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

Japanese Technical Cooperation for the Capacity Development Project for Non Revenue Water Reduction in Colombo City in the Democratic Socialist Republic of Sri Lanka

PROJECT COMPLETION REPORT

November 2012

Japan International Cooperation Agency (JICA)

Nihon Suido Consultants Co., Ltd.

Photos on Project Activities

1st Project Year

Photo on Project Activities (1st Project Year: 1/6)

Kickoff Meeting
(10th November 2009)

Field Workshop
(5th July 2010)

Seminar
(25th January 2011)

4th JCC

Weekly Meeting
(Kotahena)

Weekly Meeting
(Borella)

Photo on Project Activities (1st Project Year: 2/6)

Kotahena
Valve Locating

Kotahena
Valve Locating

Kotahena
Hydraulic Isolation of Sub-zone

Kotahena
Customer Survey

Kotahena
Flow Rate Measurement

Kotahena
Investigation for Accuracy of Customer Meter

Photo on Project Activities (1st Project Year: 3/6)

 Kotahena Tracing of Buried Pipe	 Kotahena Leak Detection (Acoustic Survey)
 Kotahena Leak Detection (Acoustic Survey)	 Kotahena Leak Detection (Pinpoint Survey)
 Kotahena Leak Detection (Pinpoint Survey)	 Kotahena Meter Installation to Free Water Outlet

Photo on Project Activities (1st Project Year: 4/6)

 Borella Valve Locating	 Borella Valve Locationg
 Borella Valve Locating	 Borella Valve Installation
 Borella Hydraulic Isolation of Sub-zone	 Borella Customer Survey

Photo on Project Activities (1st Project Year: 5/6)

 Borella Flow Rate Measurement	 Borella Investigation for Accuracy of Customer Meter
 Borella Tracing of Buried Pipe	 Borella Leak Detection (Acoustic Survey)
 Borella Leak Detection (Pinpoint Survey)	 Borella Leak Detection (Confirmation survey)

Photo on Project Activities (1st Project Year: 6/6)

<table>
<tr>
<td> 
Borella
Leak Repair Work</td>
<td> 
Borella
Leak Repair Work</td>
</tr>
<tr>
<td> 
Borella
Searching Buried Customer Meter
(Excavating buried meter)</td>
<td> 
Borella
Inner Surface of Old CI Pipe</td>
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<td> 
Borella
Inner Surface of Old CI Pipe</td>
<td> 
Borella
Installation of New Service Connection</td>
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2nd Project Year

Photo on Project Activities (2nd Project Year: 1/6)

5th JCC
(June 2011)

Training in Japan
(Inspection Tour for Water History Museum of Tokyo Waterworks)

Training in Japan
(Training, Research and Development Center of Tokyo Waterworks)

Training in Japan
(Introduction of GIS Application)

Training in Japan
(JICA Evaluation Committee)

Technical Exchange in Third Country
(Visiting PDAM Makassar in Indonesia)

Photo on Project Activities (2nd Project Year: 2/6)

Technical Exchange in Third Country
(Demonstration of Water Leakage Detection PDAM Makassar in Indonesia)

Technical Exchange in Third Country
(Monthly Meeting held at PDAM Maros in Indonesia)

Technical Exchange in Third Country
(Monthly Meeting held at PDAM Maros in Indonesia)

Terminal Evaluation
(Field Inspection)

Terminal Evaluation
(Inspection of Weekly Meeting)

6th JCC
(February 2012)

Photo on Project Activities (2nd Project Year: 3/6)

Examination for Meter Reader
(February 2012)

Seminar
(February 2012)

Weekly Meeting
(Kotahena)

Weekly Meeting
(Borella)

Activity of Pilot Project (Kotahena)
(Hydraulic Isolation of Sub-zone)

Activity of Pilot Project (Kotahena)
(Leak Detection)

Photo on Project Activities (2nd Project Year: 4/6)

Activity of Pilot Project (Kotahena)
(Bundle Pipe Replacement (1))

Activity of Pilot Project (Kotahena)
(Bundle Pipe Replacement (2))

Activity of Pilot Project (Borella)
(Interview with Customer)

Activity of Pilot Project (Borella)
(Leak Detection)

Activity of Pilot Project (Borella)
(Night Survey)

Activity of Pilot Project (Borella)
(Repairing Float Valve of Sump for Condominium)

Photo on Project Activities (2nd Project Year: 5/6)

GIS Activity
(Procured GIS Software)

GIS Activity
(Procured GPS Tool)

GIS Activity
(Procured PC and Printers)

GIS Activity
(On-site Hands-on Training of GPS)

GIS Activity
(Training for GIS Software)

GIS Activity
(Meeting for GPS Field Work)

Photo on Project Activities (2nd Project Year: 6/6)

PR Activity
(Distribution of Flyer)

PR Activity
(Briefing of Purpose of PR Activity by NWSDB)

PR Activity
(Provision of Materials to Draw Posters)

PR Activity
(A Poster Made by a Student)

PR Activity
(School Activity: Students are listening Lecture by NWSDB)

PR Activity
(School Activity: Students are Drawing a Picture on the Theme of Water)

3rd Project Year

Photo on Project Activities (3rd Project Year: 1/5)

 7th JCC (5th October 2012)	 7th JCC (5th October 2012)
 Discussion on Execution Plan with Executives of NWSDB (Meeting with DGM-WC)	 OJT for Preparation for Public Seminar (Tutoring OIC-Kotahena)
 Weekly Meeting (Kotahena)	 Weekly Meeting (Borella)

Photo on Project Activities (3rd Project Year: 2/5)

Activity of Pilot Project (Kotahena)
(Excavating Leakage Point)

Activity of Pilot Project (Kotahena)
(Exposing Leaking Pipe)

Activity of Pilot Project (Borella)
(Leak Repair)

Activity of Pilot Project (Training on Leak Detection for Large Diameter Pipes (1))

Activity of Pilot Project (Training on Leak Detection for Large Diameter Pipes (2))

Activity of Pilot Project (Training on Leak Detection for Large Diameter Pipes (3))

Photo on Project Activities (3rd Project Year: 3/5)

 Activity of Pilot Project (Night Survey)	 Activity of Pilot Project (Leakage Detection in Night Survey)
 Field Workshop (Explanation for Operation of Equipment for Leakage Survey)	 Field Workshop (Hands on Training for Equipment for Leakage Survey(1))
 Field Workshop (Hands on Training for Equipment for Leakage Survey(2))	 Field Workshop (Hands on Training for Equipment for Leakage Survey(2))

Photo on Project Activities (3rd Project Year: 4/5)

GIS Activity
(Training for GIS Software)

GIS Activity
(Checking Coordinate of Public Standpipe)

GIS Activity
(Field Training (1))

GIS Activity
(Field Training (2))

Participation for Seminar on Management of Free Water Outlet held by NWSDB
(Photo of Participants)

Participation for Seminar on Management of Public Standpipe held by NWSDB
(Drama performed by NWSDB Staff)

Photo on Project Activities (3rd Project Year: 5/5)

PR Activity
(School Activity: Students are listening to the lecture by NWSDB)

PR Activity
(School Activity: Students are listening to the lecture by NWSDB)

PR Activity
(School Activity: A Student Answers to the question by NWSDB)

PR Activity
(School Activity: Provision of Materials To Draw Posters)

PR Activity
(Calendars and Posters Drawn as a Part of PR Activity)

PR Activity
(Caps, T-Shirts, Pens and Leaflets Prepared under PR Activity)

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Chapter 1 OUTLINE OF THE PROJECT

1.1 Background

For the National Water Supply and Drainage Board (NWSDB), which is in charge of water supply and sewerage services for most of the Democratic Socialist Republic of Sri Lanka (Sri Lanka), the high rate of Non Revenue Water (NRW) has been a long-standing problem. In Colombo City, where old pipes still remain in many parts of its distribution system, the NRW rate as of 2008 is reported to be 54.1%, much higher than the national average of 33.0%. The NWSDB has been working to reduce the rate of NRW in several ways such as leakage detection and repair, elimination of illegal connections, removal of public free water outlets and converting their users to individual connections, and billing system improvements. Nevertheless, the NWSDB is still not able to reduce the rate of NRW to a satisfactory level.

The NWSDB stresses the importance of NRW reduction in its "Corporate Plan, 2007-2011" (CP-2007), by making it one of its top priorities and setting a target of reducing NRW in Colombo City by 1% per annum. The NWSDB needs assistance to improve its ability to implement NRW reduction measures to meet this target.

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

JICA organized the JICA Expert Team (JET) to Sri Lanka to conduct the Technical Cooperation Project, from 9th November, 2009 to October 2012. The 3 phases of the Project are as follows: 1st Project Year (Oct/2009 to Mar/2011), 2nd Project Year (Apr/2011 to Mar/2012) and 3rd Project Year (Apr/2012 to Oct/2012).

1.2 Purpose and Outputs of the Project

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

The "Project Purpose" is as follows.

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

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

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

into relevant plans/programs of NWSDB.

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

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

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

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

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

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

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

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

The NWSDB and the JICA Expert Team (JET) share the mutual understanding that the NWSDB has distinctive ownership and is to play a major role in conducting the Project and JET is to support the NWSDB in this effort.

1.3 Target Area

1.3.1 Location

The target area of the Project is Colombo City. Borella and Kotahena are the two pilot areas, in which the NRW reduction activities were planned and implemented. Each pilot area covers approximately 5,000 connections and is further divided into sub-zones with 500 connections each. The location and outline of the pilot areas are shown in Figure 1.3-1, Figure 1.3-2, and Figure 1.3-3.

1.3.2 Outline of the Project

The Project activities were conducted in the two PAs which have the following characteristics:

- Kotahena: area of old of pipe networks which are in relatively poor conditions
- Borella: area with pipeline networks in relatively better conditions

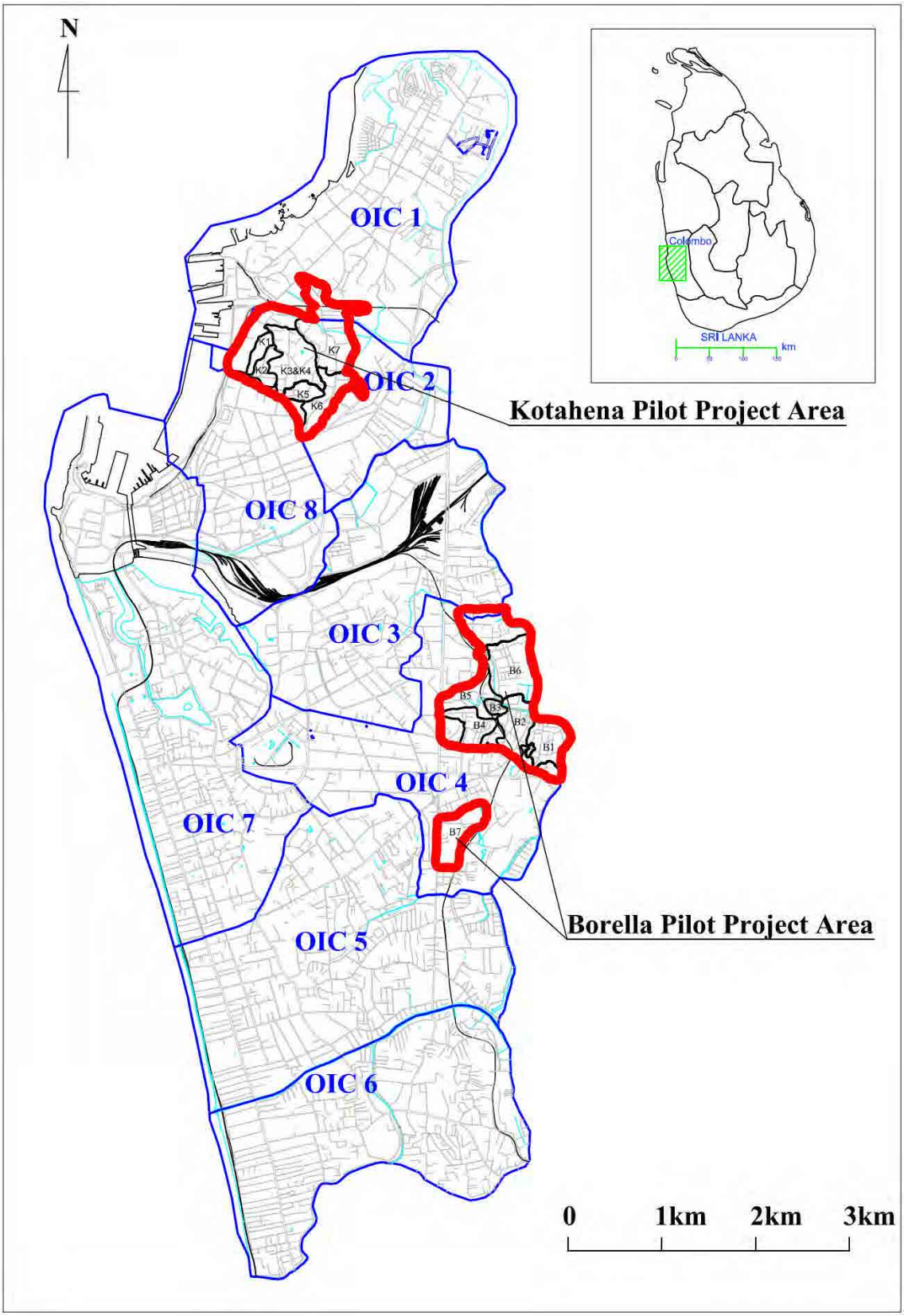


Figure 1.3-1 Locations of Pilot Project Area (Kotahena & Borella)

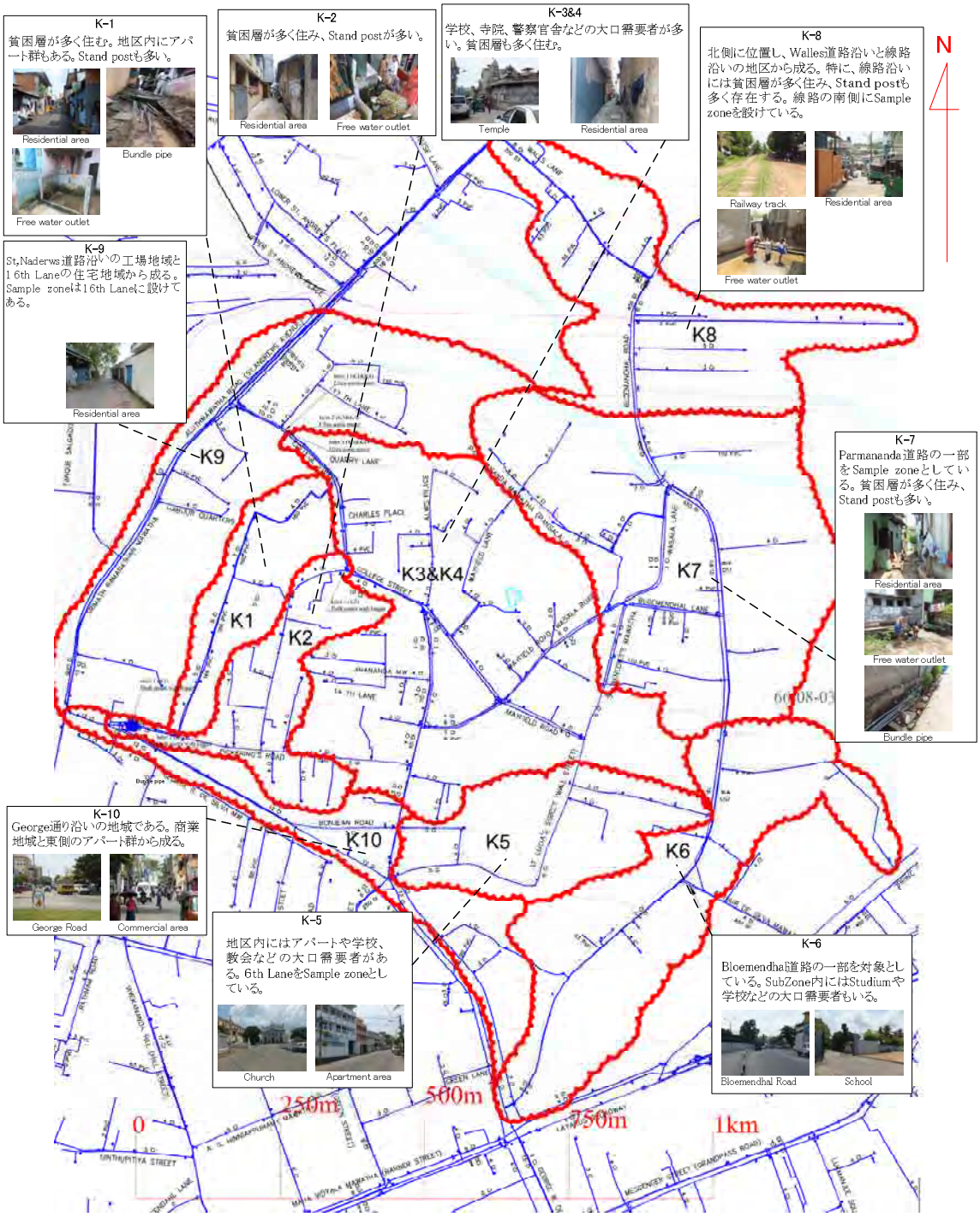


Figure 1.3-2 Kotahena Pilot Area

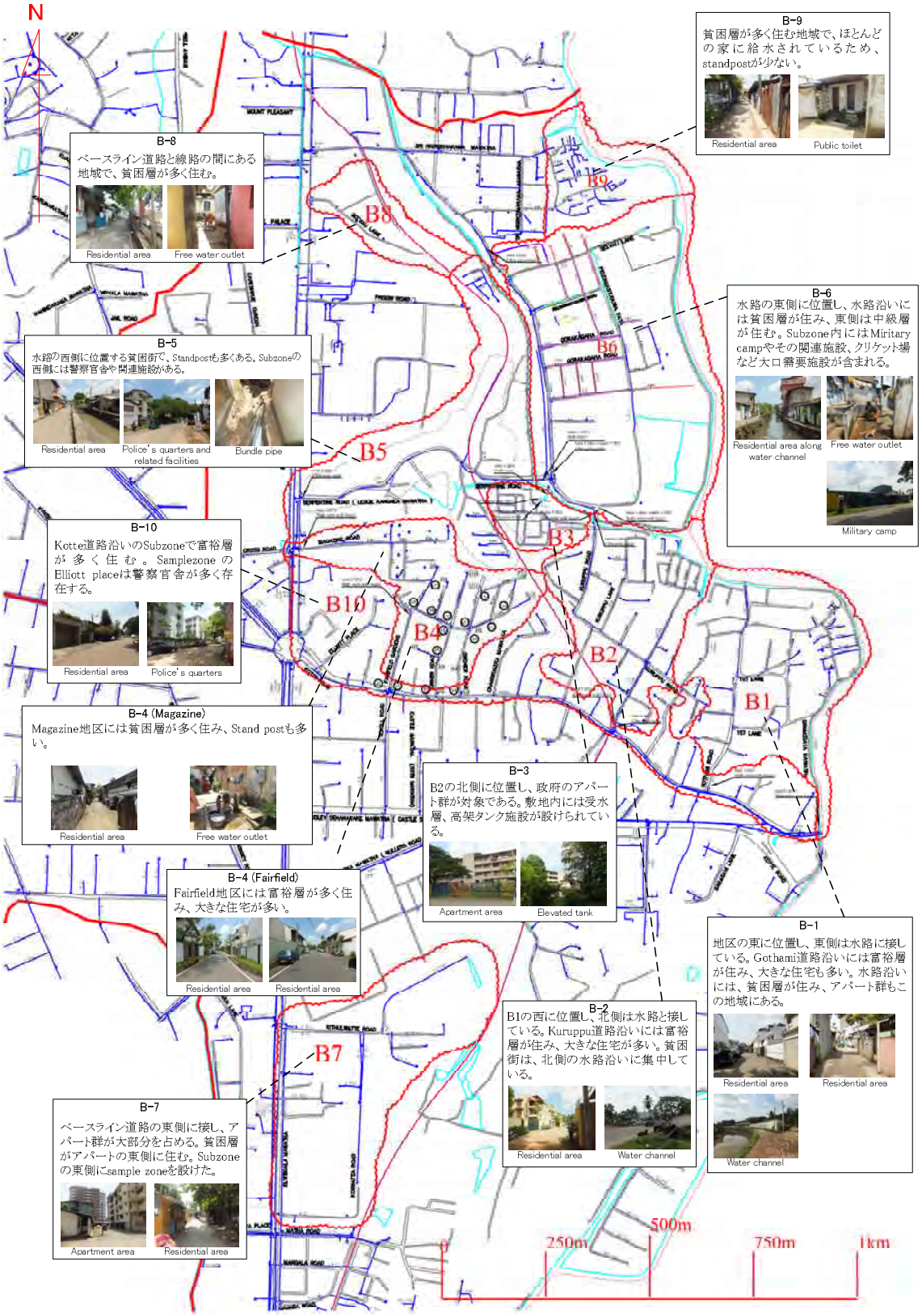
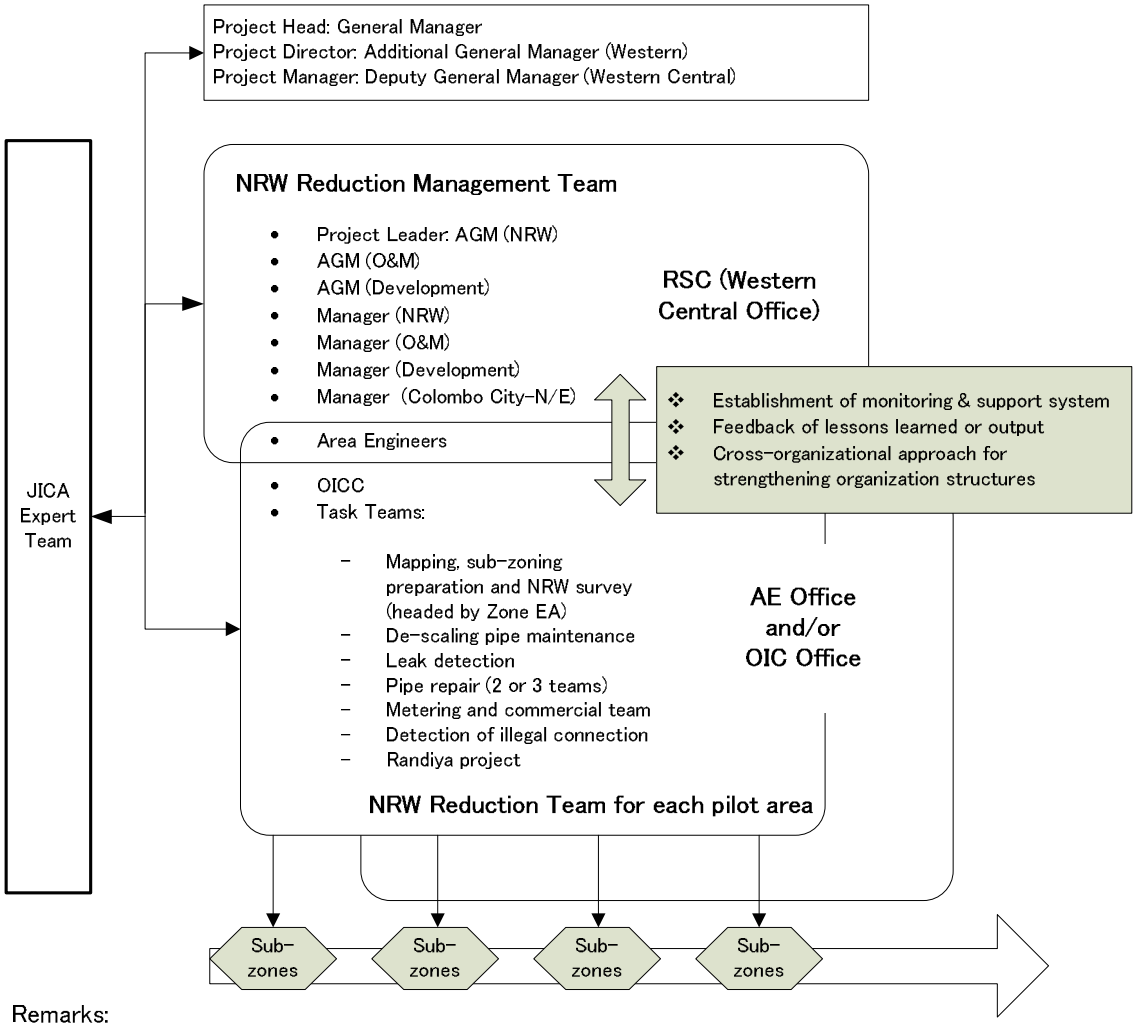


