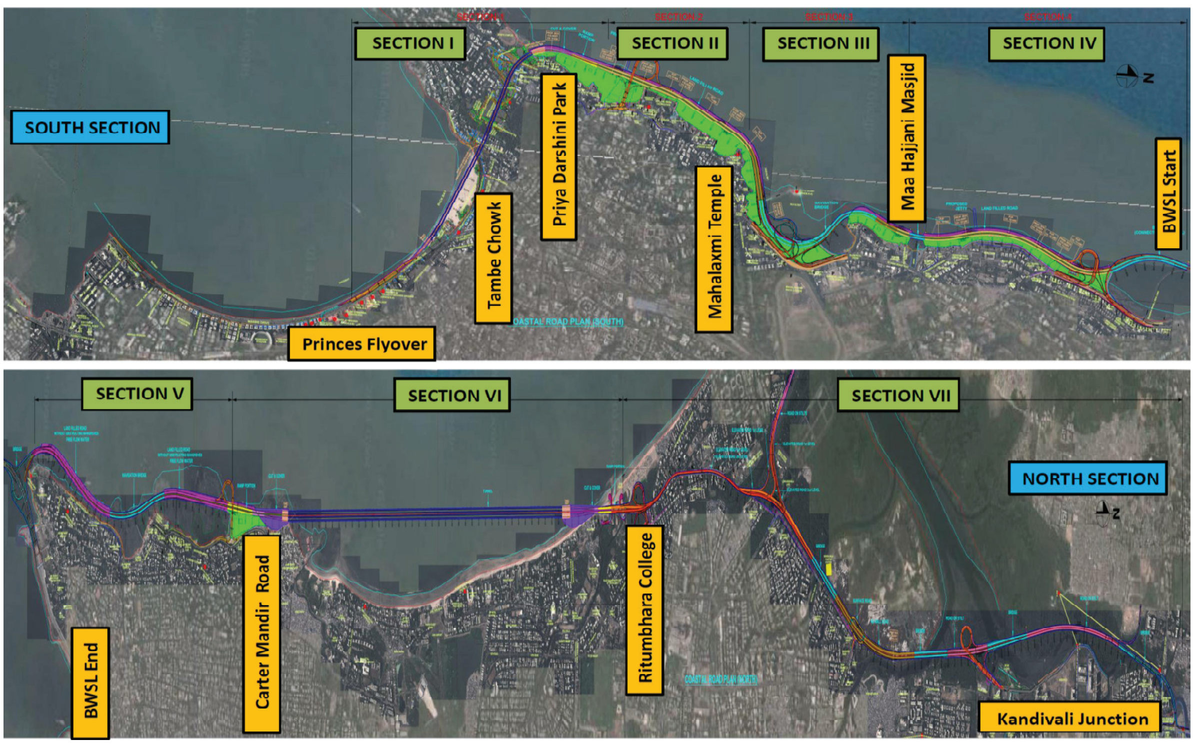
Municipal Corporation of Greater Mumbai

CONSULTANCY SERVICES FOR PREPARATION OF FEASIBILITY REPORT, DPR PREPARATION, REPORT ON ENVIRONMENTAL STUDIES AND OBTAINING MOEF CLEARANCE AND BID PROCESS MANAGMENT FOR MUMBAI COASTAL ROAD PROJECT



ENVIRONMENTAL IMPACT ASSESSMENT REPORT

August 2016

ERNST & YOUNG
Quality In Everything We Do

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CHAPTER 1

1. Introduction

1.1 Background

Mumbai reckoned as the financial capital of the country, houses a population of 12.4million besides a large floating population in a small area of 437sq.km. As 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 has resulted in extreme traffic congestion. This has lead to long commute times and a serious impact on the productivity in the city as well as defining quality of life of its citizens. The extreme traffic congestion has also resulted in Mumbai witnessing the worst kind of transport related pollution.

Comprehensive Traffic Studies (CTS) were carried out for the island city along with its suburbs to identify transportation requirements to eliminate existing problems and plan for future growth. CTS identified requirement of new arterial road along the Western Coast as part of transportation networks as shown in Figure 1.1. Therefore, Municipal Corporation of Greater Mumbai (MCGM) has proposed to construct a Coastal Road on the western side of the city

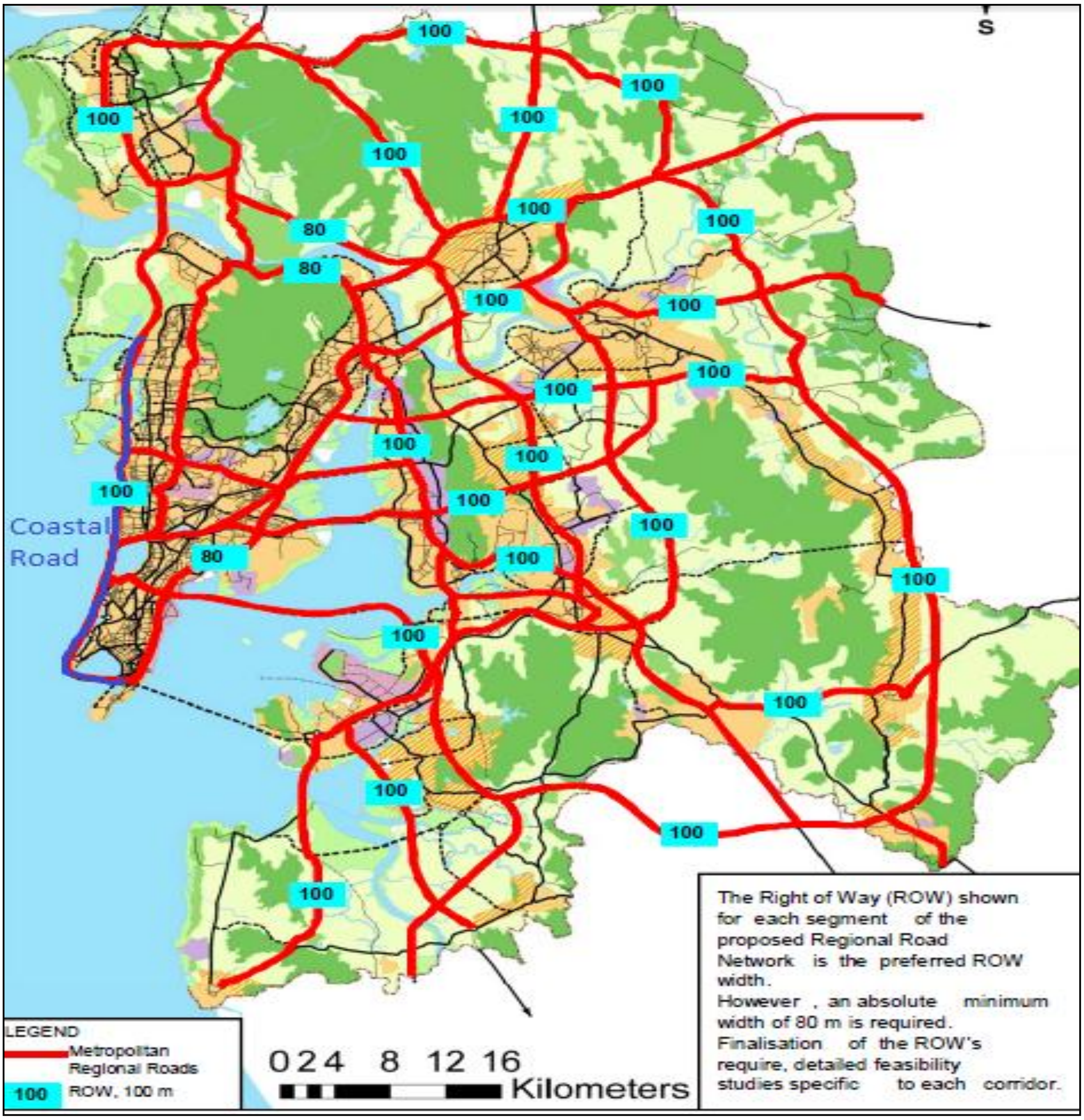


Figure 1.1: Highway Network Proposed by CTS

1.2 Proposed Coastal Road

Mumbai being island city, surrounded on three sides by Arabian Sea, sea links were 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 reason sea links were planned as bridges was the restriction placed by the earlier Coastal Regulatory Zones (CRZ) regulations preventing reclamation or stilt roads in the CRZ areas. The CRZ notification dated 6 January 2011 issued by the Ministry of Environment and Forests, Govt. of India (MOEF, GOI) now makes it possible to envisage coastal roads on stilts. During the meeting held in Mumbai on 15 April 2011, the proposal of a reclamation based coastal road encircling Mumbai was presented to the Hon'ble Minister MoEF, GoI. Hon'ble Minister suggested the proposal needed a closer examination through a committee.

The GOM, under its resolution No.ENV- 2011/CR-55/TC3 dated 30th Jun, 2011 constituted a JTC to study and make recommendations on the subject of coastal road in Mumbai. The JTC accordingly submitted the attachment on 29th December, 2011 (Attached W/w), after deliberating on various issue as per the terms of reference

To examine the various options in the construction of coastal road including road on stiltmor sea link in Mumbai.

To evaluate options on the basis of technical feasibility and environmental impact and impact on the neighborhoods.

To recommend the best option which provides improved mobility, enhances environment and leads to sustainable development of open spaces / greenery. The committee in chapter II have viewed that a coastal freeway based on reclamation also 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 would be barred on search reclaimed land.

In chapter V, "Environmental aspects", it is pointed out that the key inputs in the discussions were provided by Director CSIR-NIO in view of the reclamation proposed for costal road.

The committed 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 behavior or create problems related to coastal erosion.

The committee in its summary report has emphasized the need for coastal freeway, due to traffic congestion, declining gravity of life and health.

As per committee's report summarized vide para 7.2, it is emphasized that the coastal freeway system proposed by the committee provides a feasible solution to ameliorate traffic congestion and consequent health hazards. It generates much needed recreational spaces (90 Ha, now 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 common place abuse of the sea side spaces by ugly encroachments.

The 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 ration in Mumbai is only 0.03. Ha as against planning norm of 6.2 Ha per 1000 persons. The acquisition (75 Ha) of land will require a cost of Rs. 4500 Cr at current prices even if land were available.

Health concerns alone would justify, taking up this project in larger public interest.

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).

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 spaces to the citizens.

The Committee recommended about 35.6 km. Coastal road comprising a combination of road based on reclamation, bridges, elevated roads and tunnels on western side of Mumbai. The Committee recommended this coastal road with two options of alignments, both with a view to resolve the traffic congestion in Mumbai and to enable creation of the much needed recreational open spaces.

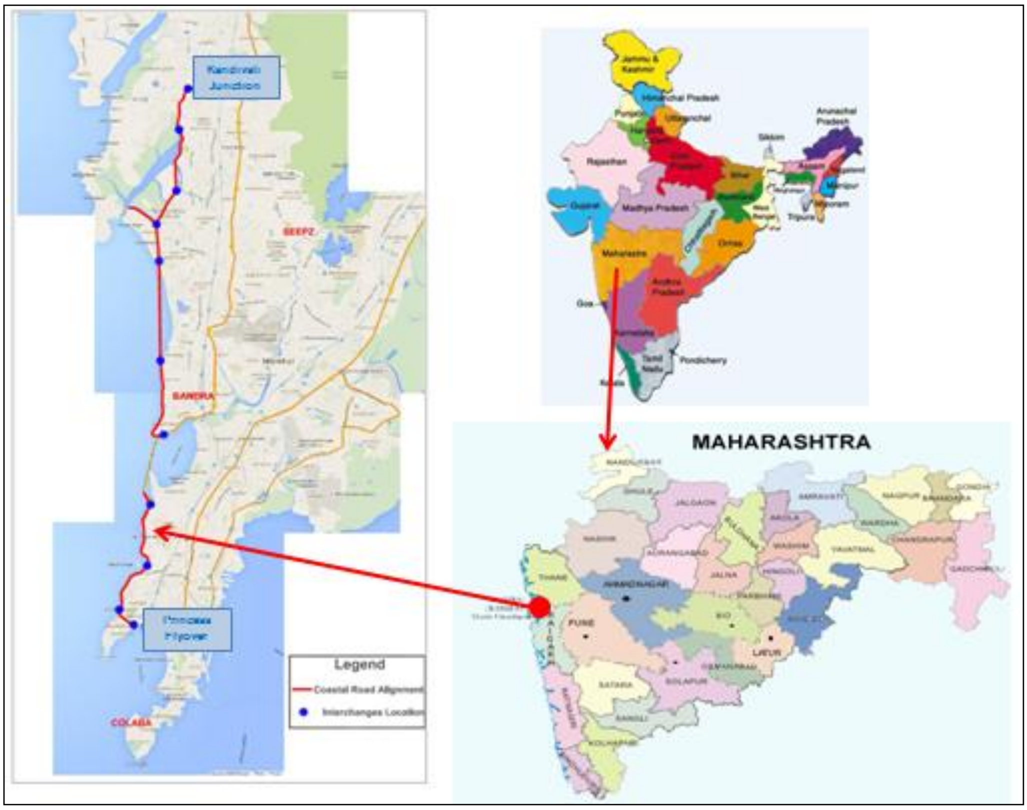


Figure 1.2: Project Location

MCGM has appointed consortium of M/S STUP Consultants Pvt. Ltd consultants and M/S Ernst & Young Pvt. Ltd for Preparation of Feasibility Report, DPR Preparation, Environmental Clearance and Bid process management for the proposed Mumbai Coastal Road Project.

The proposed project is a Sea-Link road project. It involves construction of combination of structures like land filled road, bridge, tunnel and road on stilt along west coast of Mumbai. The main purpose of this project is to reduce burden of Traffic and Transport System of Mumbai. Construction of this project will make traveling in the congested metropolitan city like Mumbai more economical, safe and fast. Traffic volume on highway and small routes would decrease because of diversion to the proposed road reducing the traffic intensity.

1.3 Location & Geography

The project site is located in the capital city of Maharashtra, Mumbai that lies on the western coast of India by the bank of Arabian Sea. Mumbai is made from the group of seven islands and is thus referred to as the Island city. These islands are Isle of Bombay, Mazagaon, Colaba, Old Woman's Island, Parel, Worli, and Salsette Island. The eastern coast of Salsette Island has rows of mangroves, wherein the western coast happens to be sandy and stony. Due to proximity to the sea, the soil cover of this region is sandy to large extent. The underlying rocks of this area are made up of Black Deccan Basalt pours, its acid and some basic variables. This island city of Mumbai is divided into two distinct regions, the city and the suburbs. The suburbs have alluvial soil type. The major creeks found in Mumbai coast are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flats and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas

1.4 History of Reclamation of Mumbai

It took over 150 years to join the original seven islands of Mumbai. These seven islands were lush green thickly wooded, and dotted with 22 hills, with the Arabian Sea washing through them at high tide. The original island of Mumbai was only 24 km long and 4 km wide from Dongri to Malabar Hill (at its broadest point) and the other six were Colaba, Old Woman's island, Mahim, Parel, Worli, Mazgaon as presented in Figure 1.3.

After the British arrival, the demand for land steadily increased, and by 1730; it was becoming impossible to accommodate the entire population of Mumbai inside the Fort. The sea was making inroads at Worli, Mahim and Mahalaxmi, which turned the ground between the islands into a swamp, making travel between Mumbai islands hazardous.

The first major reclamation took place in 1708, to construct the causeway between Mahim and Sion.

The second major reclamation took place in 1772, to stop the ingress of water and the consequent flooding of central Mumbai, and to connect Mahalaxmi and Worli. This causeway was named Hornby Vellard, sealing the Great Breach (Breach Candy) between Dongri, Malabar hill and Worli.

At the fortified Dongri hill, an esplanade and parade ground was cleared, from the walls of the Fort to the present day Crawford market. The flat lands from Mahalakshmi to Kamathipura were reclaimed only after the completion of construction at Breach Candy by Hornby in 1784. In 1803, Mumbai was connected to Salsette by a causeway from Sion.

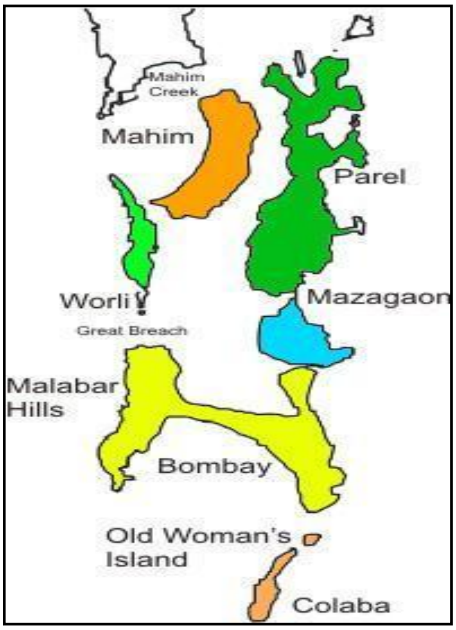


Figure 1.3: Seven Islands of Mumbai

The Thane and Colaba causeway were built during the tenure of Sir Robert Grant, the Governor of Mumbai. He was also responsible for the construction of a number of roads between Mumbai and the hinterland. The Colaba Causeway was completed in 1838 joining Colaba, Old Woman's island and the H-shaped island of Mumbai together. Land prices shot up and Colaba became the centre of commerce. The Causeway was widened and strengthened from 1861 to1863 (Cusrow Baug is built on the causeway).

The horse drawn tramcars revolutionised transport in Colaba. The Prongs Lighthouse was constructed off the island in 1875 and in the same year the Sassoon Docks were built by David Sassoon on reclaimed land. The BB & CI (Bombay and Central India) Railways established a terminus at Colaba. 90,000 sq. yards of land was reclaimed on the western shore of Colaba by the City Improvement Trust, the work was completed in 1905. A seaside promenade (Cuffe Parade) was completed the next year.

The next reclamation came in 1836, when the development of the Mumbai port had already begun. Major quarrying had already begun in 1870. The hills of Chinchpokli and Byculla were quarried and dumped into the sea, to fill the land near the railway line, the swamps and also the port to prevent the accumulation of stagnant water. The first railway line was laid down in 1855 from Bori Bunder to Thane.

By 1862 the town became widespread and the constructions that took place began to give rise to the modern city of Mumbai. This became a regular feature in the succeeding years. The Fort walls were demolished and the tanks up to Parel were filled. From 1870 to 1970, industrial and commercial development prospered, which increased the spate of reclamation that ended with the famous Backbay reclamation.

The first Backbay Reclamation Company (BRC) was formed in the 1860s with the express purpose to reclaim the whole of Backbay. With the end of the American Civil War in 1865, land prices fell. The government took over the narrow strip of land created by the BRC and gave it to the BB & CI Railways (Bombay Baroda and Central India) to construct a new line between Churchgate and Colaba.

A proposal was made in 1917 to reclaim 607 hectares of land between Colaba and Backbay. The project was taken over by the Development Directorate who planned to reclaim 463 hectares and would have to relocate the Colaba terminus, which was moved to Bombay Central. The work continued till 1945. Eventually 177 hectares was developed by 1929 of which 94 hectares was sold to the military and 6 hectares was incorporated into the Marine Drive and its sea wall. Figure 1.3 presents the map of Mumbai in 1954.

Independence did not end the reclamation work but a third Backbay Reclamation was put into effect and yielded the acreage on which stand the high rise buildings of Nariman Point and Cuffe Parade. East of the Naval Dockyards some land was reclaimed and work was done to the north too. Coastal Regulation Zone (CRZ) was introduced in 1990 banning reclamation for commercial activities.

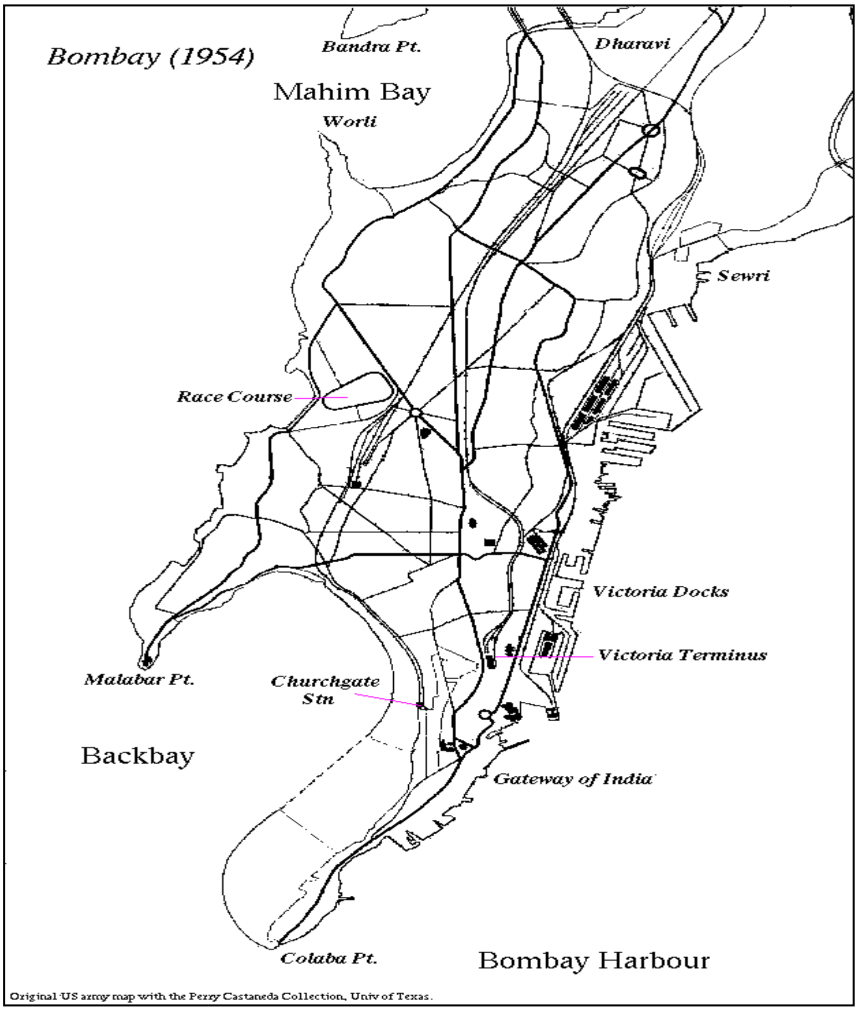


Figure 1.4: Back-bay Reclamation

1.5 Objective of the Environmental Impact Assessment Study

The objectives of the EIA study are as follows:

- To describe the proposed project and associated works together with the requirements for carrying out the proposed developmental work;
- To establish the baseline environmental and social scenario of the project surroundings;
- To identify and describe the elements of the community and environment likely to be affected by the proposed developments;
- To identify, predict and evaluate environmental and social impacts expected to raise during the construction and operation phase of the project in relation to the sensitive receptors;

- To develop mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operations of the development; and
- To design and specify the monitoring and auditing requirements necessary to ensure the implementation and the effectiveness of the mitigation measures adopted

1.6 Structure of the EIA report

This EIA report presents the existing baseline scenario and the results from the assessment and evaluation of the environmental impacts that may arise during the construction and operation of the proposed development. Following impact prediction, the requirement for mitigative measures to minimize any unacceptable environmental impacts is presented. This report also highlights the post project environmental monitoring plan and environment management system considered to be necessary during the construction and operation.

This EIA report comprises of eleven chapters as follows:

- **Chapter 1 Introduction:** Discusses the introduction and scope of study.
- **Chapter 2 Project Description :** outlines the detailed project description
- **Chapter 3 Analysis of Alternatives :** covers the details of various alternatives in respect of booth location and site and technologies to be deployed
- **Chapter 4 Description of Environment:** documents the baseline environmental status of the project site.
- **Chapter 5 Anticipated Environmental Impact and Management Measure** deals with environmental impacts associated with the project and proposed mitigation measures
- **Chapter 6 Environmental Monitoring Program** covers the planned environmental monitoring program.
- **Chapter 7 Additional Studies** covers additional studies like mangrove management plan and CRZ amendment issue.
- **Chapter 8 Project Benefits** covers the benefits accruing to the locality, neighborhood, region and nation as a whole.

- **Chapter 9 Environment Management Plan presents** the Environmental Management Plan (EMP) both during construction and operational phases of the proposed project.
- **Chapter 10 Disclosure of consultants engaged** :Includes the names of the consultants engaged
- **Chapter 11 Executive Summary** presents the summary and conclusions of the full EIA study

CHAPTER 2

2. Project Road

2.1 Introduction

The proposed coastal road has a length of 29.20 km which lies in western costal stretch of Mumbai, Maharashtra. The proposed road length is divided in to 2 Parts; from Princess Flyover to Worli Sea Link and Bandra Sea Link to Kandivali Junction includes constructions tunnels, Bridges, Road on stilts, Land fill road, Land fill road without obstructing Mangroves and Elevated roads. An overview of the project road alignment overlaid on the satellite imagery is given in the following Figure.

Figure 2.1: Alignment of the Proposed Coastal Road

Looking to growth of Mumbai Metro City Govt of Maharashtra in addition to existing authorities like MCGM established Mumbai Metropolitan Region Development Authority (MMRDA) under the MMRDA Act 1974 primarily as planning and development authority for Mumbai Metropolitan Region (MMR) whose boundaries are defined by the said Act and its subsequent amendment. The present boundaries of MMR encompass a total area of 4,355 sq. km. MMR consists of the following revenue units:

- Mumbai City District
- Mumbai Suburban District
- Part of Thane District (comprising Thane, Kalyan, Bhiwandi and Ambernath Tehsils)
- Part of Vasai Tehsil
- Part of Raigad District
- Uran Tehsil; and
- Part of Panvel, Karjat, Khalapur, Pen and Alibaug Tehsils

MMR is highly urbanized area with more than 90% of the total population of 11.9 million as per 2001 census and 12.4 million as per 2011 census is concentrated in cities and towns. The urban population is however confined to 8 Municipal Corporations, 11 Municipal Councils and 10 Non Municipal Towns. Total area under these urban units is about 1,500 sq. km. In the rest of the region, about 1 million populations is spread over 950 village settlements. The demographic census gives population and worker details according to 88 census sections in Greater Mumbai, for suitably defined wards in other urban centres and for village as a whole in MMR.

2.1.1. Climate of Mumbai

The Climate of Mumbai is a tropical wet and dry climate. Mumbai's climate can be best described as moderately hot with high level of humidity. Its coastal nature and tropical location ensures temperatures won't fluctuate much throughout the year.

The mean average is 27.2 °C and average precipitation is 242.2 cm (95.35 inches). The mean maximum average temperatures in about 32 °C (90 °F) in summer and 30 °C (86 °F) in winter, while the average minimums are 25 °C (77 °F) in summer and 20.5 °C (68.9 °F) in winter. Mumbai experiences four distinct seasons: Winter (December–Feb); Summer (March–May); Monsoon (June–Sep); and Post-Monsoon (Oct–Dec)

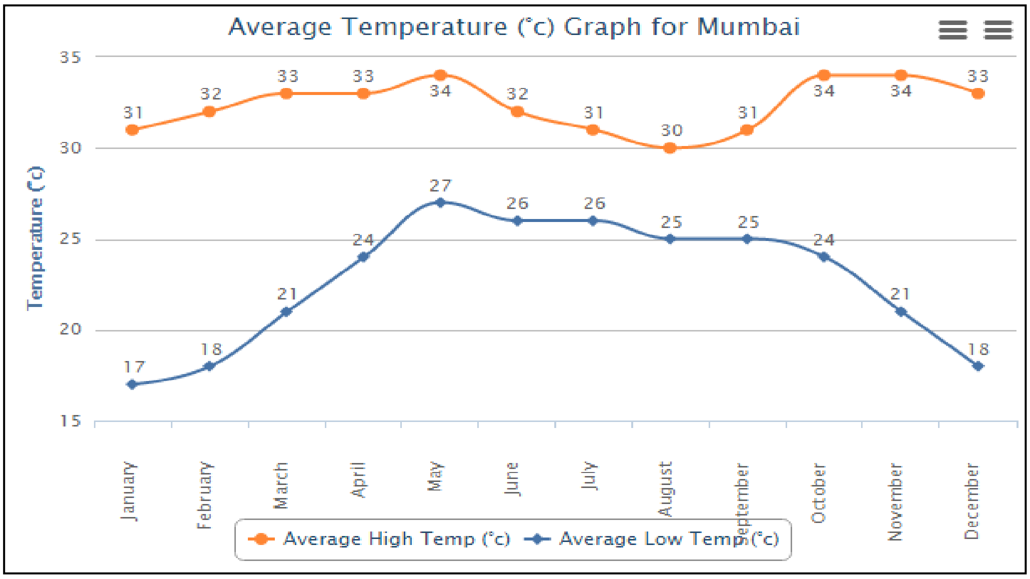


Figure 2.2: Average High/Low Temperature for Mumbai

2.1.2. Population

Mumbai's 2013 population is estimated at 19 million, but its total metropolitan area is home to more than 20.5 million. As with other metropolitan areas in India, Mumbai's population has grown very rapidly over the past two decades, and much of its population are migrants from other regions in the country who came seeking better employment opportunities.

Mumbai's population has nearly doubled since 1991, when its population was just 12.5 million. This rapid expansion has led to serious health-related issues, and a large percentage of the population lives in slums.

The number of people living in slums is estimated at 9 million, which is up from 6 million just a decade ago. That means about 62% of all Mumbaiker's live in slums. Dharavi, the second largest slum in Asia, is located in central Mumbai and is home to 800,000 to 1 million people in just 2.39 square kilometers (or 0.92 square miles). This makes it one of the most densely populated areas on the planet with a density of a minimum of 334,728 people per square kilometer. It's also the most literate slum in India with a literacy rate of 69%.

Because land is at such a premium, residents of Mumbai frequently live in cheap, cramped housing far from work, so there are usually long commutes necessary on its busy mass transit system.

Table 2-1 MMR Population as per census of India 2011

Mumbai Metropolitan	Total	Male	Female
Population	18,414,288	9,894,088	8,520,200
Literates	15,132,568	8,423,992	6,708,576
Children (0-6)	1,743,997	917,855	826,142
Average Literacy	90.78	93.85	87.19
Sex Ratio	861		
Child Sex Ratio	900		

2.1.3. Demographics

Mumbai is a real melting pot as people from all over the region move here in search of jobs. Mumbai, like most metropolitan areas of India, has a large polyglot population and 16 major languages of India are spoken here, including Gujarati, Hindi and Marathi, along with a colloquial form of Hindi called Bambaiya.

Mumbai's sex ratio is skewed, and a ward-level analysis of the last Census in 2013 found that 20 of the city's 24 municipal wards had a decline in child sex ratio in the past decade. The Worli-Prabhadevi region had the highest drop in child sex ratio. For every 1,000 boys, there are just 899 girls. This gender imbalance is visible throughout Mumbai and it's blamed on sex-selective abortions.

2.1.4. Average Rainfall in Mumbai

The maximum annual rainfall ever recorded was 3,452 mm (136 in) for 1954. The highest rainfall recorded in a single day was 944 mm (37 in) on 26 July 2005. The average total annual rainfall is 2,146.6 mm (85 in) for the Island City, and 2,457 mm (97 in) for the suburbs.

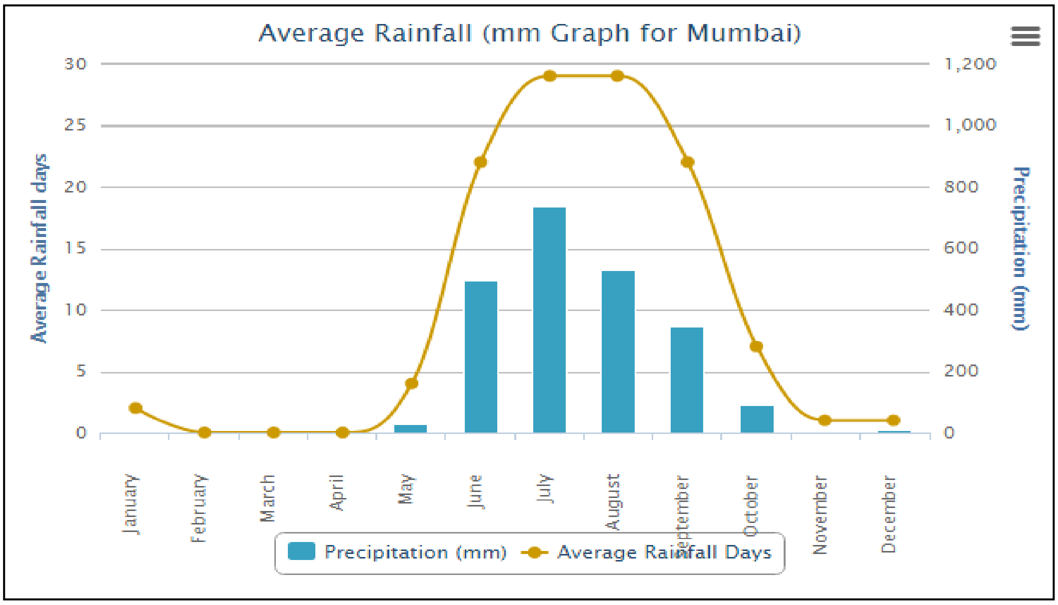


Figure 2.3: Average Rainfall for Mumbai

Note: The data for charts above are taken from year 2000 to 2012.

2.2 Comprehensive Transportation Study for MMR

Comprehensive Transportation Study (CTS) for Mumbai Metropolitan Region (MMR) has proposed extensive transport network for the travel needs of MMR for the horizon period up to 2031. Some of the proposed road corridors are missing links which can provide faster transport connectivity between Greater Mumbai and rest of the region.

As per CTS for MMR, following Highway Network is recommended on the western flank of the island city between Manora (MLA Hostel) areas in the south to Malad-Versova in the north:

Table 2-2 Highway Corridor Description

Sr. No	Highway Corridor Description	Length (kms)
H20	Western Sea Link North Extn (Bandra-Dahisar)	26
H21	Western Sea Link North Extn (Dahisar-Virar): EBL Corridor 2016	38
H22	WesternSea Link South Extn (Worli-ColabaSea Link)	13.7

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 (MTHL) 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.

MCGM authorities decided to take the planning and construction of Coastal road. Approximate length of the project corridor is about 35.6 km. The proposed Coastal road approximate length of the project corridor is about 29.20 kms from princess flyover to Kandivali Junction link road.

2.3 Project road description and proposed project elements

2.3.1. Project Influence Area

In order to formulate alignment options it is necessary to identify various site constraints that may affect the outcome of the alignment options studies. Site constraints for a road project can be of following nature or their combinations:

- Engineering constraint
- Socio-Environmental constraint
- Financial constraint

Based on estimated capacity it is coastal road is proposed as an eight lane road. Various site constraints are defined in subsequent paragraphs.

2.3.2. Project Sections

***Part A: South Section (Princess Flyover to Worli End of Sea Link*)**

Section 1: Princess Flyover Road to Priya Darshini Park

Section 2: Priya Darshini Park to Mahalaxmi

Section 3: Mahalaxmi to Baroda Palace

Section 4: Baroda Palace to Bandra Worli Sea Link (Start)

Part B: North Section (Bandra End of Sea Link to Kandivali Junction)

Section 5: Bandra Worli Sea Link (End) to Carter Road Mandir

Section 6: Carter Road Mandir to Ritumbhara College

Section 7: Ritumbhara College to Kandivali Junction

2.3.3. Engineering Constraints & Environmental Constraints

- **Engineering Constraints:**
  1. Alignment passing through tidal zone requiring protection from waves and storm surge;
  2. Highway to be designed to Expressway standards considering its functionality;
  3. Providing adequate cross sectional standards to accommodate future developments

- **Environmental Constraints:**

The proposed coastal road from Princess Flyover to Kandivali junction link road passes through densely populated city area of Greater Mumbai. Any improvements to the road such as grade separated junctions or realignments, will have impact on the surrounding area. The issues involved are:

- Alignment in CRZ/ coastal area
- Climate change/ sea level rise
- Pedestrian movement along and across the proposed road;
- Aesthetic issues related to flyovers or any other road structures;
- Aesthetic and social aspects
- Noise and air pollution due to fast moving, breaking and standing vehicles.
- Land Availability
- Storm water and sewage discharges
- Locations of Archaeological and religious importance
- Social Aspects

- **Financial Constraints**

The proposed coastal road is expressway standard road. Therefore, it will be necessary to provide traffic connectivity i.e Interchanges/at grade junctions wherever necessary and protection against tidal impact. This also will have to cater Environmental mitigation measures. It is also necessary to optimise the cost of road in order to achieve financial viability. Therefore, road alignment design will be constrained by the cost of construction, maintenance and operation. Considering this following prime objectives are considered for selecting alignment options:

- Minimum length of tunnel
- Minimum length of flyovers, bridges and viaducts
- Maximum use of existing infrastructure and land
- Minimum rehabilitation and resettlement
- Minimum impact on Mangroves and other environmentally sensitive areas
- Minimum provision of Reclamation so as to minimize cost towards the provision of Promenades, beautification of reclaimed areas

2.4 Discussion on Project Sections

Report on “Mumbai Coastal Freeway Concept” by Joint Technical Committee towards this project has been made available by MCGM to us. This report presents two alternative alignment options.

After reviewing same we explored various other alignment options. This chapter describes all the options that have been made for various aspects of the project road.

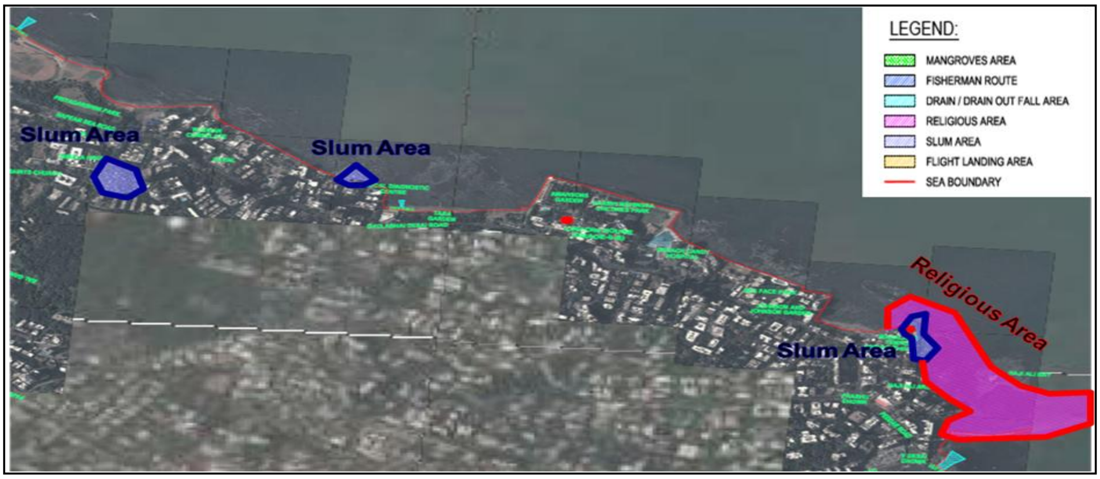
We have studied various options for the proposed road, based on the objectives mentioned in the report. Satellite imagery and levels extracted from Google Earth Pro software, assisted by site visits/reconnaissance survey were used to determine various alignment options. Six alignment options were considered including two options of joint Technical Committee and evaluated considering socio economic parameters. For each alternative block cost estimate is prepared. Total alignment is divided into two parts considering the terrain classification and further sub divided in sections as detailed below.

Part A: South Section (Princess Flyover Road to Worli Sea Link END)

- Section 1: Princess Flyover Road to Priya Darshini Park

In this section main constraint is Religious area near Girgaon Chowpati and Slum areas near Bimla House as shown above.

- Section 2: Priya Darshini Park to Mahalaxmi



In this section main constraints are slum are near Clinical Diagnostic Centre, Heritage structure at Lincolon House (Grade II-B) and Religious place at Mahalaxmi Temple as shown above.

- Section 3: Mahalaxmi to Baroda Palace

In this section main constraints are Slum area, Religious area at Haji Ali and at Baroda Palace as shown above

- Section 4: Baroda Palace to Worli End of Sea Link

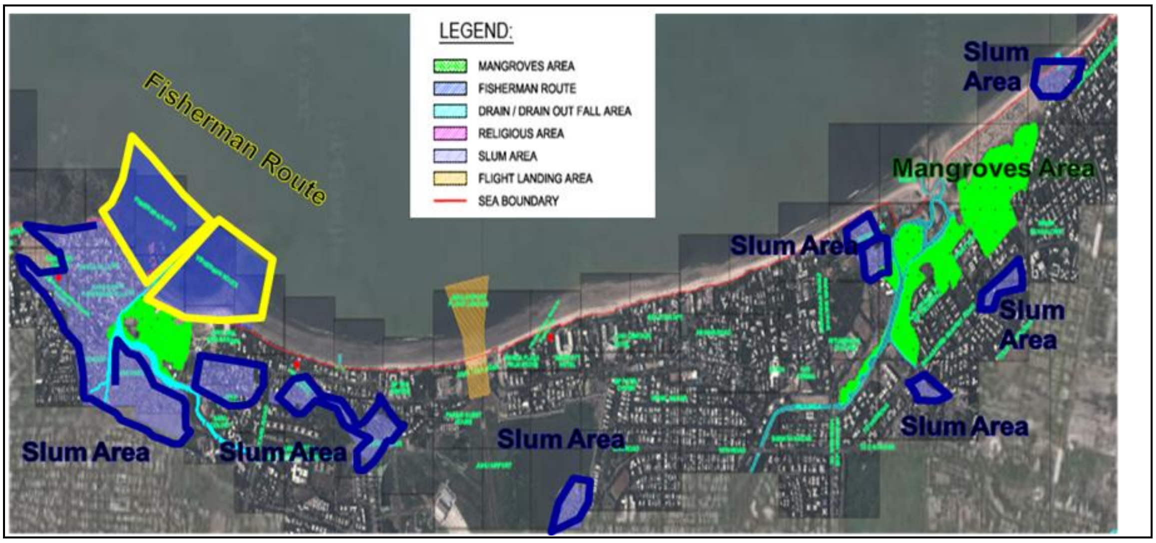
In this section main constraints are Religious area at Baroda Palace, Slum areas at near Poonam Chembers and near Worli dairy, drainage outfall of worli Dairy as shown above.

Part 2: North (Bandra End of Sea Link to Kandivali Junction)

- Section 5: Bandra end of Sea Link to Juhu Sea Side Garden

In this section main constraints are Fisherman's route near Bandra Worli Sea Link toll plazaBandra Band Stand, Chambai Village, near Khar danda village and slum area near Khar danda village and Mangroves near Bandra Joggers Park, near Pali Hill, Naushad Ali margs shown above.

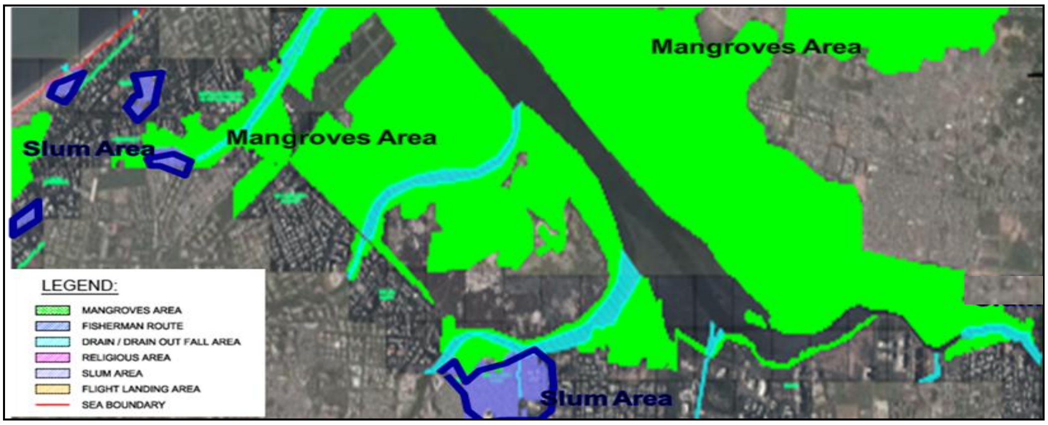
- Section 6: Juhu Sea Side Garden to Ritumbhara College



In this section main constraints are Fisherman's route near Juhu Sea Side Garden, Juhu airport Flight Landing and Slum Areas at neat Leela Bunglow, Indra Nagar, Juhu

Koliwada, near Moragaon Juhu and Mangroves area near Versova , Juhu beach,Rajiv Gandhi Institite of Technology,Bharat nagarshown above.

- Section 7: Ritumbhara College to Kandivali Junction and Central Institute of Fisheries, Versova to Madh Island



In this section main constraints are Slum Areas, Drainage outfalls towards Madh Island, near Yamuna nagar and near Oshiwara, Mangroves area as shown above.

Recommended Alignment Option- Option 7

Comparing pros & cons of all six Alignment options, we recommend alignment Option 7 as final. Giving hereunder the details of all seven Sections for the recommended alignment Options -7:

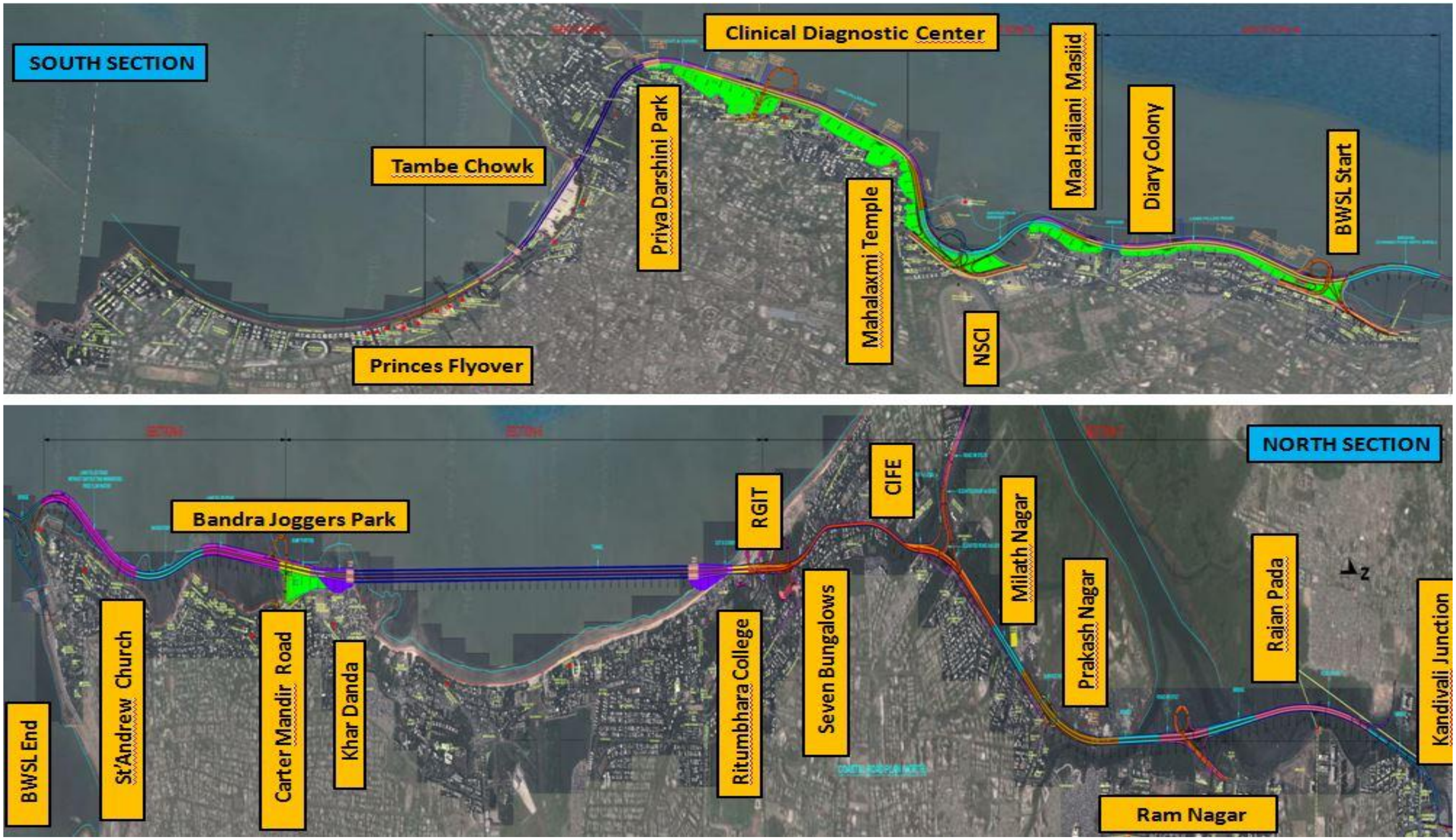


Figure 2.4: Alignment of Mumbai Coastal Road Project (Option 7)

2.5 Traffic Studies and Analysis

Traffic studies are essential for any road project, as it forms the basis for design of pavements, road capacity, and design of intersections and economic appraisal of the project. MMR has seen rapid geographic and economic growth over past two decades. This has lead to increased vehicle population causing traffic congestions during peak hours. CTS were carried out in 2006 by MMRDA to establish transportation networks necessary to cater for sustainable growth. Traffic studies for the project were conducted to relate the findings with CTS and conclusions were drawn.

2.5.1. Methodology

Traffic surveys were planned along the major highways at locations of inner cordon lines of CTS. This is to relate the current traffic with the CTS and update its impact on the project road. Seventeen locations were identified on the nodes of these inner cordon lines with existing arterial roads. Proposed traffic survey locations and its reasoning was presented to the MCGM for approval.

Following traffic surveys have been conducted along these nodes of cordon lines crossing major highways.

- 3 days Video Classified Traffic Volume Count & 4 days Manual count at 17 mid block locations
- One day Origin - Destination Survey at Seventeen mid-block locations
- Speed and Delay Survey

The map at Figure 2.6 provides the Inter Cordon lines of Mumbai as per CTS report and Figure 2.7 provides traffic survey locations.

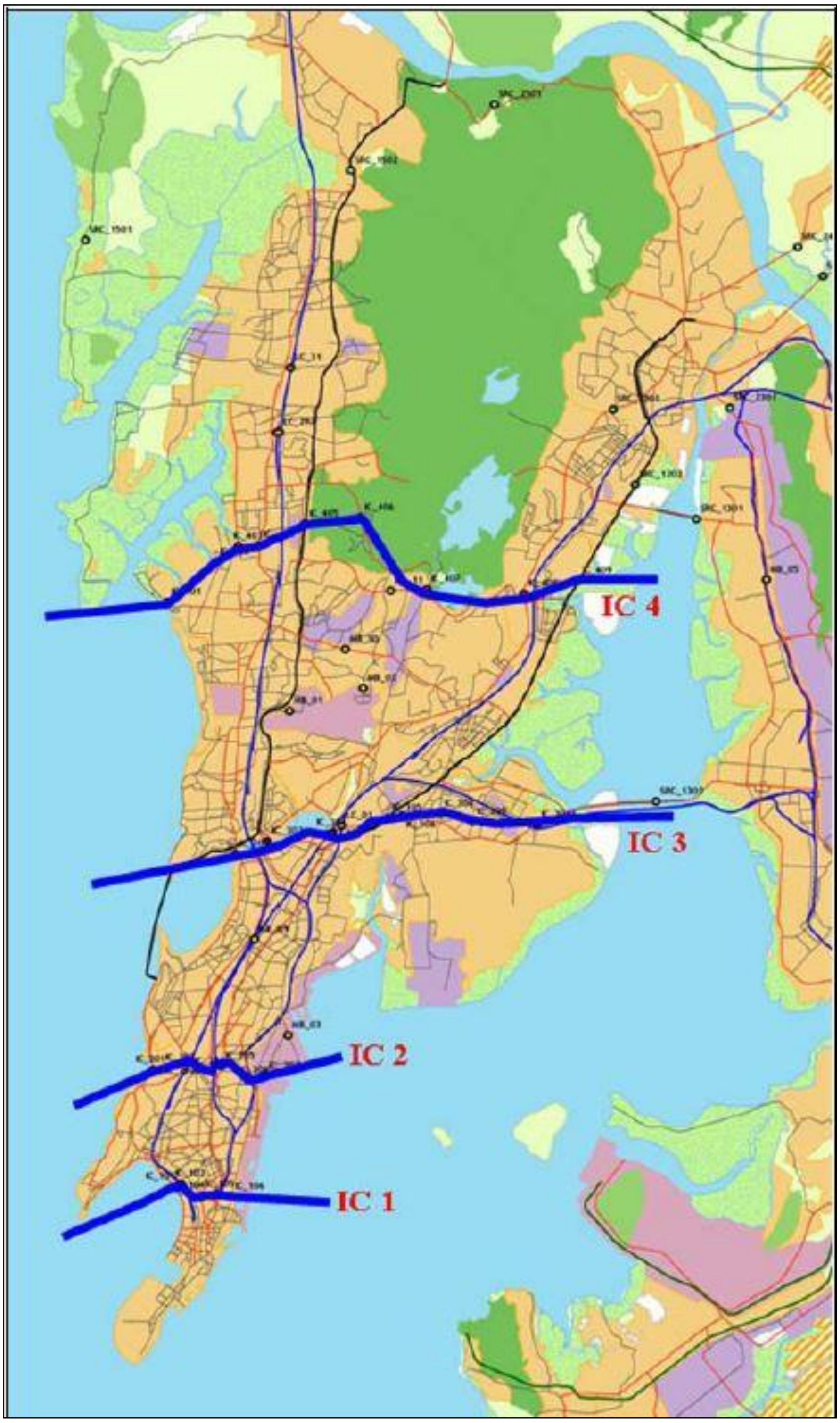


Figure 2.6: Inner Cordon lines from CTS Report

To build reliability into data collections, video surveys were carried out at all locations for minimum three days out of seven days traffic surveys. The data was then tabulated and analysed as per relevant IRC Codes. Proposed Coastal Road shall act as a bypass to existing traffic network being a completely new highway. It was necessary to establish traffic entering and exiting at each proposed interchange location. The traffic will predominantly get diverted from the current road network based on time and cost savings. Based on these parameters diversion factors were derived for each Origin & Destination (OD) data in OD matrix at each of the 17 traffic locations.

2.5.2. Classified Traffic Volume Count

Traffic studies at Mid-Blocks are conducted at Seventeen different locations for classified traffic volume count after a detailed site investigation at following locations:

1	Kurar near Foot over bridge on NH 8
2	Shankarwadi on NH 8
3	Airport on NH 8
4	Santacruz Flyover on NH 8
5	Nanawathi Hospital on SV Road
6	Amboli on SV Road
7	Malad west on SV Road
8	Infinity mall on Link Road
9	Sea link
10	Worli dairy
11	Nepean sea road
12	Peddar road
13	Marine drive
14	Times of india on NH 3
15	VT back gate on Eastern freeway
16	Gokhale road
17	Mahim on SV Road

Figure 2.7: Traffic survey locations

2.5.3. Origin Destination (O-D) Survey

Origin–Destination surveys were carried out at same locations, where classified TVC were conducted. O-D surveys are conducted to establish the travel characteristics by different modes of vehicles within the project area. Origin-Destination study has been conducted at the same place of volume count as per IRC guidelines. The different types of vehicles were broadly divided into two categories as Passenger vehicles and Goods Vehicles. Passenger vehicles constitute Two Wheeler, Three-wheeler, Car, Jeep, van, Bus & Cycle. Goods Vehicles constitute LCV, 2 - Axle, 3-Axle, Multi – Axle & Tractor. Data was recorded in the given format based on the above-mentioned categories.

The analysis of O-D data starts with coding of zones, i.e. categorizing the traffic with respect to its origin and destination. These origins and destinations depending on their distance from the project road are assigned to a region in terms of local, district and state. These regions are designated with unique code. These codes are termed as Traffic Analysis Zones (TAZ).

2.5.3.1. Traffic Zones – Internal for OD Analysis

15 internal zones have been selected considering the area of influence on the proposed road. Road connectivity and major areas have been considered in delineating the internal zones. Ward boundaries of Brihan Mumbai have been followed:

Table 2-3 Zoning System

Local Code	Place
1	CST, Churchgate
2	Mumbai Central, Grant Road, Charni Road
3	Marine Lines
4	Masjid, Sandhust Road
5	Elphiston Road, Lower Parel, Mahalakshmi
6	Byculla, Chinchpokli, Reay Road, Dockyard
7	Mahim, Sion, Matunga road, Dadar
8	Parel, Sewri, Curry Road, Cotton Green
9	Santacruz, Khar, Bandra
10	Chunabhatti, GTB Nagar, King Circle, Matunga, Wadala
11	Jogeshwari, Andheri, Vile Parle
12	Ghatkopar, Vidhyavihar, Chembur, Kurla, Govandi, Mankhurd
13	Malad, Goregaon
14	Mulund, Bhandup, Kanjur Marg, Vikhroli
15	Dahisar, Borivali, Kandivali
District Code	
16	Navi Mumbai Region
17	Panvel-Uran Region, Pen-Alibagh Region, Neral-Karjat Region
18	Thane(Part of Thane Dist), North Eastern Region
19	Mira Bayander, North Western Region
20	Rest of Thane District, Ahmedpur, Nashik, Dhule, jalgaon, Nandurbar

Local Code	Place
21	Raigad, Ratnagiri, Sindhudurg, Kolhapur, Sangli, Solapur, satara, Pune
22	Rest of Maharastra
23	Gujarat, MP, Rajasthan
24	AP, TN, Kerala, Karnataka
25	UP, Haryana, Himachal Pradesh, Punjab, Jammu & Kashmir, Uttaranchal
26	Eastern States, Rest of India

Figure 2.8: Traffic Zones - Internal

15 internal zones have been selected considering the area of influence on the proposed road. Ward boundaries of Brihan Mumbai have been followed.

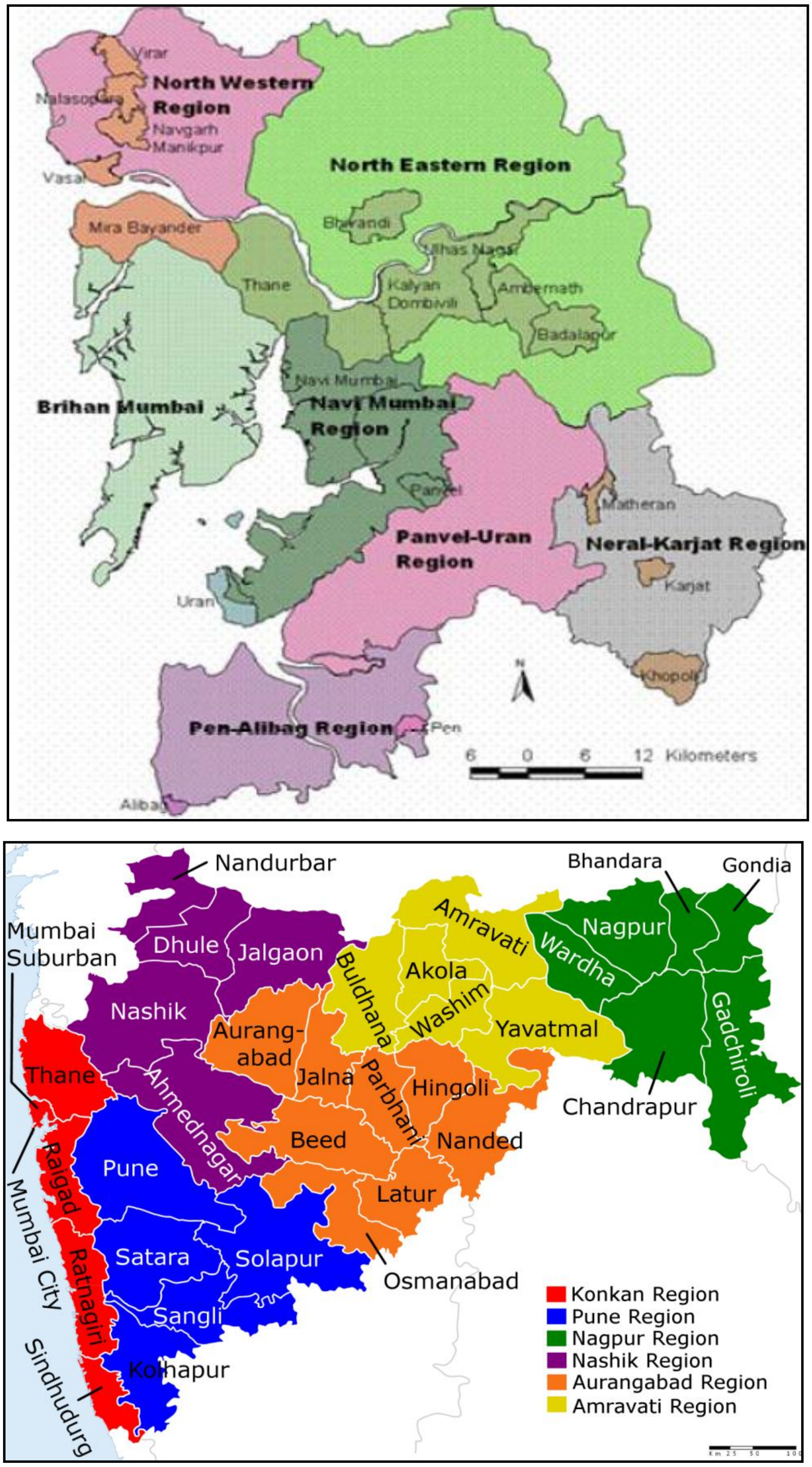
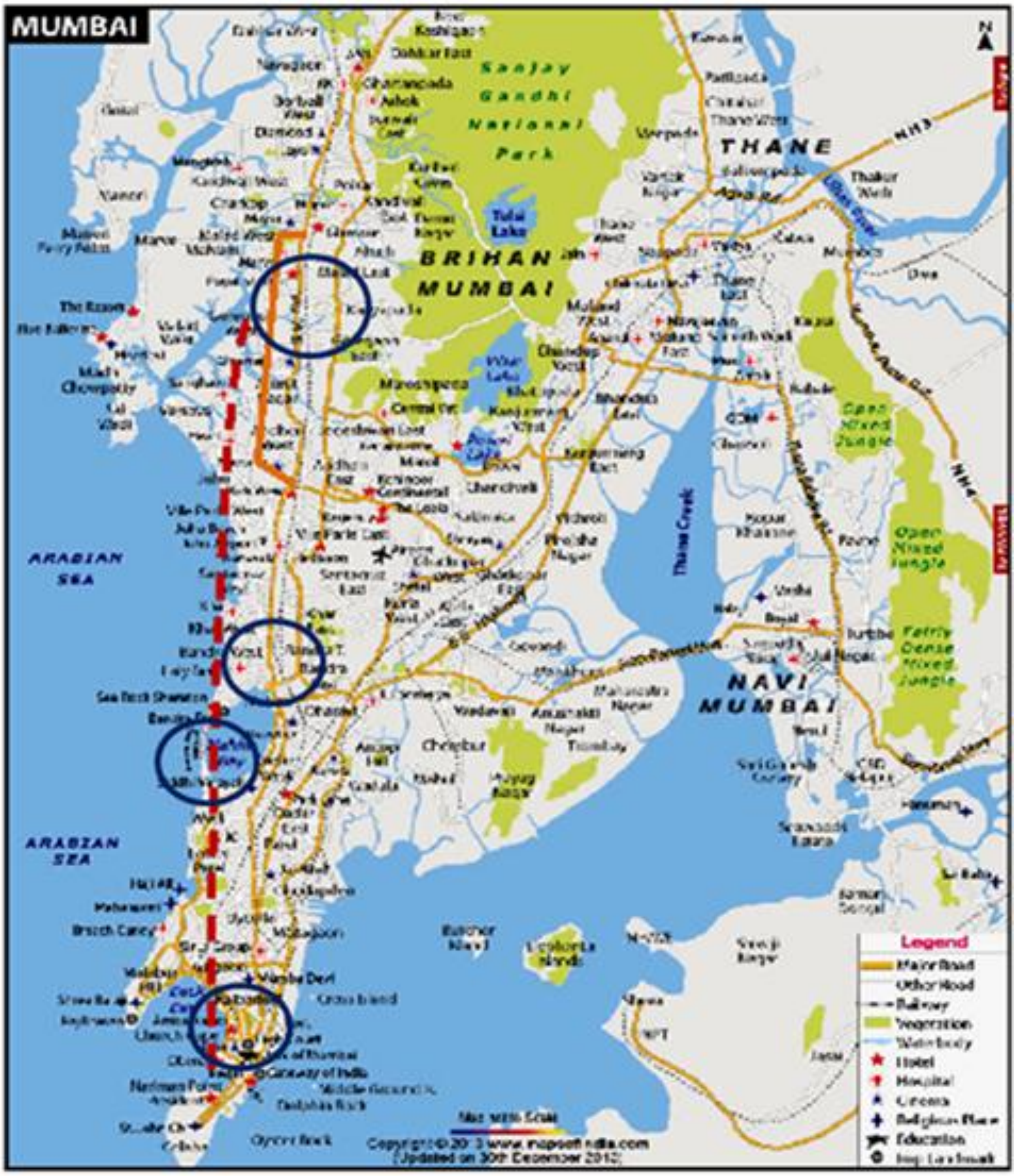


Figure 2.9: Traffic Zones - External

- The travel characteristics obtained by O-D survey facilitate the classification of O-D Matrix.
- Travel pattern on the project road
- The travel characteristics obtained from O-D surveys identified were analysed to obtain the trip distribution based on the zoning.
- One day O-D Survey was conducted at the locations of TVC surveys. The surveys are essential to estimate likely traffic volumes on new links.

The influencing traffic corridors related to the project road is shown below:

- **Influencing Traffic Corridors**



- Northern side – Diverted traffic mainly from
    - Link Road

- S V Road
- Western Express Highway (NH 8)

Figure 2.10: Influencing Traffic Corridor – North End

- Central part – Diverted traffic mainly from
  - Santacruz Flyover
  - Bandra -Worli Sea Link

- Southern side – Diverted traffic mainly from
  - Marine Drive
  - Dadabhai Naoroji Road
  - P D Mellow Road
  - Khan Abdul Gaffar Khan Road
  - Napean Sea Road
  - Pedder road
  - Gokhale Road

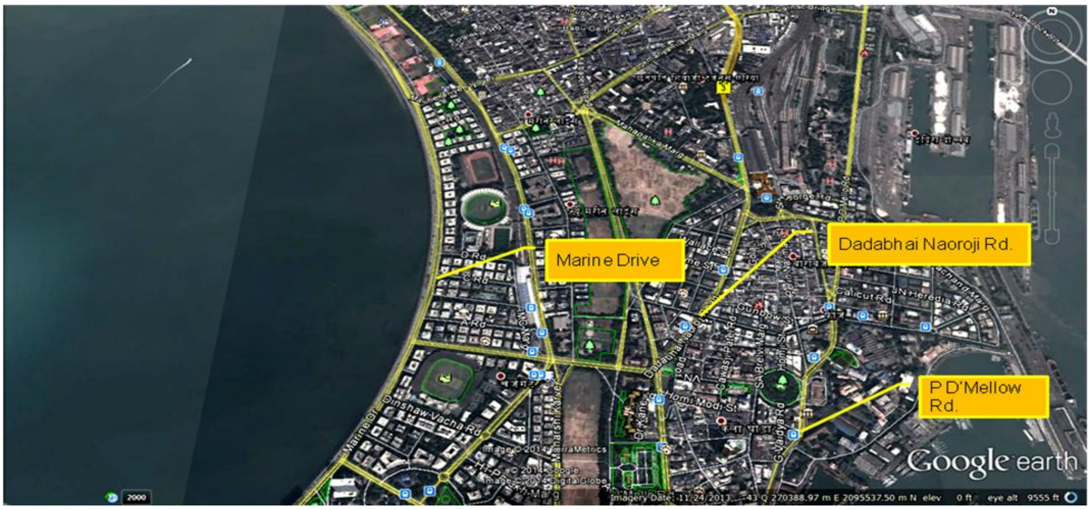


Figure 2.11: Influencing Traffic Corridor – South End

2.5.4. Classified Traffic Volume Count at Mid-Blocks

- Average Daily Traffic
- Average Daily Traffic (ADT) at all 17 locations is provided in Table 2.4

Table 2.4: Average Daily Traffic

Location	ADT (In Nos)	ADT (In PCUs)
Kurar	184727	245648
Shankarwadi	216624	273544
Airport	270864	352508
Santacruz Flyover	222426	307166
Nanawati Hospital	66078	97955
Amboli	75026	104041
Malad west	38647	53464
Infinity mall	120235	164117
Sea link	49009	51544
Worli dairy	48699	49326
Napean sea road	30349	32161
Peddar road	81943	83947
Marine drive	53466	53354

Location	ADT (In Nos)	ADT (In PCUs)
Dadabhai Naoroji Rd	59704	64882
P D' Mellow Road	46008	49220
Gokhale Road	37814	40252
Mahim	213769	220612

Figure 2.12: Findings of Traffic Survey w.r.t Survey Locations

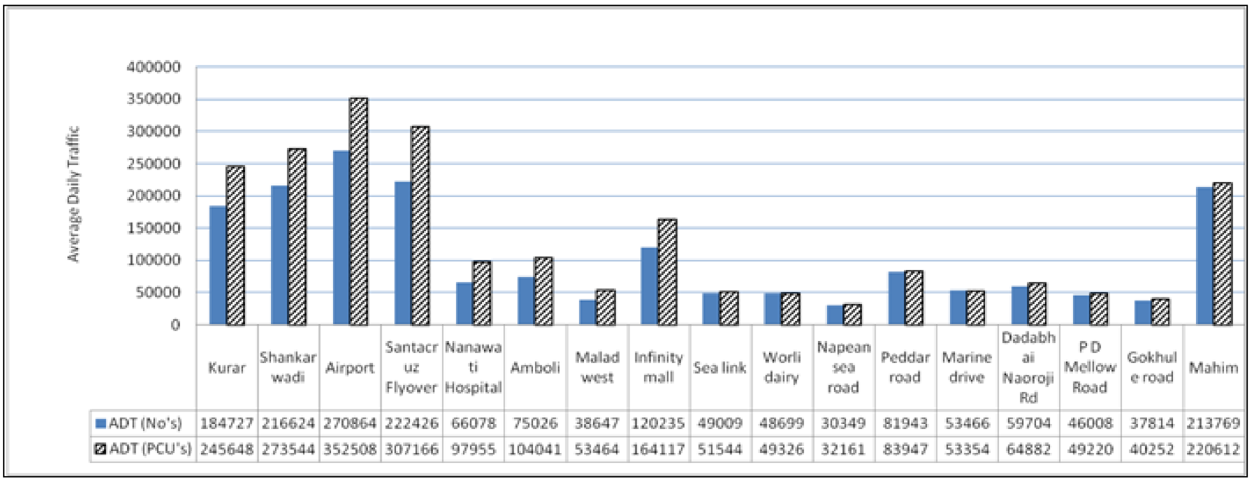


Figure 2.13: Location wise Traffic variation in AADT

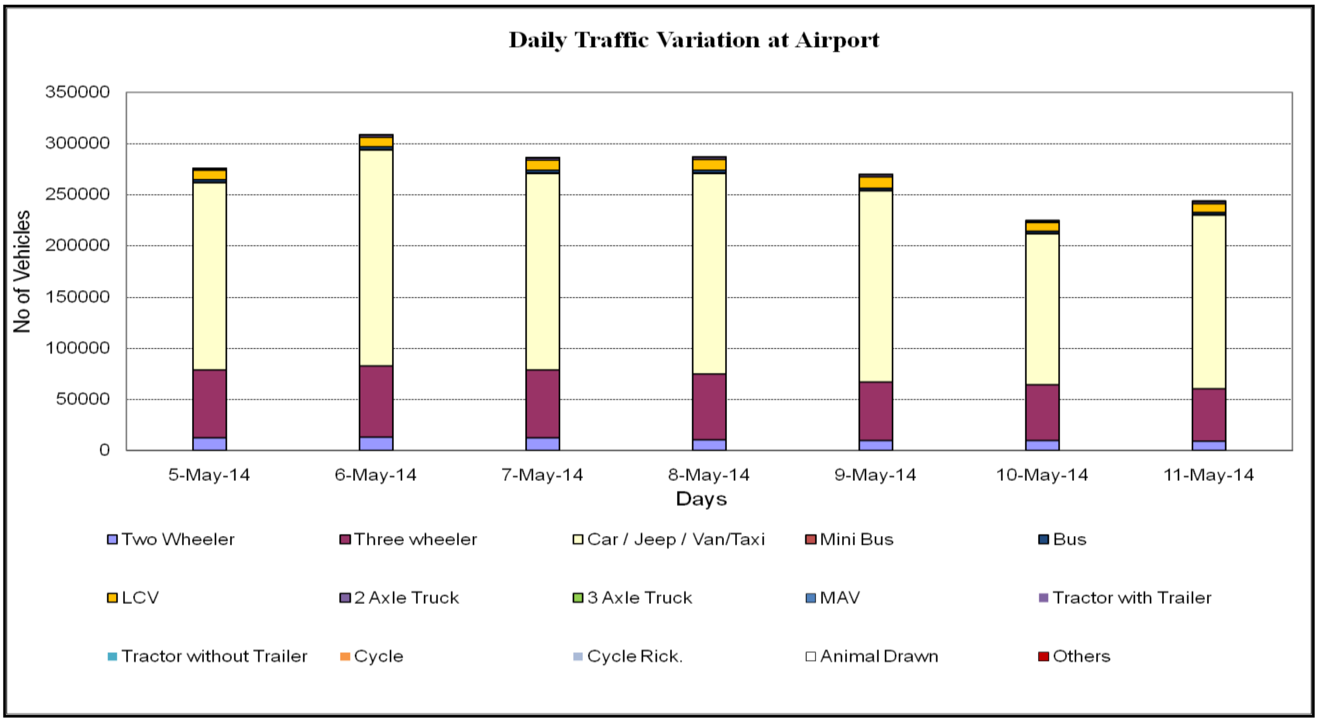


Figure 2.14: Daily Traffic Variation at Airport

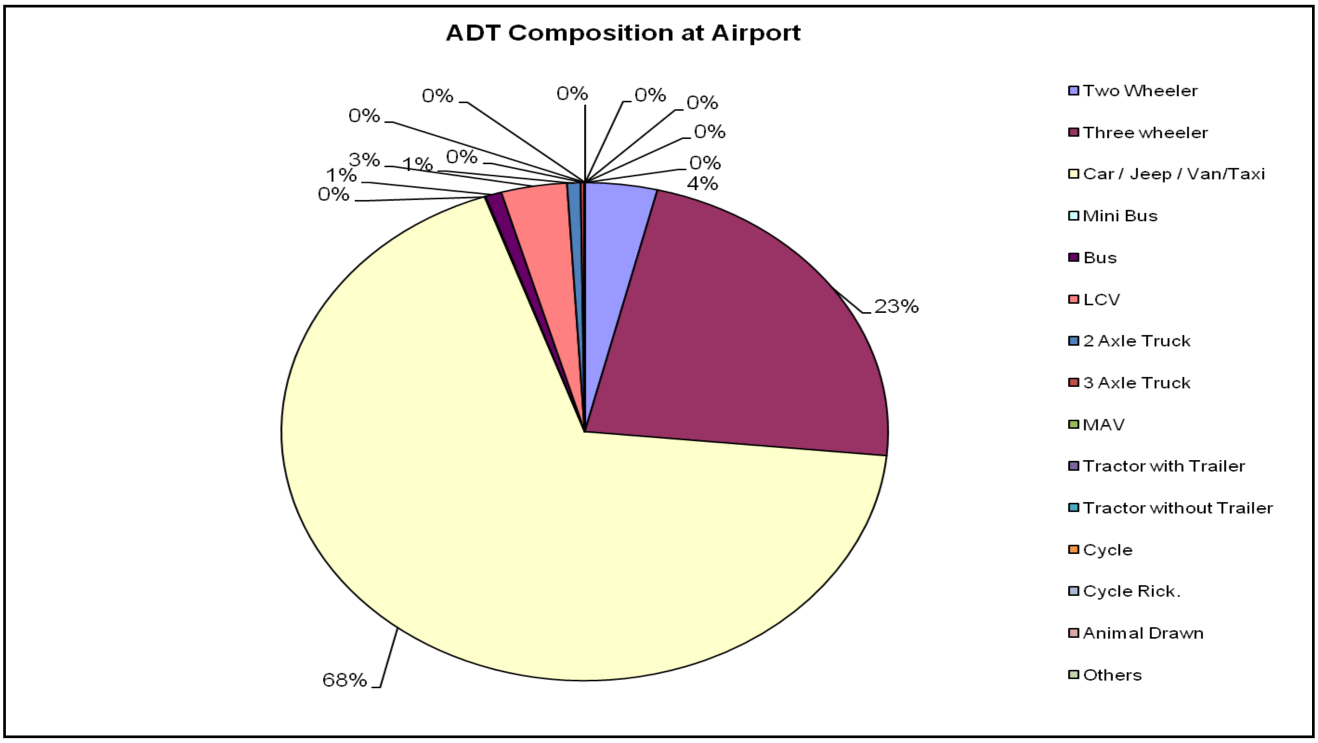


Figure 2.15: ADT Traffic Composition at Airport

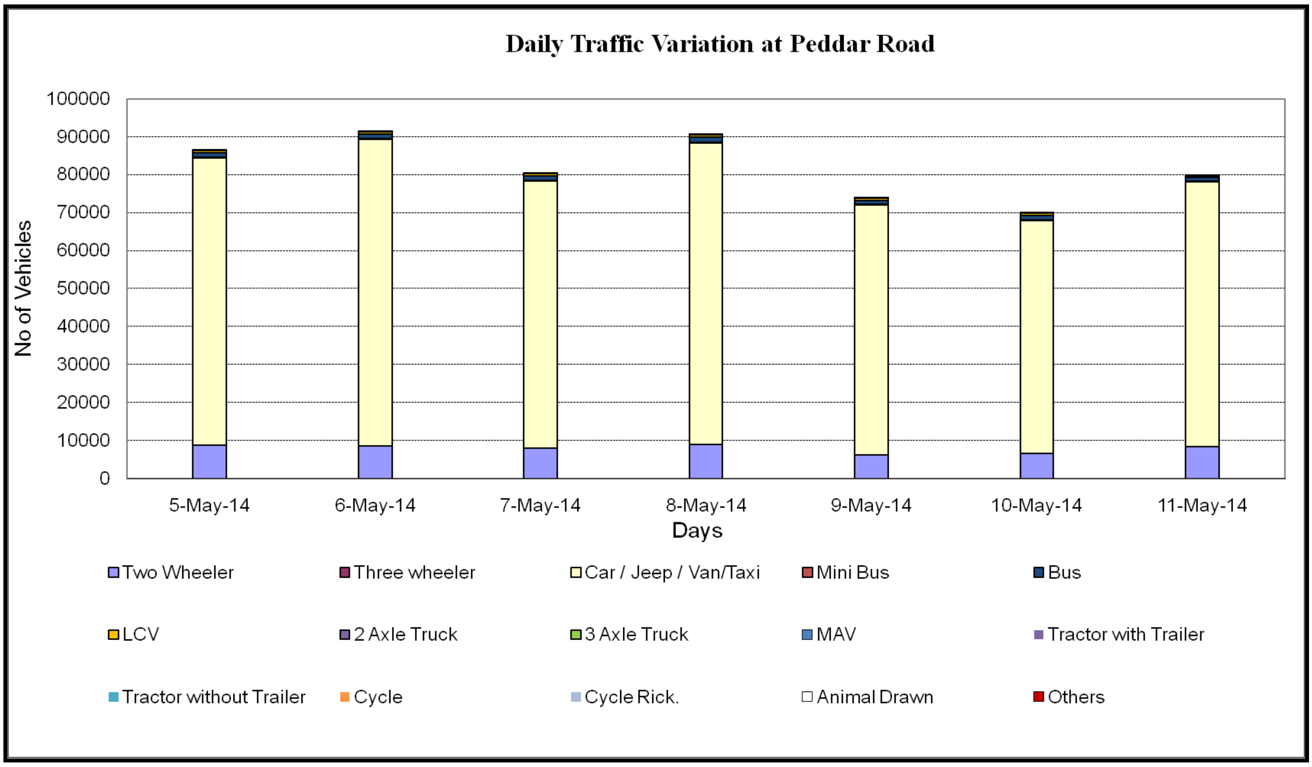


Figure 2.16: Daily Traffic Variation at Peddar Road

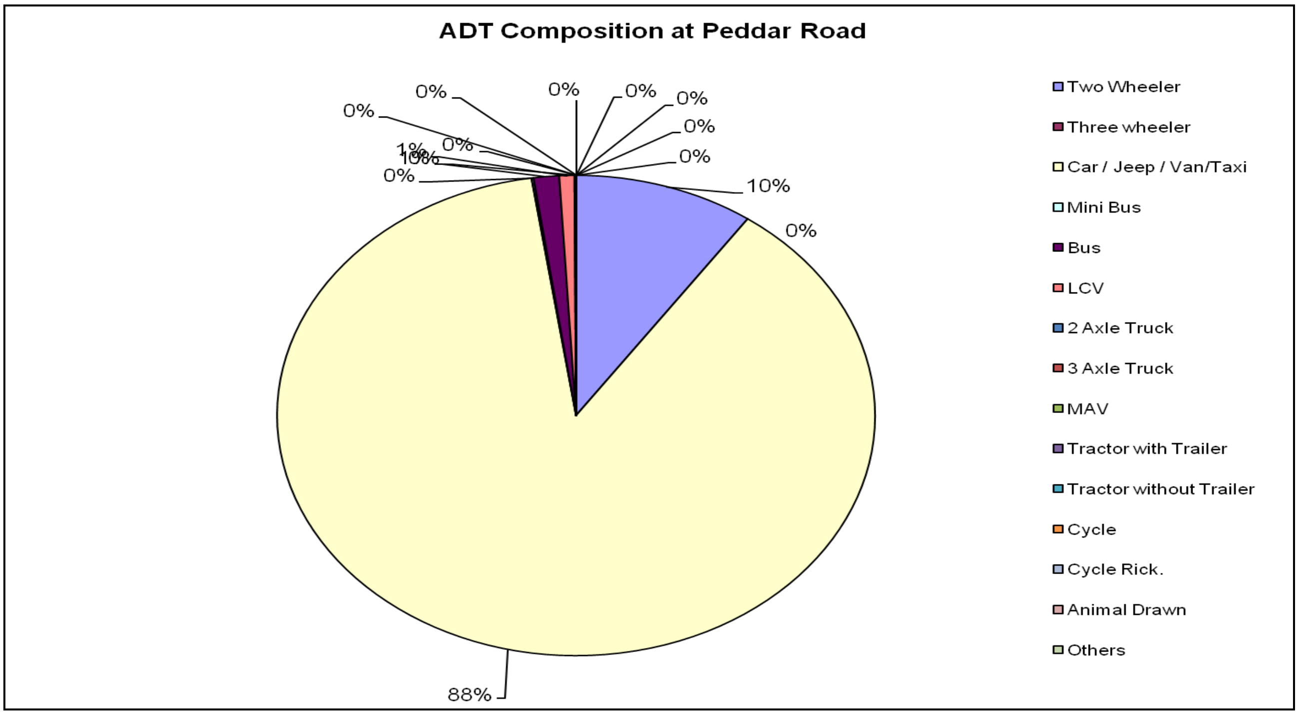
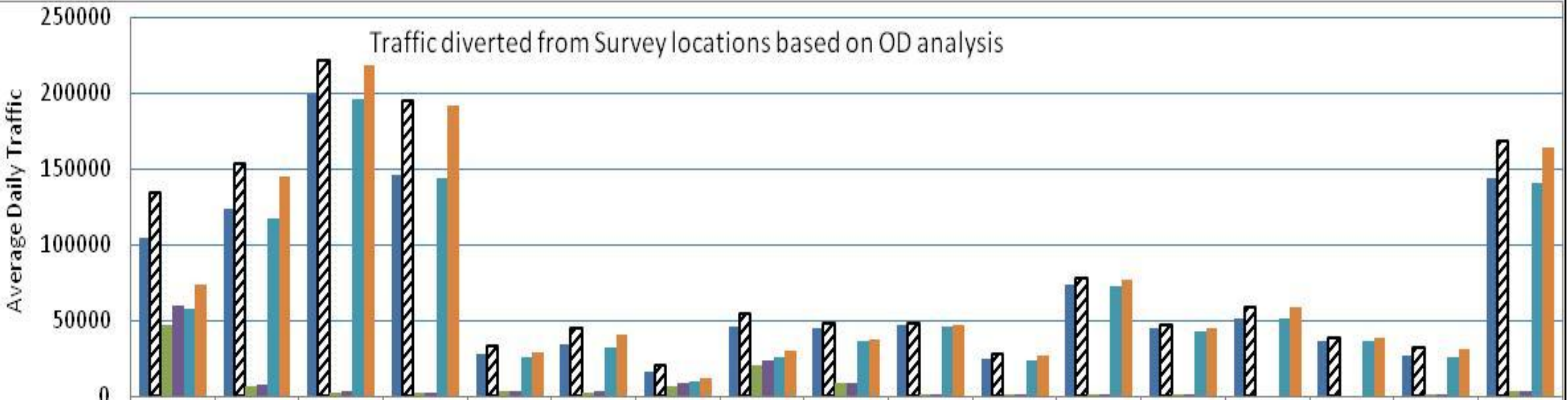


Figure 2.17: ADT Traffic Composition at Peddar Road

- For almost all the locations the composition shows predominance of light fast vehicles.
- The share for light vehicles at various locations ranges from 88% at Santacruz Flyover to 99% at Worli Dairy.
- Buses found to be high on Western Expressway, S V Road and near CST ranging from 2,330 to 7,018 per day.



