COASTAL ROAD MUMBAI

REPORT
BY

JOINT TECHNICAL COMMITTEE
GOVT. OF MAHARASHTRA

DECEMBER 2011

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Dt. 29th December 2011

To.

The Secretary,
Environment Department,
Government of Maharashtra,
Mantralaya, Mumbai.

Subject: Report of the Joint Technical Committee.

The Government of Maharashtra, under its Resolution No.ENV-2011/CR-55/TC3 dated 30th June 2011 had constituted a Joint Technical Committee to study and make recommendations on the subject of coastal roads in Mumbai.

The Committee has completed its work on its terms of reference and has pleasure to submit the accompanying report. The recommendations of the Committee are summarized in the last chapter of the report.

1. Mr. Subodh Kumar Municipal Commissioner, MCGM	Chairman	Subodh
2. Mr. B. Shrimali, Managing Director, MSRDC	Member	
3. Dr. Nalini Bhat, Advisor, Ministry of Env. & Forest, GOI	Member	
4. Dr. S.R. Shetye, Director, National Institute of Oceanography	Member	S.R. Shetye
5. Dr. Tarun Kant, Professor of Civil Engineering, IIT, Powai	Member	Tarunkant 29 Dec. 2011
6. Mr. Chandrashekhar Prabhu Architect/Urban Planner	Member	

7. Mr. Rajiv Mishra, Member .....
   Architect,
   Principal, Sir J.J. College of
   Architecture

8. Mr. Hafeez Contractor Member, ...
   Architect

9. Mr. P.K. Das, Member .....
   Architect

10. Mr. P.R.K. Murthy Member .....
    Chief, Transport Divn. MMRDA

11. Mr. Sharad M. Sabnis Member-Secretary .....
    Chief Engineer, MMRDA

D.A: Report of the Joint Technical Committee with Annexures.

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CHAPTER 1

BACKGROUND

1.1 General: Mumbai, with a population of over 12.4 million inhabitants, is the capital of the state of Maharashtra and is considered as the financial capital of the country. The relative geographical locations of Mumbai Island, Greater Mumbai and Mumbai Metropolitan Region (MMR) are illustrated in Fig. 1.1. Owing to historical reasons, over the years, economic activities developed and concentrated in the Mumbai Island. This island is narrow and long on a north-south axis and has an area of only 68.71 sq km compared to 437.71 sq km for Greater Mumbai and 4135 sq km for the MMR. The Mumbai Metropolitan Region is also one of the fastest growing regions in India and is expected to be the largest metropolitan region of the world by the year 2031. Greater Mumbai is, in effect, the mother city and acts as a significant engine of growth for the whole region. The main transport generators are the movements between home and work sites. This results in Mumbai Island (particularly its southern part) being the major nodal centre for traffic. Historically, the characteristic of traffic patterns is southbound flows (to work places) in the morning peak hours and northbound flows (homewards) in the evening, although a shift is being witnessed in this pattern owing to the growth of the suburbs as well as creation of new business districts such as Bandra-Kurla Complex and Navi Mumbai. Because of increasing economic activities, Mumbai has witnessed rapid growth in both mass transit and the private modes of transport. The number of vehicles has been increasing at a yearly rate of over seven per cent in the last two decades. Consequently, major corridors in the city are presently suffering from traffic congestion through most hours of the day.

1.2 Mumbai: Strengths and Constraints: Mumbai undoubtedly occupies a prime place among the nation's metropolises. It contributes one third of the nation's tax revenues. It has two of the country's largest sea ports (Mumbai Port and the Jawaharlal Nehru Port). It also has India's largest international airport which handles twenty five percent of the country's domestic and international air traffic. It is headquarter of the Reserve Bank, and houses corporate headquarters of almost all the banking and financial companies of the country. It is home to country's two largest stock exchanges, and therefore lays a rightful claim to its title of the financial capital of the country. It also houses the Indian film industry popularly known as "Bollywood". Mumbai's greatest strength is however, its qualified work force, an excellent work culture and above all, the cosmopolitan nature of its population. All these make this city a unique metropolis of the country unmatched by any other. Mumbai is, therefore, the focal point of hope, aspirations and opportunities for a wide range of urban migrants seeking to improve their well being and economic advancement. Ironically, this has resulted in a decline of the city in terms of what it offers to its citizens. The city's linear geometry and the Arabian Sea surrounding the city on three sides constrain its expansion to accommodate the ever increasing population. This has resulted in this city already becoming the densest

populated region of the world. The shortage of land for development and continuing influx of migrants has resulted in high real estate prices, shortage of housing, large slums and poor living conditions. There has, therefore been a noticeable slippage in the dimensions of economic growth and the quality of life in the city. One of the unmistakable features of this decline is the overburdened transport system. As explained later in this report, the roads in the city are severely congested, resulting in traffic crawling to its destinations for most parts of the day and escalating the already high levels of transport related pollution. Long average commute time, together with high levels of pollution adversely affects the overall productivity and efficiency of the city as well as the quality of life and health of the people (as detailed in the paragraph below). It has to be acknowledged that Mumbai rose to be the economic powerhouse of the country, *inter alia* due to its ability to attract intelligentsia, artists, creative persons and talented professionals from all parts of the country. The city will have to put traffic congestion behind it and create more recreational spaces, if it has to retain its status as a city of choice for talented and skilled human resource with multiple options. The need for new roads in the city to facilitate speedy travel between different parts and reduce the transport related pollution is clearly indisputable. The city has also not been able to add any significant road space; nor any significant green space owing to a scarcity of land in the city for development of gardens, jogging tracks and recreational areas. While the long coastline of the city is its asset, the sea fronts in the city are either abused by unsightly encroachers or happen to be private backyards of the chosen few and not available to public unlike beautiful waterfronts and gardens/ promenades adjoining the sea in major coastal cities of the world. The coastal road system considered in the report answers the requirements of road transport and also helps reduce pollution and generate recreational spaces in the city, in turn enhancing the quality of life in the city.

1.3 Transport Related Pollution: Motor vehicles are presently the biggest source of atmospheric pollution in the city. Motor vehicles contribute the following pollutants that enter citizen's lungs:

- 75% of Nitrogen Oxide
- 83% of Benzene
- 77% of particulate matter
- 53% of volatile organic compounds
- 29% of Carbon di oxide
- 97% of Carbon monoxide

The total number of vehicles registered in Mumbai in the years 2004 and 2011 was 12,33,675 and 19,17,798 respectively, which shows that on an average 96000 vehicles are added every year to the already congested road system in the city. The escalation in the suspended particulate matter (SPM) has also

been very significant. The SPM levels noted at the same spot indicates that level of SPM has risen from 381 µ gm /cum in 2004 to 642 µ gm /cum in 2011, thereby resulting in an increase of 68% in the pollution relating to SPM. The main reason of this increase is the continuously increasing traffic congestion and the ensuing low speeds of vehicular movements. As already explained elsewhere in this report, the vehicular speeds on most roads in the city have already reached to as low a level as 8 kmph (as against the efficient speeds of 55 miles per hour i.e. about 90 kmph). Long term air pollution from cars causes respiratory or heart diseases. Transport related air pollution is a cause of major health impacts e.g. bronchitis and asthma attacks in children. The study by MCGM pertaining to health of patients from the identical location in the city shows the following alarming rise in diseases (and the SPM levels at the spot) over the last seven years:

	Percentage of People Suffering	
	Year 2004	Year 2011
Cough	13.3	41.3
Bronchitis	21.4	31.1
Eye Irritation	14.1	38.4
Observed SPM Levels	381 µ gm/cum	642 µ gm/cum

The high levels together with the high rate of escalation of pollution in the past seven years shown in the above table should be a cause of concern for all. It is also clear that the pollution in Mumbai is caused primarily due to highly congested roads in turn compelling vehicles to crawl at low speeds thereby causing emission of large quantities of poisonous gases and suspended particulate matter. Scientific studies indicate that at speeds of about 55 miles per hour, the consumption of fuel is the least and this is the speed at which vehicular pollution would be the least. The creation of coastal freeway proposed in the report would help vehicles to travel at these efficient speeds, and thus reduce pollution. The coastal freeway would not only facilitate high travel speeds on this road but also take away traffic from the internal roads and thus help enhance vehicular movement at higher speeds, and reduce pollution. Thus the freeway project is not merely an infrastructure project it would ameliorate the health hazards posed by the present level of traffic congestion on the one hand and on the other create a large amount of open green space and contribute greatly towards enhancing the quality of life in the city. Indeed, the health concerns alone would justify taking up of this project in the larger public interest.

1.4 Committee for Coastal Freeway: As explained above, Mumbai, being an island surrounded on the east, south and the west sides by the Arabian Sea has no room to expand. Unlike other cities of the country, Mumbai does not have a ring road on its periphery to take traffic from one part to the other speedily. To provide better connectivity, sea links are planned on the western flank and the trans-harbour link on the east to connect the island city to the main land. One of the prime reasons sea links were planned as bridges (into the sea, about five hundred meters away from the coast) was the restriction placed by the earlier Coastal Regulatory Zones (CRZ) regulations preventing reclamation or stilt roads in the CRZ areas. The CRZ notification 2011 issued by the Ministry of Environment and Forests, Government of India (MOEF, GOI) now makes it possible to envisage coastal roads on stilts. During the meeting held in Mumbai on 15th April 2011 by the Hon. Minister MOEF, GOI, the proposal of a reclamation-based coastal road encircling Mumbai was presented to the Hon. Minister. The proposal envisioned a coastal road on reclamation which not only provided a speedy connectivity but also enhanced the quality of the city environment through the reduction in pollution and respiratory diseases and provision of excellent green space adjoining the road on either side and thus providing a much needed recreational space in addition to the road that connects the various parts of the city. The proposal of a coastal road based on stilts as permitted by the recent MOEF notification was also discussed. As discussed in the following chapters of this report, this is not a suitable option for Mumbai. The cost aspects of a sea link *vis a vis* a coastal road based on stilts and reclamation also came up for discussion in this meeting. Hon. Union Minister (MOEF) suggested that the proposal needed a closer examination through a committee whose recommendations could be made available to the Government for taking up further action in the matter.

