Significance of rainwater and reclaimed water as urban water resource for sustainable use

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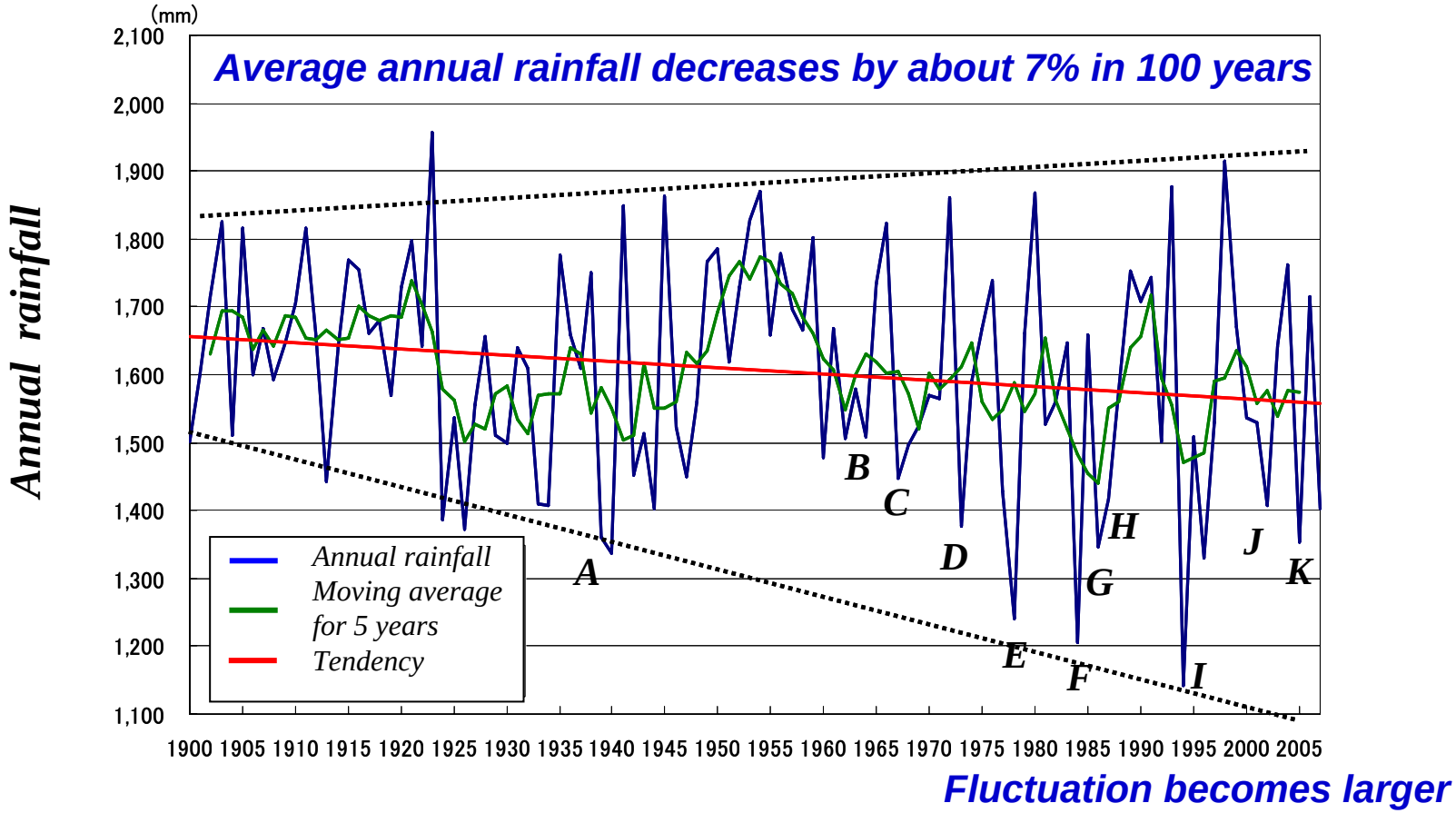
Outline

- Introduction
  - Climate change and fluctuation of annual rainfall in Japan
  - Water resource and water supply system in Tokyo
  - Concern about the sustainability of urban water use
  - Facility installation for rainwater and reclaimed water use

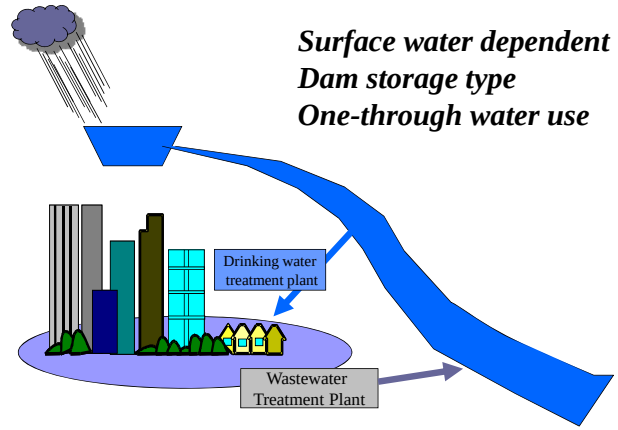
- Urban water resources for sustainable use
  - Rainwater harvesting and use
    Representative cases and new movement of rainwater use
  - Reclaimed water use and treatment technology
    Current state of reclaimed water use and new projects

