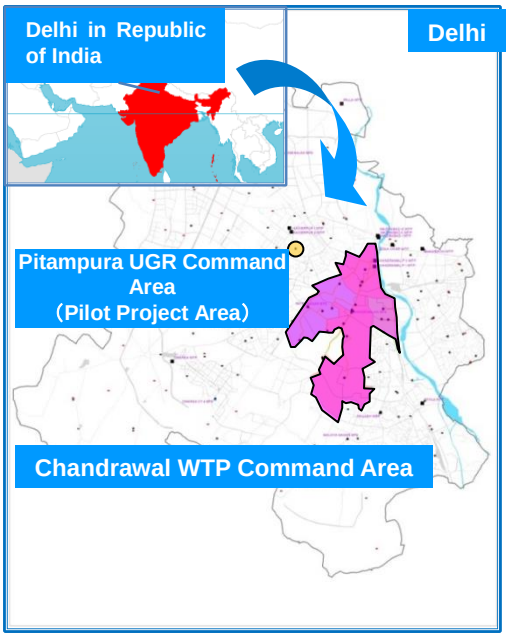
JICA PROJECT BRIEF NOTE

Japanese Technical Cooperation for THE ASSISTANCE RELATED TO DELHI WATER SUPPLY IMPROVEMENT PROJECT IN CHANDRAWAL WATER TREATMENT PLANT COMMAND AREA

- Accelerating Implementation of Delhi Water Supply Improvement Project -

March 2018



1.Background

The National Capital Territory of Delhi has high rate of non-revenue water (NRW). The current NRW level is estimated between 40 to 50%. Inappropriate operational management and aging facilities are the main causes of high NRW. Delhi has five major and a few other smaller water treatment plants (WTPs) catering to a population of about 17 million (2011 census). The oldest Chandrawal WTP was constructed in 1937 and expanded later in 1950s when additional WTPs were constructed as well. The oldest Chandrawal WTP was constructed in 1937 and expanded with additional WTPs later in 1950s. Therefore, the necessity of upgrading the facilities is becoming more demanding. However, the long-term asset management plan has not been formulated because of inadequate amount of data on facilities. Moreover, due to lack of proper maintenance management, the analysis of NRW and NRW reduction measures have not been conducted for long time. In addition to postponed upgrade, the water pressure disparity among areas is worsening the situation of NRW. The areas with higher water pressure have serious water leakage problem. High NRW ratio also results into deteriorated financial situation that hinders the availability of fund for facilities' upgrade.

Under the above situation, Delhi Jal Board (DJB) is expected to implement a project based on the Delhi Urban Planning 2021. JICA contributed to the formulation of water master plan (MP) through Study on the Delhi Water Supply Improvement Project. According to the MP, with the prospect of reducing NRW and achieving equitable distribution, water is proposed to distribute in three tiers: treatment plant to underground reservoir (UGR), UGR to District Metered Area (DMA) and inside of DMA. These three tiers are proposed to be controlled and managed by Supervisory Control and Data Acquisition (SCADA) system. After completion of the MP, the Government of India requested the Japanese ODA loan project named "Delhi Water Supply Improvement Project in Chandrawal WTP Command Area". The project aims to improve the water supply service by rehabilitation and improvement of the facilities under Chandrawal WTP area as this area was prioritized in MP.

2.Approach

(1) Outline of Project

JICA and the Government of India agreed to implement the Project, named "The Assistance related to Delhi Water Supply Improvement Project", intending to maximize the effect of the Japanese ODA loan project by strengthening the technical capacity of DJB.

JICA dispatched the Detailed Planning Survey Team to India in December 2012 to design the Project and agreed on the framework of the Project as shown below.

【Overall Goal】 To achieve the equitable and continuous water distribution in the National Capital Territory of Delhi, by improving the water supply network including service network to customers, thereby contributing in upgrading citizen's living standard.

【Project Goal】 DJB's capacity for the implementation of the Japanese ODA loan project is strengthened.

【Expected Output 1】 DJB's capacity development in management of data and information on the facilities in the Chandrawal WTP command area.

【Expected Output 2】 DJB's capacity development in monitoring and controlling of distribution for equitable distribution and reduction of NRW.

【Expected Output 3】 Development of step wise scenario for effective use of GIS (Geographic Information System) and Revenue Management System (RMS).

The Japanese ODA loan project consists of 5 main components as listed below.

