Bangalore Water Supply and Sewerage Board

Summary Report

India

Verification Survey with the Private Sector for Disseminating Japanese Technologies for the Water Leak Detection Service Using a Leakage Monitoring Technology in Bangalore

November, 2016

Japan International Cooperation Agency

Suido Technical Service Co., Ltd

Contents

1. BACKGROUND

In the Twelfth Five-year National Plan, India targets to provide 24-hour water services to the population in urban cities. In order to improve the current water services, reduction of non-revenue water (NRW) is one key factor that affects the amount of water served, and the business soundness of water services.

In November 2013, Suido Technical Service (STS) conducted a feasibly survey in Bangalore under the support of BWSSB and MOFA/JICA. In the survey the applicability of the water leak detection technology was tested in the local conditions of Bangalore. From the results, it was identified that the leakage monitoring system (L-Sign) has high potential in Bangalore to improve the quality of water leakage detection.

During the feasibility survey, it was also affirmed that it is necessary to develop both technology and human resources to achieve sustainable management of the water leakage/NRW in Bangalore. As for the technology side, it is necessary to develop an Indian version of L-Sign, which is optimized for the Bangalore water facility. As for the human resource side, it is necessary to build capacity of the BWSSB staff to operate the water leak detection technology.

The content of this verification survey is planned to meet and tackle with the above two issues.

2. OUTLINE OF THE PILOT SURVEY FOR DISSEMINATING SME'S TECHNOLOGIES

(1) Purpose

Improve quality of the water supply system in Bangalore through developing technology and skills of human resources of water leakage detection.

(2) Activities

i Water Leakage Detection Technology suitable for Bangalore will be developed.

a. Verify the water supply system and its actual environment through water leakage investigation in the pilot area in Bangalore.

b. Collect, verify and analyze data on the leakage monitoring system and water supply system currently operated.

c. Develop the program and equipment of L-Sign suitable for Bangalore water facilities, and install/review/improve the testing device of the leakage monitoring system.

ii Water leakage detection skills of BWSSB staff will be enhanced through training.

a. Conduct the water leakage detection test in the pilot area and prepare the documents based on the result analysis.

b. Provide technical training with guidance (acoustic investigation, leak noise correlator, boring) off /on site and share the result of training, and follow-up the repair of water leakage points by BWSSB.

iii A plan for the dissemination of L-Sign as a NRW reduction service in India will be formulated.

a. Collect information on intellectual property protection and analyze the market entry risk.

b. Search for potential partner companies to entry “business to business” market in India, and consider the market entry model and develop its roadmap.

c. Consider the model and project components for market entry based on information analysis for “business to government” market in India.

