Introduction to State-of-the-Art Wastewater Treatment Plants

Ariake Treatment Plant

The Ariake treatment plant is located in the Waterfront Urban Subcenter on the shores of Tokyo Bay.
The plant has the following characteristics.

1. It has the advanced treatment capabilities for the purpose of removing more nitrogen and phosphorus from the wastewater for the first time in Tokyo.

2. A pressure collection system has been partly installed.

3. The upper portion of the plant has been made available for sports and recreation facilities.

4. Ozone-treated wastewater is being reused for toilet bowl use.

5. A optical fiber communication network that has been installed is being used for the remote monitoring and control of pumping stations.

6. Effective land utilization is being sought though the adoption of a two-tier sedimentation tank and deep aeration tank.

7. A bio-deodorant system is in use.

8. The heat generated by the wastewater is being used to heat and cool the plant's management building.

Kosuge-nishi Park (Upper Portion of Kosuge Treatment Plant)

Use of the Upper Portion of the Facilities

There are thirteen wastewater treatment plants in the 23 city wards and another seven in the rigional sewerage system in the Tama district. The bureau provides these facilities and installations to the local citizens in a variety of forms.

The upper portion of most of the treatment plants is open to the citizens for use as parks, sports facilities and other similar uses.

BUREAU OF SEWERAGE
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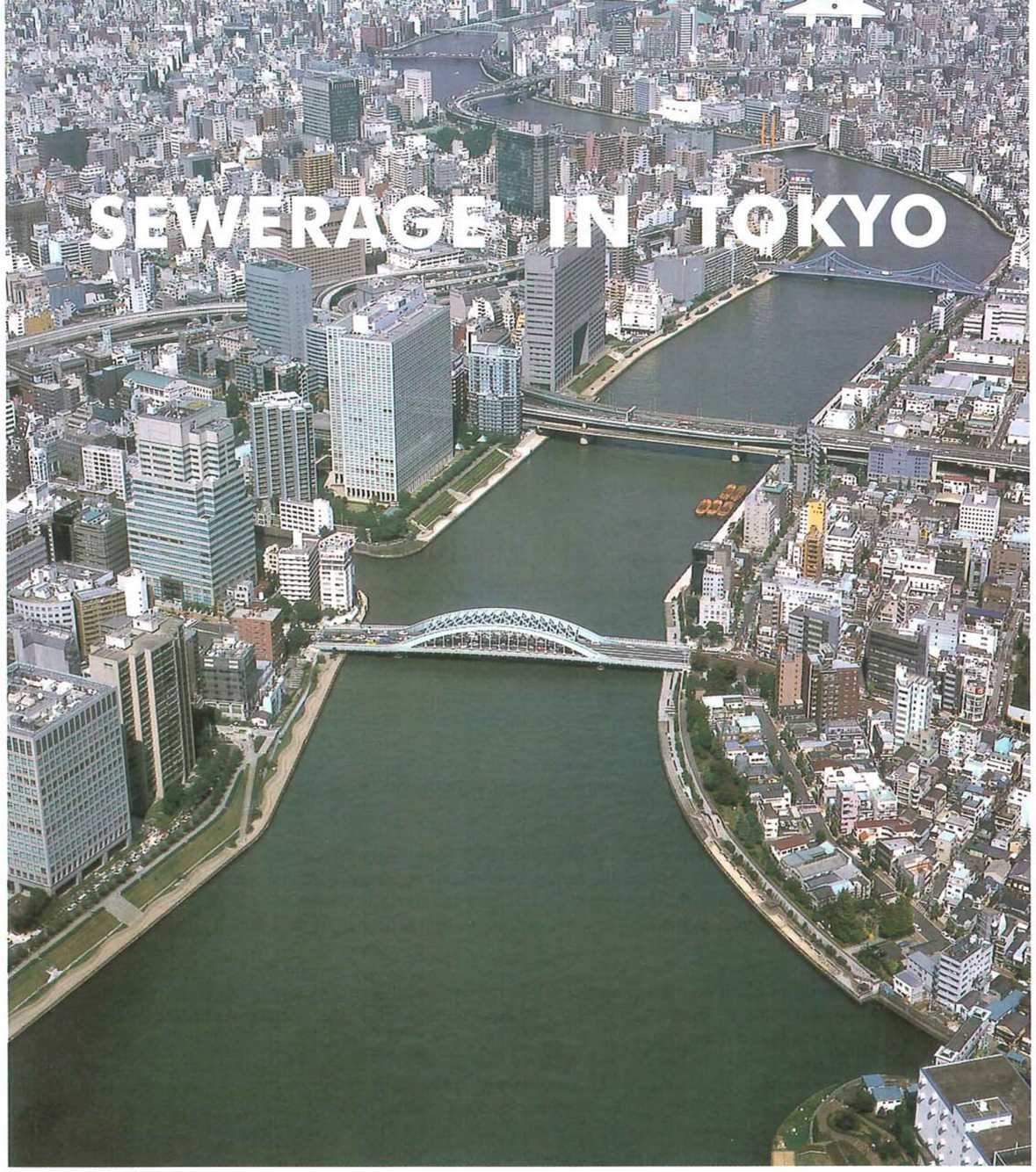
SEWERAGE IN TOKYO



