# Duplexing and Networking of Pipelines to Prepare for Risk

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## Introduction

It can be said that it is waterworks operators' mission to stably supply safe water in the future, properly responding to challenges and risks such as aging facilities, natural disasters, and climate changes that they face.
In order to fulfil its mission, Tokyo Waterworks has been promoting a wide variety of waterworks facility development such as water conservation forest management, earthquake resistance reinforcement of reservoirs and distribution reservoirs, and private power generation facilities, including introduction of advanced water treatment facilities. As a certain budget is necessary for such development, efficiency will be promoted in the aspect of securing continuousness of waterworks operation.

The development of duplexing and networking of main facilities such as water conveyance facilities and water transmission pipes is part of the facility development. In this paper, setting the duplexing and networking of main water conveyance facilities and water transmission pipes of Tokyo Waterworks as a theme, I will introduce the necessities and directions of facility development to ensure stable water supply.

【Outline of Tokyo Waterworks】
Service area 1,239km² ; Population served 13.04million people ; Facility capacity 6.86million m³/day ; Total length of distribution pips 26,774km

## Existence of Risk

○ The facilities which have important functions on the water supply operations cannot be suspended.
○ Some facilities are difficult to be replaced despite their significant aging and poor earthquake resistance. (See Figure 1)
○ A great challenge in promoting planned pipeline renewal and earthquake resistance reinforcement.

◇A water conveyance pipeline is an important pipeline that transmits raw water taken from water intake facilities to purification plants. Thus, if a leakage occurs due to damage, the purification plant will then be shut down, which directly leads to a wide-ranging outage.
◇As in many cases there is no alternative route for water conveyance pipelines, it is difficult to carry out earthquake resistance reinforcement associated with suspension of water supply operations.
◇We have promoted networking of water transmission pipes to transmit treated water to water supply stations in order to strengthen their backup functions at the time of a disaster or accident.
◇As the network is still insufficient, it is difficult to secure sufficient water transmission when water transmission pipes cease to work.

At the time of the Great East Japan Earthquake occurred in March 2011, in the affected Tohoku region, large-diameter water transmission pipes that had no alternative routes slipped off at joints, resulting in a wide-ranging outage. (See Figure 2)

Figure 1: Water leakage accident
(Source: TMG Bureau of Waterworks)

Figure 2: Slipping off of large diameter pipes
(Source: MHLW)

**◎As a massive earthquake has been expected in Tokyo , we should urgently take anti-disaster measures.**

**◎Aging pipelines, non-earthquake-resistant pipelines and pipelines that have no alternative routes constitute risk that threatens the security of stable water supply in the future.**

## Direction of Facility Development

○As waterworks facilities are the lifeline that supports people's lives and their activities in urban areas, even at the time of an accident due to aging and a great earthquake, it is necessary to minimize facility damage and secure water supply to the extent possible.
○In preparation for continuous remodeling, it is important to ensure sufficient backup functions so that we can supply water even when an individual facility is suspended.

**◇Duplexing of Water Conveyance Facilities**
In order to secure sufficient backup functions even at the time of construction works such as those for facility remodeling, as well as at the time of a disaster or an accident, we are promoting duplexing of water conveyance pipes whose operation cannot be suspended. (See Figure 3)

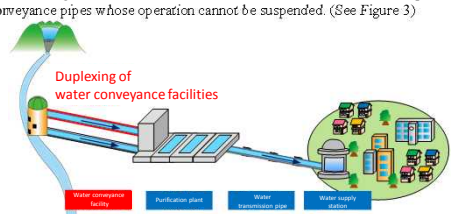



**Figure 3** Duplexing of water conveyance pipes

**◇Duplexing and Networking of Transmission Pipes**
In preparation for the full-scale renewal of purification plants and water supply stations, it is necessary to develop a wide-area water transmission pipe network to secure backup functions. (See Figure 4)

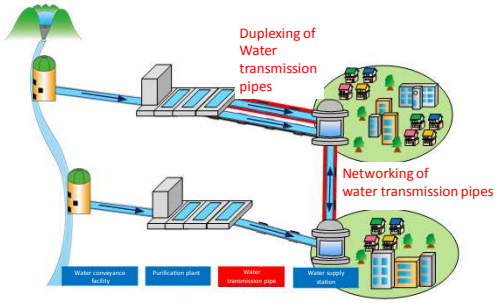



**Figure 4** Duplexing and networking of water transmission pipes

## Outline and Progress of Construction Works

The important three cases among duplexing and networking water pipe construction works underway are as below .