(3) Information of Product/ Technology to be provided

Table1 Product Summary

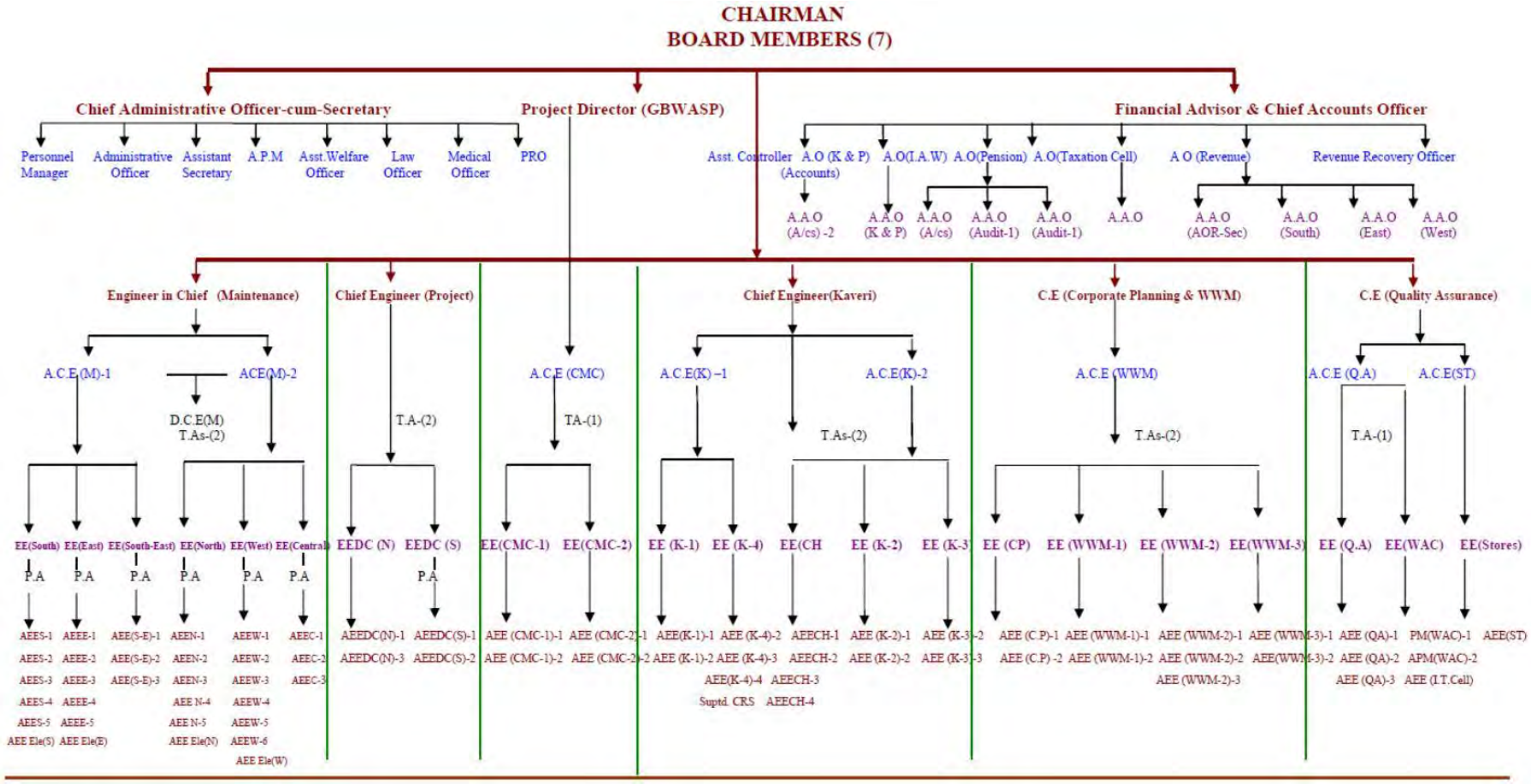
Product name	Auto leak monitoring device [L-sign for distribution pipes] 	Auto leak monitoring device [L-sign for water supply pipes] 
Features	・Internal lithium battery allows a continuous operating period of 8 years ・Visual check possible as LED blinks when leak is detected ・LCD display of leak detection date ・Has a strong magnet that allows it to be firmly fixed on a valve	・Effective monitoring made possible due to detection period customization to suit Bangalore conditions ・Visual check possible as LED blinks when leak is detected ・Attached ball-chain allows for easy installation ・Auto reset function available to match with patrol cycle
Advantages in comparison with competition	The L-sign has the following several advantages compared with other domestic and overseas competing products,: low per unit cost, detection error margin is lower, ability to detect repeat leaks as it is stays continuously installed, No analysis required as it offers visual check, lower running cost as inspection can be combined with water meter inspection, etc. Particularly, since its programming and sensitivity adjustment can be easily customized as per local conditions, it is highly suited for Bangalore conditions where water supply is provided in shifts.	
Size	Φ74.0 ㎜ × 83.0 ㎜ Main unit Φ79.5 ㎜ × 45.0 ㎜ Protective lid Φ79.5 ㎜ × 110.0 ㎜ When lid is fixed	66.0 ㎜～47.0 ㎜ × 63.4 ㎜
Installation points	Mainly on valves	Mainly on pipes close to water meters

(4) Counterpart Organization

Bangalore Water Supply and Sewerage Board (BWSSB)

Organization structure is shown in the figure below.

