Operation and Maintenance of Facilities

Source: JICA Training Course Material prepared by Sapporo City Waterworks Bureau (JICA Sapporo, 2015)

No. T4 Ver. 1

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Focus on construction & expansion of water supply facilities

Serious accidents

Focus on maintenance of facilities

Regulation & Guidelines

Safe and stable water supply

by good practices in maintenance

1. Introduction

Frequently asked questions from participants of the water supply training courses

Q1. How did Japanese utilities achieve good practices in maintenance?

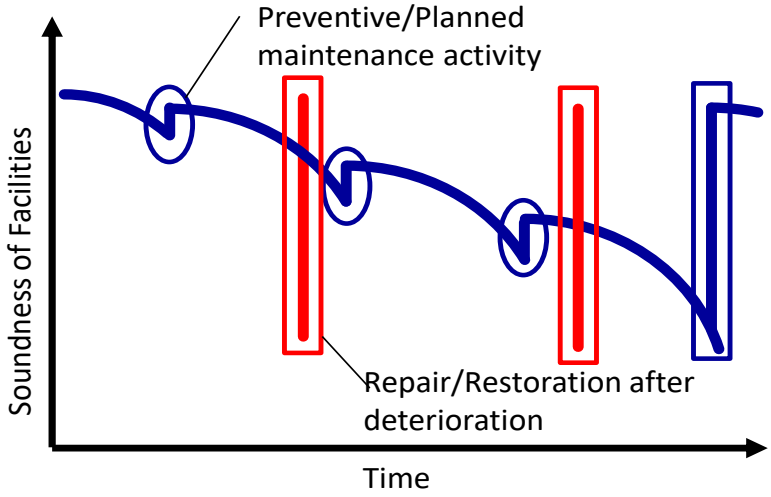
Q2. How do Japanese utilities manage to share the knowledge on maintenance and benefit from each other's experience?

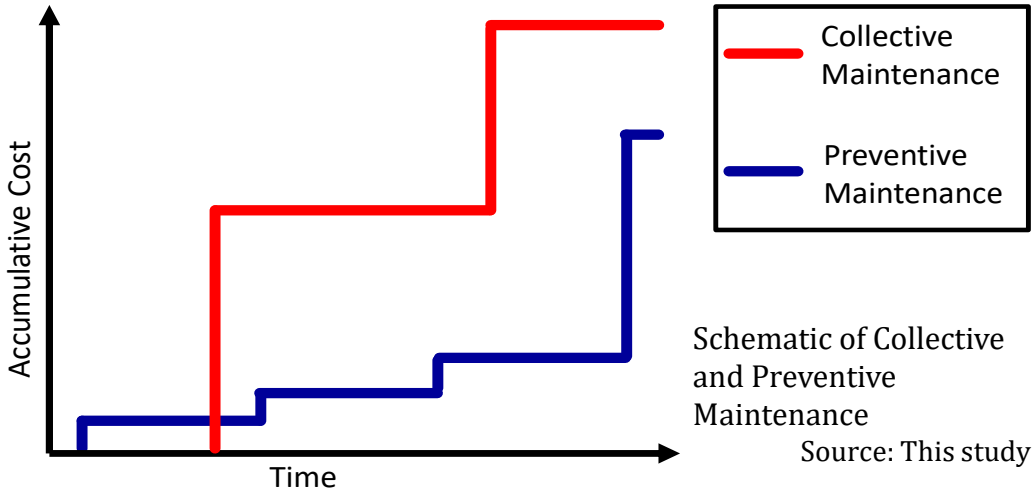
Q3. How can best practices be retained in spite of staff turnover? What is Japan's approach to sharing best practices within a utility and across the water supply sector?

2. Importance of Maintenance

Why maintenance is important?

- Inadequate maintenance can cause operation fault and service deterioration
- Secondary disaster (e.g. road collapse by pipe burst, chlorine leakage)
- Service breakdown: poor water quality, reduced pressure, perception of reduced reliability, claims from customers.
- Higher life cycle cost: early deterioration of facilities