Figure 1.3-3 Borella Pilot Area

1.4 General Structure of the Project Organization

As shown in the R/D signed on 22nd April, 2009, the C/Ps were assigned as shown in Figure 1.4-1.



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 1.4-1 Organizational Structure for Project Activities

1.5 Organization of NRW Reduction Management Team

The members of the NRW Reduction Management Team were appointed based on the R/D.

1.6 Organization of NRW Reduction Teams

The structure of the NRW Reduction Teams is shown in Figure 1.6-1.

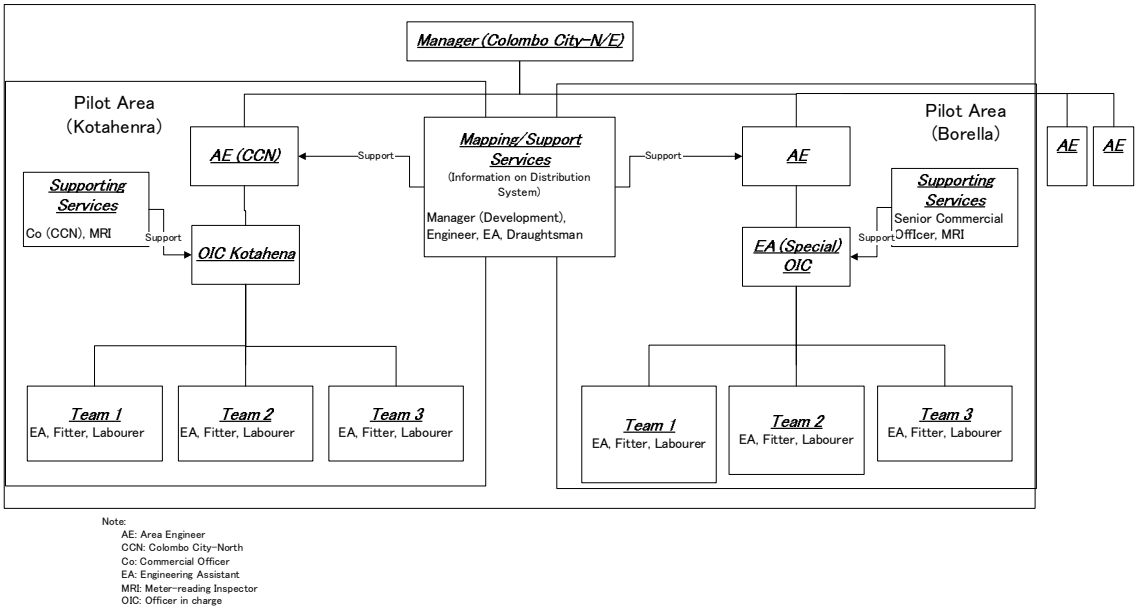


Figure 1.6-1 Organizational Chart of NRW Reduction Teams

Team 1 was headed by the zone officer in charge and its supporting staff. Team 2 was made up of staff belonging to the NRW Section.

A zone officer outside of Borella and Kotahena was to be assigned to Team 3 so that the experience and knowledge obtained could be shared with as many of the C/P staff as possible. Ultimately, Team 3 was cancelled because the NWSDB could not appoint staff for it.

Chapter 2 ACTIVITIES AND OUTPUTS OF THE PROJECT

2.1 Overview of the Activities

The Project intends to enhance the capacity of NWSDB staff to execute (i) NRW reduction measures as a part of routine O&M activities, and (ii) to formulate an Execution Plan for NRW reduction activities to be applied to the entire city of Colombo, through on-the-job training (OJT) as a component of the Project activities.

There were several immediate problems to overcome at the start of the Project.

- In order to get the clear status of NRW and to verify the effect of NRW reduction activities in a sub-zone, the sub-zone must be hydraulically isolated to measure the inflow (outflow) before and after the NRW reduction activities. However, there were several difficulties and constraints, such as (i) existing pipeline network drawings were not properly updated and locations of many pipes and valves were not known, (ii) even if hydraulic isolation had been successful, it was very difficult to maintain appropriate system pressure due to constant low pressure in and around the Pilot Areas.
- Some NWSDB officials were skeptical about the effectiveness of routine NRW reduction activities, and were of the opinion that (i) leakage from old and deteriorated cast iron pipes were the main cause of high NRW in Colombo City, (ii) and therefore routine O&M would not bring about significant NRW reduction.

The Project tackled the above problems and achieved the following.

- The Project focused on leakage and did not always attempt hydraulic isolation because of the specific situations in Colombo City.
- The Project chose practical solutions and provided training to the C/Ps on the following:
  - methods of leakage detection, repair and systematic recording of leaks.
  - measures against illegal connections, including effective methods to detect and investigate illegal connections.
  - policy on elimination of free water consumption at free water outlets
  - effective methods of cutting and transferring long-distance bundled service pipes
- The Project demonstrated the following findings
  - special attention on leakage detection and repair may be effective in reducing NRW in areas like Borella where the pipeline networks are in relatively better condition.
  - whereas in areas like Kotahena, where the pipeline networks are in poor conditions, bundled service pipe cutting/transferring would also be required to reduce NRW.
  - benefits of the above activities surpass the implementation costs.
  - the findings, lessons learned and the cost-benefit analysis increased the NWSDB staff's awareness of the importance of integrating NRW reduction activities into routine operation and maintenance.

The following subsections outline the contents of the Project activities and outputs.

2.1.1 Summary of the Activities for "Output 1"

Table 2.1-1 summarizes the "Activities" related to "Output 1" and its progress/status.

Table 2.1-1 Activities and Contents 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.		
Activities		***Progress/Stutus***
1-1	Organize a "NRW Reduction Management Team" at Western-Central Regional Support Center.	The decision was made to form the NRW Reduction Management Team and the members of the team were assigned before the start of the Project. Team Leader, AGM of NRW Section, understood well the Project and his responsibilities. After several discussions among the team as well as one on one meetings, he was able to bring the rest of the members to the same level of understanding. Special attention was paid to communication, since the members of NRW Reduction Management Team and NRW Reduction Teams work in different locations in Colombo City. Weekly meetings as proposed by JET were held. Other meetings, such as meetings with the GM and senior management, were also held to provide updates on project activities. Good communication contributed to the effective and efficient execution of the activities. It shall be noted that members of the NRW Reduction Management Teams were responsible for several important activities and the priority of the project activities was not always high. However, the Project proceeded and overcame several problems since the AGM of the NRW sections and other key members understand the importance of the activities and gave high priority to the Project. It was useful to show the good results and achievement of the Project in making the team members understand and put higher priority to the Project.
1-2	Review "Strategic Approach for Non Revenue Water Reduction in Colombo Metropolitan Region".	C/P and JET jointly reviewed the Strategic Approach for Non-revenue Water Reduction in Colombo Metropolitan Region prepared in June 2007. The Strategic Approach consists of seven Action Paths as listed below: Action Path I: Re-organization of Colombo City Action Path II: Pilot Projects in Kalutara & Gampaha Region Action Path III: Pipe Replacement in Colombo City Action Path IV: Strengthening of NRW Section Action Path V: Work Programme for Preventive Approach Action Path VI: Specification to Pipe Specials Action Path VII: Strengthening Legal Activities Action Path VIII: Incentive & Penalty to Meter Reader The Project would contribute directly to "Action Path IV: Strengthening of NRW Section" and "Action Path V: Work Programme for Preventive Approach" by developing staff capability. The organization was revised and reformed as described in Strategic Approach. Some officers for the new organization were still being selected. It was relatively easy to make the staff understand the importance of execution of NRW reduction activities since the organization was new and flexible.

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.		
Activities		***Progress/Stutus***
1-3	Prepare an annual program of NRW reduction activities for the pilot areas.	The first Annual Program for NRW Reduction Activities for the Pilot Areas was prepared in May 2010 by the NRW Reduction Management Team with the assistance of JET. The Program included intensive execution of NRW reduction activities in the two pilot areas. Procedure, timing and period of the activities were carefully planned in coordination with pipe replacement and other projects in the pilot areas. The NWSDB should bear the required cost for the NRW reduction activities, such as materials, road excavation/ restoration, staff and fuel. The required cost was estimated and budget allocation was prepared. As for coordination with the other projects, meetings were held with responsible staff to review project plans and schedules. It was agreed that JET would be informed when the plans were revised. The schedule of the Annual Program was prepared taking into consideration the progress and schedule of relevant projects. As for the Randiya Project, activities to change from free water outlets to individual connections under the control of the AGM for NRW Section, it was agreed that this will be done in the PAs as required. Several of the Project activities were delayed and the Work Plan, which was prepared following the schedule stated in the Annual Program, would have to be revised from time to time. However the delay of other related projects was much more serious and it was not necessary to pay much attention to the schedule revisions. The budget plan was prepared and submitted to ERD (External Resources Department) before the start of the Project but the required funding was not disbursed. The cost for the activities, was covered by NWSDB's regular budgets from the NRW and O&M Sections. While there were no serious budget problems, the Project was affected by staff shortage and the age of vehicles owned by the NWSDB.

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.		
Activities		***Progress/Stutus***
1-4	Review existing training programs related to NRW reduction and conduct the training for "NRW Reduction Teams".	The NRW reduction program was prepared jointly by JET and the NRW Reduction Management Team, after reviewing the training programs executed by the NWSDB. Training on NRW reduction methods, such as leakage detection/repair and service connections, were given to the members of the NRW Reduction Teams. Before preparation of the training program, JET observed the current activities to gauge the level of existing knowledge and capability of the NRW Reduction Teams and to determine the required improvements. The basic ideas and methods of NRW reduction were provided separately in a classroom setting, and training on actual execution was done on the job at the work sites. The combination of classroom and OJT was carefully arranged for the training program. As a result, NRW Reduction Teams obtained the capability to execute NRW reduction activities in a systematic manner. Training was offered not only to the team members but also to other interested staff, several staff from the O&M and NRW sections attained similar capabilities. Training on the operation of GIS software, preparation of base maps and related site survey was provided to NWSDB staff of the Mapping and NRW Sections. Staff capability will improve not only when they are being trained but also when they teach and train each other on what they have learned. NWSDB staff tended to keep their knowledge to themselves. Therefore a workshop was held under the supervision of JET for C/P members to exchange information on the operation of relevant equipment. It should be noted that JET initiated the seminar and workshops at initial stage and C/P became to take initiative in later stage.
1-5	Assess progress of NRW reduction activities in the pilot areas.	NRW reduction requires an integrated effort from the responsible teams. The NRW Reduction Teams would execute the activities in the PAs and the NRW Reduction Management Team would plan the reduction measures and monitor the outcomes. Therefore it was considered that exchange of ideas of both teams was important for capacity improvement of NRW Reduction Management Team. It was required to seek the improvement methods of the activities by both teams based on the progress and results of the field actions. Regular weekly meetings among NRW Reduction Management Team, NRW Reduction Teams and JET were very effective. Improvement methods and review of plan were discussed in the meetings after reviewing the progress. At the early stages, the meetings were not perceived positively by the C/Ps. The NRW Reduction Teams would explain the progress and problems encountered, and wait for instructions. However in time the groups became well engaged in coming up with their own ideas and finding solutions themselves. The weekly meetings took place even when JET was not able to attend.

Output 1: Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.		
Activities		***Progress/Stutus***
1-6	Review the annual program of NRW reduction activities based on the feedback/lessons learnt in the pilot areas and prepare the program for the following year.	The first annual program was reviewed before the end of the program period. The results of the monitoring mentioned above, achievement of the PA activities and obstacles encountered were all taken into consideration in the review. The NRW Reduction Management Team, with the assistance of JET, prepared the 2nd Annual Program in July 2011 and then the 3rd Annual Program in July 2012. The involvement of JET for the preparation of the Annual Programs was reduced gradually every year. It should be noted on "progress review of previous year and preparation of the new Annual Plan" that NWSDB prepared a plan to replace some pipes with its own budget in order to find the effective methods for NRW reduction when progress of other pipe replacement projects was found to be severely delayed. NWSDB tried to minimize the negative impact on the project purpose by delay of pipe replacement project.
1-7	Evaluate activities in the pilot areas through out the Project period and prepare an "execution plan" to apply the Project outcome to entire area Colombo city	The NRW Reduction Management Team prepared the Execution Plan with the help of JET. The Execution Plan took into consideration the problems encountered by the NRW Reduction Teams and the solutions found. NRW Reduction Team could not always execute NRW reduction activities smoothly, efficiently and successfully. Based on the experience of such activities, efficient methods suitable to the current condition was found and reflected to the Execution Plan, which discussed comprehensive NRW reduction activities in Colombo City. The Execution plan included the methods, schedule and required input in order for NWSDB to disseminate the activities to entire Colombo City. It should be noted that the target set in the NWSDB Corporate Plan could be achieved not only by implementing the Execution Plan but also by replacing old pipes. However it will take several years at least to undertake pipe replacement even if a budget is allocated. The Execution Plan explains supervision of immediate actions and the cost and benefits for taking these actions while waiting for pipe replacement. The Execution Plan was discussed at the JCC and at a public seminar. It was highly appreciated by the senior management of the NWSDB, including the GM. The NRW reduction activities proposed for Colombo City are expected to be of high priority

Note: Activities are basically done by C/P with support of JET

2.1.2 Summary of the Activities for "Output 2"

Table 2.1-2 summarizes the activities related to "Output 2" and its progress/status.

Table 2.1-2 Activities and Contents 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.		
Activities		***Progress/Status***
2-1	Select two (2) pilot areas.	C/P and JET worked together to select two pilot areas (PAs), one with about 5,000 house connections in Kotahena, where pipe replacement was urgently needed and would soon be carried out, and Borella, where immediate pipe replacement was not planned. The boundaries of the PAs were decided according to the maps of the areas provided by the Zone Officer (Engineering Assistant) and subsequently confirmed with site investigations. The PAs were chosen so that the effect of NRW reduction activities for areas with and without pipe replacement could be compared. This was not realized because pipe replacement in Kotahena was not completed during the Project period.. While the effects of combination of NRW reduction activities and pipe replacement was not evaluated, comparison of the NRW reduction activities could be done in "relatively poor-condition-area where pipe replacement is planed with high priority (Kotahena)" and "relatively good-condition-area where priority of pipe replacement is not high (Borella)". C/Ps gained the experience on how to set the boundary for a PA and would be able to do so by themselves in the future. When a PA is nominated, it would be prudent to carefully review again the purpose of the Project and characteristics of PA, as well as external conditions such as the the status of other relevant on-going projects. There should also be enough flexibility to adjust to changing conditions.
2-2	Organize "NRW Reduction Team (a group of OlC, EA and gangs)" at the pilot areas.	The NRW Reduction Team must have the proper composition in order to carry out the activities in the PA. The following individuals made up the key personnel: OIC (Officer in Charge) or Engineering Assistant (EA), plumber and labor made a term and Area Engineers, who were responsible for Kotahena and Borella, joined as leaders for NRW Reduction Teams. In addition, staffs executing other relevant activities such as Randiya Project joined to the pilot activities when it was necessary. Comprehensive activities for NRW reduction could be executed in PA by assigning members in charge of several activities, such as leak detection, leak repair, replacement of defective meters, findings of illegal connections, mitigation of billing error, and disconnection of free water outlets. Training in several aspects also could be done. However there was not enough staff for the rotations and the training had to be delivered separately. Training seminars open to all Colombo City O&M staff were conducted on the basics of NRW reduction methods. Staff from other areas were invited to weekly meetings and provided with advice, assistance and equipment from the Project. Staff in all the areas of Colombo City were to take turns as members of the team to get the training on NRW reduction activities (Rotation system). However it was not realized due to shortage of O&M staffs in Colombo City. Therefore it was decided to seek other methods for many staffs to be trained onexecution of NRW reduction activities in proper manner. Lots of staffs were called for the training. Seminar for basic ideas on NRW reduction methods was open to lots of staffs. O&M staffs from other areas of Colombo City were invited to weekly regular meeting and pilot activities. When they tried to execute the similar ways of the activities in their responsible areas, JET assisted them by giving advice and lending required equipment.

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.		
Activities		***Progress/Status***
2-3	Review and modify pipeline network drawings of the pilot areas.	It was necessary to collect data such as the location of pipes and valves in the PAs because existing drawings were old and not properly updated. Suitable ways to record collected data were discussed and training provided. O&M staffs in charge of the areas were able to show the teams some of the locations for pipes not shown on the drawings. The information was collected and added on existing pipe drawings. Almost all valves were covered by road surface and the exact location of valves should be identified. However, majority of surface valve covers were removed and it became very difficult to detect the locations by using metal locator. Pipe location was detected by using pipe locator but PVC pipes were difficult to find. There remain several unknown pipes and valve locatioseven after the investigation. It was required to locate unknown pipes and valves for hydraulic isolation of PA or sub-zones. However it took very long period and cost for this process. Information of required pipes for isolation was obtained in drawings but the teams did not find all the pipes and valves at sites. Data of detected pipe and valves were recorded in pipe drawings. Exact location of valves shall be recorded before they were re-covered by road surface. Therefore sketch of tie-measurement was prepared at the sites and attached /linked to the drawing. After staff was trained on the use of GIS, the GIS datbase was updated with the available data. The C/Ps were able to execute pipe detection and record the information to the GIS database. The locations of customer meters were also recorded and customer data linked to usage in the PAs. It was noted that the O&M staff used to carry out leakage repairs and other O&M activities without using pipe drawings. During the Project the C/Ps became accustomed to working with pipe drawings and became more efficient in executing these activities. The use of GIS and pipe drawings for routine O&M should become more prevalent throughout the City of Colombo
2-4	Isolate the pilot areas and conduct a survey on actual conditions of NRW in the pilot areas including identification of an initial NRW ratio.	Water inflow to the system was measured to calculate the non revenue water before and after the NRW reduction activities. Hydraulic isolation was required to carry out the measurements. However hydraulic isolation was very tough job and required very long period due to complicated unknown pipes and valves. In spite of difficulties and several failures, C/P conducted hydraulic isolation patiently. Subzones K1,K2,K3 & K4 in Kotahena and B1,B2,B3,B4,B6 in Borella were isolated and NRW was calculated. NRW for the exiting network was calculated as 85% in K1, 79% in K2, 73% in K3&K4, 40% in B1, 62% in B2, 84% in B3, 61% in B4, and 50% in B6. The members of the NRW Reduction Team became familiar with the activities required for hydraulic isolation, such as locating pipes, valve detection, valve operation, and confirmation of isolation. They also learned to measure water flow and calculate NRW. It was not practical to execute hydraulic isolation all over Colombo City as a routine O&M activity, since it takes a long time and requires huge input. In addition it was found in the PAs that NRW can be reduced even in the current conditions of Colombo City. NRW reduction activities without hydraulic isolation were tried in the remaining subzones in the PAs. Leak detection was completed in all the subzones.