Table 2 BWSSB Organization chart



(5) Target Area and Beneficiaries

i Target Area

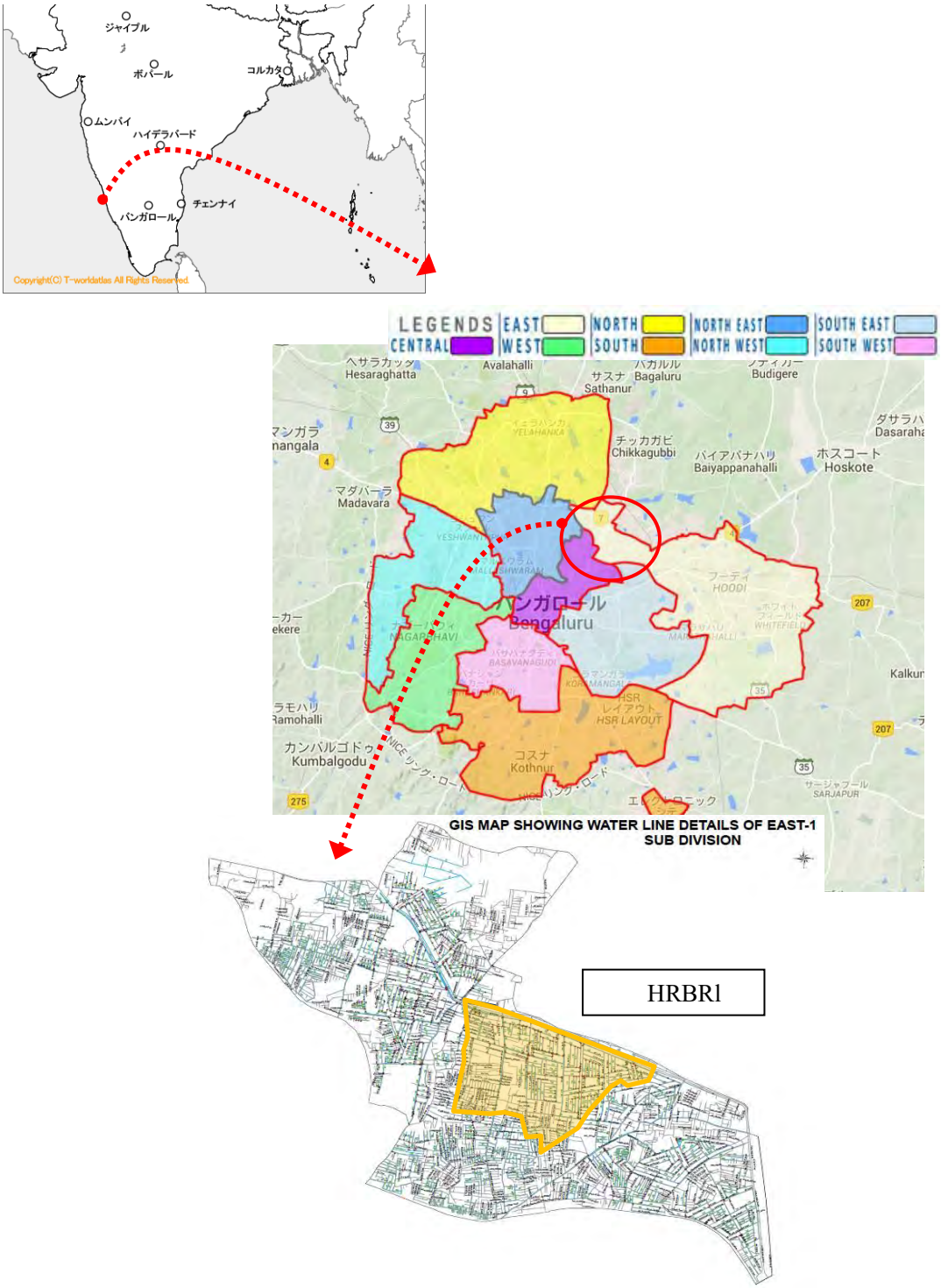


Figure 1 Target Area

ii Beneficiaries

Direct beneficiary：Bangalore Water Supply and Sewerage Board (BWSSB)

Indirect beneficiaries：The citizens of Bangalore (who subscribe to BWSSB water

services)

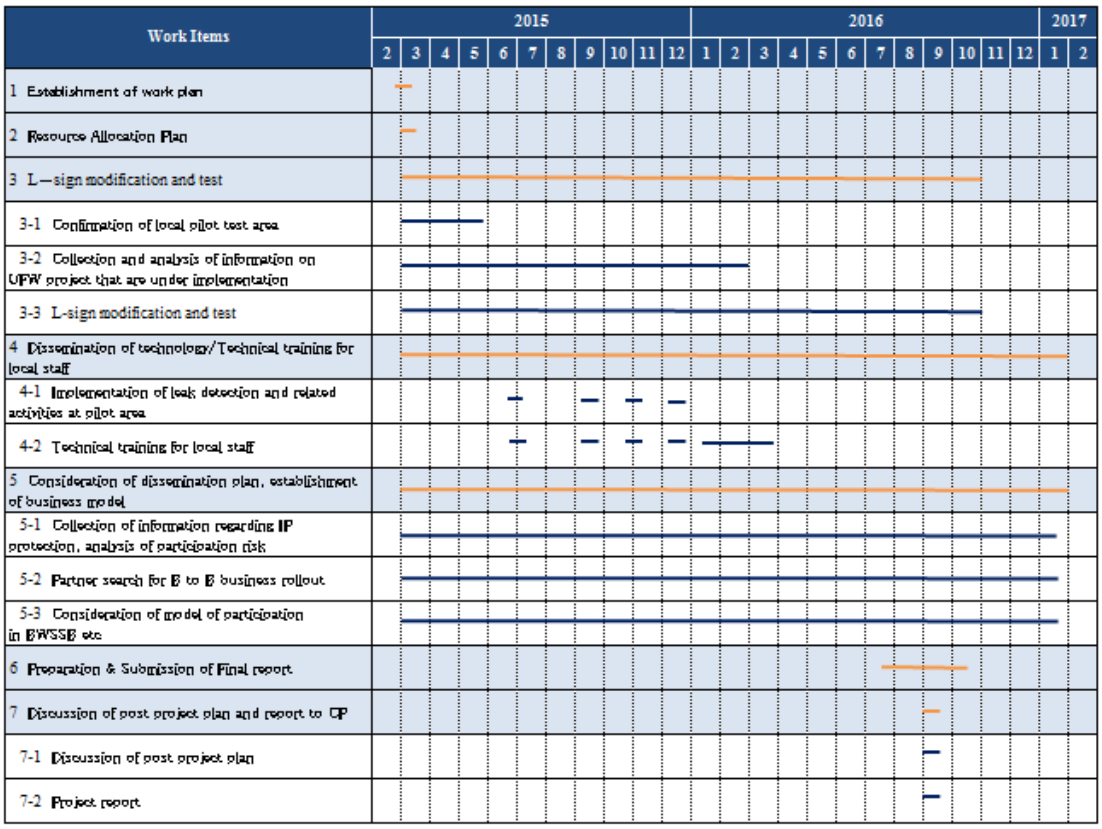
To devise a solution to address the problem of chronic water shortage by reducing the ration of water leakage in Bangalore through dissemination of water leakage detection systems and services using L-sign. This can result in higher revenues and improved water supply for water supply boards such as BWSSB, and better access to water for the citizens of Bangalore.