	Kurar	Shankar wadi	Airport	Santacruz Flyover	Nanawati Hospital	Amboli	Malad west	Infinity mall	Sea link	Worli dairy	Napean sea road	Peddar road	Marine drive	Dadabhai Naoroji Rd	P D Mellow Road	Gokhule road	Mahim
ADT (No's)	105029	123727	198981	146282	28486	34811	16827	46177	45544	46723	24518	73967	45069	51270	36641	27077	143830
ADT (PCU's)	133532	153075	221792	194527	32868	44396	20366	54571	47397	47845	27788	77967	47057	58556	38516	32200	168148
Diverted Traffic ADT (No's)	46788	6678	3029	2125	3102	2797	7128	20362	9038	1035	540	1218	1700	0	0	817	3097
Diverted Traffic ADT (PCU's)	59486	8262	3376	2825	3579	3568	8627	24064	9406	1059	612	1284	1775	0	0	971	3621
Remained Traffic ADT (No's)	58241	117049	195952	144157	25384	32014	9699	25815	36506	45688	23978	72749	43369	51270	36641	26260	140733
Remained Traffic ADT (PCU's)	74047	144813	218416	191702	29289	40828	11739	30507	37991	46786	27176	76683	45282	58556	38516	31229	164527

Note: Without significant improvement to existing east to west connectivity to coastal road

Figure 2.18: Estimated Traffic Diversion

2.6 Interchanges

Interchanges will be necessary at all crossings of highway which are to be developed as completely access controlled. An interchange may be justified at the crossing of a major arterial road with another road of similar category carrying heavy traffic.

We have studied the requirement of traffic interchanges at the major junctions on project corridor as per IRC: 92-1985 (Guidelines for the design of Interchanges in Urban Areas) and IRC: SP: 41-1994 (Guidelines for the Design of At- Grade Intersections in Rural and Urban Areas) etc.

These studies are the base for deciding many components like approach width & exit width, approach & exit angles etc. However, the objective of the present study is to assess the Directional Traffic volumes at the proposed interchanges

Traffic flow diagrams for the twelve interchanges separately for the base year (2014) and horizon year (2043) are studied and given below.

2.6.1. Proposed Interchange Locations

The proposed Interchanges Locations for coastal road are listed below:

1. Princess Flyover
2. Amarsons Garden Interchange
3. Haji Ali Interchange
4. Bandra Worli Sea Link Interchange (Worli)
5. Bandra Worli Sea Link Interchange (Bandra)
6. Carter Road Interchange (Danda Village)
7. Ritumbara College Interchange
8. MADH Island Interchange (Institute of Fisheries Education)
9. Oshiwara Interchange
10. Malad Interchange
11. Kandivali Interchange

Figure 2.19: Proposed Interchange Locations

2.7 Traffic Demand Forecast

2.7.1. Growth Factor

Traffic Growth on a road facility is generally estimated on the basis of historical trends. Demand changes are usually because of shifts in the pattern of economic activities in the surrounding regions. The proposed coastal road is from Nariman Point to Kandivali Junction link road.Hence, future traffic estimation necessitates a preview, however imprecise, of the probable pattern of future growth of the economy of the country and particularly Greater Mumbai. CTS were carried out for the MMR in 2008 to establish various parameters. The study concentrates in updating the findings of the CTS related to the impact of the Coastal Road and extend the horizon period from 2031 to 2043.

It may be noted that the Coastal Road will be mainly used by city traffic particularly by cars and taxis between southern end at Nariman Point and northern end at Kandivili. The access points are provided through 10 interchanges, four along southern stretch between Nariman Point and BWSL and eight along northern stretch between BWSL and Kandivili. However it is expected that with another proposed link between NH348 near Gavan Phata extended to coastal road by Worli Sewri link, some amount of traffic from / to Navi Mumbai and Raigad will be loaded on the Coastal Road. Moreover, the development potential along the study corridor is quite restricted. In that situation, the growth of registered vehicles, especially cars and taxis, will be the guiding factor for traffic projection. The analysis of the secondary data indicates that;

The number of total registered vehicles in Maharashtra (2008-2012) is growing at 11.46% per annum (Table 5.22).

The main influence area of the corridor has been considered as Greater Mumbai Region and Rest of MMR covering Thane, Kalyan, Vashi, Navi Mumbai and Vasai Overall increase in registered vehicles (2008-2012) in these regions is 8.46% and 8.99% respectively (Table 2.5).

While the number of cars and taxis in Maharashtra is growing at 12.69% per annum, the growth of the same in Greater Mumbai (2010-2012) is 8.30% per annum:

Table 2-5 Growth of Registered Vehicles in Maharashtra

(In Numbers)

Sr. No.	Category	As on 31 st March 2008	2009	2010	2011	2012	Percentage increase or decreas over previous year
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Two Wheelers	9394869	10212360	11181762	12429011	13921763	12.01
2	Cars / Jeeps & Station Wagons.	1822458	1979191	2182969	2440404	2750167	12.69
3	Taxi Cabs	149526	157916	168307	168496	175797	4.33
4	Auto - Rickshaws	574625	598013	626332	640700	640040	-0.10
5	Stage Carriages/Contract Carriages	55281	57353	60387	64549	62308	-3.47
6	School Buses	4154	4698	5222	7415	17781	139.80
7	Private Service Vehicles.	10154	8762	9103	8326	9451	13.51
8	Ambulances	7453	8260	9104	9571	10557	10.30
9	Arti./Multi.vehicles,Trucks & Lorries, Tankers & Delivery vans	780992	845617	896397	973788	1067825	9.66
10	Tractors	276438	302249	331694	371075	419291	12.99
11	Trailers	238080	252409	270078	293576	324824	10.64
12	Others	21331	24080	27066	27188	32557	19.75
	Total	**13335361**	**14450908**	**15768421**	**17434099**	**19432361**	**11.46**

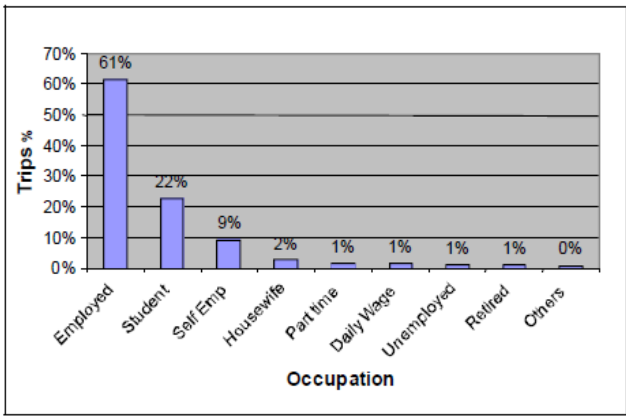
Table 2.6: Growth of Registered Vehicles in Greater Mumbai and Thane Region

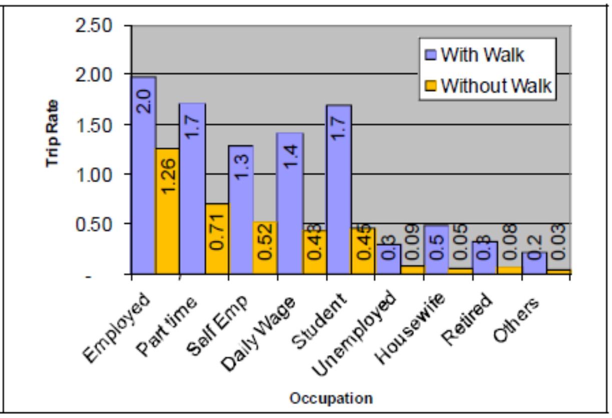
Year	Total Registered Cars and Taxis as on31st March	
	Greater Mumbai	Thane
2010	598,710	465,270
2011	637,332	499,978
2012	702,157	537,275
Growth per Annum (2010-2012)	8.30%	7.46%

Since global economic downturn and high growth of Pune, population growth of Mumbai Island and MMR has slowed down significantly. Growth of traffic in CTS report was estimated based on almost linear growth in population till 2031. However due to economic downturn, competition by surrounding cities and acute rise in property prices the population growth of MMR has stabilised over past decade. This means that organic increase in the population was compensated by migration from MMR. However, it is expected that with correction property price, the inventory of unsold houses on market will be sold out over next 5 to 8 years along with new projects mainly aimed at low income and middle income groups. It is unlikely that the actual population growth in MMR will match organic growth in population. Therefore, an increase in population by 5% is assumed over next two decades, mostly towards Navi Mumbai.

- Per Capita Trip Rates (PCTR)

The trip rates observed during CTS study and provided in the report are given below:





However, considering that coastal road traffic will mainly comprise of cars only the growth rate of traffic will be governed by car ownership. Car ownership per 1000 population in 2011 was 139 cars for MMR. CTS has estimated the car ownership of 204 cars per 1000 population of MMR in 2021 and 266 cars per 1000 population of MMR in 2031. However, considering estimates for other cities it is likely that Car ownership in MMR shall stabilise at 180 cars per 1000 population by 2031. Considering this along with 5% increase in population over next two decades and 3% growth thereafter till 2041, the growth in car traffic has been estimated as,

Year	Growth
2014 to 2024	20.86%

2024 to 2034 18.13%

2034 to 2043 03.00%

The same has adopted for projection of traffic growth over Horizon period up to 2043

Table 2.7: Growth Rates in Different Scenarios

Year	Growth Scenario – Per Annum (%)
2015 -2019	3.00
2020 - 2024	2.72
2025 - 2029	2.30
2030 - 2034	1.32
2035 - 2039	0.30
2040 - 2043	0.30
Overall Growth	1.67

However for estimation capacity an overall growth rate of 2% has been considered.

2.8 Tunnel

The idea of a traffic tunnel along the congested Mumbai city coastal line was raised by MCGM in the year 2014 and a preliminary plan of sub-surface exploration by drilling is outlined. In general, the Coastal Road Traffic Tunnel would be excavated in comparatively soft Breccia strata with their lithological variants.

There are altogether two tunnels proposed at following locations:

From Princess Flyover to Nepean sea road near Priyadarshani park Walkeshwar (3.45 km)

From End of Khar Danda village to Ritumbara College near Juhu beach. (5.76 km)

2.8.1. Tunnel Lay out

- Princess Flyover shaft and Priyadarshani Park shafts connect the tunnel along the Marin Drive.
- The tunnel length would be around 3.45 km.
- Alignment would be through the mostly unjointed rock strata.

- The tunnel would be located about 20-30m BGL.

Location of the Princess Flyover and Priyadarshani Park portals of the tunnel along the Marine Drive areas, allows the tunnel to bypass the main present day traffic bottlenecks. However, in view of the expected future expansion and development of the city.

The MHHW is considered as +4.00 MSL around the tunnel alignment the depth of water may vary from 4 to 14m.

- Outward gradients of the tunnel from both the portals would allow drainage of the tunnel under gravity both during construction and operation towards the sump pit.
- Necessary levelling to accommodate TBM assembly shall be necessary at both the portals. Once the TBM is withdrawn, final gradients as per design shall be prepared.

The finished tunnel would have a ridge-like gradient – rising from the end portals. In approaches the slopes shall be steeper.

The tunnel gradients are kept as gentle as possible for facilitating traffic movement as well as allowing drainage under gravity.

- Gradient for Tunnel shall be 0.3%. For the ramp portion 6% (1:15) gradient was indicated. But depending on the available space 4% to 3% gradient shall be adopted.
- Drains shall be provided alongside the alignment these shall be leading to sump pits at entry and exit from where water is to be pumped out.

Emergency exits are planned as cross passages at every 500m apart connecting the two Tunnels.

2.8.2. Key Components

- **Lining**: - Temporary support as and where required during construction is to be provided for safe construction. This shall be in the form of shotcrete, ribs etc. Permanent lining shall be RCC either precast or cast in site depending on construction methodology to be adapted.
- **Retaining Wall/ Diaphragms Wall**: - In the ramp portion, diaphragm wall shall be constructed as enabling work to restrict width of excavation and also to provide safety to adjoining structures.
- **Sump & Pump House**: - A deep sump shall be provided to collect drain water in tunnel and pump out enabling shaft shall be provided.

- **Cross Passage**: - At every 500 m mandatory connection shall be provided between adjacent tunnels.
- **Safety Provisions**: - Tunnel Lighting, Fire safety, ventilation shall be provided by twin fans located overhead of diameter 1.2m
- Service buildings and ancillary spaces shall be as per requirements.
- Space for casting yard and other mechanical, electric set ups.

2.8.3. Design Criteria

- Proposed speed of the vehicles shall be 80km/hr
- Maximum Gradient 4% but mostly flat
- Axle load as per class 70 R
- Traffic requirement as per feasibility report + 30000 PCU
- Signaling system beyond entry & exit points.
- Number of Lanes = 2 + 2 both ways

2.8.4. Design Standard

1. PIARC
2. SP-91
3. European Directive on Tunnel Design,operation and maintenance

Geometry of the Tunnel

Horizontal Alignment:	Being an urban tunnel, adequate speed limit of 80 kmph is considered to have design speeds close to the actual speed in fluid and uncongested traffic flow.
Vertical Alignment	0.15% gradient shall be adopted as a uniform downward gradient towards priyadarshani shaft with flat intermediate breaks
Vertical clearance :	5.5m
Diameter of the tunnel:	11m
Width of the carriageway:	The lane width is considered as 3.2m and minimum c/w width of 7.7 m.

2.8.5. Construction by TBM

Following are the technical advantages:

- Reduction of over breaks
- Minimum surface and ground disturbance
- Reduced ground vibration eliminates damage to nearby structures
- This is an important consideration for Metropolis.
- Reduced rock excavation reduces handling cost
- The speed of work is several times that of conventional drill and
- Blast technique
- Least disruption of traffic flow
- Unaffected public safety

Figure 2.21: Tunnel Boring Machine

2.8.6. Conclusion

- Soft strata consisting of Breccia, Tuff is likely to be encountered which is suitable for cutting by road header as well as TBM.
- The likely progress shall be 20-22 m per day by each of the TBMs.
- In general subsea tunneling is feasible geologically.
- For fast progress TBM tunnel is recommended.
- Diameter of Tunnel shall be 11m.
- Flat Gradient is to be adopted 0.15%.

- In general feasibility of sub sea tunneling is feasible at this location as viable alternative.

2.9 Reclamation

The Jt. Technical Committee recommended about 35.6 km. coastal freeway comprising a combination of coastal roads based on reclamation, bridges, elevated roads and tunnels on western side of Mumbai. The Committee recommended this coastal freeway system with two options of alignments, both with a view to resolve the traffic congestion in Mumbai and to enable creation of the much needed recreational open spaces. STUP has evaluated seven alignment options and Option 7 is considered as final option for design after comparison of merits and demerits of each option. The constraints of the geography and the inability of the city to expand the alignment option 7 has considered total coastal freeway length of 29.20 km out of which 12.06 km is considered to be reclaimed road. The total area of reclamation will be about 122 hectares.

2.9.1. Alignment Sections of Reclamation

As per the final alignment the reclamation is proposed at following sections –

- **South Section –**

Section No	Section	Start	End	Length
1	Princess Flyover to Priyadarshini Park	Nepean Sea Road (MSRDC Head Office)	Carmel Building	380
		Carmel Building	Clinical Diagnostic Center	250
2	Priyadarshini Park to Mahalaxmi Temple	Clinical Diagnostic Center	Mahalaxmi Temple	1620
3	Mahalaxmi Temple to Markandershwar Temple	Mahalaxmi Temple	Childrens Orthopadic Hospital	450
		Childrens Orthopadic Hospital	Maa Hajjani dargah	1410
		Maa Hajjani dargah	Poonam Chembers	220
		Poonam Chembers	Markandershwar Temple	120
4	Markandershwar Temple to Bridge Connecting Worli End	Markandershwar Temple	Worli BMC Colony	150
		Worli BMC Colony	Worli Sea Face (BMC High School)	1810

Section No	Section	Start	End	Length
		Worli Sea Face (BMC High School)	Merging with BWSL	750

- **North Section –**

Section No	Section	Start	End	Length
5	BWSL(End) to Start of Tunnel (Carter Road Mandir)	BWSL Toll Plaza Starting	Near Bandra Fort	1246
		Near Bandra Fort	Near Kane road	554
		Near Kane road	Bandstand Garden	730
		Otters Club	Carter Road Mandir	955
6	Start of Tunnel (Carter Road Mandir) to Bharat Nagar (End of Tunnel)	Carter Road Mandir	Carter Road Slum	375
		Carter Road Slum	Danda Village	500
		Param Plaza	Ruia Park	540

2.10 Oceanographic Condition:

2.10.1. Tides:

The Project Datum Level is Chart Datum as defined by the Bombay Port Authority measured by the tide gauge located at Apollo Bunder. All land and sea levels in construction work shall be set out relative to Chart Datum. The relationships between Chart Datum, sea levels and infrastructure levels shall be taken as:-

- Highest recorded tide (HRT) + 5.040 CD
- Highest astronomical tide (HAT) + 5.400 CD
- Mean High Water Springs (MHWS) + 4.420 CD
- Mean High Water Neaps (MHWN) +3.300 CD
- Mean Sea Level (MSL) + 2.510 CD
- Mean Low Water Neaps (MLWN) +1.860 CD
- Mean Low Water Springs (MLWS) + 0.760 CD
- Lowest Low Water Recorded (-) 0.46CD

The chart datum is 2.51m below the GTS benchmark. The CD levels mentioned above when adjusted to GTS datum are as below:

- Highest recorded tide (HRT) + 2.53 R.L.
- Highest astronomical tide (HAT) + 2.89 R.L.
- Mean High Water Springs (MHWS) + 1.91 R.L.
- Mean High Water Neaps (MHWN) +0.79 R.L.
- Mean Sea Level (MSL) + 0.00 R.L.
- Mean Low Water Neaps (MLWN) – 0.65 R.L.
- Mean Low Water Springs (MLWS) - 1.75 R.L.
- Lowest Low Water Recorded - 2.97 R.L.

2.10.2. Waves:

The predominant waves are the swell waves generated by deep sea storms. These mainly arise just before and during the South West monsoon. The statistical analysis indicates that most wave periods fall between 6 seconds and 10 seconds. During the continuance of the North-East monsoon, North-Easterly winds known as "Elephantas" blow for short durations during the months of October-November. Significant Wave height with return period of 100years for the Mumbai coast shall be taken as 4.5m. (Ref. Indian Journal of Marine Sciences Issue: June 1991)

2.10.3. Current

In December and January sets north-westerly with the rates of upto 1knot. In July and August, when the S W Monsoon is well established, south easterly sets with rates of upto 2 Knots are experienced. Exceptionally onshore sets of upto 1.5Knots are experienced during the N E Monsoon and upto 3 Knots during the S W Monsoon.

The tidal flow is unsteady and the magnitude and direction of the currents varies with respect to location, time and depth. Generally, the ebb currents are stronger than flood currents.

2.10.4. Siltation:

The average rate of siltation shall be taken as 3mm per day. The maximum rate of Siltation will occur during monsoon months and will be taken as 7mm per day. The siltation is maximum during the monsoon seasons. The rate reduces in the month's preceding and succeeding the monsoon. In the rest of months the phenomenon reverses and erosion occurs to a similar extent of siltation. The net effect of siltation over the entire year is minimal.

2.10.5. Littoral Drift

Longshore drift consists of the transportation of sediments (clay, silt, sand and shingle) along a coast at an angle to the shoreline, which is dependent on prevailing wind direction, swash and backwash. This process occurs in the littoral Zone, and in or close to the surf zone. The process is also known as littoral drift, long-shore current or long-shore transport.

2.10.6. Recent changes seen in sea behavior patters:

Net Sea- level rise trends from past tide gauge data

No of Years of data	Trends (mm/Year)	GIA (Glacial Isostatic Adjustment) Corrections	Net Sea level rise (mm/Yr)
133	0.77	-0.43	1.20

(Ref: Bindoff et al 2007)

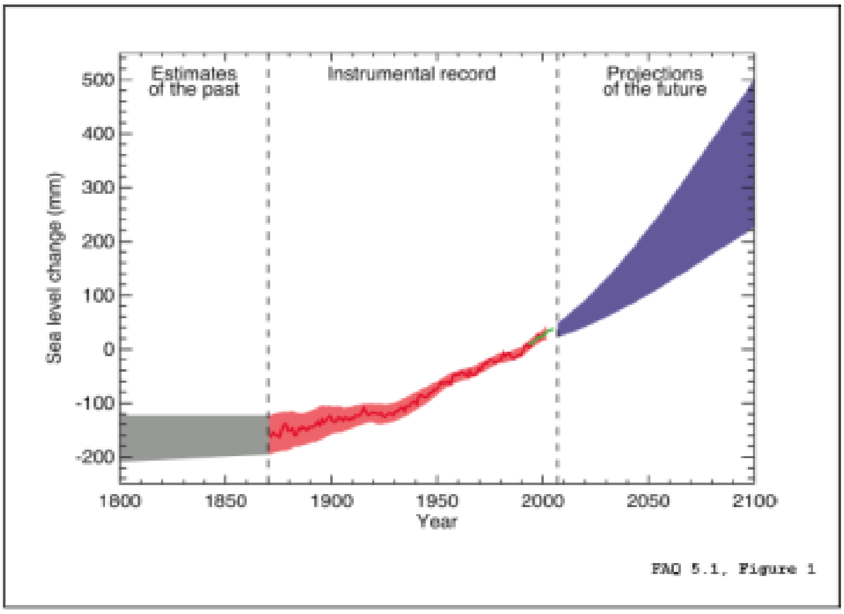


Figure 2.22: Level Changes – Past, Present and Future
(Ref: Unnikrishanan A. S and Shankar. D NIO, Goa)

2.11 Material Investigations

The probable sources of material are identified and the material is tested to check the suitability for the construction. The materials were collected from various sources and the test results are summarized and attached herewith.

2.11.1. SOURCES OF MATERIAL

For detail investigation, samples have been collected in sampling sacks and send for testing in laboratory. The tests have been performed conforming to the specifications.

Materials that have been investigated are given below:

- Sand
- Murrum
- Aggregates, Stone boulder/metal
- Fly ash, Cement
- Different types of steel
- Bitumen, RCC/ Hume pipes

The properties of materials are given in the next chapter

The sources of different construction materials have been investigated in the initial site visits. The availability of these materials is in and around the project road. The available sources of the materials are –

Sr. No.	Material Description	Unit	Lead from site	Source
	Bridge on stilt -Concrete Manufacturing & other Materials			
1	Coarse aggregate & Fine aggregate (Crushed sand)	MT	40 KM	Turbhe, Navi-Mumbai, Bombaypada
			60 KM	Bhiwandi
2	Fine aggregate - River sand	CuM	90 km	vaiterna
	Crusher sand	MT	40 KM	Turbhe & Bombaypada
3	Cement - OPC 53 Grade	MT	40 KM	Kalamboli
4	Microsilica	MT	40 KM	Turbhe Industial Area
5	Flyash	MT	145 KM	Dahanu

Sr. No.	Material Description	Unit	Lead from site	Source
			190 KM	NASIK
6	Chemical admixture	MT	40 KM	Thane-Belapu Road, Turbhe, Navi-Mumbai-
			40 KM	Mumbai
7	Water	Lit.		MCGM
8	Curing Compound	Lit.	40 KM	Mumbai
			40 KM	Mahape, Navi-mumbai
9	Steel Reinforcement (TMT Fe 500)	MT	40 KM	Kalamboli Stock Yard, Navi-Mumbai
10	FBEC (Fusion bonded epoxy coating)	MT	150 km	PSL Towers,615, Makwana Road, Marol, Andheri E
11	MS Plates - 6mm thick	MT	40 KM	Kalamboli Stock Yard, Navi-Mumbai
12	HT Strands	MT	35 KM	Borivali,Mumbai
13	Pot cum PTFE bearings	No.	2000 KM	Kolkata
			700 KM	Bhopal
14	Concrete Bonding Adhesive (Glu)	MT	40 KM	Thane-Belapu Road, Turbhe, Navi-Mumbai
15	Coal Tar Epoxy Paint	MT	40 KM	Mahape, Navi-mumbai
16	HDPE Sheathing Pipes	LM		703, Centre Point, Andhri kurla Road, JB Nagar, Andheri E, Mumbai-400
				Tex Centre, k wing, 3rd floor, chandivali Andheri East Mumbai-400 072 Tel-28474505/28478506
				366/2933, Motilal Nagar II, Mumbai-400 062 Tel-91-22-28717800,28724023
				Kumar plaza,1st floor Shivajinagar, Sangli - 0233-2621845
17	Anti Carbonation Paint for Superstructure & Substructure	LIT	40 KM	Navi-mumbai
				Kolkata
18	Cement based water proof paint	LIT		
			40 KM	Mumbai
				Pune
19	Non-shrink,high strength	Kg		, Ankleshwar ,Gujrat

Sr. No.	Material Description	Unit	Lead from site	Source
	cementitious grout (For bearing)			
20	Non-shrink cementitious grout	Kg	380 KM	, Ankleshwar ,Gujrat
				Mumbai Tel 022-27580686
21	Strip Seal Expansion Joint	LM	700 KM	Bhopal
22	Water Proofing Membrane (3mm thick)	SQ. M	30 KM	Borivali
			20 KM	Andheri
	Road on Reclamation Construction Materials			
1	Soil for Emb./Sub grade & RE wall works	Cu. M	40 KM	Turbhe,Mahape Navi-Mumbai
2	Flyash	MT	145 KM	Dahanu
			190 KM	NASIK
3	Granular Sub-base (GSB)	Cu. M	40 KM	Turbhe, Navi-Mumbai
			40 KM	Mahape, Navi-Mumbai
4	Wet Mix Macadam (WMM)	Cu. M	40 KM	Mahape, Navi-Mumbai
5	Emulsion for Prime Coat	MT	40 KM	Turbhe, Navi-Mumbai
6	Emulsion for Tack Coat	MT	40 KM	Turbhe, Navi-Mumbai
7	Bitumen - Grade 10/20,30/40,60/70	MT	40 KM	Mahape, Navi-Mumbai
	Pavement Quality Concrete & Dry lean Concrete			
8	Coarse aggregate & Fine aggregate (Crushed sand)	MT	40 KM	Turbhe, Navi-Mumbai, Bombaypada
			60 KM	Bhiwandi
9	Fine aggregate - River sand	Cu M	90 km	vaiterna
	Crusher sand	MT	40 KM	Turbhe & Bombaypada
10	Cement - OPC 53 Grade	MT	40 KM	Kalamboli
11	Joint Sealing compounds for joints in concrete	MT	25 KM	Bhandup, Mumbai
12	Poly - sulphide sealant for Joints in PUP/VUP	MT	15 KM	Sion, Mumbai
13	Thermoplastic Paint for Road Marking	MT	25 KM	Ghatkopar, Mumbai
				Andheri, Mumbai
14	Paver Blocks - 60 mm thick	NO	40 KM	Kalamboli
15	Kerb Stone	LM	40 KM	Kalamboli
16	Hume Pipes - NP-4 (Dia. 1800mm/1000mm/450mm)	NO	60 KM	Wada,Bhiwandi
				Vidyavihar,Mumbai
17	GI Strips - RE Works	NO		Mr. Kalpesh Jain -

Sr. No.	Material Description	Unit	Lead from site	Source
				(Mumbai Div.) - H.O- Unit no.902 to 906, 9th floor,Tower B, DLF Tower, Plot no.11, Jasola New-Delhi-110025 Tel-91-11-40567660-80

2.11.2. Transportation of materials

Mumbai being island city, materials can be transported to the site by sea route. Coastal shipping would be economical compared to road freight. Materials from sources within or outside Maharashtra can be conveyed to the site by accessing nearby Jetty locations. Materials coming from northern part of Mumbai like Gujarat via NH8 can use Gorai, Juhu Jetty facility.

Materials like boulders, armor rock quarry spalls, steel cement, and crush sand from sand plant area located in Uran and Navi Mumbai. Uran is considered as a potential location where continuous activity of loading & unloading of sand materials is done. Apart from these, various other locations used for jetty, ferry operations are listed below.

- Ghod bunder Road/ Reti bunder
- Juhu Jetty
- Gorai jetty
- Madh Beach
- Vashi Jetty
- JNPT
- Mora Jetty
- Sewri Timber Jetty
- Panvel Jetty
- JSW Jetty
- BWSL Jetty
- Mulund/Airoli Jetty
- Poynad Jetty

Figure 2.23 shows the details of existing Jetty's / Ferry's presently in use in nearby area.

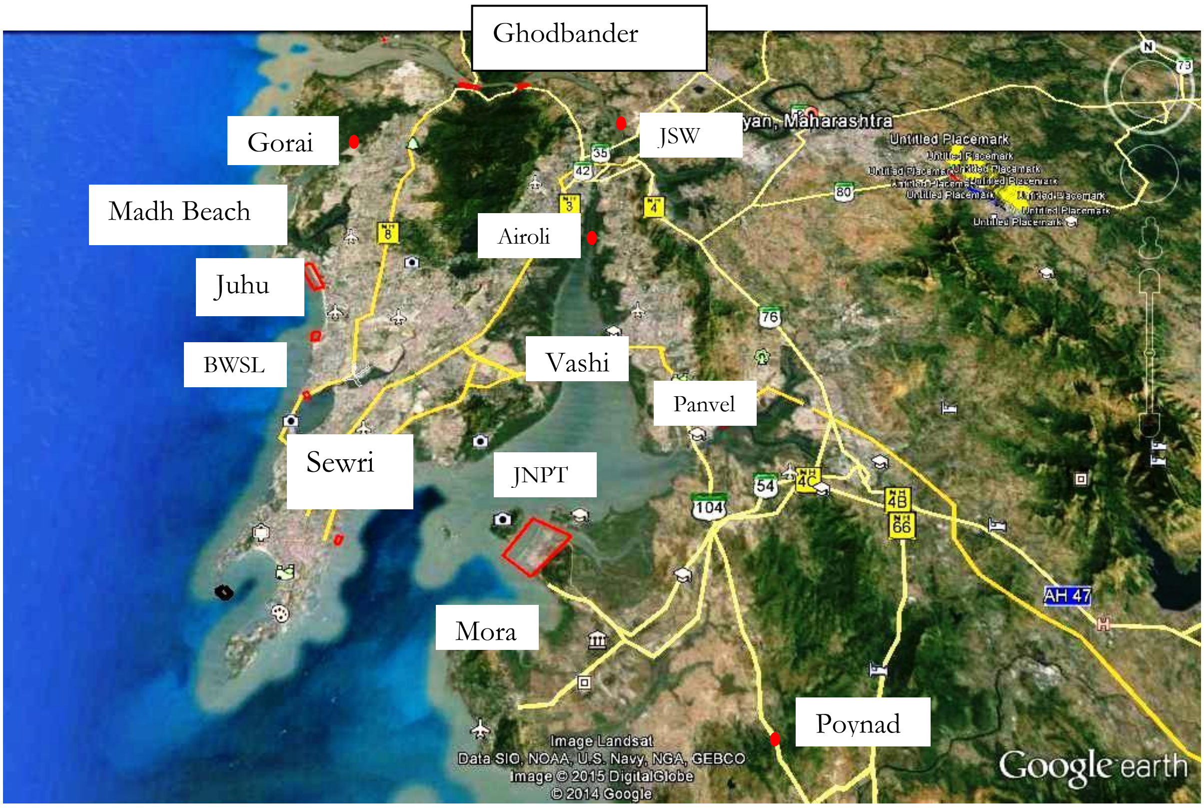


Figure 2.23: Details of Existing Jetty's / Ferry's presently in Use in nearby Area

Figure 2. Show the detailed water transportation plan.

Figure 2.24: Details of Water Transporttion Routes

2.11.3. Quarry Locations and Transportation Plan

Various quarry locations identified nearby areas are listed below. **Figure** shows the existing quarry locations nearby area along with proposed road alignment.

- Ghodbander Quarry
- Navi Mumbai Quarry
- Turbhe Quarry
- Ulwe Quarry

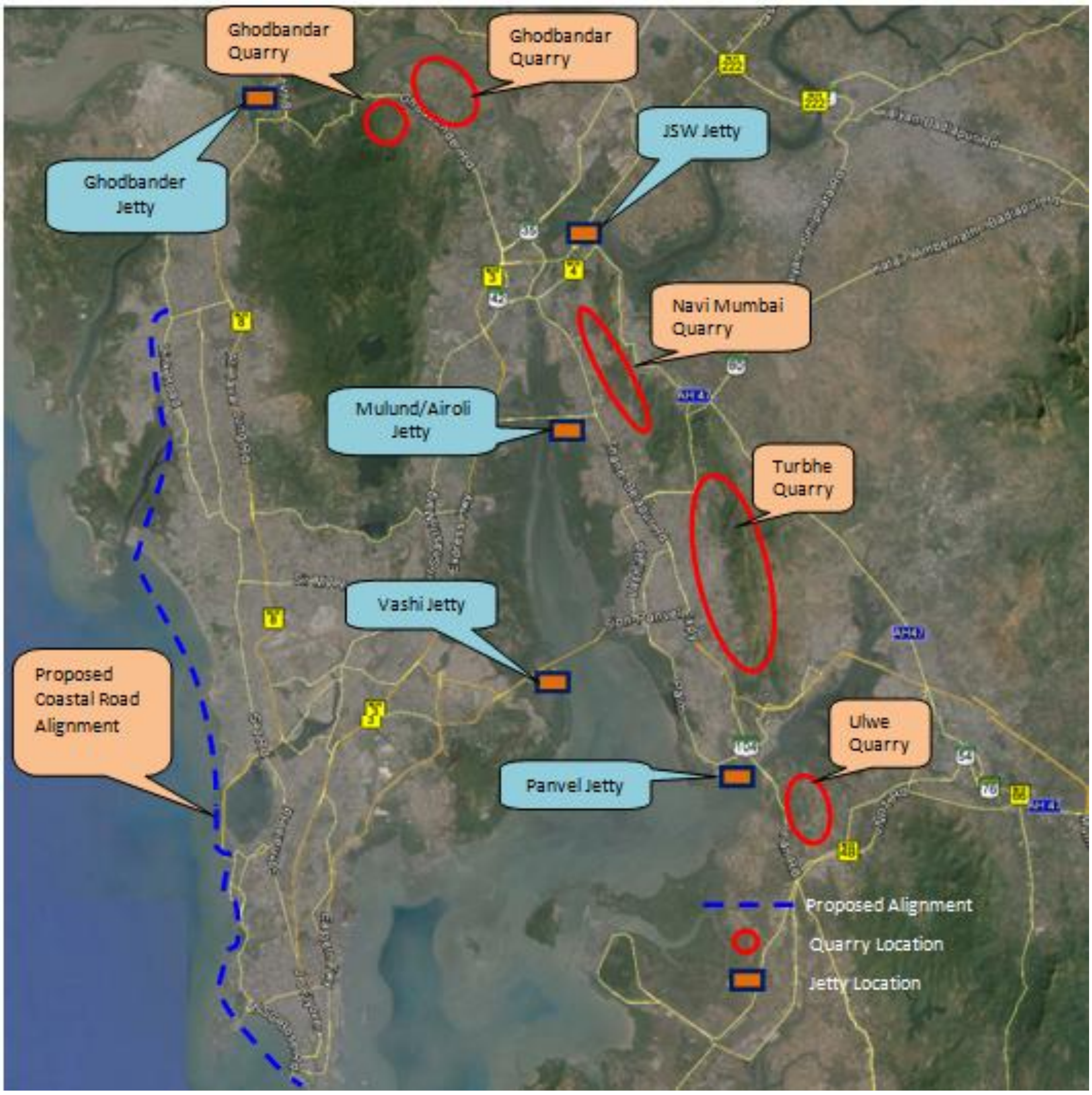


Figure 2.25: Quarry Locations

2.11.3.1. Ghodbander Quarry

Figure shows the transportation plan from Ghodbander quarry to jetty location. **Table** gives the detailed transportation plan form quarry location to jetty.

Figure 2.26: Transportation Plan from Ghodbander Quarry

Table 2.8: Detailed Transportation Plan from Ghodbander Quarry

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Earth for filling	Ghodbander Quarry	Ghodbander Jetty	8.5Km	Via Ghodbander Road

2.11.3.2. Navi Mumbai Quarry

Figure shows the transportation plan from Navi Mumbai (Airoli) quarry to jetty location. **Table 2.9** gives the detailed transportation plan from quarry to jetty location.

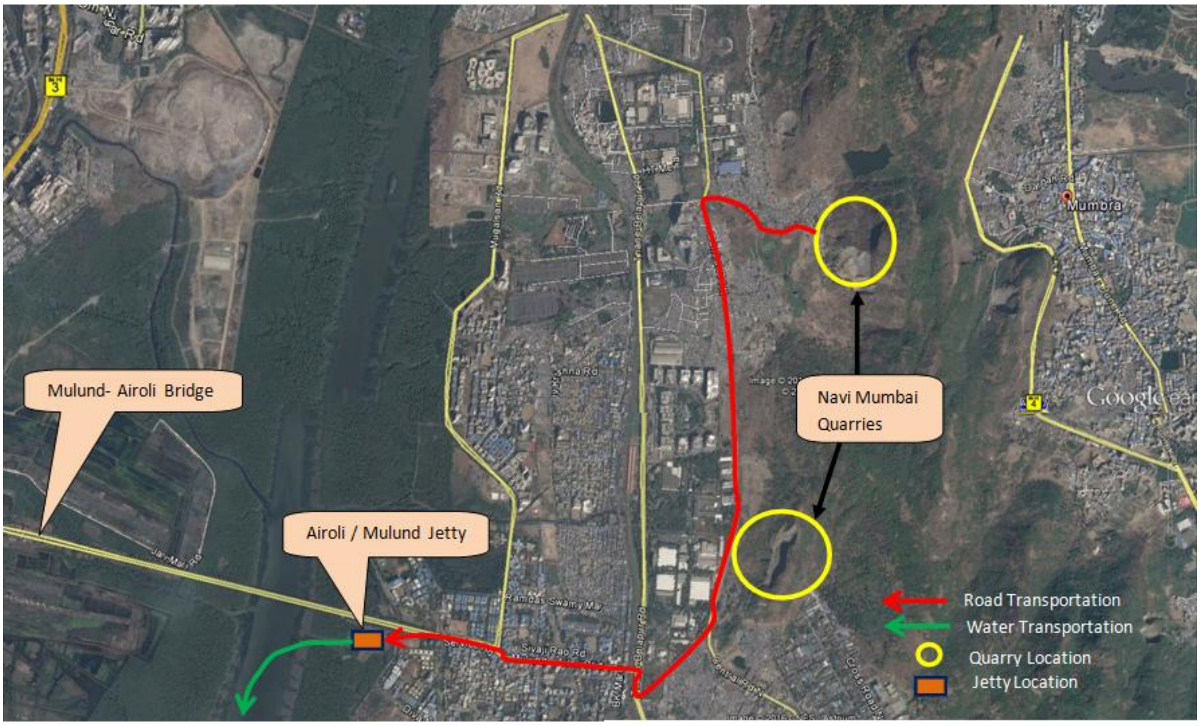


Figure 2.27: Transportation Plan from Navi Mumbai Quarry

Table 2.9 Detailed Transportation Plan from Navi Mumbai Quarry

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Earth for filling	Navi Mumbai	Airoli /Mulund Jetty	5.5Km	Central Road N → Mulund Airoli Bridge Road

2.11.3.3. Turbhe Quarry

Figure shows the transportation plan from Turbhe quarry to jetty location.**Table** gives the detailed transportation plan from quarry to jetty location.

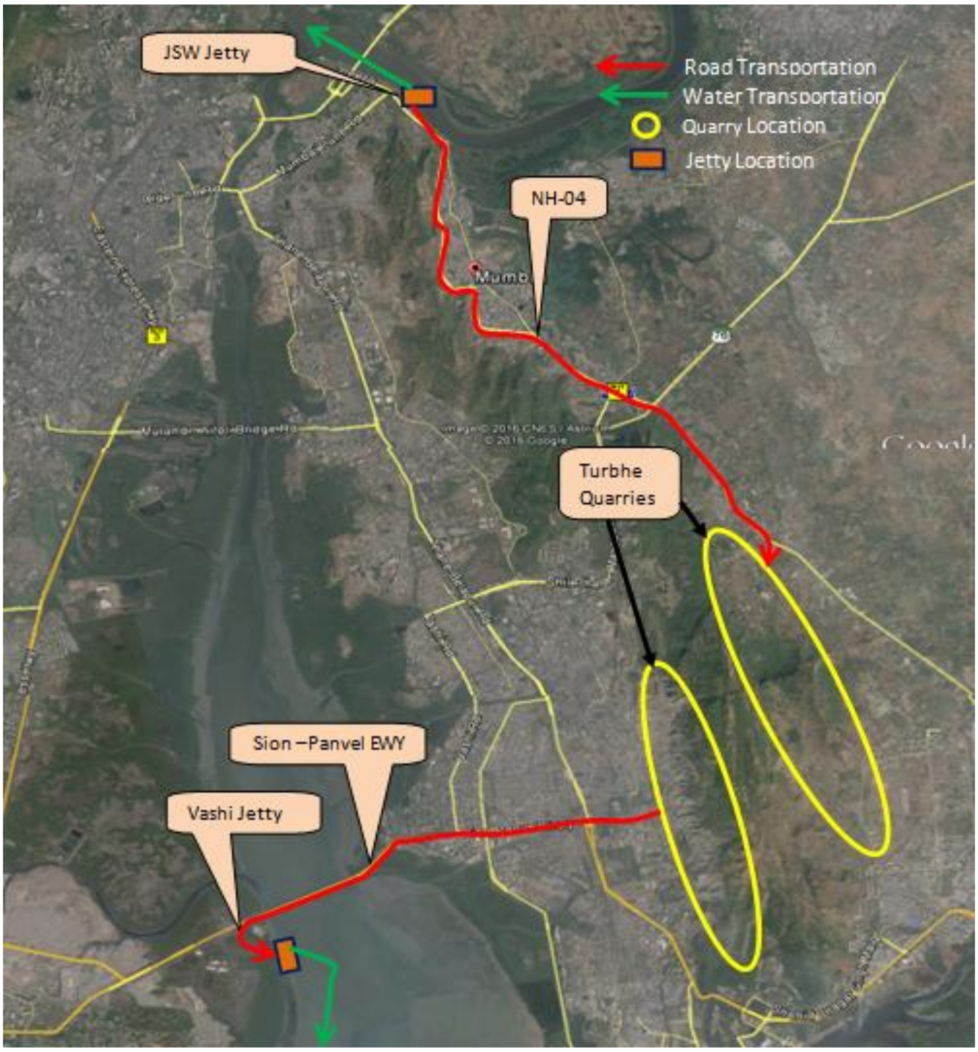


Figure 2.28: Transportation Plan from Turbhe Quarry

Table 2.10: Detailed Transportation Plan from Turbhe Quarry

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Earth for filling	Turbhe Quarry	Vashi Jetty	11Km	Via Sion- Panvel Express Way
Earth for filling	Turbhe Quarry	JSW Jetty near NH-04	16Km	Via NH-04

2.11.3.4. Ulwe Quarry

Figure shows the transportation plan from Ulwe quarry to jetty location.**Table 2.11 gives** the detailed transportation plan from quarry to jetty location.

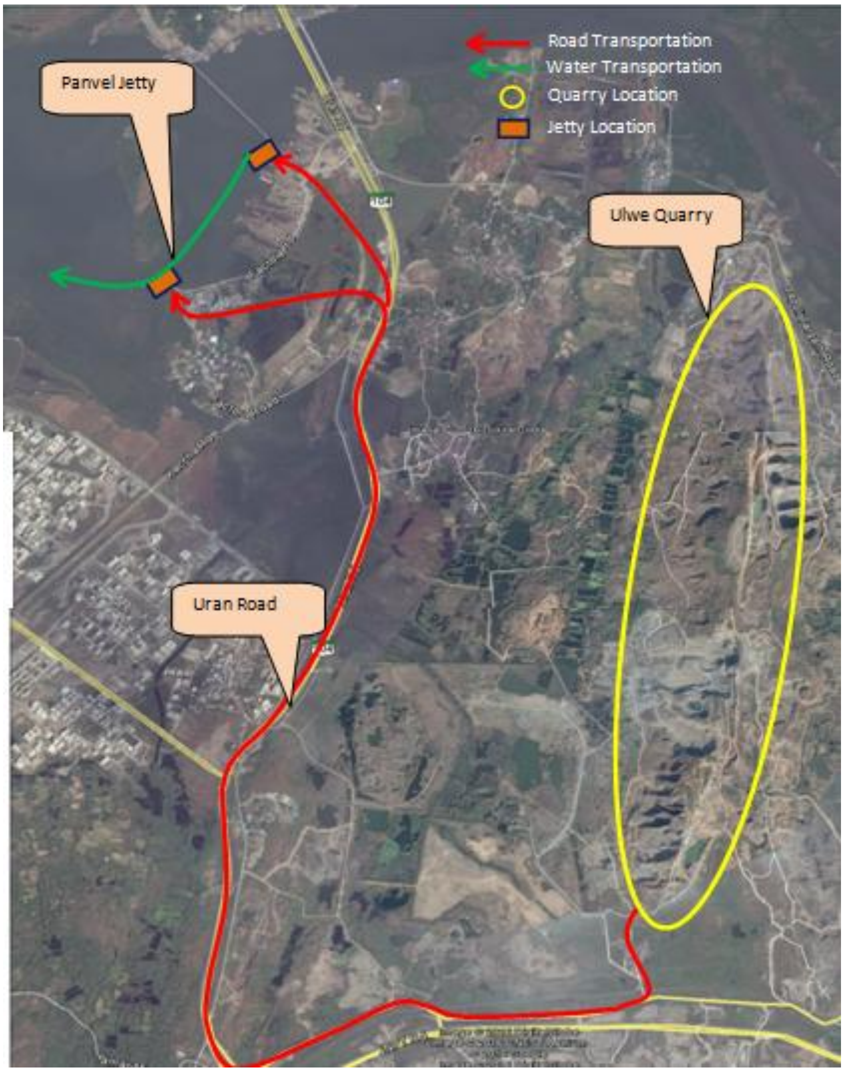


Figure 2.29: Transportation Plan from Ulwe Quarry

Table 2.11: Detailed Transportation Plan from Ulwe Quarry

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Earth for filling	Ulwe Quarry	Panvel Jetty	6.7Km	Via Uran Road

2.11.4. Steel yard Locations and Transportation Plan

Various steel yard locations identified nearby areas are listed below. **Figure** shows the steel yard locations nearby area along with proposed road alignment.

- Kalamboli Steel Yard
- JSW Steel Yard
- Turbhe Yard

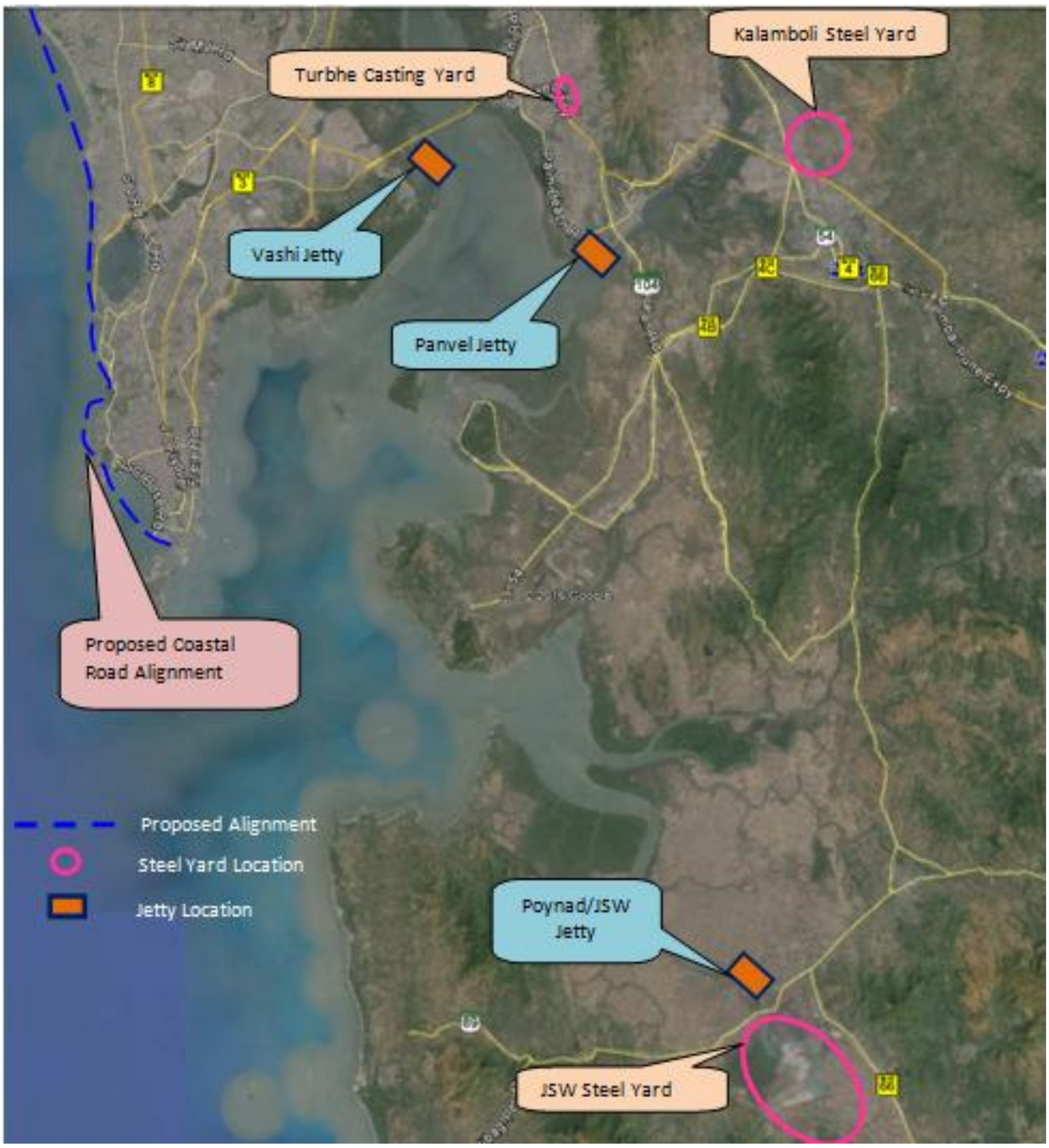


Figure 2.30: Steel Yard Locations

2.11.4.1. Kalamboli Steel Yard

Figure 2.31: Transportation Plan from Kalamboli Steel Yard

Figure 2.31 shows the transportation plan of materials from Kalamboli steel yard to jetty location. **Table 2.12 gives** the detailed transportation plan from steel yard to jetty location.

Table 2.12 Detailed Transportation Plan from Kalamboli Steel Yard

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Steel	Kalamboli Steel Yard	Panvel Jetty	15Km	Steel Market Road→ Kalamboli link Road →Sion-Panvel EWY → Uran Road

2.11.4.2. JSW Steel Yard

Figure shows the transportation plan from JSW steel yard to jetty location. **Table** gives the detailed transportation plan from yard to jetty location.

Figure 2.32: Transportation Plan from JSW Steel Yard

Table 2.13: Detailed Transportation Plan from JSW Steel Yard

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Steel	JSW Steel Yard	JSW Jetty	1.8Km	Via Alibag Pen Road

2.11.4.3. Turbhe Steel Yard

Figure shows the transportation plan from Turbhe steel yard to jetty location. **Table**

gives the detailed transportation plan from yard to jetty location.

Figure 2.33: Transportation Plan from Turbhe Yard

Table 2.14: Detailed Transportation Plan from Turbhe Steel Yard

Material	Location	Name of Jetty	Distance from Source to nearest Jetty Location	Route of Transportation
Steel	Turbhe Steel Yard	Vashi Jetty	7.8Km	Via Sion – Panvel EWY

Table 2.15 gives the source of different materials and its distance to various Jetty locations.

Table 2.15: Material Transportation Plan from Various Sources

Material	Location	Name of Jetty	Distance from Source upto Jetty
Aggregates	Navi Mumbai	Vashi Creek Jetty	9 Km
	Airoli Quarries	Airoli Jetty	5 Km
	Shilphata Quarries	NH 4 Jetty (Mumbra Bypass)	11 Km
	Ulwa Quarries	Panvel Creek Jetty (Uran Rd)	8 Km
	JWS	JWS Jetty	2.5 Km
Sand	Vaitharna	Panvel Creek Jetty	90 Km
Crush Sand	Turbhe Quarries	Vashi Creek Jetty	9 Km
Cement	Kalamboli	Vashi Creek Jetty	20 Km
Steel	Kalamboli	Vashi Creek Jetty	20 Km
Micro Sillica	Turbhe Industrial Area	Vashi Creek Jetty	9 Km
Fly ash	Dahanu	-	145 Km
	Nasik	-	190 Km
Chemical Admixture	Turbhe	Vashi Creek Jetty	9 Km
	Mumbai	Vashi Creek Jetty	9 Km
Water	MCGM		
Curing Compound	Mumbai	Vashi Creek Jetty	9 Km
	Mhape	Vashi Creek Jetty	9 Km
Steel Reinforcement (TMT Fe 500)	Kalamboli Stock Yard, Navi Mumbai	Vashi Creek Jetty	9 Km
FBEC (Fusion bonded epoxy coating)	Andheri	-	-
MS Plates - 6mm thick	Kalamboli Stock Yard, Navi Mumbai	Vashi Creek Jetty	9 Km
HT Strands	Borivali	-	5 Km
Pot cum PTFE bearings	Kolkata	-	2000 Km
	Bhopal	-	700 Km
Concrete Bonding Adhesive (Glue)	Turbhe	Vashi Creek Jetty	9 Km
Coal Tar Epoxy Paint	Mhape	Vashi Creek Jetty	9 Km
Anti Carbonation Paint for Superstructure & Substructure	Navi Mumbai	Vashi Creek Jetty	9 Km
	Kolkata	-	-
Cement based water proof paint	Mumbai	-	-

Material	Location	Name of Jetty	Distance from Source upto Jetty
Non- shrink, high strength cementations grout (fro bearing)	Ankleshwar, Gujarat	-	380 Km
Strips Seal Expansion Joint	Bhopal	-	700 Km
Water Proofing Membrane (3mm thick)	Borivali	-	5 Km
	Andheri	-	5 Km
Soil for Emb/ Sub grade & RE Wall works	Turbhe	Vashi Creek Jetty	9 Km
Fly ash	Dahanu	-	145 Km
	Nasik	-	190 Km
Granular Sub base (GSB)	Turbhe	Vashi Creek Jetty	9 Km
	Mhape	Vashi Creek Jetty	9 Km
Wet Mix Macadam (WMM)	Mhape	Vashi Creek Jetty	9 Km
Emulsion for Prime Coat	Turbhe	Vashi Creek Jetty	9 Km
Emulsion for Tack Coat	Turbhe	Vashi Creek Jetty	9 Km
Bitumen Grade - 10/20,30/40,60/70	Mhape	Vashi Creek Jetty	9 Km
Joint sealing compound for joints in concrete	Bhandup	Vashi Creek Jetty	25 Km
Poly -Sulphide sealant for joints in PUP/ VUP	Sion	Vashi Creek Jetty	15 Km
Thermoplastic Paint for Road Marking	Ghatkopar	Vashi Creek Jetty	25 Km
	Andheri	Vashi Creek Jetty	25 Km
Paver Blocks - 60mm thick	Kalamboli	Vashi Creek Jetty	40 Km
Kerb Stone	Kalamboli	Vashi Creek Jetty	40 Km
Hume Pipes – NP4 (dia 1800 mm/ 1000mm/450mm	Wada , Bhiwandi	Vashi Creek Jetty	60 Km
GI Strips- RE Works	Delhi	-	-

2.12 Legal Framework

In 1976, the 42nd Constitutional Amendment introduced Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. The legal framework for environmental issues related to road projects can be best described as National level and State level legislation:

The Government of India has laid out various policy guidelines, acts and regulations pertaining to sustenance of environment. The Environment (Protection) Act, 1986 provides umbrella legislation for the protection of environment. As per this Act, the responsibility to administer the legislation has been jointly entrusted to the Central Ministry of Environment and Forests (MOEF) and the Central Pollution Control Board (CPCB) / State Pollution Control Board (SPCB).

The lists of all applicable Government of India / State Government regulations are provided below with most relevant details.

Table 2-16 Summary of Applicable Regulations

Sl. No	Applicable GOI Policies & Regulations	Year	Objective	Reason for applicability
1	Environmental (protection) Act	1986	To protect and improve overall environment	Environment in general
2	Environment Impact Assessment (EIA) notification	1994	Requirement of Environmental impact Assessment	Direct
3	Environment Impact Assessment (EIA) notification	2006/ 2009 2013	For impact assessment of infrastructure projects	CRZ clearance
4.	Coastal Regulation Zone Notification	2011	To conserve and protect coastal stretches, its unique, environment and its marine area	CRZ Clearance
4	Air (prevention and control of pollution) Act as amended in 1987	1981	To control air pollution by controlling emission and air pollutants according to prescribed standards	Air pollution

Sl. No	Applicable GOI Policies & Regulations	Year	Objective	Reason for applicability
5	Water (Prevention and Control of Pollution) Act and Cess Act of 1977 as amended in 1988	1974	To control water pollution by controlling emission & Water pollutants as per the prescribed standards	Water pollution
6	Indian Forest (Conservation) Act	1980	Protection of Mangrove forests	Forests
7	The Wildlife (Protection) Act	1972	Protection of Wild Life	Wildlife
8	Ancient Monuments and Archaeological sites & Remains Act	1958	Conservation of Cultural and Historical remains found in India	Archaeologic al remains
9	The Land Acquisition Act	1894 & 1989	Set out rule for acquisition of land by Government.	Land acquisition
10	Noise Pollution (Regulation and Control) rules 2000	2001	Noise pollution regulation and controls	Control of Noise pollution
11	NOC from Honorable High Court	Refere nce to PIL 87 of 2006	Conservation of Mangroves	Mangrove protection
12	Maharashtra Maritime Board Act 1996	1996	Permission for activities using water front	The proposed coastal road project involves activities using the waterfront, hence permission is required.

CHAPTER 3

3. Analysis of Alternatives

3.1 Introduction

Report on "Mumbai Coastal Freeway Concept" by Joint Technical Committee towards this project has been made available by MCGM to us. This report presents two alternative alignment options.

After reviewing same we explored various other alignment options. This chapter describes all the options that have been made for various aspects of the project road.

We have studied various options for the proposed road, based on the objectives mentioned in the report. Satellite imagery and levels extracted from Google Earth Pro software, assisted by site visits/reconnaissance survey were used to determine various alignment options. Six alignment options were considered including two options of joint Technical Committee and evaluated considering socio economic parameters. For each alternative block cost estimate is prepared. Total alignment is divided into two parts considering the terrain classification and further sub divided in sections as detailed below

3.2 Project Sections

Part A: South Section (Princess Street Flyover Road to Worli End of Sea Link)

Section 1: Princess Street Flyover Road to Priya Darshini Park

Section 2: Priya Darshini Park to Mahalaxmi

Section 3: Mahalaxmi to Baroda Palace

Section 4: Baroda Palace to Bandra Worli Sea Link (Start)

Part B: North Section (Bandra End of Sea Link to Kandivali Junction)

Section 5: Bandra Worli Sea Link (End) to Carter Road Mandir

Section 6: Carter Road Mandir to Ritumbhara College

Section 7: Ritumbhara College to Kandivali Junction

3.3 Discussion on Project Sections

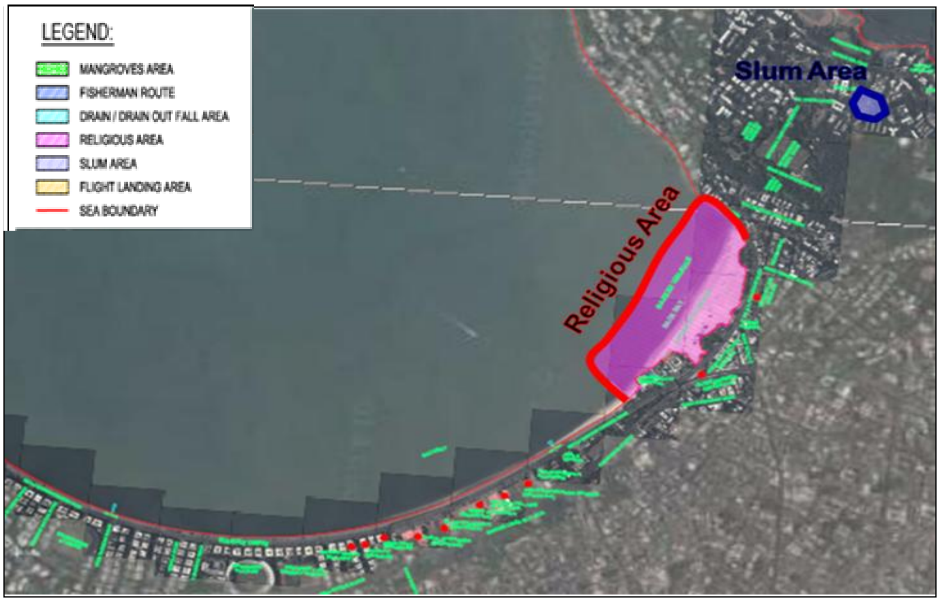
Report on "Mumbai Coastal Freeway Concept" by Joint Technical Committee towards this project has been made available by MCGM to us. This report presents two alternative alignment options.

After reviewing same we explored various other alignment options. This chapter describes all the options that have been made for various aspects of the project road.

We have studied various options for the proposed road, based on the objectives mentioned in the report. Satellite imagery and levels extracted from Google Earth Pro software, assisted by site visits/reconnaissance survey were used to determine various alignment options. Six alignment options were considered including two options of joint Technical Committee and evaluated considering socio economic parameters. For each alternative block cost estimate is prepared. Total alignment is divided into two parts considering the terrain classification and further sub divided in sections as detailed below.

Part A: South Section (Princess Flyover Road to Worli end of Sea Link)

- Section 1: Princess Flyover Road to Priya Darshini Park



In this section main constraint is Religious area near Girgaon Chowpati and slum areas near Bimla House as shown above.

- Section 2: Priya Darshini Park to Mahalaxmi

In this section main constraints are slum are near Clinical Diagnostic Centre, Heritage structure at Lincolon House (Grade II-B) and Religious place at Mahalaxmi Temple as shown above.

- Section 3: Mahalaxmi to Baroda Palace

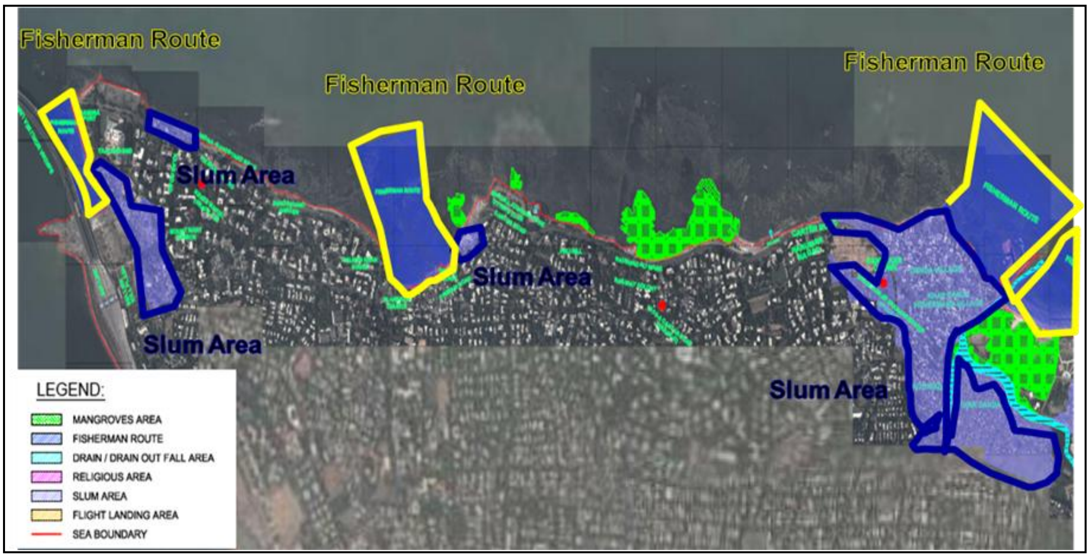
In this section main constraints are Slum area, Religious area at Haji Ali and at Baroda Palace as shown above

- Section 4: Baroda Palace to Worli End of Sea Link

In this section main constraints are Religious area at Baroda Palace, Slum areas at near Poonam Chembers and near Worli dairy, drainage outfall of worli Dairy as shown above.

Part 2: North (Bandra end of Sea Link to Kandivali Junction)

- Section 5: Bandra end of Sea Link to Juhu Sea Side Garden

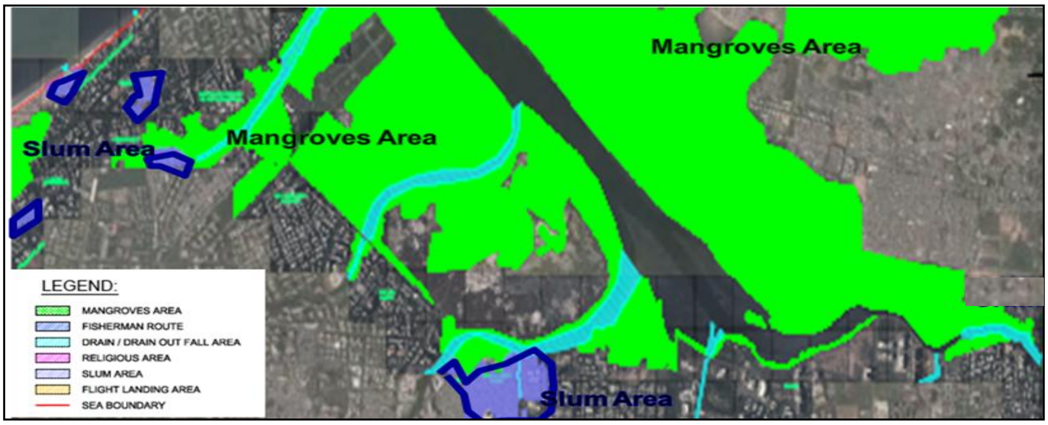


In this section main constraints are Fisherman's route near Bandra Worli sea link toll plazaBandra Band Stand, Chambai Village, near Khar danda village and slum area near Khar danda village and Mangroves near Bandra Joggers Park, near Pali Hill, Naushad Ali margs shown above.

- Section 6: Juhu Sea Side Garden to Ritumbhara College

In this section main constraints are Fisherman's route near Juhu Sea Side Garden, Juhu airport Flight Landing and Slum Areas at neat Leela Bunglow, Indra Nagar, Juhu Koliwada, near Moragaon Juhu and Mangroves area near Versova , Juhu beach,Rajiv Gandhi Institite of Technology,Bharat nagarshown above.

- Section 7: Ritumbhara College to Kandivali Junction and Central Institute of Fisheries, Versova to Madh Island



In this section main constraints are Slum Areas, Drainage outfalls towards Madh Island, near Yamuna nagar and near Oshiwara, Mangroves area as shown above.

3.4 Analysis of Alternatives

Various alternatives were considered for finalization of alignment. Comparative study is required to assess the pros and cons of each alternative. In this connection few parameters have been assigned under which platform each alternative may be compared. These parameters are as follows:

- Length of the alignment
- Reclamation area (Land filled road and Ramp portion tunnel entry and exit)
- Tunnel
- Bridge on sea
- Elevated Road
- Road on Stilts
- Interchanges
- No of Heritage structures
- Cost

On the basis of above said parameters six alternatives are described in the following table:

Table 3.1: Analysis of Alternatives

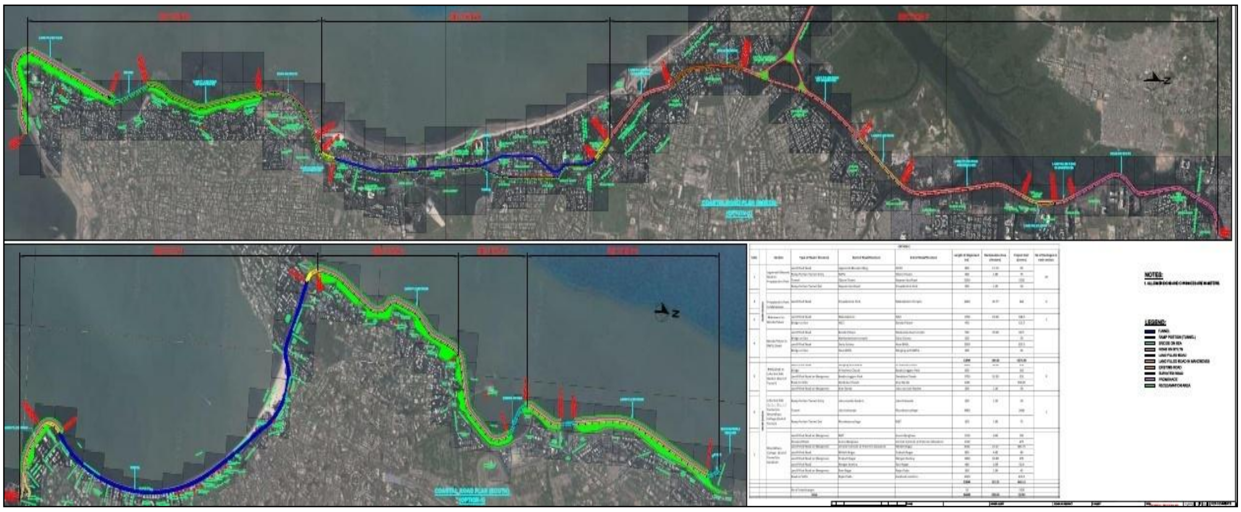
Parameters	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Length of the alignment (M)	36600	36625	35600	35600	34150	35110
Reclamation area (Hectare) *(Land filled road/Ramp portion tunnel entry and exit)*	228	153	292	180	126	132
Tunnel length (m)	9100	9100	1200	8800	8750	8750
Length of Bridge on Sea (m)	1450	1350	3225	6450	3270	1270
Land filled road on Mangroves (m)	9645	2000	9810	7420	9200	9555
Elevated Road (m)	1100	1100	1050	1040	1090	1100
Road on Stilts (m)	3475	12025	2460	2460	2450	2450
No. of Interchanges	14	14	14	14	14	14
No of Heritage structures	17	17	17	17	17	17
Project Cost (crores)	11233	12111	7367	11312	11032	9529

3.4.1. Discussions on Analysis of Alternatives

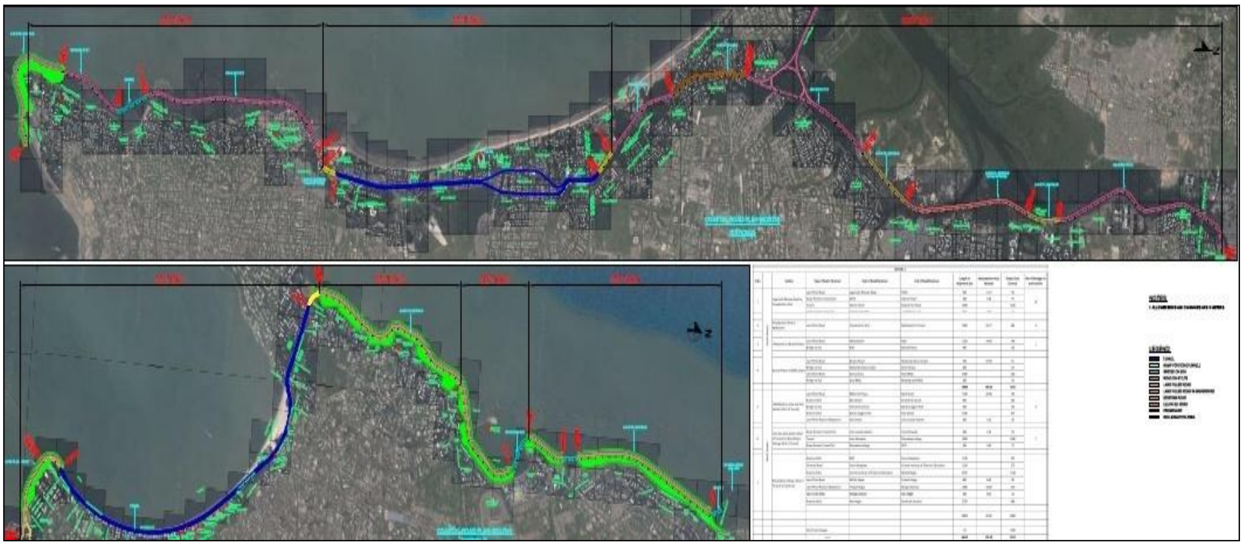
Advantages and disadvantages of various options are summarised below:

Options	Advantages	Disadvantages
Option 1	Alignment on reclamation will add to shore protection	• CRZ notification need to be amended • High social impact due to RAR • Cost of option is Rs11233cr • Alignment has sharp curves • Impact on Mangrove Forest • Construction of cut & cover tunnel under Marine Drive will be difficult. Construction of tunnel under high rise buildings is risky and also requires clearance from Airport Authority
Option 2	Alignment on Stilt is easier for CRZ clearance. Minimum impact on Mangrove forest	• CRZ notification need to be amended • Road on Stilt will block sea view, hence aesthetically not preferred • High social impact due to RAR • Cost of option is Rs12,111cr • Alignment has sharp curves • Construction of tunnel under Marine Drive will be difficult
Option 3	• Cost of option is Rs7366cr • Road on reclamation will provide additional protection to city from intensive storm surges due to Climate Change	• CRZ notification need to be amended • High environmental impact due to reclamation • High social impact due to RAR • Impact on Mangrove Forest • Alignment has fewer sharp curves • Extension of marine drive by reclamation
Option 4	• Cost of option is Rs11311cr • Road sections on reclamation will provide additional protection to city from environmental changes due to Climate Change • Muck from tunnel can be used for reclamation and strengthening of shore protection	• CRZ notification need to be amended • High environmental impact due to reclamation • High social impact due to RAR • Impact on Mangrove Forest • Tunnel inside Sea shall require provision of separate tunnel for pedestrian emergency exit • Straight bridge near Haji Ali will impact on heritage value

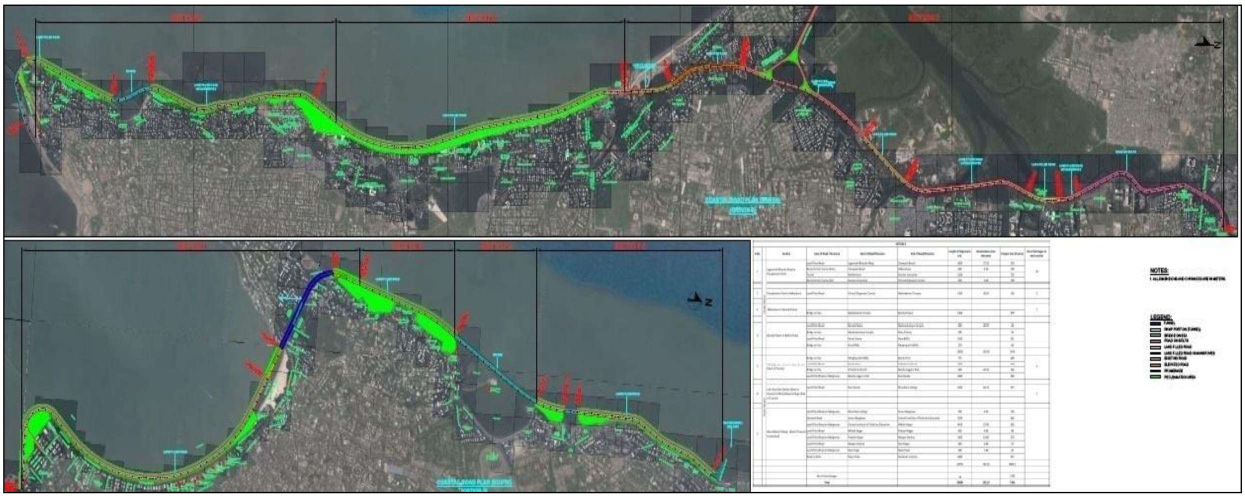
Options	Advantages	Disadvantages
	• Tunnel below sea will easier to build with TBM • Better alignment compared to other options	
Option 5	• Cost of option is Rs11033cr • Road sections on reclamation will provide additional protection to city from environmental changes due to Climate Change • Muck from tunnel can be used for reclamation and strengthening of shore protection • Tunnel below sea will easier to build with TBM • Better alignment compared to other options	• CRZ notification need to be amended • High environmental impact due to reclamation • High social impact due to RAR • Impact on Mangrove Forest • Tunnel inside Sea shall require provision of separate tunnel for pedestrian emergency exit • Straight bridge near Haji Ali will impact on heritage value.
Option 6	• Road sections on reclamation will provide additional protection to city from environmental changes due to Climate Change • Muck from tunnel can be used for reclamation and strengthening of shore protection • Tunnel below sea will easier to build with TBM • Better alignment compared to other options	• High environmental impact due to reclamation • High social impact due to RAR • Tunnel inside Sea shall require provision of separate tunnel for pedestrian emergency exit • Straight bridge near Haji Ali will impact on heritage value



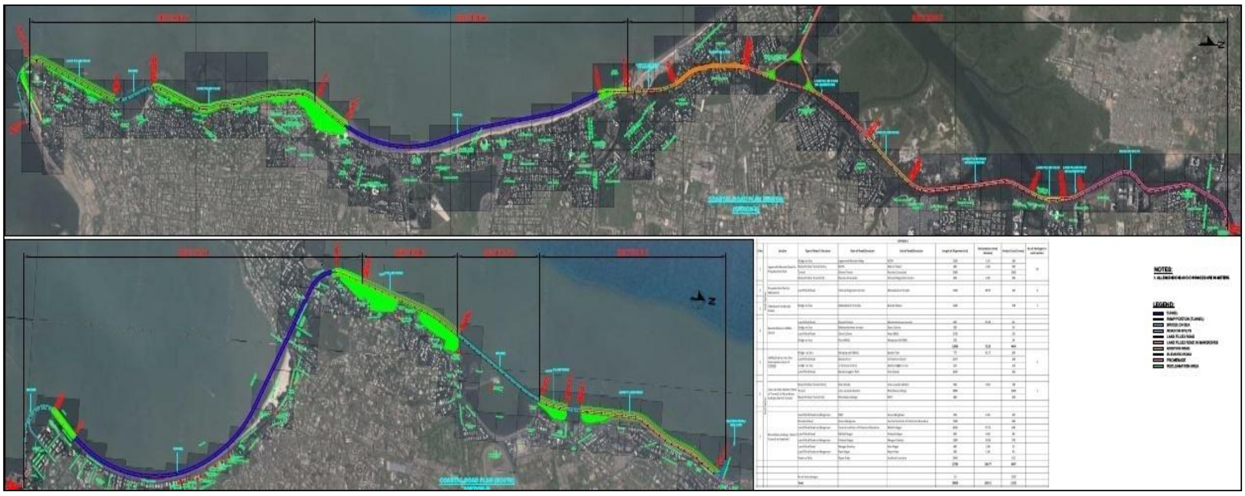
Alignment Option-1



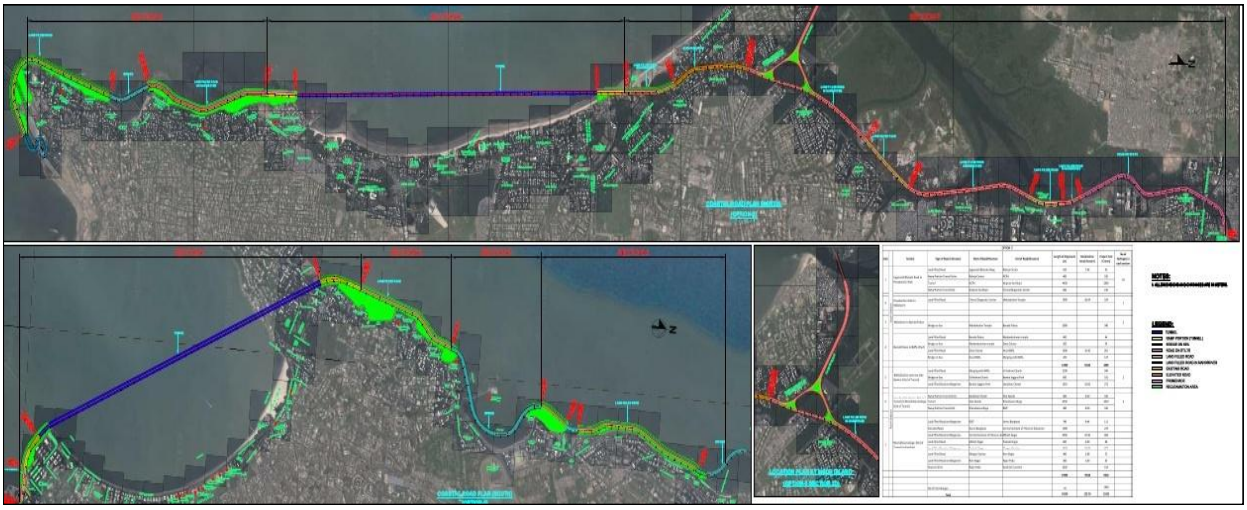
Alignment Option-2



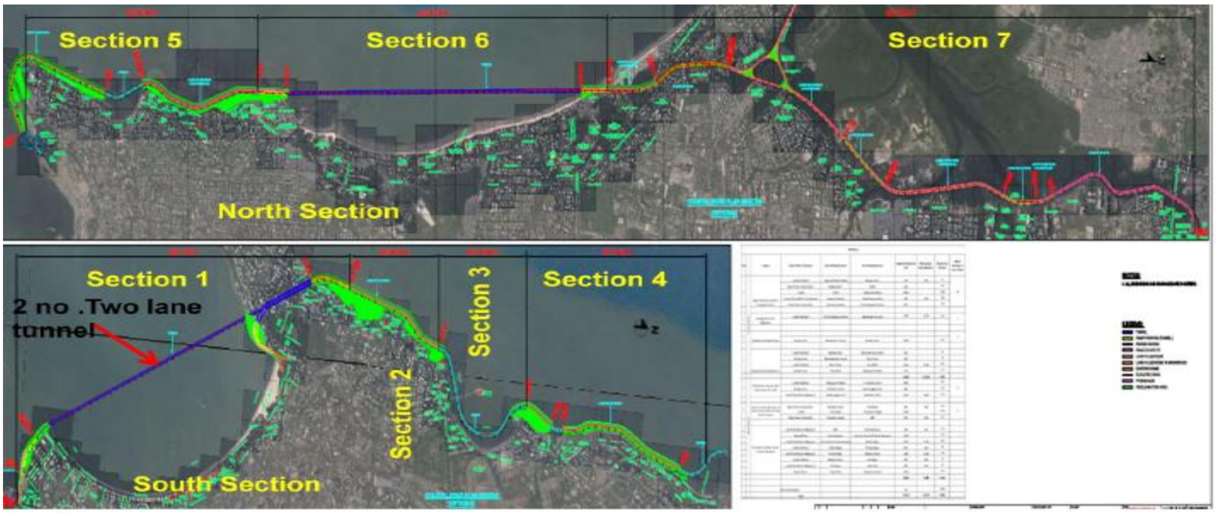
Alignment Option-3



Alignment Option-4



Alignment Option-5



Alignment Option – 6

3.5 Recommended Alignment Option- Option 7

Comparing pros & cons of all six Alignment options, we recommend alignment Option 7 as final. Giving hereunder the details of all seven Sections for the recommended alignment Options -7:

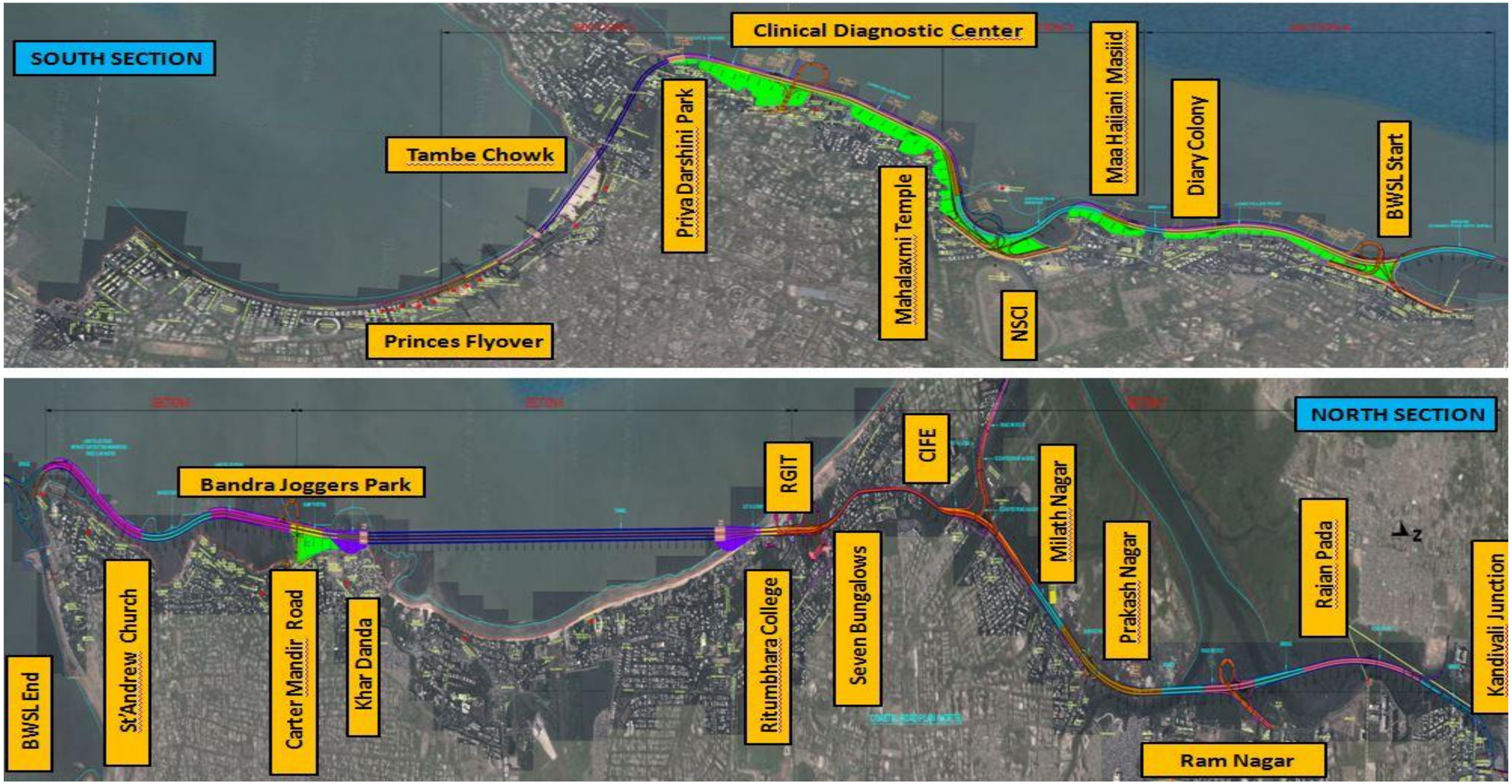


Figure 3.1: Alignment of Mumbai Coastal Road Project (Option 7)

CHAPTER 4

4. Description of the Environment

4.1 Introduction

This chapter describes the existing environmental settings in the study area. In order to identify any potential impact on and changes to the natural and socioeconomic environments, it is essential to have a thorough understanding of the nature of those existing environments prior to commencement of the proposed activities. This translates as a need to characterize the existing baseline environmental and socio-economic conditions including establishing the prevailing conditions for a range of media through primary monitoring, undertaking focused surveys, and the collection of secondary information from various published sources. This includes the physical environment comprising air, water and land components, the biological environment, and socio-economic environment. The major purposes of describing the environmental settings of the study area are:

- To understand the environmental characteristics of the area;
- To assess the existing environmental quality, as well as the environmental impacts of the future developments being studied;
- To identify environmentally significant factors or geographical areas that could influence any decision about future development.