1.5 Committee's Terms of Reference (TOR): The present Committee came to be formed under the Government Resolution dated 30th June 2011 **(Annexure 1).** The Committee has the following terms of reference.

a. **To examine the various options in the construction of a coastal road including road on stilt or sea link in Mumbai.**
b. **To evaluate options on the basis of technical feasibility and environmental impact and impact on the neighbourhoods.**
c. **To recommend the best option which provides improved mobility, enhances environment and leads to sustainable development of open spaces/greenery.**

1.6 Meetings: The Committee held ten meetings and deliberated the issues in these meetings. The minutes of the meetings and *aide memoirs* of the site visits held by the Committee are appended to the report as **Annexure 2.**

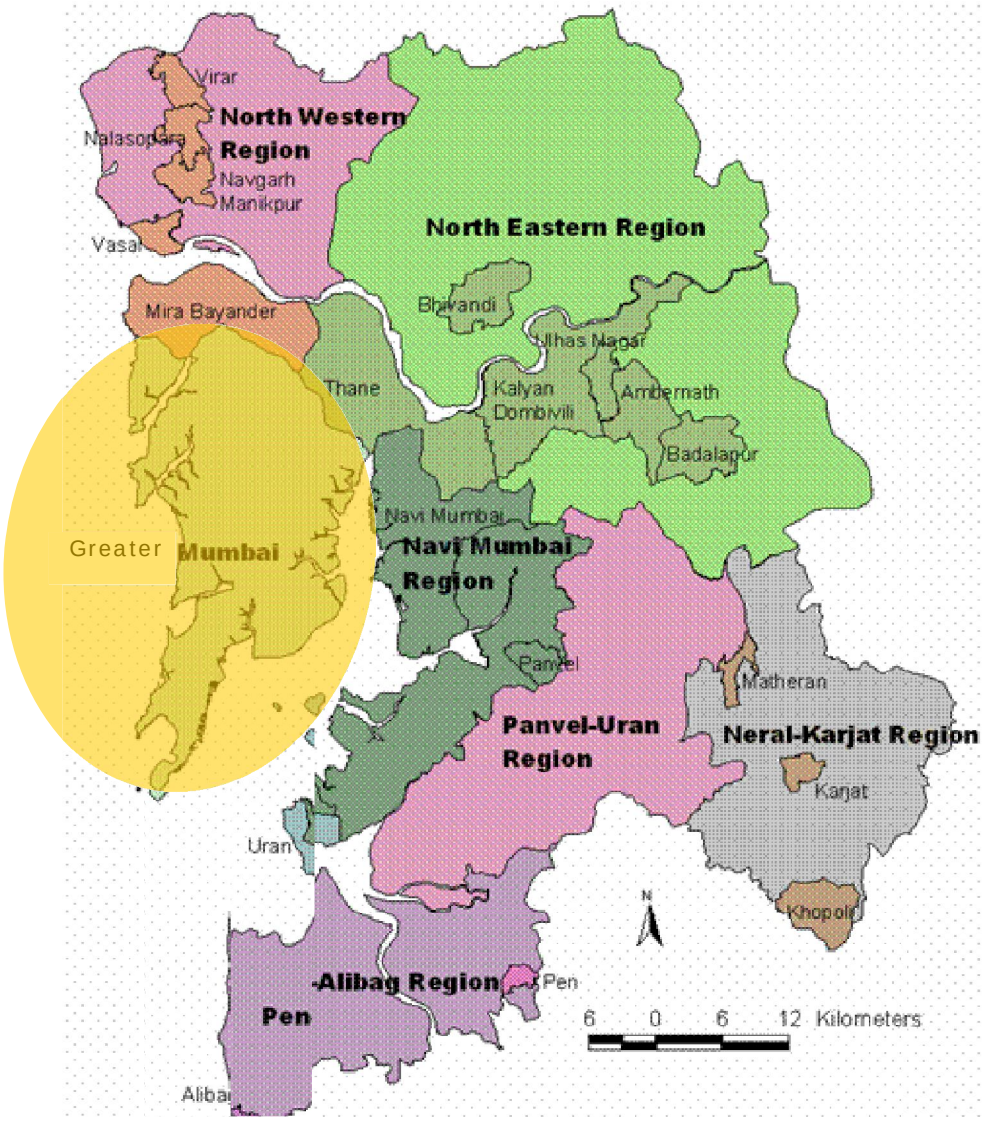

Fig. 1.1: Map showing Greater Mumbai and the Mumbai Metropolitan Region.

CHAPTER 2

NEED OF A RING ROAD/ COASTAL FREEWAY FOR MUMBAI

2.1 Review of Past Studies: The Committee began by taking a review of expert studies carried out by various agencies to take stock of the current situation as well as to assess the needs of the city/ MMR over the short and medium term future. This was with a view to enable the Committee to establish the need and characteristics of the coastal road within the purview of its TOR. The relevant studies carried out in the past are enlisted below:

A. Traffic and Transportation Study by M/s Wilbur Smith Associates (1962)

B. Planning for Road Systems for MMR by the Central Road Research Institute (CRRI) (1983)

C. Comprehensive Transport Strategy Study by M/s W.S. Atkins (1992)

D. Comprehensive Transport Strategy Study(CTS) by M/s Lea Associates (2009)

E. Concept Plan for Mumbai for the horizon year 2052 (Study In Progress)

2.2 Emphasis on CTS: The current report draws upon the Comprehensive Transport Strategy Study carried out by MMRDA under the auspices of the World Bank, especially since it is the latest report encapsulating the contemporary transport scenario and suggesting a strategy for a time horizon stretching over the next twenty years (i.e. upto 2031). The study touches upon all transport modes. However, since the subject matter within the purview of the Committee pertains to coastal roads, the observations and recommendations pertaining to the road transport mode have been kept in focus.

2.3 Transport Indicators: As regards the scenario pertaining to transport infrastructure in general, capturing the present and immediate past, the CTS has brought forth the following change in the transport indicators over a span of fifteen years between 1991 to 2005 :

MMR	Actual 15 year (1991-2005)
Population Growth	+43%
Sub-urban Train Daily Trips	+35%
Bus Daily Trips (Main Mode + Feeder Trips)	+9%
Registered Cars	+137%
Registered Two Wheelers	+306%
Registered Auto Rickshaws	+420%
Registered Taxis	+125%
Registered Commercial Vehicles	+200%
Airport Passengers	+94%

2.4 Share of Public Transport: A significant finding of the CTS is that while in the past, the MMR has been the region with the highest share captured by public transportation in the world (about 84 %), the said share is declining over the

years and suburban rail services are not keeping pace with the population growth. Suburban train ridership growth is only about 80% of the population increase. The CTS attributes this to the severe crowding conditions on the system. Although In terms of percentage, Mumbai Region should still take pride in the fact that 78% of journeys are made by trains and buses (as main mode) which is regarded as highly efficient in terms of energy consumption, environmental costs and per capita space requirement. CTS report comments that these are not the cause but effects of other phenomena such as unusually compact urban form, high densities, low incomes and lack of affordable housing. CTS views this as a sign of an overall low quality of life with lack of choices and alternatives rather than a conscious selection of most efficient mode of travel. Mumbai suburban rail network is among the most heavily crowded with average commuter density observed to be 9 persons/sq m (average standing density is 12 persons/sq m and density in the space between car doors is 16 persons/sq m). During discussions relating to city's transport strategy, sometimes one hears a view that if public transport is augmented to make it abundant and comfortable, there is no need to invest in road infrastructure since it tends to promote private transport. The Committee discussed this in the light of the CTS and came to the conclusion that this was a rather simplistic view. The Committee acknowledged the CTS finding that even though the share of public transport in Mumbai is already very high, city roads were badly congested and required substantial investments in the road transport infrastructure in the form of rings and radials. The Committee also agreed with the view of the experts that with growing income levels, there is bound to be growth in private vehicles, as is the case with other metropolises in the world. The share of private transport is bound to increase despite improvement in public transport infrastructure. The Committee noted the example of London cited in the CTS Report where even with a highly efficient public transport infrastructure, public transport accounts only for 20% of the travel trips. The Committee concluded in this context that new roads recommended by the CTS were badly needed for the city to meet its requirements along with significant investments and improvements in public transport e.g. metro, suburban rail network etc.

2.5 Congestion on Roads: As regards the road transport mode, CTS comments that increase in cars (137%), increase in two wheelers(306%), increase in autos(420%) and increase in taxis (125%) during the 1991-2005 period has created a lethal dose of traffic congestion which has categorised Mumbai urban agglomeration as one of the most congested regions in the world.

Fig. 2.1: Typical Congestion on Roads (Mahim Causeway)

The observed speeds on some of the major corridors in the study area during 1990 to 2005 indicate that the overall speeds are decreasing with time and the most probable reason is the increasing trend of traffic levels Over a period of fifteen years, minimum average travel speed in Island city ***has fallen from 18 to 8 kmph,*** in spite of major capacity expansion programs underway. Maximum average travel speed has shown marginal increase from 25 to 30 kmph, primarily due to construction of flyovers reducing location specific (and movement specific) delays. Most of the network remains, however, highly congested. In the suburbs of Greater Mumbai, Minimum average travel speed has fallen from 30 to 5 kmph, although maximum travel speed increased from 40 to 45 kmph.

