

# **Promotion of Treated Wastewater Reuse in Okinawa —In search of local community without water shortage—**

**Takashi KUROSHIMA<sup>1</sup>**

**Okinawa Prefecture Sewerage System Construction Office, Department of Civil  
Engineering and Construction**

## 1. Introduction

Okinawa Prefecture (OP), isolated island, has been historically suffering from water shortage by severe condition due to geographical feature and topography. Water rationing was repeated like an annual event, and especially, at the time of water shortage in 1987, it was performed over about one year, and it had a great influence on Okinawan's life. For this reason, many dams have been built on the mountains in the northern part of Okinawa main island, but the construction site of dam is restricted due to small OP's area. Therefore, they regarded seawater as new water resources, and constructed Desalination Plant in 1997. The Plant has played an important role as precious water sources for OP that has been suffering from water shortage.

People pay attention to Okinawa sightseeing. Because, TV programs dealing with Okinawa have been frequently broadcast recently. "Kyushu and Okinawa Summit" held in 2000 was successful. Therefore, tourist business has been in good condition for the reason that the number of tourist breaks through 5 millions. Moreover, while population decrease is indicated nationally, the population of OP is increasing in number. Therefore, it is expected that water demand will continue.

Although one hundred percent of sludge (145t/day) generated within prefecture plants was recycled for green farmland-return, treated water (270,000m<sup>3</sup>/day) was almost discharged to the sea. They have been expecting that the water is used effectively in OP that has been suffering from water shortage. Therefore, OP reuses treated wastewater which occurs constantly in urban environment as precious water resources. I introduce Sewerage Business of Recycled Water Use (SBRWU) implemented by OP to you.

---

<sup>1</sup> 〒900-0029 Okinawa Prefecture Southern Area Joint Government Building  
(The first floor) #1 Asahi-machi, Naha-city, Okinawa, Japan  
E-mail: kuroshta@pref.okinawa.lg.jp

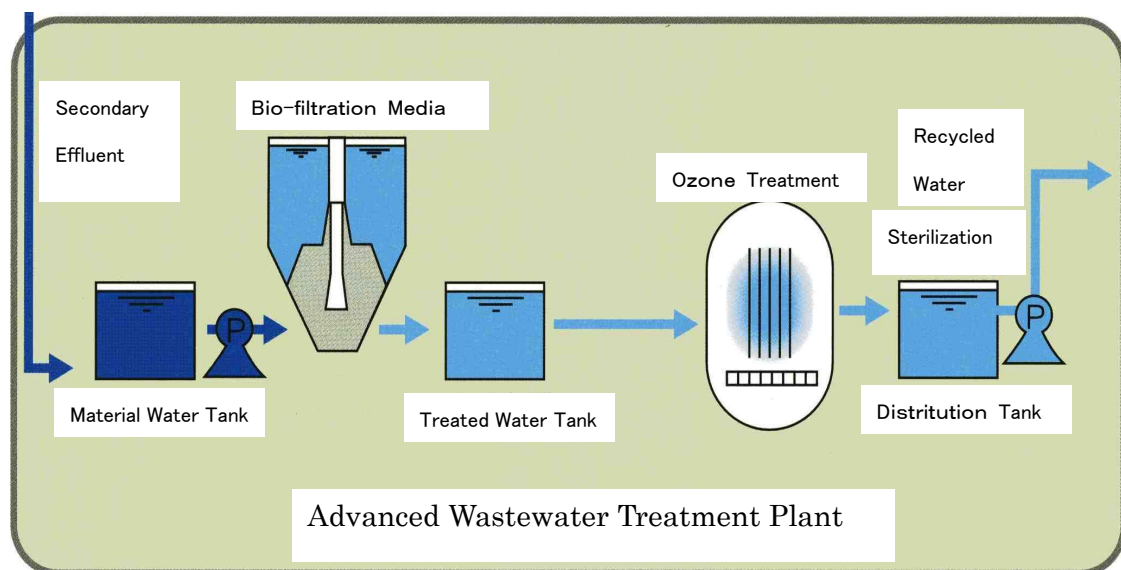
## 2. Sewerage Business of Recycled Water Use

SBRWU treats secondary disposal water discharged from Naha Sewage Treatment Plant (STP) highly, and supplies the water to Naha New Urban District (NNUD) mainly for flushing toilets and sprinkling in the parks.

