Case	Murano Water Treatment Plant (tiered water treatment plant)		
Water utility	Osaka Water Supply Authority		
General information of the utility (as of 2021)			
Operation type	Public (wholesale water supply)	Service area (km^2)	1,678.42
Population served	—	Distribution (m^3/d)	1,482,993
Service coverage (%)	—	Pipe length (km)	604.77
NRW (%)	0.61	Number of staff	353
Number of water sources	Surface water (1), Groundwater (0), Others (0)		
Water rates (JPY)	72/m^3	(unit price of drinking water to retail municipalities)	

Summary

As of 2021, the Osaka Water Supply Authority supplies approximately 75% of the total water used by 42 cities, towns, and villages in the Osaka Prefecture.

Although water demand in Osaka Prefecture is currently on the decline, during the period of high economic growth from the 1960s to the 1980s, its demand increased rapidly, and there was a constant request for purchasing water from the Authority from municipalities in the prefecture. Therefore, the planned maximum daily water supply for approximately 20 years from 1960s to 1980s increased by 2,300,000 m^3/day in total.

Table 1 Changes in Water Demand of the Authority

Approved date	Project Name	Planned maximum water supply volume (m3/d)
11/25/1948	1st construction	35,000
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3/25/1960	4th expansion	375,000
10/13/1962	4th expansion (modified)	533,000
10/14/1964	5th expansion	1,150,000
11/25/1970	5th expansion (modified)	1,450,000
3/31/1972	6th expansion	2,000,000
3/31/1980	7th expansion	2,650,000

To secure water treatment facilities that could meet such water demand in the rapidly urbanizing Osaka Prefecture, the decision was

	made to construct a layered water treatment plant (two buildings of 300,000 m3/day each) that would house water treatment facilities in a three-dimensional structure within a single building, based on a comprehensive evaluation of the required land area, acquisition method, layout plan, project cost, treatment efficiency, and rationality of operation, maintenance, and management. Construction of Building No. 1 began in October 1974 and was completed in November 1977, and construction of Building No. 2 began in October of the same year and was completed in November 1980. Since then, the plant has been supplying water to Osaka Prefecture up to the present, while adding advanced water treatment processes in 1994 to cope with the deteriorating water quality of the Yodogawa River.  Figure 1 Murano Water Treatment Plant
Current Status & Challenges	<u>1 Development of Facilities to Meet Rapidly Growing Water Demand</u> During the period of rapid economic growth from the 1960s to the 1980s, water demand in Osaka Prefecture increased rapidly, with an annual increase in demand of more than 100,000 m3/day. Therefore, it was necessary to plan and develop a distribution capacity of approximately 600,000 m3/day over 10 years. <u>2 Limited Water Sources and Project Site</u> The Yodogawa River is the only water source that can meet the water demand in Osaka Prefecture, and the existing water intake facilities at the Murano Water Treatment Plant and the Isoshima Water Intake Plant had to be utilized if facilities from intake to distribution were to be expanded within the required time frame. Therefore, it was necessary to secure a project site in the vicinity of the Murano Water Treatment Plant, but the surrounding area was

	rapidly urbanizing, making it difficult to secure a large site as in the case of conventional water treatment plant development. 3 Response to Deterioration in Raw Water Quality As the area around Lake Biwa, which is upstream from the Yodo River, the main source of drinking water, had been developed, the deterioration of raw water quality, as typified by odor, had become a problem since the 1970s. Therefore, the new water treatment facilities were required to be designed to allow additional deodorization treatment even after the facilities got into operation.
Measures & Solutions	1 Determination of the type of water treatment plant In summary, the requirements for the new water treatment facility were: "to secure a large treatment capacity in a short period of time," "on a site that can be secured even in an urbanized area," and "with the expectation of adding deodorization treatment in the future." In the first place, it was generally difficult to secure a large site in a short period of time, and in addition, the site area required for additional deodorization treatment was uncertain, and the cost of land was rising due to urbanization. Therefore, it was determined that a tiered system was more suitable than a flat system, taking into account the construction cost and required construction technology. 2 Determination of Unit Configuration for Tiered Water Treatment Plant Based on the policy of constructing a two-tiered water treatment plant, the next step was to determine the number of buildings, and after organizing and evaluating the various performance requirements, etc., it was decided that two buildings (300,000 m3/day x 2) would be used. This was because the project cost was relatively inexpensive, and because two buildings of the same design could be symmetrically placed and constructed consecutively, which was advantageous in that it would produce early and gradual effectiveness in response to ever-increasing water demand.

