01	40.27%		130.29	22.48%		89.55	16.31%
	Apparent Losses									
	Real Losses									
Total System Input			653.13	100%		579.64	100%		549	100%
MNF (l/min)			312			249			206	
MNF (converted to m3/day)			449.28			358.56			296.64	

*Note1: Breakdowns of each component are under verification.*

Table 3.2-5 shows summary of works done in this Sub-zone.

**Table 3.2-5 Work Summary in Sub-Zone-B1 (After Activities)**

No	Description		Identified thru "Primary Activities"	Identified thru "Secondary Activities"	Current Status (Feb/2011)	Remarks
1	Public Standpost (Unbilled Authorized consumption)	Found	2	0	2	1 remains
		Removed (After Providing individual house Connections )	0	1	1	
2	Unmetered	Found	12	0	12	3 remains
		Metered	9	0	9	
3	Meter working Problem	Found	7	0	7	
		Replaced	7	0	7	
4	Illegal use	Detected	8	0	8	
		Legalized or Disconnected	8	0	8	
5	Leakage	Found	24	12	36	
		Service				
		Main	10	0	10	
		Repaired	34	12	46	
6	Leakage /Overflow from Storage Tanks	Found	1	0	1	
		Repaired	1	0	1	

**3.2.4 NRW in Sub-zone B3**

Table 3.2-6 shows the result of analysis of water balance.

**Table 3.2-6 Water Balance in Sub-zone B3 (Tentative)**

Component			Water Balance (Before)		=>	Water Balance (After fixing Ball Float Valve under "Primary Activity")		=>	Water Balance ("After Primary Activity")	
			m3/day	(%)		m3/day	(%)		m3/day	(%)
Revenue Water	Billed Authorized Consumption	Metered Unmetered	186.19	15.74%		186.19	49.41%		201.29	71.38%
NRW	Unbilled un-metered		996.81	84.26%		190.64	50.59%		80.71	28.62%
	Apparent Losses									
	Real Losses									
Total System Input			1,183.00	100.00%		376.83	100.00%		282.00	100.00%
MNF (l/min)						106.00			54.53	
MNF (converted to m3/day)						152.64			78.52	

Note1: About 28 % of results of customer meter reading (After) are not yet completed due to closed house. Accordingly, assumed value has been tentatively employed in calculation.

Note2: The above table shows tentative result and should be finalized after completion of the "Secondary Activities".

Note3: Breakdown of the presented values here is calculated on a trial basis in this report. However, it should be reviewed after the "Secondary Activities".

Table 3.2-7 shows summary of works done in this Sub-zone.

**Table 3.2-7 Work Summary in Sub-Zone-B1 (After Activities)**

<i>No</i>	<i>Description</i>		<i>Identified thru "Primary Activities"</i>	<i>Remarks</i>
1	Public Standpost (Unbilled Authorized consumption)	Found	0	
		Removed (After Providing individual house Connections )	0	
2	Unmetered	Found	14	
		Metered	14	
3	Meter working Problem	Found	20	3 remains
		Replaced	17	
4	Illegal use	Detected	19	
		Legalized or Disconnected	19	
5	Leakage	Found	19	
		Service	0	
		Main	0	
6	Leakage/ Overflow from Storage tank	Repaired	19	
		Found	1	
		Repaired	1	
		Found	1	

### 3.3 Evaluation of Project Activity

#### 3.3.1 Implementation status of activities

##### (1) Project as a whole

Major activities, such as commencement of the pilot project, conduct of the seminars and workshops, provision of training opportunities in Japan and Jordan, etc., were carried as planned. However the pilot project activities had some delay from the work Plan as following manner.

##### (2) Pilot project activities

In the pilot areas, NRW Reduction Teams started activities based on the work plans. After the commencement of pilot activities, it became clear that the existing pipeline network drawings have not been properly updated and also the actual conditions of pipeline network were poorer and more complicated than the JICA experts expected, and these facts lead to a delay in basic activities such as hydraulic isolation and system input measurement. The work plans were revised several times in accordance with the actual progress of these activities.

In addition, currently the pilot activities are again behind schedule since (i) the assigned C/Ps are busy with their routine works and thus unable to spare enough time to implement pilot activities as scheduled in the work plans and (ii) members of NRW reduction team are often unable to go to the sites due to the shortage of vehicles. The measures to solve these issues should be urgently taken.

As for the personnel issue, filling the cadre of EAs and increasing at least two task units from O&M section which will fully get involved in the pilot activities are under consideration. As for the vehicle issue, hiring vehicles is considered and now in process as an interim measure. In addition, the possibility to purchase vehicles under a different project is being explored as a fundamental measure for this issue.

### **3.3.2 Implementation status of monitoring**

Up to now, the joint coordinating committee (JCC) meetings were held five times. At the meetings, participants such as NWSDB's executives, i.e. General Manager (GM), Additional General Manager (Addl. GM) and Deputy General Manager (DGM), were well informed about the progress of the entire project as well as the findings of pilot activities. Thus, it can be said that JCC functions well as a monitoring mechanism. Details such as agendas and participants of each JCC meeting are recorded in the minutes.

As for the pilot activity level, the weekly meeting held on each Tuesday functions well as a monitoring tool. Up to the end of July, the meetings were held 48 times with participation of not only members of NRW Reduction Team but also primary members of NRW Reduction Management Team. The meeting functions well as opportunities to review the progress of pilot activities discuss difficulties and their countermeasures and exchange technical information.

In addition, "NRW Meeting" coordinated by DGM (Western-Central) and participated by the related senior officers are held monthly at NWSDB. According to DGM, all the NRW related issues including the Project are discussed at this meeting; this opportunity enables the senior officers to update their information regarding the Project.

As seen above, the monitoring mechanism can be concluded as clear and appropriate. This is supported by the fact that the reasons behind the delay of pilot activities, namely insufficient human resources and vehicles, are well known among the relevant officers and engineers. Currently C/Ps and the JICA experts are trying to find effective countermeasures.

### **3.3.3 Relationship between Sri Lankan C/Ps and Japanese experts**

Both the JCC meetings and the weekly meetings are held regularly, and participants exchange views and information well at these meetings. Thus, it can be said that status of communication is indeed well. This is supported by the fact that (i) the NWSDB's executives understand the Project well and (ii) participation of NRW Reduction Team members in the weekly meeting is generally good. According to the interview with C/Ps, it became clear that status of communication between engineers at sites and the JICA experts is especially good since the project activities are concentrated in the pilot areas during the first half of the project period.

C/Ps of the Project are selected from both NRW section and O&M section, since O&M section has also been in charge of NRW reduction activities such as leak repair. Indeed, engineers from both sections are well engaged in the pilot activities; AGMs of both sections are members of NRW Reduction Management Team, and therefore it can be said that appropriate C/Ps were selected for the Project.

It is true that C/Ps reiterated (i) the difficulty to handle both their routine works and the pilot activities and (ii) shortage of vehicles. However, it is also true that C/Ps highly appreciate the



Project and the new knowledge and techniques transferred through the pilot activities. Additionally, the project leader, who is an active member of NRW Reduction Management Team and also the AGM of NRW section, confirmed that C/Ps in the pilot areas became proactive and assertive, and explore countermeasures whenever necessary by themselves

## Chapter 4 GIS &PR

### 4.1 Demand of GIS and PR activities

Through the 1<sup>st</sup> year activities, it was found that GIS introduction and PR activities are effective to advance NRW activities further. The details of demand for GIS and PR activities are described hereinafter.

#### 4.1.1 GIS

NWSDB has already introduced GIS software (AutoCAD Map 2000) for the Greater Colombo area by the NORAD's aid in 2000. Although this NORAD's aid really helped NWSDB to take very first step to create base map, NWSDB faces some problems/difficulties as follows currently.

- The above Norwegian aid focused on rather covering broader area (Greater Colombo Area) than going for preparing detailed/accurate map. In addition, functions available in GIS software are not utilized.
- This digitized map contains only limited features such as roads, boundary of major buildings, location of distribution line (2 inches or more) and location of valves.
- Pipeline drawings are not always available at AE/EA level who are engaged in day-to-day O&M work.
- Mapping Section does not create/update detailed part of drawings.
- The above software and PCs used in Mapping Section are outdated and remain un-upgraded due to budget constrain, lack of future vision on renewal and others.

These issues are mainly attributed to lack of necessary facility (PC/software). In order to fully utilize data from day-to-day works and this project activities, it is important to furnish necessary hardware and software for AE/EA level.

The aim of GIS introduction is that staff of AE/EA being involved in the Project will be able to access/update the drawings easily/quickly. Then NWSDB can advance NRW activities further.

#### 4.1.2 PR Activities

Water was supplied free during the time water was distributed by the Municipal Council, in the underserved settlements most of the occupants do not realize the value of potable water. The NWSDB provides concessionary individual water supply in lieu of disconnection of common outlets. It is realized the people need to be continuously made aware about the cost of water, use of water in an economic manner, contribute towards reduction of water in the system etc. Under capacity development project for NRW reduction in Colombo City structured method was adopted to reduce losses occurring in the distribution system, in implementing that observations made are given below

- Some customers are reluctant to accept the survey and it is not easy to enter the premises.
- Customers complain on interruption of water supply, re-location of customer meters etc. during the pilot project activities.
- Many residents do not know the penalty on illegal connection and it is difficult to discourage illegal connection.
- Consumers do not hesitate to tamper (repair or re-arrange) service connection by themselves.

- It is difficult to reduce wastage of free water from Public standposts. Users do not care water conservation and keep water running even when it is not used.

In order to advance NRW activities further, NWSDB needs to get cooperation from public and heighten the public knowledge about usage of water.

At present, NRW activities are carried out only by the staff involved this project. After this project, NWSDB needs to extend these activities for the entire Colombo City. Thus it is necessary that NWSDB directs the way of NRW activities to EA/AE staff in except for the pilot project areas.

## **4.2 Plan of GIS**

### **4.2.1 Expected Results/Effects within the Project Period**

It is very useful to incorporate information obtained through the Project into existing data for utilization. Since NWSDB already has the basic knowledge of GIS, it will be relatively easy to renew GIS to the Colombo city water supply scheme and to achieve the expected results/effects within the project period as listed below:

- 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.
- Knowledge on appropriate scale for plot-out according to usage/purpose can be obtained.

In addition to above, following effects can be expected in the future:

- GIS will be useful for asset management and generation of network statistics.
- Database will be useful for planning of meter/pipe replacement
- GIS will be very useful for designing and hydraulic modeling
- GIS will be helpful to centralize the information.

### **4.2.2 GIS Activities in the Pilot Area**

Following activities will be done for GIS preparation 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

Among the above, “Relationally linked with customer database” will be very useful. At present Colombo City is having consumer data base link to the billing activates with consumer relations. These data can effectively be used with GIS system.

#### 4.2.3 Overall Schedule

	2011								2012									
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
Procurement of equipment	■	■	■															
Team organizing	■																	
Base map preparation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Basic training			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Field survey (meter location)				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Data input (pipeline, meter, leak, etc.)									■	■	■	■	■	■	■	■	■	■
Practical use in daily O&M													■	■	■	■	■	■

\* dotted line represents intermittent work

#### 4.2.4 Manpower Input by NWSDB for the Project

It was 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.

#### 4.2.5 NWSDB's Organization for Future Expansion

The expansion of this exercise would continue for the other 20 zones in Colombo city, in a planned manner for another 10 years by using the staff who have improved their skills under this Project. The mapping section would continue to maintain the updated version and the Maligakande office would keep updating the newly found information. AE office and OIC office facilities would be improved to access the information for their daily routine work and inform any updating when required. Additional work involve in this work can be coped up by filling existing vacancies in Mapping section.

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.

#### 4.2.6 Funding

##### (1) Running Cost for the Project

To meet the expenses of consumables for the pilot project approximately Rs 500,000/= per year allocation would be made.

##### (2) Initial Investment for Expansion

To expand to Colombo City it is estimated approximately Rs. 26.5m is required. This investment could be made over a period of 10 years by incorporating in the annual budget in a planned manner.

#### **4.2.7 Role and Manpower Input by JICA for the Project**

- Role
  - Planning, assistance for procurement, training, assistance for base map preparation, advise on execution by NWSDB
- Input
  - JET: 2 MM
  - Local: 20 MM

#### **4.2.8 Procurement:**

Necessary hardware and software to be procured under the Project is listed in the following table. .

**Table 4.2-1 Procurement Plan of GIS**

<i>Package</i>	<i>Item</i>		<i>Specification/Reference Model</i>	<i>Qty</i>		<i>Remarks</i>
1	GPS	High Accuracy Hand-held GPS	Sub meter after post processed differential correction. (Geo Explorer XT 2008 Series Hand Held GPS)	2	Unit	
2	PC & Accessories	Desktop PC	OS (Windows7 Professional, 64 bit) bundled, w/sufficient CPU/RAM/monitor, internationally recognized brand.	6	Unit	<ul style="list-style-type: none"> <li>• One for Mapping Section</li> <li>• One for Maligakanda Office</li> <li>• Two for AEs (Kotahena, Borella)</li> <li>• Two for OIC (Kotahena, Borella)</li> </ul>
		External HDD	500GB, for system & data backup, compatible with Win7 Pro 64 bit	6	Unit	
		UPS	650 VA	6	Unit	
		Printer	A3 size, inkjet w/ spare cartridges (5 magenta, 5 yellow, 5 cyan, 10 black.), compatible with Win7 Pro 64 bit	4	Unit	<ul style="list-style-type: none"> <li>• Two for AEs (Kotahena, Borella)</li> <li>• Two for OIC (Kotahena, Borella)</li> </ul>
		A4 Scanner	A4 size, compatible with Win7 Pro 64 bit	1	Unit	
	Basic Software	MS Office	MS Office Professional 2010, compatible with Win7 Pro 64 bit	6	License	<ul style="list-style-type: none"> <li>• Only 1-year subscription is available.</li> <li>• Need to purchase new license for another 1 year.</li> </ul>
		Virus Protection	Kaspersky Internet Security 2011	6	License	
3	Plotter	Plotter	A0 size, inkjet w/ spare cartridges/printer heads/roll papers, compatible with Win7 Pro 64 bit	1	Unit	• For Maligakanda
4	GIS Software-0	Image Processing	ERDAS Imagine 9.2 Professional, Single User, compatible with Win7 Pro 64 bit	1	License	• For Mapping Section
5	GIS Software-1	View/edit for base map and spatial analysis	ArcView 10 Desktop, compatible with Win7 Pro 64 bit	2	License	• One for Mapping Section, one for Maligakanda Office
6	GIS Software-2	View/edit for facility data	AutoCAD Map 3D 2011 Commercial New SLM, compatible with Win7 Pro 64 bit	4	License	• For 2 AEs and 2 OICs
7	Data	Satellite Image	Processed Image, June 2010 or later, 0.50m/0.60m high resolution, multi-spectrum, pansharpened, True Colours, Mosaic Image	100	sq.km	<ul style="list-style-type: none"> <li>• Covering entire Colombo City</li> <li>• There are two options in processing, thru satellite image company or thru local distributor.</li> </ul>
			FTP Conversion	1	time	

### **4.3 Plan of PR Activities**

#### **4.3.1 Expected Results/Effects within the Project Period**

Expected Result/Effects by PR activities are listed below.

- Public get the knowledge about the cost of water, use of water in an economic manner, and contribution towards reduction of water in the system.
- NWSDB staff who would be potentially engaged in NRW activities in Colombo City in future can understand NRW activities and the way to reduce Non-revenue water.
- Achievement of NRW is advanced by the citation/awarding to staff who contributed to Pilot Project activities.

In order to achieve above issues, NWSDB needs to implement PR to public and internal PR to NWSDB.

#### **4.3.2 Activities to be done**

(1)PR to public

School children are being made aware about the importance of potable water by having lectures in schools. This method could be changed by encouraging them to draw and communicate to the public and fellow students. Various methods have to be introduced and most appropriate method could be continued thereafter.

Some of the communication that is proposed are preparation of video, posters, having competitions etc. This could be done in the pilot area which could be used for other areas in Colombo City.

(2)Internal PR to NWSDB

The PR activities in NWSDB are following:

- Encourage other NWSDB staff who would be potentially engaged in NRW activities in Colombo City in future to participate to the seminars/workshops to be held under the Project.
- Citation/awarding to staff who contributed to Pilot Project activities.

#### **4.3.3 Organization**

In Western Central Regional Support Centre there is a public relation officer who reports directly to the DGM. Presently all public relation work is initiated through this officer. In this PR activity this officer would be involved further the commercial officers who at the moment involved in the pilot zone work would be used to convey the developed posters/ messages to the customer who visit the officer.

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.

#### **4.3.4 Budget**

Budgetary provision will be made available to meet the expenses for the consumables and staff cost.

#### **4.3.5 JICA Experts Role**

The JICA experts would guide the PR activity, assist in developing the PR material and writing of video production script while NRW reduction management team and the public relation officer will take the initiative.

## Chapter 5 SCHEDULE OF THE ACTIVITIES

### 5.1 General

For smooth and effective implementation of the countermeasures and for easy monitoring and evaluation of the project activities, C/P and JET are jointly formulating a sub-zoning plan. This sub-zoning plan intends to divide a pilot area with the scale of 5,000 connections into smaller areas with the scale of about 500 connections. Order of implementation or practical schedule in each sub-zone was jointly prepared by C/P and JET. It will be modified /updated to suit the progress.

NRW reduction activities to be conducted under this Project will be supported by regular budget allocated to NRW Section and O&M Section of NWSDB. However, charges or taxes related to custom clearance for equipments and machineries to be donated by Japanese side will be specially earmarked by NWSDB. NWSDB side considers that “requesting budget on a case-by-case basis” is more realistic than “preparing special budget in advance” to cover additional or unexpected works. Accordingly, NWSDB side has allocated more budget to both NRW Section and O&M Section than the last year, so that the both sections can cover necessary cost for extra personnel input, overtime, labor, vehicle, etc. for the Project activities on a priority basis. In this connection, NWSDB has intention to extend its Project activities beyond the target Pilot Areas of the Project, as a part of its regular work program.

As for the numerical target setting of NRW reduction by the Project, JET and C/P side share the view that it is more practical to consider it after execution of the activities in a few sub-zones. The major target at the initial stage is to improve the capability of staffs, to know the actual situation of NRW and to find the effective methods for NRW reduction.

#### 5.1.1 Activities for Output 1

Table 5.1-1 summarizes the activities related to "Output 1".

**Table 5.1-1 Activities for the "Output 1"**

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.	
No.	Activities
<b>1-1</b>	Organize a “NRW Reduction Management Team” at Western-Central Regional Support Center.
<b>1-2</b>	Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region".
<b>1-3</b>	Prepare an annual program of NRW reduction activities for the pilot areas.
<b>1-4</b>	Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams".
<b>1-5</b>	Assess progress of NRW reduction activities in the pilot areas.
<b>1-6</b>	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.
<b>1-7</b>	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

### 5.1.2 Activities for Output 2

Table 5.1-2 summarizes the activities related to "Output 2".

**Table 5.1-2 Activities for the "Output 2"**

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	
<i>No.</i>	<i>Activities</i>
<b>2-1</b>	Select two (2) pilot areas.
<b>2-2</b>	Organize "NRW Reduction Team (a group of OIC, EA and gangs)" at the pilot areas.
<b>2-3</b>	Review and modify pipeline network drawings of the pilot areas by using GIS, which shall be used for the NRW reduction activities
<b>2-4</b>	Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio.
<b>2-5</b>	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.
<b>2-6</b>	Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team".
<b>2-7</b>	Implement NRW reduction activities according to the work plan.
<b>2-8</b>	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.

(Revised version after JCC, 22. 6. 2011)

### 5.2 Schedule

Figure 5.2-1 shows the work flow of the entire activities.

Following activities are scheduled in second year.

#### **Activities Related to Output1**

- Revision of the Annual Program
- Prepare an Annual Program of NRW Reduction Activities
- Review Existing Training Programs Related to NRW Reduction and Conduct the Training for "NRW Reduction Teams"
- Assess Progress of NRW Reduction Activities in the Pilot Areas

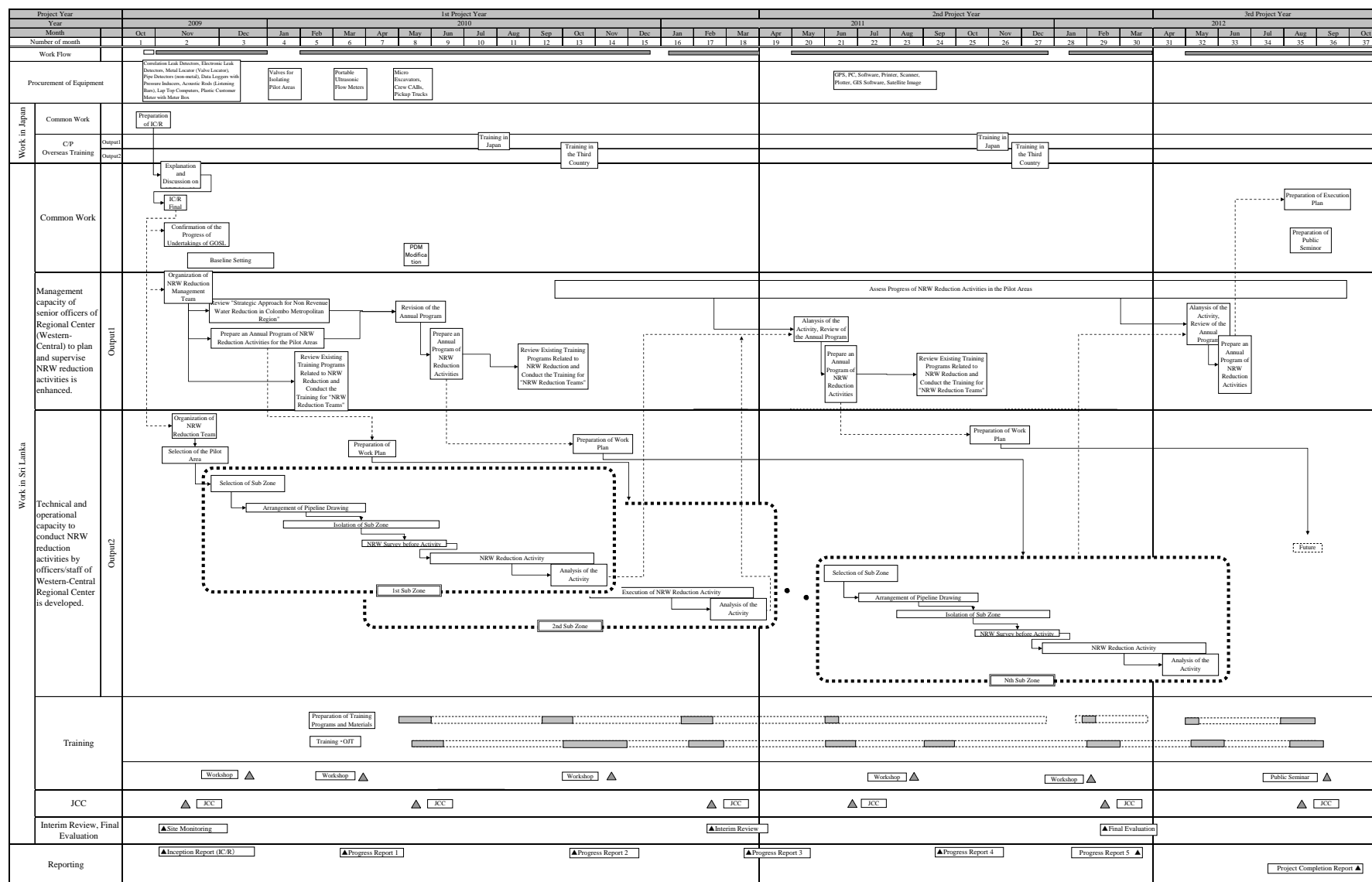
#### **Activities Related to Output2**

- Arrangement of Pipeline Drawing for sub zones
- Selection and Isolation of sub zones
- NRW Survey before Activity for sub zones
- NRW Reduction Activity for sub zones (this activity will continue up to third year)
- Analysis of the Activity for sub zones (this activity will continue up to third year)
- Preparation of Work Plan for sub zones

#### **Other Activities**

- Preparation of Training Programs and Materials
- Training / OJT
- Progress Report 4 and 5
- Training in the Third Country / Japan
- PDM Modification

# Annex – 1 Annual Program (2)



**Figure 5.2-1 Work Flow of the Future Activities**

## Chapter 6 INPUT

### 6.1 Input

At the time of the 1<sup>st</sup> JCC, budget allocation was decided as follows.

- The Sri Lankan side allocates necessary budget according to the R/D and the M/M on this Project (signed on 22 April 2009), to ensure effective implementation of the Project.
- NWSDB ensures that the budget for customs duties/taxes, 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.

As mentioned the above, it was decided to subsidize the expenses related to the Project activities from the regular budget of NRW Section and O&M Section. Afterward, budget plan for the total period of the Project was prepared as Table 6.1-1.

**Table 6.1-1 Total Estimated Cost for the Capacity Development Project for NRW Reduction in Colombo City – 2010, 2011 and 2012**

Se. No.	Description	Unit	Qty	Rate	Amount
<b>1</b>	<b><u>STAFF</u></b>				
a	Allow for Engineering Assistants. Rate to include Salary, Over time and Subsistence for three years for 06 nos of EAA	item			21,830,040.00
b	Allow for Skilled Labourers. Rate to include Salary, Over time and subsistence for three years for 06 nos of Fitters and 06 nos of Drivers	item			32,531,112.00
c	Allow for Un Skilled Labourers. Rate to include Salary, Over time and Subsistence for three years for 12 nos labourers	item			30,005,856.00
<b>2</b>	<b><u>TRANSPORT</u></b>				
a	Allow for cost of Vans. Rate to include Fuel cost, Services, Tyres & Tubes and Repair & Maintanance cost for 04 nos of Vans for three years.	item			2,882,400.00
b	Allow for cost of 02 nos of Hired Vehicles for three years	item			4,320,000.00
<b>3</b>	Allow for cost of Excavators. Rate to include Fuel Cost, Services, Tyres & Tubes and Repair & Maintanance cost for 02 nos of Excavators for three years	item			6,302,400.00
<b>4</b>	Cost for purchasing of Concrete Chambers.	Nos	180	50,000.00	9,000,000.00
<b>5</b>	Allow for cost of Taxes and custom duty for Vehicles and Equipment.	item			22,000,000.00

Annex – 1 Annual Program (2)

6	Allow for cost of Valve Raising work for three years.	item			3,000,000.00
7	Allow for cost of Leak Repaired work for three years. Rate to include 80 nos of leaks repaired per month approximately.	item			4,320,000.00
8	Allow for cost of Materials for Leak Repair works for three years.	item			15,000,000.00
9	Allow for cost of scraping and Lining of Pipe Lines for three years.	item			6,000,000.00
10	Allow for cost of Purchasing of 10 nos of Car Batteries and 02 nos of Battery Charges.	item			90,000.00
11	Office Refurbishment including Partitioning, Airconditioning, Furniture, etc.	item			2,500,000.00
	<b>SUB TOTAL 1</b>				159,781,808.00
12	Allow for cost of Road Re-instatement charges. Rate to include for installing valves & Meters and for Leak Repair works for three years.	item			3,300,000.00
	<b>SUB TOTAL 2</b>				163,081,808.00
13	Allow for 10% contingencies				16,308,180.80
	<b>SUB TOTAL 3</b>				179,389,988.80
14	Allow for VAT 12%				21,526,798.66
	<b>GRAND TOTAL</b>				200,916,787.46

The above cost has been approved by NWSDB, and required budget for each year was allocated from the total budget. However, Ministry of Finance has not approved the budget for this project and NWSDB is negotiating with the Ministry. At present the normal budget for O&M section and NRW section is used for this project.

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

**ANNUAL PROGRAM  
FOR  
NRW REDUCTION**

**prepared under the activities of**

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

**June 2012**





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## Chapter 1 PURPOSE AND EXPECTED OUTPUT

### 1.1 Purpose and Outputs of the Program

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”:

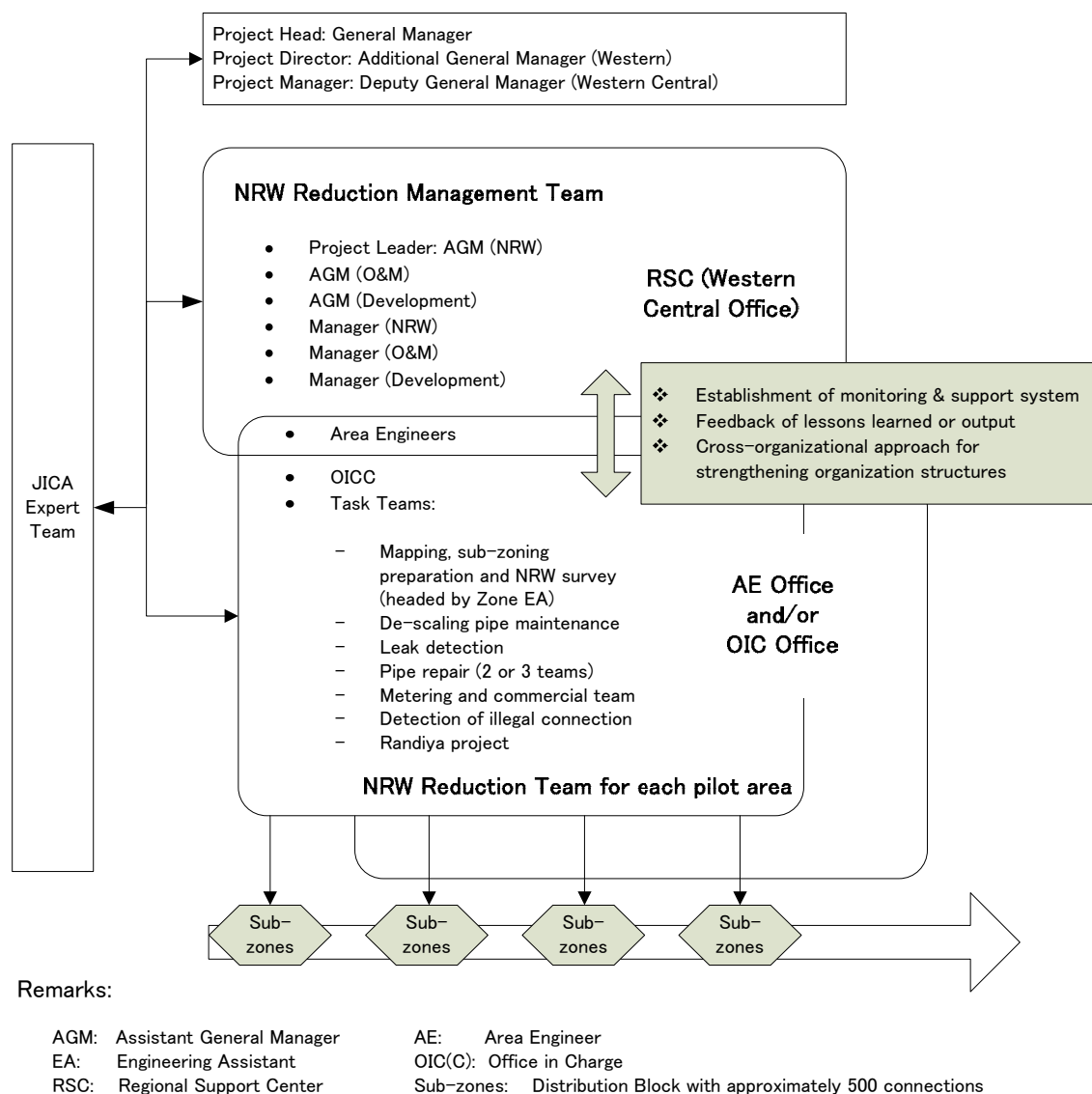
- 2-1 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan.
- 2-2 NWSDB officers/staff engaged in “NRW reduction Teams” acquire proper leak detection, plumbing and pipe repairing skills.
- 2-3 An average NRW ratio in the pilot areas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

## 1.2 Target Personnel for Training

Organization Structure for Project Activities based on the R/D signed on 22<sup>nd</sup> April, 2009, is as shown in Figure 1.2-1.



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

**Figure 1.2-1 Organization Structure for Project Activities**

### 1.2.1 Organization of NRW Reduction Management Team

Members of NRW Reduction Management Team have been appointed based on R/D.

### 1.2.2 Organization of NRW Reduction Team

Structural Image of NRW Reduction Team is shown in Figure 1.2-2.

