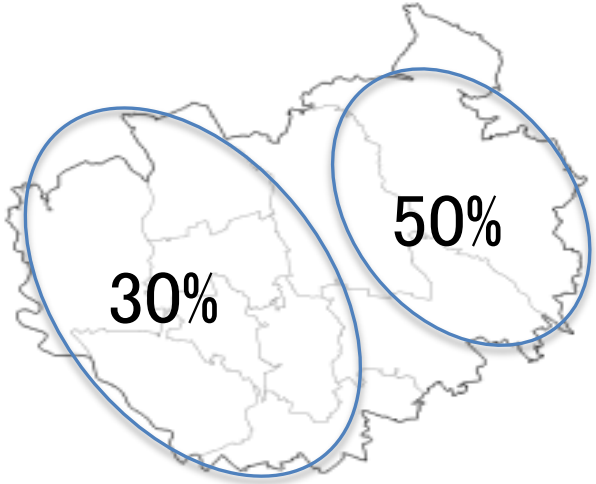
# Study report of priority evaluation of earthquake resistance on water supply facilities focused on the restoration process of water supply

NJS.CO.,LTD Akihisa Ishida
Kimiyasu Ohtake
Mikita Amano
Keisuke Baba

# Introduction

Earthquake resistance rate of water facilities

→ It is effective for earthquake resistance management




- It is difficult to comprehend the effect of earthquake resistance
- It is important when water supply is expected to restart

# Purpose

The required days for recovery
Suppliable water amount

- To create the restoration simulation model.
- To investigate the available water amount reaches the target water supply from this model.
- To investigate the model is available for determinatinig priority order.

# Evaluation Method

## Evaluation Process

① Setting the scenario earthquake

② Seismic performance evaluation of water facilities

③ Setting the restoration speed

④ Emergency restoration simulation

⑤ Determination of the priority order

⑥ Setting the target of earthquake-resistant

# Target Area

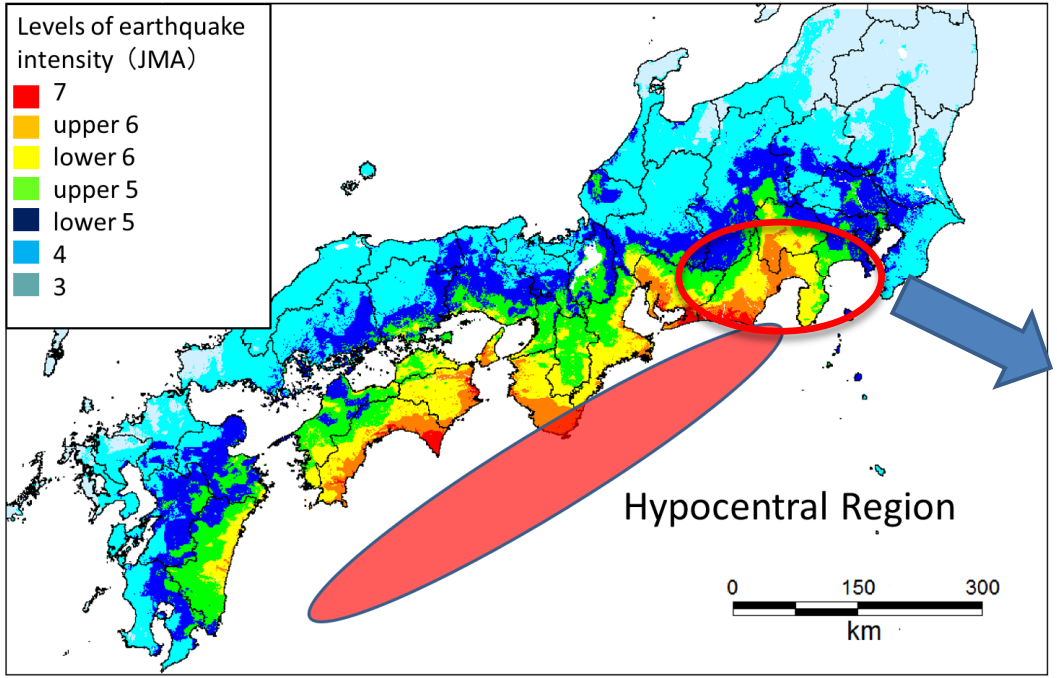
Target Area

## Characteristics

- It is a major city in Tokai area with a population of 700,000
- It consists of a plain mainly for residential and mountainous areas

