International Cooperation

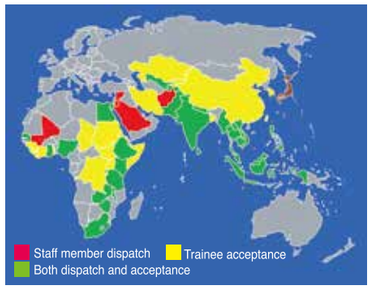
Yokohama Waterworks Bureau began international cooperation by dispatching experts to Afghanistan in 1973. We have dispatched over 400 staff members overseas including experts/investigation team members of JICA (Japan International Cooperation Agency) and other international organizations.
In 1987, the centennial anniversary of the foundation of Japan’ s first modern waterworks, we started the original program to accept trainees, and since 2003, we have focused on collaborative programs with relevant international organizations including JICA.
By dispatching staff members and accepting trainees, we make an international contribution by transferring Yokohama’ s waterworks technology to water utilities all over the world.

Staff member dispatch

approx. 400 persons to 34 countries (FY1973-2017)

Trainee acceptance

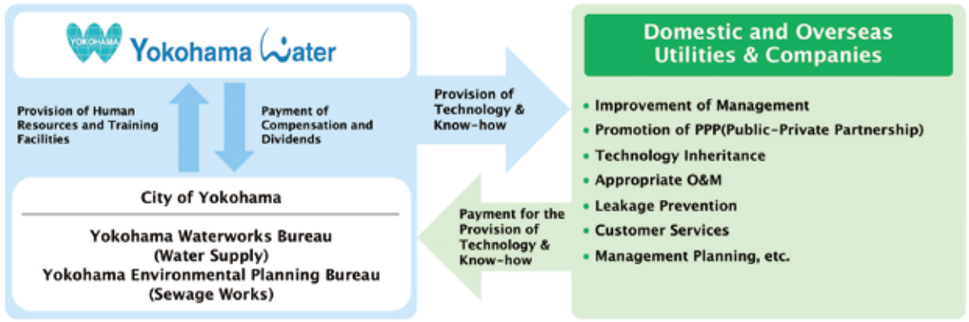
approx. 900 persons from 51 countries/regions for the YWWB's own program (Total: more than 3,800 persons including trainees at request of other organizations) (FY1987-2017)



Practical training

Cooperation with Yokohama Water Co., Ltd.

In July 2010, the City of Yokohama established the Yokohama Water Company for the purpose of using the technology and experience gained throughout the city's long history to expand water and sewerage services as a business both domestically and internationally. It aims to help water and sewerage services overseas solve problems through international projects. As part of those projects, the company provides on-site consulting and human resources development by imparting Yokohama's technology and know-how to trainees from abroad.



Yokohama Water Co., Ltd. (YWC)

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Waterworks of Yokohama

YOKOHAMA WATERWORKS BUREAU

Water Sources of Yokohama

Yokohama has five water source systems with a total capacity of **1,955,700 m³** a day.

1	**Doshi river system**	172,800m³/day — Yellow line on the map
2	**Sagami reservoir system**	394,000m³/day — Red line on the map
3	**Banyu river system**	284,700m³/day — Purple line on the map
4	**K.W.S.A. Sakawa river system**	605,200m³/day — Green line on the map
5	**K.W.S.A. Sagami river system**	499,000m³/day — Pink line on the map

