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Planning and Design of Trans-Tokyo Bay Highway

Projet de l'autoroute sur la Baie de Tokyo

Projektierung und Entwurf der Autobahn über die Bucht von Tokio

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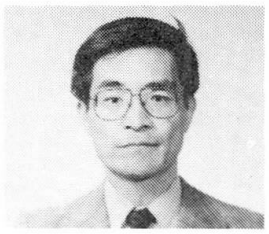

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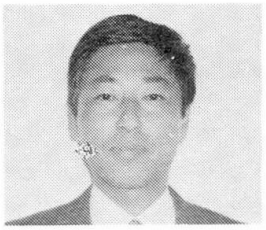

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SUMMARY

As the first phase of an ambitious plan to directly cross the Tokyo Bay over a 15km distance, the Trans-Tokyo Bay Highway Project was approved by the Government to proceed with participation of the private sector. The project scope is far beyond that of conventional ones, and the structures will be constructed in the Bay of an area 20kmx50km where surface traffic is busy, fisheries are active, and the likelihood of large-scale earthquakes is high. Therefore, impacts on the Bay environment by the construction activities were carefully studied to select optimum design and construction method whereby the environment would be best protected.

Projet de l'autoroute sur la Baie de Tokyo

Résumé

La première phase d'un projet ambitieux destiné à traverser directement la Baie de Tokyo sur une distance de 15 km a été approuvée par le gouvernement. Il prévoit la participation du secteur privé. Ce projet va bien au-delà des projets conventionnels et les constructions projetées concernent une surface de 20km x 50km avec un traffic de surface conséquent, des pêcheries actives et une probabilité élevée de tremblements de terre. C'est pourquoi l'influence des activités de construction sur l'environnement de la Baie a été étudiée avec soin afin de choisir les projets et les méthodes de construction protégeant au mieux l'environnement.

Projektierung und Entwurf der Autobahn über die Bucht von Tokio

Zusammenfassung

Als erste Phase eines ehrgeizigen Planes, die Tokioter Bucht über eine Entfernung von 15 Kilometern direkt zu überqueren, wurde durch die Regierung gebilligt, das Trans-Tokio-Bay-Highway-Projekt unter Beteiligung der Privatwirtschaft fortzusetzen. Der Projektumfang sprengt herkömmliche Massstäbe, und die Bauwerke werden in der Bucht in keinem 20 x 50 Kilometer grossen Gebiet mit regem Schiffsverkehr, Fischerei und hoher Seismizität errichtet. Deswegen wurden Einflüsse durch Bautätigkeit auf die Oekologie der Buchtsorgfältig studiert, um die am besten verträglichen Entwürfe und Bauverfahren auszuwählen.

1. INTRODUCTION(see Photo 1)

The Trans-Tokyo Bay Highway(hereinafter referred to as the TTBH) will cross the bay at its mid-section. Linking the cities of Kawasaki and Kisarazu by tunnels, a bridge and man-made islands, it will be a 15.1km route for the exclusive use of road traffic, and will be linked to the Tokyo Bay Coastal Highway, the Metropolitan Central Connecting High way, and the Tokyo Outer Loop Highway to form part of the Tokyo Metropolitan Highway Network. The construction of the TTBH began after completion of an environmental impact study carried out by the Japan Highway Public Corporation(hereinafter referred to as the JHPC), and the execution of work is mainly supervised by the Trans-Tokyo Bay Highway Corporation(hereinafter referred to as the TTB), a private enterprise company funded by t he JHPC, relevant local governments and private companies.

The paper presents:

①General outline of the project
②Environmental impact assessment in the official project approval procedure
③Follow-up environmental surveys during construction
④Environmental protective measures based on the assessment

2. GENERAL OUTLINE OF THE PROJECT

2.1 Description of the region(see Photo 1)

Metropolitan Tokyo, Kanagawa Pref. and Chiba Pref. with population of 25 million and area of 10,000 km^2, all front on Tokyo Bay, are situated in the central region of Japan. The western part of the bay has long been an important meeting place of transportation routes and a large market of goods and materials, and now a thriving focus of politics, trade and industry. Tokyo in particular is a center of all aspects of national life such as politics, economics, and culture, and is now playing an important international role.

