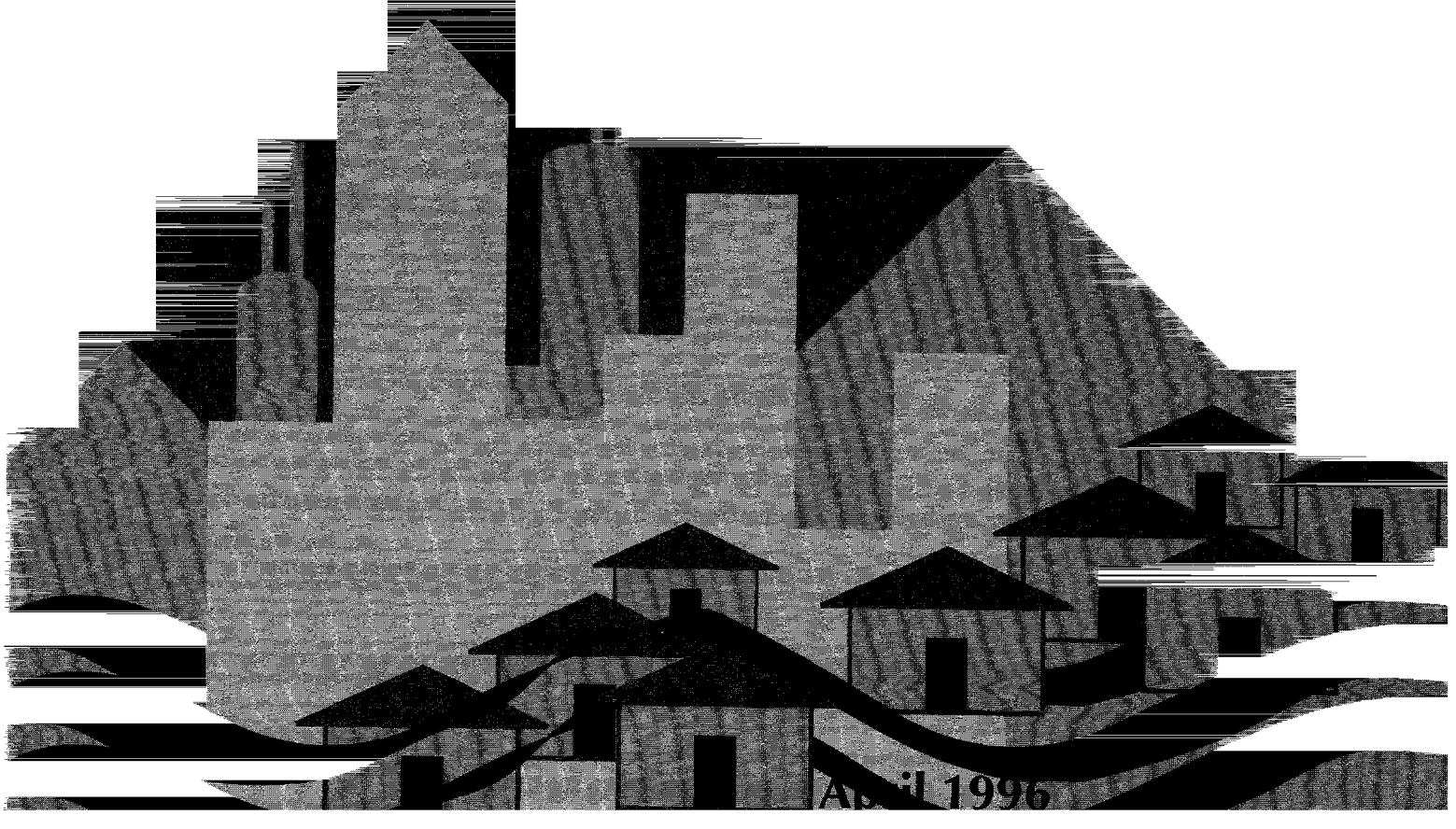

April 1996

Japan's Experience in Urban Environmental Management

Yokohama

A Case Study

Metropolitan
Environmental
Improvement
Program

April 1996

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MEIP: the Context for the Study

The UNDP-assisted, World Bank-executed Metropolitan Environmental Improvement Program (MEIP) began work in 1990 in five Asian metropolitan areas—Beijing, Bombay, Colombo, Jakarta, and Metro Manila. In 1993, this intercountry program began its second phase and Kathmandu joined as the sixth MEIP city. By 1996, MEIP will enter its third phase — with multi-donor assistance — and launch new programs in additional Asian cities.

MEIP's mission is to assist Asian urban areas tackle their rapidly growing environmental problems. The MEIP approach emphasizes the cross-sectoral nature of these problems and the failure of traditional, sectoral development strategies to adequately address urban environmental deterioration or the linkage between industrial and urban development.

The work program in each city is therefore guided by Steering Committees and technical working groups that reflect the cross-sectoral, interagency nature of urban environmental issues. The policy and technical committees develop Environmental Management Strategies (EMS) for their metropolitan regions; incorporate environmental considerations into the work of economic and planning agencies; contribute to the strengthening of environmental protection institutions, and identify high priority environmental investments.

The MEIP city office serves as secretariat to the Steering Committee and is managed by a local environmental professional, the National Program Coordinator (NPC). The NPC coordinates all MEIP activities and is responsible for developing the environmental network of government, private sector, non-governmental organizations (NGOs), research institutions, and communities. MEIP supports workshops, demonstration projects, and community environmental actions, and links these growing environmental network efforts with government policy and investment initiatives.

A further focus of MEIP is the exchange of experience and sharing of information among MEIP cities. This has been carried out through a series of intercountry workshops that review the city work programs, exchange useful experience, and develop intercountry projects.

MEIP has established the city programs, set in motion a variety of city subprojects, and mobilized the intercountry exchange. MEIP publications are intended to share insights and experiences developed from the MEIP process and its projects. The MEIP city programs work independently, with each other, and with international partners to reverse urban environmental degradation and provide useful and replicable lessons in urban environmental management.

MEIP and Urban Environmental Management Experience in Japan

To assist developing countries strengthening institutional capacity to control pollution and manage environmental resources, learning from countries and cities that have experienced similar problems is a particularly effective tool.

Japan has had a large measure of success in dealing with environmental problems associated with rapid industrialization and urbanization. As a developed country in Asia, its urban environmental management history affords an excellent opportunity to derive lessons and case studies.

This city case study of Yokohama is a companion piece and source document for the MEIP national study on Japan. In addition to the city reports

on Kitakyushu and Osaka, MEIP has published a national report entitled, "Japan's Experience in Urban Environmental Management."

The studies undertake a detailed review of Japan's experience in urban environmental protection and clean-up. The focus was to elaborate experiences of particular relevance to MEIP cities, and to other cities in Asia and elsewhere in the developing world.

Some useful conclusions concerning the applicability of Japan's experience for developing countries can be drawn. The studies demonstrate that, while much of the technology and present management practice may not be easily transferable, the way in which Japan tackled pressing environmental problems during the 1960s and 70s is directly relevant to the environmental management challenge facing MEIP cities.

On behalf of the MEIP team, I would like to express appreciation to Shunsuke Aoyama and his colleagues at EX Corporation for their superb efforts in conducting the study. We are especially grateful to the report's principal authors: Shunsuke Aoyoma, Jeremy J. Warford, Kiichiro Sakaguchi, Nahoko Nakazawa, and Hiroshi Naito for their exacting work and careful analysis. Profound thanks are due to Professor Michio Hashimoto, Chairman, and to the other members of the Central Steering Committee, and to Professor K. Saruta, Chairman, and other members of the Yokohama Committee. Finally, we are indebted to the Government of Japan for the support that enabled us to undertake this project and to the unflagging efforts of Kazuhiko Takemoto of the Japan Environment Agency and of Katsunori Suzuki, our colleague at MEIP-World Bank.

David G. Williams
Program Manager

Summary of Environmental Protection Measures in Yokohama

The City of Yokohama had been a center of trade in Japan from the opening of the port in 1859 through World War II, and an essential part of the Keihin Industrial Area. During the post-war period, however, the city was taken over by US occupation forces and financial difficulties were severe. Since the city's reputation as a center of trade was ruined, major industries in commerce, trade, and finance had left the city for other areas, primarily Tokyo. In 1951 the city introduced methods to attract new factories to the area and a new strategy to promote industrial development through projects such as the industrial zones in reclaimed coastal areas and investment in infrastructure.

The population of Yokohama was 620,000 immediately after WWII. By the first half of the 1950s, the city's population, at more than a million, exceeded the pre-war level. The downtown area developed in an unplanned manner, and reconstruction of the old coastal industrial area of the pre-war period was the means of facilitating industrial and economic revitalization. In the late 1950s, Japan embarked upon its period of rapid economic growth. Concentration of population and industry in Tokyo converted Yokohama into a dormitory town for Tokyo. The population of Yokohama increased by 100,000 per annum in the period after 1960. The rapid increase in population and industrial activities caused an expansion of the urban district and haphazard land use. It led to a "doughnut" phenomenon in the downtown area and suburban sprawl. Results included industrial pollution and shortages in public facilities, such as schools, hospitals, and sewerage.

In the mid-1960s, about 90% of SOx (a major element of air pollution) in the city was discharged from large factories in the existing coastal industrial area. Furthermore, it was at that time predicted that large factories in the new coastal industrial area would discharge the same volume of SOx as in the existing coastal industrial area. However, not having authority to control pollution directly, the City of Yokohama only conducted SOx monitoring, and dealt with grievances on a case-by-case basis.

Under these circumstances, in 1963, the Asukata municipal administration came into power, with campaign pledges to improve the quality of life of the citizenry, and to enlist citizens' participation in city government. It largely modified the old policy of Yokohama, which had given major priority to creation of industrial infrastructure. With respect to pollution control measures, the city's own pollution control agreements, which later came to be called the "Yokohama style", prevented pollution in the new industrial area, and controlled pollution in the existing industrial area. Municipal governments had no legal authority over pollution control at the time. Under the agreements, the City of Yokohama obtained, based on mutual consultation, pledges from business enterprises to implement pollution control measures. Pollution control agreements were also adopted in the existing industrial area. Since the latter half of 1970s, the guidelines were also used to generalize the environmental pollution control agreements.

Strict controls enforced for large-scale companies under the environmental pollution control agreements were effective since these companies possessed enough technological and economic capacity to respond to the measures. On the other hand, measures applied to small and medium-sized factories, which were scattered throughout the city, were difficult to enforce, and their implementation lagged behind. Therefore, during the 1980s, Yokohama started to relocate these factories to the Kanazawa Industrial Complex. Taking advantage of

factory relocation, the city was able to control pollution, rehabilitate and modernize the downtown area, and rationalize management of the factories by promoting collective and cooperative actions and strengthening managerial capacity.

In order to control industrial pollution during the high economic growth period, the city took a series of measures such as the environmental pollution control agreements, various guidelines, and relocation and cooperative actions with small and medium-sized factories. These measures were successful and largely improved conventional industrial pollution.

However, from the 1980s, the focus shifted from industrial pollution to the newer issues of pollution related to daily urban living such as that caused by automobile traffic, domestic waste water, and neighborhood noise. Yokohama recognized that it was time to shift its emphasis from exclusive concern with industrial pollution, and that it was necessary to establish the "Yokohama Environmental Basic Charter" in order to protect and create a good city environment. The city designed the environmental management plan (Environmental Plan 21) in 1986 to realize the Basic Charter. It was recognized that it was necessary not only to control industrial pollution as in the past, but also to implement a comprehensive and well-planned environmental administration for pollution prevention and creation of a better living environment. This plan became the foundation of the new environmental administration.

Based on the environmental management plan, Yokohama has recently handled various environmental problems such as environmental pollution by chemical substances, ecological degradation, large resource/energy consumption, waste disposal, global warming, and ozone destruction.

Evaluation of Environmental Protection Measures in Yokohama

In this section, we evaluate the environmental protection measures in Yokohama such as the pollution control agreements and the Kanazawa reclamation project described in Chapter Three.

Pollution Control Agreements

Overall evaluation The first pollution control agreements in Yokohama were conceived by an autonomous effort of the city during the mid-1960s when local governments did not have any legal authority over pollution control. Under the agreements, the city obtained, based on mutual consultation, pledges from business enterprises to implement pollution control measures. The city took the initiative in undertaking preventive pollution control measures with the support of citizens' movements, while allowing companies to establish their factories on a selected basis. The Yokohama pollution control agreement was different from the following two types of pollution control measures, one taken in Yokkaichi and the other in Mishima-Numazu. In the case of Yokkaichi, pollution control measures were pursued only after companies had established their factories and started causing pollution. In the case of Mishima-Numazu, the residents rejected the siting of planned plants by organizing a strong residents' movement. For this reason the Yokohama Pollution Control Agreement was frequently called "Yokohama style". The initiative taken by the Mayor of Yokohama was the main reason for the inception and success of the "Yokohama style" pollution control agreement, which was necessary to protect citizens' health and the living environment. This was a major break with tradition, for according to conventional ideas, local municipalities were not allowed to establish their own

regulating standards or methods, which would be stricter than those required according to the structure of laws and regulations at that time.

Early pollution control agreements were concluded with large companies in the new industrial area on the coastal reclaimed land in order to control increasing pollution originating from existing factories. In fact, since pollution originating from the new factories was much less than that from the existing factories, the pollution control agreements were very effective.

The agreements specified maximum pollution control targets, based on scientific data, and in light of present conditions and future prospects of air pollution, and of the level of pollution control technology available at that time. Although the agreements were much stricter than laws and prefectural ordinances established later, the companies recognized that scientifically reasonable standards based on large scale monitoring or a wind-tunnel test, were being set. The agreements played an effective role in introducing advanced technology and developing new technologies such as the country's first power generation by LNG, and the improvement in ground concentration of pollutants due to collective smokestacks.

Early pollution control agreements, which first targeted new factories, were later adopted by existing factories. Even after certain legal regulations were provided, the agreements were still innovative. For example, the agreements imposed stricter control than laws, or introduced total emission targets while existing laws only regulated emission concentrations.

Residents' movements From the early 1960s, air pollution had become a serious problem in the existing coastal industrial zone. Residents were anticipating with alarm the arrival of still more factories in the new coastal industrial zone. Residents around the zones formed a residents' organization called "Council for Conservation of Environmental Hygiene in Naka and Isogo Districts". They appealed to the national, prefectural, and city governments to implement pollution control measures. Anti-pollution campaigns by local residents in Yokkaichi and Mishima-Numazu affected this movement. Citizens' movements at that time not only promoted pollution control measures by Yokohama City, but also gave birth to the first pollution control agreement.

Thereafter, citizens' movements continued to support the city's pollution control measures. This was because the city kept residents well informed of the content and results of scientific experiments conducted by the city and factories, as well as the content and effectiveness of the agreements. This openness removed anxiety from residents, and the visual evidence of improvement in environmental quality enabled the city to win the residents' understanding and trust.

Companies' reaction Escalating anti-pollution demands from the public, and land sales contracts were the external factors that companies accepted in the early pollution control agreements. Since the city's investigation and finding were scientifically sound, the companies acknowledged the results and agreed to cooperate. On the other hand, internal factors that companies accepted such a strict agreement were as follows:

- Yokohama was blessed with a large consumer market in the outskirts of the capital;
- Good economic conditions at that time eased negotiation of the agreements; and
- Having abundant capital and management capacity, the large companies were able to cope with the pollution control costs.

As a result, the companies were able to pay for the costs of pollution control investment, and to maintain industrial competitiveness at the same time.

Later, the city signed other pollution control agreements with the existing factories. The following factors attributed to the successful agreements: First, the companies understood the Yokohama style when they reached early pollution control agreements with new factories. In addition, following increasing anti-pollution demands from the public, these companies came to realize that, in order to carry out their business in the future, it would be vital for them to obtain a consensus from local governments and residents when building or expanding factories. It turned out that to take pollution control measures is not so costly in the long term and is affordable, though large investments are required in the initial stage. Furthermore, from the factories' point of view, the conclusion of pollution control agreements meant a kind of authorization for pollution control measures from Yokohama City. As a result, the factories were able to build up good relationships with the residents.

Administrative reaction The city's administrative structure and staff attitudes and skills for pollution control were key factors. The pollution control agreements were successfully implemented through frequent monitoring, on-the-spot inspections, and guidance. Such local effort has been an important tool to induce effectiveness of the measures and this has been a distinctive characteristic of the Yokohama administration. The city administration obtained residents' trust and cooperation, and maintained it by disclosing pollution information as openly as possible. Since the city set targets based on scientific data, the companies tended to accept them.

The Bureau of Pollution Control was established with its 10 staff when the first pollution control agreement was concluded. Yokohama was able to avoid a vertical administration, though this is typical in the Japanese administrative structure, and it has maintained its flexibility to effectively handle the problems at hand. Since then, the administrative structure has basically stayed the same. Staff members were engineers who had received higher education, and were highly concerned about pollution issues and approached their task with enthusiasm and dedication. Moreover, the city made great efforts to improve its staff's capability and accumulated technology in the Bureau. This accumulation of technology, specifically reflected in the conclusion of the Yokohama pollution control agreements that were based on scientific knowledge and technology, and helped the city win credibility and understanding from the enterprises which concluded pollution control agreements.

Requirements for effective pollution control agreements The experience of Yokohama city indicates the following requirements for effective pollution control agreements.

1) The content of the agreements should be defined from a scientific and technological point of view, and not simply from an abstract and ethical point of view.

2) A strict and rigid agreement is not always good. It needs to be adjusted according to the economic, technical and managerial capacity of the firm local characteristics.

3) In order to check whether the companies carry out a comprehensive implementation of the agreements, it is necessary for the administration to be aware of best available protection technology. Therefore, it is desirable for the administration to maintain a certain number of qualified staff and train them. Local staff must have enthusiasm, as well as knowledge of advanced technology.

4) It should be recognized that the pollution control agreements exist not only for the company and local government administration, but primarily for the residents' well-being.

Kanazawa Reclamation Project and Industrial Relocation

The goal of the Kanazawa Reclamation Project was more than just creating land for industry and port as in the past. The ultimate goal was to reclaim land as a site for redeveloping the downtown area and accommodating small and medium-sized factories. Small and medium-sized factories scattered around the city were transferred into the Kanazawa Reclamation Land. This facilitated rationalization of factory management through cooperation and systemization. The industrial relocation was also effective as a measure for controlling pollution including noise, vibration, and offensive odors.

Successes of the Project

Concern about living environment The reclamation project was formulated with careful consideration of environmental aspects and urban planning. The area was divided into the industrial and residential sites by a national road running North-South in the center of the reclaimed land. A 50 m wide green tract of land was also constructed as a buffer zone along the national road. The city secured about 10% of total reclaimed land for building a seaside park, a park on the old coastal line, and green buffer zones. The construction of the green buffer zones were funded by the Japan Environment Corporation.

Pollution control measures In order to prevent pollution from occurring in their new neighborhood, companies implemented the following pollution control measures after relocation: arrangement of factory location within the industrial complexes, establishment of treatment facilities, as well as individual measures within the factories themselves.

Accordingly, the city decided to locate some small and medium-sized industry in special sections of the Kanazawa Industrial Complex and let them discharge effluent to the collective treatment system after each factory removed some hazardous substances. To have a collective treatment facility is much more economical than the case where each factory has its own industrial treatment facilities because the former requires less space for the treatment facility installation and less operation and maintenance costs.

Costs of construction, operation and maintenance of the collective facilities are borne by the user companies. The facilities were constructed by using a 30-years low interest loan provided by the Japan Environment Corporation. Yokohama city subsidized a part of the interest. Annual operation and maintenance costs are settled by the user companies according to a certain formula using contract and actual effluent volume, as well as effluent density.

Collective treatment proved more economical than individual treatment. It also made possible for Yokohama city to easily monitor the effluents of the user companies, and to give them appropriate guidance.

Incentives to relocate (land price and financial subsidy) The incentives included the availability of necessary infrastructure on the site, and low cost requirement of the relocation.

The initial sales price of industrial site was 30,000 yen/m^2. However, it actually increased to 50,000–60,000 yen/m^2 due to delays in granting reclamation licenses and soaring construction costs. There was considerable doubt as to whether the targeted small and medium-sized businesses could afford for relocation. The city therefore reduced taxes for the factories concerned over a limited period, exempting them from property tax, corporation tax, and the special land holding tax.

Taking advantage of factory relocation, the city tried to reform and rationalize management of small and medium-sized factories by promoting collective and cooperative actions, as well as improving organization in the factories themselves. Organizational promotion made it possible for small and medium- sized companies, which were financially weak, to obtain public funds such as the promotion fund for small and medium-sized companies and loans from Japan Environment Corporation.

Project execution organization The Kanazawa Reclamation Project in Yokohama was implemented by inter-departmental effort involving Planning and Coordination Division, Pollution Control Bureau, and 10 other bureaus of Yokohama city. Officials of those organization formed both the steering and technical committees for the project.

Unsuccessful aspects

Process of factory relocation The city introduced criteria to prioritize the districts from which relocated factories should be drawn. Criteria included the presence of residents and industries located in close proximity to each other, existing environmental conditions, and managerial capability. Based on the results of this investigation, the city selected factories which would require relocation, and then encouraged the process. Although the city initially wanted to relocate 2,000 out of 6,000 small- and medium-sized factories, only about 400 factories were actually relocated. Many factories which caused pollution could not be relocated due to the lack of relocation funds. Moreover, about 40% of the factories relocated were previously located in the semi-industrial area, and not in the mixed residential-industrial area. It may be said that more factories could have been identified and relocated if the city had identified candidate factories from only residential areas or commercial areas and excluded semi-industrial areas, and if more time had been spent for such identification. However, the city's financial burden of interest payments prevented the city from spending more time for the identification.

Utilization of vacated sites Yokohama either purchased the vacated sites from the relocating factories and constructed public facilities such as parks, or attempted to conclude agreements with the companies regarding the utilization of the vacated sites. In the latter case, companies were required to have prior consultation regarding their disposition, thereby limiting the future uses of the sites. However, both parties sometimes could not reach an agreement on sales prices. The city could not control the use of vacated land effectively.

Conclusion on Environmental Protection Measures in Yokohama

The national emission standard is a minimum standard to be complied with. National emission standards are not necessarily adequate for some cities where pollution problems are serious. For this reason, in order to protect local residents' health and living environment, Yokohama City found it necessary to implement its own measures through pollution control agreements or guidelines/guidance.

The experience of Yokohama presents an example of a local government which has successfully implemented its own environmental protection measures. To this end, it requires a comprehensive plan of actions including not only environmental protection but also local economic policy and local living environmental policy.

The Yokohama experience also demonstrated the importance of gaining the trust from local residents and companies. To obtain this, the city:

1) **aimed at rational, objective and effective city management;**

2) **trained special staff in environmental administration;**

3) **established cooperative relationships with external specialists and research institutions;**

4) **encouraged residents' participation and established a system to listen to residents' opinion in the city management; and**

5) **disclosed environmental and other information including environmental issues as fully as possible.**

The City of Yokohama has obtained trust from the residents for its individual measures such as municipal reform and residents' participation. These efforts made it possible for the city to successfully negotiate with companies about the pollution control agreements and to maintain effective relationships with the central government.

The City of Yokohama

Introduction

With a population of 3,220,000, the city of Yokohama is the second largest city in Japan. The city is capital of Kanagawa prefecture and a center of prefectural politics, economics, and culture. However, the city does not have a long history; it is only about 130 years since its port was first opened, but since then, the port has become the most important and largest in Japan.

Location, Topography, and Climate

The city of Yokohama, located in the eastern part of Kanagawa prefecture, is 20 to 40 km from the center of Tokyo. The city lies on the eastern edge of Tama Hill facing Tokyo Bay. Several rivers flow across the tableland, forming gentle alluvial plains. Several rivers such as the Tsurumi, the Katabira, and the Ooka Rivers flow into Tokyo Bay, while the Sakai and the Kashiwao Rivers flow south and to the Sagami Bay.

Since a large part of the city lies on gentle hill and alluvial formations, there is no area which is high enough to be called a mountain. However, Kamaridani and its vicinity, located in the southern Kanazawa reclaimed area, present a mountain-like view, owing to the "Kanazawa Ruiso," which is geologically similar to the Miura Peninsula.

The annual average temperature of Yokohama is 15.2°C; the highest temperature is 30.4°C in August and the lowest is 1.0°C in January on average.

Population

The population of Yokohama was 1.14 million in 1960. A rapid increase in population took place during the high economic growth of the 1960s, and in 1978 it overtook Osaka, becoming the second largest city in Japan. After that, its population continued to increase and reached 3.22 million in 1990, i.e. approximately tripled over the 30 years. The population density of Yokohama is 7,393 people per square km, and 95.6% of the city's population lives in the densely populated core area.

Among eleven ordinance-designated cities in Japan, only the cities of Yokohama and its neighbor, Kawasaki, have a ratio of day-time to night-time population of less than 100. Yokohama's ratio was 88.7% in 1990, indicating that the city had many commuters who lived in Yokohama but worked outside of the city in places such as Tokyo.

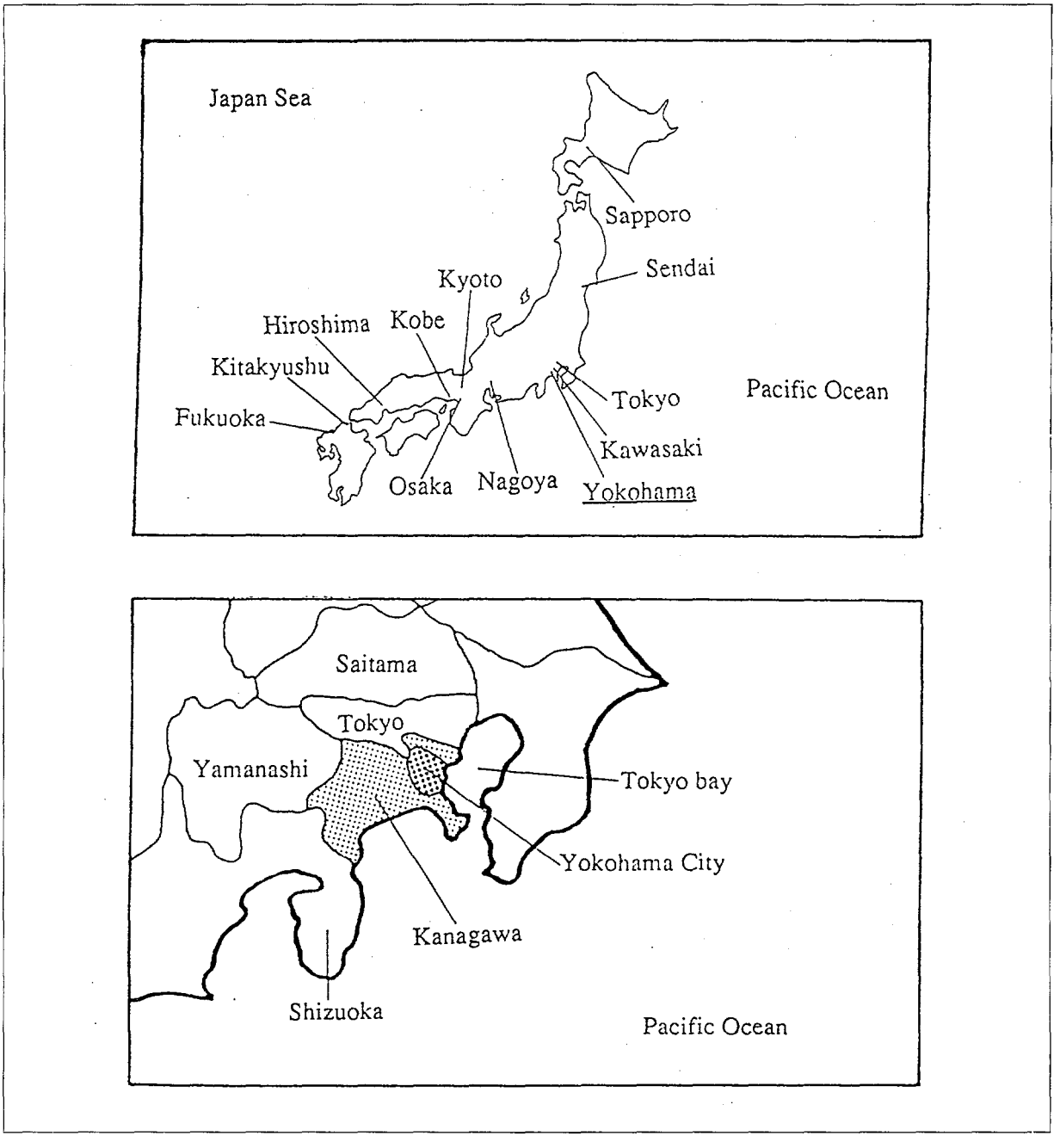
Industry

Yokohama has developed as an industrial city with high standards of technology and large-scale production based on its port. Its annual trade volume (sum of imports and exports) is about 10 trillion yen, accounting for 15% of the national total.

The tertiary industries account for 69.3% of the city's total production. In the tertiary industry, service industry in particular has had a major share and a high growth rate in recent years. The secondary industries account for 30.6%, and the primary industries only 0.1% of total output; the primary industries have in fact been on a continual decline in recent years.