Sumidagawa River

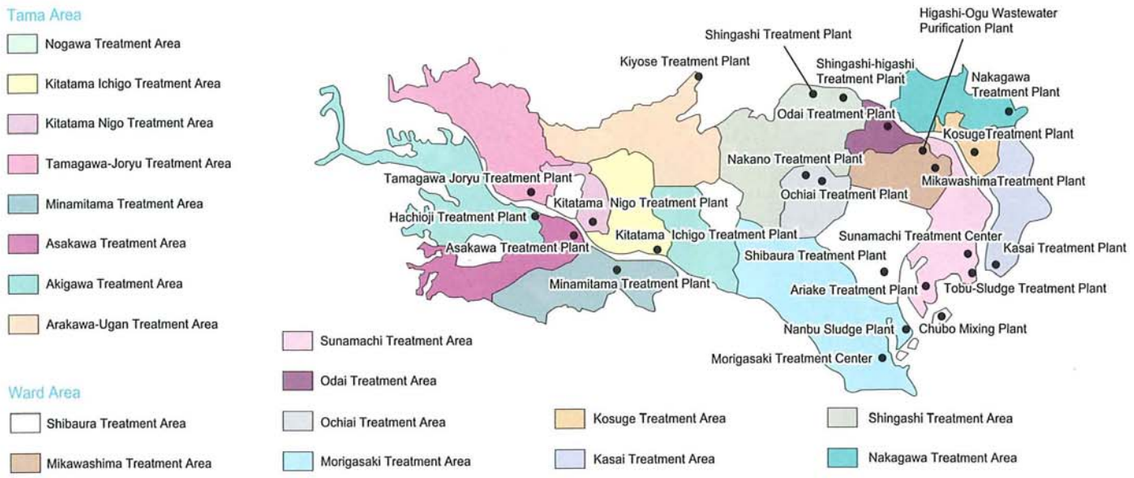
Kanda Sewer

The construction of modern sewerage in Tokyo dates back to 1884, when the Kanda Sewer was constructed. This was Japan's first step in the introduction of modern sewer systems.

As of the end of March, 1995, some 110 years after the Kanda Sewer Works, the sewerage system diffusion rate had reached essentially 100% of the city and even the Sumidagawa River, whose contaminated waters and bad odor were once a source of distress to many, has become clean again and continues to bring contentment to the lives of the citizens.

Brief Overview of the Sewerage in Tokyo

Wastewater Treatment Plants in Tokyo



1. The Role of the Sewerage

The role of sewerage has changed in response to the socioeconomic situation at the time, the structure of the city and the environment. Currently, the basic role of sewerage can be described as indicated below.

(1) Improvement in the living environment by removing and treating wastewater discharges
(2) Prevention of inundations by removing rainwater
(3) Preservation of water quality in public water areas

They play an important role as an essential element of the urban infrastructure in supporting wholesome and cultural urban life and urban activities.

In addition to their basic roles, sewage systems furthermore fulfill increasingly diversifying roles with the aim of creating a bountiful, pleasant water environment through the utilization of treated water and advanced wastewater treatment operations, the conversion of sludge to resources, the recycling of the resources and energy in wastewater such as utilization of heat and the effective use of sewerage facilities exemplified by the installation of optical fiber cables in sewers.

