KUSAKI

Water Supports Wealthy Society

DAM

Kusaki Dam

Incorporated Administrative Agency
Japan Water Agency

KUSAKI DAM

History of Project

The Kusaki Dam is a multi-purpose dam constructed to prevent flooding in the riverside areas of the Watarase River, acquire industrial and drinking water mainly for the urban areas, acquire agricultural water for the riverside areas of the Watarase River, and for the hydroelectric power generation. In 1958, the then Ministry of Construction (current Ministry of Land, Infrastructure and Transport) started preliminary investigation into a planned dam tentatively named Godo Dam (later renamed Kusaki Dam). In 1965, the Godo Dam was added to the basic plan for water resources development as part of efforts to cope with rapidly increasing water demand and transferred from the then Ministry of Construction to the Water Resources Development Public Corporation. In 1967, full-scale construction work started, and construction work continued amid various problems, including the issue of local residents' compensation, a movement against construction, measures to cope with copper poison from the Ashio Copper Mine, and rising commodity prices. About a decade later in March 1977, the Kusaki Dam was completed at a total cost of around 50 billion yen.

Since its completion, the dam, which is officially known as the Kusaki Dam of the Water Resources Development Public Corporation, has been used effectively to help maintain and improve people's lives and for flood control 22 times in 26 years, successfully reducing flood damage in the downstream reaches while supplying drinking water to urban areas and water for agricultural use.

In October 2003, the dam made a new start, changing its name from the Kusaki Dam of the Water Resources Development Public Corporation to the Kusaki Dam of Japan Water Agency. In addition to the conventional duties of flood control and water supply, the dam was bestowed with a new duty-that of helping to boost local development. The Kusaki Dam is committed to serving the people by supplying water, protecting people living in the river basin from flooding and revitalizing the mountainous communities in the reservoir areas.

August 1962
Godo Dam listed in the basic plan for water resources development

May 1975
The basic plan for water resources development partially altered

September 1976
Project execution principle for the Godo Dam issued

December 1967
Godo Dam construction office set up

December 1967
Project execution plan confirmed

January 1968
Water quality investigation committee set up

June 1968
Name changed from Godo Dam to Kusaki Dam at the request of local residents

August 1971
Public and individual compensation issues resolved

June 1972
Relocation of the Ashio Line, which was to be submerged under water, completed

May 1973
Dam cornerstone laying ceremony

August 1974
Relocation of all residents whose land was to be submerged completed

March 1977
Construction of the Kusaki Dam completed

1977
Management regulations approved

October 2003
The Water Resources Development Public Corporation reorganized as Japan Water Agency

Kusaki Dam Operation and Maintenance Office
Incorporated Administrative Agency
Japan Water Agency

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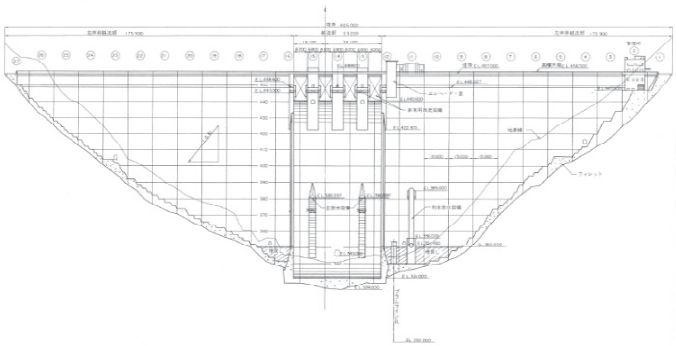
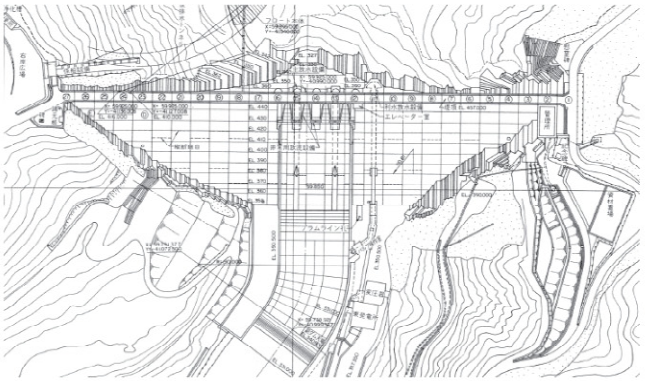
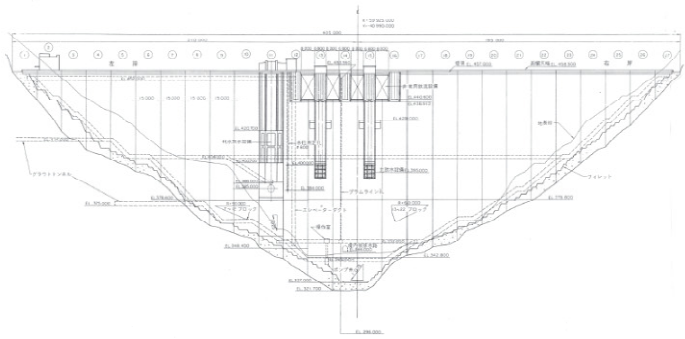
Dam