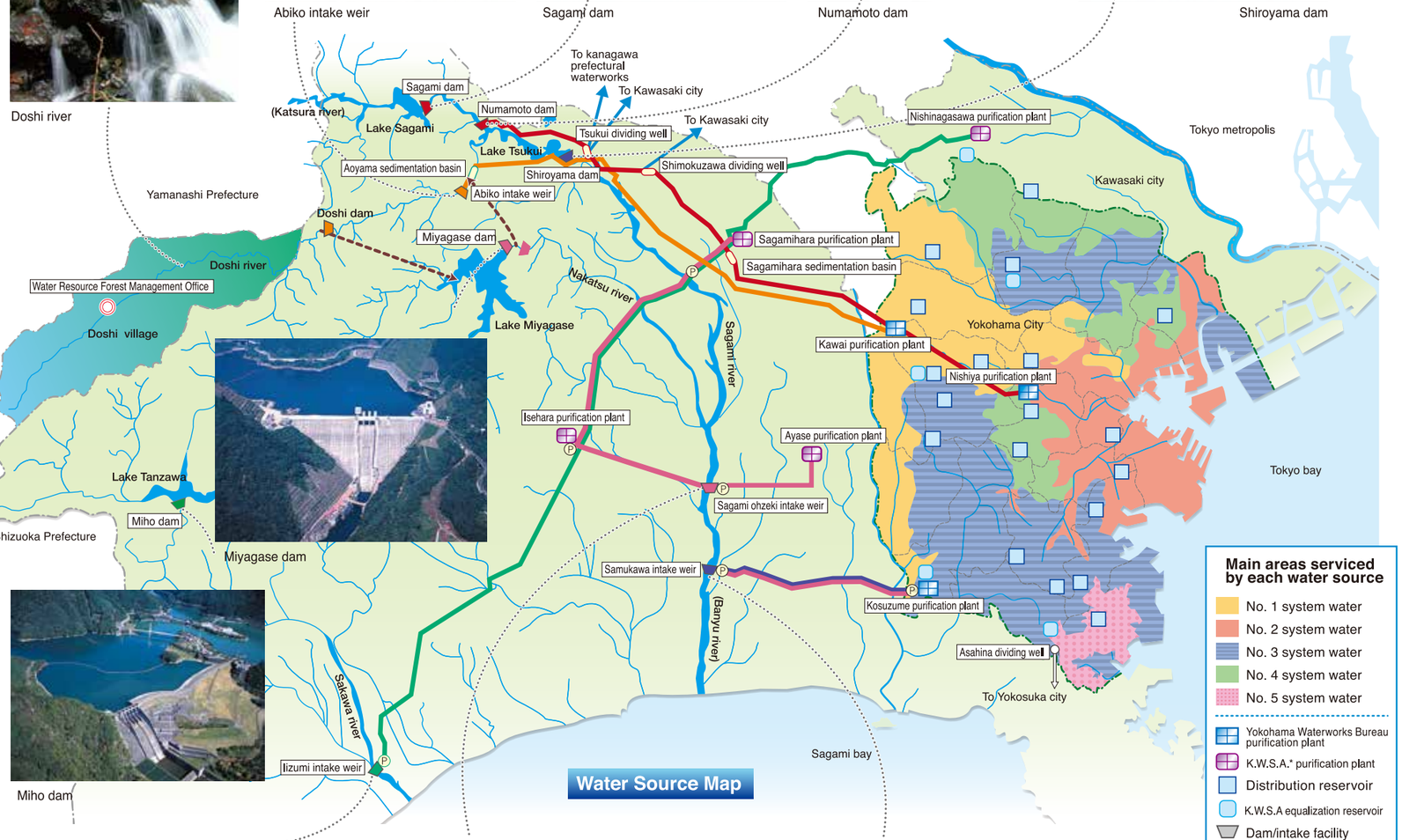

Doshi river


Abiko intake weir


Sagami dam


Numamoto dam


Shiroyama dam



Miyagase dam

Miho dam


Iizumi intake weir


Sagami ohzeki intake weir


Samukawa intake weir

Main areas serviced by each water source

- No. 1 system water
- No. 2 system water
- No. 3 system water
- No. 4 system water
- No. 5 system water

- Yokohama Waterworks Bureau purification plant
- K.W.S.A.* purification plant
- Distribution reservoir
- K.W.S.A equalization reservoir
- Dam/intake facility
- Pumping station

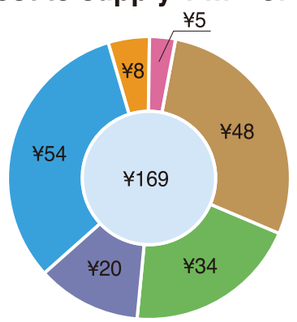
*K.W.S.A: The Kanagawa Water Supply Authority, established in 1969 by Kanagawa Prefecture and the cities of Yokohama, Kawasaki and Yokosuka to avoid overlapping investment and enable efficient location and management of water facilities. It owns purification plants in Isehara, Sagamihara, Nishinagasawa and Ayase and the water from these plants is supplied to the four water utilities.