2. Sewerage Operations in Tokyo

Public sewerage operations are in principle considered to be the responsibility of each individual municipality. Since Tokyo Metropolitan Government has adopted a prefectural system, however, unlike other local governments, it carries out the operations in the city wards as if it were a city.

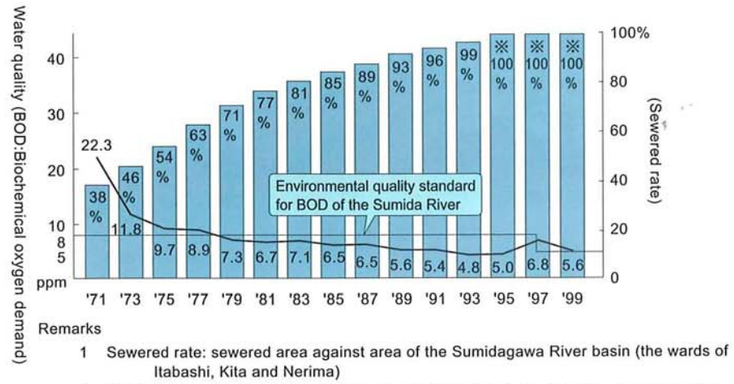
Although the various municipalities located in the Tama area of Tokyo are in charge of their own sewerage operations, the construction, maintenance and management of wastewater treatment plants, pumping stations, trunk sewers and other key facilities and other Rigional sewerage system operations are implemented at the prefectural level.

3. Current State of Sewerage in Tokyo (as of 3/31/01)

	ward area sewerage system	Rigional sewerage system
Total population	8,229,254	3,057,809
Population with sewage system facilities	8,218,819	2,866,357
Diffusion rate (in proportion to population)	*100%*	94%
Wastewater treatment volume	4,763,376m³/day	852,374m³/day
Sludge treatment volume	166,253m³/day	37,402m³/day

* The diffusion rate is in excess of 99.5%, essentially 100%. Note: $1m^3 = 263$ gallons

4. Water Quality of the Sumidagawa River and Sewerage Construction



Remarks
1 Sewered rate: sewered area against area of the Sumidagawa River basin (the wards of Itabashi, Kita and Nerima)
2 BOD: BOD measured at Odaibashi bridge (75% of the standard value, prepare by the Bureau of Sewerage from the data of the Bureau of Environmental Protection)

Sewerage Service Fees

Discharge Volume (m³)	Rates (yen)
8m³ or less	¥ 560
9— 20m³	¥ 110 /m³
21— 30m³	¥ 140 /m³
31— 50m³	¥ 170 /m³
51— 100m³	¥ 200 /m³
101— 200m³	¥ 230 /m³
201— 500m³	¥ 270 /m³
501— 1000m³	¥ 310 /m³
1001m³ +	¥ 345 /m³

* The fees that are charged consist of an amount equal to 105% of the amount obtained from the table above (amounts of less than ¥1 are discarded).

5. Sewerage Service Fees

Sewerage service fees are collected based on the volume of wastewater discharges. While there is a fixed charge for the initial 8m³, the unit charge increases as the discharge volume increases beyond that.

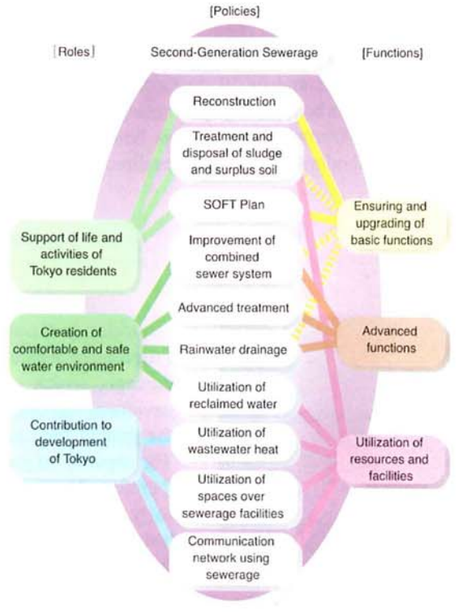
Unit fee is set at a low range for the general minimum discharge volume in our everyday lives and reductions and exemptions are also available for low-income households.