(6) Duration

From February, 2015 to February, 2017

(7) Progress Schedule

Table 3



(8) Manning Schedule

Table 4

Overseas operation

In charge of	Name	Company	2015											2016											2017	
			2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Overall Project In-Charge	Kenji Oshima	STS																									
Planning and implementation of dissemination and test Device installation & Technical guidance	Nobumitsu Kinpara	STS																									
Planning and implementation of dissemination and test Device installation & Technical guidance	Masaru Mima	STS																									
Planning and implementation of dissemination and test Device installation & Technical guidance	Hirotsugu Abe	STS																									
Overall Support & Overseas Business partner search and analysis	Hidetaka Siba	MRI																									
Overall Support & Overseas Business partner search and analysis	Shin Tanonaka	MRI																									
Analysis of UFW reduction project & Consideration of model for participation in overseas market	Takashi Endo	MRI																									
Planning and strategy for testing & Implementation support Preparation of training package & Implementation support	Yuta Katayama	MRI																									

Domestic operations

In charge of	Name	Company	2015											2016											2017	
			2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2
Overall Project In-Charge	Kenji Oshima	STS																									
Planning and implementation of nation and test Device installation & Technical guidance	Nobumitsu Kinpara	STS																									
Planning and implementation of ation and test Device installation & chnical guidance	Masaru Mima	STS																									
Planning and implementation of dissemination and test Device installation & Technical guidance to assist	Arai Yasushi	STS																									
Planning and implementation of dissemination and test Device installation & Technical guidance	Hirotsugu Abe	STS																									
Local information analysis and test Device installation & Technical guidance	Amano Satoshi	STS																									
Overall Support & Overseas Business partner search and analysis	Hidetaka Siba	MRI																									
Overall Support & Overseas Business partner search and analysis	Shin Tanonaka	MRI																									
Analysis of UFW reduction project & Consideration of model for participation in overseas market	Takashi Endo	MRI																									
Planning and strategy for testing & Implementation support Preparation of training package & Implementation support	Ayako Ugomori	MRI																									
Planning and strategy for testing & Implementation support Preparation of training package & Implementation support	Yuta Katayama	MRI																									

Abreviations : STS=Suido Technical Service Co.,Ltd
MRI=Mitsubishi Research Institute,Inc

(9) Implementation System

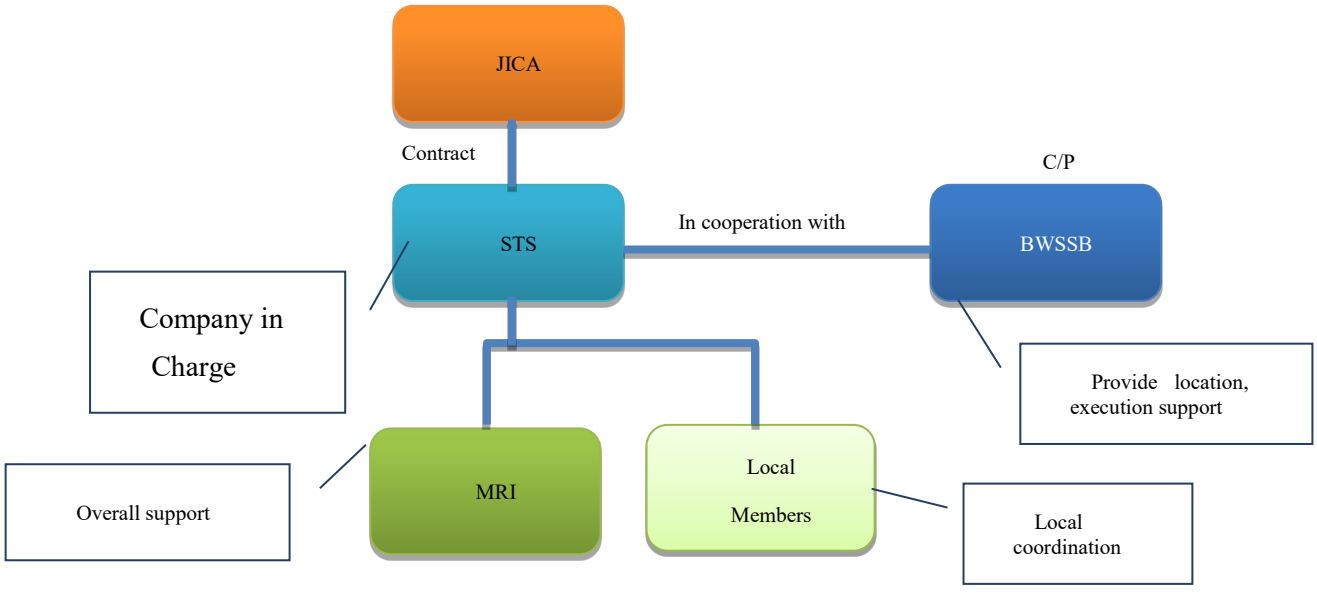


Figure2 Structure of the Survey Members

3. ACHIEVEMENT OF THE SURVEY

(1) Outputs and Outcomes of the Survey

i Verify the water supply system and its actual environment through water leakage investigation in the pilot area in Bangalore

Selection of pilot test area was done in discussion with BWSSB, and a suitable area for survey was identified along with 3000 homes and 50 kms of distribution pipes for L-sign installation in East-1 sub division. Since HRBR Layout and Kammanahalli were also shortlisted, these 2 areas were also made part of survey locations. The 2 locations chosen were of different characteristics, with different water supply conditions and infrastructure, as the intention was to test L-sign under various conditions to be able to test the leakage detection capabilities of L-sign.

ii Collect, verify and analyze data on the leakage monitoring system and water supply system currently operated

Two companies are conducting UFW project in Bengaluru with the JICA finance. STS conducted interviews the companies and collected information about the current project. Based on the interview, following are the process of the UFW.