Water Supply (FY2017)

Total Population	3,731,706
Population Served	3,731,661
Number of Households Served	1,851,450
Service Rate	100.0%
Total Length of Pipeline	9,349 km
Annual Water Supply	412,084,500 m³
Average Daily Water Supply	1,128,999 m³
Average Daily Water Supply per Person	302 L
Maximum Daily Water Supply	1,210,000 m³ (July 12, 2017)
Past Maximum Daily Water Supply	1,607,000 m³ (September 4, 1992)

Cost to supply 1 m³* of drinking water (FY2017)

*Two thousand 500 ml bottles



- Cost to send water from water sources to water purification plants (¥5)
- Cost to purify water at purification plants (¥48)
- Cost to supply water from purification plants to customers (¥34)
- Cost to repair water facilities (¥20)
- Cost to prepare for future replacement (¥54)
- Loan repayment interest (¥8)

History of Yokohama Waterworks

A common tap at the time of foundation

Yokohama' s waterworks began service on October 17, 1887, as Japan' s first modern waterworks.
The population of Yokohama, once a small village with only 87 households, increased dramatically after the opening of the port in 1859, and the urban area developed rapidly. Since it was built on reclaimed land, well water had a high salt content and was not suitable for drinking. Wanting high quality water, the prefectural governor began constructing the modern waterworks (available anytime with water drawn from rivers, filtered and distributed through iron pipes under pressure) in 1885, taking water from the junction of Sagami River and Doshi River, under the supervision of British engineer H. S. Palmer. It was completed in September 1887.
In accordance with the waterworks ordinance established in 1890, the waterworks came under the control of the City of Yokohama in April of that year (now the Yokohama Waterworks Bureau, or YWWB). Since then it has been expanded as many as eight times in response to the increasing demand for water and now supports over 3.7 million citizens in Yokohama.


A sprinkler at the time of foundation

Water Purification Plants in Yokohama

A purification plant is where tap water is produced. Yokohama has three purification plants: Kawai, Nishiya and Kosuzume.

Kawai Purification Plant

Constructed: 1901 (1st expansion)
Daily Purification Capacity: 172,800 m³
Water Source: Doshi river system
Address: 2555 Kamikawai-cho, Asahi-ku

Nishiya Purification Plant

Constructed: 1915 (2nd expansion)
Daily Purification Capacity: 356,000 m³
Water Source: Sagami reservoir system
Address: 522 Kawashima-cho, Hodogaya-ku

Kosuzume Purification Plant

Constructed: 1965 (6th expansion)
Daily Purification Capacity: 1,009,200 m³
(For Yokohama: 764,000 m³
For Yokosuka: 245,200 m³)
Water Source: Banyu river system
* Water from the K.W.S.A. Sagami river system is also treated in this plant.
Address: 2470 Kosuzume-cho, Totsuka-ku

* Water from the K.W.S.A. Sakawa river system and K.W.S.A. Sagami river system is treated in the Sagamihara, Nishinagasawa, Ayase and Isehara purification plants.

Kawai Purification Plant uses a “membrane filtration system”

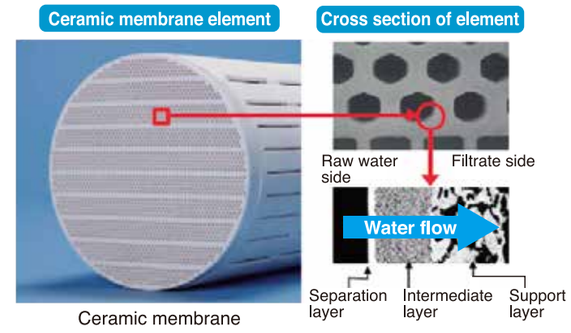
The membrane filtration system is made up of rows of upright tubes. Each tube is packed with a ceramic membrane that is strong and resistant to chemicals.

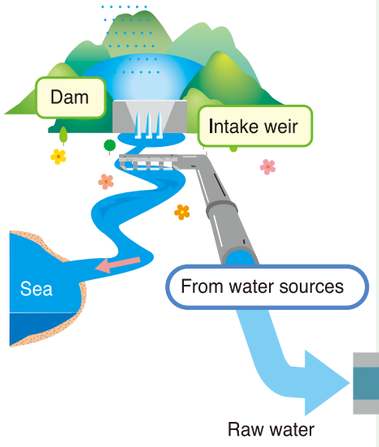
Known as “Cerarocca” *, with 2,400 ceramic membrane modules, this is the largest membrane filtration facility in Japan.

What is a membrane filtration system?