Redevelopment enterprise was planned to utilize vast area of 4.4% of Naha-City and good location of NNUD which used to be U.S. Forces housing area. At present, a large-sized commercial store, a public facility, and a large-sized apartment are under construction at NNUD.

### 2.1 Advanced Wastewater Treatment Plant

Advanced Wastewater Treatment Plant (AWTP) was built in Naha STP in 2002. The flow of advanced processing is as follows:



### 2.2 Technical problems

A few technical problems have been caused over 4 years after supply. One of them is to secure residual chlorine 0.4 mg/litter or more. At the beginning of the supply, it was difficult to keep the density, because the water remained for a long time in the pipe for small-volume use. However, it was solved by releasing the water at the end of the pipe and by changing the current of water and by adjustment of the infusion quantity of sodium hypochlorite at AWTP.

### 2.3 Supply achievement

The Number of Supply Places and Water Use per Day is the following figure:

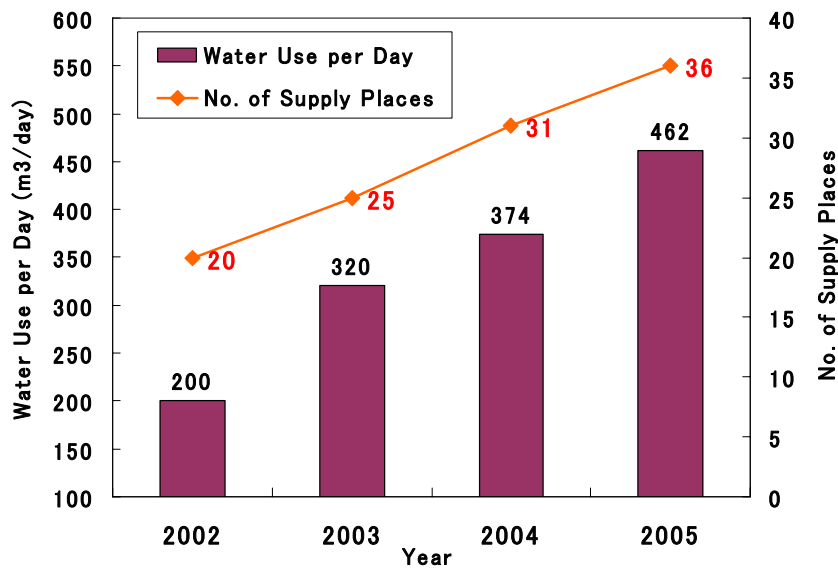


Fig. The Number of Supply Places and Water Use per Day

According to the figure, after supply, between 2002 and 2005 fiscal year, supply places increased from 20 to 36. Amount of water consumption per day also increased steadily from 200 to 462 cubic meters. Naha Water Resources Effective Use Promotion Outline created by Naha City, which encourages citizens to use recycled water. OP is also going to examine whether the demand can be increased further.

### 3. Conclusion

If water shortage happens in OP, a local newspaper begins to indicate the number of water rate of dams. Moreover, the number is also indicated on Okinawa Prefectural Enterprise Bureau Homepage, to which Okinawans pay attention. Fortunately, water rationing has never happened by hard work of the persons in charge of water works and sewage works since March, 1994. But, reservation of water resources is an important subject for our island prefecture. As stated in the introduction, it is expected that the water demand of OP will has been increasing.

STP plays a part of constantly-available dam in urban environment. It is the best to treat secondary effluent and to utilize it. We think that SBRWU is very important when water condition is considered in OP that has been suffering from water shortage, and that it is indispensable to promote and spread "Recycled Water Use without water shortage" from now on.

