FY2021
Feasibility Study Scheme for Quality Infrastructure from Japan

India Mumbai Coastal Express Highway – Versova Virar Sea Link – VVSL project Pre-F/S Review Study

Final Report

Executive Summary

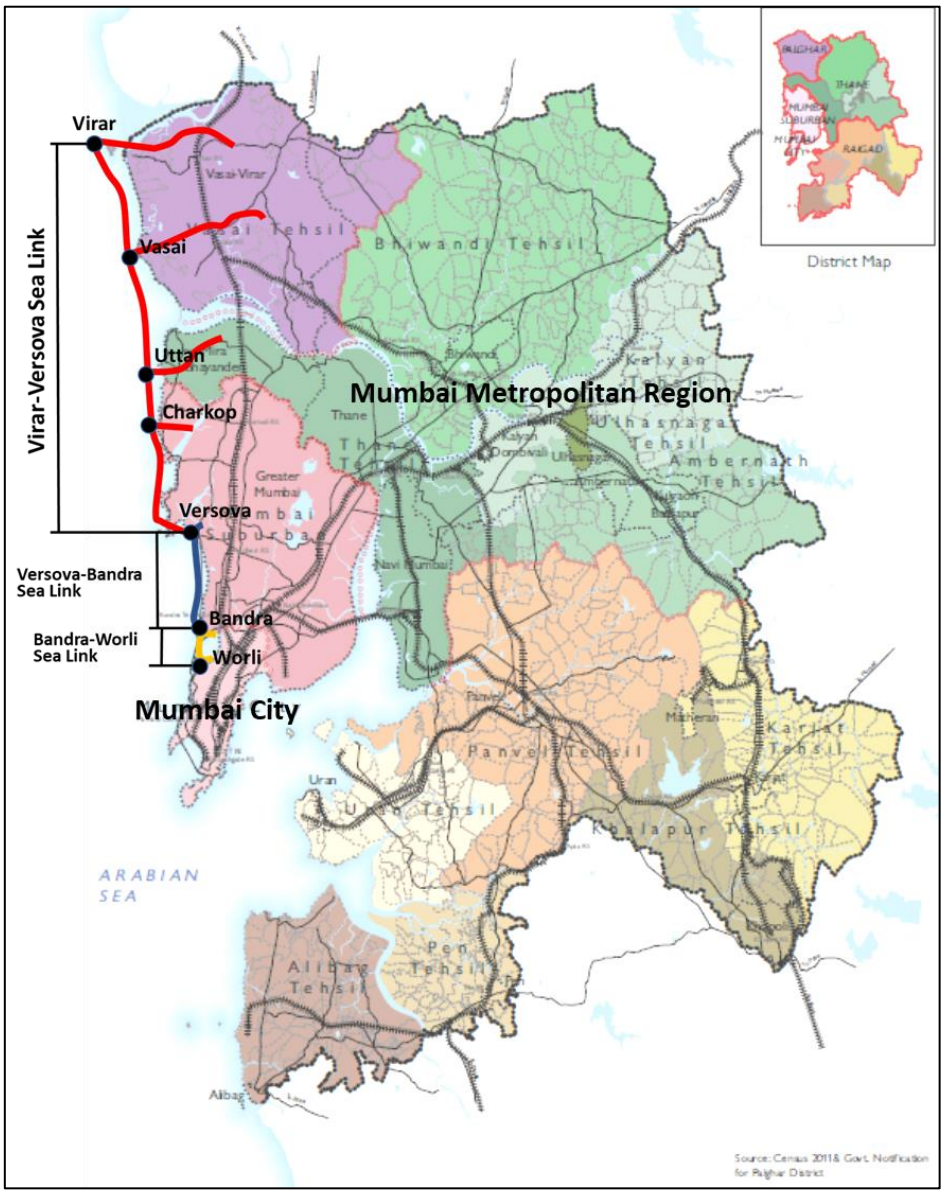
February 2022

PADECO Co., Ltd.

Executive Summary

This study reviewed the Pre-F/S prepared by the MSRDC for the Mumbai Coastal Express highway Project, Versova - Virar Sea Link (VVSL), one of the priority projects in the Maharashtra state road sector.