Attributes of the physical environment like air, water, soil, and noise quality in the surrounding area were assessed, primarily through field studies, and by undertaking monitoring and analysis of samples collected from field. Information about geology, hydrology, prevailing natural hazards like earthquakes, etc have been collected from literature reviews and authenticated information made available by government departments. Extensive surveys were carried out to understand and record the biological environment prevailing in the area and the same was verified against published information and literature

4.2 Natural Environmental setting of the Project Corridor

The existing natural environmental setting of the project area can be depicted with the help of following baseline condition as described below:

4.2.1. Location

Greater Mumbai district is located on the western most periphery of the Maharashtra State. Greater Mumbai district comprises South Salsete, Trombay and Bombay islands having a geographical area of 603 sq. km. (Mumbai City- 69 sq. km. and Mumbai Suburbs- 534 sq. km.). The district is bounded by north latitude 18°53’ and 19°19’ and east longitude 72°47’ and 72°58’. Arabian Sea lies on the southern and western side of the district while it borders Thane district in the north and eastern side.

The proposed coastal road project (approximately 29.20 km) falls within Greater Mumbai district .It starts from Princess Flyover to Kandivili. It is proposed to be extended further north connecting Madh Island, Gorai and Dahisar

Mumbai lies at the mouth of the Ulhas River on the western coast of India, Many parts of the city lie just above sea level, with elevations ranging from 10 m (33 ft) to 15 m (49 ft); the city has an average elevation of 14 m (46 ft). Northern Mumbai (Salsette) is hilly, and the highest point in the city is 450 m (1,476 ft) at Salsette in the Powai–Kanheri ranges.

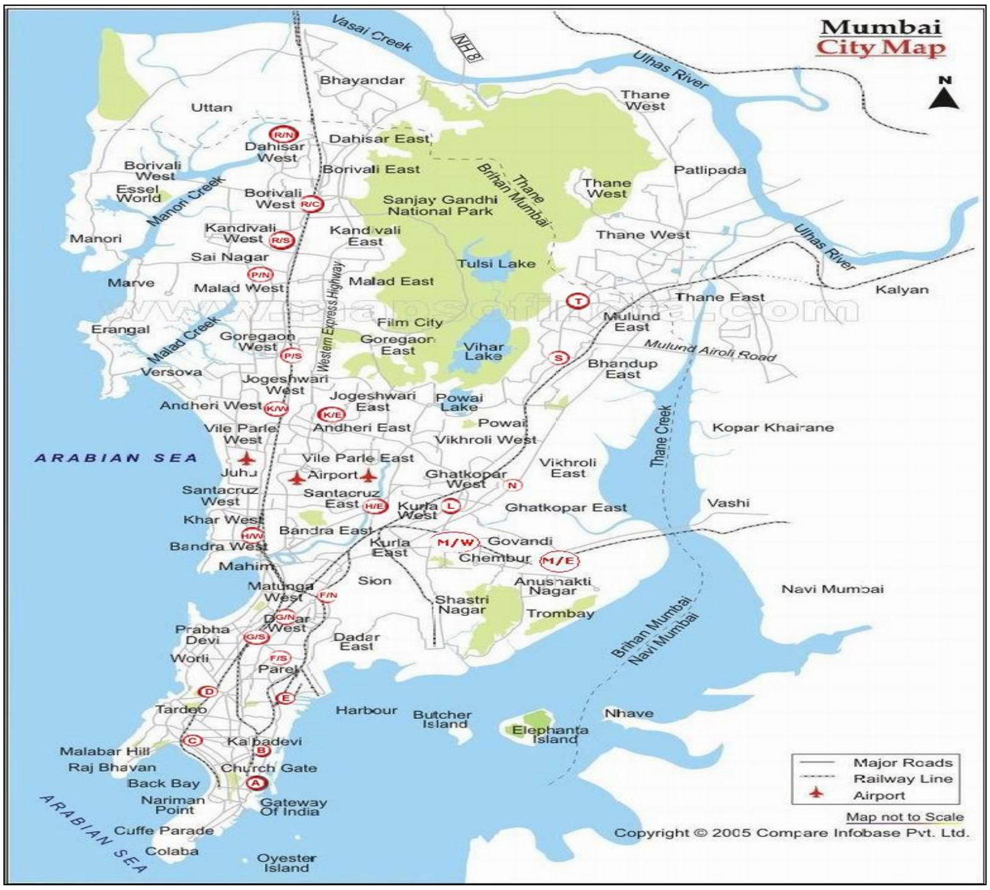


Figure 4.1: Map of Greater Mumbai Region

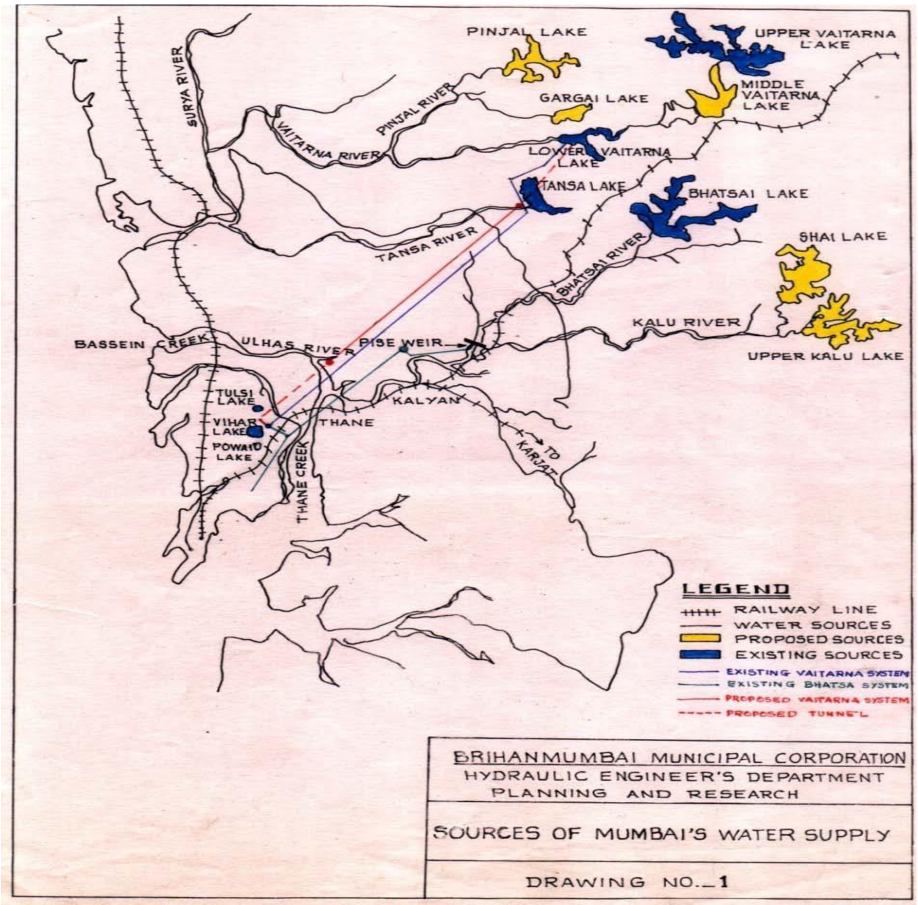
4.2.2. Climatic Conditions

Mumbai, being on the seacoast, experiences a tropical savanna climate with a heavy southwest monsoon rainfall of more than 2100 millimeters a year. Mumbai experiences three seasons– summer from March to May, monsoon between June and September and winter during October to February. The city receives heavy rainfall during monsoon and relative humidity is quite high during this season. Similarly, winds are generally moderate but pick up during monsoon months

The mean minimum temperature is 16.3°C and the mean maximum temperature is 32.2°C a t Santacruze. The normal annual rainfall over the district varies from about 1800 mm to about 2400 mm. It is minimum in the central part of the district around Kurla (1804.9 mm). It gradually increases towards north and reaches a maximum around Santacruze (2382.0 mm).

4.2.3. Water resources

Apart from the Bhatsa Dam, there are six major lakes that supply water to the city: Vihar, Lower Vaitarna, Upper Vaitarna, Tulsi, Tansa and Powai. Tulsi Lake and Vihar Lake are located in Borivili National Park, within the city's limits. The supply from Powailake, also within the city limits, is used only for agricultural and industrial purposes. Three small rivers, the Dahisar River, Poinsar (or Poisar) and Ohiwara (or Oshiwara) originate within the park, while the polluted Mithi River originates from Tulsi Lake and gathers water overflowing from Vihar and Powai Lakes. City pone to water shortages in years of scanty rainfall



4.2.4. Physiography and Soil Types

The broad physiographic features of are broad and flat terrain flanked by north – south trending hill ranges. The hill ranges form almost parallel ridges in the eastern and western part of the area. The Powai – Kanheri hill ranges are the other hill extending in the eastern and central part running NNE – SSW. The maximum elevation of the area is 450 m above mean sea level (mamsl) at some of the peaks of hill ranges. Trombay Island has north – south running hills with maximum elevation of 300 m above man sea level (m amsl). Malbar, Colaba, Worli and Pali hills are the isolated small ridges trending north – south in the western part of the district. The Powai – Kanheri hills form the largest hilly terrain in the central part of the Salsette Island and are the feeder zone for the three lakes viz., Powai, Vihar and Tulsi.

There are a number of creeks, dissecting the area. Among them, Thane is the longest creek. Other major creeks are Manori, Malad and Mahim which protrudes in the main land and give rise to mudflangs and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.

Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil. Soil cover in the city region is predominantly sandy due to its proximity to the sea. In the suburbs, the soil cover is largely alluvial and loamy.

4.2.5. Geology and Geomorphology

The entire Greater Mumbai area is occupied by Deccan basalt flows and their acid and basic variants, poured out between the late Cretaceous and Early Eocene time. The basaltic flows are horizontally bedded and are more or less uniform in character over wide areas. Certain extrusive and intrusive mafic types are associated with basalts and are found in Mumbai Island and its vicinity. Further some fossiliferous sediment mainly of tufaceous origin and partly of fresh water origin, rich in fauna are also found in Mumbai area.

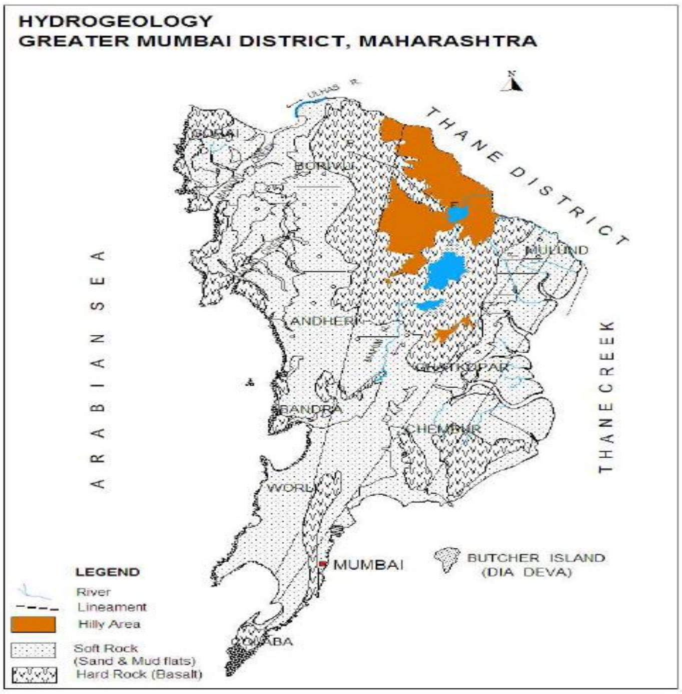
Mumbai Island has ridges along its western and eastern side. The city of Mumbai is built on central low-lying part of the Island. The western ridges comprise stratified ash beds.

4.2.6. Ground Water Scenario

The entire area is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occur as narrow stretch along the major river flowing in the area

In hard rock areas the ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing etc., of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers. Generally the phreatic aquifer range down to depth of 15 m BGL. The water bearing zone down to depth of 35 m bgl forms the semi confined aquifer and below this deeper aquifer down to depth of 60 m BGL is observed. The yield of the dugwells varies form 10 to 1000 m^3/day, whereas that of bore wells ranges between 50 and 1000 m^3/day. It is expected that the potential of deeper aquifers would be much more limited as compared to the unconfined/phreatic aquifer.

In soft rock areas which constitutes most the study area , the river Alluvium patches along the course of rivers and Marine Alluvium in the coastal area, are highly potential aquifer but with limited areal extent. The ground water occurs under water table condition in sandy / gritty layers. The alluvial fill of low lying areas underlain by weathered basalt has relatively better ground water potential.



Source : Central Gouundwater Board

4.2.7. Major Ground Water Problems and Issues

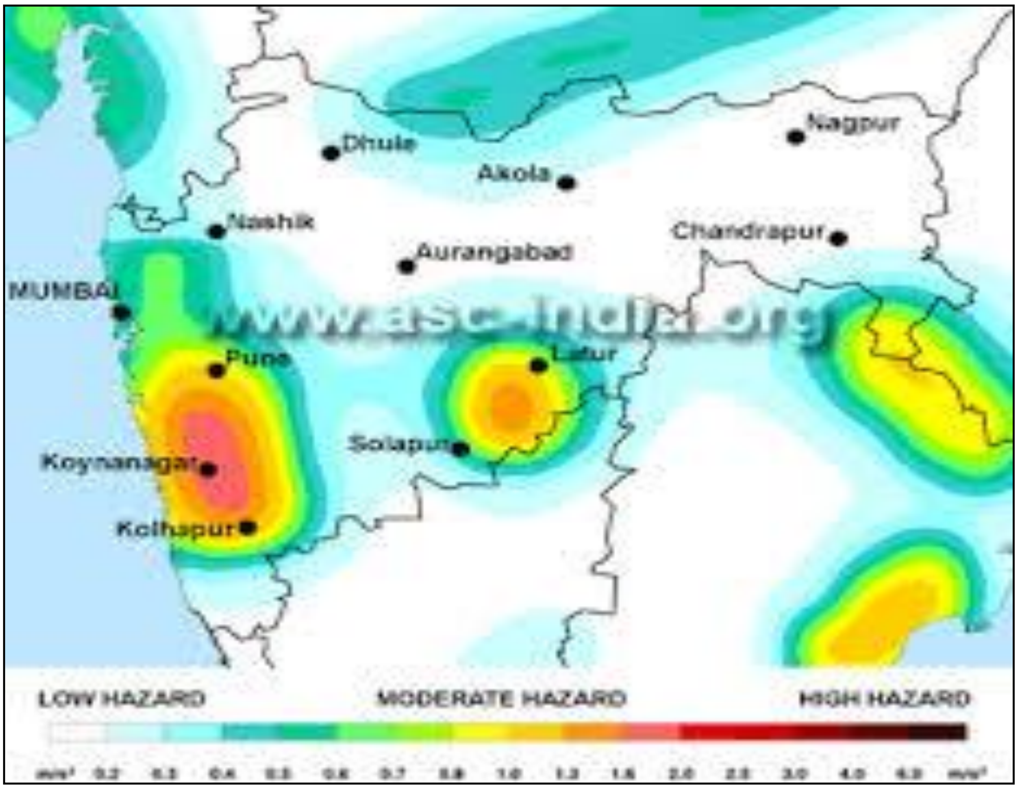
The pollution of ground water as well as surface water is the major problem in the area. The creeks in the region have become the dumping ground of sewage and industrial effluents. In addition to this, various industrial effluents from oil refineries, reactors, fertilizers plants at Chembur have polluted the sea water in eastern part and are hazardous to marine life.

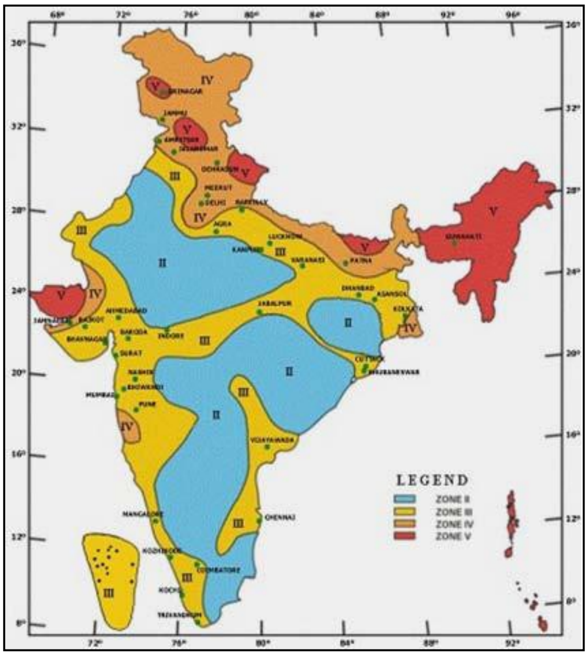
The data of Maharashtra Pollution Control Board (MPCB) indicate high concentration of Mercury (Hg) than the prescribed limit of 1.90 ppm. The higher Arsenic (As) concentration of more than 2.00 ppm and slightly more is observed in fishes from Thane and Chembur. The other heavy metals like Lead (0.60 ppm), Cadmium (12.60 ppm) and Copper (8.84 ppm) are also reported from creek water.

Ground water exploitation for commercial purpose is carried out in entire district and the water is extracted from existing dugwells and borewells, even new borewells are also being drilled for this purpose. The ground water is used for construction purposes, hotel industry and for domestic purpose of the housing societies. Excessive ground water development in the beach and coastal areas can lead to saline water intrusion as observed in some parts of Colaba, Dharavi and Khar from BMC data.

4.2.8. Seismic Hazards

Mumbai sits on a seismically active zone owing to the presence of 23 fault lines in the vicinity. The area is classified as a Seismic Zone III region, which means an earthquake of up to magnitude 6.5 on the Richter-scale may be expected.





Zone	Magnitude
Zone V	Very High Risk Quakes of Magnitude 8 and greater
Zone IV	High Risk Quakes upto Magnitude 7.9
Zone III	Moderate Risk Quakes upto Magnitude 6.9
Zone II	Seismic Disturbances upto Magnitude 4.9

Figure 4.2 : Seismic Hazard Map showing Mumbai

4.2.9. National Park

Sanjay Gandhi National Park (Borivali National Park) is located partly in the Mumbai suburban district, and partly in the Thane district, and it extends over an area of 103.09 km^2 (39.80 sq mi) falls within 10 km radius area of the proposed alignment.

4.2.10. Religious/ Historical/Archaeological Places

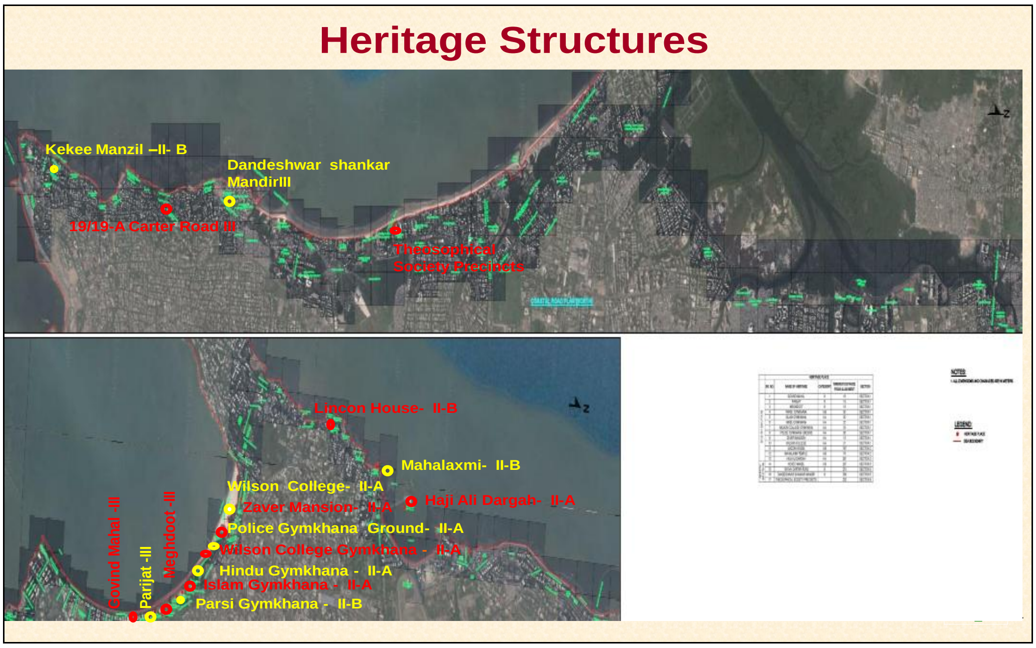
Details of 17 nos. of religious and heritage structures along the entire project stretch are given below

Sl. No	Name of the Heritage	Grade	Minimum distance from alignment (m)
1	Govind Mahal	III	18
2	Parijat	III	19
3	Meghdoot	III	18
4	Parsi. Gymkhana	II-B	30
5	Islam Gymkhana	II-A	30
6	Hindu Gymkhana	II-A	25
7	Wilson College Gymkhana	II-A	33
8	Police Gymkhana Ground	II-A	36

Sl. No	Name of the Heritage	Grade	Minimum distance from alignment (m)
9	Zaver Mansion	II-A	15
10	Wilson College	II-A	21
11	Lincon House	II-B	187
12	Mahalaxmi Temple	II-B	78
13	Haji Ali Dargah	II-A	281
14	Kekee Manzil	II-B	207
15	19/19 A Carter Road	III	210
16	Dandeshwar Shankar Mandir	III	330
17	Theosophical Society Precincts		232

Grade II (A & B) comprises of buildings and precincys of regional or local importance possessing special architectural or aesthetic merit or cultural or historical significance. They are local landmarks, which contribute to the image and identity of the region.

Grade III comprises building and precincts of importance for townscape; that evoke architectural, aesthetic, or sociological interest through not as much in Heritage Grade II.



4.2.11. Mangrove community of Mumbai

Mumbai Historical records indicate that there were several islands around Mumbai during 1670. However, the Britishers, who were ruling the country, identified the importance of these islands for commercial purpose. They deforested the fringing mangroves and reclaimed these islands into one continuous landmass, which later came to be known as "Greater Bombay". Since then the developmental and subsequently population pressure rapidly increased and being the coastal area, it took the toll of mangrove land. During the process of deforestation and reclamation, a few mangrove patches are still left in the heart of the city, which proves that today's megacity had a luxuriant past of mangrove forests Major mangroves are seen today in Mumbai along the Vasai Creek, Thane Creek, Manori and Malad, Mahim - Bandra, Versova, Siwari, Mumbra - Diva and few more places.

Importance of Mangroves for Mumbai

By trapping silt, mangroves maintain the integrity of Mumbai’s shoreline. This is a vital service to the city of Mumbai as it is very prone to erosion, having been built on reclaimed land that is battered by the sea on all three sides. The recent rains in Mumbai and the disaster that followed demonstrated the consequence of tampering with the ecology of fragile ecosystems like mangroves. Had Mumbai’s Mithiriver and Mahim creek mangroves not been destroyed by builders, fewer people would have died and the property damage would have been dramatically less.

In the early nineties, perhaps over 37 sq. km. of mangroves existed in Mumbai, largely in the Thane creek, Mahim, Versova, Gorai and Ghodbunder, with sporadic patches in places such as Bandra, Malabar Hill and Colaba. Mumbai has probably lost 40 per cent of all its mangroves in the past decade or so, largely because of reclamation for housing, slums, sewage treatment and garbage dumps. The Soonabai Pirojsha Godrej Marine Ecology Centre has undertaken several measures to protect the mangroves locally. Vast area under mangroves has been conserved by the Centre in Vikhroli a suburb of Mumbai. . Well diversified and well protected, these are the last- quality mangroves in the city.

Around 20 out of the 35 species of true mangroves found in India have been identified along the Maharashtra coast and 15 species of these are found in Mumbai. Because of the high salinity of the soil, something like 60 per cent of Mumbai mangroves comprise Avicennia marina. Nor surprisingly this species also tolerates pollution including heavy metals such as lead, mercury and chromium,

A detailed mangrove analysis and management /conservation plan is given in Chapter 7.

4.2.12. Land slides

Greater Mumbai also faces risk of Landslides with pressure on land, many vacant sites on hill slopes or bottoms of hills have turned into inhabited area and thereby become vulnerable to landslides. Most cases of landslides occur during heavy rain associated with high velocity winds. It sometimes results in loss of human lives and damage to structures.

4.2.13. Road Accidents

The major road sections in Mumbai are accident –prone.

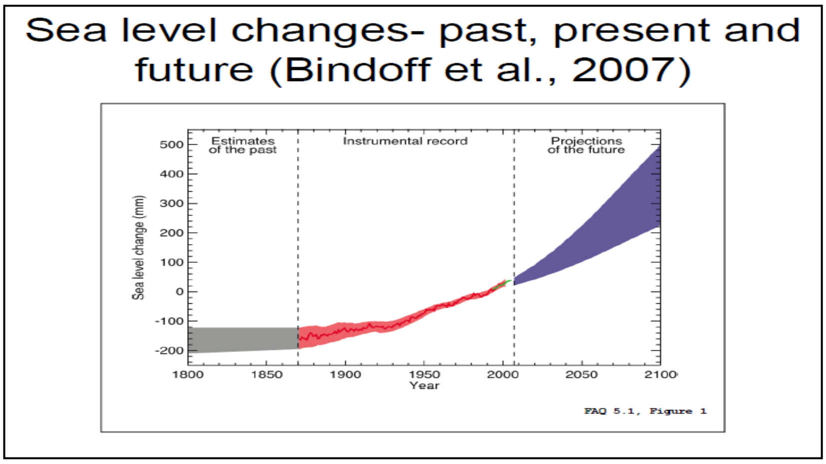
4.2.14. Industrial and Chemical Accidents

Mumbai also plays host to around 900 industries that are involved in manufacturing or processing or storage of hazardous goods. Many of these are in close proximity to residential and commercial areas, thereby increasing the risk of fires and explosions. The major concentration of such industries is in the Chembur-Trombay belt (Wards M-West and M-East). The area has major chemical complexes, refineries, fertilizer plans, atomic energy establishment and thermal power plant. The presence of such industries only enhances the vulnerability in case of extreme weather events.

4.2.15. Climate change and Sea level rise

A study conducted by the Tata Energy and Resource Institute (TERI) in partnership with Met Office Hadley Centre, U.K's climate change research center on "Assessing climate change vulnerabilities and adaption strategies for Maharashtra" showed that coastal flooding could lead to reduction in availability of fresh water due to saltwater intrusion as well as contamination of water supply through pollutants fro submerged waste dumps. The temperature of Mumbai and Maharashtra is likely to increase by 1-3 degrees in the next 50 years and evening nights would be warmer by 1.5 to 2 degrees.

According to the report in 2050s the increase in the mean sea level along the Mumbai coast may be around 2 cm and it would increase to around 4 cm by 2100. Due to increasing temperature and rainfall, coastal and Eastern Maharasthra are vulnerable to malaria outbreaks in future.



A new study using data from tide guages on the gobal effect of climate change by A. S Unnikrishanan and D Shankar at the the National Institute of Ocenography (NIO) in Goa has establisted that net sealevel rise along the Arabian Sea coast has been 1-2mm per year overe the past serveral decades, with Mumbai indicating a rise of roughly one-tenth of a mtere over the last 100years.

Net sea-level-rise trends from past tide-gauge data

Station	No of years of data	Trends (mm/year)	GIA (Glacial Isostatic Adjustment) corrections	Net sea level rise (mm/yr)
Mumbai	113	0.77	-0.43	1.20
Kochi	54	1.31	-0.44	1.75
Vishakhapatnam	53	0.70	-0.39	1.09
Diamond Harbour (Kolkata)	55	5.22	-0.52	5.74 sinking of delta

(Ref: Unnikrishanan A. S & Shankar D)

4.2.16. Cyclones & Flooding

Being a coastal city, Mumbai is prone to cyclones and gusty winds. There are a number of wards along the coast (Arabian Sea and Thane Creek) that are vulnerable to cyclonic impacts. For instance, in wards A – D, G-North, G-South, S and T, the Greater Mumbai Disaster management Action Plan (DMAP) has identified settlements that are acutely vulnerable to cyclones. There settlements were originally fishing communities, but are now home to many slums along the coast.

In addition to this, there are 40 chronic flooding locations identified in the DMAP report that are spread over the island city, eastern and western suburbs. The problem of flooding is acute when heavy rainfall coincides with high tide; i.e. more than 4.5 meters (average: 20 times during the monsoon)

4.2.17. Coastal Protection

Mumbai area as a whole is a lowland area on the west of Sayhadri Hills ranges. The area region has a 167 km long coastline that has estuaries bays, creeks, and beaches. The city of Mumbai needs to prepare itself against any natural calamities likely to occur in future. The city due to its peculiar geography acts as a natural breakwater of its own. The existing sea wall which is weakening due to wave attack requires be strengthening and protecting.

Coastal Stretches proposed for Protection Description	Island city (km)	Mumbai Suburban (km)	Total length (km)
Total coast line	29.430	43.785	73.215
Artificially protected	14.745	11.075	25.820
Naturally protected including beaches	8.300	25.650	33.950
To be protected	6.385	7.060	13.445

Source: Mumbai City Development Plan (2005 – 2025)

4.2.18. Demographic profile

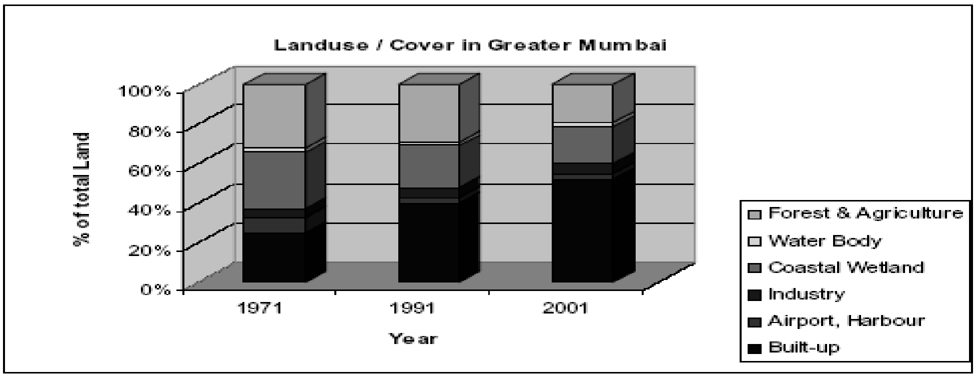
According to the 2011 census, the population of Mumbai was 12,479,608. The population density is estimated to be about 20,482 persons per square kilometre. The living space is 4.5sq metre per person. As Per 2011 census, Greater Mumbai, the area under the administration of the MCGM, has a literacy rate of 94.7%, higher than the national average of 86.7%. The number of slum-dwellers is estimated to be 9 million; up from 6 million in 2001, that is, 62% of all Mumbaikers live in informal slums.

The sex ratio was 838 (females per 1,000 males) in the island city, 857 in the suburbs, and 848 as a whole in Greater Mumbai, all numbers lower than the national average of 914 females per 1,000 males. The low sex ratio is partly because of the large number of male migrants who come to the city to work.

There are in all 2335 slum settlements as per 1985 data in Mumbai. These slums are considered as vulnerable settlements due to their location and access to infrastructure.

4.2.19. Land use pattern

The Mumbai Metropolitan Region (MMR) is one of the fastest growing regions of India. Its population increased from 7.7 million in 1971 to 18.3 million in 2001 (Census of India, 2001) and is projected to increase to 22.4 million by 2011(MMRDA, 1999). High population growth, inward migration and urbanization put stress on resources. Increasing economic activity and per capita income further stresses the resources and has resulted into changing land-uses pattern.



(Source: -Mumbai city development plan 2005-25)

This development process changed the character of the natural environment of the region. Land reclamation, vegetation clearances, changes in land use etc. created a new man-made environment. The ecology of the region also adapted to these changes. In the last four decades the population of Mumbai has been increasing rapidly. To cater this sudden rise in population, rapid and unplanned development took place, which has led to serious environmental degradation.

In the past 10 years alone, built-up land in Mumbai has soared nearly 114 percent, in the same period, forest and wetland areas shrank by 35 percent (H.P.Sawant.2004). Mangrove ecosystems which exist along the Mithi River and Mahim creek are being destroyed and replaced with construction. Hundreds of acres of swamps in Mahim creek have been reclaimed and put to use for construction by builders. The Bandra-kurla complex was created by replacing such swamps. The systematic destruction of about 1,000 acres of the city's mangrove cover - what's left, about 5,000 acres, is under threat - has deprived Mumbai of its natural flood-barrier and silt trap. July 2005 flooding is a result of ecosystem change.

Analysis information

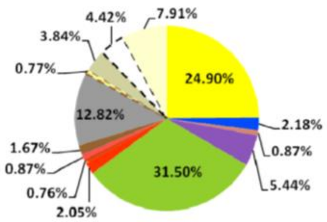
Landuse Analysis Greater Mumbai

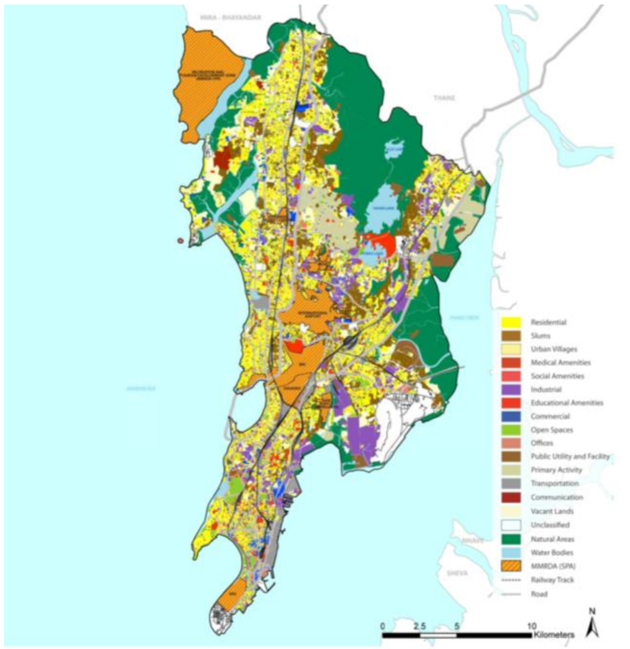
Existing Land Use Categories (2012)	Colour Codes	GREATER MUMBAI	
		Area in ha.	Area %
Residential		10333.39	24.90
Commercial		903.89	2.18
Offices		360.16	0.87
Industrial		2258.34	5.44
Natural Areas and Open Spaces		13075.55	31.50
Education Amenities		852.32	2.05
Medical Amenities		316.76	0.76
Social Amenities		361.32	0.87
Public Utilities and Facilities		693.81	1.67
Transport and Communication Facilities		5319.56	12.82
Urban Villages		319.73	0.77
Primary Activity		1594.80	3.84
Unclassified		1835.52	4.42
Vacant Land		3280.56	7.91
TOTAL AREA UNDER MCGM		**41505.70**	**100.00**

Jurisdiction	Colour Code	Area in ha.	Area %
Area under MCGM		41505.70	90.57
Area under Special Planning Areas*		4322.79	9.43
MCGM Area (Including SPA's)		**45828.49**	**100.00**

*Area not included in ELU

ELU DISTRIBUTION:





Source: ELU Survey, 2012, Groupe SCE India Pvt. Ltd

Mumbai Coastal Road project- Urban design strategies and masterplan

STUP Consultants Pvt. Ltd.
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The construction of coastal Road based on reclamation would help generate large green public spaces. The city currently has very little open space .The availability of of open space per 1000 persons in the city is merely 0.03Ha as compared to the norm of 0.2 Ha. In the last two decades Only 360 Ha of land has been acquired for public aminities in the city at cost of 22,140 Cr. By adopting present cost of acquisition (Viz. Rs. 60 Cr. per Ha) Now it is not possible to have more open area for the city due to due to high density of population and non- availability of land.

Coastal road project generates about 90 Ha of green space. These all green spaces along seaside can be developed for public by creating cycling tracks, Promenades, Landscape, Theme parks etc.

4.3 Baseline Environmental Condition based on Primary data

4.3.1. Air Environment

A systematically designed air quality surveillance programme was designed to determine the baseline air quality status keeping in view the environmental guidelines for EIA published by the MoEF (2009) it was decided to cover total project stretch of 29.20 km around the proposed project site.

Prime objective of this Ambient Air Quality survey within the project stretch was to establish the background levels of air pollution and based on it to formulate a environmental management plan.

Study was carried out for the Month December and January 2014. This season represents the dry season in Mumbai. The Parameters analysed for Particulate Matter (2.5 µm), Particulate Matter (10 µm), Oxides of Nitrogen (NO_2), Carbon Monoxide (CO) Sulphur dioxide (SO_2), PAH, Pb, HC are carried out.

4.3.2. Ambient Air Monitoring Stations

To achieve the stated objectives, four locations were selected for air quality monitoring. The location of monitoring and the details of the monitoring sites are given in Table 4.1.

Table 4-1 Location of Ambient Air Quality Monitoring Stations

Ambient air quality Stations	Approx. Height of the Sampling Stations from Ground Level (m)
1. Nariman Point	4m
2. Haji Ali	4m
3. Ram Mandir, Khardanda Village	4m
4. MCGM Garden, Malad	1.5m

The monitoring of ambient air quality was conducted twice a week at each location for 24 hours with respect to Reparable Particulate Matter (RPM_{10}), $PM_{2.5}$, Oxides of Nitrogen (NOx), Sulphur dioxide (SO_2.), Lead , CO and PAH . The sampling and analysis procedures are as per IS 5182 and according to the accepted standard technique of CPCB and MOEF.

Figure -4.3: AAQM Monitoring Locations Map

4.3.3. Ambient Air Quality Status of the Study Area

The parameter wise concentration of different pollutants is described below (Table 4.1 and Fig 4.3).

4.3.3.1. PM_{10}

The mean ambient PM_{10} concentration during the monitoring period was 82.3 $\mu g/m^3$ (Table 4.1) with a range between 70.5 $\mu g/m^3$ (at Malad) and 100.0$\mu g/m^3$ (at Haji Ali). The highest concentration was measured at Haji Ali (115.1 $\mu g/m^3$) and the least also at Malad (59.4 $\mu g/m^3$). The average compliance level of four monitoring stations was 75%, i.e 4 measurements are above the NAAQS standard (100 $\mu g/m^3$).

4.3.3.2. $PM_{2.5}$

The mean ambient $PM_{2.5}$ concentration was 47.4 μg/m^3 (Table 4.1) with a range between 42.5μg/m^3 at Malad and 60.6μg/m^3 at Haji Ali. The highest concentration was measured at Haji Ali (76.5 μg/m^3) and the least also at the Khardanda village (29.7 μg/m^3). The average compliance level with respect to National Standard (60 μg/m3) of all the monitoring stations was 100%.

4.3.3.3. Oxides of Nitrogen (NOx)

The mean ambient NOx level was 18.2 μg/m^3 with a range between 13.7 μg/m^3 (at Khardanda village) and 25.7 μg/m^3 (at Haji Ali). The highest concentration was measured at Haji Ali (24.4 μg/m^3) and the least at Malad (11.0 μg/m^3). The average compliance level with respect to National Standard of all the monitoring stations was 100%.

4.3.3.4. Sulphur Dioxide

The mean ambient level of SO_2 was 9.9 μg/m^3 with a range between 7.9 μg/m^3 (at Malad) and 12.6 at Haji Ali. The highest concentration was recorded at Haji Ali (16.0 μg/m^3) and the least at Malad (6.2 μg/m^3). All the stations show 100% compliance level.

4.3.3.5. Lead

The lead concentration in all the four monitoring station was found below the NAAQS (1.0 μg/m^3). The highest concentration was recorded Khardanda (0.132 μg/m^3) and the least at Nariman Point (0.009 μg/m^3).

4.3.3.6. Carbon Monoxide (CO)

The carbon monoxide concentrations in all the four monitoring stations were found <1.0 μg/m3 which is below the NAAQS standard (4.0 μg/m^3).

4.3.3.7. Hydro Carbon (HC)

The Hydro carbon (HC) concentrations in all the four monitoring stations were found below the detectable limit.

4.3.3.8. PAH

The PAH concentrations in all the four monitoring stations were below detectable level (<2.0 μg/m^3)

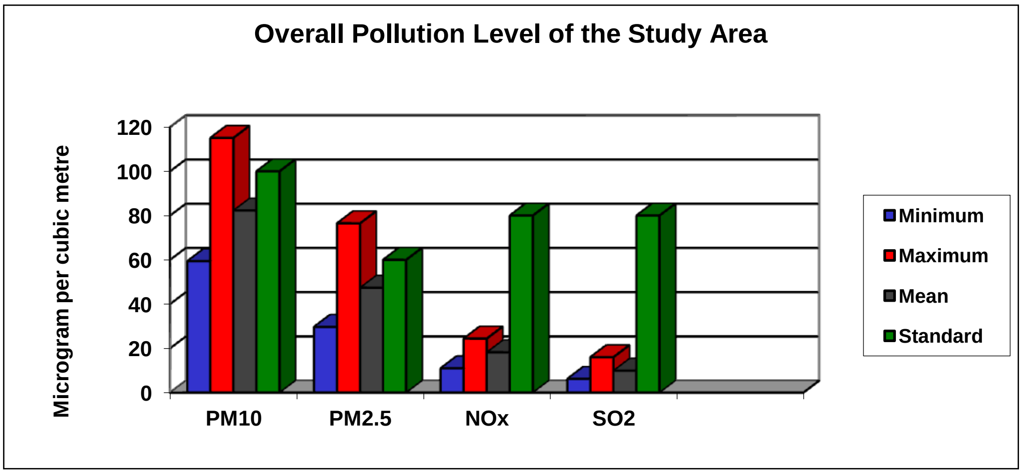


Figure 4.4: Overall Air Pollution level of the study area

Ambient Air Monitoring at Nariman point.

Ambient Air Monitoring at Khardanda village

Ambient Air Monitoring at Vir Sawarkar Udyan, Malad

Table 4.2a: Parameter wise Air Quality Status

Station	PM 10				PM 2.5				NOx				SO2			
	Min	Max	Mean	% of Comp-liance	Min	Max	Mean	% of Comp-liance	Min	Max	Mean	% of Comp-liance	Min	Max	Mean	% of Comp-liance
1. Nariman Point	74.9	92.4	83.8	100	39.0	54.9	46.2	100	12.0	23.0	16.8	100	8.0	13.5	10.4	100
2. Haji Ali	80.3	115.1	100.0	100	44.8	76.5	60.6	100	21.6	24.4	25.7	100	11.0	16.0	12.6	100
3. Ram Mandir, Khardanda Village	68.0	84.3	75.4	100	29.7	52.0	40.55	100	11.0	16.3	13.7	100	6.7	12.7	8.9	100
4. MCGM Garden, Malad	59.4	77.1	70.5	100	39.0	48.2	42.5	100	11.0	22.0	16.8	100	6.2	9.6	7.9	100
Overall	59.4	115.1	82.3	100	29.7	76.5	47.4		11.0	24.4	18.2	100	6.2	16.0	9.9	100

Concentration in µg/m^3 (24 hrs)

Table 4.2b: Parameter wise Air Quality Status

Station	LEAD				CO				PAH			HC		
	Min	Max	Mean	% of Comp-liance	Min	Max	Mean	% of Comp-liance	Min	Max	Mean	Min	Max	Mean
1. Nariman Point	0.009	0.095	0.042	100	<1.0	<1.0	<1.0	100	<0.2	<0.2	<0.2	ND	ND	ND
2. Haji Ali	0.034	0.099	0.063	100	<1.0	<1.0	<1.0	100	<0.2	<0.2	<0.2	ND	ND	ND
3. Ram Mandir, Khardanda Village	0.023	0.132	0.066	100	<1.0	<1.0	<1.0	100	<0.2	<0.2	<0.2	ND	ND	ND
4. MCGM Garden, Malad	0.012	0.074	0.048	100	<1.0	<1.0	<1.0	100	<0.2	<0.2	<0.2	ND	ND	ND
Overall	0.009	0.132	0.054	100	<1.0	<1.0	<1.0	100	<0.2	<0.2	<0.2	ND	ND	ND

Concentration in µg/m^3

4.4 Meteorological Observation

Meteorological information is collected by, installing the meteorological station at Nariman point for one month for monitoring Wind speed, wind direction, Temperature, Humidity, Oktas and Rainfall. Wind direction is reported as the direction towards the wind blows. Over the course of monitoring period, wind usually blows in between West and North Directions with varying frequencies and speeds. From the data collected on site, the wind rose was prepared for the month from 19th November to 19th December 2014.

Meteorological Station at Nariman Point, Raheja Chambers

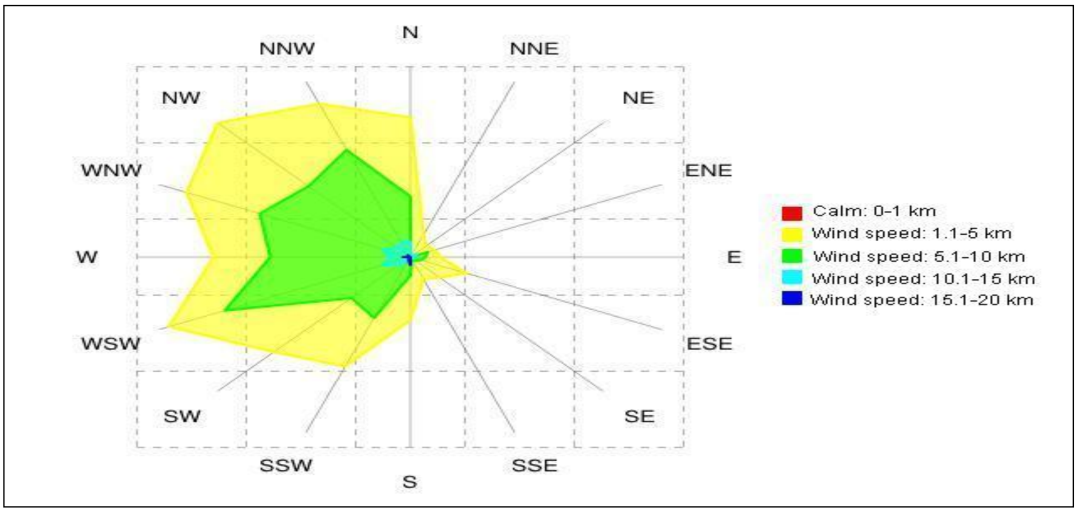


Figure 4.5: WIND ROSE Diagram

From the wind rose diagram, the wind direction is observed to be mainly towards between Southwest to North direction.

4.4.1. Wind Speed

From the wind rose diagram it is observed that, the wind is blowing towards Southwest and North direction. The wind velocities of 1.1 km to 5.0 km in the range 3.5% to 4.8%, 5.1 km to 10 km in the directions 1.5% to 3.7%, 10.1 km to 15.0 km directions are 0.3% to 0.6%. The Calm condition was observed 36%.

4.5 Noise Monitoring

Noise monitoring was conducted at 10 locations within the impact zone from the Project site. The Noise monitoring measurements were carried out continuously for 24 hrs with Sound Level Meter ID No.: AIR-I-002.

Table 4.3: Noise Monitoring Locations

Sr. No.	Locations
1	Vir Sawarkar Udyan, Malad
2	Khardanda Gaon
3	Haji Ali (Near nursery)
4	Nariman Point (Vidyut Bhavan)
5	Near Mahalaxmi Temple
6	At Carter Road
7	Near Rizvi College, Bandra
8	Near Poddar Hospital
9	At Varsova
10	At Lokhandwala Complex

Figure -4.6: Noise Monitoring Locations Map

Table 4.4: Noise Monitoring Results Summary

Sr. no.	Name of the Station	Date	Noise level in dB (A)	
1	Vir Sawarkar Udyan Malad,	27/11/2014	Min.	44.9
			Max.	69.4
			Avg.	55.1
			Leq	60.3
2	Khardanda Gaon,	21/12/2014	Min.	40.7
			Max.	73.6
			Avg.	56.6
			Leq	62.6

Sr. no.	Name of the Station	Date	Noise level in dB (A)	
3	Haji Ali,	2/12/2014	Min.	46
			Max.	76
			Avg.	65.5
			Leq	67.7
4	Nariman Point,	8/12/2014	Min.	50.2
			Max.	91.6
			Avg.	60.6
			Leq	75.9
5	Near Mahalaxmi temple,	10/12/2014	Min.	56.3
			Max.	85
			Avg.	72.4
			Leq	75.9
6	Carter Road,	11/12/2014	Min.	58.3
			Max.	92.2
			Avg.	76.2
			Leq	78.4
7	Near Rizvi College Bandra,	11/12/2014	Min.	43.5
			Max.	75.9
			Avg.	63.3
			Leq	68.9
8	Near Poddar Hospital,	12/12/2014	Min.	56.8
			Max.	81.1
			Avg.	68.7
			Leq	72.6
9	Varsova,	15/12/2014	Min.	59.4
			Max.	81.5
			Avg.	70.4
			Leq	73.6

Sr. no.	Name of the Station	Date	Noise level in dB (A)	
10	Lokhandwala Complex,	23/12/2014	Min.	50.7
			Max.	77
			Avg.	62.9
			Leq	67.9

Conclusion: Noise levels at Haji Ali, Nariman Point, Mahalaxmi Temple, Carter road, Rizvi College, Poddar Hospital, Varsova and Lokhandwala Complex, are exceeding the limits and at Vir sawarkar Udyan, Malad and Khardanda Gaon are within the limits prescribed under Environment Protection Act (Regulation & Control) rules 2000.

Table -4.5: Noise Level Limits of GoI {in Leq dB(A)}

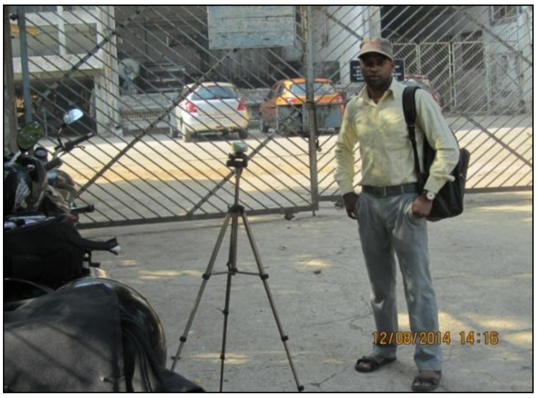
Area/Class	Day Time (6.00 AM to 9.00 PM)	Night Time (9.00 PM to 6.00 AM)
	Standard	Standard
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence	50	40

Noise monitoring at Vir Sawarkar Udyan, Malad

Noise monitoring at Carter road, Bandra

Noise monitoring at Khardanda village

Noise monitoring at Lokhandwala Complex



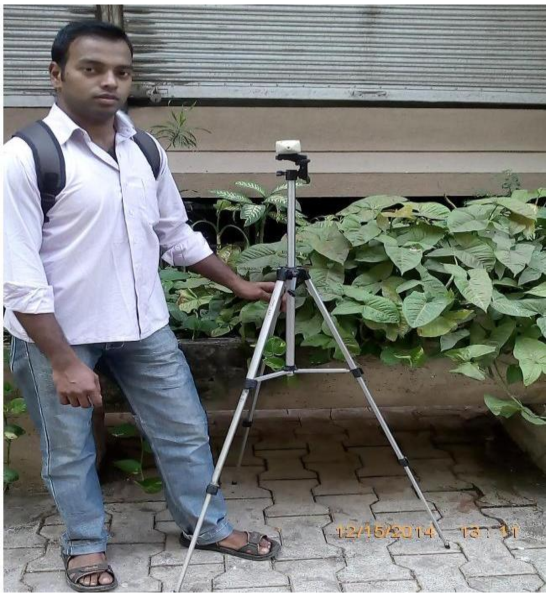
Noise monitoring at Vidyut Bhavan, Nariman point

Noise monitoring Near Mahalaxmi Temple

Noise monitoring at Podar Hospital

Noise monitoring at Rizvi College, Bandra

Noise monitoring at Haji Ali



Noise Monitoring at Versova Gaon.

4.6 Water Sampling and Analysis:

Water Sampling has been done following standard procedures for examination of physical, chemical and bacteriological parameters. Analysis has been carried out by IS method. Samples were collected from both Surface and Groundwater sources from different locations.

4.6.1. Groundwater

In order to access the groundwater quality of the study area, six groundwater samples were collected from tube wells and dug wells and analysis was carried out as per procedure of APHA

Figure -4.7: Ground Water Sampling Locations Map

Analysis of the groundwater samples and their comparison with the Indian drinking water Standard (BIS 10500, 2012) reveals the following characteristics (Table 4.6)

- pH values suggests that the water is alkaline in nature. The total dissolved solids (TDS) in tree locations are above the desirable limit (500mg/l) except at Nibhana Society, Juhu and Kasalbaug, Malad where it is below the desirable limit. However TDS in all samples are well below the permissible limit of 2000mg/l. Chloride concentration is well below the desirable limit (250mg/l) in all locations. Sulphate and Nitrate concentrations are low and within the permissible limit and thus indicate low degree of organic pollution. Fluoride is present in all the samples and above the desirable limit of 1.0 mg/l.

- Concentration of iron is low and below the desirable limit. And thus causes no adverse effect on domestic uses and water supply system and also does not promote growth of iron bacteria.
- Groundwater in general is hard in the area and the Total Hardness is above the desirable limit of 200 mg/l but well water sample in Juhu it is below the desirable. It is worth mentioning that groundwater samples are free from heavy metals like cadmium, arsenic, lead, chromium etc.
- Bacterial quality of groundwater shows all the samples drawn from both tube wells and wells shows presence of thermo tolerant coloforms or E.coli and hence the water samples are not potable and suitable for human consumption.

Table: 4.6: Ground water analysis Results

Sr. No.	Test Parameter	Unit	Acceptable Limit as IS-10500-2012	Test Method	Locations					
					P.J.Hindu Gymkhana, Marine lines (Tube well water)	Lokhandwala Complex, Rushi Tower-Andheri (Tube well)	Khardanda village (Tube well water)	Nibhana Society (Well Water)	Devari Pada, Varsova (Well water)	Kasalbaug, Malad (Tube well)
1	pH	----	6.5 to 8.5	IS:3025(P-11)1983	7.5	7.6	7.3	6.8	7.5	7.3
2	Colour	Hazen	5 Max	IS:3025 (P-4)1983	<5	<5	<5	<5	<5	<5
3	Odour	---	Agreeable	IS:3025(P-5)1983	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
4	Taste	---	Agreeable	IS:3025(P-7,8)1984	NA	NA	NA	NA	NA	NA
5	Turbidity	NTU	1Max	IS:3025(P-10)1984	4.6	2.1	4.2	<0.5	1.865	55.331
6	Total Hardness (as	mg/L	200 Max	IS:3025(P-	335	216	351	98	378	212

Sr. No.	Test Parameter	Unit	Acceptable Limit as IS-10500-2012	Test Method	Locations					
					P.J.Hindu Gymkhana, Marine lines (Tube well water)	Lokhandwala Complex, Rushi Tower-Andheri (Tube well)	Khardanda village (Tube well water)	Nibhana Society (Well Water)	Devari Pada, Varsova (Well water)	Kasalbaug, Malad (Tube well)
	$CaCO_3$)			21)1983						
7	Ammonia	mg/L	0.5	IS:3025(P-34)1988	Absent	Absent	Absent	Absent	Absent	Absent
8	Residual Free Chlorine	mg/L	0.2 Min	IS:3025(P-26)1986	Absent	Absent	Absent	Absent	Absent	Absent
9	Total Dissolved Solid	mg/L	500 Max	IS:3025(P-16)1984	752	632	870	146	524	426
10	Chlorides (as Cl)	mg/L	250 Max	IS:3025(P-32)1988	242	185	72	55	102	55
11	Fluoride	mg/L	1.0	IS:3025(P-23)1964	1.4	1.3	1.2	1.2	1.8	1.56
12	Arsenic	mg/L	0.01	IS:3025(P-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Sr. No.	Test Parameter	Unit	Acceptable Limit as IS-10500-2012	Test Method	Locations					
					P.J.Hindu Gymkhana, Marine lines (Tube well water)	Lokhandwala Complex, Rushi Tower- Andheri (Tube well)	Khardanda village (Tube well water)	Nibhana Society (Well Water)	Devari Pada, Varsova (Well water)	Kasalbaug, Malad (Tube well)
				37)1988						
13	Iron (as Fe)	mg/L	0.3 Max	IS:3025(P-53)2003	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
14	Nitrate	mg/L	45	IS:3025(P-34)1988	17	22	14	21	15	18
15	Sulphate (as SO4)	mg/L	200 Max	IS:3025(P-24)1986	32	27	17	16	157	201
16	Selenium	mg/L	0.01	IS:3025(P-56)1988	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
17	Zinc	mg/L	5.0	IS:3025(P-49)1994	0.47	0.38	0.27	0.55	0.98	0.75
18	Mercury	mg/L	0.001	IS:3025(P-48)1994	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Sr. No.	Test Parameter	Unit	Acceptable Limit as IS-10500-2012	Test Method	Locations					
					P.J.Hindu Gymkhana, Marine lines (Tube well water)	Lokhandwala Complex, Rushi Tower-Andheri (Tube well)	Khardanda village (Tube well water)	Nibhana Society (Well Water)	Devari Pada, Varsova (Well water)	Kasalbaug, Malad (Tube well)
19	Lead	mg/L	0.01	IS:3025(P-47)1994	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
20	Copper (as Cu)	mg/L	0.05	IS:3025(P-42)1992	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
21	Cyanide	mg/L	0.05	IS:3025(P-27)1986	Absent	Absent	Absent	Absent	Absent	Absent
22	Chromium	mg/L	0.05	IS:3025(P-52)2003	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
23	Nickel	mg/L	0.02	IS:3025(P-54)2003	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
24	Cadmium	mg/L	0.003	IS:3025(P-41)1992	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
25.	Thermo	MPN/100ml	Should Be	IS: 1622-	08	07	17	09	14	08

Sr. No.	Test Parameter	Unit	Acceptable Limit as IS-10500-2012	Test Method	Locations					
					P.J.Hindu Gymkhana, Marine lines (Tube well water)	Lokhandwala Complex, Rushi Tower-Andheri (Tube well)	Khardanda village (Tube well water)	Nibhana Society (Well Water)	Devari Pada, Varsova (Well water)	Kasalbaug, Malad (Tube well)
	tolerant coliforms or E. coli		Absent	1981 (R-2009)						

Ground water sampling at Devari pada Varsova

Ground water sampling at Kasalbaug Malad

Ground water sampling at Khardanda village Complex

Ground water sampling at Lokhandwala

Ground water sampling at Nibhana Society

Ground water sampling at P. J. Hindu Gymkhana

Surface Water

To ascertain the baseline conditions of the Surface water quality samples of surface water were collected from 4 lakes within the project influence zone and one sample from Mithi River. Water qualities were compared with CPCB fresh water classifications.

Figure -4.8: Locations of Surface Water Samples

The water quality criteria and analytical results are fresh water are summarized in Table 4.7.

Comparison of the results with the Indian Standards , it is clear that the in all the locations the water quality is well within the standard prescribed by CPCB for Class B, Class D and Class E type of water for most of the parameters except for DO and BOD. None of the heavy metals are found in the samples and Oil and Grease is also not detected.

Table -4.7: Water Quality Criteria and standards for Freshwater Classification (CPCB 1979)

Parameters	BOD (Mg/l)	pH	TDS (PPM)	D.O in mg/l	Lead (Pb) in µg/l	Oil and Grease in mg/l
CPCB Standard Class B (For outdoor bathing)	3.0	6.5-8.5	--	5.0		
CPCB standard Class D (For propagation of wild life, fisheries)	3.0	6.5-8.5	--	≥4	0.1	≤0.1
CPCB standard Class E (For irrigation)	--	6.0-8.5	0-700	--	--	--

Table 4.8: Surface water analysis Results

Sr. No.	Test Parameter	Unit	Test Method	Locations				
				Banganga Lake, Walkeshwar	Powai Lake	Bandra Lake	Mithi River	Aarey Colony Lake,
1.	Color	Hazen	IS:3025(P-4)1983	<05	<5	<5	<05	<05
2.	pH	--	IS:3025(P-11)1983	7.5	7.2	7.6	7.2	7.4
3.	Total Suspended Solids	mg/l	IS:3025(P-17)1984	<10	<10	<10	<10	<10
4.	Total Dissolved Solids	mg/l	IS:3025(P-16)1984	259	225	355	221	403
5.	Dissolved Oxygen	mg/l	IS:3025(P-38)1989	5.5	7.1	6.1	6.2	6.7
6.	Chemical Oxygen Demand	mg/l	IS:3025(P-58)2006	24	12	60	24	12
7.	BOD 3 days 27ºC	mg/l	IS:3025(P-44)1993	10	<05	20	10	05
8.	Oil & Grease	mg/l	IS:3025(P-39)1991	ND	ND	ND	ND	ND
9.	Chloride	mg/l	IS:3025(P-32)1988	105	30	90	50	85
10.	Sulphate as SO_4	mg/l	IS:3025(P-24)1986	24	13	66	40	157
11.	Total Hardness	mg/l	IS:3025(P-21)1983	189	157	243	151	243

Sr. No.	Test Parameter	Unit	Test Method	Locations				
12.	Sodium as Na	mg/l	IS 3025(P-45)1993	23	21	36	25	48
13.	Potassium as K	mg/l	APHA-3500K- B	05	02	08	03	12
14.	Arsenic as As	mg/l	IS: 3025(P-37)1988	<0.01	<0.01	<0.1	<0.01	<0.01
15.	Chromium as Cr	mg/l	IS: 3025(P-52)2003	<0.1	<0.1	<0.1	<0.1	<0.1
16.	Cadmium as Cd	mg/l	IS: 3025(P-41)1992	<0.1	<0.1	<0.1	<0.1	<0.1
17.	Lead as Pb	mg/l	IS:3025(P-47)1994	<0.1	<0.1	<0.1	<0.1	<0.1
18.	Iron as Fe	mg/l	IS: 3025(P - 53)2003	<0.1	<0.1	<0.1	<0.1	<0.1
19.	Total Coliform	MPN/100ml	IS:1622-1981(R-2009)	1600	1600	1600	1600	1600
20.	Fecal Coliform	MPN/100ml	IS:1622-1981(R-2009)	26	1600	1600	1600	14

- **Surface Water Sampling**

Surface water sampling at Aarey colony lake

Surface water sampling at Bandra lake

Surface water sampling at Banganga lake Walkeshwar

Surface water sampling at Powai lake

Surface water sampling at Mithi River

4.7 Sea Water

Baseline data on chemical parameters in the open sea and navigation channel and harbor area are ascertained for understanding hydro chemical characteristics in the marine environment (such as BOD, DO, pH, TSS, salinity, heavy metals etc. In order to access the sea quality of the project influenced area, four samples were collected from sea and analysis was carried out as per procedure of IS & APHA. Monitoring locations are shown below.

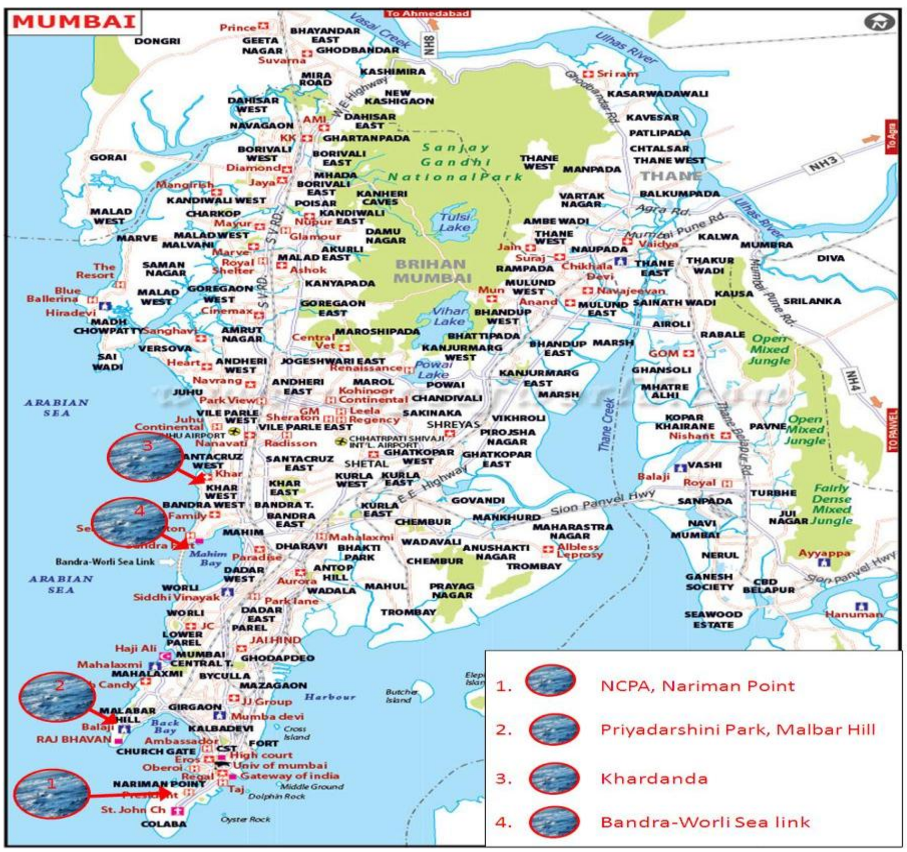


Figure 4.9: Sea Water Sampling Locations

Analysis of the sea water samples reveals the following characteristics (Table 4.9)

- pH values suggests that the water is alkaline in nature. The total suspended solids (TSS) in all samples are low. However TDS in all samples are well below the permissible limit of 2000mg/l.

- It is worth mentioning that sea water samples are free from heavy metals like cadmium, arsenic, lead, chromium etc. Oil and Grease is also not detectable in all samples

Table: 4.9: Sea water analysis Results

Sr. No.	Test Parameter	Unit	Test Method	Locations			
				NCPA, Nariman Point	Near Priyadarshini Park	Near Khardanda Village	Bandra Worli Sea link
1.	pH	--	IS:3025(P-11)1983	7.6	7.3	7.5	7.3
2.	Total Suspended Solids	mg/l	IS:3025(P-17)1984	<10	<10	<10	<10
3.	Dissolved Oxygen	mg/l	IS:3025(P-38)1989	5.6	5.7	6.1	5.7
4.	BOD 3 days 27ºC	mg/l	IS:3025(P-44)1993	<05	05	<05	10
5.	Oil & Grease	mg/l	IS:3025(P-39)1991	ND	ND	ND	ND
6.	Mercury as Hg	mg/l	IS: 3025(P-48)1994	<0.01	<0.01	<0.01	<0.01
7.	Lead as Pb	mg/l	IS:3025(P-47)1994	<0.1	<0.1	<0.1	<0.1
8.	Cadmium as Cd	mg/l	IS: 3025(P-41)1992	<0.1	<0.1	<0.1	<0.1
9.	Floating Matter	mg/l	APHA	Absent	Absent	Absent	Absent
10.	Water Temperature	^{0}c	IS:3025(P-9)1984	28	28	29	28
11.	Salinity	---	APHA 2520B	29.3	32.1	25.5	34.3

4.8 Soil

As per the agro-climatic classification, the district fall under the broader category of tropical wet and dry climate and locally it has been put coastal Land. Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil.. Soil plays very important role in over all availability of surface water as well as recharge to ground water.

The sub-soil water table is found at a depth of 5-6 meters below the surface. The texture of soil is mainly sandy loam, as per the soil investigation report the pH of soil is slightly basic.

As a part of environmental data generation 6 soil samples at a depth of 40-60 cm from the land surface were collected to understand the physico-chemical properties of the soils. The details of the sampling locations are shown in the map below

Map 4. 10: Soil Sampling Locations

The analysis results (Table 4.10) indicate that soil in the region is moderately alkaline in nature. There is no much variation in the pH range in different sites. It can be inferred that the soil pH is suitable for production of any crop.

The uptake of minerals from soil by plants is directly proportional to the electrical conductivity of soil, which is responsible for plant growth. Conductivity is a measure of evaluating the salt status of soils, the high concentration of which impairs the growth of the plant. Crop plants differ in their tolerance to salinity. However the levels of conductivity in soil above 2 milimhos, is t affected by salinity effects.

The analysis results indicate that the level of major nutrients and cations present the soil samples are within the range expected in Indian soil.

Table 4.10 : Soil Characteristics

Sr. No	Test Parameter	Unit	Test Method	Locations					
				P.J. Hindu Gymkhana, Marine Lines.	Haji Ali Nursery	Priyadarshini Park	MCGM Garden, Malad	Khardanda Village	Bandra-Worli Sea link
1	Texture	---	Soil Testing Procedure Manual 2008	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
2	Water Holding Capacity	%	Soil Testing Procedure Manual 2008	51	50	52	52	33.6	49
3	Cation Exchange Capacity	mEq/100gm	IS-2720(P-24)1976	1.14	1.16	1.12	1.14	1.39	2.10
4	Porosity	%	Soil Testing Procedure Manual 2008	45	47	43	45	48	43
5	pH	----	SW-846-9045-C	8.2	8.4	7.8	7.5	7.2	7.4
6	Conductivity	µS/cm	IS:3025(P-14)1984	515	667	123	482	463	198

7	Total Kjeldahl Nitrogen	mg/kg	IS:3025(P-34)1988	393	308	603	170	89	56
8	Potassium as K	mg/kg	APHA-3500K- B	1308	1226	108	253	456	289
9	Phosphorous as P	mg/kg	IS:3025(P-31)1988	46	121	104	03	12	08
10	Sodium Adsorption Ratio	----	IS-11624-1986	334	264	95	150	28	42
11	Zinc as Zn	mg/kg	IS:3025(P-49)1986	128	322	71	53	132	89
12	Copper as Cu	mg/kg	IS: 3025(P -42)1992	8.3	2.6	<0.1	8.5	12	06

4.9 Bed Sediment Sampling

Bottom contamination encompasses many kinds of contamination of bottom sediments by toxic or harmful substances, oils, oily mixture and other hazardous materials. Contamination of bottom sediment is often measured by the size of sediment particles, pH, color, smell, oil and grease, organic materials, and concentration of organic nitrogen, phosphorus, sulphide, and toxic substances such as heavy metals and pesticides including toxic components of antifouling paints. Construction work and dredging may accelerate sediment deposition in stagnant water behind structures and cause contamination of the sea bottom. Sediment deposition covers bottom biota and physical habitat.

Three samples were collected to understand the physico-chemical properties of the bed sediment. The details of the sampling locations are shown in the map below

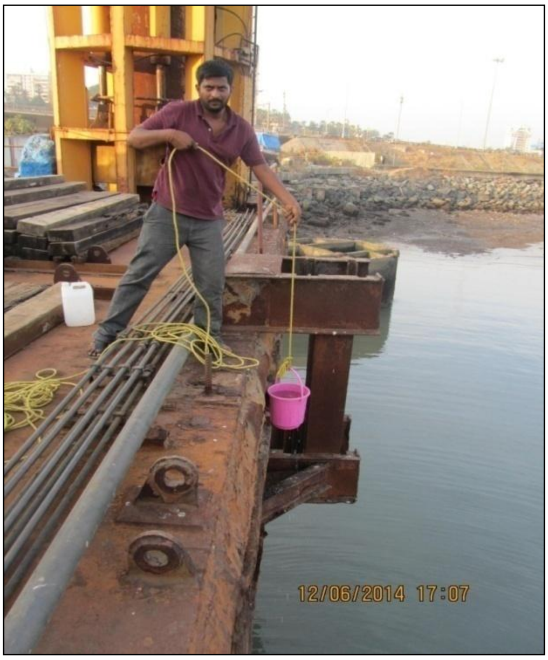
Map 4.11: Bed Sediment Sampling

Table 4.11: Bed Sediment Analysis Results

Sr. No.	Test Parameter	Unit	Test Method	Locations					
				Sea (Nariman Point)		Sea (Haji Ali)		Be Sea (Near Khardanda)	
1	pH	----	SW-846-9045-C	7.6		7.4		7.9	
2	Color	---	---	Blackish Gray		Gray		Gray	
3	Loss on Ignition @550^{0}C	%	APHA	5.9		4.0		4.8	
4	Total Kjeldahl Nitrogen	mg/kg	IS:3025(P-34)1988	199		289		524	
5	Phosphorous as P	mg/kg	IS:3025(P-31)1988	92		56		582	
6	Hexane Extractable Organics	%	SW-846-9071A	<0.01		<0.1		<0.1	
7	Sulphide	mg/kg	IS:3025(P-29)1986	Absent		Absent		Absent	
8	Particle Size >75µm >425µm >2mm- < 75µm	%	IS: 2720-1963 part 1	75µm >425µm >2mm- < 75µm	57.04 17.92 00.00 25.4	75µm >425µm >2mm >4.75mm <75µm	10 52.2 18.2 15.6 4	75µm >425µm >2mm >4.75mm <75µm	15.6 30 7.4 39.2 7.8
9	Mercury as Hg	mg/kg	IS: 3025(P-48)1994	<0.01		<0.01		<0.01	
10	Cadmium as Cd	mg/kg	IS: 3025(P-41)1992	<0.1		<0.1		<0.1	
11	Lead as Pb	mg/kg	IS:3025(P-47)1994	4.7		7.9		6.2	
12	Pesticide	mg/kg	GCMS	ND		ND		ND	

The analysis results show that there is no toxic contamination in the samples only Lead is present in higher level.