Table 2 Evaluation to determine the number of buildings

Conditions A (performance)		Conditions B (number of buildings)
Water demand	×	6 buildings (100,000 m3/d/building)
Site layout plan		4 buildings (150,000 m3/d/building)
Site area		3 buildings (200,000m3/d/building)
Maintainability		2 buildings (300,000 m3/d/building)
Structure		1 building (600,000m3/d/building)
Construction cost		
Investment effectiveness		

With the number of buildings determined to be two, the next step was to determine how each treatment facility would be contained within the building. After comparing the proposals of arranging each treatment facility vertically within the building, arranging each treatment facility on a flat surface on each floor, and dividing the treatment stages across buildings, the proposal of "arranging each treatment facility vertically within the building" was adopted because of its advantage in terms of required area and facility maintenance and manageability. As a result, the scale of each building was decided to be 2 stories below ground and 3 stories above ground (height: 31 m), with a standard plane of 72.3 m x 88.8 m, and a unit configuration of 66 water tanks inside.

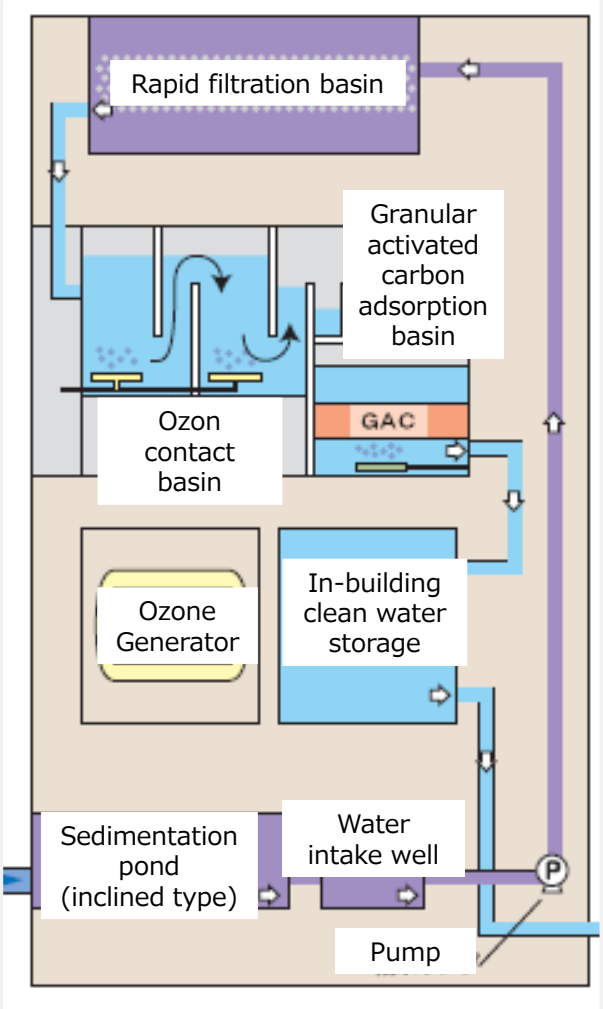

Figure 2 Adopted facility layout

	3 Structural Planning and Design At the time of the aforementioned consideration in the 1960s, there were no examples of a layered water treatment plant of this scale in the world. In designing its structure, stress analysis was conducted in accordance with the various standards set by the Architectural Institute of Japan, while also taking into account related three-dimensional effects. In addition, with the cooperation of the Faculty of Engineering at Kyoto University, vibration tests were conducted using a 1/50-scale plastic model, and the results were reflected in the structural design.
Future Plans	As of 2021, approximately 45 years have passed since the completion of this facility, and it has been operating stably and is expected to become indispensable as the overall treatment capacity has been declining due to renewal of other water treatment plants of the Osaka Water Supply Authority. On the other hand, while the "Future Vision of Osaka Water Supply Authority" currently being formulated calls for the renewal of the west system of the Murano Water Treatment Plant and the Mishima Water Treatment Plant during the planning period (~2052), water demand in the prefecture is on a downward trend. Therefore, in the next plan, which will be approximately 80 years after the No. 1 Building began operation, it is necessary to examine the desirable form of the relevant facilities from multiple perspectives, including more efficient operation and emergency response capabilities.
References	○ Osaka Water Supply Authority, Various Management Plans https://www.wsa-osaka.jp/joho/plan.html ○ Osaka Water Supply Authority, Pamphlets https://www.wsa-osaka.jp/koho_hodo/pamphlet.html