In order to formulate the project as a yen loan funded project, the project plan was assessed and reviewed to increase the possibility of Japanese companies' participation in the construction and O&M of the project by considering the introduction of Japanese advanced construction and O&M technologies as well as Japanese companies' large-scale marine bridge construction technologies.

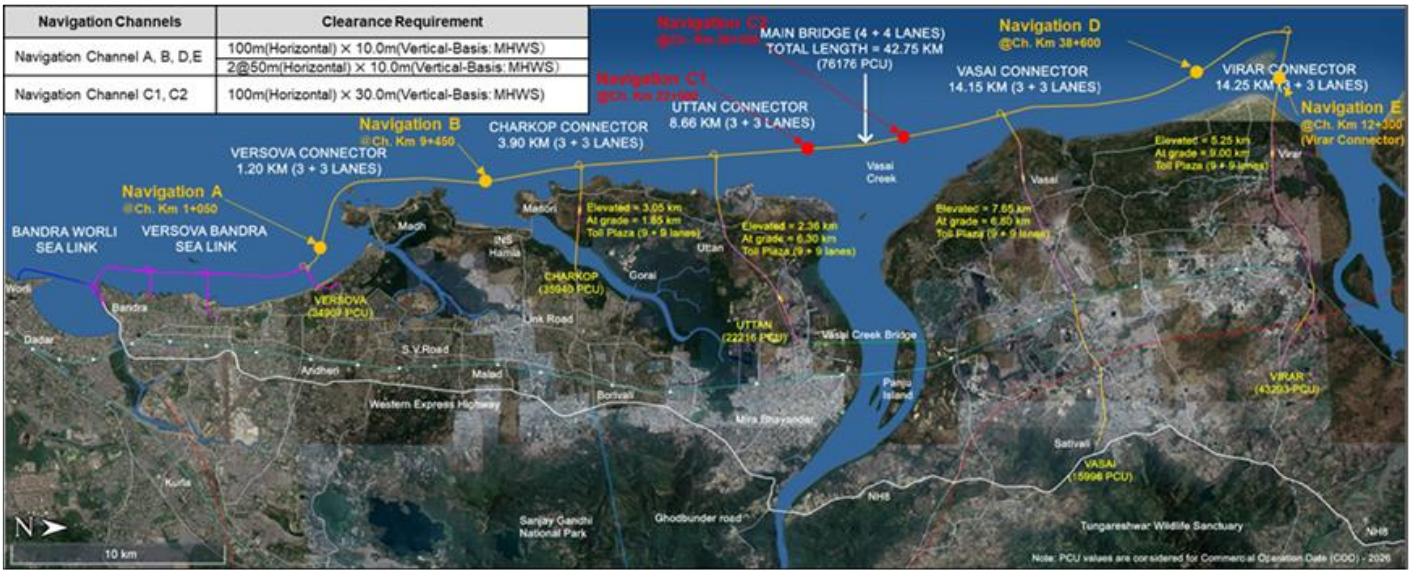


Source: Study team

Figure 1: VVSL Alignment in Mumbai Metropolitan Region

This project involves not only the construction of a 43 km road over the sea about 1 km off the coast of Mumbai, but also the construction of approximately 60 km of suburban roads, including connector roads and junctions (earthwork and elevated) in addition to the main road, which comes 101km in total.

In the marine road section, there are six navigation channels where ships can pass (1.86 km in total, red and yellow dots in the figure), and in the connector road, there are overpasses that require long spans, etc. For these sections, steel bridges, a Japanese technology, were proposed to be applied, and the possibility of introducing related technologies was examined.



Source: Pre F/S and this study

Figure 2 VVSL Alignment and Navigation Channels

Table 1: Specification of the Project

Types of Road	Elevated Section length (Km)	Earthwork (Km)	Total (Km)
Main Sea Link (4+4 lanes)	**43.00km Incl. navigation channel 1.86km**	**0**	**43.00**
Connector Road			
Virar (3+3 Lanes)	5.25	8.70	14.25
Vasai(3+3 Lanes)	7.65	6.50	14.15
Uttan(3+3 Lanes)	2.36	6.30	8.56
Charkop(3+3 Lanes)	3.05	0.85	4.90
Versova(3+3 Lanes)	1.20	0	1.20
Sub Total	19.51	22.35	
Junctions	16.6	0	16.6
Total	**79.11**	**22.35**	**101.46**

Source: Study team

The study can be summarized as follows. The number in each subtitles refers to the chapters in the main report (in Japanese).

