The Assistance Related to Delhi Water Supply Improvement Project

SCADA System

for Equitable Distribution and Non-Revenue Water Management in part of Pitampura UGR command area

29. Aug. 2017

Joint presentation by
U.K. Rastogi . E. E. (NW) E&M, Delhi Jal Board
Manabu Fukushima, SCADA Expert, JICA expert team

1 Background, Goals and Targets of achievement

1

1-1 Background

The pilot project was planned under the Detailed Planning Survey conducted by JICA in 2013. Main objective of this pilot project is to monitor and control water flow and pressure at selected DMAs for equitable water distribution by using SCADA System in under Pitampura UGR command area.

2

1-2 Goal for the pilot project

The pilot project intends to obtain the technical know-how on how to control valves for equitable water distribution and to minimize water pressure difference within DMAs. It also intends to obtain knowledge on how to measure NRW.

SCADA system would prove be a very effective tool for solving NRW issue. Valve adjustment enables equitable water supply and also it can measure the difference between quantity of water at inlet and the actual usage amount.

3

1-3 Achievement Targets

Achievement Targets of DJB staff are as follows;

- -Understand the basics of SCADA system
- -Operation of SCADA system for equitable distribution and NRW reduction
- -Monitor inflow and pressure
- -Monitor amount of water consumed that is billed
- -Estimate NRW comparing inflow amount with consumed amount
- -Develop manual on SCADA operation and NRW measurement

4

2 Water Distribution SCADA system

5

2-1 Water Distribution SCADA system

SCADA systems for water treatment plant or for water distribution monitoring are already used in DJB and in other sites across India, but this is the first attempt for using SCADA for water distribution control to achieve Equitable Distribution and Non-Revenue Water Management in India.

6

2-2 SCADA system of the pilot project

SCADA system is installed on existing Pitampura Under Ground Reservoir (UGR) command area. Water supply condition is monitored in real time, and then valves will be operated to control flow/ pressure by using SCADA system in the selected DMAs and selected control points.

Selected 3 DMAs and 14 local control points are being established and in Pitampura UGR command area as shown in next sheet.

7

2-3 Pitampura UGR command area

8

3 SCADA system Construction and Progress

9

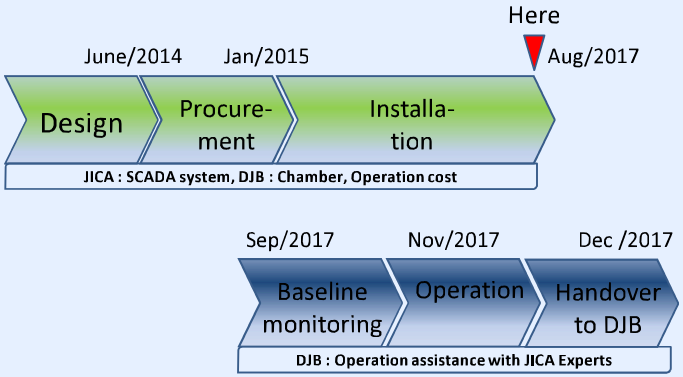
3-1 Scope of Work

	Equipment	JICA	DJB
1	SCADA equipment's installation, control valve, flow meter. pressure gauge and RTU/PLC etc.	X	
2	Control valve	X	
3	Flow meter	X	
4	Pressure gauge	X	
5	Chamber civil work and related action		X
6	Installation of equipment for DMA and SCADA system	X	
7	Operation cost (electricity and communication)		X

-JICA bears all the cost of equipment (valve, flow meter, pressure gauge, SCADA system etc.) and its installation cost.
-DJB bears the cost of chamber construction, electricity and communication for operating SCADA system.

10

3-2 Progress



11

3-3 After SCADA system Construction

Items	Activity	When
1. Trial Operation	Witness the Final Trial Operation and Training of the SCADA Operation	To September
2. Baseline monitoring	SCADA system and recording of the daily measurement data Pressure & Flow Monitoring at 14 locations and BPS	September
3.SCADA Operation for equitable	Try to control equalizing pressures and flow to each DMAs	November to December
4.Estimation of NRW (commercial and physical losses)	Estimation of NRW (commercial and physical losses) using SCADA monitoring data	September
5.Analysis of SCADA operation	Consider the issues of controlling equitable distribution to each DMAs. Formulate of guideline for equitable distribution and NRW management.	December to Febuary/2018

12

4 Challenges

13

4-1 difficulties of SCADA operation

The difficulties of the SCADA operation in pilot project are;

- It is necessary to control valves by trial and error in only 3 hours of supply time each in the morning and the evening considering the total water distribution situation.
- There are few engineers having knowledge and understanding of distribution SCADA. However, after introduction of distribution SCADA in Chandrawal command area under the ODA loan project, SCADA should be managed. Therefore, knowledge of the distribution SCADA should be acquired by every staff of DJB before it is installed.

14

4-2 Approaches of SCADA system

The following approaches are adopted to address the problems.

- Pressure in the areas will be forecast by the simulation of distribution network before controlling valves by SCADA.

- The Manual/ Guideline will include not only the SCADA operation method, but also the description on management of equitable distribution using SCADA. And This Manual/ Guideline included Know-hows will be shared among every staff of DJB even after this pilot project.

15

5 SCADA system in detail

16

5-1 SCADA system in the pilot project

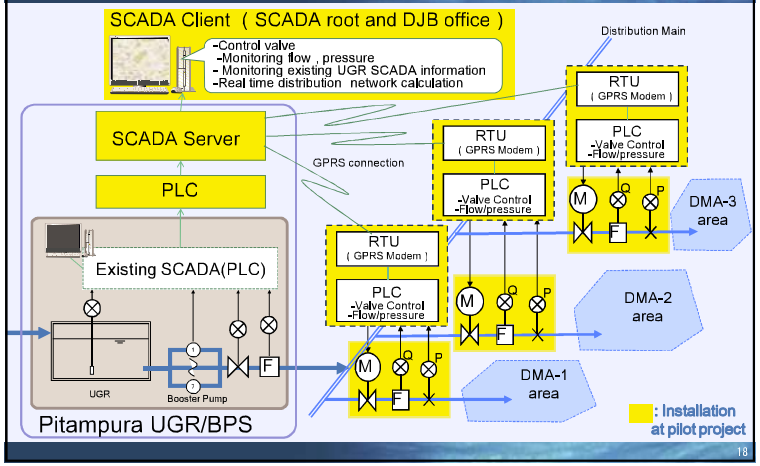
SCADA :Supervisory Control And Data Acquisition

Water Distribution SCADA system is composed of :

- SCADA Server: back-end system for control and supervisory management of SCADA.
- SCADA Client: Graphical user Interface for user operation
- PLC(programmable logic controller) Panel: Communicate with SCADA Server and field sensors and control valve actuator by instruction of SCADA
- Field sensors: Flow meters, Pressure gauges, Float level sensors
- Control equipment: Valve Actuator