- **Sea Water**



Sea water sampling at Bandra worli Sea link   Sea water sampling at Khardanda village

Sea water sampling at Priyadarshini Park

- **Soil**

Soil Sampling at Bandra Worli Sea link

Soil Sampling at Khardanda

Soil Sampling at Vir Sawarkar Udyaan, Malad.

Soil Sampling at P. J. Hindu Gymkhana, Marine Lines

Soil Sampling at Priyadarshini Park

Soil Sampling at Haji Ali

- **Bed Sediment**

Bed Sediment at Khardanda

Bed Sediment at Nariman Point

Bed Sediment at Haji Ali

4.10 Ecological Impact Assessment of Coastal Road Project in Mumbai

Ecological Survey is a component of an Environmental Impact Assessment, assessing the overall ecological status of the project site before the constructional and operational phase of a project begins. The main objective is to provide sufficient and accurate ecological data to allow a complete and objective identification and evaluation of the potential ecological impacts. The method consist of monitoring the current and changing conditions of ecological resources from which success or failure of the ecosystem can be judged without bias. Ecological assessment also takes into account the socio-economic issues.

The project site is covering 70% of coastal area and some part of urban settlement area. Coastal area include mangrove vegetation, most commonly seen are Avicennia marina, Avicenia marina acuticima, Sessuvium portulacastrum, Salvadora persica, Acanthus iliicifolius. Urban vegetation comprise of gardens, avenue tree, ornamental plants, which grow along the road dividers and traffic island at junctions of crossroads. General urban trees are Acacia arabica, Aalbizia lebbeck, Azadirachta indica, Bambusa vulgaris, Ficus benghalensis,Ficus religiosa, Mangifera indica, Peltophorum pterocarpum, Samanea saman, Schefflera actinophylla. The commonly found shrubs are Carissa carandas, Gnidia eriocephala etc.

A detailed Ecological Assessment study was carried out and given in Annexure **1**.Assessment and management &conservation of mangrove are discussed separately in Chapter 7 (Additional Studies).

CHAPTER 5

5. Assessment of Impacts and Mitigation Measures

5.1 Background

This chapter deals with the potential environmental impacts anticipated on different environmental components during the construction and operation phase of the proposed project and the mitigation measures to be adopted in the project design to minimize the impact and also the options which will be dealt with during the construction and operation period. The flow adopted for developing this chapter is depicted in Figure 5.1 below:

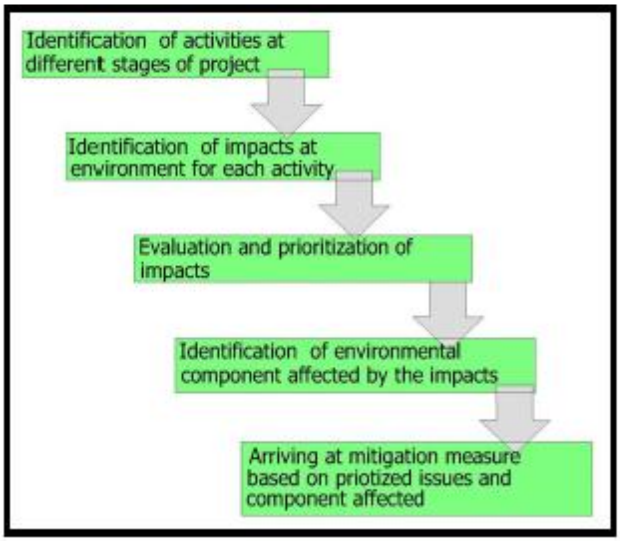


Figure 5.1: The flow adopted for developing this chapter

5.2 Meteorological Parameters

The entire area of the project road is in coastal region with marked monsoon affects. Though no change in the macroclimate setting (precipitation, temperature and wind) is envisaged due to the project, the microclimate is likely to be temporarily modified during the pre construction and construction period. However, the status of the microclimate will get restored within 3-4 years after completion of the construction work and afforestation program. Therefore, the overall impact on meteorology of the region is insignificant and has been categorized as low.

5.3 Physical Settings

The impact on physical settings means the impact of the project on Land Use, Geomorphology, Drainage, Geology, coastal erosion problem, Material Quarry area and Borrow Pits etc.

Impacts on the above elements during construction and operation of the project have been discussed in the subsequent sections.

5.4 Land

- **Construction Stage**

The total reclamation area in coastal road is 122 ha including road on stilt in mangroves.

Mangrove forest land of about 33.37 ha has to disturbed for construction of coastal road. This will have impact on mangrove forest cover and productivity of the area.

The loss of productive soil is identified in the construction stage also and is envisaged at locations of Worker's camp, stockyards, storage go-downs etc. For this proposed project there is provision of high embankments where huge quantity of reclamation material will be used.

Provision has been in the EMP for plantation along the road as a part of green belt development (Annexure 3) which will not only compensate the forest cover but also improve the forest and canopy cover.

The project is expected to enhance the aesthetic of the area, with out compromising the land use pattern of the area. The change in aesthetics and visual appeal of the region will also be positive.

If EMP will be followed during implementation of the project then the impact on land will be low in nature.

5.5 Land Use

- **Construction Phase**

Preparatory activities like use of existing access roads with/without improvements, construction of new haul roads, construction of temporary staff quarters, camp, storage go-downs, stockyards etc. will be spread over the entire project area. This will change the land use pattern of the project influence area for a temporary period. In the EMP provision has been made to ensure proper restoration of the land after the use. Therefore though it will be a direct impact but the scale will be low in nature except marginally altering the land use pattern in these places for a short period.

- **Operation Phase**

The project is requires about 122 ha of reclaimed land for coastal road. Out of which 33.37 ha is in mangrove forest. So land use pattern of the will change permanently. This will be a direct impact on land use pattern but side by side it will improve the aesthetic and socio economic condition of the area, which is a positive social impact.

Due to the development of the new roads there are will be economic development and in the long run due to development of 11 interchanges along the roads in most of the commercial areas which will have additional impact on the land use pattern of the project area in long run.

5.6 Geology

The construction and operation of the project road will have no any significant impact on the regional geology.

5.7 Drainage

- **Construction stage**

The project is crossing over creeks and Mithi River with tunnels and bridges. Provision has been made in the EMP that during construction of the road contractor will adopt all possible measure not to disturb the tidal flow and flow of any natural channel. No natural drainage channel will be diverted during the construction of the road. So Impact on drainage during construction stage will be insignificant.

- **Operation Stage**

Sufficient number of cross drainage structure like culverts and bridges have been provided in the design so that construction of road and construction of embankments will not impede the normal flow of the water channels in the operation stage. Due to 122 ha of land reclamation there will be a impact on HTL but according to National Oceanographic Organisation (NIO) reclamation upto 100 m width would not cause any adverse impact on the tidal movement. Hence impact will be insignificant.

5.8 Soil / Borrow Areas

- **Construction Phase**

For the construction of shoulder and sub-base considerable amount of soil is required. Mostly huge quantity of reclamation material will be used. Provision in the will be made in the EMP that borrow areas will be selected as per the guideline of the EMP. River banks and fertile agriculture lands will not be used as borrow area.

In this project design effort has been given for minimum use of the soil for embankment construction.

To use a land for borrow area contractor has to submit consent of that land owner along with a borrow area reclamation plan for the approval of the environmental expert of the supervision consultant. After getting approval from the supervision consultant and the client contractor will use that land as borrow area.

In some places the depression formed due to extraction of soil from the field will be used as ground water recharge area and will also act as a water body.

So construction of this project road will have no any significant adverse impact on soil of that locality.

5.9 Erosion

- **Construction Phase**

All major construction activities tend to create certain changes in the soil condition of the area.

Mumbai’s geological history reveals a pattern of soil erosion, which explains the emergence of the seven islands and the presence of partly submerged isles like Butcher and Elephanta around it. A team from the National Institute of Oceanography (NIO) has recently helped reinforce this view by establishing a rate of sea level rise along the Arabian coast over the past century, thus suggesting an age-old decline in land mass.

During construction of embankments/land reclamation there is chances of soil /coastal erosion due to rain-wash especially during the monsoon but provision for slope protection measures has been provided in the design. Implementation of such protection measures during construction of the road will not create any adverse impact on erosion potentiality of the embankments.

- **Operation Stage**

During the operation phase the erosion condition of the project site would be allowed to stabilize. The topsoil in the borrow areas would be restored and major portions of the area would be subjected to extensive plantation.

There may be chances of coastal erosion. But, the impact will be minimum as due consideration has been given for the seawall/ slope protection during embankment design. In EMP details of Erosion protection measures are discussed.

5.10 Quarries

- **Construction Phase**

The quantity of stone aggregates for the road construction (pavement and concrete) works conforming to specifications is to be sourced from the existing quarry sites and hauled to work sites. As these quarry sites are sufficient to the requirement of road construction so there is no need to open a new quarry site. Therefore no more impact on natural resource for stone materials.

- **Operation Phase**

During the operation phase there will be least impact on quarry sites as the stone requirement during the operation phase will be negligible because material required for maintenance of the road very less.

5.11 Water Resources

5.11.1. Hydro-geology/Ground Water

- **Construction Phase**

Construction water demand will be mainly depended on surface water sources like lake/pond waters as saline water is not suitable for construction purposes. In some places especially water for the work force camps and construction activities ground water will be required but the quantity will be less. If required surface water will be transported through tanks for construction works. Therefore, there will be no potential impacts on ground water due to the construction works.

According to CGWB about 500 to 800 wells can be constructing if the yield of wells is considered to be 30 to 50 m^3/ day.

Consultation with CGWB, revealed that in the Alluvial areas shallow dugwells (5 to 10 m), whereas in Deccan Trap Basalt areas dugwells (7 to 15 m) are the most feasible structures for ground water development.

- **Operation Phase**

During operation of the road there will be no impact on the ground water sources except percolation of accidental spillage or hazardous material, if any in future.

5.11.2. Surface Water Resources

- **Construction phase**
  - Major and minor bridges and several other culverts have been provided for stream crossings/sea. Thus these developmental activities will not have any significant impact on existing drainage systems.
  - There are chances of improper drainage of wastewater from the construction sites and thereby the formation of stagnant pool. The stagnant pool will promote breeding of mosquitoes and create generally insanity conditions. But implementation of the guidelines as provided in EMP in construction camp will minimize all such problems.
  - Discharge of bridge construction wastewater with high concentration of suspended solid load will disturb the aquatic ecosystem of the receiving water body. But implementation of the guidelines as provided in EMP for bridge construction sites will minimize all such problems.
  - Liquid and solid waste discharges from petroleum, oil and lubricant (POL) storage areas, work force camps and all other operational areas may impact the water quality of the receiving water body if disposed off directly. But implementation of the guidelines as provided in EMP in construction camp will minimize all such problems.

- **Operation Phase**

- Accidental spillage and highway runoff containing hazardous material may contaminate the receiving surface water body and the aquatic ecosystem may be disturbed.
- Garbage dumping on highways may also contaminate the aquatic eco-system.
- Waste discharge from the wayside amenities and the storm water run-off from the Project highway may impact the watercourses.

But implementation of the guidelines as provided in EMP during operation will minimize all such problems.

5.12 Traffic Growth Pattern in the area

The projected traffic growth pattern in the project corridor is around 2% and will not have a significant impact in the future years.

- **Construction Stage**

The main transportation of construction material & debris will be transported via sea by employing the barges so as to avoid traffic congestion on existing roads.

- **Operation Phase**

During the operation phase impact on air and noise quality due to traffic has been assessed in subsequent sections (Chapter 2). It has been found that due to faster movement and good pavement condition impact on air quality in terms of concentration of carbon monoxide, Oxides of nitrogen and Hydrocarbon will be insignificant i.e. concentrations of the pollutants will be well within the limit of the CPCB govt. of India.

5.13 Air Quality

Construction Stage: Potential impacts on the air quality during the construction stage will be due to the fugitive dust and the exhaust gases generated in and around the construction equipments and ground related activities such as crushing sites, hot-mix and asphalt plants, etc. The ambient Air quality is likely to be impacted due to activities such as site clearance, stone crushing, dumping of fill materials, earthwork etc which will create dust in the construction area and its vicinity. This will affect the health of the construction workers and dwellers with in the nearby vicinity of the construction activities. The impacts anticipated on the air quality during the construction stage, though significant, will be short-term impacts.

Operation Stage: The improved road quality will lead to induced traffic on the corridor. This additional increase in the number of vehicles will result in a slow but steady increase in the air pollution levels and pollutant concentrations.

- **Mitigation Measures**

The mitigation/management measures proposed as a part of the project are likely to improve the air quality scenario along the corridor during the operation stage. Tree plantation as per the proposed road landscape strategy will help to attenuate the air pollution levels. The tree species suggested include broad-leaved tree species, which can help settle particulates with their higher surface areas and thick foliage and reduce the distance for which particulates are carried from the road itself. This measure is of specific importance in context of the high SPM concentration as predicted in some of the receptor locations.

Other measures such as the reduction of vehicular emissions, ensuring vehicular maintenance and up-keep, educating drivers about driving behavior / methods that will reduce emissions are beyond the scope of the project but will be far more effective in reducing the pollutant levels. Apart from provision of the mitigation measures, their effectiveness and further improvement in designs to reduce the pollutant levels with increase in traffic shall be monitored. A monitoring plan to this affect will be prepared as a part of the Environmental Management Plan (EMP).

Government of India is committed EURO III & IV emission norms and providing cleaner fuels, the emissions can be expected to be lower than present levels in the coming years with the increased availability and usage of cleaner fuels.

5.14 Noise & Vibration

- **Construction Phase**

Different types of noise impacts are-

Due to haulage operation the movement of heavy vehicles will produce noise, which will have impact on the surrounding people.

The construction activities like the operation of batch operation etc may have some impact on the existing noise environment of the project corridor.

It has been suggested to transport construction materials through sea route so that there would be minimum impact of noise and vibration on surrounding localities.

All asphalt plants are outside MCGM limit; hence impact of noise, durung construction stage will not be significant.

- **Operation Phase**

The noise impact during the operation stage is generally beyond the purview of the highway authorities.

The major factors contributing to highway noise impacts are vehicular noise, driving behavior, and pavement condition and road geometry. Vehicular noise is the dominant factor.

5.14.1. Simulation Model

Noise prediction for this coastal road project has been done by using US EPA, Federal Highway Noise prediction model. The predicted noise for the same has been calculated in the year 2019, 2024, 2029 2034, 2039 and 2044.

Data indicates the fact that road side noise level will increase with the traffic volume. It has been estimated that up to 50m distance from the centre of the road noise level is exceeding the noise standards of CPCB. Predicted noise is maximum noise level considering projected number of traffic. Beyond 50m the noise level will be within the limit. The Noise predictions are tabulated in Table 5.1 and in Figures 5.2 to 5.7

Table 5.1: Noise Predictions along Mumbai Coastal Road

	Predicted L 50 Noise in Leq db (A)																													
Name of station	**2019**					**2024**					**2029**					**2034**					**2039**					**2044**				
	10 m	20 m	30 m	40 m	50 m	10 m	20 m	30 m	40 m	50 m	10 m	20 m	30 m	40 m	50 m	10 m	20 m	30 m	40 m	50 m	10 m	20 m	30 m	40 m	50 m	10 m	20 m	30 m	40 m	50 m
Vir Sawarkar Udyan Malad	73.44	69.06	66.4	64.5	63.09	73.9	69.4	66.8	64.9	63.5	74.3	69.9	67.2	65.4	63.9	74.8	70.3	67.7	65.8	64.3	75.2	70.7	68.14	66.2	64.8	75.7	71.2	68.5	66.7	65.2
Khardana Gaon	76.1	71.5	68.9	67.08	65.6	76.5	72	69.4	67.6	66.1	76.9	72.4	69.8	68.2	66.6	77.3	72.8	70.2	68.4	67	77.8	73.2	70.7	68.8	67.4	78.2	73.7	71.14	69.4	67.8
Haji Ali	76.4	71.9	69.3	67.4	65.9	76.9	72.3	69.7	67.8	66.4	77.3	72.8	70.2	68.3	66.8	77.7	73.2	70.6	68.7	67.2	78.2	73.6	71.03	69.16	67.7	78.6	74.1	71.4	69.59	68.13
Nariman Point	74.4	69.9	67.3	65.4	64	74.9	70.4	67.7	65.8	64.4	75.3	70.8	68.2	66.3	64.8	75.7	71.2	68.6	66.7	65.2	76.2	71.6	69.04	67.17	65.72	76.6	72.12	69.4	67.6	66.15
Near Mahalaxmi Temple	74.6	70.15	67.5	65.6	64.18	75	70.5	67.9	66	64.6	75.5	71	68.3	66.4	65	75.9	71.4	68.8	66.9	65.4	76.3	71.8	69.2	67.3	65.9	76.8	72.3	69.6	67.7	66.3
Carter road	76.4	71.9	69.3	67.4	65.9	76.8	72.3	69.7	76.8	66.4	77.6	72.8	70.2	68.29	66.8	77.8	73.2	70.6	68.7	67.3	78.2	73.6	71.03	69.15	67.7	78.6	74.1	71.46	69.58	68.13
Near Rizvi college , Bandra	76.4	71.9	69.3	67.4	65.9	76.8	72.3	69.7	76.8	66.4	77.6	72.8	70.2	68.29	66.8	77.8	73.2	70.6	68.7	67.3	78.2	73.6	71.03	69.15	67.7	78.6	74.1	71.46	69.58	68.13
Near Poddar Hospital	74.6	70.15	67.5	65.6	64.18	75	70.5	67.9	66	64.6	75.5	71	68.3	66.4	65	75.9	71.4	68.8	66.9	65.4	76.3	71.8	69.2	67.3	65.9	76.8	72.3	69.6	67.7	66.3
Varsova	73.44	69.06	66.4	64.5	63.09	73.9	69.4	66.8	64.9	63.5	74.3	69.9	67.2	65.4	63.9	74.8	7.3	67.7	65.8	64.3	75.2	70.7	68.14	66.2	64.8	75.7	71.2	68.5	66.7	65.2
Lokhandwala complex	75.32	70.82	68.18	66.13	64.85	75.8	71.25	68.6	66.7	65.3	76.2	71.6	69.1	67.16	65.7	76.8	72.2	69.5	67.7	66.2	77.1	72.54	69.9	68.02	66.57	77.4	72 97	70.33	68.45	67.05

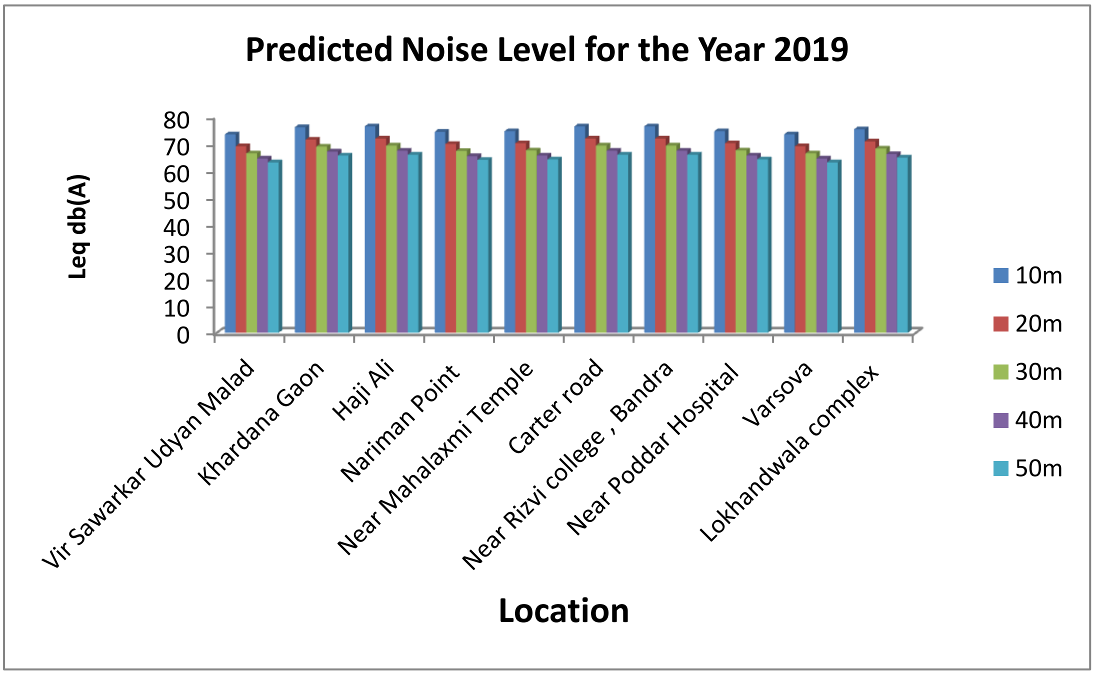


Figure 5.2: Noise prediction for the year 2019

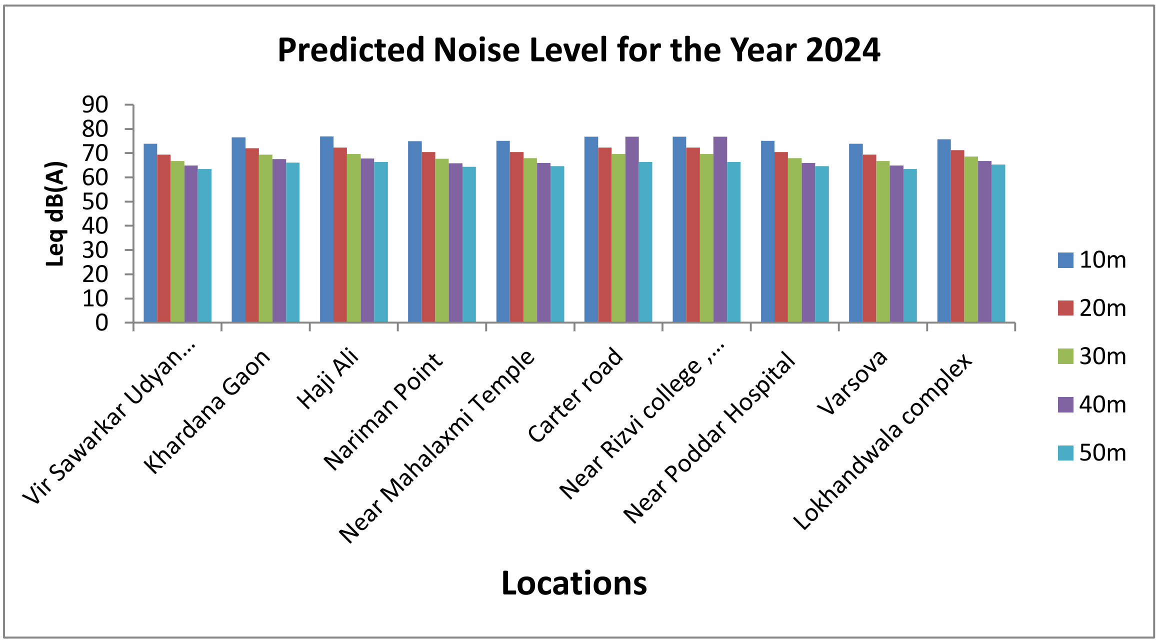


Figure 5.3: Noise prediction for the year 2024

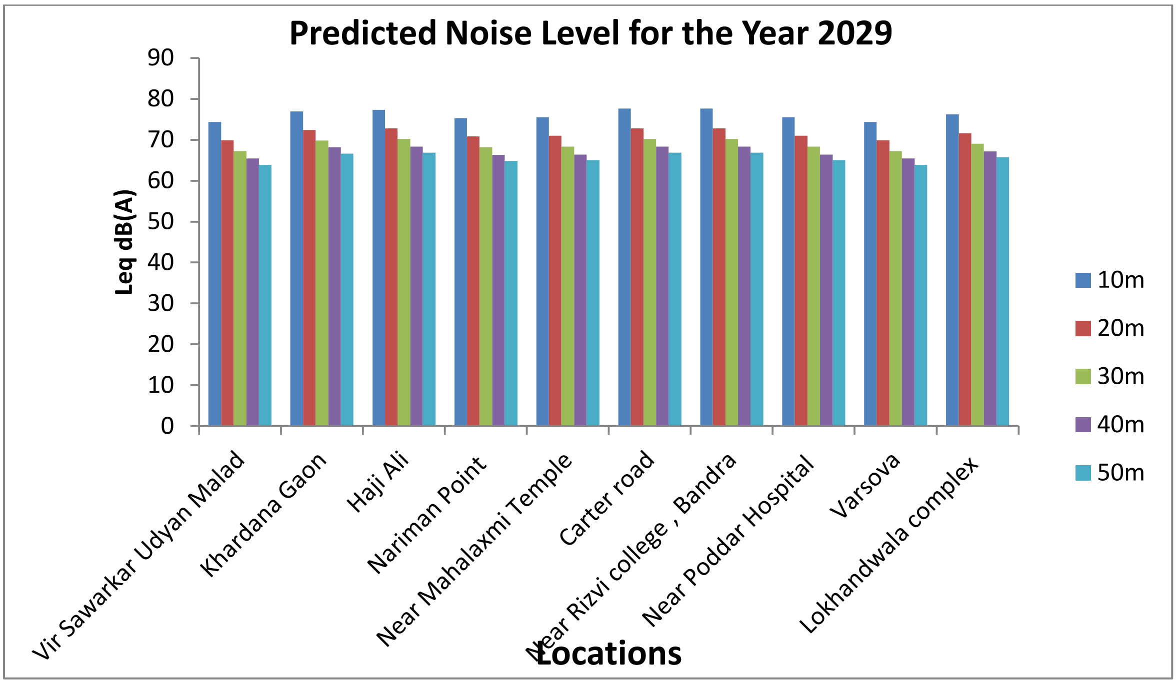


Figure 5.4: Noise prediction for the year 2029

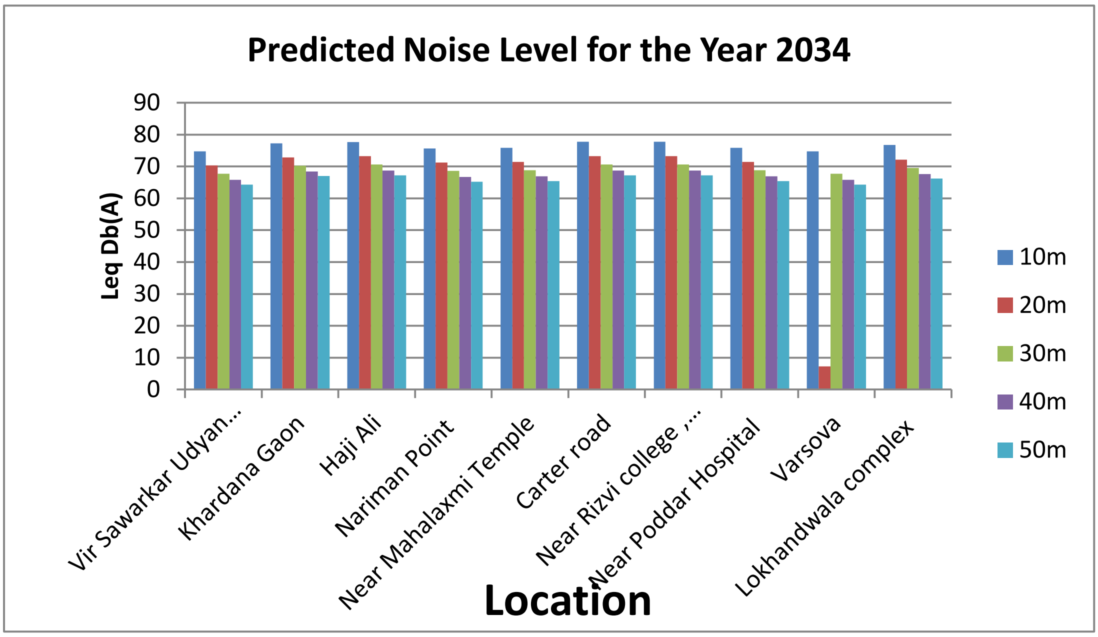


Figure 5.5: Noise prediction for the year 2034

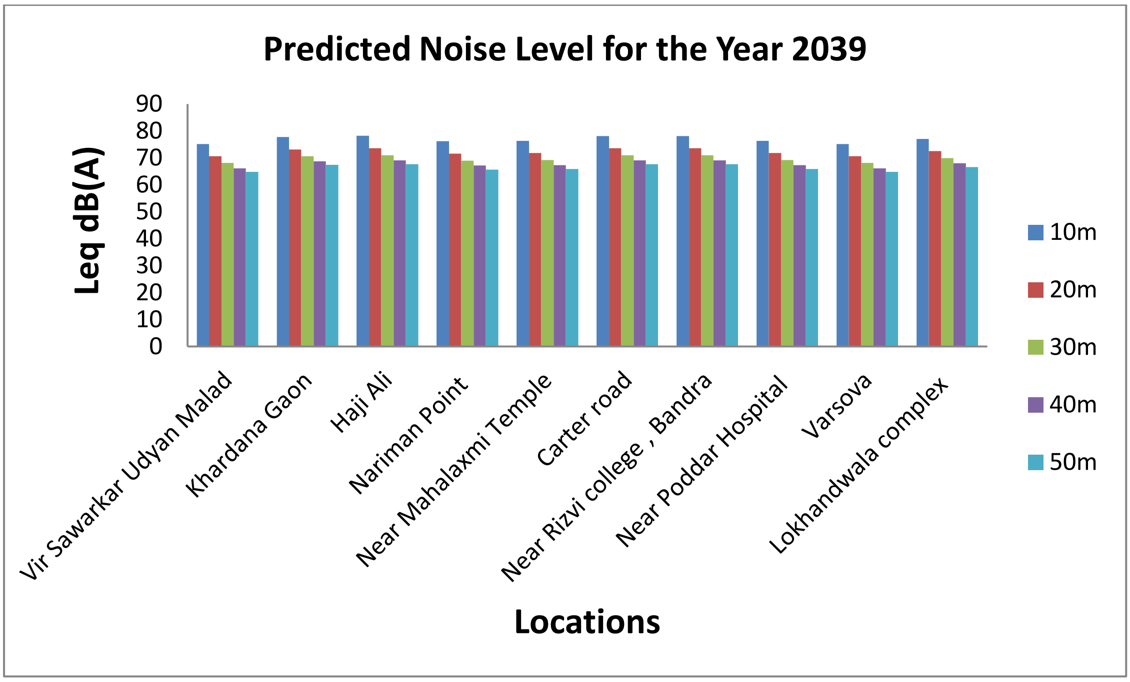


Figure 5.6: Noise prediction for the year 2039

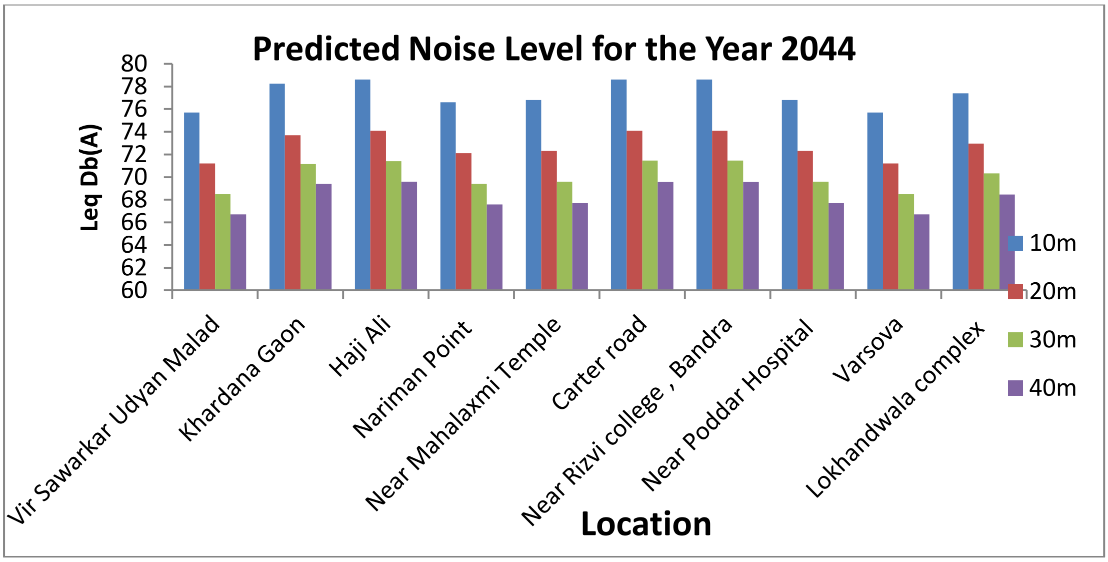


Figure 5.7: Noise prediction for the year 2044

- **Mitigation Measures**

The mitigation/management measures proposed as a part of the project are likely to reduce the noise levels along the corridor during the operation stage. Vegetative noise barriers have been proposed in front of the schools and hospitals depending on the space available. The predicted noise levels are marginally above the norms in most cases, so provisions of separate noise barrier for receptors are not called for. The green cover recommended will be sufficient to attenuate ambient noise levels to comply with relevant standards.

5.15 Impact on Ecology / Biological Environment

- **Construction Phase**

Accumulation of dust particles on the surrounding vegetation result in the decrease of the growth rate of the trees. Decrease of the number of visiting faunal species like butterflies, birds etc. due to vibrations and increased noise levels within the project Corridor, the vegetation and fauna include the common herb, shrub, trees and some domesticated animals. No any endangered species of plant and animals have been reported within the project corridor. Mangrove habitation of about 33.37 ha would be affected. About 483 road side trees along with about 321 mangrove trees would be felled during construction of the road for which three times trees will be planted under compensatory afforestation programe in consultation with forest department.

The clearing operations of the corridor will not have any impact on wild life species, threatened or endangered spices as these are not known to occur along the Project Corridor.

- **Operation Phase**

The project road is passing through mostly urban land and settlements and therefore during the operational phase due to traffic growth concentration of air pollutants will have impact on flora, fauna and human health.

A proposal for landscaping has been included in the in EMP as a part of the scope of work. Implementation of the landscaping program will give the area a good scenic beauty and bio-diversity of the area will improve. Due to development of green belt impact of air quality in the settlements and human health will be insignificant.

Spices Identified For Green Belt Development

Sl. No.	Plant Species	Vernacular Name
1	Albizzia lebbek	Kala siris
2	Terminalia arjuna	Arjun
3	Cassia fistula	Amaltas

Sl. No.	Plant Species	Vernacular Name
4	Polyalthia longifolia	Asoka
5	Embelica Officianalis	Amal
6	Bauhinia variegata	Kachnar
7	Mitragyna parviflora	Kadamb
8	Pongamia pinnata	Kranj
9	Cassia siamea	Kasod
10	Dalbergia sissoo	Sheesham
11	Delonix regia	Gulmohar
12	Ficua glomerata	Gular
13	Acacia nilotica	Keekar
14	Acacia catechu	Khair
15	Acacia arabica	Babul
16	Syzgium cumini	Jamun
17	Minusops elangi	Maulsiri
18	Madhuca indica	Mahua
19	Ficus bengalensis	Bargad
20	Ficus religeosa	Peepal
21	Azadirachta indica	Neem
22	Casurina equisitifolia	Jhau

List of Shrubs suggested for the garden

Sr no.	Botanical Name	Family	Remarks
1	Ixora chinensis Lamk	Rubiaceae	Grows well both in sun and semi-Shaded places. Produces numerous small tubular flowers all the year round.
2	Heliconia angustifolia Hook.	Heliconiaceae	Heliconias are grown for its beautiful flowers and large foliage. Used for growing along margins and hedges.
4	Clerodendrum chinense (Osbeck) Mabberley.	Verbenaceae	A hardy and free flowering shrub producing cluster of scented flowers in summer months.

5	Bougainvillea spectabilis Willd.	Nyctaginaceae	A very popular ornamental plant cultivated for its bright coloured persistent bracts.
6	Celosia cristata Linn.	Amaranthaceae	Used for ornamental purposes. The plant is suitable for growing along the garden paths or hedges

5.16 Construction Debris

- **Construction Phase**

The proposed road construction work will generate minimum of debris from excavation and embankment construction because, demolition of buildings and site clearing operations of the right of way at the existing portion of the road is negligible. All such dismantled materials are to be safely recycled to the extent possible and disposed off for filling the low-lying areas.

5.17 Impacts on Archaeological/Historical Monuments Cultural Heritage/ Sensitive/ critical natural habitats

17 Nos. of Religious and Heritage structures along the entire project stretch are given below

Sl. No	Name of the Heritage	Grade	Minimum distance from alignment (m)
1	Govind Mahal	III	18
2	Parijat	III	19
3	Meghdoot	III	18
4	Parsi. Gymkhana	II-B	30
5	Islam Gymkhana	II-A	30
6	Hindu Gymkhana	II-A	25
7	Wilson College Gymkhana	II-A	33
8	Police Gymkhana Ground	II-A	36
9	Zaver Mansion	II-A	15
10	Wilson College	II-A	21

Sl. No	Name of the Heritage	Grade	Minimum distance from alignment (m)
11	Lincon House	II-B	187
12	Mahalaxmi Temple	II-B	78
13	Haji Ali Dargah	II-A	281
14	Kekee Manzil	II-B	207
15	19/19 A Carter Road	III	210
16	Dandeshwar Shankar Mandir	III	330
17	Theosophical Society Precincts		232

Grade II (A & B) comprises of buildings and precincys of regional or local importance possessing special architectural or aesthetic merit or cultural or historical significance. They are local landmarks, which contribute to the image and identity of the region.

Grade III comprises building and precincts of importance for townscape; that evoke architectural, aesthetic, or sociological interest through not as much in Heritage Grade.

Sanjay Gandhi National Park (Borivali National Park) is located partly in the Mumbai suburban district, and partly in the Thane district, and it extends over an area of 103.09 km^2 (39.80 sq mi) which will not fall within 10 km radius area of the proposed alignment.

5.18 Social Impacts & Mitigation

The social environment consists of the lands, buildings, and other community owned assets including utilities.

However, the options for the proposed road will be finalized with a thrust to minimize the impact on structures and other properties.

5.19 Summary of Potential Impacts and remediation measures through EMP

The potential impacts arising out of the project and remediation measures are summarized in the following Table 5.2

Table 5.2: Impact Evaluation of Environmental Components and Mitigation

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
1	Air Environment – Construction phase	Movement of vehicles	Increase in PM,CO, NOx and SO2	Not significant due to the temporary nature of the activity	Movement of vehicles will be limited only in the night time. Construction materials will be transportd through sea route
		Usage of Construction equipments.	Emission of SO2, NOx, SPM, CO etc.	Not significant due to the temporary nature of the activity.	All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that pollution emission levels comply with the relevant requirements of GOI and the PMU / PMC Trucks carrying construction material will be covered with the tarpaulin sheet.
		Drilling operation	Increase in SPM levels	Not significant due to the temporary nature	Sprinkling of water can be done so as to decrease

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
				of the activity	the suspension of particulate matter in air.
	Air Environment – Operation phase	Functioning of park	Increase in aesthetics due to improved air quality. Less pollution with increase speed of vehicle	Beneficial impact	
2	Noise Environment – Construction phase	Movement of vehicles	Increase in Ambient noise in the area	Temporary nature of the activity, hence not significant	Heavy noise producing equipment and operations should not be allowed in the night time. Their operation will be restricted only in the daytime. If urgently required, noise protection covering shall be provided..
		Usage of construction equipments	Increase in intermittent noise level	Temporary nature of activity	The plants and equipment used in construction shall strictly conform to the GOI noise

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
					standards. All vehicles & equipment used in construction shall be fitted with exhaust silencers. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced. Limits for construction equipment used in the project (measured at one meter from the edge of equipment in the free field) such as compactors, rollers, front loaders, concrete mixers, cranes (moveable), vibrators and saws

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
					shall not exceed 55dB(A) Maintenance of vehicles, equipment and machinery shall be regular and to the satisfaction of the PMU and PMC keep noise from these at a minimum. Workers in vicinity of loud noise, and workers working with or in crushing, compaction, or concrete mixing operation shall wear earplugs
	Noise Environment – Operation Phase	Functioning of road	Noise level will increase due to increased human activities	Not significant, the green zone will help in reducing noise from present levels.	Proper management plan is adopted for developing the green zone within the site which will act as a buffer to check the noise

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
3	Water Environment – Construction phase	Usage of construction materials	Could lead to possible contamination of sea/lake water by throwing debris	Effect is temporary	The construction activity will not be carried out in the rainy season
		Usage of construction equipments	Accidental spillage of oil and grease from machinery in surface and groundwater	Effect is temporary	Careful handling of the construction equipments and creating awareness among the labour using it
		Usage of construction material	Surface runoffs could lead to possible contamination	No offsite impact	Ready Mix Concrete (RMC) will be used so l runoff is not expected
		Setting up of garden and transportation of red earth	Leakage of red earth through run off water leads to contamination of water	Effect is temporary	Onsite diversion ditches will be constructed to control any surface runoff during site development.
	Water Environment – Operation phase	Accidental spillage and solid waste dumping	water contamination	Offsite impact can be minimized though proper	Oil &Grease separator will be provided for the collection

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
				management plan	and treatment of surface runoffs The treated water will be recycled for gardening use.
		Accumulation of non biodegradable solid waste due to human activity	Throwing of garbage in the leading to contamination of water	No offsite impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the road
		Accumulation debris	Likely chance of throwing of garbage debris in water affecting aquatic flora and fauna	No offsite impact	Onsite vermin-composting facility will be provided and the compost will be used as a manure for gardening purpose
4	Land Environment – Construction phase	Drilling operations	No effect on loss of productive soil	No impact	

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
	Land Environment – Operation phase	Human activity	Generation of solid waste	No significant impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the garden
5	Traffic Pattern – Construction phase	Blockage of the road due to the operation onsite	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of vehicles to the site for carrying the construction material	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of labours and staff around the construction site and on the existing road	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Effective traffic diversion and management will be undertaken
	Traffic Pattern	Movement of	Create an	Impact	Adequate

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	MItigation through EMP
	– Operation phase	vehicles coming to the site	increase in the number of vehicles	minimized through implementation of EMP	parking lots will be provided
6	Ecology – Construction phase	Constructing activity	Accumulation of dust particles on the surrounding vegetation result in the decrease of the growth rate of the trees and cutting of trees	Impact minimized through plantation programe	Compensatory afforestation programme will be implemented through EMP
			Decrease of the number of visiting faunal species like butterflies, birds etc. due to vibrations and increased noise levels	Temporary impact	Biodiversity will increase once the road is constructed and adopting EMP guidelines.
	Ecology – Operation phase	Operation of road and	Increase in the green cover have positive impact		

5.20 Mitigation measure for Sea Face wall Protection for Coastal road

Seawall is a structure constructed parallel to the coastline that shelters the shore from wave action. This structure has many different designs; it can be used to protect a cliff from wave attack and improve slope stability and it can also dissipate wave energy on sandy coasts.

Various options available for Sea Wall Protection are:

- Sheet Pile Walls
- Gabions
- Geo Bags
- Pile with Counter Fort Retaining Wall
- Tetra Pods or Quarry Stones
- Caissons

Here recommended options are Caissons

- **Caissons:** Recommended for the rocky bed (cost approx. Rs. 3.5 lacs per mts.)
- Designed for a maximum height of 10mts. to be protected.
- For lesser height the truncated section from 10m profile can be adopted where in the top 3 to 4 units will be same with only the bottom most unit cast to a height suitable for the respective location.
- Top two units above +4.0m CD levels can be in situ casting at site for the structure to be monolithic.
- This can be precast in moduar units for easy handling and site assembled
- Caisson designed to be self stable against the forces from either side

Advantages of Caissons:

- Rested on rocky bed by Leveling bed with excavator in soft rock/leveling with boulder soling in hard rock.
- Good drainage ensured by back fill with good drainage properties.
- Top portion finished as a curve to reverse the wave force and contain the wave splashing

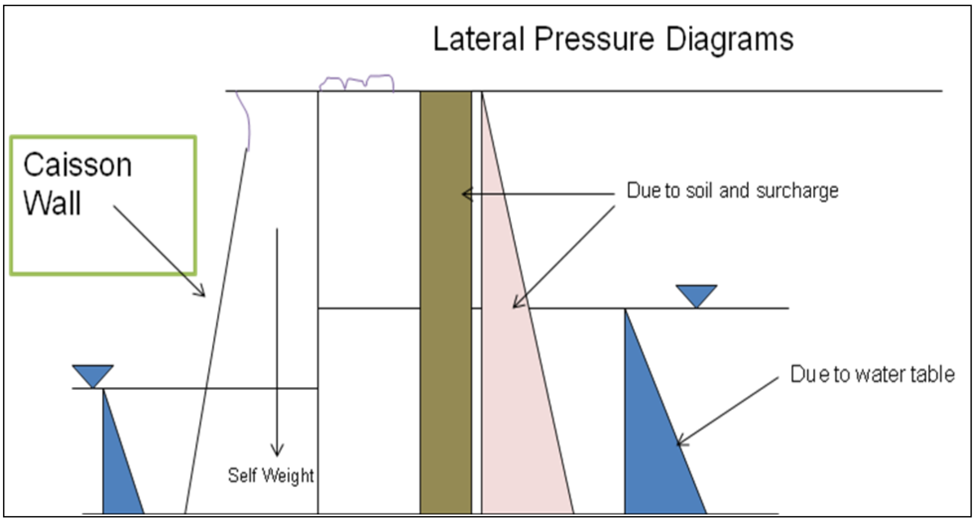
Consideration of FFL of the Road

- Sea level: HTL as +4.0m CD as the most likely high level sea water during a storm
- Surge (storm/Tsunami): storm serge as 1 in 100 years (2.1m) is higher than tsunami wave height.
- Significant wave height: 4.5m from south west as a 1 in 100 year event.
- Level of existing sea road: RL about +6.0 above MSL have stood well along the coast.
- Storm water drain: depth available for RCC box culvert to take it from present out fall to the new sea wall face
- Effect of global warming: A recently realized phenomenon, 4 to 5 mm per year which is less than built up of road due to resurfacing periodically
- Promenade level kept 0.3m above FFL of road.
- Overtopping for a small duration the too with maximum surge and maximum wave height is permitted in coastal road design

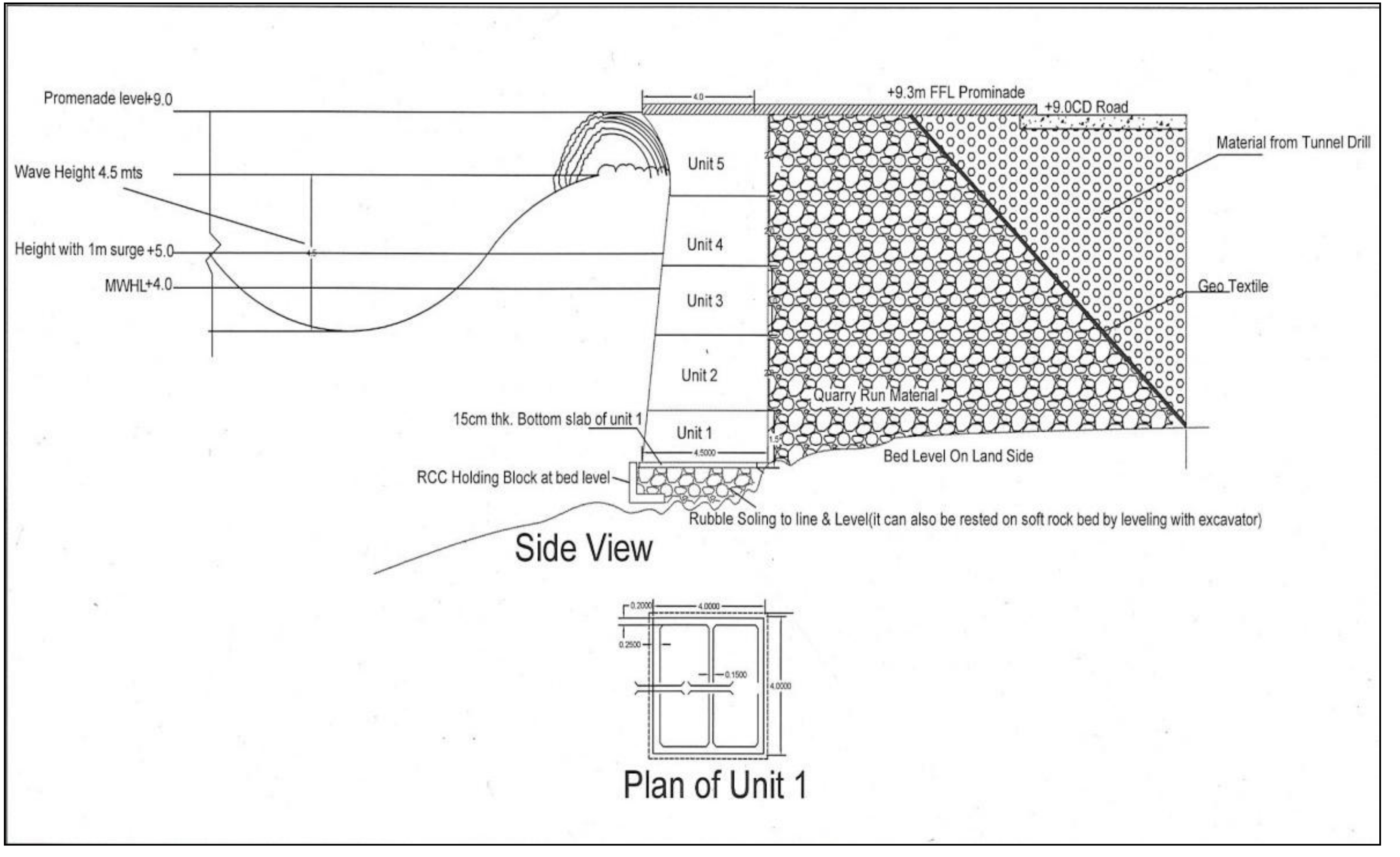
- The top unit of caisson is curved to change the direction of wave and to arrest splashing.
- Taking consideration of cost and other pros and cons FFL of road is fixed as +8.5m CD or +6.0m above MSL.

Methodology for Caisson

- Full unit of caisson of 10m high is cast in five units and weighing approx. 25 tons is cast in pre casting yard which can be any where close to the shore in Bombay or new Bombay
- Load precast unit by 100 ton shore crane on to barge(loaded draft maxi. 2.5mts) in jetty at precast yard
- Barge to unload precast units from temporary jetty at site through a 100ton shore crane during high tide window.
- Temporary road on land side of 8m width up to +4.5m CD to be done
- Boulder soling/leveling by excavator to be done to receive the caisson units
- Caisson units to be placed in position by 100ton shore crane by moving on access road
- Trailer to feed the erection crane
- Pockets of caisson and the land side to be filled up to the existing approach road.



Forces for Analysis


Promenade level+9.0
Wave Height 4.5 mts
Height with 1m surge +5.0
MWHL+4.0
+9.3m FFL Prominade
+9.0CD Road
Material from Tunnel Drill
Unit 5
Unit 4
Unit 3
Unit 2
Unit 1
Geo Textile
Quarry Run Material
15cm thk. Bottom slab of unit 1
RCC Holding Block at bed level
Bed Level On Land Side
Rubble Soling to line & Level(it can also be rested on soft rock bed by leveling with excavator)
Side View
0.2000
4.0000
0.2500
0.1500
4.0000
Plan of Unit 1

5.21 Ecological Impact Assessment

Impact Assessment takes into consideration the probable changes in the environment, such as, changes in the air quality, water quality, soil quality, noise levels, vegetation and wild life, landscape quality, land use, vehicular traffic, infrastructure, population, economic activity, etc. This may result from any development either during the course of development being carried out, or thereafter. The impact could be positive or negative, direct or indirect, local or regional, and also reversible or irreversible. Depending up on the project type the impact can be further categorized as short term or long term based on their nature, potential and magnitude.

There is a growing awareness that road development has major environmental impacts. Some of the major environmental impacts of road projects include:

- Damage to sensitive ecosystems
- Loss of productive agricultural lands
- Resettlement of large numbers of people
- Permanent disruption of local economic activities
- Demographic change
- Accelerated urbanization
- Introduction of disease

The proposed project passes through the coastal area, hence all the ecologically sensitive and the geomorphological features which play an important role in maintaining the integrity of the coast are considered while evaluating the impact due to the project activity. The ecological component of the coastal area includes the following:

- Mangroves
- Sand Dunes;
- Mudflats which are biologically active;
- Sea grass beds;
- Nesting grounds of birds;
- Areas or structures of archaeological importance and heritage sites.

5.24.1. Impact on Mangroves/Mangrove Habitat:

The proposed activity will involve construction of stilt road in the mangrove patches. The associated flora and fauna within this corridor will be subjected to many of the major impacts from the construction and operational phases of the project. The impacts of the proposed activities will be greater during construction phase than operational phase.

5.24.2. During Constructional Phase:-

- The road to be constructed will equate to a direct loss and removal of 321 Nos of Mangrove vegetation associations within 33.37 ha of affected mangrove area.
- Reduction of mangrove plant population (habitat for fauna, micro fauna, firewood).
- Insects and invertebrates that are associated with mangrove habitats will be impacted by the direct loss of habitat that these fauna rely on for food and shelter. There will also be some direct mortality of insects and invertebrates during the clearing of mangrove vegetation during construction work.
- Reduction in mangrove fauna (crabs, shrimps, egrets, herons, kingfishers, spoonbills, ibises, terns, and other species)
- Disappearance of reproduction and food zones for species of fish, aquatic and migratory birds.
- Irreversible salinization and acidification of mangrove swamp soils
- Transportation and stockpiling of the freshly excavated materials and sand can result in extreme alteration of soil and surface water salinity levels in the vicinity of construction site.
- Some areas of the mangroves may experience altered tidal flushing as a result of construction of the proposed infrastructure, particularly where a road will cross Malad Creek. Some small intertidal channels will have disrupted flows while other channels may be completely in filled.
- Dusts will be generated during the construction work which is likely to affect the Mangroves, insects and other fauna in the nearby area.

- Excessive noise generated by the machinery can scare away avifauna and other fauna, sensitive to high noise levels.
- Erosion of the coastline.
- Increase in poaching during the work period and subsequent hunting and fishing.

5.24.3. During Operational Phase:-

- During the operational phase the noise generated from vehicular traffic could affect the habitat use in the nearby Mangrove area.
- Similarly, excessive illumination due to lighting may adversely impact on the nearby fauna at night.
- Solid waste such as garbage, plastic bags etc may cause severe impacts to the mangrove and creek ecology.
- Polluted runoff and accidental fuel/oil spillage may act as a source of contamination and affect the nearby Mangrove and Creek ecology.
- Positive impacts include improved access, reduced travel time and cost, employment opportunities and perhaps reductions in accidents or noise.

5.24.4. Mitigation measures:-

- To compensate for the loss of Mangroves, mangrove species such as Avicennia marina, Salvadora persica, Acanthus ilicifolius etc shall be established on either side of the road to be constructed.
- Dust suppression measures shall be adopted in places where there is handling of cement like materials. The leaves and foliage of mangrove and other trees shall be sprinkled with water during construction time in order to avoid clogging of stomata with dust.
- Sprinkling of water and fine spray nozzles at regular intervals to suppress the dust.
- Use of covering sheets to prevent dust dispersion from the vehicles used for carrying construction materials at site.
- During constructional activities the noise shall be monitored to maintain the noise levels within the permissible limits.

- Fast growing trees shall be grown on either side of the road to serve as noise and dust barriers, and also to provide cover and nesting sites for birds and other animals.
- Street lamps shall be designed so as to illuminate only the road and avoid straying of light upwards and sideways.
- Proper instructions shall be provided to the motorists on the "dos and don't" required to maintain the nearby mangrove habitats.

5.24.5. Impact on Marine Ecosystem:

During Constructional Phase

Tunnel Construction: Cut and Cover tunnel is proposed at two places in the project at a stretch of 3.45 km and 5.76 km and width 30m respectively. A large corridor of area will greatly be negatively impacted due to tunnel construction. The impacts of the proposed activities will be greater during construction phase than operational phase. Some of the prominent impacts are illustrated below:-

- Secondary effects will be formation of sediment plumes, which may affect fish or benthos because of the smothering and clogging effect of highly turbid waters on the gills of bivalves or fish, inability to detect predators and the limiting of the photosynthetic process in plants.
- The suspension of fine sediments in the water column will create turbidity, which may scatter and attenuate light levels and potentially affect the growth of plants indirectly by reducing the availability of light and consequently the photosynthetic process in plants.
- Accidental fuel spillages and overfilling of excavated material can also affect the Marine ecosystems.
- The pH of water may increase causing imbalance in the ecosystem and also the activities will cause nutrient imbalance and algal bloom in the nearby shore areas.
- The water quality will decrease and may also cause increase in temperature thereby reducing the oxygen dissolving capacity.
- Sedimentation will be very high due to continuous drilling of the ocean bedrocks.

- The living habitats and micro habitats of the marine flora and fauna will be destroyed.
- The above impacts will directly impact on fisheries due to the mortality and migration of fishes from the area under construction.
- The food webs of the area under construction will be greatly affected thereby causing imbalance in the tropic layer.
- Immediate and long-term degradation of sensitive and essential breeding and nursery habitats for coastal and marine organisms (e.g. dunes, beaches, estuaries,) which could lead to long-term reductions of commercially important species (fish, shellfish etc);
- The presence of construction engines and equipments can also have visual impacts of the seascapes and tourist spots.

***Bridge Construction**:* Bridge construction is proposed at nine places in the project of a total stretch of 8.20 km of 46 widths. The impacts of the proposed activities will be greater during construction phase than operational phase.

Impacts may include:

- The immediate and long-term effect will be the degradation of sensitive and essential breeding and nursery habitats for coastal and marine organisms which could lead to long-term reductions of commercially important species (fish, shellfish etc)
- Destruction and damage to sensitive coastal vegetation
- Interruption of dynamic coastal ecosystem processes (dune migration)
- Visual impacts
- Degradation from increased human traffic and resultant pollution in coastal areas
- Increased pollution can also lead to eutrophication (dead zones in water due to lack of oxygen) and harmful algal bloom events in coastal waters
- Increased traffic congestion and resultant air/ noise and water pollution and Pollution from vessels (oil, litter, chemicals, cargo if vessels are grounded).

Reclamation: A total length of 12.06 km will be reclaimed in the project. Reclamation may have indirect effects to the Environment and Ecology.Some of them is illustrated below:

- It may cause increase in the concentration of suspended solids and reduce light penetration thereby affecting photosynthesis of marine vegetation.
- It may cause decrease in dissolve oxygen levels and may result in mortality of organisms.
- It may cause nutrient imbalance and result in algal blooms.
- During construction there will be increase in trampling on Rocky shores which will directly affect the intertidal organisms.
- Excavation and Extraction of Intertidal organisms may take place during constructional activities.
- Noise during the reclamation activities may affect the intertidal and nearby habitat and may disturb the movement patterns of certain organisms.

During Operational Phase:-

During the operational phase, transportation activities will increase and also the ambient noise and air quality will get affected due to the various operational activities like berthing, unloading, auctioning and transportation. Even though all the operational activities will affect the air and noise quality, the impacts are considerably negligible and will not cause much direct or indirect harmful effect on any living form around the area. Discharge of sewage effluents are predicted to increase with increasing number of people. Positive impacts include improved access, reduced travel time and cost, employment opportunities and perhaps reductions in accidents or noise.

Mitigation measures:-

- Reclamation operations shall be, undertaken only where it can be conclusively proved that these are required for operation purposes related to the activities permissible under Coastal Regulation Zone Notification.
- Best practicable technology and operating methods shall be used for drilling/ reclamation to minimize adverse environmental impact.

- Disposal of reclamation material shall be on the basis of proper scientific/ modeling studies at designated sites and during time interval so that there are no damages to surface, ground water quality and marine productivity. Dumping of dredged material on coast will not be permitted in case it is likely to cause adverse impact on marine ecology.
- Temporary bunds shall be constructed to contain surface run-off from the land sites. Collected run-off shall be passed through retention ponds to collect suspended solids before discharge.
- To prevent discharge of sewage, oily wastes and other liquid wastes into marine environment, adequate system for collection, treatment and disposal of liquid wastes including shoreline interceptor for receiving liquid wastes from the shoreline installations and special connections to receive wastes from ships must be provided.
- It shall be ensured that effluents/wastes from ships/barges are not discharged into sea, in accordance with national/international laws.
- Adequate noise control measures must be taken to maintain levels within prescribed limits in the work places as well as port areas to avoid adverse effects on the workers as well as marine life.
- To reduce the dust generation, noise pollution and emission of gaseous pollutants like SO_2 and NOx during the loading, unloading and transportation of materials like cement, the following measures shall be carried out:-
  - Installation of Dust Suppression System & Regular Water Sprinkling on haul roads
  - Proper maintenance of Transportation vehicles

CHAPTER 6

6. Environmental Monitoring Program

6.1 Monitoring Program

The purpose of the monitoring program is to ensure that the envisaged objectives of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are:

- To evaluate the performance of Mitigation measures proposed in the EMP
- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in Management plan, if required
- To enhance Environmental quality
- To satisfy the Legal and Community obligations.

6.2 Performance Indicator

The physical, biological and social components identified as of particular significance in affecting the environment at critical locations have been suggested as Performance Indicators (PIs), and are listed below.

- Air quality
- Water quality
- Noise levels around sensitive locations.
- Plantation success / survival rate
- Soil contamination
- Erosion indices
- Restoration of borrow pits
- Sedimentation rate in the downstream where bridges, culverts, etc are built
- Vital statistics on health
- Accident frequency

6.3 Selection of Indicators for monitoring

The environmental parameters that may be qualitatively and quantitatively measured and compared over a period of time, due to their importance and the availability of standardized procedures and expertise, have been selected as Performance Indicators (PIs).

- Air Quality
- Noise Levels
- Water Quality
- Biological Quality
- Soil Contamination

Following sub-sections describe each of these PIs in detail.

6.4 Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters recommended for monitoring road transportation developments are PM_{10} ,$PM_{2.5}$, Carbon Monoxide (CO), Oxides of Nitrogen (NO_X), Sulphur Dioxide (SO_2) and Lead (Pb).

These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance to the National Ambient Air Quality Standards, 2009 (Table 6.1) .The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Monitoring Plan (Table 6.5)

6.5 Water Quality Monitoring

The physical and chemical parameters recommended for analysis of water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan. The monitoring will be carried out in accordance to the Indian Standard Drinking Water Specification – IS10500: 2012 (Table 6.2).

Table 6.1: National Ambient Air Quality Standards (2009)

[भाग III—खण्ड 4] भारत का राजपत्र : असाधारण 3

NATIONAL AMBIENT AIR QUALITY STANDARDS
CENTRAL POLLUTION CONTROL BOARD
NOTIFICATION
New Delhi, the 18th November, 2009

No. B-29016/20/90/PCI-I.—In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in supersession of the Notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect, namely:-

NATIONAL AMBIENT AIR QUALITY STANDARDS

S. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO_2), µg/m³	Annual* 24 hours**	50 80	20 80	- Improved West and Gaeke -Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), µg/m³	Annual* 24 hours**	40 80	30 80	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
3	Particulate Matter (size less than 10µm) or PM_{10} µg/m³	Annual* 24 hours**	60 100	60 100	- Gravimetric - TOEM - Beta attenuation
4	Particulate Matter (size less than 2.5µm) or $PM_{2.5}$ µg/m³	Annual* 24 hours**	40 60	40 60	- Gravimetric - TOEM - Beta attenuation
5	Ozone (O_3) µg/m³	8 hours** 1 hour**	100 180	100 180	- UV photometric - Chemilminescence - Chemical Method
6	Lead (Pb) µg/m³	Annual* 24 hours**	0.50 1.0	0.50 1.0	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
7	Carbon Monoxide (CO) mg/m³	8 hours** 1 hour**	02 04	02 04	- Non Dispersive Infra Red (NDIR) spectroscopy
8	Ammonia (NH_3) µg/m³	Annual* 24 hours**	100 400	100 400	-Chemiluminescence -Indophenol blue method

(1)	(2)	(3)	(4)	(5)	(6)
9	Benzene (C_6H_6) µg/m^3	Annual*	05	05	- Gas chromatography based continuous analyzer - Adsorption and Desorption followed by GC analysis
10	Benzo(a) Pyrene (BaP) - particulate phase only, ng/m^3	Annual*	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual*	06	06	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual*	20	20	- AAS /ICP method after sampling on EPM 2000 or equivalent filter paper

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note. — Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

SANT PRASAD GAUTAM, Chairman
[ADVT-III/4/184/09/Exty.]

Note: The notifications on National Ambient Air Quality Standards were published by the Central Pollution Control Board in the Gazette of India, Extraordinary vide notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998.

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Source: Central Pollution Control Board, Delhi.

*Average Arithmetic mean of minimum 104 measurements in a year taken for a week 24 hourly at uniform interval.

**24 hourly/8 hourly values should meet 98 percent of the time in a year

Table 6.2: Indian Standard Drinking Water Specification-IS 10500:2012

Sl. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect Outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
Essential Characteristics						
1	Colour, Hazen units, Max.	5	Above 5, consumer acceptance decreases	25	3025 (Part 4) 1983	Extended to 25 only if toxic substances are not suspected, in absence of alternate sources
2	Odour	Unobjectionable	-	-	3025 (Parts 5):1984	a) Test cold and when heated b) Test at several dilutions
3	Taste	Agreeable	-	-	3025 (Part 7 and 8) 1984	Test will beconducted only after safety has been established
4	Turbidity NTU, Max.	5	Above 5, consumer acceptance decreases	10	3025 (Part 10) 1984	-
5	pH Value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation	3025 (Part 11) 1984	-
6	Total hardness (as CaCO3) MG/1, Max	300	Encrustation in water supply structure an adverse effects on domestic use	600	3025 (Part 21) 1983	-
7	Iron (as Fe)	0.3	Beyond this limit	1	32 of 3025	-

Sl. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect Outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
	mg/1, Max		taste/appearance are affected, has adverse effect on domestic uses and water supply structures, and promotes iron bacteria		: 1964	
8	Chlorides (as CI) mg/1, Max	250	Beyond this limit, taste, corrosion and palatability are affected	1000	3025 (Part 32) 1988	-
9	Residual, free chlorine, mg/1, Min	0.2	-	-	3025 (Part 26) 1986	Will beapplicable only when water is chlorinated. Tested at consumer end. For protection against viral infection it should be Min 0.5 mg/1
Desirable Characteristics						
1	Dissolved solids mg/1, Max	500	Beyond this palatability decreases and may cause gastro intestinal irritation	2000	3025 (Part 16) 1984	-
2	Calcium (as Ca) mg/1, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200	3025 (Part 40) 1991	-
3	Magnesium (as Mg), mg/1, Max	30	Encrustation to water supply structure and adverse effects	100	16, 33, 34 of IS 3025:	-

Sl. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect Outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
			on domestic use		1964	
4	Copper (as Cu) mg/1, Max	0.05	Astringent taste, discoloration and corrosion of pipes, fitting and utensils will be caused beyond this	1.5	36 of 3025: 1964	-
5	Maganese (as Mn) mg/1, Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3	35 of 3025: 1964	-
6	Sulphate (as 200 SO4) mg/1, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400	3025 (Part 24) 1986	May be extended up to 400 provided (as Mg) does not exceed 30
7	Nitrate (as NO2) mg/1, Max	45	Beyond this methaemoglobinemia takes place	100	3025 (Part 34) 1988	-
8	Fluoride (as F) mg/1, Max	1	Fluride may be kept as low as possible. High fluoride may cause fluorosis	1.5	23 of 3025: 1964	-
9	Phenolic compounds (As C6H5OH) mg/1, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002	54 of 3025: 1964	-
10	Mercury (as Hg) mg/1, Max	0.001	Beyond this, the water becomes toxic	No relaxation	(see note) Mercury ion	Will be tested when pollution is suspected

Sl. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect Outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
					analyzer	
11	Cadmium (as Cd), mg/1, Max	0.01	Beyond this, the water becomes toxic	No relaxation	(See note)	Will be tested when pollution is suspected
12	Selenium (as Se), mg/1, Max	0.01	Beyond this, the water becomes toxic	No relaxation	28 of 3025: 1964	Will be tested when pollution is suspected
13	Arsenic (As) mg/1, max	0.05	Beyond this, the water becomes toxic	No relaxation	3025 (Part 37) 1988	Will be tested when pollution is suspected
14	Cyanide (As CN), mg/1, Max	0.05	Beyond this limit, the water becomes toxic	No relaxation	3025 (Part 27) 1986	Will be tested when pollution is suspected
15	Lead (as Pb), mg/1, Max	0.05	Beyond this limit, the water becomes toxic	No relaxation	(see note)	Will be tested when pollution is suspected
16	Zinc (As Zn). Mg/1, Max	5	Beyond this limit it can cause astringent taste and an opalescence in water	15	39 of 3025: 1964)	Will be tested when pollution is suspected
17	Anionic detergents (As MBAS) mg/1, Max	0.2	Beyond this limit it can cause a light froth in water	1	Methylene-blue extraction method	Will be tested when pollution is suspected
18	Chromium (As Cr6+) mg/1, Max	0.05	May be carcinogenic above this limit	No relaxation	38 of 3025: 1964	Will be tested when pollution is suspected

Sl. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect Outside the Desirable Limit	Permissible Limit in the Absence of Alternate Source	Methods of Test (Ref. To IS)	Remarks
19	Polynuclear aromatic hydrocarbons (as PAH) mg/1, Max	00.00010	May be carcinogenic above this limit	-	APHA 6440	-
20	Mineral oil mg/1, Max	0.01	Beyond this limit undesitable taste and odour after chlorination take place	0.03	Gas Chromatographic method	-
21	Pesticides mg/1, Max	Absent	Toxic	0.001	-	-
22	Radioactive materials:				58 of 3025:1964	-
23	a) Alpha emitters Bq/1, Max	-	-	0.1	-	-
24	Beta emiters pci/1, Max	-	-	1	-	-
25	Aluminum (as Al), mg/1, Max	200	Beyond this limit taste becomes unpleasant	600	13 of 3025:1964	-
26	Aluminum (as A1), mg/1, Max	0.03	Cumulative effect is reported to cause dementia	0.2	31 of 3025: 1964	-
27	Boron, mg/1, Max	1	-	5	29 of 3025:1964	-

28	**Bacteriological Quality of Drinking Water1)**	
	Organisms Requirements	**Organisms Requirements**
i.	*All water intended for drinking*: a) *E. coli* or thermotolerant coliform bacteria2), 3)	Shall not be detectable in any 100 ml sample
ii.	*Treated water entering the distribution system*: a) *E. coli* or thermotolerant coliform bacteria2) b) Total coliform bacteria	Shall not be detectable in any 100 ml sample Shall not be detectable in any 100 ml sample
iii.	*Treated water in the distribution system*: a) *E. coli* or thermotolerant coliform bacteria b) Total coliform bacteria	Shall not be detectable in any 100 ml sample Shall not be detectable in any 100 ml sample

Surface Water Quality Monitoring:

To ascertain the Baseline conditions of the Surface water quality samples of surface water are to be collected from designated locations in two different seasons, one at Post-monsoon and the other at the pre-monsoon season. Surfacewater qualities are to compared with CPCB fresh water classifications (Table 6.3).

Table 6.3: Water Quality Criteria and standards for Freshwater Classification (CPCB, 2012)

Parameters	BOD mg/l	pH	TDS (PPM)	D.O in mg/l	Lead (Pb) in µg/l	Oil and Grease in mg/l
CPCB Standard Class B **(For outdoor bathing)**	**3.0**	**6.5-8.5**	**--**	**5.0**		
CPCB standard Class D **(For propagation of wild life, fisheries)**	**3.0**	**6.5-8.5**	**--**	**≥4**	**0.1**	**≤0.1**

CPCB standard Class E **(For irrigation)**	--	**6.0-8.5**	**0-700**	--	--	--

6.6 Noise level Monitoring

The measurements for monitoring noise levels would be carried out at all designated locations along all contract packages in accordance to the Ambient Noise Standards formulated under Gazette Notification No.643 dated 26.12.1989 of Ministry of Environment & Forest, GOI (Table 6.4). Sound pressure levels would be monitored on twenty-four hour basis. The location, duration and the noise pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan.

Table 6.4: Noise Level Limits of GoI {in Leq dB(A)}

Area/Class	**Day Time (6.00 AM to 9.00 PM)**	**Night Time (9.00 PM to 6.00 AM)**
	Standard	**Standard**
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence	50	40

6.7 Success of Plantation

To ensure the proper maintenance and monitoring of the compensatory afforestation being carried out, a regular maintenance and monitoring of the survival rate of the planted mangroves and trees are being proposed upto a period of 3 years from the operation of the project. The responsible institutional arrangements are presented in the Environmental Monitoring Plan (Table 6.5).

6.8 Soil Contamination

Contamination of the soil, especially due to increased levels of Pb, Cd and Cr are likely due to the increased traffic movement on the project corridor. The comparison of the concentrations of these parameters before and after the project coming up would aid in arriving at the increase in concentrations of these heavy metals, if any.

6.9 Monitoring Plan

The monitoring plan for the various performance indicators of the project in the construction and operation stages is summarized in Table 6.5 below.

Table 6.5: Showing Environmental Monitoring Plan

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
Air Quality	Construction Stage								
		PM10, PM2.5 SO_2 , NO_X CO,Pb	High volume sampler to be located 50 m downwind directions. Use method specified by CPCB for analysis	National Ambient Air Quality Standards CPCB, 1999	Stretch of the road where construction is in progress	3 samples, once every month for 3 years	Continuous 24 hours/or for 1 full working day`	Contractor through approved monitoring agency	Engineer

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
	Operation Stage	PM10, PM2.5 SO_2 , NO_X CO,Pb	High volume sampler to be located at 50 m from the edge of pavement.	National Ambient Air Quality Standards CPCB, 1994	At 4 (four) congested locations.	24 hourly samples per day in every alternate year		MCGM through approved monitoring agency	MCGM

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
Water Quality	Construction Stage	PH, BOD, COD, TDS, TSS, DO, Oil & Grease and Pb	Grab sample collected from source and analyse as per Standard Methods for Examination of Water and Wastewater	Water quality standards by CPCB	River and community pond	1. Down stream of the bridge construction. 2. sample from each location at 100m interval 3. From lakes during construction activity near the pond. Once every year for 3 years		Contractor through approved monitoring agency	Engineer

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
	Operation Stage	PH BOD, COD, TDS, TSS, DO, Pb, Oil and Grease	Grab sample collected from source and analyse as per Standard Methods for Examination of Water and Wastewater	Water quality standrds by CPCB	River and community lake/pond	End of summer before the onset of monsoon every alternate year.		MCGM through approved monitoring agency	MCGM
Noise Levels	Construction Stage	Noise level in Leq dB(A) scale	Free at 1 m from the equipment whose noise levels are being determined	Noise standards by CPCB	1. At equipment yards	As and when necessary	Readings to be taken at 15 seconds interval for 15 minutes every hour.	Contractor through approved monitoring agency	Engineer.

Environment Component	Project Stage	MONITORING						Institutional Responsibility	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
		Noise level in Leq dB(A) scale	Equivalent noise levels using an integrated noise level meter kept at a distance of 15 from edge of pavement.	Noise standards by CPCB	2. Construction sites as directed by the Engineer	Once every four months for 3 years at 10 locations	Readings to be taken at 15 seconds interval for 15 minutes every hour and then averaged.	Contractor through approved monitoring agency	Engineer.
	Operation Stage	Noise levels on Leq dB(A) scale	Equivalent noise levels using an integrated nosie level meter	Noise standards by CPCB	Near congested locations, Near settlements	Once every alternate months	Readings to be taken at 15 seconds interval for 15 minutes	MCGM through approved monitoring agency	MCGM

Environment Component	Project Stage	MONITORING						Institutional Responsibility	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
			kept at a distance of 15 from edge of pavement.				every hour and then averaged.		

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
Soil Quality	Construction Stage	Monitoring of Pb, Cr, Cd	Sample of soil collected to acidified and analysed using absorption spectrophotometry	Threshold for each contaminant set by IRIS database of USEPA until national standards are promulgated	At productive agricultural lands abutting traffic detours and traffic diversions, to be identified by the Engineer	Once in a year Max of 5 locations for each of the 3 years	-	Contractor through approved monitoring agency	Engineer.

Environment Component	Project Stage	MONITORING						Institutional Responsibility	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
	Operation Stage	Monitoring of heavy metals, oil and grease	Sample of soil collected to acidified and analysed using absorption spectrophotometry	Threshold for each contaminant set by IRIS database of USEPA.	At accident/spill locations involving bulk transport carrying hazardous materials	As per the occurrence of such incidents	-	MCGM through approved monitoring agency	MCGM
Plantation	Pre-construction stage	Monitoring of felling of trees	It should be ensured that only those trees that are marked are felled.	As laid out in the Detailed Design for the project	All along the corridor	During the felling of trees	-	Forest Department	MCGM ,

Environment Component	**Project Stage**	**MONITORING**						**Institutional Responsibility**	
		Parameter	Special guidance	Standards	Location (Chainage)	Frequency	Duration	Implementation	Supervision
	Operation stage	Survival rate of trees success of plantation programs	The number of trees surviving during each visit should be compared with number of saplings planted.	The survival rate should be at least 70% below which re-plantation shall be done.	At locations of compensatory plantation	Every year for 3 years	-	MCGM	MCGM

CHAPTER 7

7. Additional Studies

7.1 Introduction

Based on the Model TOR specified by the Ministry of Environment & Forest, following number of studies was carried out to fulfil the requirement of EIA study:

- Mangrove analysis, plantation and management study
- Legal options on Permissibility of Activities in CRZ Area.

7.2 Mangrove

7.2.1. Background

Mangroves are keystone coastal ecosystem providing numerous environmental services and critical ecological functions, affecting both upland and oceanic resources. They grow in an environment where land meets sea, so they have to deal with both fresh water from inland rivers and brackish waters. They are tenacious plants that thrive in these environments forming lush marine tidal forest. Once considered unimportant and transitional communities with a low productivity, mangroves have been proved to be highly productive ecologically important systems. The ecological role played by them is very significant. They protect the coast against erosion due to wind, waves and water currents and protect coral reefs, sea grass beds and shipping lanes against siltation. Mangroves host a number of different animal species – including endangered mammals, reptiles, amphibians and birds - offer nutrients to the marine food web and provide spawning grounds to a variety of fish and shellfish, including several commercial species.

However, rapid urbanization and anthropogenic causes has taken a toll on them, as is the case with all mangroves around the world. The biggest threats being **reclamation of mangrove lands for constructions, dumping of solid wastes and pollution,** logging for firewood and for other resources/products this highly productive ecosystem offers. And the biggest threat among all is people's attitudes, of ignorance and negligence. In the backdrop of the Coastal Zone Regulation (CRZ) notification published by Ministry of Environment and Forest (MoEF), for the state of

Maharashtra, Maharashtra coastal Zone Management Authority (MCZMA) has been formed with an aim to provide a comprehensive measures for the protection and conservation of our coastal environment and to safeguard its integrity from the impact it create from the developmental activities.

The proposed road alignment comprises 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 Princess Flyover area in the South and the Malad- Kandivali areas in the North. In places where there are mangrove areas, stilt roads and bridges have been proposed, to have less damage to the these ecosystem, where as in places of reclamation areas it has been provided with 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 giving speedy connectivity to various areas in the city.

A detailed site visit and the satellite image interpretation of the project area reveal that there are at least four large contiguous mangrove patch seen within the boundary of the study area. To study the health, species richness and the ecological integrity of these patches, a detailed ecological survey including the phyto-sociological assessment has been carried out and the results are documented by using a standard format as illustrated in the following sections:

7.2.2. Mangrove patches found within the study area

As discussed above, the mangrove patches that are impacted directly by the proposed road alignment are further subjected to detailed ecological assessment.The following are the four patches where in which the portion of the proposed road alignment falls on. The details regarding the area and the geographical co-ordinates are given in the following table:

Table 7.1: List of Mangrove patches found within the project boundary

Patch No.	Location details	Area (in Ha)	GPS co-ordinate Lat/Long
1	Versova-Bharat Nagar	19.25	19° 7'23.04"N/72°49'15.06"E
2	Lokhandwala	106.69	19° 8'28.02"N/72°49'3.84"E
3	Bangur Nagar	18.64	19°10'1.38"N/72°49'45.93"E
4	Malvani	55.9	19°11'2.85"N/ 72°49'35.43"E

7.2.2.1. Description of Mangrove patch found in Versova-Bharat Nagar (Patch 1)

Patch Number- 1 Versova	Date of visit: 25/12/2014, 13/01/2015	Area Distribution	
		Project Area: 5.09ha Buffer Area: 14.06 ha Total Area: 19.15 ha	
Latitude: Longitude:	19° 8'28.02"N 72°49'15.06"E	Length (m)	Area(ha)
Proposed Plan: In patch 1A	Elevated Road - Land filled Road- Bus Terminal -	1405 m 1300 175	1.3 1.3 0.8

Location/Accessibility: The site is located at Bharat nagar, Versova. The site is accessible via seven bungalow road near Raheja Park and also from the versova beach side of the patch. The important landmarks are Seven Bungalow police chowki and Versova beach. The boundary demarcation of the patch using google earth imagery is shown in the following diagram:

Map 7.1: Mangrove Patch 1 located at Versova

Mangrove Association: Avicennia marina is the most dominant species found in this patch. Along with Avicennia there are many other species like Salvodora persica found colonized towards the periphery of the patch. Species Acanthus ilicifolius also seen growing in areas where there is less canopy cover.

Avicennia marina-Salvadora persica association

Qualitative Description of Mangroves: Sparse to Dense Mangroves. Gradience and zonation is observed as we move from landward to sea. Thick canopy cover is seen in the middle portion of the patch. Canopy coverage is about 40-70 %, trees are in the girth class of 30 to 50cm. Areas near to the creek inlet show richness in species diversity. Many mangrove dependent faunal species like crabs, snails etc. are found. Pneumatophores are plenty, and cover the ground especially towards the sea side.

View of the patch

Girth Measurement

Condition & Integrity: Patch is undisturbed in areas where there is no access is possible. Human interferences in the forms of defecation, solid waste dumping, and illegal construction were observed at the periphery. The patch is frequently inundated by tidal waves carrying lots of solid wastes. Because of the low topography, the rate of receding these waves are slow, which in turn block the pnuematophores that affect the normal physiological function. Also there are many waste water inlets found coming in these patches which affect overall physiology of the mangroves. On both side of the creek inlet there is lots of siltation found deposited. Illegal construction, fuel wood collection is also normal scene found in these patch.