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.		
Activities		***Progress/Status***
2-5	Prepare a NRW reduction work plan for each pilot area incorporating leak detection, pipe repairing, plumbing and activities for the reduction of non-physical losses.	A work plan was prepared based on the NRW Reduction Annual Program. The work plan covered the activities of 20 subzones in the 2 PAs. The initial step was the selection of subzones, locating pipes and valves and hydraulic isolation of subzones. Some of the activities could not be executed as planned and the work plan was reviewed by the NRW Reduction Teams and JETat weekly meetings. The C/Ps became accustomed to preparing and amending the work plan throughout the Project. They understood the importance of the planning exercise and the execution of the planned activities in a systematic manner. It should be noted that it was good chance to discuss the reasons of delay and the ways of improvement. JET was helping with the problem solving at the initial stages. The C/Ps were able to solve most of the problems by themselves at the later stages.
2-6	Conduct on-the-job training on leak detection, plumbing and pipe repairing for "NRW Reduction Team".	The NWSDB conducted some training on leak detection and repair in the past. Some C/Ps were exposed to the use of leak detection equipment. However most were not familiar with undertaking these tasks in an organized manner. The training was designed with special attention paid to a systematic approach to leak detection and repair. Lectures at seminars and workshops covered the basic principles and measures for NRW reduction. Staff also received OJT training on the use of equipment and execution of the NRW reduction activities. The activities executed by NWSDB were observed at sites to find problems /shortage and then JET and C/P discussed and tried several methods to find effective methods to suite the existing condition. OJT was conducted on leakage detection, service connection, and leak repair. Trainees dealt with the actual conditions in the PAs while the Project was in progress. A manual for usage of leak detection equipment and replacement of bundled service pipes was also prepared. The C/Ps learned to detect underground leakage by using leakage detection equipment and execute the repairs systematically. The NRW Reduction Team became accustomed to carrying out the activitieswithout the presence of JET. One serious problem observed was with overflow and leakage from tanks before the water reaches the customers. Such ocurrences were not dealt with quickly and repairs were not made in a timely fashion. It was noted that the C/Ps were not in the habit of sharing their knowledge with each other. Therefore a workshop was held under the supervision of JET for the C/Ps to learn from each other the usage of equipment and to share information. Methods to help the C/Ps to attend quicker to leakage repair were also discussed.

Output 2: Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.		
Activities		***Progress/Status***
2-7	Implement NRW reduction activities according to the work plan.	Although the NWSDB was doing leakage detection and repair work, this was not always done in a well-planned manner. The Project found the effective /suitable measures after execution of planned activities. Execution plan was prepared based on findings. Work Plan was prepared and comprehensive NRW reduction measures, including meter replacement, leak detection/repair, installation of meter to free water outlets, and detection of illegal connections. The effective measures for PA and for entire Colombo City were looked for throughout the activities. Some of improvement methods of the current activities done by NWSDB were found. For example, the detection of illegal connections used to be done at random. Instead, household survey was conducted on all the houses and houses suspected of illegal connections would be identified from the data. If it is difficult to conduct household survey on all the houses in entire Colombo City, high priority houses can be selected from the available customer data such as billing record. JET and C/P developed some methods of selection of high priority houses using GPS.
2-8	Measure results of NRW reduction team's work (NRW ratio etc.) and provide feedback to "NRW Reduction Management Team" for revision of the annual program.	The activities by NRW Reduction Team had to be evaluated in order to reflect in the Annual Plan.Weekly meetings among NRW Reduction Teams, NRW Reduction Management Team and JET improved communication and everyone involved shared common understanding of how the activities were unfolding, the results, problems, and lessons learned. The findings and lessons learned in pilot projects are shared among the C/Ps in weekly meetings and other opportunities. In addition to the progress and obstacles of the activities, results and effects of NRW reduction activities in PA were also discussed and shared. As the results, NRW Reduction Management Team could evaluate the activities in PA and reflect the findings in the annual program for the next year and NRW Reduction Team were able to get advice and support from the management level.

Note: Activities are basically done by the C/Ps with support from JET

2.2 Achievement of Outputs and Project Purpose

2.2.1 Achievement of Outputs

(1) Achievement of Output 1

Table 2.2-1 provides an outline of Output 1 and its indicators.

Table 2.2-1 Outline of Output 1 and Its Indicators

Outline of Output 1	***Objectivly Verifiable Indicators***
Management capacity of senior officers of the Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced.	a) An annual program for NRW reduction in the pilot area is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years). b) NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget etc.) as planned. c) NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams."

On the whole, the management capability of the Regional Support Center (Western-Central) to plan and supervise NRW reduction activities has been enhanced. The details are as follows.

a) Preparation of Annual Program

The NRW Reduction Management Team formulated the first-year's annual program in May 2010 in cooperation with JICA experts. This Team prepared the second-year's annual program in June 2011 on its own. Reviewing the second year's results of the NRW reduction activities, the third annual program was prepared in June 2012. Having done so, the Team has achieved this objective and attained the desired outcome.

b) Securing of Budget, Materials and Human Resources

The second half of the project was implemented more smoothly than the first half. In response to the recommendations made by the Mid-term Review Team, the NWSDB made substantial efforts to allocate its resources and thus accelerated the progress of the activities.

After the Mid-term Review, the NWSDB added more Engineering Assistants (EAs) to the O&M Section. Despite this effort, coping with the amount of routine tasks still left the newly hired EAs limited time to devote themselves adequately to the project activities. Moreover, the six teams assigned to the two pilot areas could not concentrate solely on the Project's activities since they also had their regular responsibilities as well as attend to urgent matters. By the middle of 2011, the NRW Reduction Management Team reorganized the six teams into four teams (two teams for each pilot area) and assigned one team to each pilot area to concentrate exclusively on the project activities. Since then, the Project's activities progressed more smoothly.

In 2010 the NWSDB earmarked approximately 200 million LKR for the three-year project activities and requested matching funds from the Ministry of Finance and Planning. The amount of 25 million LKR was disbursed from the Ministry for tax payment of the procured equipment in 2010 and 970 thousand LKR for tax payment of the GIS equipment in 2011. In 2012, the NWSDB requested 20 million LKR from the Ministry, but only received the tax portion of the amount. The outstanding expenses, including personnel costs and materials for service pipe replacement and leak repair had to be disbursed from the regular budget of the NWSDB.

The NWSDB maintained its effort to secure the necessary budget and materials for the NRW reduction activities. Although the NWSDB struggled in securing the necessary human resources, they maintained the effort to assign their staff as effectively as possible and achieved the desired outcome.

c) Training for NRW Reduction Team

At the early stage of the project activities, the JICA experts and the NRW Reduction Management Team reviewed the existing training programs and organized the seminars and workshops on NRW reduction. Through the project activities, the themes or topics to be included in the training programs were clearly identified. Most of the presentations were made by the members of NRW Reduction Management Team and NRW Reduction Teams.

The C/Ps took the initiative to organize and conduct training towards the end of the Project. They had successfully achieved the desired outcome.

(2) Achievement of Output 2

Table 2.2-2 provides an outline of Output 1 and its indicators.

Table 2.2-2 Outline of Output 2 and Its Indicators

Outline of Output 2	*Objectivly Verifiable Indicators*
Technical and operational capacity to conduct NRW reduction activities by officers/staff of Regional Center (Western-Central) is developed.	a) "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan. b) NWSDB officers/staff engaged in "NRW reduction Teams" acquire proper leak detection, plumbing and pipe repairing skills. c) An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.

The management capacity of senior officers of the Regional Center (Western-Central) to plan and supervise NRW reduction activities has been enhanced. The details are as follows.

a) Implementation of NRW Reduction Activities

The six NRW Reduction Teams headed by Area Engineers (AEs) were set up in November 2009, with three teams each for Kotahena and Borella. These were later reorganized into four teams. The four teams worked well when they were able to focus on the project activities. The NRW Reduction Teams prepared the work plan for the activities together with the NRW Reduction Management Team and JICA experts, and they revised the plan several times as the project unfolded.

The project activities were often delayed when the hydraulic isolation work of the sub-zones took longer than expected because of the lack of accurate information on pipeline drawings, unexpected interconnection of pipes, low system pressure and difficulties in locating valves.

By the end of the Project, the ratios of NRW before and after the NRW reduction activities were obtained for the sub-zones of B1, B2, B3, B4-FF, B4-Mgz, B6, K1, K2, K3 & K4. The findings and lessons learned were incorporated into the Execution Plan.

According to this indicator, desired outcome has been generally achieved.

b) Acquiring of Technology on Leak Detection/Repair and Service Connection Work

The members of the NRW Reduction Teams have acquired the knowledge and techniques on the systematic methods for NRW reduction, such as sub-zoning, hydraulic isolation, system inflow measurement, measurement of minimum night flow (MNF), leakage detection and repair, meter accuracy test and meter replacement, detection/elimination of illegal connection, and meter installation to stand posts, through seminars/workshops and OJT.

The proposals on GIS and PR activities were submitted by the NWSDB in March 2011 in response to the Mid-term Review and these activities were incorporated in the Project. Training was conducted on base map preparation, update, logging customer locations and input into GIS database, relational link with existing customer database, and its practical usage. PR activities in the 3rd Project Year included: preparation of hand-bills, pens, caps, T-shirts, DVD movie, posters and calendars, school events.

In addition to the series of OJTs, the C/Ps shared the lessons learned with other staff in the NWSDB at workshops and public seminars. They also provided feedback which was reflected in the Execution Plan, and in the preparation of manuals of bundled service pipe rectification. Through these activities, desired outcome has been generally achieved.

c) NRW Ratio in Pilot Area

By the completion of the Project, the NRW ratios were established in five sub-zones in Borella and three sub-zones in Kotahena. Table 2.2-3 and 2.2-4 summarize the results of the NRW reduction activities in each sub-zone, including the NRW ratios before and after the activities. It should be noted that leakage detection was conducted in all sub-zones.

Table 2.2-3 Summary of NRW Reduction Activities in Borella

		Borella Pilot Area										
Sub-zone		B1	B2	B3	B4-1	B4-2	B5	B6	B7	B8	B9	B10
Mode of hydraulic isolation		Full	Full	Full	Full	Full	Full	Full	Sample	Full	Full	Sample
Type of sub-zone		B-similar	B-similar	B-similar	B-similar	K-similar	K-similar	B-similar	B-similar	B-similar	K-similar	B-similar
Number of connections		584	624	360	162	291	840	1,117	200	186	593	191
Populaton		2,738	3,079	1,371	692	1,311	3,798	5,310	1,000 *b)	996	2,965	1,030
Area (km^2)		0.177	0.143	0.026	0.074	0.039	0.196	0.313	0.199	0.043	0.063	0.182
Population density (person/km^2)		15,469	21,531	52,731	9,351	33,615	19,378	16,965	5,025	23,163	47,063	5,659
Length of pipeline (m)		2,333	2,962	2,397	1,789	1,462	2,031	5,720	5,468	611 *c)	1,314	1,354
Number of free water outlets		2	6	0	2	25	11	7	1	2	1	0
Number of leakages		47	31	19	5	29	36	31	9	9	65	1
Number of meters replaced/ installed	Newly installed	12	25	14	0	17	11	9	0	0	76	0
	Replaced	7	7	20	3	12	12	17	6	0	274	1
Number of illegal connections		8	15	19	0	13	9	21	0	2	–	1
NRW rate(%)	Before	40%	62%	84%	60%	62%	62%	50%	–	–	–	–
	measured on	Jun/2010	Feb/2012	Dec/2010	Oct/2011	Oct/2011	Feb/2012	Feb/2012	–	–	–	–
	After	18%	–	29%	27%	52%	–	28%	–	–	–	–
	measured on	Feb/2011	–	Jan/2011	Jun/2012	Jun/2012	–	Aug/2012	–	–	–	–

*a) Estimated based on billing record
*b) Estimated based on average number per family, multiplied by number of connection.
Average number of family is assumed to be five
*c) Pipeline drawing not available in this area. Estimated based on road lenth.

Table 2.2-4 Summary of NRW Reduction Activities in Kotahena

		Kotahena Pilot Area								
Sub-zone		K1	K2	K3&4	K5	K6	K7	K8	K9	K10
Mode of hydraulic isolation		Full	Full	Full	Sample	Full	Sample	Sample	Sample	Sample
Type of sub-zone		K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar	K-similar
Number of connections		397	426	1,383	115 *a)	159	1,545 *a)	769 *a)	201 *a)	300 *a)
Populaton		1,697	2,231	7,174	575 *b)	795	7,725 *b)	3,845 *b)	1,005 *b)	1,500 *b)
Area (km^2)		0.056	0.066	0.256	0.091	0.150	0.239	0.138	0.196	0.080
Population density (person/km^2)		30,304	33,803	28,023	6,319	5,300	32,322	27,862	5,128	18,750
Length of pipeline (m)		1,399	1,468	7,333	867	2,643	5,183	3,082	4,670	2,228
Number of free water outlets		14	33	19	4	–	3	–	3	–
Number of leakages		90	93	36	9	–	28	70	12	11
Number of meters replaced/ installed	Newly installed	45	20	8	0	–	4	–	0	–
	Replaced	19	10	14	3	–	4	–	1	–
Number of illegal connections		53	23	5	1	–	0	–	1	–
NRW rate(%)	Before	85%	78%	73%	–	45%	–	–	–	–
	measured on	May/2010	Nov/2010	Feb/2012	–	Aug/2012	–	–	–	–
	After	56%	72%	71%	–	–	–	–	–	–
	measured on	Oct/2011	Nov/2011	Aug/2012	–	–	–	–	–	–

*a) Estimated based on billing record
*b) Estimated based on average number per family, multiplied by number of connection.
Average number of family is assumed to be five
*c) Pipeline drawing not available in this area. Estimated based on road lenth.

The NRW reduction activities which focused mainly on leakage detection and repair brought remarkable results in Borella where the pipelines were in relatively better condition; and should be valid for other similar areas. Meanwhile, in Kotahena where the pipes were old and deteriorated, the one-time attempt at leakage detection and repair did not give good results and the volume of real loss rebounded to the original level within a short period. A combination of leakage detection and repair, and replacement of long-distance bundled service pipe demonstrated a more noticeable result for this area.

The Project demonstrated how NRW reduction activities delivered systematically can be effective and the practical solution for NRW reduction in areas where old and deteriorated pipes are dominant.

The reduction of NRW was quantitatively confirmed in several sub-zones where hydraulic isolation was successful. Leak detection was conducted for the other sub-zones and repairs to the leakages would be done after the Project. By addressing these detected leakages, it is expected that the NRW will be reduced. Therefore, desired outcome has been generally achieved.

2.2.2 Achieving the Project Purpose

Table 2.2-5 summarizes the Purpose of the Project and its Objectively Verifiable Indicators.

Table 2.2-5 Project Purpose and Indicators

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

(1) Records of NRW Reduction Activity

The results of the NRW reduction activities are described in "2.10.1 Result of NRW Reduction Activities in Pilot Area". As mentioned in "1.6 Organization of NRW Reduction Team", the Project originally planned to rotate personnel from within and outside the PAs in the NRW Reduction Teams, so that as many staff as possible could gain the knowledge and working experience. However, this was not accomplished because of staff shortage, as noted in the Mid-term Review in February 2011. As an alternative, the NWSDB invited all the Area Engineers (AEs), the Officer in Charge (OICs) and Engineering Assistants (EAs) in Colombo City to the weekly meetings, seminars and workshops. They were also invited to participate at the NRW reduction activities in their own areas.. By the end of the Project, the AE in Colombo South and AE and OIC in Colombo East acquired required knowledge and experience.

Accordingly, the NWSDB has increased the record of NRW reduction activities in the course of the Project's activities. Therefore, the purpose of the Project as measured by this indicator has been achieved.

(2) Budget for NRW Reduction Activities in NWSDB

Only the tax portion of the budget for the procurement of equipment was secured by the C/P. The approval for the balance of the funding to be obtained from the Ministry of Finance and Planning was delayed. Fortunately, the NWSDB was able to use their regular O&M budget to cover the necessary expenditures of the NRW reduction activities.

The executives of the NWSDB have started discussions on the policies and proposals presented in the Execution Plan. It is expected that the necessary budget will be allocated. The NWSDB is also planning and preparing the budget for old pipe replacement to further reduce NRW.

As stated, the NWSDB has maintained its effort to increase the budget for NRW reduction. Accordingly, the purpose of the project has been generally achieved.

(3) Preparation of Execution Plan

The NRW Reduction Management Team prepared the Execution Plan at the final stage of the Project and its contents are available in "2.10 Execution Plan". The executives of the NWSDB started discussions to seek the possibility of including the policy and proposals presented in the Execution Plan in NWSDB’s future implementation plan. Some executive members may contend that the replacement of old pipes, to be implemented under ADB loan, will be sufficient for NRW reduction. The NRW Section and senior management understand and support the importance of replacing old pipes as well as day-to-day NRW reduction activities as stated in the Execution Plan.

It is expected that the policies and proposals presented in the Execution Plan would be incorporated into the NWSDB's future implementation plan. Accordingly, the purpose presented in this indicator may be regarded to have been properly achieved.

It can be concluded that the NWSDB's capability to implement NRW reduction activities in Colombo City was strengthened through the Project's activities.

2.2.3 Follow-up on Recommendations Made in the Terminal Evaluation

(1) Sharing the Outcomes of the Project among NWSDB Staff

After the Terminal Evaluation, a public seminar was organized to share the findings and lessons learned with NWSDB staff and other officials.

(2) Implementation of Replacement of Old Pipes

The pipe replacement and installation of new connections under the loan project in K6 were not carried out as planned. Consequently, the Project was not able to compare the "effect of pipe replacement alone" with "pipe replacement plus NRW reduction activities".

After the Terminal Evaluation, using its own budget, the NWSDB conducted some more NRW reduction activities, such as abandoning old cast iron pipes, rectifying bundled service pipes and converting to new service pipes in K1 and K2. Through these activities, The Project could get the results to compare before and after the activities.

(3) Facilitating Internal Procedure and Securing Budget/Personnel for NRW Reduction

After the Terminal Evaluation, JET urged the NWSDB to improve its effort to secure the resources for NRW reduction. However, there is no significant improvement in securing necessary personnel.

As mentioned in "2.2.2 Achievement of Project Purpose", the NWSDB made the maximum possible effort to secure and increase the budget for NRW reduction activities. The NWSDB is to obtain financing from ADB for pipe replacement for the entire service area of Colombo City.

(4) Sharing Lessons Learned/Findings/Experiences of the Project

After the Terminal Evaluation, the C/Ps took the initiative to organize workshops to share their findings, lessons learned and experiences with other staff outside of the PAs. The latter continued to carry out the NRW reduction activities after the Terminal Evaluation. Thus, it is expected that the C/Ps directly involved would continue these activities and would share and disseminate their experiences even after the Project.

(5) Accumulating Pipeline Information and Effective Use of GIS Database

After the Terminal Evaluation, the NWSDB made an existing engineer who had a background on GIS to the Project in order to maintain and expand the GIS database.

At the request of the NWSDB, JET conducted intensive OJT for this new member on database construction.

Through OJT on GIS, the C/Ps learned to update the database and plan an effective illegal connection survey using the GIS database.

(6) Coordination with JICA Master Plan Project and ADB Project

JET shared the Execution Plan, which described the findings and lessons learned, with the officials responsible for the ongoing JICA master plan project on water supply in Colombo City and the future ADB project on pipe replacement for the city.

(7) Leakage Detection on Trunk Distribution Main

On request of the NRW Section, OJT on leak detection for trunk distribution mains inside and outside of the PAs was conducted, using procured equipments. This OJT provided another opportunity for the C/Ps to improve their ability to detect leakages which they were not able to do before the training.

(8) Cost Benefit Analysis

The cost and benefits of leakage detection and repair were analyzed after the Terminal Evaluation. The analysis demonstrated that leakage detection and repair generated significant financial benefits. By incorporating these findings to the Execution Plan and presenting the information at the public seminar, the Project promoted awareness within NWSDB on the importance of routine O&M.

2.3 Counterparts

Table 2.3-1 shows the list of counterparts who have directly or indirectly been involved in the Project activities.