17

5-2 Water Distribution SCADA Image



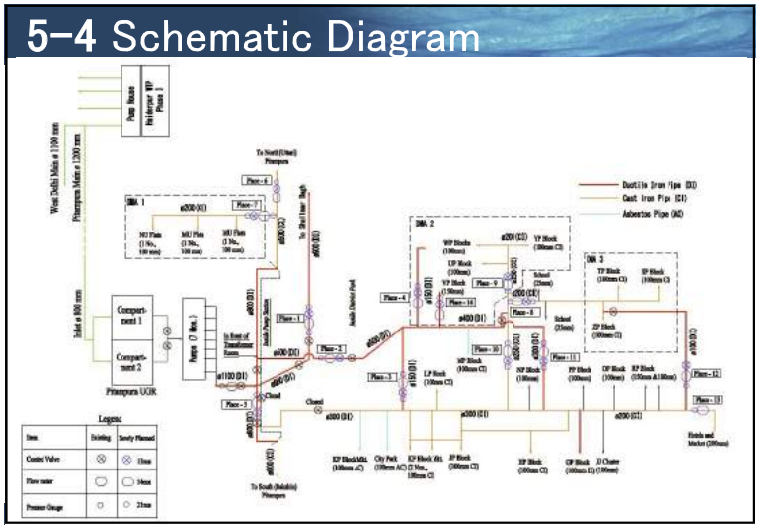
18

5-3 Features of this SCADA system

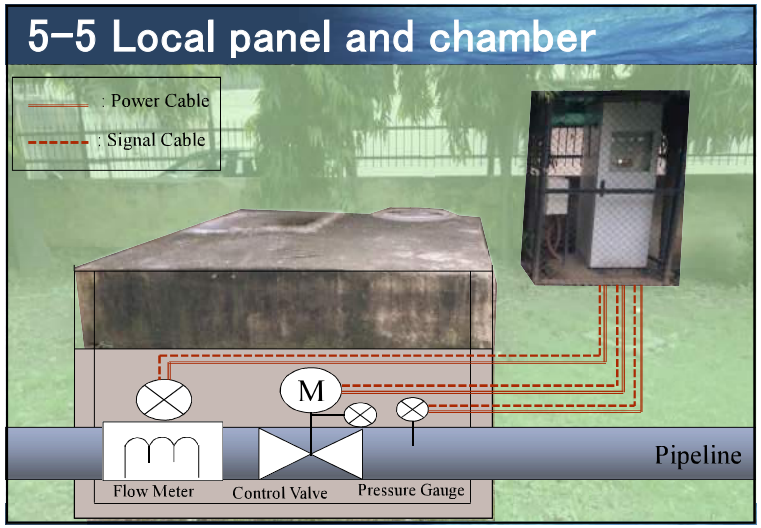
1) Monitoring of flow/pressure
2) Control of valves through the SCADA
3) Transfer of information from the existing UGR SCADA
4) Installation of exterior measurement stations and GPRS transmission for the water distribution pipeline network
5) Real time distribution network calculation

19

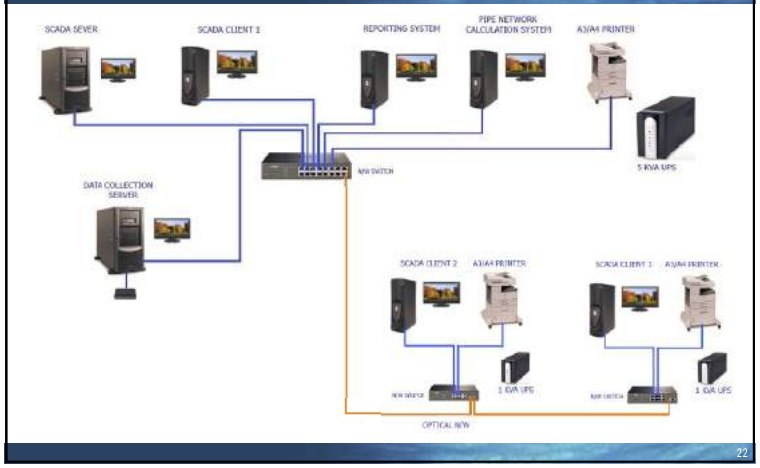
5-4 Schematic Diagram



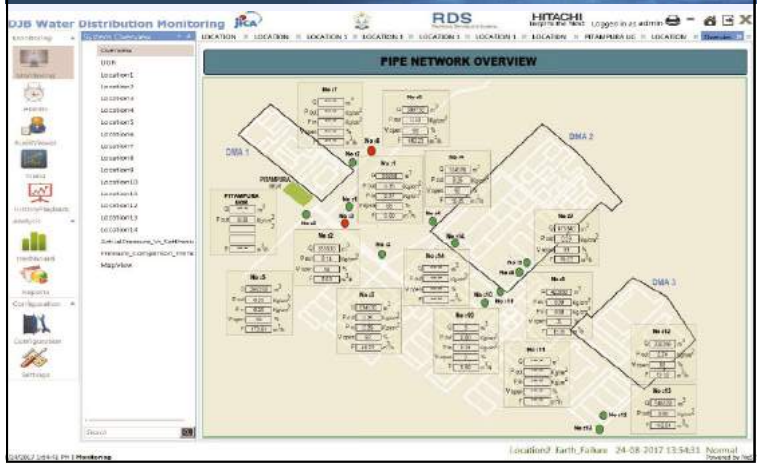
5-5 Local panel and chamber



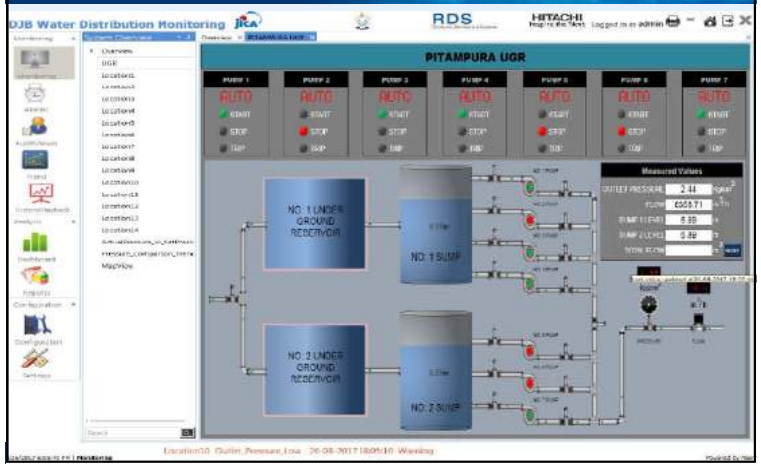
5-6 SCADA Server and Clients



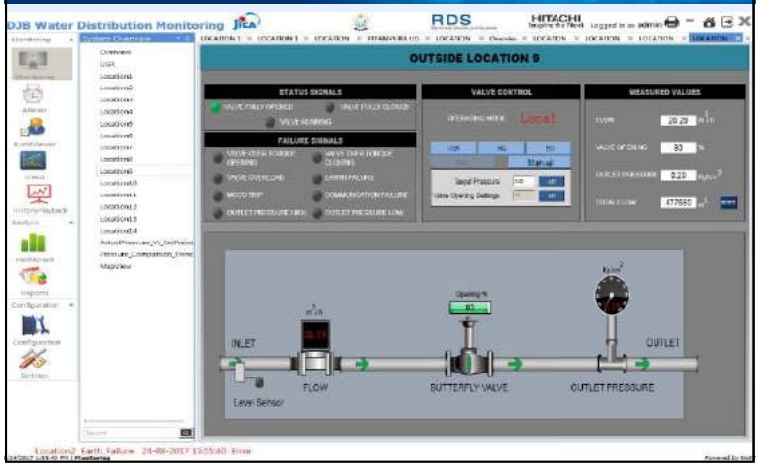
5-7 SCADA screen (Overview)