Schematic of Collective and Preventive Maintenance

Source: This study

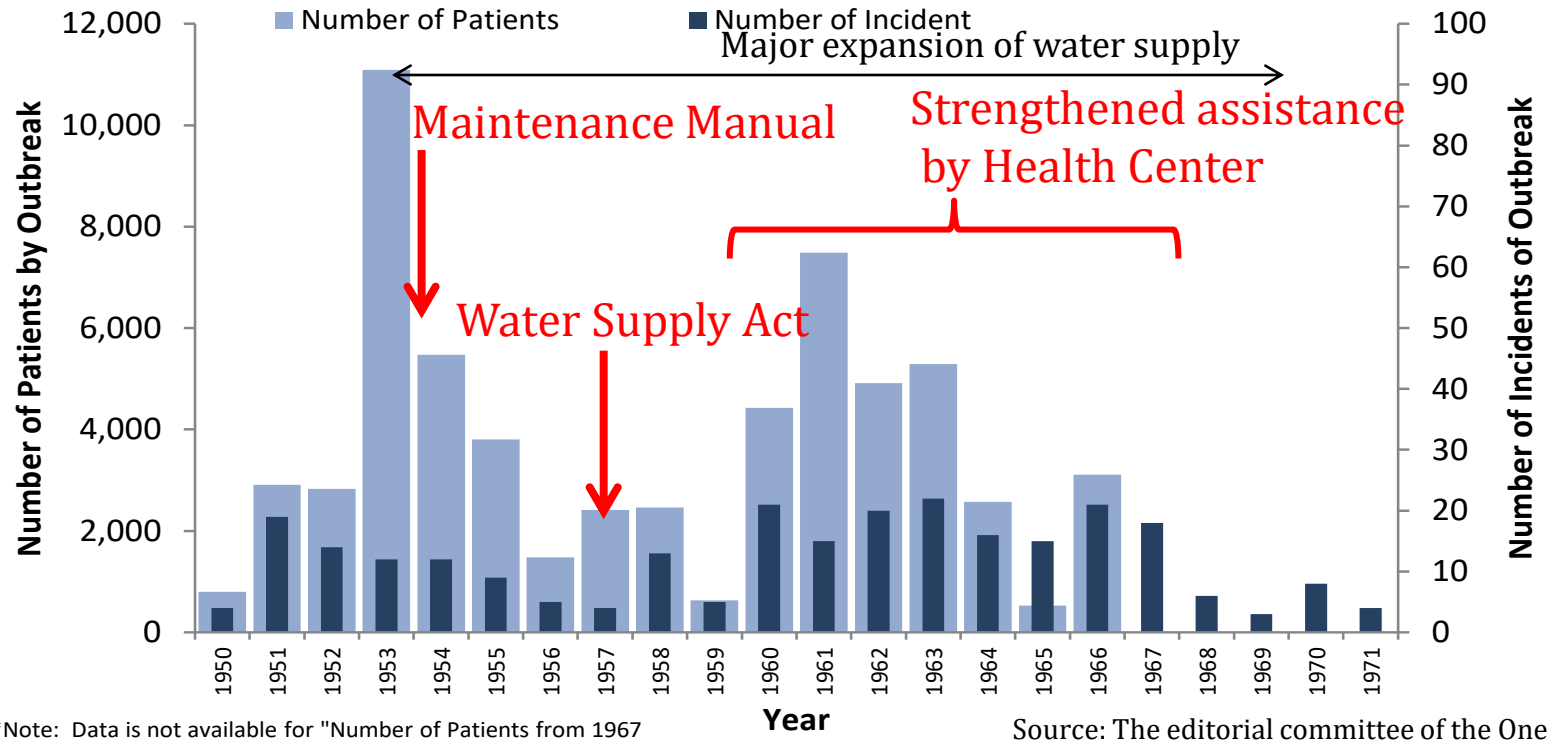
2. Importance of Maintenance

Item	Triggering events	Issues and causes
Water Treatment Facility	Poor disinfection (waterborne diseases spread by water supply)	No standard manuals nor operational procedures for O&M
	Malfunction of facility and failure of water treatment	
Pipelines	Contamination due to negative pressure (waterborne diseases spread by water supply)	No precise information nor drawings on aged pipelines
	Secondary disaster due to burst pipes	
	Public complaint of rusty/turbid water	
	Dysentery caused by cross connection	Quality control for installation of water service connections

2. Importance of Maintenance

(1) Disease Outbreaks

- Outbreaks increased when water supply coverage was expanded to rural areas where many small utilities were built (since the 1950s).
- Cases were dramatically decreased by intensive O&M measures promoted by *Water Supply Facilities Maintenance Manual* in 1953.



*Note: Data is not available for "Number of Patients from 1967

Source: The editorial committee of the One Hundred Year History of Modern Water Supply, "*One Hundred Year History of Modern Water Supply*," Nihon Suido Shimbunsha, 1988.

2. Importance of Maintenance

Causes of Outbreaks of Waterborne Diseases

42%: Lack or failure of disinfection facilities

27%: Contamination in pipelines *

1950s~1960s: Focus on Operation and Maintenance

- Laws and Regulations
- Guidelines
- Best practices and dissemination throughout the country

1970s: Outbreaks of waterborne diseases caused by water supply system were suppressed.

* caused by water supply interruption, cross contamination etc.

2. Importance of Maintenance

(2) Cross Connection

Serious Accident of Cross Connection in1969

It was found that a water distribution pipe had been connected to an industrial water pipe by mistake of pipe installation work. People had been drunk industrial water for one year.