# Scenario Earthquake

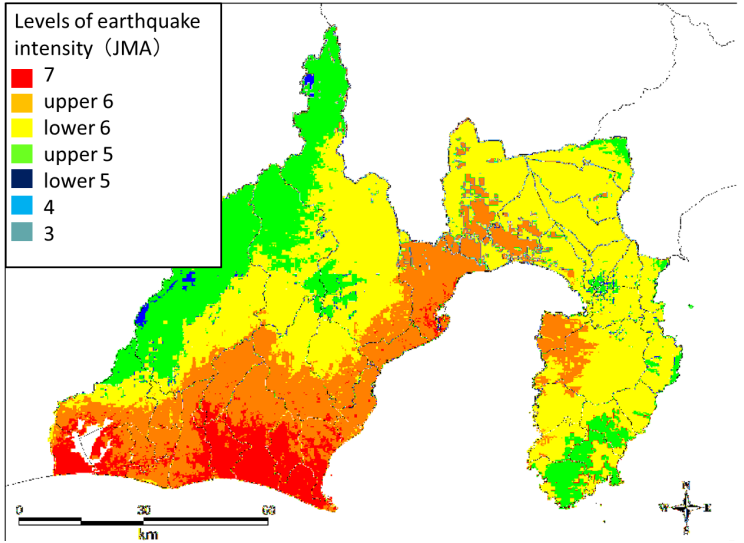
## Nankai Megathrust Earthquake




The maximum seismic intensity distribution

Nankai Trough

- 4000m deep
- Large-scale earthquake occurrence area



## Water Pipes

$$R_m(v) = C_p \times C_d \times C_g \times C_l \times R(v)$$

$R_m(v)$ : Breakage rate [spot/km]

$C_p$ : Correction factor for type of pipe

$C_d$ : Correction factor for pipe diameter

$C_g$ : Correction factor for terrain and soil

$C_l$ : Correction factor for liquefaction

$R(v)$ : Standard break rate [spot/km]

- The breakage rate is 0.6 spot/km
- The total interruption rate is 50 %

# Setting the Restoration Speed

## Restoration Term of Water Pipes

| Diameter(mm) | Restoration speed (spot/squad・day) |
|---|---|
| φ700～ | 0.20 |
| φ500～600 | 0.25 |
| φ300～450 | 0.50 |
| φ200～250 | 1.00 |
| φ150 | 1.00 |
| φ100 | 2.00 |
| ～φ75 | 2.00 |

# Setting the Restoration Speed

## Restoration Term of Purification and Distribution Stations

| Name of water faility | | Restoration term (day) |
|---|---|---|
| | Rapid filtration (not securing sesmic performance) | 30 |
| | Slow filtration (not securing sesmic performance) | 30 |
| | Membrane filtration | 3 |
| Water source | | 3 |
| Distribution station | | 3 |
| Pumping station | | 3 |

It is necessary to also consider the emergency restoration of purification and distribution stations