- Stage1
  - Research the situation in project area (plan for DMA 33 locations)
- Stage2
  - DMA set up (evaluation of facilities through water pressure survey in DMA, changing of ageing pipes, etc)
  - IWA standards followed for DMA scale (around 1500 homes, L=approx. 20 km)
  - One inlet location, use of ultrasonic flowmeter. Installation of and control through meter boxes on roads using remote method
- Stage3
  - Countermeasures against UFW (Leakage monitoring, UFW reduction, repair)
- Stage4
  - Overall evaluation and checking

According to the company conducting the project, the biggest challenge to conducting this project is to identify the pipe layout and update the GIS map of BWSSB. It is because the GIS information is not accurate in many cases. It means that

the preparation stage of the project takes much time. In addition, the companies using conventional leak detection technology since new technologies are mainly designed for 24h/7days water supply in the developed countries and not applicable in the Bengaluru situation.

iii Develop the program and equipment of L-Sign suitable for Bangalore water facilities, and install/review/improve the testing device of the leakage monitoring system

a. Customization of Auto Leakage monitoring device (L-sign)

We customized the device's detection program to adapt to the local supply conditions and tested its applicability. As a result of this exercise, we confirmed the detection capability of the device and its suitability to the local environment (reduction of margin for errors arising out of the various city sounds). We presented the results to BWSSB and started the testing on a larger scale by bringing in about 3000 of these devices and finished installing them by the beginning of February 2016.

b. Setting up of patrol system

After installing all the L-sign devices, in order to set up the leakage detection system, we obtained location information of installed devices by taking pictures with a smartphone and uploaded them to Google Maps. By doing this, we were able to display installation locations on the Web map. Management of the devices was jointly done by BWSSB and STS. Further, in order to make patrolling more efficient, we developed a smartphone based input method. While it is still under testing, we expect it to bring more efficiency into the work once it is fully adopted.

This is broadly described in Figures 3, 4 and 5.

Figure3 L-sign installation location and equipment installation

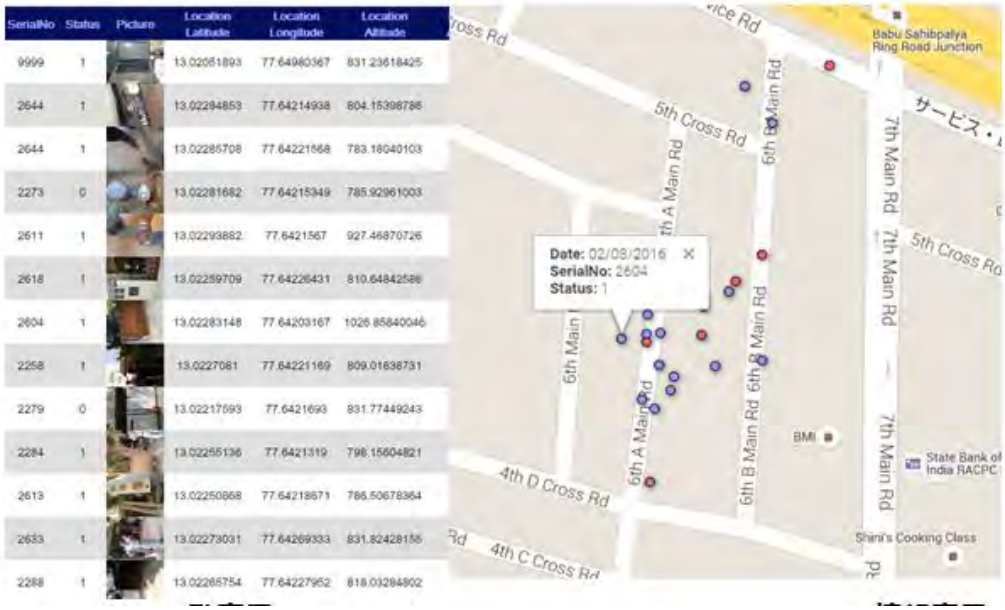


Figure4 Upload of the installation points

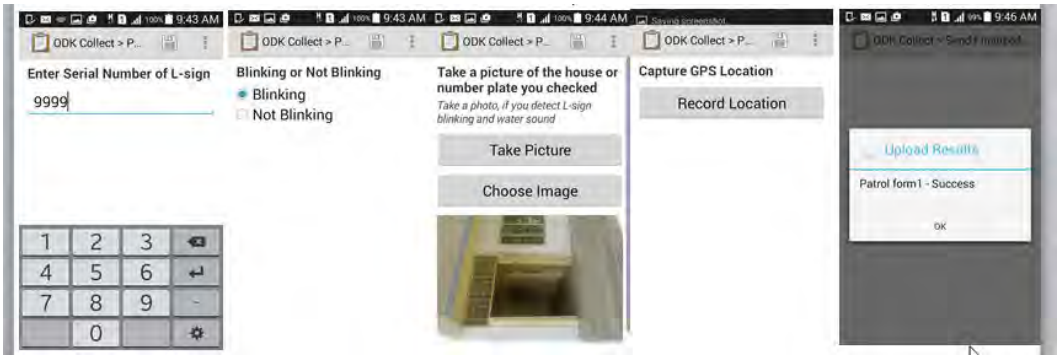


Figure5 Patrol result input procedure

c. Detection of leakages in the project area

There were 29 leakage locations identified in the pilot area, which added up to around 373.0 litres/min. The number of litres water was saved and the resultant savings are given in the table below