## References

Okinawa Prefecture Sewerage Management Office, Department of Civil Engineering and Construction, Maintenance Management Annual Report, 2004

Yoshimitu KUWAE, Sewerage Business of Recycled Water Use in Okinawa, Journal of Japan Sewage Works Association, 2006/No.525, Vol.43

Okinawa Prefecture Enterprise Bureau, Water in Okinawa, 2005

Department of Planning, Statistics Data Reading Room in Okinawa Prefecture, Statistics Division Home Page

Urban Renaissance Agency of Japan, Naha New Urban District

Home Page of Meteorological Agency of Japan, Meteorological Information

# Promotion of Treated Wastewater Reuse in Okinawa

**Takashi KUROSHIMA**  
Okinawa Prefecture Sewerage  
System Construction Office

## Location of Okinawa



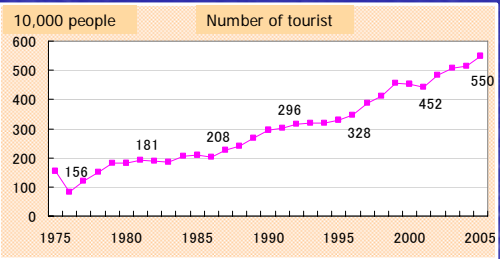
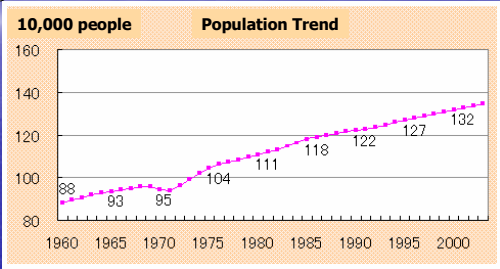
Distance Between Naha & Each City

Naha - Taipei	630 km
Naha - Kagoshima	656 km
Naha - Shanghai	820 km
Naha - Fukuoka	861 km
Naha - Seoul	1,260 km
Naha - Hong Kong	1,440 km
Naha - Manila	1,480 km
Naha - Tokyo	1,554 km

Naha: capital city in Okinawa

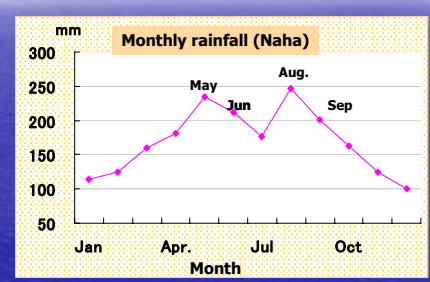
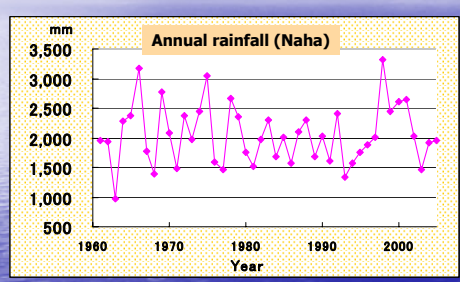
# Okinawa's Main Features

- **Land** Consists of about 160 islands  
Total area: 2,274km<sup>2</sup>
- **Population** 1.37 million as of 2005
- **Tourism** Tourism is one of the main industries
- **US Army Base**  
Presently, 75% of US Army bases in Japan are situated in Okinawa, taking up about 10% of the total land area.