2.2 Project objectives and the TTBH functions(see Photo 1)

The population distribution and the road traffic situation in the South Kanto region show a unipolar concentration on the center of Tokyo. This is a primary factor in the land and housing problems, typified by cramped housing, high living cost and traffic congestion, and the lack of safety in the case of large-scale disasters occuring in highly and densely built-up areas.

To find the answers to each of the problems, the Natioal Land Agency compiled in January 1983 a Basic Plan for the Restructuring of the Metropolis for the first half of the 21st century, aimed at "correcting the unipolar structure; restraining the growth of business and administrative functions in the metropolitan center; promoting independent city zones in the metropolitan suburbs; and, by a new mutually relational association between the zone and the central metropolitan area, restructing the association between them."

The realization of the plan requires preparation of high quality transportation network between those core cities and establishment of highway linking the metropolitan center with the Boso Peninsula. The TTBH will play an important role in the network as part of National Route 409, with the object of forming part of a greater metropolitan area highway network with the subseqently listed functions, reorganizing various functions of the metropolitan area, and raising level of industrial activity.

① To contribute to the well-ballanced development in the metropolitan area
② To improve efficiency of the industrial activities
③ To form a southern bypass for the Tokyo Metropolitan vicinity

2.3 Benefits of the project(see Table 1 & 2)

The TTBH is expected to produce a drop in the traffic figures of 20,000～30,000 vehicles a day on the roads between Tokyo and Chiba-Ichihara, thus relieving the future traffic congestion. Furthermore, the TTBH is expected to shorten the travel distance and time bet ween Kawasaki-Yokohama-Tokyo(on the Bay west side) and Kisarazu(on the east). And it is also estimated that the TTBH will bring an annual increse of ¥5 trillion in production in the entire South Kanto Region in the early 21st century, and an increse in local tax revenue of ¥200 billion per year in the same region.

2.4 General outline of the project(see Photo 2)

Scope of the project is summarized as below;

a)Name of road & route:Trans-Tokyo Bay Highway; National Highway No.409
b)Work Area & Length:Ukishima, Kawasaki, Kanagawa～Nakashima, Kisarazu, Chiba; 15.1km
c)Road standard:Type 1/Class 2, Design speed 80km/h, Design loads TL20ton and TT43ton
d)Carriageway:Dual 2-lane(Triple 2-lane in final form)
e)Traffic Forecast:64,000 veh/day(33,000 veh/day in the 1st year)
f)Work Schedule: 10 years (see Photo 8)
g)Project Cost:¥1,150 billion

2.4.1 Basic structure and construction method(see Photo 2)

The plan calls for tunnels running 9km from the Kawasaki coast where surface traffic is heavy; a bridge for 4.5km from the Kisarazu coast where the water is shallow and surface traffic is light; Kisarazu Manmade Island connecting tunnel and bridge; Kawasaki Manmade Island, midway along the tunnel section; and Ukishima Access, to functionally connect the tunnel to the land on the Kawasaki side.

①Ukishima Access(see Photo 3)
Ukishima Access consists of an tunnel access shaft and an underwater manplaced embankment extending from seashore to the bay bottom. The embankment provides stability for tunnel boring and cover for buoyancy protection. Soft soils underlying the fill is stabilized so as to maintain face stability and to prevent subsidence of soils beneath the tunnel. Steel trestles are placed to protect and enclose the tunnel path. In-between the trestles embankment fill is placed to form a mound. Side protection core and armor rock as well as crest protection concrete blocks are also placed. The ventilation shaft, also serving as tunnel access shaft is constructed by the caisson method, after stabilization of underlying soils and driving of foundation piles.

②Kawasaki Man-made Island(see Photo 4)
Selected location of the Kawasaki Manmade Island is 5km offshore of the Kawasaki Harbour, where water is 28m deep and soils under the seabed are very soft for a depth of more than 30m. Therefore, the soils are stabilized by sand compaction method, followed by a steel trestle installation which works as a retaining wall, a mole structure and a working plat form. "Island" fill is then placed within the structure. To form a cylindrical retaining structure, a diaphragm wall is excavated within the island fill to a depth of 135m. Then a reinforced concrete permanent wall will be constructed using a "top-down" construction procedure, followed by the placing of a bottom slab. The island serves as a tunnel access shaft as well as a ventilation shaft.