6. Second-Generation Sewerage Master Plan

The existing so-called first generation system is a system that removes all wastewater discharges and storm water from the urban activities of Tokyo through the sewage system and has existed for the purpose of fulfilling all of the basic requirements of sewage systems.

The Second Generation Sewerage Master Plan was formulated in 1992 for the purpose of developing sewerage operations from the new perspective of the water environment, global environment, community development and the like.

Fig. Roles and Policies of the Second-Generation Sewerage



Sewerage Facilities

The sewage and sludge treatment mechanism

1 Sewers

There are two methods used for removing wastewater, the combined type and the separate type. With the combined type, both wastewater and storm water are collected in the same sewer, while, with the separate method, they are treated separately.

The sewers that run under the streets must be repaired or replaced if they become damaged by the load of heavy vehicle traffic, vibration or land subsidence. In addition, sand and other sedimentation and accumulations of fat and oil are also known to frequently inhibit the flow of wastewater. They must therefore be inspected periodically and cleaned internally either by hand or by high-pressure cleaners designed for the removal of sedimentation.

2 Pumping stations

Wastewater that is collected in the sewers is sent to treatment plants by way of pumping stations. Since wastewater naturally flows downward, if sewers are installed at a considerable depth in flat areas, it is necessary to draw the wastewater up to the surface by means of pumps.

Virtually all pumping stations have facilities for pumping both wastewater and storm water and, at the time of a heavy rainfall, for example, pumping stations play an important role in preventing inundation by promptly discharging the rainwater flowing in the sewers into rivers or into the sea.

Forty-four of the 78 pumping stations operating in the city wards are all fully automated and are remotely controlled and monitored from manned pumping stations.

3. Wastewater Treatment Plants

Wastewater treatment plants are facilities for the purpose of removing contaminants from the wastewater and releasing clean water to the rivers and the sea. The plants consist of facilities to clean wastewater and to process sludge.

Grit Chamber

The wastewater that flows into the treatment plants is sent first to the grit chamber. Sand and grit settle to the bottom while large floating matter is screened out as the sewage flows slowly along. The water is then drawn out by pumps and sent to the primary sedimentation tank.

Primary Sedimentation Tank

Minute organic matter is caused to precipitate out here as the wastewater flows gently for two to three hours.

Aeration Tank

The primary role of the aeration tank is to remove of the soluble BOD component and scum matter that was not completely removed in the primary sedimentation tank. The mixture (aeration liquor) consisting of the wastewater and activated sludge (microorganisms) in the aeration tank is subjected to the aeration process. During the aeration period of six to eight hours, the microorganisms are completely combined with organic matter and grow while ingesting that as nutrients. That causes the organic matter to decompose into water and carbonic acid gas and other non-organic substances while the scum adheres to the microorganisms.

Secondary Sedimentation Tank

The activated sludge and treated wastewater are separated as the aeration liquor slowly flows from the aeration tank to the secondary sedimentation tank. A portion of the activated sludge that is separated and precipitated is returned to the aeration tank. The activated sludge, increased through the propagation of microorganisms, is sent to the sludge treatment facility, where it undergoes treatment as surplus sludge. Meanwhile, the supernatant after chlorination is released into the rivers and the sea.

Sludge Treatment Facility

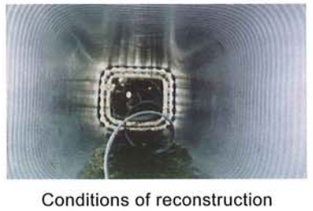
In the sludge treatment facility, the activated sludge precipitated in the primary sedimentation tank and surplus sludge are first of all sent to the concentration tank, where they are reduced in volume by about one-half to one-fourth. Moisture is then removed by means of a dehydrator (two facilities, the Morigasaki and Odai plants, have a subsequent process of passing through a digestion tank after concentration). 94% of the sludge after dehydration is incinerated and converted to ash and the total volume of ash is about 0.1% of the original activated sludge. The ash is combined along with the remaining dehydrated sludge in cement and is buried at a disposal area in Tokyo Bay for land reclamation use. In recent year, however, in order to promote the reuse of resources and extend the life span of the disposal area, it is being used as a material in the production of bricks and concrete. In FY 2000, more than 40% was converted for use as resources.