Manufacturing in Yokohama is mainly led by the chemical industry, followed by electrical machinery, general machinery, transportation equipment, food processing, oil and coal. With respect to business establishments, those with more than 300 employees, though accounting for only 4.2% of the total number of establishments, constitute 59.2% of the value of manufactured goods output.

Figure 1-1: Location of Yokohama



Land Use

Land use in Yokohama changed greatly between 1960 and 1990, due to a significant increase in population and in industrial structure. There has been an increase of about 9,000 ha in residential area and 3,000 ha in industrial area, while agricultural land, mountains and forests decreased by approximately 7,000 ha, and 75.4% of the city area is now categorized as densely populated.

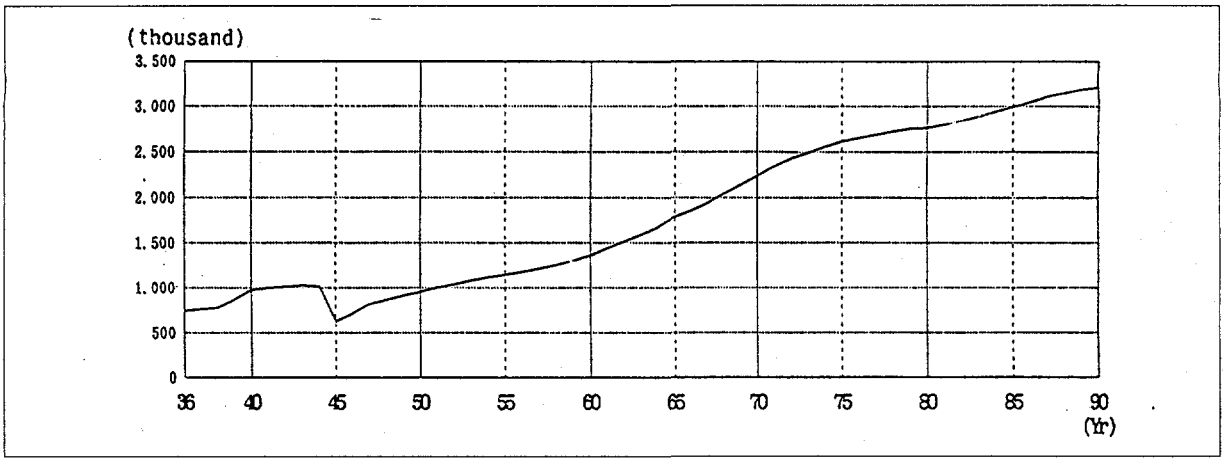


Figure 1-2: Population Growth, Yokohama, 1936–90

Living Environment and Improvement of Urban Infrastructure

The growing importance of Yokohama's port was matched by rapid, and often unplanned and haphazard urban development in the vicinity. A variety of factors, ranging from the Great Earthquake of 1923, wartime chaos, and the rapidity of economic growth and change in the 1960s, created severe problems in the urban management. These problems became very apparent by the 1970s. Although Yokohama started to implement water supply systems early in its history, the implementation of sewerage systems lagged behind other large cities in the post- war period. Population with access to sewerage was 6% in 1965, but was 60% in 1985 and 89% in 1991.

The rapid population increase and urbanization in the 1960s caused solid waste generation amount to increase rapidly, which led to the shortage of disposal sites. The word "waste war" at the

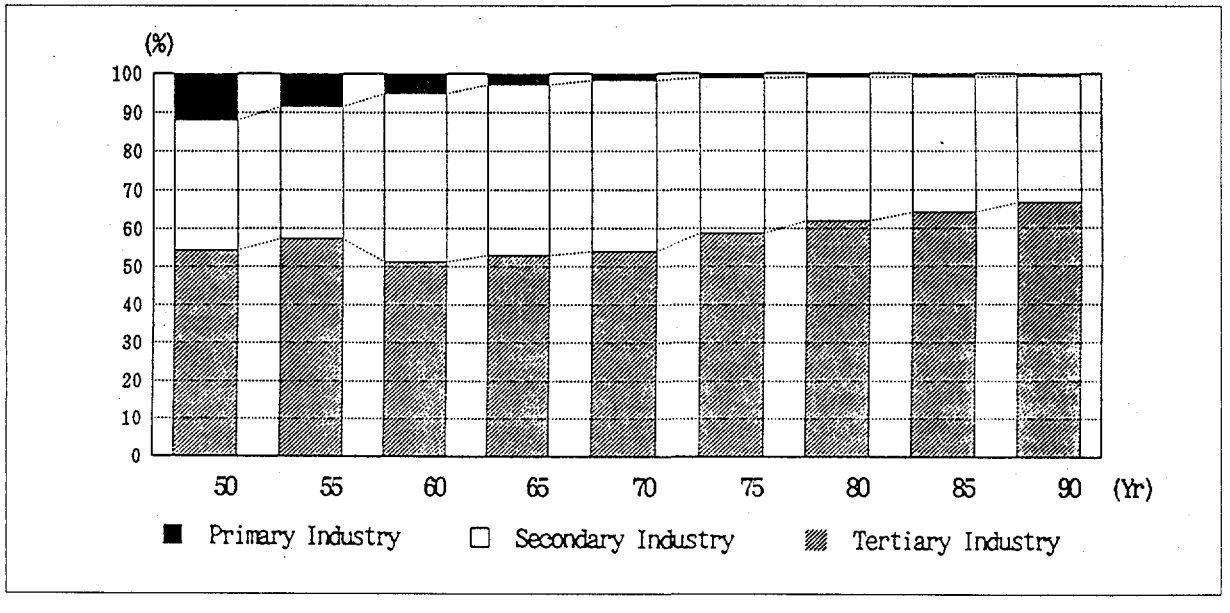


Figure 1-3: Industrial Employment in Yokohama, 1950–90

beginning of the 1970s indicated the depth of the problem. Since then, however, the construction of a series of incinerators has helped the city burn almost all its waste. Moreover, in recent years, the city has utilized energy derived from wastes incineration for operating heating and cooling systems as well as for supplying hot water to public facilities such as swimming pools and welfare institutions.

With regard to traffic infrastructure, Yokohama currently has the lowest ratio of road construction of the eleven largest cities. Road construction to keep up with rapid population growth is difficult. The city has been undertaking construction of two types of roads—a beltway which would reduce through-traffic in the downtown area and a radial road which would connect downtown and suburbs. However, Yokohama city is facing difficulties in the implementation due to a sharp increase in land prices. With respect to railroads, the city is developing a new subway system which connects downtown and suburbs, which is independent from the subway system of Tokyo.

Image of Yokohama

The name of Yokohama gives a favorable impression to people, especially to those who live outside of the city. Motor vehicle registration plates of Yokohama are very popular among young people. The city creates a very stylish and fashionable image. As a matter of fact, since its port-opening, the history of Yokohama has contributed to the creation of an open atmosphere receptive to foreign cultures, rather than a conservative atmosphere characterized by the preservation of old traditions. While Yokohama citizens are receptive to strangers, they seem to lack strong attachment to their community. There are many Yokohama citizens who work in Tokyo and consider Yokohama only as a commuter land.

History of the City

From the Port-Opening to the Pre-War Period

For many years, shelters for travelers on the Tokaido Route have existed in Yokohama. However, there was no central district which was large enough to form a town based upon a castle or a temple. Establishment of the first central district in Yokohama originated in 1854 when the US-Japan Friendship Treaty was signed. Based on that treaty, the US-Japan Commerce Treaty was signed in 1858. It was under this treaty that Yokohama became the first Japanese port open to foreign trade in 1859.

In 1889, thirty years after the port opening, Yokohama reorganized herself as a city; a mayor, a city council, and city zones were established. At that time, the city was 5.4 km^2 in area with a population of 120,000.

After the opening of the port, Yokohama prospered as a city of trade and commerce. Industrial investments in the city took place as early as the 1880s. As capital accumulation proceeded, factories were transformed from domestic industries into large-scale manufacturing industries. Thanks to the development of light industries in the country, mainly led by the spinning industries, exports of silk and cotton textiles from the Port of Yokohama rapidly increased. Industrialization also took place in areas which included production/manufacturing of city gas, soap, milk, dyeing and molding, oil, electric wires, and textiles. Local industries such as Yokohama Scarf were also born during this period.

At the turn of the 20th century, after the Sino-Japanese War and the Russo-Japanese War, heavy

industries also started to evolve in Yokohama. As World War I started in 1914, the demand for munitions and other war material increased. The city started to fill up coastal zones of Tsurumi and Kawasaki for siting heavy industry. However, the city's industrial development was halted by the Great Kanto Earthquake of 1923, which struck the city with destructive force; city development was further hampered by the world depression.

The city's population had increased to 620,000 by 1930. After the completion of the Tsurumi River reclamation project in 1931, the city began to experience sustained development of heavy industries, including iron and steel, shipbuilding, and electricity in the Keihin Industrial Zone. Thereafter, the city of Yokohama and the Kanagawa prefecture concentrated on reclaiming Tsurumi and Kanagawa districts, which had good access to imported materials, and large space for industries. Heavy industries developed rapidly later under the strong protection by the military. During the war, the area covering Isogo, Kanazawa, and Tomioka became a munitions industry zone. In addition, new factories were built in some areas in Totsuka along the Yokohama Railroad Line. The pre-war output of the Keihin Industrial Zone continued to increase, to account for about 30% of the total national output in 1940, ranking top in the country and surpassing the Hanshin Industrial Zone.

During this period, the city area expanded six fold from its 1901 size by merging neighboring towns and villages. Because of this expansion, Yokohama had a green countryside with plenty of mountains and forests in addition to the bay area. At the outbreak of World War II, the city carried out its sixth major expansion. The city's area became 400.97 km^2 and the city's population reached 0.87 million. By 1943, the city's population had increased to 1.02 million.

Post-War Reconstruction (From 1945 through the Mid-1950s)

World War II left Yokohama in ruins and ashes. Forty-two percent of the city was burned out by an air raid in May 1945, shortly before the end of the war. By 1945, the city's population had decreased to 620,000. Since Kanagawa prefecture was located next to the capital and had numerous military installations during the war, it became a strategic military point for the US occupation forces. More than 90,000 occupation troops were stationed in the city of Yokohama, taking advantage of its port facilities as an important base for transporting arms and weapons. The occupation forces seized 90% of the entire port facilities, as well as 27% of the city zone, including tall downtown buildings, buildings and school playgrounds, and children' parks. As a result, the city's tax revenue continued to decline each year, causing it to accumulate a budgetary deficit. This forced the city to lag far behind other Japanese cities in reconstruction and development.

Nevertheless, as civilian trade resumed in 1947 on limited scale and as the Yokohama International Port City Construction Act was established in 1950, the city began anticipating the reconstruction of Yokohama Port and the related economic infrastructure. After 1955, the city could recoup its normal port functions, when Takashima Wharf, Yamanouchi Wharf, Grand Pier, and other port facilities were released from the occupation force. During the prolonged period of occupation, however, the city's reputation as a center of trade and commerce had been ruined, since major industries in commerce, trade, and finance had already left the city for other areas including Tokyo. In order to revitalize the economy, in 1951 the City of Yokohama introduced a new strategy for industrial development. Under this strategy, the city developed industrial infrastructure through projects such as the creation of reclaimed coastal industrial zones, as well as invitations to new factories to locate in the area.

Thanks to the special procurement demands brought by the Korean War, industrial production started to regain full-scale operation after 1950, and reached the pre-war level in 1955. From 1950 to 1955, the number of factories increased 1.3 times, the number of employees 1.2 times, and production output 3.1 times. This rapid industrial development was achieved by revival of the pre-war industrial zone in the Tsurumi and Kanagawa coastal area. Nonetheless, the majority of the new factories were small and medium sized, and the development of the industrial infrastructure in Yokohama was still fragmented. Industrial pollution and problems such as land subsidence due to pumping of ground water, soot and smoke, dust, industrial waste water, noise, and vibration became widespread. In this period, the relative importance of primary industry decreased substantially. From 1955, the number of workers in primary industry continued to decline.

By 1952, the city's population had increased to 1.0 million, exceeding the highest level prior to the war.

Industrial Development Period (From 1955 through Early 1960s)

During the decade following 1955, passing through the Jinmu Economic Boom of 1956 and Iwato Boom of 1959, Japan started a rapid economic growth. This was reflected in industrial development in Yokohama; during the decade from 1955 to 1965, the number of factories increased 1.5 times, the number of employees 2.1 times, and production output 3.5 times.

A large petrochemical complex was formed in the existing coastal industrial zone located in the Tsurumi-Kanagawa district. Pollution due to sulfur dioxide, soot and smoke discharged from steel mills, electric power plants, and other industrial operations, became significant. Red smoke from steel mills in the Tsurumi and major dust accumulation increased.

By 1965, the Tsurumi-Kanagawa coastal industrial zone had already reached saturation point in terms of new factory space. For this reason, the city adopted a new industrial strategy, based upon the creation of new coastal industrial zones through reclamation, during this period. Two large scale reclamation projects were completed at Daikokucho in the Tsurumi ward and Negishi Bay.

The Daikokucho reclamation project started in 1955 and was completed in 1961. Large scale factories such as oil, chemical industry, electricity, and food started their operations there because of the financial incentive (exemption of municipal property tax for three years based on the municipal ordinance for forestry enticement, 1960). Air pollution was greatly worsened by a thermal electric power plant built there.

The Negishi Bay reclamation project started in 1959 and was completed in 1969. At the same time, the city laid the foundation for its future industrial development through the restoration of port facilities, construction of a new railroad line along the coastal zone, an industrial water supply system, and the expansion of the Negishi Railroad Line up to Isogo.

The city invited major Japanese companies to the new coastal industrial zones created by reclamation, and promoted development of heavy chemical industries through construction of petrochemical complexes. On the reclaimed lands in Negishi Bay, large-scale factories for petroleum, electric appliances, steel, machinery, and electricity were built by companies including Nippon Petroleum Refining Co., Showa Denko K.K., Tokyo Gas Co., Tokyo Electric Power Co., Niigata Engineering Co., Nisshin Oil Mills, Ishikawajima-Harima Heavy Industries Co., and Toshiba Corp. In addition, on the planned reclamation land in Honmoku, construction of large-scale factories for petroleum, chemistry, machinery, and transportation equipment was planned.

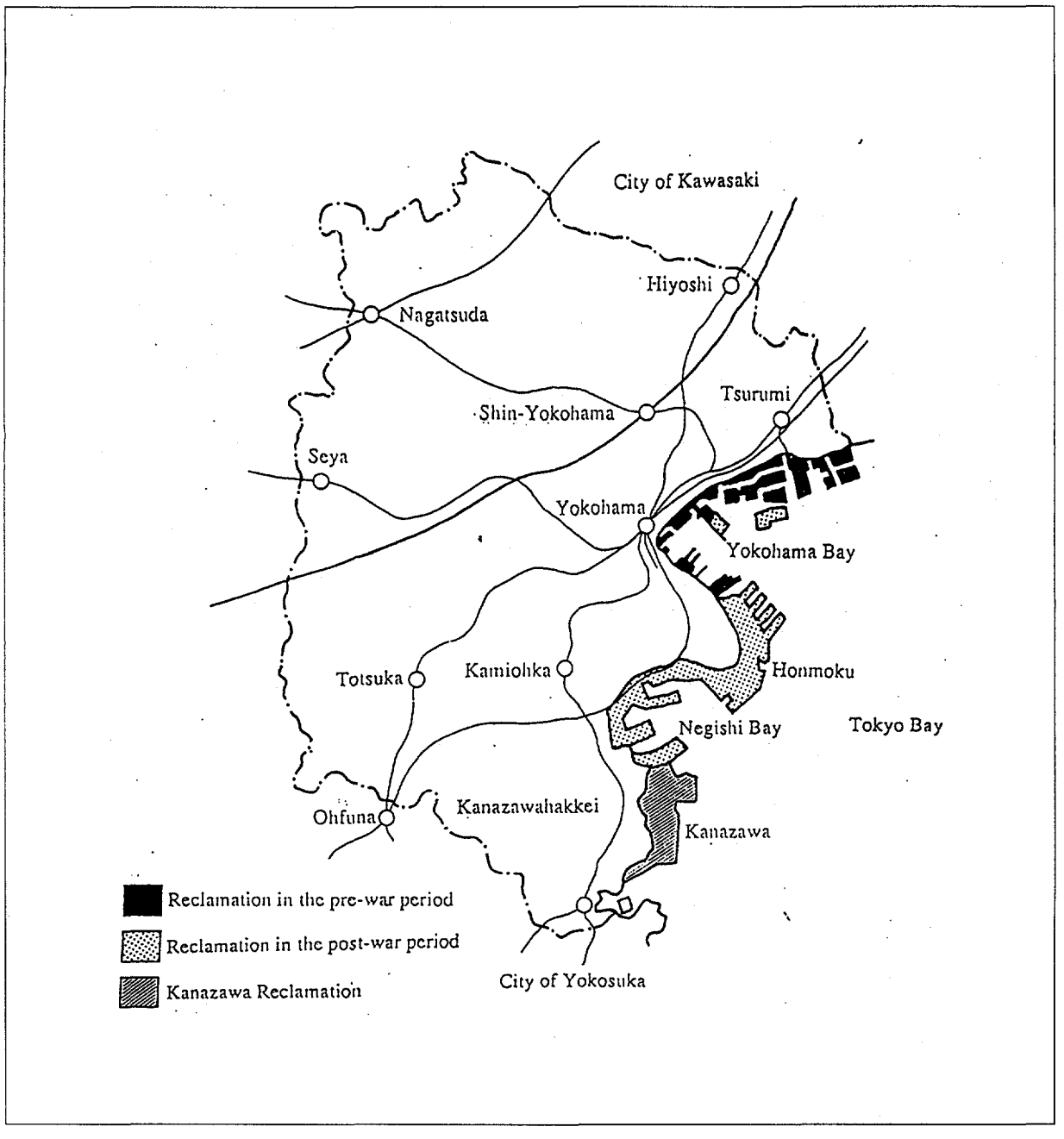


Figure 1-4: History of Land Reclamation in the Coastal Zone

Many factories were also built inland and in the suburbs of the City of Yokohama. The inland area was less attractive for companies to build their factories than the coastal zone. However, taking advantage of the inexpensive farmland, many companies built their factories inland along main roads. The majority of these new factories were machine tool factories since they did not require such vast factory space as heavy chemical industries. The tax exemption provided in the municipal ordinance for factory enticement accelerated this process. In 1963, a factory complex was built in Yabe, Totsuka district, and attracted about fifty companies.

As industrialization proceeded, the City of Yokohama also experienced a sharp increase in population especially after 1960. The population continued to grow at a rate of 100,000 per year. By 1965, the city's population had reached 1.8 million, sprawling further into the suburbs.

High Economic Growth and Rapid Population Increase (From the Mid–1960s through 1975)

As the economy continued to grow, the city rapidly changed itself into a dormitory town for Tokyo, and night-time population exceeded that of daytime. The growing centralization of political and economic activity in Tokyo resulted in an enormous population flowing into the metropolitan region from all over the country. This was an extremely difficult social phenomenon for the city of Yokohama to handle. Moreover, since it happened so quickly, it had a major influence upon the city structure of Yokohama.

The city itself witnessed a rapid increase in population. Having passed 2 million in 1968, the population continued to increase to 2.73 million in 1978, surpassing that of the City of Osaka, and ranking second in the country. This increase in population took place mainly in the suburbs of Yokohama, which developed independently from the downtown area (a doughnut phenomenon). Such an increase in population generated demand of land for housing. Agricultural land, mountains and forests were converted for housing space; between 1960 and 1970, the ratio of forest land in the city decreased by 5% from 27% to 22% and that of agricultural land decreased by 9% from 30% to 21%. In parallel with these trends, primary industry work force decreased from 5.2% to 1.8%.

During this period, the industrialization further progressed through factory construction along the coastal zones of Naka and Isogo districts (reclaimed land in Negishi Bay) as well as in the inland areas of Kohoku and Totsuka districts. The main contributors to the 1970 industrial output, which ranked third among the six largest cities in Japan, were chemical industries, followed by industries such as electricity, transportation equipment, foods, and machinery. The majority of the output was produced by large-scale factories. As the Keihin Industrial Zone became saturated and urbanization rapidly proceeded, however, further expansion and development of heavy and chemical industries was hampered by land shortages, pollution, and the resulting regulatory constraints. At this time, therefore, production output started to stagnate.

In 1965, the City of Yokohama announced the Plans for Future Development of the City of Yokohama. Under the plan, the city presented an ideal image of the city as "a port city," "an industrial city," "a residential city," as well as "an international cultural and administrative city." The city further proposed the following six main projects: Inner-City Reinforcement Project, Kanazawa Reclamation Project, Kohoku New Town Construction Project, High-Speed Railroad Construction Project, Freeway Network Construction Project, and Bay Bridge Construction Project.

These economic developments as well as concentration of population in the urban area, caused congestion and other urban problems in addition to a rapid expansion of suburbs. Moreover, an enormous increase in financial requirements to respond to these issues and to ensure minimum standards of service started to strain the city's financial resources. In order to maintain orderly urban development and to protect the living environment, the city started to strengthen its control and guidance over industrial construction and development, by establishing its own formulas and standards such as the Pollution Control Agreement, the Outline on Residential Development, and the Outline on Guidelines for Sunlight.

Urban Policies during the Last 20 Years

Social and economic changes after the 1973 oil shock were quite striking. Subsequent to two oil crises, Japan was hit hard by a contraction of supplies and demands as well as an outbreak of inflation, experiencing the most unstable state of economy in its history in the 1970s. As a result, Japan experienced negative economic development in 1974. These unfavorable economic conditions across the nation also affected industries in Yokohama. From 1972, the number of employees in manufacturing industries started to decrease, and the increase in production output slowed. From 1970 through 1979, while the number of factories increased by 20%, employees decreased by 20%, and production only increased by about 5%. Industrial output continued to decrease in the period 1980-90. In an effort to counter these trends, an industrial research institute was established in the 1980s with the objective of developing high technology industry in the Yokohama area.

Since 1970, population in Yokohama has increased by about 50,000 per year, and reached 3.22 million in 1990. Accompanying it, land development has continued, resulting in an agricultural land decrease to 11% and a forest area decrease to 8%. Employees in primary industry decreased to 0.7% in 1990, while those in tertiary industry increased to 67%. The increase in car ownership (640,000 in 1980 and 1.18 million in 1990) poses growing environmental problems for the city.

Environmental Pollution in Yokohama

This section summarizes the state of environmental pollution in Yokohama: air pollution, water pollution, noise, vibration, offensive odors, land subsidence, soil contamination, wastes and the natural environment.

Air Pollution

Ambient air pollution Figure 2-1 indicates changes in the ambient air quality in terms of concentrations of NOx, SOx, suspended particulate matter (SPM), dust fall, non-methane hydrocarbon (NMHC) in ambient air over the 1955–90 period.

Concentrations of NO and NO2 have remained almost unchanged from the mid-1980s. With respect to their distribution, high concentration is observed in areas where large-scale factories and major roads are located, and low concentration in suburban areas. SO_2 concentration reached a peak in 1967. Then, it remarkably decreased and has met environmental quality standards since 1980. SPM still does not satisfy ambient air quality standards in all monitoring stations. Dust fall decreased drastically from mid-1960 to mid-1970 and then remained virtually unchanged. Non-Methane Hydrocarbon (NMHC), which is one of the pollutants in photochemical smog, decreased substantially after 1980, but has recently started to increase again. Although the number of reported photochemical smog victims greatly decreased after the peak of 1975, smog warnings still occur in certain weather conditions.

Automobile pollution Contained in automobile exhaust, NOx and CO are major elements of air pol-

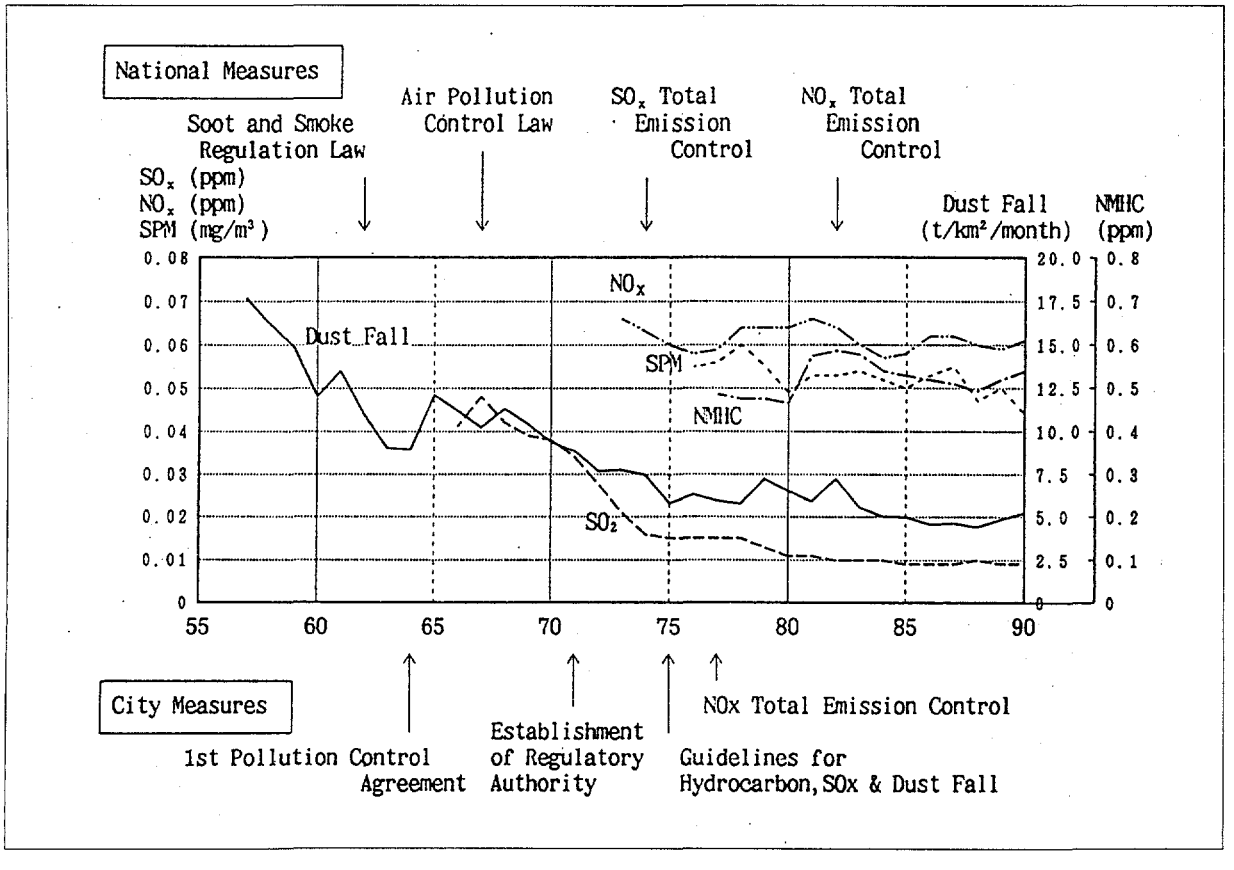
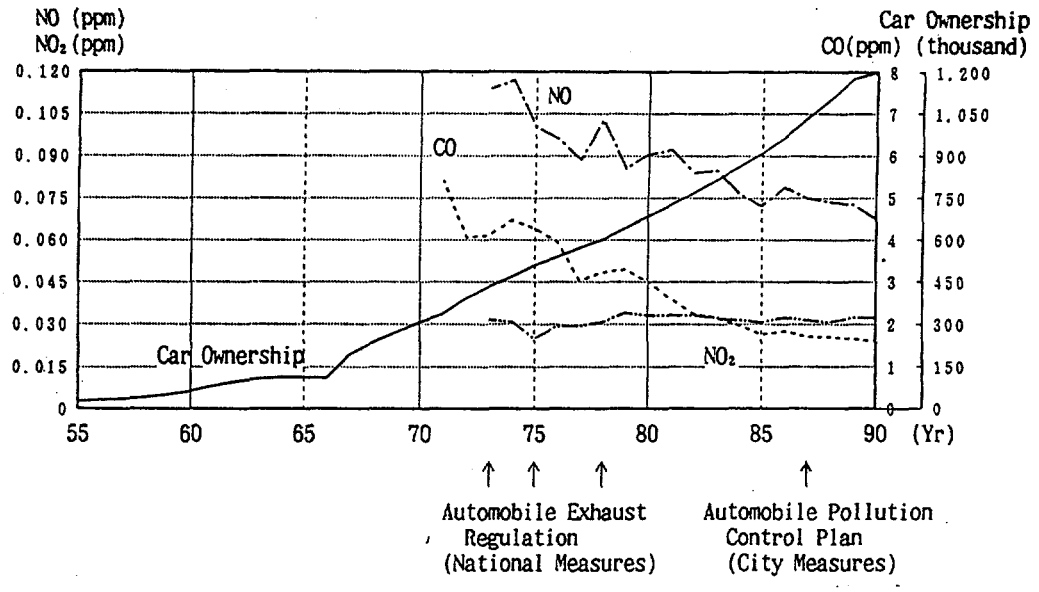


Figure 2-1: Ambient Air Quality: General Environmental Monitoring Stations, 1955–90

Figure 2-2: Ambient Air Quality Recorded at Automobile Exhaust Monitoring Stations, 1955–90



lution. Figure 2-2 shows changes in the concentrations of these substances recorded by automobile exhaust monitoring stations.