Drawing of the downstream side of Kusaki Dam

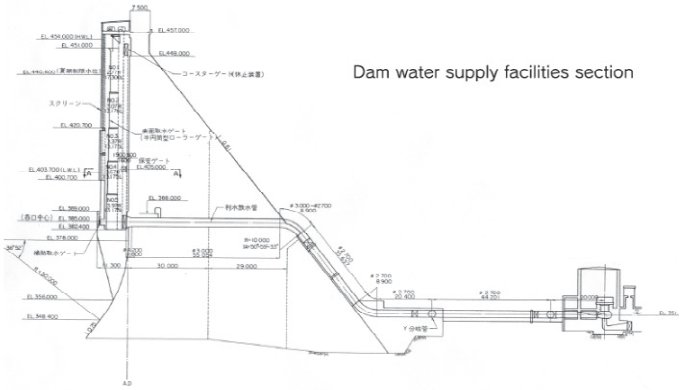




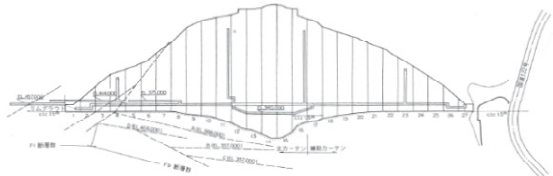
Drawing of the upstream side of Kusaki Dam



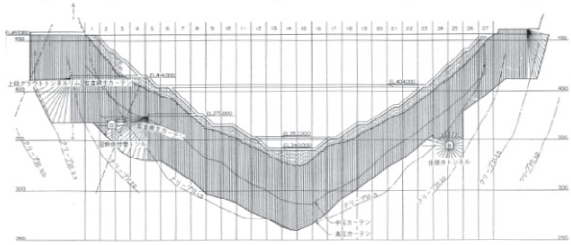
Dam water supply facilities section



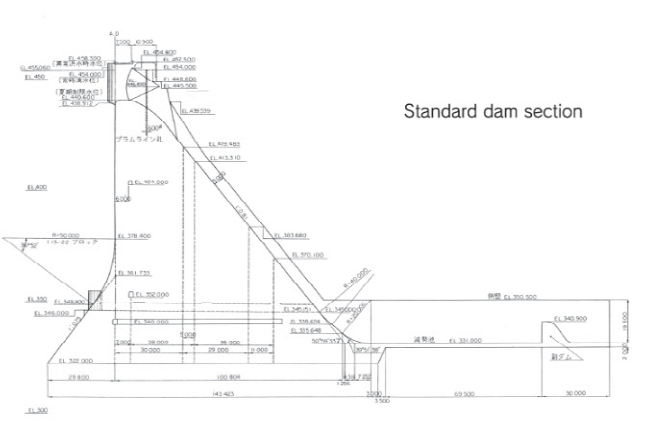
Plan of the high- and medium-pressure curtain grouting



