Toward construction of a more resilient large-scale waterworks system, for "Waterworks to support the functions of the capital city, Tokyo" and "Waterworks to support the lives of residents of Tokyo"

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INTRODUCTION

Tokyo, the capital city of Japan, is one of the largest cities in the world where numerous enterprises and financial/securities markets are concentrated as a base of economic activities, as well as the center of the legislative, executive, and judicial functions of the government.

In addition, while Tokyo is a city with a population of about 13 million people, it is also a huge destination for daily urban activities. For example, more than 3 million people flow in from neighboring prefectures in the daytime every day.

In this massive city, if the waterworks, which are the primary lifeline supporting its function as capital of Japan, were to stop, tremendous damage is expected to occur. This includes disruption of the nation's central functions, stagnation of political and economic activities, and adverse impact on the lives of residents of Tokyo. Such risk must be avoided.

Based on the two basic principles of "Waterworks to support the functions of the capital city, Tokyo" and "Waterworks to support the lives of residents of Tokyo", towards building a more resilient large-sale waterworks system, with consideration for the 2020 Tokyo Olympic and Paralympic Games to held in three years, the Tokyo Waterworks is working on a project of duplexing water conveyance facilities and duplexing/networking of transmission pipes.

In this paper, we describe the concept and state of development of this project.

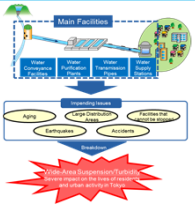

Figure 1. Issues faced and their impact

Initiatives to secure a stable water supply

1. Environment of the Tokyo Waterworks System

・The Tokyo Waterworks has built a network system that consists of water conveyance pipes, transmission pipes, and distribution pipes connecting main water sources from 4 river systems including the Tone River system and the Tama River system, 11 main water purification plants and a group of water supply stations set up in each water distribution area.

・This system was primarily built during Japan's period of rapid economic growth, so now that the threat of an earthquake with its epicenter under Tokyo looms, issues have arisen with the seismic resistance of main facilities including water conveyance pipes and water transmission pipes.

・Therefore, in order to facilitate the project to replace water conveyance and transmission pipes we must secure alternate functions which prevents the waterworks from stopping for a long time.

Initiative 1 Duplexing of Water Transmission Pipes

・Secure table water conveyance functions to water purification plants

・Secure adequate backup functions not only in times of disaster or accidents, but during construction for renewal and the like

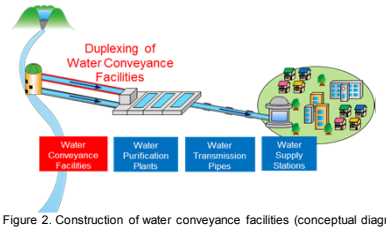

Figure 2. Construction of water conveyance facilities (conceptual diagram)

Initiative 2. Duplexing and Networking of Transmission Pipes

・Secures water transmission between water purification plants and water supply stations.

・Secure mutual accommodation between multiple water supply stations.

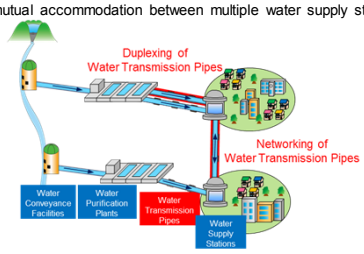

Figure 3. Construction of Water Transmission Facilities (conceptual diagram)

2-1. Status of Initiatives

・3 water conveyance facilities and 4 water transmission pipes are under construction

・Of these, we introduce duplexing construction on raw water connection pipes, which are a water conveyance facility.