The figure clearly shows a decreasing trend over time of NO concentration, while NO_2 concentration remained unchanged as is the case with many other cities. Increases of number of automobiles are the major reason for unchanged NO_2 concentration despite application of stricter NO_2 emission control. NO_2 monitoring results recorded at most monitoring stations do not meet the ambient air quality standards. High NO_2 concentration is observed especially along trunk roads.

Because of effective exhaust gas control measures, the concentration of CO has decreased in recent years. All monitoring stations have satisfied CO concentration standards since 1978. The concentration of dust fall is not satisfactory at any of the monitoring stations, although it has shown a continual decline over time. The concentration of NMHC has recently shown a slight increase.

Water Pollution

Toxic substances (Health indicators) Figure 2-3 indicates trends in compliance with water quality standards regarding the protection of human health over the period 1955–90. The existence of toxic substances (used as health indicators) such as cyanogen, cadmium, etc. recorded a high non-compliance ratio of 4.8% in 1971. Thereafter, the corresponding percentages dropped sharply due to the enforcement of the Water Pollution Control Law enacted in 1971, which was strictly applied to the industry.

Notes:

1. No data is available for the period from 1955 to 1970.
2. Compliance ratio is defined as a/b where a is number of monitoring stations of which monitoring results met the ambient water quality standards; b is total number of monitoring stations that provided monitoring data.
3. Health indicators include several substances (Pb, CN, Cd, PCB, As, Cr, organic P, Hg) that are considered harmful to human health. They are subject to strict effluent and ambient standards.

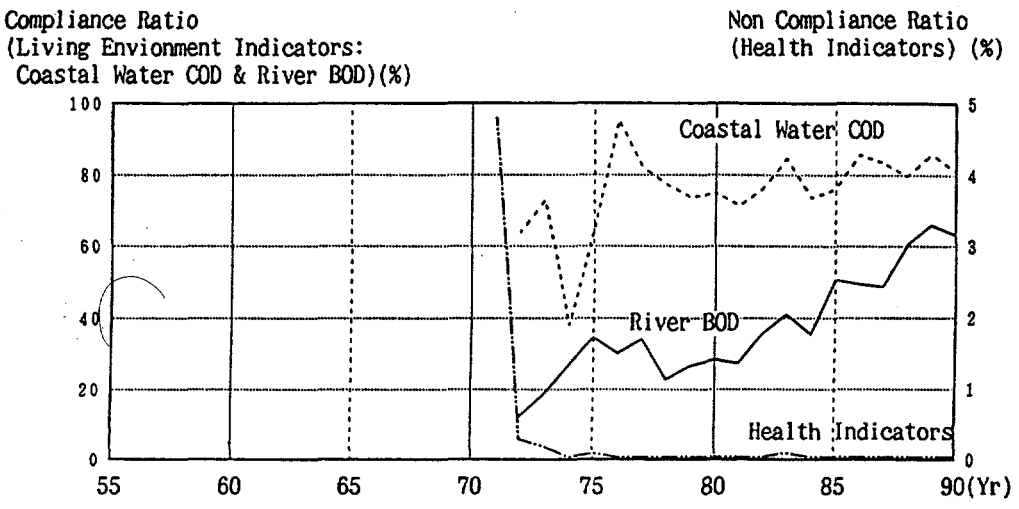


Figure 2-3: Compliance with Ambient Water Quality Standards, 1971–90

Living environment elements

Rivers Domestic waste water has historically been a major contributor to river pollution. However, there has been significant improvement in recent years due to the rapid implementation of sewerage. Figure 2-3 shows trends in meeting with water quality standards in terms of BOD, a typical indicator of river quality. The BOD standard was met at seven out of nineteen monitoring stations (37%) in 1986, and the corresponding percentage increased to 79% (fifteen out of nineteen stations) in 1992.

Coastal waters Coastal water contamination in Tokyo Bay has generally remained unchanged in recent years in spite of the fact the effluent loads have very much decreased. It is considered that this is because organism is regenerated repeatedly in the water of Tokyo Bay, which is virtually closed water body and has a small natural cleansing capacity. The coastal water quality standard as expressed in terms of COD (a typical indicator of coastal water contamination) was met at six out of seven monitoring stations 86% during the past several years.

High concentration of nutrient salt, a cause of eutrophication, has been found in Tokyo Bay. (Eutrophication is judged positive if water contains nutrient salt with concentration higher than 0.1 mg/l in T-N and 0.015 mg/l in T-P.) Eutrophication occasionally causes red tide in Tokyo Bay.

Organochlorine chemical substance (underground water) Since around 1980, underground water contamination due to chlorinated carbon substances attracted attention. Chlorinated carbon substances are used for industrial cleaning and dry cleaning of clothes. The Yokohama city administration investigated underground water contamination in 1,160 wells from 1982 to 1990, and found that contamination was widespread. The investigation also revealed that 403 wells (34.7%) had one of three substances such as trichloroethylene, tetrachloroethylene, and 1.1.1-trichloroethane. Of the 403 wells, 53 out of 1,160 wells contained the substance at levels which exceeded national standards. (In 1992, those substances were added to the health indicator items that are subject to a strict ambient and effluent standards.)

Noise and Vibration

Factory-oriented noise and vibration, specifically caused by large-scale factories, has decreased over time. However, sources of noise have become more diverse; thus, complaints about noise emanating from *Karaoke* (singing) bars, speaker phones, and construction work have increased. Also, traffic noise of trunk roads greatly exceeds environmental noise standards.

Offensive Odors

There are almost 200 complaints about offensive odors every year, which account for about 20% of the total pollution complaints. These originate from incineration, stock raising, and coating, all of which generate a relatively large number of complaints, mostly of from residential areas.

Land Subsidence

Land subsidence in Yokohama city used to originate from an overpumping of ground water for industrial uses in the coastal zone. Then, the major cause shifted to large-scale underground excavation in river basins, and downtown areas. However, the subsidence problem has been largely overcome by reduction in use of ground water.

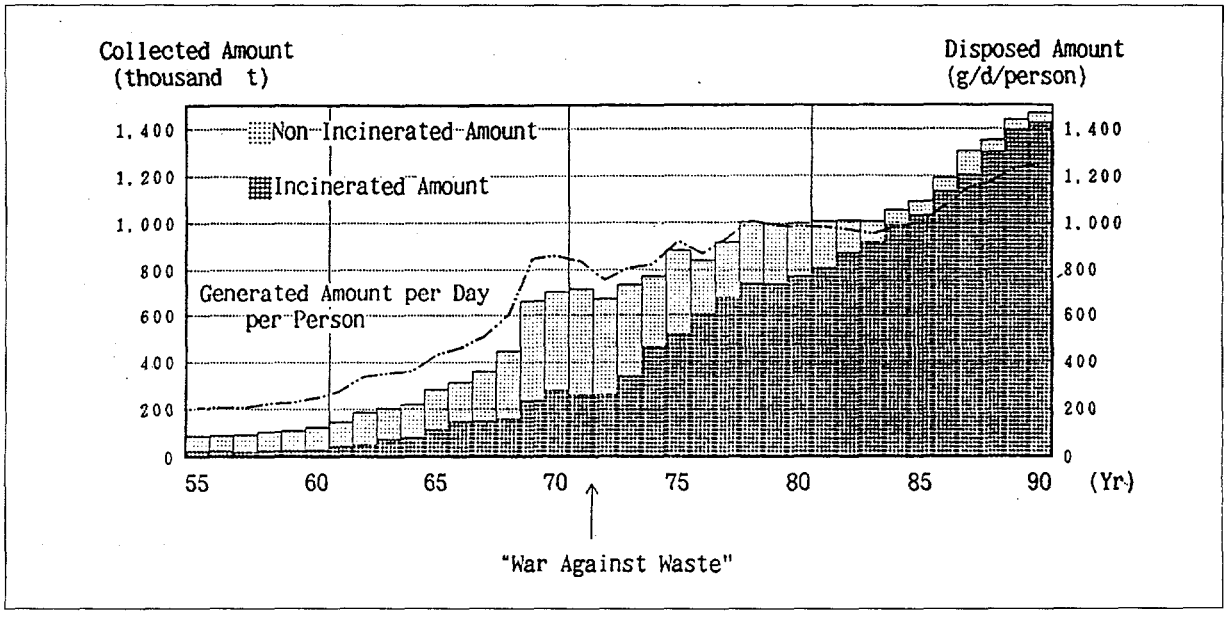
Soil Contamination

Soil contamination caused by mercury and PCB was revealed from analysis of waste generated by a chemical factory in 1973. Since then, several incidents of factory waste, contaminated by toxic substance have been identified every year. It was revealed through the factory surveys conducted for six years since 1986 that twelve out of forty eight registered factories contaminated soil.

Solid Waste and Night Soil

Domestic wastes Figure 2-4 shows annual collection amount of domestic wastes, which was 86,000 ton in 1955. Then, it continuously increased with rapid population and economic growth as well as resulting changes in lifestyle in the 1960s, and reached 1,468,000 ton in 1990. The waste generation amount became seven times larger during ten years since 1960.

Figure 2-4: Solid Waste Disposal, 1955–90



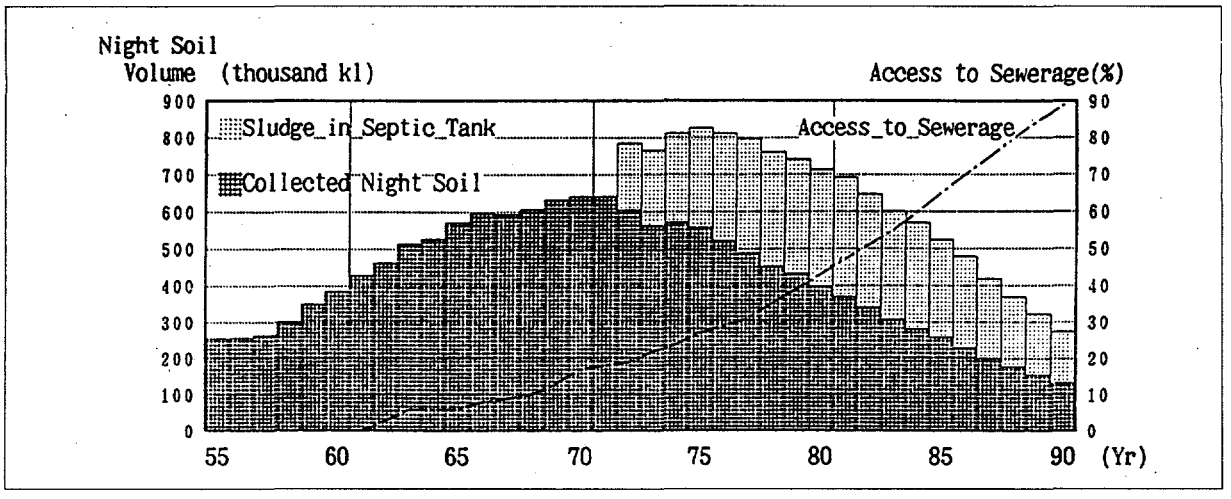


Figure 2-5: Night Soil and Access to Sewerage by Residences, 1955–90

It became increasingly difficult for the Yokohama city to find land for final disposal (landfill) sites. The situation got so serious that the mayor declared "War against Waste." The city government constructed a number of incinerators. In 1990, 97% of the municipal waste collected was incinerated, while the ratio was less than 30% in 1955.

Treatment of night soil Figure 2-5 indicates the collected night soil amount. It was 256,000 kilo liter/year in 1955, and increased because of the decrease in agricultural population and the increasing difficulty in using night soil for agricultural purpose due to urbanization. In 1970, the amount reached a peak of 641,000 kilo liter/year, and decreased thereafter.

Night soil sludge amount was in its peak in 1980, and decreased thereafter because of the development of the sewage system. In 1970, the night soil sludge was only one-third (1/3) of the night soil collection amount. However, the current sludge amount is slightly larger than the night soil collection amount.

Industrial wastes The estimated amount of industrial waste was 5,840,000 ton/year in 1980, 7,610,000 ton/year in 1986 and 9,920,000 ton/year in 1991. It grew 1.7 times over the 11 years period. The largest part of industrial waste is generated by manufacturing industry, followed by electricity, gas, water supply, and construction industry. With respect to the type of industrial waste, sludge comes first, followed by construction waste.

Because of constraints on land acquisition for final disposal, waste reduction through recycling and waste treatment for reduction is important in Yokohama and throughout Japan. Table 2-1 shows that the final disposal amount was reduced to a quarter of waste generation amount in 1991 through recycling and waste treatment such as incineration, de-watering and drying, etc. Noteworthy is that amount of waste reduction through treatment such as incineration has increased remarkably, 169% of the corresponding amount in 1986.

Environmental Protection Measures in Yokohama

This section presents a summary of environmental protection measures in Yokohama in each of main periods described earlier.

Table 2-1: Recycling and Waste Volume Reduction through Incineration, De-watering, and Drying, etc. of Industrial Wastes

	1986	1991
1. Waste Generated	7,610,000 t/d (100%)	9,920,000 t/d (100%) [130%]
2. Waste Recycled	2,420,000 t/d (32%)	2,620,000 t/d (26%) [108%]
3. Waste Reduced through Waste Treatment such as Incineration, De-watering & Drying	2,950,000 t/d (39%)	4,990,000 t/d (50%) [169%]
4. Waste Disposed of at Landfill Site (1-2-3)	2,240,000 t/d (29%)	2,310,000 t/d (24%) [103%]

Note: Percentages shown in [ ] indicate ratios of 1991 amounts to 1986 amounts.

Industrial Promotion and Pollution: Countermeasures Based on Ordinances of the Kanagawa Prefecture (1950s to mid-1960s)

Socioeconomic situation and pollution Immediately after World War II, air pollution often caused asthmatic diseases, especially among the US Army and families located at the Yokohama base. A US Army doctor in Yokohama disclosed information on this disease, which was later called "Yokohama asthma". Public health staff in Kanagawa prefecture and Yokohama jointly researched the problem.

As noted earlier, the rapid industrial development and economic growth which accompanied the post-war reconstruction, was attained by developing and integrating industry in the zone which had existed from pre-war times in Tsurumi and along the Kanagawa coast. Accompanying this process, industrial pollution such as land subsidence due to the pumping of ground water, as well as soot and smoke, industrial waste water, noise, and vibration increased rapidly. The content of the damage was similar to the one experienced in the pre-war period. Pollution in this period can be said to be an extension of pre-war pollution. Of the twenty-four cases involved in the pollution disputes in Kanagawa prefecture of 1952, noise was the most frequent problem, followed by air pollution such as soot and smoke, gas, and dust, and water pollution due to waste water.

Countermeasures taken by Kanazawa prefecture At this time, there were no national guidelines on pollution countermeasures. There was no coherent pollution control policy at the prefectural level; priority was given to the industrial development, and pollution countermeasures only took place if they were "in harmony" with economic objectives.

In this situation, following the "Tokyo Municipal Pollution Control Ordinance" (1949), which was the first of its kind enacted by a local government during the post-war times, "Kanagawa Prefecture Workplace Pollution Control Ordinance" was enacted in 1951 in Kanagawa prefecture. According to this ordinance, the objective of pollution prevention was "the harmonization of industrial development and the welfare of residents." With regard to the content of the pollution regulations, in order to avoid damages on people and property due to noise, vibration, soot and smoke, or drainage water, measures to adjust factory operations were taken. However, there were no specific regulations regarding the discharge of pollutants. Criteria for anti-pollution measures were often abstract, and no specific obligations were stipulated. The role of the prefectural administration was merely to advise companies on pollution control measures when problems arose. It is noteworthy that the administrative responsibility for environment management rested on the Commercial Division of the Economic Department of Kanagawa Prefectural Government.

National countermeasures Belatedly, following the pollution control ordinances of the local governments, the national government enacted laws for water pollution control, the "Water Quality Conservation Law" and the "Factory Effluent Control Law" (1956) and the "Soot and Smoke Regulation Law" (1962). These laws included economic harmonization provisions that could be used to relax the enforcement of the law depending on financial conditions of enterprises. Yokohama city was designated by the "Soot and Smoke Regulatory Law" in 1963. The emission standards stipulated in the laws were extremely lax, and these laws were not capable of effecting adequate pollution prevention.

Yokohama city began to deal with pollution by commencing basic studies and installation of soot particle deposit gauges in the coastal industrial zones of Tsurumi ward and Kanagawa ward in 1956. From 1958, in addition to measuring dust fall in the entire city, monitoring of sulfur dioxide resulting from the lead dioxide process also began. From 1959, the city itself began to handle all pollution complaint cases, and in that year some 657 cases were dealt with. Furthermore, as a result of the revision to the Kanagawa Prefecture Business Establishments Pollution Control Ordinance of 1961, more environmental responsibilities were entrusted to the city from the prefectural government. A pollution official was posted to the Public Hygiene Division of the Bureau of Hygiene, which was responsible for health and sanitary conditions, and the processing of complaints was conducted.

In the national laws and prefectural ordinances of that time, cities were not recognized as having any authority with regard to the regulation of pollution sources, and could not carry out any direct countermeasures. Indeed, the cities themselves often adopted an approach of not revealing pollution problems in order to attract factories for industrial growth. The period from the mid 1950s to the mid 1960s was an important one for pollution control. The measures described above were the initial steps in systematizing the measurement of pollution and handling grievances about it.

Intensification of Industrial Pollution: the "Yokohama Style" Response (1960s to mid-1970s)

Socioeconomic situation and pollution In order to promote industrialization in this period, besides the existing coastal industrial zone (the Tsurumi and Kanagawa districts), Yokohama city created factory sites by reclaiming other coastal areas such as Negishi Bay, and the Daikokucho and Honmoku areas, and attracted large-scale factories.

Amid these developments, pollution in the existing coastal industrial zones of Tsurumi and Kanagawa increased, and the "red smoke problem" occurred in Tsurumi. This was caused by emission of iron oxide. Complaints involved laundry being dyed red, blighting of garden plants, and the large quantities of dust.

In the newly reclaimed areas of the Negishi and Honmoku districts where the expansion of corporations had begun, from about 1960 petitions from local medical associations were made against the damage from soot and carbon black emitted from petroleum refineries. On the occasion of the expansion of large-scale electricity and gas plants, etc., this developed into an organized anti-pollution movement of the local citizenry.

Countermeasures taken by Kanazawa prefecture

With the abolition of the old ordinance, the "Kanagawa Prefectural Pollution Control Ordinance of 1964" was introduced. The ordinance gave the mayor the authority for pollution control. According to the ordinance, the regulatory target covered not only factory but also general business enterprises; and it introduced a license and notification system for target machinery and works. The notifi-

cation system was a pioneering innovation. In addition to the former administrative guidance and leadership method, the ordinance emphasized regulatory aspects, but the "harmony" provision remained. In June 1964,"Pollution Standards Regulations" were established. The regulations required objective standards in order to strengthen administrative authority, including the power to order a suspension of industrial operation. The determination of pollution standards according to the major use of river water was an important innovation.

Countermeasures taken by Yokohama City

Background Air pollution caused by sulfur dioxide and dustfall was the main form of industrial pollution in this period though water contamination also existed. Additionally, though the volume of sulfur dioxide discharged from the existing coastal industrial area in Tsurumi/Kanagawa accounted for about 90% of the city total, the city had no authority to directly regulate the source of pollution or take measures against it. Yokohama city continuously measured the concentration of sulfur dioxide and dealt with complaints on a case-by-case basis.

Under these circumstances, in 1963, the reformist Mayor Asukata came into power. He pledged to implement pollution prevention policies, and the foundations of the pollution prevention policies of Yokohama were rapidly laid. In 1964, a pollution section was established in the Public Health Division, Bureau of Hygiene and was promoted as the Pollution Control Center.

Pollution control agreement In 1964, the first Pollution Control Agreements was concluded between Yokohama city and a thermal electric plant that was planned to be constructed in the Negishi Bay reclamation area where there were construction plans of not only this electric power plant but also an oil refinery, and other enterprises. If all these facilities were constructed, sulfur oxide emissions were predicted to increase to the same level as in the Tsurumi and Kanagawa districts.

The pollution control agreement was the country's first genuine effort to address environmental problems caused by industry. Yokohama, which had no legal authority with regard to pollution regulations at the time, used the leverage of one item of the real estate sales contracts, and through discussion brought the industrialists to commit themselves to execution of pollution control measures. Based on scientific data on the present state and estimated future growth of air pollution, the agreement prescribed strict, extremely practical and effective measures which concretely dealt with pollution prevention measures. Agreements were concluded with petroleum plants which subsequently located in the reclaimed areas in Yokohama, as similarly done with existing large-scale steel, chemical, petroleum, and electric power enterprises before they constructed or expanded production facilities. The initial pollution control agreements demonstrated that obtaining consent of the local government and local residents when establishing plants was indispensable for the smooth execution of corporate activities. To obtain industries' cooperation, it was also necessary to ensure that the environmental studies were all scientifically sound. These series of pollution control agreements came to be called the"Yokohama method."

The pollution control agreements made possible to reduce sulfur oxides emissions from the factories in the Negishi Bay to one-third (1/3) of the level predicted without agreement. The ambient concentration of sulfur dioxides in Yokohama already began decreasing in 1968 when application of K-value (SOx emission concentration) regulation started.

Rapid Economic Growth: Strengthening of National Pollution Policy (latter half of 1960s to 1970s)

Socioeconomic situation and pollution In Yokohama as in many other large cities, rapid popu-

lation growth and industrial development in the period of high level economic development led to the mixing of commerce, industry, and residences in urban areas and the phenomenon of sprawl, bringing about the deterioration of the living environment.

Countermeasures taken by national government and Kanazawa prefecture

As pollution intensified, a full-scale response at the national level began to take shape. In 1967 the "Basic Law for Environmental Pollution Control" was enacted. This was a period of strengthening national pollution policy, with enactment of the "Air Pollution Control Law," the "Water Pollution Control Law of 1970" through the "Pollution Diet" (this Diet session was given this name because the entire session concentrated on pollution problem), the "Waste Disposal and Public Cleansing Law" and establishment of the Environment Agency in 1971, etc. In Kanagawa prefecture, the "Pollution Control Ordinance" was revised.

Countermeasures taken by Yokohama City

Expansion of organization of regulatory authority In Yokohama, the Pollution Control Center established in the Bureau of Hygiene became independent in 1971 as the Pollution Prevention Bureau. A good deal of regulatory authority with regard to air pollution and water pollution was also delegated to the mayor. As a result, the various laws and prefectural ordinances became the basis of legal regulations for pollution countermeasures. Countermeasures taken by Yokohama city include monitoring and surveillance of pollution-generating business enterprises, public waterways, and air quality, along with various types of regulations.

In 1973, Yokohama city prepared a comprehensive city development plan that has a slogan, "Create new town by citizens." In this plan, pollution control was placed at the top of the list of actions for protection of citizens' life. The city expressed its environmental protection goal in easy words instead of using figures so that the citizens could understand the environmental goals easily.

Development of pollution control agreements and changes in principles and guidelines The pollution control agreements, which targeted large-scale factories, actively progressed in the 1970s. The agreements were concluded with existing plants, when plants moved and when new extensions were undertaken. The pollution control agreements first targeted air pollution control, mainly control of sulfur oxides and subsequently, targeted water contamination control and waste control.

With regard to large corporations, from the latter half of the 1970s, uniform pollution control policies came to be executed based on the experience of making pollution control agreements. The next task was how to deal with small- and medium-sized enterprises. In contrast to the individual handling of large-scale enterprises, it was agreed that the use of relatively uniform measures was sufficient, and an approach involving guidance and directives was followed. The guidelines were prepared based on the previous pollution control agreements. The reason why the city used guidelines instead of establishing its own ordinance was that it was unnecessary for the city to create a municipal ordinance which complemented the prefectural ordinance. The guidelines were generally followed by small and medium industries.

Kanazawa reclamation project Among the pollution control measures in Yokohama, strict control of large-scale companies were enforced under the environmental pollution control agreements. This turned out to be effective since these companies possessed enough technological and economic capacity to respond to the measures. On the other hand, measures against small- and medium-sized companies, which were scattered throughout the

city, were difficult to enforce, and their implementation lagged behind.

Emission control and promotion of fuel conversion by guidelines and directives as stated above were therefore introduced. However, there were still serious pollution problems caused by small- and medium-sized enterprises which were located in the mixed district of housing and factories. Water pollution as well as noise pollution and vibration were caused by traditional local industries such as plating and textile printing along the Ooka and Tsurumi Rivers.

The small- and medium-sized companies were limited in their ability to implement pollution control measures in their existing sites in terms of economic and technical capacity and due to the condition of their location. Accordingly, the city started to consider moving these companies to more appropriate areas, such as industrial complexes. By doing so, the city intended to help promote industrial development by rationalizing factory management, as well as by reforming and strengthening their management. This would also help the city prevent and control pollution, as well as organize and redevelop the city zone.

In Yokohama city, this measure was realized by the construction of Kanazawa Industrial Park in the reclaimed land beyond Kanazawa district. The Kanazawa Reclamation Project had been formulated under the Comprehensive Construction Plan of Yokohama International Port City of 1966. The reclamation project started in 1971 and was completed in 1981. The goal of the project was more than just building an industrial site or a port facility as in the past. The ultimate goal was to reclaim land as a site for redeveloping the downtown area and accommodating small- and medium-scale factories scattered around the city, thereby strengthening land utilization and controlling pollution. Along with this, collective organization of small- and medium-sized industries and joint use of facilities was promoted and pollution control measures were implemented with rationalization and strengthening factory management.

The reclamation project was formulated with careful consideration of environmental aspects and urban planning. In determining land utilization and segmentation, the city secured about 10% of total reclaimed land for building a seaside park, a park on the original coastline, and green buffer zones. The city also developed an urban redevelopment site equipped with anti-pollution facilities, and secured sites for residential buildings and public facilities.

Air pollution control Air pollution countermeasures were mainly aimed at providing a monitoring system based on the Air Pollution Control Law, achieving the environmental quality standards for sulfur oxides, and promoting countermeasures for hydrocarbon and nitrogen oxide. Modernization of a monitoring system for ambient air and automobile exhaust gas made it possible to monitor polluting factories regularly. Sulfur oxides met the existing environmental quality standards in all the city monitoring stations through countermeasures such as Yokohama Pollution Control Agreements with the large-scale factories in the coastal district from the 1960s; K-value regulations (on SOx emission concentration) in the Air Pollution Control Law; and total emission control in the Prefectural Ordinance. However, environmental quality standards were then revised in 1974. To meet the new standards, Yokohama city formulated administrative guidelines including countermeasures relating to small- and medium-sized enterprises and established total emission control mainly on fuel. Furthermore, since total emission control was carried out based on the Air Pollution Control Law, the new environmental quality standard was met from the 1980s and then, air pollution due to sulfur oxides became less of a

national concern. Due to these regulations, annual emissions of sulfur oxides in the city fell to 3,000 tons in 1980, 3% of the peak of 103,000 tons in 1968. Trends in dust fall paralleled the reduction in sulfur oxides, and also decreased significantly, particularly between 1965 and 1970.

The "Nitrogen Oxides Countermeasures Guideline" introduced a total emission control. While the preventive measures against fixed pollution sources spread, new sources such as air pollution from automobile emissions became a problem. Japan's objective was to reduce emissions of CO, hydrocarbon, and nitrogen to about 10% of existing levels based on 1970 Amendments of the Clean Air Act. Although this objective was scheduled to be fully implemented in 1976, it was postponed, and a staged upgrading of the standard was legally accepted because of a request from manufacturers.

Opposed to this national action, Yokohama considered automobile pollution as a common problem among large cities, and joined the "research association on automobile exhaust gas for seven large cities" with Tokyo, Kawasaki, Nagoya, Kyoto, Osaka, Kobe in July 1974. Research based upon traffic surveys and cost of new emission standards made it clear that regulation by 1976 was technically and economically possible. The association therefore requested the national government to fully implement the regulation. In the summer of 1975, the city implemented an investigation of NOx and CO emission from automobiles and used the study results to establish the level of regulation. With respect to hydrocarbons, following the damage due to photochemical smog in the city in 1971, the city investigated photochemical air pollutants from factories and workplaces, and prepared guidelines for controlling photochemical air pollutants. The reported number of victims in photochemical smog reached its peak in 1975 and then, decreased drastically. However, warnings are still issued depending on weather conditions.

Because of the enactment of Air Pollution Control Law with strong objectives, many regulations were set up during this period and they forced the industries to take necessary measures. Of course, the implementation was possible because the industries had enough financial capacity and developed technology.

Water pollution control Water pollution control activities during this period included development of a monitoring system based on the Water Pollution Control Law, tightening the regulations against polluting factories to meet the environmental quality standards for toxic substances in public waters, and development of sewerage service.

The telemeter monitoring system for water quality was established following the orderly set up of regular monitoring stations for river and coastal water body.