Causes

- Drawings and documentation not properly archived
- No appropriate construction supervision
- No water quality testing after construction

Corrective measures

- Strengthening of construction supervision
- Records of construction
- Registration of drawings
- Strengthening of completion inspection
- Testing for residual chlorine

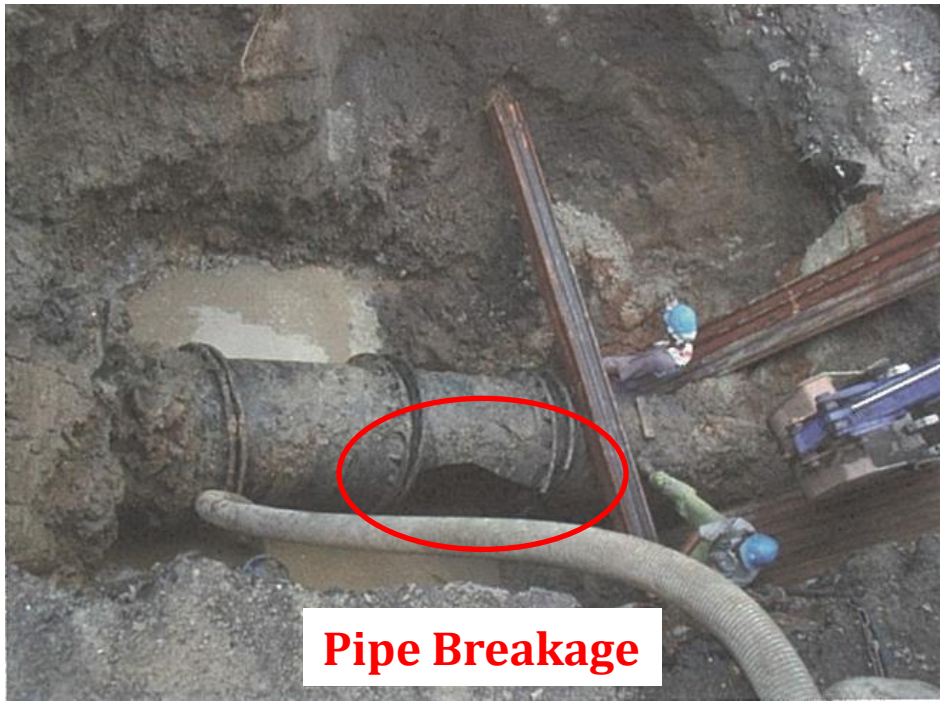
Great impact on both the citizens and utilities

2. Importance of Maintenance

(3) Pipe Bursts

Pipe materials deteriorate with age

Causes	●Corrosion ●Deterioration of materials ●Old lining method
Effect	●Water supply interruption ●Road caving ●Flooding of homes and roads
Measures	●Accelerate scheduled replacement of aging pipes ●Emergency management



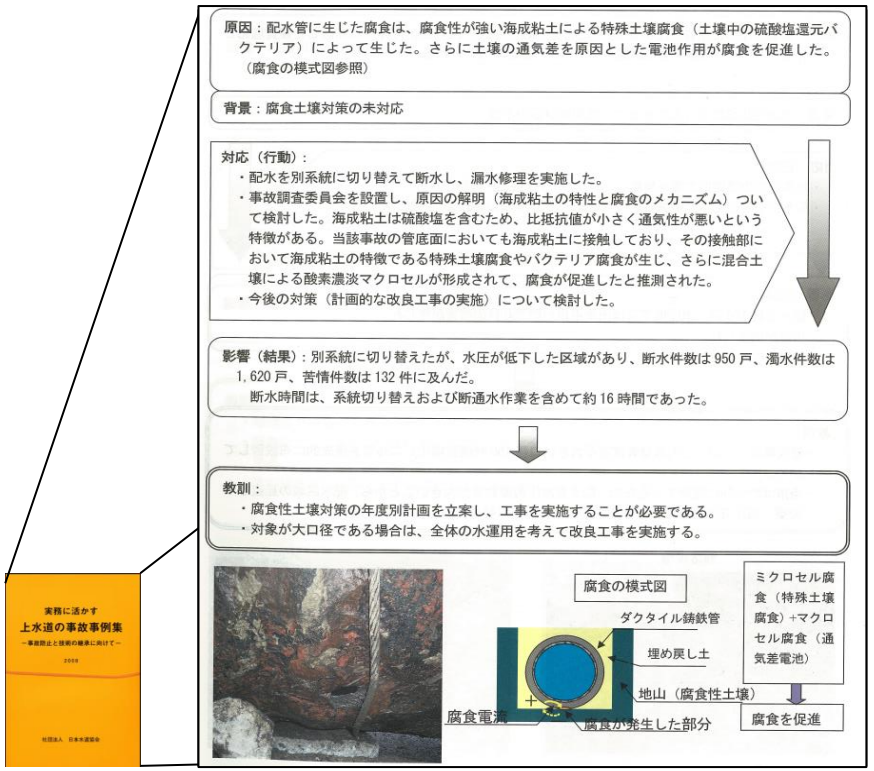
Source: JWWA, "*Casebook of Water Supply Accidents for Practical Use*," 2008.
Note: Photo is modified from original (indicated in red)

2. Importance of Maintenance

Information sharing among utilities across Japan

- Annual academic conference held in Japan Water Works Association General Assembly
- *Casebook of Water Supply Accidents for Practical Use*

Japan Water Works Association General Assembly Meeting



JWWA, "*Casebook of Water Supply Accidents for Practical Use*," 2008.