The CTS also brings out a significant growth in the private vehicles in the city over the fifteen years period between 1991 and 2005. The growth of motorized vehicles has been reported to be about 9.7% per annum in this report and the CTS attributes this high growth of private vehicles in MMR to highly intolerable crowding levels in sub-urban trains, increasing income levels, and easy availability of loans. Limited land mass with rapid increase in population in the city has compounded this growth.

2.6 Coastal Freeways/ Ring Road: Among other things the CTS highlights the need of high quality transport consisting of urban freeways and different types of transit systems. Based on the data collected and study of parameters that impinge upon the travel demand the CTS report has projected the need of railway and highway network by the year 2031. This is depicted in the **Figure 2.2**. The recommended highway corridors are presented in the Table 2.1. The recommended highway network comprises a significant road length running along the coastline of the city. The road network envisages a road running along the coastline from Nariman Point in the south to connect to Versova on

the western flank of the city. Eastern Freeway runs along the eastern coast of the island city between south Mumbai to connect to Chembur and further to link to the eastern express highway at Ghatkopar. The proposed Sewri-Nhava Trans Harbour link will establish connectivity between Sewri on the main land and Nhava on the main land. The MTHL with the connecting road network and the multi modal Virar-Alibag corridor would complete a ring road around Mumbai.

2.7 Closer Examination of the Ring Road: The examination of this ring road a considerable portion of which runs along the coastline, especially in the island city is a matter within the purview of the present committee. The committee agreed with the view that the need of a road/ freeway running along the western coastline from Nariman Point to Versova/ Malad is indisputable. This road could be extended further to Vasai and Virar using the bridge connecting Versova to Madh island and with construction of bridges across the Manori and Vasai creeks, On the southern tip of this road, link from Nariman Point to Cooperage areas and further connection up to the eastern freeway, would make the road run around the Mumbai Island making it an effective ring road. During the presentations the transport experts belonging to M/s Lea Associates (Consultants for CTS Study) pointed out that the Western Freeway between Nariman Point and Versova was proposed as a sea link only because of the restrictions placed on reclamation or stilt roads in CRZ I areas by the environmental stipulations.

2.8 Reclamation Option: The matter of whether the freeway along the coastline should be a coastal road on reclamation or on stilts or in the form of a sea link was discussed at length by the Committee. The presentation made by Mumbai Transformation Support Unit (MTSU) to the Committee pertaining to long term concept-development plan for Mumbai Metropolitan Region helped throw greater light on the fact that the reclamation option has already been usefully deployed by various coastal cities/ regions across the world. M/s Surbana International from Singapore are the consultants engaged for the preparation of development plan vision for MMR and the detailed presentation made by MTSU representative on their behalf is attached along with minutes of the Committee's second meeting in **Annexure 2.** The scheme for development of Mumbai suggested by the consultants proposes reclamation in the form of a few islands adjoining the south eastern tip of the island city to provide for large urban spaces to cater to the future needs of the city and keeping the vision of developing Mumbai into an International Financial Hub. The presentation highlighted instances of similar reclamation in other cities of the World. The presentation pointed out that large areas have been reclaimed not only for road infrastructure but also for real estate in various countries of the world e.g. Netherlands (7000 sq km), South Korea (1550 sq km), Hong Kong (86 sq km), Tokyo (249 sq km) and Singapore (135 sq km). The presentation also cites the case of coastal road based on reclamation in Singapore with its adjoining gardens and waterfront. The Committee was of the view that a coastal freeway based on reclamation along with other options where necessary, would provide speedy connectivity between various portions of the city while also facilitating

creation of green spaces and waterfronts. Residential or commercial usage could be barred on such reclaimed land.

2.9 Committee's Observations: The Committee agreed that there was indeed a strong case for constructing a coastal freeway on the western flank of the island city between Manora (MLA Hostel) area in the south to Malad- Versova in the north. Connection of this Western Coastal Freeway to the starting point of the Eastern Freeway on the P. D' Mello Road would complete the portion of the coastal ring road around the Mumbai island. The discussion about options about its form in *Sea Link*s, *Coastal Road on stilts, Coastal Road on reclamation* or a combination thereof is covered in the following chapter.

Table 2.1: Recommended Highway Network (Coastal Roads shown highlighted)

Sl. No.	Highway Corridor Description	Length (kms)
H1	Eastern Freeway	22.5
H2	Elevated Link (Sewri-WorliSea Link)	5.6
H3	MTHL: Sewree to Kharkopar (Main Link over the creek)	17.2
H4	MTHL: Kharkopar to Rave (Link overground)	18.1
H5	Inner Ring (Kaman-Bhiwandi Rd.)	22.0
H6	Inner Ring (Bhiwandi Rd-Panvel-Dronagiri): EBL Corridor (2016, 2021, 2031)	34.0
H7	Middle Ring (Bhiwandi-Nandivali-NarthenGaon)	18.6
H8	Middle Ring (NarthenGaon-Panvel-Kharkopar): EBL Corridor (2016, 2021, 2031)	35.5
H9	Outer Ring Road: Khopoli-Jite-Rewas Port	36.8
H10	Radial-1 (NH-8)	26.0
H11	Radial-2 (Part of NH-3)	36.4
H12	Radial-3 (Bhiwandi Bypass)	14.0
H13	Radial-3 (Bhiwandi Bypass): EBL Corridor (2016, 2021, 2031)	9.0
H14	Radial-4 (Nahur-Airoli-Nilaje-Badlapur): EBL Corridor (2016, 2021)	33.8
H15	Radial-5 (Chembur-Mankhurd-Vashi-Taloja)	26.0
H16	Radial-6 (Vashi-Belapur-Kalamboli)	14.9
H17	Radial-7 (Uran-Pen)	22.3
H18	Radial-8 (New Airport-Nhava-Uran-Rewas)	22.2
H19	Ghodbunder Road: EBL Corridor (2016)	16.1
H20	WesternSea Link North Extn (Bandra-Dahisar)	26.0
H21	Western Sea Link North Extn (Dahisar-Virar): EBL Corridor 2016	38.0
H22	WesternSea Link South Extn (Worli-ColabaSea Link)	13.7
H23	Ghatkopar – KoparkairaneCreekBridge	8.9
H24	Mumbai- Sawantwadi Expressway	21.2
Sub-Total		538.60
Up-gradation of Existing Arterial Roads		781.40
New Arterial Corridors/ Links		419.00
Sub-Total		1200.40
Total		1739.00

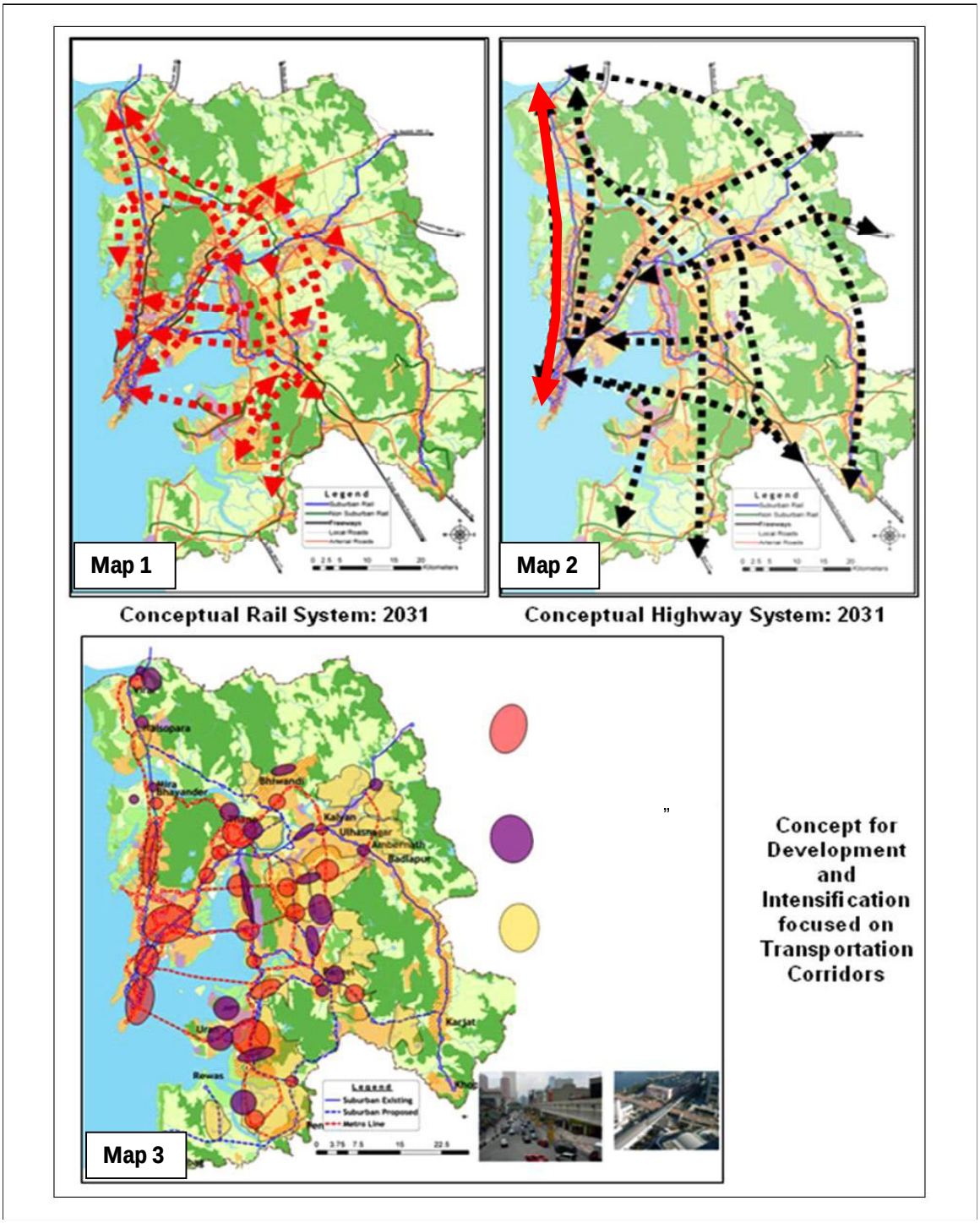

Fig. 2.2: Recommended Transport Network in CTS: *West Coast Road shown in red in Map 2*

CHAPTER 3

OPTIONS TOWARDS COMPOSITION OF COASTAL FREEWAY

3.1. Structural Options for Coastal Freeway: The various options that are available for the construction of a freeway have been discussed in the following paragraphs.