③Kisarazu Island(see Photo 5)
As the soft soil layer at the selected location for the Kisarazu island is relatively thin, the soils is dredged and replaced with selected sand and gravel. The island is subsequently reclaimed starting from the tunnel access and slope portion and proceeding to the eastward flat portion. Ventilation shaft will be structured by floating braced steel shell caisson method to be towed in position.

④Shield Tunnel(see Photo 6)
To insure stabe and watertight tunnel face under high water pressure in very soft soils, slurry shield tunneling method is selected as the optimum method. Total of eight shields start their advance, two from the Ukishima Access, four from the Kawasaki Island and two from the Kisarazu Island to meet under the bay at points midway between the shafts at the same time. The method is preferd because of advantages that it will not influence busy surface traffic in the bay even under construction, and that an additional tunnel can be constructed easily due to its phased constructability.

⑤Bridge(see Photo 7)
The bridge substructure is constructed by two different construction procedures according to the structural design and water depth. In the deepest area, open caissons with braced steel shells fabricated on land is floated in position and set down by crane barge. In the shallowest area where the water is 6m deep, cluster piles are driven with pile driver set on temporary trestle, and where the water is deep enough, cluster piles are driven from barges. For the superstructure, smaller factory-fabricated blocks are assembled to larger blocks on land, then transported to position and erected collectively using giant crane barge. In the shallow water area, fabricated girders are continuously erected backward from offing to land with stiffleg derrick traveler.

3. ENVIRONMENTAL IMPACT ASSESSMENT

3.1 Environmental impact assessment at the time of project authorization

The JHPC has undertaken the assessment according to the procedure shown in Table 3, in which the 1984 Cabinet decision on "Main Items to be Enforced Regarding Environmental Impact Assessments" was firstly applied. The assessment results showed the effects that the project would have during construction and after completion, would be limited to a narrow area around the highway, and that these effects would be extremely small. All formalities started on June 16, 1986 and were completed on July 10, 1987.

3.2 Establishing environmental factors for assessments

Considering the project scope and the characteristics of the surrounding area, environmental factors for assessment were established, as shown in Table 4.

3.3 Public inspection

Public inspection was carried out for 30 days after public announcement of July 27,'86 at Kanagawa side and July 20, '86 at Chiba side, followed by three explanatory meetings at both sides to recognize public opinion. The number of written opinions submitted by residents on the environmentalimpact assessment results numbered 1,770 in Kanagawa Pref. and 157 in Chiba Pref., for a total of 1,927. Table 5 shows the opinions by category of environmental factors.

4. FOLLOW-UP SURVEYS DURING CONSTRUCTION WORK(see Fig.1)

Follow-up surveys during construction work are now being carried out by the JHPC and the TTB with the cooperation of relevant local authorities, in order to swiftly recognize the effects that the project will have on the environment, and to prevent environmental deterioration through reflecting such recognition in the execution of works. With regards to the selection of items for surveys, decisions as to the methods and frequency of surveys, and the assessment of results will be put forward by the "Trans-Tokyo Bay Highway Environ mental Advisary Committee" composed of men of learning and experience. Items to be covered in follow-up surveys, the survey methods and their frequeucy are shown in Table 6.

5. ENVIRONMENTAL PROTECTIVE MEASURES

5.1 Environmental protective measures during construction

In order to restrict the effects of construction work on the environment to a minimum, the following measures will be adopted:

A) Reclamation with pit sand follows mole construction, in order to reduce the effects that turbidity would have on the waters of the bay.
B) Pollution control curtains will be set up during dredging activities, in order to prevent the diffusion of turbidity.
C) In sand fill work of replacement method, sand bins and tremie pipes will be used in order to prevent the spreading of particles that could worsen turbidity.
D) In order to reduce the effects of noise and vibration, work will be done in such that machinery will not be in operation simultaneously with and in close proximity to other machinery.
E) During pile driving for the bridge piers, noise reduction devices, such as noiseproof covers, will be used if necessary to reduce the impact of noise in the coastal area.
F) Pollution control curtains will be used at sites where dredged mud is treated in order to prevent the spreading of particles that might worsen turbidity.