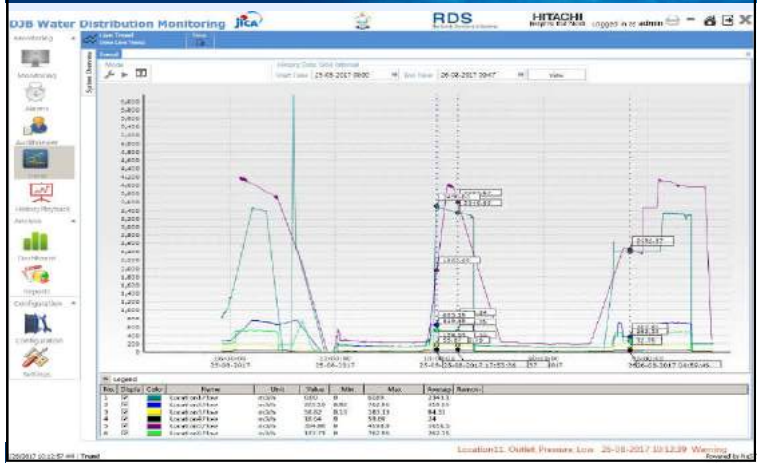
5-8 SCADA screen (UGR)



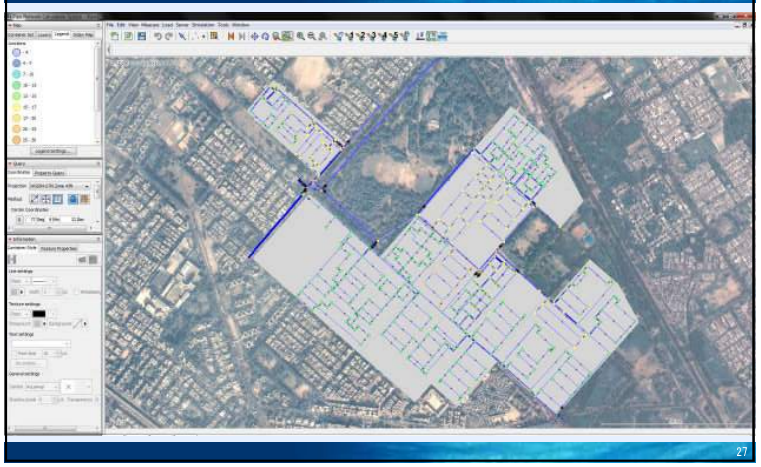
5-9 SCADA screen (Outside Location)



5-10 SCADA screen (Trend)



5-11 Pipe Network Calculation system screen (whole area)



A9-165

5-12 Remote connect to SCADA

28

6 Conclusion

29

6-1 Achievement Targets

- Water Distribution SCADA system is installed
- Flow/pressure of 3DMA and Distribution area can be monitored (Known).

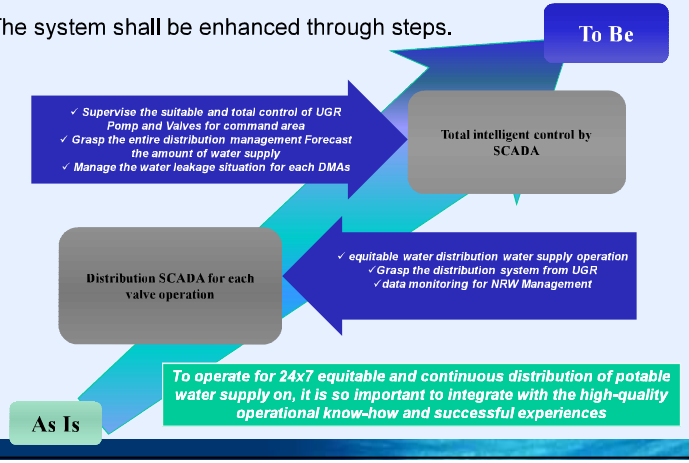
Valves of 13 locations can be controlled through the SCADA.

- SCADA system for equitable distribution and NRW reduction can be operated from now.

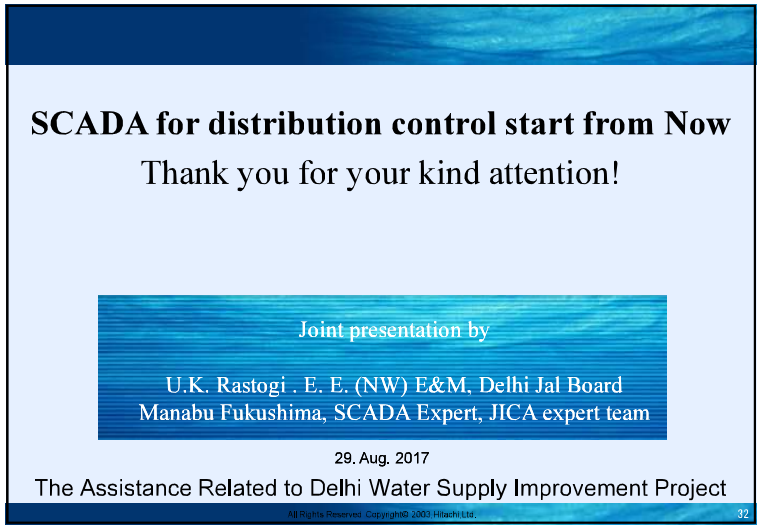
30

6-3 Scenario to 24 x 7 water supply

The system shall be enhanced through steps.



31


SCADA for distribution control start from Now
Thank you for your kind attention!
Joint presentation by
U.K. Rastogi . E. E. (NW) E&M, Delhi Jal Board
Manabu Fukushima, SCADA Expert, JICA expert team
29. Aug. 2017
The Assistance Related to Delhi Water Supply Improvement Project
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32

The realization of Equitable Water Supply and the management of NRW

～The Installation of SCADA System～

The 5th Seminar Under
"The Assistance Related To Delhi Water Supply Improvement Project"

29th August, 2017 (Tuesday)
@Hotel Crowne Plaza, Rohini India

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1

Contents

2

Contents

3

0 Self –Introduction

About Myself

✓Tokyo Metropolitan Waterworks Bureau
- Working water supply section as a director at east area first branch office
- Design about mechanical and electrical equipment for water treatment plant
- Operation and maintenance in WTP and WSS
- Environmental countermeasures for water supply (climate change, global warming, and CO_2 reduction)

✓Japan Bank for International Cooperation
- Formation and appraisal for yen loan project

✓JICA Technical Expert
- Work in Delhi for "the assistance related to Delhi water supply improvement project" from 2012 to 2015

4

Contents

5

1 The Comparison of Delhi and Tokyo

General Information

	TOKYO	DELHI
Population	13,725,788 Male 6,763,220 Female 6,962,558 As of 2017. 6.29	13,850,507 (2001) 16,787,941 (2011)
Area	Area 2190.75km^2	Area 1,483km^2
Precipitation	Annual Average Rainfall Approx. 1,530mm	Annual Average Rainfall Approx. 714mm
Average Temperature	Annual Average Temperature 15.4℃	Annual Average Temperature 25℃