3.1.1. Coastal roads based on reclamation: This is the least cost option (see para 3.2.3). However, the difficulties with this option are the specific impermissibility as per the current CRZ notification. The environmental impacts and other aspects need a closer examination. This option may be used to generate a significant green space in the city. Where rivulets and nallas joining the sea exist, stilts could be provided so as to minimize impacts. In addition, cycle tracks, jogging tracks and recreational spaces for children and old people can also be provided in this portion.

3.1.2. Coastal roads based on stilt structures: This option entails a relatively higher cost compared to the coastal roads based on reclamation. Cost aspects apart, if a relatively high stilt bridge with appropriate clearance (of about 6 to 9 m) is provided, it is subject to the dumping of garbage under it as well as encroachments. Besides, it would cause a visual obstruction to the view of the sea. If a low level stilt bridge is provided to match the level of the existing promenades/roads, it would have shallow vents making it non-amenable for inspection of the underside for maintenance and repairs. Maintenance of roads on stilts is more difficult and expensive in comparison to roads based on reclamation. In Mumbai, coastal roads on stilts, is not an environment-friendly and feasible option, where large scale development has already taken place in the neighbourhood. However, even though it is a costly, time consuming and difficult option compared to the reclamation option, silted roads may have to be proposed where reclamation is inadvisable to allow for easy flow of water in narrow creeks etc.

3.1.3. Sea Links. Sea links are bridges in the sea several hundred metres away from the coastline, with the soffit clearing the high tide level by a margin of over 9 m for passage of boats. This option involves a considerably high cost. The sea bridge option also needs to incorporate elaborate disaster mitigation measures. A visual obstruction to the view of the sea is an undesirable feature. This option was being considered thus far in lieu of the options 1 and 2 being the only option permitted by the previous CRZ notifications. One of the other difficulties is the requirement of long connectors at intermediate and end points where the sea link connects with the roads on the coast. Interchange loops going over the already high sea links at the connector locations also result in considerable obstruction to the sea view besides adding very high costs to the sea link option.

Unlike the reclamation option, sea-links do not allow creation of open and green spaces for public.

3.2. Cost Economics: While evaluating the relative merits and demerits of an option and considering its adoption for a particular stretch of coastal freeway, the cost factor of an individual option needs to be kept in focus. While the costs would depend upon the site conditions, the following cost figures would give an idea of relative cost economics in very broad terms.

3.2.1. Sea Link Option: The cost of the Sea Link option would work out to be highest among the options suggested above. Estimates could be made using per sq m rate of the Bandra-Worli Sea Link extrapolated till date. This works out to about Rs. 105000 per Sq m of the deck area. With about 36 m of deck width required for a eight lane wide sea link bridge, this translates into a cost of about Rs. 378 Cr. per km. Since the Bandra-Worli Sea Link did not have interchanges, accounting for the presence of long connectors and interchanges for the sea links to connect to the road network on the coast, the cost would work out to be significantly higher (say in the range of about Rs. 600 Cr. per km.)

3.2.2. Stilt Bridge Option: The road abutting the coast in the form of a bridge on stilt would be similar to a bridge on land with additional costs entailed due to construction in the intertidal zone. The cost of a bridge on the land would work out to about Rs. 50000 per sq m of deck area based on the construction costs of some of the recent flyover works. Adding about 20 % costs towards operations in shallow waters the cost of the stilt bridge option would work out to about Rs. 60000 per sq m at a minimum. This would translate into a cost of about Rs. 220 Cr. per km for an eight lane bridge. Adding for the cost of interchanges at intermediate points to connect to the local roads, the cost of the reclamation option would work out to about Rs 245 Cr. per km.

3.2.3. Reclamation Option: Based on the current estimates of coastal protection schemes and a similar road constructed for the approaches of the Bandra-Worli Sea Link on reclamation, the cost of reclamation option would be in the range of Rs. 60-70 Cr. per km. Allowing for some cost towards landscaping, construction of promenades (20 m and 30 m wide) and other features the cost per km for a coastal road based on reclamation would be in the range of about Rs. 75 Cr. per km. Adding for the cost of interchanges at intermediate points to connect to the local roads, the cost of the reclamation option would work out to about Rs 100 Cr. per km.

3.2.4. Tunnel Options: Tunnel options both cut and cover type and the bored type may have to be envisaged at some locations. The cut and cover tunnel carrying eight lanes of traffic would have a perimeter of about 75 m. Considering concrete walls of about 1 m thickness at ends and at the centre and the top and bottom slabs of about 1 m, it would require a concrete quantity of about 80 cum per m. Considering a rate of about Rs.

10000 per cum for concrete this would entail a cost of about Rs. 8 lacs per m and providing steel at about 200 kg per cum in the RCC structure would require a steel of about 16 MT per m. This translates into a cost of about Rs. 8 lacs per m. for steel. The total cost of RCC structure per m would thus be about Rs. 16 lacs per m. Providing for excavations inside rock and other features and adding about Rs. 9 lacs per m for all these provisions, cut and cover tunnel would entail a cost of about Rs. 25 lacs per m or about Rs. 250 Cr. per km. This of course does not include costs of operations and maintenance. The bored tunnel option is expected to cost about Rs. 500 Cr. per km including lining and ventilation accessories etc.

3.3. Discussion regarding Options: Based on the assessment of the cost economics as above, it is clear that the cost of reclamation option is the least (about one sixth the cost of the sea link bridge option). Besides, the advantage provided in the costs, it also facilitates the provision of green open spaces which the city is severely short of. The reclamation option can help create recreational spaces in the form of gardens, promenades and walking and cycling tracks by the sea side over the entire length where such roads are proposed. The reclamation option avoids visual intrusion in the view of the sea that the sea link option does. This option also offers great advantage in terms of disaster management and mitigation compared to the sea link bridge option. It also makes sea front available to masses rather than a private backyard of chosen few. The option would have to be combined with other options e.g. stilt bridge in portions where rivulets/ nallas join the sea or where mangroves exist. The land fill material aspect of the reclamation option was also discussed in the meetings of the Committee and a presentation of an expert agency in this field took place before the Committee. The Committee was of the view that fill material using dredging in the sea was both economical and suitable since it causes little or no disturbance to traffic on existing roads during construction. This could be supplemented to some extent by fill material brought from excavations on the land (e.g. for tunnels etc). The bridge option, unlike sea link deep into the sea, may be inevitable in some cases e.g. where beaches/ fishing jetties are present on the sea coast.

3.4. Scheme for Coastal Freeway: The Committee kept the above considerations in its evaluation and recommendations in regards to the structural composition of the coastal freeway in various stretches along the coast and in the hinterland. The discussion of the scheme is covered in the following chapter.

CHAPTER 4

COASTAL FREEWAY: SCHEME

4.1. Discussions in Committee's Meetings: The Committee kept its focus on the scheme of a coastal freeway especially in Greater Mumbai. Towards this end, a subgroup comprising some members of the Committee was formed to prepare a basic scheme and place it before the Committee in its meetings. Accordingly, the scheme was prepared and discussed in the meetings of the Committee. The Committee invited officials of MSRDC, the Joint Director CWPRS who has the expertise in matters of reclamation and coastal protection measures and other consultants including those engaged for the Western Freeway Sea Link / Bandra-Versova Sea Link and other marine experts to appreciate their views and incorporate these in the Committee's recommendations. The Committee carried out visits to the areas where the roads were proposed to appreciate the features of the site, the availability of lands so as to prepare a feasible coastal freeway scheme. The following paragraphs describe salient details of the various sections of the coastal freeway on the west coast going from south to north.

4.2. Jagannath Bhosle Marg-NCPA(Nariman Point)-Malabar Hill-Haji Ali-Worli:

4.2.1. General Alignment: The coastal freeway commences from near Manora (MLA Hostel) area with entry/exit from theJagannath Bhosle Marg in the form of surface roads. Road based on reclamation (900 m long) is proposed between the area near Manora (MLA Hostel) and NCPA at Nariman Point, which will enable connectivity of the Western coastal freeway to the starting point of the Eastern freeway in future as covered later in this report. From Nariman Point, the coastal freeway would be a tunnel (cut and cover or bored) going northwards under the Marine Drive. It would be possible for the on surface traffic on the Marine Drive to enter the tunnel and the traffic coming from the north to exit the tunnel at a point some distance north of the entry and exit ramps of the Princess Street Flyover. The south bound traffic would exit from the tunnel on the landward side of the Marine Drive road and the north bound traffic would enter on the seaward edge of the road. This can be done without encroaching on the width of the existing sea side promenade. This tunnel under Marine Drive would continue as a bored tunnel under the Malabar hill (total tunnel length 5.5 km). The bored tunnel under Malabar Hill exits beyond the Napean sea road and the exit point is located on the seaward side beyond the Priyadarshini Park with reclaimed space in between for easy entry and exit. The tunnel is located under the Priyadarshini Park, to avoid impacting the open green space at the Priyadarshini Park. From here, a coastal road on reclamation (2.95 km long) is proposed upto the Haji Ali Junction. At the Haji bay, the coastal freeway would be in form of a road based on reclamation adjoining Lala Lajpatrai Road upto the National

Sports Club of India (NSCI). A connector bridge (300 m) would connect the road to the Baroda palace point wherefrom a coastal road on reclamation is proposed upto Worli, right upto the point where the connector of Bandra-Worli Sea Link (BWSL) meets the Sea Face Road. Plates 3 to 11 in **Annexure 3** indicate the alignment of the road in this portion of the coastal freeway. The coastal freeway connects to the Bandra-Worli Sea Link on the Khan Abdul Gaffarkhan Road (KAGK) on the Worli Sea Face. The Committee considers that the tunnel proposed between NCPA and the Princess Street Flyover (i.e. where entry is provided on the Marine Drive for the northward tunnel) can be omitted/ deferred based on the traffic studies to be conducted at the detailed feasibility study stage. This would mean that the traffic would use the existing Marine Drive.