5.2 Environmental protective measures in service of highway

In order to reduce its effects on seawater quality, waste water from highway facilities will be discharged after treated at a waste water treatment plant to bring it to levels at or better effluent quality standards.

6. AFTERWORD

The TTBH received national government authorization in July '87, after many ups and downs over a period of 20 years from the surveys were first begun. With authorization granted, under a new type of organization taking advantage of its private enterprise structure, the TTB takes charge of construction and management of the project such as securing of low-cost funds for financing the project, drawing up detailed designs, or carrying out the construction work, after conducting whatever surveys and tests would be necesary. The JHPC undertakes deliberations on the various necessary procedures and coordinate project activities with regards to, for instance, site acquisition and compensation to local fisheries.

With all procedures regarding environmental impact assessment completed and negotiations with the local fisheries on compensation concluded on Dec. 22, 1988, the groundbreaking ceremony was held on May 27, 1989. By Oct. 1990, 22% of the project had been completed on the contract volume basis, with work steadily progressing on the construction of Ukishima Access, Kawasaki Man-made Island, Kisarazu Man-made Island and Bridge, for all of which experimental construction works and foundation improvement works have been successfully concluded.

The 1984 Cabinet decision reflects a widely accepted recognition that no large-scale project like the TTBH, which could have influence on wide area, could proceed without public consensus even if the project has higher B/C ratio and if it is socially important. In addition, maintaining once reached consensus through good public relation is essential to carry out the project smoothly and successfully.