Table 2.3-1 List of Counterpart

Name	*Position*	*Direct C/P*	*Remarks*
NRW Reduction Management Team			
Mr. S.G.G.Rajkumar	AGM (NRW)	Yes	
Mr. S.A.Rasheed	AGM (O&M)	Yes	
Mr. K.W. Premasiri	AGM (Dev. W/C)	Yes	
Mr S.S. Devaraja	M (NRW)	Yes	Withdrawn from the Project's activities (promoted as AGM (Co-ordination) Head Office in end/Sep/2011)
Mr. T.B.Heekenda	M (NRW)	Yes	Newly appointed M (NRW) with effect from 27/Sep/2011
Mr. W.D.L.Chandrasiri	M (O&M) - S/W	Yes	
Mr. R.A.N. Dharmasiri	M (O&M) - N/E	Yes	
Mr. Premakumara	CE. NRW	Yes	
Mr. A.D.K.K.Wijayagunawardana	Senior Engineer		(Mr. Kumudu): Transferred to Head Office.
NRW Reduction Team (Borella)			
Ms. W.C.A.Gunarathna	AE (CC-East)	Yes	
Mr. R.L. Wijekularathna	OIC (Boreila)	Yes	
Mr.W.A.W.T.Wickramarachchi	Special CO CB2	Yes	
Mr. W.W.G.Weerarathne	CO	Yes	
Mr. D.H.R.Hettiarachchi	Zone officer (Borella)	Yes	
Mr. K.A.D.C.U.W. Gunarathna	EA	Yes	Transferred out of the NRW Project

Mr. M.S.C. Perera	EA NRW	Yes	Appointed for full time work with effect from 11/Jul/2011 as replacement for Mr. Gunarathna
Mr. S.N.I.Somaratne	Fitter	Yes	
Mr. H.M.Chaminda Pushpakumara	Labourer		
Mr. R.A.D.M.Ranasinghe	Labourer		
Mr. G.G.C.Jayalath	Pipe fitter		
Mr. P.A.D.C.Rathnayaka	Labourer		
Mr. K.N.Karunarathna	Labourer		
NRW Reduction Team (Kotahena)			
Mr. D.A.D.Hemachandra	CE (TNC)		Fomer AE (CC-North) and promoted as Chief Engineer and appointed to P&D Division as of 12/Jul/2010.
Mr. I.R.B.Waruna	AE (CC-North)	Yes	Replacement of Mr. Hemachandra after his promotion. Withdrawn from the Project activities (transferred to RSC Anuradhapura on 22/Jun/11)
Mr. H.K.D Sunil Chandra	AE (CC-North)	Yes	Newly appointed AE with effect from Sep/2011 in replacement for Mr.Waruna
Mr.W.W.K.Jayasinghe	OIC (Kotahena)	Yes	
Mrs. G.D.Neelakanthy	CO (CCN)	Yes	
Mr. B.D.Dharmasena	Supporting Staff MRI	Yes	
Mr. P.S.Kariyawasam	EA	Yes	
Mr. E.D K. Karunarathna	EA (Illegal)	Yes	Transferred out of the NRW Project
Mr. H.G. Ariyatilake	EA NRW	Yes	Appointed for full time work with effect from 11th July 2011, as a replacement for Mr. Karunarathna
Mr. G.H.Chandana	Fitter	Yes	
Mr. E.L.R.Kamal Perera	Labourer	Yes	
Mr. K.Devasagayan	Labourer		
Mr. M.S.Silva	Pipe Fitter	Yes	
Mr. S.Dissanayake	Labourer		
Mr. J.T.Biyanwala	Labourer		
Mapping/Support Service			
Mr. M.B.Thilakarathna	Engineer		
Mr. U.L.U.A.Karunarathna	EA		
Mrs. Bulathsinhala	EA		
Others			
Mr. K. Premakumar	Senior.Eng. NRW		
Mr. R.A.Kumaranayake	EA (Maligawatte)	Yes	
Mr. H.W.Gunawardhana	OIC Maligawatte		
Mr. N.P.Tharanga	EA		
Mr. S.K.P.Samarasinghe	EA		
Mr. S.A.Lionel	EA (Maligawatte)		
Mr. W.M.D.G.B.Wickramasinghe	OIC Mattakuliya		
Mr. K. Premalal	EA (SP) NRW	Yes	
Ms. L.A.K.M. Liyanaarachchi	Eng. Maligakande	Yes	
Mr. S. Kandeepan	Eng. (NRW)		
Mr. C.Balasooriya	EA (NRW)		
Mr. P.D.D.Priya Ranjith	EA		
Mr. R.D.S.Wickramaratne	EA Maligawatte		
Mr. W.D.P. Sanjeewa	OIC Maligawatte		

Mr. A.L.Senerathne	AE - CCW		
Mr. A.V.P.Dhammika	AE - CCS		
Mr. B.K.G.D.Rodrigo	EA OIC Mattakuliya		
Ms. P.V.H.K.Suranga	EA		
Mr. M.B.Thilakaratne	Eng. Maligakande		

AGM: Assistant General Manager *M: Manager* *AE: Area Engineer*
CE: Chief Engineer *Eng: Engineer* *OIC: Officer in Charge*
CO: Commercial Officer *EA: Engineering Assistant*

(1) Target Groups and Effectiveness of Technology Transfer

The Project intended to transfer technical capability to the following two groups:

- Executives of the NWSDB in charge of NRW reduction in Colombo City. Their main roles in the Project are supervision of the NRW reduction activities and disseminating lessons learned and findings obtained through the Project to other NWSDB staff.
- Field engineers, officers (including Area Engineers, Engineering Assistants and OICs) and workers who execute the field activities in the Kotahena or Borella areas.

By conducting site activities, monitoring and evaluation of results of NRW reduction in the pilot areas with the assistance of JET, the capability of the C/Ps in planning and implementation of NRW reduction activities in Colombo City has been strengthened. The technical capability for leakage detection and repair and installation of service connections has also been augmented. Awareness of the importance of NRW reduction activities as part of the routine O&M may have been increased through the preparation of the Execution Plan.

(2) Difficulties Encountered and Attempts for Effective Technology Transfer

a) Weekly Meetings

The plan was to hold weekly meetings for the two groups separately. However, it became apparent at the early stage of the Project that management staff were too busy to meet every week. It was also recognized that management and field staff should meet together so that they could discuss the progress of the Project and exchange ideas. It was also necessary to ensure that the meetings should not add too much burden to the existing workload. Given the above considerations, regular meetings were convened among management and field staff to discuss difficulties encountered and to come up with actions to be taken. The meetings were chaired by any member of NRW Reduction Management Team available at the time. The meetings were held for the NRW Reduction Teams for Borella and Kotahena either separately, on the same day, at different times.

At first, there was not so much frank discussions (directives from management to site level staff were active, on the contrary, feedback from site level staff back to management was not so active). However, the atmosphere changed over time, so that there was active sharing of views, opinions and idea.

b) Technology Transfer

At the earlier stage of the Project, the NRW Reduction Teams were instructed by JET on hydraulic isolation, handling of leak detection devices and other activities. Later on the trained staff were able to pass their knowledge on to their colleagues at workshops and prepare quick reference manuals for leakage detection devices with the assistance of JET. These experiences deepened their understanding of the Project activities.

2.4 Annual Program

The C/Ps and JET jointly formulated a sub-zoning plan to facilitate smooth implementation of the Project. The plan divided a pilot area with 5,000 connections into smaller areas with about 500 connections. The order of implementation of NRW reduction activities in each sub-zone was also determined. It was modified and updated to reflect the progress of the Project.

The NRW reduction activities were supported by the regular budget allocated to the NRW and O&M Sections. Charges or taxes related to custom clearance for equipment and machinery donated by the Japanese side were to be borne by the NWSDB. The NWSDB initially preferred to request budget on a case-by-case basis, rather than prepare a special budget in advance to cover additional or unexpected expenditures. Accordingly, the NWSDB allocated more budget to both the NRW and O&M Sections than the year before, to cover costs for extra personnel, overtime, labor and vehicles for the Project. The NWSDB intended to extend the Project activities beyond the Pilot Areas, as a part of its regular work program.

However, NWSDB re-considered and found it more desirable to secure the budget for the total project. The necessary budget was allocated and the activities proceeded without suffering any budget shortage.

JET and the C/Ps shared the view that it was more practical to set the numerical target of NRW reduction after the execution of some activities in a few sub-zones of the PA. The major target at the initial stage was to improve staff capability, to know the actual situation of NRW and to find the most effective methods for NRW reduction.

Based on the above principle, the NRW Reduction Management Teams formulated the first-year's annual program in May 2010. The second-year's program was prepared after reviewing the previous one in June 2011. The third-year's program was prepared in June 2012. The annual programs are presented in Annex - 1.

2.5 Work Plan

The C/Ps and JET jointly prepared the work plan for activities in the pilot areas according to the annual programs prepared by the NRW Reduction Management Team (refer to Annex - 2).

2.5.1 Original Work Plan

Figure 2.5-1 and Figure 2.5-2 show general work plans that were originally formulated at the beginning stage of the Project in both Pilot Areas.

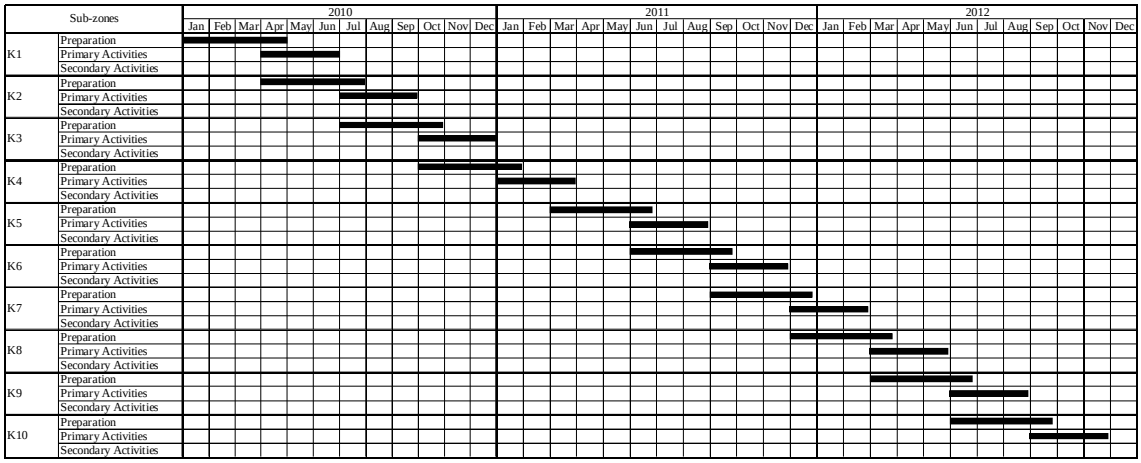


Figure 2.5-1 General Work Plan for Kotahena (Original)

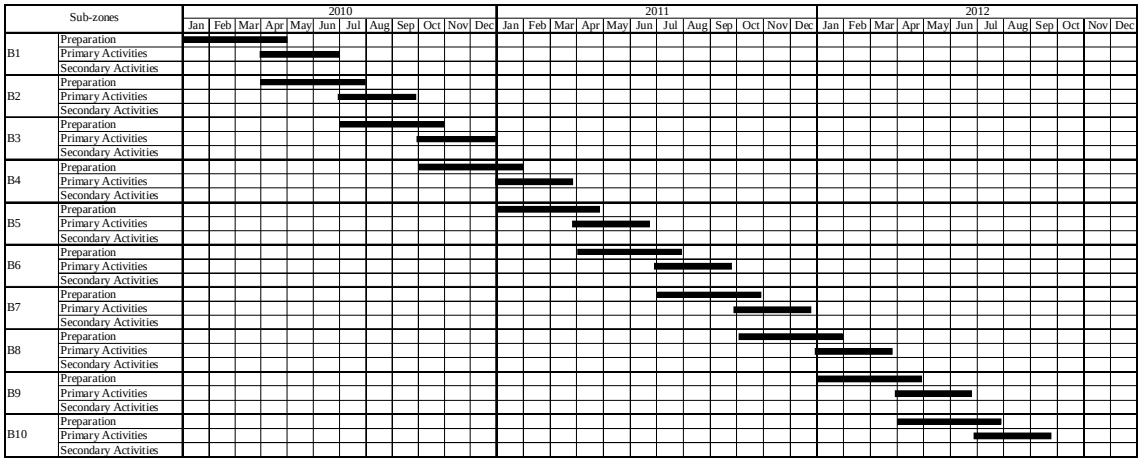


Figure 2.5-2 General Work Plan for Borella (Original)

2.5.2 Final Version of the Work Plan

Because of the difficulties mentioned earlier, the work plans had to be revised from time to time. The final version of the work plans are presented in Figure 2.5-3 and Figure 2.5-4.

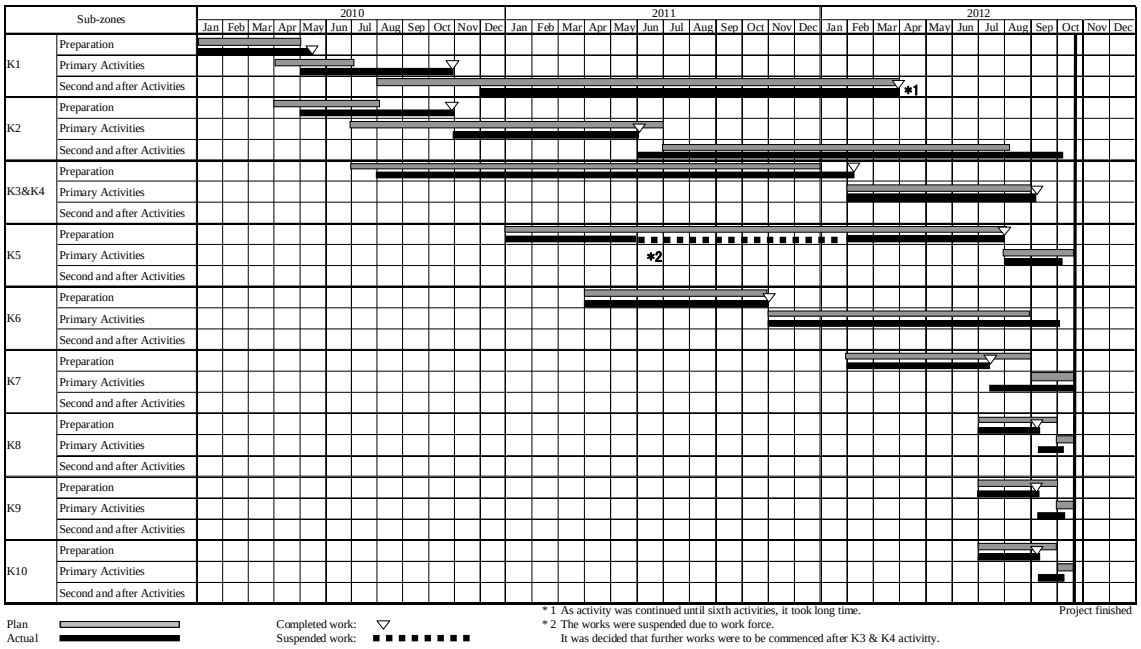


Figure 2.5-3 Updated Work Plan (Kotahena)

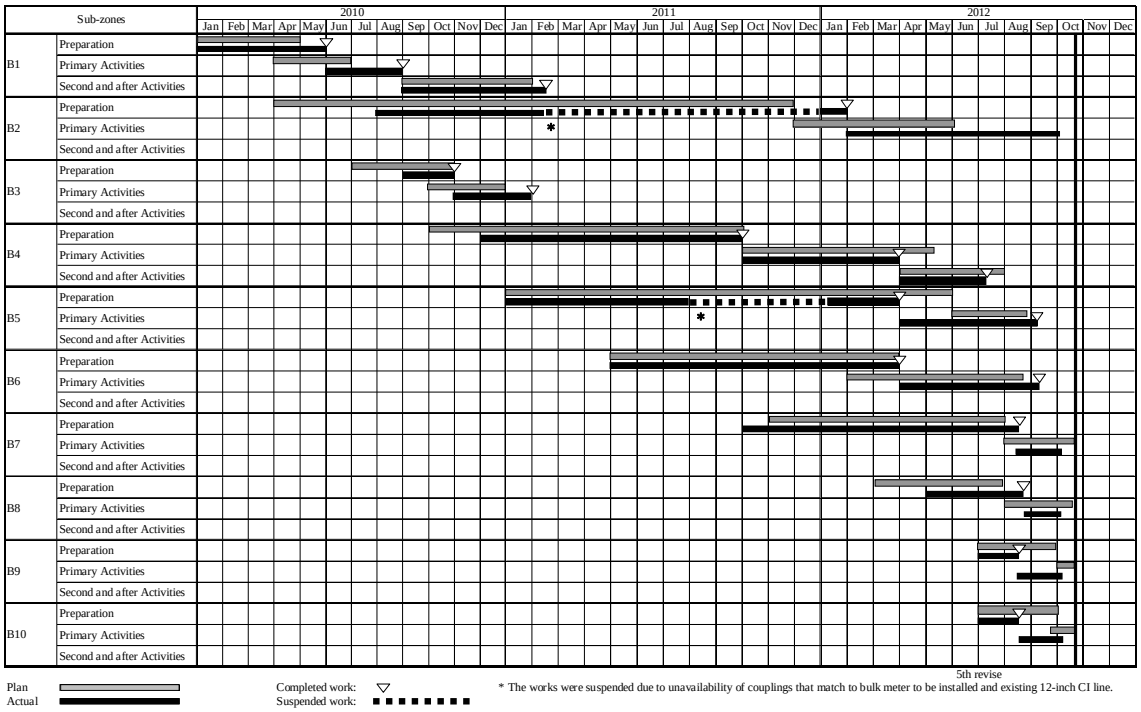


Figure 2.5-4 Updated Work Plan (Borella)

2.6 Implementation of NRW Reduction Activities in Pilot Area

A series of NRW reduction activities were conducted in each pilot area in accordance with the Annual Program and Work Plans. Details are explained in the following subsections.

2.6.1 Pilot Areas

A series of NRW reduction activities are planned and implemented at Kotahen and Borella,in Colombo City. Each pilot area has approximately 5,000 connections. The PAs are further divided into sub zones of approximately 500 connections.

The two locations could be characterized as follows:

- Kotahena: Area with old pipeline network in relatively poor conditions
- Borella: Area with pipeline network in relatively better conditions

2.6.2 Activities in the Pilot Areas

The work flow in the PAs may be divided into preparatory works and NRW reduction activities, as shown in Figure 2.6-1 and Figure 2.6-2.

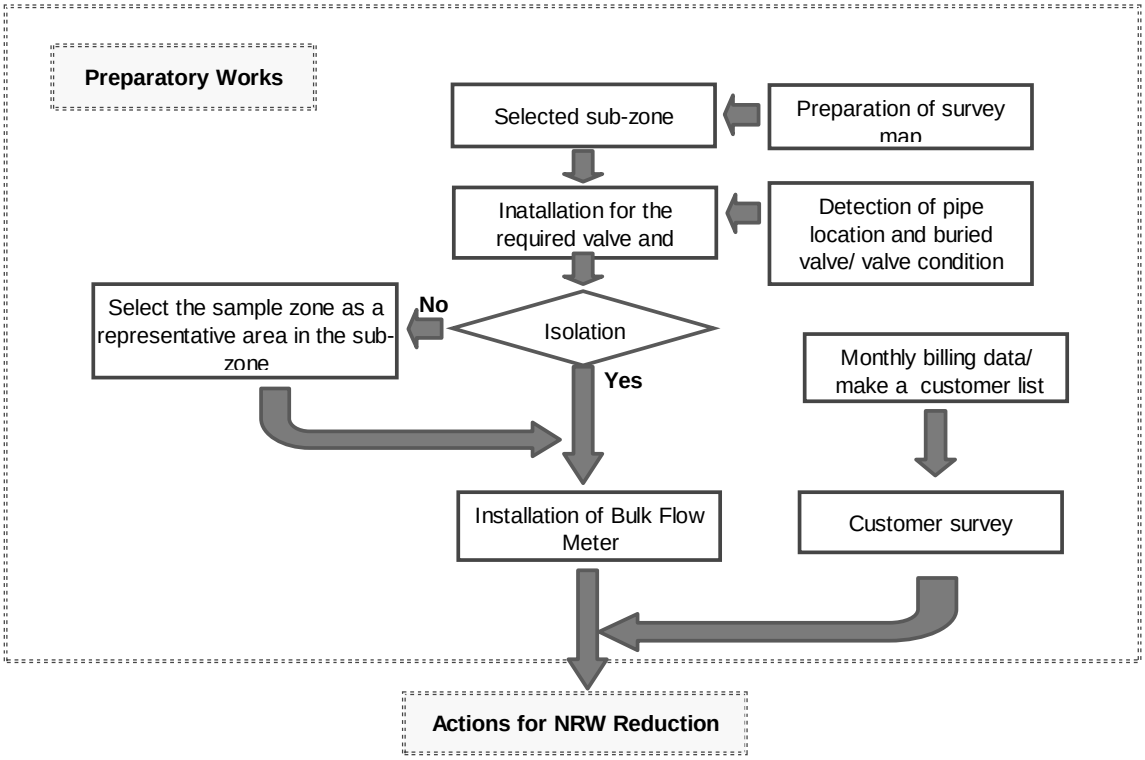


Figure 2.6-1 Preparatory Works

- Preparation of Survey Map: a sub-zone map was prepared by adding the location of key facilities (pipes or valves) on the base map which showed only roads or major buildings.
- Selection of Sub-zone: the boundary of a sub-zone was determined according to the drawings; changes were required occasionally depending on the conditions encountered at the site, because not all of the drawings have the accurate information on the locations of pipes and valves.
- Detection of Pipes and Valves: the routes of pipelines and the locations of valves and their functions were verified during site surveys.
- Installation of Valves and Meter Chambers: Additional valves were installed wherever necessary to isolate the sub-zone. A flow meter was installed at the inlet of the sub-zone. If it was very difficult to maintain system pressure after isolation, multiple inlet points and/or outlet point(s) were considered. If it was too difficult to isolate the sub-zone, the boundary of the sub-zone or point/number of inflow (outflow) point(s) was adjusted.