4.2.2. *Entries/ Exits in Jagannath Bhosle Marg-NCPA(Nariman Point)-Malabar Hill-Haji Ali-Worli Stretch:*

Exit/ Entry at Jagannath Bhosle Marg: The surface roads from Jagannath Bhosle Marg would provide entry/ exit into the coastal freeway system near Manora (MLA Hostel).

Exit/ Entry at Marine Drive: Entry/ Exits at the Marine Drive location would be at the locations indicated in the sketch. Entries and exits each of two lanes could be provided.

Exit/ Entry at Priyadarshini Park: The tunnel under Malabar Hill exits beyond the Priyadarshini Park with reclaimed space in between for exits and entry to allow free movement of vehicles going from the Napean Sea Road to the freeway and *vice versa*.

Exit/ Entry at Bhulabhai Desai Marg: Free left turns are allowed to connect the freeway to Bhulabhai Desai Marg at the Tata Garden location. This addresses the traffic requirements at this place adequately.

Connectivity at Haji Ali and NSCI: The freeway is proposed as a road on reclamation at the Haji Ali bay. The connectivity to the Lala Lajpatrai Road at Haji Ali bay is proposed in the form of two staggered flyovers. The flyover at the south end of the Lala Lajpatrai Marg allows movement of south bound vehicles from the Lala Lajpatrai Marg going to onto the coastal freeway; and also allows the vehicles existing from the south side of the freeway to join the Lala Lajpatrai Marg.. The flyover opposite NSCI at the north end of the Lala Lajpatrai Marg allows entry for north bound vehicles on to the freeway while vehicles coming from the north side of the freeway can move onto the Lala Lajpatrai Marg. Free left turn entry into the Freeway will be available near the Pedder Road Junction for south bound vehicles.

Connectivity at Worli Dairy: At the location where the road from Love grove meets the Worli Sea Face near Worli Dairy, the coastal freeway is

connected to the Khan Abdul Gaffar Khan Marg with a trumpet interchange to provide free movements to and from the freeway into the local roads and *vice versa*.

Connectivity at the meeting point of BWSL: The traffic coming out of the sea link from north would exit on the local road by taking a free left turn and move south on the KAGK road only by moving around the rotary at Trata Junction (Coast Guard) as at present. The Committee also considered the possibility of allowing connectivity of the proposed Worli Sewri east-west link to the coastal road system. The Committee suggests that this could be in the form of tunnels as and when required. This will provide a seamless connectivity between the coastal freeway and the proposed Mumbai Trans Harbour Link.

4.3. Bandra–Worli: The Bandra Worli Sea Link has already been constructed between Bandra and Worli and in the south connects to the Worli Sea Face Road near Pratiksha Building on the Khan Abdul Gaffarkhan Road to the Bandra reclamation area at its north end. The coastal freeway scheme envisages adding four lanes to the Worli connector of the sea link, to provide an eight lane freeway here. This would mean adding a bridge about 800 m long to widen the existing four lane connector.

4.4. Bandra –Versova- Malad Stretch: The committee considered alternative options available to connect the northern end of the Bandra-Worli Sea Link Bridge to Versova / Malad areas. The option of a tunnel under the Bandra Fort Hill to connect to the Lands end area was considered. The same was not found suitable owing to the presence of large buildings on pile foundations besides non availability of space for access controlled road for the freeway on the Bandra Bandstand side. The option of a loop interchange (650 m long) at the Bandra end of the Bandra-Worli Sea Link and a reclaimed road (850 m) skirting around the Bandra Fort was considered more suitable and is proposed for the scheme of the coastal freeway. It will further continue as a road based on reclamation (1.1 km long) along the Bandstand area with a promenade on the sea side upto southern end of the Chimbai village. This road will run parallel to the Bandstand road ie Byramjee Jeejibhoy road, which is maintained as a neighbourhood road. At the Chimbai village bay, a bridge (about 550 m long) is proposed to accommodate passage of fishing boats. Further northward of the Chimbai Bridge, two options are envisaged. Each of these options is described below:

4.4.1. ***Option I:*** This option I envisages connectivity from the north end of the proposed Chimbai bridge to the link road north of the Junction with Malad-Marve Road in the following manner.

a. Reclaimed road (1.8 km long) adjoining Carter Road. This will involve compensatory plantation for the mangroves impacted in this construction.

b. Elevated Road (1.15 km long) near Khar Danda village. This elevated road is needed to accommodate the fishing jetty and passage of boats

under it. The elevated road skirts the Khar Danda village goes landwards leading into the tunnel under the Juhu Airport.

c. Tunnel under Juhu Airport. The length of the tunnel is about 4.25 km and the tunnel exits near Ritmbhara College at the northern end of Juhu and continues as a surface road(350 m long).

d. Reclaimed road (950 m long) is proposed in the mangroves area between Ritambhara College and the Nana Nani Park at seven Bungalows area.

e. An elevated road(1.25 km long) near Nana Nani Park and Seven Bangalows area on the existing D.P. road, further going as an elevated road going upto the new Fisheries Institute Versova.

f. Reclaimed road going through the mangroves area from Versova to the Oshiwara. A rotary in the form of a triangle is proposed here. The westward arm (1.6 km) of the rotary is proposed as a reclaimed road going towards the Versova jetty (Location of the Madh bridge proposed in the Development Plan). The other two arms are the eastward arm from Madh bridge to Oshiwara (600 m). The north-south leg is the reclaimed road (900 m) connecting Versova and Lokhandwala area. The reclaimed road (1 km) in mangrove area continues in the Lokhandwala area and as a surface road in Oshiwara (500 m) Small bridges on the intervening creeklets and culverts / pipes would be proposed to allow free flow of water in this mangrove area.

g. Road (800 m long)partly on the existing land (where no mangroves exist) and partly reclaimed(1.05 km) in the mangrove area between Oshiwara to Mindspace area. Bridges are proposed on the intervening creeklets.

h. Reclaimed road(1.15 km long) adjoining the existing Municipal road near Mindspace area upto the junction of the road leading to Goregaon Sports Club.

k. A stilted road (2.3 km long) along the creek from the north-west end of the road leading to Goregaon Sports Club area ,going over the creek and the Malad Marve road and connecting in the end at grade (length 200m) to the Link road at the Municipal land on the west side of the Link Road.

4.4.2. Option II: Some stretches in the option I involve reclaimed roads in the mangrove areas entailing compensatory mangrove plantation. Also small bridges/ culverts/ pipes would be provided at appropriate locations to allow free movement of water in these areas. Although this implies a short term environmental impact till the mangroves are replanted, there would be no environmental damage in the long term. The Option I would be highly cost effective entailing reduction of cost by about Rs. 1000 Cr. Further, it would be easy to implement with a significantly reduced time of construction. The Committee, therefore, prefers the adoption of Option I. The Committee

suggests another option herein which replaces the reclaimed roads in mangrove areas by stilted roads. Thus there would be change in the a,d, f, g and h above in the following manner:

a. Stilted road on the sea side just beyond the mangroves adjoining Carter Road.

d. Stilted road between Ritambhara College to the Nana Nani Park in the mangrove area.

f. The rotary in the mangrove area between Versova and Oshiwara areas would be proposed as elevated road and stilted road. The westward arm leading to Varsova jetty (i.e. the Location of the Madh Bridge proposed in the Development Plan) is an elevated road on land and the other two arms are stilted roads in the mangrove areas. Northwards, it is proposed as an elevated road from Oshiwara to Lokhandwala on the existing land.

g. From Oshiwara to Mindspace area a stilted road (1.05 km) is proposed over mangroves with intermittent bridges over creeklets.

h. Elevated road (1.15 km) on the existing DP road on the west side of Mindspace area.

The drawings indicating the alignment, structural composition and interchanges on the coastal freeway in this portion is indicated in the Plates 12 to 27 of **Annexure 3**.

4.4.3. *Entries/ Exits in Bandra –Versova- Malad Stretch:*

Exit/ Entry at Bandra Reclamation: The coastal freeway connects to the northern approach of the BWSL through the use of an interchange at the northern end of BWSL. This contemplates that the coastal freeway coming from north around the Bandra fort would pass under the land spans of the Sea Link and connects to the BWSL approaches. An underpass below the present high embankment approach on the north side of the existing toll plaza location would facilitate the traffic coming from the northern side of the coastal freeway to move towards Western Express Highway. The south bound traffic on the coastal freeway would connect to the Sea Link through a loop located on the seaward side of the approach. The arrangement here has been worked out in consultation with MCGM, so as to harmonize with the proposals envisaged under the Mumbai Sewerage Disposal Project of the MCGM.