(1) Superior planning, Urban Development Momentum (Chap 2.1-2.2)

This study reviewed the road network plan and urban development plan for the Mumbai metropolitan region, and showed that the proposed project is based on the coastal road plan drafted in the Comprehensive Transportation Study (CTS) formulated in 2008. The population density in the south exceeds 25,000/km2, and in the southern region of the alignment, the population is growing at an annual rate of 5-9% in the northern section, where a large property development with 20,000 households' development in Virar for example, with a large share of the tertiary industry sector. These indicate that there is a strong demand for urban development. In terms of land use along the route, salt fields and agricultural land remain, indicating that there is ample land for future development along the route.

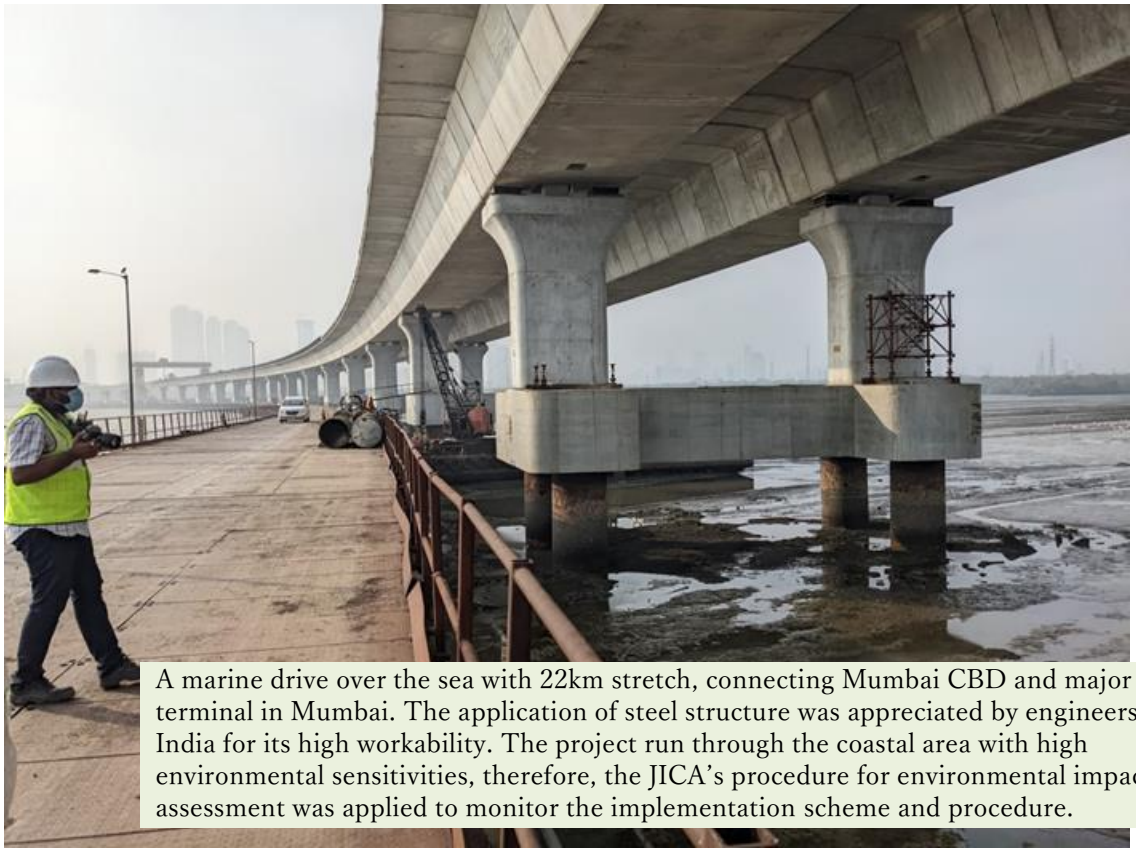
(2) Background, Necessity of the Project (Chap 2.3)

The study reviewed and summarized major regional road projects in service and under construction connected to the VVSL, with salient engineering specification, project implementation schemes and process, project cost, contractors, etc. The study identified that the significance of the VVSL's direct connection to the Delhi-Mumbai Expressway, the flagship project of the National Highway Authority of India, as well as the bypass function to the conventional Western Express Highway and NH48. In addition, the study presented the background of the Maharashtra State Road Corporation (MSRDC) was nominated as the implementing entity of this project among the three road development entities in Mumbai.