- Hydraulic Isolation: Sub-zones were hydraulically isolated by closing boundary valves. If the system pressure within a sub-zone dropped significantly, additional inflow (outflow) points were considered. If it was difficult to isolate a sub-zone due to existence of unidentified pipes or valves, the boundary of the sub-zone was changed or merged with a neighboring sub-zone. If this attempt was not practical, the part of the sub-zone that was not possible to isolate was selected as a sample zone to compare the difference between before and after project activities.
- Review of Monthly Billing Data: In parallel with the isolation work, billing records of all customers within the boundary of the sub-zone were collected and reviewed, to establish revenue water before NRW reduction activities.
- Customer Survey: Based on the review of the billing record, a customer list was prepared, to check current connection status, meter condition, number of family members, with or without of overhead tank or sump and its condition, illegal connection, and so on.

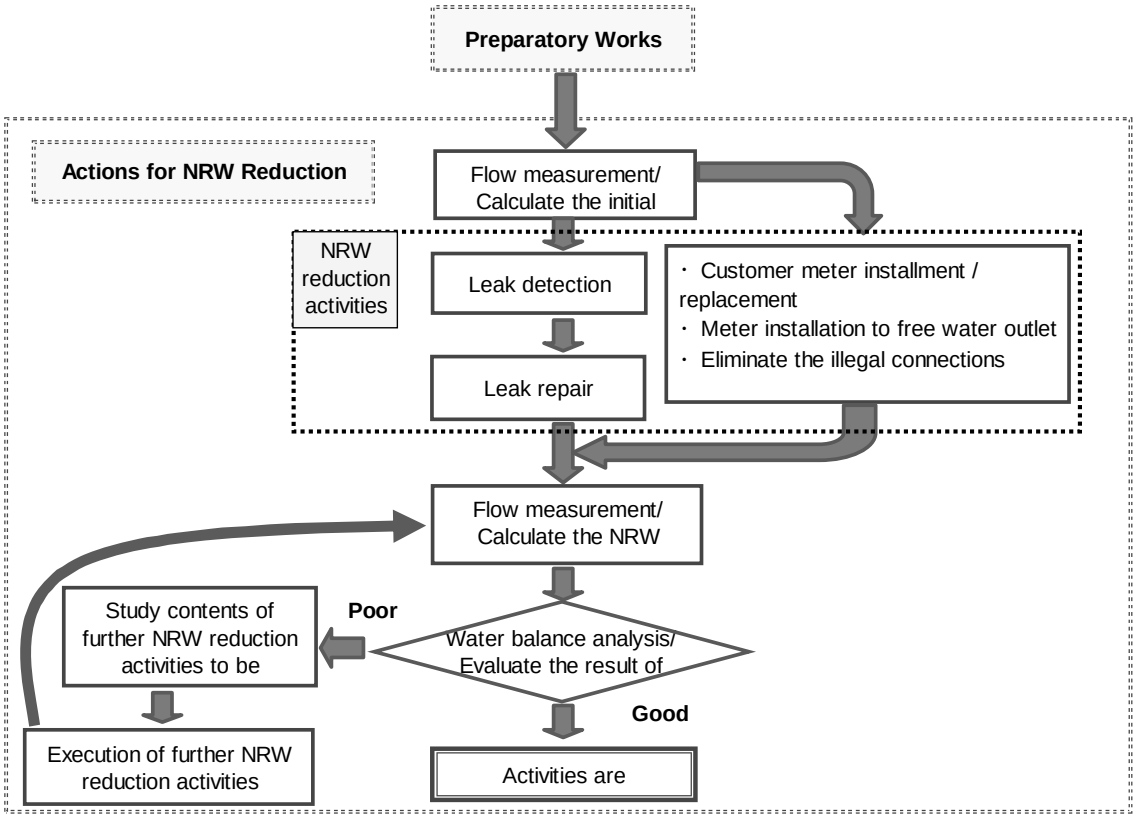


Figure 2.6-2 Procedure for NRW Reduction Activities

- Flow measurement (prior to project implementation): System inflow was measured before NRW reduction activities were implemented. At the same time, minimum night flow and pressure were measured.
- Implementation of activities: The following activities were conducted to reduce NRW in the PAs:
  - Leakage Detection & Repair:
    - ✧ detect & repair leaks found through site observations and/or reported by residents
    - ✧ detect and repair underground leaks found through acoustic survey.
  - Free Water Outlets: Install meters at free water outlets to monitor consumption.
  - Meter-related error:
    - ✧ install meters to billed-unmetered users.

        - ✧ replace defective meters.
    - Illegal users: Investigate and legalize to register these users for metering
    - Others:
        - ✧ monitor loss at sump/tank of apartment buildings
        - ✧ reduce leakage from bundled service pipes (and long-distance service connections)
- Measurement and Analysis after NRW Reduction: System inflow was measured after implementation of NRW reduction activities. At the same time, minimum night flow and pressure were measured.
- Water Balance Analysis and Evaluation of Result: Water balance was analyzed with reference to (a) the result of flow measurement, (b) billing record, and (c) loss of consumption at free water outlets, illegal connections and meter-related errors. NRW reduction activities would be stopped at this point when no problem is detected.
- Implementation of Further Activities: If the above NRW reduction activities did not give good results, possible causes that hindered NRW reduction were investigated to decide what to do next. Step testing was conducted whenever necessary to narrow down suspicious sections/areas that contribute to high NRW ratio.

2.6.3 Difficulties Encountered

Several difficulties, which were causing the delays, are listed below.

- **Information and data:** Locations of valves were not found since they were covered by pavement without valve surface covers and detailed drawings and tie-measurements were not always available. Pipeline data were missing or incorrect even if drawings were available. Pipelines and interconnections were found in unexpected locations because they were installed without proper planning.
  Due to the above circumstances, the confirmation of valve locations or pipeline routes took an extremely long time. Not knowing all the locations of the pipelines and valves, the hydraulic isolation was very time consuming because it had to be done by trial-and-error.
- **Vehicles:** Not enough vehicles were allocated to the Project even after several discussions and drivers were not always available. Field work had to be suspended on several occasions due to the shortage of heavy vehicles such as crane mounted trucks. Implementation of GIS/GPS and PR activities also suffered due to the shortage of vehicles.
- **Personnel:** After assigning the two teams to concentrate on the Project, the progress of the activities began to improve. However the activities were still interrupted on some occasions due to unexpected events such as union activities and health problems of the staff.
- **Permits for road excavation:** Road excavation permits were not obtained in time causing delays in implementing hydraulic isolations especially in B4 and B6.
- **Meter chambers:** Installing meter chambers on roads with heavy traffic was a slow process.
- **Materials and tools**: Materials and tools of the NWSDB were stored in several places without proper information. Due to uncertain whereabouts of necessary materials or tools, the NWSDB sometimes faced difficulties in preparing necessary materials/tools. This was a major problem for the hydraulic isolation activities in B4 and B6.
- **Data collection through meter condition survey and customer meter reading:** This activity was very time consuming. One of the reasons is that the billing sheet owned by each customer had to be checked at site, since they cannot be identified by the address. Another reason is that service pipes were installed inside the building in many cases and customer permission was required to enter for meter checking.
- **Activities during absence of JET:** JET was concerned that there might be lack of adequate progress, and suspension of activities as soon as trouble/problems arose and the lowering of the

priority for NRW reduction activities when the JET was not there.

To avoid running into these problems, the following measures were undertaken:

- Zone officers and EAs were briefed so that they possessed a good understanding of the long term plan.
- Senior management was informed of the requirements and shortages on a timely basis.
- Efforts were made to ensure that the necessary materials and tools were always available.
- Alternatives were available in case the isolation was not possible.
- Efforts were made to ensure that staff were always motivated.

2.7 Seminars and Workshops

Table 2.7-1 outlines record of seminars and workshops conducted under the Project acitvities.

Table 2.7-1 Record of Seminar and Workshop

	Date	***Title and Contents***	***Number of Participants****
1	21/Dec/2009	***The First Seminar*** Introduction of the Project Basic issues of NRW	33
2	31/Mar/2010	***The First Workshop*** Techniques in service pipe connection and the present Sri Lankan conditions Group discussions on NRW reduction activities	32
3	06/Apr/2010	***The Second Seminar*** Leakage mechanism and techniques in leak detection	39
4	05/Jul/2010	***The First Field Workshop*** Leak detection and techniques in service pipe connection	Approx. 25
5	18/Oct/2010	***The Second Field Workshop*** The same as the first field workshop	Approx. 25
6	25/Oct/2010	***The Third Field Workshop*** The same as the first field workshop	Approx. 25
7	25/Jan/2011	***The Third Seminar*** The progress of the pilot activities Findings in overseas training (Japan/Jordan)	66
8	18/Jan/2012	***Training on Use of GPS*** - Introduction to GPS - Usage of GPS in the field - Download, visualizing and post processing	15 (Operation Level, not C/P)
9	23/Jan/2012	***Training on Understanding of GPS Usage*** - Introduction to GPS - Usage of GPS in the field - Actual Problems faced in the field	7 (Management Level, not C/P)
10	28/Feb/2012	***Seminar on Interim Progress of the Project*** - The progress and findings of the pilot activities - Findings in overseas training (Japan/ Indonesia)	86 (all related staff of NWSDB)
11	29/Jun/2012	***The Field Workshop*** The same as the first field workshop	23
12	15/Oct/2012	***Public Seminar*** - Findings of the pilot activities - Dessemination of Execution Plan	144

*This number of participants excludes JICA experts

2.8 Weekly Meetings

As confirmed in the 1st JCC, the NWSDB convened regular meetings and appointed the chairpersons to be in charge of holding the meetings and prepared the meeting memorandum in English, throughout the Project.

The NWSDB and JET discussed holding the regular meetings for the NRW Reduction Management Team and NRW Reduction Teams in the following manner.

- Initially, concentrate on launching the activities and having the NRW Reduction Teams meet weekly.
- A member of the NRW Reduction Management Team would attend the weekly meetings whenever possible to give timely and appropriate advice.
- Once the activities were underway, many issues would arise requiring management attention. Regular meetings with management would need to be launched around this time.

The 1st Weekly Meeting was held on 22nd January, 2010 and weekly thereafter. The 122nd and final meeting was held on 9th October, 2012.

The NWSDB and JET found that it was more practical to hold the weekly NRW Reduction Team meetings with a member of the NRW Reduction Management Team present, rather than holding separate meetings for the NRW Reduction Management Team. In this way the Management Team was kept up to date with the progress of the activities. Important issues related to the activities of the NRW Reduction Teams were reported and discussed at the management level at the Monthly Meetings with Western Central Senior Management on NRW Reduction Activities. The NWSDB and JET agreed that meetings for the NRW Reduction Management Team would be convened whenever necessary.

2.9 PR Activities

PR activities were conducted to promote awareness of the necessity and the types of NRW reduction activities for the residents in Colombo City and all NWSDB staff. These included hand delivered bills and pens with awareness messages, T-shirts and caps for C/Ps as an uniforms, awareness program at schools, creation of DVD, posters and calendars. Seminars and workshops were organized. The PR activities were decided through discussions at a series of meetings including the JCC and reflected in the Annual Program and the Execution Plan. The following subsections outline the contents of the PR activities.

2.9.1 Major Purpose and Contents of PR Activities

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

- Within NWSDB
  - To motivate staff working on NRW in the pilot areas
  - To disseminate information on the activities to other NWSDB staff who may be engaged in NRW activities in Colombo City
- To the general public
  - To improve the residents' understanding of the Project
  - To reduce unauthorized consumption
  - To educate customers so that they would inform NWSDB of leakages
  - To conserve water at free water outlets

The activities and effects are summarized in Table 2.9-1.

Table 2.9-1 Effects of PR activities

No	Activities	Effect
1	Distribution of handbills and pens	· Promoted interest, drew attention to the Project, improved understanding and obtained cooperation by the customer.
2	DVD	· DVD was prepared and used in schools and other places to explain the importance of NRW activities and how the water supply service would be improved.
3	Student drawn Poster & Calendar	· Posters and calendars in public spaces encouraged customers to save water and reduced potential illegal actions. Preparation of drawings for the posters also improved the students' understanding of the importance of the water supply system.
4	School Activities	· Improved students' understanding. · Students obtained the knowledge of negative impacts of leakage, illegal connections, and wastage. · The students would in turn educate their parents.
5	Caps, T-shirts for NWSDB staff	· Customers can now easily recognize NWSDB workers by their caps and T-shirts thus facilitating their access to work sites and households. · Caps and T-shirts improved the sense of solidarity among NWSDB staffs.
6	Seminars	· Staff were able to share their findings and experiences. · The findings encouraged the staff to continue to engage with the Project

2.9.2 Current PR Activities

The NWSDB is executing similar activities for water conservation. The major activities are as follows.

- School children awareness program
- Work place awareness program
- Print and electronic media communication and publicity
- Posters and hand bill campaign

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

2.9.3 Future PR Activities

Customers are not aware that the police can take action against unauthorized connections and that it is illegal to make changes to their service pipes even for repair purposes. The PR activities would deter unauthorized connections and changes to service pipe arrangements, which are currently being done without hesitation by the customers.

In addition, it is expected that current approach for public relations should be improved, reflecting the following ideas and viewpoints to the existing PR activities.

- Discuss the purpose of PR activities for each action
- Utilize the video prepared by the Project for school children, work place awareness and other programs.
- Improve and utilize handbills, posters and calendars
- Prepare uniforms for field staff
- Prepare a manual for notification of water suspension to the customers

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

2.10 Execution Plan

2.10.1 Results of NRW Reduction Activities in the Pilot Areas

(1) Outline of the Results

The Execution Plan was formulated based on the results of the NRW reduction activities. The result are shown in Table 2.2-3 and Table 2.2-4. It should be noted that the flow measurements of several sub-zones are not available where hydraulic isolation was suspended due to difficulties encountered. Nevertheless, leakage detection was completed in all sub-zones.

(2) Results of Water Balance Analysis

Water balance analysis showed different results according to the nature of the sub-zones. The following subsections outline the results of the analysis obtained through the activities in sub-zones.

(3) Results in Borella and Implication for other Areas with Similar Conditions

Figure 2.10-1 outlines the transitional change of water balance according to NRW reduction activities in Borella, where the pipeline network is relatively new and in better conditions. This information would apply to areas with similar pipeline conditions.

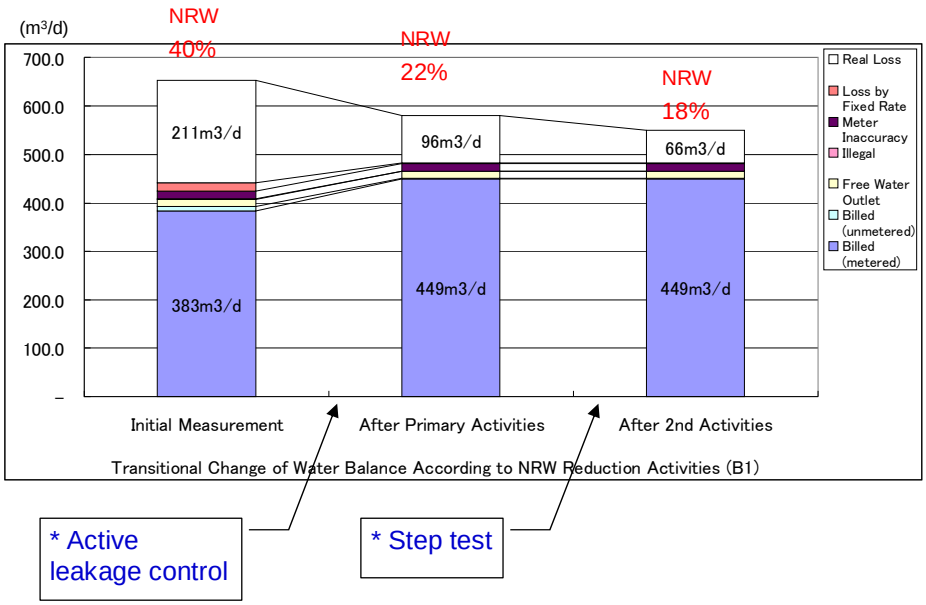


Figure 2.10-1 Transitional Change of NRW Reduction (B1)

The real loss was estimated by subtracting consumption at free water outlets, illegal connections and meter-related errors from the total NRW. The calculations show that the real loss was reduced from 32% to 17%. Other sub-zones in Borella with similar pipeline network conditions demonstrated similar results.

This results suggest that NRW activities focused on leakage detection and repair would contribute significantly to the reduction of NRW in Borella and areas with similar conditions.

(4) Results in Kotahena and Implication for Areas with Similar Conditions

Kotahena is a highly populated area with many (a) old pipes, (b) free water outlets, (c) cases of illegal usage, (d) lengthy bundle service pipes, and (e) buildings constructed above existing pipes.

Figure 2.10-2 outlines the transitional change of water balance as a result of NRW reduction activities in Kotahena, as a representative example of this kind of area.

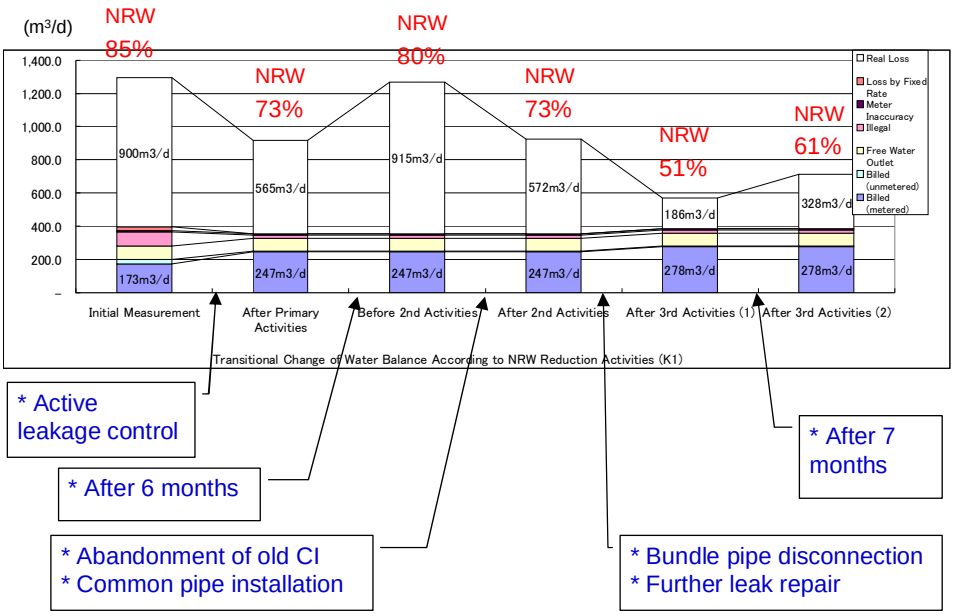


Figure 2.10-2 Transitional Change of NRW Reduction (K1)

NRW was not reduced effectively by the series of NRW reduction activities. Several further trials were conducted, such as, (a) step-testing to narrow down suspicious areas that might be the cause of high NRW; (b) replacing old CI pipes with new PVC pipes, (c) installation of new distribution lines, (d) cutting long house connections, and (e) further leakage detection and repair.

It was concluded that (a) real loss could not be reduced effectively by a series of NRW reduction activities, (b) volume of real loss would return to original levels six months after repair, (c) however, if leakage detection and repair were accompanied by converting bundled service pipes to proper service pipes, the leakage would not return as much to the original level, and (d) although the reduction is not large in terms of percentage, a large amount of water could be saved as a result of NRW reduction activities. Other sub-zones in Kotahena with similar conditions demonstrated similar results.

This result suggested that (a) the solution for this type of areas would be the replacement of old, deteriorated pipes, and (b) while waiting for pipe replacement, leakage detection and repair accompanied by converting lengthy bundled service connections to proper service pipes may help reduce NRW.

2.10.2 Contents of Execution Plan

The NRW Reduction Management Team prepared the Execution Plan, for the purpose of broadening the implementation of NRW reduction activities to the whole city. Following subsections outline the contents of the Execution Plan.

(1) Basic Principles

The basic principles of the Execution Plan are as follows.

- Old & deteriorated pipes must be replaced as soon as possible. Integrating NRW reduction activities to routine operation and maintenance (O&M) is also very important.
- The Execution Plan intends to discuss what the NWSDB can do to reduce NRW while waiting for pipe replacement.
- Activities mentioned in the Execution Plan will be also useful for O&M of the new system.

(2) Components

The Execution Plan consists of two parts: Part A describes the outcomes of the NRW reduction activities in the pilot areas. Part B presents the future plan, which NWSDB could adopt to reduce NRW and apply NRW reduction measures to the entire Colombo City.