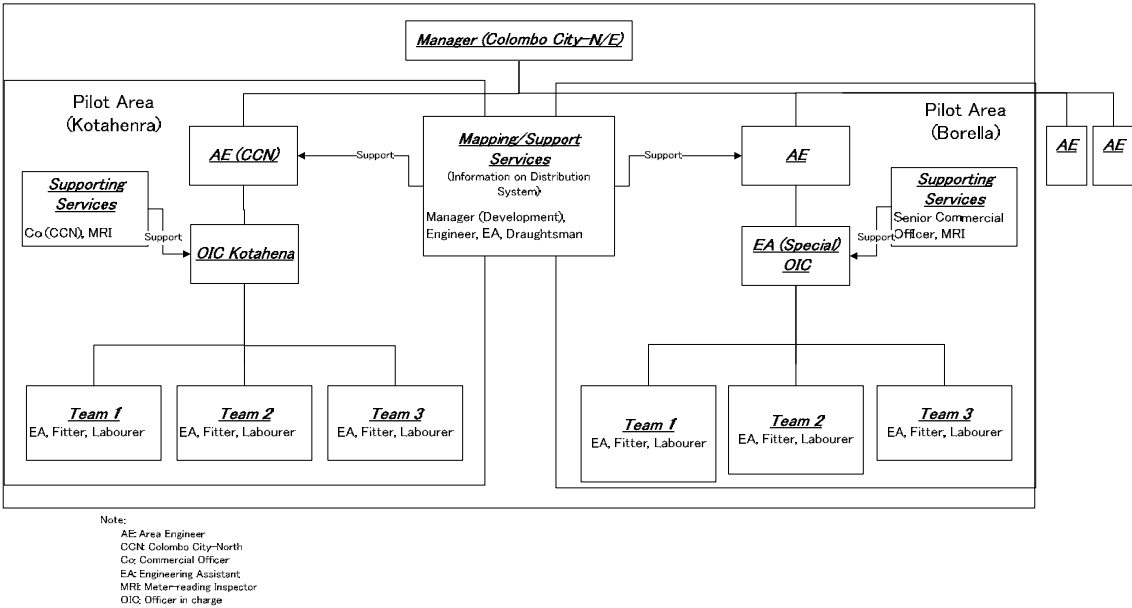


Figure 1.2-2 Structural Image of NRW Reduction Team

## Chapter 2 OUTLINE OF THE PILOT PROJECT

### 2.1 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.

### 2.2 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 39<sup>th</sup> 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 2.2-1.

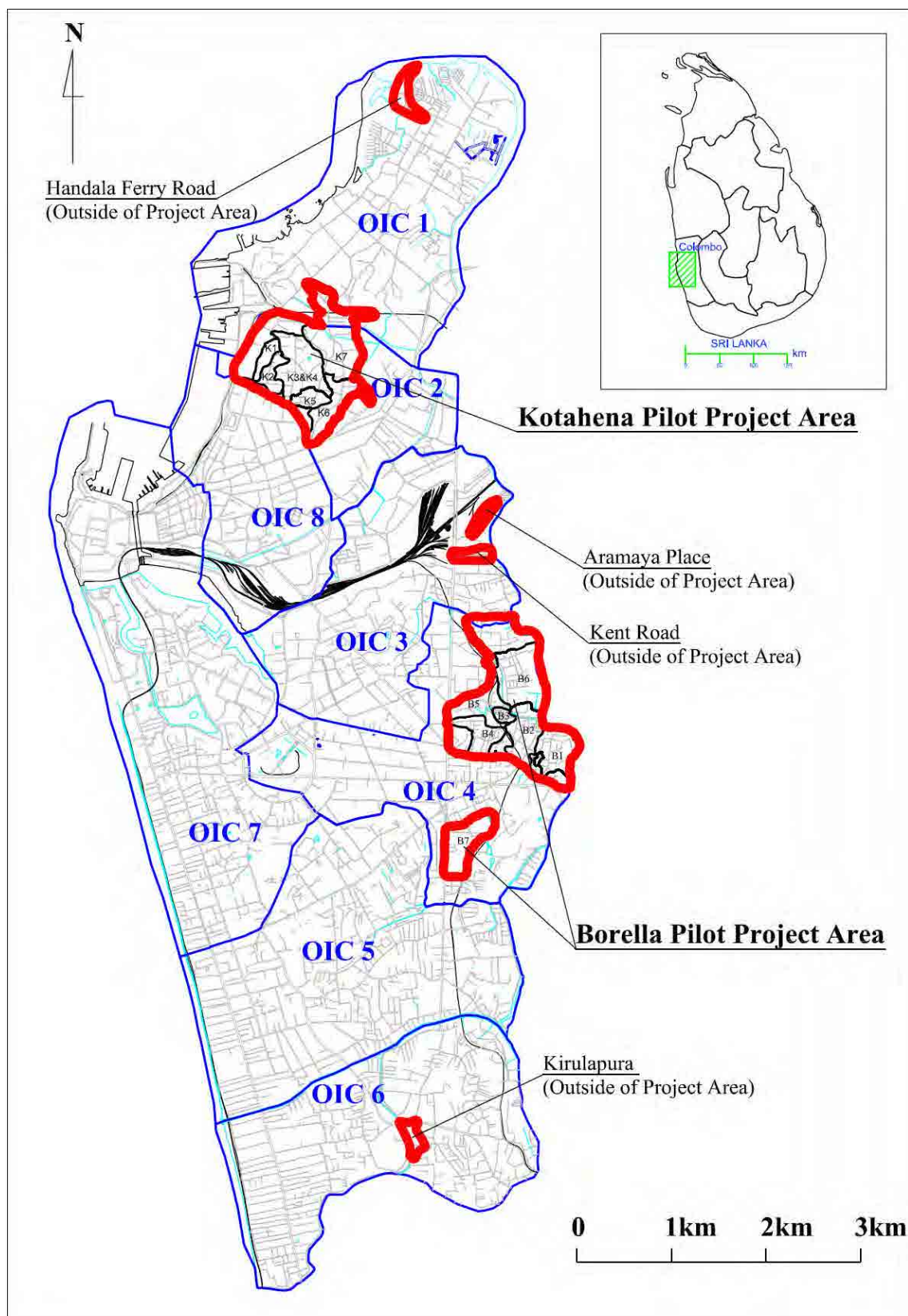


Figure 2.2-1 Locations of Pilot Project Area (Kotahena & Borella)





- Accordingly, a series of step tests were carried out in order to identify high MNF areas, with trying and seeing the effect of a series of abandonment of the CI pipe line and transferring of the house connections from CI to PVC.
- In addition, rectification works to cancel bundled pipe to re-connect service pipes to branch line have been completed in 17 locations (out of 18 in total). In spite of these rectification works, NRW rate remained still high.
- A series of step tests were carried out to narrow down suspicious part of area that would be a cause of high-NRW. With reference to the result, additional one valve was installed to narrow down further in the suspected section. Several reasons were suspected for high NRW (eg., unidentified leakages or illegal connections, unidentified pipelines that is not shown on the existing database, potential leakage generated from newly-installed common pipes due to poor workmanship) in this area. At present, following works are being conducted. MNF will be measured again after these works.
  - Flow measurement conducted at the branching point of newly-installed common pipe, for the purpose of checking if any leaks in common pipe. In this work, the team member visited every customer who are connected to the newly installed common pipe to request close the valve before meter. According to the result of flow measurement, water flow were observed even after closing every customer's connection. Accordingly, NRW Reduction Team is now tracing the reason (eg., leakage in new common pipe may be suspected due to poor installation, previous trial for closing all connected customer might have been incomplete).
  - Excavation work is considered to search if any unidentified bundle pipes.
- Recent three-months billing record is being collected and reconfirmed. This work is still being processed.
- **Sub-zone 2 (K2):**
  - The initial NRW reduction activities (Primary Activities) are completed. However, NRW ration remains high. Accordingly, further leakage survey was conducted as a part of the Secondary Activities.
  - As NRW remains still high, step tests including correlation tests are being conducted to narrow down suspicious section of high NRW.
  - Works for bundle pipe cutting and common pipe laying are planned making use of surplus of the project fund of "Greater Colombo Water Supply Rehabilitation Project (GCWRP)" by NWSDB.
- **Sub-zone 3&4 (K3 & K4):**
  - Some defective boundary valves were repaired or installed for completing the isolation. Data collection of "meter condition survey" was completed. Isolation work in this area have been taking long time due to complexity of pipeline network.
  - Isolation has once been confirmed. However, the NRW Reduction Team identified that as a result of isolation, water pressure in proximity area of the sub-zone dropped down. In order to minimize this affect, area of the sub-zone has been extended and isolation is to be confirmed soon.
- **Subone 5 (K5):**
  - Valve surfacing works have been commenced.
  - Further works (replacement of defective valves or newly installation) are to be commenced after isolation works for K3 & K4, due to convenience of work force arrangement.
- **Sub-zone 6 (K6: Bloemendhar Road):**

- Before completion of the pipe replacement work under Japanese ODA loan project, isolation work and initial measurement has been conducted.
- The above pipe replacement work along this area was completed. Connection work to individual houses are underway.
- Initially, additional works such as meter installation to inlet of sump for apartment or preparation for pit for ultrasonic sonic meter had been planned. However, due to limitation at the site, it was decided that sumps for apartment have been excluded from the measurement.
- After completion of connection work to houses, flow measurement will be conducted to verify the effect of pipe replacement.
- **Sub-zone 7 (K7):**
  - Boundary of the sub-zone has been determined. Isolation work is being underway.

## (2) Pilot Area in Borella

- **Sub-zone 1 (B1):**
  - All NRW reduction activities were completed and NRW value was established.
- **Sub-zone 2 (B2):**
  - After long time suspension due to unavailability of couplings that match to bulk meter to be installed and existing 12-inch CI line, the initial measurement has recently been conducted. Initial NRW is now being calculated.
  - The Primary Activities (leak repair, malfunctioning meter replacement and so on) are to be conducted.
- **Sub-zone 3 (B3):**
  - All NRW reduction activities were completed, and NRW value was established.
- **Sub-zone 4 (B4):**
  - As the isolation works in this area turned out to be taking long time, this sub-zone were further divided into two areas, namely Magazine Rd. area and Fairfield Rd. area. Isolation were confirmed in both areas.
  - Initial NRW has been established in this area.
  - Initial NRW remained high. Accordingly, it was decided to conduct Secondary Activities. Leak repair works under the Secondary Activities are being processed.
- **Sub-zone 5 (B5):**
  - Isolation works is being processed and completed soon.
- **Sub-zone 6 (B6):**
  - Isolation works is being processed and completed soon.
- **Sub-zone 7 (B7):**
  - Boundary of the sub-zone has been determined. Isolation work is being underway.

## (3) Difficulties Encountered

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

- **Information and data:** Location of valves cannot 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 exists 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 takes

extremely long time. In addition, hydraulic isolation works have to be subject to a try-and-error approach due to existence of unexpected interconnections and this also takes long time.

- **Vehicles:** Moderate numbers of vehicle are 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 prevents the moves of additionally introduced activities such as GIS/GPS activities and PR activities do not proceed due to shortage of vehicles.
- **Personnel:** After assigning the two teams to concentrate on the Project, progress of the pilot activities begin to improve. However the activities are sometimes suspended due to unexpected reasons such as union activities and health problem sometimes.
- **Permission for road excavation:** Application process is not necessarily taken previously considering the required time. This problem contribute to taking long time in isolation works especially in B4 and B6.
- **Meter chamber:** Preparation of meter chambers to be installed in heavy traffic roads takes times.
- **Materials and tools:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability. Due to uncertain whereabouts of necessary materials or tools, NWSDB sometimes faces difficulties in preparing necessary materials/tools at necessary time. This is one of major concern to take long time for isolation works especially in B4 and B6.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that service pipes are installed inside house building in many cases and it is required to ask permission for the meter checking from the customers.
- **Activities during absence of JET:** JET views that the progress during the absence of JET was not good enough as expected. JET feels that project activities were suspended whenever trouble/problem arose. JET also concerns that priority of the Project activities for NWSDB side would be lowered during the absence of JET.

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 improve 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. Therefore progress can be expected in these sub-zones. 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 are discussed and will be applied to the remaining sub-zones. Therefore further progress in those remaining sub-zones can be expected.

### 3.1.3 NRW in Pilot Area

#### (1) NRW in Sub-zone K1

Table 3.1-1 shows the result of analysis of water balance.

Table 3.1-1			Water Balance in Sub-zone K1								
	Initial Measurement			After Primary Activities			After 2nd Activities			Before 3rd Activities	
	m3/day	(%)		m3/day	(%)		m3/day	(%)		m3/day	(%)
RW	190.9	14.7%		248.3	23.8%		248.3	27.0%		248.3	19.6%
NRW	1,104.1	85.3%		792.8	76.2%		669.7	73.0%		1,019.7	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										(activities resumed after 6 months)	

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

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

Table 3.1-2 shows summary of works done in this Sub-zone.

**Table 3.1-2 Work Summary in Sub-Zone-K1 (After Activities)**

No	Description		Identified thru "Primary Activities"	Identified thru "2 <sup>nd</sup> Activities"	Identified thru "3 <sup>rd</sup> Activities"	Current Status (Jan/20112)
1	Public Standpost (Unbilled Authorized consumption)	Found	14	14		14
		Removed (After Providing individual house Connections )	0	0		0
2	Unmetered	Found	45	0		45
		Metered	41	0		41
3	Meter working Problem	Found	19	0		19
		Replaced	18	0		18
4	Illegal use	Detected	53	0		53
		Legalized or Disconnected	49	0		49
5	Leakage	Found	52	14	15	81
		Service Main	3	1	0	4
		Repaired	55	15	15	85
6	Leakage/ Overflow from Storage Tanks	Found	2	0		2
		Repaired	2	0		2
7	Length of abandoned CI pipe line (m)				590	590
8	Number of Transferring connections					
9	Length of common pipe	2" inch			514	
		4" inch			268	

**(2) NRW in Sub-zone K2**

Table 3.1-3 shows the result of analysis of water balance.

**Table 3.1-3 Water Balance in Sub-zone K2**

	<i>Initial Measurement</i>			<i>After Primary Activities</i>			<i>Before 2nd Activities</i>			<i>After 2nd Activities</i>	
	<i>m3/day</i>	<i>(%)</i>		<i>m3/day</i>	<i>(%)</i>		<i>m3/day</i>	<i>(%)</i>		<i>m3/day</i>	<i>(%)</i>
<b>RW</b>	267.4	21.5%		279.9	24.4%		279.9	21.5%		279.9	26.5%
<b>NRW</b>	977.6	78.5%		868.1	75.6%		1,019.1	78.5%		778.1	73.5%
<b>Total System Input</b>	1,245.0	100.0%		1,148.0	100.0%		1,299.0	100.0%		1,058.0	100.0%
<b>MNF</b>	771 l/min		=>	686 l/min		=>	797 l/min		=>	570 l/min	
<b>Pressure at MNF (Pickerring Rd.)</b>	17.4 m			17.4 m			17.3 m			17.7 m	
<b>Pressure at MNF (Gunananda Rd.)</b>	5.9 m			5.8 m			5.7 m			5.8 m	
<b>Measured on:</b>	19-23 Nov, 2010			27-28 Jan, 2011			30 Jun, 2011			5 Oct, 2011	
<b>Remarks</b>											

Table 3.1-4 shows summary of works done in this Sub-zone.

**Table 3.1-4 Work Summary in K2 (after Activities)**

<i>No</i>	<i>Description</i>		<i>Identified thru "Primary Activities"</i>	<i>Identified thru "2<sup>nd</sup> Activities"</i>	<i>Current Status (Jan/2012)</i>
1	Public Standpost (Unbilled Authorized consumption)	Found	33	-	33
		Removed (After Providing individual house Connections )	0	0	0
2	Unmetered	Found	20	0	20
		Metered	12	0	12
3	Meter working Problem	Found	10	0	10
		Replaced	8	0	8
4	Illegal use	Detected	23	0	23
		Legalized or Disconnected	23	0	23
5	Leakage	Found	51	20	71
		Service Main	0	0	0
		Repaired	51	20	71
6	Leakage/ Overflow from Storage Tanks	Found	0	0	0
		Repaired	0	0	0

**(3) NRW in Sub-zone B1**

Table 3.1-5 shows the result of analysis of water balance.

**Table 3.1-5 Water Balance in Sub-zone B1**

Component			Water Balance (Before)			Water Balance (After "Primary Activity")			Water Balance (After "Secondary Activity")	
			m3/day	(%)		m3/day	(%)		m3/day	(%)
Revenue Water	Billed Authorized Consumption	Metered	390.12	59.73%	=>	449.35	77.52%	=>	459.45	83.69%
		Unmetered								
NRW	Unbilled un-metered		263.01	40.27%		130.29	22.48%		89.55	16.31%
	Apparent Losses									
	Real Losses									
Total System Input			653.13	100%		579.64	100%		549	100%

MNF (l/min)

312

249

206

MNF (converted to m3/day)

449.28

358.56

296.64

Note1: Breakdowns of each component are under verification.

Table 3.1-6 shows summary of works done in this Sub-zone.

**Table 3.1-6 Work Summary in Sub-Zone-B1 (After Activities)**

<i>No</i>	<i>Description</i>		<i>Identified thru "Primary Activities"</i>	<i>Identified thru "Secondary Activities"</i>	<i>Current Status (Feb/2011)</i>	<i>Remarks</i>
1	Public Standpost (Unbilled Authorized consumption)	Found	2	0	2	1 remains
		Removed (After Providing individual house Connections )	0	1	1	
2	Unmetered	Found	12	0	12	3 remains
		Metered	9	0	9	
3	Meter working Problem	Found	7	0	7	
		Replaced	7	0	7	
4	Illegal use	Detected	8	0	8	
		Legalized or Disconnected	8	0	8	
5	Leakage	Found	24	12	36	
		Service	10	0	10	
		Main	10	0	10	
		Repaired	34	12	46	
6	Leakage /Overflow from Storage Tanks	Found	1	0	1	
		Repaired	1	0	1	



**(4) NRW in Sub-zone B2**

Table 3.1-7 shows the result of analysis of water balance.

**Table 3.1-7 Water Balance in Sub-zone B2 (Tentative)**

	<i>Initial Measurement</i>	
	<i>m3/day</i>	<i>(%)</i>
<b>RW</b>	441.9	38.3%
<b>NRW</b>	712.1	61.7%
<b>Total System Input</b>	1,154.0	100.0%
<b>MNF</b>	655 l/min	
<b>Pressure at MNF (Rodney 12" line)</b>	8.1 m	
<b>Measured on:</b>	16 Feb, 2012	
<b>Remarks</b>		

Table 3.1-8 shows summary of works done in this Sub-zone.

**Table 3.1-8 Work Summary in Sub-Zone-B2**

<i>No</i>	<i>Description</i>		<i>Identified thru "Primary Activities"</i>	<i>Remarks</i>
1	Public Standpost (Unbilled Authorized consumption)	Found	6	
		Removed (After Providing individual house Connections )	0	
2	Unmetered	Found	25	
		Metered	0	
3	Meter working Problem	Found	7	
		Replaced	0	
4	Illegal use	Detected	15	
		Legalized or Disconnected	0	
5	Leakage	Found	Service	Not finalized
		Repaired	Main	
6	Leakage /Overflow from Storage Tanks	Found		Not finalized
		Repaired		

**(5) NRW in Sub-zone B3**

Table 3.1-9 shows the result of analysis of water balance.

**Table 3.1-9 Water Balance in Sub-zone B3 (Tentative)**

	<i>Initial Measurement</i>			<i>Midstream of Primary Activities</i>			<i>After Primary Activities</i>	
	<i>m3/day</i>	<i>(%)</i>		<i>m3/day</i>	<i>(%)</i>		<i>m3/day</i>	<i>(%)</i>
<b>RW</b>	186.2	15.7%		186.2	49.4%		201.3	71.4%
<b>NRW</b>	996.8	84.3%		190.8	50.6%		80.7	28.6%
<b>Total System Input</b>	1,183.0	100.0%		377.0	100.0%		282.0	100.0%
<b>MNF</b>	-		=>	106 l/min		=>	55 l/min	
<b>Measured on:</b>	7-8 Dec, 2010			18-19 Nov, 2010			20-21 Jan, 2011	
<b>Remarks</b>	- Measurement conducted by removing ball valve at sump purposely			- Measurement conducted at after outlet of sump. - Measurement to see the effect of fixing ball float valve at sump.				

*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.*

Table 3.1-10 shows summary of works done in this Sub-zone.

**Table 3.1-10 Work Summary in Sub-Zone-B1 (After Activities)**

<i>No</i>	<i>Description</i>		<i>Identified thru "Primary Activities"</i>
1	Public Standpost (Unbilled Authorized consumption)	Found	0
		Removed (After Providing individual house Connections )	0
2	Unmetered	Found	14
		Metered	14
3	Meter working Problem	Found	20
		Replaced	17
4	Illegal use	Detected	19
		Legalized or Disconnected	19
5	Leakage	Found	19
		Service	0
		Main	19
6	Leakage/ Overflow from Storage tank	Repaired	1
		Found	1

## 3.2 GIS

### 3.2.1 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 are to be 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

At the initial stage, procurement of equipment and staff assignment were scheduled so that base map preparation can be started within first six months.

### 3.2.2 Input

#### (1) Manpower Input by NWSDB for the Project

At the previous 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)

#### (2) Procurement under the Project

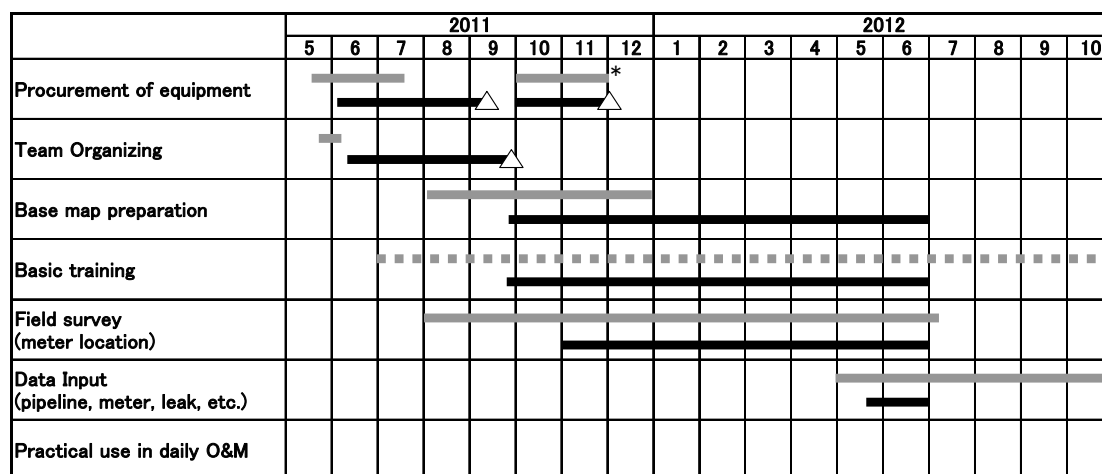
Hardware and software which were procured in this Project are as shown in Table 3.2-1.

**Table 3.2-1 Shopping List for GIS**

Package	Item		Specification/Reference Model	Qty	Remarks
1	GPS	High Accuracy Hand-held GPS	Sub meter after post processed differential correction. (Geo Explorer XT 2008 Series Hand Held GPS)	2 Unit	<ul style="list-style-type: none"> <li>only one unit will be ordered for the time being</li> <li>another one will be ordered later</li> </ul>
2	PC & Accessories	Desktop PC	Intel® Core™ i3-550 Processor (3.2 GHz, 4MB total cache) Intel® H57 Express 4GB Memory DDR3 RAM (2GB DDR3 x 4) 500GB SATA 3.5 1st Hard Drive HP USB Optical BLK Mouse SATA SuperMulti LightScribe DVD Writer Realtek ALC888S High Definition audio codec HP S1932 18.5-Inch wide LCD Monitor HP USB Standard JB Keyboard A/P Integrated Intel Graphics Media Accelerator Core i3. Windows 7 Professional License (64 bit) Integrated Realtek 8111DL Gigabit Ethernet (3 Years HP Warranty)	6 set	<ul style="list-style-type: none"> <li>One for Mapping Section</li> <li>One for Maligakanda Office</li> <li>Two for AEs (Kotahena, Borella)</li> <li>Two for OIC (Kotahena, Borella)</li> </ul>
		External HDD	500GB, for system & data backup, compatible with Win7 Pro 64 bit		
		UPS	650 VA		
		MS Office	MS Office Professional 2010, compatible with Win7 Pro 64 bit		
		Virus Protection	Kaspersky Internet Security 2011		<ul style="list-style-type: none"> <li>Only 1-year subscription is available.</li> <li>Need to purchase new license for another 1 year.</li> </ul>
	Printer	A3 Printer	A3 size, inkjet w/ spare cartridges (5 magenta, 5 yellow, 5 cyan, 10 black.), compatible with Win7 Pro 64 bit	4 Unit	<ul style="list-style-type: none"> <li>Two for AEs (Kotahena, Borella)</li> <li>Two for OIC (Kotahena, Borella)</li> </ul>
	Scanner	A4 Scanner	A4 size, compatible with Win7 Pro 64 bit	1 Unit	<ul style="list-style-type: none"> <li>For Maligakanda</li> </ul>
3	Plotter	Plotter	A0 size, inkjet w/ spare cartridges/printer heads/roll papers, compatible with Win7 Pro 64 bit * Additional Cartridges: - 5 nos. for magenta. - 5 nos. for yellow. - 5 nos. for cyan. - 10 nos. for black. * Additional 4 nos. of printer heads (for magenta, yellow, cyan and black). * Additional 5 nos. of A0 roll paper (plain, 50m).	1 Unit	<ul style="list-style-type: none"> <li>For Maligakanda</li> </ul>
4	GIS Software-1	View/edit for base map and spatial analysis	ArcView 10 Desktop, compatible with Win7 Pro 64 bit	2 License	<ul style="list-style-type: none"> <li>One for Mapping Section, one for Maligakanda Office</li> <li>Extension add-ons for ArcView are available in NWSDb</li> </ul>
5	GIS Software-2	View/edit for facility data	AutoCAD Map 3D 2011 Commercial New SLM, compatible with Win7 Pro 64 bit	4 License	<ul style="list-style-type: none"> <li>For 2 AEs and 2 OICs</li> </ul>
6	Data	Satellite Image	Processed Image, June 2010 or later, 0.50m/0.60m high resolution, multi-spectrum, pansharpened, True Colours, Mosaic Image	100 sq.km	<ul style="list-style-type: none"> <li>Covering entire Colombo City</li> <li>There are two options in processing, thru satellite image company or thru local distributor.</li> </ul>
			FTP Conversion	1 time	

### 3.2.3 Progress of Training

Figure 3.2-1 shows general schedule and its actual progress of GIS training. Starting of basic training was delayed for about three months due to delay of tax reimbursement procedure for procurement and preparation of space for GIS.



Note: Plan: Actual: Activity completed: Intermittent activities: \* for second GPS procurement

Figure 3.2-1 Schedule of GIS Training

Based on the policy for manpower input, NRW Reduction Management Team listed up more concrete grouping and assignment as follows on commencement of the training.

- Group 1:
  - AE Office - Mattakkuliya
  - AE Office - Maligawatta
  - Engineer - Maligakanda (Ms. L A K M Liyanarachchi)
  - OIC Office - Kotahena (Mr. W W W Jayasinghe)
  - OIC Office - Borella (Mr. D H R Hettiarachchi)
- Group 2:
  - Mapping Section – Thelawala
  - Mapping Office Maligakanda
- Group 3:
  - EA for GPS field staff - Kotahena (Mr. E D K Karunarathna)
  - EA for GPS field staff - Borella (Mr. S K P Samarasinghe)

Training menu according to the above grouping is as shown in Table 3.2-2. Based on the schedule, the first training was conducted on 27th September, 2011 in Maligakanda.

**Table 3.2-2 Training Menu for GIS**

	Item	Target Group	Required Time for Training
1	Introduction to AutoCAD.	For Group 1	0.5 days x 2 times
2	Introduction to AutoCAD MAP 3D.	For Group 1	0.5 days x 2 times
3	Hands on Training to AutoCAD MAP 3D.	For Group 1	0.5 days x 6 times
4	Introduction to GIS and Coordinate system.	For Group 2 and 3	0.5 days x 2 times
5	Introduction to GPS technology and Hands on Practice	For Group 2 and 3	0.5 days x 2 times 1.0 days x 2 times
6	GPS Field work	For Group 3	Starting from 6/Oct/2011 (continuously)
7	Introduction to Arc View.	For Group 2	1.0 days x 2 times
8	GIS Mapping & Database updating	For Group 2	Starting from 12/Oct/2011 (continuously)
9	Seminar of GPS use	For management level	0.5 days x 1 times

\* Training to be conducted at Maligakanda, in principle.

- Basic Training:
  - Training schedule had to go through with several changes due to GPS staff's convenience. However, all scheduled program for basic training have been completed by November 2011.
- GPS Field Work:
  - GPS field work to pick up coordination of customer meter is underway. Obtained data through the field work are now being input to the database.
  - Identification of small path, which cannot be determined by satellite image, is being surveyed through GPS field work.
- Base Map Preparation:
  - Initially, base map preparation work had intended to digitize only major landmarks and

roads with reference to the procured satellite image. Considering estimated work volume for this, it had been expected to complete by the end of 2011.

- Afterward, however, policy of digitizing work was changed so that every feature of house should be drawn on the map for convenience of practical use at a site.
- Pay-feature-data of houses or properties, which is somewhat outdated, can be obtained from the Survey Department. By obtaining these data, NWSDB does not have to go through digitizing work from the beginning and will save time for digitizing. Therefore, it is considered to be realistic for NWSDB to roll out its activities to the other area of Colombo City in future since it would not take much time as being done under this OJT program.

### **3.3 PR**

As well as the GIS issues, PR activities have been included into the Project in accordance with the conclusion reached at the previous 5th JCC. Followings outline the content of the progress related to PR activities.

#### **3.3.1 Purpose of the Activities**

Including PR activities into the Project aims to boost up internal awareness on NRW within NWSDB and obtain cooperation from public. At present, following activities are being considered.

- Internal PR to NWSDB
  - Encourage other NWSDB staff who would be potentially engaged in NRW activities in Colombo in future to participate to the seminars/workshops to be held under the Project.
  - Citation/awarding to staff who contributed to Pilot Project activities.
- PR to public
  - Preparation of video, poster, display and their usage with an assistance of NWSDB's section that is in charge of PR.
  - Picture contest/competition in school in Pilot Area.

#### **3.3.2 Contents of Each Activity**

The following activities may be revised during the course of the process depending on the decision based on the discussion among NWSDB and JET. Timeframe and concrete staff assignment by NWSDB shall also be decided through discussion among NWSDB and JET to go for full-scale activities.

##### **(1) Handbill (Distribution in the Pilot Areas)**

To encourage the interest, to draw attention and to obtain cooperation by the customer, handbills and other supplemental materials are to be distributed for PR purpose. Originally, pocket tissue paper or plastic-famed fan had been considered as supplemental materials. Afterward, it was decided that ballpoint pens would be distributed considering cost and required timeframe. In addition, it was decided that caps, with message and call number for customer relation of NWSDB, would be prepared for NRW Reduction Team who are to be engaged in site works.

The Project shall be explained in an appropriate manner to the customer when hand bills are distributed. At the same time basic information such as customer satisfaction will be

investigated.

## **(2) DVD**

DVD will introduce the activities of the Project, which improve effective usage of water and upgrading water supply conditions. Other activities by NWSDB for reduction of NRW will also explained by DVD.

At the initial stage, NRW Reduction Management Team had intended to prepare script and relevant photos for the purpose of presentation in schools and others. Considering the remaining time and budget, however, it was decided to proceed to a video DVD preparation.

## **(3) Poster**

PR officer will visit some (from five to ten) schools to be selected and explain the importance of water and the Project activities to (around ten) students who are recommended by teachers for the talent of drawing. These students will prepare posters. About 50 to 100 posters will be collected. The best posters will be selected among them and praise the and from the students.

The selected posters will be printed and pasted in customer service sections and other attractive places of NWSDB.

## **(4) School Activities**

PR officer will visit schools in the pilot areas and give presentation in order to make students understand the importance of water and the efforts of NWSDB to supply water. Students are expected to have the knowledge of negative impacts of leakage, illegal connection, and wastage. The importance of the Project will also be explained.

After the presentation, several willing students will be given chance to prepare drawings of water management. The drawing will be laminated and placed on the walls of school.

## **(5) Seminar in NWSDB**

In order to disseminate the Project activities in all over the Colombo city, a seminar will be held to explain the activities, results and findings by the Project and exchange the ideas among NWSDB staff who will work for NRW reduction. The seminar will aim to transfer the information and improve the intention of the staff.