As for the current road traffic in the northern corridor of Mumbai, this study showed that 240,000 to 310,000 PCUs of traffic per day are dependent on a single Western Express Highway (WEH), indicating that there is sufficient demand for VVSL development, suggesting the importance of forming a road network with VVSL, and ensuring redundancy compared to the traffic network in the south-eastern corridor of Tokyo, where has similarity in democracy and economy in Tokyo metropolitan.

According to the MSRDC's Pre-F/S, the unit price per km for the 43 km of VVSL main road construction was 480 Cr INR (about 7 billion JPY), but the unit price for the Mumbai Trans Harbor Link (MTHL - photo on the next page), which is currently being constructed with JICA yen loan was 650 Cr INR (about 9 billion JPY), incorporated the

Japanese steel bridges for its navigation section. This suggests that the present cost estimation at the Pre-F/S still has a room to propose Japanese technology.



A marine drive over the sea with 22km stretch, connecting Mumbai CBD and major port terminal in Mumbai. The application of steel structure was appreciated by engineers in India for its high workability. The project run through the coastal area with high environmental sensitivities, therefore, the JICA's procedure for environmental impact assessment was applied to monitor the implementation scheme and procedure.

Source: Study team

Figure 3 Ongoing MTHL, Supported by JICA Yen Loan

(3) Demand projection (Chapter 3)

In the Pre-FS, the future traffic volume of the project was estimated applying the standard four-steps estimation method as a methodology for traffic demand forecasting, however, the estimation method was not explicitly stated. Therefore, the study team attempted to re-estimate the OD and traffic demand based on the traffic volume data; the Pre-F/S estimated the daily traffic volume of the VVSL mainline to be 74,700 PCU in 2030, but this study forecasted a conservative result of 66,000 PCU at the main section and projected traffic volumes until 2050.

It should be noted that the Pre-F/S targeted the limited types of vehicles, including passenger cars, buses, and light freight vehicles due to the present operational regulation of the BWSL (Bandra Worli Sea Link). The demand estimation in this study made assuming that heavy freight vehicles will be accepted to pass through the VVSL, for

formulating the Mumbai ring road connection from JNPT, CBD and Delhi Mumbai Expressway.

(4) Engineering Specification (Chapter 4)

The three route options proposed in the Pre-F/S were re-evaluated with applying ten criteria, including India's development constraints, and the Option 1, a 1km offshore marine route, was concluded to be the optimal proposal. In addition, this study confirmed the clearance conditions for the navigation channels that are required for the Option 1 implementation. (See also Section 4.1 and Section 8.1)

For the bridge section (Sea Link section), which is the main part of the project, a comparison was made between Indian and Japanese design standards, and the appropriateness of applying Japanese standards was demonstrated (Section 4.2).

Considering the surrounding conditions including geological and meteorological conditions, the design and construction status of existing projects (MTHL, etc.), the need to shorten the construction period, and the "Make in India" policy, a PC box girder with a span of 50m is mainly adopted as the optimal plan, and the standard cross-section and construction method are presented. For the navigational channel section, a continuous steel deck box girder bridge of Japanese technology was proposed as an economical solution. This bridge can be erected in one piece and contributes to shortening the construction period and ensuring safety. (Section 4.4)

In addition to applying conventional jacket structure for temporary service road, “geotubes” are also considered for temporary roads required for offshore construction. (Section 4.7)

In this project, not only 43 km of bridges on the sea but also four connectors need to be constructed as one-package. The study team implemented on-site inspection in December 2021 and indicated the sections applying steel bridges which can make environment impact minimum along the alignment. The team also identified the regulatory issues of the nature conservation sited in the connecting location of the Virar Connector and NH48. (Section 4.8)