# Okinawa's Rainfall

The Only Semi-Tropical Region in Japan



Annual rainfall: 2,037mm Average temp.: 72.7 degF(22.7 degC)

**Periodically Hit by Typhoons**

7 typhoons per year on the average

Lots of annual rainfall occurs during typhoon and rainy seasons

# Available Water Resources

## # Okinawa

- Average rainfall  
2,037 m<sup>3</sup>/year
- ↓
- High population density
- ↓
- Available water resources  
1,973m<sup>3</sup>/year · person

## # National average

- National average rainfall  
1,718m<sup>3</sup>/year
- ↓
- Low population density
- ↓
- Available water resources  
3,337m<sup>3</sup>/year · person

Without typhoon, water shortage happens in Okinawa

# Okinawa's Water Situation

## Unstable Water Sources

- Low rainfall per capita
- Large seasonal fluctuation in rainfall
- Short river length & steep riverbed

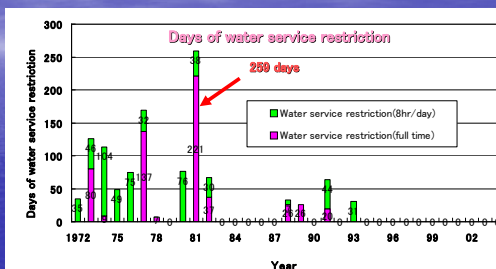
## Water Demand

- Water demand increases due to:
- increasing population
- increasing tourists



## Water Rationing

14 out of 32 years from 1972 to 2004



# Water Resources Development

## # Dam

The construction site is restricted due to small area

## # Seawater Desalination Plant

The plant is operating as important water sources

## # Advanced Wastewater Treatment Plant

Okinawa Prefecture has been suffering from water shortage. Sewage Treatment Plant plays a part of constantly-available dam in urban environment. It is the best to treat secondary effluent and to utilize it.



Advanced Wastewater Treatment Plant

# Beginning of Sewage Works

**1935** Sewage lines constructed in Naha (but not developed for public use)

**1964** Okinawa City set out on a sewage works project & formulated the Okinawa Central/South Districts Integrated Sewage Works Plan

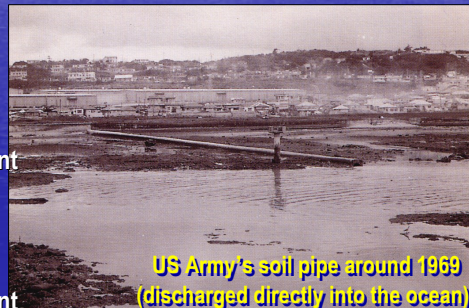
**1969** Primary treatment began at Naha Sewage Treatment Plant

**1970** Primary treatment began at Ginowan Sewage Treatment Plant

— 1972: Okinawa restored to Japan —

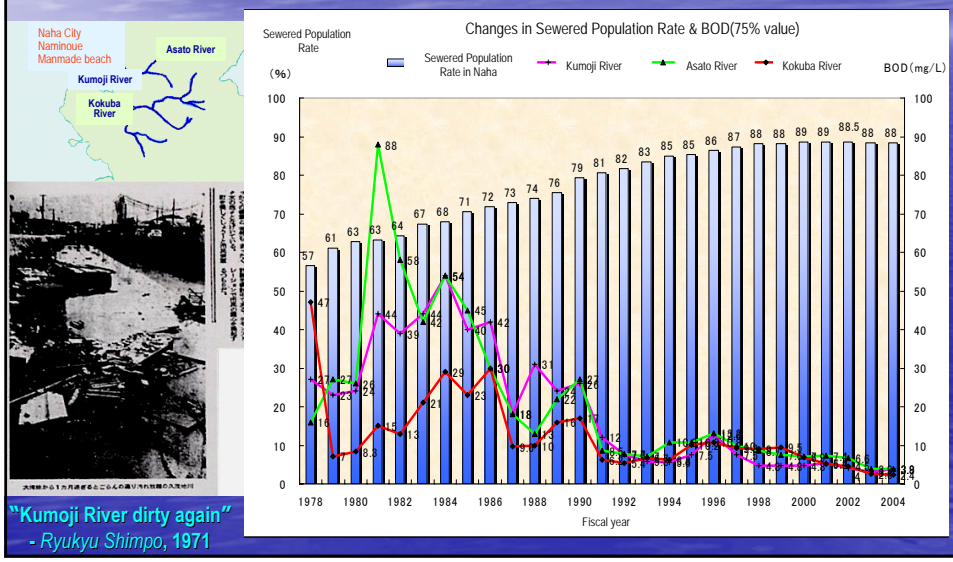
**1976** Secondary treatment began at Ginowan Sewage Treatment Plant