Polluted water coming through creek inlet

Illegal construction seen at the site

Phyto-sociology of mangrove flora found within the patch

Quantitative Analysis was carried out by using Quadrat Method. In the study area 4 quadrats of 10mx 10 m (100sq.m) size were randomly laid to study the tree and shrub species. The important quantitative parameters such as density, frequency, abundance, Important Value Index of the tree species, shrub and herb species were determined as per Curtis and Mc Intosh (1950). The Shannon-Weaver species diversity index was also determined and compared for all the three mangrove patches. Overall nine species were identified and studied in this mangrove patch. The quantification of the species identified is given below;

Quantification of species studied in mangrove patch

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	Frequency	Density	Abundance	Important Value Index
Avicennia marina	7	15	22	10	54	1	13.5	Frequent	92.09926146
Acanthus	3	2	3	0	8	0.75	2	Frequent	49.75139127
Salvodara persica	3	0	0	2	5	0.5	1.25	Frequent	58.89887918
Aegiceras	2	2	0	0	4	0.5	1	Sparse	33.88230093
Derris trifoliata	1	1	0	0	2	0.25	0.5	Sparse	15.53791543
Eucalyptus	2	0	0	0	2	0.25	0.5	Sparse	10.37174286
Euphotorium	2	0	0	0	2	0.25	0.5	Sparse	22.52912571
Lentana camera	1	0	0	0	1	0.25	0.25	Sparse	7.273820669
Acacia sps.	2	0	0	0	2	0.25	0.5	Sparse	9.65556249

Conclusion & inference: Avicennia marina is observed to be the most frequent and important species of this patch. The basal area covered is seen greater in species such as Acanthulicifolius, Salvodara persica and Aegiceras corniculatum. Some urban tree species are also observed in this patch like Eucalyptus, Acacia sps etc.

7.2.2.2. Description of Mangrove patch found in Lokhandwala (Patch 2)

Patch Number-2 **Lokhandwala**	**Date of visit:** 24/12/2014	**Area Distribution**	
		Project: 12.86 ha **Buffer: 93.83 ha** **Total Area: 106.69 ha**	
Latitude: **Longitude**:	**19° 8'28.02"N** **72°49'3.84"E**	**Length(m)**	**Area(ha)**
Proposed Plan: **In Patch 2A**	**Elevated Road -** **Bridge -** **Road on Stilts -**	**5600** **180** **1630**	**5.6** **0.3** **1.6**

Location/Accessibility: The site is located at Lokhandwala, Andheri West. The area coming under the project site is not accessible but it can be viewed from Lokhandwala Lake. The important landmarks are Reliance sub-sation and Central Institute of Fisheries road. The boundary demarcation of the patch using google earth imagery is shown in the following diagram:

Map 7.2: Mangrove Patch 2 located at Lokhandwala

Mangrove Association: Avicennia marina is the most dominant species observed in this patch. Acanthus ilicifolius is also seen growing in areas where there is less canopy cover.

Qualitative Description of Mangroves: Dense Mangroves. Gradience and zonation is observed as we move from landward to sea. Thick canopy cover is seen throughout the patch. Areas near to the creek inlet show richness in species diversity. Many mangrove dependent faunal species like crabs, snails etc. are found.

Condition & Integrity: Patch is undisturbed as there is no accessibility. Human interferences in the forms of solid waste dumping, and illegal settlement is observed at the periphery. The patch is frequently inundated by tidal waves carrying lots of solid wastes. Also there are many waste water inlets found coming in these patches which affect overall physiology of the mangroves.

Lokhandwala Mangrove patch **Polluted Creek Water/Waste Dumping**

Phyto-sociology of mangrove flora found within the patch

Quantitative Analysis was carried out by using Quadrat Method. In the study area 4 quadrats of 10mx 10 m (100sq.m) size were randomly laid to study the tree and shrub species. The important quantitative parameters such as density, frequency, abundance, Important Value Index of the tree species, shrub and herb species were determined as per Curtis and Mc Intosh (1950). The Shannon-Weaver species diversity index was also determined and compared for all the three mangrove patches. Overall nine species were identified and studied in this mangrove patch. The quantification of the species identified is given below;

Quantification of species studied in mangrove Patch 2

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	Frequency	Density	Abundance	Important Value Index
Avicennia marina	10	12	24	11	57	1	14.5	Frequent	92.18965
Acanthus ilicifolius	1	1	2	0	4	0.65	2	Frequent	43.65438
Salvodara persica	2	0	0	2	4	0.5	1.23	Frequent	58.76543
Aegiceras corniculatum	1	1	0	0	2	0.5	1	Sparse	33.878654
Derris trifoliata	1	1	0	1	3	0.25	0.5	Sparse	15.509876
Eucalyptus	2	1	0	0	3	0.25	0.5	Sparse	10.271742
Euphotorium repandum	2	0	0	0	2	0.25	0.5	Sparse	22.459876
Lentana camera	1	1	0	0	2	0.25	0.21	Sparse	7.2567890

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	Frequency	Density	Abundance	Important Value Index
Acacia sps.	3	0	0	0	3	0.25	0.5	Sparse	9.5765438

Conclusion & inference: Avicennia marina is observed to be the most frequent and important species of this patch. The basal area covered is seen greater in species such as Acanthulicifolius, Salvodara persica and Aegiceras corniculatum. Some urban tree species are also observed in this patch like Eucalyptus, Acacia sps etc.

7.2.2.3. Description of Mangrove patch found in Bangur Nagar (Patch 3)

<table>
<tr><td rowspan="2">Patch Number-3
Bangur Nagar</td><td rowspan="2">Date of visit:
25/12/2014,13/01/2015</td><td colspan="2">Area Distribution</td></tr>
<tr><td colspan="2" rowspan="2">Project Area: 6.00 ha
Buffer Area: 12.64 ha
Total Area: 18.64 ha</td></tr>
<tr><td rowspan="2">Latitude:
Longitude:</td><td rowspan="2">19°10'1.38"N
72°49'45.93"E</td></tr>
<tr><td>Length(m)</td><td>Area(ha)</td></tr>
<tr><td>Proposed Plan:
In Patch 3</td><td>Elevated Road -
Road on stilt -
Bridge -</td><td>280
360
220</td><td>0.48
2.88
0.44</td></tr>
</table>

Location/Accessibility: The site is located at Bangur Nagar, Malad West. The site is accessible via Bangur Nagar Road near Ayappa Mandir. The important landmarks are Ayappa Mandir and Kali Mandir. The boundary demarcation of the patch using google earth imagery is shown in the following diagram:

Map 7.3: Mangrove Patch 3 located at Bangur Nagar

Mangrove Association: Avicennia marina is the most dominant species found in this patch. A semi –mangrove species Aegicerus corniculatum is seen abundantly growing near the periphery of the patch. Species Acanthus ilicifolius, Salvodora persica, Bruguiera cylindrica and Rhizophora apiculata are also seen growing in areas where there is less canopy cover.

Bangur Nagar Mangrove patch

Aegiceras Corniculatum

Qualitative Description of Mangroves: Dense Mangroves. Gradience and zonation is observed as we move from landward to creek. Towards the central east side canopy cover is thick. Canopy coverage is of 80-85% in dense areas, trees are in the girth class of 4-6 m. Areas near to the creek inlet show richness in species diversity. Many mangrove dependent faunal species like crabs, snails etc. are found. Pneumatophores are plenty, and cover the ground especially towards the creek side.

Avicennia marina dense forest **Girth Measurement**

Pneumatophores **Study team at site**

Condition & Integrity: Patch is undisturbed in areas where there is no access is possible. Human interferences in the forms of defecation, solid waste dumping, and illegal construction were observed at the periphery. The patch is frequently inundated by tidal waves carrying lots of solid wastes. Healthy pneumatophores are observed in abundance. Siltation is seen on the banks of the creek.

Solid waste dumping

GPS Co-ordinate data collection

Phyto-sociology of mangrove flora found within the patch

Quantitative Analysis was carried out by using Quadrat Method. In the study area 4 quadrats of 10mx 10 m (100sq.m) size were randomly laid to study the tree and shrub species. The important quantitative parameters such as density, frequency, abundance, Important Value Index of the tree species, shrub and herb species were determined as per Curtis and Mc Intosh (1950).The Shannon-Weaver species diversity index was also determined and compared for all the three mangrove patches. Overall 8 species were identified and studied in this patch.The quantification of the species identified is given below:

Quantification of species studied in mangrove patch 3

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	Frequency	Density	Abundance	Important Value Index
Avicennia marina	12	16	8	18	54	1	13.5	Frequent	79.02010075
Bruguiera cylindrica	5	4	0	2	11	0.75	2.75	Frequent	37.51257627
Rhizophora apiculata	3	0	0	0	3	0.25	0.75	Sparse	30.03617176
Aegiceras corniculatum	0	4	0	0	4	0.25	1	Sparse	23.87914485
Acanthus ilicifolius	7	2	0	5	14	0.75	3.5	Frequent	47.99868466
Salvodara persica	2	1	0	0	3	0.5	0.75	Sparse	50.14366836
Derris trifoliate	1	2	0	1	4	0.75	1	Sparse	21.05442532
Acacia sps.	0	0	4	0	4	0.25	1	Sparse	10.35522803

Conclusion & inference: Avicennia marina is found to be the most frequent and important species of this patch.The basal area covered is seen greater in species such as Acanthus ilicifolius, Salvodara persica, Rhizophora apiculata, Bruguiera cylindrical and Aegiceras corniculatum. Acacia sps is present in one of the quadrat studied.

7.2.2.4 Description of Mangrove patch found in Malvani (Patch 4)

Patch Number-4 **Malvani**	**Date of visit:** **25/12/2014,13/01/2015**	**Area Distribution**	
		Project Area: 8.37 ha **Buffer Area: 47.53 ha** **Total Area: 55.9 ha**	
Latitude: **Longitude**:	**19°11'2.85"N** **72°49'35.43"E**		
		Length(m)	**Area(ha)**
Proposed Plan: In Patch 4	**Road on stilts -** **Road on stilts –** **Bridge -**	**1640** **210** **240**	**13.12** **0.21** **0.48**

Location/Accessibility: The site is located at Malvani. The site is accessible via Malvani village road and Samna Nagar and can be viewed from Mindspace. The important landmark is Mindspace. The boundary demarcation of the patch using google earth imagery is shown in the following diagram:

Map 7.4: Mangrove Patch 4 located at Malvani

Mangrove Association: Avicennia marina is the most dominant species found in this patch. Along with Avicennia there are many other species like Salvodora persica found colonized towards the periphery of the patch. Species Derris trifoliate is also seen near the banks of the creek.

Malvani Mangrove Patch **Salvadora persica**

Qualitative Description of Mangroves: Sparse to Dense Mangroves. Gradience and zonation is observed as we move from landward to creek. Towards west side canopy cover is thick. Canopy coverage is about 50-55 %, trees are in the girth class of 20-50 cm . Areas near to the creek inlet show richness in species diversity. Many mangrove dependent faunal species like crabs, snails etc. are found. Pneumatophores are sparse and cover the ground near the creek side.

GPS data collection

Mangroves near Malad Creek

Condition & Integrity: Patch is disturbed in easily accessible areas. Human encroachment, illegal construction, defecation and solid waste dumping are seen in the patch. The patch is frequently inundated by tidal waves carrying lots of solid wastes. Because of the low topography, the rate of receding these waves are slow, which in turn block the pneumatophores that affect the normal physiological function. On both side of the creek inlet there is lots of siltation found deposited. Illegal construction, fuel wood collection is also normal scene found in these patch.

Solid waste dumping

Burning near Mangrove patch

Study team at site

Human encroachment at patch

Phyto-sociology of mangrove flora found within the patch

Quantitative Analysis was carried out by using Quadrat Method. In the study area 4 quadrats of 10mx 10 m (100sq.m) size were randomly laid to study the tree and shrub species. The important quantitative parameters such as density, frequency, abundance, Important Value Index of the tree species, shrub and herb species were determined as per Curtis and Mc Intosh (1950).The Shannon-Weaver species diversity index was also determined and compared for all the three mangrove patches. Overall 5 species were identified and studied in this patch.The quantification of the species identified is given below;

Quantification of species studied in mangrove Patch 4

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	Frequency	Density	Abundance	Important Value Index
Avicennia marina	7	12	13	13	45	1	11.25	Frequent	98.43629984
Salvodara persica	4	0	3	0	7	0.5	1.75	Frequent	59.02452345
Acanthus ilicifolius	2	1	2	2	7	1	1.75	Frequent	75.74653859
Derris trifoliate	1	1	0	1	3	0.75	0.75	Sparse	24.80098144
Clerodendron inerme	1	0	0	1	2	0.5	0.5	Sparse	41.99165668

Conclusion & inference: Less Number of species is observed in this patch. Avicennia marina is found to be the most frequent and important species. The basal area covered is seen greater in species such as Acanthus ilicifolius and Salvodara persica.

7.2.3 Ecology of the Mangrove Patches

7.2.3.1. Flora of the Mangroves: A brief description of the species reported from the study area is given in the following paragraph;

Avicennia marina: The species belong to family Avicenniaceae and is commonly known as white mangrove. It occurs anywhere in the intertidal zone on a range of soft muddy and sandy soils and is often found along saline or brackish rivers. It is a pioneering species, which dominates developing mud banks and grows to about 15 m high. The leaves are 8x5 cm, oval, pointed and opposite, shiny green and pale grey below. Air pores (stomata) and salt glands are scattered over the whole leaf surface, but are more abundant below. The small, yellow flowers appear in clusters from April to May. The white mangrove has pale green, roughly egg-shaped propagules, with a thin, hairy seed coat and 2 seed leaves. Numerous spongy pneumatophores (peg roots) spread out at the base of the tree. Peg roots grow vertically upwards through the soil surface to allow the roots to breathe.

Salvadora persica: The species is commonly called a toothbrush plant. It belongs to family Salvadoraceae. This plant is not a true mangrove species, since it does not show any of the adaptations of true mangroves such as air breathing roots, presence of salt glands and vivipary. But it show very high tolerance to salt.

Bruguiera cylindrica: The species is a small tree growing up to 20 metres (66 ft) tall but often grows as a bush. The bark is smooth and grey, with corky raised patches containing **lenticels** which are used in gas exchange and the trunk is buttressed by roots. The aerial roots or **pneumatophores** project from the soil in knee-shaped loops and have many lenticels which allow air into the interconnecting roots while excluding water. The roots spread out widely to provide stability in the waterlogged soil. The glossy green leaves are opposite, simple and elliptical with pointed ends. The flowers are in small bunches of 2-5 in the axils of the leaves. The seed does not detach itself from the flower stalk but germinates where it is and is known as a **propagule**. It grows into a slightly curved cylinder up to 15 cm (6 in) long, with the upturned calyx still attached, and looks rather like a slender, dangling **cucumber**. The roots (lower part) absorb water and become heavier and after a few weeks the propagules float vertically and are ready to root into the **substrate**.

Acanthus ilicifolius: The species is commonly known as Sea holly. It belongs to family Acanthaceae. Sea holly gets its name from its spiny leaves which look like British Holly. This is a herb-like plant with a long stem growing up to 1.5 m and found landwards of the mangroves. Large population of this plant indicates high levels of degradation.

***Rhizophora mucronata*:** Trees, upto 20m tall, with many upwardly growing branches. leaf-scars prominent. Leaves broadly elliptic or ovate-oblong, coriaceous, abruptly acute or blunt with a rolled up tip at apex, cuneate at apex. Common and often gregarious along the intertidal banks of creeks and channels in the sheltered mangrove areas under estuarine influence. Flowering and fruiting from July – October.

Derris trifoliate: A large climber, branches glabrous, bark dark-grey, covered with scattered lenticels. Leaves are 12-20cm long, rachis striate, glabrous. Leaflets 3-7, terminal the largest, sub-coriaceous, ovate or ovate-oblong, acute or acuminate, sometimes slightly emarginated, highly polished on the upper surface. Flowers rose-coloured, in axillary racemes, the nodes of the rachis produced into short stalks about 4 mm long, each bearing one or more sub-equal slender pedicels. Pods variable in shape, orbicular-oblong, thin, flat, reticulately veined, shortly apiculate, glabrous, pale-yellow when ripe. Seed reniform oppressed. Common along sea coast and on the edges of muddy salt water creeks

***Clerodendrum inerme*:** The common name is Vanajai, Codi, Koinel, and Kadu-Mehendi. It belongs to family Verbenaceae. It is a straggling, much branched shrub, grows 1-2 m long, sometimes scandent; bark pale-brown; branches twiggy.

Fauna of Mangroves:

The mangrove ecosystem comprises of intertidal area having creeks, channels, mud-flats, rock flats, estuaries, etc., which provide varied habitats for a variety of animal species. Due to tidal action and mixing of fresh water with saline water, this ecosystem harbors highly specialized fauna and flora. The faunal communities of a mangrove ecosystem can be broadly divided into the following categories:

a. Aquatic,

b. Semi-aquatic and

c. Terrestrial.

7.2.3.2. Aquatic and Semi-aquatic Fauna

The intertidal area and the muddy-sandy floor of bays and creeks provide rich and varied habitats for a host of marine organisms. These aquatic and semi-aquatic marine organisms are called benthos which is broadly sub-divided into the following:

a**. *Micro-benthos*-** Organisms of a size smaller than 40µ, such as planktons.

b. ***Meio-benthos***- Organisms larger than 40µ, but smaller than 60µ, such as nematodes, Copepods, archeannelids, polychaetes, etc.

c. ***Macro-benthos***- Organisms larger than 60µ, such as polychaetes, mollusks, crustaceans, echinoderms and fishes.

Diverse species of phytoplankton, mollusks, fishes like mudskippers, crustaceans such as prawns, shrimps, crabs etc were observed during the field survey of the study area.

Crustaceans observed in the Mangrove patches

Mudskipper

7.2.3.3. Terrestrial Fauna

The rich floral diversity of mangrove forests, along with its associated aquatic and semi-aquatic fauna elements, attracts a large number of terrestrial animal life-forms. Many of these terrestrial faunal elements are residents of mangrove forests, while some of them, especially birds and reptiles, come to such areas during low tide for feeding on exposed mud-flats and tidal pools.

Insects- Many varieties of insects have been found associated with mangroves. Most of them utilize mangroves for food or shelter or both. While for mosquitoes and sand-flies, they provide an ideal breeding ground, many host-specific, gall; causing insects and mites have also been found associated with mangroves.

We listed 57 species of butterflies and 33 species of the insects which are associated with the mangroves as well as other flora in the region.

Table 7.5: List of butterfiles

Sr.No	Species	Common Name
1	*Hasora chromus*	Common Banded Awl
2	*Badamia exclamationis*	Brown Awl
3	*Spialia galba*	Indian Skipper
4	*Sarangesa dasahara*	Common Small Flat
5	*Caprona ransonnetti*	Golden Angle
6	*Udaspes*	Grass Demon
7	*Graphium sarpedon*	Common Bluebottle
8	*Graphium agamem*emnon	Tailed Jay
9	*Graphium nomius*	Spot Swordtail
10	*Papilio polytes*	Common Mormon
11	*Papilio demoleus*	Lime Butterfly
12	*Atrophaneura aristolochiae*	Common Rose
13	*Atrophaneura hector*	Crimson Rose
14	*Eurema hecabe*	Common Gras Yellow
15	*Catopsillia pomona*	Common Emigrant

16	*Colotis eucharis*	Plain Orange Tip
17	*Ixias marianne*	White Orange Tip
18	*Ixias pyrene*	Yellow Orange Tip
19	*Hebomoia glaucippe*	Great Orange Tip
20	*Pareronia valeria*	Common Wanderer
21	*Cepora nerissa*	Common Gull
22	*Delias eucharis*	Common Jezebel
23	*Leptosia nina*	Psyche
24	*Belenois aurota*	Pioneer
25	*Rathinda amor*	Monkey Puzzle
26	*Tajuria cippus*	Peacock Royal
27	*Spindasis vulcanus*	Common Silverline

Insect fauna observed in the Mangrove patches

Amphibians- Amphibians are very poorly represented in the mangrove ecosystem. Some of the species seen in the study area are listed below:

Table 7.6: Some species observed in the study area

Order	Family	Species	Common Name
Anura	Bufonidae	*Duttaphrynus melanostictus*	Common Indian Toad
	Ranidae	*Euphlyctis cyanophylyctis*	Skittering Frog

Order	Family	Species	Common Name
		Fejervarya limnocharis	Indian Cricket Frog
	Rhacophoridae	*Polypedates maculatus*	Common Tree Frog

Reptiles- They represented by Calotes sp., dog-faced water snake and pit viper. During low tide, water snakes are seen actively feeding on crabs and fishes, especially at night. About 33 species of reptiles were observed in the study area.

Table 7.7: List of Reptiles species observed in the study area

Order	Family	Species	Common Name
Testudines	Trionyx	*Lissemys punctata*	Indian Mud or Flap Shell Turtle
Sauria	Gekkonidae	*Hemidactylus brooki*	Brook's Gecko
		Hemidactylus leschenaultia	Bark Gecko
	Agamidae	*Calotes versicolor*	Garden Lizard
	Varanidae	*Varanus bengalensis*	Bengal Monitor
	Scincidae	*Mabuya carinata*	Brahminy Skink
Serpentes	Typhlopidae	*Ramphotyphlops*	Flowerplot Snake
	Boidae	*Python moluras moluras*	IndianPhyton
	Acrochordidae	*Acrochordus granulatus*	Wart Snake
	Colubroid	*Ptyas mucosa*	Indian Rat Snake
		Argyrogena fasciolatus	Banded Racer

Order	Family	Species	Common Name
		Xenochrophis piscator	Checkered Keelback
		Amphiesma stolatum	Buffstriped Keelback
		Macropisthodon plumbicolor	Green Keelback
		Gerarda Prevostiana	GlossyMarsh Snake
		Ahaetulla nasutus	Common Tree Snake or Vine Snake
		Cerberus rynchops	Dogfaced Water Snake
	Elapidae	*Bungarus caeruleus*	Common Indian Krait
		NajaNaja	Spectacled Cobra
	Viperidae	*Daboia russellii*	Russell's Viper
		Echis carinatus	Saw-Scaled Viper
		Trimeresurus gramineus	Bamboo Pit Viper

Birds- Mangroves provide food, roosting and nesting places for many varieties of birds. During low tide, waders can be seen feeding actively on exposed mud-flats. The birds can be broadly grouped into the following:

a. **Water birds/waders**: such as herons, egrets, sandpipers, plovers, snipe, etc.

b. **Kingfishers:** These are most noticeable in the mangroves of these islands. Kingfishers are closely associated with the mangroves.

c. **Fruit-eating/Insectivorous birds**: Pigeons, parakeets, lorikeets, crow-pheasant, swiftlets, woodpecker, orioles, drongos and mangrove whistler frequent mangroves in search of food and shelter.

d. **Predatory birds:** Sparrow hawks, crested serpent eagles also frequent mangroves, of which the most common one is the sea eagle, which can be seen fishing in mangrove fringed creeks.

Birds of the mangroves: Many birds are found in the mangroves. Following is a list of birds found in the mangroves of study area:

Table 7.8: List of birds found in the mangroves of study area

Bird Species	
Cormorants and Shags	
	Little Cormorant *Phalacrocorax niger*
Herons and Egrets	
	Little Egret *Egretta Garzetta*
	Western Reef Egret *Egretta gularis*
	Grey Heron *Ardea cinerea*
	Purple Heron *Ardea purpurea*
	Cattle Egret *Bubulcus ibis*
	Indian Pond Heron *Ardeola greyii*
	Black Ground Night Heron *Nycticorax nycticorax*
Ibisis and Spoonbill	
	Black Headed (Oriental White) Ibis *Threskiornis*
Hawks,Eagles,Ospreys	
	Black (Pariah) Kite *Milvus migrans*
	Brahminy Kite *Haliastur indus*
	Western Marsh- Harrier *Circus aeruginosus*
Waders	
	Grey Plover *Pluvialis squatorola*
	Little Ringed plover *Charadrius dubius*

	Kentish Plover *Charadrius alexandrinus*
	Little Sand Plover *Charadrius mongolus*
Lapwings	
	Red Wattled Lapwing *Vanellus indicus*
Godwits	
	Black-tailed Godwit *Limosa limosa*
Curlew	
	Eurasian Curlew *Numenius arquata*
Sandpipers	
	Common Redshank *Tringa totanus*
	Common Greenshank *Tringa nebularia*
	Wood Sandpiper *Tringa glareola*
	Common Sandpiper *Actitis hypoleucos*
Stints and *Calidris*	
	Little Stint *Calidris minuta*
	Temminck's Stint *Calidris temminckii*
	Curlew Sandpiper *Calidris ferruginea*
	Ruff Philomachus pugnax
bisbill,Stilts and Avocets	
	Black-winged Stilt *Himantopus himantopus*
Gulls	
	Palla's Gull *Larus ichtyaetus*
	Brown-headed Gull *Larus brunnicephalus*
	Black-headed Gull *Larus ridibundus*
Terns	
	Gulled- Billed Tern Gelochiledon nilotica
	Caspian-Tern *Sterna Caspia*
	Little Tern *Sterna albifrons*
	Whiskered Tern *Chilnodria albidus*

Wagtails	
	White Wagtail *Motacilla alba*
	Pied Wagtail *Motacilla maderaspatensis*
	Grey wagtail *Motacilla cineria*

Kingfisher

Common Sandpiper

Cormorant

Mammals: Many mammals are frequent visitors of mangrove habitats but only a few live there permanently and fewer are restricted to them.The fauna the mangroves present in the study area include Golden Jackal *Canis aureus* , Common Mongoose *Herpestes edwardsi* ,Bats *Pteropus giganteus* and Rats *Rattus rattus* etc.

7.2.3.4. Shannon-Weaver Index (H):

Shannon Index is a commonly used diversity index that takes into accounts both abundance and evenness of species present in the community. It is explained by the formula:

$$H = -\sum_{i=1} (P_i * \ln P_i)$$

Where,
H = the Shannon diversity index
P_i = fraction of the entire population made up of species i (proportion of a species i relative to TOTAL number of species present, not encountered)
S = numbers of species encountered.

Shannon- Weaver species index is calculated and compared for the three Mangrove patches. The detailed quantification of the Mangrove patches is illustrated in the following tables:-

Patch 1:

Table 7.9: List of Shannon-weaver species index (Patch 1)

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	
Avicennia marina	7	15	22	10	54	**1.24**
Acanthus ilicifolius	3	2	3	0	8	
Salvodara persica	3	0	0	2	5	
Aegiceras corniculatum	2	2	0	0	4	
Derris trifoliata	1	1	0	0	2	
Eucalyptus	2	0	0	0	2	
Euphotorium repandum	2	0	0	0	2	
Lentana camera	1	0	0	0	1	
Acacia sps.	2	0	0	0	2	

Patch 2:

Table 7.10: List of Shannon-weaver species index (Patch 2)

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	
Avicennia marina	10	12	24	11	57	**1.21**
Acanthus ilicifolius	1	1	2	0	4	
Salvodara persica	2	0	0	2	4	
Aegiceras corniculatum	1	1	0	0	2	
Derris trifoliata	1	1	0	1	3	
Eucalyptus	2	1	0	0	3	
Euphotorium	2	0	0	0	2	
Lentana camera	1	1	0	0	2	
Acacia sps.	3	0	0	0	3	

Patch 3:

Table 7.11: List of Shannon-weaver species index (Patch 3)

Name of Species	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Total**	
Avicennia marina	12	16	8	18	54	**1.29**
Bruguiera cylindrica	5	4	0	2	11	
Rhizophora apiculata	3	0	0	0	3	
Aegiceras corniculatum	0	4	0	0	4	
Acanthus ilicifolius	7	2	0	5	14	
Salvodara persica	2	1	0	0	3	
Derris trifoliata	1	2	0	1	4	
Acacia sps.	0	0	4	0	4	

Patch 4:

Table 7.12: List of Shannon-weaver species index (Patch4)

Name of Species	Q 1	Q 2	Q 3	Q 4	Total	
Avicennia marina	7	12	13	13	45	**0.98**
Salvodara persica	4	0	3	0	7	
Acanthus ilicifolius	2	1	2	2	7	
Derris trifoliata	1	1	0	1	3	
Clerodendron inerme	1	0	0	1	2	

Conclusions and Inference: Mangrove patch 3 shows a high value of H which represents a diverse and equally distributed community and Mangrove patch 4 shows a lower value representing less diverse community.

7.2.4 Management of Mangrove:

7.2.4.1. Introduction

Formulation of a strategic management plan with an approach to mangrove development and sustainability of the mangrove ecosystem is essential. The conservation of mangrove biodiversity and management plans may focus on several individual aspects such as historical ecology of the site, present environmental conditions and other development cum conservation activities. But the sustainability and well being of an ecosystem largely depends on management of three major factors such as Conservation, Resource and Research at the study area. Thus it is obvious here to elaborate and discuss the management activities under these three facets. Similarly management activities required for betterment of this ecosystem can also be considered under two typical approaches viz. management on scientific and social insight. Both these approaches are directly related to each other and will not work successful in isolation.

7.2.4.2. Need for Mangrove Conservation and Management

Increasing human population in coastal areas is resulting in increased pressure on mangrove ecosystems in many countries, with the growing demand for timber, fuelwood, fodder and other non-wood forest products (NWFPs) (Saenger, Hegerl and Davie, 1983). To ensure the conservation of mangroves for environmental benefits, together with a sustainable supply of various forest and other products to meet the day-to-day requirements of local people, appropriate management of mangrove ecosystems is needed. Management can also open new avenues for self-employment such as ecotourism, fishing, beekeeping and cottage industries based on mangrove forest products, helping to improve the socio-economic conditions of the local communities.

7.2.4.3. Management of Mangroves in India

India has a long tradition of mangrove forest management. The Sundarbans mangroves, located in the Bay of Bengal (partly in India and partly in Bangladesh), were the first mangroves in the world to be put under scientific management. The area's first management plan was implemented in 1892 (Chaudhuri and Choudhury, 1994).

More recently, the concern of the Government of India for the conservation of forests and wildlife was clearly demonstrated by a 1976 amendment to the Indian Constitution, which states that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife.

Recognizing the importance of mangroves, the Government of India set up the National Mangrove Committee in the Ministry of Environment and Forests in 1976 to advise the government about mangrove conservation and development. In its first meeting, the panel, which consists of scientists, research scholars and experts on the mangrove ecosystem, emphasized the need to conduct a survey of the extent of existing mangrove areas within the country. The government subsequently introduced a scheme for mangrove conservation and protection, consisting of:

- Identification of selected mangrove areas for conservation;
- Preparation of a management plan;

- Promotion of research;
- Adoption of a multidisciplinary approach involving state governments, universities, research institutions and local organizations.

  In 1979, the National Mangrove Committee recommended areas for research and development and for management of the mangroves, which included the following:
- Nationwide mapping of the mangrove areas, preferably by remote sensing techniques coupled with land surveys, and time series to assess the rate of degradation of the ecosystems;
- Quantitative surveys of area, climatic regime, rate of growth of forest trees and seasonal variations of environmental parameters;
- Assessment of suitable sites for reserve forests;
- Conservation programmes;
- Afforestation of degraded mangrove areas;
- Study of management methods, the ecology of mangroves, their flora and fauna, their microbiology and the biochemistry of organic matter and sediments.

On the basis of the National Mangrove Committee's recommendation, 15 mangrove areas were identified for conservation. The Government of India has provided guidance and financial assistance to states and Union territories for the preparation and implementation of Management Action Plans for the conservation and development of these mangrove ecosystems. Most of these plans are now being implemented. The plans broadly cover survey and demarcation, natural regeneration in selected areas, afforestation, protection measures, fencing and awareness programmes.

The government also supports research by academic institutions for development of mangrove ecosystems on a sound ecological basis. The National Forest Policy, 1988 lists effective conservation and management of natural forest ecosystems (including the mangrove ecosystem) as a priority area for forestry research.

7.2.4.4. Legislative Framework

In India, a legislative framework for the conservation and management of mangroves is already in place. The Indian Forest Act, 1927 and the Wildlife (Protection) Act, 1972 provide protection to flora and fauna. Although they do not specifically mention mangroves, these acts can also apply to the conservation of the flora and fauna of mangrove ecosystems. Since 1927, the Indian Forest Act has been applied to the mangrove forests of the Sundarbans, which have been declared as a reserved area (Naskar and Mandal, 1999).

The Forest Conservation Act, 1980 states that no forest area shall be diverted for any non-forestry purpose without prior approval of the Government of India. This act has proved very effective in preventing diversion of mangrove forest areas for non-forestry purposes.

The Environment (Protection) Act, 1986 has had a crucial role in the conservation and management of mangrove ecosystems. Coastal stretches are classified into four categories, and mangroves are included in the most ecologically sensitive category.

In Mahrasthra, Mangroves are considered as reserve forest and permission from the Honorable High Court is necessary for use of Mangrove forest land for development purposes.

7.2.4.5. Conservation and Management Approach

The management approach on conservation of biological diversity largely depends on plantation of mangrove and protection given to them.

With all the observations made around the project site with special emphasis on mangrove ecosystem, and after analyzing the records and documents, several management plans under different managing actions were driven out to foster future development and sustainability of this mangrove ecosystem. Given below are some of the most important

Management plans to be undertaken for future development of the mangrove ecosystem under three different approaches:

i) Habitat management

(a) Habitat management can be achieved under two aspects such as habitat creation and habitat restoration. Basically habitat creation means the creation of a new habitat by developing new sites and linking remaining patches. Similarly, restoration refers to modification of existing semi-natural habitat. As far as this mangrove concerned both these aspects would be quite applicable.

(b) Communities that depend on these coastal resources face the long term challenge for their sustenance and after natural disasters in terms of economic crisis. Belated responses in initiating remedial action after the damage become apparent seen almost in all developing countries.

In view of these critical situations, adoption of several preventive measures is essential to protect the coastal communities and for the conservation of these coastal ecosystems. Such defensive measures should cover all the activities of past, present and future, bearing in mind that the cumulative impact of these activities should not affect the existing biodiversity in any way. To achieve these goals best option is to set up nursery at the site itself.

ii) Establishment of a nursery

(a) Direct planting of viviparous seedlings in appropriate locations which are regularly inundated by incoming high tides, is an ideal way of mangrove establishment in new areas. In some parts of the Country, raising the mangrove seeds for transplantation in a nursery established at the site or adjacent to it is considered to be ideal for successful mangrove establishment once planted.

(b) Locations which need to be restored will have to be surveyed for their topography, exposure to tidal inundation, tidal amplitude, soil type including its salinity and anthropogenic pressures. Initial efforts could be made to restore the degraded areas with indigenous species of mangroves, which are found to be growing luxuriantly.

(c) Planting native or already successfully established species would be much appreciable than introduction of a new species. Altering the site by the introduction of strange species newer to the site will be detrimental to the already established species.

Thus, the species selection for plantation should be based on the existing environmental conditions at the site rather than trying to impose new species.

iii) Public participation

(a) Mangrove management plans often collapse especially because they fail to fulfill the very basic requirement like involvement and aspirations of local communities. Priority should be given to participation of local rural people in mangrove-based plantation activities. Emphasizing on education to encourage them to the level of self management, so that they involve themselves in protecting their own resources.

(b) Involving local people reduces the information gap between local wisdom and knowledge systems available at different levels. Information about the coastal policies, coastal protection rules, laws and coastal acts can be taught to the inhabitants and to those involved in planting. Thus making local community literally well aware of coastal policies, leads to better management achievement.

(c) Involving local people like the fishermen community, women self-help groups, youth clubs etc. motivates them to protect. Participants involved in plantation should be sufficiently cohesive, dedicated and have a common intention to plant and protect. Encouraging to plant mangroves in adjacent inundated areas initiates them to safeguard the mangrove with self intention.

VI. Conclusions

Many of the problems observed during the field study in particularly those caused by humans, can be traced to the following root causes, which need to be addressed if mangroves are to be sustainable conserved:

- The poverty of the local inhabitants, which forces them to depend on mangroves for their fuelwood, timber and fodder requirements even if collection is illegal;
- Increasing population, resulting in more pressure on mangroves;
- Lack of education and awareness regarding the importance of mangroves, and ignorance of rules and regulations regarding conservation of mangroves;
- Improper planning of development activities such as aquaculture, agriculture, construction for human habitation, mining and industrial-ization;
- Short supply of fuelwood, timber and fodder at affordable prices;

- Absence of a systematic survey of the area and the ownership of the land under mangroves, facilitating encroachment on this land;
- Difficulties of protection because of the scattered geographic distribution of mangroves;
- Acute shortage of government staff and other infrastructure.

Some suggested actions include the following:

- People's involvement in mangrove management on public lands and related benefits;
- Programmes to raise people's awareness of the importance of mangroves, e.g. Through films, exhibitions, newspapers, magazines, posters, stickers, brochures, banners, seminars, nature camps, birdwatching, study tours in the mangrove forests, establishment of mangrove parks in the mangrove areas close to towns, and the celebration of mangrove conservation day, with essay competitions, debates and drawing competitions;
- Incentives for sustainable management of mangroves on private and village community land;
- Enforcement of environmental protection laws;
- Research on problems related to pests and diseases and on appropriate management of the mangrove ecosystem;
- Restoration and rehabilitation of degraded mangrove areas.

The management of mangrove ecosystem needs an integrated approach and requires an in depth understanding of the local situations. To sustainably manage these resources various factors concerning its location utilization, local problems which act, interact and depend on it shall be analyzed. As discussed in earlier chapter’s project proposes the construction of land filled road, road on stilts, bridge and elevated road on mangrove which may impact the mangrove ecosystem directly or indirectly. Project envisage appropriate management plan, so as to reduce the impact on the mangrove ecosystem. Following are the some of the measures that can be adopted:-

- Compensatory mangrove affrorestration program shall be done to accommodate if any largescale mangrove destruction occur due to the project activity

- To compensate for the loss of mangroves, mangrove species such as avicennia marina, salvadora persica, acanthus ilicifolius etc shall be established on either side of the road to be constructed.
- Identification and demarcation of the boundaries of the dense mangrove patches and declare it as **'sensitive sites'**.
- Impact shall be minimized in every stage of project, that is from construction to operational, like dust suppression measures shall be adopted in places where there is handling of cement like materials. The leaves and foliage of mangrove and other trees shall be sprinkled with water during construction time in order to avoid clogging of stomata with dust.
- Every effort should be made to avoid changes in salinity or water circulation in mangrove swamps. As a road needs to be built through a swamp, enough bridges or culverts should be provided to allow water movement into and out of the swamp.
- In areas where sedimentation is important, the mangroves should be allowed to go ahead with their stabilizing and protective role. Similarly mangroves should be strictly protected wherever they are important in controlling coastal erosion.
- Uncontrolled dumping of constructional debris in the mangrove will be strictly probibited.
- Illegal and indiscriminate destruction of mangrove forest for fuel wood and other livelihood benefit shall be stopped and alternative resources shall be provided to those who depend on them to reduce the pressure on the existing mangrove strand.
- During operational phase of the proposed coastal road awareness and importance of the about mangroves shall be done, like through displaying hoarding along the road side.
- Street lamps shall be designed so as to illuminate only the road and avoid straying of light upwards and sideways.
- Proper instructions shall be provided to the motorists on the "dos and don'ts" required to maintain the nearby mangrove habitats.

- An eco-friendly marine park and a mangrove interpretation center can be developed for the benefits of the students, researchers, general public and for creating scientific understanding on the mangrove among public. This will prevent the uncontrolled public access to many biologically diverse sites of mangrove within the corridor.

7.3 Legal options on Permissibility of Activities in CRZ Area.

1. By virtue of the CRZ Notification dated 6th January 2011 (the "Notification") the Central Government has declared the coastal stretches of seas, bays, estuaries, creeks, rivers, and backwaters which are influenced by tidal action in the landward side upto 500/100 (in creek area) metres from the High Tide Line ("HTL") and the land between the Low Tide Line ("LTL") and the HTL and the water and the bed area between the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies as Coastal Regulation Zone ("CRZ"). The Central Government has further imposed certain restrictions on the setting up and expansion of industries, operations or processes within the CRZ.

2. The Coastal road (29.20 Kms appox.) from Princess Flyover to Kandivili is proposed comprising a combination of coastal roads based on reclamation, bridges, elevated roads and tunnels on western side of Mumbai. The Coastal road is proposed to be extended further north connecting Madh Island, Gorai and Dahisar.

   The present CRZ notification issued in January 2011 does not allow roads on reclamation however bridges and road on stilts are permissible. The MoEF, Central Government of India, is constantly instrumental for strengthening existing policies for protecting and improving the quality of the coastal environment. CRZ I Zone consists of ecologically sensitive and important areas, and includes mangrove wetlands, National parks, Sanctuaries, and Wild life habitats, places of outstanding natural beauty or Historical heritage. Areas close to breeding and spawning grounds of fish, those likely to be inundated due to sea level rise (consequent upon Global warming), and the area between LTL and HTL are covered under this category.

Land reclamation, bunding or disturbing the natural course of seawater is not allowed in CRZ I area. The CSIR-NIO team has examined the aspect of impact if any on tidal movements or coastal erosion entailed by reclamation for the coastal road. 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. Appropriate amendments are made in the current CRZ notification (which does not allow reclamation) for the proposed coastal road system in Mumbai.

3. .MCGM vide letter dated 22.1.2015 made a representation mentioning that it is necessary to amend the MoEF Notification of 2011 for coastal road project as a permissible activity to enable construction of coastal road by reclamatyion in sea and mangroves. It was further requested to MCZMA to propose necessary amendment to MoEF Notification of 2011 and forward to MOEF at the earliest.

The Authority noted that CRZ Notification, 2011 provides for construction of road on slit in CRZ I area in MCGM area. However, construction of road/ coastal road by way of reaclaimation is prohibited. Therefore, following amendments are recommended as below:

“1. Amendment required in paragraph 3 of sub- paragraph (iv) (a) is as follows:

For item 3 (iv).(a); the following item shall be substituted

3. (iv) (a) Land Reclamation, bunding or disturbing the natural course of seawater expect those:-

(a) Required for setting up, construction or modernization or expansion of foreshore facilities like port, harbors, jetties wharves, quays, slipways, bridges, sea link, road on stilts, costal roads by way of reclamation in sea and in mangroves without the benefit of future commercial or real estate development on the landward side, keeping the existing HTL. Demarcated in approved CZMP same in its effect and taking it as a reference for appraisal of all other projects from CRZ point of view, as if there was no costal road and such as meant for defense and security purpose and for other facilities that area essential for activities permissible under the notification.

2. Amendment required in paragraph 4 of sub paragraph (i) is as follows:

After item 4(i) (f) following shall be instead.

(g) Construction of coastal road by way of reclamation in sea and mangroves area in exceptional cases to be decided by concerned CZMA."

The Authority after deliberation in its 97th Meeting held on 23rd January 2015 decided to recommend the matter to MoEF proposing above said amendment in CRZ Notification, 2011, which are required in order to enable construction of coastal road by reclamation in Mumbai.

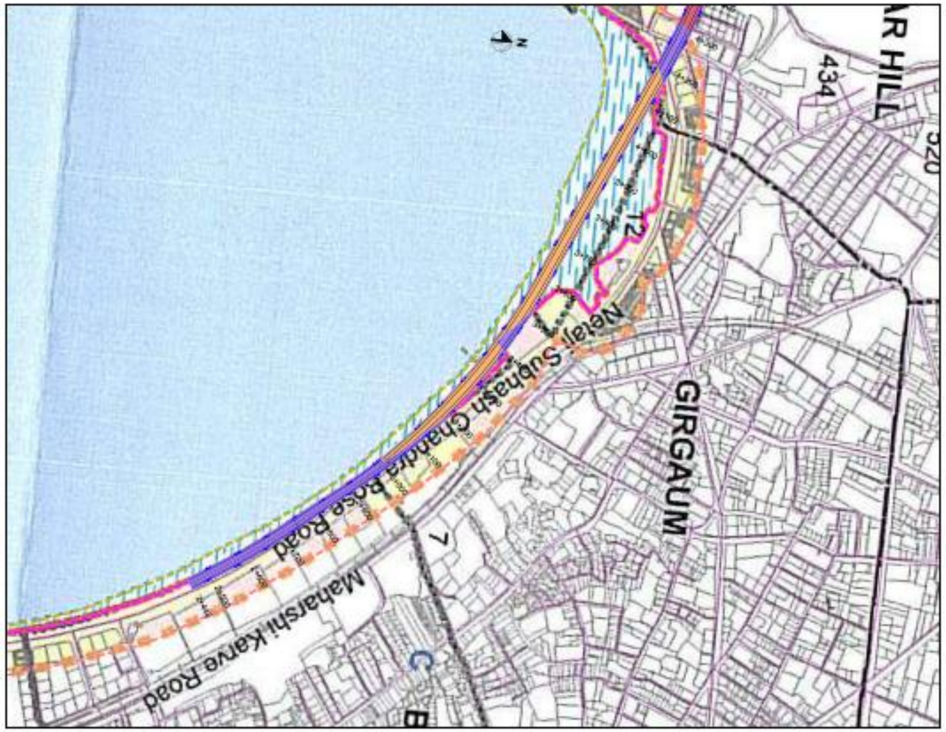
The Ministry of Environment, Forest and Climate Change vide S.O No 3552 (E), dated 30th December 2015 (Annexure 2) made amendment in the CRZ Notification 2011 in Paragraph 3 in sub-paragraph (iv) and Paragraph 4 in sub-paragraph (i) which permits construction of coastal road by reclamationin exceptional cases.

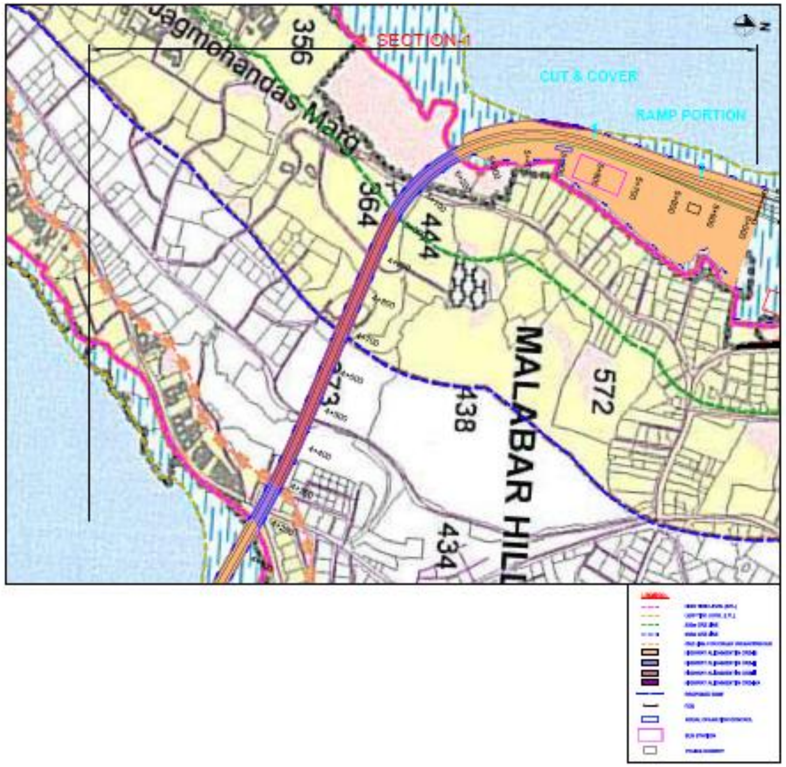
7.3.1. Area falling within CRZ for the proposed coastal road project

The proposed Coastal road is falling within the CRZ IA, IB, II, III and IV. The Table 7.13 below shows the area of project alignment in CRZ and figures below show the CRZ maps superimposed with project road alignment.

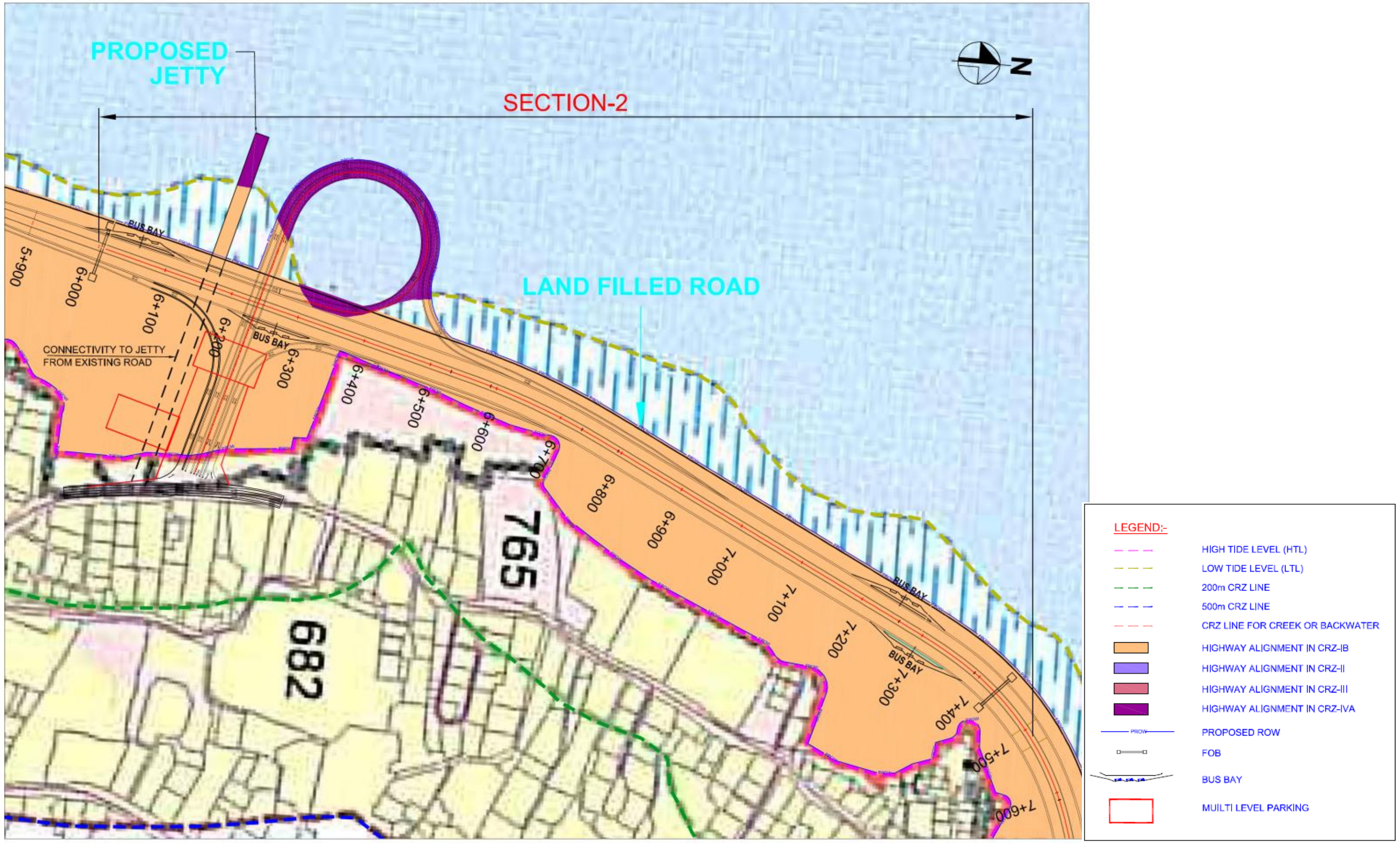
Table 7.13: Area of project alignment in CRZ

Sr.No.	Chainage	Section	AREA OF PROJECT ALIGNMENT IN CRZ									
			CRZ - IA Area (Sq m)		CRZ - I B Area (Sq m)		CRZ -II Area (Sq m)		CRZ -III Area (Sq m)		CRZ -IV A Area (Sq m)	
			Left Side	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side	Right Side	Left Side	Right Side
1	0+000 to 6+000	Section -1	-	-	48700	107911	13306	16693	13040	12953	-	-
2	6+000 to 7+500	Section -2	-	-	315277	271264	-	-	-	-	1466	-
3	7+500 to 9+700	Section -3	-	-	392861	451601	-	-	-	-	50220	27017
4	9+700 to 12+400	Section -4	-	-	64548	156396	-	-	-	-	68608	26237
5	0+000 to 4+400	Section -5	-	-	88782	92508	-	3737	-	-	64792	28966
6	4+400 to10+100	Section -6	-	-	57929	150027	-	-	-	-	169735	158112
7	10+100 to 19+300	Section -7	170093	163572	19899	21909	-	-	40513	38328	6092	6101
	Total		**170093**	**163572**	**987996**	**1251616**	**13306**	**20430**	**53553**	**51281**	**360913**	**246433**
	Total in Ha		**17.01**	**16.36**	**98.80**	**125.16**	**1.33**	**2.04**	**5.36**	**5.13**	**36.09**	**24.64**

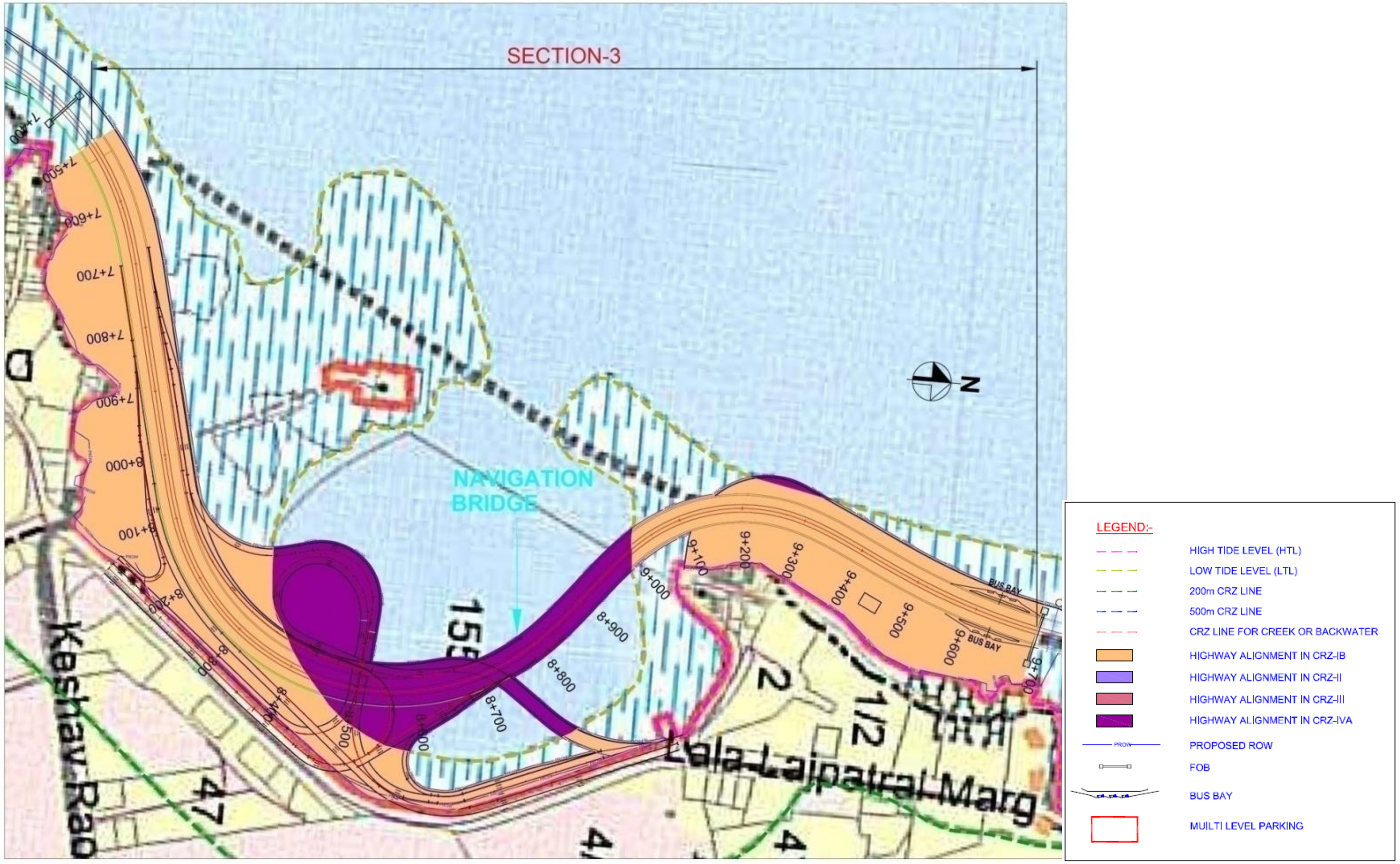




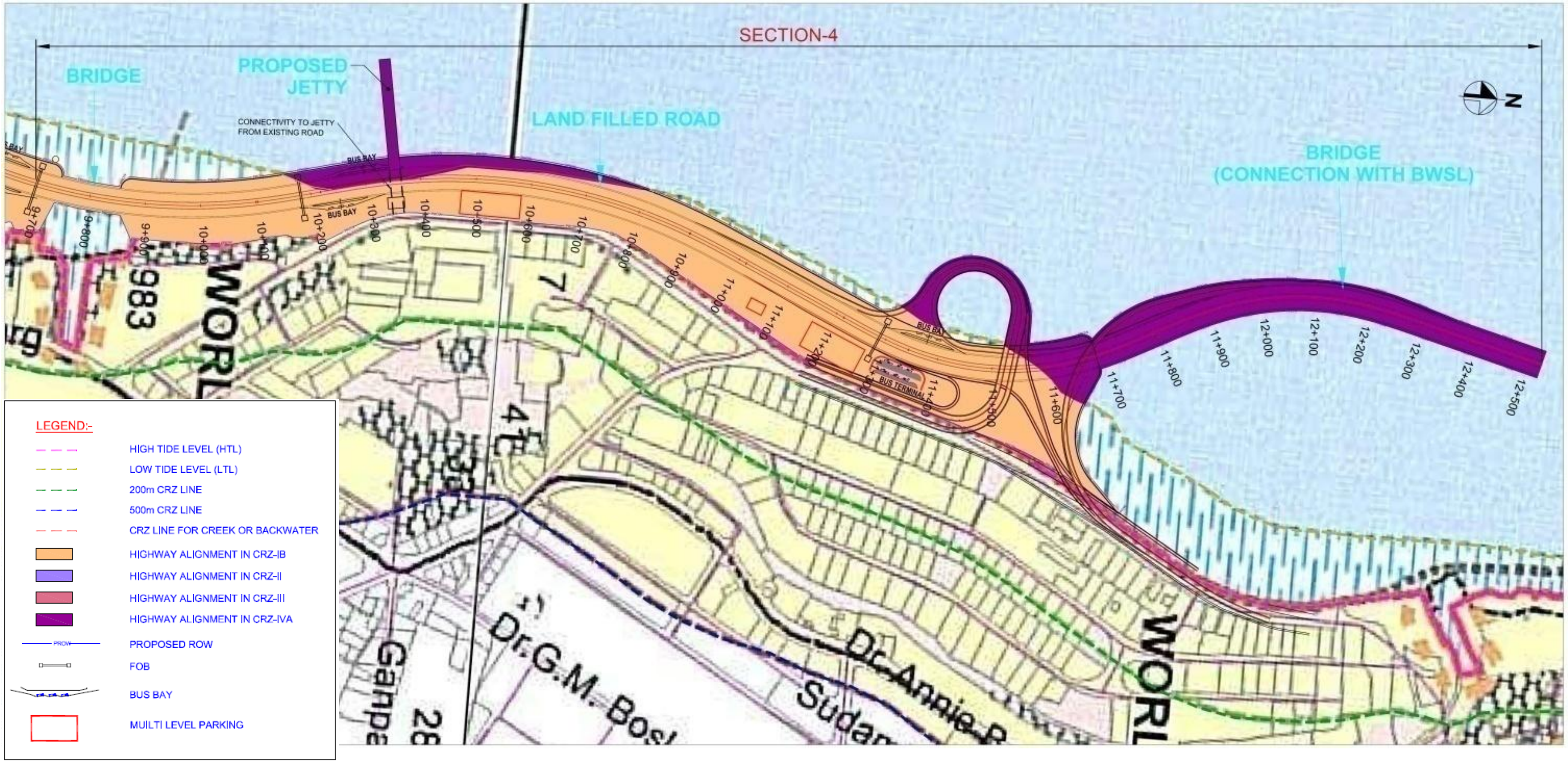
Section 1: Princess Flyover Road to Priya Darshini Park



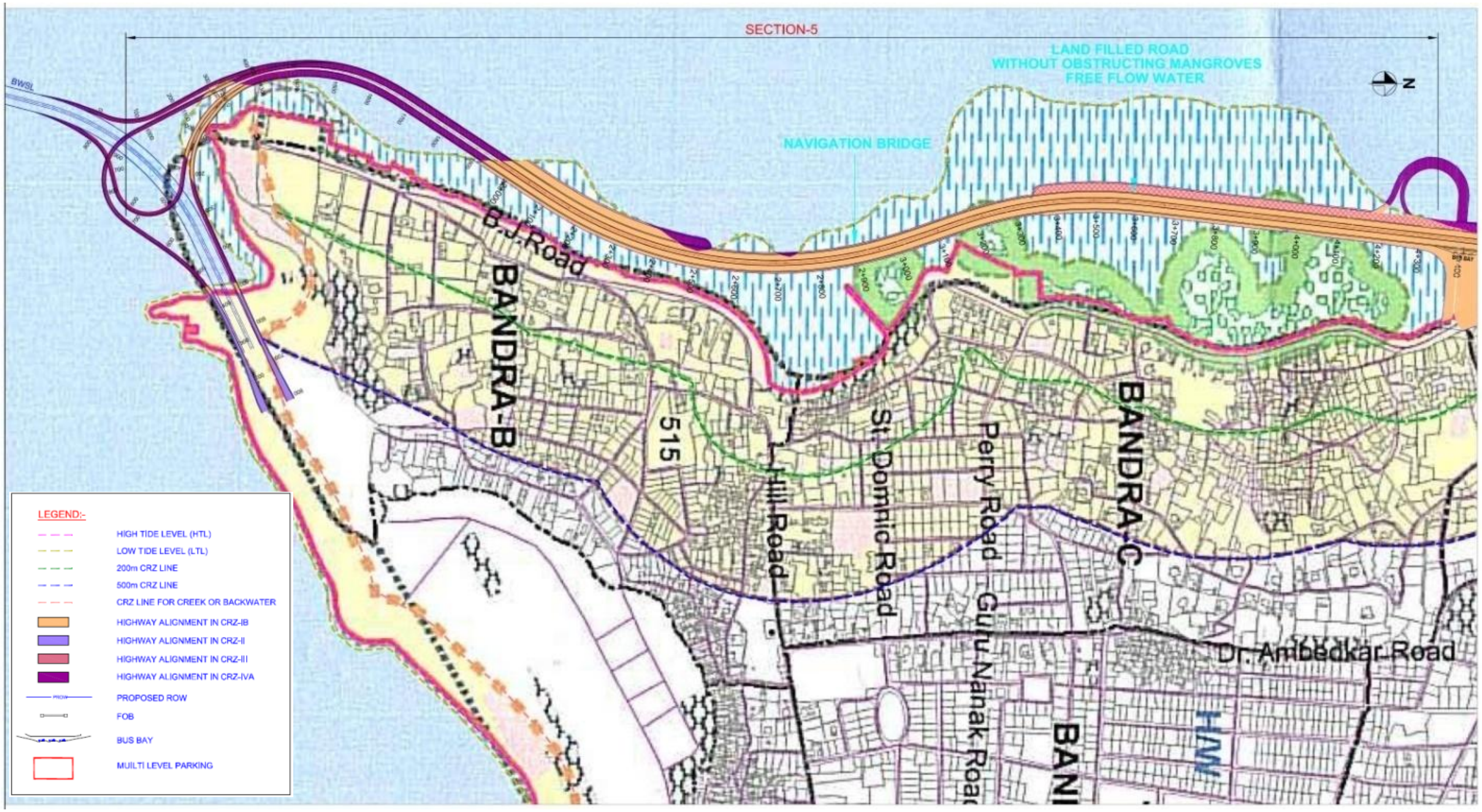
Section 2: Priya Darshini Park to Mahalaxmi



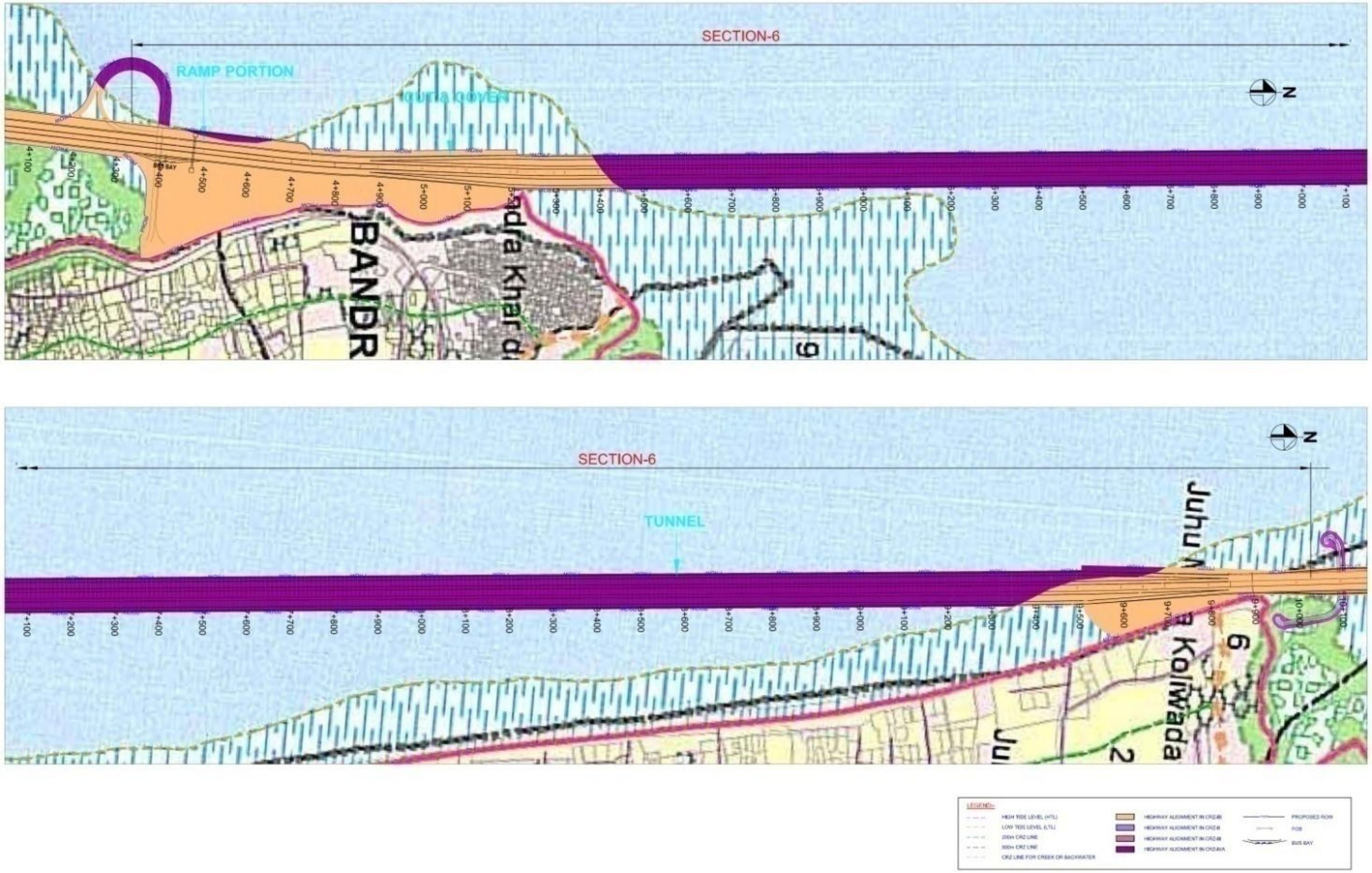
Section 3: Mahalaxmi to Baroda Palace



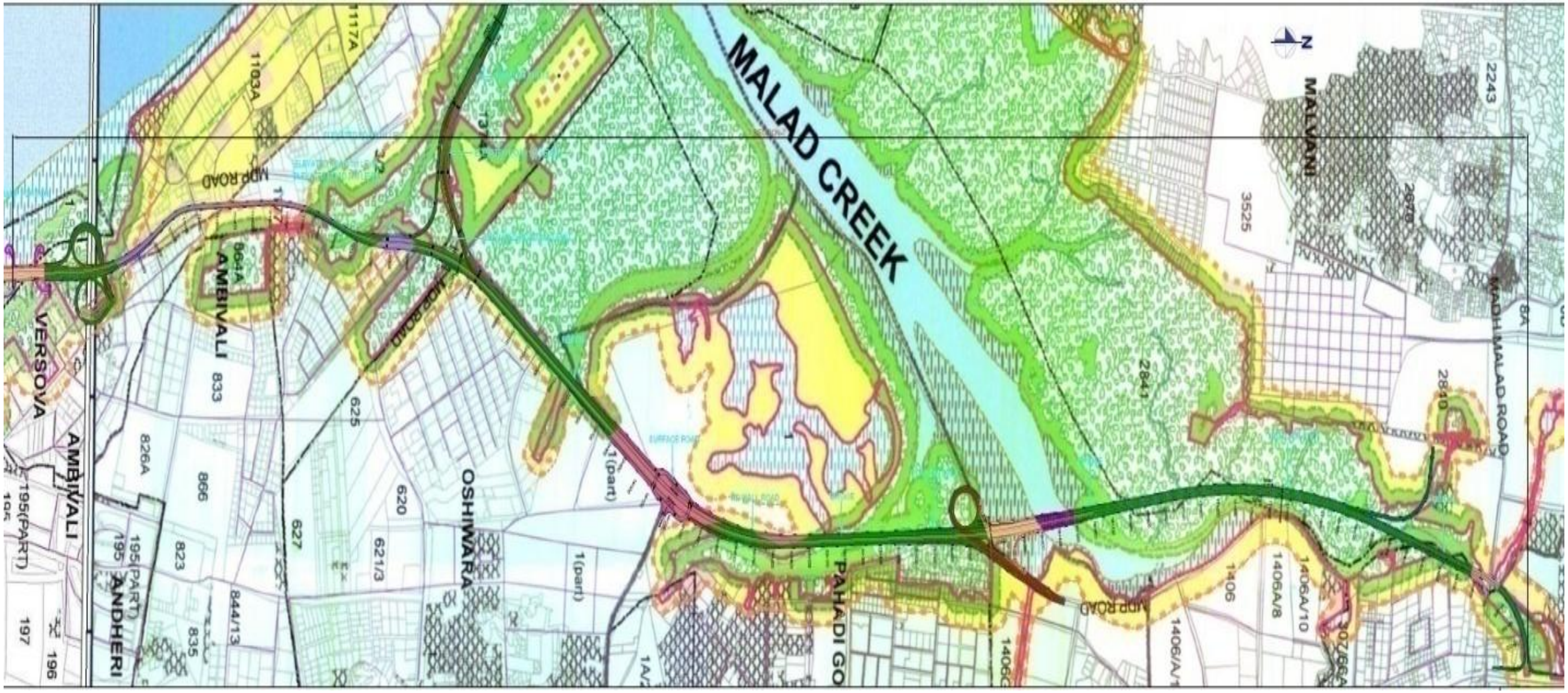
Section 4: Baroda Palace to Bandra Worli Sea Link (Start)



Section 5: Bandra Worli Sea Link (End) to Carter Road Mandir



Section 6: Carter Road Mandir to Ritumbhara College



Section 7: Ritumbhara College to Kandivali Junction

CHAPTER 8

8. Environmental Enhancement & Project Benefits

8.1 Environmental Enhancement Measures

The environmental enhancement measures are intended to provide value addition to a proposed project. These are considered in addition to the specific impact mitigation measures proposed. Environmental enhancements therefore are measures aimed at improving the project surroundings, increasing its user-friendliness and improving the services to the local inhabitants.

In this project, the environmental enhancement measures will include:

- BRTS as one of the dedicated lane of both carriageways to attract commuters to reduce private vehicles.
- At each bus stop proper entry/exit and connectivity on both carriageway through subway or aesthetically pleasing foot over bridges to be proposed.
- The toilet and drinking water facilities should be made available at suitable distances along the promenade.
- Extension of existing subway at Haji Ali chowk is proposed .Also a connectivity from coastal road to existing approach road of Haji ali Darga is proposed
- The garden and promenade spaces being very important recreational space, suitable design landscapes, illumination and street furniture is provided.
- The coastal erosion protection measures by providing tetra pods/sea walls at the end of sea side promenade.
- Proposed Connectivity to Madh island.
- Protection Wall (Break water wall) :Considering the storm surge impacts a well designed Break water wall on sea word side of proposed coastal road is planned with an elevation above HHTL
- Road level is planned in such a way that it will not impact aesthetic and sea side view of commuters
- Providing information boards for important tourist and pilgrimage locations

- Promenade with Cycle track and Seating Decks.
- Landscape areas with jogging track, kids play area, Public toilets.
- Open air museum.

8.2 Public Transport and convenience

The average journey speed along the proposed road has been assumed as 75 Kmph for cars, whereas for the existing road it is around 21 Kmph. However, for the existing road with reduced traffic the average journey speed is assumed as 45 Kmph. To have an estimate of value of travel time for passengers and cargo, the guidelines from the IRC code has been followed as far as possible.

Road user benefits will be from vehicle operating cost (VOC) savings, travel time saving, accident cost saving and saving in maintenance costs. The benefits are likely to accrue from 2019 onwards.

8.3 Interchanges

Interchanges will be necessary at all crossings of highway which are to be developed as completely access controlled. An interchange may be justified at the crossing of a major arterial road with another road of similar category carrying heavy traffic.

We have studied the requirement of traffic interchanges at the major junctions on project corridor as per IRC: 92-1985 (Guidelines for the design of Interchanges in Urban Areas) and IRC: SP: 41-1994 (Guidelines for the Design of At- Grade Intersections in Rural and Urban Areas) etc and proposed 11 interchanges.

These studies are the base for deciding many components like approach width & exit width, approach & exit angles etc. However, the objective of the present study is to assess the Directional Traffic volumes at the proposed interchanges.

The proposed Interchanges Locations for coastal road are listed below:

1. Princess Street Flyover
2. Amarsons Garden Interchange
3. Haji Ali Interchange
4. Bandra Worli Sea Link Interchange (Worli)
5. Bandra Worli Sea Link Interchange (Bandra)
6. Carter Road Interchange (Danda Village)

7. Ritumbara College Interchange
8. MADH Island Interchange (Institute of Fisheries Education)
9. Oshiwara Interchange
10. Malad Interchange
11. Kandiwali Interchange

8.4 Tunnels

There are altogether two tunnels proposed at following locations to bypass the main present day traffic bottlenecks.

- From Princess Flyover to Nepean sea road near Priyadarshani park Walkeshwar. (3.45 km)
- From end of Danda village to Ruia park near Juhu beach. (5.76 km)

8.5 Bus bays Pick-up Bus Stops

Bus bays will be provided at designated locations. The standard designs are already available for bus bays. From the safety and traffic management perspective this will keep the carriage way clear of stationary buses as well as waiting crowd. Public awareness camps for road users in the project area could be held in the post-construction phase to improve the safety and road efficiency along the coastal road.

8.6 Roadway Equipment

Illumination

Lighting of road at urban areas, intersections and junctions, parking and rest areas, lay-byes, bus stops, will be provided as per approved IRC standard. All masts and posts shall be provided with base plate bolted in concrete foundation so that they can be replaced as and when required. Arrangement of lighting and switching on/off should have automatic control with photoelectric cell and timer. Transformer rule station should be provided exclusively for these places. Solar system / bio-gas system of electricity generation should also be explored for the purpose of lighting. Underground cables feeding the lighting system may be utilized.

8.7 Guard Rails

Guardrails made up of cement concrete or Crash Barriers will be provided in the high embankment zones in accordance with IRC guidelines and standards.

8.8 Road markings and delineators

Road markings and delineators will be provided with thermo-plastic as per IRC standard.

Anti-Glare Measures

At location where due to blinding effect, the driver feels uncomfortable at night, for instance at location with short distances between opposite traffic in curve zone, it is proposed to plant thick bushes in median portion to obstruct high light beam from opposing traffic.

Traffic Signs

Traffic signs throughout the whole project stretch along with intersections with other roads and other facility location will be provided for giving proper direction and warning / caution to the driver, and to direct them on the route they want to follow. The traffic signs will be as per IRC standard and will be of “Retro Reflection Type”.

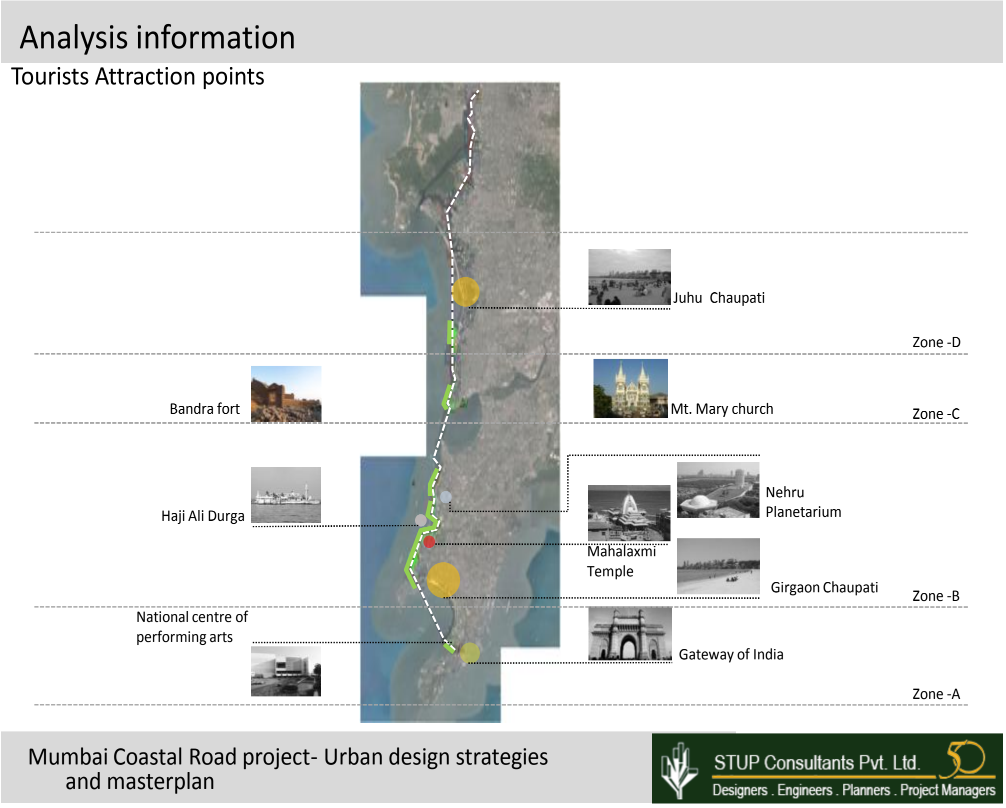
8.9 Urban Landscaping

The construction of Coastal Road based on reclamation would help generate large green public spaces. The city currently has very little open space .The availability of of open space per 1000 persons in the city is merely 0.03Ha as compared to the norm of 0.2 Ha. In the last two decades only 360 Ha of land has been acquired for public aminities in the city at cost of 22,140 Cr. By adopting present cost of acquisition (Viz. Rs. 60 Cr. per Ha)

Coastal road project generates about 90 Ha of green space. These all green spaces along seaside can be developed for public by creating cycling tracks, Promenades, Landscape, Theme parks etc.

8.10 Tourism incentives

All the cultural properties that are in the immediate vicinity of the road will be improved as a part of environmental enhancement.



8.11 Overall Enhancement

Enhancements have been based on typical and specific designs. The typical elements are adopted for the similar kind of structures that follow a particular characteristic all along the project corridor, whereas the specific designs are in particular to inherent features of the cultural property itself. Such an approach blends the socio-cultural character of the road with the enhancement and up gradation strategy of the project. Thus, as part of the Project road, a conscious effort has been made while designing the enhancement measures to ensure that the links of the local people with the road are not severed, without compromising the safety of the road users. Execution of these on the ground will go a long way towards institutionalizing people-oriented development.

Enhancement designs for the cultural properties have been prepared the bill of quantities and the technical specifications will be part of the Environmental Management Plans (EMPs) and the Contract Documents.

8.12 Project Benefits

The proposed package will have the following benefits on the residents in the Project locations:

- Improved quality of life by providing easy access to basic services and various products
- access to improved health and education facilities
- Strengthening of economy by easy transportation of various materials of daily use
- Better earning opportunity along the upgraded road
- Easy access to other locations
- Better connectivity with other major locations
- Increased employment opportunities for the local population

8.13 Conclusion

With the improvement of the road better connectivity will be ensured. Vehicle Operating costs and vehicle damage in the area will be reduced.

However, there would be an increase in vehicular pollution-air and noise, in the vicinity of the road with the increase in vehicular density but the effect is not significant. Linear development along the road in the commercial area is expected.

Due to the implementation of the project deteoriating coastal shoreline will be protected.

Therefore, the ‘with’ project scenario, with its minor adverse impacts is more acceptable than the ‘without’ project scenario which would mean an aggravation of the existing problems. The potential benefits of the proposed road improvements are substantial and far-reaching both in terms of the geographical spread and time.

Hence, it is clear that the implementation of the project will be a definite advantage to the people of Mumbai.

CHAPTER 9

9. Environment Management Plan

9.1 Introduction

The Environmental Management Plan (EMP) is a site specific plan developed to ensure that the project is implemented in an environmental sustainable manner where all contractors and subcontractors, including consultants, understand the potential environmental risks arising from the proposed project and take appropriate actions to properly manage that risk. EMP also ensures that the project implementation is carried out in accordance with the design by taking appropriate mitigative actions to reduce adverse environmental impacts during its life cycle. The plan outlines existing and potential problems that may adversely impact the environment and recommends corrective measures where required. Also, the plan outlines roles and responsibility of the key personnel and contractors who are charged with the responsibility to manage the proposed project site.