Exit/ Entry at the southern end of Carter Road: At this end only free left turns are allowed for the traffic coming from north on the freeway to move further north on the Carter Road. The traffic coming from the Carter Road area can also connect to the freeway to move south on the freeway at this junction.

Exit/ Entry at the northern end of Carter Road: This is a trumpet arrangement providing south exit from and north entry to the coastal freeway.

Interchange at the entry point of the tunnel near Khar Danda: An interchange is proposed at the entry point of the tunnel near Khar Danda to connect freely to allow traffic to move in and out of the freeway to the link proposed to connect the freeway system to the Juhu Tara Road.

Interchange at the exit point of Tunnel near Ritambhara College: A complete interchange catering to all traffic movements is provided at the exit point of the tunnel near Ritambhara College. This is possible without any separate grade separation structure at this location.

Interchange for Versova at Seven Bungalows: Complete interchange providing free movement of traffic between the freeway and the local roads

Interchange near Lokhandwala: The interchange at Lokhandwala road caters to some movements of traffic (South entry and North exit).

Interchange near Oshiwara:: Complete interchange providing free movement of traffic between the freeway and the local roads

Interchange near Mindspace: The road leading to the Western Express Highway near Inorbit mall is connected to the coastal road system through an interchange at the MCGM garden allowing free movement in and out of the coastal freeway to this road. This provides connectivity between the coastal freeway and Western Express Highway.

Exit / Entry at the Link Road: The coastal freeway connects to the Link Road at some distance north of the junction with Malad-Marve Road. A signalised intersection is provided here to connect to the Link Road. The signals could operate for right turn movements, allowing free left turns at the intersection. The availability of land belonging to MCGM at this connecting point west of the Link road makes it easy for the junction to be designed suitably.

4.5. Coastal road on the Gorai island to Virar: The Committee has provided a connectivity of the coastal freeway to the Vesova jetty. The Committee realized that a bridge is provided for in the Development Plan at the Malad Creek to connect Versova to the Madh island. The development plan on Madh island already proposes a 36 m wide road on the Madh island connecting to Marve. This opens up the possibility of connecting the coastal freeway system with the northern regions of Vasai and Virar through the widening and development of roads on the Madh island and further the roads in the Gorai and Uttan areas. There is no need of contemplating reclamation here. This stretch could be provided with a road running along the coastline by widening the existing roads (without reclamation). Bridges would need to be constructed at the Manori and Vasai Creeks to provide seamless connectivity to Vasai and Virar areas. The bridge across Manori Creek would be a relatively smaller bridge (about 500 m)

whereas the bridge across Vasai Creek would be a relatively larger bridge (about 2 km). However, even in the absence of the bridge across Vasai Creek, the road network here could be connected to the National Highway No. 8 connecting to the Vasai and Virar areas using the existing roads e.g. Bhayandar-Gorai Road. With the construction of the creek bridges, the coastal road system could finally connect to the Vasai and Virar areas by a short and convenient route.

4.6. Connectivity to Eastern Freeway: The Committee is of the view that at present traffic could move from the coastal freeway exit at Jagannath Bholse Marg to P' D Mello road and further to the Eastern Freeway (currently under construction), using the existing roads. However, connectivity to the starting point of Eastern Freeway on the P.D'Mello Road could be contemplated in future, in the form of a tunnel from Manora (MLA Hostel) area to the starting point of the Eastern Freeway.

4.7. Interchanges, Exits and Entries: The coastal freeway system contemplated by the Committee is an access controlled freeway with exit and entry points at eighteen locations in the manner described through indicative sketches in **Annexure 3**. The arrangement suggested by the Committee is a schematic arrangement and the same could be fine tuned suitably during preparation of detailed project drawings and estimates.

4.8. Widths of Roads and Reclamation: Considering the general traffic requirements and availability of Right of Way (ROW) at the DP roads where the coastal roads are located, the coastal road system is recommended with a twin four lane carriageway for its entire length, except where adequate ROW is not available *viz.* near the Nana Nani Park where the alignment near fisheries institute passes over DP road with ROW of about 75 ft. In this short stretch (about 400 m long), a twin three lane composition could be adopted. Where the road is proposed as a reclaimed road by the side of the sea, the general arrangement would comprise a 20 m wide promenade on the landward side, a twin four lane carriageway for the coastal freeway and a 30 m wide promenade on the sea side. The presence of a wide sea side promenade keeps the waves away from the coastal freeway and prevents it from wave splashing impacting the traffic movements especially when the sea is rough during monsoons. This slightly higher width also takes into account widening of the road by another two lanes in future. This would mean that the reclamation for the road adjoining the coast would be generally of the order of about 86 m. However, a reduced width of reclamation would be needed in the stretch adjoining the Lala Lajpatrai Marg at the Haji Ali bay and the Khan Abdul Gaffar Khan Road at Worli since the existing promenades there could be merged into the landward promenades of the reclaimed coastal freeway. Additional widths of reclamation in the range of about 200 m would be required at isolated locations e.g. Priyadarshini Park exit for the tunnel and one or two locations where the road would need to be provided in a gentle curve at kinks in the coastline. Reclaimed roads in the mangrove areas would be twin four lane carriageways with 5 m wide promenades on the sides, thus entailing a top width of about 46 m. Likewise,

elevated roads or stilts are proposed with a deck width of about 46 m to accommodate the carriageway and the pedestrian facilities on either side. The Options I and II envisage a total reclamation of about 160 Ha and 100 Ha respectively. Refer Plates 28 to 33 in Annexure 3 for sectional sketches and views.

4.9. Summary of the Scheme: The Committee recommends the two options described The option I involves reclaimed roads in the mangrove areas. Moreover, to allow free movement of water in the mangrove areas, small bridges, culverts and pipes are proposed in the reclaimed roads. The Committee prefers option I being less expensive and easy to implement with reduced time for construction. Although this option entails some short term environmental issues arising out of compensatory mangrove plantations, no long term damage to the environment is expected. The adoption of Option II would replace the reclaimed roads by a stilted road or elevated roads in a length of about eight km It will, however, enhance the cost of the project by about Rs. 1000 Cr. and will also be more difficult to maintain. As highlighted in the Para 4.2.1, the tunnel proposed between NCPA and the Princess Street Flyover (i.e. where entry is provided on the Marine Drive for the northward tunnel) can be omitted/ deferred based on the traffic studies to be conducted at the detailed feasibility study stage. This would mean that the traffic would use the existing Marine Drive. This would reduce the cost of the Project by about Rs. 1000 Cr. in either options.

The summary of the coastal road scheme covering the two options described above is provided in the Table below:

	Option I *	**Option II ***
Total Length of the road	**35.60 km**	**35.60 km**
Road Length involving Reclamation in Sea	**9.80 km**	**9.80 km**
Road Length involving Reclamation in Mangroves	**8.00 km**	**NIL**
Road Length not involving reclamation	**17.80 km**	**25.80 km**
Road on stilt	3.45 km	11.45 km
Elevated Road	1.15 km	1.15 km
Tunnel	9.75 km	9.75 km
Bridge in Sea	0.85 km	0.85 km
Surface road	2.50 km	2.5 km
Costs[#] (In Rs. Cr.)	8000^	9000^

* Refer Annexure 3 - Plates 1 & 2 for general alignment

See Annexure 4

^The cost would be reduced by about Rs. 1000 Cr. in case the tunnel between NCPA and Princess Street Flyover on the Marine Drive is omitted/ deferred based on the traffic study.

4.10. Schematic Drawings of the Alignment: The report includes schematic drawings of the alignment recommended by the Committee including concept sketches of proposed interchanges. These schematic drawings could be fine tuned suitable at the stage of detailed engineering when these works are taken up.

CHAPTER 5

ENVIRONMENTAL ASPECTS

5.1. Coastal Road Scheme: The issue of environmental implications on account of various forms of coastal freeway were discussed in detail in the meetings of the Committee. Key inputs in the discussion were provided by Director, National Institute of Oceanography (CSIR-NIO), who was a member of the Committee. He, in turn, sought advice from a team formed at CSIR-NIO comprising experts in Marine Biology, Geophysics, Coastal Regulations, Ocean Engineering and Physical Oceanography. This was specifically to examine oceanographic aspects of the impact of the proposed highway.

5.2. Key Issue: Reclamation for Coastal Freeway: Among the issues that were discussed during the Committee's meetings, the most important issue pertained to the possible impact of reclamation along the coastal freeway stretch on the tidal circulation around the city. The key question that came up for examination was whether the land reclamation as proposed for the coastal road scheme change tides in the coastal areas of the city leading to adverse impact such as coastal erosion.

5.3. Inputs received from CSIR-NIO: The key issue referred to the CSIR-NIO team was whether the proposed reclamation for coastal road would cause any adverse effects on the tides or erosion of the coastline. The CSIR-NIO team noted that the average width of reclamation proposed is about 100 m. This will mean moving the coastline offshore by a distance of ~100 m, at most locations Even at the few isolated locations, where gentle curves would be proposed to the coastal roads to avoid sharp kinks in the coastline, this would only smoothen the coastline and that no change in the characteristic of the boundary between the coastline and the sea is expected. The shore protection measures (*viz*. tetropods, retaining walls etc.) that are proposed to be used are the same as those that are used at present. These seem to be working well. The isolated locations where the road would be provided with a gentle curve at some sharp kinks in the coastline would only help improve the erosion protection. The team further noted that the spatial scales of variability associated with tidal circulation on the west coast of India are large in comparison to the expected perturbation length scale of 100 m, the width of the shelf off Mumbai being about 200 km. The CSIR-NIO team therefore did not expect any change in the present behaviour of tides due to moving of the coastline perpendicular to the present coastline by a distance of ~100 m. Such a move, in essence, will shift the present boundary offshore by ~100 m, parallel to the present boundary, and leave everything else, including the structure of the present sea-land interface, unchanged. The team's opinion was that such a move will not have any impact on the tides and tidal circulation around Mumbai. The team further noted that they did not really see anything to be gained by going through an exercise of

simulation of tides with present geometry and with the coastline shifted by ~100 m at a few locations. This is because tides operate on a scale much larger than the distance over which the coastline is proposed to be shifted, and the shift will put the coastline approximately parallel to the present position.