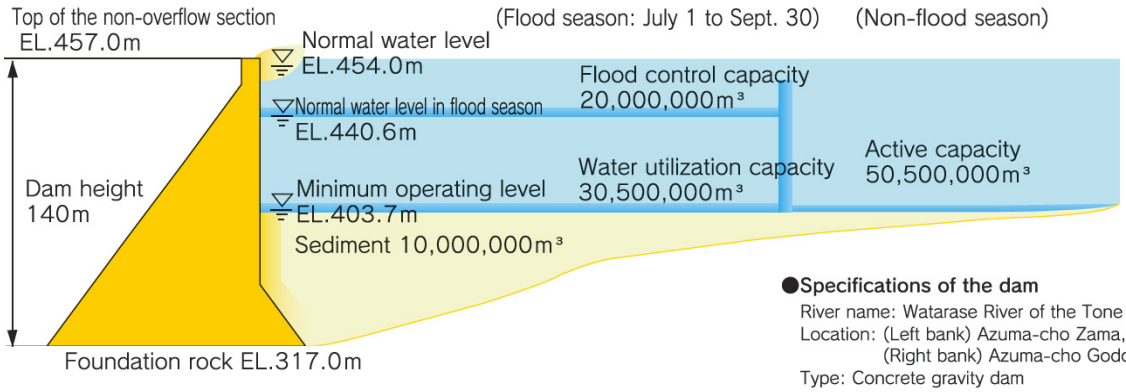
Drawing of the upstream side of the high- and medium-pressure curtain grouting



Standard dam section



Outlet Works and Reservoir



●Specifications of the dam

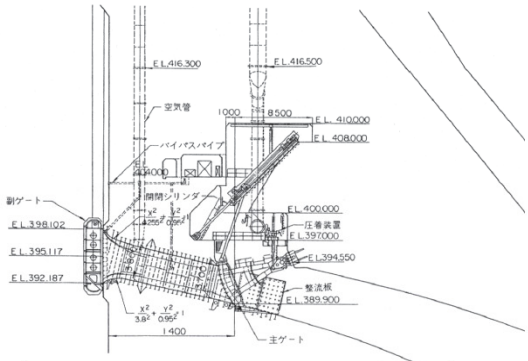
River name: Watarase River of the Tone River System
Location: (Left bank) Azuma-cho Zama, Midori city, Gunma prefecture
(Right bank) Azuma-cho Godo, Midori city, Gunma prefecture
Type: Concrete gravity dam
Geology: Slate and sandstone
Dam height: 140 m (from the lowest foundation rock to the top of the non-overflow section)
Dam crest length: 405 m
Dam volume: about 1,300,000 m^3
Elevation of the dam top: 457.0 m at the non-overflow section

●Specifications of the reservoir

Catchment area: 254 km^2
Flooding area: 1.7 km^2
Normal water level: EL.454.0m
Normal water level in flood season: EL.440.6m
Minimum operating level : EL.403.7m
Total reservoir capacity: 60,500,000m^3
Effective storage: 50,500,000m^3
Storage capacity for sedimentation: 10,000,000m^3

Discharge equipment for Flood Control

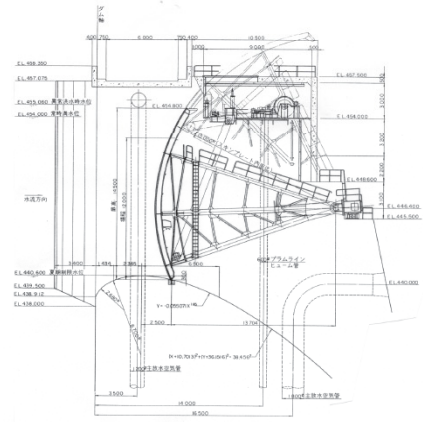
Gate	Type: Pressure-bonded high head radial gate
	Dimensions: Effective height 3.7 m x effective span 3.2 m
Outlet conduit: Semi-pipe type buried welded steel pipe (elevation at the center of the tap: 395.117 m)	
No. of gates: 2	
Discharge capability: 670 m^3/s	



Discharge equipment for Flood Control

Discharge equipment for Emergency

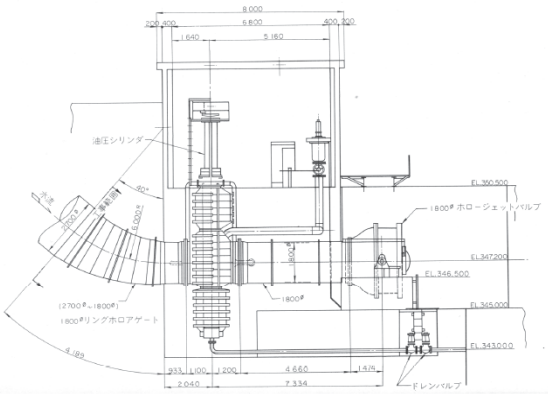
Type: Dam top overflow radial gate
Dimensions: Gate height 14.5 m x net span 8.2 m (bed height elevation: 440.3 m)
No. of gates: 4
Discharge capability: 3,650 m^3/s