6

1 The Comparison of Delhi and Tokyo

Tokyo Metropolitan Waterworks Bureau (TMWB) and Delhi Jal Board (DJB)

Commencement of Water Business	5.July.1890	6.April.1998 Shift to Delh Jal Board
Personnel Number	3,759 People As of 1.April .2016	Approx. 20,000 people
Content of Business	Water Supply	Water Supply and Swerage
Water Resource	Tone river, Ara river, Tama river, Sagami River systems(99.8%), Ground Water(0.2%)	Yamuna, Bhakhra Storage, Upper Ganga Canal & Groundwater
Water Service Pervasion	100% 24×7	About 83% households of Delhi have now access to piped water supply
Population Served	13,172,845 People	Water is supplied to about 18 million population of Delhi
Total Length of extended distribution Pipes	26,915km	Through a water supply network comprising of 11,540 kms long pipelines
Total Capacity of Facilities	6,859,000m^3/Day (1,508million Gallons per Day)	Water Production during the summer season is being maintained at 890 - 905 million gallons per day consistently. (4,100,000m^3/Day)

7

1 The Comparison of Delhi and Tokyo

Outline of the Facilities of Water Treatment Plant in TMWB

Source of Raw Water Suppiy	Name of WTP	Production		Ratio(%)		Treatment Method
		(m^3/Day)	(MGD)	WTP	Water Resource	
Tone and Arakawa River Systems	Kanamachi	1,500,000	330	21.9	79.9	Rapid Sand Filtration • Advanced Water Treatment
	Misato	1,100,000	242	16.0		Rapid Sand Filtration • Advanced Water Treatment
	Asaka	1,700,000	374	24.8		Rapid Sand Filtration • Advanced Water Treatment
	Misono	300,000	66	4.4		Rapid Sand Filtration • Advanced Water Treatment
	Higashimurayama	880,000	194	18.4		Rapid Sand Filtration • Advanced Water Treatment
		385,000	85			
Tama River System	Ozaku	280,000	62	4.1	17.0	Rapid Sand Filtration
	Sakai	315,000	69	4.6		Slow Sand Filtration
	Kinuta	114,500	25	1.7		Membrane Filtration • Slow Sand Filtration
	Kinutashimo	70,000	15	1.0		Membrane Filtration • Slow Sand Filtration
	Tmagawa		0	–		Slow Sand Filtration • Rapid Sand Filtration
Sagami River System	Nagasawa	200,000	44	2.9	2.9	Rapid Sand Filtration
Ground Water	Suginami	15,000	3	0.2	0.2	Chroline Injection Only
Total		6,859,500	1509	100.0	100.0	–

8

1 The Comparison of Delhi and Tokyo

Outline of the Facilities of Water Treatment Plant in Delhi Jal Board

Source of Raw Water Supply	Name of WTP	Production including Recycling from process (m^3/Day)	(MGD)
Wazirabad Pond	CHANDRAWAL	427,332	94
	WAZIRABAD	613,722	135
Delhi Branch (Existing Kacha Canal)	HAIDERPUR	1,027,416	226
	NANGLOI	181,844	40
Raw water will come ultimately through Munak Canal. However, as interim arrangement reclaimed water from Chandrawal Recycling Plant is being pumped to Okhla WTP	OKHLA	90,922	20
	DWARKA	195,482	43
	BAWANA	68,191	15
Upper Ganga Canal	BHAGIRATHI	486,432	107
	SONIA VIHAR	640,999	141
From surface water	Production from WTPs	3,732,340	821
From sub-surface water	Ranney Wells (15 Nos.& T/Wells (about 4400))	363,687	80
Total		4,096,027	901

9

Contents

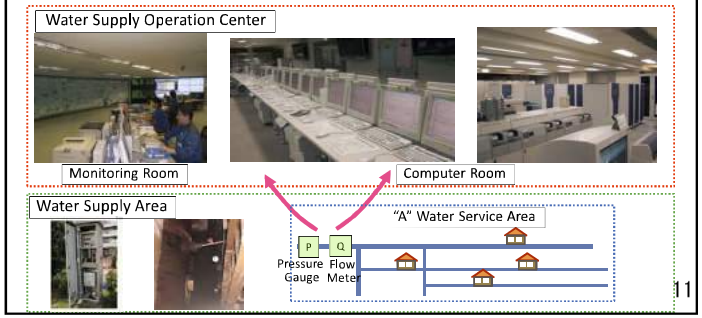
10

2 The Installation of SCADA System

What is SCADA?

SCADA; **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition

In Japan Tokyo ,The words "SCADA" is not common technical term; rather unfamiliar word. We instead use " Water Supply Operation System" more often. "SCADA" is a system consists of computers and communications equipment. The system allows the center to meticulously operate the pumps of each facility in accordance with demand fluctuation through monitoring data from the whole service area.



11

2 The Installation of SCADA System

Why does DJB need to install SCADA System?①

Delhi Jal Board wants to achieve continuous and equitable water supply through 24hours ×7days to Delhi citizens.

How is condition of Delhi Jal Board water supply system?

①Lack of water resources

②Aged Water facilities
(WTPs, Pumping Stations, Pipes)

12

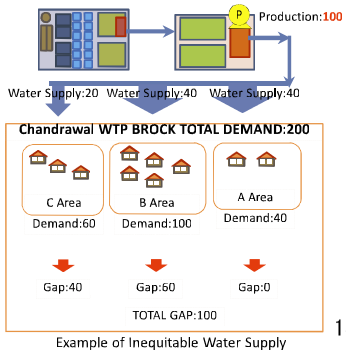
2 The Installation of SCADA System
Why does DJB need to install SCADA System?②

③Time-restricted Water Supply
(Ex. Morning from 5 to7 A.M.
Evening From5 to 8 P.M.)

Water storage tank(Households)

Booster pump

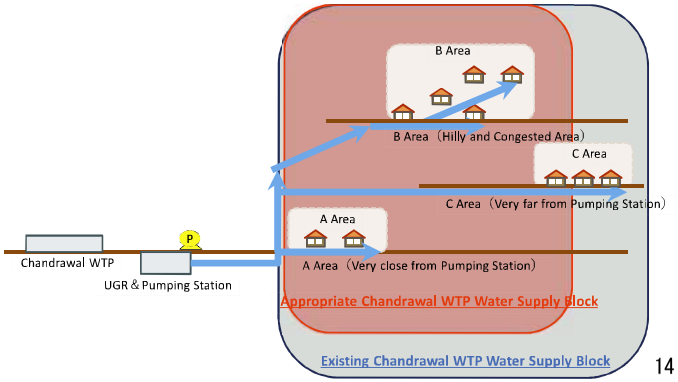
④Inequitable Water Supply-①



Example of Inequitable Water Supply

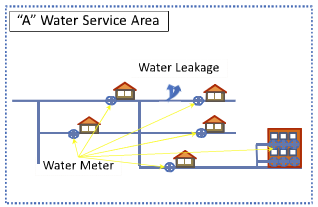
2 The Installation of SCADA System
Why does DJB need to install SCADA System?③