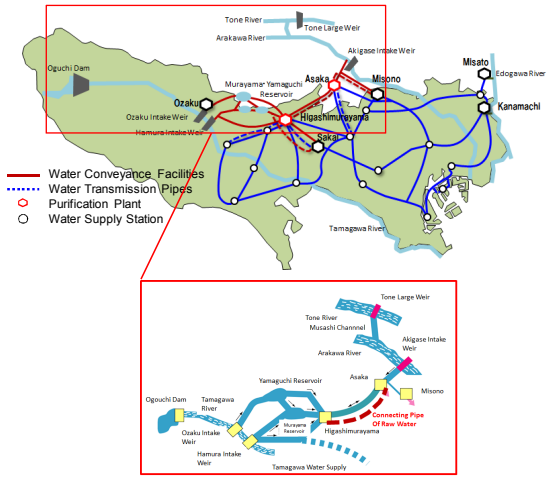

Figure 5. Duplexing of water conveyance facilities (raw water connecting pipes) (conceptual diagram)

2-2. Purpose of Construction

・Raw water connecting pipes are the only facilities with which raw water can be mutually accommodated between the Tone River/Ara River system and the Tama River system

・They are important facilities to secure the stability of water sources, as droughts have occurred frequently in recent years.

・More than 50 years have passed since these facilities were completed, and they have problems with seismic resistance.

・We started duplexing construction in 2010, and will put them in operation by the 2020 Tokyo Olympic Games

・This construction will secure a stable water supply into the future

2-3. Construction Project

・Based on conditions such as construction expenses and the construction environment, we chose the same route as existing facilities, which is the shortest route

・We chose the shield method, for its excellent workability, and ability to mitigate impact on the living space above ground

・A tunnel of about 16 km in length is being built in 5 sections on bedrock that is deeper and stronger than existing facilities

・After the tunnel is constructed, water pipes with an inner diameter of 2,000 mm will be laid.

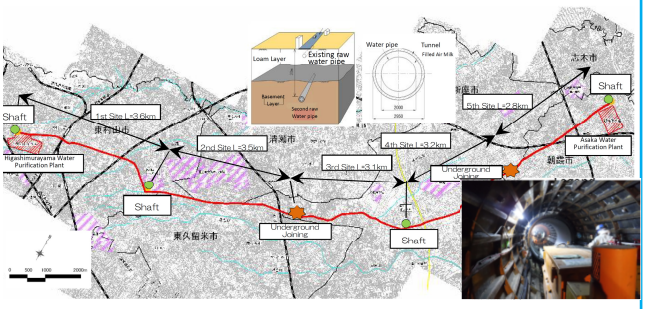

Figure 6. Line diagram

Compound Benefits of Construction

These initiatives are expected to provide compound benefits, in addition securing a stable water supply and backup function.

・Enhance maintenance and operation
It is possible to do regular inspections and repairs while securing water conveyance and transmission.

・Energy optimization
Increases pump efficiency and reduces energy consumption by reducing pipe flow velocity with the use of multiple pipes (contributing to reduce CO2 emissions).

・Effective use of renewable energy
Small hydraulic power generation utilizing excess pressure at each water supply station (See Figure 7).

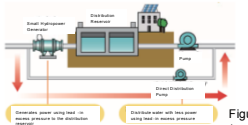

Figure 7. Using lead-in excess pressure (conceptual diagram)

Initiatives to rebuild main facilities

The Tokyo Waterworks is progressively rebuilding main facilities with the following initiatives, in addition to those introduced above.

Renewed Substitute Facilities (Water Purification Facilities)

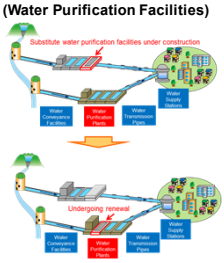

Figure 8. Construction Water Purification Plants (conceptual diagram)

New construction and renewal expansion of water supply stations

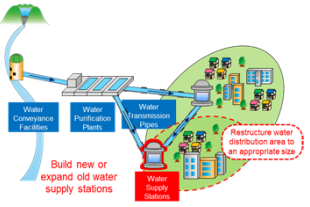

Figure 9. Construction Water Supply Stations (conceptual diagram)