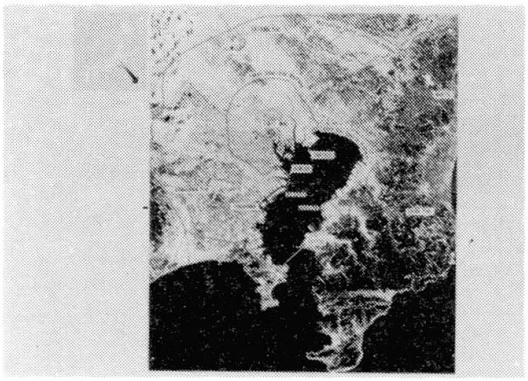

Photo 1-1 Metropolitan highway network

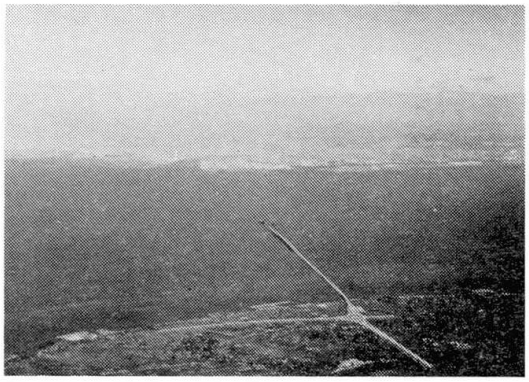

Photo 1-2 Highway bird's-eye view

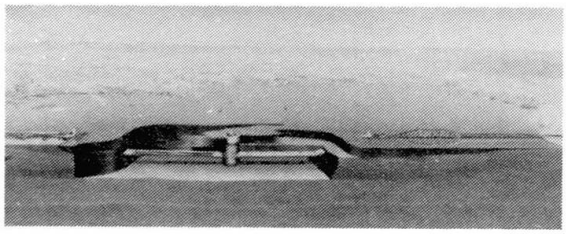

Photo 2-1 Highway conceptual plan

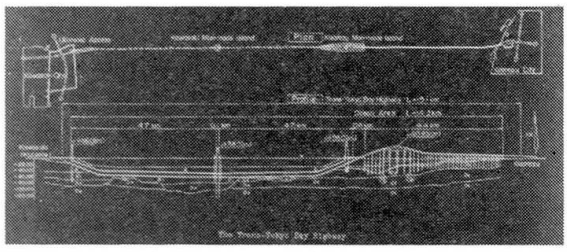

Photo 2-2 Highway plan and profile

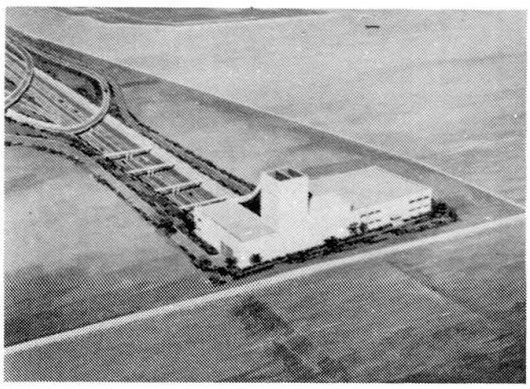

Photo 3 Ukishima access conceptual plan

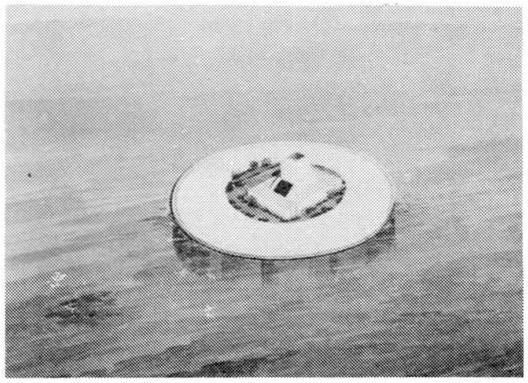

Photo 4 Kawasaki man-made island conceptual plan

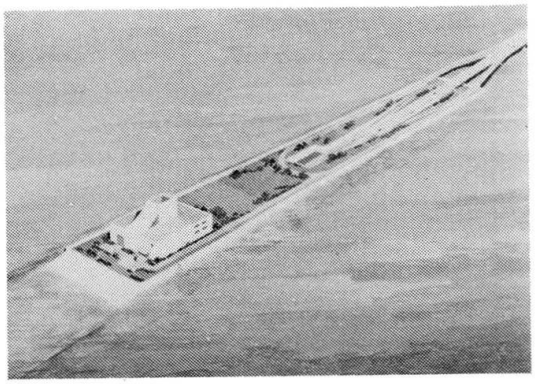

Photo 5 Kisarazu man-made island conceptual plan

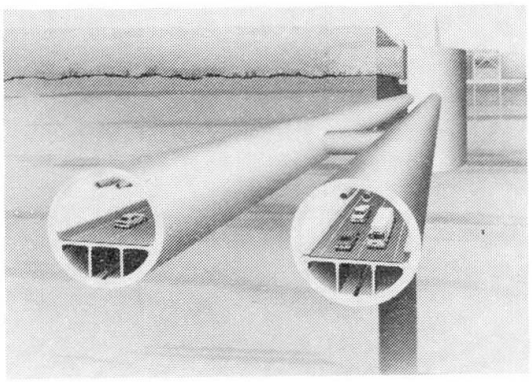

Photo 6 Tunnel conceptual plan

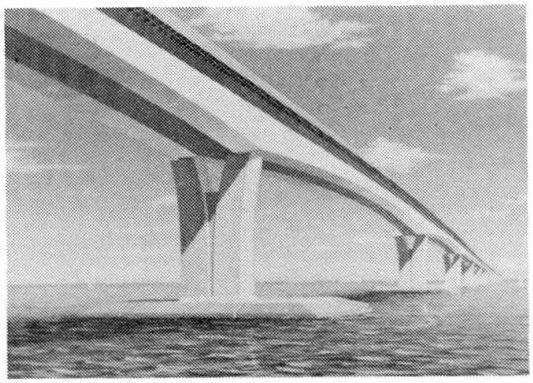

Photo 7 Bridge conceptual plan

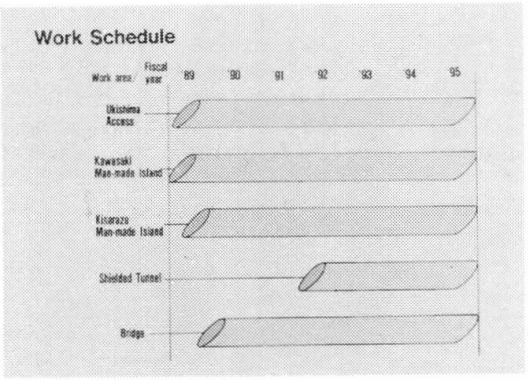

Photo 8 Construction schedule

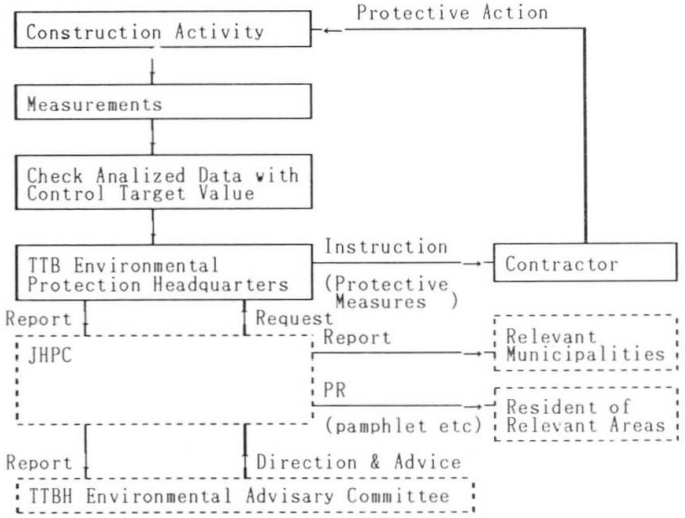

Fig.1 Environmental surveillance and protection procedure during construction

Journey Details			Kawasaki Kisarazu	Yokohama Kisarazu	Tokyo Kisarazu	Route