④Inequitable Water Supply-②



2 The Installation of SCADA System
Why does DJB need to install SCADA System?④

⑤Grasping of Non Revenue Water



Revenue Management System

Water Meter

Water Measuring

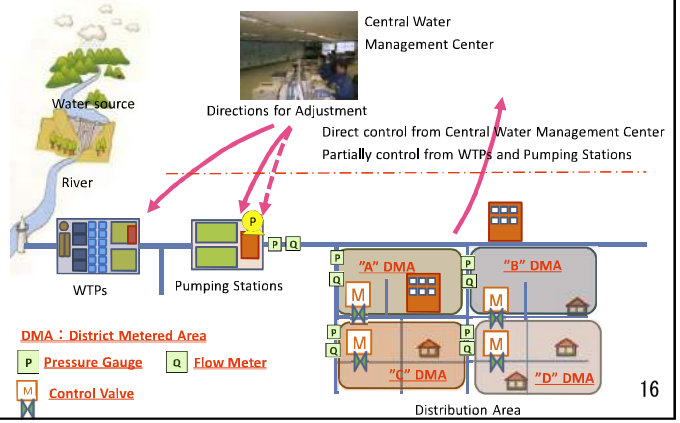
・ RMS manages water volume and water charges of each water user.

・Water meters aren't installed in some households at present, so it is difficult to grasp all water volume.

・There are no "DMA" in Water Service Area, it is also impossible to grasp "NRW".

2 The Installation of SCADA System
Future Image of DJB Water Supply Operation①

All the Water Supply Facilities of DJB will be controlled by Central Water Management Center.

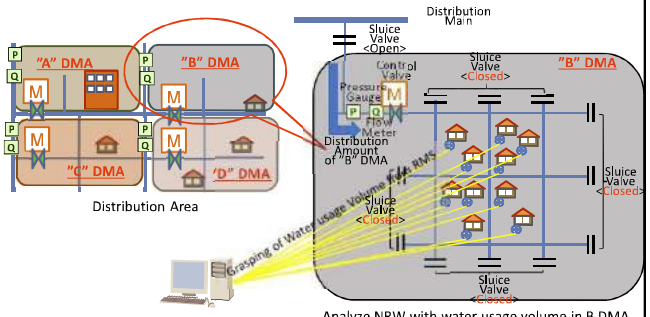


2 The Installation of SCADA System

Future Image of DJB Water Supply Operation②

Grasping of NRW with setting of DMA and utilization of RMS

⇒Pre-trial at Pitampura pilot project area

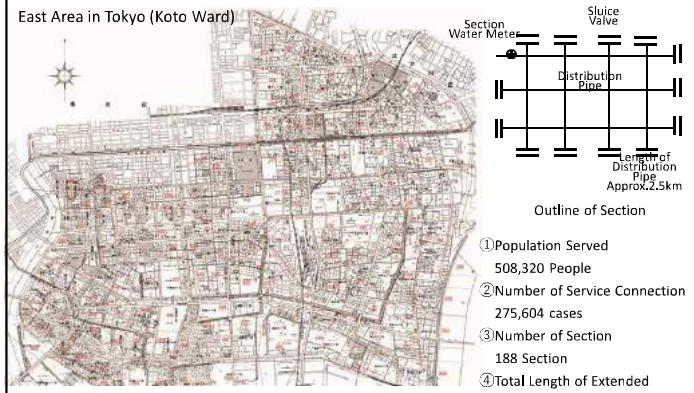


17

2 The Installation of SCADA System

Outline of Section for water leakage investigation in Tokyo

East Area in Tokyo (Koto Ward)



Outline of Section

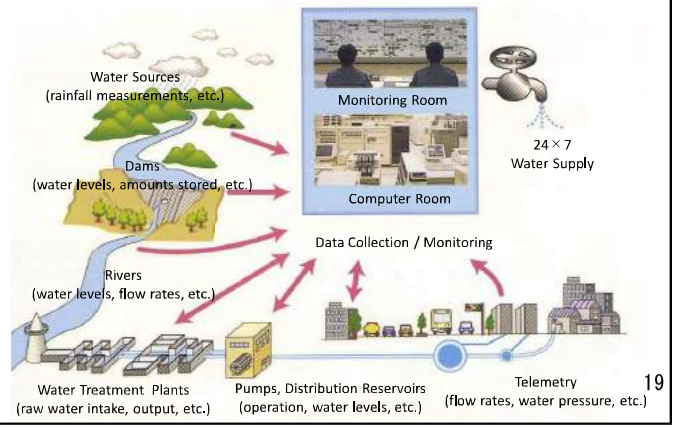
①Population Served
508,320 People
②Number of Service Connection
275,604 cases
③Number of Section
188 Section
④Total Length of Extended Distribution Pipe 642km

18

2 The Installation of SCADA System

Water Supply Operation System in Tokyo

Collecting data on pressure and flow rate from water sources, WTPs and distribution networks



19

2 The Installation of SCADA System

The History of water Supply Operation Center in Tokyo

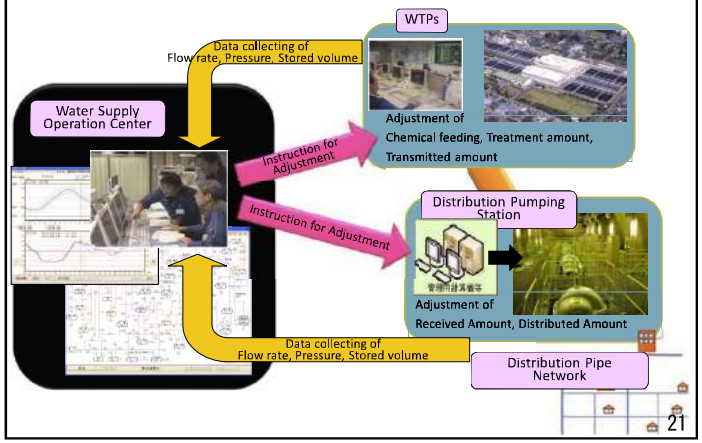
- ◆ 1964: Telemetry system began to be installed.
- ◆ 1979: Water Supply Operation Center was established.
  - 215 of Distribution Pipe Telemeters
  - 1,400 of Collecting Data

- ■ 2012: 310 of Distribution pipe Telemeters
  - 20,000 of Collecting Data
  - 54 of Monitoring Facilities
- ■ Fulltime monitoring with 24 hours per day
- ■ The operations for the water supply stations and water treatment plants are carried out on the basis of the raw water plan, main line control and management plan, distribution pump operation plan, and service reservoir control and management plan prepared by the center.

20

2 The Installation of SCADA System

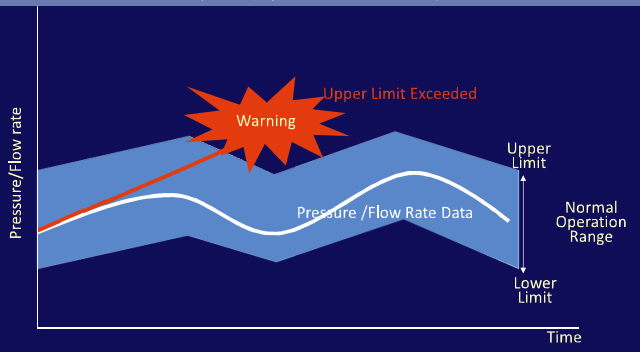
Function of SCADA System (Monitoring and Adjustment)



21

2 The Installation of SCADA System

Function of SCADA System (Pipe Trouble Detection)



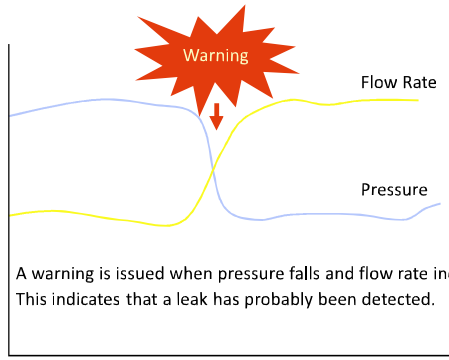
If the upper or lower limits defined are exceeded, a warning is issued.