**1977** Secondary treatment began at Naha Sewage Treatment Plant





# Effect of Sewage Works (river water quality vs Percentage of Sewered Population)



# Effect of Sewage Works (Naminoue Beach, Naha City)

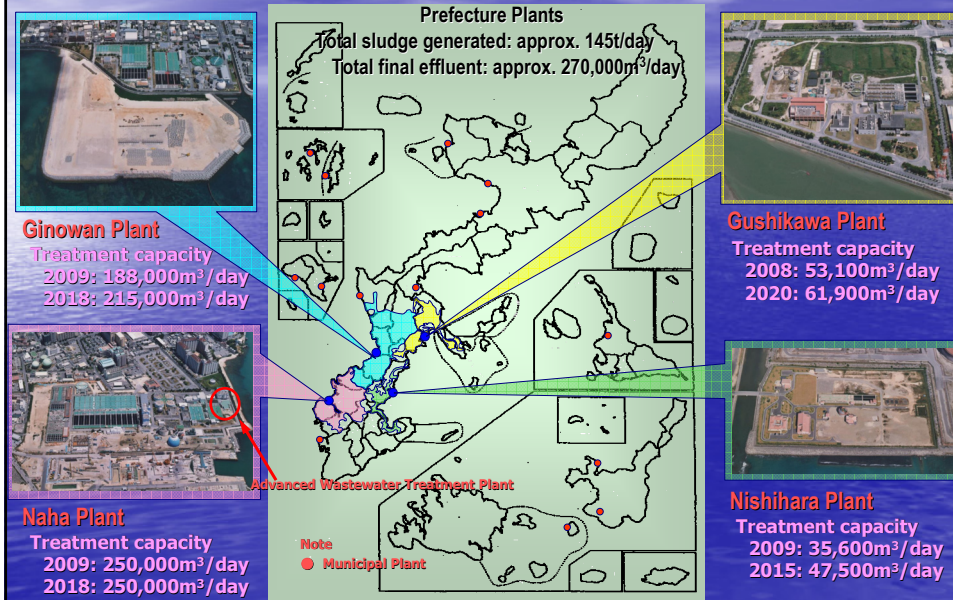
**Naminoue around 1969 (unsanitary without toilets)**

**July 4, 1972 Ryukyu Shimpo**  
 波上など九ヶ所不適  
 大腸菌と廃油が原因

**July 3, 1974 Okinawa Times**  
 沖縄の海泳げるか  
 シーズン控え水質検査  
 汚染年ごとに深刻

**Do you swim in the ocean around Okinawa ?**

# Present Status of Sewage Works in Okinawa



# Reuse of Highly Treated Water (treatment process)

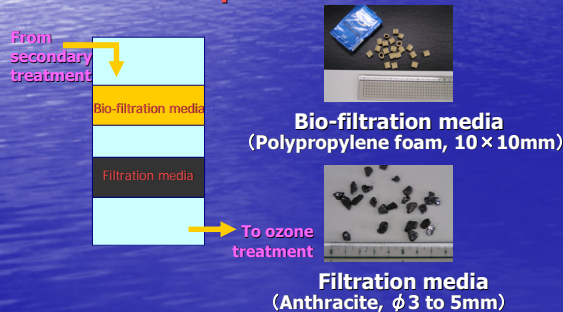
## Purpose of advanced water treatment at Naha Sewage Treatment Plant

To stabilize & conserve water resources toward the establishment of 'recycling society' by reusing treated sewage water that is abundant & constantly available in urban environment for flushing toilets and other purposes. Highly treated water means recycled water