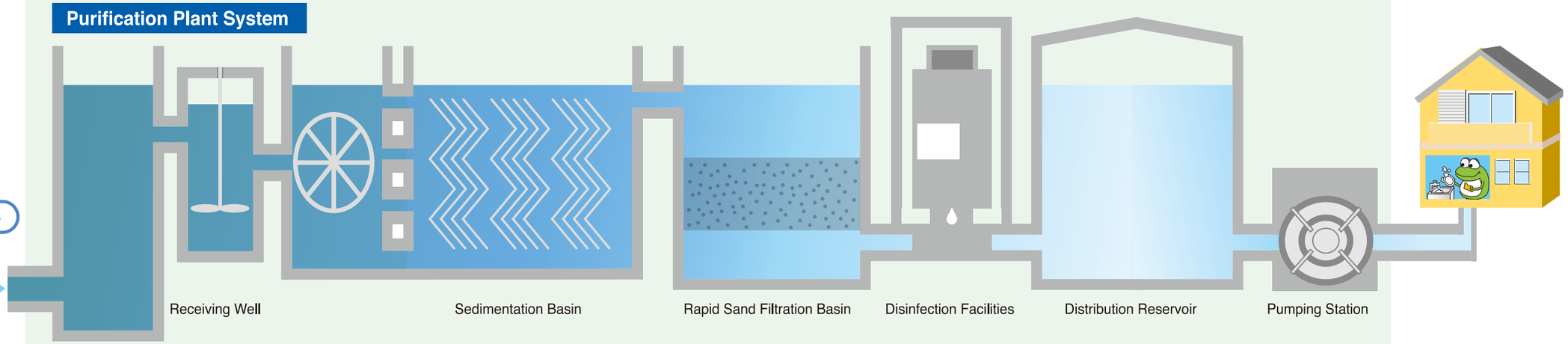
A membrane filtration system filters raw water through fine pores (approx.0.1 μm) in ceramic membranes. (1μm = 1/1000 mm)

*Made from the Japanese words for “ceramic” and “filtration” , Cerarocca is Kawai Purification Plant’ s nickname for the filtration system (chosen in a public poll).





Purification Plant System



Wastewater Treatment Facility

This is where floc removed in the sedimentation basin and filtration basin is condensed, dehydrated and then used as a construction material.

Receiving Well

This is where raw water drawn from rivers and lakes first arrives. The water level is adjusted here and water is sent to the sedimentation basin.

Sedimentation Basin

The coagulant (polyaluminum chloride) is dosed into the raw water. Suspended solids are coagulated into larger particles called floc and sedimented.

Rapid Sand Filtration Basin

Microscopic suspended solids that are not removed in the sedimentation basin are removed through a layer of sand and gravel.

Disinfection Facilities

Sodium hypochlorite is added to the filtered water to disinfect it.

Distribution Reservoir

This is where tap water is stored and volume is adjusted according to the quantity consumed. It also guarantees drinking water during a disaster such as an earthquake.

Pumping Station

This is where water is supplied by pumping at a proper pressure throughout the entire city, which is quite hilly.

Preservation of the Water Conservation Forest

Water conservation forests, also called green dams, perform three significant functions: storing water, purifying water and preventing flooding. In order to maintain and improve these functions, we are implementing various initiatives in Doshi village, one of Yokohama' s water sources.

Doshi river

Protecting and Fostering the Water Conservation Forest

Doshi River, one of Yokohama' s water sources, runs through Doshi village in Minami-tsuru-gun, Yamanashi Prefecture. Yokohama Waterworks Bureau has maintained the water conservation forest in this village since 1916. It is currently 2,873 hectares, accounting for about 36% of the total area of the village, and is about the same size as Yokohama' s Tsuzuki-ku. We established a Water Resource Forest Management Office and systematically carry out various activities such as thinning and weeding to protect and foster the water conservation forest.

Panoramic view of Doshi village

Doshi Water Source Foundation

Coinciding with the 100th anniversary of water intake from Doshi River in 1997, the City of Yokohama and village of Doshi jointly established a charitable trust, a water source foundation for Doshi village. This foundation is a charitable trust of 1.01 billion yen and is used to help protect the natural environment of the village and improve the basics of life in the community, contributing to conservation of water areas and local development as well as enhancing welfare.

Monument of the Doshi water conservation forest, selected as one of the 100 best water conservation forests.

Assisting in the domestic wastewater treatment project for Doshi village

We have been assisting in the installation of community wastewater treatment units for the village of Doshi since FY2001 in order to protect the quality of the water source, Doshi River.

Volunteer Activities for Doshi Water Conservation Forest

About 4,600 hectares of private forest in Doshi village play the role of water conservation forest. However, due to a shortage of labor, some forests are not appropriately maintained. Such private forests have been maintained by civil volunteers since 2004. The maintenance is promoted in cooperation with the volunteer organization Doshi Water Conservation Forest Volunteers' Association, which was founded by the participants in these volunteer activities. We also encourage maintenance activities carried out by NPOs or local volunteer groups.