Regarding the operation of the VVSL, the study proposed the stated of art O&M methodologies including operation monitoring technology, toll collection, and maintenance and physical inspection methodologies, referring to the existing BWSL, planned VBSL, Indian major expressways, and the operation status of Japanese expressways. In addition, the study team actively proposed technologies to provide traffic

information on road and to rationalize toll facilities in order to function as a bypass for WEH. (Section 4.9)

(5) Project Cost Estimation and Work Schedules (Chapter 5)

The construction cost was estimated by referring to existing reference construction costs of similar projects and applying them to the project scope and specification proposed in Chapter 4 above. This study estimated the cost of Case 1, which is to build the entire route with four connectors, to be 552.8 billion JPY (36,134 Crore INR – see the table below for details in INR). The unit cost per km for the main road section was estimated to be lower than that for the MTHL, despite the fact that a Japanese steel bridge was proposed. This is because geotubes were applied entirely as temporary service roads, which will be a risk of cost increase if it is not applicable. In addition, there is a possibility of additional steel bridge application at the HSR overpass section of the connectors. The O&M costs were also estimated.

The construction period was estimated to be six years for the Case 1, assuming the amount of work required for. This includes the shortening effect of applying the steel bridge.

Table 2 Project Cost (Crore INR)

Items	Whole - Case1		Partial– Case 2	
A) Main road	**23,894**	**66.1%**	**17,198**	**68.0%**
Design and Management	2,073	5.7%	1,492	5.9%
Temporary work	4,071	11.3%	2,928	11.6%
Infrastructure	5,020	13.9%	3,553	14.1%
Superstructure PC	10,573	29.3%	7,494	29.6%
Superstructure Steel	1,936	5.4%	1,548	6.1%
Facilities	221	0.6%	182	0.7%
B) Connectors and JCTs	**11,086**	**30.7%**	**7,284**	**28.8%**
Design and Management	962	2.7%	632	2.5%
Temporary work	2,418	6.7%	1,767	7.0%
Infrastructure	2,546	7.0%	936	3.7%
Superstructure PC	4,184	11.6%	3,472	13.7%
Superstructure Steel	453	1.3%	151	0.6%
Earthwork and Drainage	495	1.4%	307	1.2%
Facilities	28	0.1%	18	0.1%
C) PMC	1,154	**3.2%**	808	**3.2%**
D) Total (A+B+C)	**36,134**		**25,289**	

Source: Study team, 1.00 INR = 1.53 JPY

(6) Economic and Financial Analysis (Chapter 6)

Referring to the Pre-F/S IRR estimation, the benefits of employment increase were included in addition to the conventional benefits of vehicle operation cost reduction and time saving. In addition, the project cost was only for the 43 km section of marine road,

resulting in an EIRR of around 30%. In this study, based on the project cost presented in Chapter 5, only vehicle operation cost reductions and travel time savings were estimated using the demand forecast results, and the EIRR of 13.1% was obtained for Case 1. The EIRR comes 11.2% even under the severe condition of 10% increase in costs and 10% decrease in benefits, so the project can be recommended as an effective economic infrastructure in India.

