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PROJECT PROFILE

Japan

The OEDO Line

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Centre for Mega Projects in Transport and Development

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This report was compiled by the Tokyo Institute of Technology.

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A INTRODUCTION

Type of project

The Oedo line is a subway line, the first segment of which began operation in 1991, followed by the full line in 2000. It is operated by the Bureau of Transportation Tokyo Metropolitan Government (hereinafter referred to as 'Bureau of Transportation').

- Length: 40.7km
- Stations: 38
- Gauge: 1435mm
- Electric supply: 1500 VDC
- Top speed: 70km/h.

Overview

The Oedo line runs from Tochomae Station to Hikarigaoka Station via major stations such as Shinjuku-nishiguchi, Ueno-okachimachi, Monzen-nakacho, Shiodome, Daimon, Roppongi, Kokuritsu-kyogijo, Shinjuku and Nerima. The total operating length is 40.7km.

The operation of the first segment between Nerima and Hikarigaoka commenced in December 1991, the next segment from Shinjuku to Nerima in December 1997, followed by the service from Kokuritsu-kyogijo to Shinjuku in April 2000, and from Tochomae to Kokuritsu-kyogijo via Roppongi in December 2000, which completed the full line operation (Figure 1, Figure 2).

The Oedo line directly links the north-western area, central area, downtown area and hilly affluent area (Yamanote) of the 23 wards of Tokyo, capital of Japan. Since the Oedo line has connections with other lines at 26 of its 38 stations, it greatly contributes to the improvement and expansion of Tokyo's public transport network.

The Oedo line uses smaller cars and has adopted 'state-of-the-art' technologies: namely linear motors and light-weight all-aluminum bodies (Figure 3). Barrier-free facilities, such as elevators and escalators, are installed at all stations, and the stations are decorated with public arts to create an 'amenity space' (Figure 4).

Location

The entire line is located within 23 wards. A 12.9km radial section between Hikarigaoka and Shinjuku is extended from the loop section and connects Nerima ward and Nakano wards, the residential area located in Yamanote, with Shinjuku, in central Tokyo. Meanwhile, the loop line of 27.8km from Shinjuku to Tochomae which opened in 2000 surrounds the urban district of Edo (former name of Tokyo), running through Shinjuku ward, Bunkyo ward, Taito ward, Sumida ward, Koto ward, Chuo ward and Minato ward.

Since the Oedo line is one of the new subway lines in Tokyo, it runs very deep under many other lines, tunnels and buildings. The platform of Roppongi station is 42m underground, making it the deepest subway station in Japan.

Current status

The number of passengers has drastically increased since full line operation began in 2000. In the fiscal year 2007, the line was used by 781,487 people per day. The number of passengers per day on the Oedo line is the largest among the subway lines operated by the Bureau of Transportation (Asakusa Line, Shinjuku Line and Mita Line).

Figure 1: Toei Subway Lines Operation Map (2005): Oedo Line

Figure 2: Shape and stations of the Oedo Line

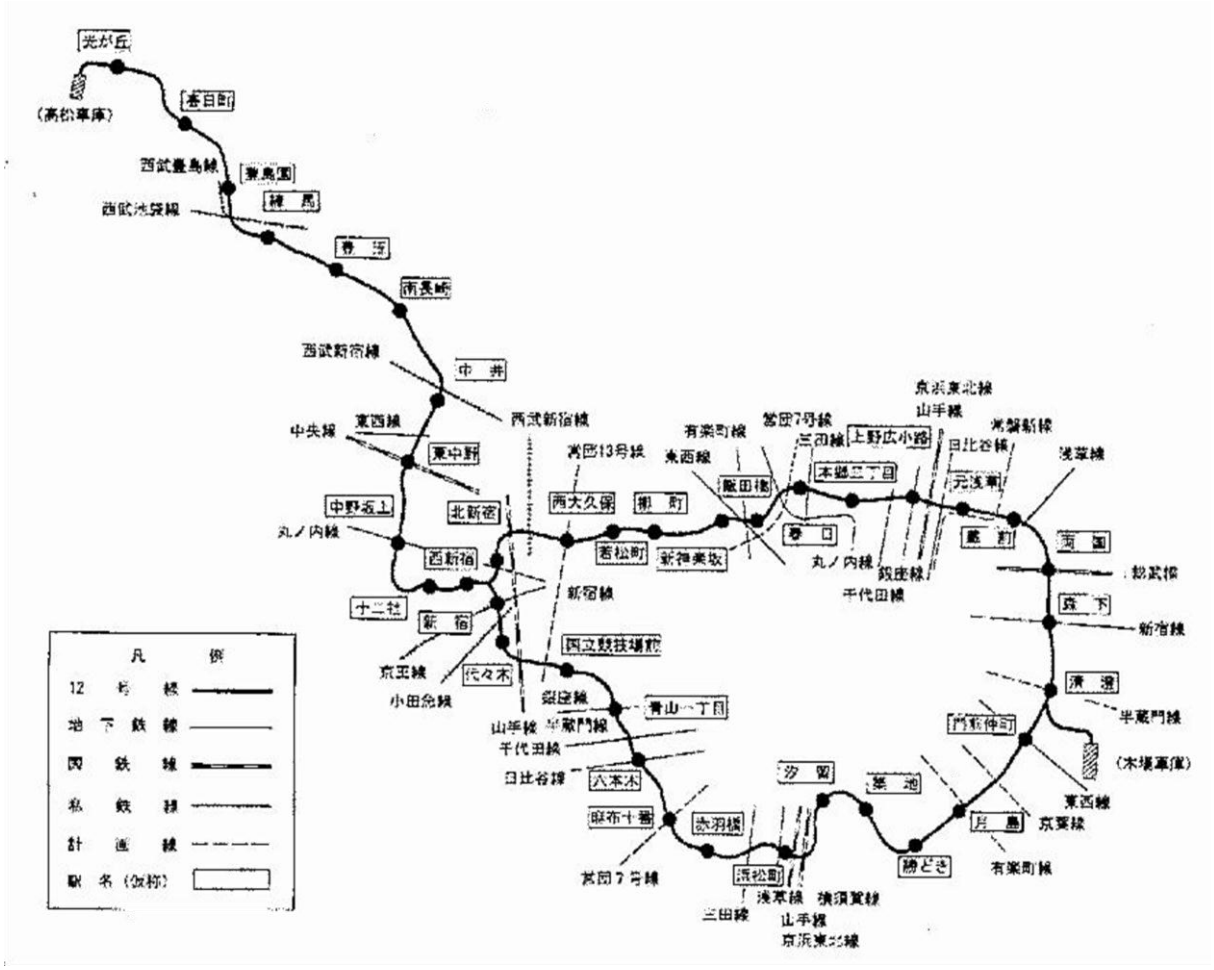


Figure 3: Cars of the Oedo Line (Left: At the time of the loop line opening) (Right: At the time of full line opening)

Figure 4: Public Art at the Station: Ticket Gate at the Azabu-juban Station

B BACKGROUND TO PROJECT

Development plan of the Oedo Line

The Oedo line (initially called Toei Line 12) is one of 13 lines listed in the Tokyo Metropolitan High-speed Railway Network Development Plan (Report No. 15) submitted in March 1972 by the Urban Transportation Council (an advisory panel to the Minister of Transportation). In response to the report, the Tokyo Metropolitan Government obtained a license for the section between Nishi-shinjuku (current: Tochomae) and Takamatsu-cho (currently Hikarigaoka) in August 1974. However, the plan was temporarily frozen due to rapid changes in socio-economic conditions.

In May 1978, the Council for the Measures against Transportation Problems in Tokyo (an advisory panel to the Governor of Tokyo) proposed to reconsider the construction of the Oedo line.

Later, the need for the development of transportation systems increased along with the construction of large apartment complexes in Hikarigaoka (former Grand Heights US Air Force Base). The plan for the Oedo line covered Hikarigaoka, and the Long Term Plan of Tokyo, formulated by the Tokyo Metropolitan Government in December 1982, included the development of a radial section of the Oedo line (from Shinjuku to Hikarigaoka).

In July 1985, Transport Policy Council (former Urban Transportation Council) released the Basic Plan for the Development of Transportation Network Focusing on Tokyo Metropolitan High-speed Railway (Report No. 7). The plan to extend the Oedo line westward (Hikarigaoka – Oizumi-gakuen towards Niiza-shi of Saitama Prefecture) was added in this report.

As described in the next section, following the revision of the maintenance criteria in the 1980s, a new construction approval was obtained from the authorities concerned. Construction work began in June 1986 between Nerima and Hikarigaoka. In August 1990, construction started between Shinjuku and Nerima.

Changes in specifications, including cars

Initially, the plan for the Oedo line was designed to use general large cars with the same specifications as the existing subways. However, reconsideration started under the following policies, based on the recommendations by the Council for the Measures against Transportation Problems in Tokyo of 1978.

- Adopt specifications of appropriate size to meet transport needs;
- Pursue introduction of new technology;
- Efforts to reduce construction and operation costs.

Using the latest documents of that time, transport needs were recalculated with consideration of various conditions under slow economic growth, and the conclusion was reached that it would be possible to reduce the size of cars from those with current specifications.

Since the Oedo line is an independent line which does not merge with other lines, it was also possible to develop its own specifications and scale. Thus, the plan pursued not only down-sizing of cars but also smaller tunnels and smaller facilities, including stations.

Plan for route and station location

It was decided in September 1985 to move the Tokyo Metropolitan Government building from Marunouchi to Shinjuku. Prompted by this, a resolution was adopted by the Tokyo Metropolitan Assembly to improve the transportation network throughout Tokyo, which included the development of the Oedo line.

In response, the Tokyo Metropolitan Government set up the Investigation Committee on Tokyo Metropolitan Subway Construction and Operation (hereinafter referred to as 'Investigation Committee') to promote the construction of the Toei subway line. The commission comprised 19 members, including academic experts, and considered the ideal state of subways and the financial issues surrounding Toei subways.

The Investigation Committee compiled an interim report in November 1986, which made proposals about cost reduction by making tunnels and cars smaller and about the route and location of stations. In March 1987, a final report was submitted to the Governor of Tokyo, which included the establishment of a third sector organization to realise these proposals.

Policies to determine the track routes and station locations proposed in the report are as follows:

- Pursue connections with major terminals and increase the transfer/connection functions with existing and planned lines;
- Consider accessibility to public facilities, such as the new Tokyo Metropolitan Government building, and large-scale facilities;
- Pursue consistency with large-scale redevelopment plans; and
- Use public space, such as roads and parks, as much as possible.

Under these policies, on-site studies were carried out with particularly detailed considerations for the routes around Nerima, Shinjuku, Iidabashi, Ueno, Shiodome and Roppongi. As a result, routes were changed except in the Ueno area. Specifically, since the change to smaller cars allowed sharp curves and steeper slopes, some routes were changed to beneath roads and parks, instead of beneath privately owned land, leading to construction cost reduction.

Regarding the location of stations, 38 stations were chosen based on convenience to passengers. Twenty six stations that are connected to other lines were selected in consideration of convenience to transfer passengers, and twelve other stations were selected considering such factors as distance between stations, the traffic situation in the neighbouring area, construction costs and scheduled speed.

Construction body and operation body

In response to the final report of the Investigation Committee, the Tokyo Metropolitan Government identified the construction of the loop section (Tochomae – Ueno-okachimachi – Daimon – Shinjuku) as one of the priority projects. Thus, the Headquarters for Promoting the Construction of Toei Line 12 (hereinafter referred to as 'Headquarters') was established with the Governor of Tokyo as the director, aiming to promote the construction of the loop section of the Oedo line.

In June 1987, the Headquarters decided on the routes and station locations for the loop section and the schedule to complete the construction in around FY1996. In October that year, it released the basic policies for the construction of the loop section.

The report on the basic policies pointed out the need to pursue early construction and simultaneous full operation of the loop section and included the following three policies.

1. A huge amount of cost is needed for the construction of the loop section. It also requires undertaking large scale construction works of about 29km in a short period of time. Thus, various private funds would be injected to ensure the necessary works and to develop a system for effective and flexible project implementation.

2. A third sector organisation would be established, led by the Tokyo Metropolitan Government, in an attempt to reduce construction costs. This organisation would be in charge of construction of the loop section and fund procurement.

3. The railway facilities built by the organisation would be transferred to the Tokyo Metropolitan Government in the form of a long-term payment by installments and the Metropolitan Government would operate the Oedo line together with the radial line.

In response, the Tokyo Metropolitan Government embodied the plan in the Tokyo Metropolitan Comprehensive Implementation Plan in November 1987. In July 1988, Tokyo Metropolitan Subway Construction Co., Ltd. (hereinafter referred to as 'Tokyo Subway') was established, comprising employees of Japan Railway Construction Public Corporation, with the Tokyo Metropolitan Government as the main body.

With this, the construction of the loop section was launched, with Tokyo Subway as the main construction body and the Bureau of Transportation as the management body after completion.

(The construction body and management policies are discussed in section E).

Negotiations on connections with other railways

The Oedo line is a long line with a constructed length of 42.7km and forms a loop in central Tokyo. Thus, the line crosses with other lines at 45 locations, of which 26 stations are connected to other lines.

At these junctions, it was decided to adopt a transfer and construction method for the best interest of users, such as crisscross, T-shaped or L-shape arrangements, with a basic aim of reducing transfer time. With this in mind, a number of discussions were conducted among parties concerned.

Discussions were held about the construction method and the offset distance for the crossing points with no junctions, so as not to affect the facilities of other lines.

Negotiations had already been conducted with the Tokyo Underground Railway Company (hereinafter referred to as Eidan) (current: Tokyo Metro Co., Ltd., hereinafter referred to as Tokyo Metro) at the planning stage of the Oedo Line about the depth of the stations and crossing modes at some stations, which only required some work on details.

Adoption of linear motor cars

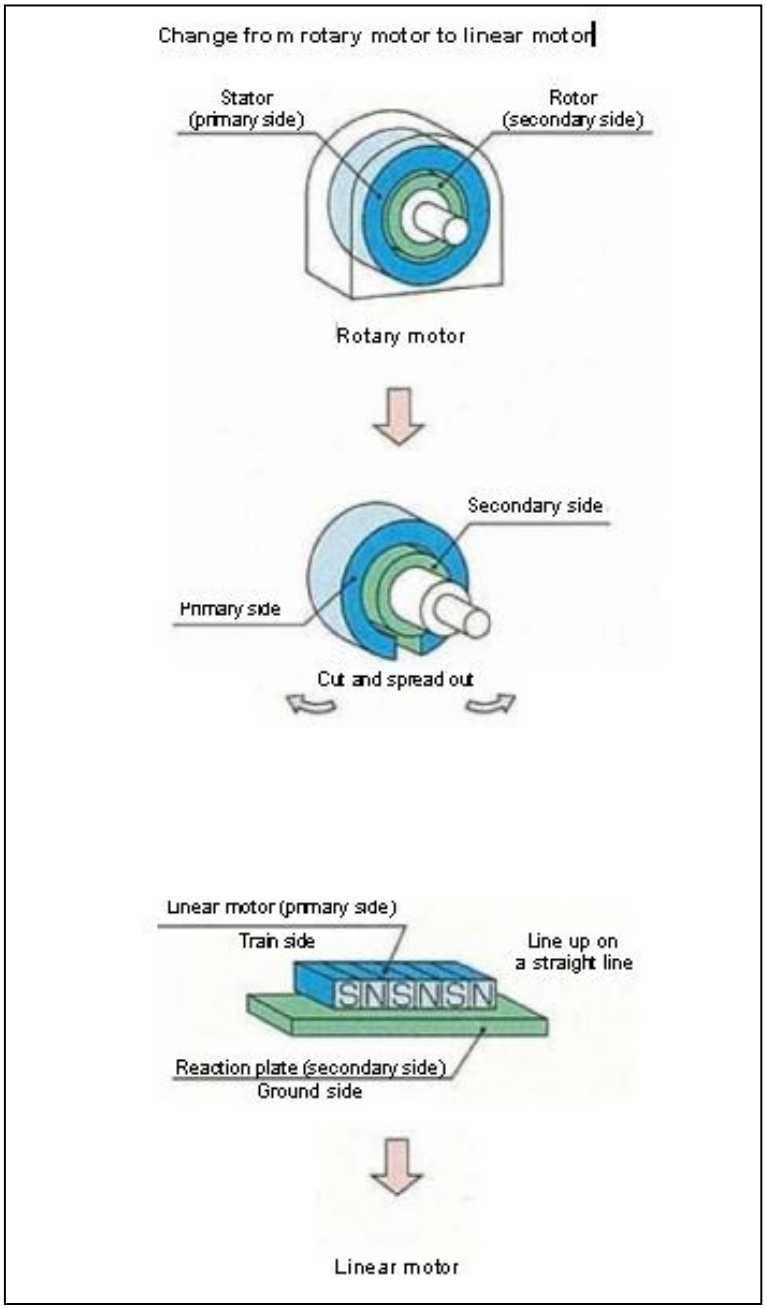
The Headquarters announced in the Basic Construction Policies released in June 1987 that it would decide on the drive system (linear method or rotary method) by the time of producing cars for the radial section.

The Bureau of Transportation implemented test drives of a prototype car equipped with a linear motor drive device in 1988 and confirmed its safety for practical operation. The Headquarters decided to adopt the linear motor system in December 1988.

Adoption of the linear system allowed motor a fan-shaped motor (Figure 5). This lowered the floor of the car, endowing it with ample passenger space, though small. Smaller cars allowed smaller tunnels, resulting in reduced construction costs (Figure 6), which also enabled smooth runs at sharp curves and steep slopes. This system requires installing a steel board known as a 'reaction plate' on the ground (Figure 7, Figure 8).