Thinning by volunteers

Doshi Forest Foundation

In order to support the volunteer activities in the Doshi water conservation forest and obtain cooperation from people who cannot participate in the activities, we established the Doshi Forest Foundation, a foundation to accept donations from citizens and part of the sales of bottled water called "Hamakko-Doshi The Water."

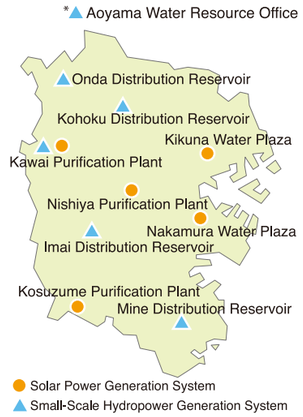
"Hamakko-Doshi The Water"

"Hamakko-Doshi The Water" is the official water of Yokohama. The water is sourced from Doshi River, a naturally abundant limpid stream in Yamanashi that is one of the water sources of Yokohama. Part of the sales of the water is donated to the Doshi Forest Foundation and also JICA (Japan International Cooperation Agency) to support African countries.

Eco-friendly Water Supply System

Renewable Energy

As more than 90% of greenhouse gases emitted in Yokohama is carbon dioxide from energy use, we must limit the use of such energy to reduce greenhouse gases – therefore, we need to move away from fossil fuels and instead raise the ratio of renewable energy usage. At the Waterworks Bureau, we are enthusiastically introducing solar power and small-scale hydropower systems to build up an environmentally-friendly water supply system.



What is Renewable Energy?

A renewable energy is any energy source among non-fossil energy sources that is approved as able to be used perpetually. A notable feature is that, unlike fossil fuels, a renewable energy source can be reused and supplied unendingly, with minimal burden on the global environment. Specific examples include solar light, hydropower and wind power.

Solar Power Generation Facilities

Since installing a movable solar power generation system above a filtration basin at Kosuzume Purification Plant in FY2000 (the first in Japan), we have installed solar power facilities providing 1,570 kW in an ongoing effort to use renewable energy.

A movable solar power generation system above a filtration basin (Kosuzume Purification Plant)

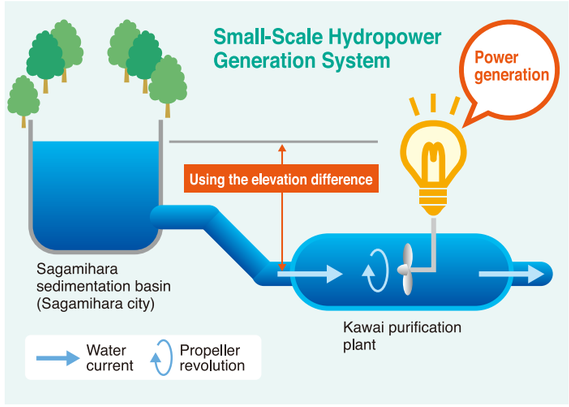
Environmental Measures for Dam Lakes (Reservoirs)

An aerator in action (Lake Sagami)

We circulate lake water and aerate it with aeration equipment to prevent proliferation of algae (Lake Sagami: 8 aerators, Lake Tsukui: 5 aerators).

Small-Scale Hydropower Facilities

We are promoting the introduction of renewable energy by installing small-scale hydropower units in water supply pipes to harness the power of flowing water. As of the end of FY2017, we have installed such units at six locations: Onda Distribution Reservoir, Kohoku Distribution Reservoir, Kawai Purification Plant, Aoyama Water Resource Office, Mine Distribution Reservoir and Imai Distribution Reservoir.



Renewable Energy Status (as of the end of FY2017)

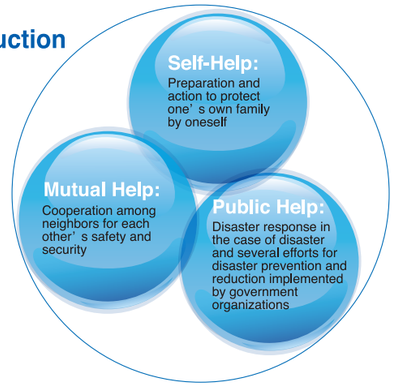
Facility name	Generation capacity (kW)	Projected power generation (kWh)	CO^2 reduction (t-CO^2)
Solar power generation system	1,570	1,650,384	803
Small-scale hydropower generation system	728	4,025,000	1,956

*For small-scale hydropower generation system, efficacy maintained by Kohoku Distribution Reservoir's installer (TEPCO) is included.