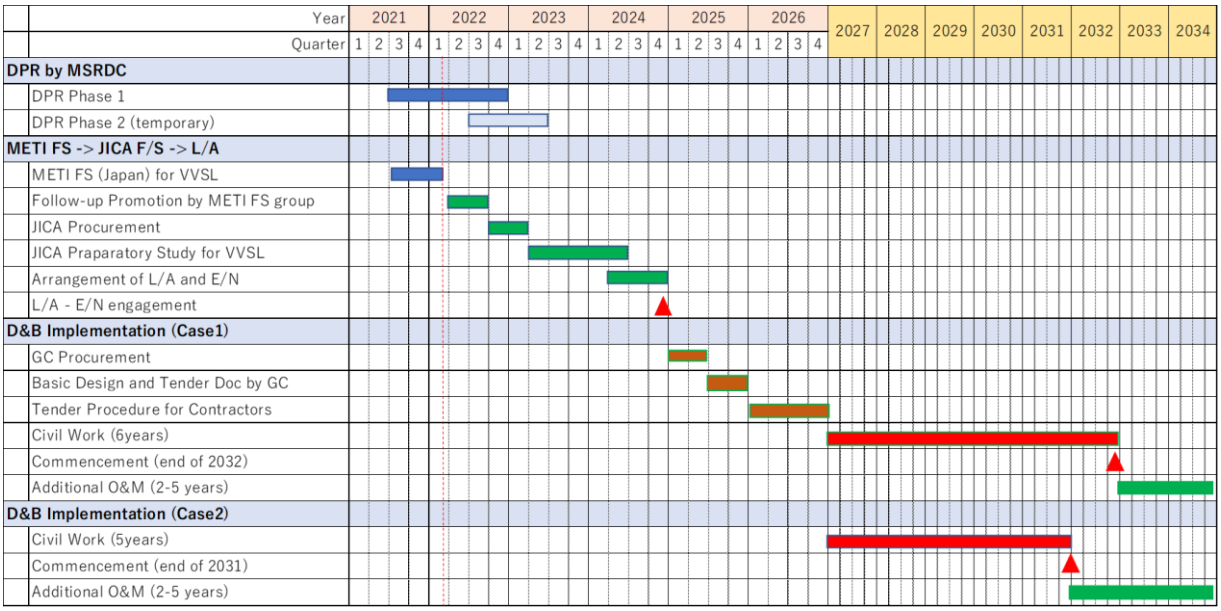
Regarding the financial analysis, this project is a toll road, and the FIRR based on the toll revenue was 2.6% for the Case 1. However, there is a toll exemption for residents in the vicinity of toll roads in India, and taking this into account, the FIRR for Case 1 came -0.1%.

(7) Implementation Schemes (Chapter 7)

This study reviewed 86 cases of JICA yen loan projects and 30 road projects (including those where PPPs have been applied) in India to date, and assessed that it would be difficult to apply PPPs to this VVSL project due to the scale of the project, recent investor interests, and trends of market. It is proposed that the VVSL project be procured as a public works project under the EPC procurement scheme. Based on the trend in India, the study also indicated that the O&M system for the initial 10 years should be included in the construction contract.

From the latest statements in Maharashtra State Government (MSRDC), it came apparent that the VVSL project is already under consideration for public financing and EPC method, and that they are interested in accessing foreign development partners including JICA. Based on the comments of MSRDC in Dec 2021 for implementation schedule, the study team presented the implementation plan, as shown in the Figure below; procurement of JICA preparatory studies in the second half of 2022, implementation of the JICA preparatory studies in 2023, loan agreement engagement by the end of 2024, contractor procurement in 2026, construction commencement in 2027, and service commencement by the end of 2032. Repayment simulations demonstrated the superiority of the JICA yen loan's terms of condition.