Toxic substances such as cyanogen and mercury continued to pose threats to public waters and, in consequence, to human health. The rate of non-compliance with environmental quality standards relating to toxic substances was 4.8% in 1971. However, toxic waste decreased due to enforcement of a strict regulation against factories, and is now rarely found. In this period, due to effective effluent control on large-scale factories in the coastal district, problems of water contamination with industrial waste water had been much alleviated. On the other hand, water contamination with domestic sewage became increasingly serious in this period. Since Yokohama city had not yet fully developed a sewerage system, quick development was felt desirable.

Soil contamination Soil contamination due to toxic substances became a problem. Soil contamination due to mercury and PCB was found on an

old chemical factory site in 1973, and since then the city has provided guidance to buyers and sellers of factory sites on which toxic substances was used. In 1986, the city established the "Guidelines for Soil Contamination Measures in Old Factory Sites" which provided instructions with respect to disposal of contaminated soil.

Solid waste management The volume of waste disposal in Yokohama greatly increased accompanied by a rapid increase in population and high economic growth in the 1960s. It doubled in five years from 1960, then, almost tripled during the five years from 1965 to 1970, and increased seven times during the decade of 1970s.

The city started construction of modern incinerators in 1969. Incinerators constructed by 1970 had a total capacity of incinerating 40% of the total waste amount collected by the city.

Acquisition of sites for final disposal became so difficult for the city that it declared "War against Waste" in 1972.

Urban Pollution and Energy Conservation: Response to the New Environmental Pollution and Creation of a Comfortable Living Environment (latter half of the 1980s)

Socioeconomic situation and pollution During this period, the population of Yokohama continued its steady increase. As mountain, forest, and farm lands gave way to housing sites, the water retention capability of the land declined. Environmental resources were strained by demands for recreational lake and river facilities, and as household income increased, the number of automobiles owned in Yokohama also grew rapidly. From the 1980s, therefore, the importance of conventional industrial pollution declined. The focus shifted from industrial pollution to the newer issues of pollution related to daily urban living, energy conservation, and the demands stimulated by increased incomes for a comfortable living environment. These problems, complicated and diverse as they are, have imposed a new challenge to environmental authorities in the country.

Countermeasures taken by Yokohama City

Environmental management policies Yokohama recognized during the mid-1980s that it was time to shift its emphasis from exclusive concern with industrial pollution, and that it was necessary to establish an environmental assessment system in parallel with existing measures in order to protect and create a good city environment. Through the discussion in the council for control of environmental pollution, the city introduced the "Guidelines for Yokohama Environmental Assessment" in April 1980. The guidelines consist of a procedure for environmental assessment and a description of the methodology by which a project proponent can undertake environmental assessment.

Further, Yokohama adopted the "Yokohama Environmental Basic Charter" in March 1986 which was intended to form a good city environment for the 21st century based upon a balance between nature and human conduct. Emphasizing that everybody should participate in the creation of a better city, the Environmental Basic Charter had a slogan, "Yokohama with good environment where the citizen can live safely and comfortably." Cooperation between citizenry, business, and administration was urged. At the same time, Yokohama designed the environmental management plan (Environmental Plan 21). This plan was expected to realize the environmental slogan stated in "Yokohama Plan for the 21st century," which was prepared in December 1981. It was recognized necessary not only to implement various environmental measures individually as in the past, but also to implement a comprehen-

sive and well-planned environmental administration from the new standpoint. Environmental Plan 21 was earmarked as a foundation of the new environmental administration.

Air pollution control Nitrogen oxides from automobiles have become a major problem. Although the city established the "Administrative Guidelines for Nitrogen Oxides Control Measures" aimed at achieving total emission control, environmental quality standards have in practice not been met. The city has therefore formulated the "Yokohama Automobile Pollution Control Plan," taking various measures to address this source of pollution, including traffic volume control, road improvements, and so on (See ANNEX 1).

Water pollution control After having improved water quality in terms of health indicators such as cyanogen and mercury, it became necessary to improve water quality in terms of living environment indicators such as SS and BOD. The relative importance of domestic pollution increased. River and sea pollution due to discharges of synthetic detergents from households became evident.

The quality of the major river in the city has improved in recent years with the rapid development of the city sewerage system. However, there are some upper reaches and branch rivers that need more improvement in water quality. A decrease in water volume in the river is anticipated due to the development of sewerage system. After having improved drinking water quality, the citizens now demand the amenities from a clean water environment and comfortable access to bodies of water.

Overall, contamination of coastal waters has remained unchanged in recent years. In Tokyo Bay, red tide due to eutrophication caused by nutrient salt (nitrogen and phosphorous) still occurs. Groundwater pollution due to an organic chlorine chemical substance (trichloroethylene) also raised apprehension in the community. The city investigated the source of this contamination at factories concerned, and prepared "Guidelines for Trichloroethylene" and "Guidance Manual," and also provided technical assistance in specific cases.

With respect to actions concerning unregulated chemical substances and high-technology pollution control, the city prepared "Yokohama tentative guidance for environmental protection in connection with high technology industry," and also provided technical supports and advises in specific cases. Furthermore, in response to the environmental pollution caused by use of agricultural chemicals at a golf course, the city concluded the "environmental

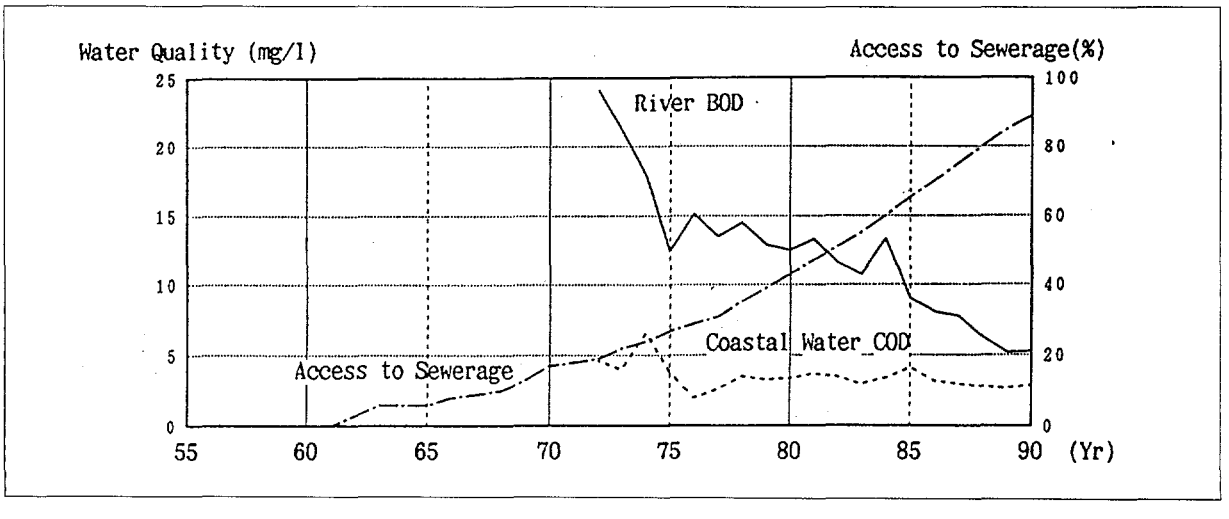


Figure 2-6: Water Quality in Public Waters and Access to Sewerage by Residences, 1955–90

protection agreements regarding the use of agricultural chemicals" with five golf courses in 1991.

General amenity The needs of the citizenry are not limited merely to pollution control, but have come to include comfortable living and recreation. In today's Yokohama, the upgrading of city parks, protection of green areas, and preparation of green buffer zones are being introduced. River facilities originally designed for flood prevention are viewed also as amenity facility. In reclamation areas, artificial beaches are being prepared, and people have begun to re-create the natural environment that was once destroyed.

Organization of Environmental Protection in Yokohama City

This section describes the initial establishment and subsequent evolution of the organization responsible for environmental protection measures in Yokohama.

Establishment and Changes in Responsibility for Sewage, Night Soil, and Waste

Yokohama city had started its basic sanitation departmental bureau for water supply, sewerage, night soil treatment, and waste disposal, and provided these services even in the pre-war period.

Sewerage system. With respect to its sewerage system, Yokohama introduced its first piped drainage installation in its foreign district (presently Yamashita-cho, Naka-ku) in 1869 right after the Yokohama port-opening. It subsequently built another drainpipe in its downtown area. However, in the pre-war period, the city still did not have a comprehensive drainage system. The Civil Works Bureau had primary responsibility for sewerage, but there was no division or section with explicit responsibility of sewerage which was temporarily set under the engineering works division of the Water Supply Bureau.

In the immediate post-war period, Yokohama could not conduct total city planning because of the long period of US army occupation, and did not carry out a systematic sewerage development. With respect to organizational structure, there were sewage sections under the Reconstruction Bureau, the Water Supply Bureau, and the Construction Bureau, respectively. In 1949, Yokohama integrated the sections into the Sewerage Division of the Construction Bureau. In 1950, a flood prevention project started in Tsurumi district as part of full-scale sewerage development scheme (excluding rainwater). Construction of a sewage treatment plant for the central district started in 1957. In 1961, the Sewage Division (later renamed as Sewage Works Department) was created under the Civil Works Bureau, becoming independent and entitled the Sewage Works Bureau in the same year.

The bureaus such as civil works, sanitation, etc. monitored the quality of public waters since the early 1950s. The sewerage facility division of the construction bureau had measured the water quality regularly between 1957 and 1966.

Solid waste A waste disposal service in Yokohama started first with the waste collection and disposal by private operators in foreign residents areas and downtown areas during the port-opening period. The city began direct operation of solid waste collection in 1917 (the Taisho period) and completed its construction of the Waste Treatment Plant in 1931. This was the largest plant in the Orient at that time. Since then, the city has gradually expanded solid waste collection and disposal facilities. In 1946, the Waste Management Division of the Sanitation Bu-

reau resumed its responsibility and expanded waste collection areas. The division was upgraded into a bureau in 1951 after which it developed a full scale waste disposal system including a series of incinerators.

Figure 2-4 shows the amount of waste collection and treatment since 1955. The amount of waste in Yokohama increased largely along with rapid population growth and high economic growth. However, the capacity of incinerators was not enough and only 40% of total collected waste in 1970.

Figure 2-7 shows trends of the city's solid waste management expenditures and of the number of staff members in the Cleansing Bureau. In the 1960s, the expenditures increased gradually and, since 1970, increased rapidly mainly due to construction of modern incinerators.

The share of solid waste management to the city's total expenditure was 1.9–2.5% during the 1960s and 4.0–4.8% during the 1970s. The number of staff of the Cleansing Department was about 1,000 in the middle of the 1960s and increased 3 times in 30 years.

Night soil Night soil management service in Yokohama was originally provided by private operators. In the port-opening period, these operators collected night soil and collection fees from households. The night soil was in turn sold to farmers. After that, the "Waste Disposal and Public Cleansing Law" imposed a legal restriction on a night soil management. In some areas private operators were not able to expand their service fast enough to keep up with increases of night soil quan-

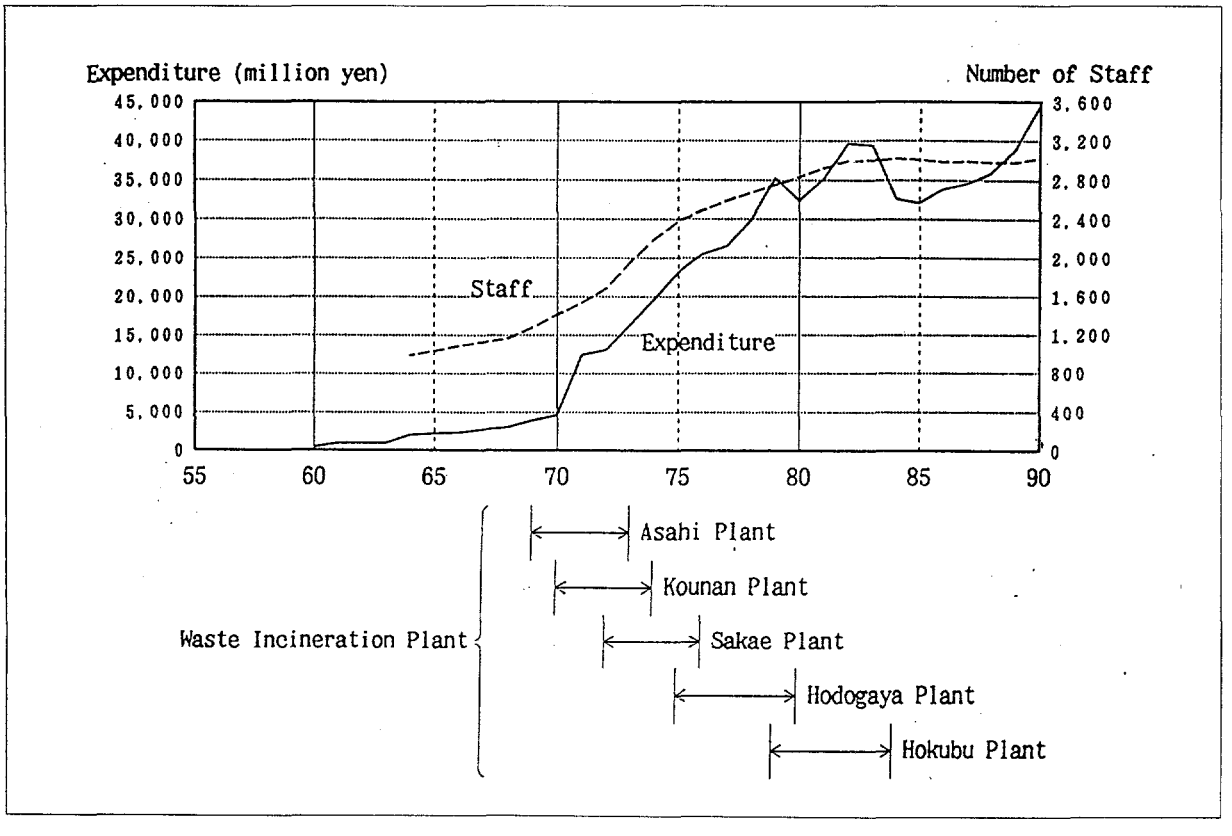


Figure 2-7: Solid Waste Management: Expenditure and Employment, 1955–90

tities. To cope with the situation, the city started its own collection service in 1924 for public facilities and private houses that applied for the service.

On the other hand, there was constant conflict over territorial expansion among private operators with the increase of private houses following downtown development. The "Kanagawa Public Cleansing Regulations of 1933" in the pre-war period introduced a business license system for night soil collection operation and regulated the business. Following WWII, private enterprises resumed its operation. The "Public Cleansing Law of 1954" stipulated that municipalities were responsible for night soil management. Municipal governments introduced a business license system for night soil management and a uniform fee for collection. They also made clear the operational territory of each night soil collection company, and thereby facilitated a smooth operation.

Institutional Development of Pollution Control and Environmental Actions

Different from the bureau in charge of sewerage, solid waste, and night soil, another bureau — responsible for pollution countermeasures — was established more than a decade after WWII. Table 2-2 shows the changes of the number of staff members in charge of pollution control and environmental actions.

Commencement of environmental measurement Pollution countermeasures in the city first started with the installation of facilities for dust fall measurement in 1956 and of sulfur dioxide measurement by the lead dioxide (PbO_2) method in 1958. Originally, these were research studies on urban sanitation in the Yokohama Health Institute. These were simple measurement methods and did not target a specific pollution source. However, these measurements have been useful in identifying long-term trends in pollution. Therefore, the city still uses the 30-year old methods of measurement in addition to its modern and expensive, automatic measurement system.

Complaint Settlement Systematic actions for environment and pollution in the Yokohama city administration originated with the creation of a post for a pollution specialist at the Public Health Division under the Sanitation Bureau in June 1961. Because revision of the Kanagawa Project Site Pollution Control Ordinance required a transfer of a part of environmental management responsibility from the prefectural government to the city, that position was created for settlement of complaints at the health center, which was a branch office of the Sanitation Bureau. The health center was responsible for handling pollution problems. Technically compli-

Table 2-2: The Changes of the Number of Staff Members in Charge of Pollution Control and Environmental Actions.

Year	*Number of Staff*	*Events*
1960	0	
1961	1	Appointment of pollution specialist at the Public Health Division
1964 (April)	7	Deployment of staff in charge of pollution
1964 (December)	10	Establishment of Pollution Control Center
1971	38	Establishment of Bureau of Pollution Control
1973	84	Reorganization of the Bureau
1976	134	Establishment of Pollution Research Institute
1980	164	Establishment of Office of Environmental Impact Assessment
1984	168	Establishment of Bureau of Pollution Control
1985	170	
1987	166	Appointment of division chief of Automotive Pollution Control
1991	208	Establishment of Environmental Protection Bureau

cated pollution problems were handled by the Public Health Division of the Sanitation Bureau. The Yokohama Health Institute was involved in the pollution issues when necessary. Since there were at that time no national laws or prefectural ordinances to give the city authority to regulate pollution sources, the Sanitation Bureau in charge of health and sanitation handled complaints.

Organizational structure in the introduction and development period of the "Yokohama Style" pollution control agreements Mayor Asukata, who pledged strong actions against the environmental pollution in his mayoral election, took office in March 1961 and organized his administration to cope with the pollution. In April 1961 Public Health Division with seven staff members under the Sanitation Bureau, the Yokohama Pollution Control Committee and, in December, the Pollution Control Center were established. The establishment of these organizations prepared for full-scale development of pollution control actions. The Pollution Control Center had approximately 10 staff members at first, and was responsible for measurement, analysis, training, settlement of complaints, etc. Around this time, Yokohama introduced a more competitive recruitment system which attracted higher caliber staff. The Pollution Control Center and later the Bureau of Pollution Control primarily expected to receive job applications from engineers with higher education.

In its technical aspect, Yokohama started air quality monitoring at an early stage and has continued to emphasize it. This foundation turned out to be useful for preparing for pollution control agreements. Air pollution is changeable within short periods of time due to fluctuations in pollutants and weather conditions. It became necessary therefore to introduce more precise measures. In 1964, Yokohama introduced regular monitoring by using automatic record measurement, and conducted various experiments in order to collect data more rapidly. In 1965, the system was replaced by telemetering. This was the first of its kind used in Japan. After the Air Pollution Control Law was enacted, the city in emergency has to seek the cooperation of industries to reduce pollution concentration based on the data obtained through regular monitoring. Yokohama sets smog warnings on its own initiative based on telemetering data, gives smog warnings to large corporations before an emergency happens, and requests their cooperation to reduce emissions of pollutants.

The Bureau of Pollution Control — a full-scale organization for pollution countermeasures In 1971, the Pollution Control Center became independent from the Sanitation Bureau and was renamed the Bureau of Pollution Control (38 staff members). This is because Yokohama, as an ordinance-designated city was given authority over monitoring and regulating sources of pollution through the enactment of the Air Pollution Control Law and the Water Pollution Control Law, as well as the Basic Law for Environmental Pollution Control.

The number of recruited staff greatly increased during the decade following the establishment of the Bureau of Pollution Control. Ten to twenty staff were recruited annually. This is because the city's actions against pollution were well known and national concern about pollution issues was growing at that time. The staff recruited by the Bureau of Pollution Control were highly concerned about pollution issues and did their jobs with enthusiasm and dedication.

Staff of the Bureau of Pollution Control conducted various types of jobs including measurement, analysis, factory guidance and settlement of citizen's complaints, and had been trained to think from the citizen's standpoint. For this reason, Yokohama was able to avoid a vertical administration, though this

is typical in the Japanese administrative structure, and to maintain its flexibility to easily handle the problems. Moreover, the city made great efforts to improve its staff's capability. Staff participation in seminars and training courses contributed to accumulation of technology in the Bureau. Yokohama environmental pollution control agreements were prepared based upon the city's accumulated experience and the latest technology.

Staff have successfully implemented the pollution control agreements and the various guidelines through frequent monitoring and on-the-spot inspection. Such local efforts have been an important tool to induce effectiveness in measures and these have been a distinctive characteristic of the city. The city has also contracted out a part of the monitoring work required by the Air Pollution Control Law and the Water Pollution Control Law to private firms. The development of private firms with a public certification will continue to be essential to the administration's success in promoting pollution countermeasures.

Organizational expansion for pollution countermeasures The Bureau of Pollution Control has continued to expand, and more divisions have been created with precisely designated responsibilities. The Pollution Research Institute was also established in 1976. Thereafter, pollution problems have been redefined more widely as environmental problems. The organization began expanding and developing itself so as to deal with new themes such as environmental assessment and environmental management. The number of the staff in the Environmental Protection Bureau and the functions in 1992 are shown in Table 2-3.

Table 2-3: The number of staff and functions of the Environmental Protection Bureau

		Functions			
Organization	*Total*	*Administrative Affairs*	*Engineering*	*Medical Affairs*	*Technical Skill*
Bureau Chief	1		1		
General Affairs Dept.	40	28	7	1	4
Planning & Coordination Dept.	79	18	28		2
Pollution Control Dept.	79	8	71		
Environmental Science Institute	38	4	34		
Total	206	58	141	1	6

Chapter Three: Key Environmental Conservation Measures and Organizations in Yokohama

This chapter shows key pollution control measures taken by Yokohama city, through the pollution control agreement and industrial relocation, and discusses the relationship between environment and economy in Section C.

Pollution Control Agreements

Pollution control agreements are defined as pacts or accords which are mutually agreed upon in advance between local government and/or community groups and business enterprises whose activities present a threat of pollution. These agreements reflect measures and steps to be taken by the enterprises in order to prevent and control business-related pollution.

Pollution control agreements in Yokohama were conceived by an autonomous effort of the city during the period when local governments did not have any legal authority over pollution control. In fact, these were the first major pollution-related agreements made in Japan. Under the agreements based on mutual consultation, the city obtained pledges from business enterprises to implement pollution control measures. In this section, we discuss the first pollution control agreement in Yokohama in 1964, its policy process and procedures, its features and effectiveness, as well as development of subsequent agreements.

Situation before the conclusion of the pollution control agreements

Industrial development and the growth of pollution from late-1950s through mid-1960s Industries in Yokohama rapidly developed after 1950, returning to their pre-war level of output by 1955. At the same time, however, pollution caused by various pollutants including sulfurous acid gas as well as soot and smoke became quite conspicuous. Yokohama's objective was to develop as an industrial city. Because the existing industrial zone, Tsurumi-Kanagawa, had already been saturated by mid-1950s, the city planned to promote further industrial development on reclaimed industrial land in the coastal zone. Large-scale reclamation projects started in Daikokucho and Tsurumi districts and in Negishi Bay. At the completion of the Daikokucho reclamation project in 1961, large-scale factories for petroleum, chemicals, electricity, and food processing were built on the new site, induced by a factory invitation act. However, construction of a thermal electric power plant on this site resulted in a further aggravation of air pollution. On the new site created through the Negishi Bay reclamation project started in 1959, construction of large-scale factories for petroleum, electricity, steel, machinery, and electricity was planned. During this period, the city observed substantial industrial development. Volume of crude petroleum used in Yokohama increased from 0.54 million kilo liter in 1961 to 1.56 million kilo liter in 1964, almost threefold growth in three years.

Residents' movements In the meantime, air pollution had become a serious problem in the existing coastal industrial zone of Tsurumi-Kanagawa district. Residents along Negishi Bay were anticipating with alarm the arrival of still more factories. When the petroleum refinery built on the first reclaimed land in Negishi Bay started its operation in April 1964, citizens started to complain about noise, odor, and soiling of washed clothes caused by generators and plant facilities. This stimulated the rapid evolution of an anti-pollution movement among citizens.

By May of the same year, residents in Negishi Bay and the Honmokucho area had formed a resident's organization called "Council on Conser-

vation of Environmental Sanitation in Naka and Isogo Districts," with 200 executive members selected from among managers of various organizations and groups. The council made an appeal to the Ministry of International Trade and Industry (MITI), Ministry of Health and Welfare, Ministry of Construction, and the Economic Planning Agency, for "a preliminary investigation on pollution in the Negishi-Honmoku industrial zone." During the appeal, the Council adhered to its position that the committee would not only directly make an appeal to government but also directly negotiate with corporate headquarters in Tokyo, if necessary, and refused any concessions regarding its principle "residents could coexist only with enterprises which would conserve living environment." In response, the Ministry of Health and Welfare replied that "while the Ministry would make efforts to improve environmental hygiene, local municipalities would also need to establish an agency responsible for conducting a preliminary investigation in the area where serious pollution was foreseen." Based on this reply, the Council requested Yokohama "to take all possible measures." Thereafter, the movement played a significant role in bringing about the success of anti-pollution measures in Yokohama.

Attitude of the city administration Prior to establishing pollution control agreements, the city administration had no authority to regulate pollution either under national laws or under prefectural ordinances. While this certainly prevented the city from taking direct measures, there was a tacit understanding within the city administration not to stir up pollution issues, in order to achieve industrial development through invitation of factories. For example, the Basic Plan For International Port City of 1956, under which reclamation projects were incorporated, emphasized industrial development. However, nothing was mentioned with regard to pollution issues.

When a local medical association in Negishi Bay appealed to the Mayor to formulate pollution control measures in the coastal industrial zone of Negishi Bay, the city responded unenthusiastically. It sent a copy of the association's request to the newly-established companies and asked for their cooperation. In addition, it promised to the association that it would provide anti-pollution guidance under prefectural ordinances, and that it would respond to the issues by establishing a new organization, Committee on Environmental Pollution Control Measures of Yokohama. However, the committee was called into session only twice, in 1962 and in 1964, without delivering any substantive measures.

Conclusion of the first pollution control agreement

Movement in the city's administration In 1963, Mr. Asukata ran for Yokohama Mayor with campaign pledges of "creating a city administration which would care about children," "building a city in which anyone would be attracted to live," as well as solving pollution and other issues. His victory in the mayoral race gave impetus to environmental efforts in the city. During the same year, a number of other reforming governors and mayors were also elected in regional elections held nationwide, with similar campaign pledges on pollution control. Indeed, pollution issues had become a center of public attention across Japan. It was during this period that MITI and the Ministry of Health and Welfare investigated into the pollution situation in Yokkaichi and proposed a plan for pollution control, and that a construction plan for large-scale industrial complexes in Mishima and Numazu was abandoned following opposition from local residents.

In order to implement promises made during the campaign, the Yokohama Mayor established a basic policy which emphasized improvements in the

living environment. In addition, with regard to pollution issues, the Mayor began building the foundation for a pollution control structure, by examination of anti-pollution strategies in consultation with academic groups as well as by strengthening the city's pollution control regime.

In response to a request made by the council, the city conducted a preliminary investigation of the pollution caused by major factories in Negishi and Honmoku. The results of the investigation predicted that "without taking any aggressive measures against air pollution from now on, the center of the city would be polluted by the end of the 1970's at the same level as in the existing coastal industrial zone in Kawasaki and Tsurumi districts." Based on the data provided by the investigation, the city requested an academic group to present their advisory opinions on pollution control measures. The group's Nine-Point Recommendations included measures such as reexamination of industrial and urban planning, strengthening health administration systems for residents, strengthening the anti-pollution regime, and adherence to the principle of information disclosure with regard to pollution issues.

Conclusion of the first pollution control agreement with the Isogo Thermal Electric Power Plant of the Electric Power Development Co. In May 1964, while Yokohama requested that an academic group present their advisory opinions, the Electric Power Development Coordination Council (EPDC), an advisory body of MITI, decided to construct coal thermal electric power plants in three cities, based on a government policy on coal. The three cities were Yokohama, Takehara in Hiroshima prefecture and Takasago in Hyogo prefecture. The coal thermal electric power plants scheduled to be built in these cities belonged to Electric Power Development Co., a national enterprise funded by the government. In Yokohama, construction of the power plant was scheduled on the reclaimed land in Negishi Bay, transferring a part of the land from the Tokyo Electric Power Co. Establishment of such power resources was implemented according to a basic plan formulated by EPDC. It was the MITI Minister that had authority to decide on the construction of power facilities based on an electric enterprise law. Therefore, municipal governments at that time had no governing authority over the construction of power resources, except that governors were requested by EPDC to present their advisory opinions. Yokohama city administration learned of the plan for the construction of the power plan through the Governor only after the plan was decided.

In June of the same year, Tokyo Electric Power Co. requested that the city grant them a concurrence in transferring part of their land which had been developed specifically for the company to EPDC, as a construction site for a coal thermal electric power plant. The company made this request because of a clause in the sales/purchases contract stating that transference of reclaimed land to a third party would require the city's concurrence.

Taking this land-transfer request as an opportunity, Yokohama started responding to the power-plant issue, not as an isolated issue related only to EPDC, but as a generic issue that would require comprehensive pollution control measures in the entire coastal industrial zone. We can conclude that Yokohama autonomously started dealing with the pollution issues for the first time.

In August of the same year, Yokohama established the Council on Environmental Pollution Control Measures, consisting of citizen's representatives, scholars and experts, and factory representatives. The council conducted scientific investigations and experiments, including an on-site air pollution study and a wind-tunnel test of electric power development, and examined detailed conditions of the

power plant such as the density of exhaust fumes and the height of smokestacks.