# Emergency restoration simulation

## Simulation Content

Scenario Earthquake

Seismic Performance

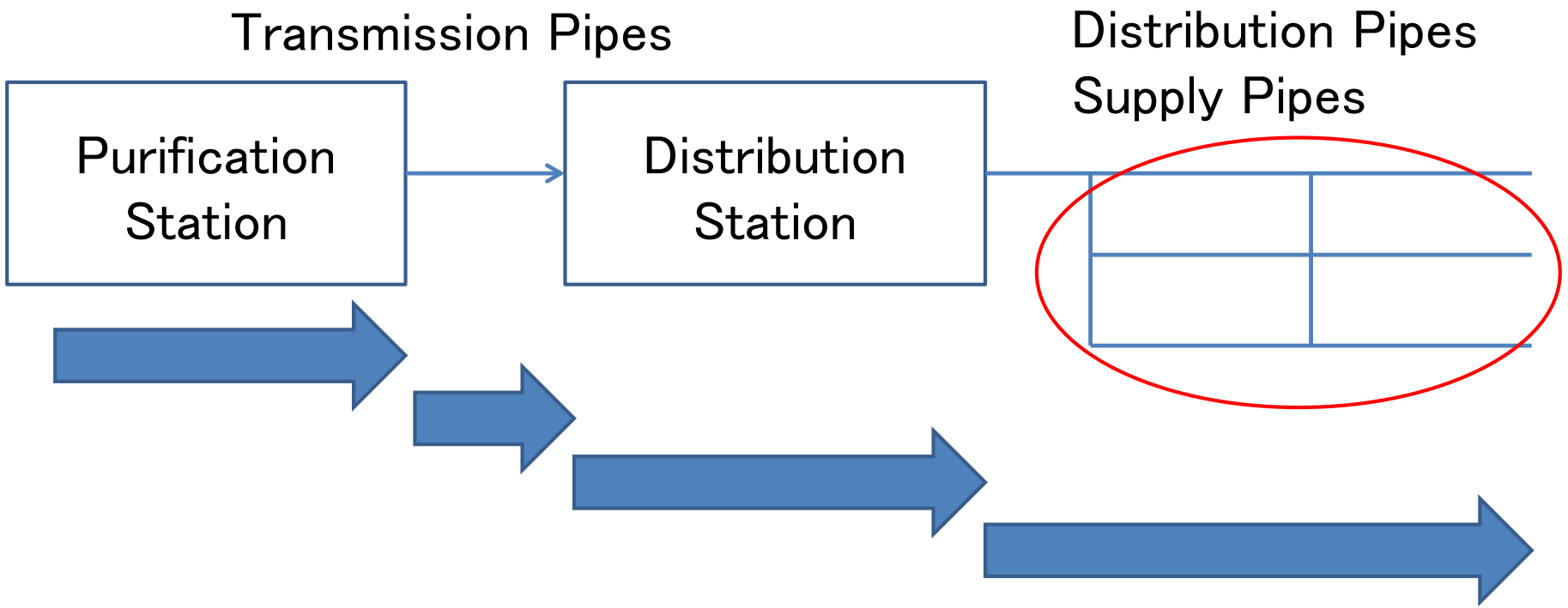
Restoration Speed

Restoration Process

} Available Water Supply