The EMP is generally:

- Prepared in accordance with rules and requirements of the MoEF/SEIAA and the State Pollution Control Board;
- To ensure that the component of facility are operated in accordance with the design;
- A process that confirms proper operation through supervision and monitoring;
- A system that addresses public complaints during construction and operation of the facility; and
- A plan that ensures remedial measures are implemented immediately.

In order to mitigate the adverse effects of the proposed construction activity an ‘Environment Management Plan (EMP)’ has to be prepared to ensure that the environment quality of the project influence area does not deteriorate beyond the expected level due to the construction and operation of the facility. The baseline assessment is expected to list the impacts on physical, ecological/ biological and social environments likely to arise during the execution and operation of the project.

The recommendations of the 'Environment Management Plan' are expected to be implemented right from the conception till commissioning and operation phases. For the sake of implementation the recommendations can be divided to the –(a) Preconstruction and design phase, (b) Construction phase and (c) operation phase.

9.2 Pre-Construction Phase

The mitigation measures against the foreseen impacts on the natural or built up environment of the project influence area need to be taken up, with a holist approach, in the preconstruction and design phase and systematically presented in the following categories:

- Environment Management Plan for implementation of mitigation measures against the foreseen impacts on physical environment
- Environment Management Plan for implementation of mitigation measures against the foreseen impacts on ecological/ biological environment
- Environment Management Plan for implementation of mitigation measures against the foreseen impacts on social environment.

A brief description of the background of the issue is discussed along with the mitigation measures.

9.2.1. Pre-Construction Phase consideration for the Environment Management Plan for implementing of Mitigation Measures against the foreseen impacts on Physical Environment

The impacts due to the project on the physical environment are evaluated in quantitative as well as qualitative terms during environment assessment and measures to mitigate these impacts worked out in EMP during the pre-construction and design phase. For this purpose it is essential to quantify the existing levels of various impacts and to ensure that the construction of the facility does not increase these beyond acceptable levels. These measures are based on the design philosophy, analysis of alternatives and its impact on the environment and ecology of the project influence area. The measures are generally proposed over following components of 'Physical Environment'

Air Pollution and Fugitive Dust Generation

- Measurement of 'Ambient Air Quality' at few locations along the project corridor, making a detailed analysis of the causes for air pollution and working out alternate to mitigate ill effects.
- Estimating the likely effect on the air quality that may be caused by increase in vehicular traffic due to development of road network.
- Working out alternates decisions for proper management of traffic to reduce Traffic Jams etc
- Making suggestions for improving Driving Habits
- Put in place a system for increasing awareness of drivers against evils of Air pollution and its relation to vehicle maintenance

Noise Pollution

- Measurement of Noise level along the corridor, at junctions and at cultural and academic institutions and suggesting mitigation measures to ensure these remain in tolerable limits during the Construction and Operational Phases by providing suitable mitigation measures
- Increase awareness among people against Noise pollution by placement of hoarding, better geometric designs, improved vehicular maintenance etc
- Limiting overloading of vehicles leading to high noise generation from engine and mechanical components
- Suggesting ways and means for improving driving habits

Hydrological System of the Project Influence area

- Measurement of various parameters about the quality of water flowing in the water bodies, anticipating additional pollution due to road construction and making suggestions for mitigating the adverse effects
- Anticipating water shortage if any due its use for construction during dry seasons
- Ensuring that water bodies are not adversely affected due to construction or dumping of construction waste

Soil Erosion, Land Slides, Mass Wasting etc. due to the proposed highway project.

- Adequate mitigation measures must be designed to protect the slopes and mitigate erosion. Major part of soil erosion and slope protection measures are based on Hard Engineering as well as Soft Engineering Techniques

Soil Contamination due to normal prevailing practices

- Soil contamination due to burning of Bitumen-Practice to be stopped
- Soil Contamination due to leeching from the dumps of waste material from cut-Avoid dumping of toxic material in such dumps and protecting the toe

Change of Land Use

- Loss of Trees and Green Cover along road under- Creation of similar land under the process of 'Compensatory Afforestation' for the affected number of trees and green cover

Transfer of Forest Land for Permanent Conversion into Non-Forestry Land Use

- Creation of similar land under the process of 'Compensatory Afforestation' for the affected number of trees and green cover

Cut and Fill Exercise, Mass Movement of Excavated Natural Material

- Effort to be made to ensure minimum amount of construction waste that may need disposal.
- Identification of site for disposal of such construction waste and to ensure such dumps do not effect the drainage of the area/ region
- To protect the dump fills to ensure that the waste does not slip further

Introduction of Construction Material in the Ecological System in and around project Influence Area

- Introduction of large quantities of construction material such as bitumen cement etc- Identify proper storage sites and to ensure these materials are not mishandled
- Introduction of large volume of Exhaust and Burnt gases by Hot-mix Plant-Keep adequate provision for use of environment friendly Hot-mix plant with clearance from State Pollution Control Board.

Solid Waste Generated as Road construction activity

- Introduction of non-biodegradable materials such as Polythene Bags, wrappers, water bottles due to the habit of throwing these away haphazardly- Coordination with construction and supervision authorities and developing proper system of safe disposal
- Physical introduction of Biological Solid Waste in ecosystem- Disposal as above with proper coordination
- Threat due to solid waste generated by labor- Disposal with friendly coordination with local authorities

9.2.2. Pre-Construction Phase consideration for the Environment Management Plan for implementing of Mitigation Measures against Ecological and Biological Impacts

The development of road network would result in felling of trees and clearing (uprooting) of shrubs. Land filling in sea cause disturbance to aquatic habitat also. The road may also cause fragmentation of ecosystems and may effect free movement of aquatic and other animals. It may have a severe adverse impact on the biodiversity of the project influence areas. These problems must be carefully analyzed and mitigation measures provided. Some of the following measures can be considered while finalizing the detailed project report:

1. **Mitigation Measures for environment management against loss of Forest Cover**

- Work out compensation package to regenerate the loss of trees and green cover
- Loss of Biodiversity- Provide similar species of plants in ‘Compensatory Afforestation’ by planting three times the number which is lost so that ecological balance is not lost
- Ensuring actual regeneration of plants-Keeping strict watch and replanting of lost plants
- Minimizing damage to existing plants

2. Mitigation Measures for environment management against Impact over flora under non Forested Area

Most of the measures suggested above would be adopted.

3. Mitigation Measures for impacts on Wildlife

- Prior consent shall be obtained from under the Wild Life Act by making application.
- Specific recommendations of Chief Wild Life Warden should be strictly followed

9.2.3. Pre-Construction Phase consideration for the Environment Management Plan for implementation of mitigation measures against the foreseen impacts on social environment

The issues identified during the Environment Assessment need to be analyzed and mitigation measures included in the Environment Management Plan. The salient features of the socio-economic characteristics and the impacts over the socio environment and the mitigation measures can be worked out under the following heads:

(i) Mitigation measures for impacts over Cultural and Religious Heritage

The location heritage / religious structures near the corridor of influence should be studied during the Environment Assessment. The alignment finalized should not have any adverse impacts on these structures. In fact some of these could be identified for enhancement by building compound walls if the boundaries fall very close to ROW.

(ii) Consideration for Impacts over Health services and System

The facilities available along the corridor of influence should be studied as a part of Environment Assessment and some facilities may need to be augmented to provide for trauma centers. Information about such Medical and Health centers should be made known to the traveling persons. Further the areas neighbouring the roads should be declared as silent zone

(iii) Consideration for Impacts over Loss of Drinking Water Source

Detailed survey was carried out during Environment Assessment of the existing water sources and those likely to be affected by the proposed facility and concerned department of the state requested to make good the loss by providing funds chargeable to the project. It should be ensured that reallocation of all services is carried out before the start of construction in the affected length.

(iv) Consideration for Impacts over Tourism

The impact on the tourism due to better transport facilities need to be studied and suitable rest places for passenger, hotels, fuel filling station and other conveniences provided for in the EMP. The tour Operators can be informed of the likely schedule of construction

(v) Consideration for Impacts over transport Services

The mitigation measures during pre-construction phase for mitigating the transport system are as under:

- Keeping drivers informed about the schedule of construction and the driving precautions they have to take in construction phase
- The Construction Methodology should take care of the requirement of the traffic management during execution of the works
- The project will bring new avenues in the transport sector of the state, would strengthen the economic development and provide greater employment
- The proposed project will bring increased passenger facility, decreased travel time, shortened distance, better and smooth geometrics and increased road safety.

(vi) Pre-construction Phase for Impact over Culture and Values

- The culture and values of the project influence area is expected to get a positive impact by increase in the modern communication and no adverse impact is expected
- A study would reveal that some of the Impacts may be beneficial to the society and the others may have adverse effects. The EMP should suggests ways and means to mitigate the adverse Impacts

9.3 Construction Phase

The construction phase is the most important phase in the entire life cycle of the project since all the Mitigation Measures, planned during ‘Pre-construction Phase’ are implemented and actually executed. It is important that the EMP is followed both in letters and spirit. Any let down may have long term affect on the operation of the facility created at a huge cost and may also cause misery to the community.

Physical Environment

The mitigation measures planned in the in the Pre-Construction Phase for physical Environment have to be implemented during the Construction Phase. Some of the activities which have to be executed to mitigate the adverse impacts on Physical Environment are as under:

i) Mitigation measures against Impacts due to Air Pollution and Dust Generation

- Excessive generation of dust and rise in Particulate Matter due to construction activity - continuous sprinkling of water during entire process, control of quality of fuel and public awareness
- Continuous monitoring of ambient air quality within the project corridor
- Monitoring of wind velocity to ascertain dispersal pattern of dust and pollutants
- Public awareness against the rise of fugitive dust, air pollution and degradation in the ambient air quality and its impacts over the people residing in the adjoining areas
- Public awareness for possible impact bovver persons suffering from Asthma and Other respiratory disorders

ii) Mitigation measures for the Impacts due to Noise Pollution

- Regular Noise Monitoring of noise pollution
- Workers safety from noise pollution- providing Personal protective devices
- Rise in noise level due to use of blasting / pilling / cutting- use limited explosives and take necessary steps and provide protective devices.
- Rise in noise level due to use of construction machinery- Use of modern machines and timely maintenance
- Rise in noise level due to crushers, hot mix-plant and batching plant etc- Use proper muffling devices and keep machinery in good working condition by timely maintenance

- Rise in noise level due to construction in the vicinity of educational institutions- The location of plant and machinery should be kept away from such institutions

iii) Mitigation measures for Impacts on the Hydrological System of the Project Influence area

Besides the recommendations made in the 'Pre-Construction Phase' some additional recommendation specific to the 'Construction Phase', are as under:

- <u>Dumping of construction waste in the water body and streams</u> - Project Proponents to monitor and ensure that unwanted materials are dumped only at the appropriate identified site.
- <u>Leaching of bituminous or oily materials in the sea / river</u> - Project Proponents to monitor and ensure that unwanted materials are dumped only at the appropriate identified site to avoid contamination of water
- <u>Contamination of water due to cement or concrete</u> - Project Proponents to monitor and ensure that unwanted materials are utilized in the sub-grade or stacked only at the appropriate identified site for later use
- <u>Water contamination due to anthropogenic activities/ labor settlement etc. during 'Construction Phase'</u>- To ensure that labor camps are sited away from the river and proper water needs are provided as per the Factory Act. Labor department officers are expected to inspect these facilities.
- <u>Consumption of water from natural streams for construction purposes</u>- It need to be ensured that the basic requirement of drinking water for the community is not adversely impacted.

iv) Mitigation measures against Impacts due to excessive Soil Erosion, Mass Wasting etc. due to the project

- To monitor and ensure that the mitigation measures suggested in the Pre-Construction Phase are followed and slopes suitably armored to avoid coastal / soil erosion and slippage

v) Mitigation measures for Impacts due to Anticipated Soil Contamination due to normal prevailing practices during 'Construction Phase'

- Soil contamination due to spillage of Bitumen and other oils - Contractor to ensure that Handling of Bitumen Diesel and other fuels shall be carried out with adequate precaution leaving no room for wastage. Proper oil traps to be provided at labor camps and workshops where machines are repaired and overhauled. Further he shall ensure that such material do not leech into adjoining areas.
- Recycling of Bituminous Material along the abandoned stretches - Effort to be made to use such materials in the new construction by recycling to the extent possible and disposing the balance at safe identified locations.
- Contamination due to heavy materials and other Toxic materials- The contractor shall dispose such materials at safe locations Project proponents to monitor and ensure that disposal of waste is carried sites away from water source and piled in a way that it does not get washed away during rains.
- Contamination of ground water due to leeching from the human waste in and around labor camps- Project proponents to monitor and ensure that such waste is disposed properly away from source of water

vi) Mitigation measures against Impacts due to change of Land Use within

Forest Areas and also in non-forest areas

- Contribute towards Re-plantation
- Maintenance of Green Cover with local grasses and trees
- Re-plantation and Naturalization of land after De-mobilization and removal of plant and machinery.
- Development of Green belt (Annexure ---)

vii) Mitigation measures for Impacts due to Cut and Fill Exercise, Mass Movement of Excavated Natural Material

- Mass scale cut and fill - Project proponents to monitor and ensure that the treatment of slopes are executed in a coherent and homogenous manner with local topography using technically sound and environmentally friendly and sustainable technology without impacting biodiversity of the project influence area.

- Most of the cut material, if found suitable, shall be utilized for filling. The balance of excavated material shall be dumped and previously approved site, properly compacted and covered with vegetation.
- Loss of grasses and shrubs shall be made good by plantation on the slopes and in the ROW. Project proponent to monitor the growth
- Disturbance of regional hydrology due to dumping of waste material in the natural stream -Contractor to be restricted to dump waste material in the natural stream.

viii) Mitigation measures for Impacts due to introduction of Construction Material in the Ecological System in and around the project Influence Area

- Introduction of large quantity of the construction material such as Bitumen and cement-Contractor to ensure creation of proper storage facility at identified site sand to ensure that these materials are not mishandled or dumped in the natural streams

ix) Mitigation measures for Impacts due to Solid Waste Generated as Road construction activity

- Physical induction of non biodegradable materials such as polythene bags, wrappers and used water bottles - Contractor to maintain general cleanliness and make arrangement for the removal of such waste material from the corridor of influence
- Physical introduction of Biological Solid waste along the corridor of influence due to lack of civic sense among road users-Increase awareness amongst the community by putting hoardings and through media, providing Garbage Bins and by cleanliness drive
- Estimated Threat due to the Introduction of substantial quantity of Solid Waste by Labor-Providing adequate facilities for proper disposal of such waste

Biological Environment

The mitigation measures planned in the in the Pre-Construction Phase for impacts on Biological Environment have to be implemented during the Construction Phase.

Issues identified for implementing, during 'Construction Phase' and details of the mitigation measures are as under**:**

i. **Mitigation Measures for Environment Management against loss of Forest Cover**

- It is recommended that project proponent should monitor the success rate of plantation and replace any of the dead plants
- The project proponent is expected to ensure that the construction work is restricted to ROW and felling of trees restricted only to those required for removal due to construction and other trees left undisturbed even within ROW.

ii. Loss of Grasses, Shrubs etc - Local species of shrubs and grasses planted on the new faces of slopes and disturbed areas (Refer annexure : Green belt Development).

This should be monitored by project authorities

iii. Mitigation Measures for Environment Management for the Impacts over Flora under Non-Forested Area

- The above criteria would be applicable even in the non-forested areas

iv. Mitigation Measures and Environment Management for the impact over Wild Life

- **Impact on Aquatic wild life-** Under no circumstances any type of debris or the construction waste shall be thrown in the water bodies
- **Impact on resident Wild life-** There was no wildlife, observed or mentioned in the reports of the State Forest Department. The proposed project activity does not involve clearing of any forest areas which act as the habitat for wildlife, adverse effect on wildlife habitat (reduction / breaking). The proposed site and the study area do not include any migratory route of animals. • However, the Project proponent personnel would be trained to be sensitive to this rare issue
- **Disturbance of Drainage Pattern-** The project proponent should monitor and ensure that the drainage pattern is not adversely impacted by blockage and no debris should be dumped in flowing water or water bodies

Mitigation Measures and Environment Management - For Impacts on Social Environment during 'Construction Phase'

Many of the mitigation measures planned in the in the Pre-Construction Phase for Social Environment have to be implemented during the initial stages of Construction Phase. These specific are given below for the identified issues:

i) For Impact over Cultural and religious Heritage

- The recommendations made in the 'Pre-construction Phase' shall be implemented during the early stage of construction. The entire process shall be implemented in consultation with the local District Administration, Affected Communities, Members of Local Bodies and other Stake-holders

ii) Construction Phase Consideration for displaced persons

- The issues of compensation are expected to be resolved during the 'Pre-construction Phase'.

iii) Consideration for the Loss of livelihood

- The 'Construction Phase' is expected to provide employment opportunity to the local residents. Other parties having roadside shops are expected to see rise in their incomes due to increased human activity.

iv) Consideration for the Impact over Health Services

- Local medical authorities should be kept informed of the schedule of construction as the labor injured due to accidents would have to be treated in these facilities

v) Consideration for the Impact over loss of Drinking Water

- The concerned department must ensure that relocation of water supply services are carried out before the start of construction

vi) Consideration for the Impacts over Tourism and Transport System

- The tourist and transport services are expected to feel inconvenience during the 'Construction Phase'. It is recommended that suitable diversions are provided for free flow of traffic and minimum inconvenience is felt by traveling public

vii) Consideration for Safety Issues during construction.

Safety to general public and the construction workers is of paramount importance. The recommendation of Factory act 1940 must be observed. Arrangement for ambulance and medical services may be kept in readiness to take care of unforeseen accident. Consideration must be given for attending to the following issues:

- Information to public by placing signboards along the project road
- Information and training to the workers about safety provisions and arranging for protective equipment.
- Restriction to access and governing traffic with the help of safety guards
- Safety for use of explosives
- Safety of construction equipment- Employ only trained manpower and follow the instructions of machinery manufacturer

viii) Consideration for the Impact over Communication

- It is expected that the affected parties having some infrastructure within the ROW would have implemented the relocation during the Pre-construction Phase. However there may be some overlap. The problems faced by any party should be sorted out by mutual discussion or by intervention of the project supervision authority.

ix) Consideration for the Impact over Culture and Values of the Region

- The induction of large number of outside workers may, sometimes, impact the cultural values of the local community.

x) Consideration for Workers Camp

Construction workers are generally a much neglected group and the environment issues of construction site management cannot be implemented unless they are trained properly and provided with basic amenities. The following recommendations are made for the Environment Management of Workers Camps. It needs to be understood that it is the responsibility of the contractor to provide basic amenities and they will be liable to penal action in case of any Violation.

- **Location-** Construction Camps will be located away from water bodies and streams and at least 500m away from habitations.
- **Construction-** Construction of these Camps / Housing shall be protective enough to provide appropriate comfort to the workers.

- **Water**-Clean and potable water for drinking and Household shall be provided by the contractor
- **Sanitation-**Contractor shall provide the facilities for adequate sanitation at the workers Camps
- **Waste Management-**The contractor to arrange for proper disposal of solid waste and sanitary waste from the workers Camps
- **Creche for the children of Workers-**Contractor is expected to provide crèche for the children of the workers as per Labor law
- **School for the Children of Workers-** The civic authorities to arrange for admission of the children of workers in the nearest school
- **First Aid and Other Health Facilities-**First Aid kit shall be provide at the camp site. And information about the nearest medical facilities made known to the worker. The Contractor is expected to arrange for immediate transport of workers to the nearest trauma centre in case of any accident.
- **Fuel for Cooking-** The contractor is expected to provide for Fuel and cooking media to the workers so that they may not cut the trees for fuel.

9.4 Operational Phase

The roads are generally planned to strengthen the life style of the area, linking the areas directly to the rest of the country and establishing linkages agricultural, industrial and commercial areas to boost the economic development. The issue of environment friendly 'Operation Phase' should be planned to ensure that foreseen adverse impacts get mitigated by providing mitigating measures in the Environment Management Plan. The issue of environment friendly 'Operation Phase' which needs to be included in the EMP for mitigating the foreseen impacts in the post construction scenario can be under the following heads:

Mitigation Measures for Impacts on Physical Environment

The 'Operation Phase' Impacts over Physical environment need to be thoroughly evaluated and mitigation measures planned against adverse impacts. The following mitigation measures need to be considered and provisions made in EMP:

(i) Mitigation Measures and Environment Management for the Impacts due to Air Pollution and Fugitive Dust Generation

It is expected that all the recommendations made in the Pre-construction and Construction Phases have been fully complied. In order to control over the Ambient Air Quality, it is recommended to permanently establish air quality monitoring stations along the road corridor. Further action to identify the dispersal pattern and mitigation measures shall be planned based upon the pollution scenario during the 'Operation Phase'.

(ii) **Mitigation measures and Environment Management for the Impacts due to Noise Pollution**

As above, it is expected all the recommendations made in the Pre-construction and Construction Phases have been fully complied. It is recommended to permanent establish "Noise Pollution Monitoring Stations" to carry out regular monitoring along the road corridor. Further action to identify the mitigation measures can be suggested after review of the noise pattern along the corridor.

(iii) **Mitigation Measures and Environment Management for the Impacts over the Hydrological System of the Project Influence Area**

- The post construction period is expected to be completely different and possible threats reduced and limited in the 'Operation Phase'. But the system may continue to have threat due to various anthropogenic activities.
- Throwing of Non-Biodegradable waste, Sanitary waste solid waste in the water bodies and natural streams-Increase awareness among Road Users against such habits and imposing penalty on habitual offenders

(iv) **Mitigation Measures and Environment Management for the Impacts due to Soil Contamination**

- The road operating agencies are expected to follow the recommendations made in the project DPR for the protection of slopes against erosion during the 'Construction Phase'. The success of the protection measures shall be monitored during the 'Operation Phase'. Further mitigation measures can be suggested after review of the adopted measures.

(v) **Mitigation Measures and Environment Management for the Impacts due to change in Land Use**

- The recommendations made during the 'Construction Phase' will be valid during the 'Operation Phase'.

(vi) **Mitigation Measures and Environment Management for the Impacts due to transfer of Forest Land for Permanent conversion for road use**

- The boundaries of the ROW having been demarcated, it shall be ensured that no further encroachment takes place on the forest land

(vii) **Mitigation Measures and Environment Management for the Impacts due to Cut and Fill exercise, Mass Movement and dumping of Excavated Natural Material**

- It shall be ensured that the implementation of recommendations of Pre-construction and Construction Phases are achieved before the start of Operation Phase and the road sites cleared of all debris and waste materials. Further the road authorities shall start awareness drive for cleanliness.

(viii) **Mitigation Measures due to Introduction of Construction Material in the Ecological System in and around Project Influence Are**

- The recommendations made during the 'Construction Phase' will be valid during the 'Operation Phase'.

(ix) **Measures and Environment Management for the Impacts due to Solid Waste generated as a result of Construction Activity**

- The recommendations made during the 'Construction Phase' will be valid during the 'Operation Phase'

Mitigation Measures for Impacts on Biological Environments

- The Biological Environment is expected to establish the equilibrium once the construction is completed. It however requires sensible treatment towards the various components. The following recommendations are being made towards these considerations:
- Regeneration of green cover over the new ROW and the freshly cut slopes
- Increase awareness among people against threatened aquatic and other wild life and issues related with its conservation, by placement of hoarding etc.
- Putting in place a system for immediate removal of carcass of dead animals to avoid foul smell and spread of diseases

Mitigation Measures for Impacts (Benefits/ Losses) on Social Environments

Operational Phase is expected to bring large number of positive benefits over the Social Environment, in the form of increased opportunity for the local population as well as for the road users. The recommendations made in the 'Pre-construction Phase' and 'Construction Phases' will pave the way for larger socio-economic benefits. However specific Mitigating Measures on some of the issues are as under:

- Impact over Cultural and Religious Heritage-Increased accessibility
- Displaced Population- Road may bring new accessibility to general population especially displaced persons
- Loss and Gain of Livelihood- Better connectivity would new set of opportunity and result in increased employment
- Impact on Educational System and Academic institutions- Provide better Educational opportunities due to ease of access
- Impact on Health Services- Provide better Health Facilities due to ease of access of habitants
- Impact over Tourism-Due to improvement of Infrastructure and improved modes of transport
- Impact on Transport System- Would result in general improvement of safe Road network

- Impact on road safety- Road safety may improve due to improved geometrics but number of accidents may increase if proper controls are not exercised
- Impact over communication – Postal and other modes of communications would improve
- Impact over Culture and Value of the Region- Provide an opportunity for propagation of culture and values of the region.

9.5 Management and Institutional Issues

The Environmental Management Cell (EMC) would be set up at the MCGM to take care of all the environmental aspects and to maintain environmental quality in the project area. The main objective of EMC would be to implement the EMP effectively and closely supervise environmental monitoring programme and to co-ordinate with the existing management system of MCGM. EMC will undertake regular monitoring of the environment and conduct yearly audit of the environmental performance during the construction and operation of the coastal road. It will also check that the stipulated measures are being satisfactorily implemented and operated.

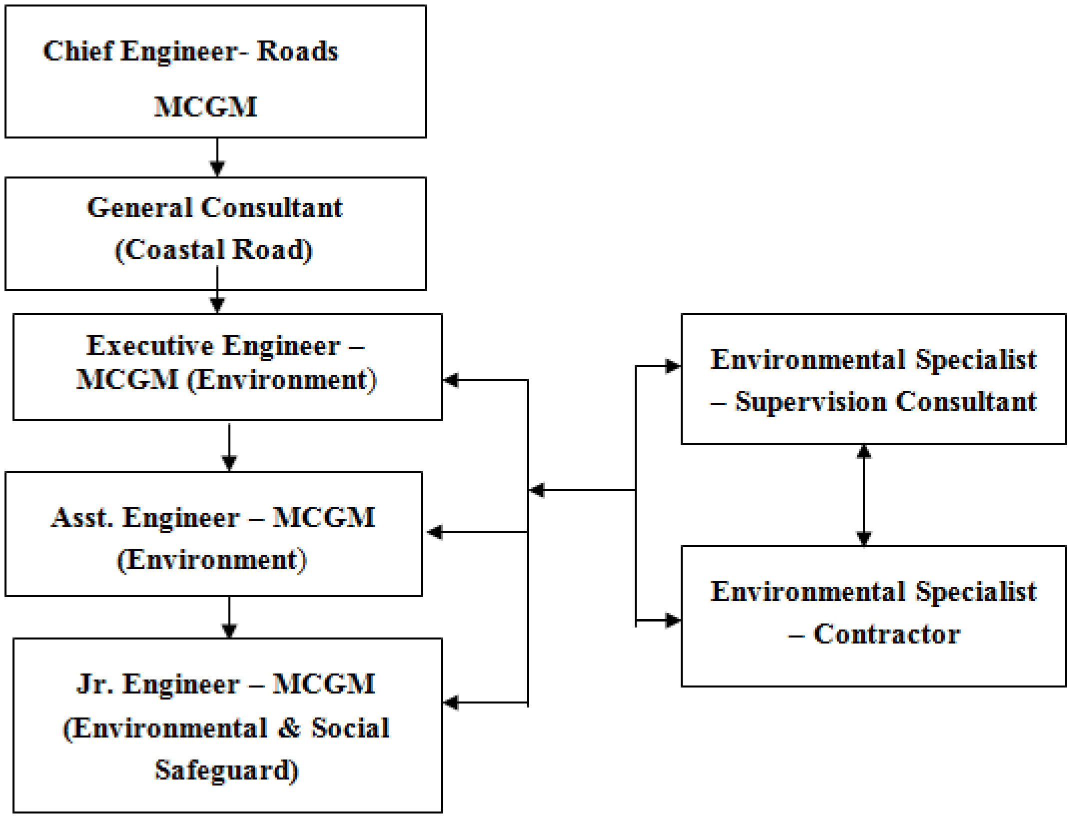
Environmental Management Cell will manage all environmental related activities on the site. This cell will be headed by the Chief Engineer (Road) along with supporting staff. The cell will be responsible for regular environmental quality monitoring and co-ordinate with regulatory bodies like MPCB, CPCB & MOEF and some the main functions include:

- Continued monitoring & assessment of environmental parameters regulations.
- To work for continuous & regular improvement in environmental performance.
- To ensure systematic and routine housekeeping to reduce generation of pollutants along the road corridor.
- To develop & maintain green belt and plant nurseries.
- To keep close liaison with environmental regulating authorities i.e. MPCB, CPCB, MOEF (as applicable) to arrange required consent under Water, Air & Environment Protection Act.
- To conduct yearly monitoring and submit statement to MPCB.
- To manage post project-monitoring plan as per approved EIA & EMP.

To follow proper documentation and monitoring practices and procedures, this will facilitate the MCGM to go for IS 14001 or equivalent environmental management systems at a later stage.

An Environmental Management System (EMS) would be put in place so as to help in smooth chain of action as and when required contract with other agencies for monitoring (when sophisticated analysis is needed) or training / capacity building of staff will be made. Regular training programmes will be organized to train the MCGM staff in using various safety devices and other equipment. Specialists from various fields of environment, health and fire safety would impart the training. The training would mainly focus on how to handle emergency issues. Monitoring and analysis of various environmental parameters and safety measures will be carried out as per the guidelines laid down by Government of Maharashtra and Government of India.

The pollution emitted during the construction and operational stages will be regularly monitored by the project proponent through Environment Management Cell with occasional checks will be made by State Pollution Control Board (SPCB).



Proposed institutional set up for EMP implementation in Coastal Road Project

9.5.1. Reporting System

Reporting system provides the necessary feedback for project management to ensure quality of the works and that the program is on schedule. The rationale for a reporting system is based on accountability to ensure that the measures proposed as part of the Environmental Management Plan get implemented in the project.

The reporting system will operate linearly with the contractor reporting to the Supervision Consultant, who in turn shall report to the MCGM. All reporting by the contractor and Supervision Consultant shall be on a quarterly basis. The MCGM shall be responsible for preparing targets for each of the identified EMP activities. All subsequent reporting by the contractor shall be monitored as per these targets set by the MCGM before the contractors move on to the site. The reporting by the Contractor will be a monthly report like report of progress on construction and will form the basis for monitoring by the MCGM, either by its own Environmental Engineer/s or the Environmental Specialist hired by the Supervision Consultant. The monitoring and the subsequent reporting would include:

- Monitoring of facilities at construction camps
- Monitoring of air, noise, soil and water parameters
- Monitoring of survival rate of trees
- Monitoring of cleaning of drains and water bodies
- Monitoring for biodiversity – protection measures during construction phase
- Monitoring of any other measures suggested by the Pollution control Board /Regulatory authorities

Table 9.1: Desired Monitoring and Reporting Process and Responsibilities

Format No.	Item	Timing	Supervision Consultant (SC)		MCGM	
			Supervision	Reporting to MCGM	Oversee/ Field Compliance Monitoring	Report to MPCB
CONTRACTOR MOBILISATION AND SITE CLEARANCE						
M1	Reporting by contractor to SC for storage/dumping locations	Before start of construction	As required	As required		Quarterly
CONSTRUCTION PHASE						
C1	Monitoring of construction site and construction camp	Before start of work		Quarterly		Quarterly After Monitoring

Format No.	Item	Timing	Supervision Consultant (SC)		MCGM	
			Supervision	**Reporting to MCGM**	**Oversee/ Field Compliance Monitoring**	**Report to MPCB**
C2	Target sheet for Pollution Monitoring		As required	After Monitoring		Half yearly
C3	Target sheet for Tree cutting		Monthly	Quarterly	Quarterly	Yearly
C4	Target sheet for monitoring of cleaning drains/roads etc		Monthly	Monthly	Quarterly	
C5	Target sheet for protection measures at specific locations where valuable flora / fauna is found	Before start of work at the location	Quarterly	Quarterly	As required	Half yearly
C6	Monitoring sheet for specific Mangrove locations to be protected	Before start of work	Quarterly	Quarterly	As required	Half yearly
OPERATION PHASE						
O1	Target sheet for Pollution Monitoring		As per Monitoring Plan	After Monitoring		After Monitoring

Format No.	Item	Timing	Supervision Consultant (SC)		MCGM	
			Supervision	Reporting to MCGM	Oversee/ Field Compliance Monitoring	Report to MPCB
O2	Target sheet for roadside plantation				Quarterly	After monitoring
O3	Target sheet for monitoring of cleaning road/culverts				Quarterly	After monitoring
O4	Target sheet for Mangrove management	As required			As required	After Monitoring

9.5.2. TRAINING

9.5.2.1. Need for Training

Staff of MCGM entrusted for coastal road project is already in place and are overseeing the project preparation activities. However, there is a need for integrating the social and environmental issues in its day-to-day operation and in internalising the environmental and social issues in the future road development projects. To achieve this goal, staffs of MCGM, need to be trained on road development and environment management and the effective implementation of the environmental issues.

9.5.2.2. Targets of proposed Training

The training programme should equip the members of the Environmental cell to implement and supervise the EMP and expose senior members of the MCGM to environmental and social issues associated with the highway projects. Such a group of senior staffs can then be given the responsibility of active dissemination of the culture of environmental/social consciousness and ethics within the rest of the organisation.

Once the staff of the MCGM have received training and have gained experience through the implementation of the EMP, they should be ready to resume leadership role within the MCGM in providing training and in implementing future projects. In order to disseminate environmental experience gained by the MCGM, each staff would be required to maintain good records and prepare dissemination notes on specific issues and problems encountered and resolved, and how the experience gained could be integrated in future road projects. Competent members of the MCGM should be offered additional environmental training and should be encouraged to train other staff.

9.5.2.3. Training Components

The environmental training (both natural & social environment) aspects of the Environmental staff of the MCGM should encompass the following:

Understanding of the relevant environmental regulations and their application to the project.

Environmental management practices in coastal roads upgradation and maintenance

Main impacts of the project on the environment.

Mitigation measures as given in the EMP and their implementation through incorporation in the design, construction supervision and monitoring.

Duties and responsibilities of the Contractors, Supervisor Engineers, Supervision Consultants and the MCGM.

Public/community consultation and its role during the implementation of the project.

Liaison with other departments and relevant agencies (such as Forestry).

Supervision of the implementation of the EMP and social issues during construction and operation. Resolution of environmental and social issues and their reporting.

Monitoring during construction and operation.

Weekly, monthly and quarterly report preparations and submission.

Preparation of dissemination notes, holding of workshops, and training of other staff in MCGM.

The training modules to be worked out for the project need to be of relevance to the specific context of the roads in Mumbai, focussing on the following issues:

Conservation of biodiversity

Slope stability and vulnerability to coastal erosion

Siting criteria for identification of dumping sites

Harnessing water resources, including rain water harvesting

Concepts of bio-engineering.

The training modules suggested are given in the Table-4. The training will be conducted in broadly two sessions. The first session will focus on the implementation aspects of the EMP involving Staff of MCGM, NGOs and other district officials. This session will be concluded before construction stage of the project. The second session will be for capacity building of the MCGM for conducting EIA in-house

Table 9.2: Training Modules for Environmental & Social Management

S. No.	Training Recipients	Mode of Training	Environmental Aspects to be covered training module	Training Conducting Agency
SESSION – I				
Module – I	Environmental staff of "Environmental and Social Management Cell". Associated NGOs in implementation and MCGM staff associated with construction supervision	Lecture System Workshops & Presentation	Environmental overview: • Key issues • Methodology • Public Consultation • Value Addition	Environmental Specialist, Supervision consultant
Module - II	Members of MCGM staff involved in supervising construction of roads, Major Maintenance; NGO representatives; District Officials	Lectures; Group discussions	Coastal Road Road Project: • Environmental Impact Assessment • Social Impact Assessment • Environmental	Environmental Specialist, Supervision consultant

S. No.	Training Recipients	Mode of Training	Environmental Aspects to be covered training module	Training Conducting Agency
			Management Plan & Environment & Social Management Plan • Resettlement & Indigenous People Development Plan	
Module - III	Contractors' representatives; NGO representatives; Supervision Consultants' representatives; Members of MCGM staff involved in supervising upgradation corridor, Major Maintenance; District Officials & Members of special committees – if any	Lectures and Presentations	Institutional Framework for Implementation of Coastal Road project • The role of the MCGM • The responsibilities of the Supervision Consultant and the NGO • Reporting requirements • Contractual Obligations and Environmental Protection	Environmental Specialist, Supervision consultant, MCGM
Module - IV	Members of MCGM staff involved in supervising Major Maintenance, Upgradation; NGO staff implementing the R&R; District Officials & Members of special committees – if any	Presentations; Site Visits; Demonstration Sessions	Special Issues in coastal road: • Bio-Diversity Assessment and Conservation • Geomorphological Assessment and Slope Protection • Consultation and Counselling • Income generation and Economic Rehabilitation • Preparation of Micro-plans	Environmental Specialist, Supervision consultant, MCGM

S. No.	Training Recipients	Mode of Training	Environmental Aspects to be covered training module	Training Conducting Agency
SESSION - II				
Module - V	Members of the MCGM; Selected Officers of the line Departments such as Forests, Officials of the Pollution Control Board, Mangrove management department	Lectures; Group Discussions	Improved Co-ordination with other departments: • Environmental & Social Impacts of the proposed improvements • Statutory permissions – procedural requirements • Co-operation with the Forests Department • Co-operation with the NGO'ss and Revenue Department	External agency.
Module - VI	Members of MCGM involved in coastal road project	Lectures; Demonstration sessions; Group Discussions	Long-term issues in Planning Roads development in Mumbai • Environmental & Social Assessment Methodology • Preparation of EMP & RAP • Stability of slope and mitigation measures • Conserving bio-diversity along roadside • Highway related diseases and AIDS • Consultation tools and techniques	External agency.

9.6 Environmental management plan budget:

The environmental management budget in the project comprises environmental monitoring, compensatory plantation, and training to contractor, PMU officials associated with the project. The EMPs as prepared and EMP budget will be part of contract document to the contractor. The monitoring program suggested will help to take remedial actions in case of environmental violations.

Component	Item	Parameters	Unit Cost	Quantity	Totalcost (in Rs)
Air	Air Quality Monitoring during construction	PM 2.5,PM10,SO2, NOx and CO	15,000/-	Continuous 24-hourly, twice a week at 4 locations for12weeks in each season during construction for 3 years (2xx2x3	8640000.00
Water	Drinking water monitoring during construction	As per IS 10500,2012	12,000/-	Pre-monsoon and post monsoon season for three years at 6 locations	432000
	Surface water	As per CPCB 1999	10, 000/-	Pre-monsoon and post monsoon season for three years at 6 locations	3,60,000
Noise	Noise Monitoring at 10 Sites	Day and Night Leq	3,000/-	Once in every month for three years	10,80,000.00
Soil	Soil quality monitoring at 6 locations	Standard physio-chemical parameters	10,000/-	Pre-monsoon and post monsoon season for three years at 6 locations	360,000.00
Green Belt	Along the stretch	Lumpsum	L.S	Landscpaing and Median plantation	10,00,000.00
	At locations of compensatory plantation and maintenance for 3 years(2550 trees @Rs.2500/=)	Lumpsum	L.S		6375000.00

Component	Item	Parameters	Unit Cost	Quantity	Totalcost (in Rs)
Training & Mobilization	Construction And Operation	As per modules developed	L.S		200,000.00
Facilities and Equipment	Construction And Operation	As worked out in the logistical support requirement	L.S		500,000.00
Total Cost					**1,89,47,000.0**

CHAPTER 10

10. Disclosure of Consultants

10.1 Introduction

STUP Consultants Pvt. Ltd. (SCPL) an ISO 9001: 2008 Company was established in 1963 at Bombay, India under the chairmanship of Mr. Yves Guyon a renowned French Civil Engineer who gave pre-stressed concrete its theoretical basis and transferred Prestressing Technology across the world by setting up Engineering Consultant Groups, as part of Etudes STUP International (France) worldwide Consultancy network. The objective of the company was to spread knowledge and technologies of the industrialized countries into the developing world. SCPL has provided diversified consultancy services of civil and structural engineering and architecture with associated electrical and mechanical engineering and has attained a very high level of competence over five decades.

SCPL served as an intellectual nucleus to attract 1500 outstanding professionals situated in 20 offices across the world dedicated to strengthening the technological capability of a large part of the free World. From the very beginning, SCPL created the most unique structures and infrastructures facilities which won international reorganization. They were distinguished by the utilization of well adapted new technologies paying particular attention to the use of local resources, resulting in substantial savings in cost and high functional and aesthetic values. This resulted in SCPL being progressively called upon to apply itself to nearly every specialization of civil, structural Engineering and architecture, as well as associated electrical, mechanical, HVAC and electronics Engineering – which made SCPL one of the leading consultants in these fields in several counties across the world. Till 2012 SCPL has worked in 35 Countries.

The specialization of SCPL is to blend modern technology with local skills and materials and thus adopt technology to suit the environment of the project site and country in which the project is executed. SCPL has a large number of technical professional, the know-how of the staff is multi- disciplinary and the synergies of their abilities ensure successful completion of the project. The consultancy services offered by SCPL includes planning, feasibility studies, detailed project report, detailed structural design, construction supervision, project monitoring project management, imparting training, assessment in respect to environment & social aspects and establishment of a sustainable maintenance management system.

10.2 Environmental and Social Assessment

Rapid Industrialization, urbanization and infrastructure growth in India have made the general public aware of environment and sustainable development. In any developing country like ours, the development will have an impact on the environment as well as on the livelihood of the people. It is to be remembered that development as a whole will be sustainable one if we take care of environment protection, conservation of energy and optimum utilization of natural resources.

Considering the importance of Environment and People SCPL have come forward and has established it self as an Environmental Consultant

As an Environmental Consultant SCPL play significant role in facilitating compliance to environmental legislation, regulations and standards. SCPL interface between the various statutory authorities, general public and project developers for making real improvement in line with the concept of sustainable development and environmental protection.

Apart from providing the right guidance, consultancy for Environmental Clearance and other allied jobs can be provided keeping parity with the requirement of valued customers. We have deep understanding of environmental regulations on which SCPL can advise to particular clients in the private industry or public government institutions to help them steer clear of possible fines, legal actions or misguided activities. SCPL deliver long-term, sustainable value and with it progress on issues that cannot be ignored. SCPL take advantage of more than decade-lasting experience in providing environmental consulting services in India and Asian countries.

SCPL is more than an environmental adviser and provider of environmental services.

Our strength is in our people, the partnerships we form with our clients and our experience.

STUP offers the full range of environmental consulting services and we look forward to joining with other organizations to help solve their environmental challenges, embrace sustainability and enhance the value of the organizations

STUP provide environmental consulting services for –

- Highways
- Railways
- Transport terminal
- Mass rapid transport system
- Port
- Harbour
- Jetties
- Marine terminal
- Break water and dredging
- Building and large construction projects
- Shopping malls, Multiplexes, commercial complexes,
- Housing estates
- Hospitals
- Township and area development projects – SEZ, EPZ
- Common Municipal Management Facility
- Airports

Our Environmental Consultancy services generally include but not limited to –

- Environmental Impact Assessment (EIA)
- Environmental Management Plan (EMP)
- Supervision of EMP implementation in construction phase
- Forest Clearance
- Environment clearance
- CRZ clearance
- Disaster Management plan
- Emergency Preparedness Plan

- Social Impact Assessment
- Resettlement Action Plan (RAP)
- Environmental and Social Awareness Programme

10.3 STUP's Environmental Consultancy Team

STUP's wide range of resources and expertise offer comprehensive and single umbrella solution to environmentally challenging projects for local and national governments, international financing institutions , private sector owners, contractors and public sector institutions. We have a multidisciplinary environmental consultancy team which consists of experts from different disciplines. The team mainly consists of – Environmental Engineers,

Environmental scientists, Air pollution experts, Air quality modeling expert, Water pollution expert, Solid waste management expert, Geologist, Hydro- geologist, Land Use and remote sensing expert, Noise and vibration expert, Soil conservation expert , Ecology and biodiversity expert and Risk and hazard expert.

10.4 QCI, NABET accreditation to STUP

STUP got NABET accreditation from QCI for following sectors:

1. Port, Harbour, jetties, marine terminals, breakwater and dredging.
2. Highways, railways, transport terminals, mass rapid transportsystems
3. Common Municipal Solid Waste Management Facility (CMSWMF)
4. Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, , institutions
5. Townships and Area development projects

QCI Scheme for Accreditation of EIA Consultant Organizations NABET

Scope of Accreditation **Annexure II**

Name of the Consultant: **STUP Consultants Pvt. Ltd.**
P=11, Darga Road, Park Circus
Kolkata- 17

Sl. No.	Sector No.	Name of Sector	Category A/B
1	33	Ports, Harbours, Jetties, marine terminals, break waters and dredging	B
2	34	Highways, Railways, transport terminals, mass rapid transport systems	A
3	37	Common municipal solid waste management facility (CMSWMF)	B
4	38	Building and large construction projects including shopping malls, multiplexes, commercial complexes, housing estates, hospitals, institutions	B
5	39	Townships and Area development projects	B
		Total = 5 Sectors*	

***Sectors allocated to individual EIA Coordinators are mentioned in Annexure III.**

(Vipin Sahni)
C.E.O.

M/s Padjama Aerobiological Pvt. A MOEF approved laboratory carried out Environmental monitoring work including ecological assessment study.

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

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पर्यावरण और वन मंत्रालय

अधिसूचना

नई दिल्ली, 1 मई, 2014

का.आ. 1190(अ).—केन्द्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 10 के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 13 और धारा 12 की उपधारा (1) के खंड (ख) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, पर्यावरण और वन मंत्रालय, भारत सरकार की अधिसूचना संख्यांक का. आ.1174(अ), तारीख 18 जुलाई, 2007 का और संशोधन करती है, अर्थात् :--

उक्त अधिसूचना से संलग्न सूची में,-

(क) क्रम संख्यांक 40, संख्यांक 44, संख्यांक 49, संख्यांक 52, संख्यांक 56 और संख्यांक 64 और उससे संबंधित प्रविष्टियों के स्थान पर निम्नलिखित संख्यांक और प्रविष्टियां रखी जाएंगी, अर्थात् :-

(1)	(2)	(3)	(4)
"40	मैसर्स आदित्य इन्वायरमेंटल सर्विसस प्रा0 लि0, प्लॉट पी-1 ललित कामर्शियल कॉम्पलेक्स, एमआईडीसी, मोहपाडा, रास्यानि, जिला- रायगढ़ - 410207 (महाराष्ट्र)	(1) श्री राजीव वासुदेव अयुंघी (2) सुश्री हिमानी प्रदीप जोशी (3) श्री रामचंद्र बालू भंडारे	01.05.2014 से 30.04.2019
44	मैसर्स ग्लोबल इन्वायरो लैब्स, 2-2-1075/14/ए/1, प्रथम तल, तिलक नगर 'X' रोड़ बाग अंबरपेट, हैदराबाद-500013 (आंध्र प्रदेश)	(1) श्री टी0मुरली कृष्णा (2) श्री आर0 रामा कृष्णा (3) सुश्री के0 गायत्री	01.05.2014 से 30.04.2019
49	मैसर्स पदम्जा एयरोबायोलॉजिकल्स प्रा0 लि0, नंदन - प्लॉट सं0 36,सेक्टर - 24 बैंक ऑफ इंडिया के समीप, तुरभे, नवी मुंबई - 4000705 (महाराष्ट्र)	(1) डॉ0 नंदकिशोर टी0 जोशी (2) श्री रामदास बी0 चौधरी (3) श्री किशोर पी0 पोटेकर	01.05.2014 से 30.04.2019
52	मैसर्स एसजीएस इंडिया प्रा0 लि0, 267, फेज - 4, उधोग विहार, गुड़गांव - 122015 (हरियाणा)	(1) श्री उत्पल मजूमदार (2) श्री अजय कुमार शर्मा (3) श्री देवेन्द्र कुमार	01.05.2014 से 30.04.2019
56	मैसर्स साई लेबोरेटरीज प्रा0 लि0, फलेट नं. 211, चाला एस्टेट, इरगड्डा मेन रोड़, हैदराबाद-500013 (आंध्र प्रदेश)	(1) श्री आलम सत्यनारायण (2) श्री डी0वी0 प्रेम स्वरुप (3) श्री के0ए0 हरिप्रिया	01.05.2014 से 30.04.2019
64	मैसर्स एनावायरो एनालिस्ट्स और इंजीनियर्स प्राइवेट लिमिटेड, रॉ हॉऊस सं0 2, 100 फुट सालम गार्डन	(1) डॉ0 जयप्रकाश त्रकू	01.05.2014

	कानकाया रोड, कामकाया कॉलेज के सामने, मीरा रोड ईस्ट, जिला - ठाणे - 401107 (महाराष्ट्र)	(2) डॉ0 निलम्बरि वी0 दरिवकर (3) सुश्री निकिता ठाकुर	से 30.04.2019";

(ख) क्रम संख्यांक 118 और उससे संबंधित प्रविष्टियों के पश्चात्, निम्नलिखित क्रम संख्यांक और प्रविष्टियां अंतःस्थापित की जाएगी, अर्थात् :--

(1)	(2)	(3)	(4)
"119	मैसर्स फेयर लैब्स प्रा0 लि0, पी- 94 , सक्टैर - 30, शिवम अस्पताल के समीप, गुड़गांव - 122002 (हरियाणा)	(1) श्री डी0 माथूर (2) श्री सी0एस0 जोशी (3) डॉ0 मीनाक्षी त्रिपाठी	01.05.2014 से 30.04.2019
120	मैसर्स प्रकृति कंसल्टेंट्स सर्विसस , 12 विश्नुपुरि चर्च रोड अलिगन, (महानगर वार्ड), लखनऊ - 226024 (उत्तर प्रदेश)	(1) डॉ0 दिव्या मिश्रा (2) डॉ0 सत्य प्रकाश पाठक (3) श्री वरूण परासर	01.05.2014 से 30.04.2019".

[फा. सं. क्यू-15018/23/2013-सीपीडब्ल्यू]

डा. राशिद हसन, सलाहकार

टिप्पण : मूल अधिसूचना भारत के राजपत्र, असाधारण, में संख्यांक. का.आ. 1174(अ), तारीख 18 जुलाई, 2007 द्वारा प्रकाशित की गई थी और तत्पश्चात् अधिसूचना सं0 का.आ. 1539(अ), तारीख 13 सितंबर, 2007, का.आ. 1811(अ), तारीख 24 अक्तूबर, 2007, का.आ. 55(अ), तारीख 9 जनवरी, 2008, का.आ. 428(अ), तारीख 4 मार्च, 2008, का.आ. 865(अ), तारीख 11 अप्रैल, 2008, का.आ. 1894(अ), तारीख 31 जुलाई, 2008, का.आ. 2728(अ), तारीख 25 नवंबर, 2008, का.आ. 1356(अ), तारीख 27 मई, 2009, का.आ.1802(अ) तारीख 22 जुलाई, 2009, का.आ. 2399(अ), तारीख 18 सितंबर, 2009, का.आ. 3122(अ), तारीख 7 दिसंबर, 2009, का.आ. 3123(अ), तारीख 7 दिसंबर, 2009, का.आ. 142(अ), तारीख 21 जनवरी, 2010, का.आ. 619(अ), तारीख 19 मार्च, 2010, का.आ. 1662(अ), तारीख 13 जुलाई, 2010, का.आ. 2390(अ), तारीख 30 सितंबर, 2010, का.आ. 2904 (अ), तारीख 8 दिसंबर, 2010, का.आ. 181(अ), तारीख 28 जनवरी, 2011, का.आ. 692(अ), तारीख 5 अप्रैल, 2011, का.आ. 1537(अ), तारीख 6 जुलाई, 2011, का.आ. 1754(अ), तारीख 28 जुलाई, 2011, का.आ. 2609(अ), तारीख 22 नवंबर, 2011, का.आ. 264(अ), तारीख 13 फरवरी, 2012, का.आ. 1150(अ), तारीख 22 मई, 2012, का.आ. 2039(अ), तारीख 5 सितंबर, 2012, का.आ. 2802(अ), तारीख 27 नवंबर, 2012 और का.आ. 2850(अ), तारीख 7 दिसंबर, 2012 तथा का.आ. 592(अ), तारीख 8 मार्च, 2013, का.आ. 945(अ), तारीख 8 अप्रैल, 2013, का.आ. 2287(अ), तारीख 27 जुलाई, 2013, का.आ. 2288(अ), तारीख 27 जुलाई, 2013 और का.आ.3489(अ), तारीख 26 नवंबर, 2013, का.आ. 21(अ), तारीख 3 जनवरी, 2014, का.आ. 561(अ), तारीख 26 फरवरी, 2014 द्वारा उसका संशोधन किया गया था ।

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 1st May, 2014

S.O. 1190(E).—In exercise of the powers conferred by clause (b) of sub-section (1) of Section 12 and Section 13 of the Environment (Protection) Act, 1986 (29 of 1986) read with rule 10 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following further amendments in the notification of the Government of India in the Ministry of Environment and Forests, number S.O. 1174(E), dated the 18th July, 2007, namely :-

In the Table appended to the said notification,-

(a) for serial numbers 40, 44, 49, 52, 56 and 64 and the entries relating thereto, the following serial numbers and entries shall be substituted, namely :-

(1)	(2)	(3)	(4)
"40	M/s Aditya Environmental Services Pvt. Ltd., Plot P-1 Lalit Commercial complex, MIDC Mahopada, Rasayani, District - Raigad -410207 (Maharashtra)	(1) Mr. Rajiv Vasudeo Aundhe (2) Ms. Himani Pradeep Joshi (3) Mr. Ramchandra Balu Bhandare	01.05.2014 to 30.04.2019
44	M/s Global Enviro Labs, # 2-2-1075/14/A/1, 1st Floor, Tilak Nagar 'X' Roads, Bagh Amberpet, Hyderabad – 500013 (Andhara Pradesh)	(1) Mr. T. Murali Krishna (2) Mr. R. Rama Krishna (3) Ms. K. Gayathri	01.05.2014 to 30.04. 2019
49	M/s Padmaja Aerobiologicals Pvt. Ltd., " NANDAN" Plot No - 36, Sector - 24, Near Bank of India Turbhe, Navi Mumbai - 400705 (Maharashtra)	(1) Dr. Nandkishor T. Joshi (2) Mr. Ramdas B. Chaudhari (3) Mr. Kishor P. Potekar	01.05.2014 to 30.04. 2019
52	M/s SGS India Pvt. Ltd., 267, Phase – IV, Udyog Vihar, Gurgaon – 122015 (Haryana)	(1) Shri Utpal Mazumdar (2) Shri Ajay Kumar Sharma (3) Shri Devendra Kumar	01.05.2014 to 30.04. 2019
56	M/s Sai Laboratories Pvt Ltd., Flat No.211, Challa Estate, Erragadda Main Road, Hyderabad – 500018 (Andhra Pradesh)	(1) Mr. Allam Satyanarayana (2) Mr. D.V. Prem Swaroop (3) Mr. K.A. Haripriya	01.05.2014 to 30.04. 2019
64	M/s Enviro Analyst & Engineers Pvt. Ltd., Row House No. 2, Shalam Gardens, 100 FT Kanakia Road, Opp. Kanakia College, Mira Road East, District - Thane - 401107 (Maharashtra)	(1) Dr. Jaiprakash Trakru (2) Dr. Nilambari V. Daripkar (3) Ms. Nikita Thakur	01.05.2014 to 30.04. 2019 ";

(b) after serial number 118 and the entries relating thereto, the following serial numbers and entries shall be inserted, namely :-

(1)	(2)	(3)	(4)
"119	M/s Fare Labs Pvt. Ltd., P-94, Sector-30, Near Shivam Hospital, Gurgaon - 122002 (Haryana)	(1) Mr. D. Mathur (2) Mr. C.S. Joshi (3) Dr. Meenakshi Tripathi	01.05.2014 to 30.04. 2019
120	M/s Prakriti Consultants Services, 12, Vishnupuri Church Road, Aliganj, (Mahanagar Ward) Lucknow - 226024 (Uttar Pradesh)	(1) Dr. Divya Misra (2) Dr. Satya Prakash Pathak (3) Mr. Varun Parasar	01.05.2014 to 30.04. 2019";

[F.No.Q.15018/23/2013-CPW]

Dr. RASHID HASAN, Advisor

Note.-The principal notification was published in the Gazette of India, Extraordinary *vide* number S.O. 1174 (E), dated the 18th July, 2007 and subsequently amended *vide* notification numbers S.O. 1539 (E), dated the 13th September, 2007, S.O.1811(E), dated the 24th October, 2007, S.O.55(E), dated 9th January, 2008, S.O.428(E), dated the 4 th March, 2008, S.O.865(E) dated the 11th April, 2008, S.O.1894(E) dated the 31st July,2008, S.O.2728(E) dated the 25 th November, 2008, S.O.1356(E) dated the 27 th May, 2009, S.O.1802(E) dated the 22nd July, 2009, S.O.2399(E), dated the 18th September, 2009, S.O.3122(E), dated the 7th December, 2009, S.O.3123(E), dated the 7th December, 2009, S.O.No.142(E), dated the 21st January, 2010, S.O.619(E), 19th March, 2010, S.O.1662(E) dated the 13rd July,2010, S.O.2390(E), dated the 30th September, 2010, S.O.2904(E), dated the 8th December, 2010, S.O.181(E), dated the 28th January, 2011, S.O. 692(E), dated the 5th April, 2011, S.O.1537(E), dated the 6th July,2011 , S.O.1754(E), dated the 28th July,2011 S.O.2609 (E) dated the 22nd November, 2011, S.O.264 (E), dated the 13 February, 2012, S.O.1150(E), dated the 22nd May, 2012, S.O.2039(E), dated the 5th September,2012, S.O. 2802(E) dated the 27 th November, 2012, S.O. 2850(E), dated the 7th December, 2012, S.O. 592 (E), dated the 8th March, 2013, S.O.945(E), dated the 8th April, 2013, S.O.2287(E), dated the 27th July, 2013, S.O.2288(E), dated the 27th July, 2013, S.O.3489(E) dated the 26th November, 2013, S.O.21(E), dated 3rd January, 2014 and S.O.561(E), the 26th February, 2014

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CHAPTER 11

11. Executive Summary:

E.S 1. Introduction

Mumbai reckoned as the financial capital of the country, houses a population of 12.4million besides a large floating population in a small area of 437sq.km. As 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 has resulted in extreme traffic congestion. This has lead to long commute times and a serious impact on the productivity in the city as well as defining quality of life of its citizens. The extreme traffic congestion has also resulted in Mumbai witnessing the worst kind of transport related pollution.

Comprehensive Traffic Studies (CTS) were carried out for the island city along with its suburbs to identify transportation requirements to eliminate existing problems and plan for future growth. CTS identified requirement of new arterial road along the Western Coast as part of transportation networks. Therefore, Municipal Corporation of Greater Mumbai (MCGM) has proposed to construct a Coastal Road on the western side of the city

The project site is located in the capital city of Maharashtra, Mumbai that lies on the western coast of India by the bank of Arabian Sea. Mumbai is made from the group of seven islands and is thus referred to as the Island city. These islands are Isle of Bombay, Mazagaon, Colaba, OldWoman's Island, Parel, Worli, and Salsette Island.

This island city of Mumbai is divided into two distinct regions, the city and the suburbs. The suburbs have alluvial soil type. The major creeks found in Mumbai coast are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flats and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.

MCGM has appointed consortium of M/S STUP Consultants Pvt. Ltd consultants and M/S Ernst & Young Pvt. Ltd for Preparation of Feasibility Report, DPR Preparation, Environmental Clearance and Bid process management for the proposed Mumbai Coastal Road Project.

Amendment in CRZ Notification 2011

The present CRZ notification issued in January 2011does not allow coastal roads on reclamation however bridge s and road on stilts are permissible.

MCGM vide letter dated 22.1.2015 made a representation mentioning that it is necessary to amend the MoEF Notification of 2011 for coastal road project as a permissible activity to enable construction of coastal road by reclamatyion in sea and mangroves. It was further requested to MCZMA to propose necessary amendment to MoEF Notification of 2011 and forward to MOEF at the earliest.

The Authority after deliberation in its 97th Meeting held on 23rd January 2015 decided to recommend the matter to MoEF proposing above said amendment in CRZ Notification,2011, which are required in order to enable construction of coastal road by reclamation in Mumbai.

The Ministry of Environment, Forest and Climate Change vide S.O No 3552 (E), dated 30th December 2015 made necessary amendments in the CRZ Notification 2011 in Paragraph 3 in sub-paragraph (iv) and Paragraph 4 in sub-paragraph (i) which permits construction of coastal road by reclamation in exceptional cases.

E.S 2. History of Reclamation of Mumbai

It took over 150 years to join the original seven islands of Mumbai. These seven islands were lush green thickly wooded, and dotted with 22 hills, with the Arabian Sea washing through them at high tide. The original island of Mumbai was only 24 km long and 4 km wide from Dongri to Malabar Hill (at its broadest point) and the other six were Colaba, Old Woman's island, Mahim, Parel, Worli, Mazgaon.
After the British arrival, the demand for land steadily increased, and by 1730; it was becoming impossible to accommodate the entire population of Mumbai inside the

Fort. The sea was making inroads at Worli, Mahim and Mahalaxmi, which turned the ground between the islands into a swamp, making travel between Mumbai islands hazardous.

The first major reclamation took place in 1708, to construct the causeway between Mahim and Sion.The second major reclamation took place in 1772, to stop the ingress of water and the consequent flooding of central Mumbai, and to connect Mahalaxmi and Worli. This causeway was named Hornby Vellard, sealing the Great Breach (Breach Candy) between Dongri, Malabar hill and Worli.

At the fortified Dongri hill, an esplanade and parade ground was cleared, from the walls of the Fort to the present day Crawford market. The flat lands from Mahalakshmi to Kamathipura were reclaimed only after the completion of construction at Breach Candy by Hornby in 1784. In 1803, Mumbai was connected to Salsette by a causeway from Sion.

E.S 3 Project Road

The proposed coastal road has a length of 29.20 km which lies in western costal stretch of Mumbai, Maharashtra. The proposed road length is divided in to 2 Parts, from Princess Flyover to Bandra –Worli Sea Link and Bandra –Worli Sea Link to Kandivali Junction.

Project Sections

Part A: South Section (Princess Flyover Road to Worli end of Sea Link)

Section 1: Princess Flyover Road to Priya Darshini Park

Section 2: Priya Darshini Park to Mahalaxmi

Section 3: Mahalaxmi to Baroda Palace

Section 4: Baroda Palace to Bandra Worli Sea Link (Start)

Part B: North Section (Bandra end of Sea Link to Kandivali Junction)

Section 5: Bandra Worli Sea Link (End) to Carter Road Mandir

Section 6: Carter Road Mandir to Ritumbhara College

Section 7: Ritumbhara College to Kandivali Junction

E.S.4 Salient feature of the project

- This project road location is on the western side of Mumbai city, Geater Mumbai district of Maharashtra extending from Princess Flyover to Kandivali Junction link road.
- The proposed Coastal road has approximate length of 29.20 kms from Princess Flyover to Kandivali Junction link road.
- The coastal road is proposed on a combination of land reclamation, bridges on sea, elevated roads, and road on stilts and under sea tunnels on western side of Mumbai.
- There are altogether two tunnels proposed at (i) Princess Flyover to Nepean sea road near Priyadarshani Park Walkeshwar (3.45 km) and (ii) end of Khar Danda village to Ritumbara College near Juhu beach. (5.76 km).
- The total reclamation area of coastal road is 122 ha
- The proposed project road falls under CRZ- IA, IB, II, III and IVA
- Mangrove population of about 33.37 ha would be disturbed.
- 17 nos. of religious and heritage structures are along the entire project stretch
- The project will lead to overall development in the region by reducing the travel time and generating green space of 90 ha. These all green spaces along seaside can be developed for public by creating cycling tracks, Promenades, Landscape, Theme parks etc.

E.S.5 Major Findings of the Environmental Assessment

Physiography and Soil Types

The broad physiographic features of are broad and flat terrain flanked by north – south trending hill ranges. The hill ranges form almost parallel ridges in the eastern and western part of the area. The Powai – Kanheri hill ranges are the other hill extending in the eastern and central part running NNE – SSW. The maximum elevation of the area is 450 m above mean sea level (mamsl) at some of the peaks of hill ranges. Trombay Island has north – south running hills with maximum elevation of 300 m above man sea level (m amsl). Malbar, Colaba, Worli and Pali hills are the isolated small ridges trending north – south in the western part of the district. The Powai – Kanheri hills form the largest hilly terrain in the central part of the Salsette Island and are the feeder zone for the three lakes viz., Powai, Vihar and Tulsi.

There are a number of creeks, dissecting the area. Among them, Thane is the longest creek. Other major creeks are Manori, Malad and Mahim which protrudes in the main land and give rise to mudflangs and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.

Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil. Soil cover in the city region is predominantly sandy due to its proximity to the sea. In the suburbs, the soil cover is largely alluvial and loamy.

Geological Set Up

The entire Greater Mumbai area is occupied by Deccan basalt flows and their acid and basic variants, poured out between the late Cretaceous and Early Eocene time. The basaltic flows are horizontally bedded and are more or less uniform in character over wide areas. Certain extrusive and intrusive mafic types are associated with basalts and are found in Mumbai Island and its vicinity. Further some fossiliferous sediment mainly of tufaceous origin and partly of fresh water origin, rich in fauna are also found in Mumbai area.

Seismic Hazards

Mumbai sits on a seismically active zone owing to the presence of 23 fault lines in the vicinity. The area is classified as a Seismic Zone III region, which means an earthquake of up to magnitude 6.5 on the Richter-scale may be expected

Hydro-geology

The entire area is underlain by basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow Alluvium formation of recent age also occurs as narrow stretch along the major river flowing in the area.

In hard rock areas the ground water exists in fractures, joints, vesicles and in weathered zone of Basalt. The occurrence and circulation of ground water is controlled by vesicular unit of lava flows and through secondary porosity and permeability developed due to weathering, jointing, fracturing etc., of Basalt. The ground water occurs under phreatic, semi confined and confined conditions. The leaky confined conditions are also observed in deeper aquifers.

In soft rock areas which constitutes most the study area , the river Alluvium patches along the course of rivers and Marine Alluvium in the coastal area, are highly potential aquifer but with limited areal extent. The ground water occurs under water table condition in sandy / gritty layers. The alluvial fill of low lying areas underlain by weathered basalt has relatively better ground water potential.

Ambient Air Quality Status of the Study Area

The monitoring of ambient air quality was conducted twice a week at four fixed locations (Nariman Point, Haji Ali, Ram Mandir, Khardanda Village and MCGM Garden, Malad) for 24 hours with respect to Reparable Particulate Matter (RPM10), PM 2.5 , Oxides of Nitrogen (NOx), Sulphur dioxide (SO_2.), Lead , CO and PAH .

PM_{10}

The mean ambient PM_{10} concentration during the monitoring period was 82.3µg/m^3 (Table 4.1) with a range between 70.5µg/m^3 (at Malad) and 100.0µg/m^3 (at Haji Ali). The highest concentration was measured at Haji Ali (115.1 µg/m^3) and the least also at Malad (59.4 µg/m^3). The average compliance level of four monitoring stations was 75%, i.e 4 measurements are above the NAAQS standard (100 µg/m^3).

$PM_{2.5}$

The mean ambient $PM_{2.5}$ concentration was 47.4 µg/m^3 (Table 4.1) with a range between 42.5 µg/m^3 (at Malad) and 60.6 µg/m^3 (at Haji Ali). The highest concentration was measured at Haji Ali (76.5 μg/m^3) and the least also at the Khardanda village (29.7 μg/m^3). The average compliance level with respect to National Standard (60 μg/m^3) of all the monitoring stations was 100%.

Oxides of Nitrogen (NOx)

The mean ambient NOx level was 18.2 μg/m^3 with a range between 13.7 μg/m^3 (at Khardanda village) and 25.7 μg/m^3 (at Haji Ali). The highest concentration was measured at Haji Ali (24.4 μg/m^3) and the least at Malad (11.0 μg/m^3). The average compliance level with respect to National Standard of all the monitoring stations was 100%.

Sulphur Dioxide

The mean ambient level of SO_2 was 9.9 μg/m^3 with a range between 7.9 μg/m^3 (at Malad) and 12.6 at Haji Ali. The highest concentration was recorded at Haji Ali (16.0 μg/m^3) and the least at Malad (6.2 μg/m^3). All the stations show 100% compliance level.

Lead

The lead concentration in all the four monitoring station was found below the NAAQS (1.0 μg/m^3). The highest concentration was recorded Khardanda (0.132 μg/m^3) and the least at Nariman Point (0.009 μg/m^3).

Carbon Monoxide (CO)

The carbon monoxide concentrations in all the four monitoring stations were found <1.0 μg/m3 which is below the NAAQS standard (4.0 μg/m^3) .

Hydro Carbon (HC)

The Hydro carbon (HC) concentrations in all the four monitoring stations were found below the detectable limit.

PAH

The PAH concentrations in all the four monitoring stations are below detectable level (<2.0 μg/m^3).

Groundwater Quality

In order to access the groundwater quality of the study area, six groundwater samples were collected from tube wells and dug wells and analysis was carried out as per procedure of APHA. Analysis of the groundwater samples and their comparison with the Indian drinking water Standard (BIS 10500, 2012) reveals the following characteristics:

pH values suggests that the water is alkaline in nature. The total dissolved solids (TDS) in tree locations are above the desirable limit (500mg/l) except at Nibhana Society, Juhu and Kasalbaug, Malad where it is below the desirable limit. However TDS in all samples are well below the permissible limit of 2000mg/l.

Chloride concentration is well below the desirable limit (250mg/l) in all locations. Sulphate and Nitrate concentrations are low and within the permissible limit and thus indicate low degree of organic pollution. Fluoride is present in all the samples and above the desirable limit of 1.0 mg/l.

Concentration of iron is low and below the desirable limit. And thus causes no adverse effect on domestic uses and water supply system and also does not promote growth of iron bacteria.

Groundwater in general is hard in the area and the Total Hardness is above the desirable limit of 200 mg/l but well water sample in Juhu it is below the desirable. It is worth mentioning that groundwater samples are free from heavy metals like cadmium, arsenic, lead, chromium etc.

Bacterial quality of groundwater shows all the samples drawn from both tubewells and wells shows presence of thermo tolerant coloforms or E.coli and hence the water samples are not potable and suitable for human consumption.

Surface Water quality

Samples of surface water were collected from 4 lakes within the project influence zone and one sample from Mithi River. Water qualities were compared with CPCB fresh water classifications.

Comparison of the results with the Indian Standards , it is clear that the in all the locations the water quality is well within the standard prescribed by CPCB for Class B, Class D and Class E type of water for most of the parameters except for DO and BOD. None of the heavy metals are found in the samples and Oil and Grease is also not detected.

Sea Water Quality

Analysis of the sea water samples reveals the following characteristics:

pH values suggests that the water is alkaline in nature. The total suspended solids (TSS) in all samples are low. However TDS in all samples are well below the permissible limit of 2000mg/l.

It is worth mentioning that sea water samples are free from heavy metals like cadmium, arsenic, lead, chromium etc. Oil and Grease is also not detectable in all samples

Soil

The analysis results indicate that soil in the region is moderately alkaline in nature. There is no much variation in the pH range in different sites. It can be inferred that the soil pH is suitable for production of any crop.

The uptake of minerals from soil by plants is directly proportional to the electrical conductivity of soil, which is responsible for plant growth. Conductivity is a measure of evaluating the salt status of soils, the high concentration of which impairs the growth of the plant. Crop plants differ in their tolerance to salinity.

However the levels of conductivity in soil above 2 milimhos, is t affected by salinity effects.

The analysis results indicate that the level of major nutrients and cations present the soil samples are within the range expected in Indian soil.

Bed Sediment Sampling

Three samples were collected to understand the physico-chemical properties of the bed sediment. The analysis results show that there are no toxic contaminations in the samples only Lead is present in higher level.

Noise

Noise levels at Haji Ali, Nariman Point, Mahalaxmi Temple, Carter road, Rizvi College, Poddar Hospital, Varsova and Lokhandwala Complex, are exceeding the limits and at Vir sawarkar Udyan, Malad and Khardanda Gaon are within the limits prescribed under Environment Protection Act (Regulation & Control) rules 2000. Plantation along the road and implementation of the EMP will reduce the noise significantly.

Ecology

The project site is covering 70% of coastal area and some part of urban settlement area. Coastal area include mangrove vegetation, most commonly seen are Avicennia marina, Avicenia marina acuticima, Sessuvium portulacastrum, Salvadora persica, Acanthus iliicifolius. Urban vegetation comprise of gardens, avenue tree, ornamental plants, which grow along the road dividers and traffic island at junctions of crossroads. General urban trees are Acacia arabica, Aalbizia lebbeck, Azadirachta indica, Bambusa vulgaris, Ficus benghalensis, Ficus religiosa, Mangifera indica, Peltophorum pterocarpum, Samanea saman, Schefflera actinophylla. The commonly found shrubs are Carissa carandas, Gnidia eriocephala etc.

E.S. 6 Critical Impacts to be addressed in this project road

On the basis of the assessment of the potential impacts, the critical environmental components that need to be addressed in the Environmental Management Plan have been identified.

Summary of Potential Impacts and remediation measures through EMP

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
1	Air Environment – Construction phase	Movement of vehicles	Increase in PM,CO, NOx and SO2	Not significant due to the temporary nature of the activity	Movement of vehicles will be limited only in the night time. Construction materials will be transportd through sea route
		Usage of Construction equipments.	Emission of SO2, NOx, SPM, CO etc.	Not significant due to the temporary nature of the activity.	All vehicles, equipment and machinery used for construction shall be regularly maintained to ensure that pollution emission levels comply with the relevant requirements of GOI and the PMU / PMC Trucks carrying construction material will be covered with the tarpaulin sheet.
		Drilling operation	Increase in SPM levels	Not significant due to the	Sprinkling of water can be done

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
				temporary nature of the activity	so as to decrease the suspension of particulate matter in air.
	Air Environment – Operation phase	Functioning of park	Increase in aesthetics due to improved air quality. Less pollution with increase speed of vehicle	Beneficial impact	
2	Noise Environment – Construction phase	Movement of vehicles	Increase in Ambient noise in the area	Temporary nature of the activity, hence not significant	Heavy noise producing equipment and operations should not be allowed in the night time. Their operation will be restricted only in the daytime. If urgently required, noise protection covering shall be provided.
		Usage of construction	Increase in intermittent noise level	Temporary nature of activity	The plants and equipment used in construction shall

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
		equipments			strictly conform to the GOI noise standards. All vehicles & equipment used in construction shall be fitted with exhaust silencers. During routine servicing operations, the effectiveness of exhaust silencers shall be checked and if found to be defective shall be replaced. Limits for construction equipment used in the project (measured at one meter from the edge of equipment in the free field) such as compactors, rollers, front loaders, concrete

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
					mixers, cranes (moveable), vibrators and saws shall not exceed 55dB(A) Maintenance of vehicles, equipment and machinery shall be regular and to the satisfaction of the PMU and PMC keep noise from these at a minimum. Workers in vicinity of loud noise, and workers working with or in crushing, compaction, or concrete mixing operation shall wear earplugs
	Noise Environment – Operation Phase	Functioning of road	Noise level will increase due to increased human activities	Not significant, the green zone will help in reducing noise from present levels.	Proper management plan is adopted for developing the green zone within the site

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
					which will act as a buffer to check the noise
3	Water Environment – Construction phase	Usage of construction materials	Could lead to possible contamination of sea/lake water by throwing debris	Effect is temporary	The construction activity will not be carried out in the rainy season
		Usage of construction equipments	Accidental spillage of oil and grease from machinery in surface and groundwater	Effect is temporary	Careful handling of the construction equipments and creating awareness among the labour using it
		Usage of construction material	Surface runoffs could lead to possible contamination	No offsite impact	Ready Mix Concrete (RMC) will be used.
		Setting up of garden and transportation of red earth	Leakage of red earth through run off water leads to contamination of water	Effect is temporary	Onsite diversion ditches will be constructed to control any surface runoff during site development

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
	Water Environment – Operation phase	Accidental spillage and solid waste dumping	water contamination	Offsite impact can be minimized though proper management plan	Oil &Grease separator will be provided for the collection and treatment of surface runoffs The treated water will be recycled for gardening use.
		Accumulation of non biodegradable solid waste due to human activity	Throwing of garbage in the leading to contamination of water	No offsite impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the road
		Accumulation debris	Likely chance of throwing of garbage debris in water affecting aquatic flora and fauna	No offsite impact	Onsite vermin-composting facility will be provided and the compost will be used as a manure for gardening purpose

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
4	Land Environment – Construction phase	Drilling operations	No effect on loss of productive soil	No impact	
	Land Environment – Operation phase	Human activity	Generation of solid waste	No significant impact	Solid waste will be segregated at source and proper dustbin will be installed Creating general awareness among the people using the garden
5	Traffic Pattern – Construction phase	Blockage of the road due to the operation onsite	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of vehicles to the site for carrying the construction material	Negative effect on the existing traffic pattern	No significant impact due to the temporary nature of the activity	Suitable traffic diversions will be made so that the traffic is unhindered
		Movement of labours and staff around	Negative effect on the existing traffic	No significant impact due to the temporary	Effective traffic diversion and management will

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
		the construction site and on the existing road	pattern	nature of the activity	be undertaken
	Traffic Pattern – Operation phase	Movement of vehicles coming to the site	Create an increase in the number of vehicles	Impact minimized through implementation of EMP	Adequate parking lots will be provided
6	Ecology – Construction phase	Constructing activity	Accumulation of dust particles on the surrounding vegetation result in the decrease of the growth rate of the trees and cutting of trees	Impact minimized through plantation programe	Compensatory afforestation programme will be implemented through EMP
			Decrease of the number of visiting faunal species like butterflies, birds etc. due to vibrations and increased noise levels	Temporary impact	Biodiversity will increase once the road is constructed and adopting EMP guidelines.

Sr.No	Environmental Component	Potential source	Potential Impact	Impact Evaluation	Mitigation through EMP
	Ecology – Operation phase	Operation of road and	Increase in the green cover have positive impact		

E.S. 7 Environmental Enhancement and Project Benefits

The environmental enhancement measures are intended to provide value addition to a proposed project. These are considered in addition to the specific impact mitigation measures proposed. Environmental enhancements therefore are measures aimed at improving the project surroundings, increasing its user-friendliness and improving the services to the local inhabitants.

In this project, the environmental enhancement measures will include:

- BRTS as one of the dedicated lane of both carriageways to attract commuters to reduce private vehicles.
- At each bus stop proper entry/exit and connectivity on both carriageway through subway or aesthetically pleasing foot over bridges to be proposed.
- The toilet and drinking water facilities should be made available at suitable distances along the promenade.
- Extension of existing subway at Haji Ali chowk is proposed .Also a connectivity from coastal road to existing approach road of Haji ali Darga is proposed
- The garden and promenade spaces being very important recreational space, suitable design landscapes, illumination and street furniture is provided.
- The coastal erosion protection measures by providing tetra pods/sea walls at the end of sea side promenade.
- Proposed Connectivity to Madh island

- Protection Wall (Break water wall) :Considering the storm surge impacts a well designed Break water wall on sea word side of proposed coastal road is planned with an elevation above HHTL
- Road level is planned in such a way that it will not impact aesthetic and sea side view of commuters
- Providing information boards for important tourist and pilgrimage locations
- Promenade with Cycle track and Seating Decks.
- Landscape areas with jogging track, kids play area, Public toilets.
- Open air museum.

E.S.8 Environmental Monitoring Program

Monitoring Program

The purpose of the monitoring program is to ensure that the envisaged objectives of the project is achieved and results in desired benefits to the target population. To ensure the effective implementation of the EMP, it is essential that an effective monitoring program be designed and carried out. The broad objectives are

- To evaluate the performance of mitigation measures proposed in the EMP
- To evaluate the adequacy of Environmental Impact Assessment
- To suggest improvements in management plan, if required
- To enhance environmental quality
- To satisfy the legal and community obligations.

Performance Indicator

The physical, biological and social components identified as of particular significance in affecting the environment at critical locations have been suggested as Performance Indicators (PIs), and are listed below.

- Air quality
- Water quality

- Noise levels around sensitive locations.
- Plantation success / survival rate
- Soil contamination
- Erosion indices
- Restoration of borrow pits
- Sedimentation rate in the downstream where bridges, culverts, etc are built
- Vital statistics on health
- Accident frequency

Selection of Indicators for monitoring

The environmental parameters that may be qualitatively and quantitatively measured and compared over a period of time, due to their importance and the availability of standardized procedures and expertise, have been selected as Performance Indicators (PIs).

- Air Quality
- Noise levels
- Water Quality
- Flora
- Soil Contamination

Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters recommended for monitoring road transportation developments are Particulate Matter (PM), Carbon Monoxide (CO), Oxides of Nitrogen (NO_X), Hydro-Carbons (HC), Sulphur Dioxide (SO_2) and Lead (Pb).

These will be monitored at designated locations starting from the commencement of construction activity. Data should be generated at all identified locations in accordance to the National Ambient Air Quality Standards 2009.

Water Quality Monitoring

The physical and chemical parameters recommended for analysis of both surface and ground water quality relevant to road development projects are pH, total solids, total dissolved solids, total suspended solids, oil and grease, COD, chloride, lead, zinc and cadmium. The location, duration and the pollution parameters will be monitored and the responsible institutional arrangements are detailed out in the Environmental Monitoring Plan in Chapter 8

Noise level Monitoring

The measurements for monitoring noise levels would be carried out at all designated locations along all contract packages in accordance to the Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) in 1989. Sound pressure levels would be monitored on twenty-four hour basis.

Plantation

To ensure the proper maintenance and monitoring of the compensatory afforestation being carried out, a regular maintenance and monitoring of the survival rate of the planted trees is being proposed upto a period of 3 years from the operation of the project. The responsible institutional arrangements are presented in the Environmental Monitoring Plan

Soil Contamination

Contamination of the soil, especially due to increased levels of Pb, Cd and Cr are likely due to the increased traffic movement on the project corridor. The comparison of the concentrations of these parameters before and after the project coming up would aid in arriving at the increase in concentrations of these heavy metals, if any.

E.S 9 Environmental budgets:

Total cost of environmental improvement plan has been estimated as **1.89 crores**

ANNEXURE 1: ECOLOGICAL ASSESSMENT

1.0 INTRODUCTION

The world's ecosystems are increasingly being threatened by human development. Ecological Impact Assessment or EcIA is used to predict and evaluate the impacts of development on ecosystems and their components, thereby providing the information needed to ensure that ecological issues are given full and proper consideration in development planning. The assessment takes into account the components of biota, i.e. Flora and Fauna already present in that area and predicts the possible impacts of the activity on that environment.