Fluctuation of annual rainfall and occurrence of drought in Japan

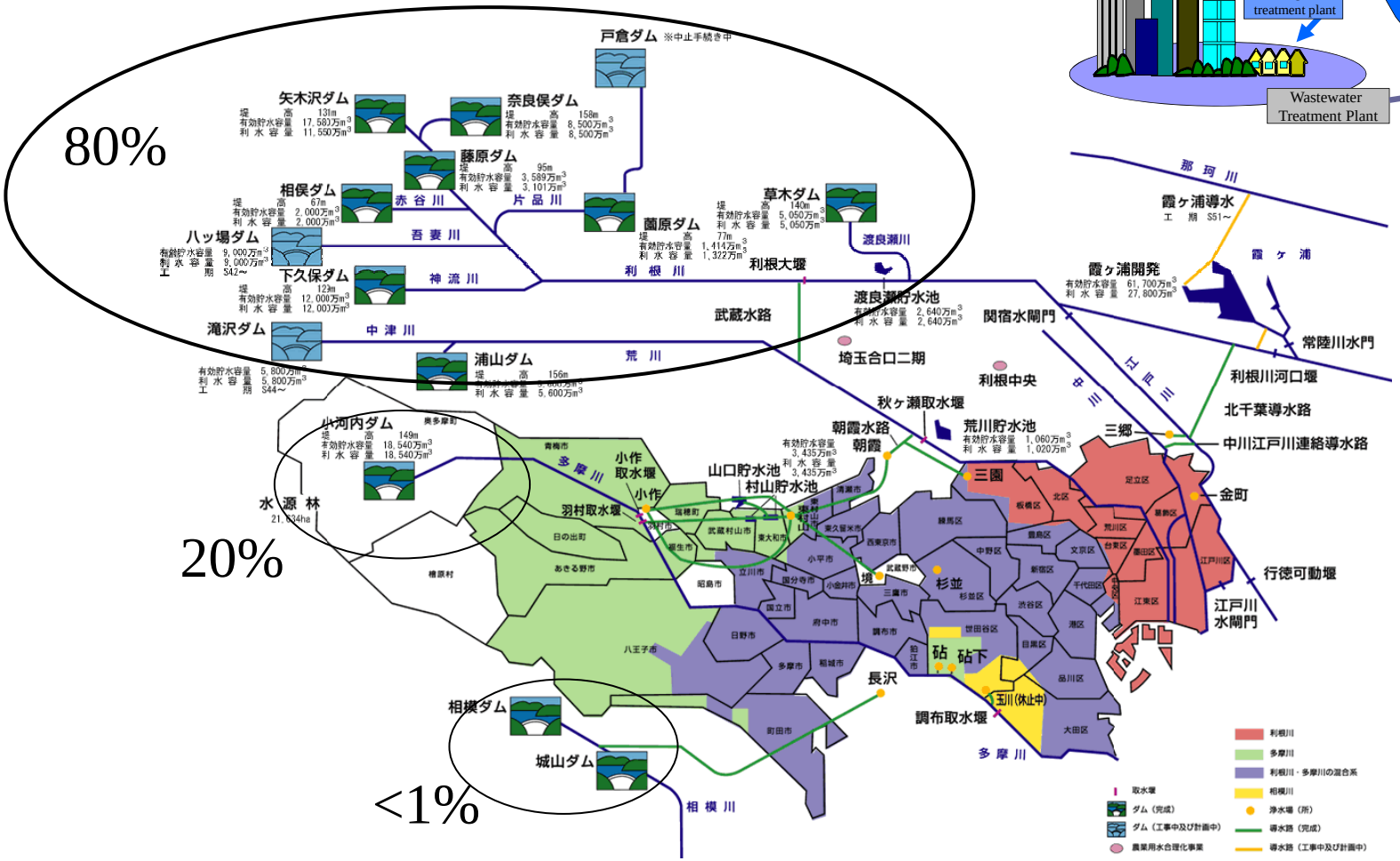


A: Lake Biwa drought(1939), B: Tokyo Olympic drought(1964), C: Nagasaki drought(1967), D: Takamatsu drought(1973), E: Fukuoka drought(1978), F: Nationwide winter drought(1984), G: West Japan winter drought(1986), H: Metropolitan area drought(1987), I: Japan Islands drought(1994), J: Matsuyama drought(2002), K: Chubu and Shikoku area drought(2005)

Water resource and Water supply system in Tokyo



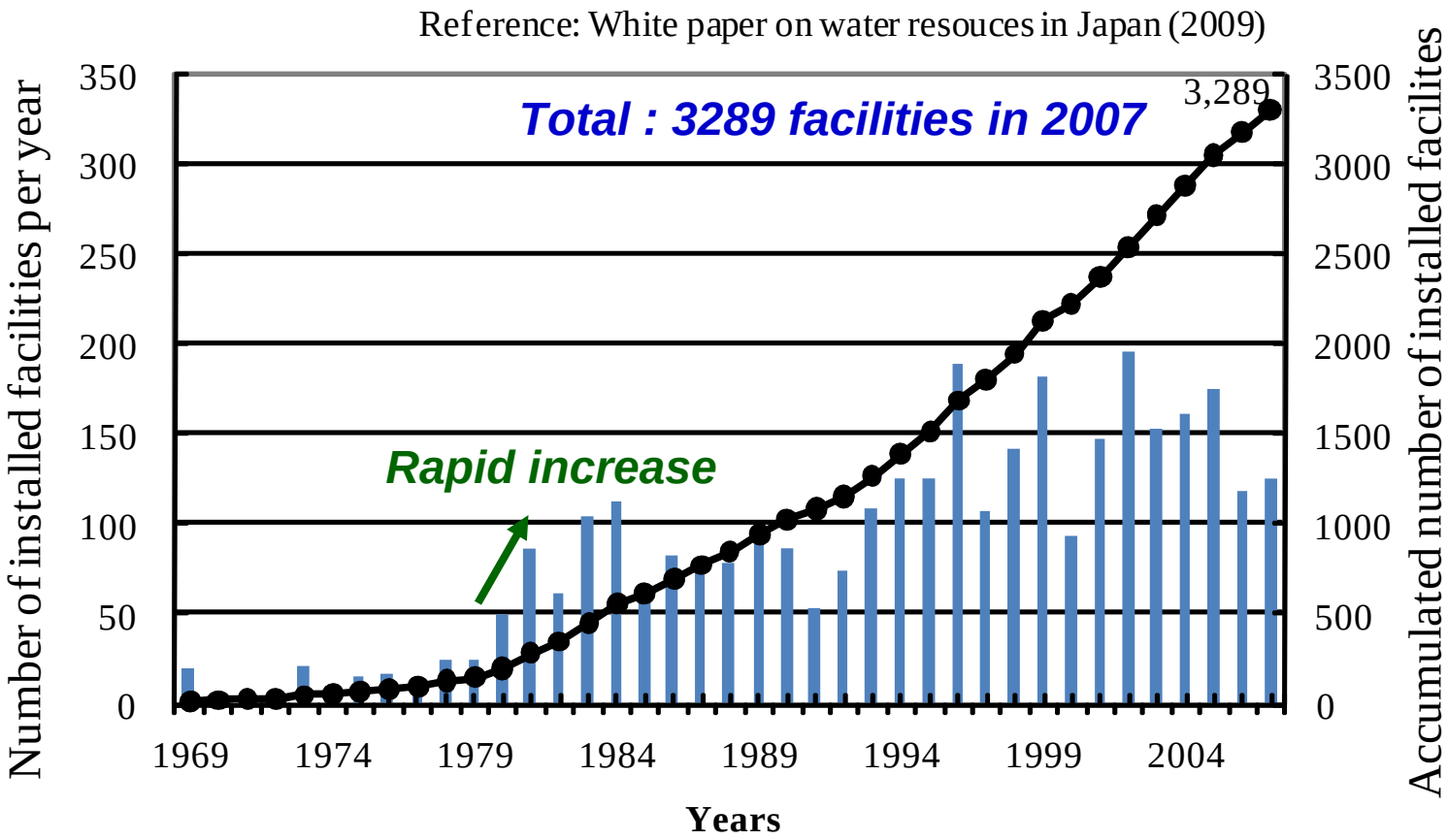
Surface water dependent
Dam storage type
One-through water use



Concern about the sustainability of urban water use

- Increased water demand had led to the dam construction at the upstream and the extensive water withdrawal from rivers in Japan.
- Stable water supply and efficient water use have become concerning in growing mega cities in Asia.
- Efficient water use have been implemented to reduce water intake from natural water system and to secure the sound water cycle.
- Achievement of the sustainability is required ensuring a long-term water supply with adequate quality and minimizing adverse economic, social and ecological impacts.

Facility installation for Rainwater and Reclaimed water use

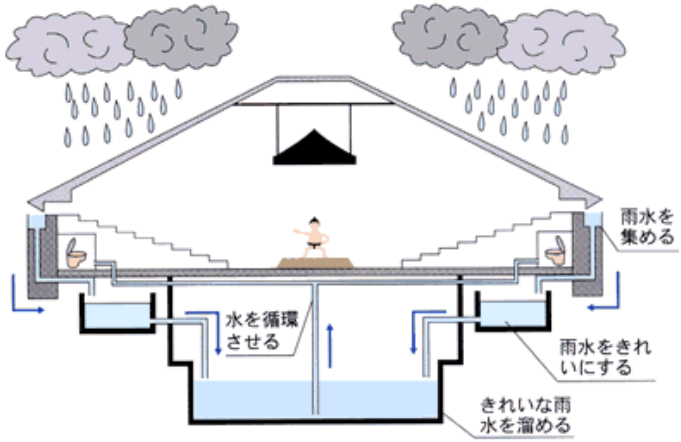


The number of facilities has been increased since 1980s, in which government financing system was introduced.