We compare available water supply
and target water supply

# Available Water Supply

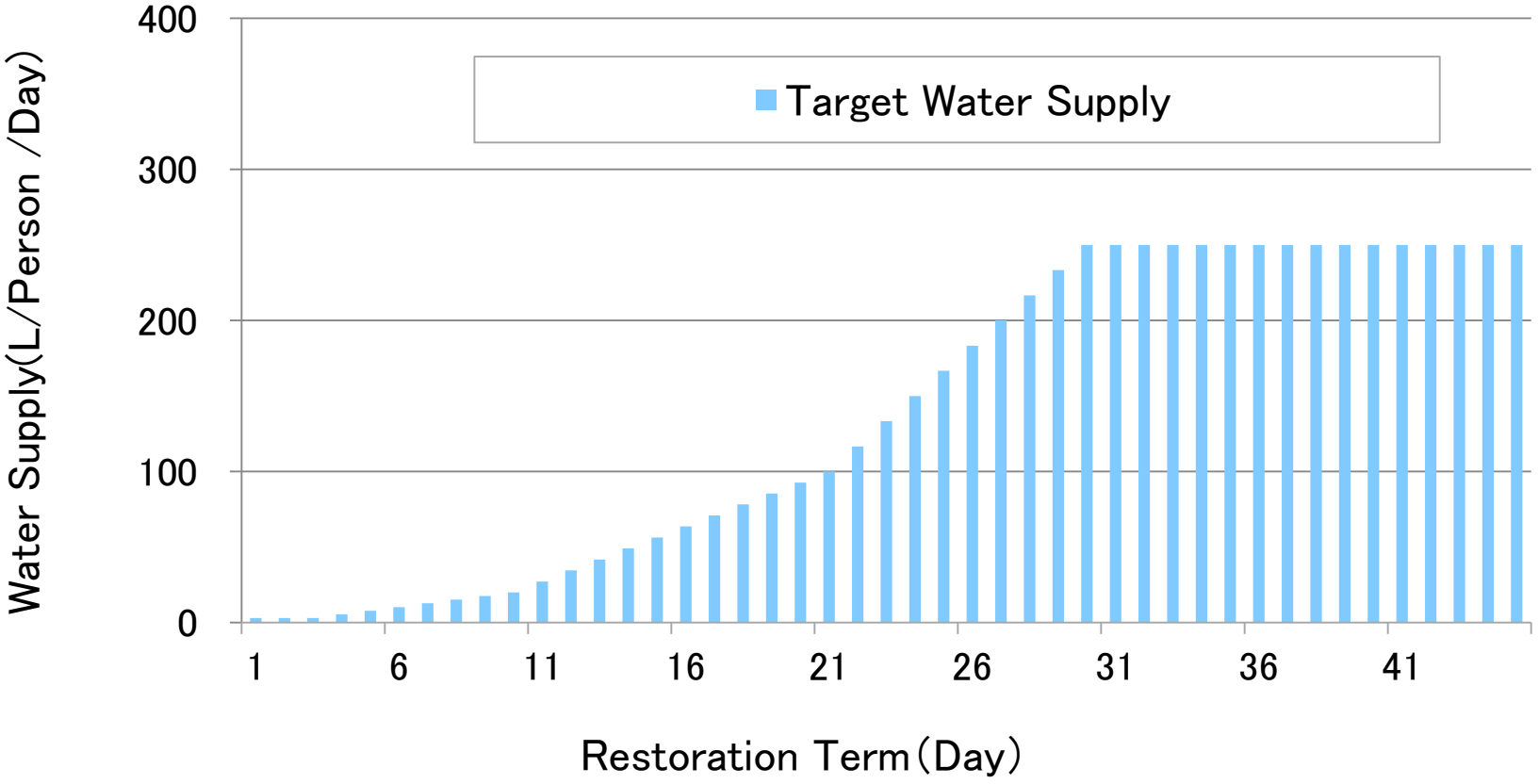



The available water supply starts to increase
when distribution and supply pipes get restored