### **3.3.3 Progress of the Activity**

Regarding the above itemized ideas, JET and NWSDB have discussed what NWSDB can do and what should be done first at following occasions.

- 2<sup>nd</sup> September, 2011:  
Discussion among DGM, AGM (NRW), AGM(O&M), Manager (NRW) and JET
- 6<sup>th</sup> September, 2011:  
Discussion among AGM (NRW), PR officer and JET
- Since then, a series of discussions have been made so far among working level (AGM, PR Officers in Head Office and Rajagiriya Office, JET), to decide practical contents

Following outlines progress of the activities.

**(1) Hand Bill (Distribution in the Pilot Areas)**

- 10,000 of handbills has been printed by the middle of November 2011. Final design of the handbill is attached as Annex 3-1.
- Distribution has been started in the Sub-zones of K3&K4, B5 and B6.
- Pens with printed messages to draw attention from customer will be prepared. Pens are to be ready for distribution by the end of February 2012.
- Caps with messages and call number of customer relation will be prepared by the end of February 2012.

**(2) Poster**

- Record of the poster activities is presented in Annex 3-2
- Target schools have been named by the beginning of February 2012.
  - Schools in the Pilot Areas
    - ✧ C.W.W. Kannagara Maha Vidyalaya – Borella
    - ✧ Ratnaweli Balika Vidyalaya – Borella
    - ✧ Carey College – Borella
    - ✧ Yashodhara Balika Vidyalaya – Borella
    - ✧ Wesley Collge – Kotahena
  - Schools outside of the Pilot Areas
    - ✧ Rajasinghe Maha Vidyalaya – Dematagoda
    - ✧ St. Anthonies Balika Vidyalaya – Dematagoda
    - ✧ St. Mathews Vidyalaya – Dematagoda
    - ✧ Gothami Balika Maha Vidyalaya – Maradana
    - ✧ Anurudda Balika Vidyalaya – Dematagoda
- Poster painting are to be completed by the middle of February 2012.
- Selection and awarding will be processed by the end of February 2012

**(3) School Activities**

- Target schools have been named by the beginning of February 2012.
  - St. Benedicts College - Kotahena
  - S.W.R.D. Bandaranayake Vidyalaya - Borella
- Presentation material was prepared by the PR officer of NWSDB, with reference to the existing material that is for the purpose of promoting water saving awareness. The material is to include following issues for the Project's purpose:
  - Inform NWSDB when you find leak or illegal connection.
  - Do not touch/repair/modify pipe by yourself. If you find any such case, call NWSDB
  - Issue of common tap (sandpost) to be mentioned in the part of water saving.
- PR officers and JET conducted their first school visit to "S.W.R.D. Bandaranayake Vidyalaya (Borella)" on 22<sup>nd</sup> February, 2012, with the manner described in Annex 3-3. Through the activities, following comments have been raised.
  - NWSDB explained about water treatment process, water charge, importance of water, NRW, and "Call 1939". However, some aspects (especially treatment process) seemed complicated for students. To draw attention by students and for easy understanding, appropriate way such as Q and A session may be considered.



- Presentation by the PR Officers was about 75 minutes in total, without break. It may be too long for students. Duration of presentation should be shortened.
- Presentation tools (projector, microphone or screen) are not always available at a school. NWSDB should prepare its own tools to continue school activity by themselves.

**(4) DVD**

- Script writing is being processed by the PR officer of NWSDB and expected to complete by the middle of February 2012.
- Shooting and editing are underway as of the end of February 2012.

**(5) Seminar in NWSDB**

Seminar was held on 28<sup>th</sup> February, 2012 at Berjaya Mount Royal Hotel in Mount Lavinia, for the purpose of sharing findings obtained through the Project's activities among NWSDB staff. In this seminar, top levels of NWSDB (Chairman, GM, Additional GM (Western) and DGM (Western - Central)), JICA officials in Sri Lanka and member of Master Plan Study in Colombo were attended. Following topics were presented by the relevant staff of NWSDB and JET and the presentation Materials are compiled in Annex 3-4.

- Brief Explanation on the Project: by AGM (NRW)
- Findings in Training Program in Japan: by CE (Construction)
- Findings in Technical Exchange Program in Indonesia: by OIC (Maligawatta)
- Usage of GIS: by Engineer (Maligakanda)
- Results of the Pilot Project Activities in Borella: by EA (Zone Officer - Borella)
- Results of the Pilot Project Activities in Kotahena: by OIC (Kotahena)
- Similar Activities in Other Areas: by EA (Maligawatta)
- PR Activities: by Senior PR Officer (Western - Central)
- Dissemination of Activities to the Other Areas: by JET

### 3.4 Trainings in Japan and Third Country

#### 3.4.1 Training in Japan

As a part of the Project activities, overseas training was conducted in Japan, with the manner shown in Table 3.4-1.

**Table 3.4-1 Outline of Counterpart Training in Japan**

Program Title	Counterpart Training under the Capacity Development Project for Non-Revenue Water Reduction in Colombo City
Duration	3 <sup>rd</sup> to 11 <sup>th</sup> November, 2011
Target	NRW Reduction Management Team
Purpose	Study historical transition on NRW reduction measures, billing collection and PR activities related to NRW reduction in Japan
Trainees' Name & Position	A.B Hiyarapitiya, Assistant General Manager (North Western) L.P.A.P. Perera, Chief Engineer, Operation & Maintenance Manager (Kalutara) Susil Wijerathna, Chief Engineer, Operation & Maintenance Manager (Towns North Colombo) D.A.D Hemachandra, Senior Engineer, RSC (Western - North) W.M.Y.A Wijesinghe, Engineer, Class 1 (Western - Central)

Detailed schedule and contents of the training are specified in Table 3.4-2. Materials for training prepared by Japan Water Works Association (JWWA), Tokyo Metropolitan Waterworks Bureau (TMWWB) and Nihon Suido Consultants Co., Ltd. (NSC) are compiled in Annex 3-5.

On completion of the training, the trainees summarized their findings and outcome as an output of the training and it is attached to this report as Annex 3-6. In addition, questionnaire distributed to trainees and its aggregated result is compiled as Annex 3-7

**Table 3.4-2 Schedule & Contents of Training in Japan**

Date	Day	Time	Schedule	Place	Hosted by	Contents	
3-Nov	Thu	1	-	Departure from Colombo / Arrival in Tokyo	Tokyo	-	
4-Nov	Fri	2	9:00-12:00	Briefing of training by JICA	Tokyo	JICA TIC	
		14:00-16:30	Lecture on general history of NRW reduction in Japan and commercial activities for NRW reduction in Japan	Tokyo	Nihon Suido Consultants (NSC)	To understand how much effort and time the Japanese water supply utilities have spent to tackle with the NRW issues. Lecture and discussion on commercial activities in Japan (to maintain accuracy of meters, role of meter reader, supervision of meter readers, etc).	
5-Nov	Sat	3	-	-	Tokyo	-	
6-Nov	Sun	4	-	-	Tokyo	-	
7-Nov	Mon	5	9:00 - 10:00	Water History Museum	Tokyo Metropolitan Waterworks Bureau	History of water supply in Japan	
		10:00 - 11:00	Water Supply Operation Center of Tokyo Metropolitan Waterworks Bureau	Importance of integrated controlling/monitoring water conveyance system			
		14:00 - 16:30	Lecture on NRW Reduction Measures	Tokyo Metropolitan Waterworks Bureau	Lecture and discussion at Tokyo Metropolitan Waterworks Bureau Development and Current Practices of Water Loss Management and Evaluation Methods		
8-Nov	Tue	6	10:00 - 12:00	Visit water treatment plant	Tokyo Metropolitan Waterworks Bureau	To understand outline of advanced treatment and importance of water quality control. To gain valuable insights about PR activities and its effect through receiving visitors from public.	
		14:30 - 16:30	Effective use of GIS in water supply	Tokyo	NSC	Effective use of GIS in water supply regarding NRW reduction.	
9-Nov	Wed	7	10:00 - 12:00	PR activities by waterworks bureau	Tokyo Metropolitan Waterworks Bureau	Observing one of the methods of PR activities to improve the awareness on importance of water to get cooperation from the customers	
		14:00- 17:00	Summarizing results of training in Japan for presentation on next day	Tokyo	NSC	Based on the lessons learned during the training, and considering history of water supply system development in Japan, basic framework of policies and strategies for development of Colombo City water supply system and waterworks management will be developed.	
10-Nov	Thu	8	10:00 - 12:00	Presentation of outcomes of the training by the Trainee (Theme: Basic Strategies and Policies of Water Supply System Development and Management of NWSDB) and JICA Evaluation Meeting on the Training	Tokyo	JICA TIC	Presentation and reporting training results
		-	-	-	-	-	
11-Nov	Fri	9	-	Departure from Tokyo / Arrival at Colombo	-	-	-

### 3.4.2 Training in Third Country

As a part of the Project activities, overseas training was conducted in Indonesia, with the manner shown in Table 3.4-3. Originally, visiting to Metropolitan Waterworks Authority (MWA) in Bangkok, Thailand had also been included in this program. However, due to prolonged flooding that had been prevailing in and around Bangkok at the latter half of 2011, it was decided to exclude visiting MWA from the original schedule.

**Table 3.4-3 Outline of Counterpart Training in Indonesia**

Program Title	Technical Exchange Program between National Water Supply & Drainage Board (NWSDB)" in Sri Lanka and Water Supply Authorities (PDAMs) of Maros/Makassar/Gowa/Takalar in South Sulawesi Province in Indonesia
Duration	5 <sup>th</sup> to 16 <sup>th</sup> December, 2011
Target	NRW Reduction Team
Purpose	Exchange the ideas with capacity developments projects in Indonesia on NRW reduction activities
Trainees' Name & Position	<ul style="list-style-type: none"> <li>✓ Heenkenda Thushantha Bandara Senior Engineer, Priority Section, Western - Central, NWSDB</li> <li>✓ Dewasurendra Jayantha Senior Commercial Officer, Area Engineer's Office (Colombo - South), Western - Central, NWSDB</li> <li>✓ Fonseka Alias Fernando Hettiyakandage Shanti Chandanie Samanmalie Engineer Assistant (Special), Area Engineer's Office (Colombo - West), Western - Central, NWSDB</li> <li>✓ Kalumarakkala Jayasiri Engineer Assistant (Special), RSC (WC), Western - Central, NWSDB</li> <li>✓ Gunawardhena Hettipathirannehelage Wasantha Engineer Assistant (Special), Officer in Charge, Maligawatte, Western - Central, NWSDB</li> <li>✓ Perera Illeperuma Arachchige Karunasiri Engineer Assistant II, Officer in Charge, Soyasapura, Western - South, NWSDB</li> </ul>

Detailed schedule and contents of the training are specified in Table 3.4-4.

**Table 3.4-4 Schedule & Contents of Training in Indonesia**

Date		Venue	Topics	Place of Stay
5-Dec	Mon	JICA JKT	- Traveling - Courtesy call to JICA Jakarta Office	Jakarta
6-Dec	Tue	JICA MFO	- Traveling - Courtesy call to JICA Makassar Field Office (MFO)	Makassar
7-Dec	Wed	DPU PDAM Makassar	- Courtesy call to Head of Department of Spatial Planning and Settlement - Briefing by PDAM on Project Activities - Discussion with NRW Reduction Committee - Site Visit (with leak survey equipments)	Makassar
8-Dec	Thu	PDAM Maros (Bantimurung)	- Attend Monthly PIU Meeting * Presentation by Sri Lankan side - Site Visit (eg., WTP, Pilot District for NRW Reduction Activities)	Makassar
9-Dec	Fri	DPU JICA MFO	- NRW Comprehension Test (at DPU) - Preparation of Presentation Material for Summarizing Training (at Meeting Room of MFO)	Makassar
10-Dec	Sat	-	- Site visit (Bili-bili dam and Malino area)	Makassar
11-Dec	Sun	-	- Site visit (Taman Kayangan Pilot Project Area for NRW Reduction Activities for PDAM Makassar)	Makassar
12-Dec	Mon	PDAM Gowa	- Briefing on Project Activities by PDAM - Discussion with GIS Management Team - Site Visit (eg., Intake, WTP, reservoir)	Makassar
13-Dec	Tue	PDAM Takalar	- Briefing on Project Activities by PDAM - Discussion with NRW Reduction Committee - Site Visit (with leak survey equipments)	Makassar
14-Dec	Wed	JICA MFO	- Preparation of Presentation Material for Summarizing Training (at Meeting Room of MFO) - Report to JICA MFO	Makassar
15-Dec	Thu	PDAM Maros	- Briefing on Project Activities by PDAM * Especially on GIS and School Visit Activities * Discussion with NRW Reduction Committee - School Visit * Brief Presentation by Sri Lankan Side for School Children - Traveling	Jakarta
16-Dec	Fri	JICA JKT or Cipta Karya	- Report to JICA Jakarta Office and/or Cipta Karya (depending on availability) - Traveling	Airplane

### 3.5 Overall Evaluation

Results of Evaluation by Terminal Evaluation Team are shown in below.

#### 3.5.1 Relevance

The Project is assessed as relevant because of the following points.

The policy on water supply sector in Sri Lanka has not been changed much since the commencement of the Project. “Sri Lanka, the Emerging Wonder of Asia, the Mahinda Chinthana, Vision for the Future 2010 – the development policy framework, government of Sri Lanka” clearly specifies the province wise development targets with respect to safe water supply. The overall target to be achieved is 44% piped water connected coverage by 2015 and 60% by 2020. The safe water supply coverage target specified therein is 94% by 2015 and 100% by 2020. The document also addresses the sustainable safe drinking water for all at an affordable price and identifies the specific actions to be taken, such as implementation of non-revenue water (NRW) reduction program to minimize the NRW rate up to 20 % by 2020. Therefore, the Project still keep the consistency with the policy direction of the GOSL.

The Country Assistant Program for Sri Lanka prepared in April 2004 by the GOJ addresses two pillars of assistance to Sri Lanka: (i) assistance to support the “consolidation of peace” and reconstruction, and (ii) assistance that is in line with the country’s long-term vision for development. The prioritized areas include the improvement in water supply. Therefore the

Project components are along with the policy of the GOJ.

Colombo city had suffered from high NRW ratio of 54.1%, higher than its nationwide average of 33.0%, as recognized at the stage of project formulation in 2008. “Corporate Plan 2007-2011” set the target of reducing NRW by 1 % per annum in Colombo city and achieving a 30% national average. NWSDB prepared the draft version of “Cooperate Plan 2012-2016,” in which the NRW reduction remains among the goals to achieve by 2016. It addressed the target of “reducing NRW by 9.4 % in Colombo city during the period of 2012 - 2016 and achieving a 26 % national average in 2016.” NWSDB still has strong needs of enhancing the capacity of NRW reduction to meet this target; therefore, the components of the Project have been along with the needs of NWSDB.

### **3.5.2 Effectiveness**

The Project is assessed as effective in achieving its purpose envisaged at planning.

The Project still have nine months to complete the cooperation period and will present more tangible effects on NRW reduction in the remaining period. It is, especially, expected that the specific data on the pilot activities such as system input volume, MNF, pressure, billed/unbilled authorized consumption, illegal use and metering inaccuracies, will be compiled and utilized to identify the most effective options for NRW reduction activities in Colombo city, considering the cost-effective aspects.

To pursue the effective NRW reduction, capacity enhancement at both technical and management level is very crucial. To date, the Project has enhanced NWSDB’s capacity to implement NRW reduction activities in Colombo city at both levels. NWSDB officers/staff engaged in pilot activities has acquired the practical and systematic techniques for effective NRW reduction. The NRW Management Team has gained a lot of findings on what methods would bring more effects on NRW reduction through project activities. In this respect, two Project Outputs are very essential and sufficient to achieve the Project Purpose.

In this Project, the strong leadership and commitment of the members of NRW Management Team toward NRW reduction has fostered the project activities and will lead to fulfillment of the Project Purpose. Any external factors negatively affecting the Project have not been observed. Some of the members of NRW Reduction Management Team and NRW Reduction Team were transferred, promoted, or assigned to additional work; however, JICA experts and the counterparts have tried to keep up with the activity plan, and this issue has not seriously affected the project performance as a result.

### **3.5.3 Efficiency**

The Project is assessed as partly efficient. Although some of the project activities are behind schedule, various activities have been carried out and the Project Outputs have been produced as described in “3-2. Achievement of Project.” The positive aspect is that the overseas training programs promoted the participants’ motivation toward NRW reduction, and the participants also encouraged their staff to promote NRW reduction. Through the training in Japan which was organized twice, the participants promoted their awareness of the importance of O&M practice and learned the well disciplined way of work. The technical exchange programs in Jordan and Indonesia gave the participants confidence in the NRW reduction activities which they have been practicing through project activities, by observing the similar methods applied in other countries. In addition, the quality and the quantity of inputs were mostly appropriate and the

inputs were fully utilized for project activities to date.

Since hydraulic isolation work in pilot areas has taken longer time than expected due to local characteristics in water supply system in Colombo City such as lack of accurate information on pipeline drawings, unexpected interconnection of pipes, low system pressure and difficulties in valve locating. It is true that this issue has caused the delay of project progress, but this is also a very important learning for NWSDB and JICA experts to gain experience and lessons learned, and figure out the effective and suitable means in the situation in Colombo city. At this moment, hydraulic isolation works in most of the sub-zones are nearly completed and the Project will make up for the delay until now in the remaining period. In addition, the NWSDB and JICA experts have made lots of efforts to further promote the project activities after Mid-term Review. Especially, after reorganization of the NRW reduction teams in the middle of 2011, the progress of pilot activities have been accelerated.

Other than the issue of isolation work, there are some causes which had adverse effects on the project progress and the efficiency from the beginning until now. Main issues are summarized as below.

- The inter-agency's application process takes very long time to implement NRW reduction activities such as permission for road excavation,
- The internal procedures within NWSDB usually take time to make an arrangement. Sufficient numbers of vehicle and driver are not always available for project activities. The vehicles, personnel and heavy equipment were not always arranged together for pilot activities,
- The counterpart personnel has multiple tasks and struggles with difficulties in focusing on the project activities. They have to take care of their routine works and/or other works that is regarded as higher-priority by NWSDB such as the urgent pipe replacement works,
- The project activities have slowed down during the absence of JICA experts, especially when the problems, such as allocation of vehicle or equipment, arose.

#### **3.5.4 Impact**

The Overall Goal of the Project is “the NRW ratio in Colombo city is reduced. ” The Project will prepare an execution plan, which suggests strategy and effective methods of NRW reduction activities suitable in Colombo city along with the cost estimation and required manpower. When the NRW reduction activities are continued by NWSDB based on the execution plan with high commitment of NWSDB's executives, it is expected that the results of the Project will contribute to NRW reduction in Colombo city in the future.

Since the Project has involved several AEs or OICs of non-pilot areas in project activities, NWSDB now has a certain level of foothold in extending NRW reduction activities. If more number of AEs or OICs will gain experience by participating in pilot activities in the remaining cooperation period, the possibility of realizing NRW reduction will be further promoted.

As generally recognized, the combination of soft-measures, such as leakage detection/ repair, detection of illegal connection, reduction of stand posts, and hard-measures of pipe replacement are very effective to reduce NRW. Therefore, as stated in PDM2, other conditions to fulfill the Overall Goal need to be satisfied. Those are securing the budget and equipment for scaling up of NRW reduction activities or aged pipe replacement. Currently, the study for a master plan update of water supply sector in Colombo city and NRW engineering study are undertaken with the assistance from JICA program. NWSDB will be able to have more specific plan for NRW

reduction including the effective combination of pipe replacement and NRW reduction activities. Since the master plan update and NRW engineering study will incorporate the strategy shown in the execution plan and the lessons learned from the Project, the Project will also contribute to moving forward to reducing NRW ratio.

### **3.5.5 Sustainability**

The project sustainability will be ensured when several conditions identified are satisfied.

#### **■ Policy and Institutional Aspects**

The policy environment is still likely to be favorable for NWSDB. The GOSL keeps the improvement of water supply services among its prioritized areas, addressing the sustainable safe drinking water for all at an affordable price and identifying the specific actions to be taken, such as implementation of non-revenue water (NRW) reduction program to minimize the NRW rate up to 20 % by 2020.

#### **■ Financial Aspects**

While it is difficult to identify the allocated amount for NRW reduction activities at NWSDB, a certain amount of budget has been allocated and disbursed for NRW related activities. The amount for the repairs and maintenance for water service was 461.4 million LKR in 2009, and this partially include the amount allocated for NRW reduction activities. At NWSDB, the cost associated with O&M is currently covered by water charge. The financial statement in NWSDB Annual Plan of 2009 indicated that the sales of water exceeded the direct cost, while the financial condition of NWSDB was overall in deficit in 2009 due to the large amount of financial cost. In addition, NRW Reduction Management Team mentioned that the budget for NRW reduction is not sufficient but the budget is certainly allocated. Therefore, it can be judged that a certain amount of budget will be continuously allocated when the executives admit the effectiveness of NRW reduction activities and commit to its implementation.

#### **■ Technical Aspects**

The counterpart personnel has well accepted the knowledge and techniques introduced by the Project and recognized the usefulness of the systematic technologies of NRW reduction. Especially, the AEs and OICs in pilot and non-pilot areas have learned about the systematic techniques to pursue the NRW reduction activities and gained sufficient experiences. Since the counterpart personnel originally had basic knowledge and techniques on NRW reduction, it would not be difficult to sustain their techniques learned from the Project.

To ensure the technical sustainability in Colombo city, it is important to consider how the systematic methods of NRW reduction introduced by the Project will be disseminated to other areas. Since the rotation system, which was a proposed mechanism to disseminate the technologies to non-pilot areas, has not functioned well, it is important to provide opportunities for AEs or OICs in non-pilot areas to participate in pilot activities and weekly meetings in the remaining cooperation period.

The counterpart personnel has tried to store and maintain the provided equipment with the utmost care. In this respect, the equipment provided by the Project will be maintained after the project cooperation is terminated. On the other hand, it should be noted that some of the equipment, especially electronic products, were foreign products, and NWSDB may need to contact the overseas manufacturers through email when those of equipment have problems.



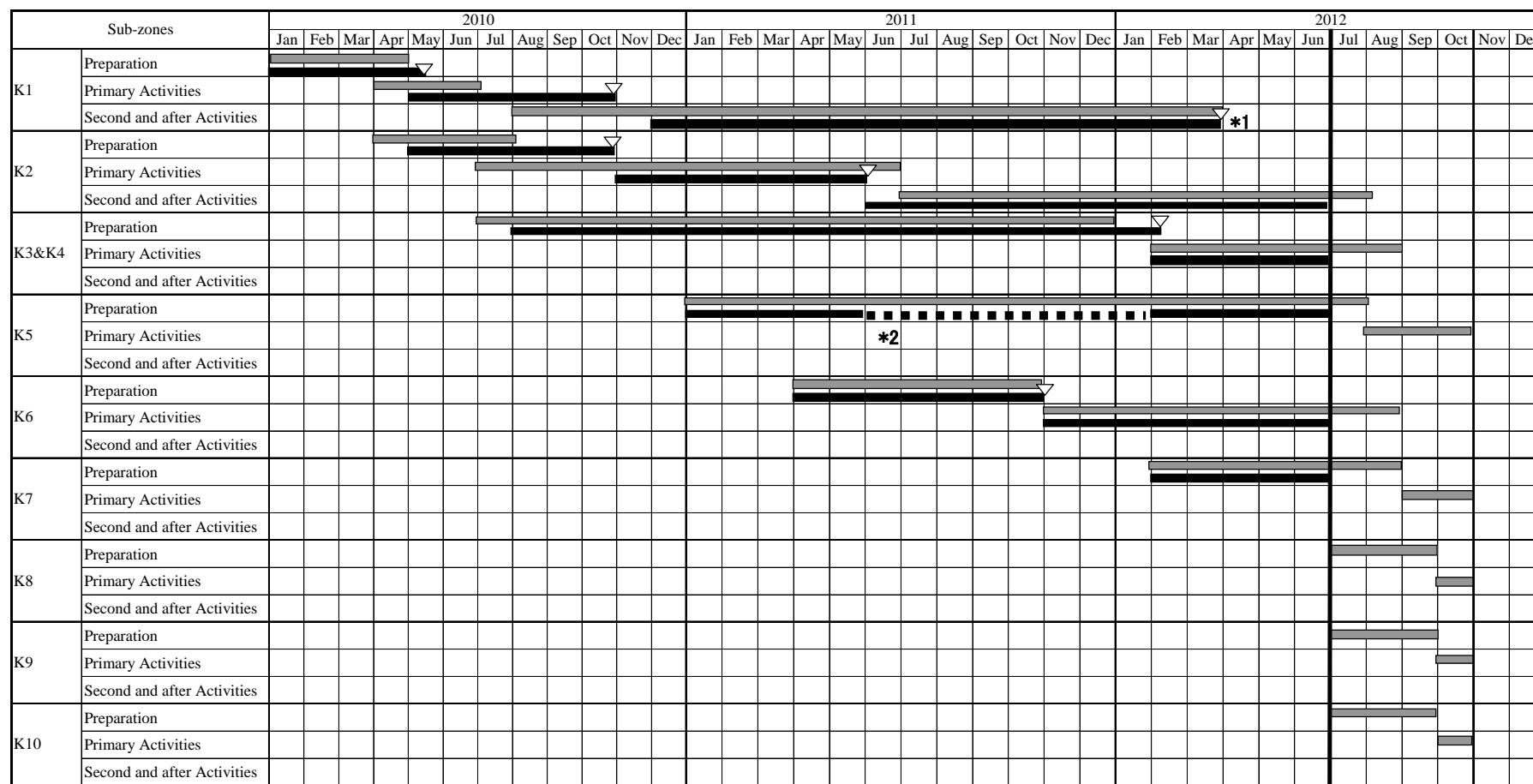
## **Chapter 4 PLAN OF THE EACH ACTIVITIES**

### **4.1 Pilot Project**

Considering the past Pilot Activities, original work plans for both areas have been revised by the NRW Reduction Management Team and JET in June 2012. The tentative schedules for both areas are shown in Figure 4.1-1 and Figure 4.1-2.

It would be difficult to complete pilot activities in all project zones. However, this plan revised in June 2012 was intended to try to complete the activities in all zones.

# Annex – 1 Annual Program (3)



Plan   
Actual 

Completed work: ▽  
Suspended work: ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

\* 1 As activity was continued until sixth activities, it took long time.

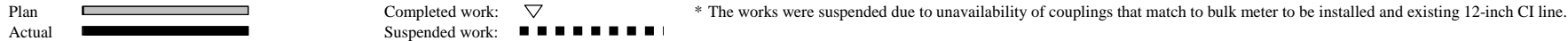
\* 2 The works were suspended due to work force.

It was decided that further works were to be commenced after K3 & K4 activity.

5th revise

**Figure 4.1-1 Revised Work Plan (Kotahena)**

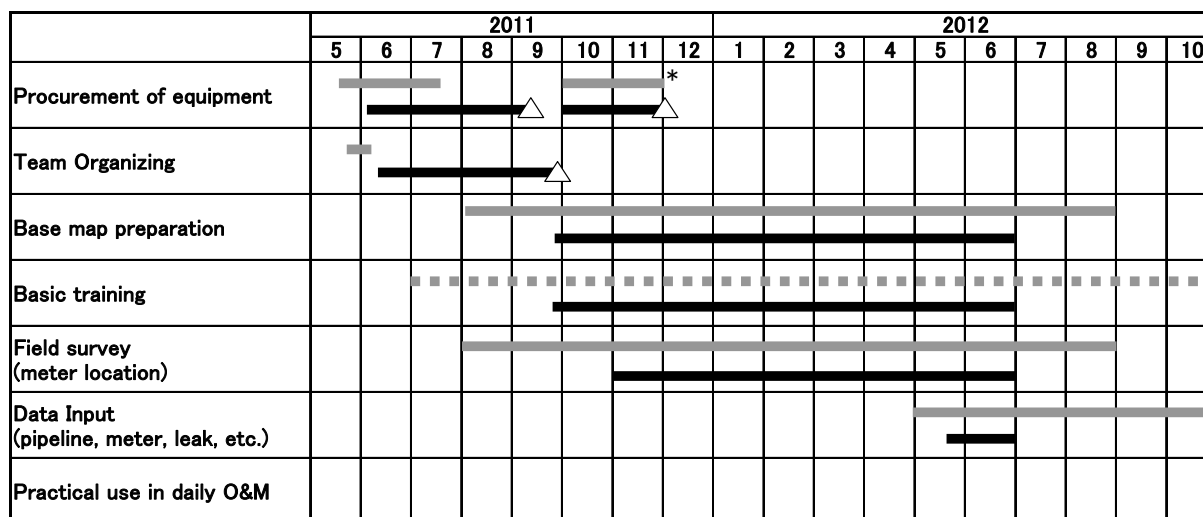
## Annex – 1 Annual Program (3)



**Figure 4.1-2 Revised Work Plan (Borella)**

## 4.2 GIS

As training for GIS was somewhat delay so far, NRW Reduction Management Team revised the schedule as shown in following figure.



Note: Plan:   
 Actual:   
 Activity completed:   
 Intermittent activities:   
 \* for second GPS procurement

Figure 4.2-1 Revised Schedule of GIS Training

## 4.3 PR

Following actions will be implemented as PR activities. These actions were considered the experience of the past PR activities.

### 4.3.1 Handbill, Pen

Handbill and Pen were prepared and distributed to customers for PR purpose in last year. As all the handbill and Pen were not distributed, each AE will continue distribution of those to customers.

### 4.3.2 Calendar

Poster competition with theme of NRW and water saving was held in last year. One hundred Posters were collected for the competition. Each poster drawn by students had various and eye-catching messages. Those posters will be able to get attention of customers. Therefore, Calendar will be prepared in this year to utilize the eye-catching posters.

### 4.3.3 School activities

PR staffs in NWSDB confirmed that students understood the contents of presentation about NRW and water savings by NWSDB. As the students may talk the knowledge to their parents, their parents collaterally may have the knowledge about NRW. Therefore school activities will be executed with modification/improvement throughout discussion among NWSDB and JET. As school activities were held in relatively wealthy schools, the activities of this year will target

relatively poor areas.

#### **4.3.4 T-shirts**

Caps with message were prepared in last year. Customers can easily recognize as NWSDB workers in Site by the caps. At the same time, caps improve a sense of solidarity among NWSDB staffs. Furthermore, NWSDB staffs who attended Training in Japan and Third Country had a comment in last seminar that uniforms would be helpful for NWSDB. Therefore T-shirts with NWSDB logo will be prepared to expand the effect further.

#### **4.3.5 Workshop**

JICA supplied several equipments to detect and repair leak waters. All EAs are expected to know how to use those equipments to execute survey effectively. However some EAs don't know how to use some equipment, others know. The knowledge is not shared. Work shop will be held to share the knowledge of those equipments among EAs.

#### **4.3.6 Seminar**

Seminar will be held to share the experience and knowledge in this Project to extend NRW activities in all Colombo City after this project. The seminar will discuss Execution Plan prepared based on experiences and knowledge obtained through the past activities to achieve better results in all Colombo City. The seminar will invite the authorities concerned.

#### **4.3.7 DVD**

DVD was made up by March 2012. DVD will be revised as necessary.

#### **4.4 Execution Plan**

Execution Plan will be developed to disseminate NRW Reduction Activities to entire Colombo City mainly by NRW Reduction Management Team. The plan will be prepared considering the knowledge and experiences obtained by this project in order to execute the activities effectively. A draft of the content is as follows.

#### **PART A: CAPACITY DEVELOPMENT PROJECT**

- Chapter A1 Outline of the Project
- Chapter A2 Findings in the Project
- Chapter A3 Water Audit

#### **PART B: EXECUTION PLAN**

- Chapter B1 Policy of NRW Reduction of NWSDB
- Chapter B2 Target of NRW Reduction
- Chapter B3 Improvement of Measurement System
- Chapter B4 Improvement of GIS
- Chapter B5 Unbilled Authorized Consumption
- Chapter B6 Reduction of Apparent Losses
- Chapter B7 Reduction of Real Losses
- Chapter B8 PR Activities
- Chapter B9 Organizational Improvement
- Chapter B10 Evaluation and Monitoring of Implementation
- Chapter B11 Action Plan and Recommendation
- Chapter B12 NRW Reduction Master Plan

## Chapter 5 INPUT

At the time of the 1<sup>st</sup> JCC, budget allocation was decided as follows.

- The Sri Lankan side allocates necessary budget according to the R/D and the M/M on this Project (signed on 22 April 2009), to ensure effective implementation of the Project.
- NWSDB ensures that the budget for customs duties/taxes, 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.

As mentioned the above, it was decided to subsidize the expenses related to the Project activities from the regular budget of NRW Section and O&M Section. Afterward, budget plan for the total period of the Project was prepared as Table 4.4-1.