(3) Contents of "Part A - Capacity Development Project"

The following subsections outline the key project outcomes and lessons learned.

a) Findings and Lessons in Borella-type Area

- Leakage detection and repair (1st Activities) followed by another round of leakage detection and repair (2nd Activities) after narrowing down problematic and suspicious areas by step-testing contributed to significant reduction of NRW in Borella. This approach is expected to be effective for areas with similar pipeline network conditions.
- The cost and benefits analysis showed that the first round of leakage detection and repair is practical and achievable.

b) Findings and Lessons in Kotahena-type Area

- In Kotahena, leakage detection and repair did not demonstrate significant reduction of NRW. In addition, leakage rebounded to the original level within a short period of time (approximately six months).
- Combination of leakage repair and bundled service pipe rectification demonstrated better results, with moderate rebound of NRW after repairs.
- The ultimate solution would be replacement of old and deteriorated pipes in these kind of areas. A combination of leakage detection and repair and bundled service pipe rectification would be a promising way to reduce NRW while waiting for pipe replacement.

c) Manual for Service Connections

- A manual for service connections (bundled service pipe rectification) was prepared.
- This manual recommends that (i) long distance service pipes be cut immediately after branched position from the distribution main, (ii) the destined house be verified when a line of the lengthy bundled service pipes are stopped and cut, (iii) these actions be properly documented, and (iv) pressure tests be conducted after the connections were made.

(4) Contents of "Part B - Execution Plan"

- Some executives in the NWSDB supported the opinion that (i) routine O&M would not reduce NRW significantly even with a lot of time and manpower, (ii) therefore, the NWSDB should wait for pipe replacement under ADB.
- To counter this thinking, the Execution Plan emphasizes (i) the importance of NRW reduction activities under routine O&M while waiting for pipe replacement, (ii) the proposals presented in the Execution Plan would also be useful for O&M of the new pipeline networks after pipe replacement. The following subsections outline the recommendations for each measure for NRW reduction.

a) Consumption at Free Water Outlets

- Consumption at free water outlets, which was generally much smaller than real loss volume, could become too large to ignore after real loss comes down.
- The Execution Plan recommends that the NWSDB continue to convert free water outlets to individual connections (Randiya Project) and seek a way to collect bills from free water outlet's users.

b) Illegal Connections

- The NWSDB investigated illegal connections on a random basis.
- The Execution Plan recommends that an illegal connection survey be conducted in planned manner (e.g., users suspected of illegal connections be identified using existing available information such as, billing record, record of previous offense, distance from the nearest free water outlets, present contract status (disconnected or not)).

c) Metering Errors

- The Execution Plan recommends that the NWSDB issue higher estimated bills over a three month period and then settle the balance when the actual meter readings are done later. By this practice the users may be more cooperative in providing access for meter reading.
- The Execution Plan also emphasizes the importance of strengthening the discipline of meter readers.

d) Real Loss

- Real loss is the main component to be tackled in the reduction of NRW.
- The Execution Plan recommends that leakage detection and repair be repeated twice, because the system pressure would be increased as a result of the first round of leak repairs. Leakage detection at individual houses may be skipped in the second round.
- The Execution Plan recommends using polyethylene pipes (PEP) for service connections, to make it more difficult to modify pipe arrangements without special tools. This should prevent tampering or illegal connections by users.
- The Execution Plan highlights the importance of not only leakage, but also overflows at apartment building tanks.
- The Execution Plan also mentions the necessity of a record keeping system for reports of leakage and records of repairs, so that the executives of the NWSDB may be able to monitor the NRW status.

e) Cost and Benefits for Leakage Detection and Repair

At the final stage of the Project, the NRW Reduction Management Team formulated the Execution Plan, for the purpose of broadening the NRW reduction activities to the other areas in Colombo City. The Execution Plan discusses the following:

- Old and deteriorated pipes must be replaced as soon as possible. It will take many years to replace all the old pipes.
- What the NWSDB can do to reduce NRW while waiting for pipe replacement.
- The activities mentioned in the Execution Plan will be also useful for O&M for the new system.

The cost exceeds the benefits for Kotahena and areas with similar conditions. If leakage detection and repair activities could be conducted together with replacement of lengthy bundled service pipes in an appropriate manner, more benefits could be obtained because there would be more leakage reduction and the leakage would likely not return to the same level after repair.

Cost required for leakage detection and repairs and the resulting benefits were calculated and compared. Table 2.10-1 summarizes the results of the analysis.

Table 2.10-1 Cost versus Benefit for Leakage Detection and Repair

	Cost (yen)	Benefit (Yen)				
		Saved Real Loss per 5,000 Connections		Unit Rate for Water (Yen/m3)	Benefit per 5000 Connections (Yen)	Benefit in Entire Colombo (Yen)
		m3/d Initial	m3/y Compensated			
Borella-similar Area	26 million	1,886	311,191	14.7312	4.6 million	50 million
Kotahena-similar Area	80 million	4,861	802,141	14.7312	11.8 million	130 million
Total	**106 million**					**180 million**

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

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

The following conditions and assumptions were employed in this calculation.

- Work to be done:
  For Borella and areas with similar conditions: only leakage detection and repair.
  For Kotahena and areas with similar conditions: leakage detection and repair plus lengthy bundled service pipe cutting and converting to proper service pipe.
- Two rounds of leakage detection and repair
- Number of leaks to be repaired and required work volume: based on the result obtained through activities in the PAs.
- Unit cost for labor and materials: referred to "NWSDB Rate Book (2011)" and interviews with NWSDB staff.
- Unit rate for water lost: based on information given by the NWSDB for cost versus benefits calculation.
- Rebound rate of leakage: 10 %
- Cost for rectification of bundled service pipes: assumed to be approximately 46 million. This value is based on assumptions made by NWSDB which could not be substantiated by JET.
- The number of Borella- and Kotahena-type areas in the entire Colombo City: 11 zones each (5,000 connections per one zone). Colombo City is divided into 22 zone officer's areas.

The analysis for cost versus benefits for leakage detection and repair for the entire Colombo City demonstrates that:

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

According to the analysis, the benefits for leakage detection and repair more than justify the cost. Although this calculation is based on many assumptions, implementing leakage detection and repair would significantly reduce NRW in Colombo City.

f) GIS

- The ADB is interested in supporting the NWSDB to enhance its GIS database. However, the ADB intends to deal with rather the larger diameter pipes for hydraulic analysis purpose.
- The Execution Plan prefers to enhance the GIS database for the purpose of O&M, by incorporating customer data into the existing database.
- Through OJT on GIS, it was noted that identifying the positions of all the houses in a sub-zone by GPS required huge amount of time and manpower. Therefore, the Execution Plan proposes a simpler and more practical approach (only key locations would be picked up by GPS and other positions would be sketched schematically).
- Base map creation requires a one time input of fairly huge magnitude. Therefore, the Execution Plan suggests that it would be more practical and effective for NWSDB to out-source the work to a contractor.

g) PR Activities

On the whole, the NWSDB may keep on what it is undertaking and reinforce the on-going activities, as mentioned in "2.9.3 Future PR Activities".

h) Organizational Improvement

The Execution Plan states the minimum necessary staff for implementing the activities recommended in the Plan.

i) Action Plan

Scheduling for the action plan shown in the Execution Plan takes validity of loan period into account.

j) Evaluation and Monitoring

- Without hydraulic isolation, it is impossible to quantify the effects of NRW reduction activities.
- The Execution Plan suggests that the NWSDB may verify the effect of NRW reduction activities on a larger scale, by measuring inflow volume entering into Colombo City after conducting NRW reduction activities and compare it with revenue water of the entire city.

k) Others

- The Project found that there were many cases of leakage, illegal connections and unidentified PVC pipelines to houses. The Execution Plan recommends that not only cast iron pipes, but also PVC be replaced. If it is difficult to replace all the pipes due to budget limitations, however at least the pipelines and valves at the boundary of the sub-zones should be replaced.
- The Execution Plan notes the necessity of establishing a certification system for contractors conducting service pipe connections.
- The Execution Plan also mentions that the revision of the current Water Act would provide

more power to the NWSDB so that it can take punitive actions against illegal users.

(5) Current Status of the Execution Plan in NWSDB

At the 7th JCC, the executives of the NWSDB agreed to remove the word "draft" from the proposed Execution Plan. The Execution Plan has the support of the GM but has yet to be formally adopted by the NWSDB.

2.11 Plans and Manuals Prepared under the Project

Plans and documents prepared under the Project activities are available in the following Annexes.

Annex 1: Annual Program
Annex 2: Work Plan
Annex 3: Training Material
Annex 4: Manual for Bundle Pipe Replacement
Annex 5: Manual for Operation Methods of Leak Detection Equipment
Annex 6: Execution Plan

Chapter 3 GENERAL SCHEDULE

Figure 2.10-1 shows the general schedule of the Project.

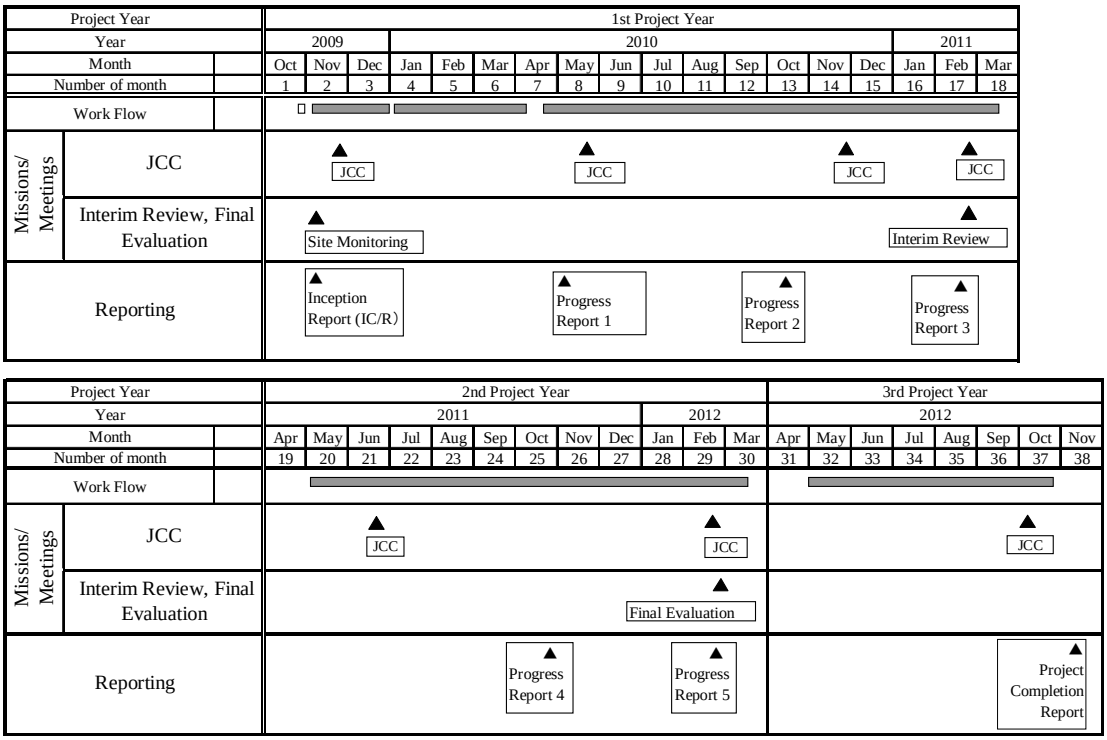
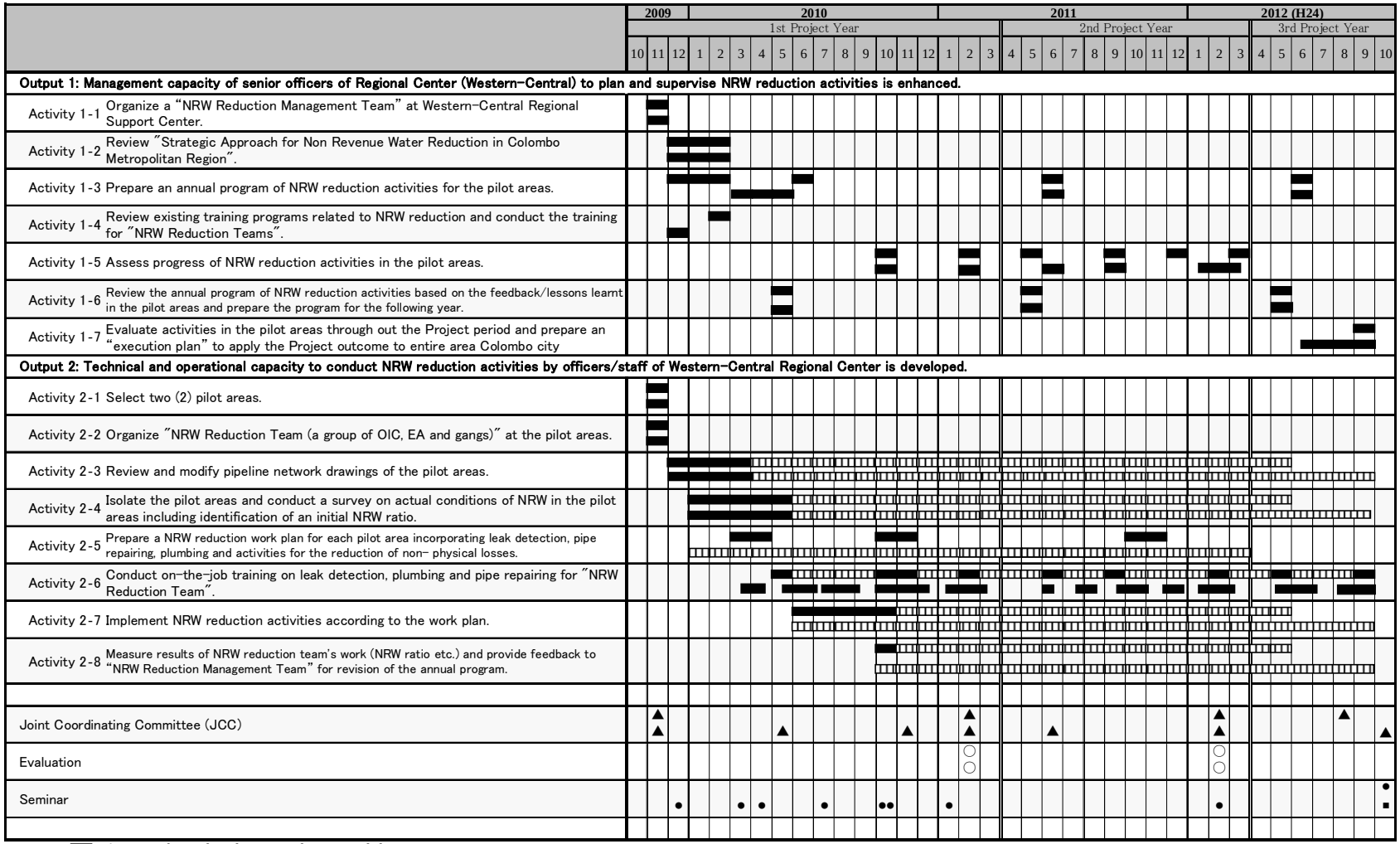


Figure 2.10-1 General Schedule of the Project

The Project activities were carried out according to the above schedule and as shown in the Plan of Operation (PO) presented in Figure 2.10-2.



Remark ▭ Activity to be conducted continuously or as needed

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

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

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

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

*****: Bars/symbols on top: Planned, Bars/symbols on bottom: Actual progress

Figure 2.10-2 Plan of Operation

Chapter 4 INPUTS TO THE PROJECT

4.1 Input of Japanese Experts

Table 4.1-1 outlines record of input for Japanese experts.

Table 4.1-1 Record of Input for Japanese Experts

No	*Position*	*Name*	*Main Task*	*Breakdown of Input*				
				Work in:	*Project Year*			*Total*
					1st	*2nd*	*3rd*	
1	Chief Advisor /NRW reduction programming	Shinkichi KOBAYASHI	- Supervision of all aspects of the Project's activities - Assistance with the preparation of the Execution Plan	Sri Lanka	10.20	5.80	4.20	20.20
				Japan	0.50	0.30	0.80	1.60
2	Deputy Chief Advisor / NRW reduction monitoring and evaluation	Tetsuji KAWAMURA	- Monitoring of NRW reduction activities in the PA - Assistance with water balance analysis	Sri Lanka	6.80	3.60	3.90	14.30
				Japan	0.30	0.10	0.20	0.60
3	Leak detection Advisor	Akihiko OKAZAKI	- Assistance with the procurement of equipment for leak detection Training on leak detection technology	Sri Lanka	5.90	4.53	4.50	14.93
				Japan	0.30	0.10	0.10	0.50
4	Arrangement of pipeline drawings and customer data	Hiroki NIIMURA	- Assistance with the preparation and organization of pipeline network drawings and customer data. - Training on leak detection technology	Sri Lanka	6.80	1.47	1.00	9.27
				Japan	0.00	0.00	0.00	0.00
5	Service pipe connection advisor	Hiroshi YOSHIUCHI / Masami OGURA	- Training on service pipe connection and assistance with the preparion of operation manual - Training on leak repair and assistance with the preparation of operation manual	Sri Lanka	2.40	2.00	2.00	6.40
				Japan	0.00	0.00	0.00	0.00
6	Coordinator	Naoto TAKATOI / Toru AOKI	- Assistance with all aspects of the Project activities - Assistance with PR activites - Assistance with organizing seminars and workshops	Sri Lanka	2.80	2.00	2.00	6.80
				Japan	0.00	0.00	0.00	0.00

Figure 4.1-1 shows the assignment schedule for Japanese experts

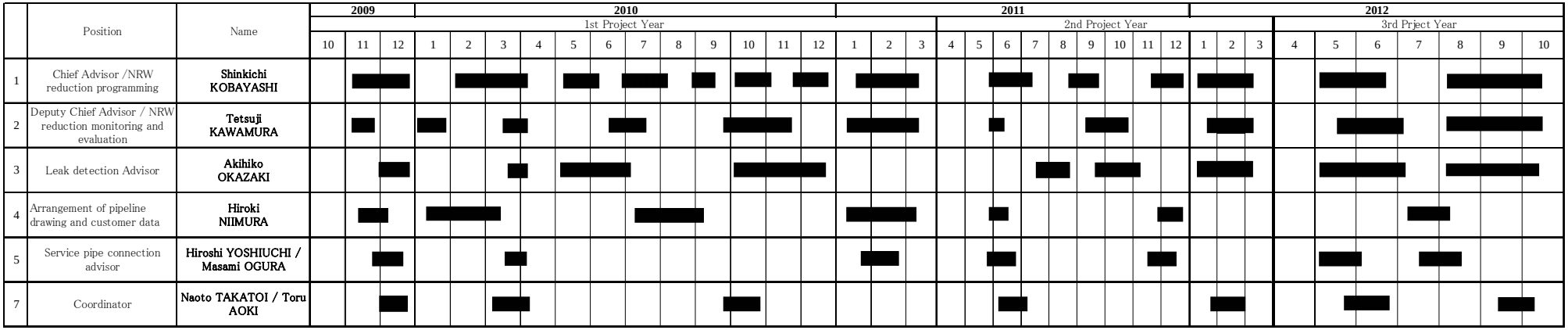


Figure 4.1-1 Assignment Schedule for Japanese Experts

4.2 Training Program in Japan

4.2.1 Training in Japan in the 1st Project Year

As a part of the Project activities, overseas training was conducted in Japan, as shown in Table 4.2-1.

Table 4.2-1 Outline of Counterpart Training in Japan

Program Title	Counterpart Training under the Capacity Development Project for Non-Revenue Water Reduction in Colombo City
Duration	8th to 16th September, 2010
Target	NRW Reduction Management Team
Purpose	Study historical transition of NRW reduction measures, billing collection and PR activities related to NRW reduction in Japan
Trainees' Name & Position	S.A.Rasheed, AGM (O&M, Wsetern Central) H.T.R. Wijesooriya, AGM (Rural Water Supply) K.Premakumara, Chief Engineer (Illegal Connection, Western Central) R.A.N.Dharmasiri, Manager (O&M, Colomobo City North East) K.L. Chandrasiri, Chief Engineer (Construction, North Central)

Detailed schedule and contents of the training are specified in Table 4.2-2.

Prior to the training, the trainees prepared the presentation materials to explain the activities and progress of the Project to the Japanese side. On completion of the training, the trainees summarized the findings and outcomes as an output of the training.

Table 4.2-2 Schedule & Contents of Training in Japan

Day	Date		Time	Schedule	Place	Organization	Study Contents
1	8-Sep-10	Wed	-	Departure from Colombo / Arrival at Tokyo	Tokyo	-	-
2	9-Sep-10	Thu	9:00 - 12:00	JICA Briefing	Tokyo	JICA TIC JICA HQ	-
			14:00 - 15:00	Report on Project Progress to JICA			-
5	10-Sep-10	Fri	9:30 - 11:30	Lecture on history of water supply system development and on strategy of future development in Tokyo	Tokyo	Japan Waterworks Association (JWWA)	After the World War II, how water supply system have developed in Tokyo What kind of problems Tokyo waterworks encountered and how they solved the problems Policies and development strategies for future water supply development
			13:30 - 16:30	Lecture on NRW Reduction Measures	Tokyo	Tokyo Metropolitan Waterworks Bureau	Lecture and discussion at Tokyo Metropolitan Waterworks Bureau Development and Current Practices of Water Loss Management and Evaluation Methods
3	11-Sep-10	Sat	-	-	Tokyo	-	-
4	12-Sep-10	Sun	-	-	Tokyo	-	-
6	13-Sep-10	Mon	10:00 - 12:00	Lecture on Commercial Activities for NRW reduction in Japan	Tokyo	Nihon Suido Consultants (NSC)	Lecture and discussion at Nihon Suido Consultantas (NSC) Development and Current Practices of Commercial Activities
			14:00 - 15:00	Water Supply Operation Center of Tokyo Metropolitan Waterworks Bureau	Tokyo	Tokyo Metropolitan Waterworks Bureau	Importance of integrated controling/monitering water conveyance system
			15:00 - 16:00	Water History Museum	Tokyo	Tokyo Metropolitan Waterworks Bureau	History of water supply in Japan
7	14-Sep-10	Tue	10:00 - 12:00	PR activities by waterworks bureau	Tokyo	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	Nihon Suido Consultants (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 develop
8	15-Sep-10	Wed	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
9	16-Sep-10	Thu	-	Departure from Tokyo / Arrival at Colombo	-	-	-

4.2.2 Training in Japan in the 2nd Project Year

As a part of the Project activities, overseas training was conducted in Japan, as shown in Table 4.2-1.