※ When an alarm sounds, the condition is displayed on the multiscreen.

22

2 The Installation of SCADA System

Function of SCADA System (Pipe Trouble Detection)



A warning is issued when pressure falls and flow rate increases, suddenly. This indicates that a leak has probably been detected.

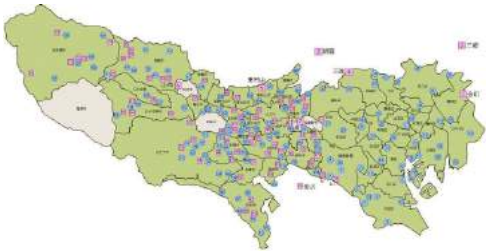
※ When an alarm sounds loudly and the condition is displayed on the multiscreen.

23

2 The Installation of SCADA System

Water Quality Monitoring System

- Install 131 auto water quality meters at water tap within the Tokyo Metropolitan area
- Continuously monitor "Residual chlorine density" , "Turbidity" ,"Chromaticity "



The Location of meter

Auto water quality meter

24

A9-173

2 The Installation of SCADA System

The role sharing for monitoring and maintenance of SCADA

☆Main tasks of Pumping station after the installation of SCADA are three, "Monitoring and Control", "Maintenance" and "Planning". These tasks rotate among all Pumping Station's staffs. Specific tasks are as follows.

◇Monitoring and Control
- ○Pump Operation
- ○Pressure, Flow volume monitoring
- ○Valve control

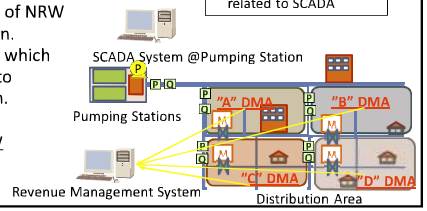
◇Maintenance
- ○Mechanical Equipment
- ○Electrical Equipment
- ○Pressure Gauge and Flow Meter(DMA)
- ○Valve(DMA)
- ○Drain Pump in the chamber

◇Planning
- ○Pump Operation Plan
- ○Analysis of Pressure and Flow Volume from SCADA data within each DMA

※Red letters show tasks related to SCADA

☆And also, as for the estimation of NRW usually carry out special section. Because there are lots of data which analyze these data and need to collaborate the related section.

◇Management of NRW
- ○NRW Estimation



25

Contents

26

3 Conclusion; A New Challenge of Water Supply in Delhi Jal Board

The First Stage

Rehabilitate aged water facilities
(WTPs, Pumping Station, Pipes)


Old WTPs


Old Pumping Stations


Aged Water Pipes


Dwarka WTP

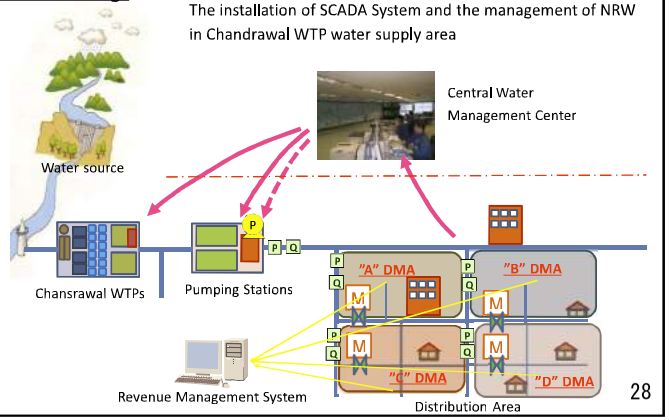

Under construction of WTP

27

3 Conclusion; A New Challenge of Water Supply in Delhi Jal Board

The Second Stage

The installation of SCADA System and the management of NRW in Chandrawal WTP water supply area

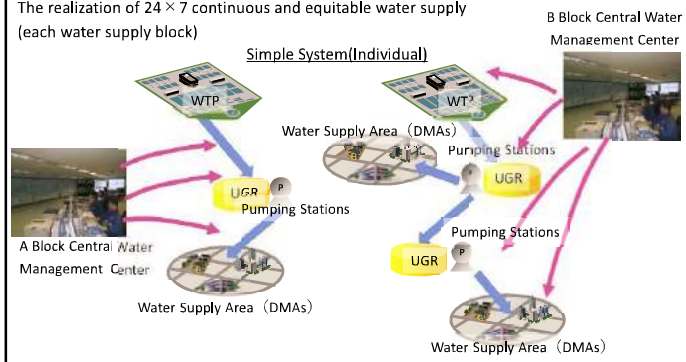


28

3 Conclusion; A New Challenge of Water Supply in Delhi Jal Board

The Third Stage

The realization of 24×7 continuous and equitable water supply (each water supply block)



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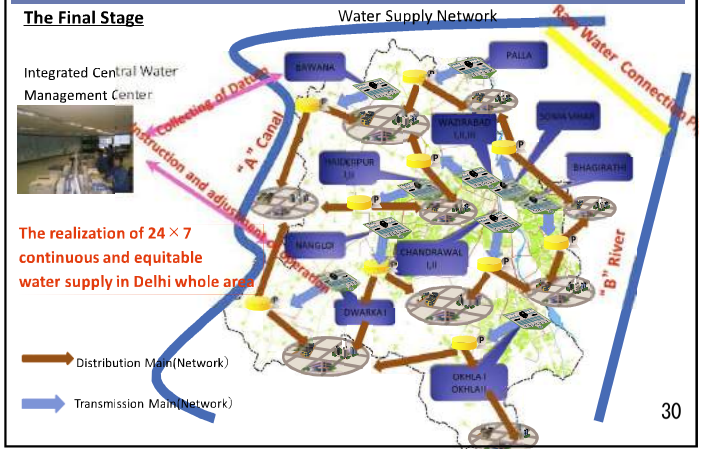
3 Conclusion; A New Challenge of Water Supply in Delhi Jal Board

The Final Stage



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Thank you very much

for your kind attention

31

Human Resources Development for Sustainable Water Supply Business

- Examples of Tokyo Metropolitan Waterworks Bureau -

The 5rd Seminar in Delhi
29th August, 2017

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1

Today's Topic

1. Current Staff Conditions at Tokyo Metropolitan Waterworks Bureau (TMWB)
2. Past Human Resources Development
3. Current Human Resources Development