Table 5 Volume of water saved: Conversion to savings calculated

Unit	Conversion to Leakage amount per unit (liter)	Conversion to savings (saved volume X supply unit: 0.040Rs/1L)	Conversion to yen 1Rs=1.5917Yen	Remarks
1minute	373	14.92	23.74	
1hour	22,380	895.2	1,424.88	
4hours	89,520	3,580.8	5,699.55	Average water supply for 1 day
1 month	895,200	35,808.0	56,995.59	10 times/month + 40 hours
1 year	10,742,400	429,696.0	683,947.12	12 months＝480H water supply
5 years	53,712,000	2,148,480.0	3,419,735.61	In case of no survey for 5 years

Supply unit is 0.040 Rs, which gives us the calculation as below

Calculation of supply unit = Total amount (2506) ÷62000L＝0.040Rs/1L

iv Conduct the water leakage detection test in the pilot area and prepare the document based on the result analysis

a. Preparation of Leakage monitoring manual

The training for BWSSB members was conducted in a systematic manner, imparting of basic knowledge through classroom training and practical knowledge through field training. A detailed and systematic Leakage monitoring manual was prepared in order to ensure continuous learning among the members and raising their level of knowledge.

With an intent to impart comprehensive knowledge ranging from leakage monitoring to pipe maintenance and repair (not limited to L-sign only), and to enable the members to independently carry out monitoring by using L-sign even after completion of this project, the manual was prepared as per the given topic below.

Table 6 Structure of Leakage Monitoring Manual

1. NRW Management
1.1 Definition of NRW
1.2 Components of NRW
1.3 NRW Reduction Measures and its Importance
1.4 NRW Reduction Measures
1.5 Procedures for NRW Reduction
2. Basic Concept of Leak Detection
2.1 Components of physical losses
2.2 Main Causes of Physical Losses
2.3 Reduction Measures for Physical Losses
3. Leak Detection Techniques
3.1 Utilizing DMA
3.2 L-sign
3.3 Sounding Survey
4. Repair of Leakage
4.1 Introduction
4.2 Repair of Cast Iron Pipe / Ductile Iron Pipe (CIP・DIP)
4.3 Repair of High Intensity Chlorinated Polyvinyl Pipe (HIVP)
4.4 Repair of Stainless Steel Pipes
4.5 Repair of Polyethylene pipes
4.6 Repair of water leakage caused by joints

v Provide technical training with guidance (acoustic investigation, leak noise correlator, boring) off /on site and share the result of training, and follow-up the repair of water leakage point by BWSSB

a. Training on Leakage monitoring technology

In order to smoothly execute leakage detection, 3 BWSSB members of Assistant Engineer (AE) were identified and trained in leakage monitoring methods with a focus on acoustic and correlation technologies and were also taught to operate the leakage detection system. As a result, the engineers fully understood the use of leakage detection device and correlation devices, and successfully used them at the location site. In the final stages of the training, the AE members detected and confirmed one underground leak. Though only 1 leak was detected, a marked improvement in knowledge and the concerned technology was noticed among the

members.

During the course of the project, there was a marked change in the understanding of the BWSSB senior members regarding Leakage technology, and we conducted a training session that saw participation by many AEs from other departments too.

Figure6 Training landscape

vi Collect information on intellectual property protection and analyze the market entry risk

The risk for the market entry of STS was analyzed as follows.

Table7 Expected risks and countermeasures

Risk classification	Risk factors	Countermeasures
IP & Legal risks	・Development and sale of products similar to L-sign	・L-sign is a patented product in Japan. However, it is not patented in India yet. Even if the product is patented, it would be difficult to take effective measures in case of any rights infringement. For this reason, measures to be taken to prevent imitation by having core parts of L-sign, such as sensors, in black box.
Business profit	・Possibility of not realizing profits from planned business model	・Check tender system, pricing of similar products, and procurement of raw material and parts. ・Continue inquiries and proposal submissions to the 3 companies involved in NRW project in Bangalore, check for intended payable amount and evaluate profitability of overseas business.
Business risks	・Limitations in leak monitoring timings due to lack of continuous water supply ・Limitations in monitoring of leaks in valves due to long distance between valves	・Adjustment of water supply timings in consultation with BWSSB. ・Improvement of valves involved in NRW project.

vii Search for potential partner companies to entry “business to business” market in India, and consider the market entry model and develop its roadmap

In the case of business rollout for comprehensive UFW project, it is necessary to participate in the following order structure. In the business being implemented in Bangalore, the general contractors who have a direct contract with BWSSB have the contract period set to 7 years, where they are carrying out survey of pipe conditions, DMA set up, leakage monitoring and pipe maintenance and improvement on a consistent basis. The nature of the contract is such that it is an outcome based payment model based on obtaining a fixed rate of improvement in NRW ratio. The companies that have the general contract for the 3 projects currently running are L&T (2 projects) and Suez (1 project). Both companies have rich experience in construction of large

water purification plants. The conditions for the selection of contractors are technical capabilities, project management capability and risk management capability with respect to the project scope described above. As STS is not in a position to meet the conditions, it is certain that STS will be seen by the contractors as an entity that can add value to their leak monitoring operations.