Change from rotary motor to linear motor

Figure 5: Rotary Motor and Linear Motor



Comparison of the cross-section view of the tunnel

Figure 6: Effect of Downsizing (dotted lines in the tunnel indicate the construction boundary)

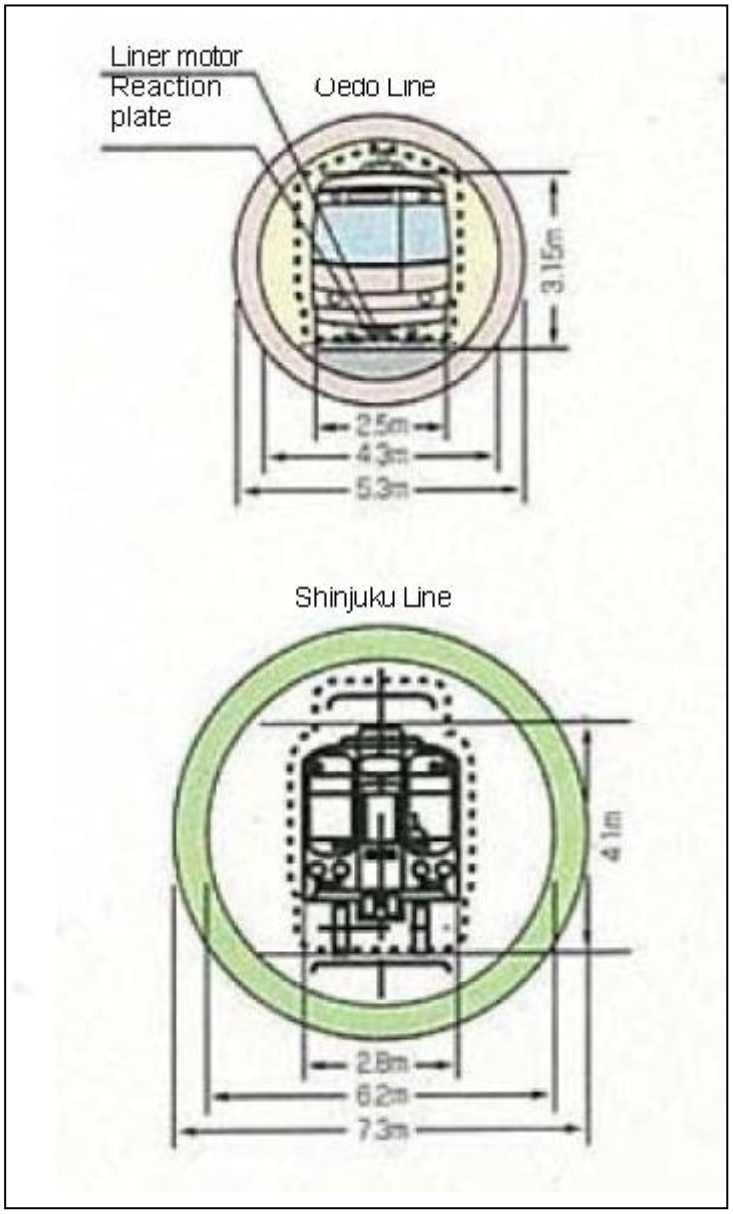


Figure 7: Reaction Plate

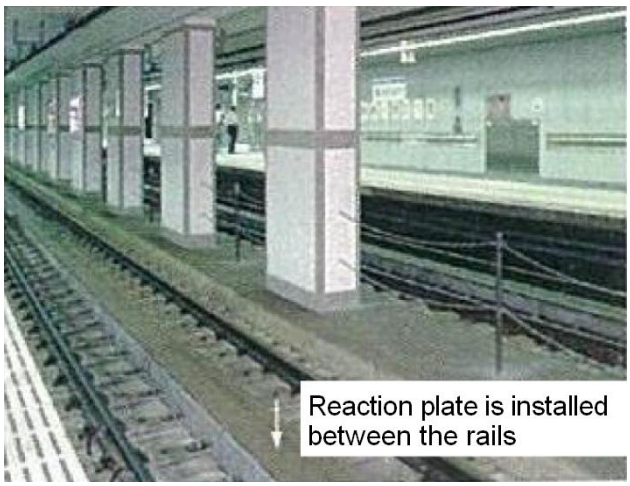
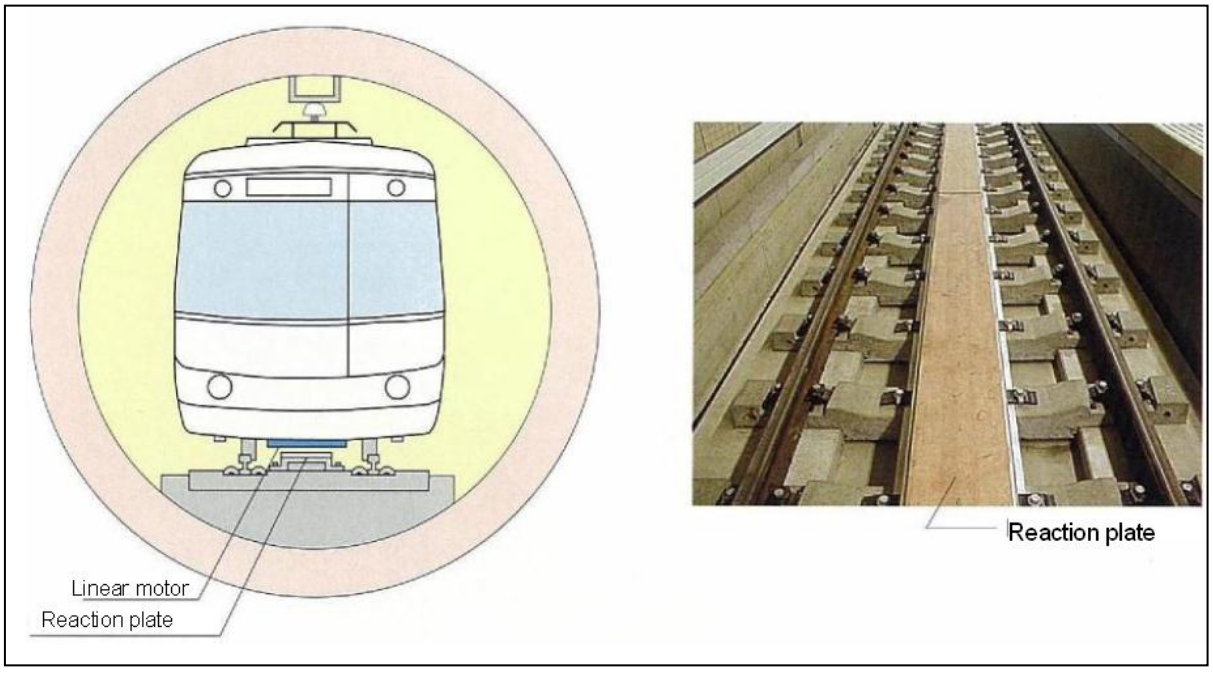


Figure 8: Locations of Reaction Plate and Linear Motor



Cars are equipped with ATC/ATO devices (see following section), air conditioning, and electric displays in Japanese and English, as well as wheelchair spaces to improve services. A VVVF inverter regenerative brake control device is mounted to conserve energy.

The car design was considered by a group led by the Car Design Committee for Toei Line 12 (hereinafter referred to as 'Design Committee') set up in December 1988 (Chairperson: Yoshinosuke Yasoshima, President of Teikyo Heisei University (former Teikyo University of Technology). The Design Committee pursued an original design with a theme of 'amenity and friendliness', suitable for the capital of Tokyo in the 21st century.

The cars were completed in this way, and 30 cars from the first production 12-000 series were delivered to the Takamatsu depot in September 1990, six cars from the second production in 1994, 84 cars from the third production in 1997, and 16 cars from the fourth production in 1999. In 2000, 288 cars from the fourth production were delivered to the Kiba depot. The cars from the first and second production have a round and soft appearance with a magenta border line on an ivory background. The front face of the cars from the third and later productions has been simplified without body paint, but simply with a line (See Figure 3 for the appearance of the car).

Adoption of one-person operated train (OPOT)

Streamlining of operations was required for cost reduction, including personnel cost. Thus, the Oedo line adopted a system of 'one-person operated train (OPOT)'.

To do this, Automatic Train Control (ATC) and Automatic Train Operation (ATO) were mounted on the train: the former automatically controls the speed of the train according to the condition of the rails and the latter automatically operates the train from start to stop. Automatic announcement devices and emergency devices for direct communication with the train driver are installed in the passenger space. Another system is installed to send the image of the platform to the train driver by the optical space transmission device from the ground, which is then shown on the two liquid crystal displays in the train cockpit. (The

interior of the passenger car and cockpit are shown in Figure 9).

Figure 9: Passenger Car and Cockpit of the Oedo Line

C PRINCIPAL PROJECT CHARACTERISTICS & CONSTRUCTION PROCESS

Opening process of the line

Opening of the radial section of the Oedo line

On the Oedo radial line, the operation between Nerima and Hikarigaoka (operating distance 3.8km) started on 10 December 1991. This section has four stations (Nerima, Toshimaen, Nerima-kasugacho, and Hikarigaoka) and connects with the Seibu Ikebukuro Line at Nerima station.

The line between Shinjuku and Nerima (operating distance 9.1km) was opened on 19 December 1997. This section has eight stations: Shinjuku (which connects to the Keio line, the Odakyu line and the JR line), Tochomae, Nishi-shinjuku-gochome (Shimizubashi), Nakano-sakaue (which connect to the Tokyo Metro Marunouchi line), Higashi-nakano (which connects to the JR line), Nakai (which connects to the Seibu Shinjuku line), Ochiai-minami-nagasaki, and Shin-egota.

This has completed the full line between Shinjuku and Hikarigaoka (operating distance 12.9km) constructed by the Bureau of Transportation, and the north-west of Tokyo has been directly connected with the Shinjuku sub-centre.

Opening of the loop section of the Oedo Line

Advance opening of the section between Kokuritsu-kyogijo and Shinjuku

The Kokuritsu-kyogijo station has an emergency track, which facilitated the earlier opening of the line between Kokuritsu-kyogijo and Shinjuku, generating positive effects, such as improved convenience for users and an increase in the number of passengers. Thus, the Bureau of Transportation purchased the facilities in this section from Tokyo Subway in advance of other facilities. The service between Kokuritsu-kyogijo and Shinjuku commenced on 20 April 2000.

Opening of full line

Since the loop section is 28.8km long, the Bureau of Transportation had set the trains on the track in six separate sections from October 1999 according to the progress of the construction work. After the final installation between Shiodome and Akabanebashi of July 2000, the Bureau of Transportation conducted tests for signals, safety and communications facilities and training for drivers.

The railway facilities were completed on 29 November 2000, and were transferred from Tokyo Subway to the Bureau of Transportation on the following day, 30 November 2000. The full line operation began on 12 December 2000. Operation of 23 stations started, with the exception of Shiodome station, and the number of stations in service increased to 37.

Tokyo citizens were highly interested in the line; the first day of the operation attracted a particularly huge crowd and tickets commemorating the opening were sold out on the day of release.

Among 38 stations, including Shiodome, 26 have connections with other lines (including stations at which connections were created after the opening of the line), and a new

transportation network was created in Tokyo by the full line operation.

With the opening of the line, nearly all JR Yamanote line areas are within a ten-minute walking distance from a train station. As a result, it became necessary to separate the roles of railway and bus services, and the Toei bus routes were revised concurrently with the full opening of the line.

Public voting for the name of the new line

The name of the new line was selected by public voting. About 30,000 proposals were made during the period from 1 August to 20 August 1999.

Through the selection at the Committee for Selecting the Name of Toei Line 12 (Chairperson: Ms. Sumiko Takahara, economic analyst) held on 29 November 1999, the name of the new line was decided to be 'Oedo Line' on 15 December. The reasons for the selection are as follows:

- The line almost completely encompasses the area formally called 'Edo';
- The line passes through the historical areas and towns formed in the Edo era;
- At the turn of a new 21st century, the historical term 'Oedo' sounds rather new; and
- Addition of the prefix 'O' (meaning grand or large) expresses geographic, economic and cultural expansion.

Replacing the former name of Toei Line 12, the name 'Oedo line' began to be used since 20 April 2000, when the line between Kokuritsu-kyogijo and Shinjuku opened.

Progress of project

Construction of the Oedo radial line (Shinjuku-Hikarigaoka)

Land acquisition

The distance between Nerima and Hikarigaoka is 4.5km (including a depot), of which about 2.2km was to pass through private land. The distance between Shinjuku and Nerima is 9.1km, of which about 3.6km was to compete with the Widening Project of the Loop Road No. 6, passing through private land for 1.4km.

The methods of acquisition of private land include purchase, creation of superficies and leased land.

Land to be bought was basically the land required for railway facilities at ground level. The land was used for installing ground level facilities such as entrance/exits, ventilation, ventilation towers, depots and buildings, and for maintenance of railway facilities, such as permanent way, electricity and water drainage.

Land subject to creation of superficies was required for the installation of underground railway facilities. This includes land used for installing underground structures by temporarily removing private houses, land where temporary objects, such as soil retaining, cannot be removed and private land under which a shield passes through. However, land with little earth covering from the ground surface to the underground structure and land required for security reasons was subject to purchase.

Land subject to lease was used temporarily for the subway construction. Such land to be

used during construction work included working zones, material storage, shield base, and roads for construction work.

Vegetable fields, residential areas, theme parks, and apartment complexes were located in the area between Nerima and Hikarigaoka and the road was narrow, with a width of 8m. The total area acquired for the project was 46,400m^2. In addition, a total of 66,000m^2 was used temporally as leased land. Land acquisition, including purchase and creation of superficies, was carried out between FY1985 and FY1992.

The line between Shinjuku and Nerima runs under private land near the Nerima station, through the Mejiro-dori and major roads.

The total area acquired for the project was about 12,800m^2. In addition, a total of about 46,110m^2 was used temporarily as leased land. Land acquisition, including purchase and setting superficies, was carried out between FY1990 and FY1996.

Of the parallel section between the Loop Road No. 6 and the Central Circular Route, the acquisition of the eastern part of each of Nakano-sakaue, Higashi-nakano, and Nakai stations was undertaken by the Bureau of Transportation, commissioned by Metropolitan Expressway Co., Ltd.

Outline of construction work

The section between Nerima and Hikarigaoka is located on the Musashino Highland, and is in the alluvial fan of the Tamagawa River. The land is on the loamy layer of the Kanto Plain. The land is flat at around 38-42m above sea level, but the eastern side is a little lower. The Shakujii River runs through the Toshimaen Park, creating a large gauge (32-34m above sea level).

Construction work for the Nerima-Hikarigaoka section started on 1 June 1986. The open-cut method was used for each station between Nerima and Hikarigaoka, loading and unloading rail yards and Takamatsu depot. A double-track shield (mud pressure) tunneling method was used for the sections between Nerima and Toshimaen and between Toshimaen and Nerima-kasugacho and a single-track shield (mud pressure) method was used for the section between Nerima-kasugacho and Hikarigaoka.

The section between Shinjuku and Nerima is located on the Musashino Highland, as is the section between Nerima and Hikarigaoka. Many small and medium rivers, such as the Kanda River and the Myoshoji River, wind through the highland, forming a number of incised valleys on the highland.

The construction work for the section between Shinjuku and Nerima began on 1 August 1990. An open-cut method was basically used for Shinjuku station, but the shield method was used for the track floor due to the influence of the neighbouring buildings. An open-cut method was used for Tochomae, Nishi-shinjuku-gochome, Ochiai-minami-nagasaki and Shin-egota stations. The Nakano-sakaue, Higashi-nakano and Nakai stations used the open-cut method in such a manner that the subway and metropolitan expressway could be integrally structured. Slurry pressure type single-track shield was used for the shield between Tochomae and Nerima stations.

Construction of the loop section of the Oedo line (Tochomae – Ueno-okachimachi– Daimon – Shinjuku)

The construction of the loop section (Tochomae – Ueno-Okachimachi – Daimon – Shinjuku) was undertaken by Tokyo Subway (third sector) and was transferred to the Bureau of Transportation after completion. Tokyo Subway acquired the license as a third class railway enterprise (business operator to construct railways with an aim to transfer to a first class railway enterprise, which operates the railway) in May 1989.

Land acquisition

- Basic policies for land acquisition

The loop section was to be constructed in existing urban areas where land prices were high. Thus, efforts were made to reduce land-related costs as much as possible, and the following land acquisition policies were set forth.

1. For the route selection, efforts should be made to use public space, such as roads and parks;
2. Efforts should be made to reduce construction costs by constructing re-development buildings incorporating entrance/exit facilities, joint building and station-related facilities;
3. Special measures should be taken regarding land owned by the Tokyo Metropolitan Government: for example, giving approval to use land for free for a maximum of ten years since the use started. Cooperation from wards concerned should be requested so that they could take similar measures regarding land in their ownership.

- Background and record of land acquisition

Based on the above-mentioned policies for the Oedo line, the route was designed to pass through and be constructed under roads as much as possible. The adoption of the linear motor system allowed the construction of sharp curves, which contributed to the improvement in the underground laying rate.

However, since both station buildings and entrance/exit facilities required land along with the main roads in the business districts of urban areas, negotiations for land acquisition were difficult.

Acquired land was used for subway facilities, such as station buildings, administrative facilities, entrance/exit facilities, ventilation towers, coolant towers, and shield construction, as well as for construction works (such as shield starter base and material storage).