2

1 Current Staff Conditions at Tokyo Metropolitan Waterworks Bureau (TMWB)

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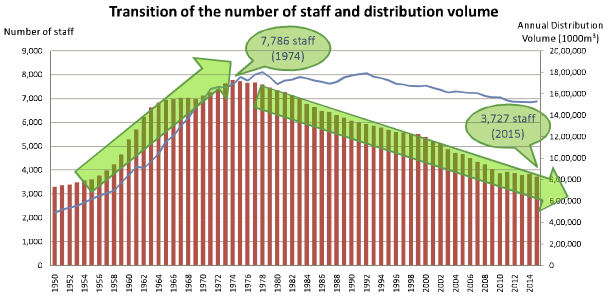
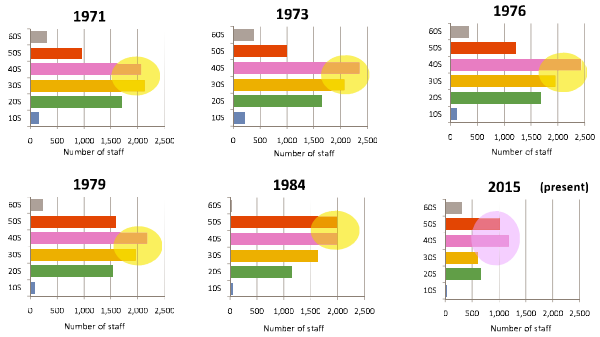
1.1 Transition of the Number of Staff (1950 ~ 2015)



- 1955～1975: The number of staff doubled in 20 years
- 1975～2015: The number of staff halved in 40 years ⇒ expanded outsourcing

4

1.2 Changes in Age Composition of Staff



- From 35 to 50 years ago, the main workforce was staff in their 30s, 40s and 50s.
- Today, the number of staff decreased significantly, halving the staff in their 30s to 50s.

5

2 Past Human Resources Development

6

2.1 Past Personnel/Appointment System

Postwar Reconstruction Period (1945 to 1954)

- A large number of temporary staff were hired for reconstruction
- Many were junior high school graduates
- Enforcement of The Local Public Enterprise Law (1952)

High Economic Growth Period (1955 to 1973)

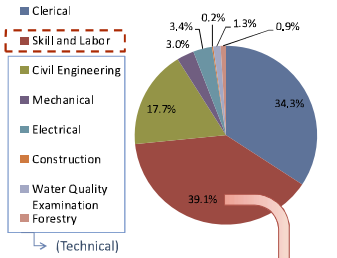
- A large number of staff were hired for 1964 Tokyo Olympics
- A large number of staff were hired during the booming period
- 50% were high school graduates, 30% were skill and labor staff
- Introduction of the salary grade system (1957)
- Implementation of managerial exam (1958)
- Establishment of capacity certification system (1963)

Abolition of academic requirements in employment exam (1968)

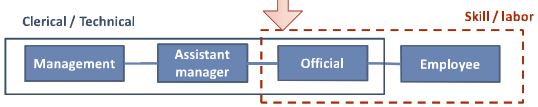
- Establishment of rules concerning job titles (1971)

7

2.2 Staff Composition By Job Type (1970)

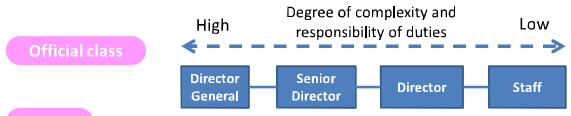


Job Type	
Clerical	Clerical
Technical	Civil engineering, construction, machinery, electricity, forestry, water quality inspection
Skill / labor	Patrol, car driver, crew, janitor, non- clerical



8

2.3 Appointment System Based on Professionalism on the Duty (1971)



Duty

Job Grouping	Duty
Clerical	General clerical work
General technical	Civil engineering, construction, mechanical, electric, forestry, water quality inspection technology
Skills	Car driving, seamanship, patrol
Labor	General non-clerical, general janitoring work
Business	Water service and general business

- Set new job titles according to the authority and responsibility of duties
- Structured by the names of the level and the duty of the job

9

2.4 Past Training System

Postwar (1945 – 1954)

- Establishment of a training center for TMG staff (1949)
- Implemented broad administrative training and general staff training for general office workers and technical staff, but no trainings specific to TMWB

Municipal training was not sufficient for TMWB staff to carry out their duties

Construction of TMWB-specific training system was necessary

Must acquire knowledge and skills necessary for TMWB staff,

High economic growth period (1955 – 1973)

- Enactment of the guideline for TMWB staff training (1965)
- Establishment of TMWB's own training center (1969)

10

2.5 Implementation of Training (1966)

Guidelines for TMWB staff training

- Improve staff capacity, demonstrate and improve work efficiency
- Promote efficient operation of water supply business

Implemented training for the staff deliberately and systematically

Category	Name of Training	Days	Number of Trainee
Bureau Training	New recruits lecture Lectures for special project staff, etc.	7 days 7 days	976
Municipal Training	Deputy manager training Manager training Specialty training (budget, contract, urban planning, electric technology etc.) etc.	7 days 3 N 4 D 5 - 8 days	299
Outsourced Training	Electronic computer training seminar Dam/Reservoir development and multipurpose utilization seminar Automatic control seminar, etc.	12 days 2 days 5 days	142

11

2.6 Training Plan (1975)

Basic Policy

- Based on the management philosophy of the waterworks, cultivate the sense of mission and morale in TMWB staff
- Develop skills necessary to carry out duties and cultivate officials who can live up to the citizens' trust

Category	Name of Training	Number of Trainee
In-house Training	New recruit training (clerical, technical), Management supervisor training, In-service practical training (meter reading, water supply device, water distribution work, water leak prevention), etc.	4,300
Central Training	New recruit training, Specialty training, etc.	480
External Training	Instrumental analysis workshop, etc.	194

12

3 Current Human Resources Development

3.1 Placement Management

Purpose

- Familiarizing staff with duties in waterworks
- Evaluating staff's personnel aptitudes

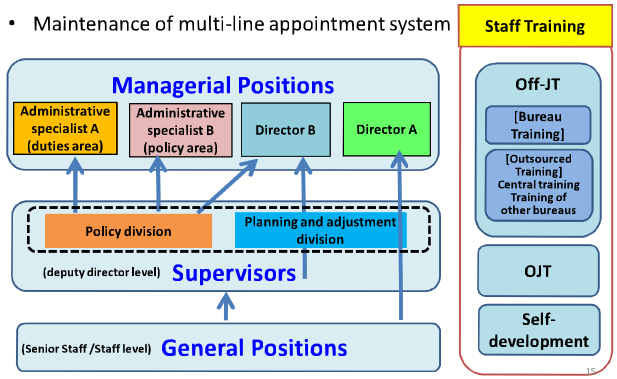
Implementing periodic personnel change where staffs change duties and departments based on the basic policy

- Human resource development through placement management
- Appropriate business management

14

3.2 Appointment System and Training

- Maintenance of multi-line appointment system



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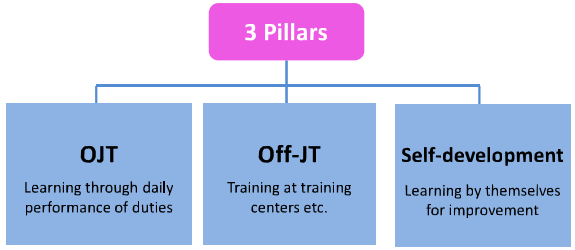
3.3 Human Resources Development System