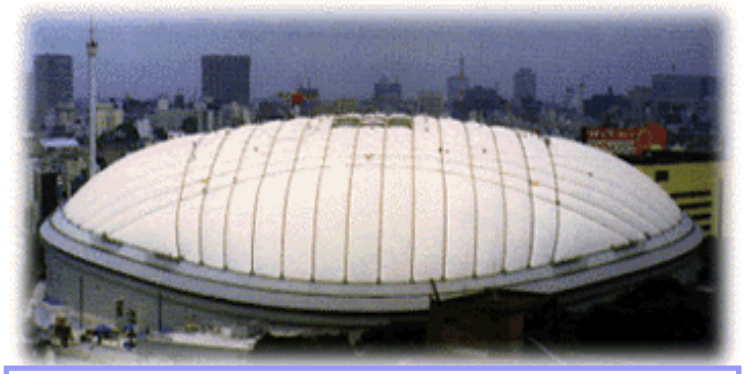
Rainwater harvesting facilities: ap. 1600 in 2007

Milestones of rainwater harvesting (RWH) facility

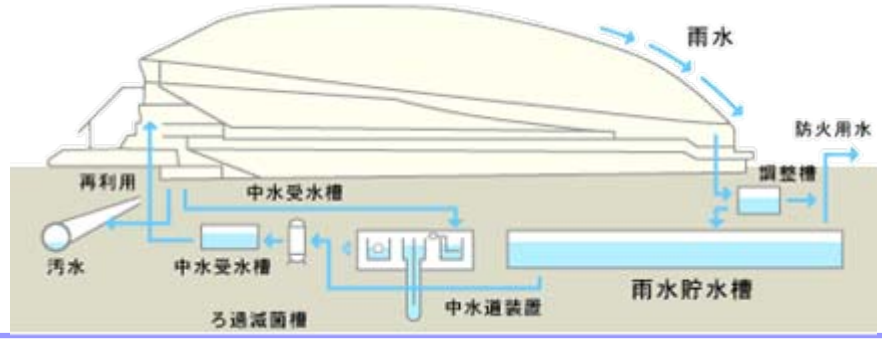
Sumo-wrestling Arena
(Kokugi-kan) 1984



Tank Capacity of 1000m³ (effective vol. 750m³)



Tokyo Sport Stadium
(Tokyo Dome) 1988



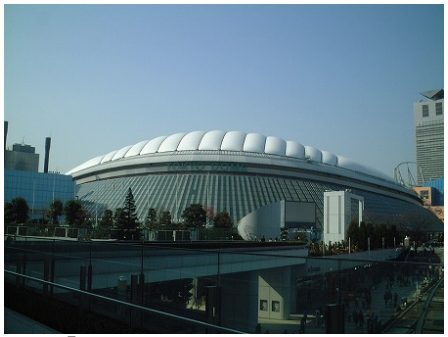
Tank Capacity of 3000m³

1000m³ for flood control
1000m³ for miscellaneous water use
1000m³ for emergency water use such as fire events

Representative examples of large-scale rainwater harvesting (RWH) in stadiums and domes

Saitama Super Arena

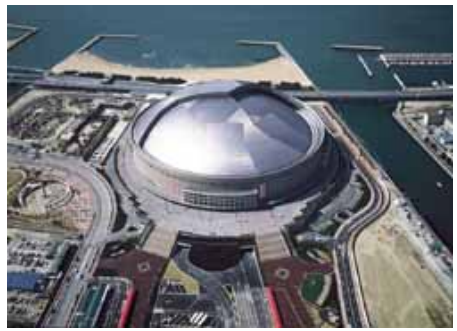
Nagoya Dome



Tokyo Dome

Osaka Dome

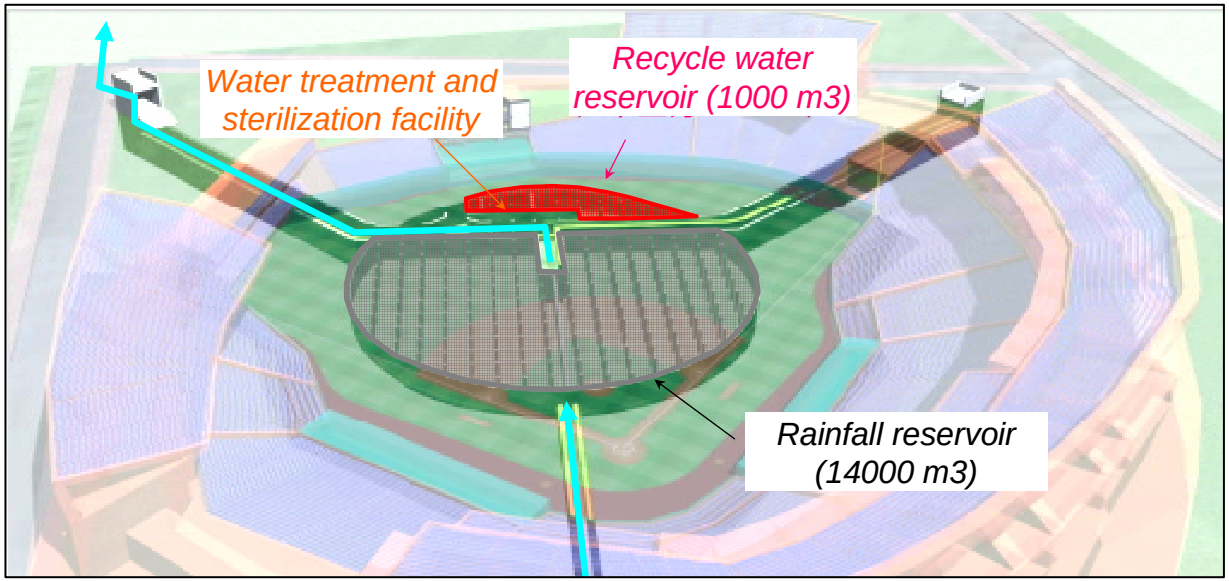
Yokohama Stadium



Fukuoka Dome

Name of facilities	Constructed year	Storage capacity (m^3)	Roof catchment area (m^2)
New Hiroshima Stadium	2009	1,000	23,000
Saitama Stadium 2002	2001	3,250	29,000
Saitama Super Arena	2000	1,200	28,000
Sendai Dome	2000	1,300	19,800
Yokohama Stadiuam	1998	2,000	30,000
Tajima Dome	1998	3,000	19,000
Kitakyushu Media Dome	1998	2,000	22,000
Nagoya Dome	1997	2,800	35,000
Osaka Dome	1997	1,700	31,400
Ohdate Extensive forest Dome	1997	4,320	21,000
Fukuoka Dome	1993	2,900	34,000
Izumo Dome	1992	1,210	36,000
Akita Sky Dome	1990	1,200	12,000
Green Dome Maebashi	1990	1,120	20,000
Tokyo Dome	1988	1,000	15,700

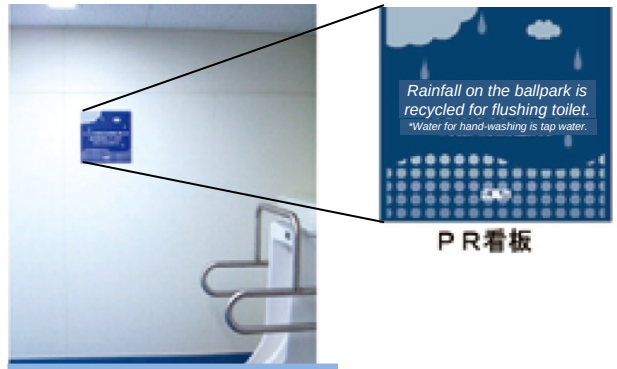
Recent RWH project at a stadium in Hiroshima



Installed storm water reservoir under the stadium mitigates urban flooding and utilizes rainwater for watering, toilet and water amenity.