In view of the above recommendation, the Committee decided that reclamation along the Coastal Freeway stretch abutting the sea coast is both a feasible and economically an attractive option. Implementing it would not generate any adverse impact on tidal behaviour or create problems related to coastal erosion, etc.

5.4. Legislative Framework: The present CRZ notification issued in January 2011 does not allow coastal roads on reclamation. Coastal roads based on stilts are, of course, allowed. The Committee noted that the implementation of the reclamation option would require an amendment to the CRZ notification to permit coastal roads based on reclamation. The Committee recommends that such an amendment should be put in place. For this purpose, the state government will need to move a proposal to the Ministry of Environment and Forests, Government of India (MOEF, GOI) for the limited purpose of the proposed reclamation. The Committee, however, is of the view that the change in the High Tide Line should not be considered for planning and development purposes. The Committee also stresses that the reclaimed land shall not be used for real estate development.

5.5. Further Studies: The matter of further environmental and other studies and the investigations that were needed towards obtainment for the CRZ clearance were also discussed. It was observed that the CRZ clearance would normally require a pre-feasibility report/traffic studies/ related technical studies including EIA indicating the likely impacts and mitigation measures. The Committee is of the view that such studies should be entrusted only to the consultants accredited by the Quality Council of India (QCI). As regards impact on mangroves, since mangrove areas are now declared as reserved forests in Maharashtra, any construction work impacting mangroves would necessitate compensatory mangrove plantation. The detailed project preparation studies should be accordingly taken up to incorporate these aspects.

CHAPTER 6

POLICY INTERVENTIONS AND IMPLEMENTATION STRATEGY

6.1. Costs: The coastal road scheme as envisaged in the Committee's report comprises about 35.6 km long coastal freeway on the west coast of Mumbai. The cost of the freeway is estimated to be approximately Rs. 8000 Cr. corresponding to Option I and Rs. 9000 Cr. corresponding to Option II. **(Annexure 4).** The cost in either option would be reduced further by about Rs. 1000 Cr. in case the tunnel between NCPA and Princess Street Flyover on Marine Drive is omitted/ deferred based on the traffic study. The Committee emphasizes that this cost is far less in comparison of the cost of sea link in the equal lengths (estimated in the range of Rs. 20000 Cr). The Committee deliberated about the modalities of taking up the implementation of the project. The views of the Committee on this aspect are covered in the following paragraphs.

6.2. Funding and Construction through PPP/EPC Routes: The first option examined by the Committee pertaining to the implementation of the Coastal Freeway was the adoption of the PPP- BOT route or the PPP annuity route. In the former, the Concessionaire would be allowed to realize revenues through toll charges on the users. In the latter route the entrepreneur would be paid through annuities over a period of time. This option would help deploy private finance for the implementation. The Committee realizes that the greatest difficulty with this arrangement would be in the construction of toll plazas and tolling arrangement at all the exit and entry points in the coastal freeway system. The coastal freeway system will be predominantly an urban freeway and creation of toll plazas and elaborates arrangements as at the toll plazas currently operational in the city at some locations are clearly not advisable and would defeat the very purpose of the coastal freeway system through creation of stoppages. The levy of user charges can however, be considered feasible only if the Electronic Non Stop Toll system is adopted. This can be done using the RFID system with On Board Units using prepaid cards and overhead gantries at the entry points for verification. The collection system can be simplified by charging flat rate for each entry into the coastal freeway system irrespective of the distance travelled. Technology also permits on line identification of vehicles which use coastal freeway without payment, along with the actual distance travelled. While no stoppages are envisaged, all users without adequate or no balance on the prepaid card would be detected at each entry point and penal charges can be imposed through automatic reading of his number plate. Such systems are already installed in metros of the world (e.g. congestion pricing system in London) Adoption of this system with user charge levied for every entry in the freeway system would help generate an adequate source of revenue to meet the costs of construction. The revenues could be utilized to pay for the annuities in the PPP-annuity option. The viability gap, if any, could be supported from budgetary sources or through the VGF grants

available from the GOI for the projects to be implemented on the PPP mode. In case the EPC route is to be adopted a suitable funding arrangement will have to be envisaged. EPC mode of implementation with repayment of costs of construction through the levy of user charges can also be thought of.

6.3. Maintenance Costs/ Funding: The Committee considered the importance of maintenance and the requirement of funds for maintenance. The Committee was of the view that resources could be raised through a minor cess on the petrol/ diesel sold in the city. Data collected by the Committee shows that a cess of Re. 1 on petrol and diesel sold in the city would help raise about Rs. 100 Cr. annually. This sum could be used for maintenance of the coastal freeway system since the long term maintenance aspect of the freeway system also needs to be kept in view.

6.4. Implementation Strategy: The Committee considered the course of implementation of the Coastal Freeway system covered in the Committee's work. The following steps will have to be taken towards implementation of the project:

1. Amendment in the CRZ Notification.
2. Detailed Project Report involving surveys , investigations and preparation of detailed drawings.
3. Environmental Impact Studies.
4. CRZ Clearance
5. Preparation of detailed plans and estimates
6. Bid Processes
7. Actual Implementation.
8. Maintenance and Upkeep

6.5. Implementation Agency: The Committee also considered the aspect of how the project would be implemented. The Committee suggests that the Government should set up a special purpose vehicle on the lines of Delhi Metro Rail Corporation (DMRC), which should be equipped with the personnel and powers to take expeditious decisions and implement the project.

6.6. Construction Aspects: The Committee stresses that the coastal freeway involves the construction of a thirty five kilometre long road running along the western coast of Mumbai with several interchanges for the local roads to connect to this access controlled system. The Committee noted that the coastal freeway is to be constructed along the coastline and may not result in any significant disturbance to the existing traffic being away from the areas of habitation and congested roads. In fact there would be only some small lengths in the project where the coastal freeway is proposed as elevated roads on the existing roads that some disturbance to traffic might occur during construction.

The Committee emphasizes that construction could be taken up here in a manner that causes least disturbance to the traffic during construction. The aspect of keeping adequate clearances at the connectors for Ganapati immersion should also be kept in view. The Committee noted that there are fishing jetties at various places e.g. Haji Ali, Chimbai and Khar Danda where the coastal freeway system needs to account for these and provide adequate clearances. The Committee also noted that the entire coastal freeway scheme envisages no land acquisition except at Versova where the coastal freeway passes through the government land belonging to fisheries department. Further, the R & R component involved is also negligible.

6.7. Gardens, Green Spaces and Facilities: The construction of coastal freeway based on reclamation would help generate large green public spaces. The city currently has very little open space. The availability of open space per 1000 persons in the city is merely 0.03 Ha as compared to the norm of 0.2 Ha. In the last two decades, only 360 Ha of land has been acquired for public amenities in the city valued at a staggering cost of Rs. 22140 Cr. by adopting the present cost of acquisition (viz. Rs. 60 Cr. per Ha). It has not been possible to increase the open space area in the city due to sheer non-availability of land, since the city has limited land area, high density of population and nowhere to expand. The coastal freeway scheme generates about 75 Ha of green space asset (valued by the above norms at about Rs. 4500 Cr.) as an additional facility along with the freeway at a highly reduced cost.

The Committee suggests that all the green spaces on the sea side needs to have an easy access for pedestrians. The following facilities need to be provided for the public using the recreational space.

a. Overpasses: This would necessitate connections through over bridges preferably in the form of ramps for the ease of connectivity. The connectivity through these overpasses could be facilitated by slightly lowering the coastal carriageway (by about 1.5 m). However, the Committee acknowledges that this is a design issue and alternative designs can be evolved at the detailed project study stage.

b. Cycling Tracks: The Committee recommends that cycle tracks be provided on the landward side promenade in the entire coastal freeway portion based on reclamation. Thus cycling tracks would be available in considerable length.

c. Toilets/ Drinking Water: The toilet and drinking water facilities should be made available at suitable distances along the promenade. The Committee felt that toilets could be suitably located on the landward promenade and generally near the connectors to the freeway system so that the sewerage and drainage of the toilet areas could be connected to the local system. Also, considering the need of the public visiting the gardens and promenades, tea/ coffee vending machines and kiosks housing these could be provided in a very small space (say 100 Sq m) at these locations only.

d. Landscapes/ Illumination/ Street Furniture: The garden and promenade spaces being a very important recreational space, suitably designed landscapes, illumination and street furniture needs to be provided.

e. Coastal Protection/ Beaches: The coastal erosion protection measure at the end of sea side promenade could be in the form of hard protection measures (e.g. tetrapods/sea walls etc). The possibility of providing beaches through soft protection measures (e.g. geotubes etc.) at appropriate locations can also be considered.

6.8. Maintenance and Asset Management: The Committee underscores the importance of the aspects of maintenance and asset management after construction of the coastal freeway and the adjoining promenades, gardens and appurtenant structures. Maintenance would involve garden and landscape maintenance, maintenance of street lighting and street furniture, cleaning/ housekeeping, maintenance of toilet facilities, security etc. The Committee feels that the aspects of maintenance and asset management should continue to be entrusted to the specialist agency that constructs the coastal freeway and this agency should look after maintenance and management of the system in a professional manner so that the coastal freeway and the promenades and appurtenant facilities are maintained to the required standards.