Discharge equipment for Emergency

Discharge equipment for Downstream Water Use

Type: Steel hollow jet valve
Diameter: φ1,800mm
No. of valves: 1
Discharge capability: 65 m^3/s



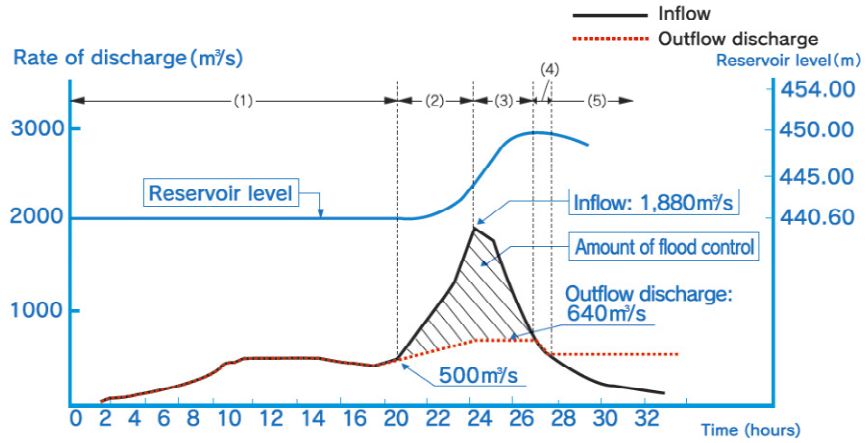
Discharge equipment for Downstream Water Use

Purpose - Flood Control

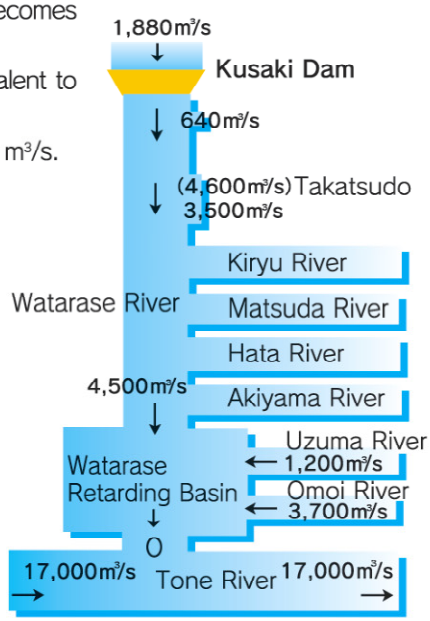
Flood Control

The Kusaki Dam plans to control 1,240 m³/s of water relative to a flood discharge of 1,880 m³ and discharge 640 m³/s of wate to the Watarase River. The control is conducted by fixed discharge-rate operation.

(1) The amount of water equivalent to the inflow is discharged from the dam until the inflow reaches 500 m³/s.
(2) The amount of [(inflow - 500 m³/s) x 0.1 + 500 m³/s] is discharged from the dam after the inflow reaches 500 m³/s.
(3) After the inflow peaks, the peak discharge is released from the dam until the inflow becomes equal to the outflow discharge.
(4) After the inflow becomes equal to the outflow discharge, the amount of water equivalent to the inflow is discharged from the dam until the inflow reaches 500 m³/s.
(5) 500 m³/s of water is discharged reduce the reservoir level after the inflow reaches 500 m³/s.
▨ is stored in the dam reservoir to reduce the flood discharge.