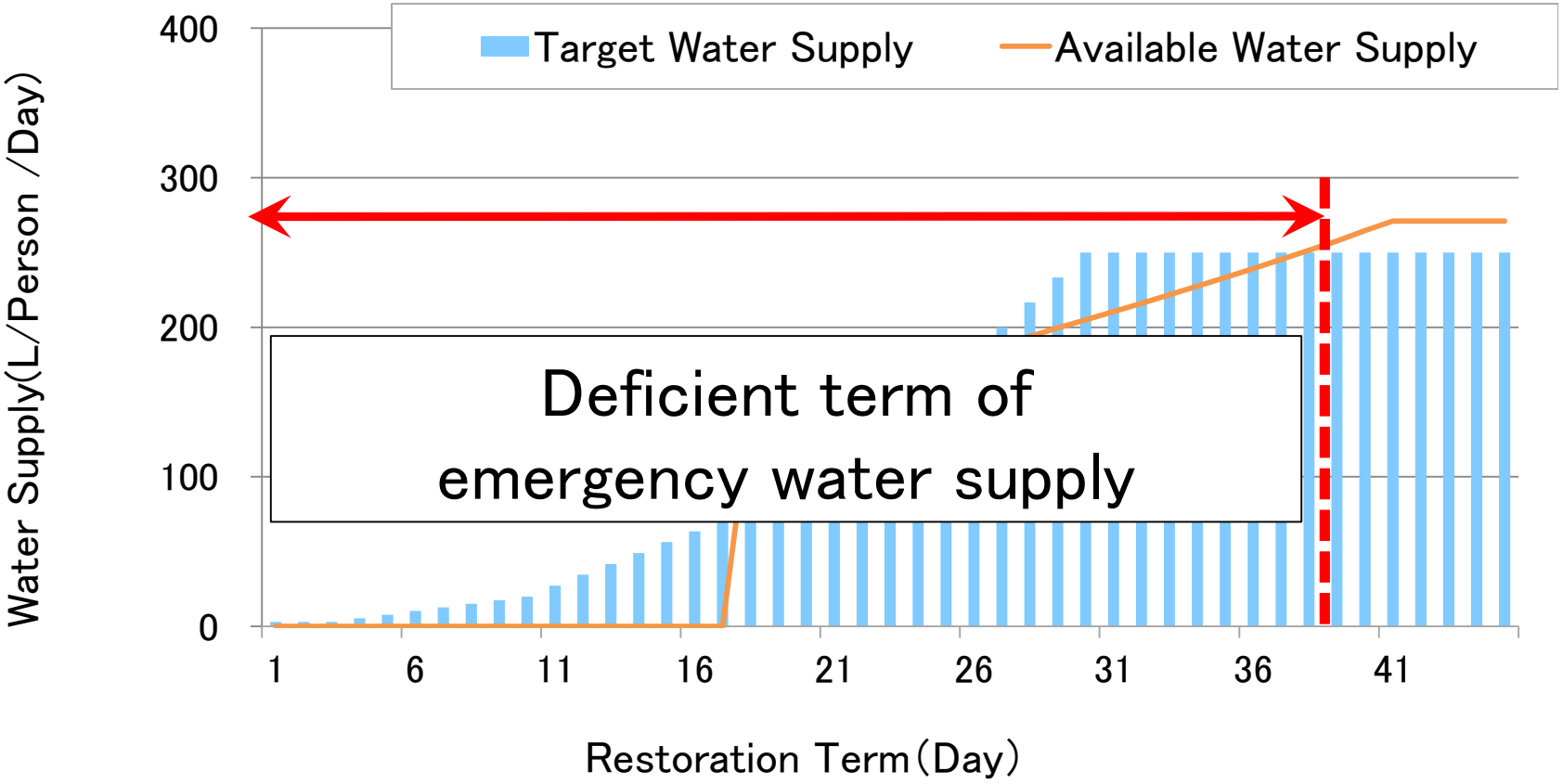
# Target Water Supply

| Term | Purpose | Target Water Supply (L/person/day) |
|---|---|---|
| 3rd day | minimum water supply to survive | 3 |
| 10th day | bevarage, toilet | 20 |
| 21st day | bathroom, loundry | 100 |
| 30th day | genereal water supply | 250 |