1. Reconstruction and renovation of treatment plant and installation of SCADA
2. Construction and replacement of transmission and distribution pipes in West zone
3. The same in Central zone
4. The same in East zone
5. Strengthening of GIS mapping

The Project aimed at bringing in much positive effect on the Japanese ODA loan project by implementing the following activities:

a) To select facilities for replacement
b) To develop the capacity of distribution management by installing SCADA
c) To develop the capacity of the business management by utilizing GIS and RMS

The activity a) was intended to reduce leakage by replacing selected aging pipes and all house connections in the Japanese ODA loan project. The Project conducted surveys of roads and facility sites and developed database of existing facilities that can be used for making decision on rehabilitation or replacement in the Japanese ODA loan project.

In the activity b), SCADA system was installed in the pilot area. Operational skills of SCADA system were transferred to DJB on how to achieve equitable water distribution. Method of NRW calculation by comparing supplied water volume (measured by SCADA system) and billed water volume (extracted from RMS) was also transferred.

The activity c) would greatly contribute to strengthening management of DJB including reduction of NRW. The medium-term and long-term visions were considered based on the review and analysis of existing management issues of DJB. Step wise GIS/RMS development scenarios were formulated to meet these visions. Data will be collected based on these scenarios in the Japanese ODA loan project. DJB can formulate asset management plan using the accumulated data that would ensure well-planned and effective facility update. This will contribute to strengthening of the management of DJB including NRW reduction.

These three activities will support Japanese ODA loan project achieve its goal and break the current vicious cycle (high ratio of NRW, low revenue, worsening of financial status) and will realize the equitable water supply. Overall, the Project will contribute to water supply service with stable supply and efficient use of limited water resources.

The relationship between the Japanese ODA project and the Project are shown in Figure 1.