CHAPTER 7

SUMMARY

The Committee summarizes its observations and recommendations as follows:

7.1. Mumbai: Traffic Congestion, Declining Quality Of Life & Health: Mumbai, reckoned as the financial capital of the country, houses a population of 12.4 million besides a large floating population in a small area of 437 sq km; is surrounded by sea and has nowhere to expand. The constraints of the geography and the inability of the city to expand have already made it the densest metropolis of the world. High growth in the number of vehicles in the last 20 years (7% per annum) has resulted in extreme traffic congestion in the city evidenced by the minimum speed of travel on most roads reducing from 18 kmph to 8 kmph over a period of fifteen years. This has led to long commute times and a serious impact on the productivity in the city as well as declining quality of life for its citizens. It needs to be emphasized that Mumbai rose to be the economic powerhouse of the country, *inter alia* due to its ability to attract intelligentsia, artists, creative persons and talented professionals from all parts of the country. The city will have to put traffic congestion behind it and create more recreational spaces, if it has to retain its status as a city of choice for talented and skilled human resource with multiple options. The extreme traffic congestion has also resulted in Mumbai witnessing the worst kind of transport related pollution with ambient levels of Nitrogen Oxide, Carbon di Oxide, Carbon Mono Oxide, Benzene as well as Suspended Particulate Matter rising by over 68% in the last seven years. This has resulted in doubling the incidence of pollution related diseases. The need for new roads such as the proposed coastal freeway proposed by the Committee is therefore, indisputable. The freeway would facilitate speedy travel at speeds of about 90 kmph (efficient speed with the least fuel consumption and causing least emissions). It would also relieve the internal roads by taking traffic away and thus enhance speeds and reduce pollution on city roads. As highlighted in the Section 1.3 of the report, a large number of patients in a particular area were found to be suffering from diseases directly caused by transport related pollution(Cough, Bronchitis and Eye Irritation found in 41.3%, 31.3% and 38.4% patients respectively). The coastal freeway system is therefore not merely a solution that offers speedy connectivity to different parts of the city; it is one that reduces the health hazards caused by pollution to the citizens. Together with this, it also offers to the city a vast green open space (about 75 Ha) and waterfronts, thus contributing to the enhancement of the quality of life.

7.2. In Eminent Public Interest: The coastal freeway system proposed by the Committee provides a feasible solution to ameliorate traffic congestion and the consequent health hazards. It generates the much needed recreational spaces (about 75 Ha) by the sea side through creation of beautiful sea side promenades, and cycle tracks. All these sea side facilities would be within the

easy reach of the common public as opposed to such spaces being private backyards of a few or the commonplace abuse of sea side spaces by ugly encroachments. Mumbai has been able to add only 360 Ha of public amenity spaces (including green spaces) over the last two decades. It has not been possible to expand the open space area in the city due to sheer non-availability of land, since the city has limited land area, high density of population and nowhere to expand. The Open space ratio in Mumbai is only 0.03 Ha as against planning norm of 0.2 Ha per 1000 persons. The acquisition of this quantum (75 Ha) of land will require a cost of Rs. 4500 Cr. at current prices even if land were available. The coastal freeway system constructed in a cost effective manner, is therefore, in eminent public interest being not merely a road infrastructure project but one that ameliorates health hazards posed by the extreme traffic congestion and generates large public spaces. Indeed, as brought out in Section 1.3, health concerns alone would justify taking up this project in larger public interest.

7.3. Reclamation Option: The Committee has studied the various options in the form of a sea link, stilted roads, reclaimed roads, tunnels and bridges for the coastal freeway system. The option of a sea link here before contemplated for the entire length is not considered suitable owing to high costs (six times the cost of the option involving reclamation) and other demerits covered in this report. The Committee considers reclamation for the purposes of coastal freeway in some length as a highly cost effective option and one that also entails other benefits through creation of the large open green spaces to the citizens.

7.4. Coastal Freeway System: The Committee recommends the coastal freeway (comprising a combination of coastal road based on reclamation, bridge, elevated roads and tunnels as well roads on existing lands and stilts) on the west coast of Mumbai between the Manora (MLA Hostel) area /Nariman Point area in the south and the Malad- Kandivali areas (refer Plates 1 to 28 in Annexure 3) in the north as per the scheme prepared by the Committee. It comprises a reclaimed road between Manora (MLA Hostel) upto NCPA, Tunnel commencing at NCPA and going under the Marine Drive, continuing further as a tunnel under Malabar Hill and exiting beyond the Priyadarshini Park. Further it is a reclaimed road adjoining the coastline between Priyadarshini Park to the NSCI on the Lala Lajpatrai Marg (Haji Ali). With a connecting bridge between NSCI and the Baroda Palace the road would continue as a reclaimed road upto the connecting point of the Bandra Worli Sea Link. (Thus, in this stretch, it would be a road adjoining the existing promenades on Lala Lajpatrai Marg at Haji Ali bay and the Khan Abdul Gaffar Khan Marg at Worli). At the north end of the Sea link it is proposed as a road based on reclamation skirting Bandra Fort going along Bandra Bandstand, a bridge at the Chimbai village, a reclaimed road adjoining Carter Road, an elevated road skirting Khar Danda Village and going in a tunnel under the Juhu airport. The tunnel would exit at Ritambhara College and the coastal freeway then runs as a reclaimed road upto the Nana Nani Park wherefrom an elevated road takes it to the new fisheries institute at

Versova. Northward of that point, it branches into two directions, one arm of the road is proposed as a reclaimed road (road on land in part length) right upto the Mindspace area in Malad and the other arm extends as a reclaimed road upto Versova village jetty. From the junction of the road leading to Goregaon Sports Club the road is proposed in the form of an elevated road going over the creek and the Malad Marve Road and joining the Link road north of the junction with Malad Marve Road. The proposed tunnel between NCPA and Princess Street Flyover can be omitted/ deferred based on the traffic study to be conducted at the detailed feasibility study stage. (In case of Option II, a stilted road is provided in the mangrove areas replacing the reclaimed roads provided in Option I). The coastal road is an access controlled freeway with interchanges at the intermediate connecting points. It also provides connectivity to the Madh island and the Western Express Highway near Malad. Where the coastal road is provided on reclamation it has promenades on the sea side and the landward side consisting of jogging, cycling tracks and gardens/ landscapes, thus enabling creation of green public spaces besides speedy connectivity to various areas in the city. The Committee suggests two options, the first involving reclaimed roads in some mangrove areas. This option is considered suitable since it is less costly (costing about Rs. 1000 Cr. less than the other option), easy to implement through a reduced construction time. This will however, mean a short term environmental impact through re-plantation of the affected mangroves but of course, no long term environmental damage. The entire 35.6 km of the coastal freeway system is proposed as an access controlled freeway with twin four lane carriageway with entry and exit facilities at the eighteen locations (refer section 4.2.2 and 4.4.3) to allow movement of traffic between the coastal freeway and the local roads. The Committee recommends this coastal freeway system both with a view to resolve the traffic congestion in Mumbai and to enable creation of the much needed recreational open spaces. The Committee feels that completion of this project would mean a quantum leap towards enhancing the quality of life in this city. The added advantage of the proposed project is that it involves no land acquisition and virtually no resettlement component. The Committee recommends that the project should be taken up for detailed feasibility studies and implementation as expeditiously as possible.

7.5. Future extensions of Coastal Road system: On the southern end of the coastal freeway, the Committee suggests examination of linking the coastal freeway ending presently at Manora/ Cooperage area to the starting point of the eastern freeway in the form of a tunnel at a point in future, although at present the existing local roads can cater to this movement. On the northern side, the coastal freeway system could be extended upto Vasai and Virar areas taking up widening of the existing roads close to the coast on the Madh and Gorai islands and the construction of bridges across the intervening creeks at Manori and Vasai in future.

7.6. No Change in the HTL: The Committee strongly recommends that the above coastal road system proposal should not alter the existing HTL to allow any development in the areas where it is impermissible as of now.

7.7. Environmental Impacts: The Committee has examined the aspect of impact if any on tidal movements or coastal erosion entailed by reclamation for the coastal freeway. The Committee has found that the proposed reclamation in an average width of about 100 m does not cause any impact on the tidal movements and no adverse effects to the coastline are envisaged.

7.8. Amendments in the CRZ Notifications: The Committee recommends that the appropriate amendments be made in the current CRZ notification (which does not allow reclamation) for the proposed coastal road system in Mumbai. For this purpose, the state government needs to move a proposal to the MOEF, GOI for the limited purpose of the proposed reclamation.

7.9. Recreational Facilities: The coastal freeway scheme recommended by the committee also generates recreational spaces comprising sea side gardens and promenades. The Committee recommends that these reclaimed spaces should provide for suitable accesses across the freeway for the common public. The Committee has also suggested all facilities e.g. toilets, drinking water for the public visiting these landscaped recreational areas with jogging tracks, cycle tracks in a significant length. The coastal erosion protection measure at the end of sea side promenade could be in the form of tetrapods/sea walls etc. The possibility of providing beaches through soft protection measures (e.g. geotubes etc.)at appropriate locations can also be considered.

7.10. Construction / Maintenance Aspects: The cost of the proposed coastal freewaysystem is of the order of Rs. 8000 Cr. The Committee recommends that a non-stop ETC (Electronic Toll Collection) system through levy of user charge for every entry into the coastal freeway system could be considered. The implementation could be in the PPP BOT or PPP Annuity form with the revenues available from such user charges. The Committee recommends that the construction should be carried out in a speedy manner causing least disturbance to the existing traffic. The Committee also stresses the importance of maintenance and asset management and recommends that these aspects along with construction should be entrusted to a professional agency on the lines of Delhi Metro Rail Corporation (DMRC) in Delhi.