Table 1: Status of land acquisition of the Loop Section of the Oedo Line (estimate)

Classification	**Number of projects**	**Area (m^2)**
Purchase	62	15,920
Creation of superficies	158	15,460
Leased land	22	11,020
Approval for use	48	60,270
Lease for use	3	20
Total	293	102,690

Outline of construction work

The geography of the loop section divides into the western highland and the eastern lowland around the Yushima and Azabu area. The height of the highland is 20-40m above sea level, while the eastern part is lower. The boundary of the highland generally forms a cliff, although it is unclear due to urbanisation. The highland shape can be observed around Iidabashi with the Kanda River. The lowland is formed by large rivers such as the Arakawa and Edogawa and is rather flat at a height of about 2m above sea level.

The construction work for the loop section started in 1992; an open-cut method was employed for the stations and a shield method for the line between the stations. The open-cut method used highly rigid earth retaining walls, such as diaphragm walls, soil mortar walls and slurry walls, and soil improvement work was conducted by quicklime piles as an auxiliary work. The work between the stations employed a closed-type slurry shield, a mud earth pressure balance shield and an earth pressure balance shield.

The works in the business district, under major roads, and in places where underground facilities were installed, employed a three- and four-circular face shield method and developed new technologies and methods for segments with rational joining structures in the shield lining, such as honeycomb segment and tenon segment. The backfill at the station section used liquefied backfill soil that had been improved from surplus soil, in an attempt to reduce environmental destruction from the collection of natural soil and traffic pollution caused by transportation.

All stations are decorated with public art to provide 'amenity space' and the upper sections of the stations are used for underground disaster provisions warehouses (of the Tokyo Metropolitan Government) and underground bicycle parking lots (of municipal governments), contributing to the formation of a disaster prevention network and traffic measures in the vicinity of the station.

Table 2 shows the details of construction works of each loop station.

Table 2: Outline of works of Oedo Loop Line Stations

Station	Construction work
Shinjuku-nishiguchi	Since large underground facilities, such as water pipes, are laid in Oume Kaido, the first and second underground floors could not be built and the station was divided. The first underground floor was integrated into part of the Shinjuku Pedestrian Network and will be connected to the Oume Kaido in the future.
Higashi-shinjuku	The first underground section was divided in order to secure the space for the underpass of the Meiji Doori, and the concourse located on the second underground floor. Underneath is the station of Eidan No.13 line (Currently Tokyo Metro Fukutoshin line).
Wakamatsu-kawada Ushigome-yanagicho Ushigome-kagurazaka	Since the area is residential, the earth retaining method was employed for the work on narrow roads of 17m width, and an integrated station wall structure was built by an underground diaphragm wall. An emergency crossover was installed at Ushigome-kagurazaka Station on the Ushigome-yangicho side.
Iidabashi	Since the area has heavy traffic and overlaps with the Tokyo Expressway, the Kanda River and Tokyo Metro lines, the station section was constructed with three-circular face shield.
Kasuga	Connected with the Toei Mita line and Marunouch line/Nanboku line of the Eidan (currently Tokyo Metro). The work of the junction with the Nanboku line

Station	Construction work
	was commissioned to Eidan and constructed simultaneously with the work of the Nanboku line.
Hongo-sanchome	Constructed under the crossing between the Hongo-dori and Kasuga-dori, but the width of the platform was narrow (6.1m-6.6m) because the Tokyo Metro roads have not been expanded.
Ueno-okachimachi	An underground pathway has been constructed to connect with the Ginza line and Hibiya line of Eidan (currently Tokyo Metro). There were many restrictions since it crossed with Eidan (Tokyo Metro) lines, JR lines and the Tohoku Shinkansen line and the ventilation room and fire extinguishing pump room were installed on the third underground floor, beneath the train tracks. The underground crossing with the Shinkansen Ueno tunnel was commissioned to JR East by employing a very special method: floor boards of the Oedo line were set by cutting out the ceiling of the Shinkansen's shield tunnel which was in operation.
Shin-okachimachi	This station was initially designed to have a two-strata structure with two lead tracks. However, it was later decided that the station would be shared with the Joban Shinsen (currently Tsukuba Express) and it employed a four-strata structure. The construction work was assigned to integrate 350m of the 457m extended length with the Joban Shinsen. The construction of an underground bicycle parking lot was commissioned by the Taito ward government. Two lead tracks were laid on the Kuramae side.
Kuramae	Although connected to the Toei Asakusa line, the underground pathway could not be built since the two stations were far apart. Since the station runs underneath the Sumida River, watertight doors have been installed at two locations of the station ends on the right bank.
Ryogoku	Located in the shallow underground with a two-strata structure. Water bars and watertight doors have been installed as anti-flood measures for the Sumida River.
Morishita	The junction with the Toei Shinjuku line was partially built at the time of the construction of the Shinjuku line. An underground bicycle parking lot for Koto ward was installed.
Kiyosumi-shirakawa	Since the line diverts to the Kiba depot at this station, the station has two platforms with three tracks. The grade crossing between the main line and the entering and departing line were installed toward the Monzen-nakacho. The open-cut method involves the Onagi River (high bridge). After installing a provisional bridge on the western side, the station was built with the open-cut method and then the bridge was rebuilt. A disaster provision warehouse and an underground bicycle parking lot for Koto ward were installed.
Monzen-nakacho	Connected with Eidan (currently Tokyo Metro) Tozai line. Since the ground is soft, the Tozai line section was reinforced, and the underpinning method was used.
Tsukishima	Connected with Eidan (currently Tokyo Metro) Yurakucho line. The junction had already been built at the time of the construction of the Yurakucho line. One of the exits/entrances was built within the Tsukishima Civic Center of Chuo ward. An underground bicycle parking lot for Chuo ward was installed.
Kachidoki	In order to secure the space for the underpass of the Harumi-dori, the first underground floor was divided and there are two ticket gates. The elevator was initially to be installed within a redeveloped building, but it was actually installed on the pedestrian road since the redevelopment was not in progress. An underground bicycle parking lot of Chuo ward was installed.
Tsukijishijo	A watertight door was installed toward the Kachidoki, which pairs up with the ones at the Kuramae station. An underground bicycle parking lot for Chuo ward was installed.
Shiodome	Since the area is designated as buried cultural property, excavation research was conducted before construction began. Initially, approval was given to a

Station	Construction work
	single Oedo line structure with two-strata three-span. However, in October 1989, the Shiodome Development Liaison Council decided to conduct an integral development with three-strata five-span for the underground pedestrian pathway, underground driveway, joint duct, foundation of Yurikamome and the Oedo line. Thus, the Bureau of Transportation undertook an integral work commissioned by each business operator. Two lead lines were installed on the Tsukijishijo side.
Daimon	Adopted underpinning method to be connected to Daimon station of the Asakusa line. Protective work with the JR line around JR Hamamatsucho station was commissioned and undertaken by JR East and JR Tokai.
Akabanebashi	Emergency track was installed on the Azabu-juban side.
Azabu-juban	Connected to Eidan (currently Tokyo Metro) Nanboku Line. This station is at a deep location because the Oedo line runs beneath the Nanboku line, which runs under the foundation pits of the Tokyo Expressway. A disaster provisions warehouse was built, using the upper space of the station.
Roppongi	Considering the distance between the foundation pits of the Tokyo Expressway and transfer to Eidan (currently Tokyo Metro) Hibiya line, the station has two platforms on upper and lower levels. The busy streets were on the ground level with heavy traffic and there were large buried facilities underground, which required the world's first four circular face shield method. Received the 1999 Technology Award of the Japan Society of Civil Engineering (Group I).
Aoyama-itchome	Crosses with Eidan (Tokyo Metro) Ginza line and Hanzomon line and was constructed with the underpinning method.
Kokuritsu-kyogijo	The Gaien-bashi was protected with the underpinning method, and the open-cut method was used while protecting large buried facilities. There is an emergency track on the Yoyogi side, which allowed an advance opening.
Yoyogi	The station is built under the road at the west side of the JR line, allowing easy transfer.
Kibashako	This station was planned underneath the Tokyo Kiba Park. After the park opened in April 1992, a structure consisting of two-strata ten-spans was constructed with materials being delivered from the temporal opening installed on a deck floor constructed as a foundation for the park construction.

Increase in construction costs and delay in opening

Increase in construction costs

The construction cost increased from the initial 682.6bn yen to 988.6bn yen due to difficulties in working with junctions with other railways and buried facilities, the additional installment of exit/entrance facilities and escalators which had not been included in the initial plan and improvement of services and safety, such as air-conditioning and disaster prevention measures.

Delay in opening

The loop segment was initially scheduled to open at the end of FY1996, but was postponed to 2000. The following are the major reasons for the delay:

- Commencement of work was delayed because preliminary negotiations with local people, required before the work started, took much time and securing the land for construction (Iidabashi, Ueno and Okachimachi, etc.) ran into difficulty; and

- Since the work was to be undertaken in busy business districts (e.g. Roppongi and Kita-shinjuku), there were work restrictions and removing buried facilities, protective work and negotiations on junctions took a huge amount of time.

Reduction in construction costs

The Bureau of Transportation set up the Committee on the Reduction of Subway Construction Costs in June 1995. Tokyo Subway participated in the committee, which pursued ways to reduce construction costs of the loop section of the Oedo line. Using the results of discussions as guidelines, construction cost reduction measures were implemented.

The cost reduction measures were taken at each stage of planning, design and construction. Specifically, they included revision of the pump structure, cancellation of secondary lining, adoption of new segment styles, adoption of SM materials for steel pillars, expansion of a suspension pitch to protect buried facilities, consideration for drainage, use of recharge well, and improvement of segment (expansion of the segment width and review of joint materials).

Technological characteristics

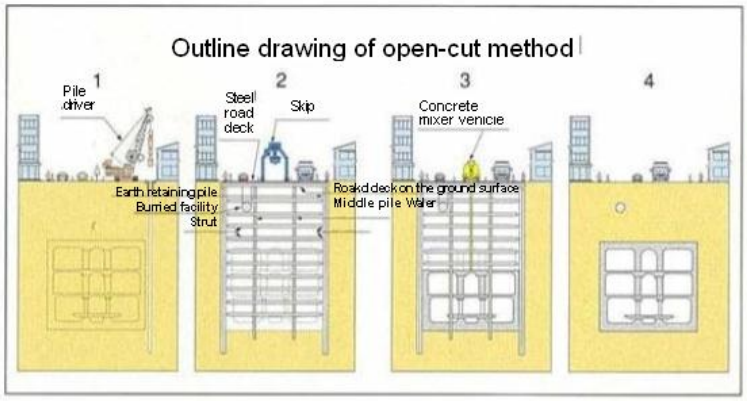
The construction of the Oedo line employed the following methods to minimise the impact on the surrounding environment and people living along the roads, giving consideration to the depth of the tunnel, geographic and soil quality in the neighbouring area, conditions of buried facilities and streets, buildings and structures along the roads.

Open-cut method

This is the most common subway construction method and was used for the construction of stations. It starts with installing earth retaining piles with sufficient depth. Then, underpinning plates are placed on the piles and covered with steel road deck so as not to hinder traffic. Then, earthwork starts, while carefully protecting buried facilities, such as water/sewage and gas pipes. When the ground is drilled to a necessary depth, a tunnel is constructed and the upper part of the tunnel is refilled to restore the road (Figure 10).

Most of the stations on the Oedo line, Takamatsu depot and Kiba depot were constructed using this method.

Figure 10: Outline of Open-cut Method



Open-cut method working site

This is the method of constructing a tunnel by assembling a circular cylinder (copper)

corresponding to the cross section of the tunnel, by driving this cylinder forward, while excavating the soil and sands, and by assembling the iron or iron concrete segment in the hole. The merit of this method is that the ground surface is not much affected and the work progresses safely. This method is often utilised for tunnels between stations.

Much of the construction of the tunnel between the stations of the Oedo line employed this method. There were other subways running and large buried facilities underneath the Roppongi and Iidabashi stations, and it was not possible to construct the stations entirely with the open-cut method, which excavates the ground. Thus these two stations were built also by using a shield method with a special shield tunneling machine (Figure 11, Figure 12).

Figure 11: Outline of Shield Method

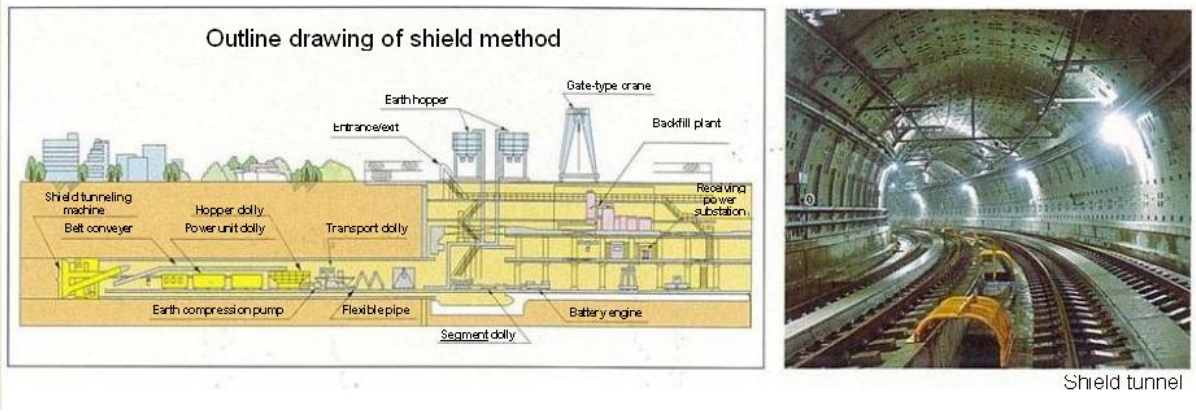
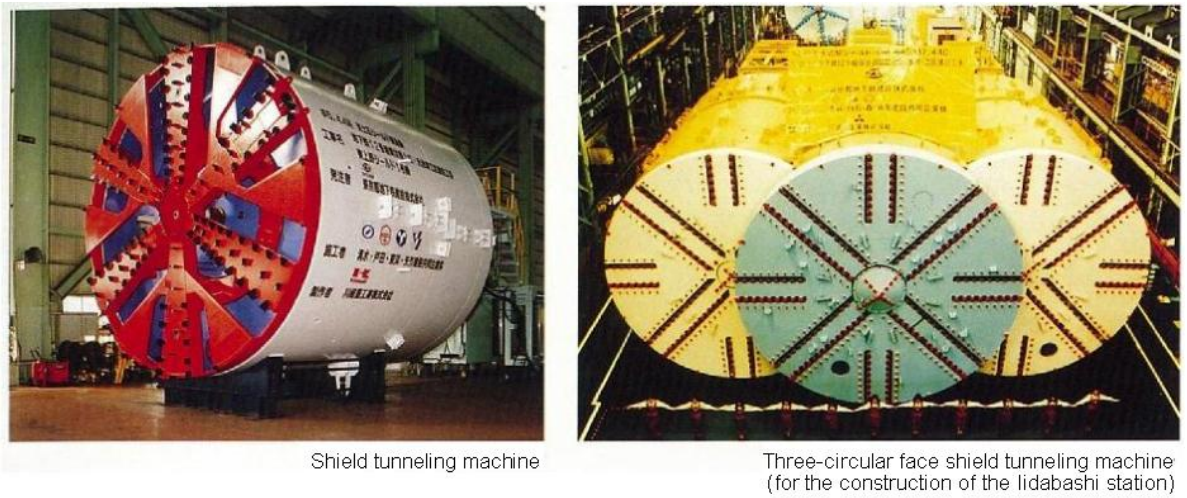


Figure 12: Shield Tunneling Machine


Shield tunneling machine

Three-circular face shield tunneling machine (for the construction of the Iidabashi station)

Caisson method

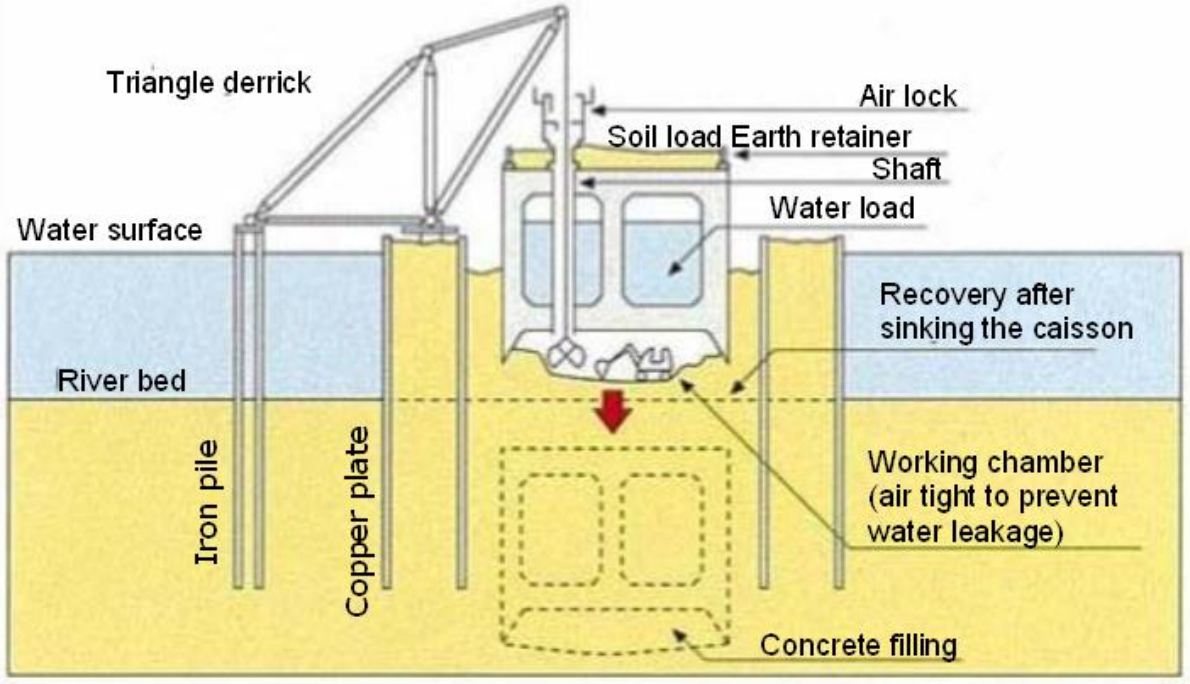
This method is used where there is a risk of water hazard, such as when running beneath a river.