Disaster-Resistant Water Supply System

Our Basic Approach to Disaster Management – Prevention and Reduction

The Great East Japan Earthquake in March 2011 caused massive, widespread damage centered on the Tohoku region. The water supply was cut off across a wide area, leaving as many as 2,570,000 households in 19 municipalities without water.
Based on this disaster, in March 2013, the City of Yokohama undertook a review of the earthquake section of its disaster prevention plan and moved forward with measures that incorporate the concepts of self-help, mutual help and public help.
Likewise, at the Waterworks Bureau, we are strengthening our ability to mitigate disasters, which involves people protecting themselves on an individual basis (self-help), communities and companies assisting each other (mutual help) and official help via the Waterworks Bureau (public help).



Self-Help Encouraging the Stocking of Drinking Water

At the Waterworks Bureau, we strive to be ready for disasters, and we ask citizens to stock a minimum of three days' worth of drinking water, a total of nine liters per person (3 L/day). During a disaster, water trucks will prioritize supplying facilities such as hospitals. In addition, in most locations in the city, there are underground water supply tanks every 1 km for emergencies. However, operating these underground tanks may be difficult at nighttime or during bad weather, and carrying 9L of water home is arduous work.
Therefore, we at the Waterworks Bureau implore people to keep at least a three-day supply of drinking water in their homes.

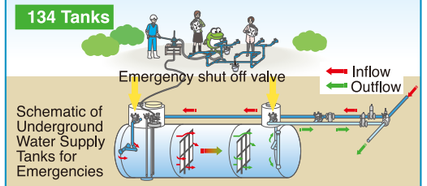
"Yokohama Canned Water" with 7-year shelf life.

Mutual Help Emergency Water Supply Stations

Sign

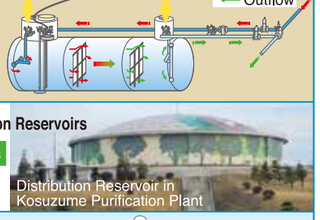
Banner

Underground Water Supply Tanks for Emergencies
134 Tanks



Schematic of Underground Water Supply Tanks for Emergencies

Distribution Reservoirs
22 Locations



Distribution Reservoir in Kosuzume Purification Plant

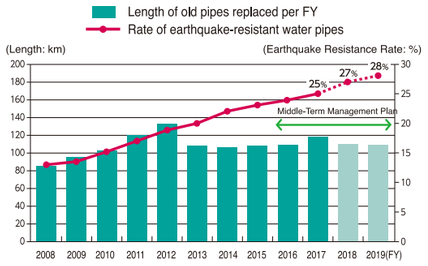
Emergency Water Taps
358 Taps

Schematic of Emergency Water Taps

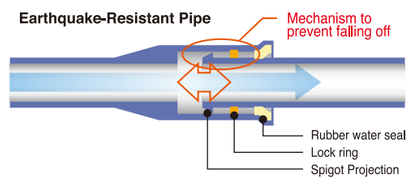
Water Trucks

Public Help Aged Pipes Replacement and Earthquake Resistant Pipes

At the Waterworks Bureau, we began replacing aged pipes in FY1969. In FY1996, we began progressively adopting earthquake-resistant pipes and since FY2006 we have used earthquake-resistant pipes in every replacement. The aged pipes installed during the ten-year period of high economic growth from 1965 have been updated.
To maintain water facilities, we replace 110 km of aged pipes annually and continue to advance the earthquake resistance project.
Within this project, our target rate for earthquake-resistant water transmission and distribution pipes is 28% and 68% for main water pipes by FY2019. In addition, we give priority to replacement pipes connected to ward offices, public work offices, hospitals and other important facilities.



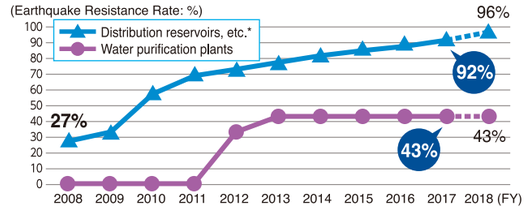
Earthquake resistant pipes are tough, made of a durable material. Because the connecting joints have a mechanism to prevent falling off and are elastic and very flexible. For that reason, the pipes can handle the shaking of the ground caused by earthquakes. Moreover, the pipes can resist damage and prevent joints from falling off.



Public Help Making Main Water Facilities More Earthquake-Resistant

Main water facilities such as intake and conveyance facilities, water purification plants and distribution reservoirs are important to ensure a stable water supply and we have systematically endeavored to make these facilities more earthquake-resistant. We have completed redevelopment of Kawai Purification Plant, which made it more earthquake resistant. Nishiya Purification Plant and Kosuzume Purification Plant are also being improved.
We have also made progress in improving distribution reservoirs, which are meant to be used as water supply stations during disasters.