2. Importance of Maintenance

Improved Management of Pipelines

Laws and regulations were enforced in response to the accident.

Year	Events Related Leakage Control in Japan
1945	**End of World War II** (pipeline damage by war)
1946	***Water Leakage Prevention Guidelines*** (Ministry of Health and Welfare, Japan Water Works Association)
1950s	**Aged pipelines installed before the war and deterioration of pipes of poor material manufactured during the war.**
1960	***Revision of the Water Leakage Prevention Guideline*** (Bureau of Waterworks, Tokyo Metropolitan Government water leakage prevention committee)
1960	Notice of the Ministry of Health and Welfare: **on water leakage prevention measures**
Around 1970	Media reports on rusty water causing public concern.
1970	Notice of the Ministry of Health and Welfare: **on pipeline repair and replacement to prevent leakage and removal of rusting pipes**
1977	***Guidelines for Water Leakage Preventive Measures***

3. Laws and Institutional Framework

Legal Basis on Maintenance

- The Water Supply Act clearly stipulates the importance of abiding by the maintenance and facility standards.
- Japan Water Works Association published *Design Criteria for Water Supply Facilities* and *Water Supply Facilities Maintenance Manual*.

Water Supply Act

"Article 5, 2 ... In determining the location and arrangements of water supply facilities, it is necessary to make their construction, ***operation and maintenance*** *as economically and easily as possible, and to give consideration to assurance of water supply...*

Based on the Act, technical standards are developed & regularly updated.

Technical standards

3. Laws and Institutional Framework

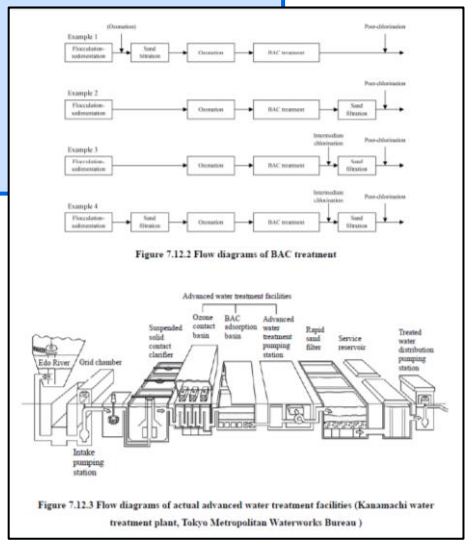
Chronology of Laws and Regulations

1953: *Water Supply Facilities Maintenance Manual*

1955: *Water Supply Facilities Standards*

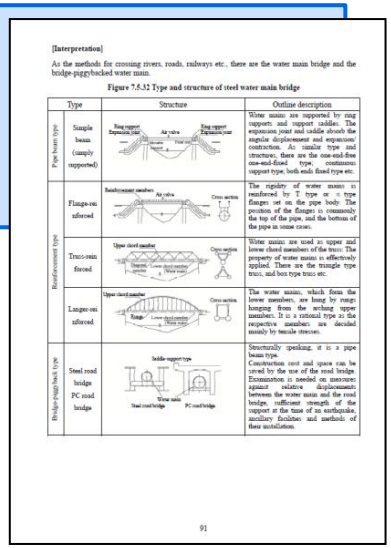
1957: Water Supply Act was enacted

1964: Revision
1970: Revision
1982: Revision
1998: Revision
2006: Revision



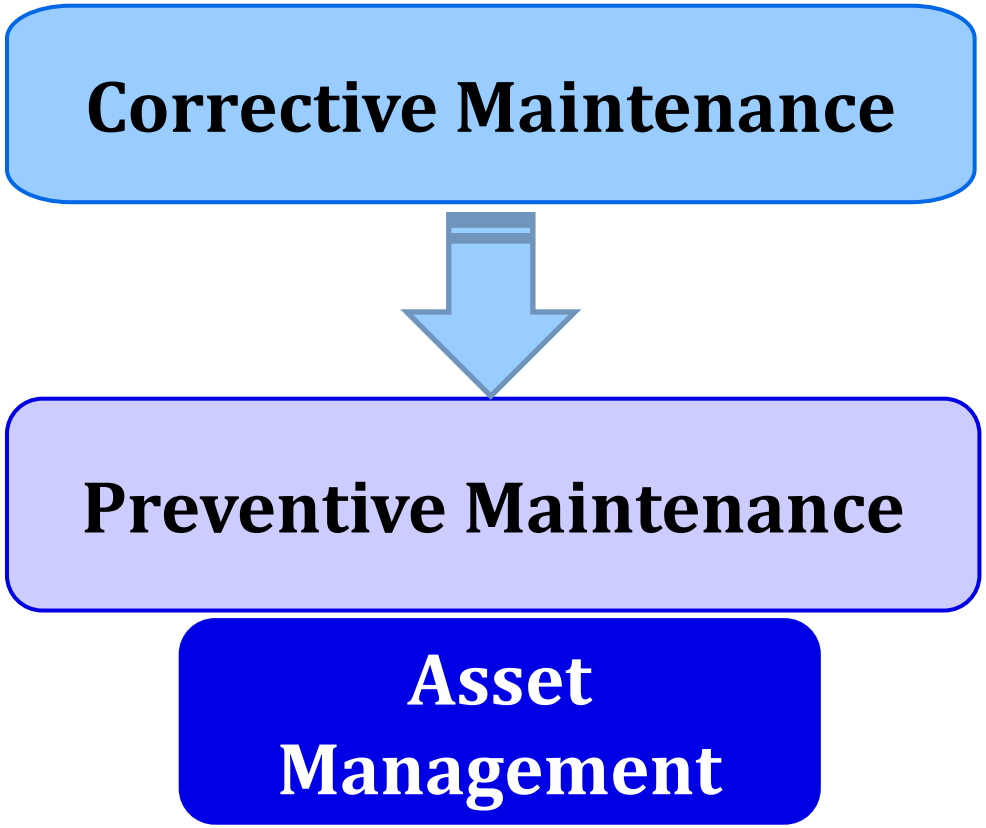
1966: *The Design Criteria for Water Supply Facilities*