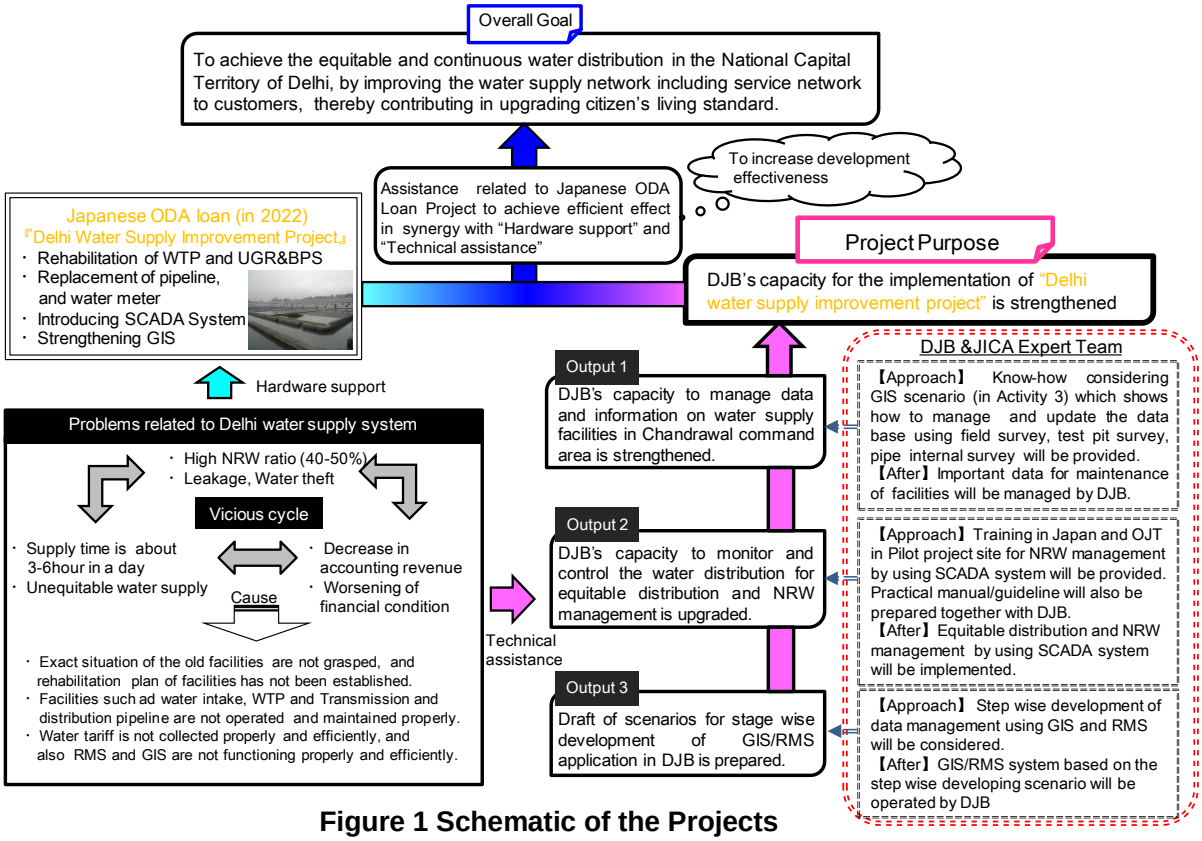


Figure 1 Schematic of the Projects

(2) Organization of Project Implementation

Additional Chief Executive Officer (CEO) of DJB was the director of the Project, and Superintending Engineers, Executive Engineers and Japanese Experts were assigned to each of the 3 activities. The organization chart is shown in Figure 2.

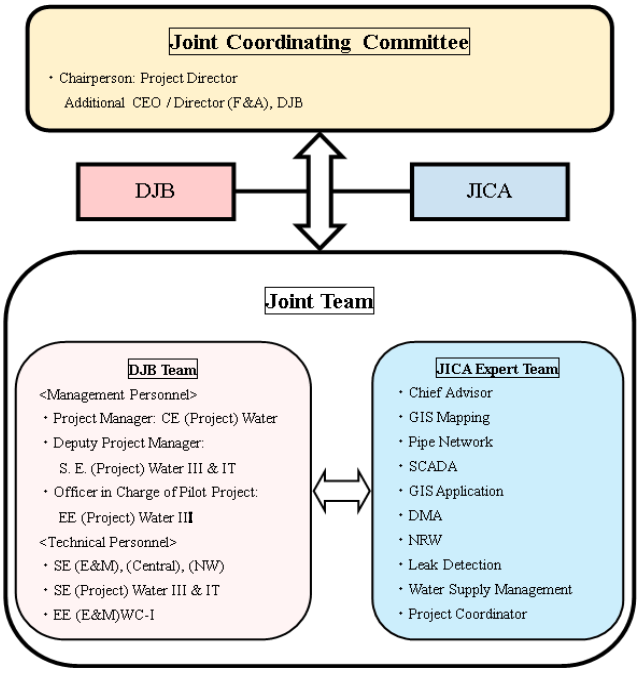


Figure 2 Organization Chart of the Project

(3) Output 1: Strengthening Capacity to Manage Data and Information on Water Supply Facilities in Chandrawal WTP Command Area

1) Basic policy

Activities for Output 1 provides the Japanese ODA loan project team basic data for detailed design and preparation of Detailed Project Report (DPR) necessary for approval of loan project execution by the Indian government. Based on the data, the Japanese ODA loan project team was conducting detailed design and preparing DPR. The DPR also includes drawings, implementation schedule and project cost.

2) Planned Activity

Activities for Output 1 were divided into the following:

【Activity 1-1】Collect necessary information for detailed design of the Japanese ODA loan project

【Activity 1-2】Surveys and GIS data creation on Chandrawal WTP and booster pumping station and examination of pipe information.

The purpose of Activity 1-1 was to collect data on the existing pipelines and underground utilities. Survey of

WTP, pumping station, UGR and pipeline route was conducted under Activity 1-2. Relations of these activities under the Project and the Japanese ODA loan project are shown in Figure 3.

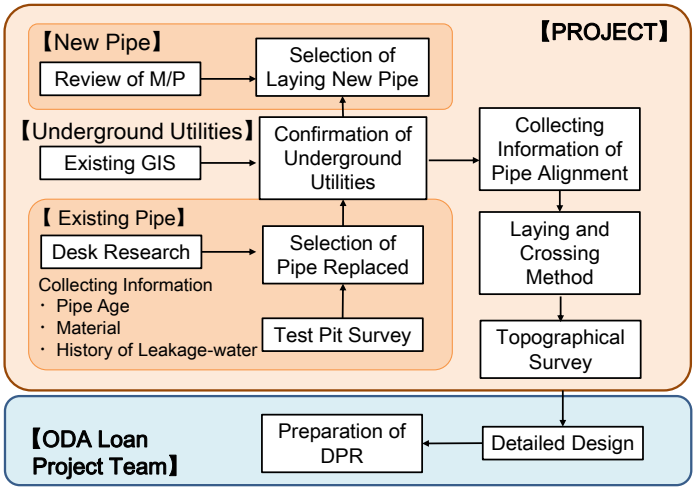


Figure 3 Allocation of activity with the Project and the Japanese ODA loan project in the Activity 1-1

3) Implemented Activity

3-1) Confirmation of Existing Pipe

Maps developed by Delhi State Spatial Data Infrastructure (DSSDI), a body of the Delhi government, covers information on administrative boundary, building, housing, road, underground utilities such as electricity cables, sewers, gas pipe lines and so on.