Flood control diagram of the Kusaki Dam



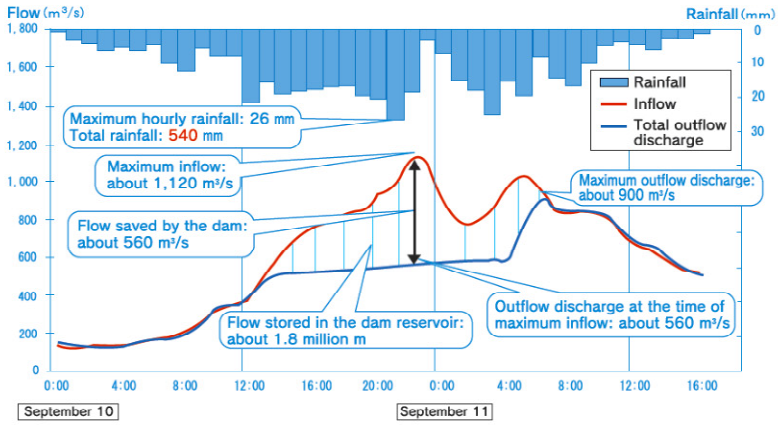
Values in parentheses refer to design high water discharge.

Design high water discharge diagram of Watarase River

Emergency Operation (Operational procedure used when the flood flow exceeds the design flow)

On September 10, 2001, a significant flood event occurred with the arrival of Typhoon No. 15.
Although the maximum inflow was smaller than the design flood discharge, the duration of rainfall was such that the water volume in the reservoir had almost reached the capacity. Thus, the mode of operation was shifted to the Emergency one.

Maximum inflow: 1,120 m³/s
Cumulative rainfall averaged in the river basin: 540 mm



Past flood control chart of the Kusaki Dam (Typhoon No. 15, 2001)

Purpose - Water Use and Coordinated Operation

Industrial Water, Drinking Water-Coordinated Operation

The Kusaki Dam and the Shimagawa Dam, each of which has users of different rivers, are operated through coordinated efforts of three authorities, namely the Ministry of Land, Infrastructure and Transport, Gunma prefecture and the former Water Resources Development Public Corporation (present Japan Water Agency).

Design Water Allocation

Drinking water supply

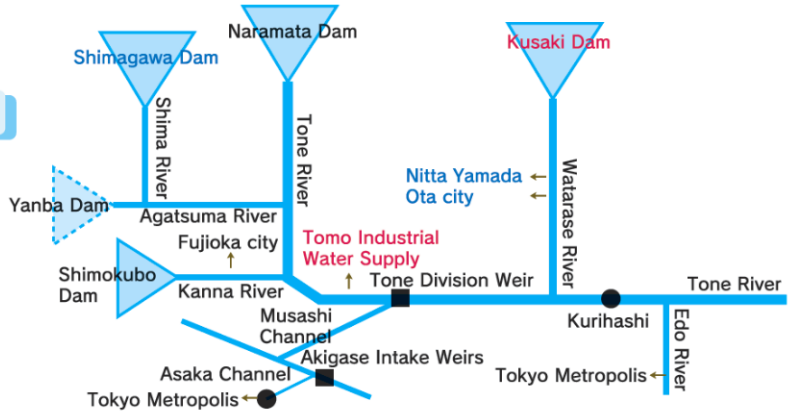
- Kiryu city: 0.52 m³/s
- Sano city: 0.30 m³/s
- Saitama prefecture: 0.54 m³/s
- Tokyo Metropolis: 5.68 m³/s

Total: 7.04 m³/s

Industrial water supply

- Gunma prefecture: 0.60 m³/s
- Ashikaga city: 0.30 m³/s
- Tokyo Metropolis: 0.98 m³/s