Major Policies of the Bureau of Sewerage

1 Reconstruction

In addition to age deterioration, the sewerage facilities in Tokyo, which have been developed over a period of more than 110 years, have seen progressive deterioration caused by the effects of vehicle traffic above, land subsidence and so forth. Insufficient capacity is also evident due to diversification in life styles and changes in the urban structure. Accordingly, reconstruction is being systematically and effectively promoted so that the sewerage facilities adequately demonstrate their functions and fulfill their roles and also in order to maintain and improve safety and comfort in urban life by promoting the reinforcement of capacity and more advanced functions. Meanwhile, priority is being given to countermeasures to deal with roadway collapses, foul odors and other issues directly linked to the lives of the local citizens.

Deteriorated sewer pipe



Conditions of reconstruction

Flood conditions

2 Inundation Countermeasures

Progressive urbanization has been the cause of more instances of "urban-type" water damage, which occurs when the land surface becomes covered with buildings, pavement and other structures, rendering it difficult for rainwater to seep readily into the ground and causing much of it to flow into the sewage system within a short time. The capacity of pumping stations and sewer pipes to remove storm and wastewater is therefore being strengthened while emergency measures are being adopted for the early alleviation of damage in regions susceptible to flood damage due to localized heavy downpours. We are furthermore assisting in the disaster prevention activities of the citizens by providing rain and weather forecasts.

3. Improvement of the Combined Sewer System

With the combined type sewage system (a method in which both wastewater and storm water are combined in the same sewer and removed), which accounts for some 82% of those in the city wards, a portion of the wastewater during rainy weather is released into the rivers and the sea together with storm water without being treated first. Therefore, in order to deal with urgent issues such as sending as much wastewater as possible to treatment plants when rain begins to fall and preventing the discharge of oil or refuse, measures are being implemented within a short time with priority on the facilities and districts.

Furthermore, initiatives are also be implemented for the purpose of preserving the water quality in public water areas, which include the establishment of facilities for the discharge of rainwater.

Conditions during clear weather

Discharges during rainfall

Advanced Sewerage Technology

1. Utilization of Treated Water

Treated water is used for cleaning the facilities and equipment in treatment plants and pumping stations and as water for cooling apparatus. In addition, it is also adapted to a broad range of other uses as a valuable source of water in the city, such as toilet bowl water in redeveloped areas such as the Shinjuku Urban Subcenter, as river environment water and as water for cleaning commuter trains.

A) Miscellaneous water use

A Water Recycling Center has been set up in the Shinjuku Urban Subcenter to supply treated water throughout the area. Sand-filtered water from the Ochiai treatment plant is piped to the center where it is chlorinated and supplied to twenty-five high-rise buildings in the area for use as toilet bowl water. Besides that, treated water is also being supplied to the Waterfront Urban Subcenter, the Shinagawa Station East Entrance district and the Osaki district.

Toilet bowl water

B) Revitalization of clear streams

There has been a gradually rising tide of voices among the local citizens in recent year calling for improvements in amenities. In response to this, the prefectural government has been making efforts to revitalize streams with the aim improving the waterside environment and creating a green network. The Nobidome waterway was revitalized in 1984, the Tamagawa waterway in 1986 and the Senkawa waterway in 1989. The flows of the three rivers in the southern downtown area, which had become extremely small during ordinary times due to the effects of urbanization, was revitalized by the end of FY 1994.

Nobidome waterway (Higashiyamato City,Kodaira City)

2. Reuse of Sludge

In FY 2000, the average daily wastewater treatment volume and the sludge treatment volume in the 23 wards of Tokyo was 4,763,376m^3 and 166,253m^3, respectively. Along with changes in urban life styles and the introduction of more advanced treatment methods, the volume of sludge is expected to increase in the future.

Currently, the disposal areas required for land reclamation using dehydrated sludge are limited. Some 94% of the sludge is therefore incinerated and the volume is reduced down to about 1/20th of the original. Besides the use of sludge for reclamation, efforts are also being made to reutilize sludge by converting it to a resource.

A) Bricks

Bricks are being produced with sludge ash as a material. After press molding, they are baked at a temperature of about 1,050℃. This produces bricks that are strong and durable and they are used for pavement, in parks and for other uses.