**Table 4.4-1 Total Estimated Cost for the Capacity Development Project for NRW Reduction in Colombo City – 2010, 2011 and 2012**

Se. No.	Description	Unit	Qty	Rate	Amount
<b>1</b>	<b><u>STAFF</u></b>				
a	Allow for Engineering Assistants. Rate to include Salary, Over time and Subsistence for three years for 06 nos of EAA	item			21,830,040.00
b	Allow for Skilled Labourers. Rate to include Salary, Over time and subsistence for three years for 06 nos of Fitters and 06 nos of Drivers	item			32,531,112.00
c	Allow for Un Skilled Labourers. Rate to include Salary, Over time and Subsistence for three years for 12 nos labourers	item			30,005,856.00
<b>2</b>	<b><u>TRANSPORT</u></b>				
a	Allow for cost of Vans. Rate to include Fuel cost, Services, Tyres & Tubes and Repair & Maintenance cost for 04 nos of Vans for three years.	item			2,882,400.00
b	Allow for cost of 02 nos of Hired Vehicles for three years	item			4,320,000.00
<b>3</b>	Allow for cost of Excavators. Rate to include Fuel Cost, Services, Tyres & Tubes and Repair & Maintenance cost for 02 nos of Excavators for three years	item			6,302,400.00
<b>4</b>	Cost for purchasing of Concrete Chambers.	Nos	180	50,000.00	9,000,000.00
<b>5</b>	Allow for cost of Taxes and custom duty for Vehicles and Equipment.	item			22,000,000.00
<b>6</b>	Allow for cost of Valve Raising work for three years.	item			3,000,000.00
<b>7</b>	Allow for cost of Leak Repaired work for three years. Rate to include 80 nos of leaks repaired per month approximately.	item			4,320,000.00

Annex – 1 Annual Program (3)

8	Allow for cost of Materials for Leak Repair works for three years.	item			15,000,000.00
9	Allow for cost of scraping and Lining of Pipe Lines for three years.	item			6,000,000.00
10	Allow for cost of Purchasing of 10 nos of Car Batteries and 02 nos of Battery Charges.	item			90,000.00
11	Office Refurbishment including Partitioning, Airconditioning, Furniture, etc.	item			2,500,000.00
	<b>SUB TOTAL 1</b>				159,781,808.00
12	Allow for cost of Road Re-instatement charges. Rate to include for installing valves & Meters and for Leak Repair works for three years.	item			3,300,000.00
	<b>SUB TOTAL 2</b>				163,081,808.00
13	Allow for 10% contingencies				16,308,180.80
	<b>SUB TOTAL 3</b>				179,389,988.80
14	Allow for VAT 12%				21,526,798.66
	<b>GRAND TOTAL</b>				200,916,787.46

The above cost has been approved by NWSDB, and required budget for each year was allocated from the total budget. However, Ministry of Finance has not approved the budget for this project and NWSDB is negotiating with the Ministry. At present the normal budget for O&M section and NRW section is used for this project.





## **Annex - 2**

### **Work Plan**



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## 1 General

NRW Reduction Team and JET jointly prepared the work plan to conduct activities in sub-zones in Pilot Area based on annual program that was prepared by NRW Reduction Management Team. The work plan was revised from time to time according to actual progress of activities.

## 2 Change History of Work Plan

### 2.1 Work Plan (version 1: May 2010)

C/P and JET has jointly prepared the work plan to conduct activities in Pilot Project Area, considering Annual Program. Figure 2-1 and Figure 2-2 specifies immediate work plan to be conducted in Pilot Project Areas.

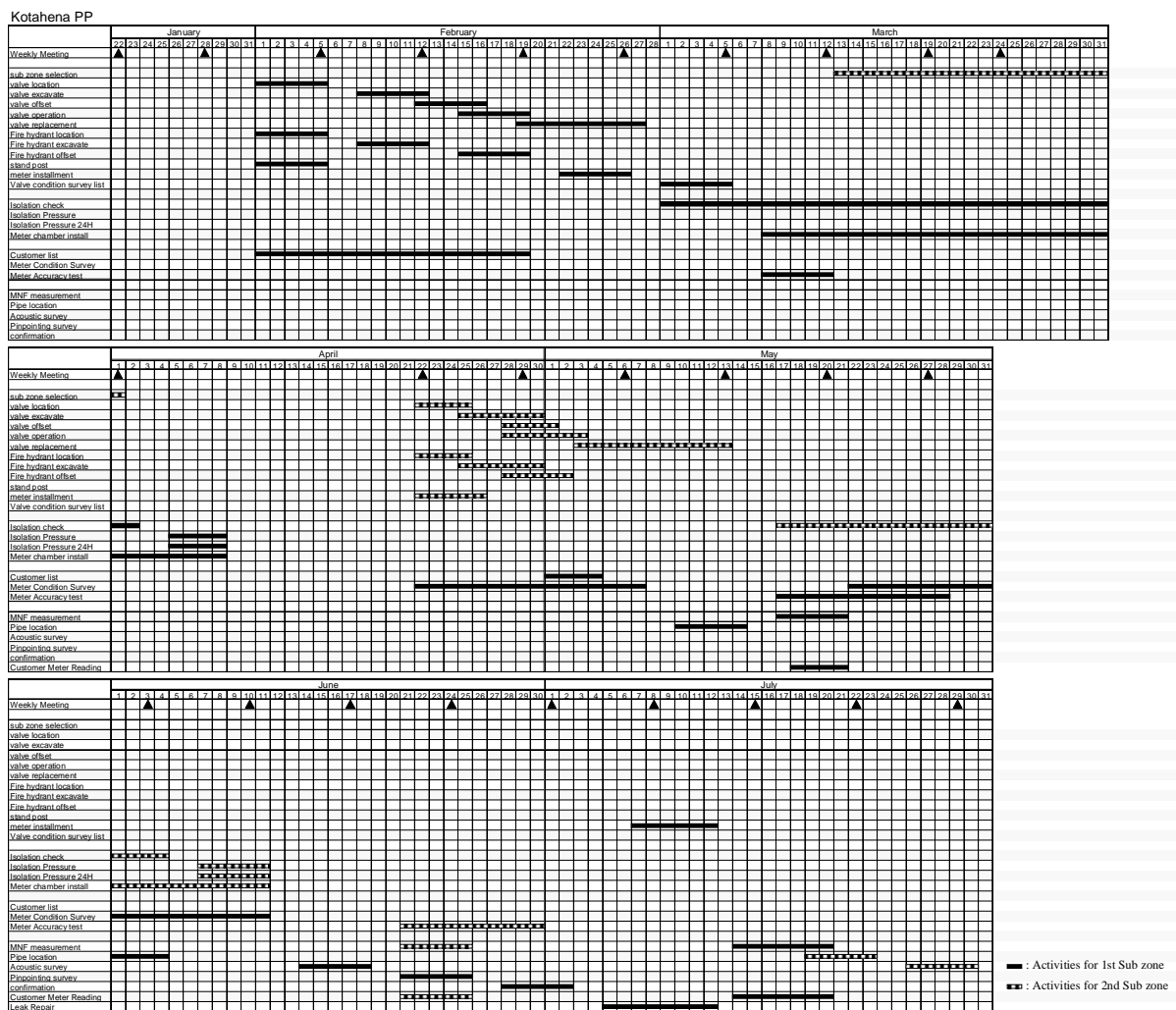


Figure 2-1 Work Plan (Kotahena) (version 1: May 2010)

## Annex -2 Work Plan

Borella Firstst

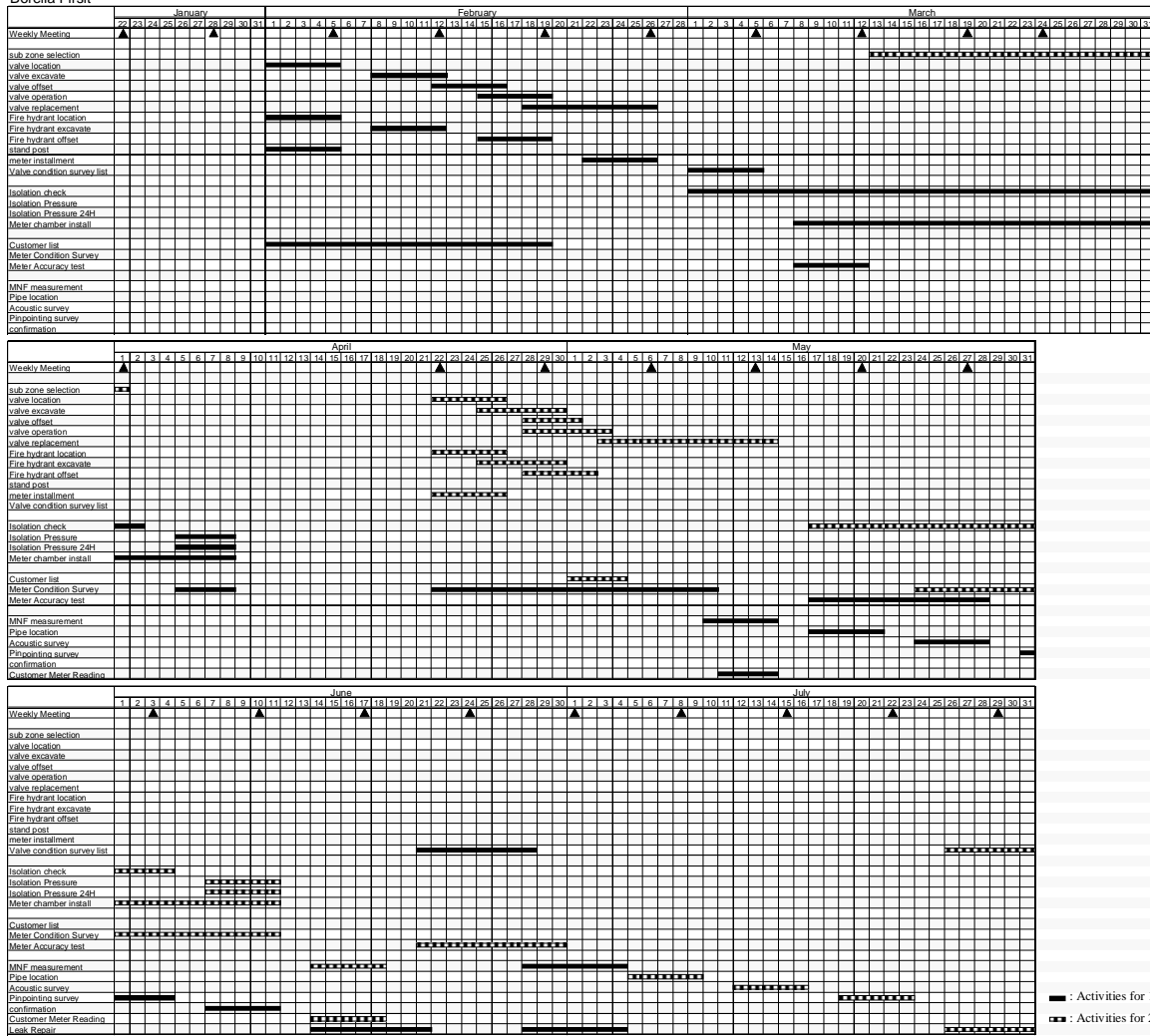


Figure 2-2 Work Plan (Borella) (version 1: May 2010)

### 2.2 Work Plan (version 2: Oct 2010)

C/P and JET has jointly prepared the work plan beforehand to conduct activities in Pilot Project Area, considering Annual Program. Figures from Figure 2-3 to Figure 2-6 specify immediate work plan to be conducted in Pilot Project Areas.

## Annex -2 Work Plan

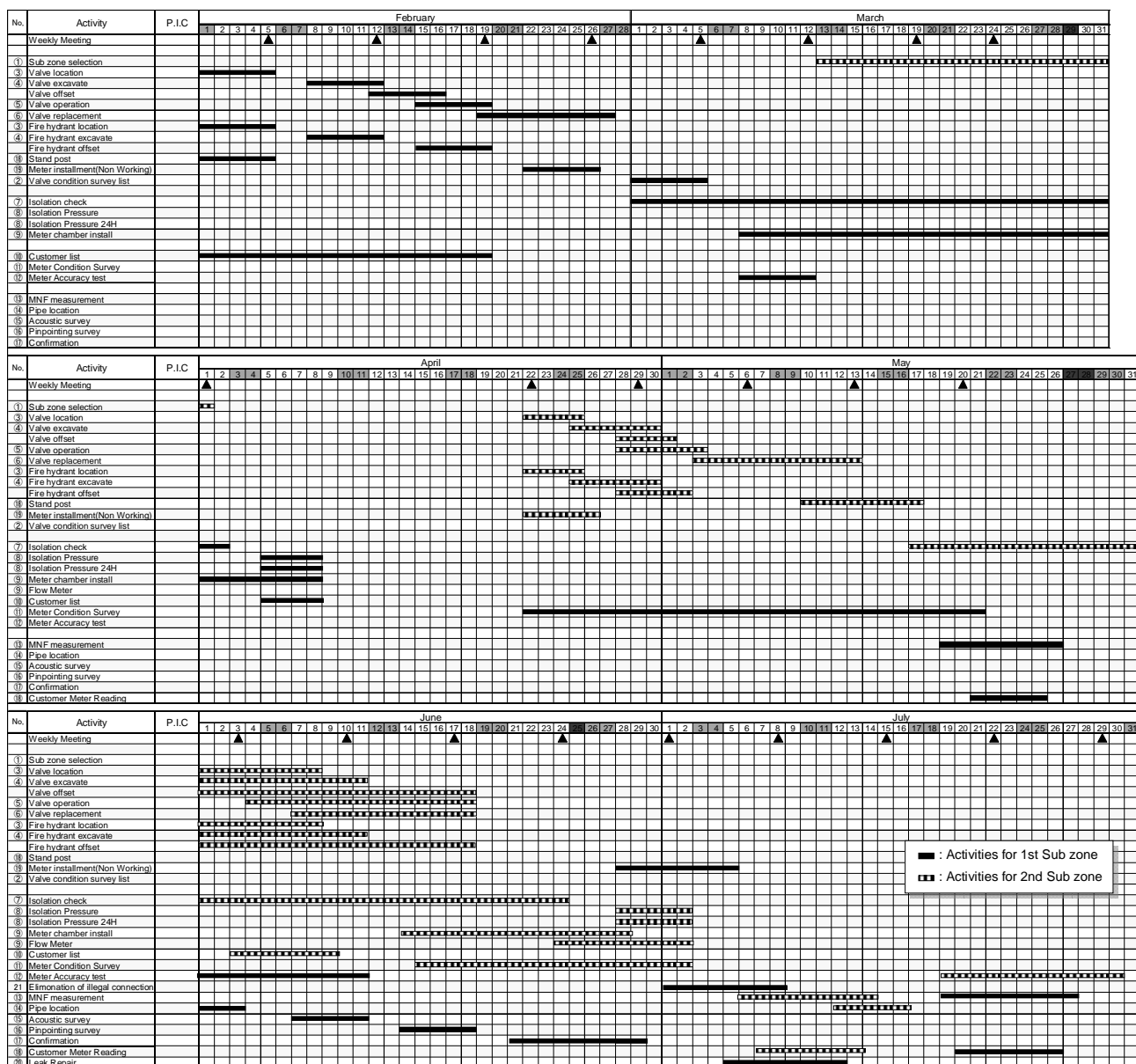


Figure 2-3 Work Plan (Kotahena) (1 of 2) (version 2: Oct 2010)

## Annex -2 Work Plan

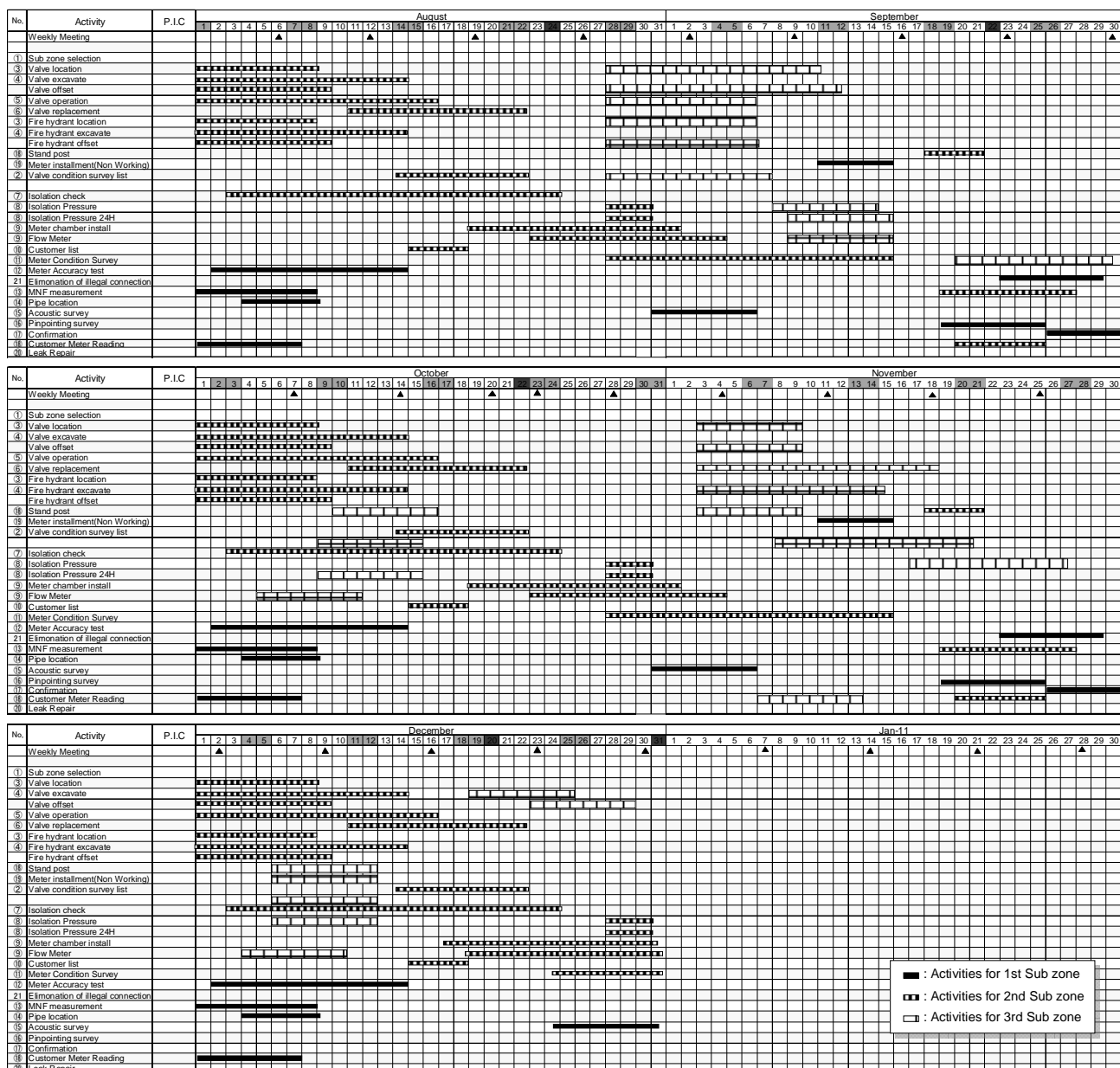


Figure 2-4 Work Plan (Kotahena) (2 of 2) (version 2: Oct 2010)



## Annex -2 Work Plan

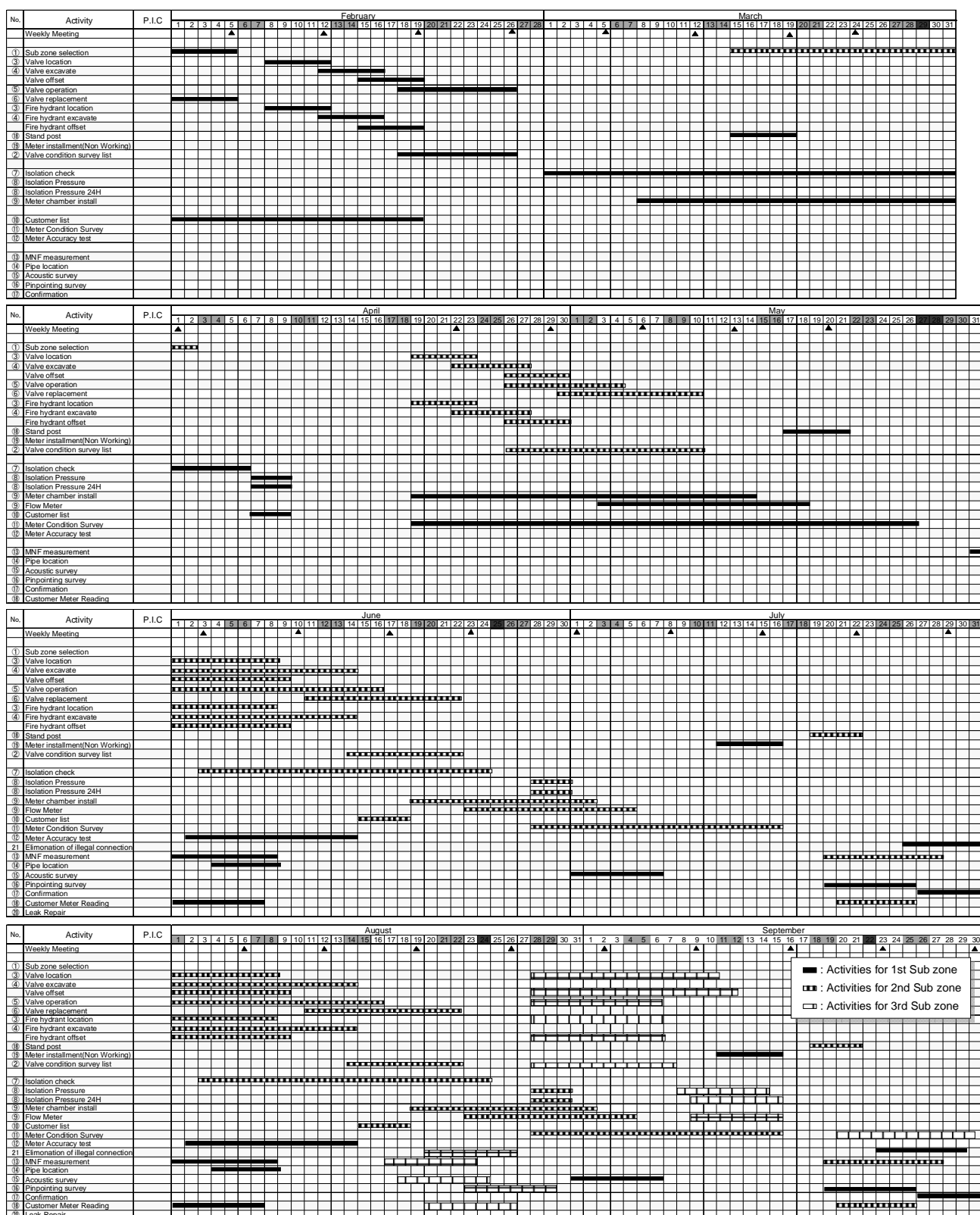


Figure 2-5 Work Plan (Borella) (1 of 2) (version 2: Oct 2010)

## Annex -2 Work Plan

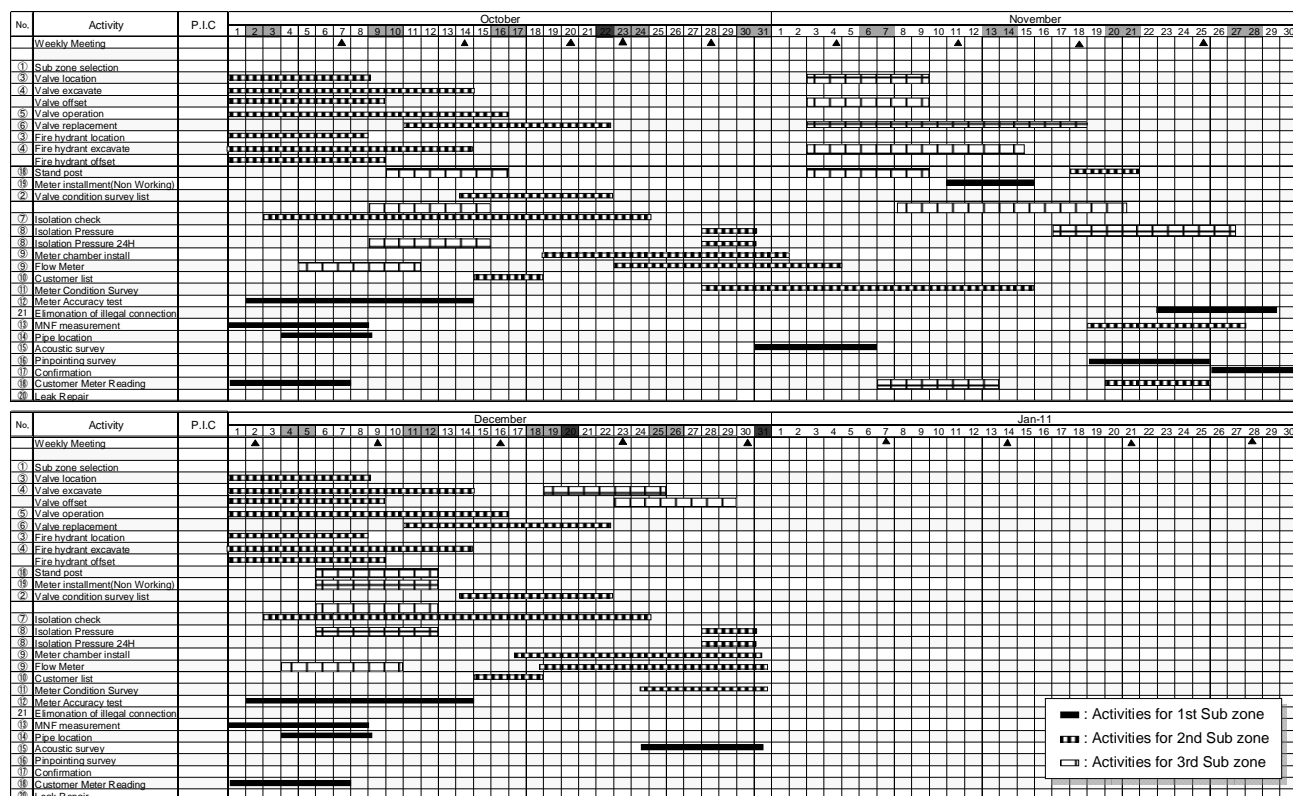


Figure 2-6 Work Plan (Borella) (2 of 2) (version 2: Oct 2010)

Isolation of two sub-zones in Kotahena and Borella was completed as scheduled by the end of May 2010 after a series of preliminary works, such as selection of pilot areas, organizing NRW reduction teams, procurement of equipment, seminar and workshops, and investigation of exiting pipelines and valves.

It was originally planned to complete leakage detection and repair works in these two sub-zones by the end of August 2010. While the major field activities for these two sub-zones in Kotahena and Borella has finished on 10 July 2010 and 2<sup>nd</sup> September 2010 respectively, data collection through “meter condition survey” and “customer meter reading” takes long time and calculation of NRW ratio is delayed from the schedule. Data collection was repeated several times due to numerous errors in the collected data and absence of customer at the houses.

Isolation activities in the second sub zone for both pilot areas have been executed simultaneously in order to start the leak detection and leak repair from September. However initial MNF reading in both sub-zones has not started so far.

The situation of the progress for both pilot areas at the end of October 2010 is summarized below.

### (1) Pilot area in Kotahena

- **Sub-zone 1 (K1):** The initial NRW reduction activities are completed. However, NRW ratio remains high. New leakage occurrence caused by improved water pressure and other reasons can be considered. In order to find the reasons and reduce NRW ratio, the second NRW reduction activities are started.
- **Sub-zone 2 (K2):** Isolation of the area has completed and meter chambers are installed. It is ready to start initial MNF measurement.

- **Sub-zone 3 / 4 (K3 / K4):** Isolation valves are under investigation.

**(2) Pilot Area in Borella**

- **Sub-zone 1 (B1):** Data collection of customer meter reading has not been completed. MNF shall be measured after repair of some new visible leakages which are found just after the NRW reduction activities.
- **Sub-zone 2 (B2):** Isolation of the sub-zone is finished. Meter chamber installation is under the progress.
- **Sub-zone 3 (B3):** Isolation of the sub-zone is finished. Meter installation is not started.

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

- **Information and data:** Location of valves cannot 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.
- **Vehicles / drivers:** Sufficient numbers of vehicle and driver are not always available. Field works sometimes suspended without information due to shortage of vehicles.
- **Personnel:** Several assignments are given to the key personnel, while the priority is given to the Project.
- **Backhoe:** There are several heavy duty activities which require larger capacity than the back hoes procured in the Project.
- **Permission for road excavation:** Application process is not necessarily taken previously considering the required time.
- **Meter chamber:** Preparation of meter chambers to be installed in heavy traffic roads takes times.
- **Meter installation:** Replacement of large sized pipes for meter installation faces difficulty due to material shortage and others.
- **Valves and fittings:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that NRW reduction teams are not accustomed to meter readings.

In order to expedite the progress, several countermeasures shall be considered. Some of the important measures are listed below.

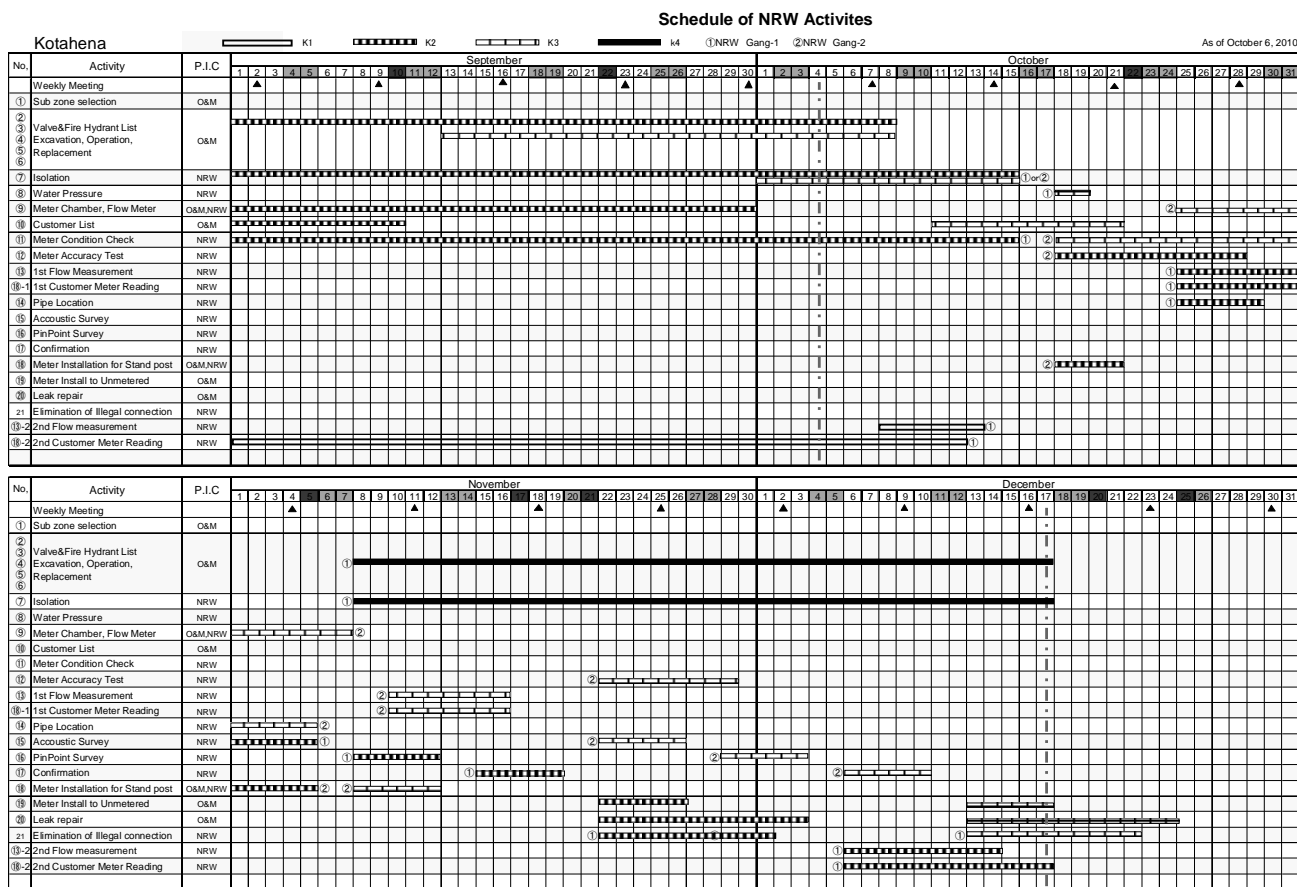
- Review adequate allocation of NWSDB resources (personnel, equipment, budget, etc. )
- Area engineers / OIC take initiative to prepare weekly schedules by reviewing longer term work plan and then instruct the zone officers and EA to take actions according to the plan.
- Zone officers and EA understand the long term plan and find the required preparation works.
- Make clear the responsibility and contents of each works
- Inform the requirement / shortage to upper level without delay
- Prepare manual for meter condition survey and customer meter reading
- Make understand the contents / filling methods of leak repair records

The measures to be taken will be reviewed throughout the execution of the activities. The work procedures will also be revised / modified to suite the actual situation.