1977: Revision
1990: Revision
2012: Revision



4. Best Practices in Japan

(1) Corrective and Preventive Maintenance

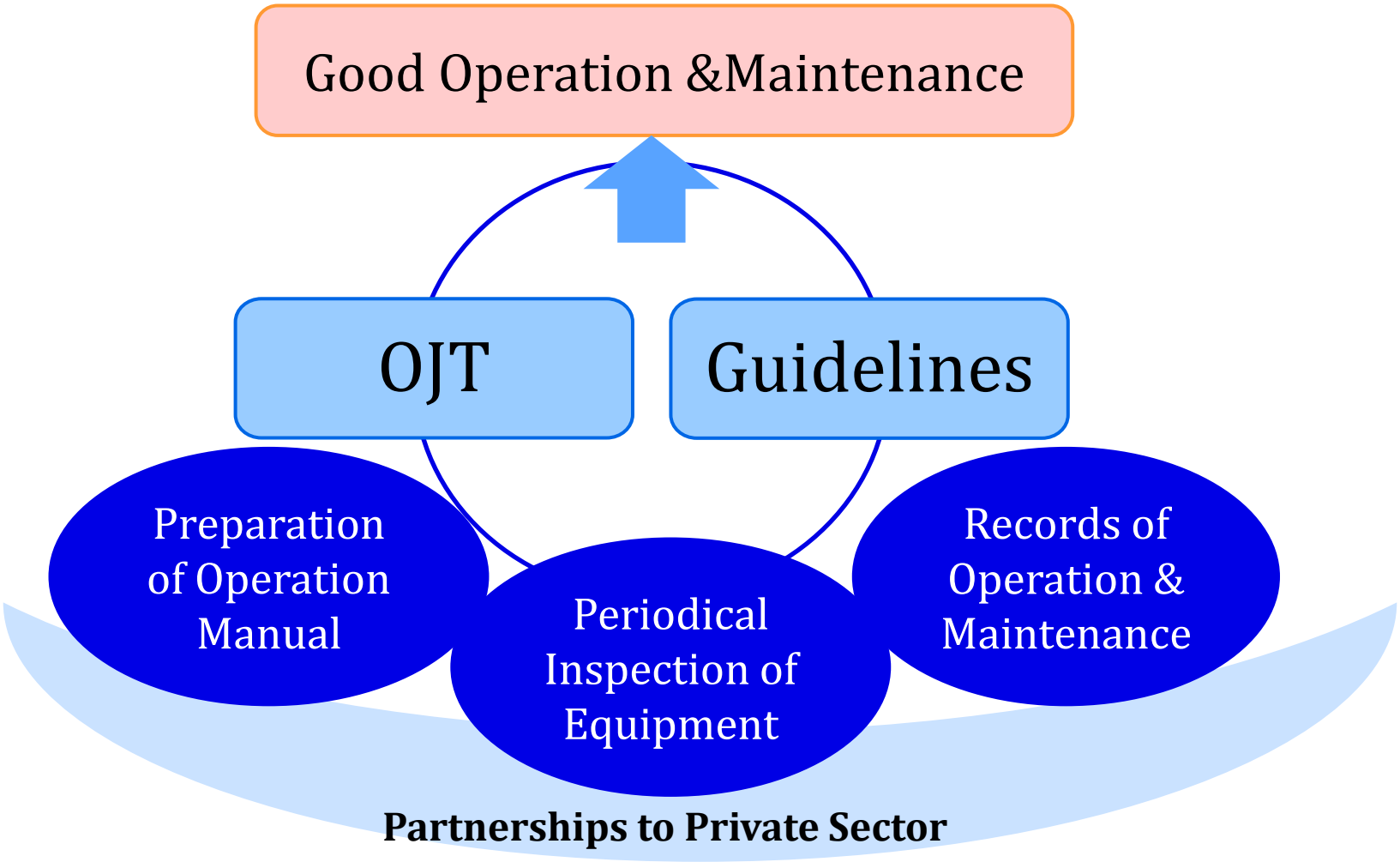


Repaired or replaced when the problem was discovered

Planned renewal of facilities

4. Best Practices in Japan

(2) Maintenance in Water Treatment Plants

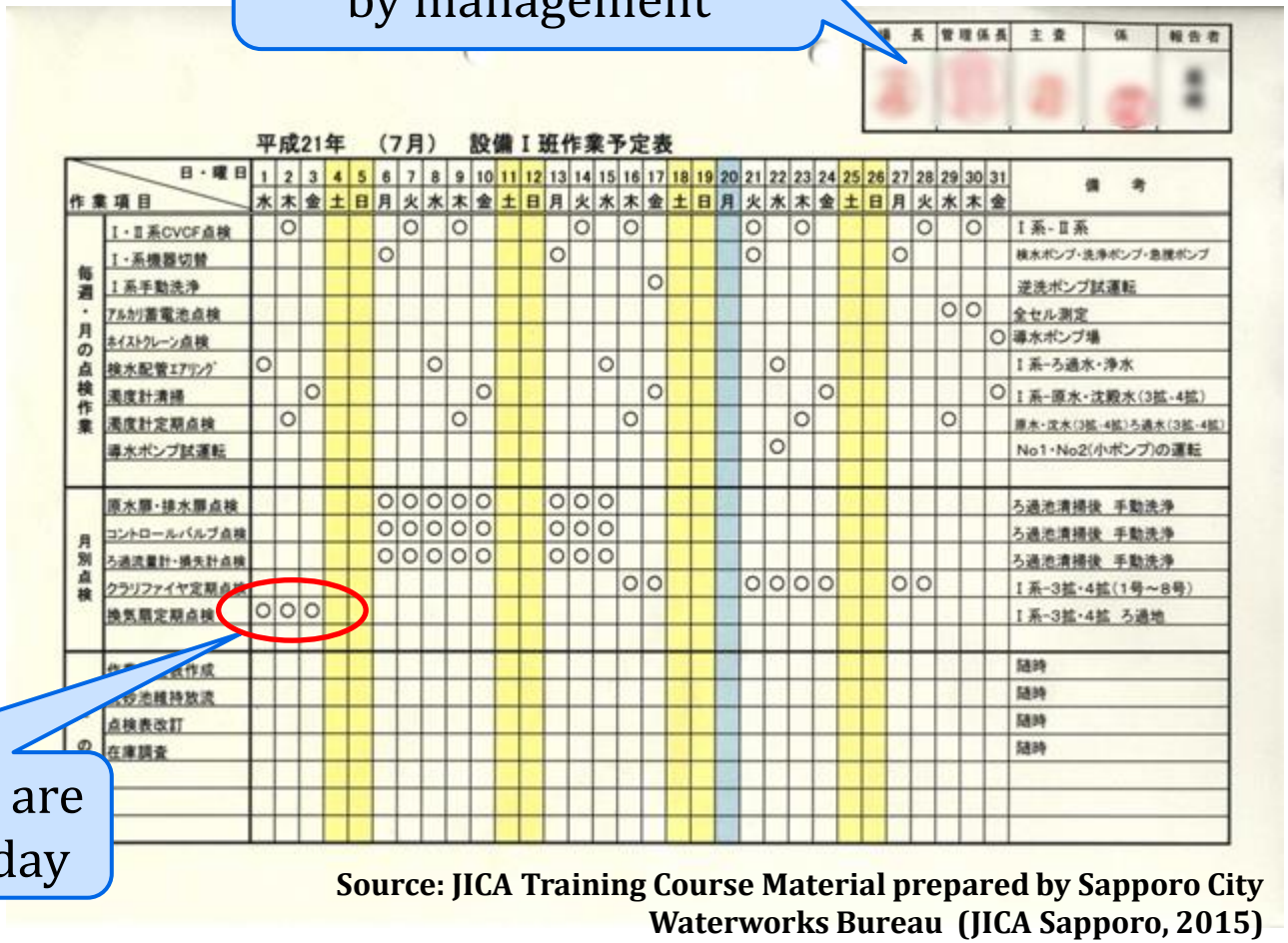


4. Best Practices in Japan

Example of Checklist

Check list of periodical inspection (Sapporo City)

Shared and approved by management



Items to be checked are identified for each day

Source: JICA Training Course Material prepared by Sapporo City Waterworks Bureau (JICA Sapporo, 2015)

4. Best Practices in Japan

(3) Pipeline Maintenance

Materials for distribution pipelines change as new materials and technologies become available .