First, a part of the river is land-filled to construct a structure (caisson) that would be a tunnel, and burrow at a working chamber at the bottom. Then, the caisson is lowered by using a load, such as self-weight or water, to complete the tunnel. Finally, the artificial island is removed to finish the work (Figure 13).

This method is used for the Oedo line crossing the Sendaihorikawa River, because the train

crosses the river when it departs and returns to the Kiba depot.

Figure 13: Outline Drawing of Caisson Method

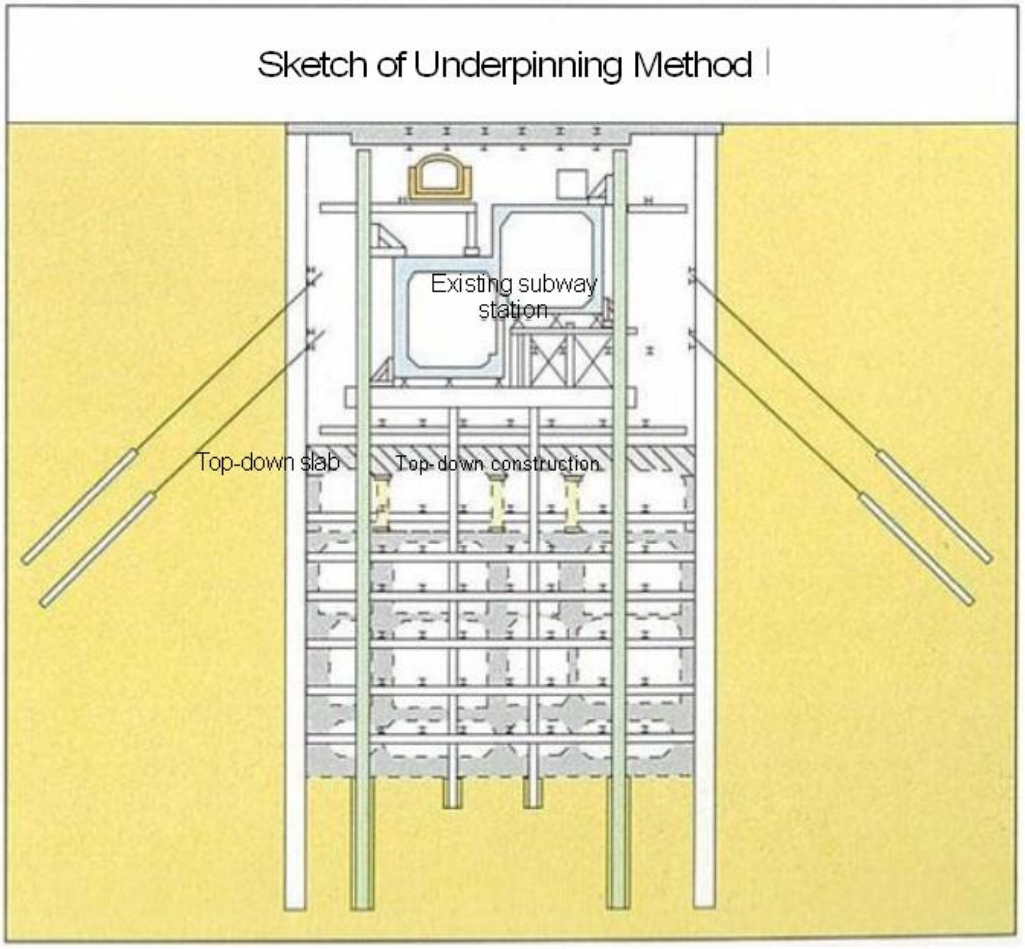


Underpinning method

When constructing a tunnel under a subway station in service, the tunnel is built by burrowing beneath the existing station while underpinning it with a jack by installing piles and beams. Then concrete is filled between the station and the tunnel to sustain the structure. This allows the construction of a tunnel without obstructing the safe operation of other trains (Figure 14).

This method was used at stations such as Daimon, Ueno-Okachimachi and Iidabashi, since these stations cross with other subways in service.

Figure 14: Sketch of Underpinning Method



Station design and amenity space

The Japan Subway Association considered the design of stations.

The Association set up the Committee for the Design of Stations of Toei Line 12 in 1987 to undertake the task. In March 1988 the committee reported the result, which recommended installing amenity space decorated with public art around the ticket gate in each station, to feature the characteristics of the area and the station and to attract popularity.

In order to enhance the character of each station, it was decided to commission the design work from a number of creative architects. The architects who would be responsible for the basic design of 26 stations of the loop section were sought through a public proposal system in September 1990. Screening meetings were held three times between December 1990 and March 1991, and 15 design offices were selected.

The station space with unique characters was made a reality based on the basic design plan of the selected design offices. The 'amenity space' using the area around the ticket gate was developed by the contribution of donor companies. Figure 15 shows the 'amenity space' in the Tsukishima station.

The station designs on the Oedo line were highly recognised. In October 2001, ten stations, Shinjuku-nishiguchi, Ushigome-kagurazaka, Iidabashi, Kasuga, Morishita, Kiyosumi-shirakawa, Daimon, Azabu-juban, Aoyama-itchome and Kokuritsu-kyogijo were awarded

with the Good Design Award, Gold Prize, from the Japan Industrial Design Promotion Organization (JIDPO), and many other awards such as Awards of the Architectural Institute of Japan.

Figure 15: Public art in the Tsukishima Station (amenity space)

Characteristics of stations and car facilities

Barrier-free measures

Based on the Guidelines for Welfare Town Development in Tokyo compiled by the Tokyo Metropolitan Government in April 1988, the Oedo line planned the installation of elevators and escalators in all stations. Slopes, double handrails, and tactile blocks for visually impaired persons were installed, enabling the elderly and disabled persons to reach the destination safely without much burden. Specific measures are as follows:

- Installation of elevators and upward escalators for access from the platform to ground level and downward escalators when placed 16m in depth distance;
- Staircases in different colors, and installation of double handrails (with Braille plate);
- Installation of wheelchair accessible ticket machines and wide ticket gates;
- Installation of tactile signs for Braille display and sound information, fare information in Braille, route information, and neighbourhood map;
- Installation of tactile guide blocks, riding location, train approaching warning display, and sound assistance for visually impaired persons; and
- Installation of wheelchair accessible water fountains and telephones, wheelchair accessible toilets (toilets for all users), baby seats and child seats.

Furthermore, cars are equipped with wheelchair stabilizers, emergency communicators, electric information billboards, and audio information in both Japanese and English.

Besides these measures, handrails were installed on the staircase walls at the platform as

measures against the wind pressure generated as the train enters the platform into a narrow station. Ample space is secured between the staircase wall and the platform edge so that a person in a wheelchair can pass by other people, improving safety.

In order to make the location of the elevator more noticeable, elevator indicator lines were installed in Ueno-okachimachi and Aoyama-itchome stations in March 2001, followed by other stations. In March 2002, in-train Braille stickers were installed on each door of all trains, indicating the car and door numbers. Figure 16 shows some of these measures.

The results of the 'Study on the Social Effect of Barrier-free Facilities Found in the Case of the Full Operation of the Oedo Line' conducted by the Ministry of Land, Infrastructure and Transport was released in November 2001. The study indicates various social effects of barrier-free facilities of the Oedo line: increased opportunities for free outings, activated consumption activities, expansion of employment opportunities and change in awareness of disabled persons.

Figure 16: Barrier-free measures

Air-conditioning/ information facilities

All cars and all stations on the Oedo line have been fully air-conditioned since its start in 1991. At the same time, AM radio can be heard on all trains and stations through re-transmission of radio waves.

The station building has plenty of information displays, including information on building facilities, neighbourhood maps and entrance/exit signs. An information sign to indicate the location of the station was installed on the ground level of the station as a result of discussions between the Bureau of Transportation and the road administration. Since the start of the service between Kokuritsu-kyogijo and Shinjuku in April 2000, bus transfer information has been provided in the station buildings and bus stops by the station. 'Mobile signs' and shared information signs with Eidan (currently Tokyo Metro) installed at the entrance/exit of stations indicate the location of stations.

Installation of bicycle parking lots and disaster provisions warehouse

The Oedo loop line runs underneath urban facilities, including existing train tracks. Since the subway station facilities are enough with two-three-strata structure, various discussions had been held for an effective use of the upper space of the subway. As a result, underground bicycle parking lots and disaster provisions warehouses were installed.

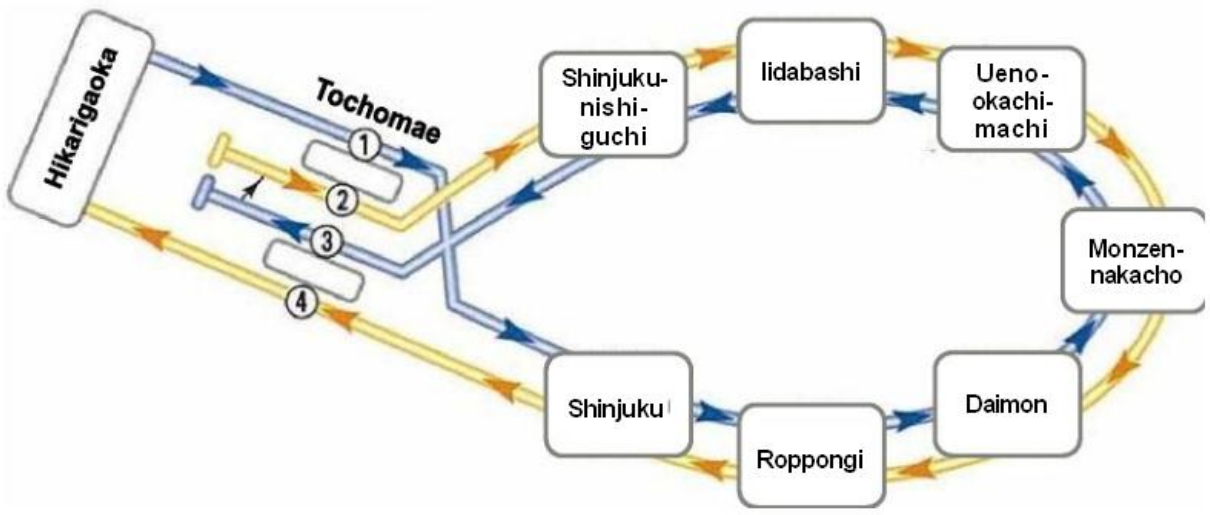
Underground bicycle parking lots were discussed from the viewpoints of demand and construction costs, and were installed in eight stations: Kasuga (Ministry of Land, Infrastructure and Transport), Ueno-okachimachi (Ministry of Land, Infrastructure and Transport), Shin-okachimachi (Taito ward), Morishita (Koto ward), Kiyosumi-shirakawa (Koto ward), Tsukishima (Chuo-ward), Kachidoki (Chuo-ward) and Tsukijishijo (Chuo). The construction of the six ward facilities was undertaken by the Bureau of Transportation and the facilities were opened at the same time as the loop line.

Underground disaster provisions warehouses were built in Kiyosumi-shirakawa and Azabu-juban stations, which constitute a Toei Line 12 disaster prevention network by utilising the disaster-resistance transportation capability of subways. The size of the warehouses is 775m^2 in Kiyosumi-shirakawa and 1,375m^2 in Azabu-juban.

Overview of the operation of the Oedo line

The Oedo line runs from Hikarigaoka to Tochomae, then through Daimon, Monzen-nakacho, Ueno-okachimachi, Shinjuku-nishiguchi, comes back to Tochomae, and returns on the same route at Tochomae back to Hikarigaoka, thus operating a route that looks like a letter 6 lying on its side (Figure 17).

Figure 17: Operation System of the Oedo Line



The operation system is called ‘A track’ and ‘B track’. The A track starts from Hikarigaoka, travels a circle from Tochomae via Shinjuku, Roppongi and Iidabashi, and terminates at Tochomae. The B track turns back at Tochomae and reverses the same route back to Hikarigaoka.

The operation interval is four minutes during morning rush hours, six minutes during the day and five minutes in the evenings on weekdays, and six minutes all day on Saturdays and holidays. The train consists of eight cars and 53 trains, with 424 cars in service.

The travel time for the Hikarigaoka – Roppongi – Daimon – Tochomae section is 81 minutes and for Tochomae – Roppongi – Daimon – Tochomae is 59 minutes.

Development of the facilities required for the operation of the Oedo line

Improvement of the Magome depot

The Magome depot had long been used since the opening of the Toei Asakusa line in 1969 and needed to be rebuilt due to aging. In the meantime, daily inspections for the Oedo line were conducted at Kiba and Hikarigaoka depots, which needed to be re-developed to meet an increase in cars due to the full operation of the line. However, the Oedo line mainly runs through central Tokyo and it was difficult to secure a depot plot along the line.

Meanwhile, the downsizing of the depot facility was made possible for the following reasons:

- Reduction of maintenance works through introduction of new cars;
- Revision of effective inspections;
- Extension of the interval of essential parts inspections and overall inspections;
- Adoption of a line inspection system.

Thus, the Magome Depot Development Plan was formulated to build a new factory at the Magome Depot Base to realise integrated inspections on cars of both Asakusa and Oedo lines.

Details of construction of the base

For the renewal of the Magome depot and the construction of the Oedo line depot, in order to build a depot base with comprehensive functions integrating the existing Magome inspection plant for the Asakusa line and a depot for both Asakusa and Oedo lines, facilities for the inspection plant was realigned and a comprehensive administrative building and car factory built.

Since the cars of the Oedo line adopt the linear motor system, a Shiodome connection track was installed between Shimbashi station on the Asakusa line and Shiodome station on the Oedo line, with out-of-service trains towed to the Magome Depot Base using an electric engine.

Characteristics of a new depot (Line Inspection System)

The conventional inspection was conducted on each part of a set of trains after disconnecting each car, and separating and temporarily placing the passenger part and driving part by a crane. At a new plant, they are not divided or temporarily placed, but each inspection machine is set on an inspection line for the entire set of a train for a line inspection and maintenance in a given time, which reduces the time for inspections on essential parts and overall inspection, as well as the size of the plant.

Construction process

The construction work was carried out from 2000 to 2003 in Phase 1 and Phase 2.

Phase 1 Construction (May 2000 – February 2002):

- Construction of a new general administration building, material storage and warehouse and work on outer channel;
- Dismantling of the existing general administration building, canteen and warehouse and removal of retained tracks.

Phase 2 Construction (November 2002 – December 2003)

- Construction of new car plant, re-development of tracks and construction of outer channel;
- Implementation of ex-post environmental assessment study.

Operation after the completion of work

Inspection plant: functions as an inspection plant for the Asakusa line (daily inspection, car wash, retention)

Car plant: functions as a car plant for both Asakusa and Oedo lines (essential parts and overall inspection)

The Shiodome connection track has been installed to retreat the not-in-service train of the Oedo line. The Shiodome connection track is described in the next section.

<u>Shiodome connection track</u>

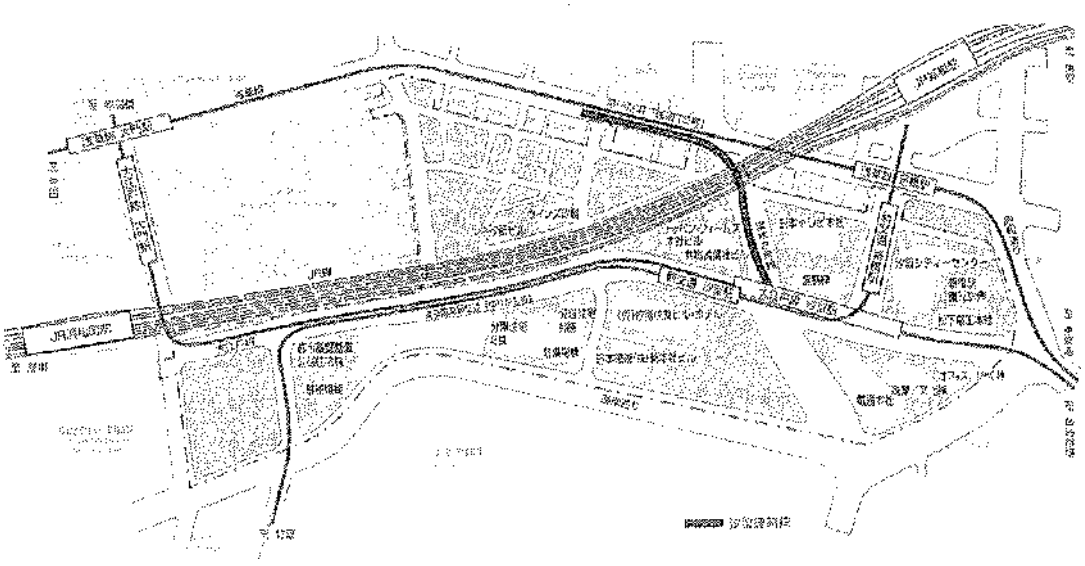
Outline of the facility

It was decided that the trains on the Oedo line would be inspected in Magome on the

Asakusa line. However, since the Oedo line adopts a linear motor system, it cannot travel on the track of the Asakusa line. Thus, the train needs to be connected to a special electric engine at a retreating track of Shiodome station, towed on the Shiodome connection track and within the Asakusa line to the Magome depot.