Water channel/stream

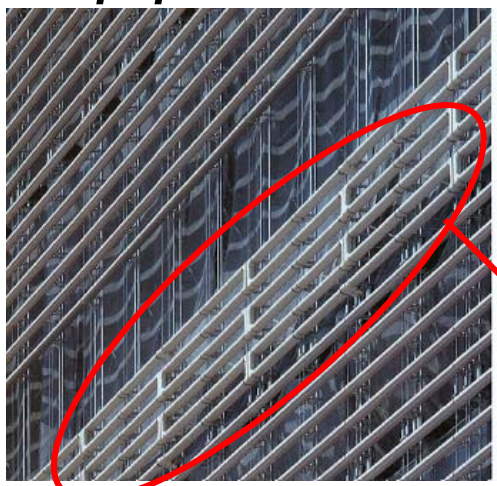
Sprinkling of water on the baseball field

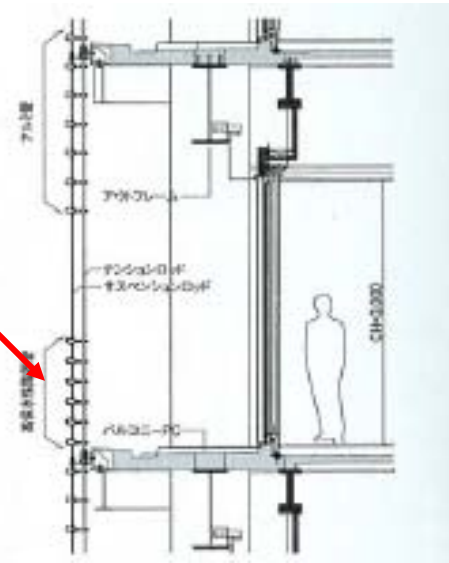


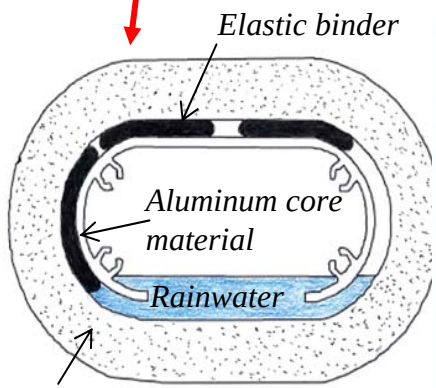
Flush toilets

New watering technology in a new Sony building using ceramic pipe as louver

Completed in 2011

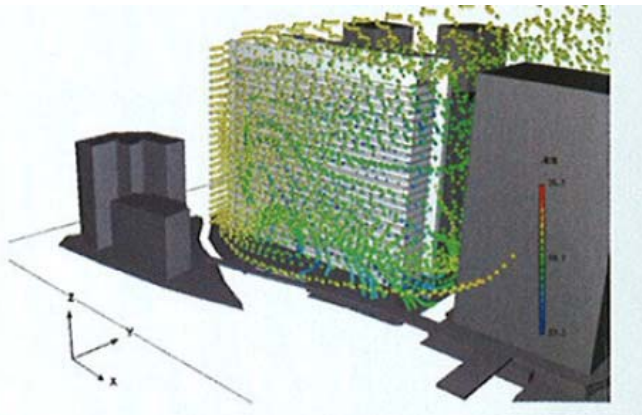






Ceramic pipe with high performance of water retention

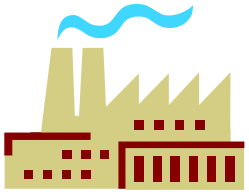
Cooling device

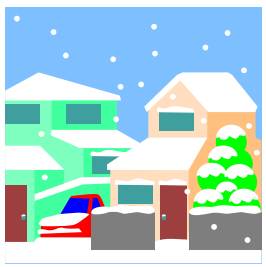


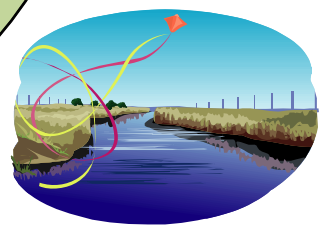
Reduction effect on Surface temperature simulated by Nikken Sekkei Ltd

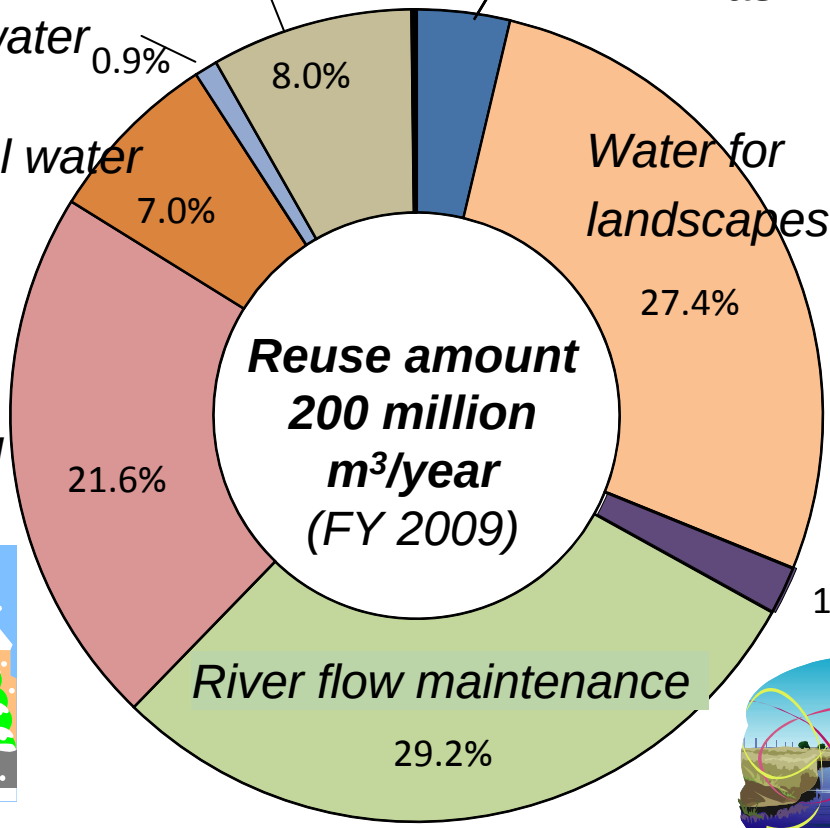
Reclaimed water use in Japan

The annual treated wastewater is 14.4 billion m^3 in Japan. 1.4 % of the treated wastewater is reused.









Applications of reclaimed water in Tokyo

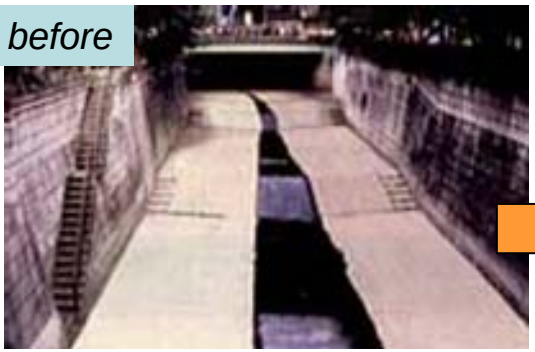
Tokyo Metropolis

[Population:8.45 million]

River maintenance

Water source for revival of Meguro River, etc. about 68,000m³/day

before



after

Miscellaneous waters

Water for toilet flushing in West-Shinjuku and Nakano Sakaue areas, etc. :about 9,300m³/day