Having conducted a number of scientific investigations on pollution prevention and control, the city could finally establish a method for designing pollution control measures. Based on this method, in December the city requested that EPDC should take pollution prevention and control measures proposed by the city. The company accepted the request, and signed a formal voluntary agreement on the pollution control with the city. This had not been possible earlier under any existing regulations, including a construction standard law, a fire prevention law, and a soot and smoke control law. In October, two months prior to the conclusion of the agreement, using referral opinions as a basis of argument, the city asked the MITI to guarantee the enforcement of the pollution control measures against the EPDC and obtained a confirmation note from MITI.

Content of the agreement The agreement numerically specified maximum pollution control measures based on scientific data and findings, such as present conditions and future prospects of air pollution, and in consideration of the level of pollution control technology available at that time. For example, under a soot and smog regulation at that time, emission levels of sulfur dioxide at gas-producing facilities and petroleum refining facilities in Yokohama had been set under 2,200 ppm. Under the new agreement, however, the emission level was reduced to 500 ppm, enforcing drastically stricter targets. The agreement also set detailed measures on air pollution control, including establishment of dust collectors, height of smokestacks, emission speed, exhaust fume temperature, and fuel quality, as well as provisions for anti-noise measures.

In order to determine the details of the agreement, the city not only encouraged factories to participate in the experiments and/or to conduct their own experiments, but also facilitated extensive discussions between them. Moreover, the city kept residents well informed of the content and process of the experiments. The companies respected the agreement. As a result, the city won the residents' understanding and trust. Furthermore, the agreement required the companies not only to take pollution control measures but also to monitor and report on pollution conditions. The agreement also authorized the city to conduct on-site investigations, when necessary.

In addition, the city obtained from the Tokyo Electric Power Co. a written confirmation that it would not start constructing a scheduled thermal electric power plant without obtaining the city's approval, and that it would freeze construction for three years.

Features of the pollution control agreement Under the pollution control agreement of Yokohama, the city took initiatives in undertaking preventive pollution control measures with the support of the citizens' movement, while allowing companies to establish their factories on a selected basis. "I don't intend to restrict industrialization. The issue is how municipalities control incoming factories," said Mayor Asukata in a magazine interview at that time. The Yokohama pollution control agreement was unique and different from the following two types of pollution control measures, one taken in Yokkaichi and the other in Mishima-Numazu. In the case of Yokkaichi, pollution control measures were pursued only after companies had established their factories and started causing pollution. In the case of Mishima-Numazu, construction of factories was rejected through the strong citizens' movement. Because of its uniqueness, Yokohama Pollution Agreement was called "Yokohama style" later.

From the companies' point of view, there were several reasons for accepting the agreement. The companies had no other alternatives but to sign the

agreement since the construction of the power facility was based on a sales/purchases contract of land. The company thought it was necessary for its sustainable business operation to comply with the residents' request. The company's decision was also influenced by the MITI's concern that MITI's plan for future national power development might be affected by the citizens' anti-pollution movements if it ignored such movements.

Yokohama's pollution control agreement is considered a major breakthrough in the history of pollution as no local government in Japan had power to set its own pollution control standards at that time. It should be said that the Yokohama Mayor played a great role in bringing about such breakthrough.

Pollution control agreements in early years (1964–1970)

Conclusion of the pollution control agreements with newly-established factories Taking the opportunity at the conclusion of the pollution control agreement with the Isogo Thermal Electric Power Plant of the Electric Power Development Co., the city signed another agreement with the following three factories that were planned to be constructed in Negishi and Honmoku by Nippon Oil Co., Tokyo Gas Co., and Tokyo Electric Power Co. respectively. Noteworthy is that the city successfully made Tokyo Electric Power Co. change the type of plant from the one which uses crude petroleum to the one which uses only natural gas in view of reducing emission of sulfur oxides, which was at the center of pollution debate at the time.

Conclusion of agreements with existing factories Early pollution control agreements after 1964 concentrated on the emission control of mainly sulfur oxides and dust fall of new factories planned to be constructed. This implies that Yokohama gave little attention at that time to effective measures against existing polluting factories.

In 1965, however, when Tokyo Electric Power Co. planned an expansion of a thermal electric power plant, the company asked the city for an advisory opinion about its pollution abatement plans. The volume of sulfur oxide emissions from this thermal plant was the largest in the city, accounting for 65 percent of total emissions. Taking this opportunity, the city concluded an environmental pollution control agreement with the company. Under the agreement, the company was required to integrate smokestacks and to follow new emission standards. A reason for the electric company to enter the voluntary agreement is that to conclude such agreement was a necessary condition for the company to obtain an approval from the Electric Power Development Coordination Council.

Following this success, Yokohama signed an environmental pollution control agreement with Asia Oil Co. in 1968. This agreement originated from the exchange of memorandum on "the agreement on pollution control cooperation in connection with factory expansions" between the company and the city in 1967 when the company requested permission for reclamation prior to the actual expansion of facilities.

The pollution control agreements with the existing two factories were made based on preceding memoranda instead of land sale/purchase contracts that had previously served as a basis for agreements with new factories. The following factors attributed to the successful agreements: First, companies trusted in Yokohama city that made pollution control agreements based upon the findings of scientific investigation in earlier cases. In addition, following escalating anti-pollution demands from the public, these companies came to realize that, in order to carry out steady business activities, it would be vital for them to obtain a consensus from local governments and residents when building or expanding factories. Furthermore, Yokohama was blessed with a large consumer market adjacent to

the capital. As a port city, it was also endowed with excellent conditions for the establishment of factories, which enabled the companies to pay off the costs for pollution control investment and to maintain industrial competitiveness. The fact that the city possessed virtual authority over matters such as the approval of industrial water supplies also contributed to the success. Finally, economic conditions at that time also contributed to the negotiation of these agreements. During this high economic growth period, companies invested actively. With favorable financial and managerial conditions, these large companies were able to make investments in the pollution control.

Effectiveness In conclusion, these pollution control agreements greatly contributed to the prevention pollution aggravation in Negishi district. According to a projection in 1964, new factories scheduled in Negishi and Honmoku were expected to emit 300 tons of sulfur oxides per day by 1970. Thanks to the pollution control agreements, however, the actual emission of sulfur oxides was about 60 tons per day although there was a difference between the initial factory construction plan and what has been actually constructed. Ambient air quality also improved following the worst peak in 1967.

Pollution control agreements in the middle and later period (1970–1975)

"Ten-Point Recommendations" by an academic group and strengthening of national and prefectural responses While the pollution generated by new factories in Negishi district was successfully controlled to a satisfactory level, the Tsurumi-Kanagawa district still was the most heavily polluted area in Yokohama in 1970. In order to promote pollution control measures in the existing industrial zone of the Tsurumi-Kanagawa district, the city commissioned an academic group to conduct an investigation, and received its Ten-Point Recommendations in 1970.

The recommendations presented the following pollution control measures in the existing industrial zone: (i)development of a comprehensive system, in which the city would establish principles of pollution control measures and provide such services as evaluation, advice, and guidance in a consistent manner (ii)making factories aware of their social responsibilities in causing pollution; (iii)searching for strategies which would increase the possibility of obtaining companies' cooperation; (iv)establishment of an organizational system in which companies' efforts could be accurately evaluated. In addition, considering the extent to which the pollution control measures would have an effect, the recommendations referred to the relationship between municipal measures and intermunicipal measures, consideration of long-term planning of the Keihin Industrial Zone and mutual cooperation with related administrative bodies and research institutes.

Furthermore, the recommendations indicated a new approach by which the city would aggressively respond to water contamination and industrial waste, in addition to air pollution which had been the center of anti-pollution debate.

In the meantime, national attitudes toward pollution, as well as those of prefectures, had been drastically changed. During a Diet meeting on pollution in 1970, more than fourteen laws and regulations were enacted or amended. In addition, under the Pollution Control Law of Kanagawa Prefecture which was newly established in 1971, the city's pollution control authority over existing factories was further strengthened. This Law authorized the city to conduct on-site investigations in all factories and offices in the city, and to receive reports from them. It also required companies to obtain mayoral approval when establishing or modifying their factories and offices.

With these events, pollution control agreements continued evolving with amendments.

Amendment of the pollution control agreements It is common to amend pollution control agreements when the factory planned an expansion or a change in the original plan, in order to introduce new pollution control technologies and to set new standards based on the level of technologies (See Annex 2).

For example, sulfur dioxide emission standards agreed upon between the city and EPDC was based on emission concentration, and was stricter than the standard under the Soot and Smoke Regulation Law at that time. This standard based on emission concentration was transformed later to a new standard based on landing density, regulating the entire volume. Moreover, under an Environmental Pollution Control Law enacted in 1968, sulfur dioxide standards in Yokohama were set at K-value of 20.4 (maximum ground level concentration was 0.035 ppm per facility). However, under the Yokohama Environmental Pollution Control Agreement of 1968, a maximum ground level concentration of sulfur dioxide per facility was set below 0.01 ppm, enforcing more advanced pollution control measures.

Evolution of pollution control agreements Achievement in Negishi and Honmoku by the early Yokohama-style pollution control agreements soon started to have an impact on the attitude of existing factories in Tsurumi-Kanagawa in dealing with pollution. These factories started negotiating a pollution control agreement, despite the fact that they did not have a sale/purchase contract for land which had served as a basis for reaching agreements between the city and newly establishing factories. Public opinion against pollution became so strong that the factories tried to get public trust by reaching a pollution control agreement with the city. It could be said that pollution control agreement became a process through which a factory as whole would be accepted by the citizens and the city.

Under the Basic Law for Environmental Pollution Control, amended in a Diet meeting on pollution and enacted in 1970, regulations over pollution sources in Yokohama were less strict than those set by the Yokohama pollution control agreements, and not sufficient to achieve environmental standards. For example, sulfur dioxide concentration was set at K-value of 11.7 (maximum ground level concentration 0.02 ppm). Taking advantage of flexibility in the pollution control agreements, Yokohama further strengthened its pollution control measures against large-scale factories by restricting the level of sulfur in fuel, using kerosene and gas, and converting the standard for sulfur oxides from a maximum ground-level concentration standard to a compound ground-level concentration standard. Moreover, in order to stimulate factories' awareness of social responsibility for pollution control, the city added to the agreement a new clause regarding the cessation of operations in the event of occurrence of pollution.

Furthermore, the city also consulted with factories located in the existing industrial zone over water pollution control measures during negotiation and incorporated the results into the agreements. The city began enforcing definite numerical standards in 1972, when it reached a pollution control agreement with Ajinomoto Co. In previous agreements, a water pollution control item was limited to density of oil content contained in the effluent, except in the case of laboratory where more items are subject to standards. However, after the agreement with Chiyoda Chemical Engineering & Construction Co. (Laboratory) in 1973, the city established a new clause which set a concentration of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) under 10 ppm. Moreover, the city introduced another check, namely the ability of fish to breed in drainage.

Development of pollution control agreements and transformation into guidance and guidelines (after 1975)

Standardization of pollution control agreements Until 1975, details of the pollution control agreements had been determined in accordance with the state of respective factories with which the agreements had been made, as well as pollution control technologies available at the time of agreement. By 1975, however, as a growing number of agreements and amendments were concluded, some items started to commonly appear in their content. These items included evaluation and report, on-site inspection, cost bearing, prior consultation, public disclosure, cessation of operations, and reconsultation. Most of these became standard items in the agreements. This standardization was helpful in eliminating impartiality that might possibly arise in the presence of non-standardized pollution control agreements, and in strengthening the city's authority for pollution monitoring and for on-site investigation, which was further strengthened by later amendments of relevant guidelines.

Transformation to guidelines and directives During the mid-1970s, major companies implemented pollution control measures based on the pollution control agreements. However, there remained problems concerning the small- and medium-sized enterprises in dealing with pollution control measures. Their compliance was necessary in order to meet the sulfur dioxide standards of ambient air quality which were revised in 1974.

With regard to small- and medium-sized enterprises, enforcing pollution control measures by individual agreement was not efficient because their emission volume was relatively small although there were numerous such enterprises. In addition, as the contents of the agreements with large-scale enterprises became standardized, the city came to the conclusion that similar measures could be taken for small-and medium-scale companies. Accordingly, the city started to control the small-and medium-scale companies, not under agreements, but under guidelines. The content of pollution control agreements had been restricted by the level of pollution control technologies available at the time of making the agreements. As pollution control technologies developed, however, it became increasingly feasible to apply uniform emission standards to most factories. Furthermore, under guidelines, the city could exercise more precise control and guidance than under prefectural ordinances. Guidelines included measures against sulfur oxides; soot and smoke; hydrocarbon material; nitrogen oxide; land subsidence; factory noises; and domestic discharges to drainage, as well as directives on factory drainage and fish breeding.

There had also been resentment over unfair distribution of the burden for pollution control measures among factories which reached agreements and those in the same industries which did not, as well as among offices which received city's guidance through on-site inspections and those which did not. In order to ease this discontent, the city horizontally regulated companies under guidelines. The guidelines could also be established by the mayor, and could therefore be introduced promptly and effectively. It is extremely important to note that there are no legal penalties for failing to observe the guidelines. Companies always adhere to them, apart from the accidents, this being a uniquely Japanese characteristic.

In establishing the guidelines, the city followed the procedure appropriate to the Yokohama-style pollution control agreement, i.e. establishing a basis of scientific data and having extensive consultations with the target factories. For example, in order to control sulfur dioxide and nitrogen oxide in the air, the city established regulations based on scientific models simulating entire city zones. With regard to the guidance approach, the city tried to obtain a consensus from companies by holding regional briefings.

Yokohama did not establish its own by-laws on pollution control regulations for several reasons. During the period when the city was not allowed to establish regulations more stringent than the Basic Law for Environmental Pollution Control and the Water Pollution Control Law, it used pollution control agreements, which are more stringent. After the city was permitted to establish its own regulations, it did not need to do so because the Kanagawa prefectural government established regulations stricter than the national ones, and Yokohama city could apply them.

Kanazawa Reclamation Project and Industrial Relocation

The Kanazawa Reclamation Project had been formulated as a project under the Comprehensive Construction Plan of Yokohama International Port City of 1966. The goal of the project was more than just building an industrial site or a port facility as in the past. The ultimate goal was to reclaim land as a site for redeveloping the downtown area and accommodating small- and medium-sized factories scattered around the city, thereby strengthening land utilization and controlling pollution.

A strict control over large-scale companies was enforced under respective pollution control agreements as stated before. This turned out to be effective since these companies had possessed adequate technological and economic capacity to take necessary measures. On the other hand, pollution control of small- and medium-sized companies, which were scattered throughout the city, was difficult to enforce, and their implementation lagged behind.

This section discusses pollution control measures achieved through the organization and relocation of small and medium-sized companies under Kanazawa Reclamation Project and Kanazawa Industrial Complex.

Reclamation projects in Yokohama prior to the Kanazawa reclamation project The reclamation of coastlines in Yokohama had started during the Edo period in areas which included Ishizaki, Kanagawa, and Takashima-cho. Today, these areas are located in the center of the city, constituting the commercial district. During the Meiji period, reclamation for industrial purposes began. The first major industrial reclamation was the 495 ha of reclamation in Tsurumi completed in 1931. By this time, Keihin Industrial Zone had been formed by reclaiming the major part of the coastline from Tokyo to Kawasaki and Yokohama. By 1940, industrial output of the Keihin Industrial Zone had surpassed that of Hanshin Industrial Zone, ranking first across Japan.

Reclamation continued after the war in order to promote the city's policy of industrialization. With the reclamation of 80 ha of industrial land in Daikokucho in 1955, most of the land suitable for reclamation in Tsurumi-Kanagawa district had been reclaimed. In order to foster economic growth at that time, the city started a large-scale 613 ha reclamation project in Negishi Bay and attempted to promote industrial development by inviting large-scale factories to locate there. Due to this reclamation, however, resort beaches such as Isogo, Byobugaura, and Sugita, which had been located along the eight km-long coastal line and enjoyed by the Yokohama citizens, disappeared. Another reclamation project began in 1963 in Honmoku district and was 340 ha in size. It aimed at building sites for a wharf and Honmoku-related industries. However, given the strong public fear that the reclamation would obstruct a view of the famous Japanese garden, *Sankeien*, about 11 ha of parks and green tract of lands was arranged. Nevertheless, these green tracts

of land constituted only three percent of the total reclaimed land.

We can conclude that the major goal of coastal reclamation projects in Yokohama was to build industrial sites and port facilities. As a result, the coastal area was formed as a place separated from the daily life of the citizens.

Planning of Kanazawa reclamation project
Kanazawa district in Yokohama was located in the southernmost area of the city, and possessed the only natural coastline remaining in the city at that time. Three fishery cooperatives possessed rights to fishing in this area. There were people who made a living by seaweed farming, trawler net fishing, net fishing, or pole-and-line fishing. Around 1955, when the reclamation projects in Daikokucho and Negishi Bay were being formulated and implemented, a reclamation plan was also being formulated by private companies for Kanazawa area, which was the only reclaimable land left in Yokohama. The goal was to utilize the area for industrial promotion during the high economic growth period at that time. The "Yokohama Basic Comprehensive Plan for Constructing an International Port City" in 1957 also aimed at stimulating industry through the Kanazawa reclamation.

However, during the decade following 1955, a rapid increase in population, and a rapid expansion of industry resulted in unplanned city development, and destruction of farmlands and forests. As a result, residential buildings and factories mingled together in the narrow, crowded city zone, causing environmental problems such as odor and noise. A dramatic increase in road traffic also caused serious problems such as air pollution, noise, and traffic jams. Use of the coastal areas to alleviate these worsening urban conditions was thought to be an obvious solution.

Local pollution caused by small- and medium-sized companies in their neighborhoods became a serious problem. These companies had been established during the period when little attention was paid to urban planning, and they were located in areas where residential buildings and factories were mingled together. These small- and medium-sized factories faced the challenge of streamlining and modernizing production facilities and equipment while preventing and controlling pollution mainly due to noise and vibration. However, there was a limit to the extent these issues could be solved at existing factory locations.

Accordingly, the city started to consider relocating these companies to an appropriate area such as industrial complexes. By doing so, the city intended to help promote industrial development by rationalizing factory management through cooperation and organization of small- and medium-sized companies, as well as by reforming and strengthening their management. This would also help the city prevent and control pollution, as well as organize and redevelop the city zone.

However, in order to obtain the concurrence of small- and medium-sized factories located in the area where residential buildings and factories were mingled, the city had to provide them with incentives to relocate. The incentives included low relocation costs and an assurance that relocation sites would be provided with infrastructure. Since it was almost impossible to secure an inexpensive site suitable for large-scale industrial complexes in the inland of Yokohama, there was no alternative but to reclaim coastal land in order to create sites suitable for relocating small- and medium-sized companies.

With the growing perception of the sea's role in the natural environment and recreational use, the city reviewed coastal development projects. From the mid-1960s, the value of the coastal areas in the

city began to be reexamined. More generally, the Asukata administration in 1963 published the "White Paper on Citizen's Life", which emphasized the balance between industrial development and the quality of life of the citizens; and from this viewpoint, the White Paper said that policy for inviting large industries should be reexamined.

Moreover, in October 1965, the publication entitled *A Future Yokohama Created by its Citizens* fundamentally reexamined the "Comprehensive Basic Plan for Constructing a Yokohama International Port City" and gave a different orientation from the former one specifically with regard to reclamation in the Tomioka/Kanazawa district. The old type of reclamation aimed at siting heavy chemical industry, while a new type of reclamation aimed at the improvement of urban environmental conditions by relocation factories located in the downtown. It also aimed at construction of recreation facilities that the citizens can enjoy along coastal line, an important property for the public. The city had a sense of regret about the planned reclamation of Tomioka/Kanazawa areas because the areas had natural coastal line which did not exist in any other places in Yokohama. However, the reclamation with main emphasis on the city's environmental improvements was judged to bring about better overall results for the citizens in the end.

In 1966 "Comprehensive Construction Plan of the Yokohama International Port City" was prepared. This plan combined the city's infrastructure development plan and welfare plan.

As a part of the "Comprehensive Construction Plan of the Yokohama International Port City", Kanazawa Reclamation Project was formulated aiming at both solving urban issues and promoting industrial development. This was a new approach because in the previous time, sea reclamation in Yokohama aimed at industrial development alone by inviting large industries.

Project development

The project moved into an important implementation stage with the city council's resolution in 1968.

Institutional structure The Kanazawa Reclamation Project in Yokohama was implemented by involving many departments including the Planning and Coordination Division, Pollution Control Bureau, Waste Incineration Bureau, Economic Bureau, Planting Bureau, Road Bureau, Sewerage Works Bureau, Water Works Bureau, City Development Bureau, and the Kanazawa ward. Steering and technical committees were organized and staffed by officials of those departments.

Funding plan The city found it difficult to secure financial sources since it could not expect to receive advanced income, such as deposits, which had been paid by the newly established companies in the previous reclamation projects for industrial sites. Of 41.3 billion yen required for the total project expense from 1968 to 1972, the city planned to finance 28.8 billion yen of future investment by issuing bonds. The rest was to be financed by the sale of the reclaimed land upon completion. However, since the city could not finance such a large amount of funds by issuing domestic bonds alone, it also planned issuance of foreign bonds denominated in German marks.

Setting the selling price for reclaimed land Originally, Yokohama planned to sell reclaimed land at a constant unit price throughout the whole Kanazawa area. The selling price was to be based on the cost of reclamation, including all construction costs, including the sea park. However, such a policy turned out to be unprofitable, due to delays in granting reclamation licenses and soaring construction costs. The city, therefore, introduced a pricing formula which took account of inflation.

Specifically, Yokohama established an initial sales price in October 1975; the price of industrial

sites being 48,000 yen/m^2 in the second half of 1975. Thereafter, the city increased prices at a rate of 4.4% per year. By 1978, therefore, the price of an industrial site was 53,300 yen/m^2. It meant that the unit sales price (160,000 to 200,000 yen/tsubo[1]) had almost doubled from the original estimate of about 100,000 yen/tsubo at the beginning of the plan in 1971. Although this price was still less than the average price (210,000 yen/tsubo) of "Ha" district in the Negishi reclaimed land which had come into the market a little earlier, there was considerable doubts as to whether the targeted small- and medium-sized businesses could afford to relocate. The city therefore reduced taxes for the factories concerned over a limited period, exempting them from property tax, corporation tax, and the special land-holding tax.

Utilization of reclaimed land

The total area of land reclaimed in the Kanazawa reclamation project is 660 ha. With regard to land utilization, 258 ha are used as industrial sites, 253 ha for public facilities, 82 ha as residential sites, 67 ha as a sea park site. The residential site is separated from the industrial site by a national road running north-south in the center of the reclaimed land. A 50m-wide green tract of land was also constructed as a buffer zone along the national road. This buffer zone was constructed by the city using a loan provided by the Japan Environment Corporation. Trees were planted in the buffer zone to block out the sight of traffic, reduce noise, and clean the air. It divides the reclaimed land into two sites: the residential and the industrial sites.

The residential site was used for building 10,000 housing units for employees of the factories which had been scheduled for construction on the industrial site.

The Kanazawa industrial site (258 ha) that can accommodate about 600 enterprises is divided into three sections: 1) a wood industry and shipyard site, 2) wholesale and transportation industry site and 3) a manufacturing. Kanazawa Industrial Complex is one of the largest industrial parks in Japan. There are presently about 400 enterprises in the Kanazawa industrial park.

The public facility site was used for building schools, bicycle roads, and pedestrian roads, and also for a sewage treatment plant, an incineration plant, loading area, and a heliport.

Significance of the Kanazawa reclamation project in environmental conservation The reclamation project was formulated with careful consideration of environmental aspects and urban planning. In determining land utilization and segmentation, the city secured about 10% of total reclaimed land for building a seaside park, a park on the original coastline, and green buffer zones, developed an urban redevelopment site equipped with anti-pollution facilities and equipment, and secured sites for residential buildings and public facilities.

Pollution control measures through organization and rearrangement of small- and medium-sized companies in the Kanazawa Industrial Complex

Relocation to the Kanazawa Industrial Complex, as well as organizing and rationalizing small- and medium-sized companies, were the first major efforts to solve factory/residence mixture problems and to strengthen their company management—although the city had a similar experience of reclamation and industrial relocation in much smaller scale before this major effort. During implementation, the city conducted a detailed investigation about factories, and tried to strengthen the management basis of small- and medium-sized companies by improving their organization, simultaneously paying careful attention to pollution control measures at the relocation site.

Process of factory relocation

Registration, relocation planning, and guidance Since available space for industrial relocation in the reclaimed area was limited, the city had to set criteria to prioritize the districts from which factories should be moved. Criteria included the need for a complete rehabilitation and reconstruction of a particular area rather than a piecemeal approach, disaster prevention planning, and the presence of residences and industries located in close proximity to each other.

In order to better understand the actual situation of the companies considered for relocation, the city investigated the factories that should be relocated from viewpoint of pollution control. Based on the results of this investigation, the city selected factories to be relocated, and then encouraged the process.

Types of pollution caused by pre-relocating factories are as follows:

(1) Noise and vibration associated with press and rolling operations (about 60% of the relocating factories);

(2) Odor and dust particles caused by painting and metalworking (about 30%);

(3) Effluent-related pollution associated with washing of oil drums, plating, and food processing (the remaining 10%).

About 50% of the incoming factories were originally located in residential areas, 40% in industrial/residential mixed areas, and the remaining 10% in commercial areas.

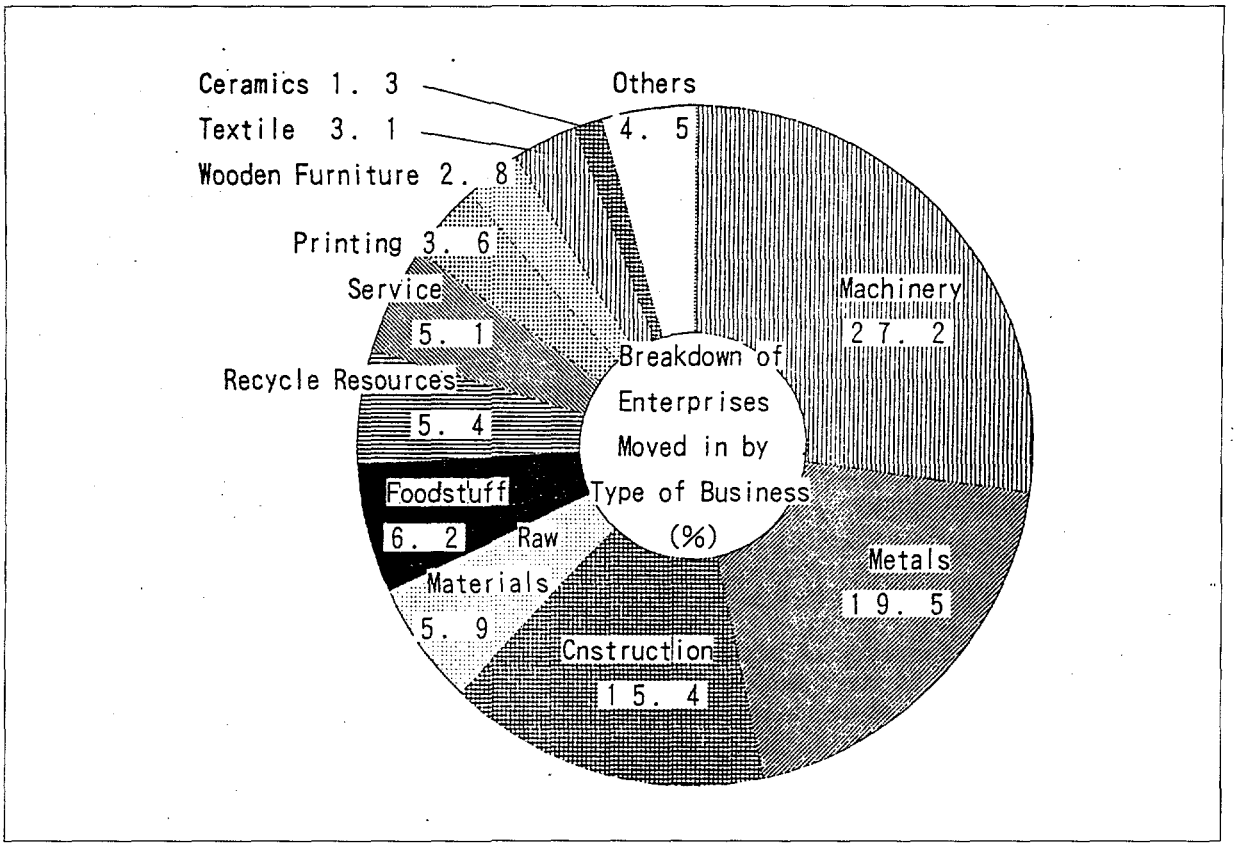
Based on the results of this investigation, the city conducted a registration of factories which desired relocation to the Kanazawa Industrial Complex, including those which the city had targeted for investigation. In 1977, while 497 companies applied in total, only 40% of the factories which required relocation actually registered. About 10% of the factories that desired relocation did not eventually register due to a lack of relocation funds or a fear of losing customers through relocation.