## Advanced water treatment at Naha Sewage Treatment Plant (capacity: 2,130m<sup>3</sup>/day)



### ● Bio-filtration process



### ● Ozone treatment process

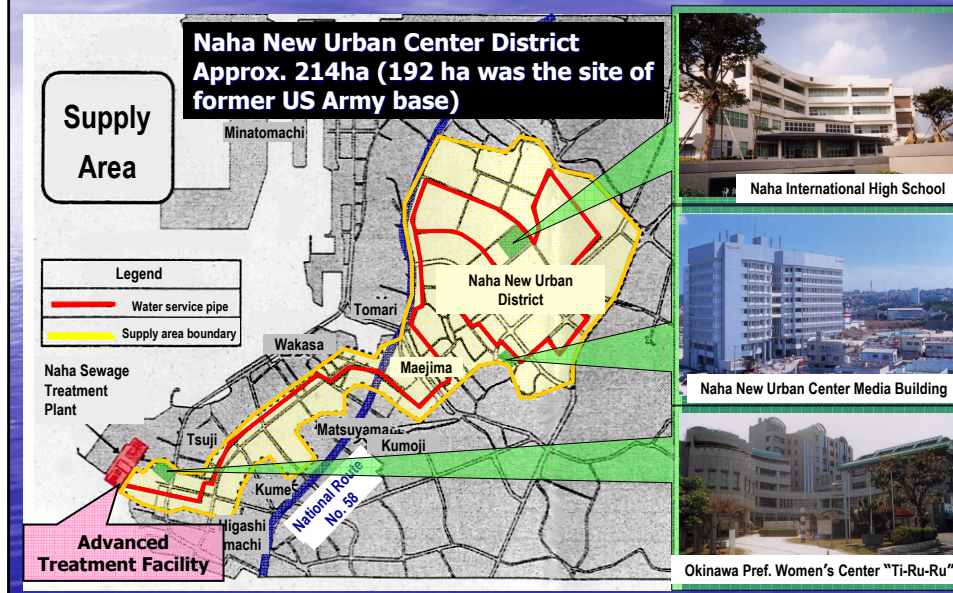
Ozone contact: about 40 min.  
 Ozone injection: 11.2mg/L



## Reuse of Recycled Water (quality of recycled water)

	Secondary treated water	Recycled water
pH	7.2	7.3
Chromaticity (degree)	20 or higher	2 or less
Turbidity (degree)	0.5 or less	0.5 or less
BOD (mg/L)	2.8	1.2
Cl <sup>-</sup> (mg/L)	650	660
NH <sub>4</sub> -N (mg/L)	9.2	0.2
NO <sub>2</sub> -N (mg/L)	0.7	N.D.
NO <sub>3</sub> -N (mg/L)	2.0	7.5
Coliform (count/100mL)	66 × 10 <sup>4</sup>	0

## Reuse of Recycled Water (supply area)

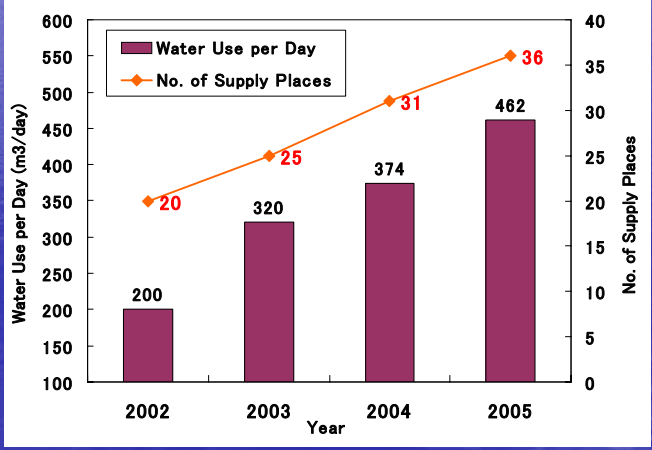


# Reuse of Recycled Water (change of consumption, etc.)



Naha New Urban District  
(Photoed by Urban Renaissance Agency)