Although the information of water pipeline can be displayed on the base map of DSSDI, accuracy of the information was not so high. Therefore, accuracy was improved with DJB by updating pipeline information. DJB was correlating the household information in DSSDI with its billing data. If this is completed, illegal connections are expected to be easily detected and, hence drastic reduction in commercial losses and accounts receivable can be envisaged.

3-2) Implementation of Plane and Route Surveys

The Chandrawal command area includes many government buildings, embassies, official residences of high officials, etc. Therefore, obtaining permission from road administration for laying pipelines through open cut method is expected to take time and even not possible in some cases.

In order to collect information on alignment of pipeline suitable for specific site environment and to make decisions easy at detailed design stage of Japanese ODA loan project, road survey of approximately 1,415 km was carried out.

3-3) Investigation of Existing Pipe Condition

Existing pipe condition was investigated to decide criteria of pipe replacement, and test pits were dug at 259 locations for investigation of external pipe condition. In addition, pipes were cut at 50 locations out of the 259 locations for investigation of internal pipe condition.

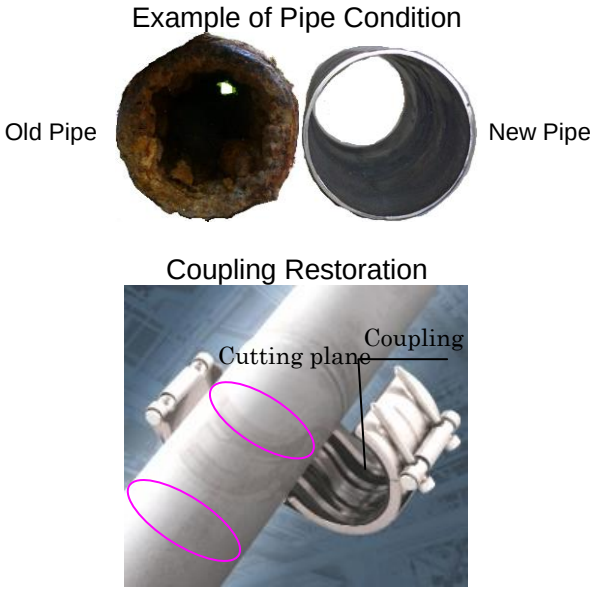


Figure 4 Internal/external Condition of Pipe and Method of Pipe Connection

(4) Output 2：DJB's Capacity to Monitor and Control the Water Distribution for Equitable Distribution and Non-Revenue Water Management is Upgraded.

1) Basic Policy

A SCADA system was installed on existing Pitampura UGR command area as pilot project to monitor and control water supply for equitable distribution and NRW monitoring. In the pilot project, water supply condition was monitored in real time, and then valves were operated to control flow/pressure by using SCADA

system for equitable distribution in the selected DMAs. In parallel, NRW was estimated by comparing flow from SCADA records with water billing data, then monitoring and operation manual/guideline was prepared based on the results of above experience.

2) Planned Activity

Flow chart of the pilot project is shown in Figure 5. SCADA was procured and installed and after that test operation started in September 2017.

Demonstration of leak detection in Delhi, training in Japan, and seminar by Tokyo Metropolitan Waterworks Bureau were carried out to transfer know-hows of NRW reduction.

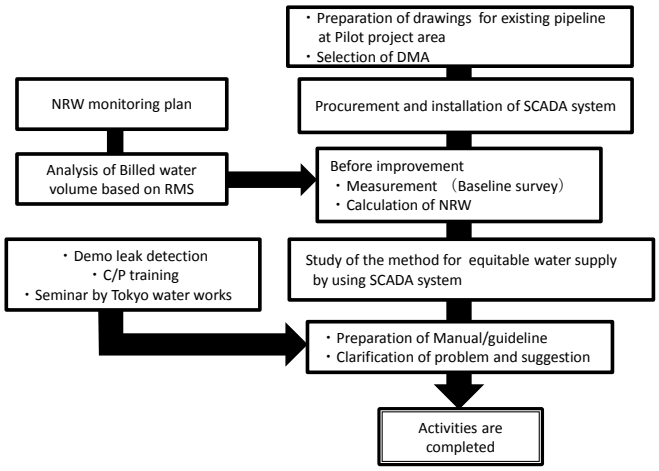


Figure 5 Flow Chart of the Pilot Project

3) Implemented Activity

3-1) Distribution SCADA

Distribution SCADA covered 3 DMAs at pilot-scale. Operation of this SCADA faced several challenges:

- Water supply time is limited to 3 hours each in the morning and the evening. It is necessary to control valves by trial and error in only these short supply times considering the total water distribution situation.
- There are a few engineers in DJB having knowledge and understanding of the distribution SCADA. However, after introduction of distribution SCADA in Chandrawal command area under the Japanese ODA loan project, DJB should manage/monitor the distribution SCADA. Therefore, DJB should acquire knowledge of the distribution SCADA before it is installed.
- DJB built chambers for installing bulk meters and flow control valves with actuators which was part of the SCADA system. However, some flow control valves with actuators were found to be submerged in rainwater. There was a possibility that if any actuator that was not fully waterproofed, is submerged, it might cause accidents.

The following approaches were adopted to address the above challenges.

- The valves were controlled considering forecasted pressures in the area based on the simulation of distribution network.
- The Manual/Guideline was prepared which covered not only operation method of the SCADA system, but also management for equitable distribution using the SCADA system.
- JICA expert team (JET) and DJB investigated effective measures to improve the water tightness of the chamber by construction of a demonstration chamber and test of water tightness of the chamber. Based on the evaluation of the test, JET and DJB carried out improvement work on the 14 existing chambers. Also, water level alarm sensors and earth leakage circuit breakers were installed in the chambers as preventive measures against leakage accident even if the valves in the chamber were submerged under water.

3-2) Monitoring of Non-revenue Water

Leakage, inaccurate billing due to defective meter, and water pilferage are major causes of NRW in Delhi. Detecting leakage from underground pipe in Delhi is difficult because of low water pressure in distribution pipe and limited water supply duration. Some of defective meters are owned by individuals and are not repaired by them. Also, there are many illegal connections with water

pilferage. However, only limited information is available on NRW. Therefore, effective and efficient measures against reduction of NRW could not be found and were not implemented.

In the pilot project, NRW was simply estimated as a) supplied water amount to DMA minus b) billed water amount in DMA. The supplied water amount was measured by flow meters installed at inlet of DMA while the billed water amount was estimated as total of billed water amount in DMA using RMS.

(5) Output 3: Develop the capacity of the project operation by utilizing GIS and RMS

1) Basic Policy

Sustainable water supply operation requires not only facilities' upgrade, but also soft component improvement such as finance, human resources and customer services. Nowadays, water supply utilities in Japan are experiencing an era of major update and restructuring. Under this circumstance, property management and facility upgrade have been conducted utilizing effective asset management method with the purpose of well-planned and healthy water supply operation. DJB is also in the similar situation as in Japan. Since water supply facilities constructed during the reign of British are aged, urgent re-construction or rehabilitation of these facilities are required.

2) Planned Activity

In this activity, after the review of management policies and vision, and business plan of DJB, "GIS and RMS utilization application scenario by 2021" and "Asset management guideline" are prepared.

3) Implemented Activity

3-1) Formulation of Scenario for Development of GIS

Current utilization and development of GIS/RMS in DJB was firstly analyzed. Then, scenario and guideline of GIS/RMS was developed jointly by JET and DJB so as to be utilized for formulation of asset management plan. The developed scenario includes methods of collection of basic data, sharing of GIS data, efficient process of data update, and recording of daily inspections. Items to be developed and their development schedule were prepared jointly. The outline of development scenario is listed below.

- Re-design structure of GIS database (add or change layer and attribute items)
- Input available existing information to GIS such as surveyed data and as-built drawings. (Introduction of GIS filing system)
- Add new information to GIS and improve data accuracy (additional topographic survey, improvement of data accuracy based on daily inspection)
- Expand GIS user in DJB (Introduction of web-GIS and data update by site offices)
- Advanced application of GIS system (Development of hydraulic analysis model and introduction of asset management)

3-2) Formulation of Guideline for Asset Management

The executives of DJB understood importance of creation, accumulation and update of database for facilities management and proper O&M of facilities that would be a base of asset management. The guideline of asset management was formulated which will help DJB manage water supply system effectively and efficiently.

3.Results

(1) Output 1

1) Confirmation of Existing Pipe

Existing pipelines shown in 280 sheets of GIS drawings were reviewed, corrected and updated together by JET and DJB. The updated data were integrated with pipe alignment data and then used for detailed design by Japanese ODA loan project consultant.