Ecological Survey is a component of an Environmental Impact Assessment, assessing the overall ecological status of the project site before the constructional and operational phase of a project begins. The main objective is to provide sufficient and accurate ecological data to allow a complete and objective identification and evaluation of the potential ecological impacts. The method consist of monitoring the current and changing conditions of ecological resources from which success or failure of the ecosystem can be judged without bias. Ecological assessment also takes into account the socio-economic issues.

The proposed project is a sea-link road project. It involves construction of bridge, tunnel and road along coast of Mumbai. The main purpose of this project is to reduce burden of Traffic and Transport System of Mumbai. Construction of this project will make travelling in the congested metropolitan city like Mumbai more economical, safe and fast. Traffic volume on highway and small routes would decrease because of diversion to the proposed road reducing the traffic intensity and hence the positive impact of the project the environment will be reduction in the air and noise pollution, which will have a positive influence on the ecological well-being of the area on a longer time scale.

However, it is a proven fact that all road projects, without exception, can be expected to affect the ecology in some way. Review of the published literature reveals that the impacts of road projects on ecology and wild life can be broadly grouped into the following categories:

-Habitat fragmentation and modification

-Restriction of animal movements

-Injury and mortality of wildlife species

-Soil erosion and hydrological alterations

-Environmental contaminations

-Human colonization-induced disturbances

Projects can also be expected to vary in the nature and extent of their effects on surrounding areas, including the flora and fauna found in them. The setting in which a road project is to be

Under taken and the activities the project is to include are major determinants of the type and severity of the impacts. Hence in the present study a careful consideration has been made on type, scale, and design of the project and also the existing habitat of the project area while formulating the ecological assessment study. Accordingly the objective and scope are delineated as elaborated in the following paragraph.

1.1. OBJECTIVE OF THE STUDY

The purpose of the report is to study baseline ecology and biodiversity present within the project area and buffer area, where buffer area is comprised of 0.5 km from the either side of projected road.

To document the baseline ecological features present within the study area by giving emphasis on the following biological resources:

i)

Flora

- General vegetation pattern and floral diversity
- Forest and forest types
- Species diversity index (Shanon –Weaver Index) of the biodiversity in the project area as well as plant fossil and phytoplankton
- Documentation of ecologically important plants medicinal as well as timber, fuel wood etc
- Endemic, endangered and threatened species
- Impact of impoundment and construction activities on the vegetation
- Cropping and horticulture pattern and practices in the study area
- Location of any biosphere reserve, National park or sanctuary in the vicinity of the project if any
- For categorization of sub-catchments into various erosion classes and for the consequent CAT plan, the entire catchments (Indian portion) to be considered and not only the directly draining catchments

ii) Fauna

- Fauna study shall be carried out for all groups of animals
- Inventorization of terrestrial wildlife and present status
- Zoogeographic distribution/affinities, endemic, threatened and endangered species and animal fossil

iii) Avifauna

- Fauna study shall be carried out for all group of animals
- Status – Resident/ Migratory/ Passage migrants
- Zoogeographic distribution/affinities, endemic, threatened and endangered species and animal fossils
- Impact of project on threatened/endangered taxa if any
- Inventorization of terrestrial wildlife and present status along with schedule of the species

iv) Aquatic ecology

- Aqua-fauna like macro-invertebrates, zooplankton, phytoplankton, benthos etc
- Conservation status
- Fish and fisheries
- Fish migrations if any
- Breeding ground
- Impact of dam building on fish migration and habitat degradation

v) Conservation areas and status of threatened/endangered taxa

- Biotic pressures
- Management plan for conservation areas and threatened/endangered taxa

1.2. SCOPE OF WORK

In order to achieve the above stated objectives, we have delineated our scope of study as follows:

- Identification of Ecosystems and habitats, (including the types of ecosystem and habitat that are present, with maps of their location, quantification of their current and past extent and condition, and descriptions of their use and management by local communities)
- Preparation of habitat map of suitable scale showing the various habitats of the site and its surrounding area.

- Ground truthing for land use and land cover category.
- Identification of flora and fauna, including threatened species, utilized wild species, ecological keystone species and species of cultural importance and species information on:
- Quantity: population sizes, abundance, stock volume, basal area.
- Quality: importance, trends in abundance, productivity and viability.
- Location: distribution; relationship between place and cultural value.
- Value: use by humans (e.g. Food, forage for livestock, materials, medical uses, and cultural uses) trends in uses, conservation importance, aesthetic values, etc.
- Domestic livestock, pest species and introduced species (list and identify their interactions with native species and ecosystems)
- Factors affecting habitats and important flora and fauna

1.2.1 Terrestrial ecosystem

Primary terrestrial ecosystem data shall be collected through extensive survey of the project site with reference to the flora and fauna. Secondary information may also be collected from different Govt. organizations such as Forests department, Social forestry, Department of agriculture etc. A checklist for the flora and fauna shall be prepared on the basis of the field observations as well as Govt. Dept records.

1.2.1.1 Flora assessment

The vegetation under the project site shall be characterized by using Standard Quadrat method and Random sampling approach. The properties of the vegetation with reference to species composition and functional attributes will be expressed on a quantitative basis.

Assessment techniques

The density measurements reflect as to how many individuals were present, the dominance measurements denote which species is largest in terms of its presence and the frequency measurements indicate how widely species is distributed among the same plots. Importance value is a reasonable measure to assess the overall significance of a species since it takes into account several properties of the species in the vegetation. Important value index shall be calculated as per Shanon Weaver index. The following parameters shall be assessed from the field data measurements

Importance Value Index

(i) Density = Number of species A/ Area sampled

(ii) Frequency = No. of plots in which species A occurs/ Total no. of plots sampled

(iii) Dominance = Total cover of basal area of species A/ Area sampled

Relative density = (Density of species A/ Total density of all Species) X 100

Relative frequency = (Frequency value of species A/ Total of all Frequency values for all species) x100

Relative dominance = (Dominance for species A/ Total dominance of all species) x 100

Importance value Index = (Relative density + relative dominance+ Relative frequency) (2) Shannon – Weaver Index ‘

Shanon – Weaver Index ‘The number of species and number of individuals in a community is a measure of species diversity which depends on stability of the habitat. Vegetation of the study area should be assessed by determining Shannon – Weaver diversity index.

1.2.1.2 Fauna Assessment

The domestic animals will be listed based on direct observation during field survey. The list of wild life will be obtained from the Forest department office as well as onsite observations (direct/ indirect method). On the basis of onsite observations as well as forest department records a checklist of fauna will be prepared. Birds survey will be done with the help of experienced field ornithologist.

1.2.2 Mangrove ecosystem

Detailed ecological studies of coastal mangrove flora of project area for understanding the quantitative aspects of mangroves shall be analysed with phyto-sociological studies. Observations of Structural characteristics [Relative frequency, relative density, relative dominance and the Importance Value Index (IVI)] of various species observed in different locations of project area will also be provided.

1.2.3 Marine Ecosystem

The flora and fauna of the marine ecosystem will be listed based on the field visit and secondary data. Laboratory analysis will be performed if necessary. On the basis of onsite observations as well as literature review a checklist of fauna will be prepared. Birds survey will be done with the help of experienced field ornithologist.

1.2.4 Assessment of proposed developments on biodiversity

The impact of study will address biodiversity at all appropriate levels and will require enough survey time to take seasonal features and changes into account. The focus will be on processes and services that are critical to human well-being and the integrity of ecosystems. It will address the full range of factors affecting biodiversity, including direct drivers of change associated with the proposed project and indirect drivers of change including demographic, economic, socio-political, cultural and technological processes and interventions. Impact of alternatives will be evaluated with reference to the baseline situation.

1.2.5 Proposed Conservation Plan

This will include adverse impact mitigation measures (Remedial action – prioritized recommendations in the short, medium and long-term) and suggestions for improving the biodiversity of the project site taking into consideration of socio economics and sustainable livelihood of local forest dependent communities.

2.0 AREA OF STUDY

The study area consists of road length of 29.20 km which lies in costal stretch of Mumbai, Maharashtra. The study area also includes a buffer of 0.5 km on either side of the entire road length. The proposed road length is divided in to 2 phases, from Princess Flyover to– Worli end of Sea Link and Bandra end of Sea Link to Kandivali Junction.

2.1 Location & Geography

The project site is located in the capital city of Maharashtra, Mumbai that lies on the western coast of India by the bank of Arabian Sea. Mumbai is made from the group of seven islands and is thus referred to as the Island city. These islands are Isle of Bombay, Mazagaon, Colaba, Old Woman's Island, Parel, Worli, and Salsette Island. The eastern coast of Salsette Island has rows of mangroves, wherein the western coast happens to be sandy and stony. Due to proximity to the sea, the soil cover of this region is sandy to large extent. The underlying rocks of this area are made up of Black Deccan Basalt pours, its acid and some basic variables. This island city of Mumbai is divided into two distinct regions, the city and the suburbs. The suburbs have alluvial soil type. The major creeks found in Mumbai coast are Manori, Malad and Mahim which protrudes in the main land and give rise to mud flats and swamps. The area is drained by Mahim, Mithi, Dahisar and Polsar rivers. These small rivers near the coast, form small rivulets which inter mingle with each other resulting in swamps and mud flats in the low lying areas.

2.2 Climate

The Climate of Mumbai is moderately hot with high level of humidity is seen. Its coastal nature and tropical location ensures temperatures won't fluctuate much throughout the year.The mean average is 27.2 °C and average precipitation is 242.2 cm (95.35 inches). The mean maximum average temperatures in about 32 °C (90 °F) in summer and 30 °C (86 °F) in winter, while the average minimums are 25 °C (77 °F) in summer and 20.5 °C (68.9 °F) in winter. Mumbai experiences four distinct seasons: Winter (December–Feb); Summer (March– May); Monsoon (June–Sep); and Post-Monsoon (Oct–Dec).

2.3 Phyto-geography

Maharashtra lies in the western portion of the Indian Peninsula. Western Ghats (Sahyadri) run along its Western boundary leaving a narrow coastal strip. Above the Western Ghats and the East lie vast Deccan plateau and the northern part the Satpuda hills and Tapi River run west to east. The vast Deccan plateau is devoid of abundance of forests except for patches of dry-deciduous and mixed deciduous forests. The main forest areas lie within the range of Sahyadri on the Western Ghats with its ramifications. The bulk of the forests of Maharashtra is composed of mixed deciduous forests ranging from moist deciduous forests to dry-Deciduous forests and dry thorn jungle or scrub forests. Tropical evergreen forests cover a relatively small area in localities with high rainfall, in patches, along the Western Ghats. There are swamp forests found along the coastal areas.

Forest of this region fall under **Southern moist mixed deciduous forest** and the project site also cover some mangrove forest, which belongs to the following class as given by the Champion and Seth in "A Revised Survey of the forest types of India"

Group 4: Littoral and swamp forests;

Sub group: 4B: Tidal swamp forest;

Sub division: TS1: Mangrove scrub/TS2: Mangrove forest

The project site is covering 70% of coastal area and some part of urban settlement area. Coastal area include mangrove vegetation, most commonly seen are Avicennia marina, Avicenia marina acuticima, Sessuvium portulacastrum, Salvadora persica, Acanthus iliicifolius. Urban vegetation comprise of gardens, avenue tree, ornamental plants, which grow along the road dividers and traffic island at junctions of crossroads. General urban trees are *Acacia arabica*, A*albizia lebbeck*, *Azadirachta indica, Bambusa vulgaris, Ficus benghalensis,Ficus religiosa*, *Mangifera indica*, *Peltophorum pterocarpum*, *Samanea saman*, *Schefflera actinophylla. The commonly found shrubs are Carissa carandas, Gnidia eriocephala etc.*

Urban Tree Cover

Garden Vegetation

Mangrove Vegetation

2.4 Project site alignment

The proposed Sea Link road includes constructions of different types of road like surface roads, tunnels, Connector Bridge, road on stilts, land fill road, and elevated roads. An overview of the project site alignment overlaid on the satellite imagery is given in the following diagram:

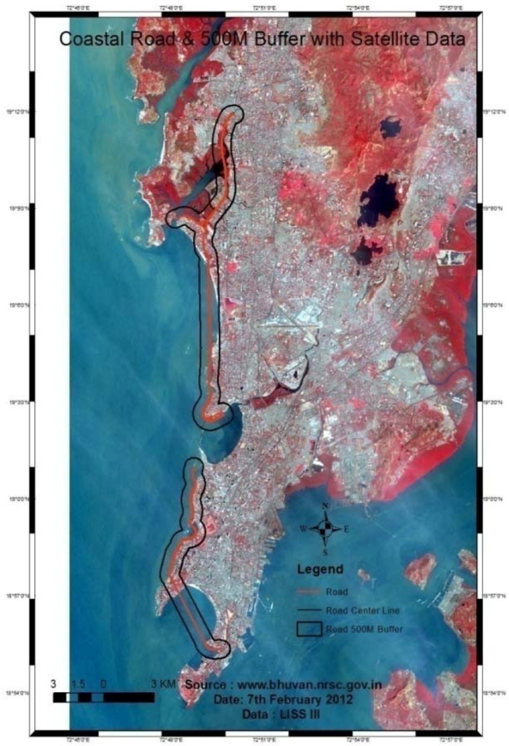
The project envisages construction of following structures:

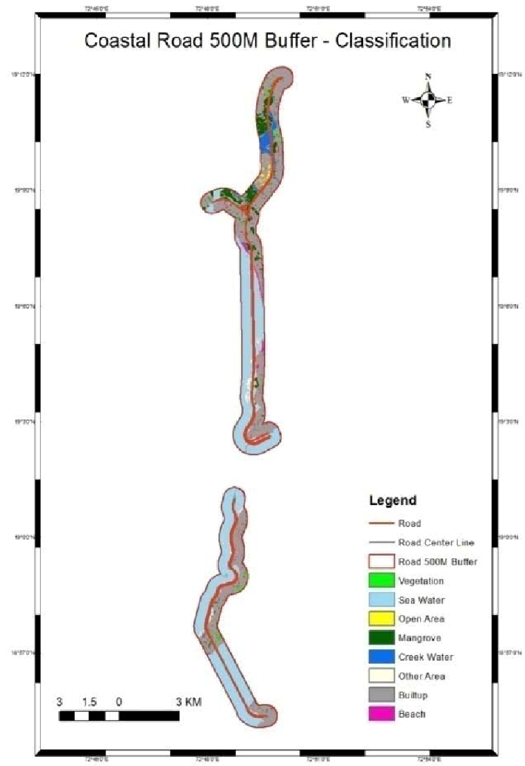
Structure Type	Sections							
	1	2	3	4	5	6	7	Total
Tunnel	3.5	0.0	0.0	0.0	0.0	5.8	0.0	**9.2**
Highway	0.0	1.6	0.1	1.8	2.2	0.0	0.0	**5.8**
Flyovers / Bridges / Road on Stilts	0.0	0.0	2.1	0.9	2.1	0.0	9.1	**14.2**

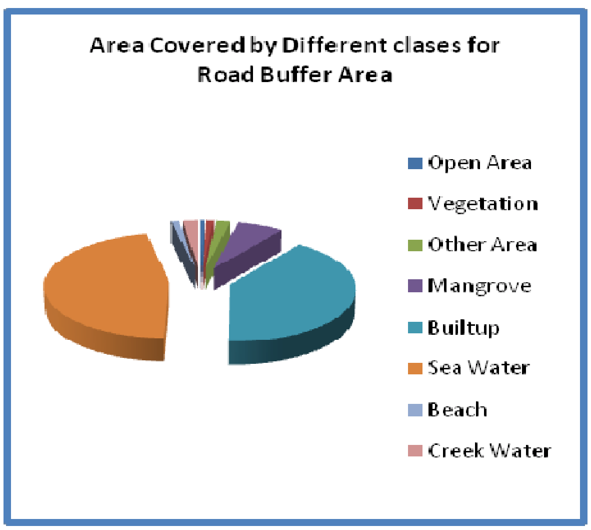
2.5 Land use and land cover of study area

As described earlier, the study area comprises an area of 6.4788 ha & 23.5885 ha belonging to project and buffer area respectively. As far as the land cover of the study area is concerned, it includes a mixed type of classes ranging from open area, Vegetation, mangrove, build-up area, Sea-water, Beach and Creek water.

In order to study the land use & land cover class of study area, Remote sensing technique has been employed. The following diagram illustrates the result of the image interpretation for demarcating the land use and land cover class:







Class	Area Sq_Km
Open Area	170496
Vegetation	413568
Other Area	738432
Mangrove	2444544
Build-up area	15137856
Sea-Water	17315712
Beach	424512
Creek water	841536

Hence, as per the above analysis, mangrove occupies the most dominant land cover class covering approx. 6.5% of the total project area. The area shown above includes project area as well as buffer area of 0.5 Km on either side of the route alignment.

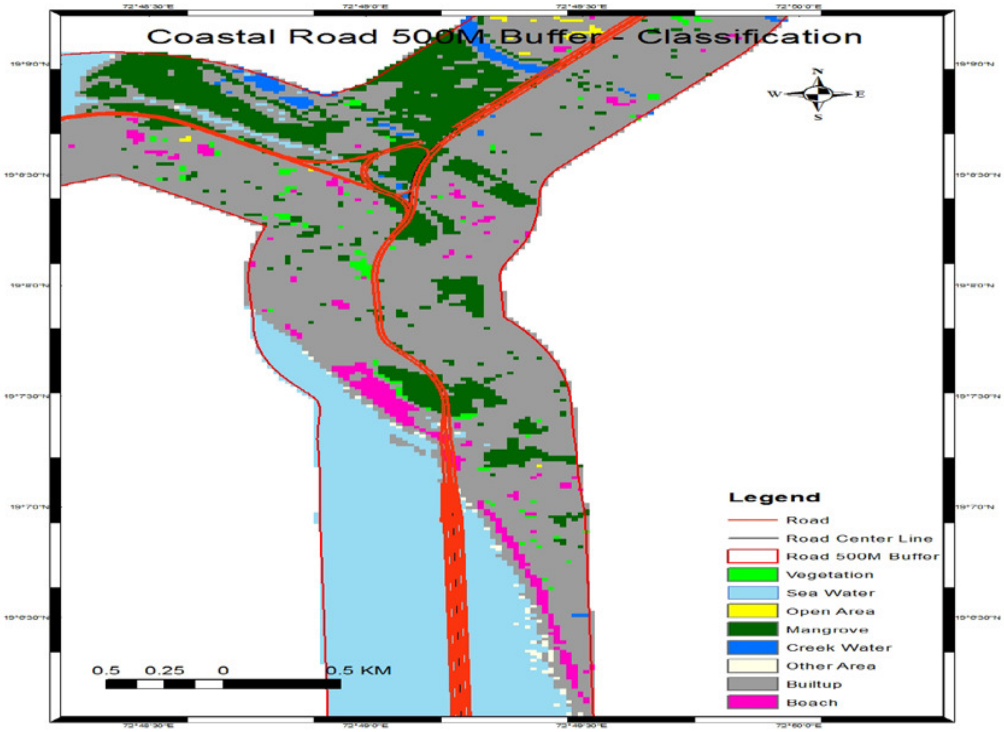
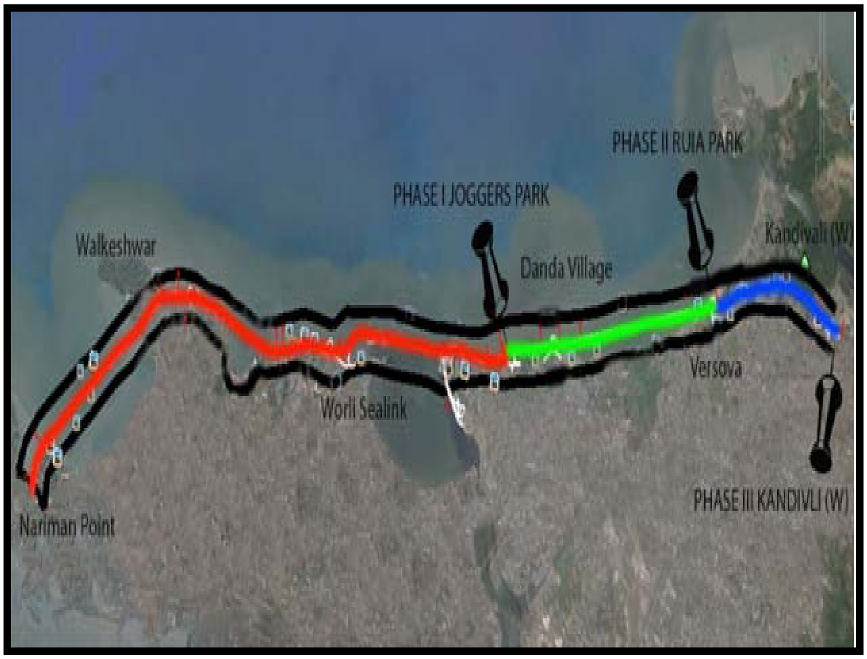


Fig. 3 Satellite imagery of the Habitats present in study area

Further, to study the detailed ecology of the project site, the entire project area is divided into two different phases. The phase 2 is further divided into 2 sub phases, ie, Phase 2A and 2B. The road length (in Km) and the area coverage of these phases are given in the following table:

Table No. 2 Phase wise distribution of Project Area including Buffer Area

Phases		Distance (Km)	Project(PA) area(ha)	Buffer(BA) area (ha)	Description
Phase 1	Phase 1 A	15.50	3.6371	14.6909	Colaba (Jagannath Bhosale Marg) – Bandra Jogger's Park (Start of landfilled road on mangrove)
Phase 2	Phase 2 A	6.50	0.9326	3.0222	Bandra Jogger's Park - Ruia Park(end of the tunnel-ritumbhara college)
	Phase 2 B	10.00	1.9091	5.4354	Ruia Park(end of the tunnel-ritumbhara college) - Kandivali Junction



Map No.2 Phase wise distribution of project area.

LEGENDS	
	PHASE 1 A
	PHASE 2 A
	PHASE 2 B

3.0 Methodology

The baseline study is the corner stone of any ecological assessment, since it define the existing status of the ecosystem potentially threatened by the road project. The data collected during the baseline study serves as a reference point against which potential or actual project-induced changes can be measured. Hence, a careful observation has been made on the type of the project and the ecological dimensions of the project area before adopting a suitable methodology for this study.

The methodology selected for the present work, involves a combination of desk study and field surveys. All the secondary data available on the project site are also compiled and documented. Historical information, maps, satellite imageries are also procured in order to get a thorough understanding of the project site. A rapid site visit also has been conducted as part of this exercise to get a general understanding of the ecology of the area and also to fix the boundaries of the study area.

Habitat mapping of the project area is done by using Survey of India toposheets, maps and satellite imageries, in order to delineate the different ecosystems present within the study area. The study area consist of projected road of length 30.5 km covering the area of approx.29.63(ha) purposes the construction of bridge on sea, tunnel, promenade, elevated road, land filled road in mangroves, reclamation area, road on stilts etc. For mapping the ecological baseline features a 500m X 500m grid lines are selected and demarcated by using a google earth imagery and other related softwares. Further the project area is divided into 3 phases. Phase 1 of road length 15.50 km covers total 96 Grids of them 69 falls in PA and 27 falls in BA Phase 2 A of road length of 6.50 km covers total 70 Grids of them 19 falls in PA and 51 falls in BA and phase 2 B of road length covers total 42grids of them 29 falls inpa and 13 falls in ba. Thus there are altogether no. of 151 grids demarcated in this study. These are denoted as P1L1 that is Phase 1 Left grid no.1 and so on.

Further, these individual grids are subjected to a detailed analysis by using a high resolution satellite imagery data sets and relevant software in order to demarcate the different habitat types present within these grids. Also a stratification exercise has been carried out to distinguish areas that are homogenous and require less ground study from that of more complex areas having different ecosystem types.

To study the ecology of the area the entire road length was accessed using a vehicle and data were collected by random sampling method. The points were randomly taken at an average drive of 1.5km. Apart from this, data were also collected from in between spots whenever the change in habitat was observed. Data pertaining to the type of the habitat, species observed, habitat disturbances were collected besides geographical location of the spot.

Geographical locations are collected by using a hand held GPS instruments by using its track function on. Thus the GPS readings along with the colour photographs were taken at several

Ground locations to have accuracy in the identification and demarcation of each habitat type coming under the study area.

The detailed field survey has been carried between 29/11/2014 to 3/12/2014 during the winter season of the year. The main focus was given to the identification of the different taxonomic groups found in the project area and the buffer area. Additionally, visits to mangrove area are also made for assessing the phyto-sociologic characteristics of the coastal forests present within the identified patches. Following table illustrate the field technique used for inventorying the different taxonomic groups for the purpose of this study:

Table 2: **Summary of field techniques for establishing ecological baselines**

Parameters	Methods adopted	Remarks
Floristic inventory and description of major plant communities	Check list of plant names and references of local and regional flora	Use of classification system of forests provided by champion and Seth (1968) is used for developing ecological understanding of plant communities in the study area
Estimation of tree, shrub and ground cover	Point-centered quadrant method and transect method	It is a sampling method used for investigating density and species composition
Vegetation and habitat mapping	Google earth imageries Remote sensing and GIS technique	Used for demarcating the habitat boundaries
Estimation of animal abundance of large and medium sized animals	Direct method including animal sighting	Fairly reliable and most commonly used methods for estimating density and abundance (also used data from published literature)
Reptile and amphibians	Spotlight count and pitfall traps, Habitat and population consideration	Secondary sources like published literature
Birds	Calls, spot mapping, nest searching, mark home ranges, checklist, survey: local people/ornithologist,	Secondary sources like published literature
Marine organisms	Direct method Biodiversity and Topographic survey	Secondary sources like published literature

The mangrove patches present within the study area are separately analyzed for species diversity indexing. In order to estimate the quantitative characters such as frequency, density and abundance, the most commonly used quadrate method is used. A quadrate is a sample unit or plot, which is an area of a definite size. For the present study a rectangular quadrate of size 10m X 10m is used, for analyzing trees shrubs and herbaceous vegetation.

For the preparation of floral inventory, every attempt was made to collect the plants in flower and fruit so as to make the identification work easier. Plants which were not able to be identified from the field were collected and tagged. These were then provisionally identified by using floras, and were then poisoned, pressed and made into herbarium sheets accordin to the conventional method. The photograph and the specimen of the identified material were collected and preserved for future reference. Each plant thus collected was critically studied and the identities were later confirmed by comparing the specimen with the authentic or type specimen in the local Herbaria at Blatter Herbarium, Mumbai.

4.0 Habitat Mapping

Habitat mapping is the standard approach used for mapping the extent and distribution of broad ecosystem types. It is used to make an initial assessment of a site's habitat interest, and document the baseline ecological features by using an ecosystem wide approach. The method adopted here uses Geographical Information system (GIS) and Remote sensing image interpretation technique and field based suvrey.

The main habitats on site are Marine and Terrestrial ecosystem. On west side of the proposed road is pre-dominantly marine ecosystem and east side have terrestrial ecosystem.. In order to trace the entire different habitat present within the vicinity of the site, a detailed ground truthing exercise has been carried out. The following are the strategic waypoint locations selected for ground truthing survey.

Table No.3: List of geo co-ordinates used for ground Habitat Demarcation

Sr. No.	GPS readings		Category	Description
	Latitude	Longitude		
1.	18°55'8.12"N	72°49'31.95"E	Macchimar nagar	Urban Settlement
2.	18°55'33.48"N	72°49'7.30"E	Nariman point	Coastal area
3.	18°56'49.30"N	72°49'15.60"E	Marine Drive (sea face)	Rocky shore
4.	18°56'41.28"N	72°47'43.00"E	Near ruby apartments (walkeshwar)	Housing society
5.	18°58'45.03"N	72°48'42.62"E	Near Haji Ali	Near Highway
6.	18°59'30.44"N	72°48'50.53"E	Markandeshwar temple	Built-up Area
7.	18°55'8.12"N	72°49'31.95"E	Worli diary	Built-up Area
8.	18°55'33.48"N	72°49'7.30"E	Bandstand	Mangrove vegetation
9.	18°56'49.30"N	72°52'15.60"E	Danda village	Coastal area
10.	18°56'41.28"N	72°60'43.00"E	Juhu	Beach
11.	18°56'41.28"N	72°66'43.00"E	Prakash nagar	Mangrove vegetation
12.	18°58'45.03"N	72°88'42.62"E	Reliance Pumping station	lake
13.	18°59'30.44"N	72°95'50.53"E	Kandivali Junction	Built-up Area

4.1 ECOSYSTEM WIDE CLASSIFICATION OF PROJECT AREA

To understand the different ecosystem in detail of the present project we divide the project area in three phases. This is explained in following table

Phases		Length (Km)	Project (PA) Area (ha)	Buffer (BA) area (ha)	Description
Phase 1	Phase 1 A	15.50	3.6371	14.6909	Colaba (Jagannath Bhosale Marg) – Bandra Jogger's Park
Phase 2	Phase 2 A	6.50	0.9326	3.0222	Bandra Jogger's Park - Ruia Park
	Phase 2 B	10.00	1.9091	5.4354	Ruia Park- Kandivali Junction

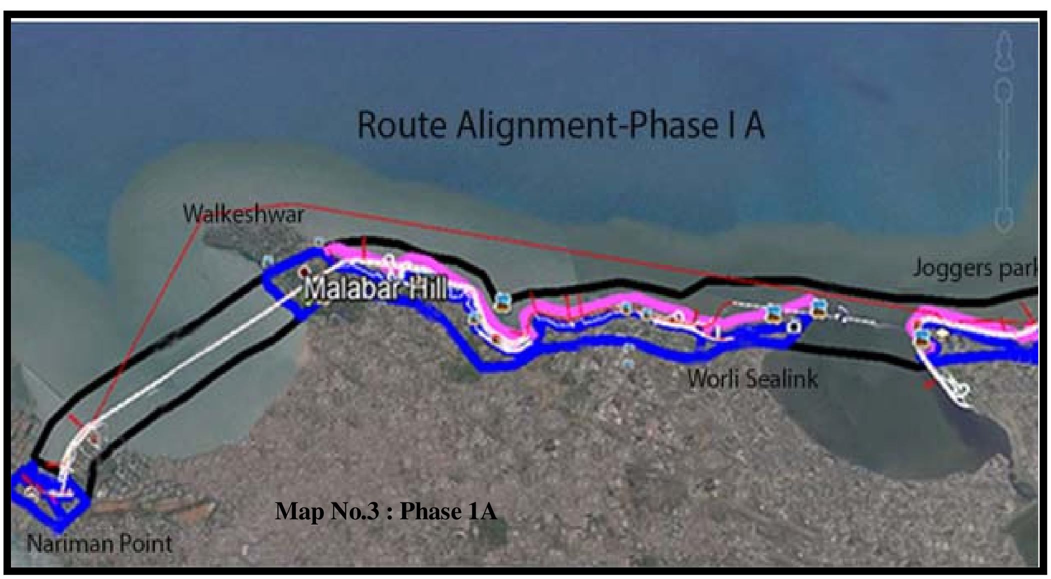
The project have different ecosystem and to study the diversity of ecosystem, the entire study area is divided in 500x500 grids. There are 217 Grids (Project and Buffer Area) .Each grid is studied separately and the baseline ecology is assessed. Ecology of the present study area is studied by classifying the girds on the basis of homogeneity of the ecological habitat present in study area. Which are as follows:-

Part 1- Marine Ecosystem

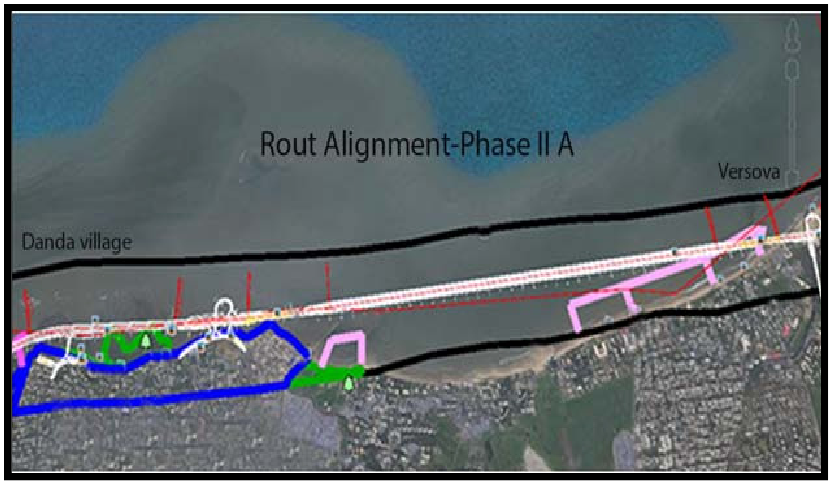
Part 2-Urban Ecosystem

Part 3- Mixed Ecosystem (Marine and Urban Ecosystems)

Ecology for PA and BA are described separately



Map No.3 : Phase 1A



Map No.4 : Phase 2

No.5 : Phase 2B Map

	IT ZONE
	MANGROVES
	BUFFER ZONE
	OPEN SPACES/GROUND
	SETTLEMENTS

The map shown above give the overall distribution of project area with the habitat present in it

Different types of ecosystems found within the study area:

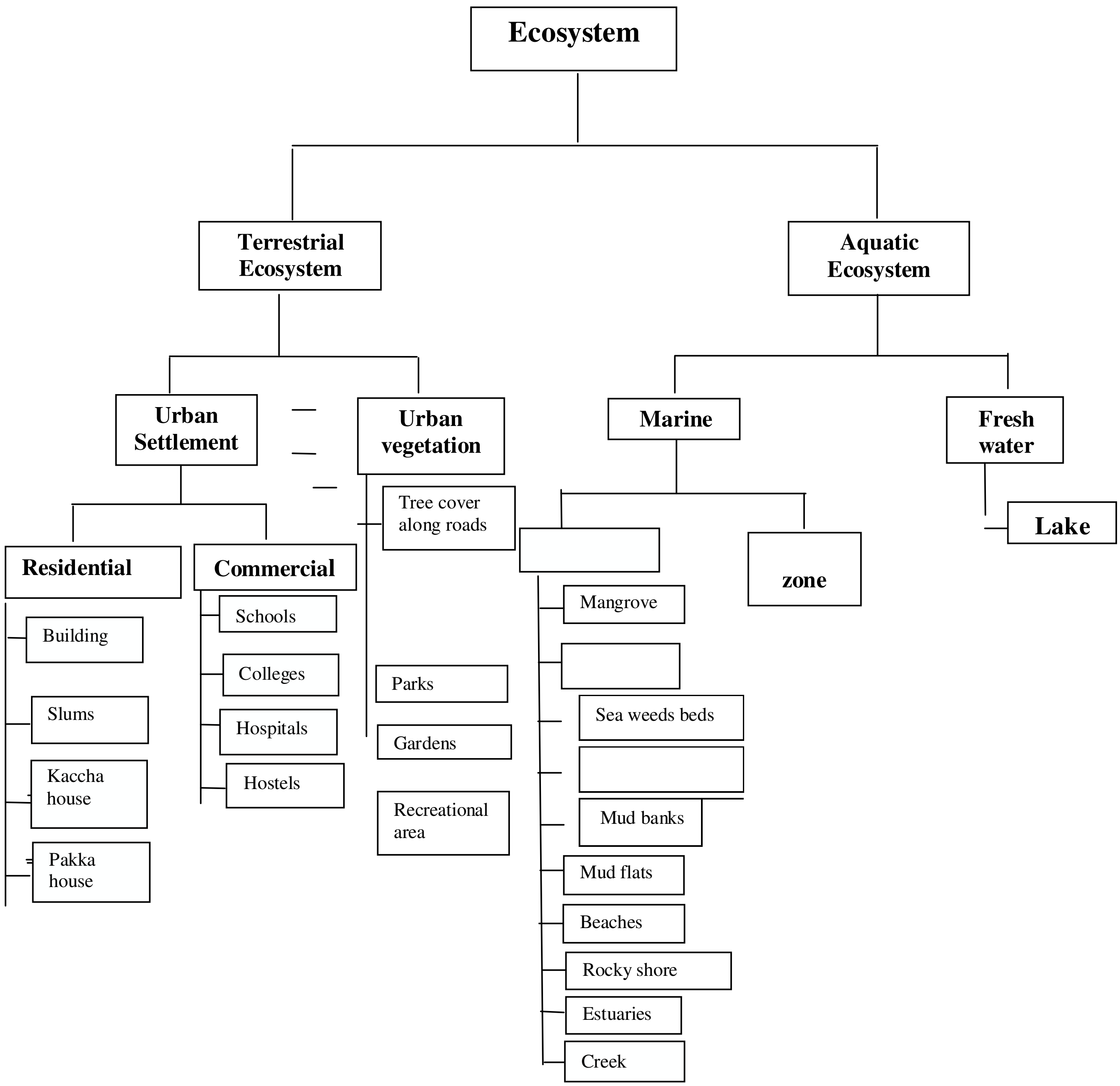


Table No.4: Classification of the Habitat seen in study area

The characteristics of the above listed habitat types is illustrated in the following sections.

4.3 Habitat wise classification of study area

4.3.1 Terrestrial Ecosystems

4.3.1.1 Urban Settlement

Urban settlement is a large nucleated settlement in which the majority of the employed inhabitants are engaged in non-agricultural activities. Urban areas may be defined by national governments according to different criteria; for example, size, population density, occupation of the people, and type of local government. In context to the project the urban settlement is divided into residential area and commercial area.

Residential area includes Building, Slums Kaccha houses, Pakka houses and temple. High rise buildings are seen in colaba, Malabar hill, walkeshwar, worli, Bandra, Andheri lokhandwala, and Mind space malad west.

Commercial is futher break down into school, colleges, hospitals, hostels, Business Park..Manora MLA hostel is at start point of proposed road. Hospitals like breach candy, Mahalakshimi race course ar ealso seen in buffer area.

4.3.1.2 Urban Forestry/Tree Cover

Urban forestry is the management of trees contributing to the physiological, sociological, and economic well-being of urban society. Urban forestry deals with woodlands, groups of trees, and individual trees. Urban areas include a great variety of habitats (streets, parks, derelict corners, etc. Trees and other vegetation also can improve air as well as provide other amenity and aesthetic benefits such as shade and beauty.

Urban vegetation is further classified into 2 parts tree along the road side and garden, park, recreational area are grouped together. Tree along the road side of walkeshwar road ,Napeansea road and carter falls under project as well as buffer area In project area parks like Priyadarshani park, MCGM garden, Joggers park, chakravarti garden, BMC garden, kamla Nehru park etc. are seen.

4.3.2 Aquatic Ecosystem

4.3.2.1 Marine Ecosystems

4.3.2.1.1 Mangroves

Mangroves are specialized ecosystems formed by a variety of salt-tolerant species growing in the intertidal areas and estuary mouths in tropical and subtropical regions of the world. The ecosystem has developed a set of physiological adaptations such as Pneumatophores to overcome problems of salinity and frequent tidal inundations. The ecosystem is also considered as most productive and diverse providing significant functions in the coastal zones as buffer against erosion and storm surges. The carbon fixed in mangroves is highly important in the coastal food webs and the litter from mangroves and the subsequent formation of detritus and its tidal export have also profound effect on promoting biodiversity richness.

In project area four patches of Mangroves are seen which are as follows**.**

1. Malvani mangroves.
2. Versova mangroves.
3. Lokhandwala mangroves.
4. Near bangur nagar and mind space.

4.3.2.1.2 Sea grass beds

The Sea grass beds are shallow marine habitat where there is undergrowth of sea grass present. They provide an important feeding ground for number of marine species including turtles and dugongs and spawning and nursery for many species. Sea grass beds are stabilizing the coastal sediment, substrate and provide vital oxygen to surrounding water masses.

In project site Sea weeds are seen in coastal area.

According to secondary data collected rich species diversity is seen with dominance of Halophila and halodula species.

4.3.2.1.3Seaweed bed

Seaweeds refer to any large marine benthic algae that are multicellular, macrothallic, and thus differentiated from most algae that are of microscopic size. They belong to the groups of red algae, green algae, and brown algae and most commonly found in the littoral zone.

In project site rich species diversity is of sea weed beds is seen. Sargassum*, Gelidiella and Gracilaria are* the dominant species and also over exploited.

4.3.2.1.4 Mudflats

Mudflats are wide expanse of fine grained soft mud along the shore and are coastal wetlands that form when mud is deposited by the tides or rivers, sea and oceans. They are found in sheltered areas such as bays, lagoons, and estuaries. These Mudflats may be further classified based on their relation with tidal condition viz.,

(i)High-tide (ii)Inter-tidal slopes and(iii) Sub-tidal zones. Open Mudflats in the intertidal regions support rich growth of algae belonging to the genera Ulva, Enteromorpha and Chaetomorpha and number of Cyanophycean members.

As stated mudflats are seen in intertidal zone, some part of project area falls in intertidal zone where species like mollusk, crustaceans, phytoplankton, zooplankton, small fishes etc is seen.

4.3.2.1.5 Beaches

Beaches are relatively level land areas which are contiguous with the water and are directly affected by marine waters even to the point of origination. It usually consists of loose particles which are often composed of sand, gravel, shingle, pebbles, or cobble. The particles of the Beach sometimes contain biological origins, such as shell fragments or coralline algae fragments. Usually Beaches are dominated with sand particles Muddy shores occur where the energy of coastal currents and wave action is minimal, allowing fine particles of silt to settle to the bottom. Some part of juhu and versova beach comes under the project area. All beaches are tourist spot.Fishing activity is also seen here.

4.3.2.1.6 Rocky Shores

A rocky shore is an intertidal area on seacoasts where solid rock predominates. Their character depends on the prevailing rock types and their profile is usually related to strata formation. Rocky shores are biologically rich environments, and make the ideal natural laboratory for studying intertidal ecology and other biological processes. They are the coastal habitats with the most abundant shore life. The upper beach zone is frequently very dry, limiting inhabitants to species which can tolerate a dry environment. The rocky shores are predominantly distributed in the West Coast of India.

In project site rocky shore habitat is found in khar danda, bandra band stand and bandra reclamation. All of them are tourist spot. Illegal construction is seen along the shore.

4.3.2.1.7 Creeks

Creek is a small narrow bay or arm of the sea longer than it wide and narrower and extending farther into the land than a cove, a recess in the shore of the sea, or of a river. It is hydrologically connected to a waterway above and below the site or is connected to a spring, headwaters, lake, estuary, or bay. Thus, this portion of the stream has variable salinity and electrical conductivity over the tidal cycle. The creeks are seen with predominant vegetation of mangroves.

Malad creek is seen in the project area. Creek is located west of Malad, the Oshiwara River drains into it. To the west is Madh Island, and to the east lies Versova. Earlier it was surrounded by a 1,000-acre (4.0 km^2) area of mangroves. But now this area has shrunk to 400 acres (1.6 km^2) as the real estate prices in Malad went up. Malad creek is 5 km in length.

4.3.2.2 Freshwater Ecosystem

4.3.2.2.1 Lake

Lakes are enclosed basins which can trap standing water.Lake ecosystems are a prime examples of lentic ecosystems. *Lentic* refers to standing or relatively still water, Lentic waters range from to lakes to wetlands. Lentic ecosystems can be compared with lotic systems, which involve flowing terrestrial waters such as rivers and streams. Lake provide habitat to aquatic and terrestrial ecosystem.

The photograph displays the lake habitat observed in the project area Lokhandwala Lake is seen adjacent to project area. This is a manmade lake formed sometime around 1980 as a result of the road leading to the electricity sub-station. Before it was a part of the creek. The depression formed got filled with water and it became a fresh water lake.

5.0 ECOLOGICAL ASSESSMENT OF ROUTE ALIGNMENT

5.1 ECOLOGY OF ROUTE ALIGNMENT – PHASE 1

As discussed in the chapter- 'Ecosystem wide classification of project area' the route alignment of phase 1 falls majorly in the marine and urban habitat. In this phase route alignment starts from Macchimar Nagar (Fisherman village) near jaganath bhosale marg, colaba and ends at jogger's park, Bandra. The total length of this phase is 16 km composed of an area of 16.3252 ha, out of which 2.7754 ha falls within project area (PA) and the remaining 13.3498 ha come under the buffer area (BA). The following Google earth imagery shows the over view of the alignment.

Google Map No.1 : Showing the overview of phase 1

As per the methodology adopted for the study,the entire road length in this phase is divided into 500mx500m grids, There are altogether 103 nos of grids seen within phase-1. A diagrammatic sketch showing the distribution of different habitat is shown in the following diagram.

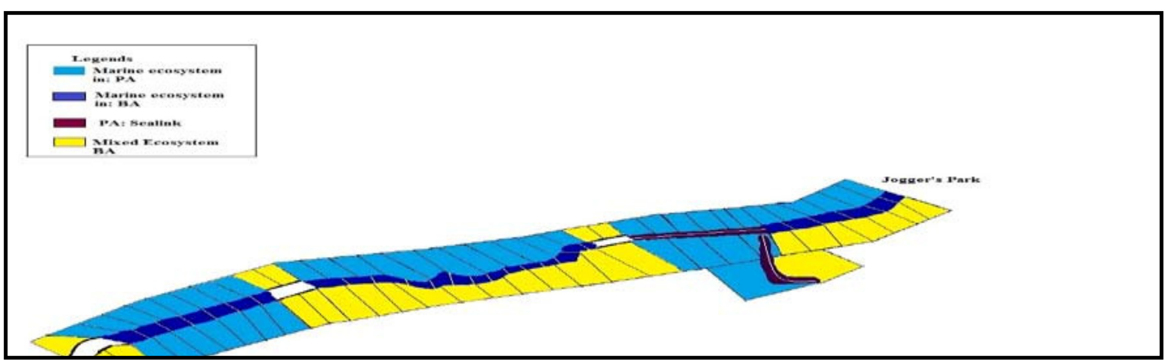


Fig 1.1: Diagrammatic sketch showing habitats of Phase 1 Not to scale

The following are the no. of grids and the type of habitat found within these grids.

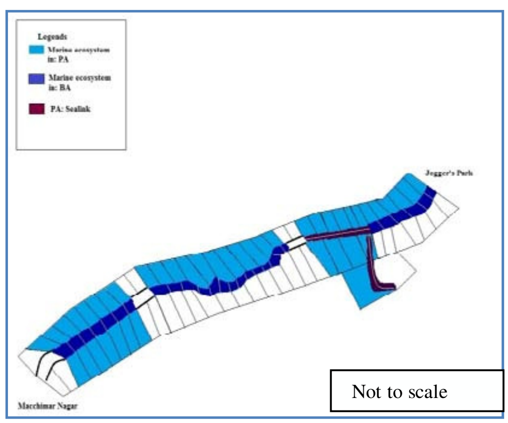
Habitat type	No. of grids (in nos.)		
	Project area (PA)	Buffer Area (BA)	Total area
Marine habitat	27	38	65
Urban habitat	NA	NA	NA
Mixed habitat- having marine and urban component	NA	31	31
Total			**96**

Thus, depending on the habitat found within these grids, they are classified into three classes and the no. of grids falling in these classes are further studied. The ecological description of these grids is explained in the following section.

5.1.1. Marine Habitat found in Phase 1

Marine habitat is the most dominant habitat type found within Phase 1. The entire project area of this phase comprised of 30nos of grids out of them 27nos of grids falls in the marine habitats, where as there are 38no.of grids in buffer area out of which 38nos of grids falls in the marine habitat.A diagrammatic sketch showing of grids coming under the marine habitat

	No. of grids	Area (in ha)
Project area (PA)	27	1.5844
Buffer area (BA)	38	5.7000
Total	67	7.2844
Date of visit	03/12/2014	
Lat/ Long	19° 3'10.27"N/72°49'5.28"E	
Grid name	PA: P2-P9,P12-P32 BA: L2-L9, L13-L34-R4-R8, R28-R30	



Location showing marine habitat in Phase 1

The ecology observed in the above grids consists of different flora and fauna belonging to different zones of marine ecosystem. The flora and fauna observed and studied through field visit/secondary data have been briefly described in the following section.

5.1.1.1. Ecology of Marine habitat falls within Project area

According to the field visits and secondary data collected we have found the presence of intertidal and sub tidal regions within the project area, which harbor major biota like marine algae, planktons, sea grasses, mollusks, crustaceans, small fishes, clams, shells, worms, shorebirds, snails, sea stars and the associated flora and fauna.

1. View of proposed tunnel area

2. Project site near bandstand, Bandra

The Project area shows a highly variant generic diversity. Phytoplanktonic species belonging to genera *Skeletonema , Nitzschia, Thalassiosira, Navicula and Rhizosolenia* contribute to the phytoplankton abundance. According to the secondary data studied 75-100 species are reported along the study area. Major genera found are Ulva, *Enteromorpha, Chaetomorpha, Caulerpa, Bryopsis, Ectocarpus, Sargassum, Gracilaria etc.* The maximum numbers of algal species occur during October to April, when generally a high salinity level is recorded.

Seagrasses of *Halophila* and *Halodule* sps are most commonly found in the western coast. The dominant species representing the sand dune vegetation are *Spinifix littoreaus,Hydrophylax meristima, Ipomea pescaprae, Asparagus sps, Gliricidia sepium, Delonix regia, Acacia auriculiformis, Jatropha curcas etc.*

The marine fauna consists of highly diverse phylas, classes, genera and species consisting of Zooplanktons, Macro Benthos, Corals, Fishes, Amphibians, Reptiles, Water Birds and Marine Mammals.

3. Tunnel region of the study Area

4. Intertidal Fauna in the buffer area

Major fauna are present in the Pelagic and Benthic zones. Zooplanktons are characterized by their faunal diversity and include organisms varying in size. The study area is dominated by copepods, cladocerans and decapods contributing to about 80% of the community. Crustaceans, Fish larvae tintinnids, larvae of economically important species like *Macrobrachium sp* , *Metapenaeus affinis, M. monoceros, M. dobsoni* and *Palaemonids* are occasionally encountered.

Macrobenthic fauna is dominated by polychaetes and crustaceans over important groups like mollusks, echinoderms and foraminiferans. Some of the major Macro Faunal species present in the Intertidal species

Littorina intermedia	*Aplysia cornigera*	*Lytocheria angustifrons*
Balanus Amphitrite	*Balanus Amphitrite*	*Eluchelus indicus*
Crassostrea cuculata	*Anthopleura* sp.	*Netograpsus messor*
Calliostoma scobinatum	*Boleopthgalmus* sp.	*Eluchelus tricarinatus*
Littorina ventricosa,	*Bursa tuberculata*	*Trapezium vellicatum*
Crassostrea cuculata	*,Planaxis sulcatus*	*Gibbula swainsonii*
Planaxis	*Plancais sulcatus*	*Ibla cumingi*
Oncidium verraculatum	*Gelasimus annulipes*	*Lithophaga cinnamomea*
Littorina subgramosa	*,Pisodonophis bore*	*Calliostoma scobinatum*
Neritina pulchella	*Neritina pulchella*	*Tethya lybcurium*
Aplysia cornigera	*Gelasimus mariones*	*Seila bandorensis*
Cerithium rubus	*Ophiactis savignyi*	*Cerithium rubus*
Tectarinus malaccanus	*Nereid* sp.	*Scutus unguis*
Onuphis sp.	*Crassostrea cuculata*	*Cellana radiate*
Bursa tuberculata,	*Glycera* sp.	*Cyprea pallid*
Cellana radiate	*Trochus radiates*	*Pisodonophis bore*

Ligia exotica	*Ozius rugulosus ,*	*Astrea stellata ,*
,Coecolin transversalis,	*Clanculus depicts ,*	*Ophiactis savignyi ,*
Potamides cingulatus,	*Leptodius crassimans, Eluchelus asper ,*	*Pterolisthes boscii, Dedrostomum signifier ,*
Trapezium vellicatum,	*Ibla cumingi*	*Harrnothoe ampullifera ,*

In accordance with the secondary data collected and field visit some of the fin fisheries which are present Moray Eel, Conger Eel, Bombay duck, Dog sharks, Grenadier anchovy, Mustached thyssa, Hilsa Shad, Striped Mullet, Big scale Mullet, Red Sea Bream, Mudskipper, Little tuna, Indian Mackerel, Whipfin mojorra, Croaker, Dhoma, Sea Bass, Ribbon Fish, Mackerel Scads, Black Promfret, Silver Promfret, Indian salmon, Bull eye Scad, Spotted scat, Three striped Tiger fish, Blue tilapias, Stingrays, Cat fish, Puffer fish etc.

Presence of various hydrozoa, reptiles such as Bombay sea snake, worms and annelid, star fishes, Cnidarians can also be present in the study area. Marine mammal such as Porpoise is occasionally encountered in the near shore areas. Avifauna mostly comprises of shorebirds some of them are Common Kite, Grey Heron, Little Egret, Intermediate Egret etc.

5. Little Egret at the Patch

6.View of the Project site

5.1.1.2. Ecology of Marine habitat falls within Buffer area

The buffer area shows a similar pattern of Ecology as seen in the project area, since it also falls under Marine habitat. Mahim Creek which falls under the buffer area shows a high avifaunal diversity. The birds noted down during the field study are Common or Black Kite, Brahminy Kite, Grey Heron, Indian Pond Heron, Western Reef Egret, Large Egret, Inter- mediate Egret, Little Egret, Black crowned Night Heron, Little Ringed Plover, Peregrine Falcon, Slender Billed Seagull, Little Tern, Whiskered Tern, Gull Billed Tern,Caspian Tern, Black Headed Seagull, Brown Headed Seagull, Little Cormorant, Common Sandpiper,Common Red Shank, Common Green Shank, Eurasian Curlew, Whimbrel, Curlew Sandpiper, Black Tailed Godwit, Marsh Sandpiper etc. Winter visitor birds and migratory birds are occasionally encountered.

7. **Marsh Sandpiper at the Site**

8. Indian pond heron at the site

5.1.2. Urban Habitat found in Phase 1

There is no urban habitat found in Phase I

5.1.3. Mixed Habitat of route alignment Phase 1

Mixed habitat type comprises both ecosystems marine and urban. Mixed Habitat is not observed in project area .Whereas out of 73 grids belonging to buffer area 28 grids falls in the mixed habitat. A diagrammatic sketch of grids coming under mixed habitatis shown in the Following diagram.

	No. of grids	Area (in ha)
Project area (PA)	NA	NA
Buffer area (BA)	31	6.5702
Total	31	6.5702
Date of visit	03/12/2014	
Lat/ Long	19° 3'10.27"N/72°49'5.28"E	
Grid name	PA:NA, BA: L1, L10, L12-R3, R9, R11-R27, R31-R34,	

Diagram:3 Location showing marine habitat in Phase 1

The ecology observed in the above grids consists of different flora and fauna belonging to different zones of marine ecosystem. The flora and fauna observed and studied through field visit/secondary data have been briefly described in the following section.

5.1.3.1. Ecology of Mixed habitat falls within Project area

The proposed road and bridge in the study area acrosses through the coastal and rocky shore habitat. The ecology observed in the study area shows a similar pattern observed in marine ecosystem with a high dominance in molluscan diversity. The avifauna observed during the field study showed the presence of various different bird species. Some of them are Common Kite, Grey Heron, Little Egret, Intermediate Egret etc.

5.1.3.2. Ecology of Mixed habitat falls within Buffer area

The Muddy Banks and Rocky shore areas surveyed in the buffer region majorly showed the presence of mollusks, crustaceans, and foraminifera's, algae, shells, clams etc. Major commercial fin fisheries and shell fisheries were seen during the visit in the nearby fishing villages of Koliwada and Bandstand- ChimbaiVillage.

The Urban area in the buffer region shows various diverse habitats from Settlements, Existing road and Infrastructure, Commercial and Residential buildings, Institutes, Heritage sites, Recreation parks, Udyans Fishing village, Schools, Institutes, Restaurants, Religious Places etc. Some of the structures are given below:

Schools, Hostels and Institutes – NCPA , Green lawns high school, Topiwala Medical College, Mount Mary convent High School, St. Catherine of Sienna School, Fatima girls Hostel etc.

Hospitals - Podar Hospital, Breach Candy Hospital, BMC hospital, International School etc.

Recreational Parks, Udyans, Parks and Gardens – Amarson's Garden,Lala Rajpat Rai Udyan, Lal Bahadur Shastri Udyan, Novartis Garden, Gautam Buddha Udyan.

Religious Places - Mount Mary Church, St. Andrews Church, St. Stephen 's Church, Mahalakshmi Temple Khandoba Temple etc.

Other Features - Sardar Vallabhai Patel Stadium, Heera Panna Area, Haji Ali area and Colony, Worli Dairy, Mahalakshmi Racecourse,Taj Lands End Hotel,Police Camp Worli, Bus Stops, FICCI Western Regional council, Kalachawki Area etc.

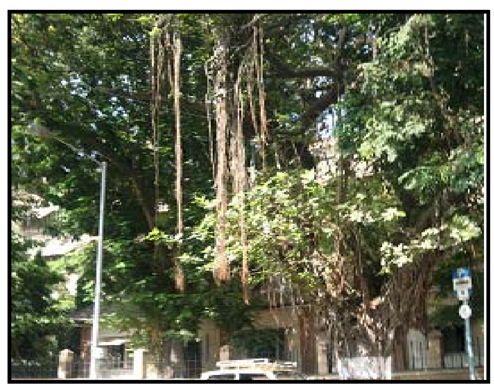
Major **heritage** and important **tourist** places noted from the field survey and secondary data are Nehru Planetorium, Dairy colony, Lal Bahadur Shastri Udyan, Worli Sea Face, Bandra Bandstand, Bandra Bandstand Garden, Joggers park, Worli Tip, Bandra Fort, Mahalakshmi Temple etc. Highly active **fishing areas** of Koliwada and Bandstand- Chimbai village also fall under the buffer zone of the study area. Small patch of **Mangroves** near the Chimbai village are observed in the buffer area. The ecology of this mangrove patch is described in the chapter three mangrove patches.

The Urban vegetation and tree cover observed in the buffer area consists of various tree species. Some of the common tree species observed during the survey is listed below:-

Sr. No.	Botanical Name	Local Name	Family
1.	*Terminalia catapa Linn.*	Badam	Combretaceae
2.	*Peltophorum inerme Llanos.*	Copper pod	Caesalpinae
3.	*Samanea saman Merril.*	Rain tree	Mimosaceae
4.	*Ficus religiosa Linn.*	Pipal	Moraceae
5.	*Sygium cumini (Linn.) Skeels*	Jambhul	Combretaceae
6.	*Ficus bengalensis Linn.*	Wad	Moraceae
7.	*Ficus racemosa Linn.*	Umber	Moraceae
8.	*Delonix regia Raf.*	Gulmohar	Caesalpinia
9.	*Mangifera indica Linn.*	Mango	Anacardiaceae
10.	*Ficus elastica Roxb.ex Horn*	Rubber Plant	Moraceae
11.	*Artocarpus heterophyllus Lam.*	Phanas	Moraceae
12.	*Polyalthia longifolia (Sonn.) Thw.*	Ashok	Anonaceae
13.	*Azadirachta indica A.Juss.*	Neem	Meliaceae
14.	*Moringa oleifera Lam.*	Shevga	Moringaceae
15.	*Alstonia scholaris (L.)R.Br.*	Saatvin	Apocynaceae
16.	*Thespesia populnea (L) Soland.ex Corr*	Parasbhendi	Malvaceae
17.	*Nerium indicum Mill.Gard.*	Kanher	Apocynaceae
18.	*Acacia auricuiformis A Cunn.ex.Bth.*	-	Mimosaceae
19.	*Lawsonia inermis L.*	Mehendi	Lythraceae
20.	*Quisqualis indica Linn.*	Madhumalati	Combretaceae
21.	*Derris indica (Lamk)Bennet*	Karanj	Fabaceae
22.	*Samanea saman Merril.*	Rain tree	Mimosaceae

15.Mahalakshmi Temple **16. Bandra Fort**

17.Koliwada Fishing Village in buffer area **18. Tourist Spot**



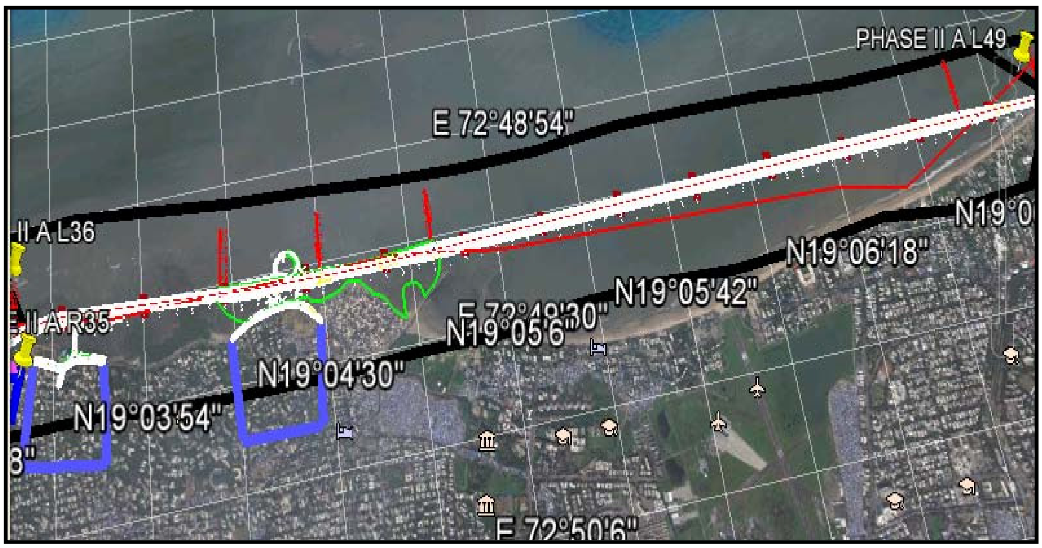
19. Ashok Tree **20. Banyan Tree**

The Avifauna observed during the field visit are House sparrow, House crow, Blue Rock Pigeon, Black Kite, Little egret, Oriental Magpie Robin, Common Myna, Red Vented Bulbul, Rose Ringed Parakeet, Red Whiskered Bulbul, White throated fantail flycatcher, Indian Golden Oriole, Drongos etc.

No major mammals were observed during the field visit except dogs. The other mammals in the area could be squirrels and rodents like mice and rats. Insects, butterflies, garden lizards were also observed in the field study.

5.2 ECOLOGY OF ROUTE ALIGNMENT – PHASE 2 A

As discussed in the chapter- ‘Ecosystem wide classification of project area’ the route alignment of phase 2 A falls majorly in the marine habitat. In this phase route alignment starts from Joggers Park of Bandra and ends at the beginning of versova beach. The total length of this phase is 6.5 km composed of an area of 6.3851ha, out of which 5.2713 ha falls within project area (PA) and the remaining 5.2713 ha comes under the buffer area (BA). A walk through survey of the entire route reveals that, other than marine habitat there are areas with urban habitat like settlements, roads, infrastructure etc. The following Google earth imagery shows the overall view of the alignment.



Google Map No. 2: Showing the overview of phase 2 A

As per the methodology adopted for the study, the entire road length in this phase is divided into 500mx500m grids, There are altogether 42 nos of grids seen within phase-1. A diagrammatic sketch showing the distribution of different habitat is shown in the following diagram.

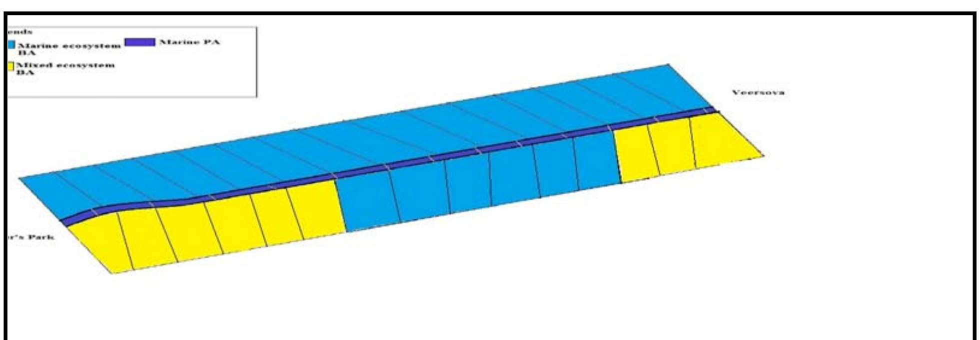


Fig 2.1 Diagrammatic sketch showing habitats of Phase 2A **Not to scale**

The following are the no. of grids and the type of habitat found within these grids.

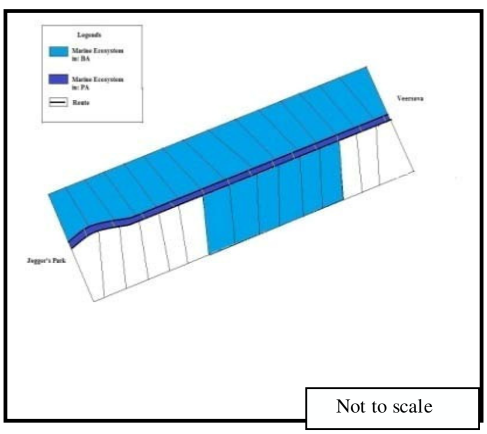
Habitat type	No. of grids (in nos.)		
	Project area (PA)	Buffer Area (BA)	Total area
Marine habitat	13	20	33
Urban habitat	NA	NA	NA
Mixed habitat- having marine and urban component	NA	9	9
Total			**42**

Thus, a detailed ecological assessment has been carried out for the grids falling in the above habitat categories and the description of the ecology found within these grids are illustrated in the following section.

5.2.1. Marine Habitat found in Phase 2 A

Marine habitat is the most dominant habitat type found within Phase 2 A. The entire project area of this phase comprised of 13grids all of them falls in the marine habitat. Whereas out of 44 grids belonging to buffer area 20grids falls in the marine habitat. A diagrammatic sketch of grids coming under the marine habitat is shown in the following diagram.

	No. of grids	Area (in ha)
Project area (PA)	13	0.9943
Buffer area (BA)	20	3.6213
Total	33	4.6156
Date of visit	03/12/2014	
Lat/ Long	19° 3'10.27"N/72°49 '5.28"E	
Grid name	PA: P33 - P45, BA: L36 - L49, R40 -	



Diag:4 Location showing marine habitat in Phase 2 A

The ecology observed in the above grids consists of different flora and fauna belonging to different zones of marine ecosystem. The flora and fauna observed and studied through field visit/secondary data have been briefly described in the following section.

5.2.1.1. Ecology of Marine habitat falls within Project area

The proposed road to be constructed passes through the intertidal and sub tidal regions, rocky shores seen in Bandra bandstand and Khar Danda and some portion of Juhu and Versova beach within the project area. These classes harbor major biota like marine algae, planktons, sea grasses, mollusks, crustaceans, small fishes, clams, shells, worms, shorebirds, snails, sea stars, foraminifera etc.

Zooplanktons such as Fish eggs, Fish larva, Copepods, Rotifers, Cladocera, Ostracoda, Medusa, Polychaete, Tunicates, Amphipods, Siphonophore, and Stomatopoda were observed during the field visit and laboratory analysis. Macrobenthic fauna is dominated by polychaetes and crustaceans over important groups like mollusks, echinoderms and foraminiferans.

Some of the common intertidal species observed and studied from the secondary data are listed below,

Sr. No.	**Species**	**Sr. No.**	**Species**
1.	*Alpheus spp*	14.	*Diodora lima*
2.	*Aplysia benedicti*	15.	*Drupa contracta*
3.	*Astrea semicostata*	16.	*Diodora lima*
4.	*Astre stellata*	17.	*Littorina intermedia*
5.	*Bursa granularis*	18.	*Meretrix meretrix*
6.	*Cellana radiate*	19.	*Nerita polita*
7.	*Cerithium morus*	20.	*Onchidium spp*
8.	*Cerithium rubus*	21.	*Planaxis similis*
9.	*Clanculus ceylanicus*	22.	*Octopus spp*
10.	*Clanculus depictus*	23.	*Tectarius malaccanus*
11.	*Conus figulinus*	24.	*Sea anemone*
12.	*Cyprea arabica*	25.	*Turbo brunneus*
13.	*Diodora bombayana*		

The common fauna and fishes observed in Khar Danda and Versova during the field visit were Boi, Catfish, Prawns sp, Tilapias, Pompret, Mackeral, Bombay Duck, Dussumeiri, Mackeral, Barbs, Sharks, Tilapia, Guppies, Snake eels, Pipe fishes etc. Presence of various hydrozoa, reptiles such as Bombay sea snake, worms and annelid, star fishes, Cnidarians can also be occasionally seen. Marine mammal such as Porpoise is occasionally encountered in the near shore areas. Hawksbill, green olive ridley and leatherback turtles are occasionally sighted in the near shore areas.

Avifauna mostly comprises of shorebirds. Some of them are Common Kite, Grey Heron, Sandpipers, Little Egret, and Intermediate Egret etc.

The proposed road on stilts passes through dense Mangrove patches present near Versova beach. *Aviccenia marina* was observed in dominance during the site visit to Versova beach. The ecology and phyto-sociology of the area is discussed separately in the Chapter 3 mangrove ecosystem,

During the field visit, it was also observed that the beaches apart from being a tourist spot and fishing area also were being used for cultivation of some edible roots by the people living in the nearby slum settlements.

21. Fishing observed at Khar Danda

22.Solid waste dumping at Bandra Shore

23. Tourist Spot- Reclamation

24. Field survey at the Juhu Coas

5.2.1.2. Ecology of Marine habitat falls within Buffer area

The buffer area shows a similar pattern of Ecology as seen in the project area, since it also falls under Marine habitat. Khar Danda a major fishing region and Juhu- Versova beach a major tourist spot also falls under the buffer zone.

25. Fishing Racks at Khar

26. Muddy Banks at Khar

27. Juhu beach-Tourist Spot

28. *Ipomea biloba* observed in the patch

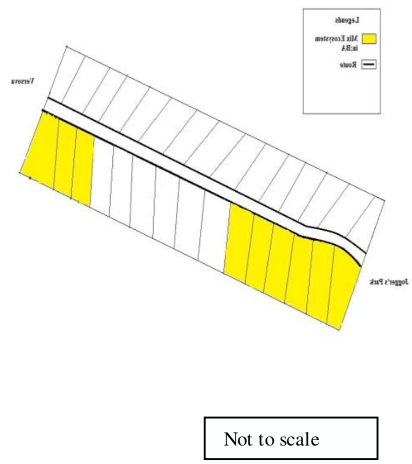
5.2.2. Urban Habitat found in Phase 2 A

There are no urban habitat found in Phase II A

5.2.3 Mixed Habitat found in Phase 2 A

Mixed habitat type comprises both ecosystems marine and urban. No project area is found falling within the maine habitat. Where as out of 44 grids of buffer area only 9 grids falls in the mixed habitat. A diagrammatic sketch showing of grids coming under mixed habitat is given in the following diagram.

	No. of grids	Area (ha)
Project area (PA)	NA	0.0000
Buffer area (BA)	9	1.3500
Total	9	1.3500
Date of visit	03/12/2014	
Lat/ Long	19° 3'29.33"N/72°49'20.30"E	
Grid name	PA: NA BA: R35-R40,R46-R48	



Diag:6 Location showing marine habitat in Phase 2 A

The ecology observed in the above grids consists of different flora and fauna belonging to several zones and classes present both in marine and urban ecosystem. The flora and fauna observed and studied through field visits / secondary data have been briefly described in the following section.

5.2.3.1. Ecology of Mixed habitat falls within Project area

The proposed road and bridge cut through the coastal and rocky shore habitat. High dominance in molluscan diversity is seen. The avifauna observed during the field study showed the presence of various different bird species. Some of them are Common Kite, Grey Heron, Little Egret, Intermediate Egret etc.

In accordance with the field visit and satellite imagery studied, it was observed that some portion of Mangroves present in Khar Danda and Versova area are getting affected by the road proposed in the project. As they belong to a sensitive ecosystem their ecology is discussed separately in the Chapter 6 Mangrove ecosystem.

5.2.3.2. Ecology of Mixed habitat falls within Buffer area The Muddy Banks, Beaches and Rocky shore areas surveyed and studied in the buffer region majorly showed the presence of mollusks, crustaceans, foraminifera’s, algae, shells, clams etc. Major commercial fin fisheries and shell fisheries were seen during the visit in the nearby fishing villages of Khar Danda and Bandstand- Chimbai Village. Dense and Sparse Mangroves are also present in the Buffer area.

The Urban area in the buffer region showed various diverse habitats from Settlements, Existing road and Infrastructure, Commercial and Residential buildings, Kaccha Pakka Houses, Slums, Institutes, Heritage and tourist sites, Recreation parks, Udyans Fishing village, Schools, Institutes, Restaurants, Religious Places ,Urban Vegetation and Tree cover etc. Some of the features are given below:

Existing Road: Hanuman Nagar, Dr. B.R Ambedkar Road, Chuim Village Road and Area, St. John Road, Vinayak Road, Ram Mandir Road,Juhu Tara Road,Mora Gaon, Military Road, Shanti Roa, St. Monicas Road etc.

Schools, Colleges and Institutes: Southern Sea Education School, Rizvi College of Arts, Science and Commerce, Silvabrooks Playschool, M.K Sangvi College etc.

Recreational Parks and Udyan: Katrak Park, B.R Ambedkar Garden, Sambhaji Udyan, Union Park etc.

Residential and Commercial places: Railway Colony, Bandra Gymkhana,Otters Club, Hanuman Nagar, Oakwood Prime, New Sunrise Hotel, Eicher Guest House, Out of Blue hotel, Candies Restaurant, Hotel Novotel, Sagar Samrat, Ramada Palace etc.

Major **tourist spots** such as Juhu Beach, Versova Beach, Bandra Reclamation etc also fall in the Buffer Zone. **Khar Danda** a major and well known fishing village of Kolis also comes under the buffer zone.

33. Sparse Mangroves near Khar Danda

34. Fishing at Khar Danda village

35. Recreational area near the Coast

36.Udyan near the Reclamation Area

Urban Vegetation: The urban vegetation observed in the buffer region harbors different tree species, shrubs and herbs belonging to different classes and phylas. Some of the common trees observed in the area are listed below:

Sr. No	Common Name	Botanical Name	Sr. No	Common Name	Botanical Name
1	Asupalav (D)	*Polyalthia longifolia var. pendula (Sonn.) Thw*	15	Bottle palm	*Roystonia regia (H.B.K) Cooke*
2	Naral	*Cocos nucifera L.*	16	Karanj	*Pongamia pinnata (L.) Pierre*
3	Subabhul	*Leucaena leucocephala (Lamk.) De Wit*	17	Vad	*Ficus benghalensis L.*
4	Amba	*Mangifera indica L.*	18	Suru	*Casuarina equisetifolia J.R & G. Forst.*
5	Sonmohar	*Peltophorum pterocarpum (DC.) Bk. ex Hyn.*	19	Vilayati chinch	*Pithecellobium dulce (Roxb.) Benth.*
6	Pimpal	*Ficus religiosa L.*	20	Tad Supari	*Borassus flabellifer L. Areca catechu L.*
7	Deshi badam	*Terminalia catappa L.*	21	Chapha	*Plueria alba L.*
8	Gulmohar	*Delonix regia (Hook) Rafin.*	22	Singapore cherry	*Muntingia calabura L.*
9	Kala Umber	*Ficus hispida L.f.*	23	Australian Babhul	*Acacia auriculiformis A. cunh ex Benth.*
10	Jambhul	*Syzygium cuminii (L.) Skeels*	24	Parijatak Ficus benjamina	*Nyctanthus arbor-tristis L. Ficus benjamina L.*
11	Rain tree	*Samania saman (Jacq.) Merrill*	25	Dhaman	*Grewia titiaefolia Vahl.*
12	Bhend	*Thespesia populnea (L.) Sol. ex Cor.*	26	Lettuce Tree Saptaparni	*Pisonia alba Spanog. Alstonia scholaris (L.) R.Br.*
13	Kaduneem	*Azadirachta indica (L.) A. Juss.*	27	Shevga	*Moringa pterigosperma Gaertn*

Sr. No	Common Name	Botanical Name	Sr. No	Common Name	Botanical Name
14	Phanas	*Artocarpus heterophyllus Lamk.*			

The Avifauna observed during the field visit are House sparrow, House crow, Blue Rock Pigeon, Black Kite, Little egret, Oriental Magpie Robin, Common Myna, Red Vented Bulbul, Rose Ringed Parakeet, Red Whiskered Bulbul, White throated fantail flycatcher, Indian Golden Oriole, Drongos etc.

No major mammals were observed during the field visit except dogs. The other mammals in the area could be squirrels and rodents like mice and rats. Insects, butterflies, garden lizards, chameleon were also observed in the field study.

5.3. Ecology of route alignment – Phase 2 B

As discussed in the chapter- ‘Ecosystem wide classification of project area’ the route alignment of phase 2 B falls majorly in the marine habitat. In this phase route alignment starts from beginning of versova beach and ends at Kandivali Junction. The total length of this phase is 9.5 km composed of an area of 9.5643ha, out of which 2.8143ha falls within project area (PA) and the remaining 6.7500 ha comes under the buffer area (BA). A walk through survey of the entire route reveals that, other than marine habitat there are areas with urban habitat like settlements, roads, infrastructure etc. The following Google earth imagery shows the overall view of the alignment.

Google map no.3 showing the overview of phase 2 B

As per the methodology adopted for the study the entire road length in this phase is divided into 500x500 grids. There are altogether 70 no. of grids coming within PhaseII BThe following are the no. of grids and the type of habitat found within these grids. A diagrammatic sketch showing the distribution of different habitat is shown in the following diagram.

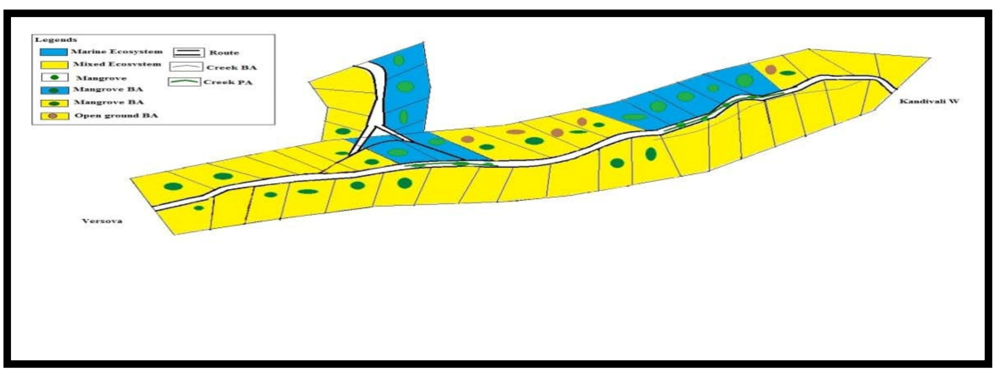


Fig 2.1 Diagrammatic sketch showing habitats of Phase 2 B Not to scale

The following are the no. of grids and the type of habitat found within these grids.

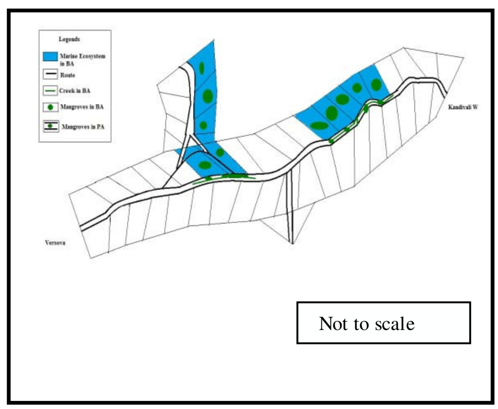
Habitat type	No. of grids (in nos.)		
	Project area (PA)	Buffer Area (BA)	Total area
Marine habitat	NA	10	10
Urban habitat	NA	NA	NA
Mixed habitat- having marine and urban component	19	41	60
Total			**70**

Thus, a detailed ecological assessment has been carried out for the grids falling in the above habitat categories and the description of the ecology found within these grids are illustrated in the following section..

5.3.1. Marine Habitat found in Phase 2 B

There is no presence of marine habitat in this phase, but there isurban habitat, hence explained in mixed habitat section below. Whereas out of 52 grids belonging to buffer area, 10 grids falls in the marine habitat. A diagrammatic sketch of drids coming under the marine habitat is shown in the following diagram,

	No. of grids	Area (in ha)
Project area (PA)	NA	0.000
Buffer area (BA)	10	2.8500
Total	33	2.8500
Date of visit	03/12/2014	
Lat/ Long	19° 3'10.27"N/72°49'5.28"E	
Grid name	PA:NA, BA: L55,L56 ,L61 – L65, AR5,AR6,AR7	



Dig:7 Location showing marine habitat in Phase 2 A

The ecology observed in the above grids consists of different flora and fauna belonging to different zones of marine ecosystem. The flora and fauna observed and studied through field visits / secondary data have been briefly described in the following section.

5.3.1.1. Ecology of Marine habitat falls within Project area

Presence of marine habitat is not seen in project area

5.3.1.2. Ecology of Marine habitat falls within Buffer area

The buffer area shows a similar pattern of Ecology as seen in the project area, since it also falls under Marine habitat.