The Shiodome connection track has a single-track, box-shaped tunnel of 450m in length, and its route starts from the Oedo Shiodome station, crosses underneath the elevated railway tracks of the Tokaido Shinkansen, Keihin Tohoku and Yamanote lines, continues towards Daimon for about 200m along the National Highway 15, then merges into the Asakusa line (Figure 18).

Figure 18: Location of the Shiodome Connection Track



Construction plan

The Shiodome connection track was identified as part of the Oedo loop line, constructed by Tokyo Subway and transferred to the Bureau of Transportation. Tokyo Subway constructed about 134m in the Shiodome district, whilst the 248m that runs along and connects to the Asakusa line was constructed by the Bureau of Transportation, and about 73m of elevated interchange with the JR line was constructed by JR East and JR Tokai.

Shiodome (Sio-Site) station opened on 2 November 2002, two years after the start of full operation, in accordance with the progress of urban re-development in the vicinity.

Shiodome station is located in the centre of the redevelopment area targeting the former National Railways' Shiodome Freight Terminal and its vicinity. A series of high-rise building complexes with offices, stores and hotels has been constructed. The station is also connected to Yurikamome station of Tokyo Waterfront New Transit, serving as an important public transportation connection between central Tokyo and the waterfront area.

An average of 10,600 passengers per day had been expected at Shiodome station. About 20,000 people have been using this station in recent years. With the opening of Shiodome station, the train schedule of the Oedo line was revised to increase the number of train services.

Pathway between Shimbashi station and Shiodome station

The road of 175m length and 40m width from Shimbashi station front to Shiodome station on the Oedo line was included in the Shiodome Land Readjustment Programme.

The road, in a three-tier structure, facilitates smooth access to the Shiodome area and effectively uses space, including underground. The New Transit Yurikamome runs on the upper deck, there is a pedestrian deck leading to each block, and the underground floor is a road exclusively for pedestrians.

The project was carried out by the Bureau of Construction as part of the Land Readjustment Programme. Of the underground pedestrian pathway, about 73m connected to the Supplementary Road 313 was built by the Bureau of Construction, and the central section of about 86m and the section of about 16m connected to the Asakusa line were built jointly by Tokyo Subway and the Bureau of Transportation. With respect to facilities, about 159m, including the part built by the Bureau of Construction, was carried out by Tokyo Subway and the section connected to the Asakusa line was carried out by the Bureau of Transportation. The underground pathway connects the Shimbashi station of the Asakusa line, the JR line, and the Eidan Ginza line with Shiodome station on the Oedo line as well as with each commercial block, creating a comfortable and attractive pedestrian space.

D PROJECT TIMELINE

Year	Month	Key Decision/Event
1972	March	Identified as one of the lines to be constructed in the Tokyo Metropolitan High-speed Railway Network Development Plan (Report No. 15) compiled by the Urban Transportation Council.
1973		The First Oil Shock.
1974	August	Tokyo Metropolitan government obtained the license for the section between Nishi-shinjuku (currently Tochomae) and Takamatsu-cho (currently Hikarigaoka) of the Toei Line 12 (currently Oedo line).
Around 1975		The plan was temporarily frozen due to the deterioration of Tokyo's financial conditions and slowdown of population growth and industrial concentration.
1978	May	The Council for the Measures against Transportation Problems in Tokyo recommended in the Measures for Stability and Development of Toei Transportation that "the new line should be constructed upon considering line locations, structure of transportation means, economic efficiency, subsidies systems and other factors by performing demand projections for of transportation once again".
1981	February	Establishment of the Liaison Council for Promotion of Toei Line 12, comprising eleven ward-mayors.
1982	December	The development of the radial section (Tochomae – Nerima – Hikarigaoka) was included in the Long-term Plan of Tokyo.
1984	August	Changes made to the Urban Plan (includes Nerima – Hikarigaoka, Takamatsu depot).
1985	July	Transport Policy Council Report No. 7 (addition of the section between Hikarigaoka and Oizumi-gakuencho).
	August	Approval for Phase 1 construction of the section between Nerima and Hikarigaoka (small scale specification, civil engineering, Ministry of Transport).
	September	Resolution passed to move the Tokyo Metropolitan Government building.
1986	February	Approval for underground facility work on the section between Nerima and Hikarigaoka (Ministry of Construction).
	April	Establishment of the Investigation Committee on Tokyo Metropolitan Subway Construction and Operation.
		Prototype car of the Oedo line was completed and made public.
	June	Start of construction of the section between Nerima and Hikarigaoka.
		Magenta chosen as the colour of the line.
	November	The Second Long-term Plan of Tokyo listed the completion of the loop section (Tochomae – Shinjuku) between 1995 and 2005 as a long-term goal.
1987	March	Final report of the Investigation Committee on Tokyo Metropolitan Subway Construction and Operation.
	April	Establishment of the Headquarters for Promoting the Construction of Toei Line 12 with the Governor of Tokyo as the director.
	October	The Headquarters for Promoting the Construction of Toei Line 12 released the basic policies for the construction of the loop section.
	November	The construction of the loop section was specifically mentioned in the Tokyo Metropolitan Comprehensive Implementation Plan.
1988	May	Test ride of an iron ring-type linear motor car system.
	July	Establishment of a third sector organization, Tokyo Metropolitan Subway Construction Co., Ltd., which is the main construction body for the loop section.

Year	Month	Key Decision/Event
	December	Decision made by the Headquarters for Promoting the Construction of Toei Line 12 to adopt a linear motor car system.
1989	May	Tokyo Metropolitan Subway Construction Co., Ltd. acquires a license as a third class railway enterprise for the section between Nishi-shinjuku (currently Tochomae) and Shinjuku.
	November	Release of Environment Assessment Report for the section between Shinjuku and Nerima (Tokyo Metropolitan Government Notice No. 1145).
1990	February	Approval of construction work on the section between Shinjuku and Nerima (Ministry of Transportation).
		Change in urban planning (between Shinjuku and Nerima) Tokyo Metropolitan Government Notice 157.
		Approval of underground facility work on the section between Shinjuku and Nerima (Ministry of Construction).
	June	Approval of construction work on the section between Shinjuku and Nerima (Ministry of Transportation) (excluding the section of the Loop Road No. 6).
1990	August	Start of construction of the section between Shinjuku and Nerima.
1991	January	Approval of construction work on the section between Shinjuku and Nerima (Ministry of Transportation) (Loop Road No. 6).
	April	Approval of construction work on the section between Nishi-shinjuku (currently Tochomae) and Shinjuku (Ministry of Transportation).
	May	Change in urban planning (loop section between Nishi-shinjuku (current: Tochomae) and Shinjuku) Tokyo Metropolitan Government Notice No. 567.
	May	Approval of underground facility work on the section between Nishi-shinjuku (currently Tochomae) and Shinjuku (Ministry of Construction).
	December	The segment between Nerima and Hikarigaoka began operation.
1992	February	Start of construction of the section between Nishi-shinjuku (current: Tochomae) and Shinjuku.
	March	Approval of the construction of the section between Nishi-shinjuku (currently Tochomae) and Shinjuku (Ministry of Construction) (excluding Shiodome area).
	August	Approval of the construction of the section between Nishi-shinjuku (currently Tochomae) and Shinjuku (Ministry of Construction) (Shiodome area).
1997	December	Opening of the section between Shinjuku and Nerima.
1998 -1999		Pilot operation of IC Card.
1999	December	The name of the line was decided to be the Oedo line by the Committee for Selecting the Name of Toei Line 12.
2000	January	Transport Policy Council Report No.18 identified that the extension of the line from Hikarigaoka to Oizumi-gakuen should start construction by around 2015.
	April	Opening of the section between Shinjuku and Kokuritsu-kyogijo.
	December	Full line opening.
2002	November	Opening of Shiodome station.

Figure 19: location of each station (Radial Section)

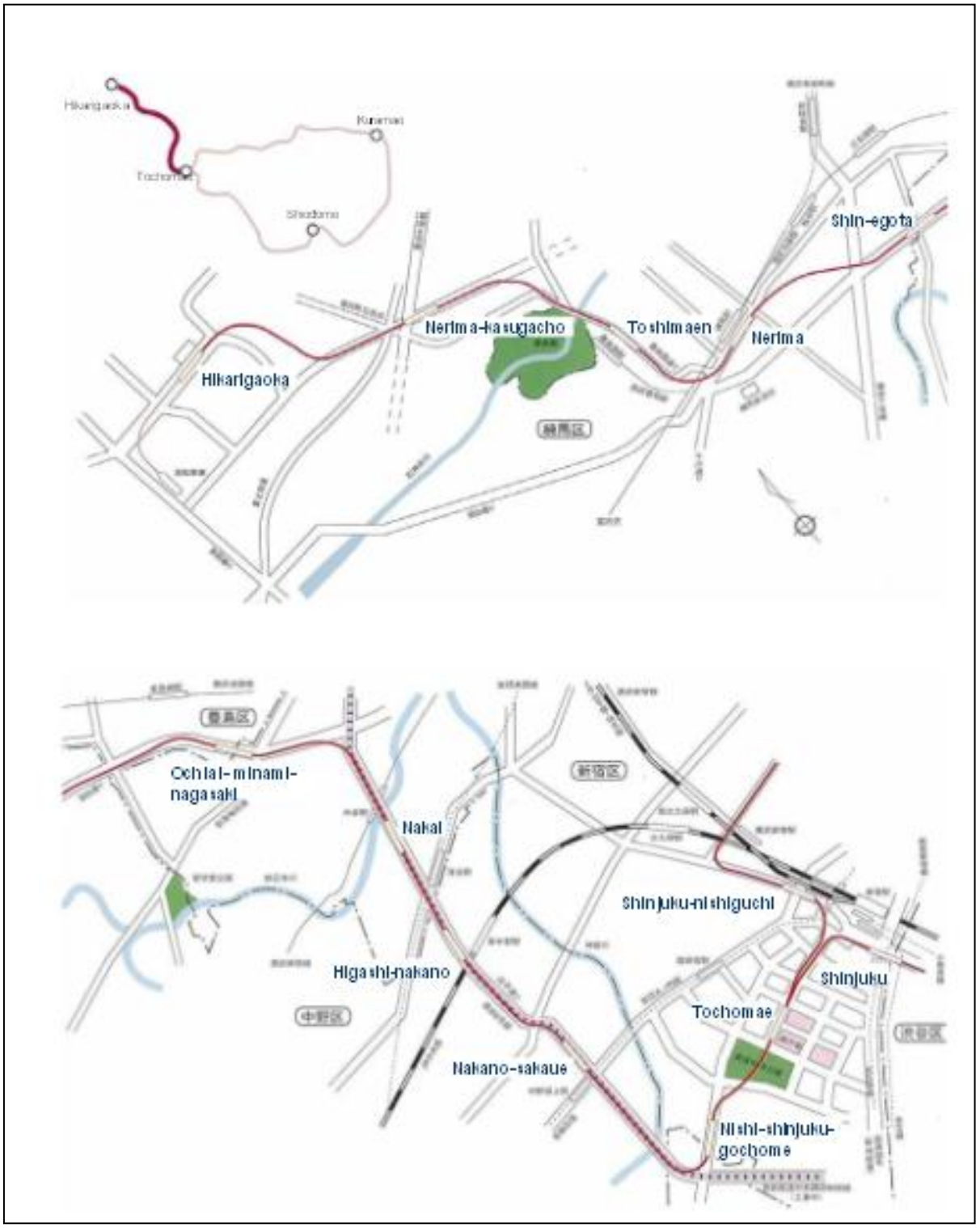


Figure 20: location of each station (Loop Section/ Shinjuku – Shiodome)

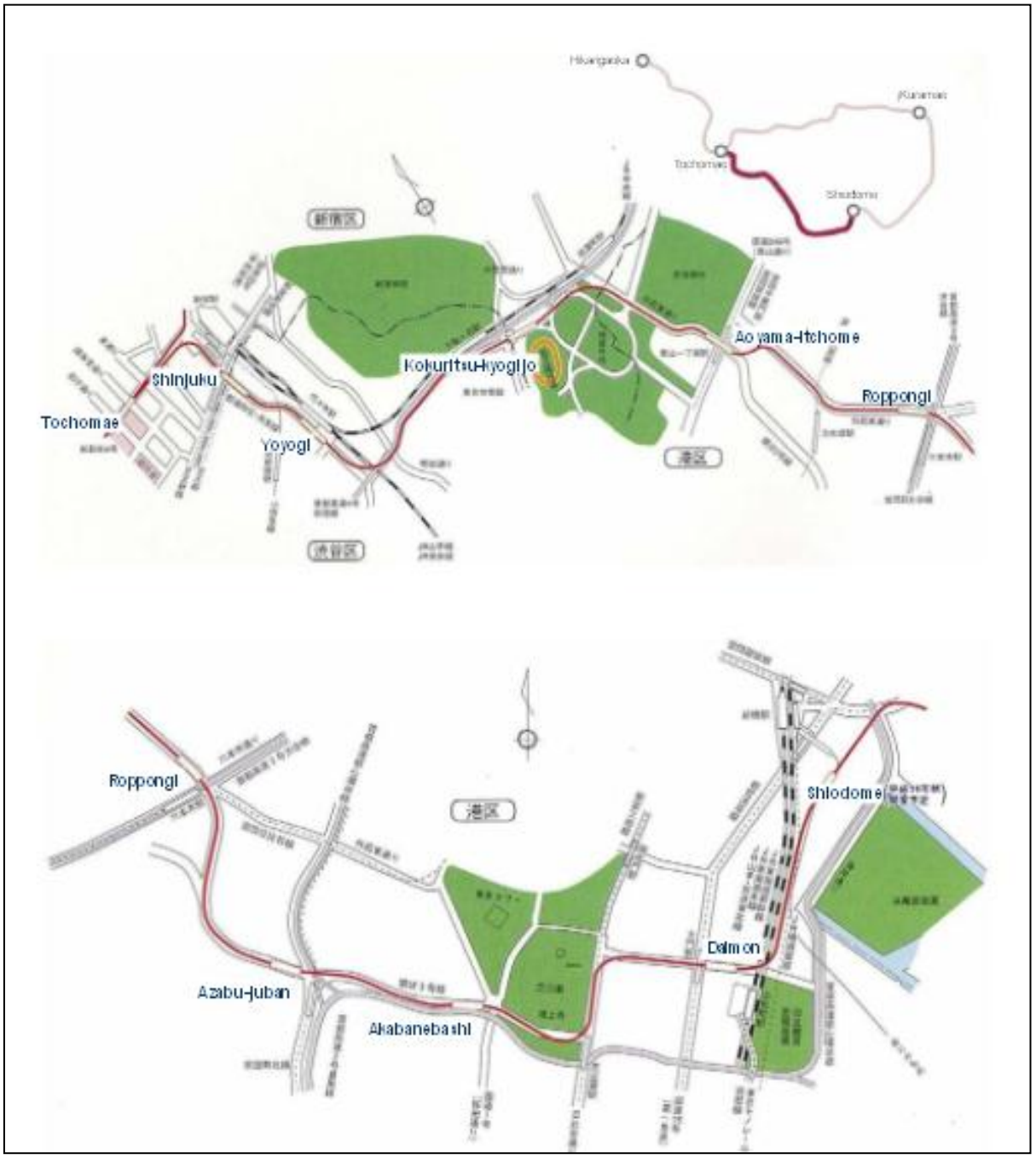


Figure 21: location of each station (Shiodome – Kuramae)