Miscellaneous waters

Cleaning water for train systems, YURIKAMOME :about 1,800m³/year

Conventional activated sludge process

+

Sand filtration or Membrane treatment & Ozone treatment

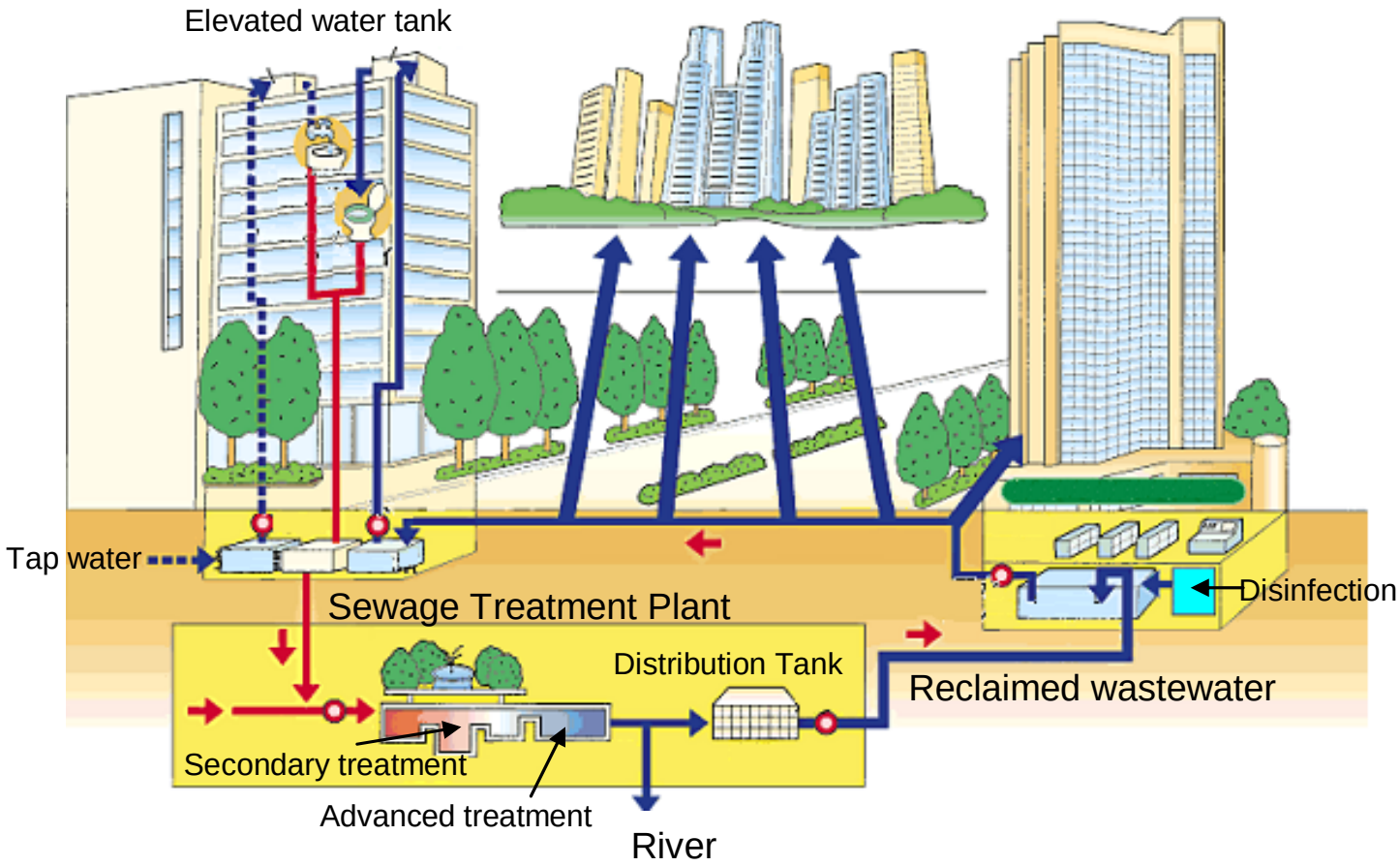
Recreational Use

Ochiai Water Reclamation Center SESERAGI NO SATO :about 16,000m³/year

Total: about 78,000m³/day

Reclaimed water use in skyscrapers in Shinjuku, Tokyo

Large-scale recycling

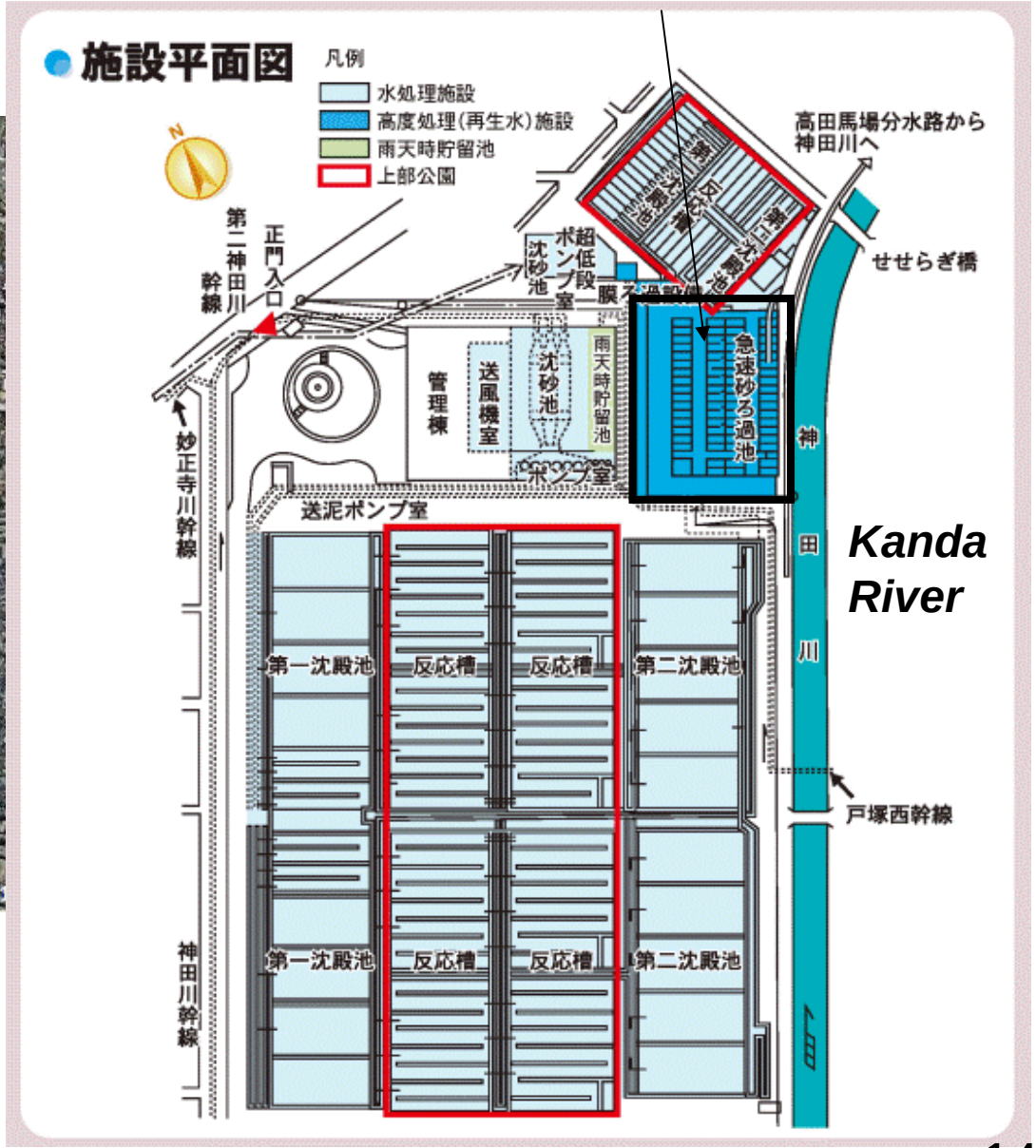


Double pipe-supply system and Closed loop use

Ochiai Water Reclamation Center
落合水再生センター

Shinjuku Subcenter

Rapid Sand Filtration Process



Kanda River

Reclaimed water use for restoration of water environment and aquatic amenity

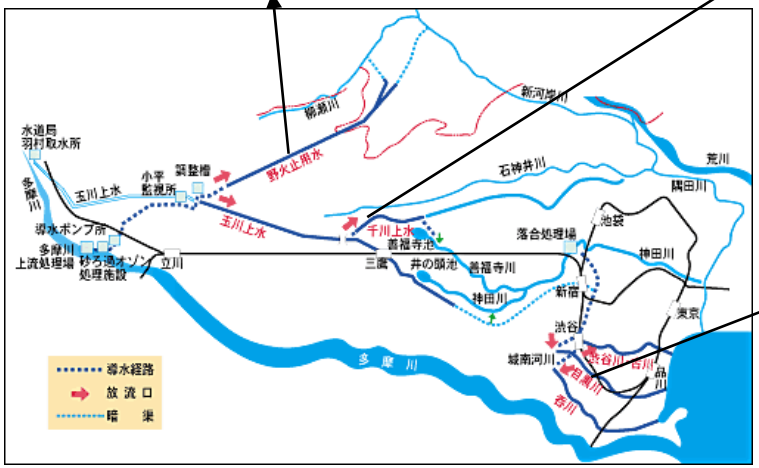
In 1984
15,000m³/d (Max)

Off-site use of reclaimed water use