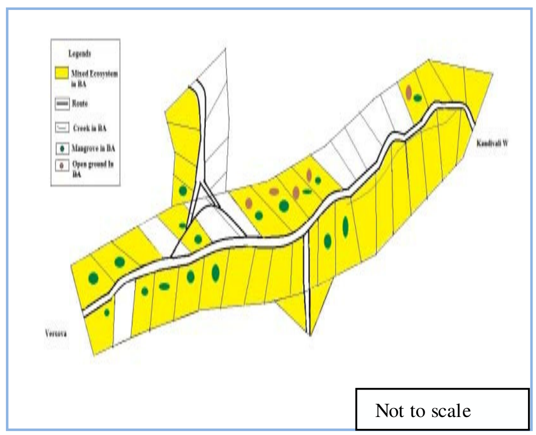
5.3.2. Urban Habitat found in Phase 2 B

There are no urban habitat found in this phase

5.3.3. Mixed Habitat found in Phase 2 B

Mixed habitat type comprises both ecosystems marine and urban. The entire project area of this phase comprised of 19 grids out of them 17 grids falls in the mixed habitat. Where as out of 52 grids of buffer area, 35 grids falls in the mixed habitat. A diagrammatic sketch of drids coming under the mixed habitat is shown in the following diagram,

	No. of grids	Area (in ha)
Project area (PA)	19	1.5797
Buffer area (BA)	41	3.6000
Total	52	5.1797
Date of visit	03/12/2014	
Lat/ Long	19°3'29.33"N 72°49'20.30"E	
Grid name	PA: P47,P50-P65 BA: R49,R51-R67,L50-L53,L54,L57-60,L66-69,AR3,AR4,AR9,AL2, AL3	



Dig:9 Location showing marine habitat in Phase 2 B

The ecology observed in the above grids consists of different flora and fauna belonging to several zones and classes present both in marine and urban ecosystem. The flora and fauna observed and studied through field visits / secondary data have been briefly described in the following section

5.3.3.1. Ecology of Mixed habitat falls within Project area

The proposed road cuts through dense mangrove patches, Creek area, Open space and existing roads. The Urban area harbors different structures from Settlements, Existing road and Infrastructure, Commercial and Residential buildings, Kaccha Pakka Houses, Slums etc. The proposed road was observed to pass through the following features,

Existing Roads: Ce1ntre of Fisheries Education Road, Ram Nagar, Mindspace Road, Link Road, Kandivali Junction etc.

Open Space: Area near Millat nagar showing sparse vegetation.

Other Features: Commercial and Residential areas near Mindspace, Janta Colony Kandivali, Mindblast Landscape Garden, BMC Udyan etc.

The ecology of the Mangrove patches present is discribed separately in the chapter6 mangrove ecosystem.

42.Dense Mangroves near Versova

43. Dense Mangroves in Malad Creek

5.3.3.2. Ecology of Mixed habitat falls within Buffer area

The Urban habitat in the buffer region shows various diverse structures from Settlements, Existing road and Infrastructure, Commercial and Residential buildings, Kaccha Pakka Houses, Slums, Institutes, Recreation parks, Udyans, Schools, Institutes, Restaurants, Religious Places, Urban Vegetation and Tree cover etc. Some of the features are given below;

Existing Road and Areas: Bharat Nagar, Seven Bungalows, Aram Nagar, Central Institute of Fisheries Education Road, Lokhandwala Complex, Mindspace Area, Yamuna Nagar, Rajan Pada,Laxmi Nagar, Ayappa Temple Road, Millat Nagar, Link Road etc.

Schools, Colleges and Institutes: Versova Welfare Association High School, Cambridge Playgroup, St. Mary's High School, Central Institute of Fisheries Education, St. Mary's High School, Bangur Nagar Vidya Bhavan, Atharva College of Engineering etc.

Recreational Parks and Udyan: Seven Bungalow Garden, BMC Garden Near Bangur Nagar, Sanjay Parikh Garden, Sai Baba Garden etc.

Residential and Commercial places: Bhagat Singh Colony, Sony Entertainment Television India Ltd, Multi Screen Media pvt ltd, Reliance Power Company, Janta Colony, Lourdes

Colony,Ayappa temple,Kali Mandir etc

Hospitals: Sanghavi Hospital, OMNIPOTENT Medical and Physiotherapy Centre, Endosys
International Hospital etc.

Urban Vegetation: The tree cover observed during the site visit showed the presence of dense tree cover near the Lokhandwala Lake and Reliance Power station, mainly consisting *Acacia sps.* Some of the trees observed during the visit are listed below:-

Sr.No	Common Name	Scientific Name
1	Asupalav (D)	*Polyalthia longifolia var. pendula (Sonn.) Thw.*
2	Naral	*Cocos nucifera L.*
3	Amba	*Mangifera indica L.*
4	Pimpal	*Ficus religiosa L.*
5	Deshi badam	*Terminalia catappa L.*
6	Gulmohar	*Delonix regia (Hook) Rafin.*
7	Kala Umber	*Ficus hispida L.f.*
8	Jambhul	*Syzygium cuminii (L.) Skeels*
9	Rain tree	*Samania saman (Jacq.) Merrill*
10	Kaduneem	*Azadirachta indica (L.) A. Juss.*
11	Phanas	*Artocarpus heterophyllus Lamk.*
12	Bottle palm	*Roystonia regia (H.B.K) Cooke*
13	Karanj	*Pongamia pinnata (L.) Pierre*
14	Suru	*Casuarina equisetifolia J.R & G. Forst.*
15	Australian Babhul	*Acacia auriculiformis A. cunh ex Benth.*
16	Parijatak	*Nyctanthus arbor-tristis L.*
17	Ficus benjamina	*Ficus benjamina L.*
18	Lettuce Tree	*Pisonia alba Spanog.*
19	Samudraphol	*Barringtonia asiatica (L) Kurtz*
20	Fan Palm	*Livistonia chinensis*

44. Tree cover near Millat Nagar

45. Tree cover near Reliance PowerStation

The buffer area also consists of **Lokhandwala Lake** near the Reliance Power Station.During the site visit and survey the lake was found to be highly eutrophicated due to continuous anthropogenic activities and interferences. The major source of anthropogenic acitivities found to be were Ganpati immersions and discharge of effluents in the water body.

The secondary data revealed that the lake has shown a decline in the avifauna once observed. Some of the Avifauna found near this lake are Spot billed duck, Spotted sandpiper, Green Sandpiper, Cattle Egret, Little Egret, Pond Heron, Little Cormorant, Little Grebe, Black Kite,Brahminy Kite, White-throated Kingfisher, Common Kingfisher, Alexandrine Parakeet, Red-Vented Bulbul, Red Whiskered Bulbul, Purple rumped sunbird etc.

46 Eutrophication at Lokhandwala lake

47Solid Waste Dumping at the Lake

48 Collection of Sample from the Lake

The buffer area during the site visit showed the presence of dense mangrove patches near Versova, Lokhandwala and Mindspace. The ecology of the Mangroves have is separately discussed in the Mangrove Ecosystem chapter.

Trees like, **Samanea saman** (Jacq.)Merill, **Alstonia scholaris** (Linn.)R.Br., **Azadirachta indica** Juss., **Cassia fistula** Linn., **Anthocephalus chinensis** A.Rich. ex Walp., etc. can be seen widely as avenue trees on roadside plantation. The photograph of some of the roadside trees planted on roads is given underneath.

LIST OF FLORA PRESENT IN STUDY AREA

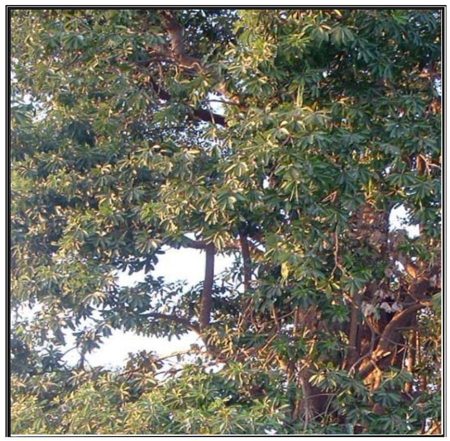


Photo No. 10: Alstonia scholaris (Linn.)R. Br.

It is a tall evergreen tree used chiefly as avenues, Leaves smooth, shining and narrow. Scented greenish white flowers appear between Nov-March. It is commonly called as Satvin. The specific name scholaris is derived from the fact that in earlier days, the wood was used for making school slates.

Photo No. 11: Lagerstroemia speciosa (L.) Pers.

A large, deciduous tree with globular crown, Leaves from elliptic to lanceolate. Flowers in April to June. It is the Tree of Maharashtra, commonly known as Pride of India, the tree is known for its large mauve coloured attractive flowers.

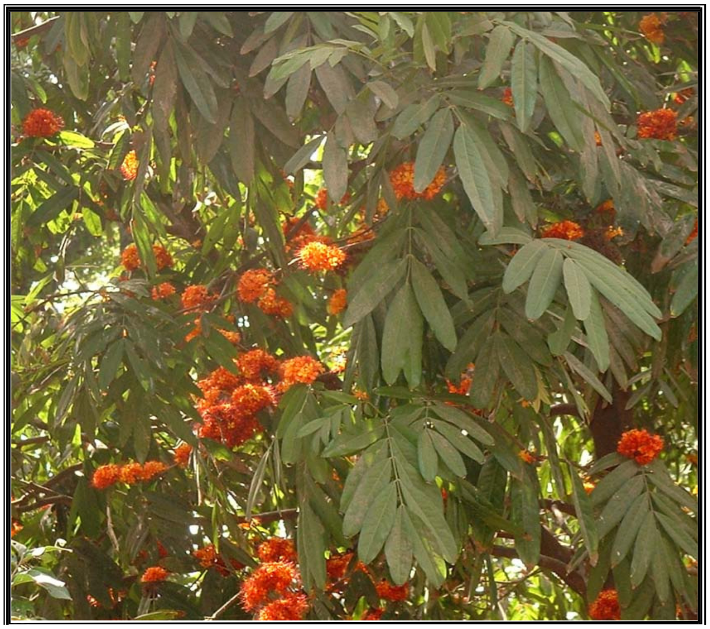


Photo No. 12: Saraca ashoka (Roxb.)de. Willde Linn.)Pers

A handsome medium-sized, spreading, evergreen tree. Flowers in March to May with dense orange-red corymbose clusters. It is one of the most sacred, medicinal and ornamental trees of India. Hindus regard it as sacred, being dedicated to Kama Dev, the God of Love.

Table No. 2.6: List of Avenue trees planted in the study area

Sr. No.	Botanical Name	Family	Local Name
1	Acacia auriculiformis A. cunh ex Benth.	Mimosaceae	Australian Acacia
2	Ailanthus excelsa Roxb.	Simarubaceae	Ghod-limb
3	Alstonia scholaris (Linn.)R.Br.	Apocynaceae	Satvin
4	Artocarpus heterophyllus Lamk.	Moraceae	Phanas
5	Artocarpus incisa Linn.	Moraceae	Kapa phanas
6	Artocarpus lakoocha Roxb.	Moraceae	Lowi
7	Azadirachta indica Juss.	Meliaceae	Neem
8	Barringtonia asiatica (Linn.)Kurz.	Lecythidaceae	-
9	Barringtonia racemosa (Linn.)Roxb.	Lecythidaceae	Samastravadi
10	Bauhinia malabarica Roxb.	Caesalpiniaceae	Koral
11	Bauhinia purpurea Linn.	Caesalpiniaceae	Dev-kanchan
12	Bauhinia racemosa Lamk.	Caesalpiniaceae	Apta

13	Bauhinia variegata Linn.	Caesalpiniaceae	-
14	Bixa orellana Linn.	Bixaceae	Shendri
15	Bombax ceiba Linn.	Bombacaceae	Silk Cotton Tree
16	Callistemon citrinus (curtis) Skeels.	Myrtaceae	Australian Bottle Brush
17	Calophyllum inophyllum Linn.	Clusiaceae	Ponna
18	Cassia fistula Linn.	Caesalpiniaceae	Bahava
19	Cassia grandis Linn.	Caesalpiniaceae	Pink shower
20	Cassia javanica Linn.	Caesalpiniaceae	-
21	Cassia renigera Wall. ex Benth	Caesalpiniaceae	Kassod
22	Cassia siamea Lamk.	Caesalpiniaceae	-
23	Casuarina equisetifolia Forst.	Casuarinaceae	-
24	Cordia sebastana Linn.	Ehretiaceae	Geiger Tree
25	Couroupita guianensis Aubl.	Lecythidaceae	Cannon -ball Tree
26	Crataeva tapia Linn.	Capparaceae	Vaivarna
27	Delonix regia (Boj. Ex. Hook.)	Caesalpiniaceae	Gul-mohur
28	Ficus benjamina	Moraceae	-
29	Ficus elastica Roxb.	Moraceae	Rubber Plant
30	Filicium decipiens (Wight & Arn.)Thwait	Sapindceae	-
31	Gliricidia sepium (Jacq.) Kunth,ex	Fabaceae	Undarmar
32	Hibiscus tiliaceus Linn.	Malvaceae	Pariti
33	Ixora brachiata Roxb.	Rubiaceae	-
34	Jacaranda acutifolia Humb.& Bonpl	Bignoniaceae	-
35	Lagerstroemia speciosa (Linn.)Pers.	Lythraceae	Taman
36	Lagerstroemia thoreli Gagnepin	Lythraceae	-
37	Michelia alba Dc.	Magnoliaceae	-
38	Michelia champaca Linn.	Magnoliaceae	Son Champa
39	Morinda citrifolia Linn.	Rubiaceae	Indian Mulberry
40	Morinda pubescens Sm.	Rubiaceae	-
41	Pisonia alba	Nyctaginaceae	The Lettuce Tree
42	Plumeria alba Linn.	Apocynaceae	-
43	Plumeria rubra Linn.	Apocynaceae	Deo-chapha
44	Polyalthia longifolia (sonnerat) Thwaites	Anonaceae	Mast tree
45	Polyalthia longifolia (sonnerat) Thwaites var. pendula	Anonaceae	-
46	Ravenala madagascarensis	Musaceae	Travellers Palm

47	Samanea saman (Jacq.)Merill.	Mimosaceae	Rain Tree
48	Spathodea campanulata Beauv.	Bignoniaceae	Jhumbar
49	Tabebuia argentea (Bur & Schum.)Britt.	Bignoniaceae	-
50	Tabebuia pallida (Lindl.)Miers.	Bignoniaceae	-
51	Tabebuia rosea (Bertol)Dc	Bignoniaceae	Rosy Trumpet Tree
52	Tecoma stans (Linn.)	Bignoniaceae	-
53	Terminalia catapa Linn.	Combrataceae	Deshi-Badam
54	Thespesia populnea (linn.)	Malvaceae	Paras Bhendi
55	Thevetia peruviana (Pers.)K.Schum	Apocynaceae	Pivla Kanher

Trees that are commonly seen cultivated for fruits and other economic purposes are the following:

Table No. 2.7: List of Cultivated Trees found within the project site

Sr. No.	Botanical Name	Local Name	Family
1	Achrus sapota L.	Chickoo	Sapotaceae
2	Annona reticulata Linn.	Ramphal	Annonaceae
3	Annona squamosa Linn.	Sitaphal	Annonaceae
4	Carica papaya Linn.	Papaya	Caricaceae
5	Cocos nucifera Linn	Coconut	Palmae
6	Mangifera indica Linn.	Amba	Anacardiaceae
7	Punica granatum Linn.	Pomegranate	Punicaceae

Also there are many shrubs that are grown for enhancing beauty of gardens and public places. They also serve as hedges to road side and private premises. A list of shrubs grown as horticultural plants in the project area is given below:

Table No. 2.9: List of Horticultural Shrubs reorded from

Sr. No.	Botanical Name	Family
1	Acalypha hispida Burm. f.	Euphorbiaceae
2	Agave americana L.	Agavaceae
3	Agave angustifolia Haw.	Agavaceae
4	Allamanda cathartica Linn.	Apocynaceae
5	Allamanda cathartica Linn. var. hendersonii Bailey	Apocynaceae
6	Allamanda cathartica var. padmachari Almeida	Apocynaceae
7	Allamanda neriifolia Hook.	Apocynaceae
8	Allamanda violacea Gaerdn. & Field.	Apocynaceae

9	Angelonia biflora Benth.	Scrophularaiaceae
10	Anthurium andraeanum Linden	Araceae
11	Antigonon leptopus Hook.	Polygonaceae
12	Ardisia solanacea Roxb.	Amyrsinaceae
13	Artabotrys hexapetalus (Linn. f.) Bhandari	Annonaceae
14	Asclepias curassavica Linn.	Asclepidaceae
15	Barleria strigosa Willd.	Acanthaceae
16	Bauhinia acuminata Linn.	Caesalpiniaceae
17	Bauhinia galpinni Brown	Caesalpiniaceae
18	Bauhinia tomemtosa Linn.	Caesalpiniaceae
19	Beloperone oblongata Lindl.	Acanthaceae
20	Bougainvillaea glabra Choisy	Nyctaginaceae
21	Breynbia vitis-idaea (Burm. f.)	Euphorbiaceae
22	Breynia nivosa (Bull.)	Euphorbiaceae
23	Breynia retusa (Dennst.) Alston	Euphorbiaceae
24	Brunsfelsia americana Linn.	Solanaceae
25	Brunsfelsia calycina var. floribunda Raffill. ex Bailey	Solanaceae
26	Caesalpinia pulcherrima (Linn.) Sw.	Caesalpiniaceae
27	Caladium hortulanum	Araceae
28	Calliandra emarginata (Thumb. & Bonapl.ex Willd.) Benth	Mimosaceae
29	Calliandra haematocephala Hassk.	Mimosaceae
30	Calliandra inermis (L.) Druce.	Mimosaceae
31	Calliandra selloi (Spr.) Mc Bride	Mimosaceae
32	Campsis radicans (Linn.) Seem.	Bignoniaceae
33	Canna indica L.	Cannaceae
34	Cassia alata Linn.	Caesalpiniaceae
35	Cassia bicapsularis Linn.	Caesalpiniaceae
36	Cassia glauca Lamk.	Caesalpiniaceae
37	Cestrum aurantiacum Lindl.	Solanaceae
38	Cestrum diarnum Linn.	Solanaceae
39	Cestrum noctornum Linn.	Solanaceae
40	Cissus quadrangularis Linn.	Vitaceae
41	Cleome speciosa H. B. K.	Cleomaceae
42	Clerodendron chinense (Osbeck) Mabber.	Verbenaceae

43	Clerodendrum incisum var. microsiphon (Hook. f.) Baker	Verbenaceae
44	Clerodendrum indicum (L.) Kuntze.	Verbenaceae
45	Clerodendrum splendens G. Don	Verbenaceae
46	Codiaeum variegatum (Linn.) Blume	Euphorbiaceae
47	Combretum coccineum Lamk.	Combretaceae
48	Cordyline terminalis Kunth. Enum.	Liliaceae
49	Crossandra infundibuliformis (Linn.) Nees	Acanthaceae
50	Cuphea micropetala H. B. K.	Lythraceae
51	Datura fastuosa Linn.	Solanaceae
52	Dieffenbachia maculata (Lodd.) G. Don	Araceae
53	Dieffenbachia picta Schott.	Araceae
54	Dizygotheca elegantissima Vig. & Guill.	Araliaceae
55	Dracaena draco L.	Agavaceae
56	Dracaena fragrans (L.) Ker. Gawl.	Agavaceae
57	Dracaena sandreriana Sandre	Agavaceae
58	Duranta erecta Linn.	Verbenaceae
59	Epiphyllum oxypetalum Haworth	Cactaceae
60	Epiphyllum strictum (Lem.) Britton & Rose	Cactaceae
61	Epipremnum aureum Linden ex Andre.	Araceae
62	Eranthemum nigrum Linden	Acanthaceae
63	Eranthemum pulchellum Anders.	Acanthaceae
64	Ervattamia divaricata (Linn.)	Apocynaceae
65	Ervattamia divaricata (L.) Burkill var. plena, (Voight) Almeida	Apocynaceae
66	Euphorbia cyathophora Murr.	Euphorbiaceae
67	Euphorbia pulcherrima, Willd. Ex Klotzch	Euphorbiaceae
68	Euphorbia tirucalli Linn.	Euphorbiaceae
69	Excoecaria cochinchinensis Lour.	Euphorbiaceae
70	Fittonia argyroneura Coem.	Acanthaceae
71	Fittonia vershaffeltti Lemaire van Houte	Acanthaceae
72	Fortunella japonica (Thunb.) Swingle.	Rutaceae
73	Galphimia gracilis Bartling	Malphigiaceae
74	Gardenia jasminoides Ellis.	Rubiaceae
75	Gardenia jasminoides var. plana (Voight) Almeida	Rubiaceae
76	Graphtophyllum pictum (Linn.) Griff.	Acanthaceae

77	Hamelia patens Jacq.	Rubiaceae
78	Hedychium coronarium Koen.	Zingiberaceae
79	Hibiscus rosa-sinensis Linn.	Malvaceae
80	Hibiscus schizopetalus (Masters) Hook. f.	Malvaceae
81	Holmskioldea sanguinea Retz.	Verbenaceae
82	Homalocladium platycladum (Muell.) Bailey	Polygonaceae
83	Ixora chinensis Lamk.	Rubiaceae
84	Ixora lutea Hutchins.	Rubiaceae
85	Jacobenia carnea (Lindl.) G. Nicolson	Acanthaceae
86	Jasminum auriculatum Vahl.	Oleaceae
87	Jasminum grandiflorum Linn.	Oleaceae
88	Jasminum humile Linn.	Oleaceae
89	Jasminum officinale, Linn.	Oleaceae
90	Jasminum sambac (Linn.) Alt.	Oleaceae
91	Jatropha podagrica Hook.	Euphorbiaceae
92	Kopsia fruticosa A. DC.	Apocynaceae
93	Lantana camara Linn.	Verbenaceae
94	Lantana montevidensis (Spr.) Briq.	Verbenaceae
95	Leea coccinia Planch.	Leeaceae
96	Magnolia pumila Andrews.	Magnoliaceae
97	Malphigia coccigera Linn.	Malphigiaceae
98	Malphigia glabra Linn.	Malphigiaceae
99	Malvaviscus arboreus Dillon ex Cav. var. penduliflorus (DC.) Shery	Malvaceae
100	Manihot esculenta Pohl var. variegata Almeida	Euphorbiaceae
101	Maranta bicolor Ker.	Marantaceae
102	Maranta leuconeura E. Morr. Bely.	Marantaceae
103	Melastoma malabathricum Linn.	Melastomaceae
104	Mussanda aegyptiaca Poir.	Rubiaceae
105	Mussanda erythrophylla Schum. & Thorn.	Rubiaceae
106	Mussanda frondosa Linn.	Rubiaceae
107	Mussanda philippica A. Rich.	Rubiaceae
108	Nerium oleander Linn.	Apocynaceae
109	Ochna kirkii Oliver	Ochnaceae
110	Pachystachys coccinea (Aubl.) Nees	Acanthaceae
111	Pachystachys lutea Nees	Acanthaceae

112	Pandanus sanderi Mast.	Pandanaceae
113	Pedilanthes tithymeloides (Linn.) Poit.	Euphorbiaceae
114	Pentas lanceolata (Forsk.) Deflers	Rubiaceae
115	Petrea volubilis Linn.	Verbenaceae
116	Philodendron erubescens Schott.	Araceae
117	Philodendron laciniatum Engl.	Araceae
118	Pleomele reflexa (Lemk.) N. E. Brown	Araceae
119	Plumbago auriculata Lamk.	Plumbaginaceae
120	Plumbago indica Linn.	Plumbaginaceae
121	Polyscias balfouriana Bailey	Araliaceae
122	Polyscias filicifolia Bailey	Araliaceae
123	Polyscias fruticosa (L.) Harms.	Araliaceae
124	Polyscias guillfoylei (Cogn. & March.) Bailey	Araliaceae
125	Polyscias scutellaria (Burm. f.) Fosberg.	Araliaceae
126	Potulacaria afra Jacq.	Portulacaceae
127	Pseudoeranthemum atropurpureum Radlk.	Acanthaceae
128	Pseudoeranthemum bicolor (Sims.) Radlk.	Acanthaceae
129	Pseudoeranthemum reticulatum (Hort.) Radlk. f.	Acanthaceae
130	Quassia amara Linn.	Simarubaceae
131	Quisqualis indica Linn.	Combretaceae
132	Ravenia spectabilis Engler	Rutaceae
133	Rondeletia odorata Jacq.	Rubiaceae
134	Rosa damascena Mill.	Rosaceae
135	Russelia coccinea (Linn.) Wettest	Scrophularaiaceae
136	Russelia equisetiformis Schlecht & Cham.	Scrophularaiaceae
137	Salvia leucantha Cav.	Labiatae
138	Sanchezia nobilis Hook. f., ex Planch.	Acanthaceae
139	Schefflera venulosa (Wight & Arn.) Harms.	Araliaceae
140	Setcreasea purpurea Boom	Commelinaceae
141	Spathiphyllum clevalandii Schott.	Araceae
142	Stachytarpheta jamaicensis (Linn.) Vahl.	Verbenaceae
143	Stachytarpheta mutabilis (Jacq.) Vahl.	Verbenaceae
144	Talinum portulacifolium (Forsk.) Asch. ex Sweni.	Portulacaceae
145	Tecoma stans (L.) Juss.	Bignoniaceae

146	Tecomaria capensis (Thunb.) Spach.	Bignoniaceae
147	Thunbergia erecta (Benth.) T. Anders.	Acanthaceae
148	Thunbergia fragrans Roxb.	Acanthaceae
149	Tithonia rotundifolia (Mill.) Blake	Asteraceae
150	Vernonia elaeagnifolia DC.	Asteraceae

Cultivated shrubs have a variety of uses. They are mainly used as commercial crop. The tender pods of **Cajanus cajan** (Linn.) Mill sp. is used as vegetable. **Gossypium hirsutum** Linn.commnly known as cotton is grown for its cotton fibre. Lists of shrubs that are cultivated in the study area are given in the following table:

Table No. 2.10: List of Cultivated shrubs seen in the study area.

Sr. No.	Botanical Name	Family
1	Abelmoschus esculentus (L.) Moench.	Malvaceae
2	Cajanus cajan (Linn.) Millsp.	Fabaceae
3	Citrus limon (Linn.) Burm. f.	Rutaceae
4	Colocasia esculenta (L.) Schott.	Araceae
5	Cyamopsis tetragonoloba (Linn.) Taub.	Fabaceae
6	Fragaria vesca Linn.	Rosaceae
7	Gossypium hirsutum Linn.	Malvaceae
8	Gossypium hirsutum var. religiosa Watt.	Malvaceae
9	Hibiscus sabdariffa Linn.	Malvaceae
10	Lycopersicon lycopersicum (Linn.) Farwell var. cerasiforme (A. Gray)	Solanaceae
11	Manihot esculenta Cranz.	Euphorbiaceae

To add the aesthetics of gardens and public parks, there are lots of climbers are also planted. They are plants that readily grow up on support or over other plants. They have special structures like tendrils hook-like thorns to climb on supports. The climbers that are seen growing in the study area are listed in the table below:

Table No. 2.12: List of Climbers grown for Horticultural purpos

Sr. No.	Botanical Name	Family
1	Aparagus plumosus Baken.	Liliaceae
2	Asparagus setaceus (Kunth.) Jassop.	Liliaceae
3	Beaumotia grandiflora Wall.	Apocynaceae
4	Bignonia capreolata Linn.	Bignoniaceae
5	Bougainvillaea spectabilis Willd.	Nyctaginaceae
6	Caesalpinia gilliesii (Wall. ex Hook.) Dietr.	Caesalpiniaceae
7	Campsis grandiflora (Thunb.) Schum	Bignoniaceae
8	Clematis flammula Linn.	Ranunculaceae
9	Clematis gouriana Roxb.	Ranunculaceae
10	Clerodendrum thomsonae Balf.	Verbenaceae
11	Clitoria ternatea Linn.	Fabaceae
12	Cryptostegia grandiflora R. Br.	Periplocaceae
13	Epipremnum pinnatum (L.) Engler	Araceae
14	Ficus pumila Linn.	Moraceae
15	Gomphocarpus physocarpus E. Mey.	Asclepidaceae
16	Hedera helix Linn.	Araliaceae
17	Hoya carnosa (Linn. f.) R. Br.	Asclepidaceae
18	Ipomoea quamoclit Linn.	Convolvulaceae
19	Jaquemontia paniculata (Burm. f.) Hallier f.	Convolvulaceae
20	Jaquemontia pentantha (Jacq.) G. Don	Convolvulaceae
21	Jasminum angustifolium (Linn.) Vahl.	Oleaceae
22	Jasminum flexile Vahl.	Oleaceae
23	Lonicera japonica Thunb.	Caprifoliaceae
24	Lonicera sempervirens Linn.	Caprifoliaceae
25	Monstera deliciosa Liebm.	Araceae
26	Monstera obliqua Miq.	Araceae
27	Passiflora caerulea Linn.	Passifloraceae
28	Philodendron lacerum Schott.	Araceae
29	Pyrostegia venusta (Ker.-Gawl.) Presl.	Bignoniaceae
30	Scindapsus aurens Engl.	Araceae
31	Senecio confusa Britten	Asteraceae
32	Solanum jasminoides Paxt.	Solanaceae
33	Solanum seaforthianum Andrews	Solanaceae
34	Stephanotis floribunda (R. Br.) Brogn.	Asclepidaceae
35	Thunbergia alata Hook.	Acanthaceae
36	Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.	Acanthaceae
37	Thunbergia laurifolia Lindl.	Acanthaceae
38	Thunbergia mysorensis (Wight) T . Anders	Acanthaceae
39	Tropaeolum majus Linn.	Tropaeolaceae
40	Vallaris solanaceae (Roth.) O. Kuntze	Apocynaceae
41	Wollastonia biflora DC.	Asteraceae

Fruits of **Coccinea grandis** (Linn.) Voight and **Momordica charantia** Linn.are edible and Therefore cultivated for economical purpose. Majority of the vegetable yielding plants are climbers.

Table No. 2.13: List of Cultivated Climbers seen in the study area.

Sr. No.	Botanical Name	Family
1	Citrullus lanatus (Thunb.) Matsu.	Cucurbitaceae
2	Coccinea grandis (Linn.) Voight.	Cucurbitaceae
3	Cucumis callosus (Rottl.) Cogn.	Cucurbitaceae
4	Cucumis melo Linn.	Cucurbitaceae
5	Cucumis sativus Linn.	Cucurbitaceae
6	Lagenaria siceraria (Molina) Standl.	Cucurbitaceae
7	Luffa acutangula (Linn.) Roxb. var. amara (Roxb.) Clarke	Cucurbitaceae
8	Momordica charantia Linn.	Cucurbitaceae
9	Momordica dioica Roxb. ex Willd.	Cucurbitaceae
10	Piper betle Linn.	Piperacaea
11	Piper longum Linn.	Piperacaea
12	Piper nigram Linn.	Piperacaea

Herbs are plants whose stem does not produce woody, persistent tissue and generally dies back at the end of each growing season. Herbs complete their life cycle in a year and they flower in rainy season. Lists of such herbs that are seen during the site visit are listed in the following table:

Table No. 2.14: List of Wild Herbs in the study area.

Sr. No.	Botanical Name	Family
1	Abelmoschus manihot (Linn.) Medicus	Malvaceae
2	Abelmoschus manihot ssp. tetraphyllus (Roxb. ex Hornem.) Borssum	Malvaceae
3	Acalypha indica Linn.	Euphorbiaceae
4	Acalypha lanceolata Willd.	Euphorbiaceae
5	Acampe praemorsa, (Roxb.) Blatt. & McC.	Orchidaceae
6	Acanthospermum hispidum DC.	Asteraceae
7	Achyranthes aspera Linn.	Amaranthaceae
8	Achyranthes porphyrostachya Wall. ex Moq.	Amaranthaceae
9	Adenostemma lavenia (Linn.) Kuntze	Asteraceae
10	Aegentia indica Linn.	Orobranchaceae
11	Aerva lanata (Linn.) Juss.	Amaranthaceae
12	Aerva sanguinolenta (Linn.) Blume	Amaranthaceae
13	Aeschynomene indica Linn.	Fabaceae
14	Ageratum conyzoides Linn.	Asteraceae
15	Alternanthera pulchella Kunth.	Amaranthaceae
16	Alternanthera sessilis (Linn.) R. Br.	Amaranthaceae
17	Alysicarpus buplerifolius (Linn.) DC.	Fabaceae
18	Alysicarpus glumaceus (Vahl.) DC.	Fabaceae
19	Alysicarpus hamosus Edgeworth	Fabaceae
20	Alysicarpus longifolius (Rottl. ex Spr.)	Fabaceae
21	Alysicarpus narimanii Almeida &	Fabaceae
22	Alysicarpus vaginalis (Linn.) DC.	Fabaceae
23	Alysicarpus vaginalis var. nummularifolius (DC.) Baker	Fabaceae
24	Amaranthus spinosus Linn.	Amaranthaceae
25	Ammania baccifera Linn.	Lythraceae
26	Ammania multiflora Roxb.	Lythraceae

27	Anagallis minima (L.) Krause	Amyrsinaceae
28	Anisomeles heyneana Benth.	Labiatae
29	Argemone mexicana Linn.	Papaveraceae
30	Asystasia nemorum Nees	Acanthaceae
31	Baccharoides scabridum (DC.) Almeida	Asteraceae
32	Bacopa monnieri (L.) Wettst.	Scrophularaiaceae
33	Bergia ammanioides Heyne ex Roth. W	Elatinaceae
34	Bidens biternata (Lour.) Merrill & Sheriff.	Asteraceae
35	Biophytum sensitivum (Linn.) DC.	Oxalidaceae
36	Blumbea paniculata (Willd.) Almeida	Asteraceae
37	Blumea belangeriana DC.	Asteraceae
38	Blumea eriantha DC.	Asteraceae
39	Blumea oxyodonta DC.	Asteraceae
40	Blumea solidaginoides (Poir.) DC.	Asteraceae
41	Boerhavia repens Linn.	Nyctaginaceae
42	Borreria articularis (Linn.) Will.	Rubiaceae
43	Borreria pusilla (Wall.) DC.	Rubiaceae
44	Bremekampia tentaculatus (L.) Sree. var. plumose (Clarke) Amleida	Acanthaceae
45	Buchnera hispida Buch.-Ham.	Scrophularaiaceae
46	Burmania pusilla (Wall. ex Miers) Thw.	Burmanaciaceae
47	Caesulia axillaria Roxb. Pl. Cor.	Asteraceae
48	Cajanus platycarpus (Benth.) Vander Meusen	Fabaceae
49	Cannabis sativus Linn. ssp. indica (Lamk.) Small & Crong.	Cannabaceae
50	Canscora concanensis Clarke	Gentianaceae
51	Canscora diffusa (Vahl.) R. Br.	Gentianaceae
52	Cassia kolabensis Kothari	Caesalpiniaceae
53	Cassia mimosoides Linn.	Caesalpiniaceae

54	Cassia pumila Lamk.	Caesalpiniaceae
55	Cassia tora Linn.	Caesalpiniaceae
56	Cassytha filiformis Linn.	Cassythaceae
57	Centella asiatica (Linn.) Urban	Apiaceae
58	Centranthera indica (Linn.) Gamble	Scrophularaiaceae
59	Centurium centauroides (Roxb.) Rao & Hemadri	Gentianaceae
60	Ceropegia attenuata Hook.	Asclepidaceae
61	Chlorophytum tuberosam (Roxb.) Baker.	Liliaceae
62	Chrozophora prostrata Dalzell	Euphorbiaceae
63	Cleome chelidonii Linn. f.	Cleomaceae
64	Cleome gynandra Linn.	Cleomaceae
65	Cleome rutidosperma DC.	Cleomaceae
66	Cleome viscosa Linn.	Cleomaceae
67	Clitoria annua Graham	Fabaceae
68	Coldenia procumbens Linn.	Boraginaceae
69	Corchorus fascicularis Lamk.	Tiliaceae
70	Corchorus aestuans Linn.	Tiliaceae
71	Corchorus capsularis Linn.	Tiliaceae
72	Corchorus olitorius Linn.	Tiliaceae
73	Costus speciosus (Koen.) J. E. Sm.	Zingiberaceae
74	Crinum asiaticum L.	Amaryllidaceae
75	Crinum latifolium L.	Amaryllidaceae
76	Crotalaria burhia Buch. Ham. ex Benth.	Fabaceae
77	Crotalaria filipes Benth.	Fabaceae

78	Crotalaria juncea Linn.	Fabaceae
79	Crotalaria linifolia Linn. f.	Fabaceae
80	Crotalaria montana Heyne ex Roth	Fabaceae
81	Crotalaria prostrata Rottl.	Fabaceae
82	Crotalaria stocksii Benth. ex Baker	Fabaceae
83	Crotalaria trifoliastrum Willd.	Fabaceae
84	Crotalaria triquetra Dalz.	Fabaceae
85	Curculigo orchioides Gaertn. Fruct.	Hypoxidaceae
86	Curcuma inodora Blatt.	Zingiberaceae
87	Cuscuta australis R. Br.	Cuscutaceae
88	Cuscuta reflexa Roxb.	Cuscutaceae
89	Cyathocline purpurea (Don) Kuntze	Asteraceae
90	Cyathula prostrata (Linn.) Blume	Amaranthaceae
91	Cynarospermum asperrimum (Nees) K. Vollesen	Acanthaceae
92	Dendrophthoe falcata (Linn. f.) Etting	Loranthaceae
93	Dentella repens (Linn.) J. R. & G. Forst.	Rubiaceae
94	Desmodium dichotomum (Klein ex Willd.) DC.	Fabaceae
95	Desmodium scorpiurus (Sw.) Desv.	Fabaceae
96	Desmodium triflorum (Linn.) DC.	Fabaceae
97	Dicliptera foetida (Forsk.)	Acanthaceae
98	Dipteracanthus prostratus (Poir.) Nees	Acanthaceae
99	Drosera indica Linn.	Droseraceae
100	Eclipta prostrata (Linn.) Linn.	Asteraceae
101	Elephantopus scaber Linn.	Asteraceae
102	Emilia sonchifolia (Linn.) DC.	Asteraceae
103	Ensete superbum (Roxb.) Cheesm.	Musaceae
104	Epaltes divaricata (Linn.) Cass.	Asteraceae
105	Eulophia herbacea Lindl.	Orchidaceae
106	Eulophia ochreata Lindl.	Orchidaceae
107	Euphorbia heterophylla Linn.	Euphorbiaceae
108	Euphorbia hirta Linn.	Euphorbiaceae
109	Euphorbia parviflora Linn.	Euphorbiaceae
110	Euphorbia serpens Benth.	Euphorbiaceae

111	Evolvulus alsinoides (Linn.) Linn.	Convolvulaceae
112	Evolvulus nummularius (Linn.) Linn.	Convolvulaceae
113	Exacum carinatum Roxb.	Gentianaceae
114	Exacum pumilum Griseb.	Gentianaceae
115	Geissaspis cristata Wight & Arn.	Fabaceae
116	Glinus lotoides Linn. ssp. hirta (Thumb.) Almeida	Mulluginaceae
117	Glinus oppositifolia (Linn.) DC.	Mulluginaceae
118	Gloriosa superba L.	Liliaceae
119	Gnaphalium polycaulon Pers.	Asteraceae
120	Gomphrena celosioides Mart.	Amaranthaceae
121	Grangea maderaspatana (Linn.) Poir.	Asteraceae
122	Guizotia abyssinica (Linn.) Cass.	Asteraceae
123	Hebenaria commelinifolia (Roxb.) Wall. ex Lindl.	Orchidaceae
124	Hebenaria grandiflora Blatt. & McC.	Orchidaceae
125	Hebenaria marginata Coleb.	Orchidaceae
126	Heliotropium indicum Linn.	Boraginaceae
127	Heliotropium marifolium Retz.	Boraginaceae
128	Heliotropium ovalifolium Forsk.	Boraginaceae
129	Heliotropium supinum Linn.	Boraginaceae
130	Hemigraphis latebrosa (Hoyne ex Roth) Nees	Acanthaceae
131	Heracleum grande (Dalz. & Gibs.) Mukhopadhay	Apiaceae
132	Hewittia malabarica (Linn.) Suresh	Convolvulaceae
133	Hibiscus panduraeformis Burm. f.	Malvaceae
134	Hoppea dichotoma Willd.	Gentianaceae
135	Hybanthus enneasperma (L.) Muell.	Violaceae
136	Hydrilla verticillata (L. f.) Royle	Hydrocharitaceae
137	Hydrolea zeylanica (L.) Vahl.	Hydrophyllaceae
138	Hygrophila anomala (Blatter) Almeida	Acanthaceae
139	Hygrophila erecta (Burm. f.) Hochr.	Acanthaceae
140	Hygrophila schulli (Buch.-Ham.)	Acanthaceae
141	Hygrophila serpyllum (Nees) T. Anders.	Acanthaceae
142	Hypoxis aurea Lour.	Hypoxidaceae

143	Impatiens balsamina Linn.	Balasaminaceae
144	Impatiens minor (DC.) Bennett	Balasaminaceae
145	Indigofera glandulosa Wendl.	Fabaceae
146	Indigofera linifolia (Linn. f.) Retz.	Fabaceae
147	Ipomoea aquatica Forsk.	Convolvulaceae
148	Kosteletzkia vitifolia (Linn.) Almeida & Patil	Malvaceae
149	Lablab purpureus (Linn.) Sweet	Fabaceae
150	Lagarosiphon alternifolia (Roxb.) Druce	Hydrocharitaceae
151	Lagascea mollis Cav.	Asteraceae
152	Laportea interrupta (Linn.) Chev.	Urticaceae
153	Launaea fallax (Jaub. & Spach.) O. Kuntze	Asteraceae
154	Leea macrophylla Roxb.	Leeaceae
155	Lepidagathis trinervia Wall.	Acanthaceae
156	Limnophila dubia (Linn.) Almeida	Scrophularaiaceae
157	Limnophila sessiliflora (Vahl.) Blume	Scrophularaiaceae
158	Linbuum usitatissimum Linn.	Linaceae
159	Lindenbergia muraria (Roxb. ex D. Don) Bruehl	Scrophularaiaceae
160	Lindernia anagallis (Burm. f.) Pennel	Scrophularaiaceae
161	Lindernia ciliata (Colsm.) Pennel	Scrophularaiaceae
162	Lindernia crustacea (Linn.) Mueller	Scrophularaiaceae
163	Lindernia oppositifolia (Retz.) Mukherjee	Scrophularaiaceae
164	Lindernia parviflora (Roxb.) Haines	Scrophularaiaceae
165	Linum mysorensis Heyne ex Benth.	Linaceae
166	Lobelia chinensis Lour.	Lobeliaceae
167	Ludwigia perennis Linn.	Ongaraceae
168	Macrosolen capitellatus (Wight & Arn.) Danser	Loranthaceae
169	Macrotyloma uniflorum (Lamk.) Verdcourt	Fabaceae
170	Malachra capitata Linn.	Malvaceae
171	Martinia annua Linn.	Martyniaceae
172	Melochia corchorifolia Linn.	Sterculiaceae
173	Mimosa pudica Linn.	Mimosaceae

174	Mitreola petiolata (Gmel.) Torr.& A. Gray	Loganiaceae
175	Mollugo pentaphylla Linn.	Mulluginaceae
176	Neanotis paniculata (L.) Ameida	Rubiaceae
177	Neanotis tenuiflora (Sm. ex Rees) Almeida	Rubiaceae
178	Nervilia aragoana Gaud.	Orchidaceae
179	Neuracanthus sphaerostachys (Nees) Dalz.	Acanthaceae
180	Nothosaerua brachiata (Linn.) Wight	Amaranthaceae
181	Nymphoides indica (Linn.) O. Kuntze	Menyanthaceae
182	Ocimum americanum Sensu.	Labiatae
183	Oldenlandia corymbosa Linn.	Rubiaceae
184	Orthosiphon thymiflorus (Roth.) Van der Steenser	Labiatae
185	Osbeckia truncata D. Don. ex Wight & Arn.	Melastomaceae
186	Ottelia alismoides (L.) Pers. Syn.	Hydrocharitaceae
187	Oxalis corniculata Linn.	Oxalidaceae
188	Oxalis dehradunensis M. B. Raizada	Oxalidaceae
189	Papaver somniferum Linn.	Papaveraceae
190	Parthenium hysterophorus Linn.	Asteraceae
191	Pentanema indicum (Linn.) Ling.	Asteraceae
192	Peperomia pellucida (Linn.) Kunth	Piperacaea
193	Persicaria barbata (Linn.) Hara	Polygonaceae
194	Persicaria glabra (Willd.) Gomez	Polygonaceae
195	Phyla nodiflora (Linn.) Greene	Verbenaceae
196	Phyllanthus erecta (Medic.) Almeida	Euphorbiaceae
197	Phyllanthus urinaria Linn.	Euphorbiaceae
198	Phyllanthus virgatus Forst. f.	Euphorbiaceae
199	Physalis minima Linn.	Solanaceae
200	Pimpinella adscendens Dalz.	Apiaceae
201	Plumbago zeylanica Linn.	Plumbaginaceae
202	Pogostemon frutescens Graham	Labiatae
203	Pogostemon purpurascens Dalz.	Labiatae
204	Polycarpon prostratum (Forsk.) Asch. Sweinf.	Caryophyllaceae

205	Polygala chinensis Linn.	Polygalaceae
206	Polygonum plebeium R. Br.	Polygonaceae
207	Portulaca oleracea Linn.	Portulacaceae
208	Pouzolzia zeylanica (Linn.) Bennett & Brown	Urticaceae
209	Rhamphicarpa longiflora (Arn.) Benth.	Scrophularaiaceae
210	Rivina humilis Linn.	Phytolaccaceae
211	Rorippa indica (Linn.) Hiern.	Brassicaceae
212	Rostellularia japonica (Thumb.) Ellis	Acanthaceae
213	Rostellularia procumbens (Linn.) Nees	Acanthaceae
214	Rotala indica (Willd.) Koechne.	Lythraceae
215	Rotala occultiflora Koechne.	Lythraceae
216	Rumex dentatus Linn. Ssp. klotschianus (Meissn.) Rech.	Polygonaceae
217	Rumex nepalensis Spreng.	Polygonaceae
218	Rungia pectinata (Linn.) Nees	Acanthaceae
219	Salvia plebeia R. Br.	Labiatae
220	Scoparia dulcis Linn.	Scrophularaiaceae
221	Securinega leucopyros (Willd.) Muell.	Euphorbiaceae
222	Senecio bombayensis Balakrishnan	Asteraceae
223	Sesuvium portulacastrum (Linn.) Linn.	Aizoaceae
224	Sida cordata (Burm. f.) Borssum	Malvaceae
225	Sida rhombifolia Linn.	Malvaceae
226	Sida rhombifolia var.retusa (Linn.) Masters	Malvaceae
227	Smithia conferta Smith.	Fabaceae
228	Smithia salsuginea Hance.	Fabaceae
229	Smithia sensitiva Ait.	Fabaceae
230	Solanum mammosum Lour.	Solanaceae
231	Solanum nigram Linn.	Solanaceae
232	Solanum virginianum Linn.	Solanaceae
233	Sopubia delphinifolia (Linn.) G. Don.	Scrophularaiaceae
234	Sphaeranthus africanus Linn.	Asteraceae
235	Sphaeranthus indicus Linn.	Asteraceae
236	Sphenoclea zeylanica Gaertn.	Sphenocleaceae
237	Spilanthes clava DC. Wight	Asteraceae

238	Stemodia viscose Roxb.	Scrophularaiaceae
239	Striga asiatica (Linn.) O. Kuntze	Scrophularaiaceae
240	Striga gesneroides (Willd) Vatke var. minor Santapau	Scrophularaiaceae
241	Striga gesneroides (Willd.) Vatke	Scrophularaiaceae
242	Synedrella nodiflora (Linn.) Gaertn.	Asteraceae
243	Tacca leontopetaloides (L.) O. Ketz.	Taccaceae
244	Tephrosia purpurea (Linn.) Pers.	Fabaceae
245	Tolypanthes lagenifer (Wight) var Tiegh.	Loranthaceae
246	Tragia hispida Willd.	Euphorbiaceae
247	Trapa natans Linn. var. bispinosa, (Roxb.) Makino.	Trapaceae
248	Trianthema portulacastrum Linn.	Tetragoniaceae
249	Trichodesma indicum (L.) Lehm. var. amplexicaulis (Roth.)	Boraginaceae
250	Trichodesma indicum (Linn.) Lehm.	Boraginaceae
251	Tricholepis glaberrima DC.	Asteraceae
252	Tridax procumbens Linn.	Asteraceae
253	Triumfetta annua Linn.	Tiliaceae
254	Uraria rufescens (DC.) Schindl.	Fabaceae
255	Urena lobata Linn.	Malvaceae
256	Utricularia stellaris Linn. f.	Lentibulariaceae
257	Utricularia striuatula Smith.	Lentibulariaceae
258	Vahlia digyna (Retz.) O. Kuntze	Vahliaceae
259	Vanda testacea (Lindl.) Reichb. f.	Orchidaceae
260	Verbascum chinense (Linn.) Santapau	Scrophularaiaceae
261	Vernonia cinerea (Linn.) Less.	Asteraceae
262	Vigna dalzelliana (O. Kuntze) Verdcourt	Fabaceae
263	Vigna radiata (Linn.) Wilczeck.	Fabaceae
264	Vigna trilobata (Linn.) Verdcourt	Fabaceae
265	Viscum nepalense Burm. f.	Loranthaceae
266	Waltheria indica Linn.	Sterculiaceae
267	Zornia gibbosa Spanoghe	Fabaceae

There are a number of herbs that are specially grown in gardens and other public places to enhance beauty of the surrounding area.

Table No. 2.15: List of Horticultural Herbs recorded from the study area.

Sr. No.	Botanical Name	Family
1	Acalypha hispida Burm. f. var. sanderi (N. E. Br.) J. Sm.	Euphorbiaceae
2	Acalypha wilkesiana Muell.-Arg.	Euphorbiaceae
3	Adenium obesum (Forsk.) Roem. & Schultes	Apocynaceae
4	Ageratum houstonianum Mill.	Asteraceae
5	Aglaonema commutatum Schott.	Araceae
6	Alocacia lawii H. K.	Araceae
7	Alocasia macrorhiza (L.) G. Don.	Araceae
8	Althaea rosea (L.) Cav.	Malvaceae
9	Antirrhinum majus Linn.	Scrophularaiaceae
10	Artemisia capillaris Thunb.	Asteraceae
11	Asparagus densiflorus (Kunth.) Jassop.	Liliaceae
12	Asparagus officinalis L.	Liliaceae
13	Aster amellus Linn.	Asteraceae
14	Asystasia chelonoides Nees var. variabilis (Nees in DC) Almeida	Acanthaceae
15	Barleria cristata Linn.	Acanthaceae
16	Begonia rex Butz.	Begoniaceae
17	Begonia semperflorens Link. & Otto.	Begoniaceae
18	Bellis perennis Linn.	Asteraceae
19	Brunsfelsia undulata Sw.	Solanaceae
20	Caladium bicolor Vent.	Araceae
21	Calandula officinalis Linn.	Asteraceae
22	Calathea medio-picta Makoy ex Morr.	Marantaceae
23	Calathea zebrine Lindl.	Marantaceae
24	Canna orchioides Bailey	Cannaceae
25	Catharanthus roseus (Linn.) G. Don	Apocynaceae
26	Celosia argentea Linn.	Amaranthaceae
27	Celosia cristata Linn.	Amaranthaceae
28	Chlorophytum comosus (Thunb.) Jaques	Liliaceae
29	Chlorophytum laxum R. Br.	Liliaceae
30	Chrysanthemum sinense Sabin.	Asteraceae
31	Coleus scutellarioides (L.) Benth.	Labiatae

32	Cosmos artemisifolia (Jacq.) Almeida	Asteraceae
33	Cotyledon orbiculata Linn.	Crassulaceae
34	Crassula arborescens Willd.	Crassulaceae
35	Croton bonaplandianus Ball.	Euphorbiaceae
36	Cyperus flabelliformis Rottb.	Cyperaceae
37	Dahlia pinnata Cav.	Asteraceae
38	Dianella tasmaica Lamk.	Liliaceae
39	Dianthus caryophyllus Linn.	Caryophyllaceae
40	Dianthus chinensis Linn.	Caryophyllaceae
41	Dracaena surculosa Lindl.	Agavaceae
42	Duranta erecta var variegata Bailey	Verbenaceae
43	Echeveria agavoides Lem.	Crassulaceae
44	Echeveria elegans Rose	Crassulaceae
45	Echeveria gibbiflora DC.	Crassulaceae
46	Episcia chontalensis Hook.	Gesneriaceae
47	Episcia reptans Mart.	Gesneriaceae
48	Euphorbia marginata H. B. K.	Euphorbiaceae
49	Fittonia pearcei Woodrow	Acanthaceae
50	Furcraea foetida (L.) Haw.	Agavaceae
51	Gaillardia pulchella Fouger	Asteraceae
52	Gerbera jamesonii Bolus.	Asteraceae
53	Gomphrena globosa Linn.	Amaranthaceae
54	Haworthia fasciata Haw.	Liliaceae
55	Helianthus annus Linn.	Asteraceae
56	Helichrysum bracteatum (Vent.) Andr.	Asteraceae
57	Heliconia angustifolia Hook.	Heliconiaceae
58	Huernia kirkii Br.	Asclepidaceae
59	Hydrangia macrophylla (Thunb.) Seringe DC.	Saxifragaceae
60	Iberis amara Linn.	Brassicaceae
61	Impatiens sultanae Hook. f.	Balasaminaceae
62	Iresine herbstii Hook. f.	Amaranthaceae
63	Ixora chinensis Lamk. var. blumeana Kurz.	Rubiaceae
64	Kaempferia rotunda L.	Zingiberaceae
65	Kalanchoe blosfeldiana Poellnitz	Crassulaceae

66	Kalanchoe pinnata (Lamk.) Pers.	Crassulaceae
67	Lilium wallichianum Sch. f. var. neilgherrense (Wight) Hara	Liliaceae
68	Mirabilis jalapa Linn.	Nyctaginaceae
69	Neoregelia spectabilis (T. Moore) L. B. Smith	Amaryllidaceae
70	Ocimum basilicum Linn.	Labiatae
71	Ocimum basilicum Linn.var. thyrrsiflora Benth.	Labiatae
72	Ocimum gratissimum Linn.	Labiatae
73	Ocimum tenuiflorum Linn.	Labiatae
74	Oxalis rosea Jacq.	Oxalidaceae
75	Papaver rhoeas Linn.	Papaveraceae
76	Pedilanthes tithymeloides (L.) Poit. var. nanus Almeida	Euphorbiaceae
77	Pelargonium inquinans (Linn.) Ait.	Geraniaceae
78	Pelargonium lateripes L'Herit. Geran.	Geraniaceae
79	Pelargonium peltatum (Linn.) Ait.	Geraniaceae
80	Pellionia daveauana Brown	Urticaceae
81	Pellionia pulchra Brown	Urticaceae
82	Peperomia argyereia E. Morr.	Piperacaea
83	Peperomia bicolor Sodiro	Piperacaea
84	Peperomia fosteri Graf	Piperacaea
85	Peperomia peltifolia C. DC.	Piperacaea
86	Peperomia urocarpa Fish. & Mey.	Piperacaea
87	Peperomia velutina Linden & Andre.	Piperacaea
88	Petiveria alliacea Linn.	Phytolaccaceae
89	Petunia integrifolia (Lodd) Schinz & Thell.	Solanaceae
90	Petunia minima Linn.	Solanaceae
91	Phlox drumondii Hook.	Polemoniaceae
92	Pilea microphylla (Linn.) Liebm.	Urticaceae
93	Pilea pubescens Liebm.	Urticaceae
94	Portulaca pilosa Linn.	Portulacaceae
95	Portulaca pilosa Linn. ssp. grandiflora (Hook.) Gesink	Portulacaceae
96	Pseudoeranthemum alatum (Nees) Almeida	Acanthaceae

97	Rhoeo spathaceae (Swartz) Stearn	Commelinaceae
98	Saintpaulia ionantha Wendl.	Gesneriaceae
99	Salvia coccinea Buchoz. & Etlinger	Labiatae
100	Sansevieria cylindrica Hort.	Liliaceae
101	Sansevieria trifasciata Hort. ex. Prain.	Liliaceae
102	Sedum acre Linn.	Crassulaceae
103	Sedum sarmentosum Bunge	Crassulaceae
104	Solidago microglossa DC.	Asteraceae
105	Spilanthes oleracea Linn.	Asteraceae
106	Strelitzia reginae Banks	Sterlitziaceae
107	Syngonium podophyllum Schott.	Araceae
108	Syngonium wendlandii Schott.	Araceae
109	Tagetes erecta Linn.	Asteraceae
110	Tagetes patula Linn.	Asteraceae
111	Tagetes tenuifolia Cav.	Asteraceae
112	Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae
113	Torenia asiatica Linn.	Scrophularaiaceae
114	Verbena tenera Spr.	Verbenaceae
115	Viola tricolor Linn.	Violaceae
116	Yucca gloriosa L.	Agavaceae
117	Zebrina pendula Schnizl	Commelinaceae
118	Zinnia elegans Jacq.	Asteraceae

Presences of many cultivated herbs are also found in the study area. Palak, Methi, Lettuce, Math are some of the common herbs that are cultivated for economic purposes within the study area.

Table No. 2.16: List of Cultivated Herbs seen in study area.

Sr. No.	Botanical Name	Family
1	Amaranthus cruentus Linn.	Amaranthaceae
2	Amaranthus viridis Linn.	Amaranthaceae
3	Apium graveolens Linn.	Apiaceae
4	Coriandrum sativum Linn.	Apiaceae
5	Cuminum cyminum Linn.	Apiaceae
6	Daucus carota Linn.	Apiaceae

7	Foeniculum vulgare Muller	Apiaceae
8	Acorus calamus L.	Araceae
9	Amorphophallus bulbifer (Roxb.) Bl. Rumph.	Araceae
10	Amorphophallus commutatus (Schott) Engl.	Araceae
11	Basella alba Linn.	Basellaceae
12	Basella alba Linn.var. cordifolia (Lamk.) Almeida	Basellaceae
13	Beta vulgaris ssp. maritima (Linn.) Doel.	Basellaceae
14	Beta vulgaris, L. ssp. cicla (L.) Cock.	Basellaceae
15	Chenopodium album Linn.	Basellaceae
16	Spinacea oleracea Linn.	Basellaceae
17	Brassica juncea (Linn.) Czern. et. Cross	Brassicaceae
18	Brassica napus Linn.	Brassicaceae
19	Brassica nigra (L.) Koch.	Brassicaceae
20	Brassica oleracea Linn. var. botrytis Linn.	Brassicaceae
21	Brassica oleracea var. capitata Linn.	Brassicaceae
22	Brassica oleracea var. gongylodes Linn.	Brassicaceae
23	Brassica oleracea var. itaulica Plenck.	Brassicaceae
24	Brassica rapa Linn.	Brassicaceae
25	Brassica rapa L. ssp. campestris (Linn.) Clapham	Brassicaceae
26	Raphanus sativus Linn.	Brassicaceae
27	Ananas comosus (L.) Merr.	Bromeliaceae
28	Ipomoea batatas (Linn.) Lamk.	Convolvulaceae
29	Cucurbita maxima Duch. ex Lamk.	Cucurbitaceae
30	Arachis hypogea Linn.	Fabaceae
31	Cicer arietinum Linn.	Fabaceae
32	Lathyrus sativus Linn.	Fabaceae
33	Pisum sativum Linn.	Fabaceae
34	Trigonella foenum-graceum Linn.	Fabaceae
35	Vicia faba Linn.	Fabaceae
36	Mentha arvensis Linn.	Labiatae
37	Allium cepa L.	Liliaceae
38	Allium sativum L.	Liliaceae
39	Aloe vera (L.) Burm. f.	Liliaceae
40	Musa paradisiaca L.	Musaceae

41	Oryza sativa L.	Poaceae
42	Ruta graveolens Linn.	Rutaceae
43	Capsicum annum Linn.	Solanaceae
44	Capsicum annum Linn. var. acuminatum Fingerh.	Solanaceae
45	Capsicum annum Linn. var. grossum (Willd.) Sendt.	Solanaceae
46	Capsicum annum Linn. var. longum Sendt.	Solanaceae
47	Capsicum frutescens Linn.	Solanaceae
48	Lycopersicon lycopersicum (Linn.) Karst.	Solanaceae
49	Solanum tuberosum Linn.	Solanaceae
50	Alpinia galangal (L.) Swartz	Zingiberaceae
51	Curcuma longa L.	Zingiberaceae
52	Zingiber officinale Rosc.	Zingiberaceae

Threatened Plants:

Due to land use change and habitat destruction many of our rare and economically important species are on the brink of extinction. Following is a list of plants which are vulnerable and need concerted efforts to preserve the habitat.

Table No. 2.17: List of Endangered Plants in study area.

Sr. No.	Botanical Name	Local Name	Family
1	Ceropegia attenuata Hook.,	Tilori	Asclepiadaceae
2	Crotolaria filipes Bth.	Phatphati	Pappilionaceae
3	Eulophia ochreata Lindl.	-	Orchidaceae
4	Hygrophila anomala (Blatter) Almeida	-	Acanthaceae
5	Trilobachne cookei (Stapf) Schenck ex Hen.	Dhokri	Poaceae
6	Triplopogon ramosissimus (Hack) Bor.	-	Poaceae

Table No. 2.18: List of Medicinal plants recorded from the study area

Sr. No.	Botanical Name	Local Name	Family
1	Abrus precatorius Linn.	Gunj	Fabaceae
2	Achyranthes aspera Linn.	Aghada	Amaranthaceae
3	Allium sativum L.	Lasun	Liliaceae

4	Aloe vera (L.) Burm.	Korphad	Liliaceae
5	Alstonia scholaris (L.)Br.	Saptaparni	Apocynaceae
6	Asparagus racemosus Willd	Shatavari	Liliaceae
7	Azadirachta indica Juss.	Kaduneemb	Meliaceae
8	Bacopa monnieri (L.) Wettst	Bam	Scrophulariaceae
9	Barleria prionitis Linn.,	Pivali Koranti	Acanthaceae
10	Biophytum sensitivum (Linn.) DC	Lajjaluka	Oxalidaceae
11	Calotropis gigantea (Linn.) R. Br	Ruei	Asclepiadaceae
12	Calycopteris floribunda Lamk.	Ukshi	Combretaceae
13	Curcuma longa L	Haladi	Zingiberaceae
14	Eclipta prostrata (Linn.) Linn. Mant.	Maka	Asteraceae
15	Ficus religiosa Linn.	Pipal	Moraceae
16	Gloriosa superba L.	Kal-Lavi	Liliaceae
17	Grewia tiliaefolia Linn.	Dhanuvrikhsa	Tiliaceae
18	Helictoris isora Linn.	Murudsheng	Sterculiaceae
19	Heliotropium indicum Linn	Bhurundi	Boraginaceae
20	Hemidesmus indicus (L.) Schultes	Anantmul	Periplocaceae
21	Jatropha curcas Linn.	Mogli Erand	Euphorbiaceae
22	Madhuca indica Gmelin	Mahuva tree	Sapotaceae
23	Mangifera indica Linn.	Amba	Anacardiaceae
24	Mentha arvensis Linn	Pudina	Labiatae
25	Mimosa pudica Linn.	Lajalu	Mimosaceae
26	Plumbago indica Linn.	Lal Chitrak	Plumbaginaceae
27	Prosopis cineraria (Linn.)Druce	Eishani	Mimosaceae
28	Punica grantum Linn.	Anar	Sonneratiaceae
29	Ricinus communis Linn.	Eranad	Euphorbiaceae
30	Rauwolfia serpentina (Linn.) Benth. ex Kurz	Sarpagandha	Apocynaceae
31	Semecarpus anacardium Linn.	Bhallataka	Anacardiaceae
32	Tectona grandis Linn.	Sagwan	Combretaceae
33	Terminalia arjuna (Rox) Wight & Arn.	Arjuna	Combretaceae
34	Terminalia catappa Linn.	Deshibadam	Combretaceae
35	Tridax procumbens Linn.	Ekdandi	Asteraceae

ANNEXURE 2: CRZ Notification (30th December 2015)

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
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पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 30 दिसम्बर, 2015

का.आ. 3552(अ).— तटीय विनियम जोन अधिसूचना, 2011, जिसे का.आ. सं. 19(अ), तारीख 6 जनवरी, 2011 को जारी किया गया था, भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (ii) में का.आ. 1741(अ), तारीख 25 जून, 2015 को उसके द्वारा संभाव्य प्रभावित व्यक्तियों से आक्षेप और सुझाव उक्त अधिसूचना को उपलब्ध करवाने की तारीख से, जब राजपत्र की प्रतियां जन साधारण को उपलब्ध कराई गई थी उस तारीख से 60 दिन की अवधि के भीतर आमंत्रित करने के लिए पर्यावरण संरक्षण नियम, 1986 के नियम 5 के उपनियम (3) के अधीन प्रारूप अधिसूचना प्रकाशित की गई थी ;

उक्त अधिसूचना की प्रतियां जन साधारण को 25 जून, 2015 को उपलब्ध कराई गई थी;

केंद्रीय सरकार द्वारा उपरोक्त प्रारूप अधिसूचना के उत्तर में प्राप्त आक्षेपों और सुझावों की परीक्षा की गई है;

अत: केंद्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उपनियम (3) के खंड (घ) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3 की उपधारा (1) और उपधारा (2) के खंड (v) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए तटीय विनियम जोन अधिसूचना, 2011 में निम्नलिखित और संशोधन करती है, अर्थात् :—

उक्त तटीय विनियम जोन अधिसूचना, 2011 में, -

(क) पैरा 3 में, - उपपैरा (iv) में मद (क) के स्थान पर निम्नलिखित मद रखी जाएगी, अर्थात् :—

"(क) पत्तन, बंदरगाह, जेटी, घाट, जहाजी घाट, जलावतरण-मंच, पुल, सीलिंग, स्टिल्ट पर सड़क, सुधारे हुए धरातल पर सड़क रक्षा और सुरक्षा प्रयोजनों के लिए अभिप्रेत और अन्य सुविधाओं जो अधिसूचना के अधीन अनुज्ञेय क्रियाकलापों के लिए आवश्यक है जैसी तटाग्र सुविधाओं की स्थापना, विनिर्माण या आधुनिकीकरण या विस्तार के लिए अपेक्षित:

परंतु ऐसी सड़के विद्यमान हाइ टाइड लाइन तक ऐसी सड़कों के लेंड वार्ड साइड पर विकास अनुज्ञात करने हेतु यथाप्राधिकृत नहीं मानी जाएगी :

परंतु यह और कि किसी औद्योगिक प्रचालन, मरम्मत और अनुरक्षण के सिवाय, सुधारी गई भूमि का उपयोग ऐसे सड़कों के लेंड वार्ड साइड पर सड़कों, मास रैपिड या मल्टीमॉडल ट्रांज़िट प्रणाली, विनिर्माण और स्थापन, ऐसी ट्रांजिट या परिवहन प्रणाली जिसके अंतर्गत वैद्युत या इलैक्ट्रानिक सिगनल प्रणाली, अनुज्ञात डिजाइनों के ट्रांजिट स्टाक ओवर हैं, सभी आवश्यक सहबद्ध जनउपयोगिताओं और अवसंरचना के लिए अनुज्ञात की जा सकेगी।";

(ख) पैरा 4 में, उप पैरा (i) में, मद (च) के पश्चात् निम्नलिखित मद अंत:स्थापित की जाएगी, अर्थात् :—

"(छ) सीआरजैड क्षेत्र में सुधार द्वारा सड़क का विनिर्माण केवल आपवादिक मामलों में, संबंधित तटीय जोन प्रबंधन प्राधिकरण की सिफारिश पर और पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय द्वारा अनुमोदित होगा; और यदि ऐसी सड़क का निर्माण कच्छ वनस्पति में से होकर गुजर रहा हो या कच्छ वनस्पति का संभावित क्षति पहुंचाने वाला हो, विनिर्माण प्रक्रिया के दौरान क्षतिग्रस्त कच्छ वनस्पति या काटी गई वनस्पति का तीन गुणा पुन:रोपित किया जाएगा।";

(ग) उक्त अधिसूचना में, उपाबंध 4 के पश्चात्, प्ररूप - I, निम्नलिखित अंत:स्थापित किया जाएगा, अर्थात्

स्पष्टीकरण – अधिसूचना के प्रयोजन के लिए, उक्त अधिसूचना में प्रयुक्त "विद्यमान" शब्द से 19 फरवरी, 1991 को जिसमें सीआरजैड अधिसूचना अधिसूचित की गई थी, की विशेषताएं की विनियमितीकरण या संन्नियम विद्यमान होना अभिप्रेत होगा।

[फा. स. 19-27/2015 – आई ए – III]

विश्वनाथ सिन्हा, संयुक्त सचिव

टिप्पण : मूल अधिसूचना भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (ii) में अधिसूचना सं. का.आ. 19(अ), तारीख 6 जनवरी, 2011 को प्रकाशित की गई थी और तत्पश्चात् निम्नानुसार संशोधित की गई :—

1. का. आ. 2557 (अ), तारीख 22 अगस्त, 2013
2. का. आ. 1244 (अ), तारीख 30 अप्रैल, 2014
3. का. आ. 3085(अ), तारीख 28 नवंबर, 2014
4. का. आ. 383(अ), तारीख 4 फरवरी, 2015; और
5. का. आ. 556 (अ), तारीख 17 फरवरी,2015;
6. का. आ. 938 (अ), तारीख 31 मार्च, 2015
7. का. आ. 1599 (अ), तारीख 16 जून, 2015

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 30th December, 2015

S.O. 3552(E).—Whereas, a draft notification under sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 for making certain amendments in the Coastal Regulation Zone Notification, 2011, issued vide number S.O. 19(E), dated the 6th January, 2011, was published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (ii) vide number S.O. 1741(E) dated the 25th June, 2015 inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the date on which copies of Gazette containing the said notification were made available to the public;

And whereas, copies of the said notification were made available to the public on 25th June, 2015;

And whereas, the objections and suggestions received in response to the above draft notification have been examined by the Central Government;

Now, therefore, in exercise of the powers conferred by sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) read with clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following further amendments in the Coastal Regulation Zone Notification, 2011, namely:—

In the said Coastal Regulation Zone Notification, 2011 ,-

(a) in paragraph 3, in sub-paragraph (iv), for item (a), the following item shall be substituted, namely:-

" (a) required for setting up, construction or modernisation or expansion of foreshore facilities like ports, harbours, jetties, wharves, quays, slipways, bridges, sealink, road on stilts, road on reclaimed surface, and such as meant for defence and security purpose and for other facilities that are essential for activities permissible under the notification:

Provided that such roads shall not be taken as authorised for permitting development on landward side of such roads till existing High Tide Line.

Provided further that the use of reclaimed land may be permitted for roads, mass rapid or multimodal transit system, construction and installation, on landward side of such roads, of all necessary associated public utilities and infrastructure to operate such transit or transport system including those for electrical or electronic signal system, transit stopover of permitted designs; except for any industrial operation, repair and maintenance." ;

(b) in paragraph 4, in sub-paragraph (i), after item (f), the following item shall be inserted, namely:

"(g) construction of road by way of reclamation in CRZ area shall be only in exceptional cases, to be recommended by the concerned Coastal Zone Management Authority and approved by the Ministry of Environment, Forest and Climate Change; and in case the construction of such road is passing through mangroves or likely to damage the mangroves, three times the number of mangroves destroyed or cut during the construction process shall be replanted.";

(c) in the said notification, after Annexure-IV, Form-1, the following shall be inserted, namely:—

Explanation:- For the purpose of the notification, the word "existing" used in the said notification shall mean existence of the features or regularization or norms as on 19th February, 1991 wherein CRZ notification, was notified."

[F. No.19-27/2015-IA-III]

BISHWANATH SINHA, Jt. Secy.

Note: The Principal Notification was published in the Gazette of India, Extraordinary, Part II, Section 3, sub-section (ii), vide number S.O. 19(E) dated the 6th January, 2011 and subsequently amended as follows:—

1. S.O. 2557(E), dated the 22nd August, 2013;
2. S.O. 1244(E), dated the 30th April, 2014;
3. S.O. 3085(E), dated the 28th November, 2014;
4. S.O. 383(E), dated the 4th February, 2015; and
5. S.O. 556(E), dated the 17th February, 2015;
6. S.O. 938(E), dated the 31st March, 2015.
7. S.O. 1599(E), dated the 16th June, 2015

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ANNEXURE 3

Guidelines for Developing Green Belt

(Source: Central Pollution Control Board, 2000)

Introduction

While making choice of plant species for cultivation in green belts, weight age has to be given to the natural factor of bio-climate. It is also presumed that the selected plants will be grown as per normal horticultural (or forestry) practice and authorities responsible for plantation will also make adequate provisions for watering and protection of the saplings.

For effective removal of pollutants. it is necessary that (1) plants grow under conditions of adequate nutritional supply (for health and vigor of growth), (2) absence of water stress (to maintain openness of stomata apertures and form of epidermal structures) and (3) are well-exposed to atmospheric conditions of light and breeze (i e. away from engineering structures htnder.ng free flow of air to maintain free interaction with gases.

Characters of plants including shapes of crowns considered necessary for effecting absorption of pollutant and removal of dust particles are as follows:

For absorption of gases

i) Tolerance towards pollutants in question at concentrations, that are not too high to be Instantaneously lethal).

2) Longer aurat1on of foliage.

3) Freely exposed foliage through

a. Adequate height of crown.

b. Openness of foliage in canopy

c. Big leaves (long and broad laminar surfaces).

d. Large number of stomata apertures,

e. Stomata well-exposed on level w1th the general epidermal surface).

For removal of suspended particulate matter

1 Height and spread of crown

2. Leaves supported on f1rm pet1oles,

3. Abundance of surfaces on bark and foliage, through

a. Roughness of bark,

b. Epidermal outgrowths on petioles.

c. Abundance of axillary hairs,

d. Hairs or scales on laminar surfaces.

e. Stomata protected (by wax, arches / rings, hairs, etc)

Plantation along Roadsides Automobiles may be considered as ground level, mobile sources of pollution of both types - gaseous as well as particulate. Components of green belts on roadsides hence should be both absorbers of gases as well as of dust panicles including even lead particulate. Sorption of the latter type has been estimated by Joshi {1990) who found high levels of lead sorption on ornamentals cultivated in traffic islands. Choice of plants for roadside (and Traff1c Island) plantations may be for conta1nment of pollut1on and for formation of a screen between traffic and roads de res1dences. This choice of plants should include shrubs of height 1 to 1.5 m and tree of 3 to 5 m height. The inter mixing of trees and shrubs should be such that the foliage area density in vertical is almost uniform. A green belt of such a design and having a width of 30 to 50 m will give a pollution attenuation factor of 2 to 100 for unsuitable to plants atmospheric conditions Thus medium- sized and small trees alternating with shrubs, aimed at sorption of particulates and gases, will be suitable here Since safety of traffic is a major consideration, shrubs in traffic islands and along road-dividers will have to be short enough to be below the eye-level of motorists. Still, it is necessary to emphasize that each traffic island has its own character and needs to be studied separately for design1ng 1ts green belt a comprehensive list of plants recommended for green belts in the country is presented in Table 1. The list consists of Latin and common names of plants natural order to which they belong and a number of relevant characteristic features. viz. tolerance or otherwise towards air pollution habit growth rate flowering phonology, crown shape and approximate surface area, etc. The list is not complete in itself. Several more spec1es could be added to it. Criteria for inclusion of species 1n this list include availability, knowledge about their horticultural aspects, particularly propagation methods and growth rates and (sometimes) observed or reported information about their tolerance to air pollution. Numerous species, indigenous to certain regions, may also be included wherever possible in extreme areas (E.g where stresses due to water salinity. salt-sprays, etc. are acute) only tolerant species should be chosen.

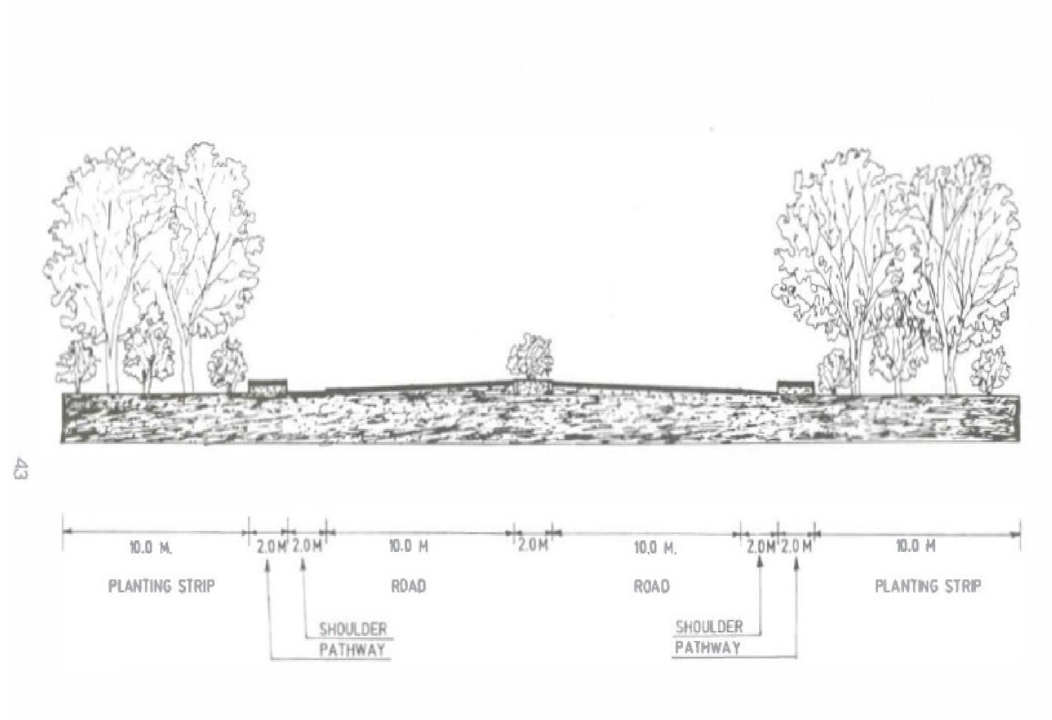
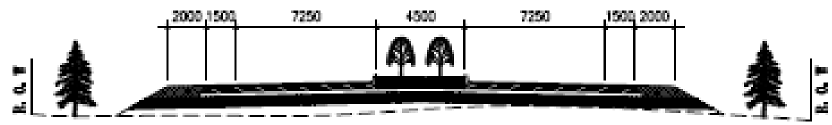


Fig 1: Typical Road Side Plantation



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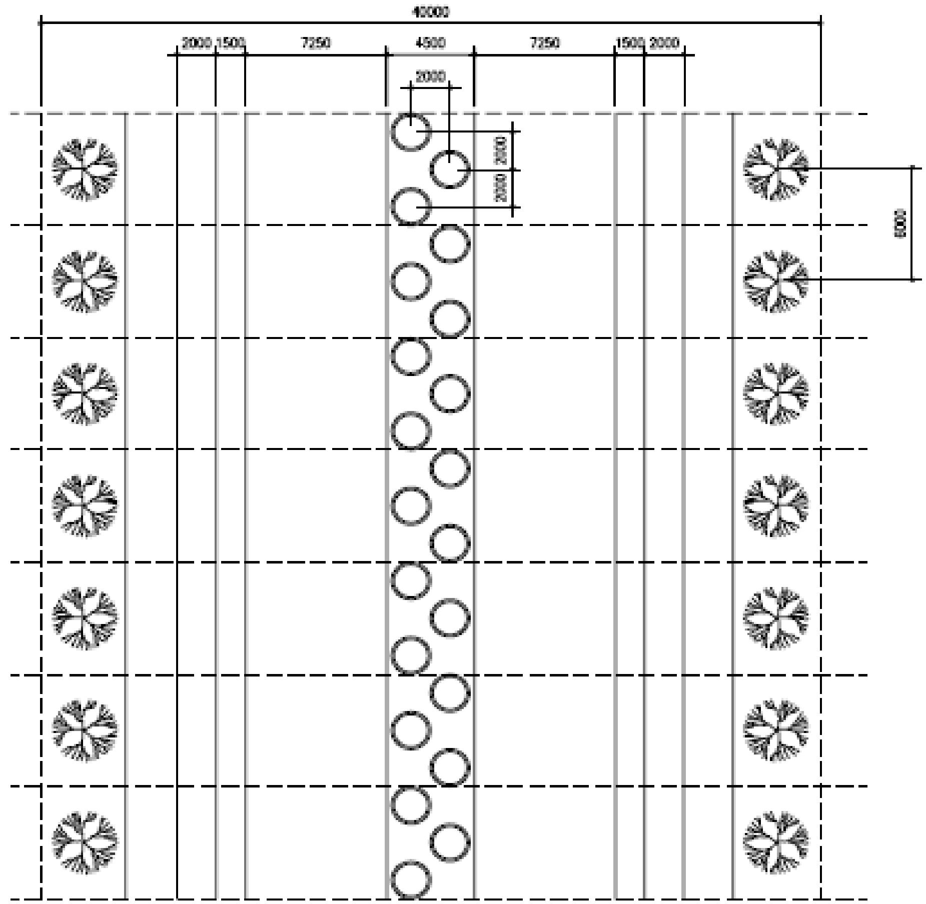

P L A N

NOTES:
1) FOLLOW WRITTEN DIMENSIONS ONLY.
2) ALL DIMENSIONS IN MM UNLESS OTHERWISE STATED.
3) ANY CHANGES TO BE MADE TO BE APPROVED BY THE SUPERVISION CONSULTANT.

Table 1: PLANT SPICES IDENTIFIED FOR GREEN BELT DEVELOPMENT

Sl. No.	Plant Species	Vernacular Name
1	*Albizzia lebbek*	Kala siris
2	*Terminalia arjuna*	Arjun
3	*Cassia fistula*	Amaltas
4	*Polyalthia longifolia*	Asoka
5	*Embelica Officianalis*	Amal
6	*Bauhinia variegata*	Kachnar
7	*Mitragyna parviflora*	Kadamb
8	*Pongamia pinnata*	Kranj
9	*Cassia siamea*	Kasod
10	*Dalbergia sissoo*	Sheesham
11	*Delonix regia*	Gulmohar
12	*Ficua glomerata*	Gular
13	*Acacia nilotica*	Keekar
14	*Acacia catechu*	Khair
15	*Acacia arabica*	Babul
16	*Syzgium cumini*	Jamun
17	*Minusops elangi*	Maulsiri
18	*Madhuca indica*	Mahua
19	*Ficus bengalensis*	Bargad
20	*Ficus religeosa*	Peepal
21	*Azadirachta indica*	Neem
22	*Casurina equisitifolia*	Jhau

Sl. No.	Plant Species	Vernacular Name
	Shurbs	
	Plant Species	**Vernacular Name**
23	*Nerun Odorum*	Kaner
24	*Parkinsonia aculeata*	Vilayati Jhau
25	*Hibiscus rosasinesis*	Gudhal
26	*Dracaena*	
27	*Callistemon lanceolatus*	Bottle brush
28	*Salvadora oleoides*	Peelu
29	*Zigyphus maruitiana*	Ber
30	*Lantana camara*	Kuri
31	*Prosopis juliflora*	Vilayati babul