Considering the above, Work Plans have been revised by C/P and JET in October 2010. The

## Annex -2 Work Plan

revised schedule are shown in Figure 2-7 and Figure 2-8.



**Figure 2-7 Revised Work Plan (Kotahena) (version 2: Oct 2010)**

## Annex -2 Work Plan

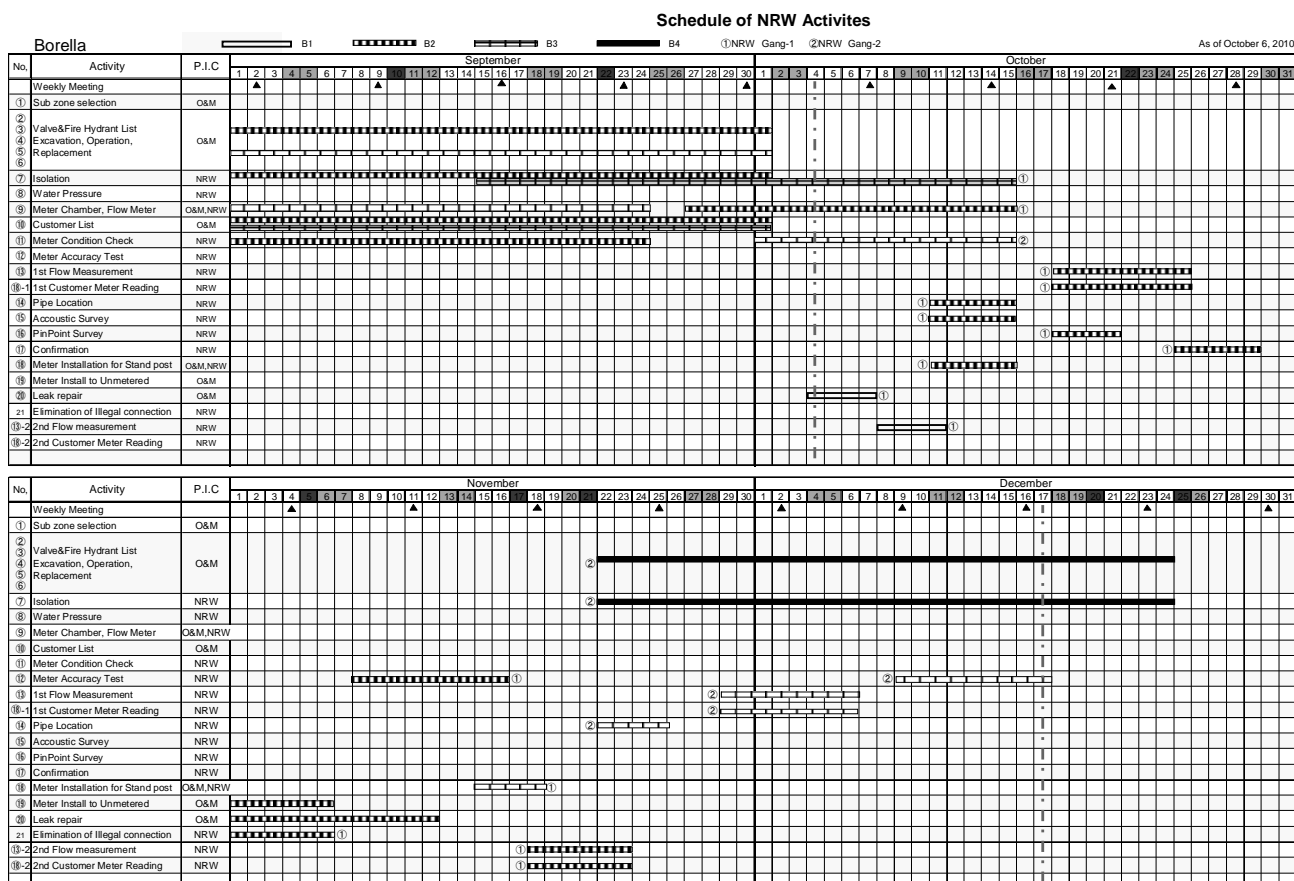


Figure 2-8 Revised Work Plan (Borella) (version 2: Oct 2010)

### 2.3 Work Plan (version 3: Mar 2011)

C/P and JET have jointly prepared the work plan beforehand to conduct activities in Pilot Project Area, considering Annual Program. Figure 2-9 and Figure 2-10 shows general work plan in both Pilot Project Area.

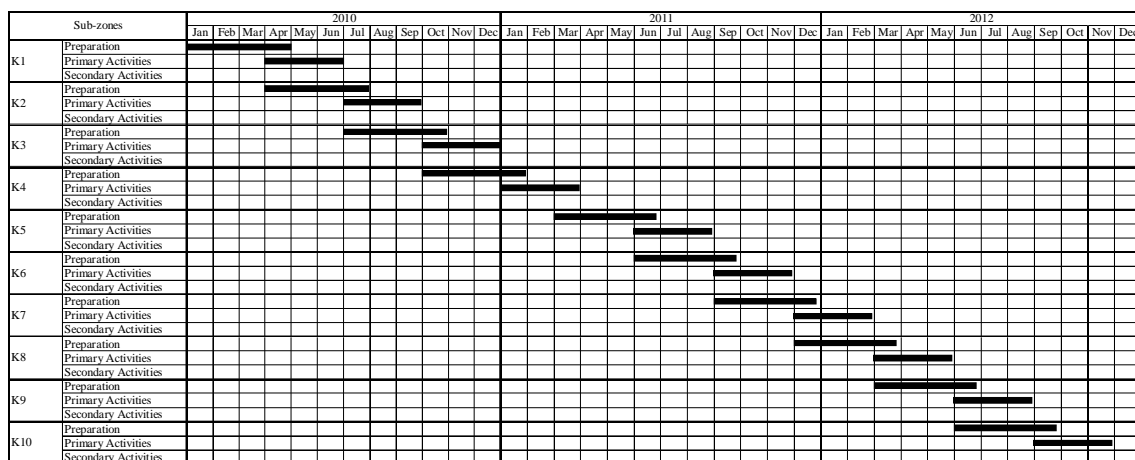
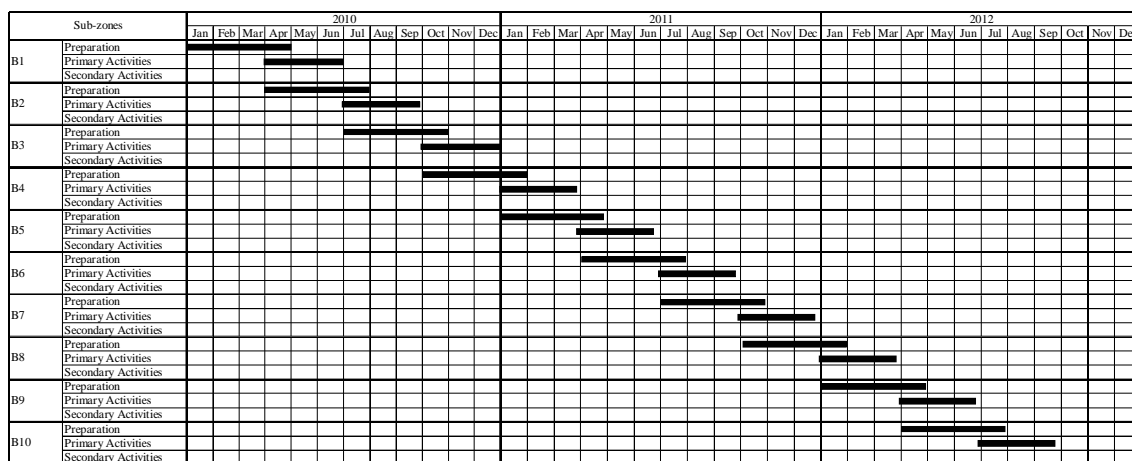


Figure 2-9 General Work Plan (Kotahena) (version 3: Mar 2011)

## Annex -2 Work Plan



**Figure 2-10 General Work Plan (Borella) (version 3: Mar 2011)**

Isolation of two sub-zones in Kotahena and Borella was completed as scheduled by the end of May 2010 after a series of preliminary works, such as selection of pilot areas, organizing NRW reduction teams, procurement of equipment, seminar and workshops, and investigation of existing pipelines and valves.

It was originally planned to complete leakage detection and repair works in these two sub-zones by the end of August 2010. While the major field activities for these two sub-zones in Kotahena and Borella have finished on 10 July, 2010 and 2<sup>nd</sup> September, 2010 respectively, data collection through “meter condition survey” and “customer meter reading” needed long time and calculation of NRW ratio was delayed from the schedule. Further, data collection had to be repeated several times due to numerous errors in the collected data and absence of customer at the houses.

Even though the NRW reduction activities were followed as per originally planned, the NRW value remain still high in some sub-zones in Kotahena.

In order to identify high-NRW-contributing segment in K1, a "step testing" has been conducted in K1. In this step testing, K1 was divided into three areas. However, this step testing could not clearly identify the high-NRW-contributing area. This result implies that numbers of unidentified leakages that are yet to be discovered are more contributing to high NRW ratio in this area, than unidentified major illegal uses. Some of leakages are not detected where leak sound is very weak due to constantly low pressure and where house connection pipes are not located due to pipe routes under buildings.

Therefore, some new activities were introduced to implement in Kotahena such as abandonment of the existing CI pipe line after transferring the house connection from CI line to existing PVC line, and introduction of common pipe line instead of existing bundle pipes. In addition to the above, extra resources & time were allocated to implement the step testing for identifying high MNF area in these two sub zone for reducing the NRW further. These additional input/activities may also make some work items behind the schedule.

As NWSDB had strong interest whether it was possible to reduce NRW further in Borella as well, a step testing was conducted in B1 as done in K1. The step testing contributed to identifying a segment with larger volume of leakage and to reducing it. These additional works were also one of the cause of delay from the original schedule.

The situation of the progress for both pilot areas in February 2011 is summarized below.

### (1) Pilot area in Kotahena

- **Sub-zone 1 (K1):** The initial NRW reduction activities are completed. However, NRW ratio remains high. The step testing is carried out in order to identify high MNF areas and the abandonment of the CI pipe line and transferring of the house connections from CI to PVC are under the progress.
- **Sub-zone 2 (K2):** The initial NRW reduction activities are completed. Data input work for individual consumption is under progress.
- **Sub-zone 3&4 (K3 & K4):** Some defective boundary valves were repaired or installed for completing the isolation. Data collection of “ meter condition survey” has been completed. Isolation work in this area is taking long time due to complexity of pipeline network.
- **Bloemendhar Road (Number yet to be specified):** Pipe replacement work under Japanese ODA loan Project in progress. Surfacing boundary valves for isolation in progress. Once isolation work is completed, “initial NRW”, “NRW after pipe replacement” and “NRW after a series of reduction activities” are to be compared. Pipe replacement work by the ODA loan project is in progress. Surfacing boundary valves for isolation is also in progress. As this area is relatively difficult condition for isolation due to complexity of pipeline network and heavier traffic, isolation work (especially for existing valve confirmation survey) is taking long time.

### (2) Pilot Area in Borella

- **Sub-zone 1 (B1):** Final NRW value was established and the leak detection activities were implemented for further reducing NRW, after identifying the high MNF area by carrying out the step testing.
- **Sub-zone 2 (B2):** the activities for the leak detection work were completed. The Initial flow measurement work has not been completed because meters has not been installed yet. Ultrasonic meter has already been tried however it could not get signal from the 12 inch CI pipe line (due to possible internal encrustation and/or severe surface rust/corrosion). At the moment, trial for pipe replacement in measurement part is being processed.
- **Sub-zone 3 (B3):** The Primary NRW reduction activities were completed and figures are under verification. Further leakage detection is being considered.
- **Sub-zone 4 (B4):** Isolation valves are under investigation.

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

- **Information and data:** Location of valves cannot 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.
- **Vehicles / drivers:** Sufficient numbers of vehicle and driver are not always available. Field works sometimes suspended without information due to shortage of vehicles.
- **Personnel:** Several assignments are given to the key personnel, while the priority is given to the Project.
- **Backhoe:** There are several heavy duty activities which require larger capacity than the back hoes procured in the Project.
- **Overtime:** Since overtime is limited and allowance for night work is not applied, it is difficult to keep incentive for NRW activities.
- **Permission for road excavation:** Application process is not necessarily taken previously

considering the required time.

- **Meter chamber:** Preparation of meter chambers to be installed in heavy traffic roads takes times.
- **Meter installation:** Replacement of large sized pipes for meter installation faces difficulty due to material shortage and others.
- **Valves and fittings:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that NRW reduction teams are not accustomed to meter readings.

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

- Review adequate allocation of NWSDB resources (personnel, equipment, budget, etc. )
- Area engineers / OIC take initiative to prepare weekly schedules by reviewing longer term work plan and then instruct the zone officers and EA to take actions according to the plan.
- Zone officers and EA understand the long term plan and find the required preparation works.
- Make clear the responsibility and contents of each works
- Inform the requirement / shortage to upper level without delay
- Prepare manual for meter condition survey and customer meter reading
- Make understand the contents / filling methods of leak repair records

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 effort could not completely improve the delayed schedule.

According to the original schedule, at least three Sub-zones should have been completed in Pilot Areas of Kotahena and Borella by the end of January 2011. However, they are yet to be completed. Major reasons of delay are as follows.

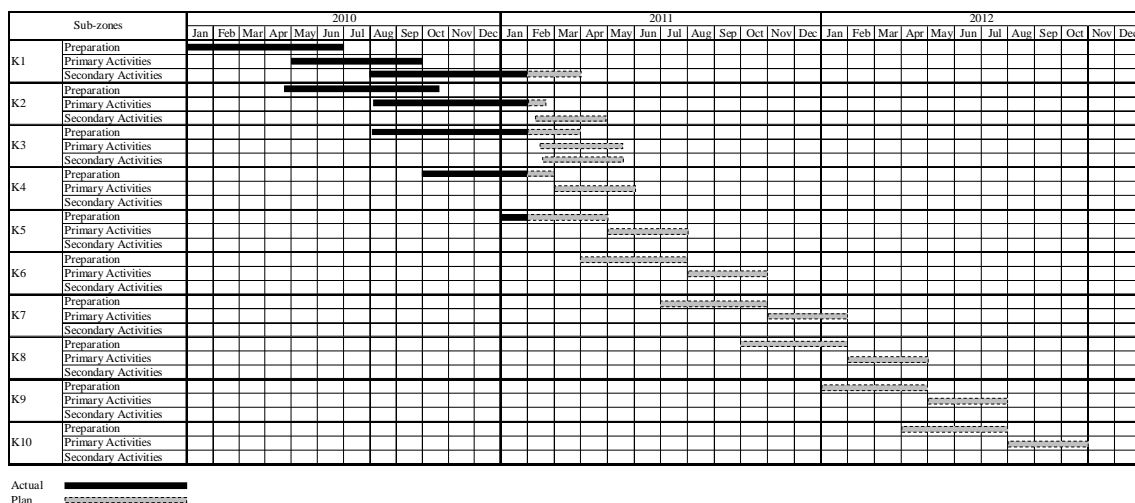
- Isolation works took long time due to inaccurate drawings.
- C/P staff who are engaged in the Pilot Activities as a key member struggle with difficulties in focusing on the activities because they have to take care other routine works as well.
- JCBs (backhoes) or vehicles cannot always be arranged properly or promptly.
- It took long time to install meter chamber (especially in B2).

On the whole, it is estimated that the original work plan is delayed about three to four months.

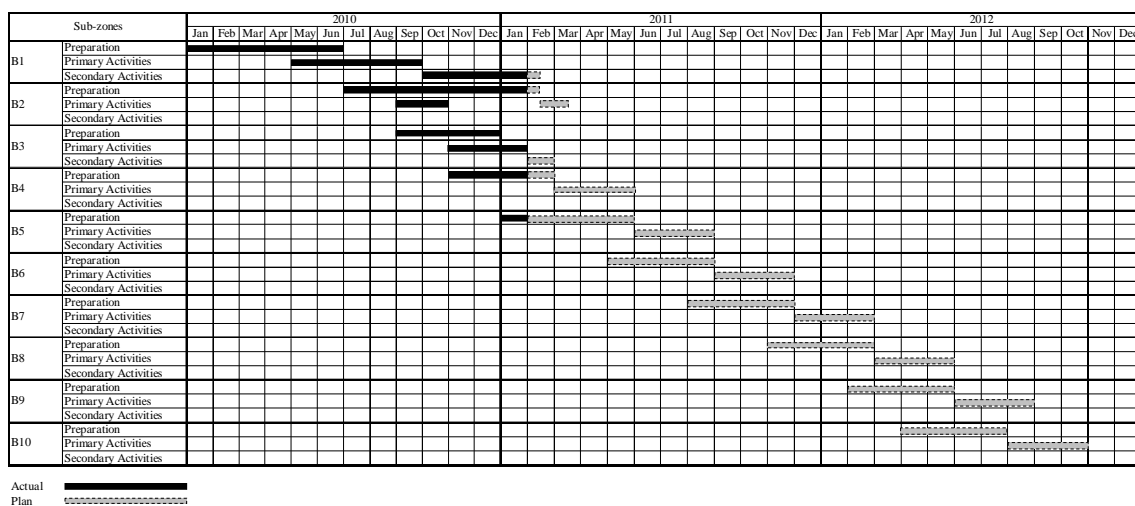
Considering the above, original work plans for both areas have been revised by C/P and JET in January 2011. The tentative schedule for both areas are shown in Figure 2-11 and Figure 2-12.



## Annex -2 Work Plan



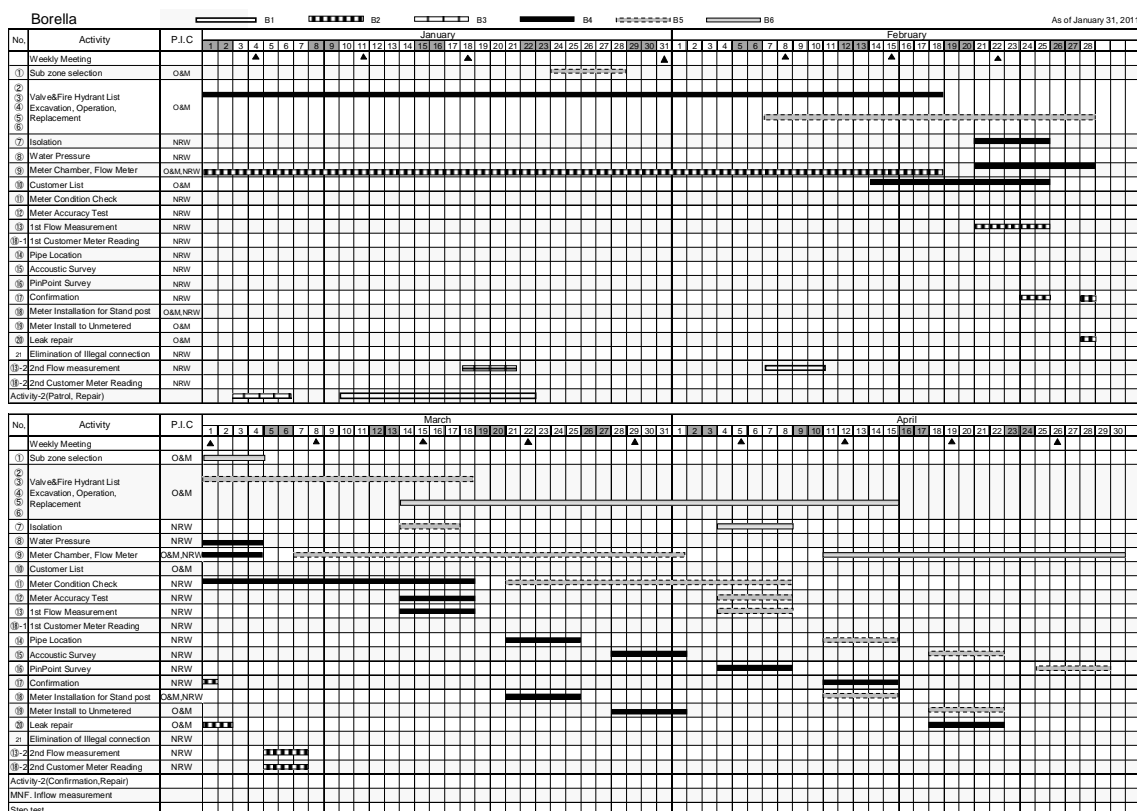
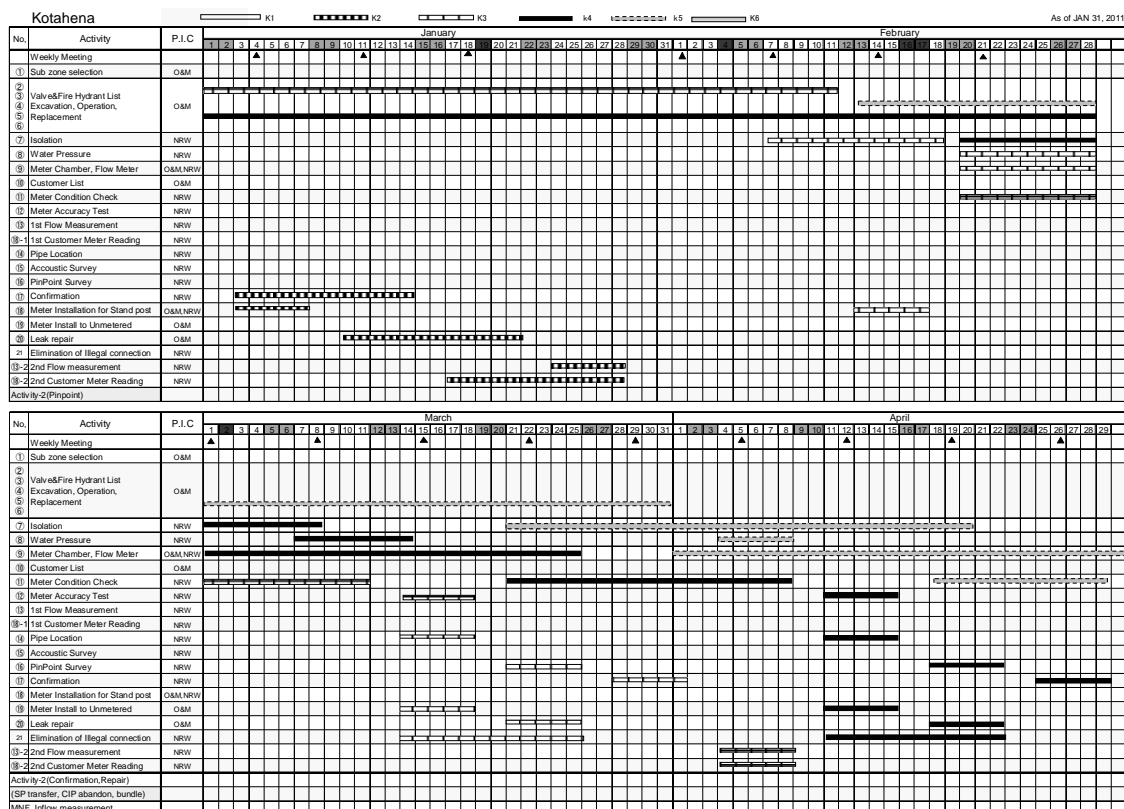
**Figure 2-11 Revised Work Plan (Kotahena) (version 3: Mar 2011)**



**Figure 2-12 Revised Work Plan (Borella) (version 3: Mar 2011)**

In addition, a detailed (short-term, until April 2011) work plans for both areas are prepared according to the General Work Plan and they are presented in Figure 2-13 and Figure 2-14.

## Annex -2 Work Plan



As mentioned before, the pilot activities may not be able to conduct according to the work plan,

due to constraints in site level (e.g.; isolation works often delayed due to inaccuracy of existing drawings; meter condition survey and/or meter reading cannot be completed at one time and have to be conducted repeatedly due to house close; staff who are engaged in the pilot activities cannot concentrate, lack of vehicles/drivers, and others).

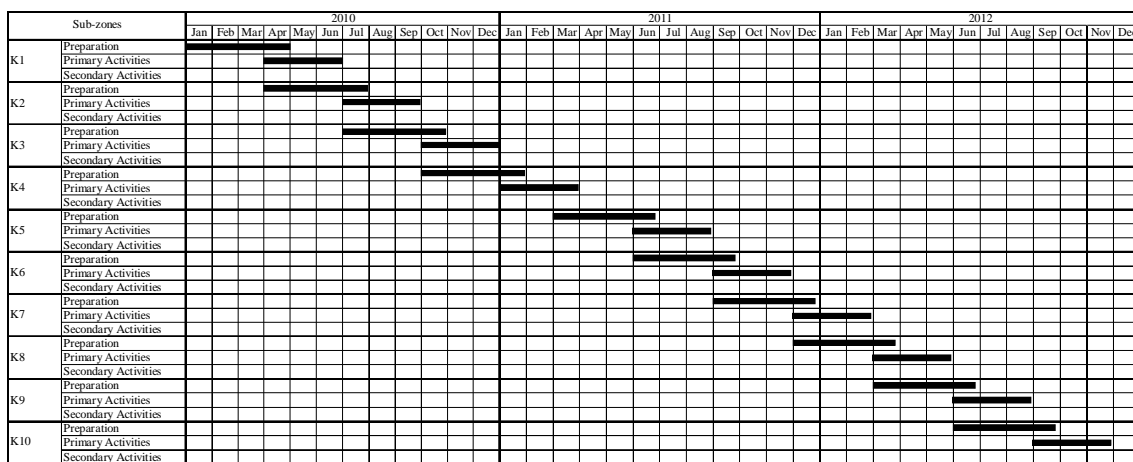
As stated in PDM, the primary purpose of the Project is capacity development regarding NRW reduction. If staff is exposed under strong pressure to catch up the schedule, this may result in inadequate NRW reduction activities or examination of effective/practical countermeasures.

All who are engaged in the Project, regardless of the position/level should maintain same understandings/view for the followings for example.

- What is actual condition and constrains at a site.
- How much work volume and time required at a site.
- What are major reasons of delay.
- How to overcome the obstacles.

## 2.4 Work Plan (version 4: Oct 2011)

C/P and JET have jointly prepared the work plan beforehand to conduct activities in Pilot Project Area, considering Annual Program. Figure 2-15 and Figure 2-16 show general work plans that were originally formulated at the beginning stage of the Project in both Pilot Project Area.



**Figure 2-15 General Work Plan for Kotahena (Original) (version 4: Oct 2011)**

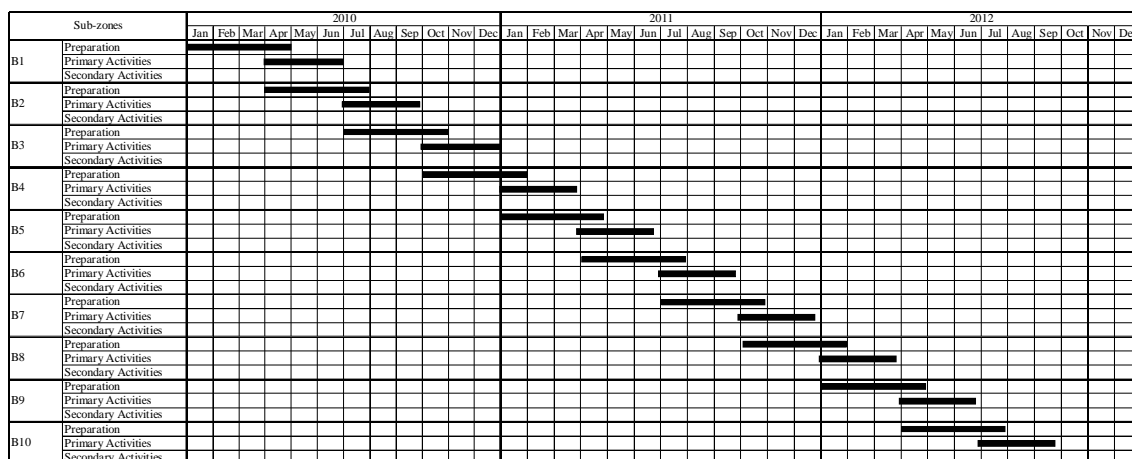


Figure 2-16 General Work Plan for Borella (Original) (version 4: Oct 2011)

The situation of the progress for both pilot areas as of September 2011 is summarized below.

#### (1) Pilot area in Kotahena

- **Sub-zone 1 (K1):** The initial NRW reduction activities (Primary Activities) were completed. However, NRW ratio remained high. Accordingly, a series of step tests were carried out in order to identify high MNF areas, with trying and seeing the effect of a series of abandonment of the CI pipe line and transferring of the house connections from CI to PVC. In addition, rectification works to cancel bundled pipe to re-connect service pipes to branch line have been completed in 17 locations (out of 18 in total). In spite of these rectification works, NRW rate remains still high. MNF is to be reconfirmed after rectifying remaining one location. Recent three-months billing record is being collected and reconfirmed.
- **Sub-zone 2 (K2):** The initial NRW reduction activities (Primary Activities) are completed. However, NRW ration remains high. Accordingly, further leakage survey was conducted as a part of the Secondary Activities and its data aggregation work is being processed.
- **Sub-zone 3&4 (K3 & K4):** Some defective boundary valves were repaired or installed for completing the isolation. Data collection of “meter condition survey” was completed. Isolation work in this area have been taking long time due to complexity of pipeline network. However, this work is estimated to be completed soon.
- **Sub-zone 5 (K5):** Valve surfacing works are under progress. Further works (replacement of defective valves or newly installation) are to be commenced after isolation works for K3 & K4, due to convenience of work force arrangement.
- **Sub-zone 6 (K6: Bloemendhar Road):** Pipe replacement work under Japanese ODA loan Project in progress. Surfacing boundary valves for isolation in progress. Once isolation work is completed, “initial NRW”, “NRW after pipe replacement” and “NRW after a series of reduction activities” are to be compared. Pipe replacement work by the ODA loan project is in progress. Surfacing boundary valves for isolation is also in progress. As this area is relatively difficult condition for isolation due to complexity of pipeline network and heavier traffic, isolation work (especially for existing valve confirmation survey) is under progress. Isolation has potentially been completed. Additional works such as meter installation to inlet of sump for apartment or preparation for pit for ultrasonic sonic meter are to be expedited.

## (2) Pilot Area in Borella

- **Sub-zone 1 (B1):** Final NRW value was established and the leak detection activities were implemented for further reducing NRW, after identifying the high MNF area by carrying out the step testing.
- **Sub-zone 2 (B2):** The activities for the leak detection work were completed. The initial flow measurement work was not completed because meters could not have been installed. Ultrasonic meter has already been tried however it could not get signal from the 12 inch CI pipe line (due to possible internal encrustation and/or severe surface rust/corrosion). For the time being, activities in this area is being suspended, waiting for couplings that match to bulk meter and the existing 12-inch CI line.
- **Sub-zone 3 (B3):** All NRW reduction activities were completed, and NRW value was established.
- **Sub-zone 4 (B4):** As the isolation works in this area turned out to be taking long time, this sub-zone has been further divided into two areas, namely Magazine Rd. area (isolation has been confirmed) and Fairfield Rd. area (isolation has not yet been confirmed). For the time being, Magazine Rd. area is to be firstly picked up for its NRW measurement. Another Fairfield Rd. area is to be worked out once isolation is confirmed.
- **Sub-zone 5 (B5):** Buried valves are being identified. Further works (replacement of defective valves or newly installation) are to be commenced after isolation works for B6, due to convenience of work force arrangement.
- **Sub-zone 6 (B6):** At present, replacement of defective valves and installation of new valves are under progress, This work is estimated to be completed after confirmation of additional one to two locations.