Travelling Distance	Existing Roads		Approx. 110km	Approx. 120km	Approx. 90km	
	TTBH Route		Approx. 30km	Approx. 40km	Approx. 45km	
Travelling Time	Existing Roads		166 min.	197 min.	145 min.	Yokohama · Haneda route Metropolitan Expressway National Highway No.16
	Future Option	Not Via TTBH	118 min.	135 min.	106 min.	Tokyo Bay Coastal Highway East Kanto Kisarazu route
		Via TTBH	46 min.	50 min.	53 min.	Tokyo Bay Coastal Highway TTBH

Table 1 Travel times and distances from Kawasaki · Yokohama · Tokyo to Kisarazu

Effects / Instances	Reduction in Total Travelling Distances	Reduction in Total Travelling Times	Direct Benefits
Without Induced Changes in Traffic	Approx. 700,000 veh./day	Approx. 60,000 veh.hrs/day	Approx. ¥200 mill./day
With Induced Change in Traffic	Approx. 3,100,000 veh./day	Approx. 160,000 veh.hrs/day	Approx. ¥680 mill./day

Table 2 Direct effects to be introduced by the TTBH

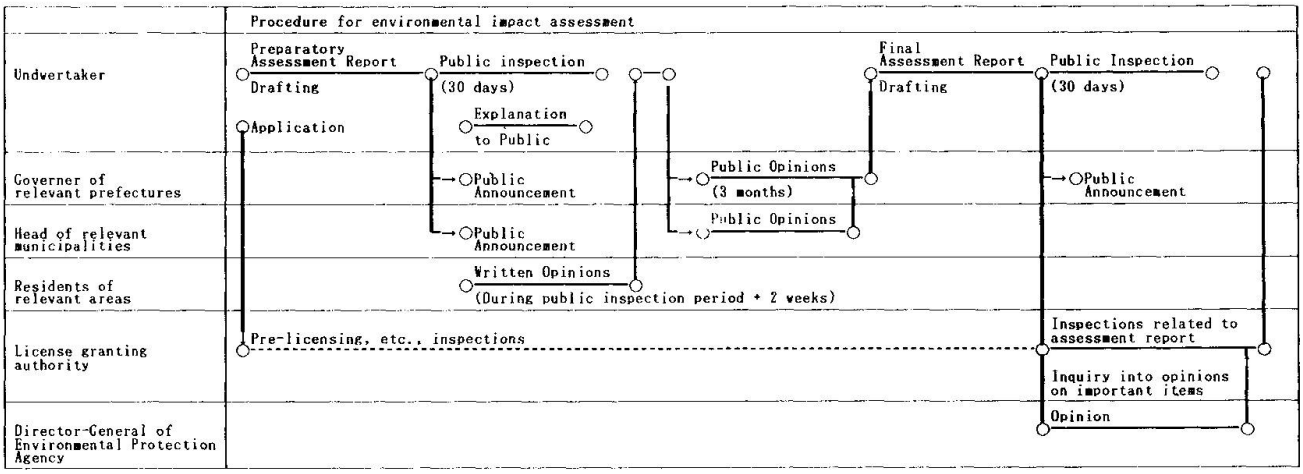

Table 3 Environmental impact assessment implementation guideline by Cabinet decision