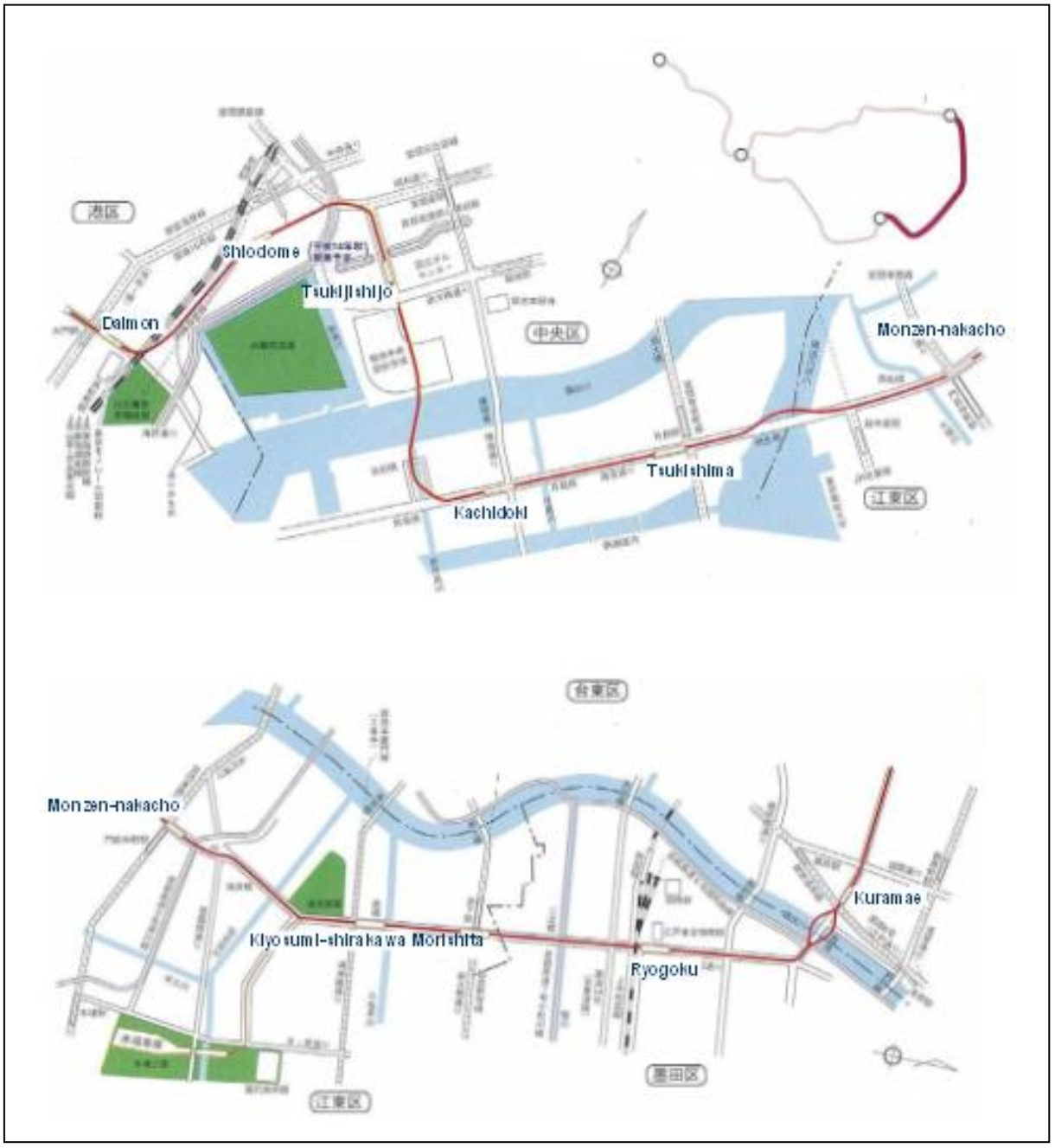
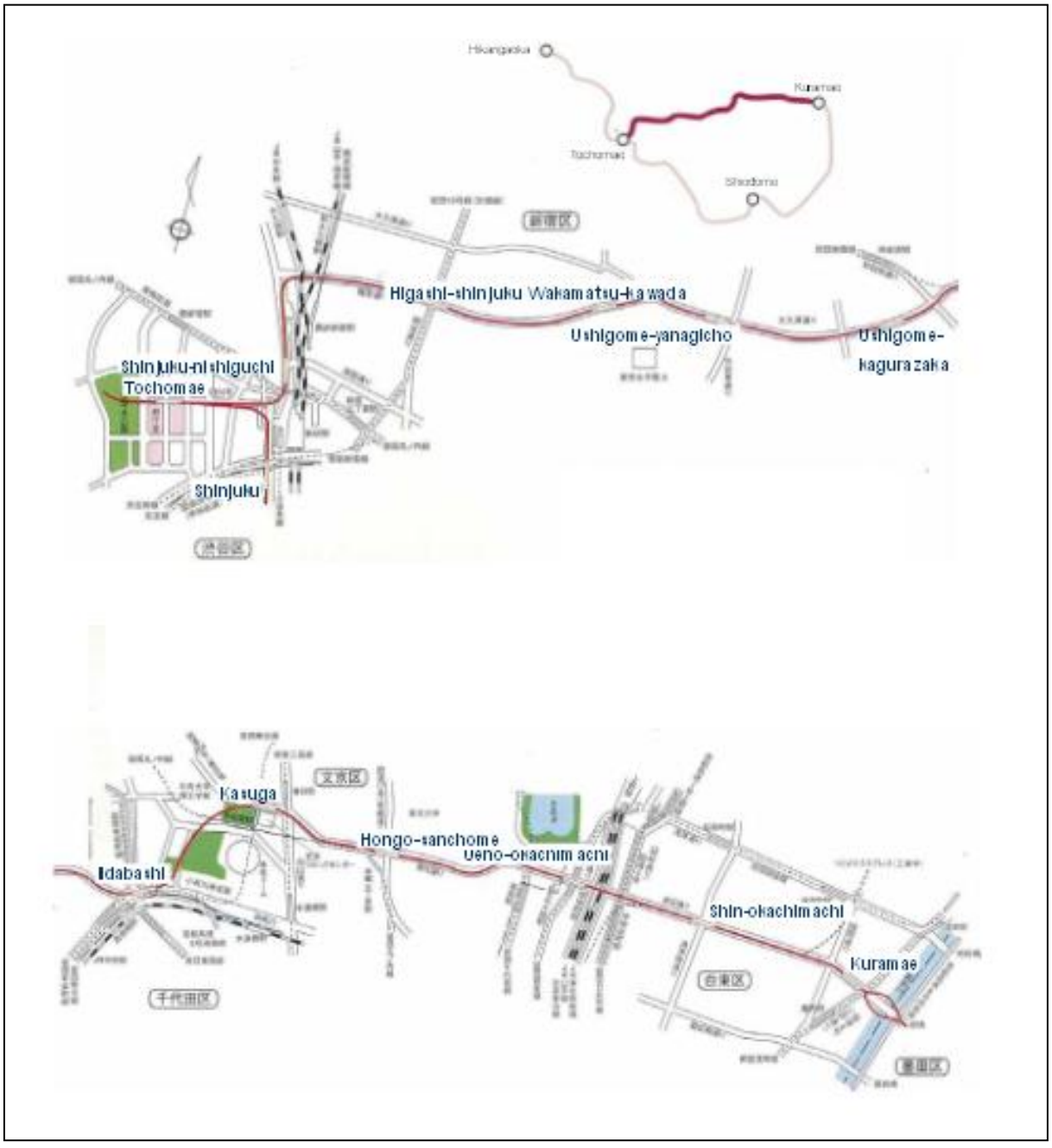


Figure 22: location of each station (Kuramae – Tochomae)



E PROJECT FUNDING/FINANCING

Role of demand projection

The Investigation Committee made recommendations on the construction of the Oedo line in 1987.

It is fair to state that the actual construction was carried out in accordance with these recommendations.

The revised demand projection contained in the recommendations had a great impact on the progress of the project. The method of demand projection of the Investigation Committee categorised users into the following five groups and the demand of each group was projected using the latest data of that time.

1 New users transferring from existing lines;

2 Passengers due to an increase in the night-time population and working population along the line (excluding 3 and 4);

3 Passengers due to large development projects in progress or planned;

4 Passengers due to regional development effects (increase in floor area along the line promoted by the construction of the Oedo line);

5 Passengers due to induced effects (increase in the rate of railway use induced by the construction of new stations).

The outline of the demand projection is explained below.

Number of users

As shown in Table 3, the total number of users per day was projected to be 985,000 at the time of opening (end of FY1996), increasing by 23% to 1,213,000 in ten years and to about 1,300,000 in 20 years, using the data on the existing lines as a reference.

These figures are equivalent to 24,000 passengers per operation-kilometres, at the time of opening and 30,000 in ten years' time, exceeding the average passenger numbers of the existing Toei lines (21,000 passengers in FY1985) at the time of opening and becoming nearly equal to the average number of passengers of the entire subway network including the Eidan (current Tokyo Metro) lines (32,000 passengers in FY1985) in ten years' time.

The following four factors are listed as reasons for such an increase in passenger numbers:

1 The Oedo line runs through existing urban areas in Tokyo and there is already a large demand for transport;

2 There would be many transit passengers when the Oedo line is connected with existing and planned lines;

3 Feasible large development projects are in progress or planned along the Oedo line, such as in Hikarigaoka, Shinjuku, Shiodome and Okawabata;

4 The construction of the Oedo line would promote redevelopment projects in each area along the line (regional development effects).

As described above, the demand projection is greatly influenced by various conditions, such as development of planned lines connected to the Oedo line, convenience of transfer, and redevelopment projects in the areas along the line. It was pointed out that it was necessary to meet these conditions in order to ensure the projected number of passengers.

Table 3: Projection of passengers of Line 12 (per day)

(Unit: 10,000 people, 10,000 people/km, %)

Projection Target Fiscal Year	Total passengers			Passengers per operation kilometres
	Regular	Non-regular	Total	
Opening (FY1996)	58.8	39.7	98.5	2.4
In ten years (FY2006)	70.9	50.4	121.3	3.0
Rate of increase in ten years	21	27	23	23

(Note) Calculated based on 'FY1980 Transportation Census of Urban Cities', 'Estimate of Daytime Working Population (published in 1985)' and other data

Most crowded section and transport capacity

The most crowded section of the Oedo line during the morning rush hours was projected to be between Nakai station and Higashi-nakano station on the radial section, both at the time of opening and ten years later, and one-way passenger flow of one hour peak time was estimated to be 25,000 and 26,000, respectively.

On the other hand, the maximum transport capacity of the small cars of the line was estimated to be 40,000 people per hour when the congestion rate is 180% (people can read a newspaper but with body contact), so there is ample space and the line was thought to be able to meet a future increase in passengers.

Based on the demand projection, the cars were made smaller and the route change was made possible. This demand projection has great significance since it led to the construction cost reduction, full line opening and increase in user numbers.

Estimates of investment effects

The construction of the line is thought to have brought about various direct and indirect effects to the local area and people. Together with the demand projection mentioned above, the Investigation Committee performed a quantitative cost and benefit comparison in 1988.

The Investigation Committee categorised investment effects generated by the construction of the line into construction effect (economic ripple effect at the construction stage) and operation effect (at the operation stage), and further broke down the operation effect into effect on users (direct operation effect) and effect on the local area (indirect operation effect).

The direct operation effect is regarded as time reduction and indirect effect as the change in floor area as a local development effect.

Investment effects generated by the construction of the line:

- Construction effect (economic ripple effect at the construction stage);
- Operation effect:
  - Direct operation effect: time reduction effect (effect on the users of the line);
  - Indirect operation effect: Regional development effect (effect on the area along the line).

An outline of the effects that had been measured and obtained by the Investigation Committee is given below.

Construction effect

Construction effect is an expansion effect induced by the investment injected for the construction of the line, which includes an expansion of production, income and employment.

The investment in the construction of the line primarily induces a chain of demand in various business sectors, increases production and raises income (direct effect). The income increase secondarily expands consumption, which brings about a circle of increase in production, leading to increase in income, hence to increase in consumption, resulting in economic expansion (overall effect).

This is the economic ripple effect of investment in the construction of the line. Table 4 shows the direct effect and the overall effect of 759bn yen, which is obtained by deducting the land-related cost from the total investment of 849bn yen.

Table 4: construction effect of Line 12 (amount of investment: 759bn yen)

(Unit: 100m yen, 1,000 people)

Classification	Induced production	GNP	National income	Employment increase
Direct effect	(2.18) 16,519	6,532	5,036	132
Overall effect	(4.16) 31,580	14,199	10,948	282

Note 1: The figure in the bracket indicates the induced production coefficient.
Note 2: The 1984 Nikkei Industrial Input Output Table (extrapolation table) was used for measurement.
Note 3: The measurement period is eleven years from 1986 to 1996; the figures in the table are the sum of this period.

Looking at the whole of the construction effect, the construction of the line induces production worth about 3,200bn yen on the national base, which is 4.16 times the investment (759bn yen) and generates national income of about 1,100bn yen.

Furthermore, a total of 280,000 jobs would be created. An annual average increase in employment opportunities of 26,000 is quite significant when considering the fact that more than 1.5m people, affected by slow economic growth, are now wholly unemployed in Japan (Labour Force Survey of the Ministry of Internal Affairs and Communications, 1985).

Under today's economic situation, which requires domestic demand expansion, investment

in the construction of the line, by generating such economic effects, would contribute greatly to the national and regional economy.

Direct operation effect (time reduction effect)

Users' benefits from the line (direct operation effect) include reduced fares, increased safety and increase in comfort and certainty, among others. Time reduction effect was measured in this section.

The time reduction effect means the reduced commuting time when the line is used instead of existing means of transportation.

As mentioned above, the number of passengers per day at the time of opening was expected to be 985,000. When the reduced time per day is measured using this figure, it is 75,491 hours as Table 5 shows.

If users use these reduced hours for work, a certain income would be created for the users. This is small for each individual user, but as a whole, it would create 170m yen a day (62.2bn yen a year), and this effect should not be overlooked.

Table 5: time reduction effect

At the time of full opening/day	Number of passengers	Reduced time	Money equivalence
	985,000	75,491 hours	170m yen

Note 1: Subjects are passengers with the benefit of time reduction among all passengers obtained from the demand projection.
Note 2: Money equivalence is obtained by multiplying the reduced time by the average wage per work hour of 1985 (2,259 yen) (from 1986 Labor and Economic Statistics Year Book of Tokyo), using the income approach.

Indirect operation effect (regional development effect)

The operation of the Oedo line is believed to promote the development of the area along the line coupled with the development of other lines, roads and other necessary public facilities under plan. As a method to quantify the regional development effect of the line, changes in the floor area would serve as an index, focusing on the fact that the construction of a new line generally increases the night-time population or working population, which increases the floor area and advances the land use, based on the cases of the existing lines.

The target areas of the measurement were the vicinities of 38 stations on the line (areas within a 500m radius) covering 3,000ha, which accounts for 5.4% of the area of Tokyo's 23 wards. For measurement of changes in floor area, the following factors were taken into consideration.

- Characteristics of the district and direction of development of each station area;
- Buildable area and feasibility of renewal of existing structures;
- Railway conditions;
- Presence of urban re-development plans and road expansion plans, etc.;
- Cases of other similar stations;
- Other.

Changes in floor area

As Table 6 shows, the station areas mentioned above had 2,715ha of floor area in private buildings as of 1986, and this was expected to increase to 3,450ha in 2006 (ten years after the full opening of the Line), an increase of 735ha (27%), except for large projects in Hikarigaoka, Shinjuku (the new Metropolitan Government building), Shiodome, and Okawabata.

Assuming the floor area ratio remains the same, the area sufficiency to the floor area ratio would increase by 12 points from 46% to 58%.

Table 6: changes in floor area of the station areas of Line 12 (Units: ha, %)

Classification	1986	2006	Increase
Floor area	2,715	3,450	(855) 735
Area sufficiency to the floor area ratio	46	58	12

Note 1: The floor area does not include public buildings or large projects in Hikarigaoka, Shinjuku (new Metropolitan Government building), Shiodome and Okawabata (estimation: 281ha).
Note 2: The increase of the floor area of 735ha is a net increase, and the figure in the bracket is calculated on a construction start basis.

Significance of the increased floor area

The Investigation Committee pointed out that attention must be paid to the following three points in terms of the significance of increased floor area in the areas along the line (regional development effects).

First is the contribution of the line to the realignment of the urban structure. An increase in the floor area of the areas along the line, including sub-centres, such as Shinjuku, Ueno/Asakusa, means progress and vitalisation of re-development of these areas and indicates the effect of alleviating demand for floor area in the city centre. It was pointed out that this proved that the line is one of the very important projects contributing to the balanced development of each area of Tokyo and to the re-structuring of Tokyo into a multi-centered city.

The second point is the contribution to the expansion of domestic demand. As mentioned earlier, the line has a construction effect and contributes to the expansion of domestic demand through an increase in floor area in the areas along the line. When the amount of construction investment to the increased area in the areas along the line is calculated on a construction start basis (855ha), it is estimated to be 1,600bn yen in 20 years from 1986 to 2006, indicating a huge economic effect.

(Note) The breakdown of the increased floor area of 855ha on a construction start basis is 272ha of housing floor area and 583ha of office floor area. To estimate the amount of construction investment, the construction unit value was set at 500,000 yen/3.3m^2 for housing floor and 700,000 yen/3.3m^2 for office floor.

The third point is the ensured number of passengers of the line. The line generates its own passengers through the regional development effect. The number of increased passengers from this was calculated to be 113,000 people a day in FY2006, which accounts for 9.3% of the total number of passengers a day (1,213,000 people).

The ex-post evaluation of this cost-benefit analysis has yet to be performed; however, it is clear that the results of the projection supported the implementation of the project.

Construction body and operation body

Consideration for the issues of the loop section

A huge amount of construction funding was required in a short period of time for the construction of the loop section, which allowed various forms of fund procurement. Also, since some of the work was expected to be difficult and the work load was heavy, it was necessary for a construction body to be flexible in securing construction workers and executing the project.

Meanwhile, an operation body which assumes management after completion of construction needed to not only be able to conduct effective and flexible operation, but also be eligible for subsidies from central and Metropolitan governments (general account) in pursuit of the stabilisation of future operation.

The Investigation Committee made recommendations for the construction and operation bodies with consideration of the status of regional public corporations, relations with existing lines and active utilisation of private vitality. And the project proceeded mostly according to the recommendations.

The outline of the details of considerations for the construction and operation bodies of the loop section is described below.

Situations of construction and operation of railway projects in around 1988

With respect to railway operations in large cities, Japan National Railway (currently JR), private rails and public rails have played an important role as public transportation systems in large cities; in addition to that, there is the Eidan subway (currently Tokyo metro) in Tokyo metropolitan area.

In nature, railway operation is a labour intensive industry and a competition principle can be applied to the transportation market; therefore, it is generally desirable for it to be run by a private body capable of effective and flexible management. However, private management is not suitable for the subway business because the construction investment is huge and the gestation period of capital is long. Thus, the subways had basically been constructed and operated by public corporations under the principle that municipal governments are responsible for public transportation.