Total: 1.88 m³/s



After water resource transfer

Drinking water supply

Nitta Yamada Waterworks, Watarase River Waterworks Company Group

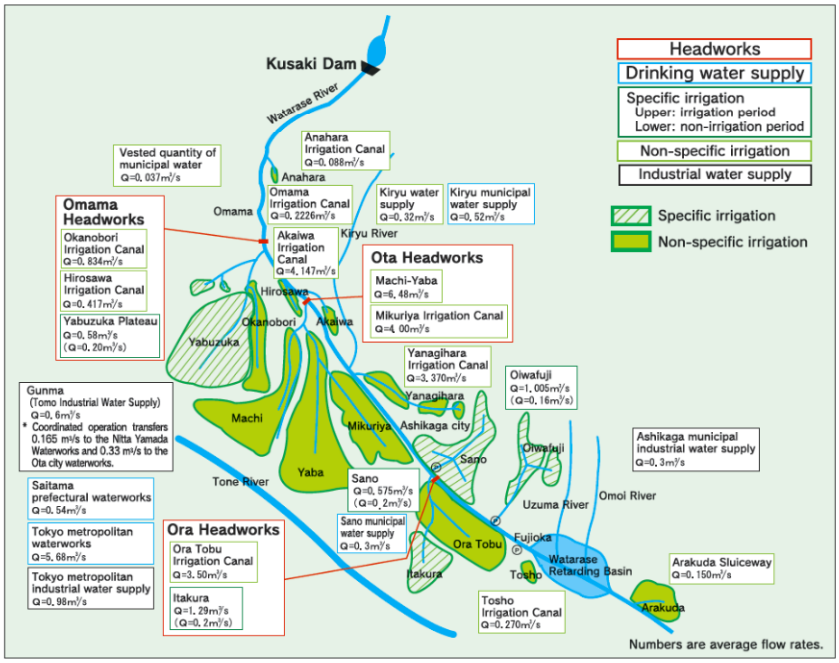
- Ota city: 0.33 m³/s
- Gunma prefecture (Nitta Yamada Waterworks): 0.165 m³/s
- Kiryu city: 0.52 m³/s
- Sano city: 0.30 m³/s
- Saitama prefecture: 0.54 m³/s
- Tokyo Metropolis: 5.68 m³/s

Total: 7.535 m³/s

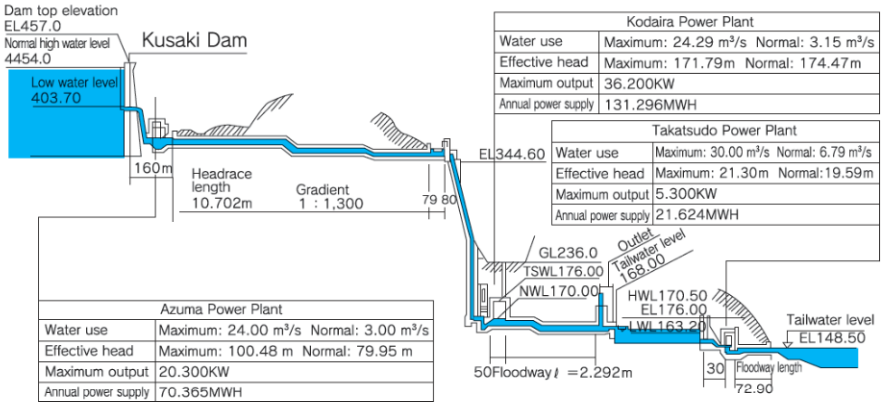
Industrial water supply

- Gunma prefecture (Tomo Industrial Water Supply): 0.495 m³/s
- Gunma prefecture: 0.105 m³/s
- Ashikaga city: 0.30 m³/s
- Tokyo Metropolis: 0.98 m³/s

Total: 1.385 m³/s



Power Generation



Kodaira Power Plant	
Water use	Maximum: 24.29 m³/s Normal: 3.15 m³/s
Effective head	Maximum: 171.79m Normal: 174.47m
Maximum output	36.200KW
Annual power supply	131.296MWH

Takatsudo Power Plant	
Water use	Maximum: 30.00 m³/s Normal: 6.79 m³/s
Effective head	Maximum: 21.30m Normal:19.59m
Maximum output	5.300KW
Annual power supply	21.624MWH

Azuma Power Plant	
Water use	Maximum: 24.00 m³/s Normal: 3.00 m³/s
Effective head	Maximum: 100.48 m Normal: 79.95 m
Maximum output	20.300KW
Annual power supply	70.365MWH

Longitudinal section of Higashi, Kodaira and Takatsudo Power Plants

These three power plants (Higashi, Kodaira, and Takatsudo) generate a maximum power output of 61,800 kWh, which is equal to power to be consumed by some 20,000 households.