In 1989
10,000m³/d (Max)

Nobidome

Senkawa



Megura River

In 1995
86, 400m³/d
(Max)=1.0 m³/s

Needs of stream flow and urban water amenity

Water reclamation project at Tokyo Shibaura Water Reclamation Center

Supplied area: 376 ha
No. of buildings supplied: 60
Supply :ap. 3,900m^3/day

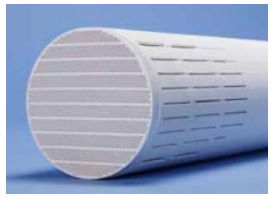
Secondary effluent

Sand filtration → 5,000m^3/day

Biological Filtration → **Ozonation** → **Ozone resistant membrane** → 4,300m^3/day

Biological Filtration → **Ozonation** → **Flocculation** → **Ceramic membrane** → 7,000m^3/day

Max14,900m^3/day

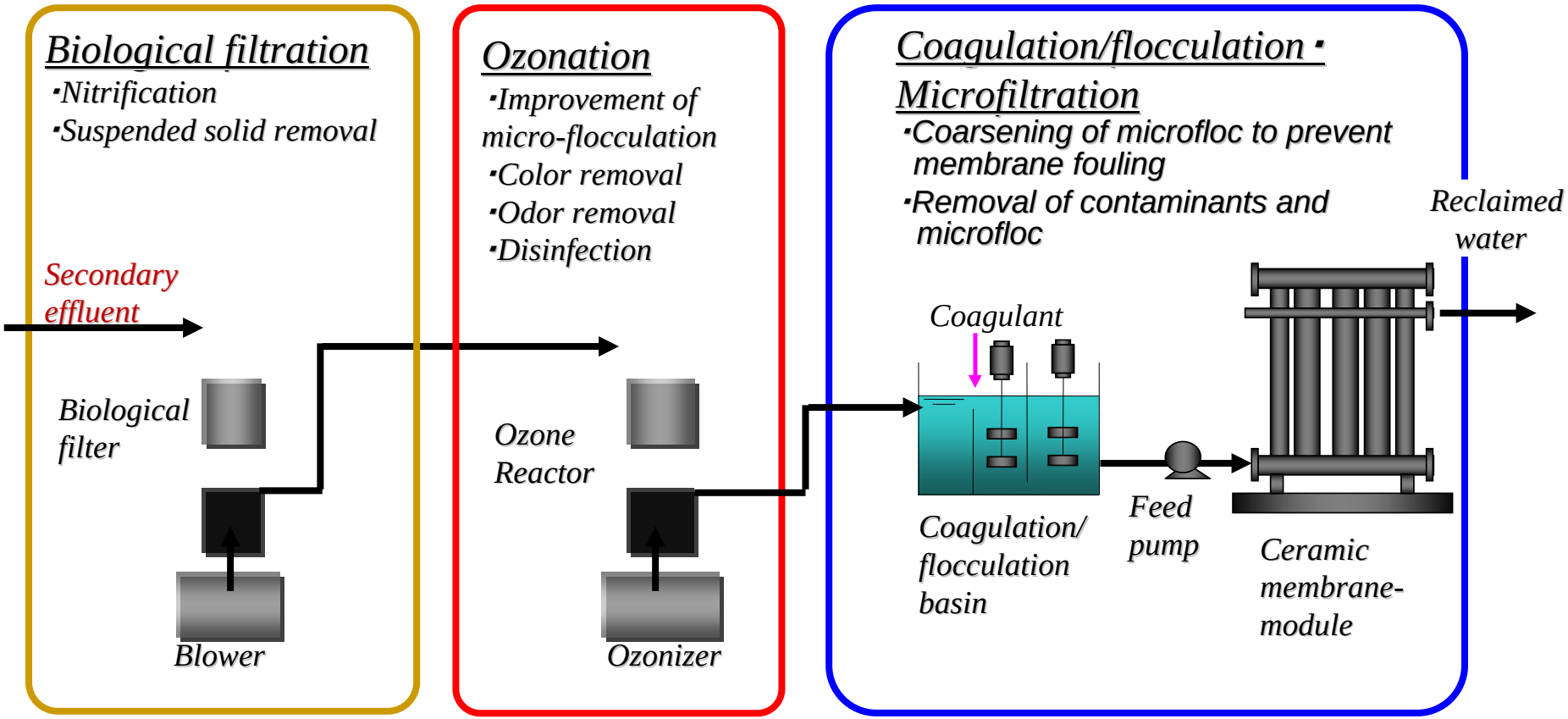


Charge 260JY /m^3

Flush toilet water, spray water, cleaning water, and water for landscape etc.

Biological Filtration, Ozonation and Ceramic Membrane Technology (example in Tokyo)