Process of transfer In 1979, the city publicly invited factories to transfer to Kanazawa Industrial Complex and received applications from 462 companies. The city then investigated the companies which applied for land in light of a number of criteria, including financial capacity, the pollution associated with their factory operations, and the environmental condition of their existing neighborhoods. The decision on whether to permit or reject factories was examined by the Council on Selection of Relocating Companies, created under a city ordinance. Following this, 372 companies from various manufacturing industries were selected. Figure 3-1 shows the breakdown of 372 companies by type of business. Considering the fact that many of them were already located near the Kanazawa Industrial Complex, factors such as the proximity of the factories to their customers seemed to play a major role in the selection.

As shown in Table 3-1, 372 enterprises actually relocated themselves to the Kanazawa Industrial Park, 81% of enterprises that applied for relocation in 1979. Of the 372 enterprises that actually relocated, 108 enterprises (29% of 372) had been identified by the City as requiring relocation, and the remaining 264 enterprises (71% of 372) relocated though not identified by the City as requiring relocation.

There were 108 enterprises (38% of 285) that had been identified by the City as requiring relocation. The difference, 177 enterprises (285 - 108) did not relocate though identified by the City as requiring relocation. Reasons for the 177 enterprises not having relocated though recommended by the City are listed as follows:

Figure 3-1: Breakdown of the Relocated Companies by Type of Business



1)	Could not determine to relocate:	68
2)	Lack of fund for relocation:	37
3)	Took pollution control measures on the existing locations:	27
4)	Relocated to other places:	23
5)	Judged later by the City as not requiring relocation:	15
6)	Out of business:	7
Total:		**177**

Guidance on organization Taking advantage of factory relocation, the city tried to reform and rationalize the management of small- and medium-sized factories by promoting collective and cooperative actions, as well as improving organization in the factories themselves. The creation of the collective management system has the following advantages: 1) government low-interest loans are made available for this purpose; 2) sales and purchase transactions among participating companies are increased; and 3) investments can be reduced by having common facilities such as common effluent treatment facilities.

Initially, participating firms were classified into twenty groups by type of industry, but eventually in fifteen groups after integration and coordination.

The Funds for Advancement of Small and- Medium-Sized Companies were used for a group of medium-sized companies for construction of a detached industrial complex, based on the factory collectivization project; for a group of small-sized factories, and for construction of a factory apartment with a view based on the factory cooperation project. For the remaining seven organizations, a cooperative factory was constructed, assisted by the Japan Environment Corporation.

	Number of Enterprises	
a. Enterprises applied for relocation (1979)	462	
b. Enterprises actually relocated (1979)	372	(b/a = 81 %)
c. Enterprises identified by the City as requiring relocation and applied for relocation (e – d) (1977)	108	(c/b = 29 %) (c/e = 38 %)
d. Enterprises identified by the City as requiring relocation, but did not apply for relocation (e – c) (1977)	177	(d/e = 62 %)
e. Enterprises identified by the City as requiring relocation (c+d) (1977)	285	
f. Enterprises not identified by the City as requiring relocation but actually relocated (b – c) (1977)	264	(f/b = 71 %)

Table 3-1 Number of Enterprises in connection with Relocation

Financing and assistance with relocation

For companies relocating their factories, securing funds became the most critical issue, since a large amount of funds was needed to finance various activities including obtaining factory sites, constructing factories, landscaping, and establishing pollution control facilities and equipment. These relocation expenses imposed a particularly heavy burden on small and medium-sized factories which were facing recession after the first oil shock.

In order to encourage relocation, Yokohama introduced long-term, low-interest public funds, gave preferential tax treatment, and promoted advancement and collectivization of the small- and medium-sized factories involved in the relocation.

The city not only actively utilized governmental financial systems, such as the Fund for Advancement of Small- and Medium-Sized Factories and funds from Japan Environment Corporation, but also provided loans for companies which did not qualify for governmental funds. In addition, the city subsidized a part of loan interest to be paid by companies as noted earlier. The city also gave tax breaks over a limited period in connection with property tax, the special land holding tax, and the corporation tax.

Pollution control measures

Companies were relocated to the Kanazawa Industrial Complex in order to solve problems such as neighborhood pollution. Nevertheless, in order to prevent secondary pollution in their new neighborhoods, the companies took the following pollution control measures after relocation: arrangement of factory location within the industrial complexes, and establishment of common treatment facilities, as well as individual measures, within the factories.

Arrangement of factory locations within the complex. In planning factory locations within the industrial complex, the city designated zones based on type of industry. After locating light industries close to residential sites, the city located general manufacturing industries, followed by industries causing loud noise and odor in the section near the seashore, far away from the residential site. In order to alleviate environmental impacts on the neighboring area, measures were also taken to arrange the location and the combination of buildings.

In addition, the city grouped together factories which would use common treatment facilities. These grouped factories were located near the common facilities to make economical piping arrangements. Furthermore, measures were taken to maintain amenity by preserving the landscape within the industrial complex and by establishing green buffer zones along public roads and coastlines.

Collective wastewater pretreatment facilities A form of pollution caused by factories in areas where they were in close proximity to residences was ef-

fluent containing hazardous substances which was discharged from small- and medium-sized companies in the fields of press dyeing, dyeing, surface treatment, and plating. While the number of these incidents was not large, the city had been encouraging small- and medium-sized companies to maintain and manage hazard-removing facilities within each factory through visits and guidance. However, it was not only inefficient for the city but also it was difficult for the small- and medium-sized companies that lacked economic and technological capacities to maintain and upgrade hazard-removing facilities to meet discharge standards, which became more and more stringent.

Accordingly, the city decided to locate some small- and medium-sized companies in special sections of the Kanazawa Industrial Complex, and let them discharge effluent to collective treatment system after each factory removed specified hazardous substances.

To have collective treatment facility is much more economical than the case where each factory has own individual treatment facilities because the former requires less space for facility installation and less operation/management costs. The collective pretreatment facilities treat the following five types of substances: high-density cyanogen, low-density cyanogen, chrome, acid, alkali, press dyeing, and dyeing. After removing hazardous substances, waste is discharged into the public sewerage system. Sludge, which is produced during the treatment process, is also treated. Currently, thirty two companies use the collective pretreatment facility. Although Yokohama city actually built these facilities, necessary expenses were borne by user companies.

The Japan Environment Corporation provided 30-year loans (normally such loans are for 20 years) to the companies for construction costs, and the city paid a part of interest to ease companies' financial burden.

Maintenance and management services of the facility are provided by the water and sewage department of the Yokohama city. Centralization of factory effluent treatment enabled the city to efficiently monitor and guide companies. Maintenance and management expenses consist of the costs of labor, chemical supplies, repairs, and electricity. Annual operation/maintenance expenses are about 0.16 billion yen in 1991, and paid fully by user companies. Cost-sharing among users is determined by a formula which includes the contract volume of effluent, the actual volume, and effluent density. The cost per factory ranges from 0.8 to 40 million yen/year.

More than ten years have now passed since the collective pretreatment facility was constructed. Repair costs began to increase significantly in recent years, and the facility has required partial replacement. Full-scale replacement will become necessary in the future, and this will be an extremely costly exercise.

Pollution control measures for individual factories In order to prevent the Kanazawa Industrial Complex from becoming a new pollution source, besides taking prevention and control measures under the regulations targeted at individual factories, the city required the following pollution control measures and facilities, as a condition for their relocation:

- **Industrial heat sources were limited to electricity or gas;**
- **The city established minimum standards, such as limiting types of building structures and materials to reinforced concrete, concrete blocks, and steel-frame slates in order to combat noise and vibration-related pollution, mainly caused by metal processing industries such as forging and pressing, and by transportation;**
- **The city required construction and recycling industries to construct buildings on more**

than 30% of the factory site, and, as a general rule, prohibited outdoor work;

- **Companies were required to plant trees on more than 10% of the factory site (13% for factories of which sites larger than 1,000 m²).**

Further, with respect to the above pollution control measures, the city required the companies to submit a planning document, which facilitated the enforcement of comprehensive pollution control measures. It also required pre-consultation by each company planning relocation and establishment, so that companies could not apply for a construction permission without consulting the city.

Utilization of vacated sites Yokohama either purchased the vacated sites from the relocating factories and constructed public facilities, or concluded agreements with the companies on the utilization of the vacated sites. In the latter case companies were required to have prior consultation regarding their disposition, thereby controlling the future uses of the sites. Active discussions were sometimes held among residents over the utilization of vacated land. Some of the sites were purchased to construct public facilities such as parks.

In utilizing the vacated sites, the city established a Managing Committee for Vacated Sites of the Kanazawa Relocating Companies, as well as a Special Inter-Departmental Committee for Controls of Utilization of Vacated Sites. This facilitated smooth guidance and control over purchases of vacated sites and private development.

Relationship Between Environment and the Economy in Yokohama

This section addresses the relation between economic development and the environment in Yokohama in recent years. Fig.3-2 shows a trend of industrial output (expressed in terms of value added) and of ambient SOx concentration. The trends of energy consumption and SOx emission load are shown in

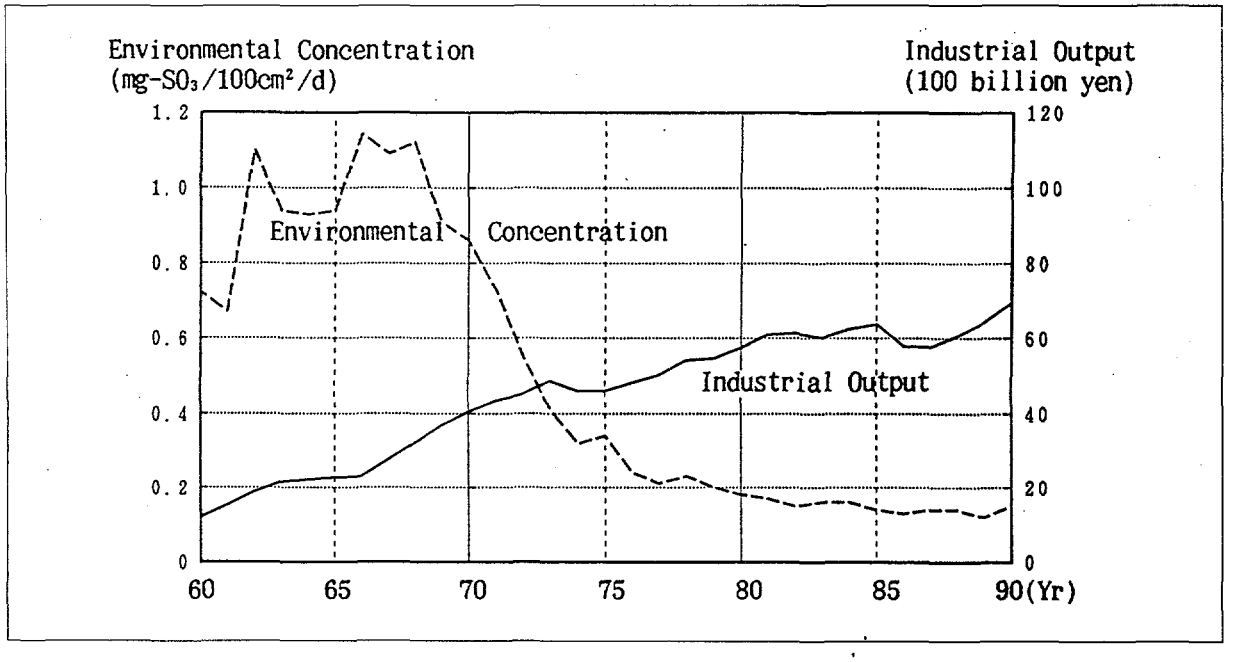


Figure 3-2: SOx Concentration and Industrial Output (Value Added), 1960–90

Figure 3-3: Fuel Consumption by Type, 1960–90

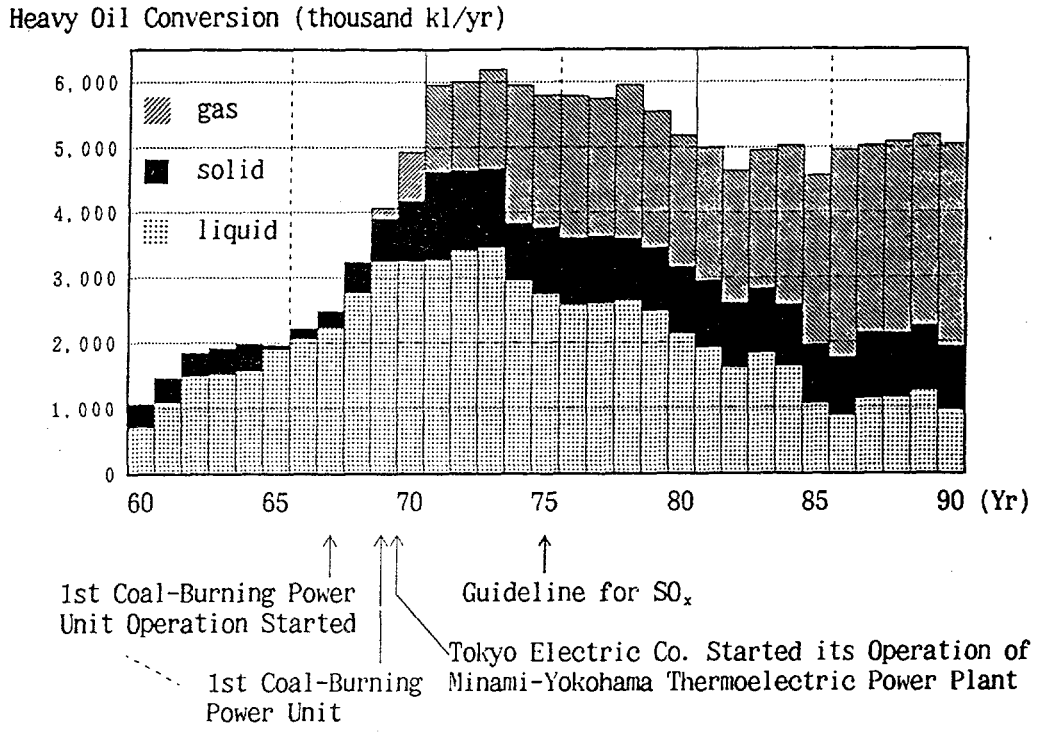
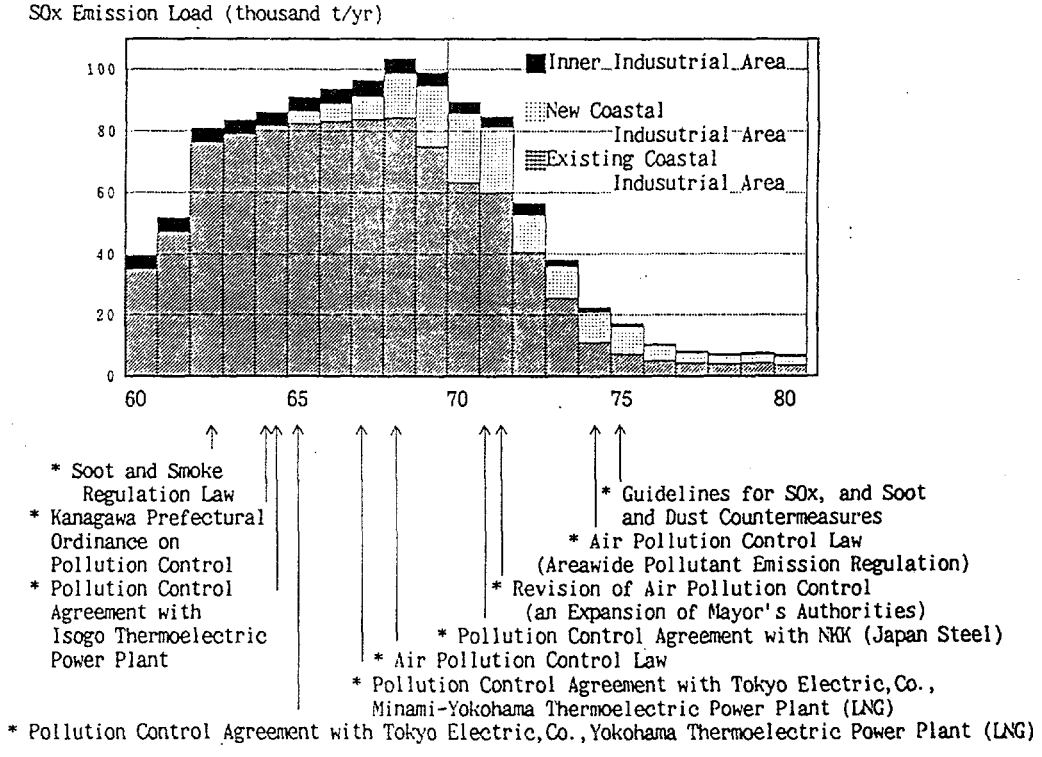


Figure 3-4: SOx Emissions in Yokohama, 1960–80



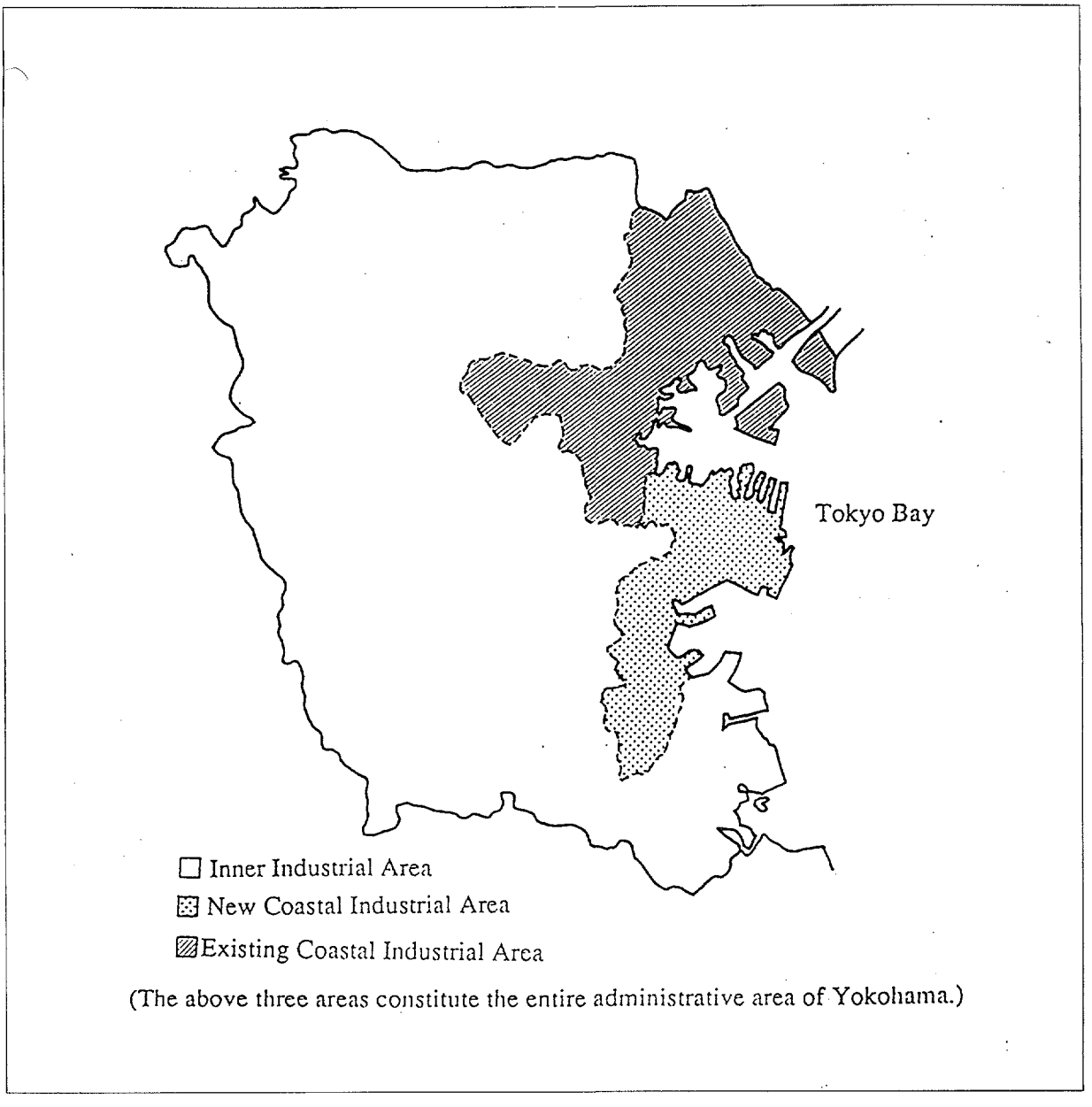


Figure 3-5: Location of Industrial Area

Fig.3-3 and Fig.3-4 respectively. Relation between those environmental indicators and industrial output (value added) is shown in Fig.3-6, 3-7 and 3-8.

Economic and environmental indicators

Relation between industrial output (value added) and SOx concentration Figure 3-6 shows the relation between industrial output and ambient concentration of SOx. Since concentration of SOx varies by location of monitoring station and by weather conditions, the correlation in Figure 3-6 is less significant than that between actual emissions and industrial value added. From 1960 to 1965, the correlation was basically positive; as industrial value added increased, the concentration of SOx also in-

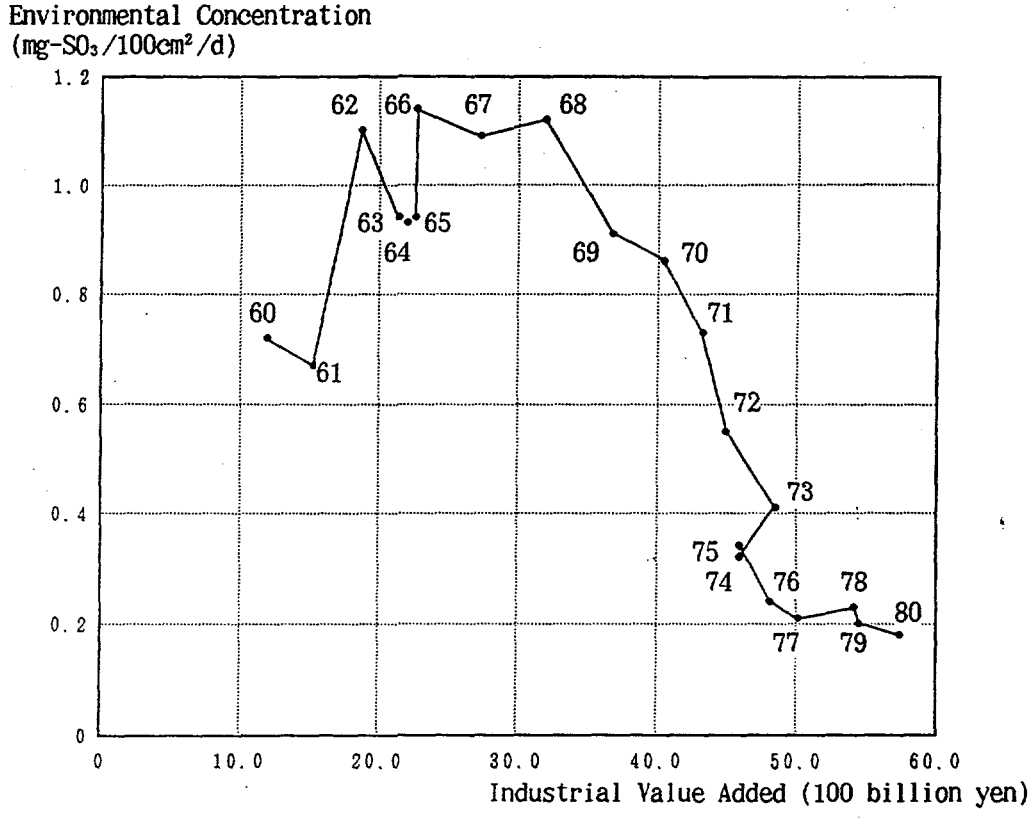
creased. Since 1968, although industrial value added continued to increase, the concentration of SOx decreased. This reflected the impact of SOx countermeasures. Conversion of SOx to low sulfur fuel, as well as the use of taller stacks contributed to the lowering of the SOx concentration.

Relation between industrial value added and SOx emissions Figure 3-7 presents the relation between industrial value added and SOx emissions. From 1960 to 1968, as industrial value added increased, so did the emissions of SOx. The correlation is more positive than that for ambient values. Following the peak of SOx emission in 1968, it started decreasing though the economic growth continued. The use of low sulfur fuel is the major reason for the dramatic decrease in the SOx emission.

Relation between industrial value added and energy consumption Figure 3-8 depicts the relation between industrial value added and energy consumption. In the high economic growth period from 1961 through the mid-1970s, the correlation was positive; as output value increased, energy consumption also increased but at a slower rate.

Since the latter half of the 1970s, industrial value added has continued to increase, but energy consumption has actually declined. The second oil shock of 1979 brought about a significant decrease in energy consumption. Consumption of energy in 1982 was approximately 20% less than that consumed in 1979. While the energy conservation and the efficiency improvement has been a major explanation of this trend, changes in industrial structure, including the growth in importance of less energy-inten-

Figure 3-6: Industrial Value Added and SOx Concentration, 1960–80



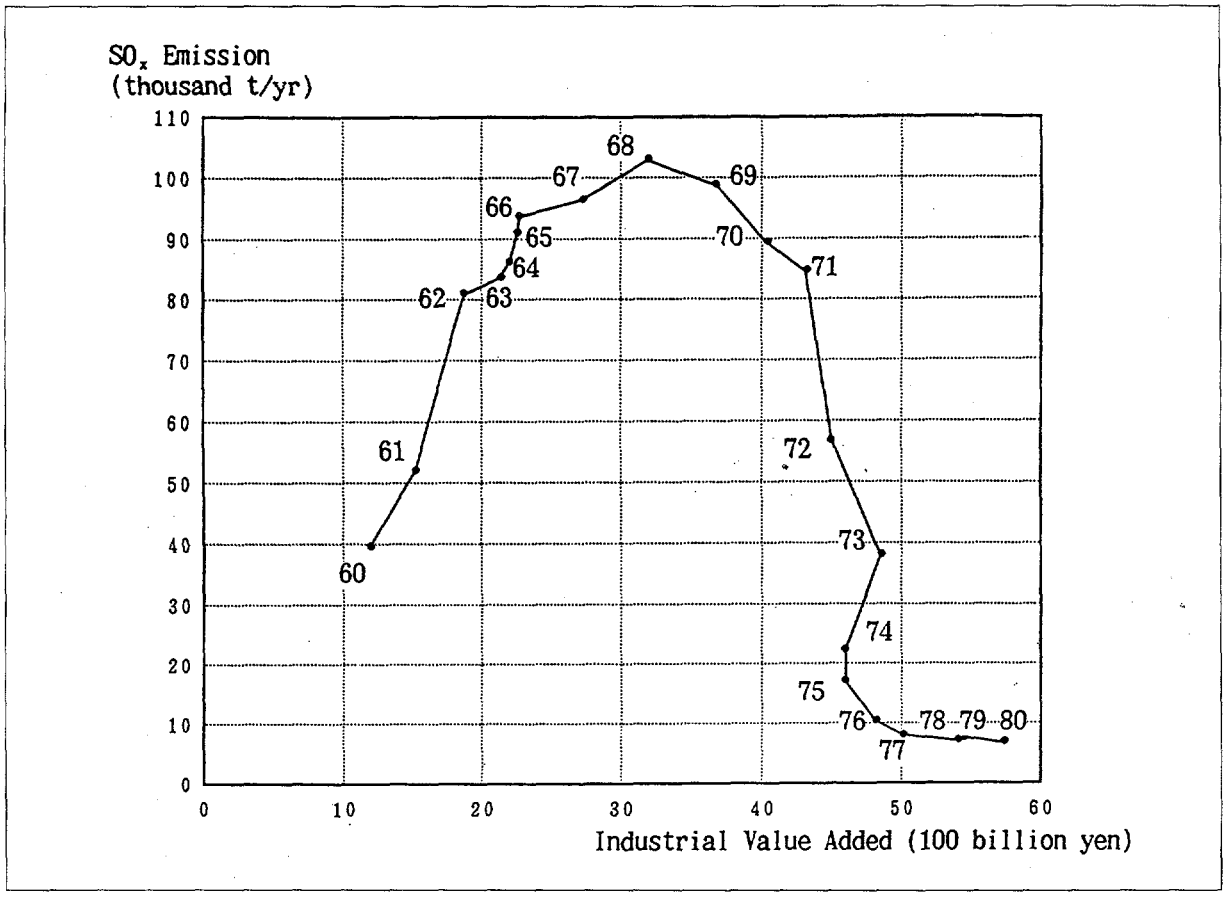


Figure 3-7: SOx Emissions and Industrial Value Added, 1960–80

sive industry, has also contributed to the trend. Currently, total energy consumption in Yokohama appears to be fairly constant, or increasing very slightly from year to year. Annual energy consumption (measured in terms of heavy oil) is currently about 1 million kilo liter/year less than that in the peak year of 1972.