Irrigation

Specific irrigation

Watarase riverside
(4 areas of Yabuzuka, Itakura, Sano and Oiwafuji)

Irrigation period:
average ≒ 3.45 m³/s
Non-irrigation period:
average ≒ 0.76 m³/s

Irrigation period:
May 1 to Sept. 25
Non-irrigation period:
Sept. 26 to April 30

Non-specific irrigation

Watarase riverside
(from Omama point to Sagawada point)

Irrigation period:
Average ≒ 9.86 m³/s
Maximum ≒ 24.19 m³/s
(From Sagawada point to the convergence of the main course of the Tone River)
Average ≒ 1.78 m³/s
Maximum ≒ 3.84 m³/s

Non-irrigation period:
(Omama point)
Average ≒ 5.08 m³/s
Maximum ≒ 5.27 m³/s
(Sagawada point)
Average ≒ 0.51 m³/s

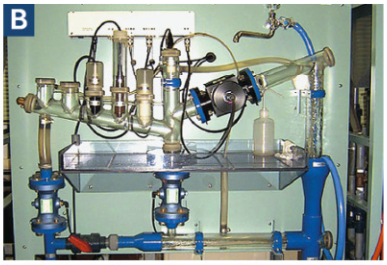
Environmental Preservation

1 Measures against Heavy Metal

We operate the surface intake system to prevent elongation of turbidity during or after flooding and to reduce the concentration of heavy metals. Water temperature, pH, turbidity, electric conductivity, and dissolved oxygen are usually measured on the hour every hour using an automatic water quality monitoring equipment. Copper, zinc, lead, arsenic, cadmium, iron and manganese are also measured to know the concentration of heavy metals.

■ **Surface intake system**

This equipment takes surface water from the water surface of the reservoir down to a depth of 4 m. Even if turbid water caused by a flood enters the reservoir, intake of the surface water allows a discharge of less turbid water to the downstream flow.