However, it is inevitable that these public corporations or state-owned corporations such as National Railway are influenced by political considerations and management responsibility gets unclear since the term of executive offers is short, which may cause lax or even reckless management practices, incurring huge deficits which management often struggles to deal with.

Thus, in order to actively utilise private vitality in railway business, each municipal government was promoting a third sector system as a joint project between public and private sectors.

This system incorporates effective management practices of the private sector and intends to inject various forms of funds and technologies into the railway business in an attempt to attain sound management. This project indicates one such attempt to integrate private

sector resources into regional administration.

Comparison between public management system and third sector system

Possible options for the construction and operation bodies of the line include the public management system (Bureau of Transportation), third sector system and combined system. The following show the advantages and disadvantages of the public management system and third sector system.

Table 7: comparison of public management and third sector systems

Classification	Public Management System (Bureau of Transportation)	Third Sector System
Fund procurement	Possible to procure stable long-term low interest funds. Borrowing requires approval of the Minister of Home Affairs within the framework of local bond scheme.	Possible to use various private funds and to absorb development profits, but conditions for issuance are less advantageous than local bonds and long-term fund procurement is difficult.
Public subsidy	Current subway construction subsidy system is applied, but affected by national fiscal conditions.	It is difficult to apply the current subway construction subsidy system as it is, which requires the creation of a new system.
Construction capacity	Construction is possible by improving business, such as expansion of design outsourcing and accepting temporary workers, and possible to utilise accumulated technologies and experiences.	It is possible to adopt private vitality, such as ensuring human resources, and to reduce construction costs through construction of combined buildings and advance land acquisition. Execution of budget and implementation of construction can be done with flexibility, but requires measures for workers after the completion of construction.
Business management	Contributes to the strengthening of the business foundation of the existing Toei lines and it is possible to take effective and flexible measures for employees of a whole Toei transport network. On the other hand, it lacks management efficiency in terms of payroll system and flexible management, such as introduction of incidental business under the current law.	It is possible to introduce a payroll system and the number of employees at the same level as private sector, in an attempt to conduct effective management, and to adopt multilateral and flexible management, including incidental business.
Transfer fare	Aggregate fare with existing Toei lines.	Fare system becomes complicated due to ternary management.
Passenger convenience	While transfer to existing Toei lines becomes easier and transfer discount fare with a Toei bus can be adopted more easily, fares may rise.	Higher-quality services can be provided than under public operation and the fare may be lower than existing Toei lines; however, there will be double ticket gates, which sacrifices the convenience of transfer.
Taxation	Corporate tax, corporate inhabitant tax, corporate enterprise tax, fixed asset tax, and city planning tax will not be levied.	Corporate tax, corporate inhabitant tax, corporate enterprise tax, fixed asset tax, and city planning tax will be levied.

Construction body

- Ideal state of a construction body

The loop section greatly contributes to the formation of a new transport network and elimination of inaccessible areas in Tokyo, as well as to vitalisation of the areas along the line, and is an important and essential subway for urban creation that aims for the balanced development of Tokyo as a whole. In order to fully achieve these roles, it was thought necessary to carry out early construction and simultaneous full opening.

However, its construction required a huge amount of funding and relevant construction capacity. Particularly with respect to fund procurement, it required funding of more than 100bn yen every year from 1992 to 1996. In order to deal with this, it was necessary to take various fund procurement measures.

With respect to construction capacity, the Bureau of Transportation was thought to be capable of construction. But the construction of the loop section was expected to be difficult since the section crosses with existing railways and urban facilities. Furthermore, land acquisition in central Tokyo and setting various rights was expected to take a certain time. In order to achieve a simultaneous full opening at the end of 1996, it was believed desirable to establish a system with construction capacity that allows flexible project implementation without adhering to conventional methods.

The Investigation Committee concluded to establish a third sector organisation with capacity to procure various forms of funds and relatively few restrictions on execution of budgets, but with capacity for implementation of construction and recruitment of construction workers. It was then decided that the third sector organisation should carry out fund procurement and implement construction works, in order to realise early construction and simultaneous full opening of the loop section.

- Characteristics and composition of the third sector organisation

The Tokyo metropolitan government offers the majority of the investment because it plays the main role in establishing the third sector organisation. As for construction workers, staff of the Bureau of Transportation were to actively cooperate in order to utilise accumulated construction technologies and experience in land acquisition and negotiations with competent authorities.

This third sector organisation also involves participation by financial institutions and municipal governments to utilise private sector funds and technologies and the municipal governments' connection with the local society. With this, it was possible to gain the understanding and cooperation of local residents, in addition to reduced construction costs through advance land acquisition, flexible project and recruitment of construction workers.

- Fund procurement

The construction of the loop section required large funds, amounting to 600bn yen, in a short period of time. It was decided to secure the funds and to procure low-interest funds in order to reduce the future interest burden as much as possible.

- Operation

The third sector system combines the strengths of the public and private sectors. However, there are often cases where only the weaknesses of the public and private sectors are generated, resulting in unintended management. Thus, it was decided to clarify the

management responsibilities of the third sector and to give full consideration to communications among investors and improvement of employees' morale so that the intended functions could be performed.

- Responsibilities of Tokyo metropolitan government

Since the construction of the loop section was an important project of the Tokyo metropolitan government, it was necessary to complete the project early in a short period of time. Thus, the Tokyo metropolitan government decided to take a proactive role in the construction and operation of the third sector to promote the project smoothly.

The Tokyo metropolitan government, then, acted positively in funding, sending construction workers, various procedures for the construction and land acquisition.

Operation body

- Ideal state of operation body

The financial conditions of the Toei subway operations were severe and it was expected that the deficits would increase due to an increase in the capital burden along with an extension of the operation of existing lines.

One contributing factor to deteriorating financial conditions is management inefficiency, particularly the payroll system based on that of administrative workers. It was difficult to achieve sound management of the Toei subway without correcting this system. It is thus desirable to carry out effective management of the subway business under an appropriate wage system. However, in reality, it was not easy to drastically revise the payroll system of the employees of the Bureau of Transportation. Therefore, it was believed that the management of the line should be conducted by the third sector organisation which could exercise the same level of efficiency as the private sector.

However, in Tokyo, the Toei subway had long been directly managed by Tokyo as a local public corporation, together with the Eidan subway (currently Tokyo Metro). Considering the fact that subways in other large cities are all publicly managed, it was not easy to decide to place the line under third sector management.

If a third sector organisation manages the line, the subways in Tokyo will come under the ternary management system, with Eidan (currently Tokyo Metro), Toei and the third sector, which would cause inconvenience to passengers in terms of fares and transfers, etc. It was also necessary to consider consistency with the radial section of the Oedo line which was to be constructed and managed by the Bureau of Transportation.

It has been pointed out that the business outlook of the line involves uncertain factors, such as a drastic increase in construction costs due to difficult construction works, delays in construction, an increase in the interest burden, an increase in interest levels, and lower demand than expected.

- Current and future measures

As described above, after considering relations with the existing Toei lines, the ideal state of public subway business and several uncertain factors involved in the business outlook, the Investigation Committee found it appropriate that the Tokyo metropolitan government should take over the railway facilities of the line from the third sector and that the Bureau of Transportation should assume the management.

This was ten years before the full opening of the line. Thus, a recommendation was made that the Tokyo metropolitan government would examine the business outlook of the line and the ideal state of the public subway business in the next ten years and if it was found that a transfer of the management of the line to the third sector would not cause any troubles, it would be desirable to transfer the business to the third sector at that stage.

- Points to remember for operation by Tokyo metropolitan government

In the case where the Tokyo metropolitan government operates the line, the conventional lax management would be quite problematic. Thus, the Investigation Committee recommended utilising the third sector in a wide range of areas within the scope allowed by the current law, expect for crucial items, such as the project plan, budget and fares, so that effective management could be achieved as close as possible to the private lines by adopting all measures for efficient management and further improving management practices.

In the meantime, it was also recommended the current laws should be revised if there were provisions that would hinder the introduction of private vitality or adoption of private-oriented methods.

- Procurement of facility acquisition fund and application of subsidy system

In the case where the Tokyo Metropolitan government takes over all railway facilities constructed by the third sector organisation, the acquisition cost would be paid in annual instalments over the long term. It would be funded by bond issuance and the Tokyo government's general accounting fund as in the case of the current construction fund.

The construction of the loop section of the line is a special project which aims to commence earlier and complete earlier than normal cases. To achieve this, the Tokyo Metropolitan government should take appropriate measures on an 'as needed' basis to promote smooth project implementation. However, since the national subsidy is necessary for stable management, seeking the understanding and cooperation of the national government for the application of a subsidy system for acquisition of funds in every fiscal year was recommended.

When the construction of the loop section had started, the Investigation Committee recommended that construction and management by the third sector would be desirable. While the decision on management was not made, since coordination with other elements was necessary, it strongly asserted that the third sector should assume the construction.

Considering that the construction of the loop section would involve procurement of a huge amount of construction costs and difficult construction works, it seemed difficult for the Tokyo metropolitan government to directly assume the construction work. As a result, the facilities were constructed by the third sector organization and transferred to the Tokyo metropolitan government after completion, and the operation has been carried out by the Bureau of Transportation since opening.

Now, the question is how the construction costs were procured by a third sector system. The next section describes the basic framework and background.

Change in financial scheme for the loop section

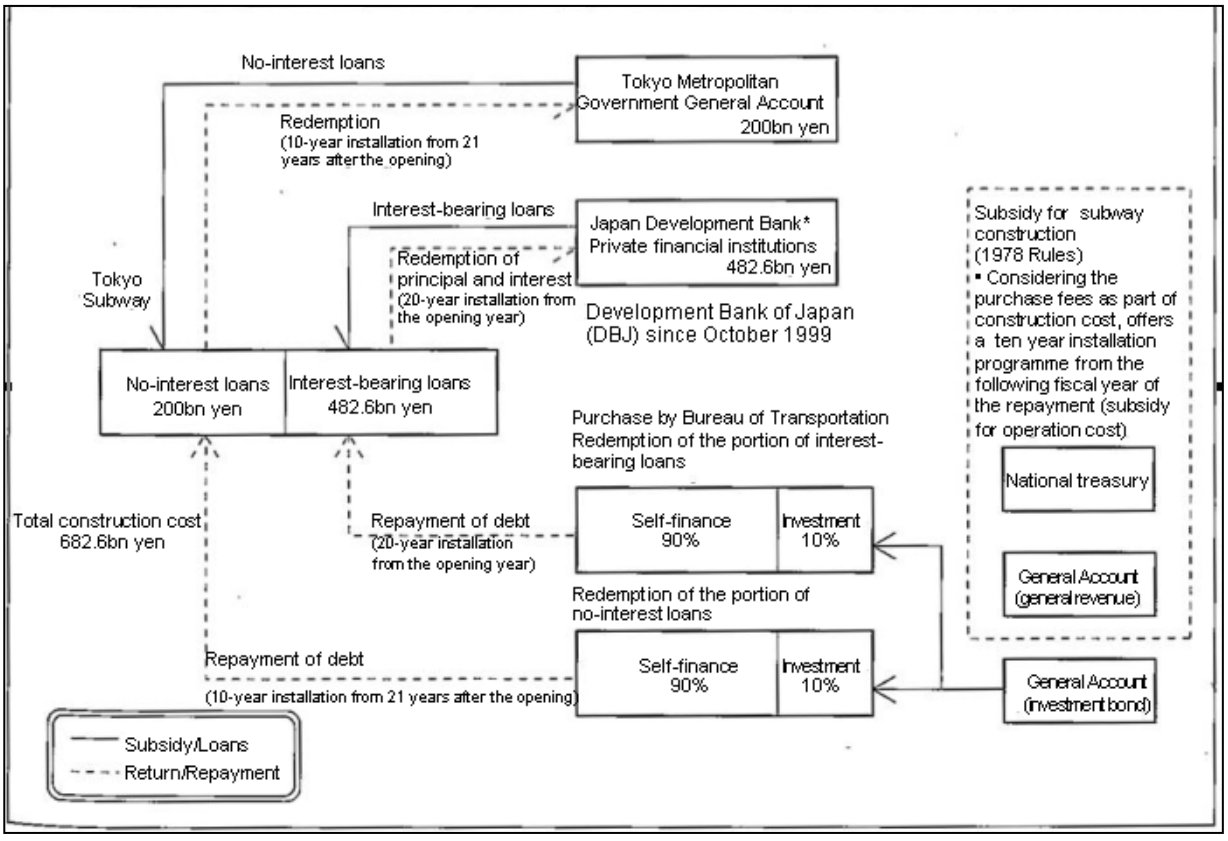
<u>Change in financial scheme caused by an increase in construction cost</u>

The opening of the loop section, which was scheduled for FY1996, was postponed to 2000

due to prolonged construction caused by difficult works and limitations on time to use the construction zone. Prolonged construction and changes in construction methods caused construction costs to rise; thus, changes in the financial scheme were discussed.

The initial financial scheme of the loop section was roughly as follows (Figure 23):

Figure 23: initial financial scheme for the Oedo Line



- The construction work was to be assigned to Tokyo Subway (the third sector construction body) using the resources financed by no-interest loans of 200bn yen from the Tokyo metropolitan government and interest-bearing borrowing of 482.6bn yen from the Japan Development Bank and other private financial institutions;

- The Bureau of Transportation was to receive a bulk transfer after the facilities were complete and to assume operation of the service;

- The transfer money would be paid to Tokyo Subway in installments over 30 years, and Tokyo Subway would use the money to repay the debt;

- The installments paid by the Bureau of Transportation would be considered as part of the construction cost, and would be eligible for the Subsidy for Developing Underground High-speed Railways (Subway development subsidy from the national government).

Due to socio-economic changes, such as the collapse of the bubble economy and decline in rail passenger numbers caused by the declining birthrate and aging population, it became necessary to re-calculate the estimated number of passengers, an important element of the financial scheme.

The review of the financial scheme for the loop section was conducted within the Bureau of Transportation. The Subway Construction Operation Group, set up in FY1998 to take on a full revision of the financial scheme, started negotiations with the Bureau of Finance of the Tokyo metropolitan government, Ministry of Transportation (currently Ministry of Land, Infrastructure, Transport and Tourism), and Ministry of Home Affairs (currently Ministry of Internal Affairs and Communications).

The Bureau of Transportation and Tokyo Subway took a number of cost reduction measures, but the total construction cost increased to 988.6bn yen, an excess of 300bn yen. Thus, additional loans were requested from financial institutions which had already made loans. The additional loans were approved, with the revised and below-mentioned financial scheme acknowledged by the central and Tokyo metropolitan governments.

Addition of no-interest loans

The initial financial scheme allocated 200bn yen, which accounted for about 30% of the total construction cost and was excluded from the subsidy due to budgetary constraint. Thus, the national government called upon financial institutions to increase the no-interest loans to 90bn yen, accounting for about 30% of the increment of the construction cost.

The initial 200bn yen was lent by withdrawing the fund from Tokyo Subway 12 Construction and Development Fund but it was difficult for the Tokyo metropolitan government to finance the additional 90bn yen since the general account was facing more severe financial difficulties than in the initial period.

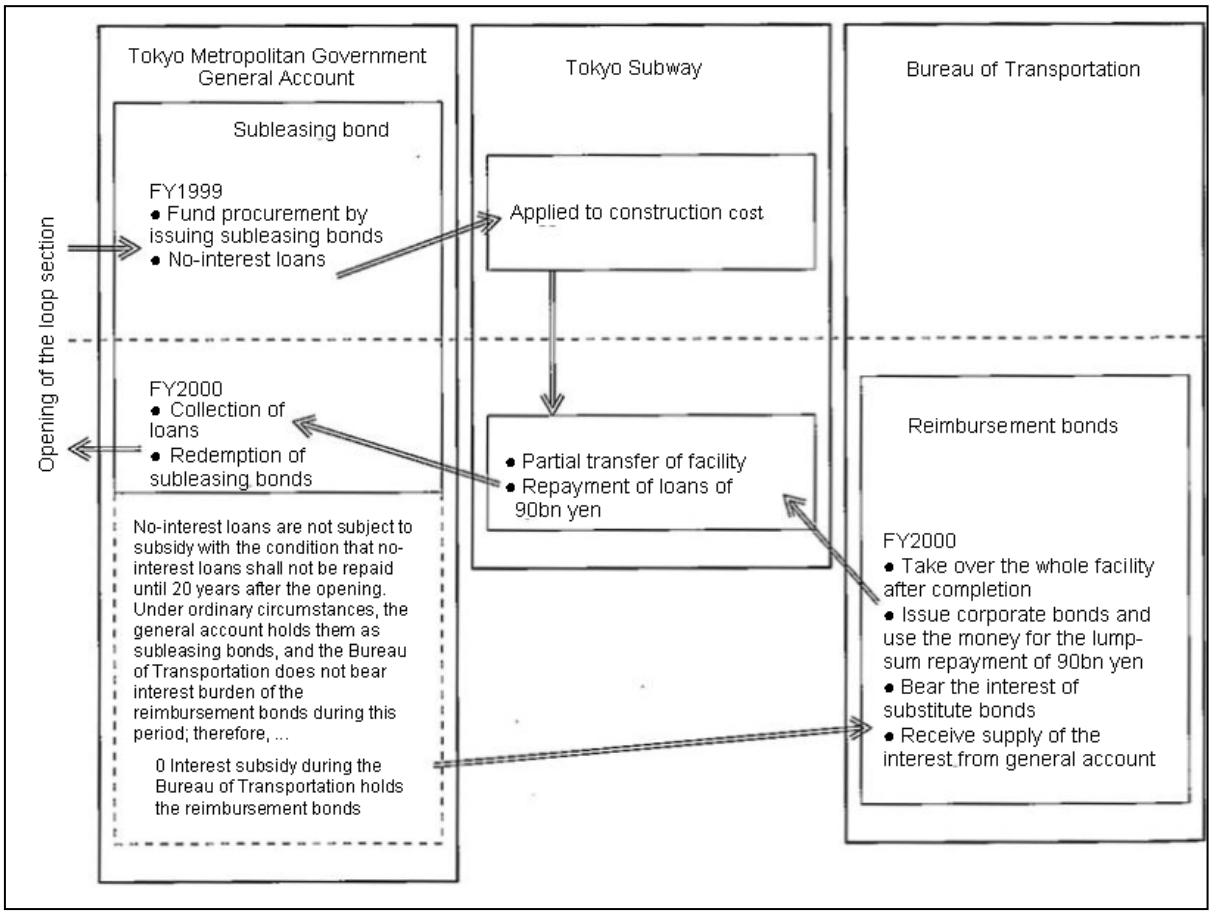
The Bureau of Finance decided to raise the funds by a bond issue, as financing from the general account was difficult, and it was decided to provide loans by issuing ‘subleasing bonds’ to the third sector, after a series of negotiations with the Ministry of Home Affairs.