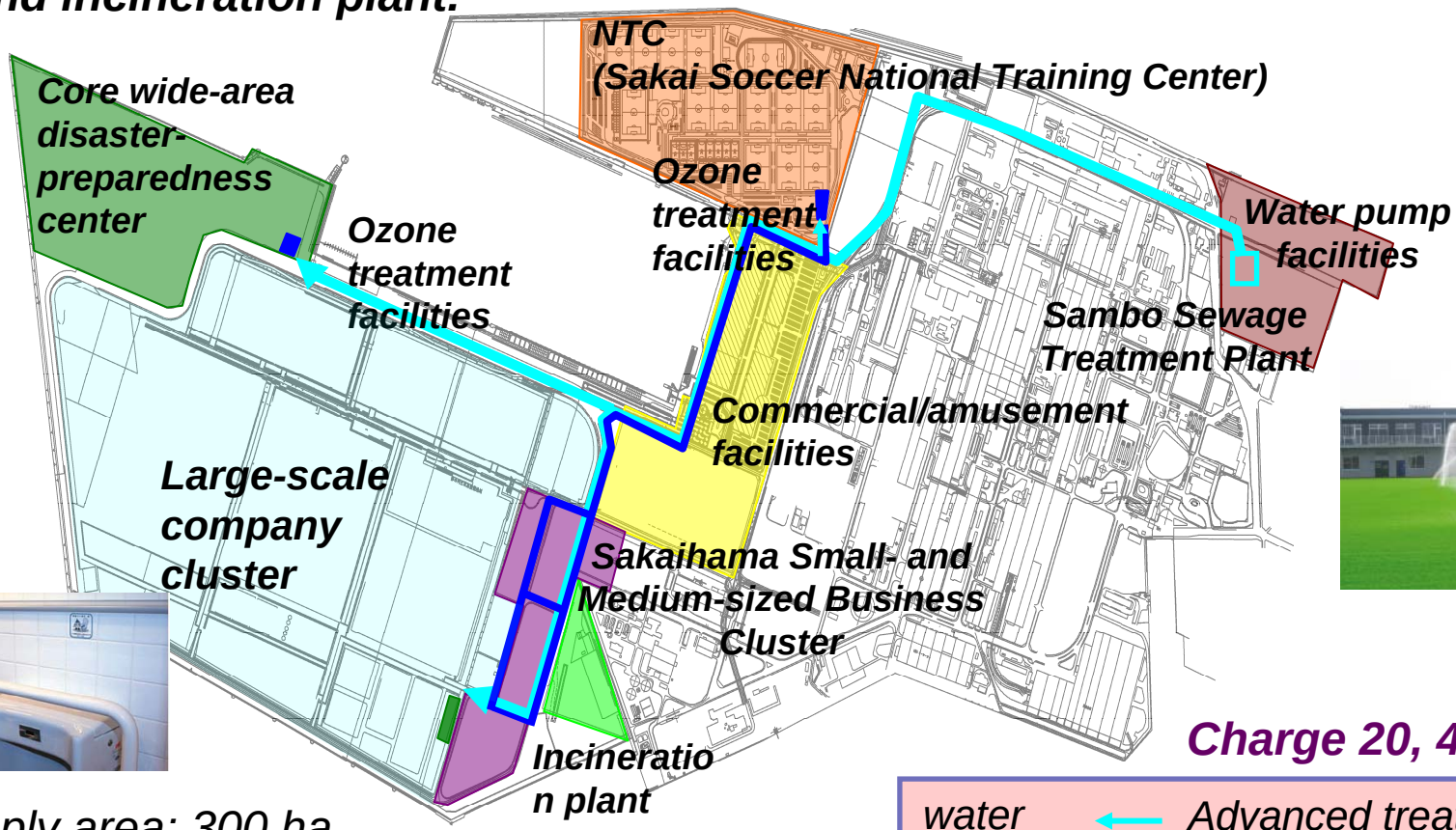
A highly durable ceramic filter ensures steady production of reclaimed water



Water reclamation project at Sampo WWTP in Skai City

Media added ASP + Fiber filtration=>MBR

- ***Reclaimed water use for watering in the national football training center, and toilet flushing water for buildings and industrial water for factories and incineration plant.***



Supply area: 300 ha
Supply capacity: Max 34,000 m³/day

Charge 20, 40JY /m³

water line	Advanced treated water / ozonated water

Applications of reclaimed water in a medium-scale community (Tadotsu Town)

Agricultural Use

Discharge into agricultural farm ponds :2000m^3/day
(During June – September)

Activated carbon adsorption

Recreational Use

Ozonation+ activated carbon adsorption

recreational water :20m^3/day

Conventional activated sludge process + Sand filtration, AC adsorption Ozonation

Activated carbon adsorption

Groundwater Recharge

Recharge to groundwater, the principal water source of Tadotsu Town :2000m^3/day

[Population:24,000]

WQ standards for reclaimed water use

Established in 2005

Use and Water Quality	Toilet flushing	Sprinkling	Landscape use	Recreational use
E.coli	N.D./100mL	N.D./100mL	T. coliform 10CFU/mL	N.D./100mL
Turbidity	≦2（target value）			≦2
pH	5.8～8.6			
Appearance	Not unpleasant			
Color	—	—	≦40	≦10
Odor	Not unpleasant			
Treatment	Sand filtration			Chem. precipitation and sand filtration
Residual chlorine（target）	free:0.1mg/L or combined: 0.4mg/L	free:0.1mg/L or combined: 0.4mg/L	—	free:0.1mg/L or combined: 0.4mg/L

Advance of Japan Ultimate Membrane Bioreactor Technology Project, A-JUMP

Advanced treatment is required for appropriate reclaimed water use, achieving the water quality standards.

Treatment options

Sand filtration + Ozonation
Sand filtration + Ultraviolet disinfection
Biofilm filtration + Ozonation
Chemical precipitation + Sand filtration + UV

MBR (Membrane bioreactor) + Ozonation/UV

The government-initiated project to demonstrate the validity of MBR to an actual system with model municipalities.(FY2009～2010)

model cases

①Introducing MBR to an existing treatment plant coordinating with reconstruction

②Satellite treatment※ using MBR

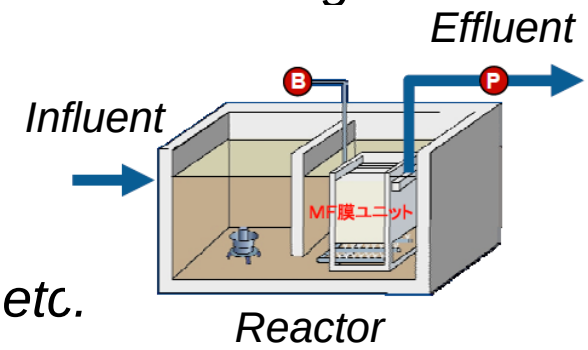
※Direct treatment of wastewater from sewer pipe before reaching a sewage treatment plant for the purpose of wastewater reclamation

Membrane Treatment Technology (A-JUMP)

(1) Renovated MBR demonstration project

- *Immersed MBR combined with biological phosphorous removal*
- *Demonstration of the applicability of MBR based on remodeling and utilization of existing facilities*

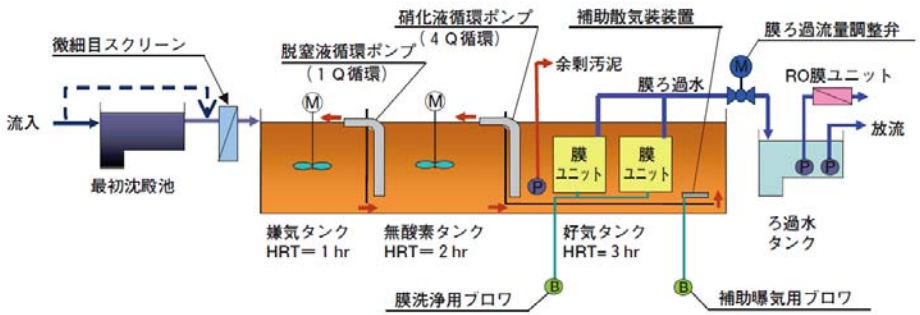
=> Simple installation of membrane units to existing facilities without expansion of facilities



- *Review efficiency based on use of air-lift pumps etc.*

=>Significant reduction of power consumption

Moriyama WWTP in Aichi prefecture
- Treatment capacity: 5,000 m^3/day
- Treatment method: Anaerobic-Anoxic-Oxic MBR

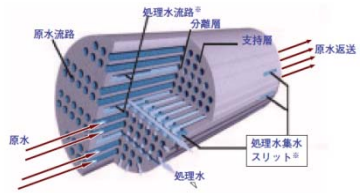


Membrane unit inside reactor(downward view)

MF membrane (flat membrane) unit

Membrane Treatment Technology (A-JUMP)

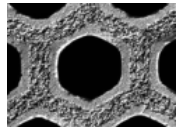
(2) Satellite MBR demonstration project



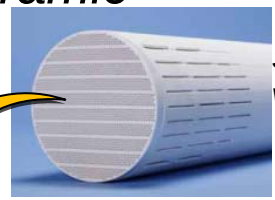
- *MBR using ceramic MF membrane*
- *Review operating efficiency such as of the establishment of high permeation flux that makes use of the characteristics of ceramic*