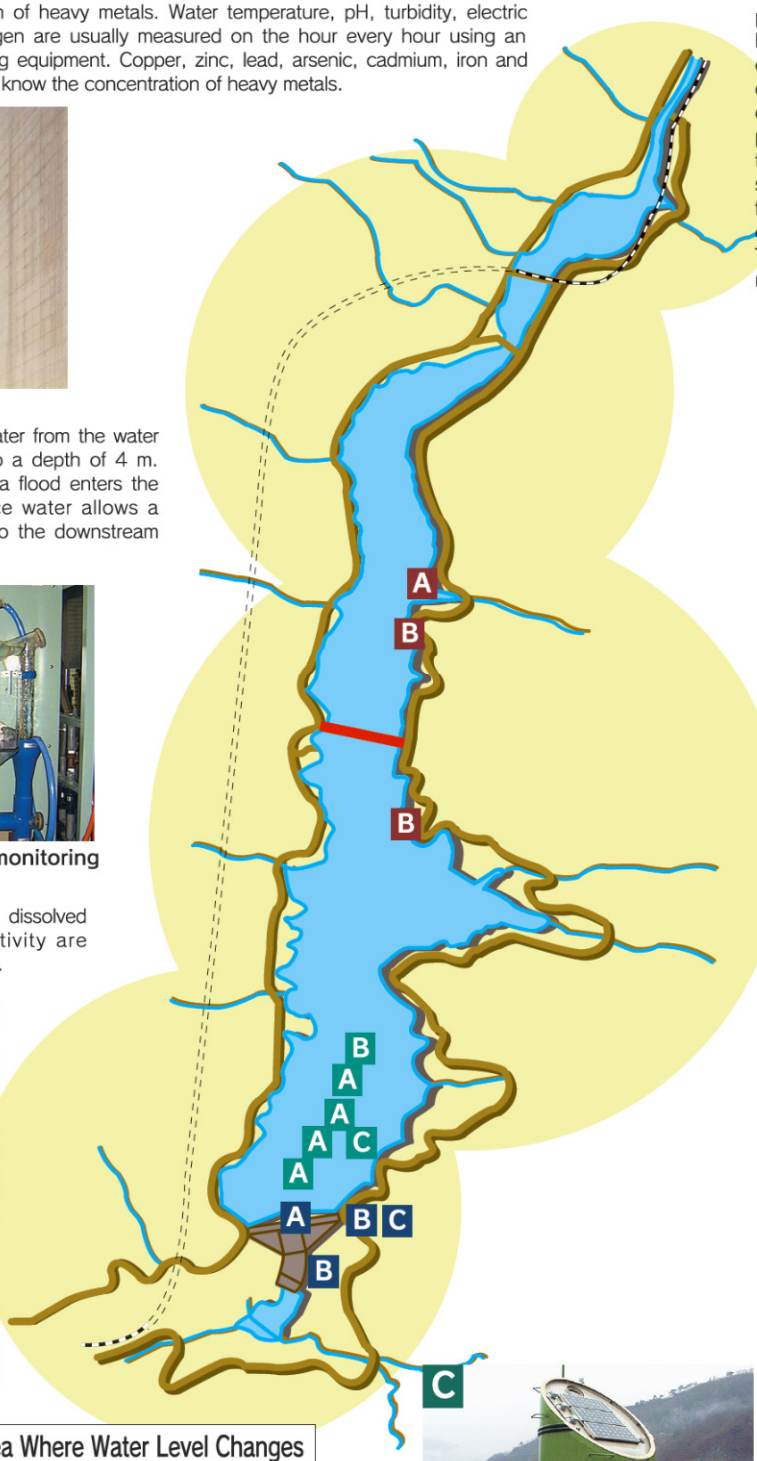


■ **Automatic water quality monitoring equipment**

Water temperature, pH, turbidity, dissolved oxygen and electric conductivity are measured on the hour every hour.

■ **Water quality analysis**

The Kusaki Dam has a water quality analysis room, which is very rare for dam facilities, in which analysis of heavy metals and counting of plankton are conducted.



2 Greening of the Area Where Water Level Changes and Slope Protection

Slope greening is conducted by planting water-resistant plants on the slope of the reservoir in order to enhance the safety of the slope of the reservoir bank and create a more attractive landscape.

■ **Automatic water quality monitoring equipment, known as Takenoko (bamboo shoot)**

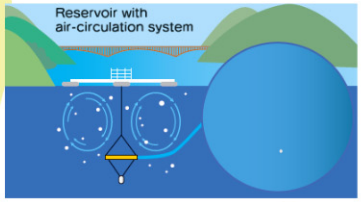
Water temperature, pH, turbidity, dissolved oxygen, electric conductivity and chlorophyll a are measured on the hour every hour.

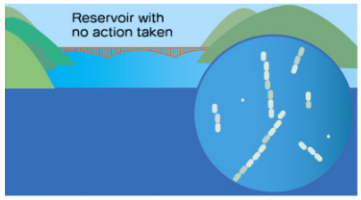
3 Countermeasures against Foul Smell and Taste

Mass-growth of cyanobacterial plankton, phormidium, in the Kusaki Dam reservoir began in 1984, and the resulting foul smell contaminated the drinking water of users downstream. Diffuser tube-type circulation equipments, installed by the "Clean Up Lake" project in 1992, are designed to reduce the temperature of the surface water, limit sunlight irradiation to the plankton, and fluidize the lake water, thereby eliminating the conditions needed for the alga to flourish. These equipments have considerably reduced the odor problem.

Ecology of Phormidium

Phormidium is a kind of blue-green algae with cells measuring about 3 to 5 μm. When it forms a colony, cells join in chains. This plankton generates a substance called 2-MIB, which gives water a moldy smell.





■ **Epilimnion derating and recirculating equipment**

Four sets are installed at location A.

■ **Fountain-combined epilimnion aeration and recirculating equipment**

A fountain reduces the number of plankton by pumping.

Reservoir Area Development

Exchange between Reservoir Areas and Cities — Reservoir Area Vision

Reservoir Area Vision for the Kusaki Dam aims to enhance the appeal of the reservoir area and help as many people as possible realize the importance of the reservoir area. For the activities, the Kusaki Dam and Azuma-cho in Midori city (former Azuma village) as the main promoters coordinate with local residents, private corporations, the central and prefectural government.

Appeal of Azuma-cho in Midori City

Appeal of Azuma-cho, which is located in Midori city, is its natural splendor and balanced nature. As one example, the poetic paintings by Tomihiro Hoshino that depict the beautiful nature of Azuma-cho have greatly attracted and inspired a large number of people. The Tomihiro Museum, a gallery dedicated to this uniquely gifted artist, and a variety of tourist facilities located around the museum make Azuma-cho an inspiration-filled hometown for both visitors and local residents together with the colorfully woven raviney scenes of the Watarase Valley, the breathtaking landscape of the Kusaki Dam, and many locally produced items with designs based on or featuring the rich local nature.