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

- **Information and data:** Location of valves cannot 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.  
Due to the above circumstances, especially in B4, B6, K3 & K4 and K6, confirmation of valve location or pipeline route takes long time. In addition, hydraulic isolation works have to be subject to a try-and-error approach and this also takes long time.
- **Vehicles / drivers:** Sufficient numbers of vehicle and driver are not always available. Field works sometimes suspended without information due to shortage of vehicles.
- **Personnel:** Several assignments are given to the key personnel, while the priority is given to the Project. C/P staff who are engaged in the Pilot Project activities as key member struggle with difficulties in focusing on the activities because they have to take care of their routine works and/or other works that is regarded as higher-priority by NWSDB (eg., urgent pipe replacement works along Galle Rd. or other strong request made by outside of NWSDB).  
To improve the above-mentioned situation, NWSDB re-organized the team grouping (reduce the number of teams from six to four, two are especially for the pilot activities). Since this re-organizing, progress of the pilot activities begin to show a favorite move.
- **Backhoe:** There are several heavy duty activities which require larger capacity than the back hoes procured in the Project.
- **Overtime:** Since overtime is limited and allowance for night work is not applied, it is difficult to keep incentive for NRW activities.
- **Permission for road excavation:** Application process is not necessarily taken previously considering the required time. This problem contribute to taking long time in isolation

works especially in B4 and B6.

- **Meter chamber:** Preparation of meter chambers to be installed in heavy traffic roads takes times.
- **Meter installation:** Replacement of large sized pipes for meter installation faces difficulty due to material shortage and others.  
Due to severe encrustation at the inlet point (12-inch CI line) of B2 and B5, it is impossible to measure inflow by ultrasonic meter. Therefore, NWSDB tried to mount the bulk meters at these points. However, due to unavailability of compatible couplings, bulk meters remain uninstalled. To expedite this, NWSDB has been going for tender procedure for several months to procure the couplings. Despite this effort, NWSDB could not obtain a bid that met to the specification as of the end of September 2011. At present, NWSDB is seeking the way out to realize isolation for these sub-zones.
- **Materials and tools:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability. Due to uncertain whereabouts of necessary materials or tools, NWSDB sometimes faces difficulties in preparing necessary materials/tools at necessary time. This is one of major concern to take long time for isolation works especially in B4 and B6.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that NRW reduction teams are not accustomed to meter readings.  
To cope with these disadvantages, NWSDB agreed to conduct PR activities (to disseminate contents of pilot activities under the Project to the residents) and data collection work (to obtain basic information) separately.
- **Activities during absence of JET:** JET views that the progress during the absence of JET, especially during March to May 2011, was not good enough as expected. JET feels that project activities were suspended whenever trouble/problem arose. JET also concerns that priority of the Project activities for NWSDB side would be lowered during the absence of JET.
- **Further activities:** Despite the effort to reduce NRW, NRW in K1 remained in high-value. Accordingly, as a further action, NWSDB has started canceling bundled pipes and laying common pipes, and replacing old CI pipe with new PVC at NWSDB's own cost. It takes time to prepare necessary materials and work force.

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

- Area engineers / OIC take initiative to prepare weekly schedules by reviewing longer term work plan and then instruct the zone officers and EA to take actions according to the plan.
- 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 effort could not completely improve the delayed schedule.

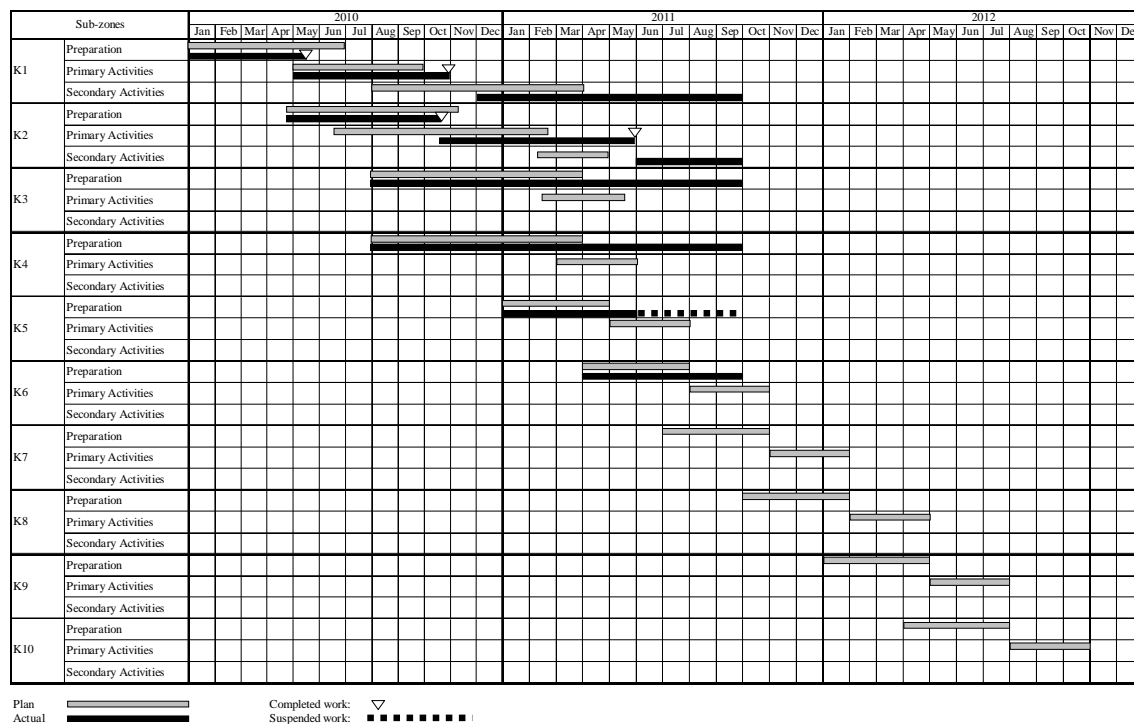
According to the original schedule, at least three Sub-zones should have been completed in Pilot Areas of Kotahena and Borella by the end of January 2011. However, they are yet to be completed. Major reasons of delay are as follows.

## Annex -2 Work Plan

- Isolation works took long time due to inaccurate drawings.
- C/P staff who are engaged in the Pilot Activities as a key member struggle with difficulties in focusing on the activities because they have to take care other routine works as well.
- JCBs (backhoes) or vehicles cannot always be arranged properly or promptly.
- It took long time to install meter chamber (especially in B2).

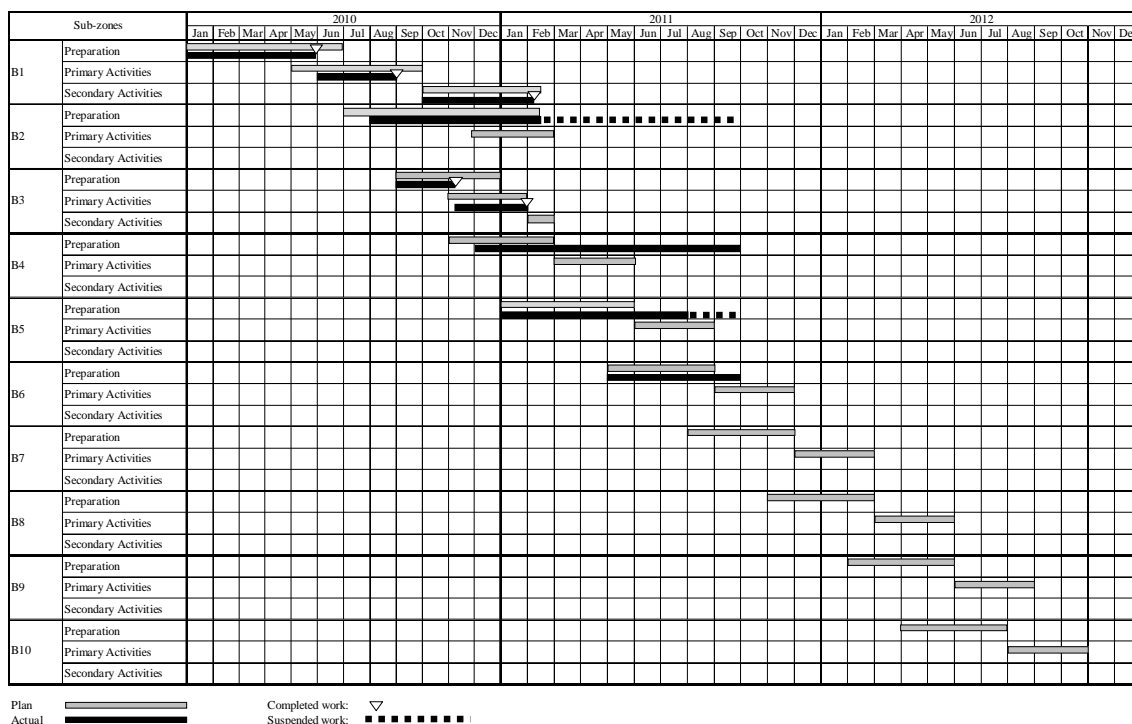
On the whole, it is estimated that the original work plan is delayed about three to four months.

Considering the above, original work plans for both areas have been revised by C/P and JET in January 2011. The tentative schedule for both areas are shown in Figure 2-17 and Figure 2-18.



**Figure 2-17 Updated Work Plan (Kotahena) (version 4: Oct 2011)**

## Annex -2 Work Plan



**Figure 2-18 Updated Work Plan (Borella) (version 4: Oct 2011)**

As mentioned before, the pilot activities may not be able to conduct according to the work plan, due to constrains in site level (e.g.; isolation works often delayed due to inaccuracy of existing drawings; meter condition survey and/or meter reading cannot be completed at one time and have to be conducted repeatedly due to house close; staff who are engaged in the pilot activities cannot concentrate, lack of vehicles/drivers, and others).

As stated in PDM, the primary purpose of the Project is capacity development regarding NRW reduction. If staff is exposed under strong pressure to catch up the schedule, this may result in inadequate NRW reduction activities or examination of effective/practical countermeasures.

All who are engaged in the Project, regardless of the position/level should maintain same understandings/view for the followings for example.

- What is actual condition and constrains at a site.
- How much work volume and time required at a site.
- What are major reasons of delay.
- How to overcome the obstacles.

### 2.5 Work Plan (version 5: Feb 2012)

#### (1) Original Work Plan

C/P and JET have jointly prepared the work plan beforehand to conduct activities in Pilot Project Area, considering Annual Program. Figure 2-19 and Figure 2-20 show general work plans that were originally formulated at the beginning stage of the Project in both Pilot Project Area.



## Annex -2 Work Plan

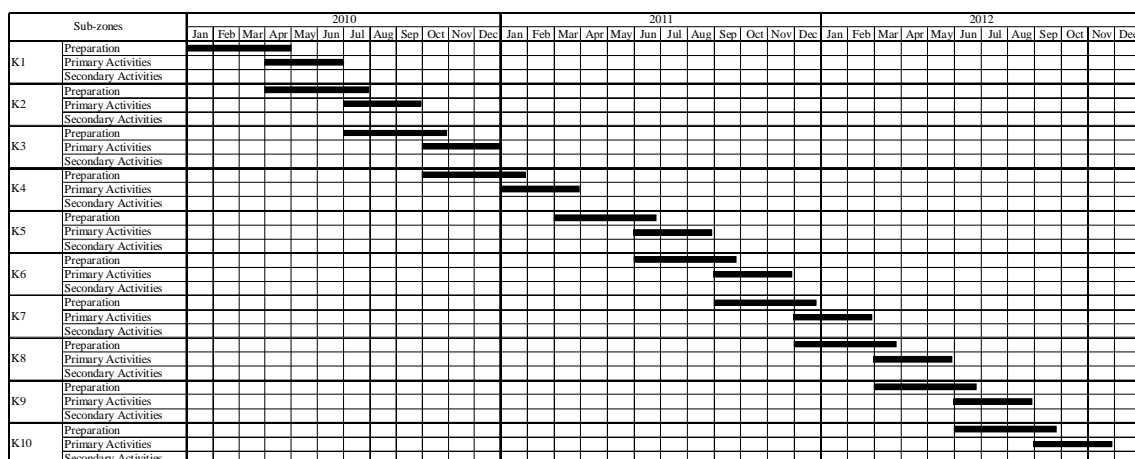


Figure 2-19 General Work Plan for Kotahena (Original) (version 5: Feb 2012)

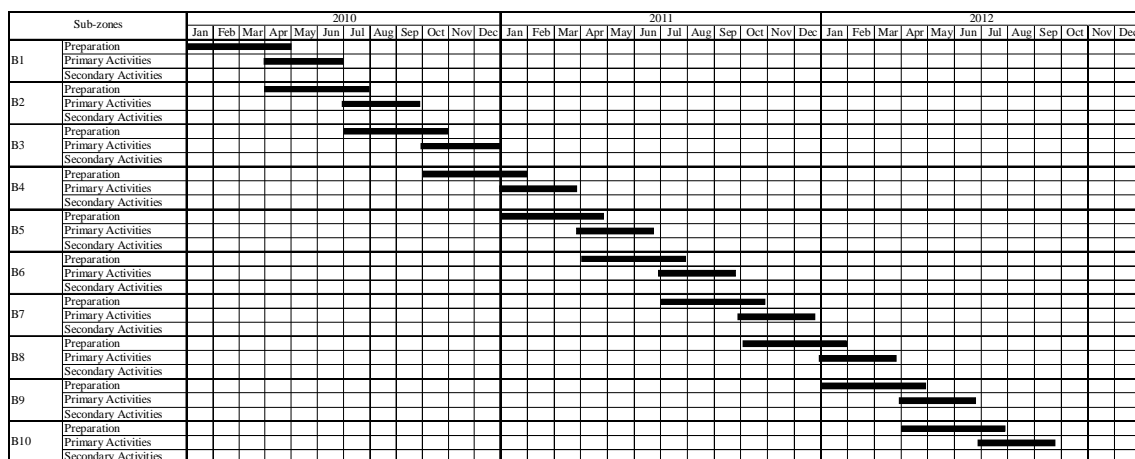


Figure 2-20 General Work Plan for Borella (Original) (version 5: Feb 2012)

Present situation of the sub-zones as of February 2012 is summarized in succeeding (2) and (3). Difficulties encountered during the course of the activities are outlined in (4). Present progress is summarized in (5).

### (2) Present Situation in Pilot Area in Kotahena

#### • Sub-zone 1 (K1):

- The initial NRW reduction activities (Primary Activities) were completed. However, NRW ratio remained high.
- Accordingly, a series of step tests were carried out in order to identify high MNF areas, with trying and seeing the effect of a series of abandonment of the CI pipe line and transferring of the house connections from CI to PVC.
- In addition, rectification works to cancel bundled pipe to re-connect service pipes to branch line have been completed in 17 locations (out of 18 in total). In spite of these rectification works, NRW rate remained still high.
- A series of step tests were carried out to narrow down suspicious part of area that would be a cause of high-NRW. With reference to the result, additional one valve was installed to narrow down further in the suspected section. Several reasons were suspected for high NRW (eg., unidentified leakages or illegal connections, unidentified pipelines that is not

shown on the existing database, potential leakage generated from newly-installed common pipes due to poor workmanship) in this area. At present, following works are being conducted. MNF will be measured again after these works.

- ✧ Flow measurement conducted at the branching point of newly-installed common pipe, for the purpose of checking if any leaks in common pipe. In this work, the team member visited every customer who are connected to the newly installed common pipe to request close the valve before meter. According to the result of flow measurement, water flow were observed even after closing every customer's connection. Accordingly, the C/P is now tracing the reason (eg., leakage in new common pipe may be suspected due to poor installation, previous trial for closing all connected customer might have been incomplete).
- ✧ Excavation work is considered to search if any unidentified bundle pipes.
- Recent three-months billing record is being collected and reconfirmed. This work is still being processed.
- **Sub-zone 2 (K2):**
  - The initial NRW reduction activities (Primary Activities) are completed. However, NRW ration remains high. Accordingly, further leakage survey was conducted as a part of the Secondary Activities.
  - As NRW remains still high, step tests including correlation tests are being conducted to narrow down suspicious section of high NRW.
  - Works for bundle pipe cutting and common pipe laying are planned making use of surplus of the project fund of "Greater Colombo Water Supply Rehabilitation Project (GCWRP)" by NWSDB.
- **Sub-zone 3&4 (K3 & K4):**
  - Some defective boundary valves were repaired or installed for completing the isolation. Data collection of "meter condition survey" was completed. Isolation work in this area have been taking long time due to complexity of pipeline network.
  - Isolation has once been confirmed. However, the NRW Reduction Team identified that as a result of isolation, water pressure in proximity area of the sub-zone dropped down. In order to minimize this affect, area of the sub-zone has been extended and isolation is to be confirmed soon.
- **Subone 5 (K5):**
  - Valve surfacing works have been commenced.
  - Further works (replacement of defective valves or newly installation) are to be commenced after isolation works for K3 & K4, due to convenience of work force arrangement.
- **Sub-zone 6 (K6: Bloemendhar Road):**
  - Before completion of the pipe replacement work under Japanese ODA loan project, isolation work and initial measurement has been conducted.
  - The above pipe replacement work along this area was completed. Connection work to individual houses are underway.
  - Initially, additional works such as meter installation to inlet of sump for apartment or preparation for pit for ultrasonic sonic meter had been planned. However, due to limitation at the site, it was decided that sumps for apartment have been excluded from the measurement.
  - After completion of connection work to houses, flow measurement will be conducted to verify the effect of pipe replacement.

- **Sub-zone 7 (K7):**
  - Boundary of the sub-zone has been determined. Isolation work is being underway.

### (3) Present Situation in Pilot Area in Borella

- **Sub-zone 1 (B1):**
  - All NRW reduction activities were completed and NRW value was established.
- **Sub-zone 2 (B2):**
  - After long time suspension due to unavailability of couplings that match to bulk meter to be installed and existing 12-inch CI line, the initial measurement has recently been conducted. Initial NRW is now being calculated.
  - The Primary Activities (leak repair, malfunctioning meter replacement and so on) are to be conducted.
- **Sub-zone 3 (B3):**
  - All NRW reduction activities were completed, and NRW value was established.
- **Sub-zone 4 (B4):**
  - As the isolation works in this area turned out to be taking long time, this sub-zone were further divided into two areas, namely Magazine Rd. area and Fairfield Rd. area. Isolation were confirmed in both areas.
  - Initial NRW has been established in this area.
  - Initial NRW remained high. Accordingly, it was decided to conduct Secondary Activities. Leak repair works under the Secondary Activities are being processed.
- **Sub-zone 5 (B5):**
  - Isolation works is being processed and completed soon.
- **Sub-zone 6 (B6):**
  - Isolation works is being processed and completed soon.
- **Sub-zone 7 (B7):**
  - Boundary of the sub-zone has been determined. Isolation work is being underway.

### (4) Difficulties Encountered

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

- **Information and data:** Location of valves cannot 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 exists 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 takes extremely long time. In addition, hydraulic isolation works have to be subject to a try-and-error approach due to existence of unexpected interconnections and this also takes long time.
- **Vehicles:** Moderate numbers of vehicle are 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 prevents the moves of additionally introduced activities such as GIS/GPS activities and PR activities do not proceed due to shortage of vehicles.
- **Personnel:** After assigning the two teams to concentrate on the Project, progress of the pilot activities begin to improve. However the activities are sometimes suspended due to

unexpected reasons such as union activities and health problem sometimes.

- **Permission for road excavation:** Application process is not necessarily taken previously considering the required time. This problem contribute to taking long time in isolation works especially in B4 and B6.
- **Meter chamber:** Preparation of meter chambers to be installed in heavy traffic roads takes times.
- **Materials and tools:** Materials of NWSDB are stored in several places without proper information and it sometimes takes time to find the availability. Due to uncertain whereabouts of necessary materials or tools, NWSDB sometimes faces difficulties in preparing necessary materials/tools at necessary time. This is one of major concern to take long time for isolation works especially in B4 and B6.
- **Data collection through meter condition survey and customer meter reading:** It takes long time. One of the reasons is that billing sheet owned by each customer shall be checked at site, since they cannot be identified by the address. Another reason is that service pipes are installed inside house building in many cases and it is required to ask permission for the meter checking from the customers.
- **Activities during absence of JET:** JET views that the progress during the absence of JET was not good enough as expected. JET feels that project activities were suspended whenever trouble/problem arose. JET also concerns that priority of the Project activities for NWSDB side would be lowered during the absence of JET.

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.

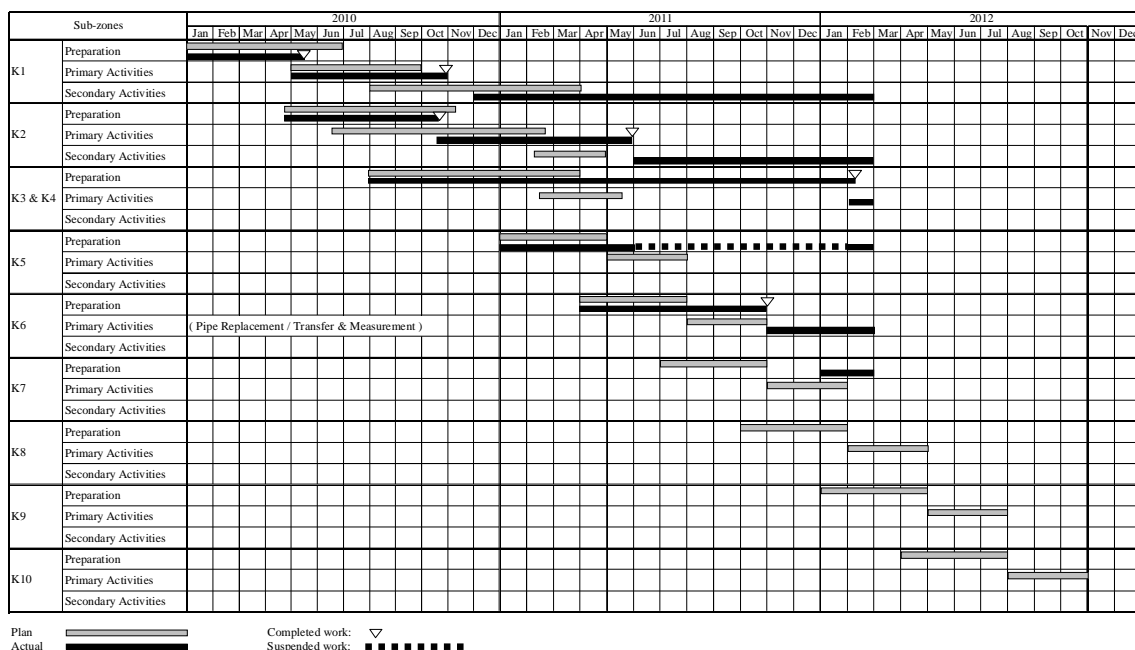
The measures to be taken were reviewed throughout the execution of the activities. The work procedures were also revised / modified to suite the actual situation. Nevertheless, these efforts could not completely improve the delayed schedule.

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. Therefore progress can be expected in these sub-zones. 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 are discussed and will be applied to the remaining sub-zones. Therefore further progress in those remaining sub-zones can be expected.

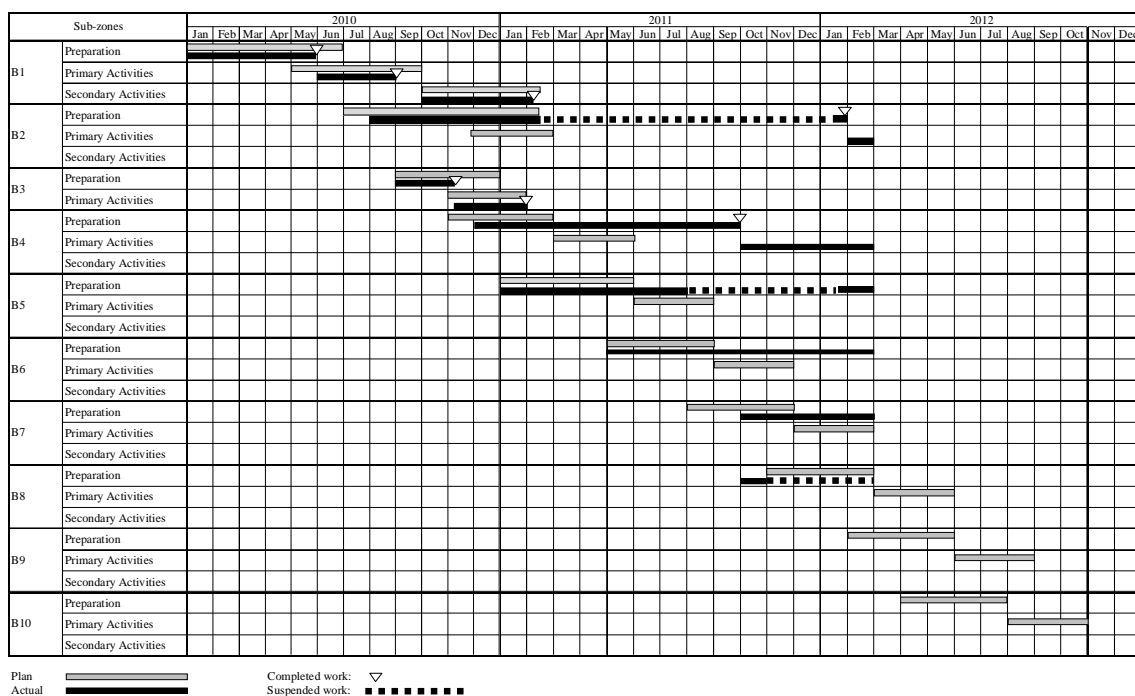
##### (5) Present Progress of Pilot Activities in Sub-zones

Present progress for both areas are shown in Figure 2-21 and Figure 2-22.

## Annex -2 Work Plan



**Figure 2-21 Updated Work Plan (Kotahena) (version 5: Feb 2012)**



**Figure 2-22 Updated Work Plan (Borella) (version 5: Feb 2012)**

As described, the pilot activities may have not been able to conduct according to the work plan till now, due to constrains in site level (e.g.; isolation works often delayed due to inaccuracy of existing drawings; meter condition survey and/or meter reading cannot be completed at one time and have to be conducted repeatedly due to house close; staff who are engaged in the pilot activities cannot concentrate, lack of vehicles/drivers, and others).

As stated in PDM, the primary purpose of the Project is capacity development regarding NRW reduction. If staff is exposed under strong pressure to catch up the schedule, this may result in

inadequate NRW reduction activities or examination of effective/practical countermeasures.

All who are engaged in the Project, regardless of the position/level should maintain same understandings/view for the followings for example.

- What is actual condition and constrains at a site.
- How much work volume and time required at a site.
- What are major reasons of delay.
- How to overcome the obstacles.

## Annex - 3

# Training Materials





## Table of Contents

- (1) Handout Materials for Seminar Held on 21<sup>st</sup> December, 2009
- (2) Presentation Material on Service Connection on 31<sup>st</sup> March, 2010
- (3) Procedure for Brain Storming Held on 31<sup>st</sup> March, 2010
- (4) Presentation Material on Methodology of Leak Detection on 6<sup>th</sup> April, 2010
- (5) Handout Materials for Field Workshop Held on 5<sup>th</sup> July, 2010, 18<sup>th</sup> October, 2010  
and 25<sup>th</sup> October, 2010
- (6) Presentation Materials for Seminar/Workshop Held on 25<sup>th</sup> January, 2011
- (7) Handout Materials for GIS Training from September 2011 to February 2012
- (8) Presentation Materials for Seminar Held on 28<sup>th</sup> February, 2012
- (9) Presentation Materials for Public Seminar Held on 15<sup>th</sup> October, 2012



**(1) Handout Materials for Seminar  
Held on 21st December, 2009**



**THE FIRST SEMINOR  
FOR  
THE CAPACITY DEVELOPMENT PROJECT  
FOR NON REVENUE WATER (NRW) REDUCTION  
IN COLOMBO CITY**

Time and Date: At 10:00HR on 21 December 2009

Place: Conference Room at the Thalawala Office of NWSDB

**Agenda**

1. Welcome Address (NWSDB)
2. Basic Issues for the Project (Kobayashi, JICA Expert Team)
3. Work Flow and Activities of the Project (Takatoi, JICA Expert Team)
4. Methodology Adopted to Execute the Pilot Project (Okazaki, JICA Expert Team)
5. Discussion
6. Any Other Matters



**THE CAPACITY DEVELOPMENT PROJECT  
FOR NRW REDUCTION IN COLOMBO CITY**

**BASIC ISSUES FOR THE PROJECT**

**(Considering The Strategic Approach)**

21 December 2009

S. Kobayashi  
JICA EXPERT TEAM

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Contents

1. Purpose and basics of the Project
2. NRW and its contributing factors
3. How to tackle NRW - Real Loss ?
4. Expectation by the activities
5. Pilot Area
6. Some others to be discussed soon

2

**1. Purpose and basics of the Project**  
**1.1 PROJECT PURPOSE and OUTPUTS**

**(1) Project purpose**

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

**(2) Expected “Outputs” of the Project**

- Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.
- Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.

3

**1.2 Role of NWSDB and JET for the Project standpoint**

- NWSDB is executing NRW reduction activities. JET(JICA Expert Team) is to advise and support (but not execute) the NRW reduction activities by C/P of NWSDB for improvement.
- The most important thing is NWSDB's primary role and initiative toward the achievement of the “Project Purpose” and “Outputs” of the Project.
- Sub-zone shall also be decided by NWSDB

4

**1.3 Contents of the activities**

**Activities (in the 1st Project Year)**

- Procurement of equipment
- Indicator setting for monitoring/evaluation of the Project and confirmation of its baseline data
- Activities related to Output 1 and Output 2 (to be explained by Mr. Takatoi)
- Preparation and Implementation of Overseas training for C/P

5

**2. NRW and its contributing factors**

**NRW :**

**Difference between the “System Input Volume” and “Billed Authorized Consumption”**

System Input Volume: The volume of water input to a transmission and distribution system

6

## IWA's Terminology for NRW

System Input Volume	Authorized Consumption	Billed Authorized Consumption M <sup>3</sup> /year	Billed Metered Consumption	Revenue Water M <sup>3</sup> /year
			Billed Non-metered Consumption	
	M <sup>3</sup> /year	Unbilled Authorized Consumption M <sup>3</sup> /year  <b>Legitimate Free Water <sup>1)</sup></b>	Unbilled Metered Consumption (water used for fire fighting, etc)  Unbilled Un-metered Consumption (free water distributed at standpipes)	<b>Non- Revenue Water M<sup>3</sup>/year</b>
	M <sup>3</sup> /year	Apparent Losses M <sup>3</sup> /year	Unauthorized Consumption <b>Thefts <sup>2)</sup></b>	
	Water Losses		<b>Metering Inaccuracies Administrative Loss <sup>3)</sup></b>	
	M <sup>3</sup> /year		Leakage or Transmission and/or Distribution Mains	
	Real Losses M <sup>3</sup> /year  <b>UFW</b>	Leakage and Overflows at Utility's Storage Tanks		
	<b>Leakages <sup>4)</sup></b>	Leakage on Service Connecting up to Customers' Metering		

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

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## 2.1 NRW

NRW =

System Input Volume – Billed Authorized Consumption

How to estimate NRW in Pilot Area ?

- System Input Volume  
From measurement of inlet and outlet in the pilot area for a period of 24 to 72 hrs
- Billed Authorized Consumption  
From reading of consumer meters before and after the end of the flow measurement and consider billing data
- NRW  
Calculate from system input and consumption and Billing Data

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## 2.2 Unbilled Authorized Consumption **Legitimate Free Water <sup>1)</sup>**

- Fire fighting, Training, Flushing of mains and sewers, Street cleaning, watering of municipal gardens – unbilled ?
- Community stand-posts, Bath taps, Toilet taps
- Way-side stand-posts
- Bowser supply

How to estimate the amount in the Pilot Area ?

As an idea,

Install meters and measure the consumption in standpost or estimate by observation (tap open duration) / Hearing

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## 2.3 Unauthorized Consumption **Thefts <sup>2)</sup>**

- Unauthorized connection
- Illegal tapping
- Damaging water meter willfully
- Conniving with NWSDB employees

How to estimate the amount in the Pilot Area ?

As an idea,

Count number of Illegal Connection after the survey and multiply by house member and per-capita consumption

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## 2.4 Metering Inaccuracies **Administrative Loss <sup>3)</sup>**

- Estimated Billing due to - no meters  
- meters not working  
- not accessed
- Metering Errors
- Billing Errors
- Meter Inaccuracy

How to estimate the amount in the Pilot Area ?

As an idea,

Sample test of meters,  
Billing data comparing with estimate  
(house numbers) x (assumed per capita consumption)

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## 2.5 REAL LOSS **Leakages <sup>4)</sup>**

NRW reduction

⇒ For discussion on Improvement of management of NWSDB (Revenue loss)

Real loss (leakages) reduction

⇒ For discussion on saving water sources (Water loss)

How to estimate real losses in the Pilot Area ?