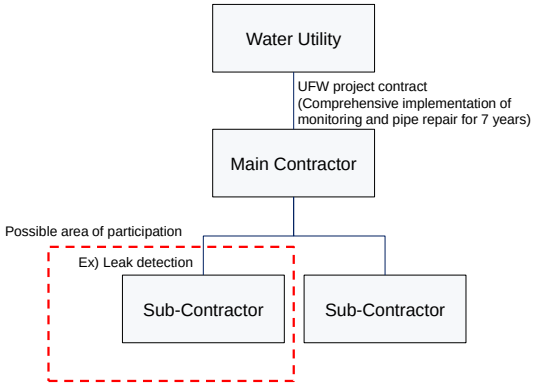


Figure 7 Expected order routing

There is currently very little clarity on what role the contracting companies would play once the UFW project completes its slated period (of 7 years). After completion of the UFW project, BWSSB may choose to have direct control over leakage management, or may opt to have contractors to comprehensively manage the pipelines. In either case, BWSSB would need to overhaul and expand its leakage management system. In 2015, BWSSB published a book named 'Active Leak Management Best Practice Guide', which advocated a shift from passive to active leak management. The book also recommended establishment of a dedicated structure within BWSSB for this purpose. This structure set up on the end customer side can be supported through a technical cooperation project from JICA, which can result in a long term leak management structure and a strong base for long term business.

viii Consider the model and project component for market entry based on information analysis for "business to government" market in India

In the case of normal leak detection business implemented in Japan, the payout is based on a combination of personnel expenses and overhead expenses for X kms, and payment is done on the basis of number of leakages detected and the leakage volume.

Keeping the above in mind, during our 9th visit in relation to the final report on our dissemination and test project, it has been agreed that, on the basis of a proper fit with the scheme involving the local company as mentioned before, the proposal would be as practical as possible. Further, as having an outright outcome-based payment model

is not favorable in terms of profitability or risk, we think that it is more suitable if the model is a combination of fixed price and an outcome based price in case the result would be better than we expected.

(2) Self-reliant and Continual Activities to be Conducted by Counterpart Organization

The objective of technical training and manual preparation was to enable BWSSB members to get self-reliant in leakage detection system technology. Transfer of technology towards the AE members with regard to overall system operation, water supply shift proposal and monitoring procedures (see Figure 7) were provided. We hope that these will enable BWSSB to continue operating the leakage detection system even after this project is completed.

Further, senior members from BWSSB participated in L-sign testing and technical training, and in observation exercises at leakage sites. As a result of this, a deeper understanding among them regarding the importance of leak management and improved understanding of the details of leakage detection were observed. As an indication of this, there is also consideration within BWSSB to set up a new department to handle planning of new pilot projects and leakage management.

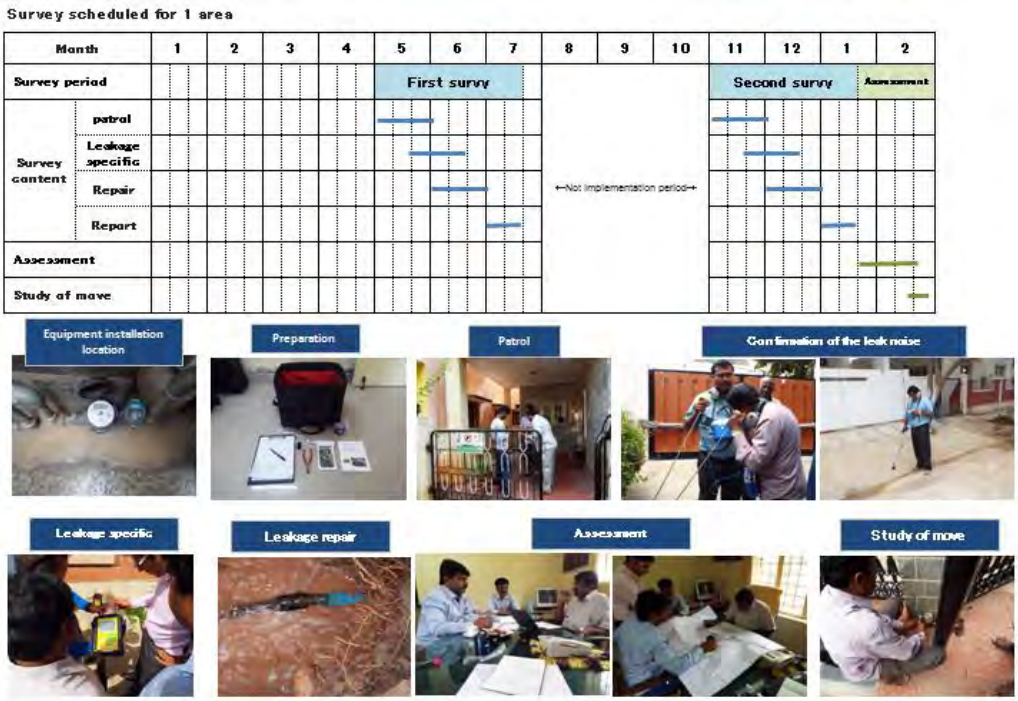


Figure8　leakage monitoring system process

4. FUTURE PROSPECTS

(1) Impact and Effect on the Concerned Development Issues through Business Development of the Product/ Technology in the Surveyed Country

i Issues in the current UFW project

As per our analysis done locally, the existing UFW project is an outcome-based scheme where the contracting company is bound to pay penalty to BWSSB if the criteria of 16% for UFW is not achieved. According to BWSSB, the targeted UFW ratio for the current project appears hard to achieve as in June 2016. BWSSB has also commented that one of the reasons for this is that the existing contractors do not have adequate technology to implement leak detection.