16

3.4 OJT Promotion System at Each Workplace

Person in charge of promoting OJT at each department / site
(Director of personnel affairs)

↕

OJT Manager (Section Director)

↕

OJT Supervisor (Section Deputy Director)

↕

Target staff

General Staff
- New recruits
- Inter-bureau transferee
- Intra-bureau transferee

17

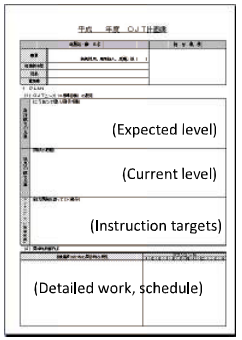
3.5 OJT Procedures

Plan
- Set OJT needs (instruction targets)
- Make detailed plans to achieve them

Do
- Proceed as planned

Check
- Evaluate the results (midterm and final)

Action
- Revise targets and goals according to the evaluation
- Reflect them in the targets and plans in the next term
- Develop into the next step



OJT Plan

18

3.6 Tutor System

Goal
- Train new recruits smoothly and effectively, and promote self-awareness and self-reliance as TMWB staff
- Improve tutoring staff's ability to provide organizational support

Items	Contents
Period	Day of hiring to the end of its fiscal year
Tutors' role	● Actively promote OJT to the new recruits. ● Provide consultation and mental support to the new recruits on the workplace environment
Instruction contents	● Knowledge and know-how necessary to carry out tasks in charge ● Mindset, attitude and compliance required as bureau staff

19

3.7 Examples of OJT (Civil Engineering)

(1) Connecting earthquake-resistant joint pipes

(2) Water control valve leak repair

(3) Water distribution tube leak repair

(4) Leak check

20

3.8 Training System (Off-JT)

21

3.9 Outline of Training and Technical Development Center

- One of the largest facilities in Japan dedicated for waterworks training and research & development
- Established the field that provides hands-on experience and the development of water technology

22

3.10 Facilities of Training and Technical Development Center

Lecture room

Electric room

Mechanical training room

Large diameter piping training facility

Small diameter piping training facility

Water purification training plant

23

3.11 Practical staff training with hands-on experimental training

Large-diameter（500㎜）piping practice

Small distribution pipe Leakage repairing practice

24

3.12 Practical staff training with hands-on experimental training

Electrical training
(special circuit training board)

Mechanical training
(Assembling-disassembling pump)

25

3.13 Training by Job Level

Goals

- Mastering knowledge etc. required for each job level
- Fostering the role of waterworks as a lifeline and service spirit

New Recruits
- Summary of TMWB business
- Water supply related laws
- Work condition
- Information security etc.

2nd Year Staff
- Fostering service spirit

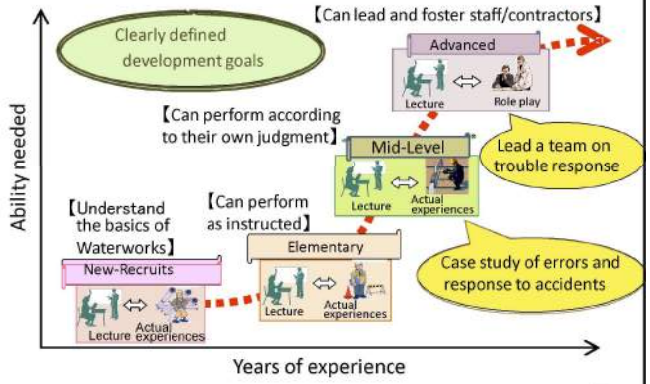
3rd Year Staff
- Problem solving skills
- Current state and challenges of TMWB
- Fostering service spirit

Mid-level Staff / Senior Staff
- Current state and challenges of TMWB
- Fostering service spirit
- Role of chief level staff

Deputy Director
- Current state and challenges of TMWB
- Team management
- Improvement of organizational manageability

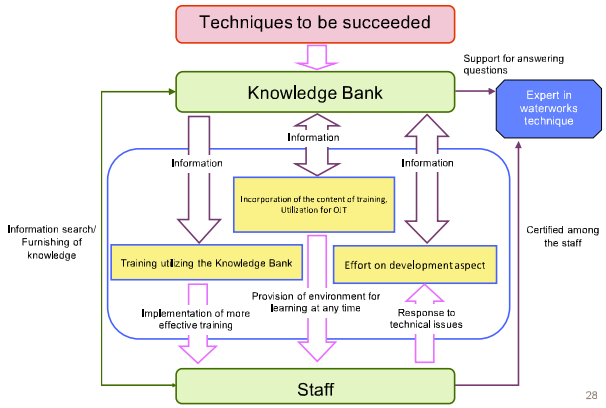
26

3.14 Practical Training with a Clear Level (Image)



27

3.15 Knowledge Management System(image)



28

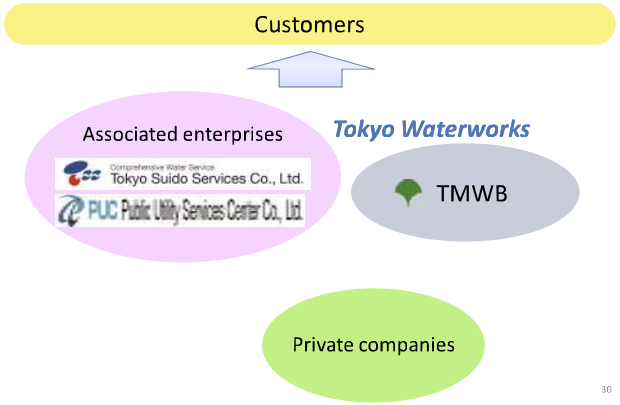
3.16 Experts in Waterworks Techniques

- Certify staff with abundant and highly technical experiences as water technology experts
- A total of 71 staff are certified
- 8 fields; Design and Construction Management; Water Purification; Water Distribution; Water Supply; Water Management; Water Quality; etc.

Main Activity	Expected Effects
1 Instruct and Advise Staff	● Raise motivation of staff who possess highly technical skills and knowledge
2 Formalize Knowledge	● Pass over the skills effectively by sharing the experts' highly technical skills and knowledge with others
3 Participate in Various Study Meetings	

29

3.17 Management Structure



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3.18 Duties sharing

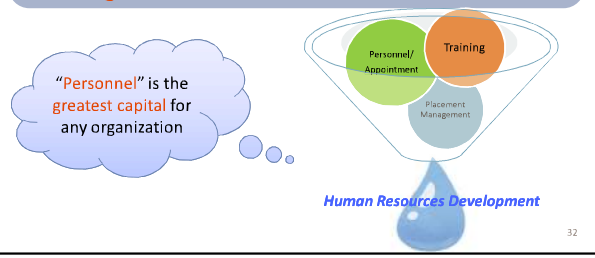
TMWB	Core operation	• Drawing up of management policy and facility improvement • Control of water quality • Maintenance of major infrastructure • Wide-range water services etc.,
Associated enterprises	Semi-core operation	• Supervising of the works contracted by private company • General reception service • Operation & maintenance of facilities etc.,
Private companies	Routine tasks	• Inspection of water meter • Subcontracted work etc.,

31

Conclusion

Important factors for Human Resources Development

- Programs that improve the capacity and will of each staff
- Personnel and appointment system that activates the entire organization
- Training institute that provides various experience-based training fields



32