Metro-brick paving

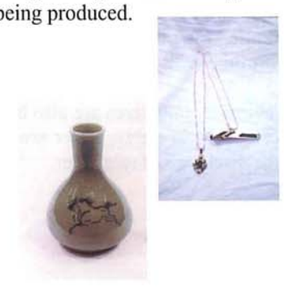
B) Lightweight aggregate

An effective use for one non-organic component of sludge is a lightweight aggregate. It has a quality that enables it to be used as an alternative to natural aggregate and it is being used for permeable blocks, construction-use aggregate and other uses.

C) Flowers vases and ornamental accessories

Flower vases and other ceramic objects are being produced with the admixture of 20-30% sludge ash to the clay, which have been well received as recycled products.

In addition, necktie pins, necklaces and other ornamental accessories using sludge melted slag are also being produced.



3. Utilization of Wastewater Heat

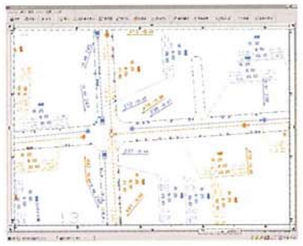
Wastewater is characterized by having a temperature that is lower in summer and higher in winter than the temperature of the atmosphere. Using this as a source of heat for cooling and heating apparatus makes it possible to reduce the use of petroleum, natural gas and other fossil fuels and, at the same time, contributes to environmental conservation by reducing atmospheric contaminants and conserving energy.

In July 1994, the Koraku district was the first in the nation to begin supplying heat for the regional heating and cooling system using untreated wastewater as the heat source and it also intends to begin supplying heat in the Shinsuna district in April 2002.

4. Sewerage Mapping and Information System (SEMIS)

In order to be able to effectively implement the management of facilities, it is essential to be able to grasp vast amounts of sewage system data at all times.

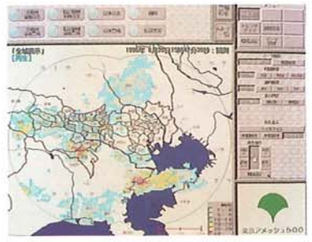
The bureau developed and activated the Sewerage Mapping and Information System (SEMIS) in 1985 to systematize sewage system data in the 23 wards of Tokyo and is in the process of developing a database.



5. Rainfall Data System

The rainfall data system, known as Tokyo Amesh, has two radar facilities located in Minato Ward and in Inagi City and it is being managed to enable the appropriate implementation of pump operations at pumping stations and treatment plants in the even of a typhoon or local downpour.

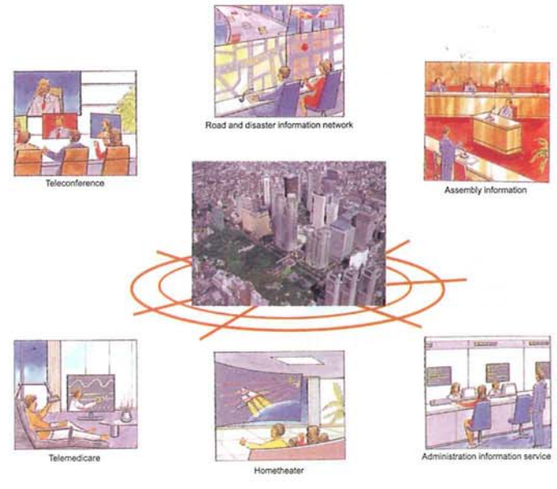
Once the data obtained by radar is transmitted to the central data processing equipment and is analyzed, it is sent to the pumping stations, treatment plants and field offices as well as the Tokyo Disaster Preparedness Headquarters. The real time rainfall data in each district can thus be seen on the CRT displays of those facilities.



6. Use of the Sewerage Facilities in Data Communication Networks

The secure and effective management of sewerage facilities is being promoted through the installation of optical fiber cable in the open spaces within sewers and the development of sophisticated data communications networks between sewerage facilities. In addition, the leasing of dark fiber and sewer space in the sewage system to government agencies or telecommunications operators is also being pursued, thereby contributing to the further development of the data communication infrastructure in Tokyo.

Note 1: Dark fiber leasing: Leasing of a portion of the optical fiber network installed in the sewage system for use by telecommunications operators or others
Note 2: Space leasing: Leasing of space within the sewers to telecommunications operators or others for their own installation of optical fiber cable



Conceptional Illustration of Communication Networks