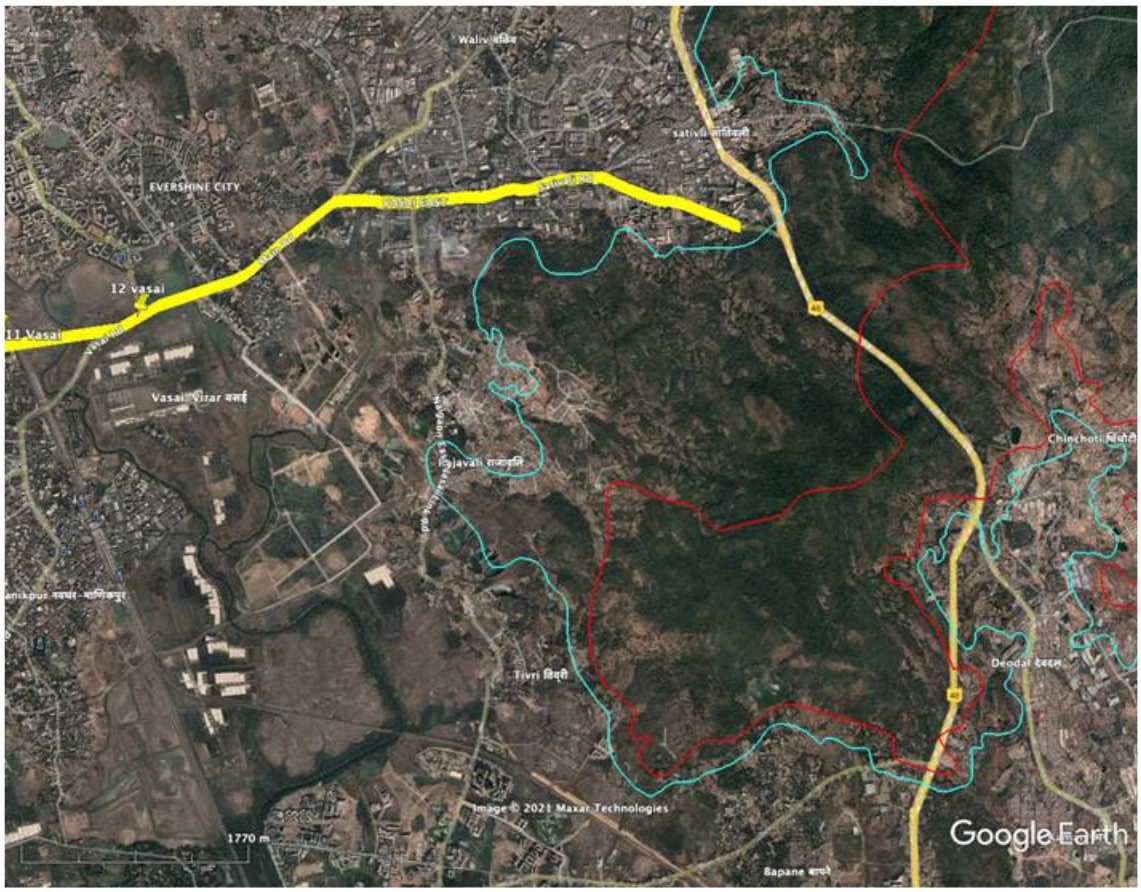
Table 3 Implementation Schedule



Source: Study team

(8) Environmental Assessment (Chapter 8)

The JICA Guidelines for Environmental and Social Considerations, the Indian legal system (including land acquisition and relocation), and the impact assessment process related to the implementation of this project were summarized. In particular, the study team summarized the coastal environmental regulations and fishery rights that should be considered in the construction of the main road, and proposed measures that affect the construction of the connector road in the natural environment protected area. Although Mumbai is a large city, it is adjacent to a national park and biological reserve where wild leopards and other animals exist, and there is a high level of interest in mangrove protection, which needs to be carefully considered in the project implementation. The predicted environmental impacts and scoping are summarized in Section 8.3 of the main report.



Source: Study team

Figure 5 Connecting location of the Vasai connector (yellow thick line) with NH48 is close to the Eco-sensitive Zone boundary of Tungareshwar Wildlife Sanctuary (light blue thin line), which is identified as a risk of implementation

Estimation of CO2 Emission Reduction

Reduction of greenhouse gas emissions is essential aspect for every project. If VVSL project were realized, vehicles traveling on congested existing roads will be converted to the project roads, which will result in reduction of fuel consumption and CO2 emissions. This effect was calculated and estimated to be 1.2 Lakh tons of CO2 reduction per year for the with-without comparison (at the year of Case 1 opening).

(9) Advantage of Japanese Technology Application (Chapter 9)

Due to its scale and magnitude of engineering work, the project requires strong incentive of shortening the construction period. Application of steel bridges, application of anti-corrosion measures, environmental protection, disaster prevention, and wide-area traffic management were proposed with referring to the experience of Japanese companies, and

the details of the "spec-in" in each technical needs are summarized to promote Japanese technologies in the VVSL project.

The project itself is a very large that will not only affect the road transport sector, but will also re-organize the Mumbai metropolitan region and affect the lives of the citizens in Mumbai. Recommendations on the branding of the VVSL project with consideration of Japanese experience were proposed, including road pricing for environment improvement, and development of rest-area on the sea for tourism and emergency evacuation, with applying temporary structures.

Courtesy of NEXCO EAST Japan

Figure 6 “Umihotaru" parking area on the Tokyo Bay Aqua-Line
Such facilities for tourism, resting, and evacuation purposes are necessary along VVSL