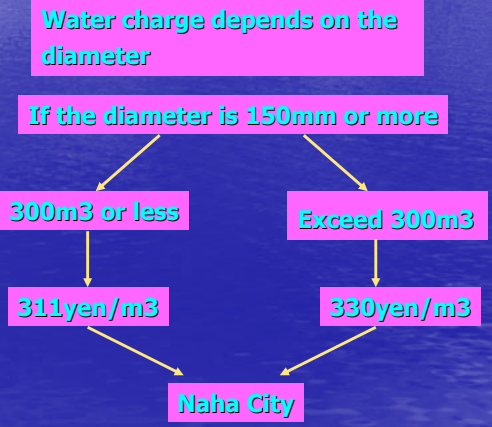
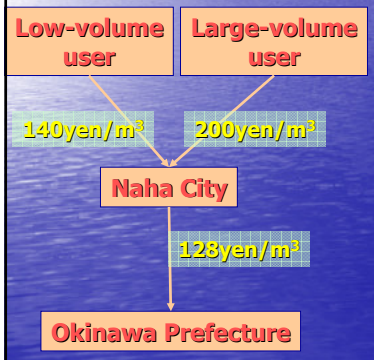
No. of Supply Places & Water Use per Day



# Comparison of Charge

## Rates of Recycled Water

## Rates of Tap Water



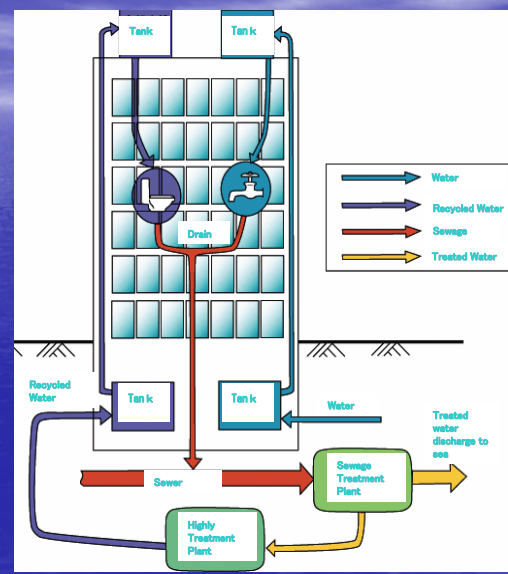
# Promotion of Recycled Water Use

## # Naha City Water Resources Effective Use Outline

Mayor must try to promote reuse of treated waste water and treated drain water.

## # Naha City Home Page for recycled water

On the homepage, they try to promote and spread recycled water by introducing people the meaning of recycled water and the system of the business of recycled water use and the area in which they can use it.



Naha City Home Page

# Reuse of Highly Treated Water for creating soothing cityscape

- Itoman City (capacity: 400m<sup>3</sup>/day)
- Nago City (capacity: 4,000m<sup>3</sup>/day)

Secondary treated water

Bio-filtration process

Chlorine sterilization

Send water to Nishizaki Aquatic Park



Secondary treated water

Bio-filtration process

Ozone treatment

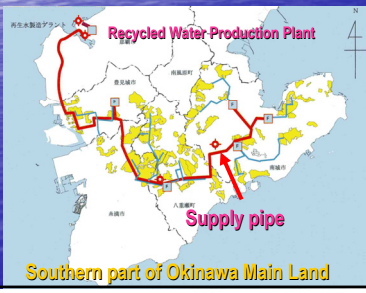
Send water to Nago Central Park



# Plan of Treated Water Reuse

## ● Planning for Agricultural Water

Secondary treated water  
↓  
Advanced water treatment  
↓  
Sterilization  
↓  
Send the water to farmland



## ● Proposal

Secondary treated water or highly treated water  
↓  
Send the water to the upstream of the river that flows through Naha City for purification