As an idea,

Assume from minimum night flow

12



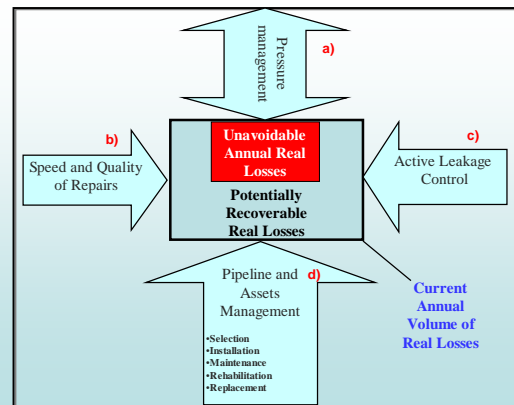
### 3. How to tackle NRW – Real Losses?

- **Legitimate Free Water <sup>1)</sup>**  
Policy - Depending on how big is the consumption  
Meter / assume consumption in public tap
- **Thefts <sup>2)</sup>**  
Action Path 7\* – Legal Activities  
Action Path 8\* – Encouraging Meter Readers
- **Administrative Loss <sup>3)</sup>**  
Action Path 8\* – Encouraging Meter Readers
- **Leakages <sup>4)</sup>**

\* : A Strategic Approach for NRW reduction in Colombo Metropolitan region.

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### The four basic methods of leakage management

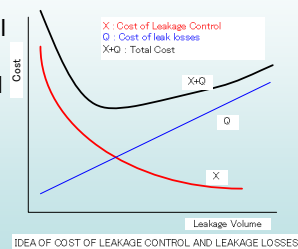


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### 3.1 Unavoidable Real Loss

- Economic level of investment and activity

- Depending upon local circumstance and practice, the marginal value on marginal value placed on real losses change.



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### 3.2 Pressure Management <sup>a)</sup>

- When pressure in pipe becomes low, leakage decrease.
- When pressure in pipe becomes high, leakage increase.
- Normally pressure control will cost a lot.

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### 3.3 Speed and Quality of Repairs <sup>b)</sup>

- Quick response to leaks and repair
- Poor quality of repair will cause reappearance of leaks

How to improve the activities ?

- 
- 
- 
- Leak repair records

This is the most cost effective method.

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### Example of leak repair records

Date	February 1, 2006
Location	A street, B district
Response Time	30 minutes
Pipe Type	DIP
Pipe Dia.	300 mm
Leak Spot	Joint
Leak Type	Joint Leaks
Leak Cause	Shoddy Workmanship
Repair Time	5 hours
Material Used	1 short Pipe (Bell - Plain), 1 collar, 2 accessories
Equipment Used	Wrench, Crane, Cutter
Labor	3 persons
Vehicle	1 truck
Sketch	-
Necessity of Replacement	No

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### 3.4 Active Leakage Control <sup>c)</sup>

#### PREVENTATIVE APPROACH ON LEAKAGE

The active leakage control strategy controls how long unreported leaks run for before they are located.

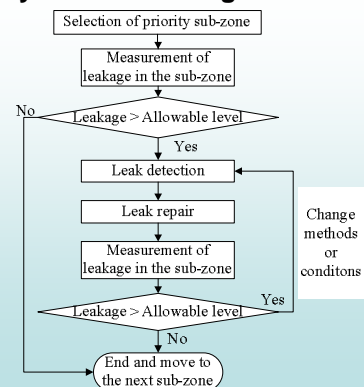
Once pipe bursts, the higher level of efforts have to be put in. It is effective to find leakage before pipe bursts.

#### How to improve the activities ?

- Leakage detection and repair  
~ Capacity Development Project

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### Systematic leakage control



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### 3.5 Pipeline and Assets Management <sup>d)</sup>

- Selection
- Installation
- Maintenance
- Rehabilitation
- Replacement

In Kotahena, pipe replacement will take place.

This method requires the most high cost.

However, it will be the essential method for aged system.

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### 4. Expectation by the Activities

In addition to Technical Improvement, it is expected to obtain ideas on:

- Amount of NRW
- Amount of each factor for NRW
- Effects of Activities on NRW reduction
- Costs and expected effects of activities

#### Preparation of adequate Future Plan

Updating maps and improving recording system

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### 5. Pilot Area

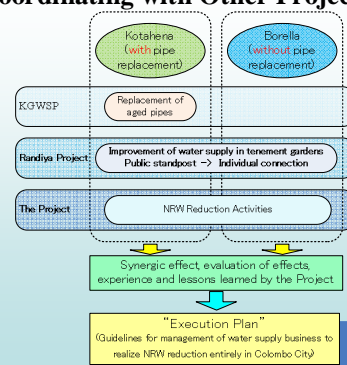
Characteristics of “Pilot Area”

- **Pilot Project in Kotahena:**  
Conduct a series of NRW reduction activities with replacement of aged pipes by KGWSP.
- **Pilot Project in Borella**  
Conduct a series of NRW reduction activities without replacement of aged pipes.

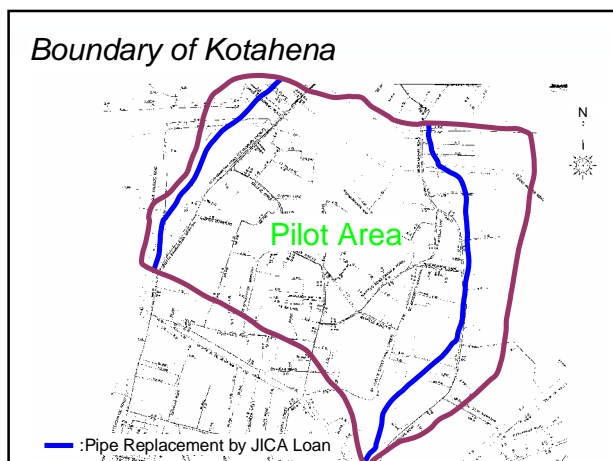
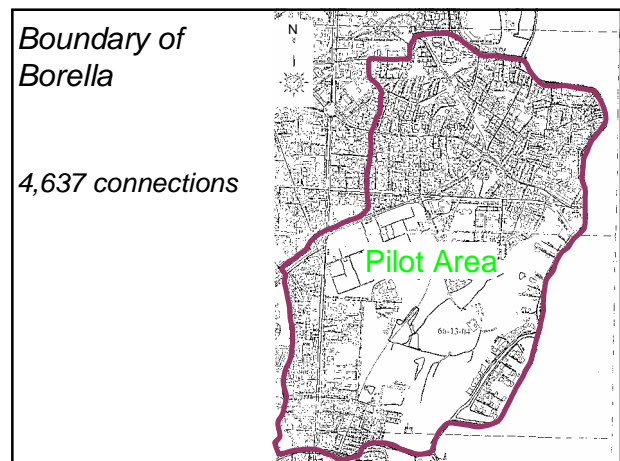
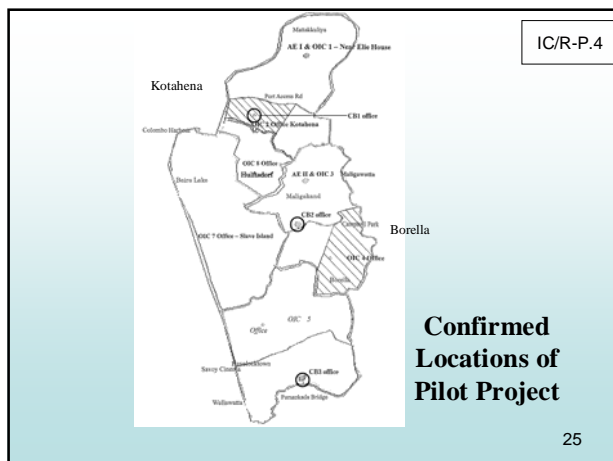
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### Comprehensive Activities by Coordinating with Other Projects

IC/R-P.15



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**6. Some others to be decided soon**

- 6.1 C/P Training
- 6.2 Seminar and Workshop
- 6.3 Public Relations

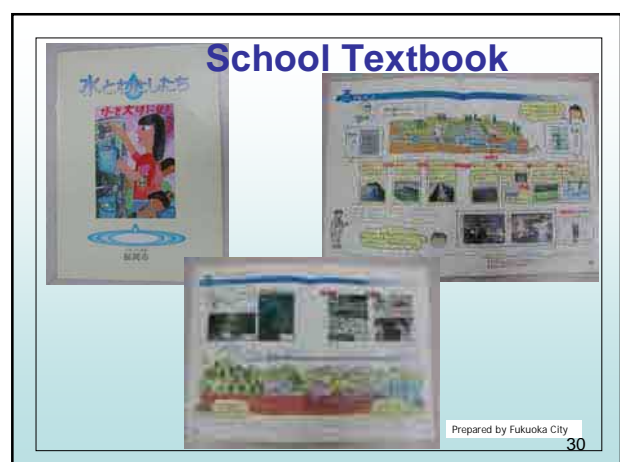
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**6.3 PUBLIC AWARENESS**

**USEFUL FOR**

- Legitimate Free Water
- Thefts
- Administrative Loss
- Encourage reports on anticipated leaks (pressure drop, visible leaks)
- 
- 
- Water saving

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## Work Flow of the Project

**Annex -3 Training Materials (1)**

The diagram illustrates the project timeline and activities for the 'Work in Sri Lanka' project, spanning from 2009 to 2013. The timeline is organized into columns for each year and month. The activities are represented by boxes and connected by arrows, showing a sequential process.

**Timeline and Activities:**

- 2009:**
  - Jan: Preparation of Equipment
  - Feb: Procurement of Equipment
  - Mar: Common Work
  - Apr: Management Capacity Building
  - May: Technical Training
  - Jun: JCC
  - Jul: Interim Review
  - Aug: Progress Report 1
  - Sep: Progress Report 2
  - Oct: Progress Report 3
  - Nov: Progress Report 4
  - Dec: Progress Report 5
- 2010:**
  - Jan: Preparation of Equipment
  - Feb: Procurement of Equipment
  - Mar: Common Work
  - Apr: Management Capacity Building
  - May: Technical Training
  - Jun: JCC
  - Jul: Interim Review
  - Aug: Progress Report 1
  - Sep: Progress Report 2
  - Oct: Progress Report 3
  - Nov: Progress Report 4
  - Dec: Progress Report 5
- 2011:**
  - Jan: Preparation of Equipment
  - Feb: Procurement of Equipment
  - Mar: Common Work
  - Apr: Management Capacity Building
  - May: Technical Training
  - Jun: JCC
  - Jul: Interim Review
  - Aug: Progress Report 1
  - Sep: Progress Report 2
  - Oct: Progress Report 3
  - Nov: Progress Report 4
  - Dec: Progress Report 5
- 2012:**
  - Jan: Preparation of Equipment
  - Feb: Procurement of Equipment
  - Mar: Common Work
  - Apr: Management Capacity Building
  - May: Technical Training
  - Jun: JCC
  - Jul: Interim Review
  - Aug: Progress Report 1
  - Sep: Progress Report 2
  - Oct: Progress Report 3
  - Nov: Progress Report 4
  - Dec: Progress Report 5
- 2013:**
  - Jan: Preparation of Equipment
  - Feb: Procurement of Equipment
  - Mar: Common Work
  - Apr: Management Capacity Building
  - May: Technical Training
  - Jun: JCC
  - Jul: Interim Review
  - Aug: Progress Report 1
  - Sep: Progress Report 2
  - Oct: Progress Report 3
  - Nov: Progress Report 4
  - Dec: Progress Report 5

**Key Activities and Milestones:**

- Preparation of Equipment:** Includes Procurement of Equipment, Common Work, Management Capacity Building, Technical Training, and JCC.
- Common Work:** Includes Management Capacity Building, Technical Training, and JCC.
- Management Capacity Building:** Includes Management Capacity Building, Technical Training, and JCC.
- Technical Training:** Includes Management Capacity Building, Technical Training, and JCC.
- JCC:** Includes Management Capacity Building, Technical Training, and JCC.
- Interim Review:** Includes Management Capacity Building, Technical Training, and JCC.
- Progress Report 1-5:** Includes Management Capacity Building, Technical Training, and JCC.

**Future:** The diagram also includes a 'Future' section for 2013, showing the continuation of the project activities.

## THE CAPACITY DEVELOPMENT PROJECT FOR NRW REDUCTION IN COLOMBO CITY

### Methodology adapted to Execute the Pilot Project

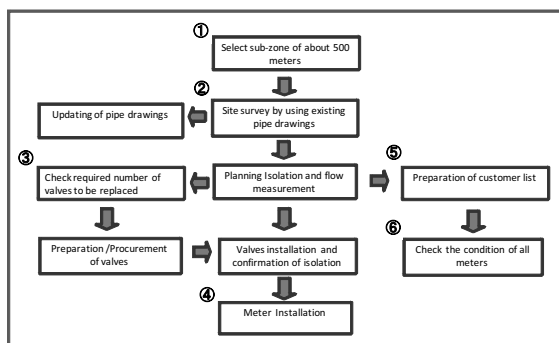
December 21, 2009

Akihiko OKAZAKI  
JICA Expert Team

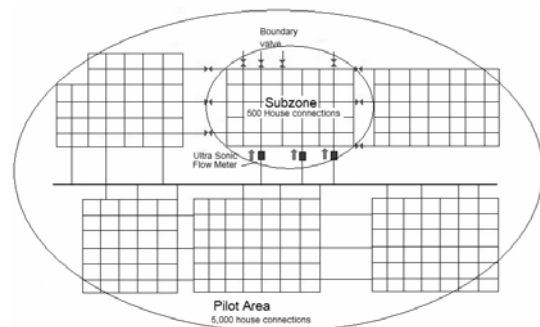
### Contents

- 1.Preparatory work
- 2.Pilot Study
- 3.Activities to be implemented by our next visit

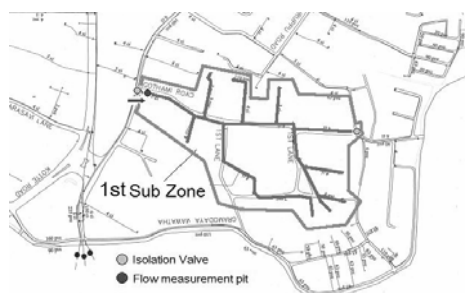
### 1. Preparatory work



### ① Select Sub Zones in the Pilot Area

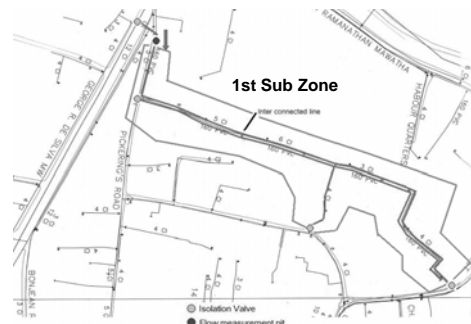


### Borella Area



Distribution length: 1,320m  
Number of House connection: 569

### Kotahena Area



Distribution length: 1,360m  
Number of House connection: 320

## ② Site survey by using existing pipe drawings

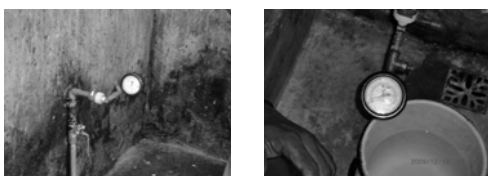


NRW Reduction Team and JICA experts have conducted site survey in Borella and Kotehana

## Detecting buried valve by using metal locator and pipe locator



## Water pressure survey in the sub zone



NRW Reduction team have checked water pressure condition in the sub zone by using water pressure gauge in the day time.

On the cast iron line has only 2 to 4m.

## ③ Valve condition survey

- Condition of boundary valves which are needed for the isolation of the sub zone should be checked.
- If they cannot completely close, they should be replaced /replaced.
- Installed additional valves if required.
- Several valves will be prepared by JICA team.
- Data sheet shall be filled.

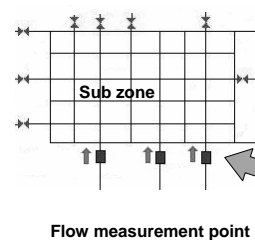
## Valve condition survey

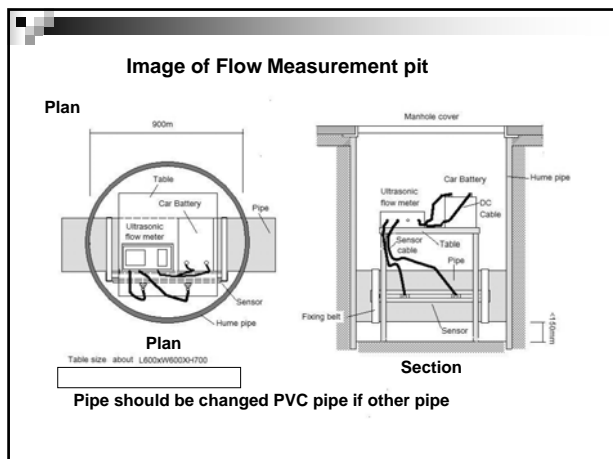
Valve condition checking list

Name of Pilot area:									
Name of Sub zone:									
Item	No.	Size(mm)	Pipe material	Location (Existence, Buried)	Valve cover (OK, Non.)	Direction (Clockwise, Anticlockwise)	Condition		
							Operable (C, NC)	Number of rotation to be closed	Need for a replacement
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								
Water out	W-1								
	W-2								
	W-3								
Flow point	No.	Size	Material	Meter(Y, N)	Condition	Remarks			
	PT-1								
	PT-2								
	PT-3								

All valves, fire hydrant,

## ④ Flow meter installation and flow measurement





**⑤ Preparation of customer list**

- Prepare the customer list of sub zone including the customer name, customer-ID, address and meter-conditions.
- Customer meter condition should be checked one by one house based on the customer list.

**⑥ Customer Meter Survey**

**Working Meter**

**Non Working Meter**

**Case in El Salvador**

**Unmetered**

**Illegal Connection**

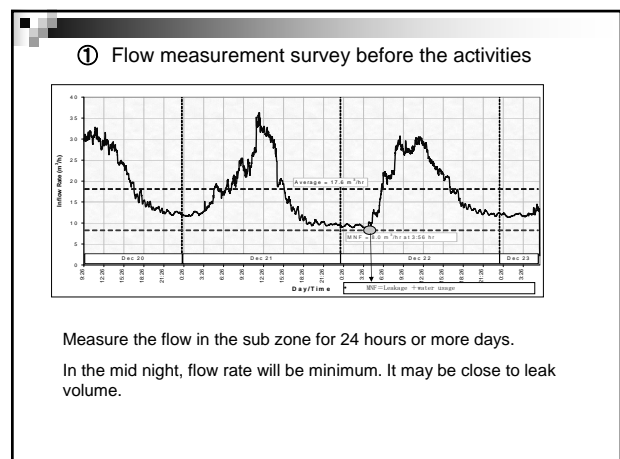
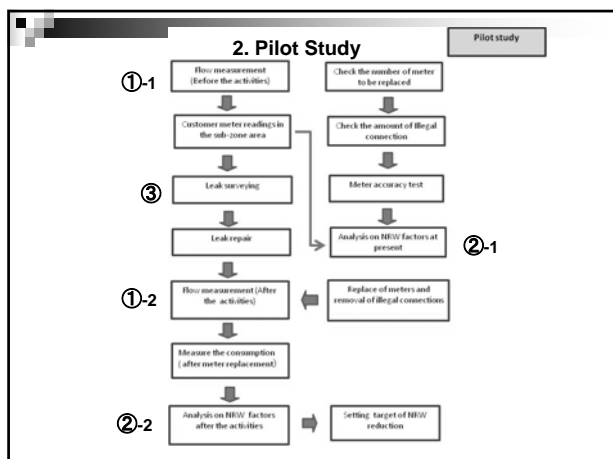
**Customer list**

**Customer list**

Customer meter check list						Name of Pilot area				
Record						Name of Sub zone				
No	Customer name	Customer ID	Road name / House No.	Previous month consumption (m <sup>3</sup> )	Meter condition (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

**Customer list should be prepared and all meter condition should be checked.**



## ② Analysis on NRW factors at present

### Revenue water

- System input volume in the sub zone is measured by the flow measurement survey.
- Revenue water in the sub zone will be calculated by consumption of meter reading. (or meter reading records will be considered)

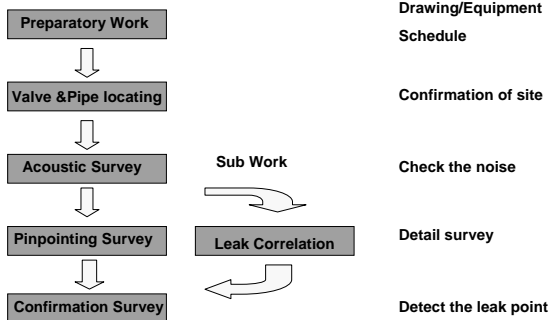
### Non revenue water

- Check the number of uncounted meter such a nonworking meter, illegal connection and unmetered house and others.
- Consumption at the stand posts will be measured with water meter to be installed as a commercial losses .
- 20 working meters will be selected from the sub zone and the meter accuracy will be measured by the meter test bench as a customer meter inaccuracies.
- Leakage volume should be estimated from Minimum night flow.
- Estimate other NRW factors.
- Calculate the Water balance sheet in the sub zone.

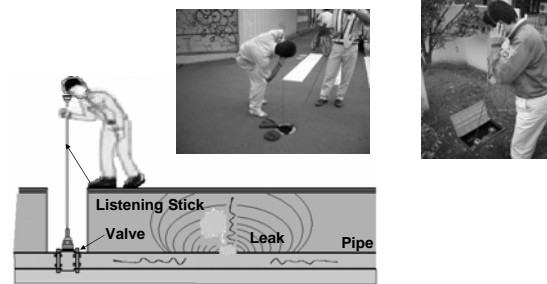
## ③ Leakage detection survey

- Visible leakage survey is to find the leaking on the surface or flowing into the ditch.
- Mobile leakage survey is to detect the underground leak by using the leak detection equipments.

## Procedure of Mobile Leakage Detection

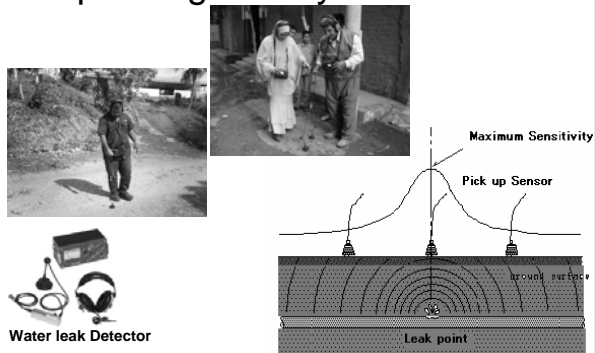


## Acoustic survey



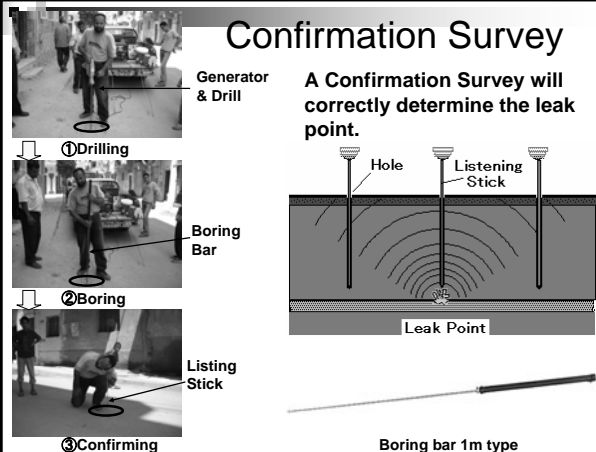
Check each valve for finding leak by the listening stick

## Pinpointing Survey



Water leak Detector

## Confirmation Survey



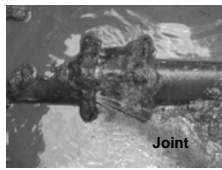
A Confirmation Survey will correctly determine the leak point.



### ■ Leakage on Distribution Pipe



CIP



DCIP



PVC

#### Types of pipe material

- DCIP
- CIP
- ACP
- GP
- PVC

### ③ Activities to be implemented by our next visit.

- Detect and excavate the buried valve, fire-hydrant and wash-out.
- Check condition of all valves of the sub zone and fill in " Valve check list".
- Make a customer list of sub zone by using existing records.
- Check condition of all customer meter and fill in it customer list. (remaining parts )
- Measure water pressure for 24 hours at the several places in the sub zone.
- Prepare flow meter installation (permission of excavation, procurement of chamber, etc., )

Thank you for your attention!



**(2) Presentation Material on Service Connection  
on 31st March, 2010**



The Capacity Development Project for Non Revenue Water (NRW) Reduction  
in Colombo City

**1<sup>st</sup> Workshop**

Venue: Seminar Room at Ratmalana NWSDB

Date and Time: March 31, 2010 / 9:30 – 12:30

**Timetable**

9:30 - 9:45	Opening Remarks	Mr. S.G.G. Rajkumar (AGM NRW)
9:45 – 9:55	Briefing of the Workshop	Mr. S. Kobayashi (JET)
9:55 - 10:40	Presentation on Service Pipe Connection	Mr. H. Yoshiuchi (JET)
10:40 - 10:50	Question and Answer	
10:50 - 11:10	Break	
11:10 – 12:30	Brain storming & Questionnaire	Mr. T. Kawamura (JET) Mr. N. Takatoi (JET)



# Annex -3 Training Materials (2)

<b>Capacity Development Project for NRW Reduction in Colombo City</b>	
<b>Attendance Sheet</b>	
Subject : 1st Work Shop	
Place: Training Centre, Telewala, NWSDB	Date: 31st March 2010
Please fill your name, position and signature in this sheet. Then pass it to the next person. The last person is kindly requested to return this sheet to a JET Member.	

Name	Title and Organization
<b>NRW Section</b>	
Mr. S.G.G.Rajkumar	AGM (NRW)
Mr S.S. Devaraja	M (NRW)
Mr. A.D.K.K.Wijayagunawardana	Senior Engineer
<b>Borella</b>	
Mr. R.L. Wijekularathna	OIC (Borella)
Mr. D.H.R.Hettiarachchi	Zone officer (Borella)
Mr. K.A.D.C.U.W. Gunarathna	EA NRW
Mr. S.N.I.Somaratne	Fitter
Mr. H.G.C.Jayalath	Fitter
Mr. H.M.Chandana Pushpakumara	Labourer
Mr. R.A.D.M. Ranasinghe	Labourer
Mr. P.A.D.C.Rathnayake	Labourer
Mr. K.N.Karunaratna	Labourer
<b>Kotahena</b>	
Mr. D.A.D.Hemachndara	A. Eng (CC-North)
Mr.W.W.K.Jayasinghe	OIC (Kotahena)
Mr. P.S.Kariyawasam	EA - Kotahena
Mr. E.D K. Karunaratna	EA N.R.W.
Mr. G.H.Chandana	Fitter
Mr. E.L.R.Kamal Perera	Labourer
Mr. K. Devasagayan	Labourer
Mr. M.S.Silva	Pipe Fitter
Mr. S.Dissanayake	Labourer
Mr. J.T.Biyawela	Labourer
<b>Other Concerning Members</b>	
Mr. W.M.D.G.B.Wickramasinghe	OIC Mattakuliya
Mr. S.K.P.Samarasinghe	EA NRW
Mr. K. Premalal	EA (SP) NRW
Mr. A.L.Senarathne	A.E. CC West
Mr. A.V.P.Dhammika	A.E. CC South
<b>Telewala</b>	
Mr. E.G.U.P.De Silva	EA
Mr. R.Premaratne	P/F
Mr. M.A.R.Fernando	P/F
Mr. R. Karunatilake	Labourer
<b>JICA Advisor</b>	
Mr. Yoshiki Omura	JICA Advisor, NWSDB
<b>JET</b>	
Mr. Shinkichi Kobayashi	Chief Advisor / NRW Reduction Program
Mr. Tetsuji Kawamura	Deputy Chief Advosor / NRW Reduction Monitoring and Evaluation
Mr. Akihiko Okazaki	Leak Detection Advisor
Mr. Hiroshi Yoshiuchi	Service Pipe Connection Advisor
Mr. Naoto Takato	Coordinator
Mr. Mahesh Jayanthipura	Supporting Staff

THE CAPACITY DEVELOPMENT PROJECT  
FOR NRW REDUCTION IN COLOMBO CITY

SERVICE connection WORKS

MARCH 31,2010  
HIROSHI YOSHIUCHI  
JICA EXPERT TEAM

## Contents

1. Joint of service pipe
2. PVC solvent cement
3. Excavation and back-fill
4. Water meter
5. Water service ledger
6. Safety work

## 1.Joint of service pipe

### ①Method of connecting hard polyvinyl chloride pipe

- Bonding joint with adhesive
  - a) Taper sized solvent welding method
    - (Hereinafter we call it TS method )
  - b) One step sleeve method
  - c) Two step sleeve method
- Rubber ring joint
- Mechanical joint

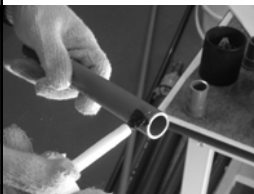
### a) TS method



- The pipe is squarely cut, and chamfer the outside of pipe



- The adhesive is uniformly spread on the inside of fitting



- The adhesive is uniformly spread on the outside of pipe



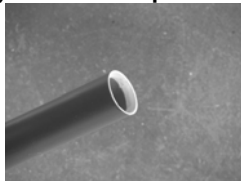
- The pipe is inserted in the fitting at a dash



- The state of inserting the pipe in the fitting has to be maintained for about 30 second
- In the case of no keeping the state, the pipe moves to out



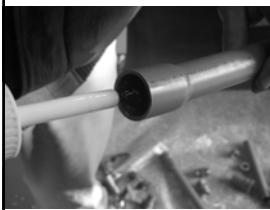
## b) Two step sleeve method



- The pipe of receiving mouth side is squarely cut, and chamfer the inside of pipe
- So as not to scorch with the gas burner, the pipe of the receiving mouth side is uniformly heated



- After the pipe of receiving mouth side softens
- Insert the pipe into the pipe of receiving mouth side
- Maintain the pipe straight (correct bending after insertion is completed)
- After cooled, put I-mark to the pipe



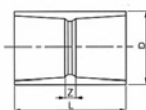
- The adhesive is uniformly spread on the inside of the pipe of receiving mouth side
- Chamfer the outside of pipe
- The adhesive is uniformly spread on the outside of pipe



- The pipe is inserted in the pipe of receiving mouth side at a dash, and I-mark is matching
- The state of inserting the pipe in the pipe of receiving mouth side has to be maintained for about 30 second

## ② Summary of each method

呼び径 13~50mm



呼び径 65~150mm



- TS method
  - use the socket
  - the inside of the socket has taper (to use the compression elasticity of the vinyl chloride)
  - Cold short joint work method

- One step sleeve method
  - The pipe is uniformly heated
  - The adhesive is uniformly spread
  - Then insert the pipe at a dash
  - Pipe heat method
- Two step sleeve method
  - The pipe is uniformly heated
  - Cooling down the pipes (I-mark)
  - The adhesive is uniformly spread
  - Then insert the pipe at a dash
  - Pipe heat method

### ③ Service pipe connection by NWSDB



- The pipe of the receiving mouth side is uniformly heated



- After the pipe softens
- Insert the pipe into the pipe of receiving mouth side without the adhesive (I marek ?)



- The adhesive is uniformly spread ?
- Then insert the pipe at a dash
- Maintained for about 30 second
- Service pipe connection in NWSDB is Two step sleeve method
- Pipe heat method

### ④ Joints of service pipe in Japan at present

- Only TS method is used in Japan at present

(Reason)

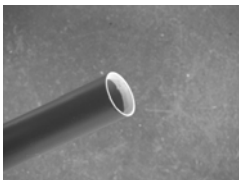
- It is possible to connect the pipes in an inconvenient place. for example the small place, the place of fire prohibition, and the high place, etc.
- The skilled technology is not needed

## 2. PVC solvent cement

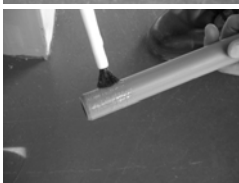
### ① What is PVC solvent cement

- Adhesive of solution type that melted vinyl chloride resin in solvent
- Swelling the vinyl chloride of the pipes by adhesive
- Then the pipes are connected by evaporation of solvent

### ② Chamfer



- chamfer the inside of pipe
  - It is easy to insert pipe after heating



- chamfer the outside of pipe
  - without chamfer, the corner of pipe scratch the adhesive off the pipe

### ③ Cleaning the pipe

- Cleaning the inside of pipe
- Cleaning the outside of pipe

(Method)

- wipe by dry cloth

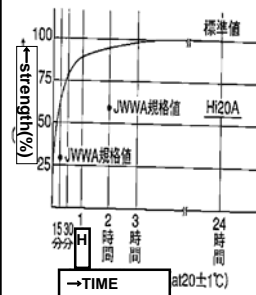
(Reason)

- When mud and sand, especially oil and moisture adhere, enough strength of bond is not obtained.