Type	Diameter	Year	1960	1965	1977	1983
Main Distribution Pipe	>Φ1000	Cast Iron Pipes (Aged Pipes)	DIP (No Lining)	DIP (with Lining)		DIP (with Lining, with Polyethilene Sleeve)
	>Φ400					
Distribution Pipes	>Φ250					
	>Φ75					

Cast Iron Pipe (Lead Coaking)


DIP (Polyethilene Sleeve)

4. Best Practices in Japan

(4) Construction Quality Management

Standardization and Replacement of Lead Pipes

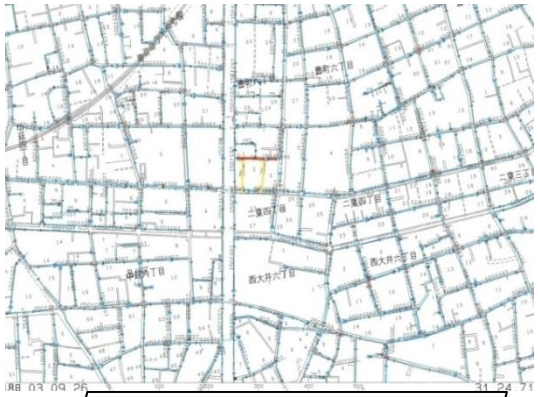
- Lead pipes were historically widely used but are now intensively replaced because of negative health effect and leakage problems.
- Intensive replacement and standardization will prevent future problems.

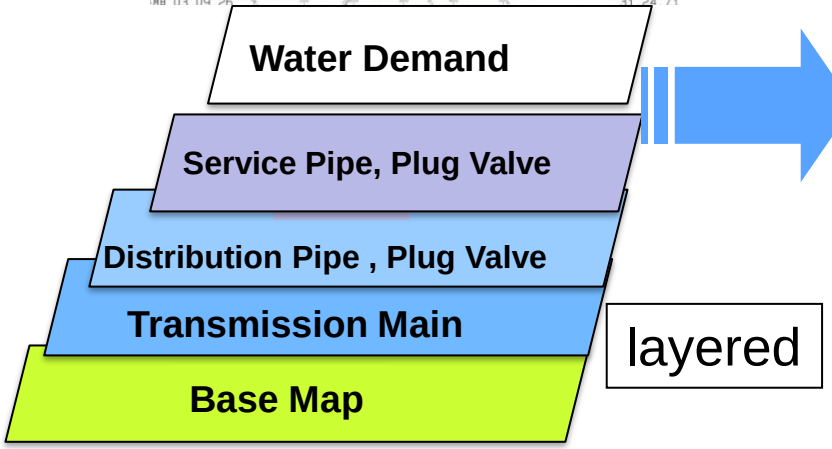
Year	Change in standards for lead pipes
1928	Standards were set for lead pipes for water supply in Japan.
1990	Lining of lead pipes with zero elution were added to the standards.
1993	Based on the revision of the Water Quality Standards, the traditional unlined lead pipes were removed from the standards.

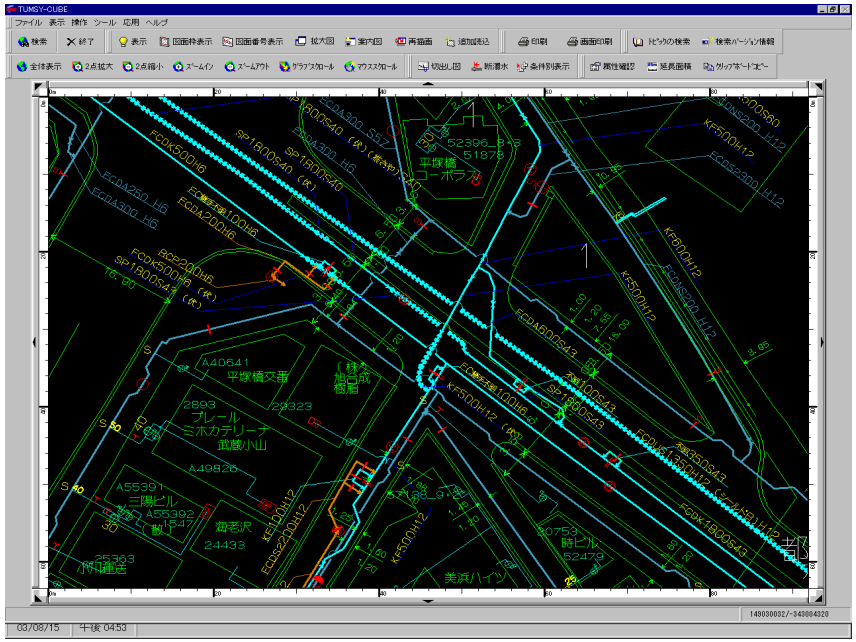
4. Best Practices in Japan

3) Mapping of Distribution Networks

Summarized knowledge and information on pipelines
are incorporated into a mapping system to share the information
internally and with other utilities.