# Target Water



# Emergency restoration simulation



# Determination of the priority order

## Simulation Result

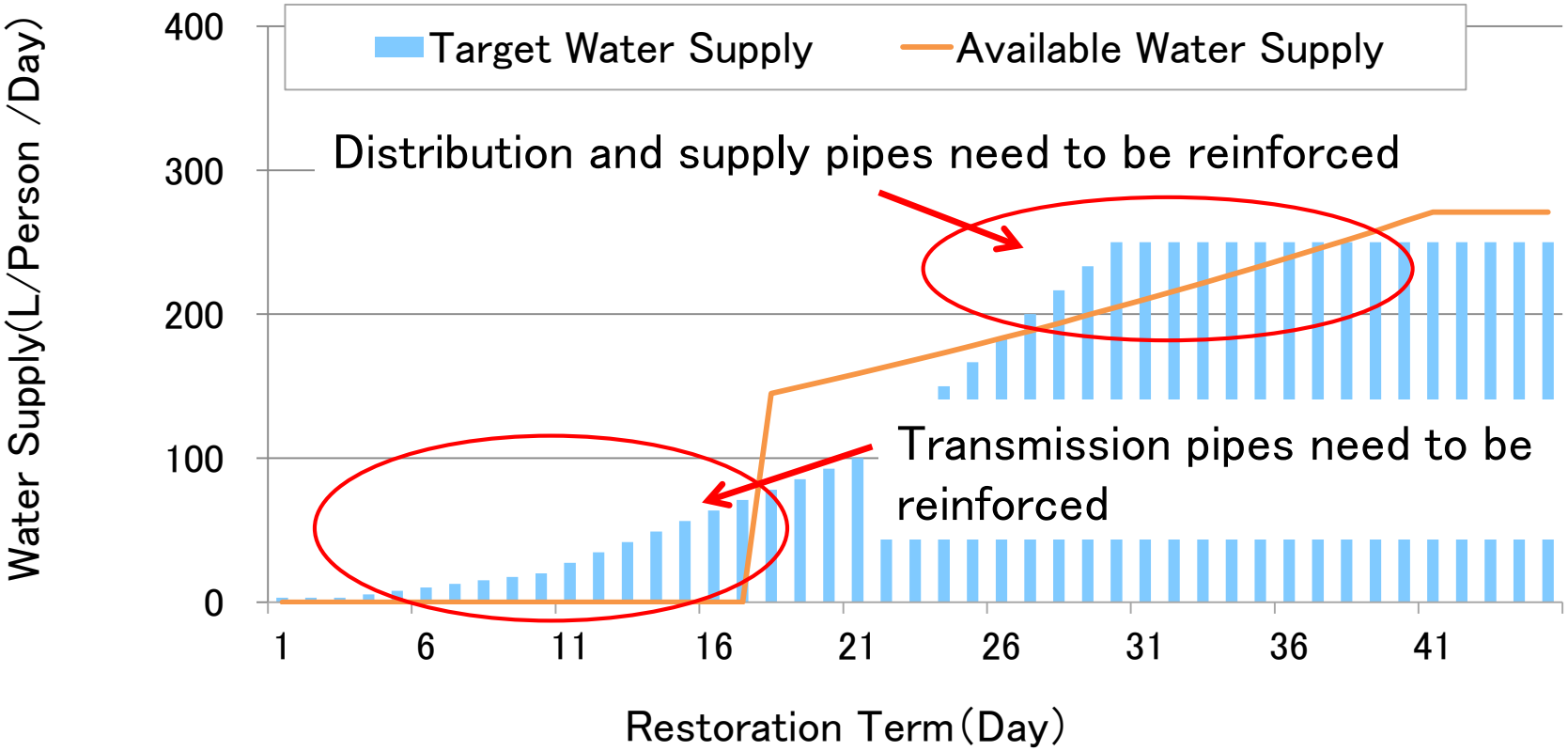
| Area | Restoration Term (days) | | | | | Priority Order |
|---|---|---|---|---|---|---|
| | Purification Station | Transmission Pipe | Distribution Station | Distribution Pipe | Deficient Term of Emergency Water Supply | |
| A | 0※ | 10 | 3 | 24 | 37 | 3 |
| B | 15 | 8 | 3 | 12 | 38 | 2 |
| C | 0※ | 2 | 3 | 7 | 12 | 4 |
| D | 30 | 6 | 3 | 11 | 50 | 1 |