Table 4.2-3 Outline of Counterpart Training in Japan

Program Title	Counterpart Training under the Capacity Development Project for Non-Revenue Water Reduction in Colombo City
Duration	3rd to 11th 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 4.2-2. On completion of the training, the trainees summarized their findings and outcome as an output of the training.

Table 4.2-4 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	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 controling/monitoring water conveyance system
			14:00 - 16:30	Lecture on NRW Reduction Measures	Tokyo	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	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	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	-	-	-

4.3 Technical Exchange Program in the Third Countries

4.3.1 Program in Jordan in the 1st Project Year

As a part of the Project activities, overseas training was conducted in Japan, as shown in Table 4.3-1.

Table 4.3-1 Outline of Counterpart Training in Jordan

Program Title	Technique Exchange Program between NRW Reduction Team and Water Authority of Jordan (WAJ)
Duration	9th to 20th October, 2010
Target	NRW Reduction Team
Purpose	Exchange the ideas with capacity developments projects in Jordan on NRW reduction activities
Trainees' Name & Position	Mr. W.A.W.T Wickramarachchi, Senior Commercial Officer, Mattakuliya Area Engineer Office Mr. M.B.Thilakaratne, Engineer, Manager (CC-O&M-North East) Mr. R.A.Kumaranayake, Engineering Assistant, Manager (CC-O&M-North East) Mr. J.A.W.W.K Jayashinghe, Engineering Assistant, Kotahena Office Mr. F.D.K Karunarathna, Engineering Assistant, NRW Section Mr. K Premalal Silva, Engineering Assistant, NRW Section

Detailed schedule and contents of the training are specified in Table 4.3-2.

Table 4.3-2 Schedule & Contents of Training in Jordan

Date		*Time*	*Venue*	*Lecturer*	*Japanese Expert for NWSDB*	*Japanese Experts for WAJ*	*Mode of Training*	*Subject*
Oct. 9	Sat	Arrival						
Oct. 10	Sun	10:00	JICA Office	Mr. Okamoto, Mr. Hani Ms. Okumura	Kobayashi	-		Courtesy call, Orientation
		11:00	WAJ HQ	Eng. Hanan, Eng. Sukkar	Kobayashi	Yokota, Thapa		Welcome & Opening
		11:30	WAJ HQ	Eng. Sukkar	Kobayashi	Yokota, Thapa	Lecture	NRW in Jordan & JICA NRW Project
		12:30	WAJ HQ	Srilankan Engineer	Kobayashi	Yokota, Thapa		NRW in Sri Lanka
		13:30	WAJ HQ	Eng. Sukkar	Kobayashi	Yokota, Thapa	Discussion	NRW Countermeasures
Oct. 11	Mon	9:00	Marka T.C.	Eng. Saeed (Salt)	Kobayashi	Thapa	Lecture	District Metering and Various NRW Countermeasures (Experience of Phase 1 Project)
		10:00	Marka T.C.	Eng. Jamal (Fuhais)	Kobayashi	Thapa	Lecture	Pressure Control for NRW Reduction (Challenge of Phase 2 Project)
		11:00	Marka T.C.	Eng. Sukkar	Kobayashi	Thapa/Suzuki	Lecture/Practice	NRW Reduction Activities
Oct. 12	Tue	9:00 ～ 14:00	Marka T.C.	Eng. Firas Mr. Mustafa	Kobayashi	Sugawara, Sakamoto	Lecture/Practice	Service Connection Installation (HDPE Pipe)
Oct. 13	Wed	9:30	Salt	Eng. Saeed	Kobayashi	Thapa	Site Visit	Visit Balqa Office GIS Section, Al-Salalim Pilot Area
		12:00	Fuhais	Eng. M. Juma, Eng. Jamal	Kobayashi	Thapa	Site Visit	Pilot Area
Oct. 14	Thu	11:00	Tafilah	Eng. Mustafa	Kobayashi	Yokota	Site Visit	Pilot Area
Oct. 15	Fri	holiday	-	-		-	-	-
Oct. 16	Sat	holiday	-	-		-	-	-
Oct. 17	Sun	9:00	Zarqa	Eng. Qassam	Kobayashi	Thapa	Site Visit	GIS for Network Information and Cutomer Complaint Management
		12:00	WAJ HQ	Mr. Munir Oweis (Secretary General)	Kobayashi	Yokota		Courtesy call
		12:30	WAJ HQ	Eng. Sukkar	Kobayashi	Yokota, Thapa	Discussion	NRW Reduction Activities
Oct. 18	Mon	9:00	Zai WTP	Eng. Hayatham Kilani	Kobayashi	Yokota	Site Visit	Water Treatment Plant
		13:00	JICA Office	Mr. Okamoto, Mr. Hani Ms. Okumura	Kobayashi	-	Discussion	Reporting & Evaluation
Oct. 19	Tue	Leaving						

Prior to the training, the trainees prepared the presentation materials to explain the activities and progress of the Project to the Japanese side. On completion of the training, the trainees summarized the findings and outcomes as an output of the training.

4.3.2 Training in Indonesia in the 2nd Project Year

Overseas training was conducted in Indonesia in the 2nd Project year, as shown in Table 4.3-1. The visit to the Metropolitan Waterworks Authority (MWA) in Bangkok, Thailand was cancelled due to prolonged flooding in the area at that time.

Table 4.3-3 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	5th to 16th December, 2011
Target	NRW Reduction Team
Purpose	Exchange ideas on NRW reduction activities with capacity development projects in Indonesia
Trainees' Name & Position	• Heenkenda Thushantha Bandara Senior Engineer, Priority Section, Western - Central, NWSDB • Dewasurendra Jayantha Senior Commercial Officer, Area Engineer's Office (Colombo - South), Western - Central, NWSDB • Fonseka Alias Fernando Hettiyakandage Shanti Chandanie Samanmalie Engineer Assistant (Special), Area Engineer's Office (Colombo - West), Western - Central, NWSDB • Kalumarakkala Jayasiri Engineer Assistant (Special), RSC (WC), Western - Central, NWSDB • Gunawardhena Hettipathirannehelage Wasantha Engineer Assistant (Special), Officer in Charge, Maligawatte, Western - Central, NWSDB • Perera Illeperuma Arachchige Karunasiri Engineer Assistant II, Officer in Charge, Soyasapura, Western - South, NWSDB

Detailed schedule and contents of the training are specified in Table 4.3-2.

Table 4.3-4 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	- Courtesy call to Head of Department of Spatial Planning and Settlement	Makassar
		PDAM Makassar	- Briefing by PDAM on Project Activities - Discussion with NRW Reduction Committee - Site Visit (with leak survey equipments)	
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	- NRW Comprehension Test (at DPU)	Makassar
		JICA MFO	- Preparation of Presentation Material for Summarizing Training (at Meeting Room of MFO)	
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 Activitie * 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

Prior to the training, the trainees prepared the presentation materials to explain the activities and progress of the Project to the Japanese side. On completion of the training, the trainees summarized the findings and outcomes as an output of the training.

4.4 Procured Equipment

The equipment procured for this project is shown in Table 4.4-1.

Table 4.4-1 List of procured equipment

Equipment	Qty	unit	Date of arrival	Date of acceptance	Stored/Installed /Used by	Condition of Usage etc
Correlation Leak Detector	2	pieces	30-Mar-10	31-Mar-12	NRW section	Effectively in use for Leak detection for pipelines at greater depth under high noise level circumstances.
Electronic Leak Detector	5	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use fo Picking up sound of leak noise that travels across soil.
Pipe Detector (Non-Metal)	3	pieces	30-Mar-10	31-Mar-12	NRW section	Used for Detecting buried non-metal pipe.
Data Logger with Pressure Inducer	8	pieces	30-Mar-10	31-Mar-12	NRW section	Used for Measuring water pressure in a sub-zone.
Acoustic Rod - Digital Type	5	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for Picking up sound of leak noise with amplifier.
Pipe Detector (Metal)	4	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for Detecting buried metal pipe.
Laptop Computer	2	sets	30-Mar-10	31-Mar-12	NRW section	Effectively in use for Data analysis for flow and pressure measurement.
Listening Stick	6	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for Picking up sound of leak noise.
Boring Bar	2	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for boring road surface to confirm location of leakage.
Drill Bit	30	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for boring road surface to confirm location of leakage.
Hammer Drill	2	pieces	30-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use for boring road surface to confirm location of leakage.
Pressure Gauge for House Connection	6	pieces	30-Mar-10	31-Mar-12	NRW section	Effectively in use for Measuring water pressure at a water tap in a sub-zone.
Portable Ultrasonic Flowmeter	2	pieces	30-Mar-10	31-Mar-12	NRW section	Effectively in use for Measuring flow in a sub-zone.
Portable Ultrasonic Flowmeter	8	pieces	30-Mar-10	31-Mar-12	NRW section	Effectively in use for Measuring flow in a sub-zone.
DC12V Cable for Ultrasonic Flowmeter	8	pieces	5-Oct-10	5-Oct-10	NRW section	Effectively in use for car battery for ultrasonic flowmeter
Generator	2	sets	12-May-12	12-May-12	OIC Borella/Kotahena	Effectively in use to drive hammer drill.
Valves (φ100-200mm)	60	pieces	26-Mar-10	31-Mar-12	Sites Borella/Kotahena	Used for isolation of pilot areas
Plastic customer meter assembly	200	pieces	30-Mar-10	31-Mar-12	Sites Borella/Kotahena	Used for measurement of water consumption by customer
Crew CABs (Double cabin trucks)	2	sets	26-Mar-10	31-Mar-12	NRW section	Effectively in use to convey tools and equipment together with workforce
Pickup trucks	2	sets	23-Apr-10	23-Apr-10	NRW section	Effectively in use to convey tools and equipment together with workforce
Micro excavators	2	sets	30-Apr-10	30-Apr-10	Maligakanda Office	Effectively in use to excavate soil for installation of valves and pipes
Metal locator (Valve locator)	5	pieces	16-Mar-10	31-Mar-12	OIC Borella/Kotahena	Effectively in use to find out buried valves
Projector	1	piece	30-Mar-10	31-Mar-12	NRW section	Effectively in use for presentation during discussion
High Accuracy Hand-held GPS	2	set	16-Sep-11	16-Sep-11	Maligakanda Office	Effectively in use in field work for GIS activity
Desktop PC	6	sets	6-Sep-11	6-Sep-11	Maligakanda Office, OIC Borella/Kotahena	Effectively in use to utilize GIS softwares
External HDD	6	pieces	6-Sep-11	6-Sep-11		Effectively in use to file GIS data
UPS	6	pieces	6-Sep-11	6-Sep-11		Effectively in use to make ready for electric power failure
MS Office	6	sets	2-Oct-11	2-Oct-11		Effectively in use to utilize MS Office soft ware
Virus Protection	6	sets	2-Oct-11	2-Oct-11		Effectively in use to guard PC from Virus
A3 Printer	4	sets	6-Sep-11	6-Sep-11		Effectively in use to print out documents and drawing
A4 Scanner	1	set	6-Sep-11	6-Sep-11	Maligakanda Office	Effectively in use to scan documents and drawing
Plotter (A0)	1	set	6-Sep-11	6-Sep-11	Maligakanda Office	Effectively in use to print out drawing of A0 size
GIS Software-1 (Arc View 10)	2	sets	16-Sep-11	16-Sep-11	Maligakanda Office	Effectively in use for GIS acttivity (Ex. To update pipeline location)
GIS Software-2 (AutoCAD Map 3D 2011)	4	sets	20-Sep-11	20-Sep-11	OIC Borella/Kotahena	Effectively in use for GIS acttivity (Ex. To update pipeline location)
Satellite Image	1	set	26-Sep-11	26-Sep-11	Maligakanda Office	Effectively in use as basemap in GIS softwares

4.5 Project Expenditures

Expenditures for this Project are summarized in Table 4.5-1.

Table 4.5-1 Expenditure for the Project

Item	*Expense (in Japanese Yen)*		
	1st Project Year	*2nd Project Year*	*3rd Project Year*
Personnel emplyment	3,958,138	3,039,629	2,579,861
Repair & maintenance of equipment	0	0	0
Consumable	22,370	9,172	13,945
Transport expenses	336,072	610,008	0
Communication & delivery	12,851	8,416	86,984
Preparation of training material	17,939	450,241	333,992
Lease	2,219,860	1,313,634	1,228,850
Electricity & Water	0	0	0
Staff training	0	0	0
Operation & maintenance	0	0	0
Training in Sri Lanka	693,380	918,025	202,190
Activities in Japan	0	0	0
Sub contract in Japan	0	0	0
Miscellaneous	0	0	0
Total	7,260,610	6,349,125	4,445,822
Total (after rounding down to the nearest 1,000)	***7,260,000***	***6,349,000***	***4,445,000****

**) Expenditure in 3rd Project Year is the tentative one as of Nov/2012*

The Project was executed without “Sub-contract”.

Chapter 5 FINDINGS AND LESSONS LEARNED

This chapter discusses the findings and lessons learned throughout the Project activities.

5.1 Training Program in Japan and Other Countries

5.1.1 Training in Japan

As described in Section 4.2, ten management level staff of the NWSDB were dispatched to Japan for training on advance technologies and systems related to NRW reduction. The training was conducted twice in the 1st and 2nd Project Year. The program covered: i) NRW activities after World War II, ii) leakage detection and meter reading and iii) customer relations and PR activities. The participants were trained on the knowledge and skills required for NRW reduction, including the preparation of the Execution Plan and establishment of a call center. They were shown advanced facilities and high level of discipline at the work place, which they can envision for their future work environment. These experiences were later shared with other NWSDB staff at seminars.

It took much longer time than expected to arrange the overseas training program. It took a long time for the NWSDB to nominate the trainees to be dispatched. The initial nominations included members who were not directly involved with the Project activities. JET and JICA Sri Lanka Office had to explain the purpose of the training program a number of times to the executives of the NWSDB and urged them to reconsider the selections. The NWSDB's internal rules and policies on training overseas may not allow the project level officials to nominate trainees. It is preferable that there should be clear consent with C/P side on purpose of overseas training and eligibility of trainees to be dispatched.

5.1.2 Technical Exchange Program in Other Countries

JICA is executing similar capacity development projects in other countries. In order to share experience and ideas with these projects, twelve members of the NRW Reduction Teams and other site officers were dispatched to Jordan in the 1st project year and to Indonesia in the 2nd project year as described in Section 4.3. The participants observed the activities in these countries, presented an outline of the activities in Sri Lanka and had fruitful discussions. On their return, they shared what they learned with other staff of the NWSDB and contributed to the improvement of the NRW reduction activities, such as the use of GIS database and public relations. They confirmed the validity and value of what they were undertaking in NRW reduction and appreciated that other countries also face the same challenges.

At the time of the Technical Exchange Program in the 1st Project Year, the NRW Reduction Teams were having difficulties with the hydraulic isolation attempts and might be losing some confidence in their ability to successfully achieve NRW reduction in the PAs. Their discussions with the Jordanian staff, demonstrated that the Jordanians were also taking similar approaches to tackle high NRW and they could understand the similarities and differences between the NRW activities being undertaken in both countries (e.g., differences of weather, geographical characteristics, system pressure, complexity of pipeline networks). They also understood how difficult it was to work with old and complex pipeline networks in Colombo City.

On the occasion of the Technical Exchange Program in the 2nd Project Year in Indonesia, the C/Ps further reinforced their confidence in the Project. They could see what they were achieving success even though they were working under more challenging conditions than their Indonesian colleagues. They were also more convinced of the importance and usefulness of PR and GIS database after seeing these activities being conducted in the Indonesian project.

The Technical Exchange Program in other countries energized and inspired the C/Ps and they became more active and positive in their engagement in the Project's activities.

5.2 Progress Monitoring at Weekly Meeting

The NRW Reduction Teams, Management Team and JICA experts met every week to discuss the work progress, conditions of the sites, difficulties and obstacles encountered, solutions to the problems and how to improve the meeting discussions (e.g. by projecting the required information on the walls). At the earlier meetings, JICA experts offered suggestions on what could be done to deal with problems. As the Project progressed, the C/Ps began to be more involved in discussing the problems and were finding the solutions on their own. Management and field officers exchanged ideas and improved their understanding of the situations and difficulties each side faced.. Field officers of the NRW Reduction Teams, who tended to follow instructions and were not able to carry on their work when unexpected conditions arose, started to adjust their activities on their own to deal with the changing conditions.

The NRW Reduction Teams and Management Team appreciated the weekly meetings and obviously benefited from the exchanges.

5.3 Hydraulic Isolation

Hydraulic isolation is necessary in order to measure the effects of the NRW reduction activities. A lot more time than envisioned was spent on this task because the information of some pipes and valves were not available. Nevertheless it was found that NRW can be reduced to a certain level in the PA without full isolation. Some of the sample areas, which were easier to isolate, were selected and NRW was measured before and after the activities to evaluate the effects.

5.4 NRW Reduction Methods for Colombo City

The Execution Plan describes the effective methods for NRW reduction in Colombo City, as established through the Project activities.

The effect of the NRW reduction activities in a designated area is usually judged by isolating it hydraulically and measuring its system inflow before and after the activities. It is, however, not practical to conduct hydraulic isolation as part of O&M in Colombo City due to the complex layout of the pipeline networks, as well as the many unknown locations of some pipes and valves. The network conditions should be improved after pipe replacement by creating district metering areas (DMA) to make the system easier to monitor.

Therefore, while waiting for future network improvement, the NWSDB may focus on what is recommended in the Execution Plan to gain immediate NRW reduction benefits in Colombo City.

As it is very difficult to monitor the effect of NRW reduction activities by sub-zone under the present pipeline network conditions, the following methodologies were recommended, such as (i) measure total inflow volume entering into Colombo City, as the measuring system is already in place, (ii) estimate the reduction in water loss based on the leaks that were repaired, and (iii) monitor the improvement in transitional change of pressure.

According to the results of the activities in the PAs, leakage contributed to high NRW both in Kotahena and Borella. The findings also indicate that the following can be useful for effective NRW reduction, (i) conduct 2 rounds of leakage detection and repair, (ii) establish a sound system to record reported and repaired leaks to facilitate timely action, (iii) rectify any lengthy bundled service pipes, and (iv) monitor losses in storage tanks (sumps). In addition, it was found that measures against over consumption at free water outlet, illegal connections and maintaining discipline of meter readers by education programs were also important.

Details of the above recommendations are available in the Execution Plan. The following subsections outline the essence of these recommendations.

In addition, an outline of the results of the cost benefits analysis of leakage detection and repair without hydraulic analysis is available in "2.10.2 Contents of Execution Plan".

5.4.1 Leak Detection Methods

The largest component of NRW in the PA was leakage. Hence, leakage detection and repair is one of the most important activities in Colombo city in addition to pipe replacement. It would be useful to execute these activities in a systematic manner as shown in Figure 5.4-1.

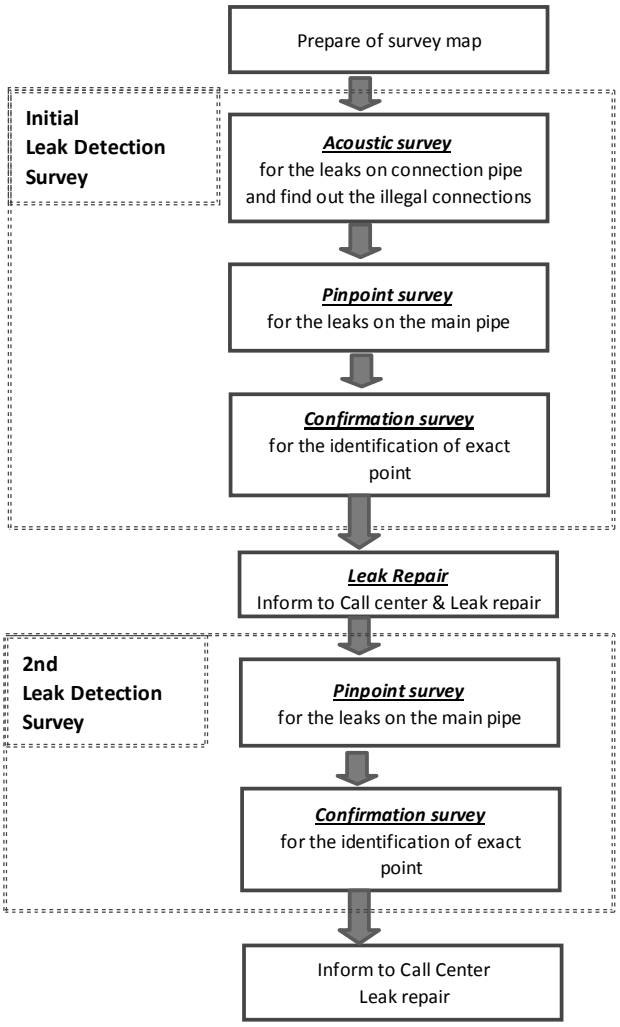


Figure 5.4-1 Work Flow of Leak Detection

As a start, leaks around all customer meters (service pipes) would be detected by acoustic survey. Next, leaks along all distribution pipelines would be detected at night. Finally all the detected leakage points would be confirmed by making small holes on the road surface. This would reduce the excavation area required for leakage repair. The leakage points found in these activities would be repaired properly and quickly.