**①Development of the Second Raw Water Connection Pipeline 【Duplexing of Water Conveyance Pipes】**
Raw water connection pipeline, which are the pipelines by which we mutually accommodate with raw water between different river systems, have aging and earthquake resistance problems.

- Pipe length : about 16km, shield tunneling method for the whole line
- Pipe diameter: φ 2,000 mm
- Pipe types: ductile cast iron and steel
- Construction period: from 2010 to 2018
- Cost : about 25 billion yen

※ The tunnel will be completed within this year

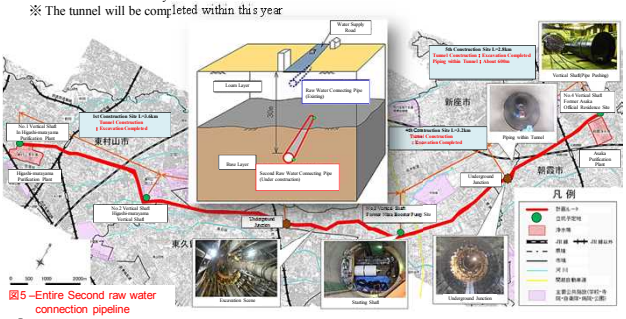



図5 –Entire Second raw water connection pipeline

**②Development of the Second Asaka-Kamiigusa Line 【Duplexing of Water Transmission Pipes】**
As the Asaka-Kamiigusa Line is already more than 45 years old and has no alternative route, it is concerned that serious water suspension damage may occur at the time of an accident.

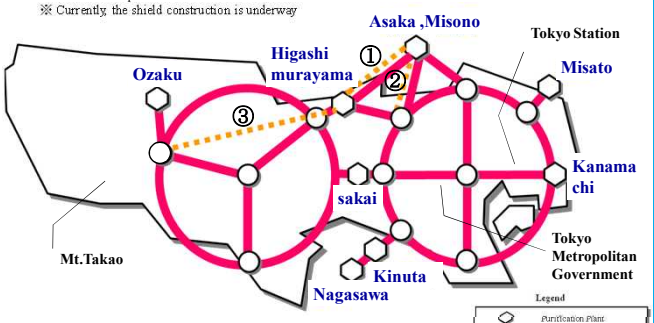
- Pipe length : about 13km shield, tunneling method for the whole line
- Pipe diameter: φ 2,600 mm
- Pipe types: ductile cast iron and steel
- Construction period: from 2015 to 2020
- Cost: about 37 billion yen

※ Currently, the vertical shaft construction is underway

**③Tama North-South Line 【Networking of Water Transmission Pipes】**
The Tama North-South Line will strengthen the backup function in Tama Region where a wide-area networking is not sufficient.

- Pipe length : about 16km shield, tunneling method for the whole line
- Pipe diameter: φ 2,000 mm
- Pipe types: ductile cast iron ( under consideration)
- Construction period: from 2011 to 2018

※ Currently, the shield construction is underway




Total Water Conveyance and Transmission Pipe Length: About 880 km

**Figure 6** Water conveyance and transmission pipe network

## Conclusion

◎In order to stably supply safe and potable water in the future, we have to systematically and steadily carry out measures such as facility renewal.
◎It is crucial to strengthen the backup functions of the whole water supply system through the promotion of duplexing and networking of pipelines so that we can supply water even in cases when individual facilities are suspended not only at the time of facility renewal work, but also at the time of a disaster or an accident.
◎Although it requires significant efforts, time, and costs to work on these projects, we should not put them off to ensure stable water supply for the next generation.

☆Tokyo invites you people to the 2018 IWA World Water Congress & Exhibition in Tokyo and the 2020 Tokyo Olympic and Paralympic Games.

Reference Materials: [1] TMG Bureau of Waterworks; Basic Concept for Renewal of Tokyo Waterworks Facilities, March 2012, [2] TMG Bureau of Waterworks; Master Plan for Construction of Tokyo Waterworks Facilities, February 2016, [3] TMG Bureau of Waterworks; Tokyo Waterworks Main Facilities Renewal Program, June 2015, [4] TMG Bureau of Waterworks; Tokyo Waterworks Management Plan, February 2016

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