2) Implementation of Plane and Route Survey

Plane and route surveys were carried out from November

2013 to March 2015. Plane survey results of all WTPs and UGRs were reflected in the DPR of package 1of the Japanese ODA loan project. Road survey results of 1,910 km were also reflected on DPRs of packages 2 to 4 of the Japanese ODA loan project. The above length was longer than the planned one as it required to survey more roads to improve the existing service pipes by stopping spaghetti-type house connection.

Spaghetti service pipes

3) Pipe Condition Survey

Although the survey was often interrupted by the delay in obtaining digging permission and the activities of Delhi elections, pipe condition survey was ended in March 2015. Total number of test pits dug was 259 and number of pipe cutting was at 50 locations.

Internal Condition of Cut pipe

4) Criteria for Pipe Replacement

According to pipe thickness measurement of the cast iron pipe, decrease in pipe thickness was small indicating low level of corrosiveness of soil in Chandrawal area. On the other hand, shrinkage in internal cross-sectional area in internally unlined pipes was remarkable. Thus, it is identified that using old pipe further will cause a high friction loss and drop of water pressure.

As a result of the above survey of pipe internal/ external conditions and referring to Japanese standards on criteria for pipe replacement derived from extensive surveys in Japan, 30 years or older pipes are proposed for replacement. Renewal pipelines on GIS are shown in Figure 7. This information was reflected in the DPR of package 2 to 4 of the Japanese ODA loan project.

5) Selection of Renewal/new Pipeline

Based on the underground utility information of DSSDI and plane and route surveys, pipe alignment data with depth was confirmed and then renewal pipelines with total length of 1,415 km were identified. In addition, sections were identified where open-cut method is difficult to lay pipelines, such as crossings of railway, drainage and heavy traffic roads, and appropriate crossing methods were proposed. These results were summarized as "Results of pipe alignment survey", and were reflected on DPRs of packages 2 to 4 of the Japanese ODA loan project.

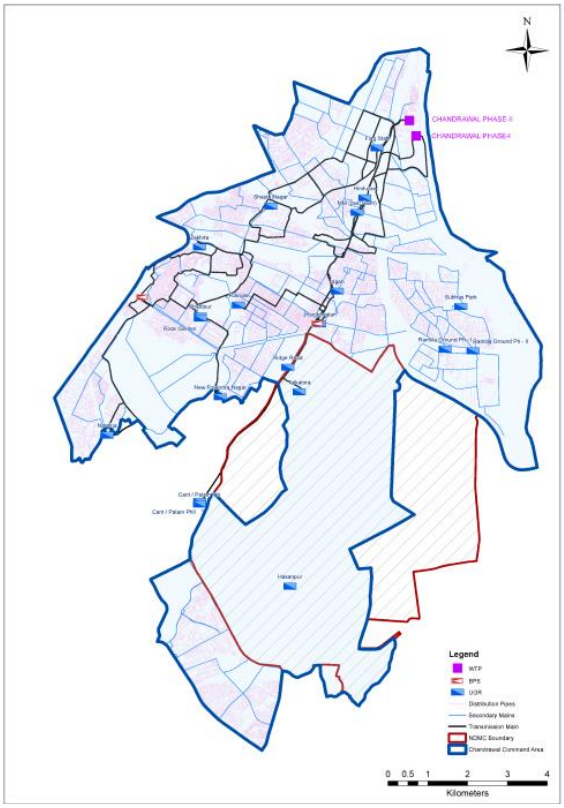


Figure 6 Renewal pipe (pink-colored) on GIS

(2) Output 2

1) Distribution SCADA

In order not to repeat water ingress to the constructed chambers, the followings were considered: a) plastering of walls with water-proof mortar, b) closure of openings on the top slab of the chambers, and c) filling of the gaps between the manholes and the top slabs with water-proof materials. The considered measures were found effective when applied to the demonstration chamber. Then the

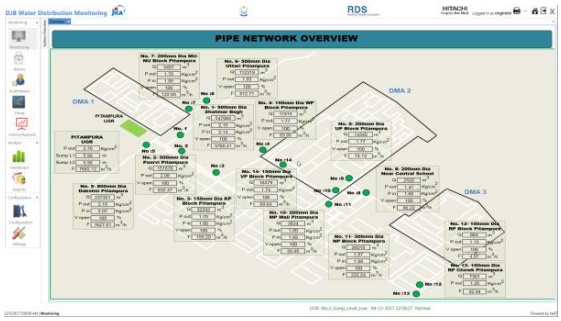
measures were applied to all the constructed chambers. Also, water level alarm sensors and earth leakage circuit breakers were installed in the chambers.