Relation between SOx emissions and ambient concentration. Figure 3-9 shows the relation between SOx emissions and ambient concentration of SOx. Two distinct periods may be observed. In 1960-67, ambient concentration increased rapidly but subsequently declined. Ambient concentration in the second period being almost 0.2-0.3 mg/day/100 cm^2 lower than that in the earlier one. However, actual emission levels were the same in both periods. The explanation for this is that ambient quality, as measured by monitoring stations on the ground appeared to improve due to the introduction of taller stacks. This brought about an improvement in local air quality that apparently was greater than any additional background SOx pollution originating in neighboring cities such as Tokyo and Kawasaki. To make a judgment about trends in ambient quality, a regional rather than a city-wide approach must obviously be used.

Endnotes

1. One "tsubo" = 3.945 sq. yards

Figure 3-8: Industrial Value Added and Energy Consumption, 1960–80

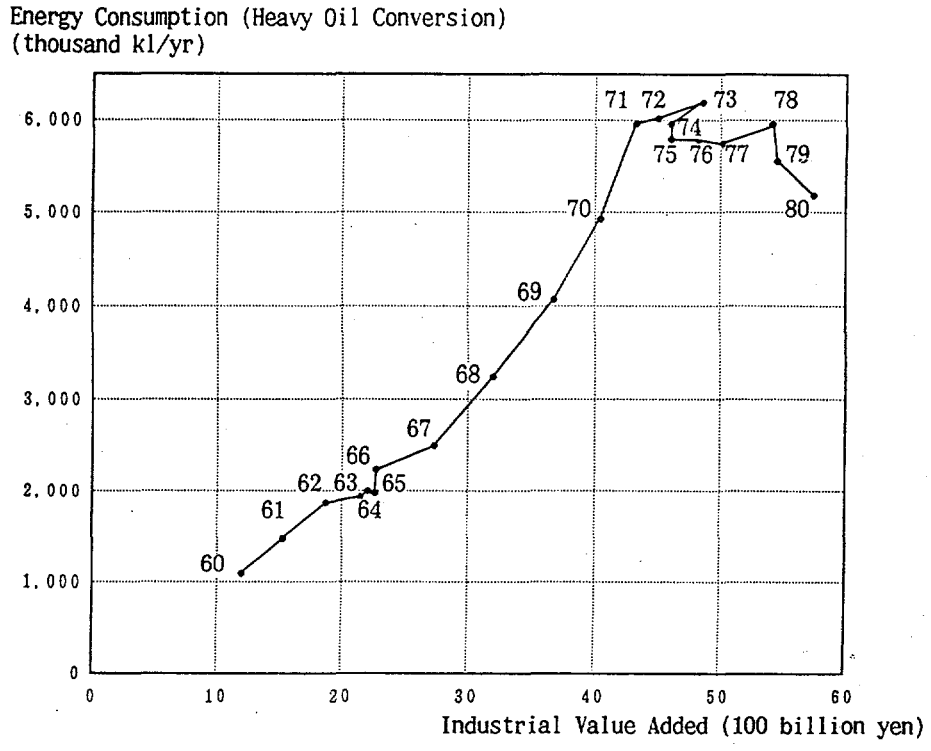
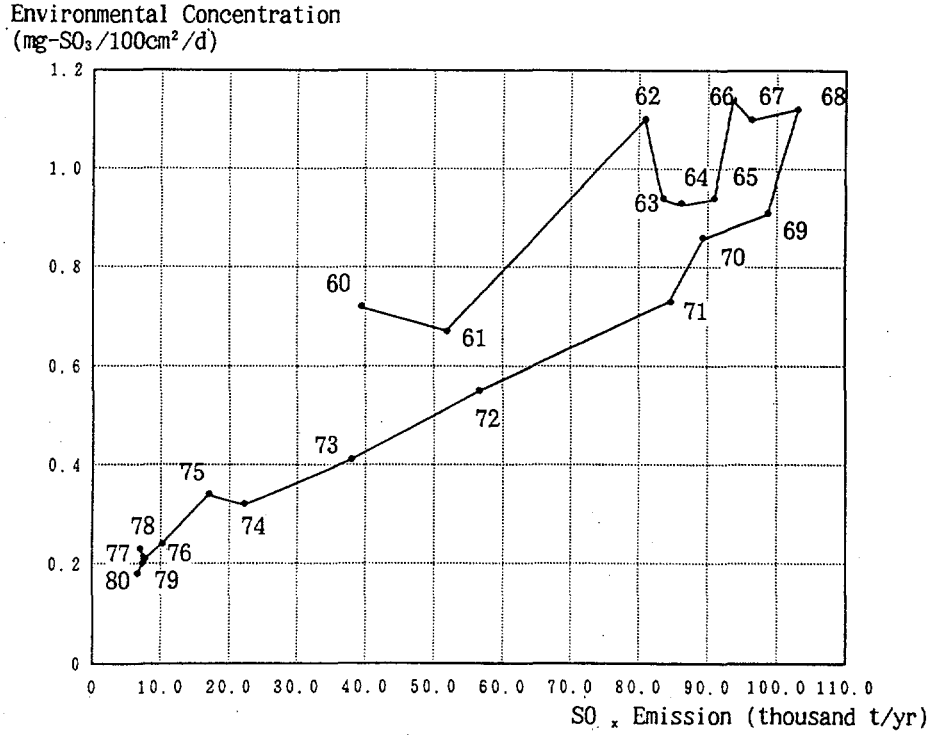


Figure 3-9: SOx Emission and Environmental Concentration, 1960–80



This chapter focuses on environmental protection measures taken by the private sector in Yokohama. Four examples are presented. These are large scale business establishments in electricity (coal-fired electric power plant), chemical industry (acrylonitrilo production), food industry (food oil production), and a medium-sized business establishment in the electronics industry (electronic parts plating). The first two firms (electric power company and chemical company) have pollution control agreements, which have been an important feature of Yokohama's environmental history. The electronic parts manufacturer relocated itself to the Kanazawa Industrial Park described in Chapter 3. The food processing firm reduced its emission of waste by improving its production process instead of installing new treatment equipment. It also introduced energy and labor saving measures based upon its own cost-benefit analysis.

Power Generation: Coal-Fired Electric Power Plant

This power plant is the first plant in Japan that made a pollution control agreement with the city in 1964. Major SOx countermeasures include the use of low SOx coal and installation of stack gas desulfurization equipment.

Use of Low-sulfur Coal

SOx countermeasures, from the start of operations in May 1967 to 1975, have depended upon the use of low-sulfur coal. Figure 4-1 shows the shift in a sulfur content ratio, and emission standards for burned coal under the Soot and Smoke Regulation Law, Air Pollution Control Law, the Yokohama Pollution Control Agreement, and the Yokohama Guidelines for SOx countermeasures. Compared with the earlier standard of 2,200 ppm under the Soot and Smoke Regulation Law, the standard of 500 ppm established in the Yokohama Pollution Control Agreement was extremely stringent. Since 1968, K-value regulation has been adopted in the Air Pollution Control Law. It should be noted that, in general, the application of K-value regulation and dilute dispersion made it possible for factories having high stacks to comply with the K-value regulation even with more SOx emissions.

Installation of Stack Gas Desulfurization Equipment

The power plant installed stack gas desulfurization equipment and started its operation in March, 1975. The plant adopted the wet limestone-plaster method for desulfurization, which treated all exhaust gas discharged from the plant.

Reasons for taking measures There were a number of reasons why the company took these measures. The main external factor was growing concern and pressure for strengthening of pollution regulation at the national level. There were a number of internal factors as well. Located in a large city, the company was concerned about its social responsibility to provide pollution control measures. Moreover, subsidies for installing stack gas desulfurization equipment — a new technology that could treat exhaust gas from coal-fired power plants — were provided by the national government in view of the promotion of use of domestic coals.

Effect of measures The positive effects of these measures were as follows: 1) the plant was able to meet the SOx emission standard set out in the Agreement; 2) it helped to meet domestic fuel supply needs and also made possible to control pollution even with the use of high sulfur coal, thereby alleviating the overall fuel supply problem; 3) desulfurization also reduced the emission of soot and dust; 4) it produced a useful, by-product, plaster. As Figure 4-1 indicates, the sulfur content of coal

was 0.29% before the installation of the stack gas desulfurization equipment. However, it became possible to use coals of 0.6% sulfur content (this is a maximum; generally it is 0.4%) after the installation of the stack gas desulfurization equipment. On the negative side, use of the equipment contributed to water pollution: waste water with high COD loads was generated. It was also costly to install and operate, resulting in higher electricity bills.

Chemical Industry

This is the case where a large-scale chemical manufacturer producing various kinds of chemical products took water pollution countermeasures, including both modification of its production process as well as investment in an effluent treatment facility. Although the company entered a pollution control

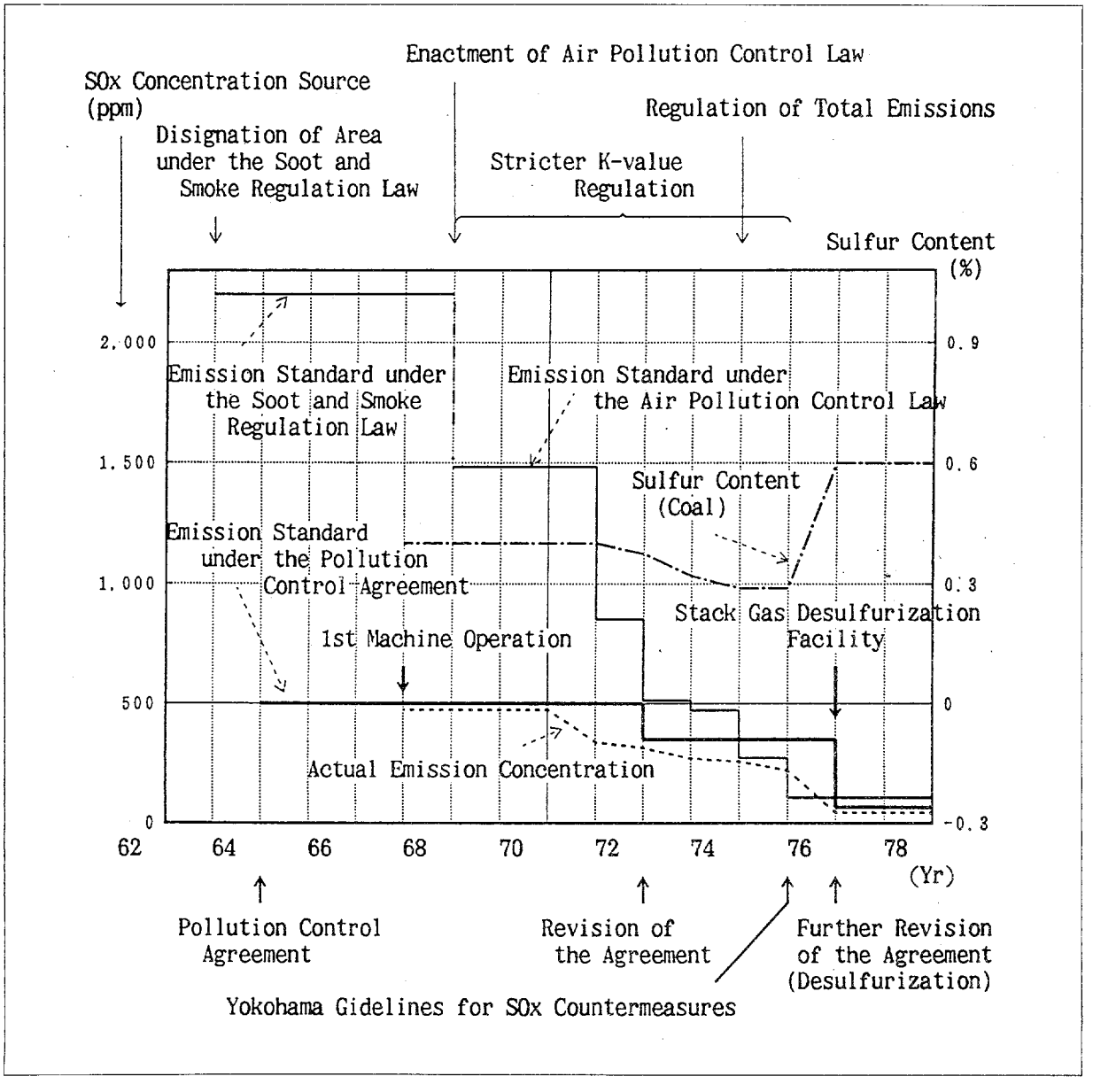


Figure 4-1: Change in SOx Emissions at the Coal-fired Power Plant, 1962–78

Figure 4-2: Factors Leading to the Installation of Stack Gas Desulfurization Equipment in a Coal Fired Power Plant, and Its Effects

External Factors	Internal Factors
Legal/Regulatory Clear direction for stricter regulation on pollution * Guidelines for SOx countermeasures in Yokohama * Revision and reinforcement of the Pollution Control Agreement * Air Pollution Control Law - reinforcement of K-value regulation * Air Pollution Control Law - an introduction of the regulation of total emission Socio-Economic * National policy for promotion of use of domestic coal Technical * In the early 1970s, desulfurization equipment which could treat all exhaust gas from heavy oil thermal power plants was introduced.	Managerial * Corporate responsibility (corporations located in large cities) Technical * From the beginning of the 1970s, the technical development of desulfurization equipment, which can treat all exhaust gas from the coal-fired thermal power plant, began. Economic * The government provided subsidy for installing stack gas desulfurization according to the 5th national coal policy.

↓

Installation of stack gas desulfurization equipment

↓

Positive Effects	Negative Effects
Technical * The migratory restriction in fuel supply (The use of mixed coal with a relatively high content of sulfur became possible.) * The reduction of soot and dust emission due to the equipment Economic * 100% use of plaster (by-product) for cement material * A decrease in the contribution for the Pollution Health Damage Compensation Prevention Association Other * Technological accumulation - later, it helped in overseas technological cooperation	Economic Effect * Investment and operating costs of the equipment led to higher prices for electricity Other Pollution * Drainage with persistently high COD was discharged

↓

Stricter countrermeasures for drainage treatment

agreement with the city, the agreement, merely meant a goal for the company to be achieved instead of regulations to be imposed.

The chemical plant began its operation in 1936 as a fertilizer factory, producing ammonia, sulfuric acid, ammonium sulfate, urea, and acrylonitrilo. It currently produces dry ice, methylamine, acrylamide, and other products. In the latter half of the 1960s, air pollution and water pollution caused by the plant became increasingly serious. This plant used to emit such pollutants as SOx from various sources, as well as a sulfide ore, calcinar, nitrogen oxides from the production of sulfuric acid, and offensive odors from organic synthetic compounds. In the early 1970s, the plant was restructured; this restructuring involved the dismantling of the ammonia and related facilities and ten boilers, which were used for air separation, ammonia synthesis, and fertilizer production, were gradually phased out. The need for air pollution control countermeasures was then significantly reduced. However, water pollution due to factory effluents containing cyanogen and originating from acrylonitrilo production, a major product of the company, continued to create a problem. The next section describes environmental control measures taken by the company to address this problem.

Measures to Reduce Effluent Load

Reason for taking measures Although the plant continued to expand its capacity, it did not for several years expand its pollution control facilities at the same rate. Waste water treatment was unsystematic. For example, it had six drainage channels in 27ha sites, but discharged cooling water, rain water, and polluted effluent together. Many factories operating in the coastal district were not even aware of the pollution they were causing since effluents were diluted in a large volume of sea water.

The plant used public water, industrial water, and sea water. The total volume of water used was about 100,000 m^3/d at the end of the 1960s. Cooling water accounted for more than 90%, the remainder being used for boilers, materials, washing, and personal use. Effluent were largely of two types:

- Highly concentrated acrylonitrile effluent
  Acrylonitrile was produced by an ammonia oxidation method that a catalyst oxidized ammonia and then synthesized propylene. As a side reaction, cyanogen was produced. Highly concentrated acrylonitrile effluent was a dark brown effluent with a pH value of 7-8, and contained about 1,000 ppm cyanogen. The company did not treat it in the factory, but dumped it into the ocean once a month (equivalent to 500m^3/d). The cost to the firm of ocean dumping was about 0.1 billion yen per year.

- Effluent from ordinary processes
  Polluted waste water from processing of materials and direct cooling were discharged into the sea after it being treated by coagulation, sedimentation, and filtration.

In the early 1970s, when pollution regulations became stricter, the City of Yokohama introduced emission/effluent control guidelines for air and water, and the company then took various measures, including improved processes, and installation of effluent treatment equipment. Moreover, after several discussions with the city, the company entered a pollution control agreement in January, 1974.

Prior to the pollution agreement, the company had treated highly concentrated acrylonitrile effluent in its treatment facility. The volume of effluent from ordinary processes was 15,000 m^3/d, its COD being 270ppm after treatment, the effluent load of COD was 4t/d. Since the effluent standard for this plant was set at COD 60ppm by Kanagawa Prefectural Ordinance, waste water was diluted by sea water before its discharge.

The contents of the agreement were: 1) reduction of the COD effluent load from 4t/d to less than 40 kg/d (i.e. a 99% reduction); 2) separate use of drainage channels for rain water/cooling water and polluted water; 3) unification of the drainage channels and drainage exits; and 4) substitution of indirect for direct use of cooling water, and water reduction and recycling measures.

The reduction of effluent load by 99% suggests that the pollution control agreement was extremely strict. However, this figure was not an immediate target, but a future goal. It was immediately possible to reduce effluent to about 1/4, i.e. 4,000 m^3/d. Also, to keep effluent concentration at the level of 10ppm by treatment was the basis for achieving a 40kg/d effluent load. An effluent concentration of 10 ppm was in-

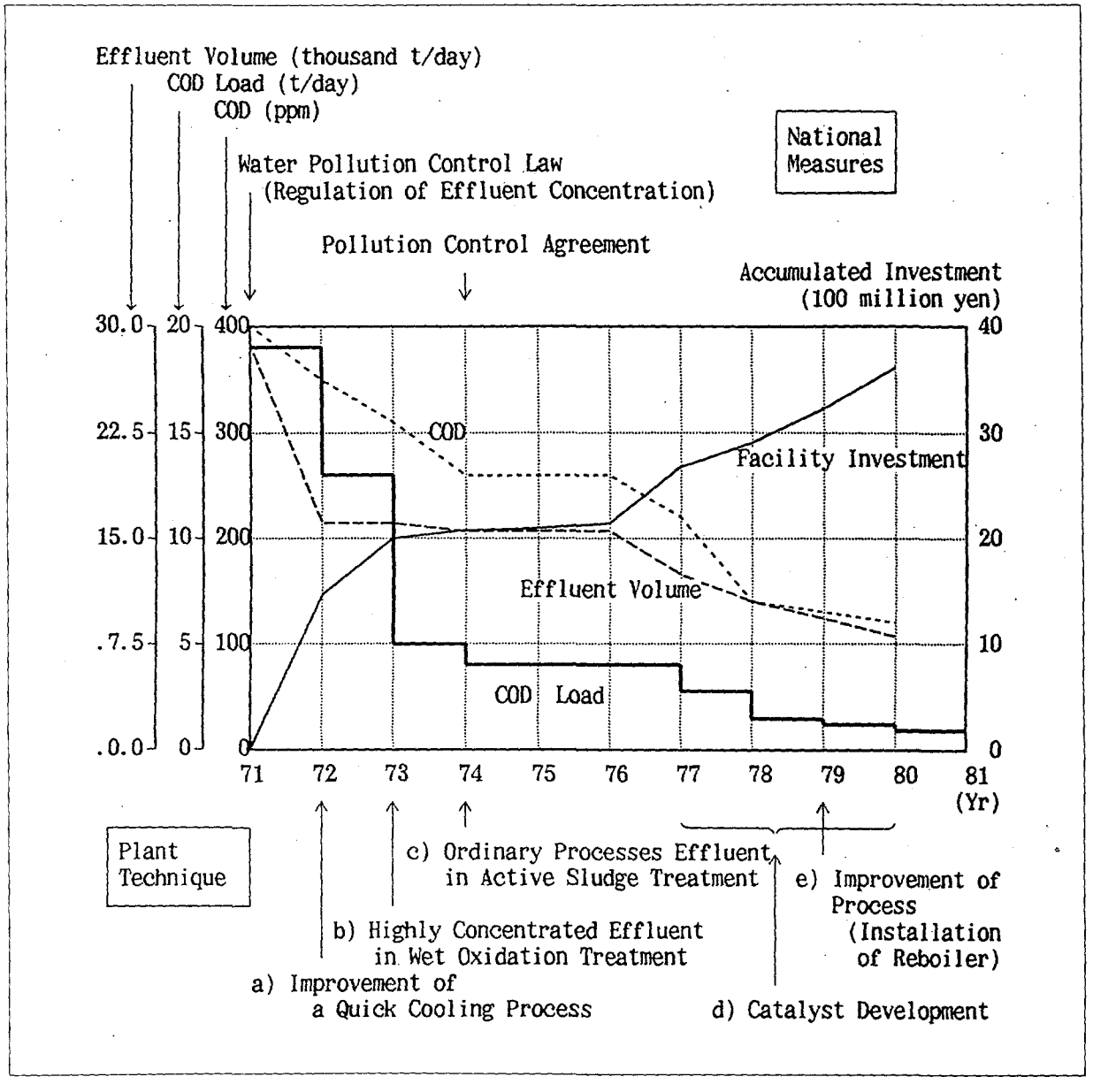


Figure 4-3: COD Load and Investments in Chemical Plant, 1971–81

tended to achieve consistency with other companies which also entered the agreement. Although the effluent from the chemical industry contained toxic substances such as cyanogen and other chemicals and was generally difficult to treat, 10 ppm was technically possible with tertiary treatment. Since other business establishments had adopted a 10 ppm target, it was difficult for the factory alone to adopt 20 or 30 ppm.

Actual methods

The following measures, which include process improvement, were implemented in order to reduce the effluent load. (These are also summarized in Figure 4-3).

Catalyst development The company developed its own catalyst, which was capable of converting propylene (material) to acrylonitrile, and of absorbing residue in acrylonitrile production process. This process reduced non-reactive substances and impure by-products (primarily cyanogen) and a great deal of COD load in the effluent process. This measure reduced COD effluent load by about 33%, i.e. from 4t/d to 2.7t/d.

The company installed a boiler at its distillation towers with a direct steam blow method. This decreased effluent by separating steam from polluted effluents, and the steam was reused for condensation. This measure reduced COD effluent load by about 44%, i.e. from 2.7t/d to 1.5t/d.

The company also installed new drainage channels that made possible to separate effluent from rain/cooling water, and reduced volume of effluent to be treated. The number of drainage channels reduced from six to three.

Effect of measures

Although COD effluent load decreased from 4t/d to 0.98t/d (75%), the effluent load standard (40 kg/d) set by the agreement was not achieved.

During the period 1972-1977, investments for pollution control facilities were 2.68 billion yen for water pollution and 1.70 billion yen for air pollution. This added to the production costs. These were financed by the company itself, by raising the price of its main product, acrylonitrile, by 17.5 yen/kg, or about 20%. During this time, COD load decreased by about 92%, i.e. from 19t/d to 1.56t/d.

In the end, however, implementation of the above pollution abatement measures turned out to be difficult for economic reasons, primarily the slump in acrylonitrile demand due to structural depression. The company discussed with the city about the possibility of a more gradual implementation of the agreement. In 1983, due to heavy competition from other factories producing acrylonitrilo and related products, 2/3 of the factory site was sold.

Food Processing Company

This case is one in which a large-scale food processing company took measures to reduce air/water pollution, offensive odors, and solid wastes. The characteristics of environmental pollution control measures in this case were: 1) reduction in effluent load was achieved by process improvement rather than by installation of end of pipe treatment equipment, 2) the measures took account of saving in energy and labor costs, and 3) the measures were implemented based on a cost-benefit analysis.

This company started operation in 1963. It produces food oil and related food processing products. All materials such as beans, rapeseed, cottonseed and sesame are imported. The company produces salad oil, margarine, sesame oil, etc. by pressing, extracting, and refining. Figure 4-4 shows the process flow in the production of vegetable oil from beans or rapeseed.

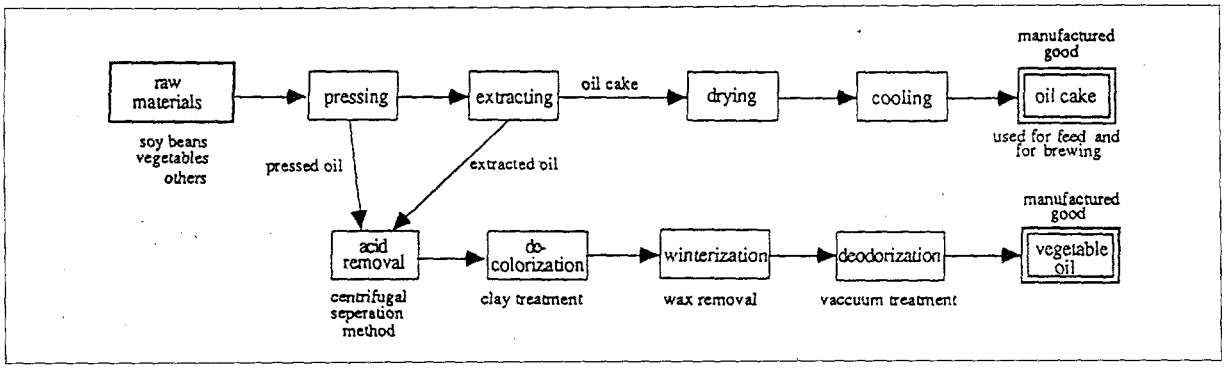


Figure 4-4: Process Flow: Production of Vegetable Oil

The factory is located in the Negishi reclamation area. In recent years, high-rise apartments have been built in an area close to the factory site.

This company has a corporate policy which emphasizes social responsibility and product quality, as well as the speed and cost of production. It is especially concerned about its responsibility for environmental protection and food sanitation. Costs incurred to implement the measures described below were offset by other savings, rather than by raising product prices. In fact, the company implemented the measures only after it determined their rationale based on its own cost-benefit analysis.

Air Pollution Control Measures (NOx Countermeasures)

Reason for taking measures The company examined the case for remodeling its NOx reduction system in its large boiler of C heavy oil (high sulfur content) in order to respond to the Yokohama NOx countermeasures guidelines. At the same time, boiler control was computerized, thereby saving energy and labor. Prior to its implementation, the company had made a cost-benefit calculation, in which benefits (savings) amounted to 100 million yen/year, due to a decrease in fuel/labor cost, and energy-saving. Capital costs amounted to 70 million yen/year. The analysis indicated that the company would achieve a net reduction in costs of 30 million yen/year. Therefore, the company decided to undertake the proposed NOx countermeasures.

Summary of measures

a. The remodeled large boiler included a NOx reduction combustion technique. Membrane water pipes were built in the boiler and a two-stage combustion burner decomposes the NOx produced in the main burner.

b. Computerization for optimum load distribution control in the boiler has improved its efficiency. Also, the rotational frequency control in a forced ventilator was remodeled and saved energy. Investment in this facility was 290 million yen.

Effect of measures

As a result of these countermeasures, NOx emissions amount and concentration decreased by 25% respectively. The introduction of an auto-control system in the bo iler made operational management and information processing easier and replaced four operators.

Air Pollution Control (SOx Countermeasures) and Energy-saving (Fuel Conversion)

Reason for taking measures As a NOx countermeasure, the company installed stack gas desulfurization equipment in its large C heavy oil boiler. Because it was difficult to maintain the quality of low sulfur heavy oil, the company agreed, under the guidance of Yokohama city, to install a stack gas desulfurization. However, local residents complained about re-evaporated steam (wet flue-gas

desulfurization equipment lowers temperature around the emission exit and produces steam).

Kanagawa prefecture and the city of Yokohama subsequently provided guidelines for fuel conversion in order to reduce SOx emissions. The company, at that time, was using two kinds of fuel: *A*, heavy oil (lower sulfur content) at four small boilers and *C*, heavy oil (high sulfur content) at its large boiler.

Following the new guidelines, as a comprehensive means of addressing NOx, SOx, soot and dust, etc., the company planned to change fuel from heavy oil to city gas, and therefore remove flue-gas desulfurization. Then, considering the fuel conversion as a first step, the company planned to reduce total energy cost by introducing a co-generation system (installation is scheduled in April 1995). The company's decision was based on an economic calculation which indicated that, although operating costs will temporarily increase, in the long run there will be operating cost savings.

Summary of measures

Investment in fuel conversion cost 300 million yen. It was implemented as follows:

a. The company remodeled combustion equipment in its large boiler and converted fuel from C heavy oil to city gas. A charcoal-saving machine was also installed in the boiler to save energy from exhaust gas. The old flue-gas desulfurization equipment was removed.

b. The company remodeled combustion equipment in four small boilers and converted fuel from *A*, heavy oil to city gas.

Effect of measures

As a result of these measures, NOx emission concentration of its large boiler decreased by 30% and NOx emissions decreased by 5%. Five heavy oil storage tanks were now used for plant oil after clean-up. The economic calculation indicated that operating costs would increase by 10% but decrease by 75% when the co-generation system is introduced.