On the other hand, there is currently very little clarity on what role the contracting companies would play once the UFW project completes its slated period (of 7 years). After completion of the UFW project, BWSSB may choose to have direct control over leakage management, or may opt to have contractors to comprehensively manage the pipelines. In either case, BWSSB would need to overhaul and expand its leakage management system.

ii Effectiveness in resolving issues

The results of the in-progress UFW project can significantly improve with the introduction of the leakage detection and monitoring system (combination of acoustic and correlation methodologies) that was developed as part of our dissemination and test project. Further, we also hope that the trainings and knowledge transfer given to the senior members and field personnel of BWSSB would contribute to increasing awareness of the importance of leakage monitoring as an effective method for UFW, and that this would show up in the form of improved results in the UFW project.

iii Dissemination of Leakage monitoring technology in India

Currently, there are no private companies in India that can implement leakage monitoring at the level being done in Japan. Commercial implementation of this technology can be carried out by tying up with a private Indian company. Assuming that there would be a transfer of technology involved, this would result in a marked improvement in the level of leakage monitoring technology among Indian private companies. With improved awareness among BWSSB members, and training of private companies that are a major support to the water board, we are hopeful that this will contribute to overall improvement in the implementation capability of leakage monitoring in India.

(2) Lessons Learned and Recommendation through the Survey

iv Design and implementation of training for leakage monitoring technology

a. Training program design

While we designed a training program for 3 AE members of East 1 Division, there were several requests from BWSSB to conduct a short 1-day training program for senior BWSSB members including the Chairman, too. The background for this was that, since BWSSB was in charge of CP, there was a need to not only provide training on leakage monitoring technologies but also offer content that would contribute to improvement in awareness of the senior members regarding leakage monitoring.

b. Implementation of training program

Technical training was conducted for 3 AE members of East 1 Division in the area of leakage monitoring. While the 3 members were quite motivated in undergoing the training, they often had to juggle their training with their day-to-day responsibilities, which sometimes had an impact on the continuous availability of the members for the said training. Though a request was made to the CP to have their full concentration during the training program, which the CP had accepted, it was difficult to implement this at the field level, and the trainee AE members sometimes appeared quite burdened during the training. Additionally, since BWSSB does not currently have a dedicated department for leakage monitoring, questions still remain on how the trained members would utilize their knowledge and expertise in a sustained manner.

Further, in July 2016, STS has proposed to the BWSSB Chairman to institute a dedicated department to oversee water leakage and NRW. The Chairman has shown an active interest in this proposal, and a continuous pursuance of this is highly desirable.

v Proposals on a few other issues observed during this project

a. To decide on suitable evaluation criteria for UFW project (leakage monitoring).
b. To institute a dedicated pipeline maintenance team within BWSSB with focus on water leakage management.
c. To impart requisite technical training and knowledge on water leakage management to project members.
d. To improve facilities to carry out appropriate maintenance work.
e. Speedy implementation of projects centered around leakage monitoring.

Appendix

ATTACHMENT: OUTLINE OF THE SURVEY

India

Verification Survey with the Private Sector for Disseminating Japanese Technologies for the Water Leak Detection Service Using a Leakage Monitoring Technology

Suido Technical Service Co., Ltd., Kanagawa Prefecture, Japan

Concerned Development Issues in INDIA

- Need to secure quality, quantity and supply time for water services
- Water Leaks due to aging pipes and faulty infrastructure
- Under-developed technology for leak detection (ground patrolling)

Implemented Activities in the Survey

- Modification of leak detection devices based on local water supply conditions (low pressure, supply in shifts), implementation and dissemination of water leakage detection test in the pilot test area
- Training in leak detection technology imparted to BWSSB (Bangalore Water Supply and Sewage Board) members

Proposed Products/Technologies

Installation of Automatic leak detection device（L-sign）

Acoustic + **Correlation**

Identify leakage points by combination of various leak detection methods

Detection of water leakage area by L-Sign made it easy to specify leakage points with acoustic and correlation methods.

Impact on the Concerned Development Issues in INDIA

- Early prevention of leakage
- Improved revenues and profitability for water board on account of reduction in NRW
- Improved services of water board on account of effective utilization of water resources

Outputs and Outcomes of the Survey

- Suitability of the proposed product (L-sign) to local environment
  Development of leakage detection program suitable to the local water supply situation
- Development and operation of leakage detection system
  Setting up of L-sign operation method applicable to shift-based water supply schedule
- Implementation of leakage monitoring technology training and preparation of leakage monitoring manual
- Development of business with local partner company after project completion
  Conclusion of NDA with local partner company