Trial run of the SCADA system started in September 2017 and ended in December 2017. Zero-pressure tests were conducted for the created DMAs to confirm their hydraulic isolation. As a result, DMA 1 was confirmed completely isolated while DMA 2 had some doubt. On the other hand, DMA 3 was not isolated.

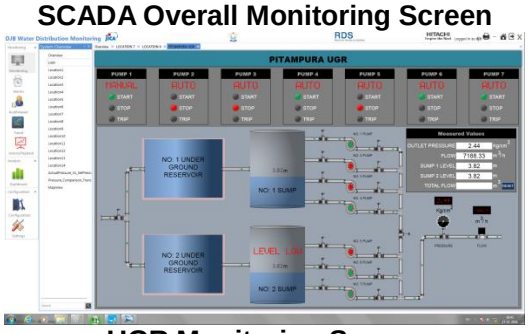
Valve and Flowmeter installation

Local Measurement Stations

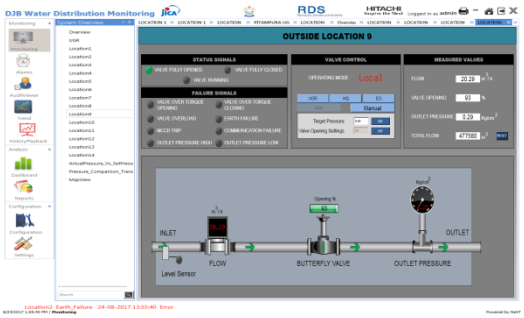
SCADA operation started in December 2017 for equitable water distribution between DMAs 1 and 2. As a result, water amount as well as water pressure could become almost the same between the 2 DMAs.



SCADA Overall Monitoring Screen



UGR Monitoring Screen



Measurement Point Monitoring and Operation

Trainings were held twice and guideline on SCADA operation and achieving equitable water distribution was prepared and stored in the DJB library.

Afterwards, the training cell of DJB will organize internal training of SCADA targeting the concerned officers of DJB. The trainees of the training held twice in the past will be the trainers and utilize the prepared guideline and the constructed SCADA system in the trainings.

Training of SCADA

2) Monitoring of NRW

NRW was simply estimated as a) supplied water amount to DMA (measured by SCADA system) minus b) billed water amount in DMA extracted from RMS.

Water inflow to DMAs for about 10 days was available during the Project while the billed water amount for corresponding period was not available from RMS. As an alternative, NRW was calculated using past annual average billed quantity.

Door to door surveys were conducted in 2015 and 2017 to investigate water pilferage, large portion of commercial loss and to confirm house connections in the DMAs. DJB formed an investigation team (13 people) in DJB Pitampura office in 2015. As a result, 710 households (approximately 21%) were identified as using water illegally. After this investigation, DJB recognized the

significance of this investigation for NRW reduction and arranged an investigation drive and began investigation in whole Delhi while getting advice from JET.

Investigation for commercial loss

Filling up the survey report

Billed water amounts in DMA were estimated as follows: Firstly, house connections in DMA were identified in the door to door survey. Secondly, KNO that was assigned to each house connection in the RMS were obtained in the same survey. Finally, billed amounts in DMA were extracted from RMS system using KNO.

Technical Assistance for Leak Detection

(3) Output 3

1) Formulation of Scenario for Development of GIS

The scenario and guideline for development of GIS/RMS was formulated in the Project. Based on the scenario and guideline, development of GIS and integration of GIS with RMS will be conducted under Package 5 of Japanese ODA loan project.

DJB started reconstruction of GIS database and introduced web-GIS system partially that were recommended in the formulated scenario.