※ Chlorination only

We set the priority order by deficient term of emergency water supply

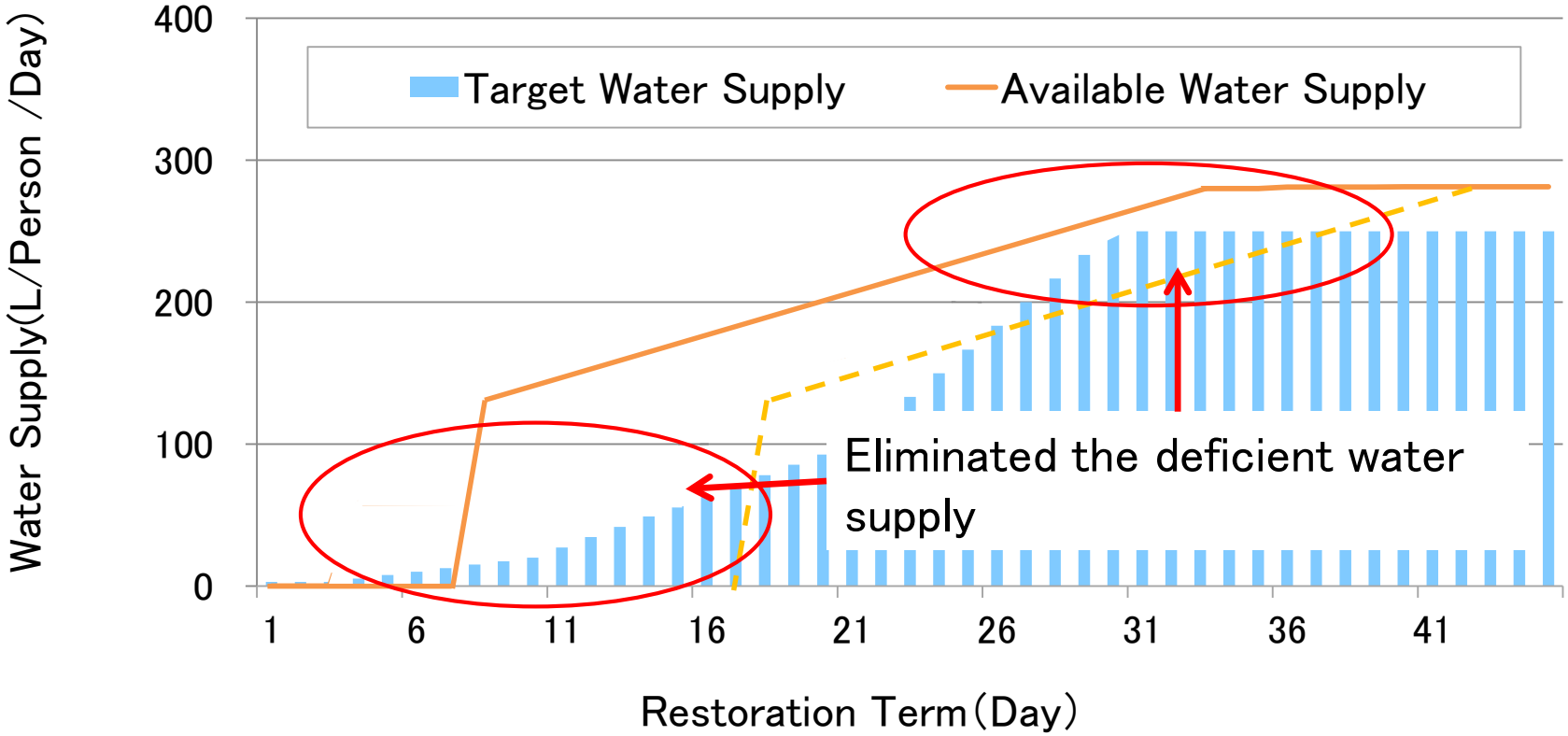
# Setting the target of earthquake-resistant