  => Favorable treatment water quality that is adapted to reuse

  => High permeation flux was achieved



Enlarged



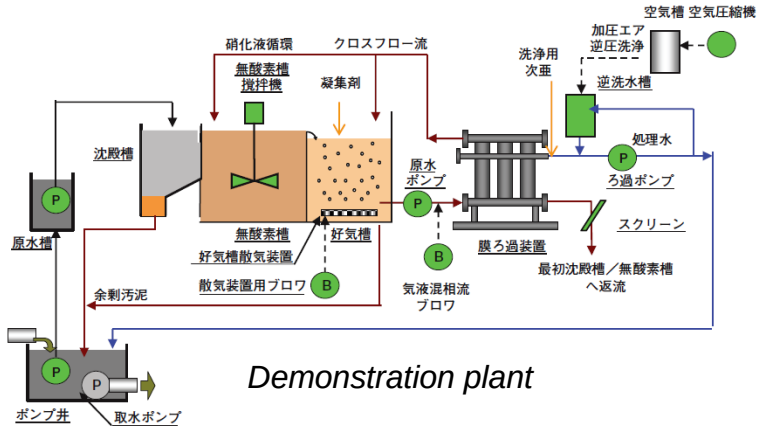
Side view

MF membrane (ceramic)

- *Demonstration of applicability of MBR in satellite sewerage treatment*

  => Stable treatment at pump station

Miai pumping station in Heklinan City
- Treatment capacity: 360 m³/day
- Treatment method: Circulating nitrification-denitrification MBR



Demonstration plant

Breakthrough by Dynamic Approach in Sewage High technology for GHG reduction project, B-DASH

Verification project concerning to energy management system using ultrahigh efficiency solid-liquid separation technique (Nakahama WWTP, Osaka)

[Water treatment line] <Energy conservation>

Sewage water

[Ultrahigh efficiency solid-liquid separation]

M

verification boundary

[Sludge treatment line] <Energy generation>

Electricity Supply and control

Garbage

[High-efficiency high-temperature digestion]

[Smart electrical generation system]

Hybrid-type electric generator

Plant operation optimizing control

Breakthrough by Dynamic Approach in Sewage High technology for GHG reduction project, B-DASH

Verification project for recyclable energy production and innovative technologies

(Higashinada WWTP, Kobe)

Kobe Sweets Biomass project

Accepting facility

Food biomass

Regulation facility

Sewage sludge

Advanced steel digestion tank

Biogas

New-type biogas purification, storage, and pumping system

Purified biogas

Kobe Green Biomass project

Wood biomass

Pretreatment facility

Regulation facility

Sewage sludge

Digestion sludge

Verification of dewaterability

Sludge dehydration facility

Recovery of sewage water heat

High-efficiency heat pump

Hot water

Sewage water heat

Aims to Japanese version of biogas standard

Kobe Biogas Station

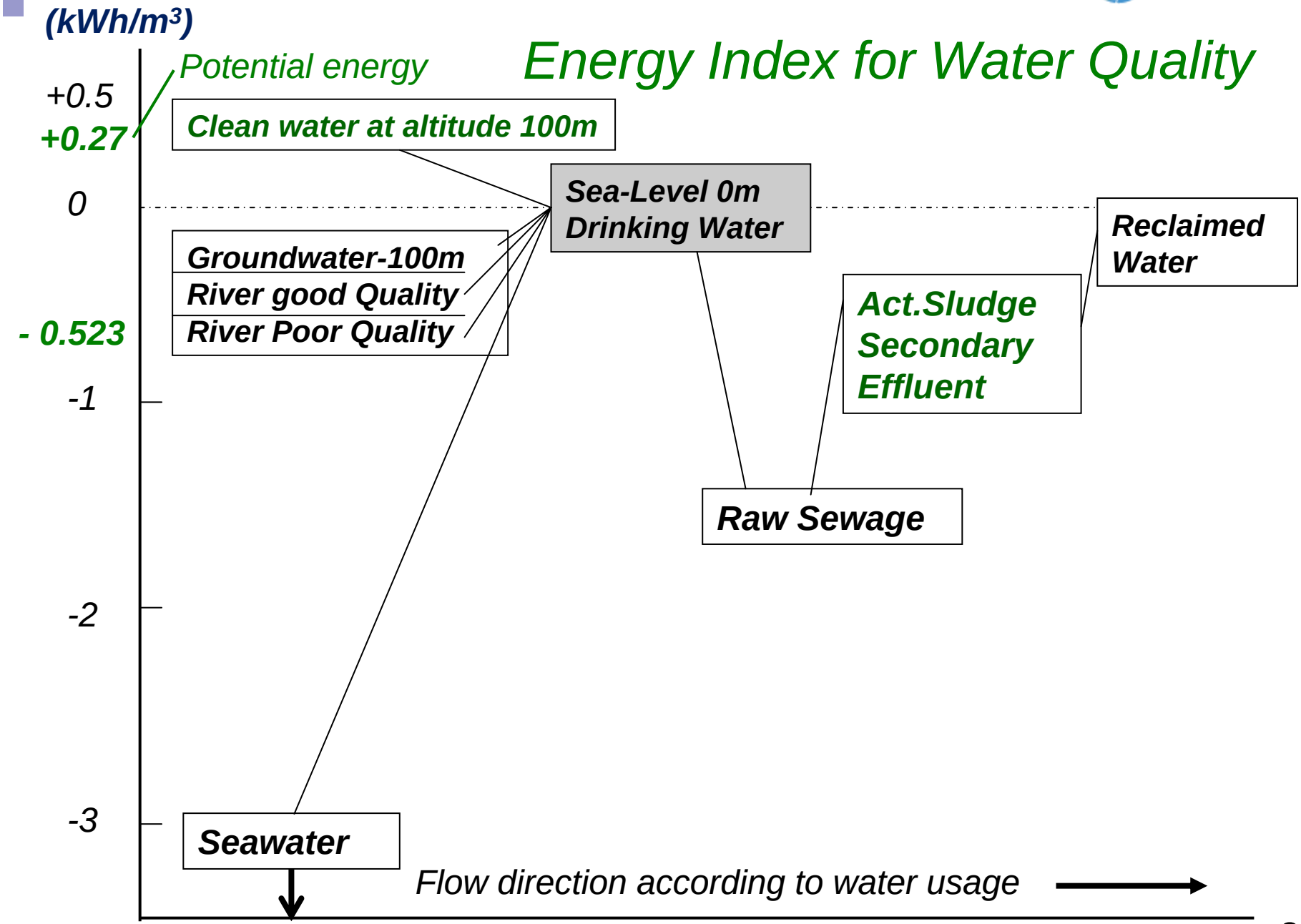
Urban gas pipe filling facility

Urban gas pipes

Summary

- Climate change would accelerate localization of water resources and consequently it would become more difficult to secure stable water resource.
- To assure the safe and stable urban water supply under such circumstances, “rainwater” and “reclaimed water” have been recognized as *self-own (community-own) water resources* in urban area. They can be used for miscellaneous purposes and restoration of waterways and water environment.
- From the viewpoint of human health risk, water quality and its safety should be managed properly to promote the reclaimed water use by new treatment technologies.
- We also have to develop a new concept of well-balanced urban water use system under climate change conditions, considering energy saving and environmentally friendliness of the technologies.

Energy Index for Water Quality



Thank for your attention

One of the most recent RWHM projects in Tokyo

The Tokyo Sky Tree is a broadcasting tower in Sumida ward, Tokyo. It was just built on Feb. 29, 2012.

This building has a rainwater harvesting system for miscellaneous purposes and for community use such as gardening.

Capacity: 2635m^3 (800m^3 is for water use)

http://blog.skytree-obayashi.com/?day=20120229