2) Formulation of Guideline for Asset Management

In order to formulate the guideline for asset management, followings were conducted:

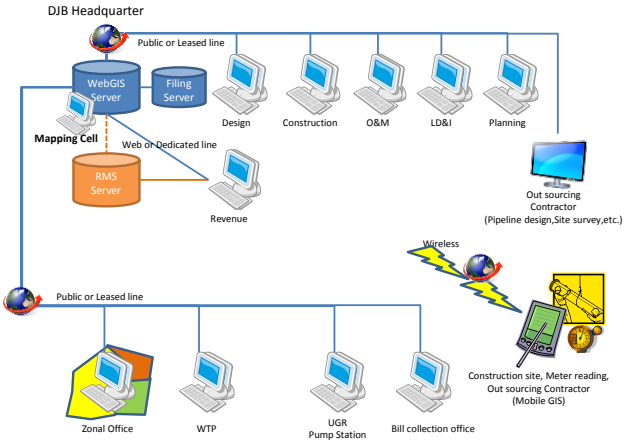


Figure 7 Schematic Diagram of Introducing Web-GIS System in DJB

a) Preparation of database for O&M of Chandrawal water treatment plant

Database of Chandrawal water treatment plant was prepared, consisting of 3 parts: general outline of facilities, general drawings of facilities and flow chart of facilities. DJB started to prepare similar database in other facilities.

b) Preparation of daily maintenance sheet and practicing daily inspection

Asset management guideline included necessity of accumulation of the recorded data of daily inspection in order to implement rehabilitation/renewal of the facilities effectively in future. Daily inspection sheet for Chandrawal WTP was prepared and practiced in order to enhance the knowledge of O&M and improve the awareness on issues such as analyzing the condition of machines or equipment and taking prompt action in case of mechanical trouble.

DJB started to inspect machines and equipment in other facilities.

c) Formulation of Guideline for Asset Management

The formulated guideline contains the following items: 1) methods of accumulation, utilization and analysis of GIS/ RMS data necessary for asset management, 2) importance of updates and expansion of the facility, 3) impact of updates and expansion of the facility on water service

users, 4) financial plan to implement updates and expansion of the facility.

Daily inspection of Chandrawal WTP

Presentation on Asset management

4.Findings and Lessons Learned

(1) Joint Work with C/P

It was important to place the person of the higher rank in the project implementation organization for smooth Project implementation since the organization of DJB has the hierarchical order like a pyramid and directive orders differ for each division. Additional CEO was in the position of a higher rank from management divisions and assumed the position of project director in the Project. As a result, the top down approach functioned effectively.

(2) Dissemination of the Outputs

The outputs in the Project are necessary to be disseminated widely in the DJB. So the followings were conducted: 1) storing manuals and guidelines of SCADA, asset management, pipe replacement and so on in library for easy access to everybody, 2) training program of SCADA was incorporated into regular annual training program of DJB which is organized by the training cell.

(3) Lot of Work and Work Management

It was a challenge that the chambers and various equipment of SCADA were constructed or installed by not a single contractor but 2 contractors. Sub-works of construction of chamber and installation of various equipment of SCADA were not independent but were interrelated each other. Many meetings were held to coordinate and manage the work process of construction and installation work among the 2 contractors, 2 employers and JET, and the work could be managed to some extent.

This kind of work had better be implemented by a single contractor who can manage schedule of sub-works timely and efficiently.

(4) Hydraulic Isolation of DMA

DJB's asset data on pipe was not accurate. So the selected Pitampura pilot area was chosen from areas where information on pipe seemed fairly accurate to create hydraulically isolated DMA. In addition, pipe information was confirmed with the distribution office in the pilot area and also by some trail diggings.

Hydraulic isolation of the created DMAs could be confirmed by zero-pressure test; pressures inside of DMA should be zero when all inflow valves to DMA are closed. The test was conducted in December 2017 when SCADA system including all inflow valves with actuators was completed. Two DMAs were almost isolated while 1 DMA was not isolated.

Confirmation of DMA isolation had better be conducted at an earlier stage.

(5) System of Information Update

Various systems of SCADA, GIS, RMS and so on are powerful tools for effective and efficient management of DJB. In order for the above systems to be always functional, the latest information should be provided to the systems. So system, mechanism or organization should be developed to update the information on facilities such as pipe, house connection, O&M records and so on timely and precisely.

(6) Transfer of Know-hows and Experiences of Waterworks Bureau of Tokyo Metropolitan Government

The Project was conducted with the cooperation of Waterworks Bureau of Tokyo Metropolitan Government. It contributed to the Project (particularly output 3) by providing its know-hows and experiences gained through managing the utility in the large-scaled metropolitan.

Training in Japan : Introduction of SCADA

(7) Synergistic Effect of this Project and Japanese ODA loan project

Service in water supply will be improved effectively and management of DJB will be strengthened effectively by matching construction of the facilities in the Japanese ODA loan project with strengthening of the capacity of DJB in the Project.

(Project Period: From June 2013 to March 2018)

Reference:

"Study on Improvement of Water Supply System in Delhi in the Republic of India"
Japan International Cooperation Agency (2011)