Several leaks were found after repairs were made in the PA since there were lots of weak points such as inadequate joints. Therefore a 2nd round of detection activities would be necessary. At this stage, acoustic survey would not be done in order to minimize the required input.

5.4.2 Lengthy Bundled Service Pipes (Bundle Pipes)

In Kotahena and similar areas with poor water supply conditions, the reduction of real loss after leakage detection and repair was found to be small. Leakage detection and repair in combination with replacement of lengthy bundled service pipes was found to be more effective. Bundled service pipe replacement costs less than distribution pipe replacement. Before the project the NWSDB was conducting replacement of these pipes. However, improvements have to be made in several aspects,

such as to stop water flow to the abandoned bundled service pipes, to do pressures test on the new pipes and to record the new connections. A manual, which includes standard drawings and a record sheets, was prepared as part of a proposed method for bundled service pipe replacement.

5.4.3 Storage Tanks (Sumps) before Customer Meters

A large amount of water is lost in the PA from storage tanks (sumps) before the water supply reaches the customer meters. This was especially serious in old government owned housing schemes and public compounds. The NWSDB is not the owner of these tanks which made it complicated to conduct leakage detection and repair. A comprehensive list of these tanks has to be compiled, followed by a survey to document the location, capacity, condition of the water meter, and if there is any leakage and overflow. Then, meters would be installed at all the inlet pipes. The inflow volume would be compared with consumption of all the customers.

5.4.4 Quick Attendance to Leakage

It is important that the O&M Section should attend quickly to any leakage after they are detected and reported. However, leakage repair was sometimes delayed in the PA due to the shortage of heavy transport vehicles or because of budget constraints. Some customers repaired the leaks by themselves in order to increase water supply pressure. Leakage repair by customers did not always work and leakage would recur and could also lead to illegal water usage.

Monitoring of timely leakage repair could be done more easily during the Project activities, than after Project completion. The Teams discussed and made recommendations in the Execution Plan on improving the monitoring system. The recommendations included: informing the call center of detected leakages so that the information can be shared with management, issuing leakage repair order sheets, reporting result of repair actions having been taken, recording the information, and indicating any potential delay and issuing warning that a delay.

5.4.5 Other NRW Reduction Activities

(1) Free Water Outlets

It was found that when leakage is reduced, the relative impact of free water usage on NRW increases. In the Execution Plan it is planned to enhance the actions on free water currently taken by the NWSDB.

(2) Illegal Connections

The NWSDB is taking actions against unauthorized consumption by conducting surveys and ensuring that legal connections are made. However, this is done on a random basis. The Execution Plan discusses improvement in this practice by identifying suspected illegal connections.

(3) Discipline and Training for Meter Readers

The Execution Plan points out problems with meter reading and advocates training of meter readers, in addition to rotating meter readers to different areas to prevent corruption.

5.5 Pipe Replacement and Capacity Development

A lot of NWSDB staff were not convinced that NRW could be reduced to a satisfactory level in Colombo City by conducting leakage detection and repair. They believed that the old pipe system is the major cause of NRW and that the leakage volume could not be reduced without pipe replacement or rehabilitation. It is true that the old pipe system needs to be replaced or rehabilitated. The Project activities demonstrated that NRW can be reduced by an appropriate level of leakage and repair activities, especially if this is properly integrated in the routine of field officers.

However, there are several limitations such as inadequate work time allocated for the NRW reduction activities, frequent change of schedule due to unexpected urgent tasks and overworked field staff. Even if the members of the Teams understood the importance of NRW reduction, sometimes it was difficult to keep them committed to the activities. They were motivated when they saw the positive results, shared the information with colleagues, and received their feedback and appreciation. The field staff were encouraged when the audience at the seminars wanted to learn more about the methods after the presentations.

The capability of the field officers on NRW reduction activities showed clear improvement through the Project activities. A set of effective activities to reduce NRW in the whole of Colombo city was also established. The Execution Plan and the Project findings were presented at a public seminar which was highly appreciated by senior management at the NWSDB. The success of the Project can be attributed to the effort in coming up with the appropriate technologies. Japanese technologies were modified to suit the local conditions. Over the course of the Project the Teams made improvements through trial and error to arrive at the suitable methodologies.

Rehabilitation or replacement of old cast iron pipes is still required to reduce NRW and to prevent recurrence of leakage. There are also other problems, such as leakage and illegal connections with PVC pipes as noted during the implementation of the Project. It was very difficult to detect leakage where houses were built over PVC distribution pipelines. Hydraulic isolation was very difficult where pipes not identified on drawings were connected to the PVC pipes, making it an additional impetus to consider replacement of PVC pipes as well as old CI pipes at the boundaries of areas where hydraulic isolation would be conducted. It is also recommended that water supply to old CI pipes be stopped when new pipes are being installed. Such pipes caused leakage and water shutdowns for leakage repair could not be accomplished due to unknown interconnections.

5.6 Lessons Applicable to Similar JICA Projects

5.6.1 Difficulties with Hydraulic Isolation

NRW measurement after hydraulic isolation is necessary to quantitatively verify the effect of NRW reduction activities. However, when the location of many pipelines and valves are unknown and there is constantly low system pressure, it is more practical and effective to consider alternative methodologies.

5.6.2 Considerations to Designing PDM

The PDM for this Project did not state the target NRW to be achieved after the implementation of reduction activities, as is sometimes the case in similar JICA projects.

The extent of NRW reduction depends on the specific conditions of the region such as the condition of the pipeline networks. For example, the results of the NRW reduction activities in Kotahena was totally different from the results in Borella, even when the same activities were conducted in both areas. Without being influenced by the need to meet quantified targets of NRW reduction, the Project may be able to focus on pursuing the reasons for the difference in outcomes.

5.6.3 Promote Awareness on Procured Equipment under the Project

Project equipment (cars or heavy vehicles) delivered, during the absence of JET were not always made available for the Project activities. The NWSDB might have misunderstood that the equipment was for general activities and not limited to the Project. It would have been preferable that delivery of granted equipments be done in the presence of JET as much as possible, so that JET can support JICA in giving the explanation to the C/Ps on how the granted equipments should be handled during the Project.

5.6.4 Selecting Trainees for Training Overseas

The NWSDB has its internal rules and policies for nominating trainees for training overseas, and the

selection process always takes a long time. As this kind of program involves many parties in the host country, the delay of the process would have wide spread negative consequences. The problem could be avoided if the eligible members could be identified before the start of the project and agreed upon by all sides.

5.7 Necessary Follow-up Activities by JICA

The following subsections explain what JICA could do to ensure the continuation of the NRW reduction efforts even after Project termination. The NWSDB should be aware of the importance of leakage detection and repair as part of routine O&M. Nevertheless, some of executives in the NWSDB may still have the opinion that the replacement of old pipes is more important. JICA should keep reminding the NWSDB of the importance of implementing NRW reduction as part of the routine O&M.

(1) Execution Plan

It is necessary for JICA to encourage the NWSDB to incorporate the recommendations and action plans stated in the Execution Plan into future corporate plans.

(2) Follow-up on Implementation of Leakage Detection to Entire Colombo City

The C/P staff engaged in the Project acquired the necessary skills and knowledge in leakage detection and repair. However, there is still the concern that they may suspend activities when they come across difficult problems when the implementation expands to other parts of Colombo City. The initiative could also be suspended if the work load becomes too much and other top down priorities take over. JICA could maintain its support and involvement to ensure that the recommendations in the Execution Plan are implemented and that the priority for NRW reduction remains high.

(3) Follow-up on Supervision of Leakage Repair and Service Connection

It is necessary for the NWSDB to follow-up on asset management (e.g., recording, record keeping and practical use of as-built drawings, asset ledgers and construction records) to build necessary capacity to conduct construction supervision appropriately by themselves.

The manuals on rectification of lengthy bundled service pipes were prepared. The Project missed the opportunity to apply to practical site works because rectification works for lengthy bundled service pipes did not conducted as it was planned. To try, check and give feedbacks to the prepared manual for its improvement, it is necessary for NWSDB to have external assistance.

The Execution Plan recommends that systematic monitoring procedures be established for the recording of leakage detection, work orders and repairs, in order to facilitate prompt response to reported leaks. The NWSDB would need external support to expand this activity to the whole of Colombo City.

(4) Follow-up on GIS

The NWSDB may be able to expand GIS-related activities stated in the Execution Plan on its own. However, it may take a long time for the database to be expanded to cover the entire city because the engineer assigned to the task has other responsibilities.

It is necessary for the NWSDB to out-source some of the works (e.g., field work and data input for base map preparation) to speed up the expansion of the GIS database to the whole of Colombo City.

The external expert would also be useful for maintaining and expanding the knowledge base in the NWSDB.

(5) Follow-up on PR Activities, Training for Meter Readers and Legal System Improvement

External support in terms of augmenting current and planned NWSDB PR programs may be useful (e.g., PR activities, programs for training and education for meter readers and reconsideration of their roles, and legal system improvement such as for actions against illegal connections).

(6) Follow-up on Pipeline O&M

Replacement of the old and complicated pipelines will improve the network system. The new network would need proper maintenance. The NWSDB would require external assistance to promote to all staff the importance of O&M. The ADB is aware of the importance of this issue. At present it has not been decided which donor will undertake this initiative.

(7) Facilitation of Smooth Internal Procedures for Securing Budget and Human Resource for NRW Reduction Activities

It is necessary for JICA to encourage the NWSDB to secure necessary funds and human resources for NRW reduction. The budget for NRW reduction under the Project was adequately secured. JICA should approach the NWSDB with the suggestion of allocating the necessary budget for continued NRW reduction as it did during the Project. JICA should also encourage the NWSDB to secure the budget to implement the Execution Plan. The required additional inputs are as follows.

a) Preparation of GIS base map:
   - It is recommended that the preparation of the base map for the GIS database be out-sourced(as detailed in " B6.5 Required Input for Preparation of GIS for Entire Colombo City " of "Annex - 6 Execution Plan").

b) Updating of GIS database:
   - At least one engineer for updating the GIS database and one GIS operator for data input are required at the Maligakanda Office.

c) Conducting customer survey:
   - A customer survey should be conducted by meter readers as part of their routine job.

d) Record keeping of leakage repair:
   - One officer is required at each OIC office for issuing repair order forms, and inputting data to leakage repair database that includes the locations of repaired leakage on the GIS base map.

e) Special teams for leakage detection:
   - At least one leakage detection team should be organized under every OIC office. The leakage detection team would conduct a leakage detection survey of the area every 12 to 16 months.
   - The leakage detection team with the participation of the zone officer would focus solely on leakage detection and repair, (or a sub-contractor under the supervision of the zone officer).
   - The team would include one EA, three laborers, one vehicle and one driver.

(8) Use of Trained Staff under the Project

It is necessary for JICA to encourage the NWSDB to make full use of the C/P staff in Kotahena and Borella trained by the Project when NRW reduction activities are being expanded to the entire City of Colombo.

(9) Sharing Findings and Lessons Learned through the Project with ADB

The NWSDB plans to conduct pipe replacement in Colombo City using ADB loan. JICA should provide the Project Report to the ADB and share the findings and lessons learned.

Chapter 6 PROJECT DESIGN MATRIX AND ITS CHANGING HISTORY

6.1 General

A Project Design Matrix (PDM) is a logical framework that summarizes a project. The original PDM (PDM_0) is based on the minutes of the meeting between JICA and the Democratic Socialist Republic of Sri Lanka signed on April 22, 2009 (M/M). The PDM_1 is presented in Table 6.1-1. The PDM_0 was revised at the part of "Duration of the Project" and the "Input of Japanese Personnel" at the occasion of 1st JCC Meeting. The PDM_2 is presented in Table 6.1-2. Another revision was made at the 5th JCC Meeting on commencement of the 2nd Project Year. The latest PDM (PDM_2) is shown in Table 6.1-3.

Table 6.1-1 PDM_0 (Original)

Project title: **Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka**

Duration: **November 2009-October 2012**

Target Area: **Colombo City, Sri Lanka**

Target Group: **Officers and staff of NWSDB (Western-Central Division)**

Date: **April 22, 2009**

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

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

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

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

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

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

Table 6.1-2 PDM$_1$ (1st Revision)

Project title: Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka

Duration: November 2009, October 2012

Target Area: Colombo City, Sri Lanka

Target Group: Officers and staff of NWSDB (Western-Central Division)

Date:

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

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

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

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

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

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

Note: Modified part is being shaded

Table 6.1-3 PDM$_2$ (2nd Revision)

Project title: **Capacity Development Project for Non Revenue Water (NRW) Reduction In Colombo City In Sri Lanka**

Duration: **November 2009-October 2012**

Target Area: **Colombo City, Sri Lanka**

Target Group: **Officers and staff of NWSDB (Western-Central Division)**

Date:

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal The NRW ratio in Colombo city is reduced.	1 NRW reduction activities are comprehensively conducted by 22 zone offices in CMC area in accordance with the execution plan. 2 Decrement of NRW ratio per annum in CMC area exceeds one (1) percentage point up to 2017.	1 Annual report of NWSDB 2 Record of NRW ratio	
Project Purpose NWSDB's capacity to implement NRW reduction activities in Colombo city is strengthened.	1 Number of NRW reduction activity records will increase compared to what was before the Project. 2 The budget to be allocated for NRW reduction will increase compared to what was before the Project. 3 An execution plan to achieve reduction of NRW ratio by one (1) percentage point per annum, as per the Goal 2.1 of "Corporate Plan 2007-2011", is prepared and incorporated into relevant plans/programs of NWSDB.	1 Annual report of NWSDB	1 NWSDB secures the budget for scaling-up of the NRW activities. 2 Necessary equipment such as pipes, saddles and meters are provided by NWSDB. 3 Over-aged pipes in selected zone of CMC area are replaced.
Outputs 1 Management capacity of senior officers of Regional Center (Western-Central) to plan and supervise NRW reduction activities is enhanced. 2 Technical and operational capacity to conduct NRW reduction activities by officers/staff of Western-Central Regional Center is developed.	1.1 An annual program for NRW reduction in the pilot area is prepared every year (the programs for 2nd and 3rd years are based on the results of the activity in previous years). 1.2 NRW reduction activities in the pilot areas are conducted smoothly through adequate allocation on NWSDB resources (personnel, equipment, budget etc.) as planned. 1.3 NRW reduction related training programs are reviewed and organized for "NRW Reduction Teams". 2.4 "NRW Reduction Teams" are organized at two (2) pilot areas and implement NRW reduction activities based on the work plan. 2.5 NWSDB officers/staff engaged in “NRW reduction Teams” acquire proper leak detection, plumbing and pipe repairing skills. 2.6 An average NRW ratio in the pilot areas is reduced compared to the initial NRW ratio.	1.1 Annual report of NWSDB 1.2 Project record, Quarterly progress report 1.3 Project record, Quarterly progress report, training materials 2.1 Project record, Quarterly progress report 2.2 Project record, Quarterly progress report 2.3 Project record, Quarterly progress report	1 Officers and staff trained by the project will continue with NRW activities of NWSDB.

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

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Note: Modified part is being shaded

Chapter 7 RECORD OF JOINT COORDINATION COMMITTEE

The following sub-sections outline the contents of the JCCs held in the course of the Project. The minutes of the meetings are available in Annex 8.

7.1 1st JCC

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

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

7.2 2nd JCC

The 2nd Joint Coordination Committee (JCC) was held on 31st May, 2010. JET explained the contents of the Progress Report. The following topics were raised and discussed by both sides.

- Progress of project activities in the pilot areas
- Importance of dissemination of findings and lessons learned through the project
- Difficulties in incorporating the newly obtained information (location of valves and pipes) into the existing GIS database
- Schedule of the next JCC Meeting (3rd JCC Meeting)

7.3 3rd JCC

The 3rd Joint Coordination Committee (JCC) was held on 30th November 2010 and JET explained the Progress Report. The following topics were raised and discussed by both sides.

- Progress of project activities in the pilot areas
- Initial and present NRW values of each pilot zone
- Estimation of cost and requirement of resources for completing the activities in pilot zone.
- Possibility of implementing similar activities in other parts of Colombo City
- Schedule of the next JCC Meeting (3rd JCC Meeting)

7.4 4th JCC

The 4th Joint Coordination Committee (JCC) was held on 23rd February, 2011, in order to agree on the contents and the "Joint Mid-Term Review Report for the Capacity Development Project for Non Revenue Water (NRW) Reduction in Colombo City in the Democratic Socialist Republic of Sri Lanka". The Mid-term Review Team presented the following recommendations:

- For the Project

- The mid-term review revealed that out of date information on pipeline networks and locations of valves and fire hydrants hinders the smooth implementation of the project activities. The Team recommends that the Project explore measures to tackle this issue and find an effective way to gather the required location information.
- The Team recommends that the Project come up with reliable benchmarks to explicitly demonstrate the benefits of NRW reduction, e.g., increase of revenue and reduction of O&M cost.
- The Team recognizes the importance of the Execution Plan, and recommends that the Project facilitate its implementation and ensure that the technology is available for the sustained effort in NRW reduction. The Execution Plan would be utilized as an action plan towards achieving the NRW reduction target set in the new Corporate Plan as well as the new Business Plan from 2012 to 2016.
- The Project should explore an effective collaboration between ODA loan program and technical assistance.

- For the NWSDB
  - The NWSDB executives shall take immediate actions to mobilize more EAs, filling the cadre of EAs in O&M section and hiring at least two more EAs, and increase the number C/P staff involved in the NRW reduction activities. The additional input of personnel and the rotation system would increase the number of EAs with experience in NRW reduction. This would be useful in expanding the activities to the entire city.
  - The NWSDB executives shall tackle the problem with shortage of vehicles which hindered the smooth implementation of project activities. The Team recommends that the NWSDB explore the possibility of utilizing its own funds or seek foreign funds such as ODA loan for Water Sector Development Project to implement a comparative study on pipeline replacement versus other NRW reduction techniques as soon as possible in order to complement what was learned from the project activities. For the time being, the NWSDB should proceed with the replacement of bundled service connections using its own funds.
  - Regarding activities for (i) GIS database restructuring and (ii) public relations, the NWSDB will submit proposals to JICA on March 4, 2011.
  - The NWSDB will submit action plans for each recommendation mentioned above to JICA.

7.5 5th JCC

Before the end of the 1st Project Year, the NWSDB prepared its proposal to include GIS and PR activities in the Project. The NWSDB convened the 5th JCC to determine several essential points, such as revision of the PDM or organization and implementation system under the Project and future expansion. The conclusions of the JCC were as follows:

- GIS
  - The JCC decided to update the PDM to clarify the status of the GIS component in the Project. The organization and implementation system under the Project were decided. The activities under the Project and future expansion will be conducted under Additional GM (P&P).
- PR Activities
  - PR activities under the Project should be reviewed every year.
  - The results of the reviews will be incorporated into successive annual programs and the Execution Plan to be prepared on completion of the Project.
  - The Project Leader of the NRW Reduction Management Team will be responsible for the PR activities of the Project

7.6 6th JCC

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

- Dissemination of systematic approach to NRW reduction
  - It is recommended that AEs and OICs/EAs from all OIC areas participate in the weekly meetings and project activities in order to disseminate the methods of NRW reduction to other areas.
- Replacement of old pipelines
  - The NWSDB should proceed with pipe replacement under Japanese ODA loan project in Kotahena as soon as possible to complete the work by June 2012, so that the comparative analysis can be obtained before the completion of the Project.
- Smooth implementation of internal procedures
  - The NWSDB should allocate vehicles for field activities for GPS field work and PR activities.
  - The NWSDB should review the efficiency of GIS operators in the effort to promote the data input on GIS.
- Budget and human resources for NRW reduction
  - The NWSDB should secure sufficient budget and human resources for NRW reduction even after the Project is terminated.
- Utilization of experienced staff
  - The NWSDB should make full use of trained staff under the Project in order to disseminate their experience to other areas.
- Updating of the pipeline network information in routine O&M and effective utilization of the information.
  - The NWSDB should keep updating the GIS database based on collected information.
  - The NWSDB should expand these activities to other areas.
- Establishing and utilization of GIS database
  - The NWSDB should continue the activities for GIS database construction and subsequent updates and utilize it in its planning and O&M efforts.
- Coordination with M/P by JICA and other projects
  - The NWSDB should coordinate with on-going and up-coming projects including the M/P study under JICA.

7.7 7th JCC

The 7th Joint Coordination Committee (JCC) was held on 5th October, 2012, in order to agree on the followings:

- Results / achievement of the activities under the Project
- Contents of the Execution Plan
- Contents of the Project Completion Report
- Contents of the Project Briefing Note