Project Stage	Environmental Indicator / Environmental Impact Factor			Atmospheric Pollution		Water Contamination		Noise	Vibration	Geography Geology	Flora and Fauna			Landscape
											Terrestrial		Marine Organism	
				NO_2	CO	COD	SS				Fauna	Flora		
After Completion	Installations	Marine Section	Man-made Islands			○				○			○	○
			Tunnels											◎
			Bridge			○				○			○	○
		Land Section	Highway Structure								○	○		
	In Use	Vehicular Traffic		○	○	○		○	○		○	○	○	
During Construction	Construction	Marine Section	Man-made Islands	○			○						○	
			Tunnels											
			Bridge	○			○	○	○				○	
		Land Section	Highway Structure	○				○	○		○	○		

Note: ◎ indicates ventilation shafts.

Table 4 Emvironmental impact factors and emvironmental indicators

Survey Items	Frequency of Survey
Air Quality *SO_2, NO_2, Wind Direction & Velocity	* Quarterly(4 seasons) before construction begins. * Quarterly during construction(in each season when construction is in full progress); continuous measurements over a week in every case
Noise & Vibration *Noise Level, Vibration Level	* Once before construction begins. * Quarterly during construction(when construction is in full progress)
Water Quality *Turbidity *SS, VSS, DO *pH, COD, n-hexane Extract, Chlorophyll α *T-N, I-N, T-P, PO_4-P *Mercury, Cadmium, Cyanogen, Hexavalent, Arsenic, Lead, Organoposphorus, Chrome, PCB	* Weekly before construction begins. Daily during construction * Weekly * Monthly * Quarterly(4 seasons) before construction Monthly during construction * Quarterly before costruction During construction, once on each man-made island when dredging is in full progress
Sea Currents *Tidal & Constant Currents	* Twice a year(summer and winter) in every other year
Bottom Sediment *Particulate Composition, Water Content, Sulfides, Specific Gravity, IL, COD, Sediment Volume, ORP	* Twice a year(summer and winter)
Terrestrial Flora *Flora	* Twice a year(summer and winter) * Once every three years for plant community distribution
Terrestrial Fauna *Birds *Mammals, Amphibians, Reptiles, Insects	* 6 times a year(4 seasons, and twice during migratory periods) * Quarterly(4 seasons)
Marine Organisms *Zooplankton, Phytoplankton, Benthos, Fishes & Molluscs, Banzu Mudflats Biota	* Quarterly(4 seasons)
Topography & Geology *Topography of Banzu Mudflats *Topography around Bridge Piers	* Yearly * Yearly, after erection of bridge piers begins.

Table 5 Follow-up environmental survey -items and frequency-

Area	Kawasaki	Kisarazu
General		
Project Scope	8	39
Project Benefit	2,806	24
Existing Environment		
Atmospheric Pollution	14	-
Water Contamination	5	9
Noise	1	-
Terrestrial Flora & Fauna	-	12
Marine Organisms	3	7
Selected Environmental Indicator	34	12
Prediction		
General	4	-
In Use		
Basic Conditions for Prediction	23	1
Atmospheric Pollution	37	19
Water Contamination	4	14
Noise	-	5
Vibration	-	1
Topography & Geology	-	9
Terrestrial Flora & Fauna	-	2
Marine Organisms	-	3
During Construction		
Water Contamination	5	12
Noise	-	1
Marine Organisms	2	1
Assessment		
Aimed Environments	-	12
In Use		
Atmospheric Pollution	585	22
Water Contamination	4	5
Noise	-	5
Terrestrial Flora & Fauna	-	3
Marine Organisms	9	6
Landscape	-	1
During Construction		
Noise	-	1
Marine Organisms	-	6
Protective Measures		
In Use	5	121
Follow-up Survey	-	1
Others	6,252	261

Table 6 Opinion count on environmental impact assessment