#### ④ Quantity consumed of PVC solvent cement

- The proper quantity is painted thinly, and uniformly (Reason)
- a) Too much solvent cement
  - causes that reduction of inside diameter of pipe
  - causes the nasty smell of tap water
  - takes time until enough strength of solvent cement goes out
  - causes a possibility of damaging the vinyl chloride
- b) Uniformly
  - when the painting is not uniformly, it causes the water leak

#### ⑤ Curing



- The state of inserting the pipe has to be maintained for about 30 second
- Relation between the time of curing of adhesive and strength of bond

#### ⑥ Management of adhesive

- The fire shall be avoided and keeps in the cool dark place
- Keep free from earth, sand and water
- Not use the adhesive that becomes old and started hardening. ( even if thinned with thinner)
- The different kind of adhesive shall not be mixed
- An old adhesive shall not be mixed with the new one.

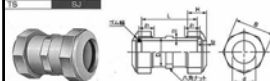
#### ⑦ Connection of service pipe that should be improved



- The pipe is connected without stopping the water service ( Problem )
  - The adhesion effect cannot be expected and it causes the water leak
- (Measures)
  - a) Stop the water service. And connection
  - b) Improve the joint method

#### ⑧ MC-union

伸縮継手 (シンブルジョイント)



呼び径	D	d	L	H	d1	t1	t2	B	規格・品番
15	22.0	18.0±0.3	68±0.5	27	24	3.0	4	38	(O) SMJ13
20	35.0	28.0±0.3	78±0.5	28	29	3.5	4.5	50	(O) SMJ20
25	42.0	33.0±0.4	88±0.5	29	29	4.0	6	56	(O) SMJ25
30	49.0	39.0±0.4	97±0.5	34	25	4.0	8	62	(O) SMJ30
40	63.0	48.2±0.4	106±0.5	35	25	4.5	7	80	(O) SMJ40
50	73.0	58.5±0.5	116±0.5	36	25	5.0	7.5	92	(O) SMJ50

備考 1. 材質はSUS304に準じます。  
2. ねじの形状はJIS B 0202 (ネジの規格) に準じます。  
3. ねじの深さは標準品に準じます。  
4. 0.05mm未満は0.05mmとします。  
5. 0.1mm未満の寸法は0.1mmとします。  
6. 0.1mm未満の寸法は0.1mmとします。


- The part from which water has come out are connected by the MC-union

### 3. Excavation and back-fill




#### ① Excavation

- It is necessary to survey the ground and the underground structure before excavation
- Because not to damage them
- depth of trench
  - On the road 60cm or more
  - Excluding the road 30cm or more




② Back-fill

- Use pit sand first
- (at least about 10cm from the pipe top)
- Afterwards, back-fill by gravel



- enough surface compaction




③ In the case of NWSDB

- The depth of trench is insufficient
- back-fill with excavated soil
  - The pipe receiving the stress by the gravel etc. has the fear of damage


## 4. Water meter

### ① location of Water Meter to be installed

- In water service device owner's site
- Place where meter-reading and changing, etc. can be done from road or passage always easily
- Not the place where a kitchen, a washing place, etc. and various things are put easily



- Good example
  - It is easy to read a meter and meter changing is also easy
- Bad example
  - a) Meter is buried under the wall, and changing is difficult



b) The meter is indoors, and it is not possible to read a meter when the resident is not there

## ② clogging of strainer

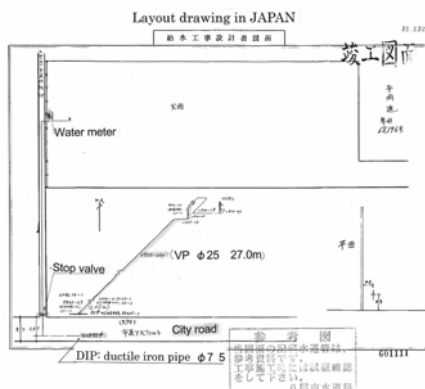


- Cause of clogging
  - The adhesive is thought as one of the causes of clogging
- (Reason)
  - The piping is connected without stopping the water service
  - The viscous adhesive flows by pressure of water
  - Then there is a possibility of collecting in the strainer of the meter

## 5. Water service ledger

- ①What is the water service ledger
  - Application form for water service installation works
  - Layout drawing for water service installation
  - Maintenance record etc.
- ②Keeping of the water service ledger
  - All of the number of service connections
  - With paper or an electronic base
- ③Use of the water service ledger
  - Maintenance for water service installation
  - Conference with another construction

## ④Layout drawing of water service installation



National Water Supply and Drainage Board  
Application for water supply service  
Manager - Operation & Development

Important: Please read the instructions before filling up this application.  
(Valid only for six months from the date of issue)

Official Purpose: \_\_\_\_\_  
Date of Issue: \_\_\_\_\_ Number: 000 \_\_\_\_\_ 2004  
Place of Issue: Colombo City Waterworks Directorate, Maldives

To be filled up by the applicant

01. Type of service required: ☐ New Construction ☐ New Water Connection ☐ Extension ☐ Certificate of Conformity

02. Full name of the applicant:  
Res. Abn / Mrs / Miss: \_\_\_\_\_  
Name: \_\_\_\_\_  
Surname: \_\_\_\_\_  
(Please only block letters, last name first)

03. Address of the premises where service applied:  
Telephone No.: \_\_\_\_\_

04. Postal Address (if different from the above address):  
\_\_\_\_\_

05. Category: ☐ Religious ☐ Commercial ☐ Construction ☐ Government Institution ☐ (Please Specify): \_\_\_\_\_  
Home / Tourist: \_\_\_\_\_ (Please Specify): \_\_\_\_\_  
Any other: \_\_\_\_\_ (Please Specify): \_\_\_\_\_

7. Annexures:

- i. Building Plan / Plumbing Drawing
- ii. Assessment Notice
- iii. Title deed / Ownership certificate
- iv. Last month water bill
- v. Any other \_\_\_\_\_

## 6. Safety work



- Uniform etc.
  - Wearing of uniform
  - Wearing of boots
  - Wearing of helmet
  - Wearing of gloves
- Security of work
  - Installation of barricade
  - Place the traffic arrangement member



- Wearing of boots
- Wearing of helmet



### **(3) Procedure for Brain Storming**

**Held on 31st March, 2010**





(English Version)

THE CAPACITY DEVELOPMENT PROJECT  
FOR NON REVENUE WATER (NRW) REDUCTION  
IN COLOMBO CITY

Brainstorming Session  
- How Can We Reduce NRW  
in Colombo City?-

31 March 2010  
JICA Expert Team

1

What is brainstorming?

Brainstorming is a group creativity  
technique designed to generate  
a large number of ideas  
for the solution of a problem.

In this case, a problem means  
“high Non Revenue Water”.

2

Basic Rules in Brainstorming

1. One card one topic (simple sentence)
2. Focus on quantity
3. Welcome unusual ideas
4. Welcome to repeat same ideas
5. Welcome to combine and improve  
other person's ideas
6. Withhold criticism/comment to others

3

Procedure

Group formation  
Make groups of 5-7 people

↓

Brainstorming  
Write an idea on a card, then post it  
on the paper, one by one

↓

Summary  
Categorizing & Presentation

4

Card Examples

- How Can We Reduce NRW in Colombo City?-

Improve quality of  
repairs

Preparation of work  
plan for each sub-  
zone

Training of pipe fitter

Remove all the  
standposts

Service pipe  
replacement

Increase the number  
of staff

Public relations to  
reduce water  
consumption

Improvement of leak  
detection technique

Update of GIS map

Double the payment  
of staff

Billing Illegal  
connections

5

Let's Get into Five Groups

Group A

Group B

Group C

Group D

Group E

6

## Let's Start

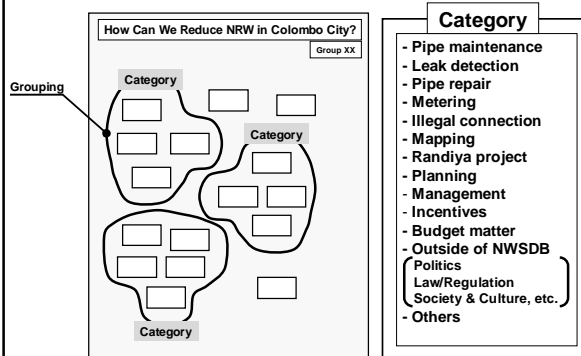
7

### Next Step

- Categorizing
- Presentation of the result

8

### Categorizing



9

### Presentation of the result

Summarization in 3 minutes

10

බොහෝම ස්තූතියි

11

### Annex -3 Training Materials (3)

<i>Group</i>	<i>Opinion of Attendants</i>	<i>Categorized by attendant</i>	<i>Categorize by JET</i>	
Group C	Master plan for NRW reduction.	Planning	Planning	
Group C	Introduce reasonable tariff rates to consumers.	Planning	Outside of NWSDB	Water tariff
Group C	NRW reduction as continuous process.	Planning	Planning	
Group C	Remove Stand-post.	Planning	Randiya project	
Group C	Measure water quantity at inlets and outlets.	Planning	Others	Monitoring
Group C	Replace all CI pipes.	Planning	Planning	
Group C	Alternative materials for PVC (PE)	Planning	Planning	
Group C	Attend for repairing as early as possible.	Planning	Management	
Group C	Improving leak repairing methods.	Planning	Pipe repair	
Group C	Quality material	Planning	Planning	
Group C	Thinking alternative material for solvent cement.	Planning	Others	Service connection
Group C	SLS standard maintain (TQM)	Planning	Management	
Group C	Leak repair – main line/service line	Activity	Pipe repair	
Group C	Meter rectification program.	Activity	Planning	
Group C	Properly identification of illegal connections.	Activity	Illegal connection	
Group C	Identification of sudden failure.	Activity	Pipe repair	
Group C	Defective meters to be changed.	Activity	Metering	
Group C	Improve mapping systems for future reference (GPS)	Activity	Mapping	
Group C	S.P. to be decrease.	Activity	Randiya project	
Group C	Illegal connections to be legalized.	Activity	Illegal connection	
Group C	Night survey to find leakage.	Activity	Leak detection	
Group C	Technical knowledge improvement programs to skilled labourers.	Activity	Management	Education/disciplin
Group C	Measuring systems for area flow patterns.	Activity	Others	Monitoring
Group C	Modern technology for identification of leaks and flows.	Activity	Leak detection	
Group C	De-scaling method – chemical/mechanic.	Activity	Pipe maintenance	
Group C	Developing scientific methods to trace PVC lines.	Activity	Leak detection	
Group C	Reduce admin losses.	Activity	Metering	
Group C	Use proper fittings.	Material & Technology.	Pipe repair	
Group C	Sensitive instruments to find out leaks.	Material & Technology.	Leak detection	
Group C	Use of rapid hard adhesives.	Material & Technology.	Others	Service connection
Group C	Safety (maintenance) standards.	Material & Technology.	Others	unclassifiable
Group C	Old pipes to be replaced.	Material & Technology.	Planning	
Group C	Pipe to be laid standard methods.	Material & Technology.	Management	
Group C	Proactive methods for NRW reduction.	Material & Technology.	Others	unclassifiable
Group C	Public awareness programme	Awareness	Others	Awareness
Group C	To work for customer satisfaction.	Awareness	Management	Education/disciplin
Group C	Improve technical knowledge of NWSDB contractors.	Awareness	Others	Service connection
Group C	Obtain workers ideas for repair work.	Awareness	Management	
Group C	Better awareness for water wastage.	Awareness	Others	Awareness
Group C	Improve welfare of NWSDB staff.	Awareness	Incentives	



**(4) Presentation Material on Methodology of  
Leak Detection on 6th April, 2010**



The Capacity Development Project for Non Revenue Water (NRW) Reduction  
in Colombo City

**2<sup>nd</sup> Seminar**  
**on Mechanism of Leakage and Leak Detection**

Venue: Maligawatta Office, NWSDB

Date and Time: April 6, 2010 / 14:00 – 16:30

**Timetable**

14:00 -14:15	Opening Remarks	Mr. S.G.G. Rajkumar (AGM NRW)
14:15 – 14:30	Briefing of the Workshop and Some Results of 1 <sup>st</sup> Workshop	Mr. S.Kobayashi (JET)
14:30 - 16:00	Methodology of Leak detection Trial usage of some equipment Question and Answer	Mr. A. Okazaki (JET)
16:00 – 16:30	Some Results of 1 <sup>st</sup> Workshop Questionnaire	Mr. T. Kawamura (JET)

# Annex -3 Training Materials (4)

<b>Capacity Development Project for NRW Reduction in Colombo City</b>	
<b>Attendance Sheet</b>	
Subject : 2nd Work Shop	Time: 2.00 pm
Place: Training Centre, Telewala, NWSDB	Date: 6th April 2010
Please fill your name, position and singnature in this sheet. Then pass it to the next person. The last person is kindly requested to return this sheet to a JET Member.	

Name	Title and Organization
Mr. S.G.G.Rajkumar	AGM (NRW)
Mr S.S. Devaraja	M (NRW)
Mr. W.D.L.Chandrasiri	M (O&M)
Mr. A.D.K.K.Wijayagunawardana	Senior Engineer
<b>Borella / Maligawatte</b>	
Ms. W.C.A.Gunaratna	A. Eng (CC-East)
Mr. R.L. Wijekularathna	OIC (Boreila)
Mr. D.H.R.Hettiarachchi	Zone officer (Borella)
Mr. K.A.D.C.U.W. Gunaratna	EA NRW
Mr. H.W.Gunawardhana	OIC Maligawatte
Ms. Udeni Deepika	EA
Mr. W.D.P.Sanjeewa	EA
Mr. D.S.Wickramaratne	EA
Mr. P.D.P.Ranjith	EA
Ms. N.G.Sandamali	EA
Mr. S.A.Lionel	EA (Maligawatte)
Mr. P.D.Gunaratne	Minor Supervisor
Mr. S.N.I.Somaratne	Fitter
Mr. G.G.C.Jayalath	Fitter
Mr. E.D.Sumathipala	Fitter
Mr. K.G.Sarathchandra	Fitter
Mr. A.Sunil Shantha	Fitter
Mr. B.Upali	Fitter
Mr. S.R.Priyadharshana	Fitter
<b>Kotahena</b>	
Mr. D.A.D.Hemachndara	A. Eng (CC-North)
Mr.W.W.K.Jayasinghe	OIC (Kotahena)
Mr. P.S.Kariyawasam	EA - Kotahena
Mr. N.P.Tharanga	EA
Mr. W.M.D.G.B.Wickramasinghe	OIC Mattakuliya
Mr. M. Senaratne	EA
Mr. W.D.A.L.Devapriya	EA
Mr. L.H.W.P.Silva	EA
Mr. B.K.G.D.Rodrigo	EA
Mr. E.D K. Karunarathna	EA N.R.W.
<b>OPD</b>	
Mr. R.A.Kumaranayake	EA (Maligawatte)
Mr. Ujith Karunaratne	EA
Mr. D.P.Jayawardena	EA
<b>CC WEST</b>	
Mr. Susantha Ekanayake	EA
Mr. Vijitha	EA
Ms. Thusitha	EA



# Annex -3 Training Materials (4)

<b>Capacity Development Project for NRW Reduction in Colombo City</b>	
<b>Attendance Sheet</b>	
Subject : 2nd Work Shop	Time: 2.00 pm
Place: Training Centre, Telewala, NWSDB	Date: 6th April 2010
Please fill your name, position and singnature in this sheet. Then pass it to the next person. The last person is kindly requested to return this sheet to a JET Member.	

Name	Title and Organization
<b>CC South</b>	
Mr. C.K.Welikala	EA
Mr. Athula Ranasinghe	EA
Mr. D.Sanath	EA
Mr. B.A.Wijesiri	Fitter
Mr. D.P.Perera	Fitter
Mr. L. Suranimal	Fitter
Mr. Kamal Nishantha	Fitter
<b>Telawala</b>	
Mr. K. Premalal	EA (SP) NRW
Mr. E.G.U.P.De Silva	EA
Mr. M.S.C.Perera	EA
Mr. M.G.Ariyathilaka	EA
Mr. H.G.M.Chandima	EA
Mr. R.Premaratne	P/F
Mr. M.A.R.Fernando	P/F
Mr. K.A.D.M.Pushpakumara	P/F
Mr. J.K.P.D.Bandula	P/F
Mr. H.K.Ebert	P/F
Mr. S.K.P.Samarasinghe	EA NRW
<b>JICA Advisor</b>	
Mr. Yoshiki Omura	JICA Advisor, NWSDB
<b>JET</b>	
Mr. Shinkichi Kobayashi	Chief Advisor / NRW Reduction Program
Mr. Tetsuji Kawamura	Deputy Chief Advosor / NRW Reduction Monitoring and Evaluation
Mr. Akihiko Okazaki	Leak Detection Advisor
Mr. Hiroshi Yoshiuchi	Service Pipe Connection Advisor
Mr. Naoto Takato	Coordinator
Mr. Mahesh Jayanthipura	Supporting Staff

Japan International Cooperation Agency (JICA)  
Ministry of Water Supply & Drainage (NWSDB)

## Methodology of Leak Detection

April, 2010

JICA Experts Team  
AKIHIKO OKAZAKI

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## Contents

1. What is a water leak?
2. Characteristics of water leak
3. Method of water leak detection and  
Principles of leakage detection equipment
4. Principles of Pipe locator

2

### 1. What is a water leak?

#### 1) Major Causes of a water leak

- Corrosion,  
(Different types of metallic pipe, corrosive soil, etc. )
- Deterioration (Packing, Sealing)
- Poor plumbing (Improper construction )
- Rapid water pressure fluctuation
- Damages by other works  
(Excavations works by Electric companies,  
Telecom, Gas, etc.)
- Traffic load, Etc. (Main pipe )

3

#### 2) Conditions of a water leak

- Metal pipe (Galvanized pipe, Cast iron pipe)
- Holes, Breaks, Joints (Seals of lead, packing), Etc.,



Hole caused by corrosion



Corrosion of bolts



Break caused by heavy traffic load

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#### 3) Non-Metallic pipe

- PVC (Polyvinyl chloride), PEP (Polyethylene),  
ACP (Asbestos Cement) Etc,
- Cracks, Loose Joints, Breaks



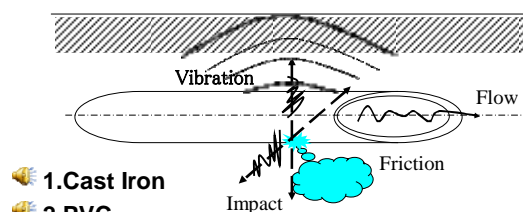
Cracks due to heavy  
traffic load



Loose joints due to rapid water  
pressure fluctuation

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#### 4) Mechanism of a water leak



- 1. Cast Iron
- 2. PVC

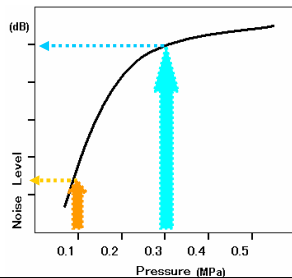
Leak noise consists on four elements, these are: impact, friction, flow and vibration.

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## 2.Characteristics of water leak

### 1) Leak Noise

- Leak noise level will be high if water pressure becomes high due to pushing out energy from inside would be strong.

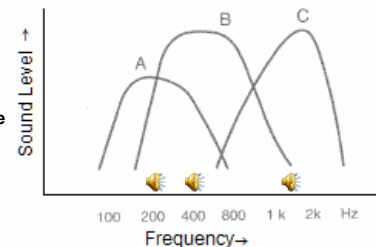


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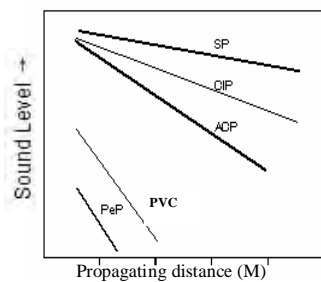
### 2) Pipe material

Sound level and frequency are different in each material.

- A: PVC
- B: Cast Iron pipe
- Asbestos cement pipe
- C: Galvanized pipe or shallow places



### 3) Propagating Distance



The propagating distance of noise and sound levels are different for each material.

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The Propagating distance of noise and sound level from leak position depends on:

- Size of leak
- Water pressure
- Pipe Material
- Pipe Diameter
- Soil Condition

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## Similar to leak sound

- Water leak
- Water Usage (at meter )
- Sewer
- Transformer
- Motor (Machine)

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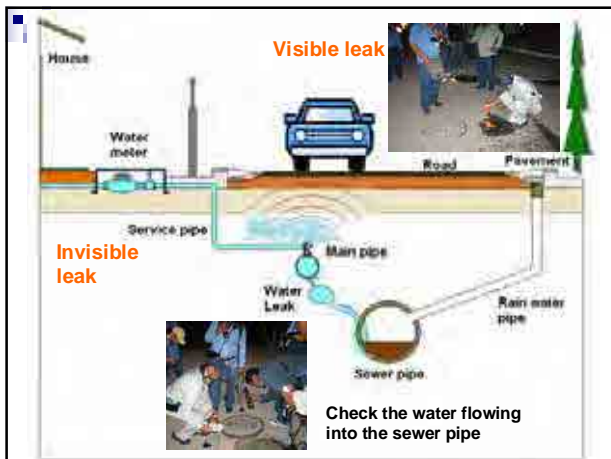
## 3. Method of water leak detection and equipment

1) Visible leak.....Patrol or information from inhabitant

2) Invisible leak

- ①Acoustic Survey
  - Listening stick
  - Electrical Acoustic rod
- ②Pinpointing Survey
  - Electric leak detector
  - Correlation leak detector
- ③Confirmation Survey

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### 1) Search Strategy for Finding Leaks

Area

**Area Analysis**

- Close valves temporarily and make an isolation area.
- Measure the minimum flow in the isolated area

↓

Line

**Line Survey**

- Only lines within area of largest water losses
- Check sounds at hydrants, valves and meters

↓

Point

**Leak Pinpointing**

- Map water pipeline and other utilities with a locator
- Listen over pipeline with leak detector
- Confirm suspected locations with bore-holes, correlator, etc.

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### 2) Equipment for Flow Measurement

Flow

Ultrasonic Flow meter

Water Pressure

Water pressure gauge

**Flow Measurement for Isolated Area**  
Minimum Night Flow  $\approx$  Leakage Volume

Flow Meter and Water Pressure recorder at the starting point of Isolated area

### 3) Principle of Ultrasonic Flow Meter

■ Ultrasonic flow meter measures time different between the outward and return

$Q = AV$

$Q = K \times \pi (D/2)^2 \times (t_1 - t_2)$

Velocity makes time different

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### Component of Ultra sonic flow meter

### Sub Zone in Bollera

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### Sub Zone in Kotehana



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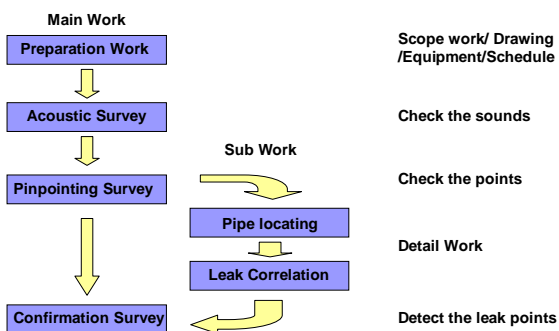
### 4) Image of flow measurement in the sub zone



Minimum flow in the sub zone during the mid night (MNF) is very close to leakage volume.

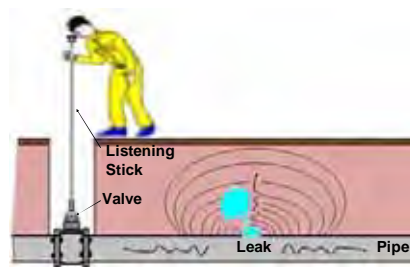
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### 5) Procedure of Water Leak detection



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### 6) Acoustic survey



With the listening stick, check the Leak sound which is transmitted from leak point to the valve or other fittings.

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### Acoustic survey



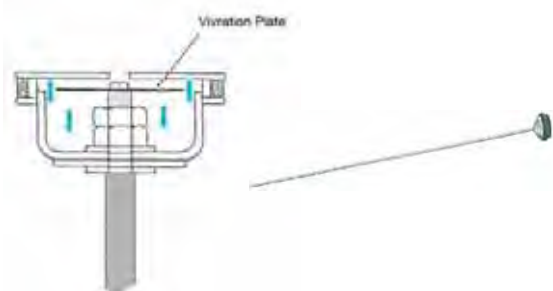
Listen to the noise at the Valve



Listen to the noise at the customer meter

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### 7) Structure of Listening stick



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### Acoustic Survey using Electrical Acoustic rod

- Leak sound decreases in PVC and non-metallic pipelines drastically.
- Electrical acoustic rod can amplify the small sound.

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### Acoustic Survey using Electrical Acoustic Rod



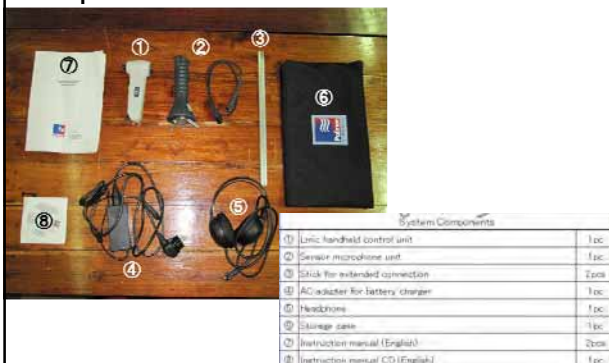
Contact the rod to the water tap



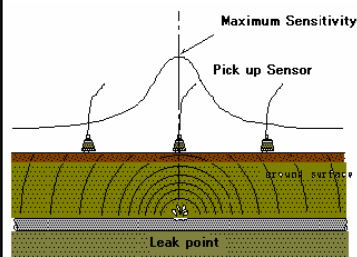
Contact the rod to the water meter

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### Components of Electrical Acoustic Rod



### 8) Pinpointing survey



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### Components of Electric leak detector



### Correlation leak detector



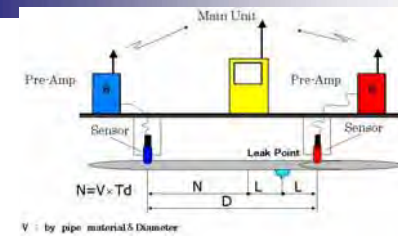
#### Benefit

It is not affected by noises such as traffic and factories, therefore survey is possible during the day.

It is possible to detect the pinpoint even though leak sound does not reach the surface.

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**Condition of finding**

Leak point must be between B and R sensor.  
 Leak sounds must reach to two sensors.  
 Input the pipe data

- ★ Pipe material
- ★ Pipe diameter
- ★ Distance to two sensors

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### Component of correlation leak detector

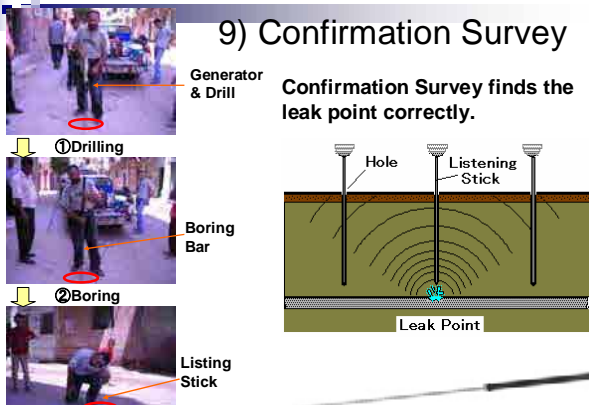


Component	Quantity	Unit
1. Main Unit	1	Set
2. Sensor	2	Pair
3. Pre-Amplifier	2	Pair
4. Leak Point	1	Point
5. Pipe Material	1	Material
6. Pipe Diameter	1	Diameter
7. Distance to two sensors	1	Distance
8. Leak Sound	1	Sound
9. Leak Point	1	Point
10. Pipe Material	1	Material
11. Pipe Diameter	1	Diameter
12. Distance to two sensors	1	Distance

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### 9) Confirmation Survey

Confirmation Survey finds the leak point correctly.



Generator & Drill  
 ① Drilling  
 Boring Bar  
 ② Boring  
 Listing Stick  
 ③ Confirming

Boring bar 1m type

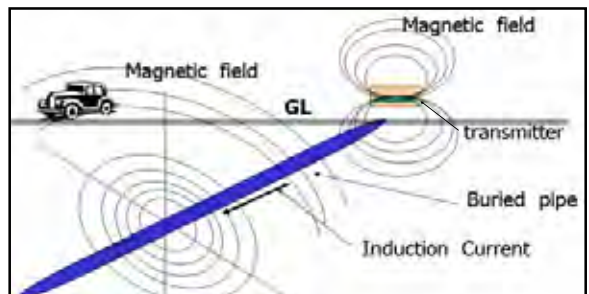
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### 4. Principles of Pipe locator

- Pipe locator (Metallic)
- Pipe locator (Non-Metallic)
- Magnetic locator (Valve)

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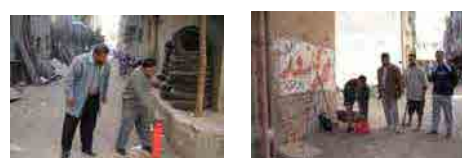
### 1) Pipe locating (Metallic Pipe)



Magnetic field  
 GL  
 transmitter  
 Buried pipe  
 Induction Current

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### Locating the Metal Pipe



Moving the receiver for the pipe detection

Set the transmitter on the pipe line

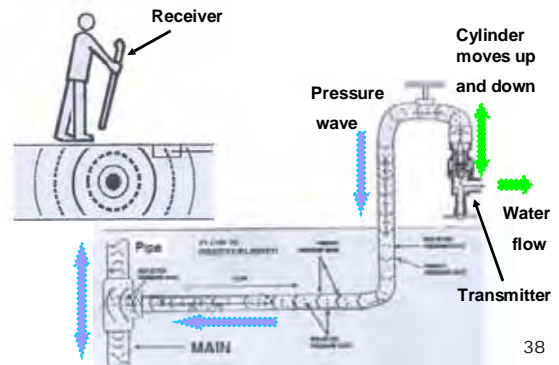
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## Components of Pipe locator



Sl. No.	Part Name	Qty
1	Receiver	1
2	Transmitter	1
3	Cable	1
4	Connector	1
5	Probe	1
6	Probe	1
7	Probe	1
8	Probe	1
9	Probe	1
10	Probe	1
11	Probe	1

## 2) Pipe locator (Non-Metallic)



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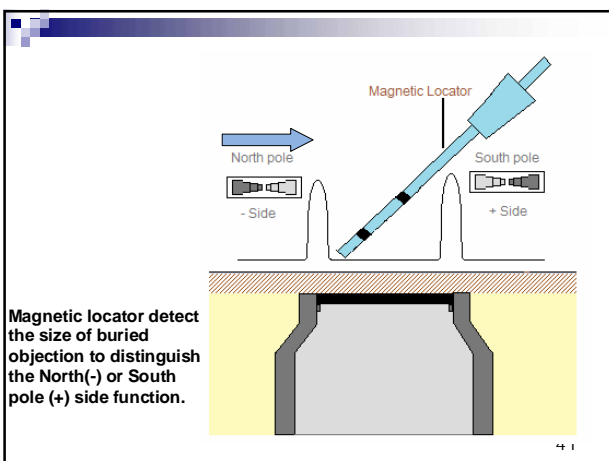
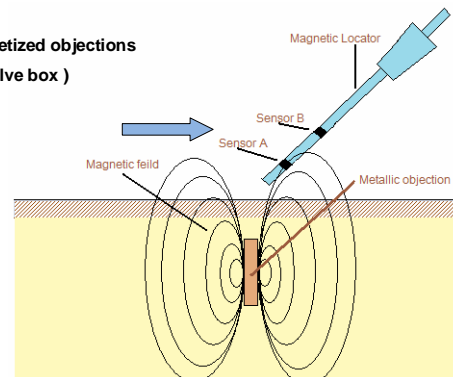
## Components of Pipe locator (Non-Metallic)



Sl. No.	Part Name	Qty
1	Receiver	1
2	Transmitter	1
3	Cable	1
4	Connector	1
5	Probe	1
6	Probe	1
7	Probe	1
8	Probe	1
9	Probe	1
10	Probe	1
11	Probe	1

## Magnetic locator

Find magnetized obstructions  
(Buried valve box)



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## Components of Magnetic Metal Locator



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