## The Result before earthquake resistance



# Setting the target of earthquake-resistant

## The Result after earthquake resistance of Transmission Pipes



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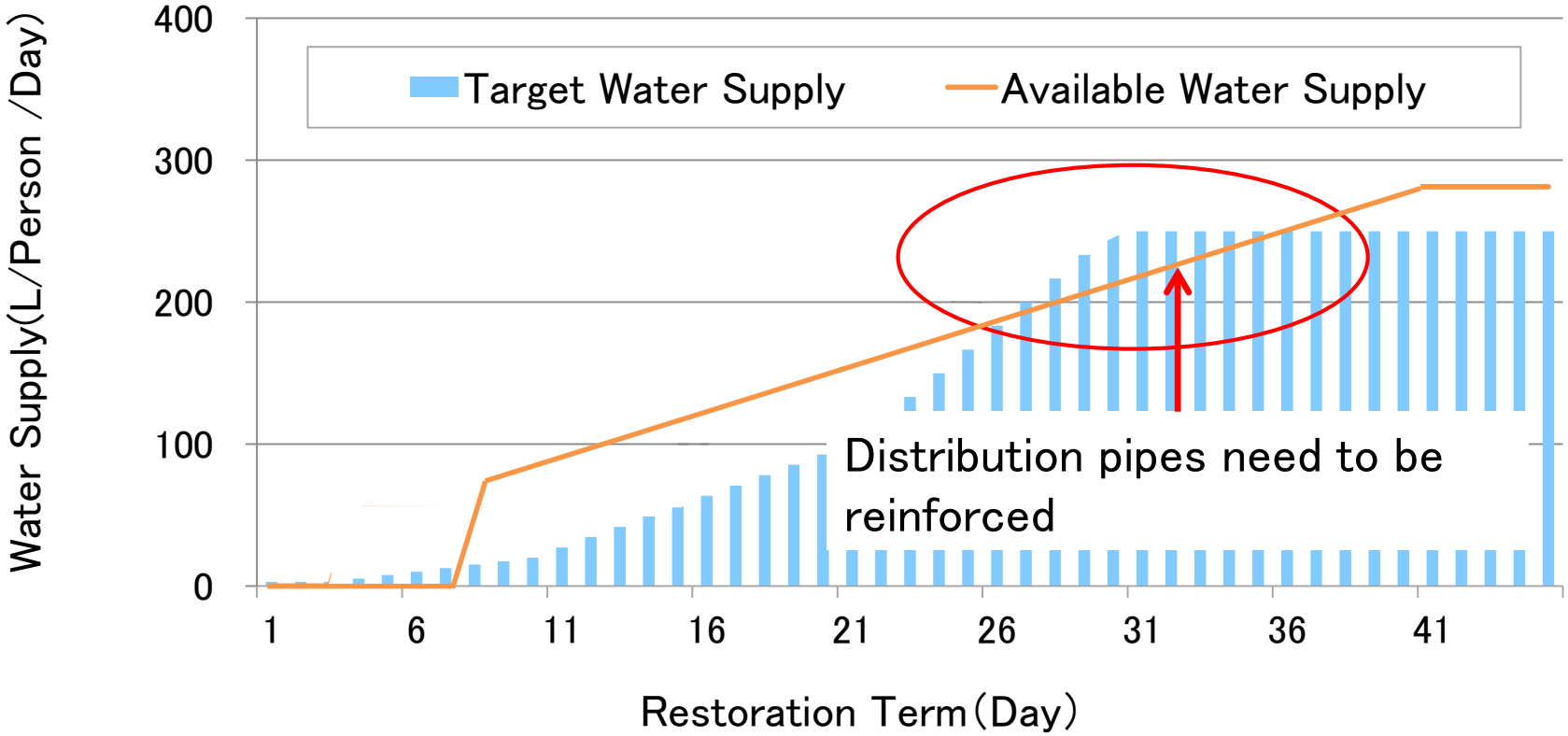

# Conclusion

- We evaluated the priority order quantitatively.
- It is important to consider the restoration of purification and distribution stations.
- We need to focus on transmission pipes not just on distribution pipes.

# Conclusion

- We consider it would be useful for the staff of water works to comprehend the current station and future plan of earthquake-resistance.

- We need to see the difference between urban areas and local areas.