Water Pollution Control Measures — Phosphorous

Reason for the measures The company had some effluent treatment facilities from its earliest days: pressurized flotation for industrial process effluent, and activated sludge for household effluents. It had no problems with COD effluent concentrations or loads. However, the effluent from salad oil production contained highly concentrated phosphorous. Because the pressurized flotation method could not remove phosphorous, its concentration in the plant's effluent was 60 ppm. Yokohama city requested eutrophication countermeasures under its administrative guidelines for improving the quality of effluents discharged into public waters.

The company was determined to introduce a new treatment facility equipment and strengthen the process rather than to improve the old facility, and considered how to develop the needed technology. A cost-benefit analysis of this measure indicated net economic advantage will be 100 million yen per year. The analysis is as follows:

Merit 240 million yen/year:
a cost reduction in chemical use and effluent treatment, an improvement of production speed, etc.

Demerit 140 million yen/year:
capital cost and cost of electric power, etc.

Actual methods In the salad oil production process, the company reduced the phosphoric lipid content of crude oil by improving its pressing process, then reduced phosphoric acid consumption by

deoxidization, thereby reducing the phosphorous content of the final effluent. The total cost of equipment was 572 million yen. Specific measures were as follows:

a. Improvement of the pressing process

The extract expander equipment (an extruding grain machine) which crushes, mixes, kneads, and makes pellets was introduced after the pre-treatment process (a pressed process). The company found that this process inactivated oxygen of materials by pressing oxygen and adding steam. This prevented hydrate phosphoric lipid from changing to a non-hydrate one and reduced the phosphoric lipid content in crude oil.

b. Intensification of gum removal equipment in the deoxidization process

The deoxidization process originally only removed gum from extract oil. However, new equipment was installed to remove gum from all pressed oil, which improved the rate of oil production.

c. Effects of measures

Eighty percent of phosphorous lipid content was removed from crude oil, 75% of phosphoric acid consumption in the deoxidization process, and 50% of the phosphorous content of the final effluent. However, the effluent concentration was still high at about 30 ppm. In light of probable future trends in effluent standards for phosphorous, the company is now considering more phosphorous removal techniques, such as anaerobic treatment.

Water Pollution Control Measures — Polluted Cooling Water

Reason for taking measures Salad oil is deodorized with high temperature (270 degree centigrade) and high vacuum (3-5 Torricelli) in the final refining process. Vacuum generation equipment originally used a large amount of sea water. The waste water from this process was contaminated and created a large pollution load. Consequently, Yokohama city regulated the volume of effluent discharged under its administrative guidelines for improving the quality of effluent discharged into public waters.

The company conducted research with an equipment manufacturer, aimed not only at reducing the amount of waste water, but also at improving the efficiency of the production process. New cooling technology was developed. Water cooled by freezer was used for vacuum generation equipment, and recycled cost-benefit analysis indicated that this measure would be economically advantageous: cost saving due to reduction in the use of steam was greater than cost of using additional electricity for the new technology.

Effects of the measures As a result of the measure, the vacuum condition in the deodorization process became rigid and the operation became stable, leading to increases in the efficiency. The measure decreased steam use by 70-80% and also decreased specific effluent (sea water) by 85% by recycling the industrial water which was converted from the sea water. The clean up of scum in water pipes became unnecessary because of the conversion to industrial water. The overall process became cleaner. The company obtained a patent for this technology and sold the equipment to four Japanese plants and three foreign plants in the same industry.

Offensive Odors

Reason for taking measure In the process of producing salad oil, after the oil from crude oil was pressed, the oil sludge treatment process dried and cooled, producing offensive odors. The residents who lived around the factory complained, and the city of Yokohama advised the company to reduce

the offensive odors. The company's own view was that it should secure a proper work environment for its labor force. The approach taken was to control offensive odors by applying a recycling and closed system in the production process, and also to recover heat from exhaust gas.

A cost-benefit analysis indicated that such a measure would yield a small economic gain. Costs of the project were about 33 million yen/year, including both investment and additional operating costs. The energy savings due to reduction in use of steam were 35 million yen/yr.

Actual method and effect The company invested 113 million yen in the system to control offensive odor generation. This consisted of a closed system which recycles exhaust gas from the sludge drying process. The exchange gas from a heat exchange machine is showered in the cooling tower and returned again to the drying process. At the same time, the company undertook an energy-saving measure (use of recovered showering drainage water as auxiliary heat source for operating machines). The concentration of offensive odors treated by the deodorization equipment met regulatory emission standards.

Industrial Waste Measure (Reduction in the Volume of Sludge)

Reason for taking measures The original activated sludge effluent treatment facility treated domestic waste water except oil bearing effluent. The extra dehydrated sludge was given to farmers to apply to agricultural land. Originally, since the water content of the sludge which was dehydrated by five belt presses was in fact high and variable, the system always required operators to be aware of changes in weight and volume and to react accordingly. Also, although the treatment system operated continuously, the belt press system only operated during the day time. This discontinuity in the overall waste disposal process was inefficient. Consequently, the company examined the case for replacing the dehydration equipment in order to decrease the water content of newly generated sludge and to reduce treatment costs by stabilizing the activated sludge process, and reducing the volume and weight of sludge.

Cost-benefit analysis indicated that this measure, involving an investment of 56 million yen, would yield a slight economic gain. Annual costs of the project (investment costs plus energy costs) were 5 million yen. Savings were 16 million yen/year, comprised of a reduction in the cost of sludge treatment and disposal, including labor cost savings.

Actual method The company introduced a belt press using electric osmosis, which operated 24 hours a day, and also introduced a measuring and monitoring system to reduce water content, as well as to increase efficiency. The figure of facility investment was 56 million yen.

Effects of the measure The measure resulted in a reduction in the water content of dehydrated cake from 85% to 65%. This decrease corresponded to a 60% reduction in the generation of dehydrated cake. Also, it made use of fertilizer easier. Moreover, it reduced the load of sedimentation of 24-hours-operating activated sludge facilities. It also decreased the work load of operators by introducing remote control and improving the working environment.

Small and Medium-sized Electronics Parts Manufacture

This case refers to a medium-sized electronics parts manufacturer which specializes in metal plating. The factory moved from a mixed residential/industrial area to the Kanazawa Industrial Park during the

period 1980-83. Upon relocation to the new site, the company renewed its production process, used the joint effluent treatment facility, and recycled its effluent.

The firm, which currently has 130 employees, actually started operation in 1950. It originally produced a special small resistance bulb or a heat coil for a vacuum pipe, etc. and then shifted its production to electronics parts and materials. The company now specializes in electroplating precious metals such as gold and silver, as well as high value-added electronics components. This product diversification required new production facilities and raised major funding issues.

Relocation to the Kanazawa Industrial Park

Reason for the relocation In 1960, the factory was located in a rural Yokohama suburb, which was in a valley with springs and pine tree forests. The City Planning Law then designated the site as a residential district and its neighboring district as a category I exclusive residential district. In summer time, the residents complained about night noise. Because the factory was located in a residential district, it was impossible to even construct a building for a renewal or an extension of the production facility or a renewal of an effluent treatment facility. This factory was located in an area designated and promoted for relocation by the Factory Regulatory Law.

One of the problems the factory had at that time was that the old effluent treatment facility became obsolete, and its treatment capacity had not kept up with the increase in production. The facility required more space and repairs would incur additional major costs. It was clearly preferable at this time to invest in a new facility than to repair the old one. Moreover, the company was expecting a rapid growth in demand for its products because of the overall growth of the electronics industry in Japan. Accelerating demand for high quality electronics products required the company to modernize its production facilities. The situation also demanded that the company discard its old metal plating image and create a modern and clean working environment for its labor force.

Decision-making process and relocation

Decision-making and relocation The company concluded that the old factory could not deal with the new situation and should be relocated. It was expected that the sale of the old factory site would generate about 50% of the total relocation cost. The reason for moving the factory to the Kanazawa Industrial Complex was that the Complex had the infrastructure for controlling pollution and was a project which the city of Yokohama supported by providing subsidies to relocating firms. An important factor was that factories in the Park could make use of the joint effluent treatment facility.

Relocation When the company decided to relocate in 1979, the city of Yokohama was already registering prospective relocation companies. The company belatedly became a member of a metal plating trade association. The company later became a representative firm of the association.

Cost-sharing The total cost of relocation including land, buildings, and production facilities was about 3 billion yen. The purchase price of the new land was 55,400 yen/m^2. About 2.3 billion yen out of the total cost was provided by a loan from the Japan Environment Corporation, which charged a 7.35% interest rate and a twenty year repayment period. Grants covering interest and relief from the special land holding tax and corporation tax provided by the city of Yokohama over a limited period were also effective. Yokohama city proposed to buy the old factory site, but could not agree on a price. In the end, a private company bought it for 200,000 m^2 or about 3.5 times higher than the land price in the Park. An apartment building was built at the old site.

Effect of relocation

Relocation to the new site enabled the company to improve the quality of its products. The company could satisfy its clients' demands with a better production environment, therefore obtaining new clients. With regard to technical aspects, the wider factory floor made it possible to introduce a sophisticated surface analyzer such as a scanning electron microscope. Metal plating techniques could also be improved and technological innovations, including the most precise IC products, were introduced. Investment in the production increased production and profitability. The number of employees at the time of relocation was about 120, but increased to 180 as production expanded. With respect to pollution countermeasures, vibration and noise were no longer problems. Night work no longer resulted in citizens' complaints.

As to other effects, the company could now obtain more labor supply from the Miura and Yokosuka areas in addition to the Kanazawa area. Location in a high-technology environment also yielded benefits. For example, the company established business relations with other companies in the park and enjoyed the improved technologies of those companies.

Effluent Treatment

Collective industrial wastewater treatment facility

Summary of the measure The Sewerage Bureau facilitated the use of the collective wastewater treatment facility (industrial wastewater treatment facility at the Fukuura factory). The construction cost of the facility and the maintenance cost were charged to the companies that used them.

Effect of measures The company decided not to install a wastewater treatment facility at its own site, but to use the collective wastewater treatment facility. Economies of scale in the collective facility meant that the firm could dispose of its waste much more cheaply than if it had to install and operate its own treatment facility.

Evaluation of Environmental Protection Measures in Yokohama

In this section, we evaluate the environmental protection measures in Yokohama such as the pollution control agreements and the Kanazawa reclamation project described in Chapter Three.

Pollution Control Agreements

Overall evaluation The first pollution control agreements in Yokohama were conceived by an autonomous effort of the city during the mid-1960s when local governments did not have any legal authority over pollution control. Under the agreements, the city obtained, based on mutual consultation, pledges from business enterprises to implement pollution control measures. The city took the initiative in undertaking preventive pollution control measures with the support of citizens' movements, while allowing companies to establish their factories on a selected basis. The Yokohama pollution control agreement was different from the following two types of pollution control measures, one taken in Yokkaichi and the other in Mishima-Numazu. In the case of Yokkaichi, pollution control measures were pursued only after companies had established their factories and started causing pollution. In the case of Mishima-Numazu, the residents rejected the siting of planned plants by organizing a strong residents' movement. For this reason the Yokohama Pollution Control Agreement was frequently called "Yokohama style." The initiative taken by the Mayor of Yokohama was the main reason for the inception and success of the "Yokohama style" pollution control agreement, which was necessary to protect citizens' health and the living environment. This was a major break with tradition, for according to conventional ideas, local municipalities were not allowed to establish their own regulating standards or methods, which would be stricter than those required according to the structure of laws and regulations at that time.

Early pollution control agreements were concluded with large companies in the new industrial area on the coastal reclaimed land in order to control increasing pollution originating from existing factories. In fact, since pollution originating from the new factories was much less than that from the existing factories, the pollution control agreements were very effective.

The agreements specified maximum pollution control targets, based on scientific data, and in light of present conditions and future prospects of air pollution, and of the level of pollution control technology available at that time. Although the agreements were much stricter than laws and prefectural ordinances established later, the companies recognized that scientifically reasonable standards based on large scale monitoring or a wind-tunnel test, were being set. The agreements played an effective role in introducing advanced technology and developing new technologies such as the country's first power generation by LNG, and the improvement in ground concentration of pollutants due to collective smokestacks.

Early pollution control agreements, which first targeted new factories, were later adopted by existing factories. Even after certain legal regulations were provided, the agreements were still innovative. For example, the agreements imposed stricter control than laws, or introduced total emission targets while existing laws only regulated emission concentrations.

Residents' movements From the early 1960s, air pollution had become a serious problem in the existing coastal industrial zone. Residents were anticipating with alarm the arrival of still more facto-

ries in the new coastal industrial zone. Residents around the zones formed a residents' organization called "Council for Conservation of Environmental Hygiene in Naka and Isogo Districts." They appealed to the national, prefectural, and city governments to implement pollution control measures. Anti-pollution campaigns by local residents in Yokkaichi and Mishima-Numazu affected this movement. Citizens' movements at that time not only promoted pollution control measures by Yokohama City, but also gave birth to the first pollution control agreement.

Thereafter, citizens' movements continued to support the city's pollution control measures. This was because the city kept residents well informed of the content and results of scientific experiments conducted by the city and factories, as well as the content and effectiveness of the agreements. This openness removed anxiety from residents, and the visual evidence of improvement in environmental quality enabled the city to win the residents' understanding and trust.

Companies' reaction Escalating anti-pollution demands from the public, and land sales contracts were the external factors that companies accepted in the early pollution control agreements. Since the city's investigation and finding were scientifically sound, the companies acknowledged the results and agreed to cooperate. On the other hand, internal factors that companies accepted such a strict agreement were as follows:

- Yokohama was blessed with a large consumer market in the outskirts of the capital;
- good economic conditions at that time eased negotiation of the agreements; and
- having abundant capital and management capacity, the large companies were able to cope with the pollution control costs.

As a result, the companies were able to pay for the costs of pollution control investment, and to maintain industrial competitiveness at the same time.

Later, the city signed other pollution control agreements with the existing factories. The following factors attributed to the successful agreements: First, the companies understood the Yokohama style when they reached early pollution control agreements with new factories. Second, following increasing anti-pollution demands from the public, these companies came to realize that, in order to carry out their business in the future, it would be vital for them to obtain a consensus from local governments and residents when building or expanding factories. It turned out that to take pollution control measures is not so costly in the long term and is affordable, though large investments are required in the initial stage. Furthermore, from the factories' point of view, the conclusion of pollution control agreements meant a kind of authorization for pollution control measures from Yokohama City. As a result, the factories were able to build up good relationships with the residents.

Administrative reaction The city's administrative structure and staff attitudes and skills for pollution control were key factors. The pollution control agreements were successfully implemented through frequent monitoring, on-the-spot inspections, and guidance. Such local effort has been an important tool to induce effectiveness of the measures and this has been a distinctive characteristic of the Yokohama administration. The city administration obtained residents' trust and cooperation, and maintained it by disclosing pollution information as openly as possible. Since the city set targets based on scientific data, the companies tended to accept them.

The Bureau of Pollution Control was established with its ten staff when the first pollution control agreement was concluded. Yokohama was able to

avoid a vertical administration, though this is typical in the Japanese administrative structure, and it has maintained its flexibility to effectively handle the problems at hand. Since then, the administrative structure has basically stayed the same. Staff engineers who had received higher education were highly concerned about pollution issues and approached their task with enthusiasm and dedication. Moreover, the city made great efforts to improve its staff's capability and accumulated technology in the Bureau. This accumulation of technology, specifically reflected in the conclusion of the Yokohama pollution control agreements that were based on scientific knowledge and technology, and helped the city win credibility and understanding from the enterprises which concluded pollution control agreements.

Requirements for effective pollution control agreements The experience of Yokohama city indicates the following requirements for effective pollution control agreements:

1) The content of the agreements should be defined from a scientific and technological point of view, and not simply from an abstract and ethical point of view.

2) A strict and rigid agreement is not always good. It needs to be adjusted according to the economic, technical and managerial capacity of the firm local characteristics.

3) In order to check whether the companies carry out a comprehensive implementation of the agreements, it is necessary for the administration to be aware of best available protection technology. Therefore, it is desirable for the administration to maintain a certain number of qualified staff and train them. Local staff must have enthusiasm for, as well as knowledge of, advanced technology.

4) It should be recognized that the pollution control agreements exist not only for the company and local government administration, but primarily for the residents' well-being.

Kanazawa Reclamation Project and Industrial Relocation

The goal of the Kanazawa Reclamation Project was more than just creating land for industry and port as in the past. The ultimate goal was to reclaim land as a site for redeveloping the downtown area and accommodating small- and medium-sized factories. Small- and medium-sized factories scattered around the city were transferred into the Kanazawa Reclamation Land. This facilitated rationalization of factory management through cooperation and systemization. The industrial relocation was also effective as a measure for controlling pollution including noise, vibration, and offensive odors.

Successes of the Project

Concern about living environment The reclamation project was formulated with careful consideration of environmental aspects and urban planning. The area was divided into the industrial and residential sites by a national road running North-South in the center of the reclaimed land. A 50 m wide green tract of land was also constructed as a buffer zone along the national road. The city secured about 10% of total reclaimed land for building a seaside park, a park on the old coastal line, and green buffer zones. The construction of the green buffer zones were funded by the Japan Environment Corporation.

Pollution control measures In order to prevent pollution from occurring in their new neighborhood, companies implemented specific pollution control measures after relocation, namely, arrangement of factory location within the industrial complexes,

establishment of treatment facilities, as well as individual measures within the factories themselves.

Accordingly, the city decided to locate some small- and medium-sized industry in special sections of the Kanazawa Industrial Complex and let them discharge effluent to the collective treatment system after each factory removed some hazardous substances. To have a collective treatment facility is much more economical than the case where each factory has its own industrial treatment facilities because the former requires less space for the treatment facility installation and less operation and maintenance costs.

Costs of construction, operation and maintenance of the collective facilities are borne by the user companies. The facilities were constructed by using a 30-year low interest loan provided by the Japan Environment Corporation. Yokohama city subsidized a part of the interest. Annual operation and maintenance costs are settled by the user companies according to a certain formula using contract and actual effluent volume, as well as effluent density.

Collective treatment proved more economical than individual treatment. It also made possible for Yokohama city to easily monitor the effluents of the user companies, and to give them appropriate guidance.

Incentives to relocate (land price and financial subsidy) The incentives included the availability of necessary infrastructure on the site, and low cost requirement of the relocation.

The initial sales price of industrial site was 30,000 yen/m^2. However, it actually increased to 50,000–60,000 yen/m^2 due to delays in granting reclamation licenses and soaring construction costs. There was considerable doubt as to whether the targeted small and medium-sized businesses could afford for relocation. The city therefore reduced taxes for the factories concerned over a limited period, exempting them from property tax, corporation tax, and the special land holding tax.

Taking advantage of factory relocation, the city tried to reform and rationalize management of small- and medium-sized factories by promoting collective and cooperative actions, as well as improving organization in the factories themselves. Organizational promotion made it possible for small- and medium- sized companies, which were financially weak, to obtain public funds such as the promotion fund for small- and medium-sized companies and loans from Japan Environment Corporation.

Project execution organization The Kanazawa Reclamation Project in Yokohama was implemented by inter-departmental effort involving Planning and Coordination Division, Pollution Control Bureau, and 10 other bureaus of Yokohama city. Officials of those organization formed both the steering and technical committees for the project.

Unsuccessful aspects

Process of factory relocation The city introduced criteria to prioritize the districts from which relocated factories should be drawn. Criteria included the presence of residents and industries located in close proximity to each other, existing environmental conditions, and managerial capability. Based on the results of this investigation, the city selected factories which would require relocation, and then encouraged the process. Although the city initially wanted to relocate 2,000 out of 6,000 small- and medium-sized factories, only about 400 factories were actually relocated. Many factories which caused pollution could not be relocated due to the lack of relocation funds. Moreover, about 40% of the factories relocated were previously located in the

semi-industrial area, and not in the mixed residential-industrial area. It may be said that more factories could have been identified and relocated if the city had identified candidate factories from only residential areas or commercial areas, and excluded semi-industrial areas, and if more time had been spent for such identification. However, the city's financial burden of interest payment prevented the city from spending more time for the identification.

Utilization of vacated sites Yokohama either purchased the vacated sites from the relocating factories and constructed public facilities such as parks, or attempted to conclude agreements with the companies regarding the utilization of the vacated sites. In the latter case, companies were required to have prior consultation regarding their disposition, thereby limiting the future uses of the sites. However, both parties sometimes could not reach an agreement on sale prices. The city could not control the use of vacated land effectively.

Conclusion on Environmental Protection Measures in Yokohama

The national emission standard is a minimum compliance standard. National emission standards are not necessarily adequate for some cities where pollution problems are serious. For this reason, in order to protect local residents' health and living environment, Yokohama City found it necessary to implement its own measures through pollution control agreements or guidelines/guidance.

The experience of Yokohama presents an example of a local government which has successfully implemented its own environmental protection measures. To this end, it requires a comprehensive plan of actions including not only environmental protection but also local economic policy and local living environmental policy.

The Yokohama experience also demonstrated the importance of gaining the trust from local residents and companies. To obtain this, the city:

1) aimed at rational, objective and effective city management,

2) trained special staff in environmental administration,

3) established cooperative relationships with external specialists and research institutions,

4) encouraged residents' participation and established a system to listen to residents' opinions in the city management, and

5) disclosed environmental and other information including environmental issues as much as possible.

The City of Yokohama has obtained trust from the residents for its individual measures such as municipal reform and residents' participation. These efforts made it possible for the city to successfully negotiate with companies about the pollution control agreements and to maintain effective relationships with the central government.

ANNEXES

Contents of the Program

The City of Yokohama made a comprehension program, "Yokohama Automobile Pollution Control Program" in 1987 in order to prevent any further automobile pollution and improve roadside environment. The program includes various counter measures such as pollution source control, rationalization of material and people's flows, roadside measures, etc. The system of the countermeasures in this program is summarized in Figure A-1.

Effects and Problems of the Program

As a result of these countermeasures taken based on the program, NO_2 concentration measured at automobile exhaust monitoring stations did not increase. However, comparing with national level, the higher concentration is observed especially trunk roadsides, and many monitoring stations cannot meet environmental standard.

The main reason for this high NO_2 concentration is the rapid increase of car ownership and the traffic volume in the city. The number of cars registered exceeded 1,275,000 in 1990 which is two and a half times as many as that in 1975.

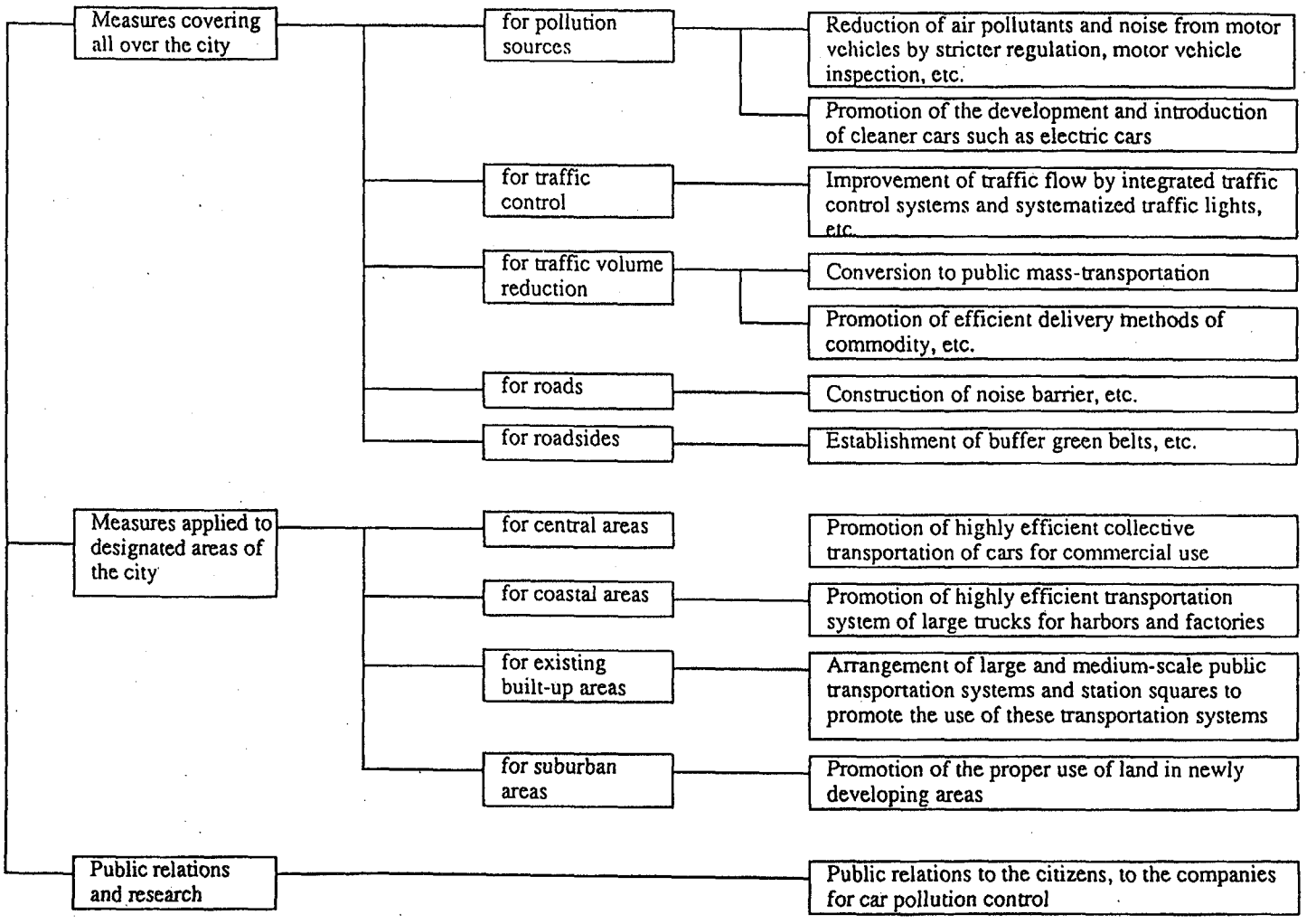


Figure A-1: System of the countermeasures in Yokohama

ANNEX 2: Changes of Pollution Control Agreement between Yokohama City and Isogo Thermal Electric Power Plant, Electric Development Inc. (Major contents of the agreements)

		December 1964 (New Construction)	*July 1967 (Extension)*	*February 1972*	*March 1976*
Air Pollution	Dust collector	Removal rate should be more than 98%	Removal rate should be more than 98% by electric dust collection	Removal rate should be more than 98% by electric dust collection	Removal rate should be more than 98% by electric dust collection
	Smoke stack	120m in height	More than 140m in height	More than 140m in height	More than 140m in height
	Velocity of emission	30m/sec	More than 30m/sec	More than 30m/sec	More than 30m/sec
	Emission amount	—	—	Less than 490Nm^3/h (SOx)	Less than 490Nm^3/h (SOx)
	Emission temperature	More than 130C	More than 130C	More than 130C	More than 130C
	Fuel	Low sulfur and low ash	Low sulfur and low ash	Low sulfur and low ash	Less than 0.13% (Sulfur content of heavy oil equivalent)
	Soot & Smoke	Less than 0.6g/Nm^3	Less than 0.6g/Nm^3	Less than 0.4g/Nm^3	Less than 0.05g/Nm^3
	SO2	Less than 500ppm	Less than 500ppm	Less than 350ppm	Less than 60ppm • Installation of blue gas desulfurization facility • Reduction of fuel consumption of afterburner • Measures to be taken in case of desulfurization facility failure
	NOx	—	—	Reduction through improvement of combustion method	• Improvement of combustion method • NOx reduction through research on stack gas denitration facility
Water Pollution	Effluent treatment	• completely equipped with treatment facilities • Sea water pollution control by oil separator	• completely equipped with treatment facilities • Sea water pollution control by oil separator	• completely equipped with treatment facilities • Sea water pollution control by oil separator	• Compliance with effluent standard • Improvement of waste water quality to the level of fish living • Recycling of waste water, etc.

		December 1964 (New Construction)	*July 1967 (Extension)*	*February 1972*	*March 1976*
	Cooling water	—	—	Stop use of liquefied chlorine	Stop use of liquefied chlorine
Waste	Dust collected	• Prevention of dispersion	• Prevention of dispersion	• Prevention of dispersion	• Prevention of dispersion
	Industrial waste	—	—	—	• Treatment responsibility • Agreement on waste disposal, if necessary
	Coal management	• Prevention of spontaneous ignition • Prevention of dust	• Prevention of spontaneous ignition • Prevention of dust	• Prevention of spontaneous ignition • Prevention of dust	• Prevention of spontaneous ignition • Prevention of dust
Noise	Noise	Less than 40dB	Less than 40dB	Less than 40dB	Less than 40dB
Others	Measurement	• Regular measurement • Reporting upon City's request	• Regular measurement • Reporting upon City's request	• Regular measurement • Reporting upon City's request	• Regular measurement • Reporting upon City's request
		on-the-spot inspection by the City	on-the-spot inspection by the City	on-the-spot inspection by the City	on-the-spot inspection by the City
	Cost to be borne	Cost for pollution control should be borne by the company	Cost for pollution control should be borne by the company	Cost for pollution control should be borne by the company	Cost for pollution control should be borne by the company
	Suspension of business	—	—	—	• According to the City's decision
	Others	—	—	—	• Guidance to the related industries • Development of planting

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