The following conditions were set for the additional no-interest loans due to the constraints on the bond issue approval:

- The Bureau of Transportation would buy facilities equivalent to 90bn yen in the form of corporate bonds at the time of the opening of the loop section;
- Tokyo Subway would repay the no-interest loans to the Tokyo metropolitan government using the money;
- The general account would redeem the subleasing bonds using the repaid loan money.

However, since the no-interest loans, which are excluded from the subsidy, become the corporate bonds (interest-bearing borrowings) of the Bureau of Transportation when the subway line opens, it was decided that the general account would provide an interest subsidy for the corporate bonds in order to maintain the effect of non-interest loans.

Figure 24: no interest loan scheme



Advance purchase of facilities equivalent to loan bearing loans

The escalation in construction costs not only requires acquisition of new financial resources but also weighs down the management after the opening.

Meanwhile, the estimated number of passengers on the entire line after the opening of the loop section, based on the FY1995 Transportation Census of Urban, was reduced to 824,000 per day from the original estimate of 1 million passengers, indicating a deterioration of the revenue picture for the Oedo Line. Thus, it was decided to bring forward the redemption of interest bearing loans, as a measure to alleviate the heavy interest burden, a major factor weakening the financial position.

In the initial financial scheme, the interest bearing loans were to be redeemed evenly over the first 20 years and the no-interest loans in the following ten years. Reducing the redemption period of the interest bearing loans lowers the interest burden, which would put the financial position back under control.

However, the repayment of the interest bearing loans is subject to the Subway Construction Subsidy and an increase in the amount of repayment in a single fiscal year would lead to an increase in the subsidy. Thus, the redemption period was agreed to be 13 years as a result of the negotiations with the central government and the general account.

Advance purchase and reimbursement corporate bond under supplemental budget as an emergency economic package

In the negotiations on the revision of the financial scheme for the line, the purchase of the loop section was included in the 1998 supplementary budget. This aims to supply funds to Tokyo Subway by buying up completed parts of facilities, which allows the construction and job creation for the incomplete sections, and furthermore, reduces the interest payment.

The same measure was repeated in FY1999. In FY1998, Kiba Depot and other facilities were purchased. In FY1999, Kiyosumi administration building and part of the Kiyosumi work site were purchased by the initial budget, the facilities between Shinjuku and Kokuritsu-kyogijo were purchased by the supplementary budget, and the subsidies were delivered.

However, the Tokyo metropolitan government lacked financial resources to compile a supplementary budget for Tokyo for the subsidies in accordance with the national supplementary budget, and thus, the budget gap was filled by 'reimbursement corporate bonds' approved as an exception. In other words, the Bureau of Transportation ensures the funds equivalent to the general account subsidy by issuing the corporate bonds, the general account would provide the subsidy in a five-year installation program after five years, and the interest and others from the corporate bonds during this period would be separately financed.

Figure 25: opening of Oedo Line between Shinjuku and Kokuritsu-kyogijo

Table 8: Reimbursement corporate bond

FY1998 Supplementary Budget			
National economic measures	General economic measures		
Ministry of Home Affairs' Notice	Handling of municipal bonds in relation to the general economic measures		
Summary of provisions of Tokyo metropolitan government subsides	Outline of the Provision of FY1998 Subsidies for Tokyo's Underground High-speed Railway Development Project		
Facilities to be purchased	Completed facilities at the Kiba Depot		
Amount of general account subsidy	10,975,624,127 yen		
Value of issued reimbursement corporate bonds	10,975,000,000 yen		
Breakdown	Foreign bond	4,639,000,000 yen	Borrowing period: 10 years Redemption in bulk upon maturity
	Private bond	6,336,000,000 yen	Borrowing period: 10 years Redemption in bulk upon maturity
Period of provision of subsidies (Principal)	Five years from FY2004		
Period of provision of subsidies (Interest, etc.)	From FY1998 until the fiscal year when the provision of subsidies for principal terminates		
FY1999 Supplementary Budget			
National economic measures	Measures for Economic Rebirth		
Ministry of Home Affairs' Notice	Handling of municipal bonds in relation to the Measures for Economic Rebirth		
Summary of provisions of Tokyo metropolitan government subsides	Outline of the Provision of FY 1999 Subsidies for Tokyo's Underground High-speed Railway Development Project		
Facilities to be purchased	Facilities located in between Shinjuku and Kokuritsu-kyogijo		
Amount of general account subsidy	13,728,051,147 yen		
Value of issued reimbursement corporate bonds	13,728,000,000 yen		
Breakdown	Government bond	13,728,000,000 yen	Borrowing period: 30 years Payment deferred for five years, redemption over 25 years
Period of provision of subsidies (Principal)	Five year from FY2005		
Period of provision of subsidies (Interest, etc.)	From FY1999 until the fiscal year when the provision of subsidies for principal terminates		

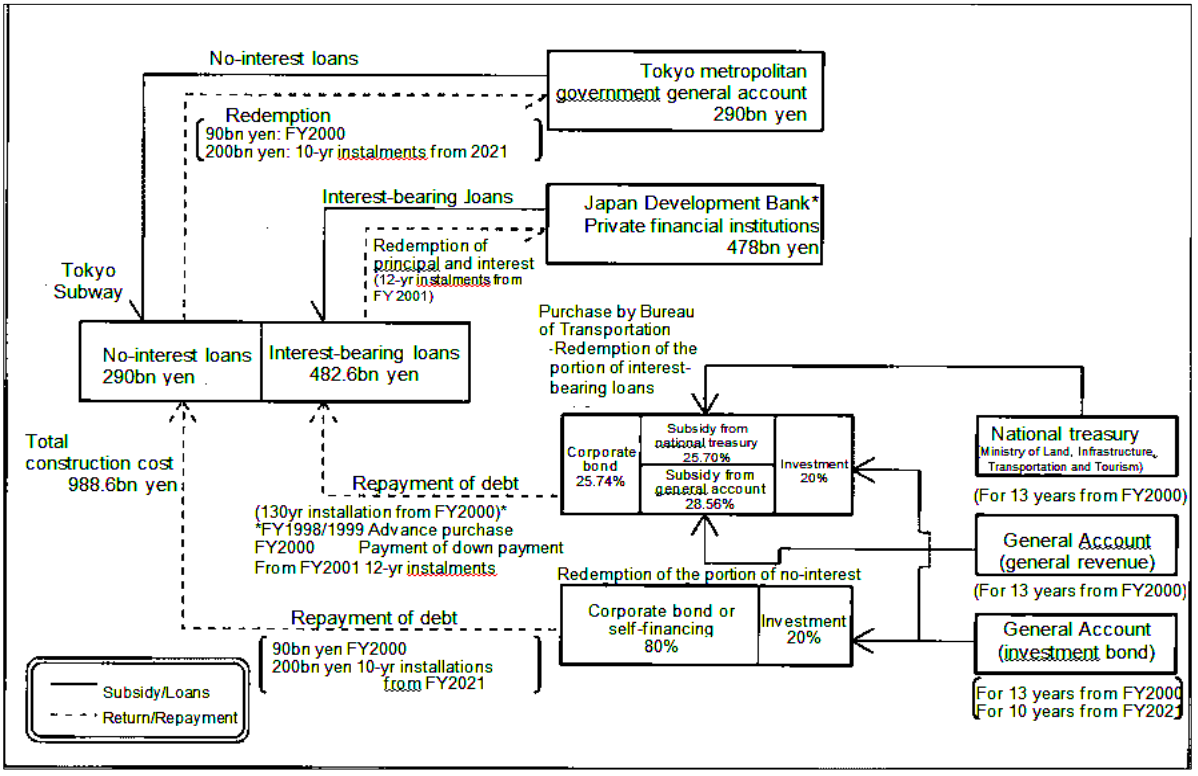
Final financial scheme

Through the process described above, the financial scheme was revised with the following items:

- Tokyo metropolitan government would lend a no-interest loan of 290bn yen to Tokyo Subway (of which 90bn yen would be implemented in FY1999);
- Some completed facilities would be transferred in advance of the opening to restrain the borrowings of Tokyo Subway;

- The remaining facilities would be transferred in bulk at the time of the opening, the down payment of the transfer cost would be paid in FY2000 (including the portion equivalent to the subleasing bond), the remaining interest bearing loans would be paid in installments over a period of twelve years from FY2001, and no-interest loans over ten years from FY2021, respectively;
- The purchasing money paid by the Bureau of Transportation would be recognised as the construction cost and be eligible for the national construction subsidy. However, the source of the general account subsidies in FY1998 and FY1999 would be reimbursed by corporate bonds of the Bureau of Transportation, and the subsidies would be allocated equally over the course of five years from FY2004 and from FY2005, respectively.

Figure 26: final financial scheme



F OPERATION

Oedo Line opening PR and passenger attraction measures

Opening events

In 1997, various events were held to commemorate the opening of the section between Shinjuku and Nerima stations, such as a visit to Hikarigaoka Depot, the Family Tunnel Walk, concerts and movie events in front of Tochomae station. In 2000, in order to publicise the full opening of the line, a series of visits to new stations and Rakugo performances were held and walking events along the line were also conducted. On the day of the official opening on 12 December, a special train 'Queen' was run, attracting many passengers to celebrate the opening.

Figure 27: Opening announcement by the animation character, 'Doraemon'

Environmental billboard at west gate of Shinjuku station

Opening campaign for the full operation of the Oedo line

For one year before and after the full opening of the line, the opening announcement campaign was launched using a popular animation 'Doraemon' as an image character. Posters, pamphlets, and special goods became quite popular. Around the opening date of 12 December 2000, TV commercials and radio and newspaper adverts were delivered. Other PR activities included wrapping buses, billboard visions and adverts in magazines.

Business Promotion Council and passenger attraction measures

The number of passengers after the full opening of the line was forecast to be 824,000 per day; however, actual numbers were 393,000 in January 2000, 434,000 and 430,000 in February and March, respectively.

If the number of passengers falls far below the estimates, the financial position of the Oedo line would not improve. Then, further publicity for the line and passenger attraction measures were launched.

The Business Promotion Council was set up in February 2001 under the Bureau of Transportation aiming to comprehensively examine and implement passenger attraction measures, thus contributing to improving business performance.

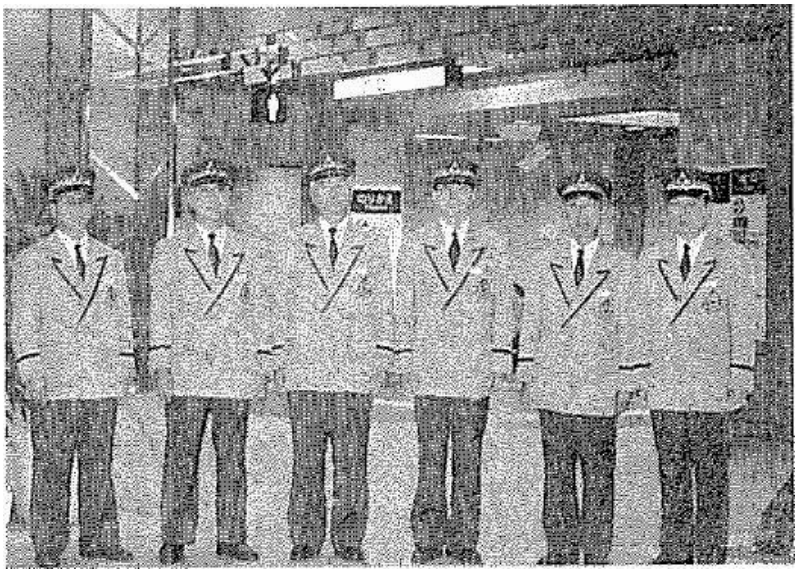
Along with the Business Promotion Council, ideas to attract more passengers were collected from employees of the Bureau of Transportation, including implementation of events inside stations, station businesses, sales of special trip tickets, distribution of PR pamphlets and timetable revisions. These ideas were examined by the Business Promotion Council and implemented when found feasible.

After the first anniversary of the commencement of full operations in December 2001, the target of the Business Promotion Council was expanded to cover the enhancement of business of the entire subway operations, including other lines than the Oedo line.

Table 9: Major Passenger Attraction Measures

Type	Passenger attraction measures implemented after the opening
Events and related business campaigns in stations	Opening events of the line, station concert, Japanese art exhibition and art gallery, taking gravure pictures in the station.
Sale of tickets for special trains	Stamp rally. Sale of One-day Pass for Toei lines for a limited time.
Improving information on transfer and exit/entrance information	Allocation of Oedo line service staff. Installation of unified information signs for Toei and Eidan, mobile signs, transit signs for major junctions, and signs indicating travel time.
Formulation of PR posters and pamphlets	Formulation of the map of major station vicinity, route search guide, vicinity information. Place adverts in newspapers. Formulation of image posters for passenger attraction.
PR to companies and schools in the vicinity	Implementation of sales activities for companies in the vicinity. Distribution of Oedo Line Trial Tickets.
Tie-up with facilities in the vicinity	Implementation of campaigns tied up with companies and shopping streets in the vicinity.
Other PR activities	Implementation of visit to depot on the HATO Bus sightseeing tour. Participation in local events.

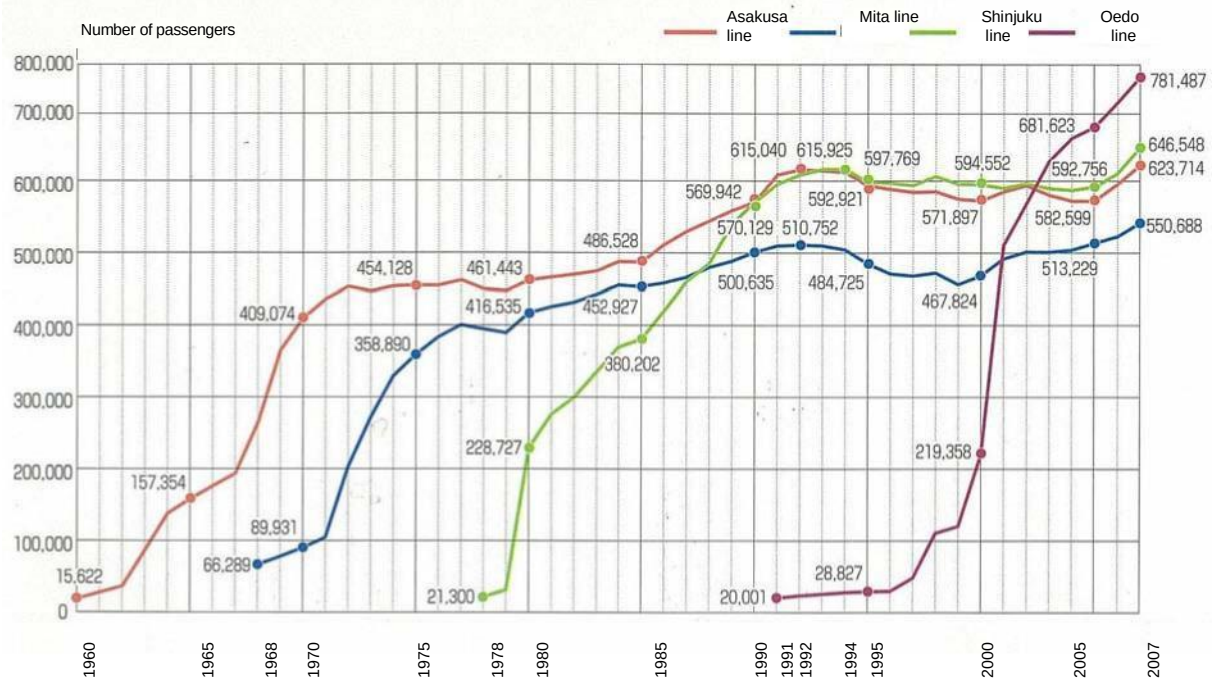
Figure 28: Oedo Line Service Staff



Transportation volume

The number of passengers on the line was 219,358 per day in 2000, and increased drastically to 681,623 per day in 2005 and to 781,487 per day in 2007. Although the number has not reached 1 million per day as estimated in the demand projection by the Investigation Committee, the number of passengers of the line surpasses other existing subways.

Figure 30 Changes in the Number of Passengers by Subway line (daily average)



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