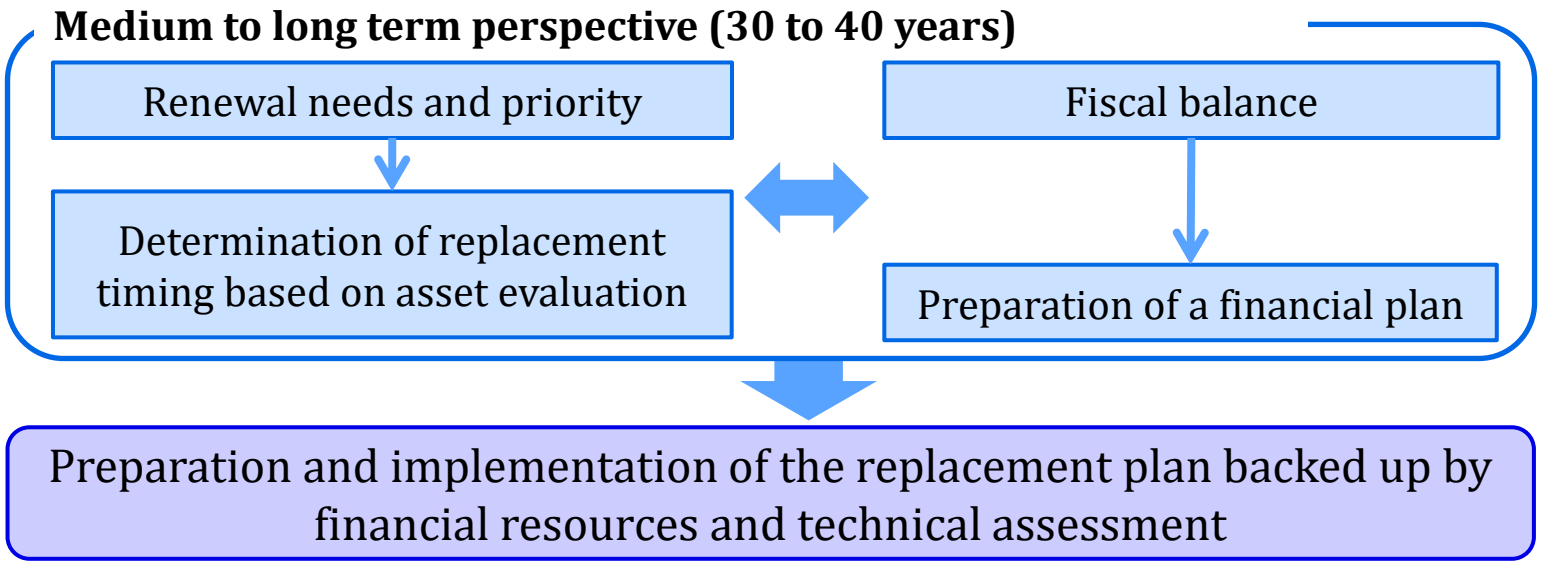
Source: Created from training course material for JICA Project prepared by Tokyo Metropolitan Government Waterworks Bureau

4. Best Practices in Japan

Asset Management

Leakage management and pipe replacement are dealt with cohesively under "Asset Management."

Key features of asset management:
(1) Consolidated information on facilities, (2)Facility assessment and evaluation, (3)Understanding of replacement needs and priorities, and (4) Clear outlook on fiscal balance



Source: MHLW, *Guidelines for the Asset Management for Waterworks*, http://www.mhlw.go.jp/za/0826/d11/d11-01.pdf

4. Best Practices in Japan

Designated Prequalified Contractors and the Registration System for the Contractors for Service Connection

Construction by water utilities

Increased construction activities after Great Kanto Earthquake in1923 and the end of WWII in1945

- Using inappropriate materials
- Poor construction
- Need for standards to be set for materials and installation of service connections
- Necessity for ensuring rapid repair of burst pipes

Registered (private) contractors for the installation for service connections

5. Lessons Learned (1)

- **(Preventive Maintenance)** Inadequate operation and maintenance practices lead to serious disease outbreaks and compromise the reliability, safety and quality of the water supply. Preventive maintenance is important both in terms of quality management and reducing life cycle cost.
- **(Guidelines and Standards)** Utilities are strongly supported by national guidelines and standards, enhanced regulations and inspection services by health centers. Water Supply Act, *Water Supply Facility Standards* and *Water Supply Facility Maintenance Manuals* were developed which explicitly state maintenance responsibility.
- **(Concepts and Tools)** (1) Preventive maintenance, (2) Standardization of materials, (3) National design criteria, (4) Information sharing have played key roles in maintenance. Introduction of new management tools such as digital mapping and asset management are great opportunities for utilities to work collaboratively.

5. Lessons Learned (2)

- **(Maintenance of Water Treatment Plant)** Each utility or facility has its own manuals in operation and maintenance of water treatment plants, checklists, and handover procedures, all passed on to workers through OJT. Meetings organized by Japan Water Works Association facilitate information sharing across the country .
- **(Quality Control)** Quality of materials and appropriate construction were the keys for maintenance of pipelines. Various kinds of cooperation with private sector was also essential.