Rate of earthquake-resistant water facilities such as purification plants



*Distribution reservoirs, distribution tanks, emergency-use underground water supply tanks

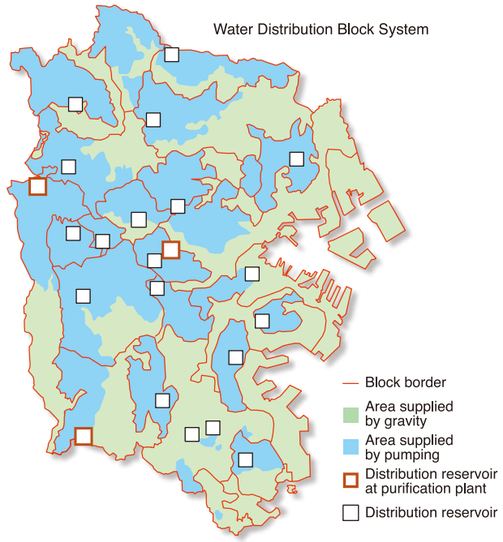
Public Help Water Distribution Block System

As Yokohama consists of rolling hills, distributing water to the entirety of the city at a proper pressure requires some ingenuity. To cope with this, we adopted the water distribution block system, dividing the city into 25 water distribution blocks. Those blocks are further divided in two: supply by gravity and supply by pressurized pumping. Generally each block has one distribution reservoir and one pumping station.

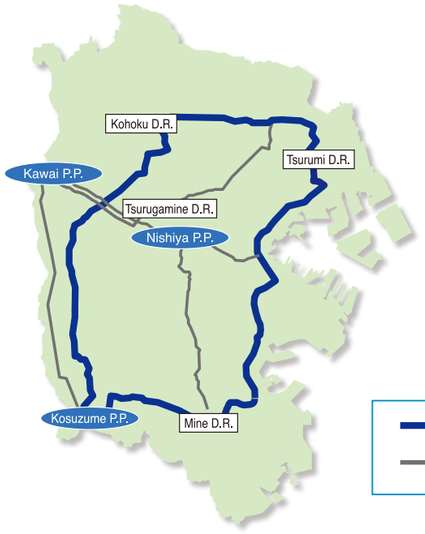
Merits of Water Distribution Block System

1. The problem of excessively low or high water pressure is cleared with the pressure in the block equalized, and the water pressure can be controlled more easily.
2. If an accident ever occurs in a block, other blocks can support the block, supplying water mutually.
3. Aggregating water supply information allows more economical and efficient water supply.
4. When an unanticipated event occurs, the impact, including the disruption of water supply, is minimized and quickly recovered.

Water Distribution Block System



Public Help Circular Network



A circular network, which connects purification plants and distribution blocks with a total length of approx. 70 km, was developed to enable emergency backup in the event that a purification plant is shut down by a massive earthquake, water quality accident or blackout. Even if a purification plant is shut down during a disaster, conveying water from other purification plants through the circular network ensures stable water supply to citizens.

1,350 mm-diameter water pipe

Safe and Quality Water

Water Quality Testing Plan and Results Disclosure

The government' s water supply quality standards were set to ensure that people can drink tap water through their entire lives without any ill effects and to prevent water being a hindrance in daily life in ways such as causing abnormal odors, discoloring laundry, etc. These rules apply in the same way to all water supply utilities nationwide and we are obligated to maintain water quality as well as conduct examination to check quality.
In order to maintain appropriateness and visibility in our water quality examination, we compile "water quality examination plan" annually that clearly defines the items, locations and frequency of water quality examination, and then implement examinations based on that plan. Moreover, we compile the results of examinations in "water quality examination report" . This report can be viewed at local libraries in Yokohama city and is available along with "water quality examination plan" and "water quality examination results" on the City of Yokohama website.

GLP certificate

Water Quality Examination

To ensure greater safety and reliability for our customers, we are certified under the GLP for Water Supply, the national standard for Tap Water Quality Testing Good Laboratory Practice, and strive to conduct accurate water quality inspection. We inspect about 120 items including 51 items defined in the national water quality standards.

Bacteriological Examination

We examine standard plate count and *Escherichia coli* to ensure that pathogenic microorganisms are not polluting the water supply. Indeed, water supply is disinfected with chlorine but we check conclusive safety. Examination is taken in a clean room with all equipment sterilized not to pollute samples during examination.


Bacteriological examination in clean room

Testing Organic and Inorganic Substances

We also examine minute amounts of organic and inorganic substances in raw water and supplied water. Organic substances examined are agricultural chemicals, substances that cause musty odors and trihalomethane generated by chlorine disinfecting. We examine these by using a gas chromatograph mass spectrometer (GC-MS) and a liquid chromatograph mass spectrometer (LC-MS). Inorganic substances we examine are metals and ionized substances. We examine these by using an induction-coupled plasma mass spectrometer (ICP-MS).


Organic substance examination using GC-MS

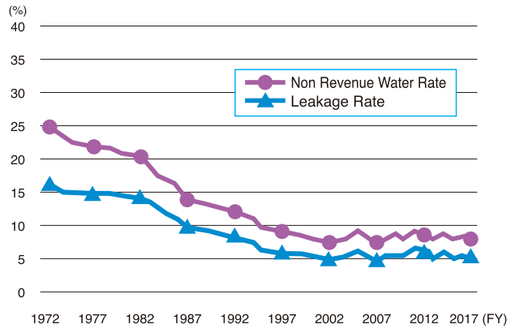
Tap Water Quality Examination

When customers are concerned about the quality of tap water and request a water quality testing, we conduct an examination to inspect the five basic items (taste, odor, color, turbidity, and residual chlorine concentration). For customers who are still concerned after receiving the result or ask for a detailed examination, we conduct further examination for water safety confirmation (turbidity, color, pH, organic substances, etc.) and other examinations required. We issue "water quality report" as the examination results to the customers.


Tap Water Quality Examination

Reduction of Non-Revenue Water

Water that does not generate any revenue is a major challenge for waterworks management based on the comprehensive cost principle.
While non-revenue water once accounted for over 70% of the total, we have successfully reduced this rate through leakage detection work with various kinds of technology and enhancement of the system for pipe renewal, water meter introduction. In FY2017, non-revenue water accounted for 7.7% and the leakage rate was 5.0%. Today, Yokohama is divided into 915 blocks where leakage detection work is conducted once every three years by our staff and contractors.
We utilize this experience reducing non-revenue water and the technology accumulated through it to help improve waterworks at home and abroad by accepting trainees and sending experts.




Leakage detection work


Training for leakage detection with acoustic rods

Yokohama's Water Tariffs

Yokohama Waterworks Bureau introduced a progressive water rate system according to category of water use. This system is based on the idea that the unit price of domestic water used every day should be low. The rate is differentiated by water use category and the higher the amount of water used, the higher the unit price becomes.
The three categories are domestic water use for the home, business use and public bath use.
Generally the water meter is read and billed once every two months. The amount billed is calculated according to the water tariff which is determined by multiplying the consumption tax and local consumption tax rate (rounded down if less than 1 yen).

(As of 1 April, 2001)

Water Tariff (per 2 months)

Category	Water volume	Rate/m³	Calculation
Domestic water use	0 m³～ 16 m³		¥1,580 (basic rate)
	17 m³～ 20 m³	¥ 43	¥ 43 × water volume + ¥ 892
	21 m³～ 40 m³	¥158	¥ 158 × water volume − ¥ 1,408
	41 m³～ 60 m³	¥226	¥ 226 × water volume − ¥ 4,128
	61 m³～ 100 m³	¥269	¥ 269 × water volume − ¥ 6,708
	101 m³～ 200 m³	¥293	¥ 293 × water volume − ¥ 9,108
	201 m³ or more	¥320	¥ 320 × water volume − ¥ 14,508
Business use	0 m³～ 16 m³		¥1,580 (basic rate)
	17 m³～ 20 m³	¥ 43	¥ 43 × water volume + ¥ 892
	21 m³～ 40 m³	¥158	¥ 158 × water volume − ¥ 1,408
	41 m³～ 60 m³	¥226	¥ 226 × water volume − ¥ 4,128
	61 m³～ 100 m³	¥269	¥ 269 × water volume − ¥ 6,708
	101 m³～ 200 m³	¥293	¥ 293 × water volume − ¥ 9,108
	201 m³～ 600 m³	¥320	¥ 320 × water volume − ¥ 14,508
	601 m³～2,000 m³	¥369	¥ 369 × water volume − ¥ 43,908
	2,001 m³ or more	¥409	¥ 409 × water volume − ¥123,908
Public bath use	0 m³～ 16 m³		¥1,580 (basic rate)
	17 m³ or more	¥ 42	¥ 42 x water volume + ¥ 908


Yokohama Waterworks Bureau
Mascot "Hama-pyon"